Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide

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Contents

Introduction

This recommended practice (RP) provides guidelines for pressure testing steel pipelines for the transportation of gas, petroleum gas, hazardous liquids, highly volatile liquids, or carbon dioxide. The RP provides guidance so that:

a) pipeline operators can select a pressure test suitable for the conditions under which the test will be conducted—this includes, but is not limited to, pipeline material characteristics, pipeline operating conditions, and various types of anomalies or other risk factors that may be present;

b) pressure tests are planned in order to meet the overall objectives of the pressure test;

c) site-specific procedures are developed and followed during all phases of the pressure testing process;

d) pressure tests consider both personnel safety and environmental impacts;

e) pressure tests are implemented by qualified personnel;

f) pressure tests are conducted in order to meet stated acceptance criteria and pressure test objectives;

g) pressure test records are developed, completed, and retained for the useful life of the facility.

Users of this RP should be aware that further or differing requirements may be necessary for some applications. Nothing in this RP is intended to inhibit the use of engineering solutions that are not covered by the RP. This may be particularly applicable where there is innovative developing technology. Where an alternative is offered, the RP may be used, provided any and all variations from the RP are identified and documented.

The guiding principles of this RP as as follows.

a) This RP provides a consistent means of preparing, assessing, using, and verifying pressure test results in order to help insure that the objectives of the pressure test are met. It also provides guidance for meeting the requirements of Integrity Management as stated in API 1160 and ASME B31.8S.

b) This RP is not technology specific. It accommodates present and future technologies used for pressure testing steel pipelines.

c) This RP is performance-based and provides guidelines for the qualification of the pressure testing processes. It does not, however, define how to meet those guidelines.

d) This RP provides guidelines for documenting important information during each phase of the pressure testing process.

e) Wherever possible, this RP utilizes existing terms and definitions from other applicable industry documents. Definitions of terms used in this RP are listed in Section 3.

f) The use of a pressure testing process to manage the integrity of pipelines requires an appropriate amount of interaction between the provider of the inspection service (service provider), if one is used, and the beneficiary of the service (operator). This RP provides guidelines that will enable service providers and operators to clearly define the areas of cooperation required and thus facilitate the satisfactory outcome of the pressure testing process.

Although many operators use service providers during various phases of the pressure testing process, it is important to note that the operator is ultimately responsible for:

a) identifying specific risks (threats) to be assessed as part of the pressure testing process,

b) choosing the proper pressure test in order to assess identified risks (threats), and

c) confirming and verifying pressure test results.

Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids or Carbon Dioxide

1 Scope

This RP applies to all parts of a pipeline or pipeline facility including line pipe, pump station piping, terminal piping, compressor station piping, metering station piping, delivery station piping, regulator station piping, appurtenances connected to line pipe, appurtenances connected to facility piping, fabricated assemblies, valves, tees, elbows, reducers, flanges, and any other pipeline equipment or appurtenances.

This RP does not apply to pumping units, compressor units, breakout tanks, pressure vessels, control piping, sample piping, instrument piping/tubing, or any component or piping system for which other codes specify pressure testing requirements (i.e. ASME *Boiler and Pressure Vessel Code*, piping systems covered by building codes, etc.).

Although this RP contains guidelines that are based on sound engineering judgment, it is important to note that certain governmental requirements may differ from the guidelines presented in this document.

This RP does not address piping systems that are pressure tested with natural gas, nitrogen, or air.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Standard 1160, *Managing System Integrity for Hazardous Liquid Pipelines*

ASME B31.4 [1], *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*

ASME B31.8:2007, *Gas Transmission and Distribution Piping Systems*

ASME B31.8S, *Managing System Integrity of Gas Pipelines*

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1.1
anomaly
A deviation from the norm in pipe material, coatings, or welds.

3.1.2
appurtenance
A component attached to the pipeline (e.g. valve, tee, instrument connection, supports, anchors, etc.).

3.1.3
bend
A physical configuration that changes pipeline direction.

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[1] ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.

3.1.4
carbon dioxide
A fluid consisting of more than 90 % carbon dioxide molecules compressed to a supercritical state.

3.1.5
certification
A written testimony of qualification.

3.1.6
characteristic
Any physical descriptor of a pipeline or an anomaly, such as length, depth, shape, severity, orientation, and location.

3.1.7
component
Any physical part of the pipeline, other than line pipe, including but not limited to valves, welds, tees, flanges, fittings, taps, branch connections, and outlets.

3.1.8
corrosion
The deterioration of a material, usually a metal, that results from a reaction with its environment.

3.1.9
crack
A very narrow elongated separation caused by mechanical splitting.

3.1.10
deadweight tester
An instrument consisting of a finely machined piston mounted vertically in a close-fitting cylinder used for maintaining a calculable pressure; also known as a "piston gauge."

NOTE When fitted with a means of pressure control, additional pressure ports, masses etc., the complete system is commonly known as a "deadweight tester."

3.1.11
examination
A direct physical inspection of an anomaly by a person, which may include the use of nondestructive examination techniques.

3.1.12
feature
Any physical object detected by an in-line inspection device.

NOTE Features may be anomalies, components, nearby metallic objects, or some other item.

3.1.13
freeze plug
A pipeline isolation point created by freezing hydrostatic test water inside the pipeline by the application of liquid nitrogen to the outer surface of the pipe.

NOTE Normally used to separate a test section into smaller test segments in order to identify leaks more readily or used to establish a test boundary.

3.1.14
gas
Natural gas, flammable gas, or gas that is toxic or corrosive.

3.1.15
gouge
Elongated grooves or cavities caused by mechanical removal of metal.

3.1.16
hazardous liquid
Petroleum, petroleum products, or anhydrous ammonia.

3.1.17
highly volatile liquid
A hazardous liquid that forms a vapor cloud when released to the atmosphere and has a vapor pressure exceeding 40 psia (276 kPa) at 100 °F (37.8 °C).

3.1.18
inspection
The use of a nondestructive testing technique.

3.1.19
leak test
A pipeline test designed to determine the presence or absence of leaks in a pipeline system.

NOTE A leak test can be used alone or in addition to a spike pressure test and/or a strength pressure test as required by the pressure testing plan.

3.1.20
nondestructive testing
A process that involves the inspection, testing, or evaluation of materials, components, and assemblies for materials' discontinuities, properties, and machine problems without further impairing or destroying the part's serviceability.

3.1.21
operating pressure
The actual steady state pressure at a discrete point within a pipeline system at a specific time.

3.1.22
operating pressure limit
A generic term used to describe the upper end of the operating pressure range of a pipeline.

NOTE In international codes and standards, it is often referred to as the maximum steady state operating pressure or maximum allowable operating pressure.

3.1.23
operator
A person or organization that operates pipeline facilities.

3.1.24
petroleum
Crude oil, condensate, natural gasoline, natural gas liquids, and liquefied petroleum gas.

3.1.25
petroleum gas
Propane, propylene, butane (normal butane or isobutanes), and butylenes (including isomers), or mixtures composed predominantly of these gases, having a vapor pressure not exceeding 208 psig (1434 kPa) at 100 °F (37.8 °C).

3.1.26
petroleum products
Flammable, toxic, or corrosive products obtained from distilling and processing of crude oil, unfinished oils, natural gas liquids, blend stocks, and other miscellaneous hydrocarbon compounds.

3.1.27
pipeline
A continuous part of a pipeline facility used to transport a gas, petroleum gas, hazardous liquids, highly volatile liquids, or carbon dioxide, which includes pipe, valves, and other appurtenances attached to pipe.

3.1.28
pipeline system
All portions of the physical facilities through which gas, petroleum gas, hazardous liquids, highly volatile liquids, or carbon dioxide moves during transportation.

NOTE This includes pipe, valves, and other appurtenances attached to the pipe, compressor units, pumping units, metering stations, regulator stations, delivery stations, breakout tanks, holders, and other fabricated assemblies.

3.1.29
pressure reversal
A phenomenon whereby a pipeline segments fails at progressively lower test pressures during subsequent pressure tests.

3.1.30
qualification (personnel)
The process of demonstrating skill and knowledge, along with documented training and experience required for personnel to properly perform the duties of a specific job.

3.1.31
seam
The longitudinal or spiral weld in fabricated line pipe.

3.1.32
service provider
Any organization or individual providing services to operators.

3.1.33
specified minimum yield strength
SMYS
The minimum yield strength prescribed by the specification under which pipe and fittings are purchased from the manufacturer.

3.1.34
spike pressure test:
A pressure test of short duration (typically less than 1 hour) and high amplitude (test pressure ratio typically greater than 1.25).

3.1.35
strength pressure test
A pressure test designed to establish the operating pressure limit of a pipeline as required by code or regulation.

3.1.36
stress
Tensile, shear, or compressive force per unit area.

3.1.37
stress corrosion cracking
SCC
A form of cracking of a material produced by the combined action of tensile stress (residual or applied), a corrosive environment, and material that is susceptible to SCC.

3.1.38
test medium
The fluid or gas used to conduct a pressure test.

3.1.39
test pressure ratio
The test pressure divided by the operating pressure limit of a pipeline system.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

ILI	in-line inspection
SCC	stress corrosion cracking
SMYS	specified minimum yield strength

4 Pressure Test Planning Process

4.1 Guidelines for Planning a Pressure Test

4.1.1 General

Pipeline systems are pressure tested to demonstrate their fitness for service under intended operating conditions. Tests may be conducted prior to placing newly constructed pipelines into service; to revalidate historical operating conditions as part of an integrity assessment process; to verify the integrity of a pipeline before returning it to service after being idle or inactive; and to establish the pipeline's ability for modified operations such as operating at higher operating pressures or transportation of different products.

The following issues should be considered when planning a pressure test.

4.1.2 Purpose

Pressure tests may be conducted for the following reasons.

a) Detect and eliminate time dependent anomalies in a pipeline segment. This can be accomplished by maximizing the ratio between the test pressure and the operating pressure limit of the pipeline. A higher ratio will increase the interval between integrity assurance pressure tests for pipelines with time dependent anomalies.

b) Detect and eliminate stable anomalies and verify the structural integrity of a pipeline segment. This can be accomplished by testing the pipeline segment to a pressure higher than its operating pressure limit.

c) Establish the operating pressure limit of a pipeline segment.

d) Verify the integrity of a pipeline before returning it to service after it has been idle or inactive.

e) Verifying the integrity of a pipeline when changing its service.

f) Verify that a pipeline segment does not show evidence of leakage.

4.1.3 Categories of Flaws/Threats

API 1160 and ASME B31.8S have identified flaws/threats that may be assessed through the use of pressure testing. To manage the flaws/threats associated with corrosion, stress corrosion cracking (SCC), manufacturing, materials, and construction, the pressure test procedure must be designed for the specific threat and the type and size of any anticipated flaw(s).

a) Internal and external corrosion threats are typically managed by a spike test, strength test, and/or a leak test commensurate with an appropriate test pressure ratio that provides the desired reassessment interval. The reassessment interval is a function of the remaining pipe wall thickness, the pressure test ratio, and the estimated corrosion rate.

b) SCC threats are typically managed through the use of a spike test and/or a strength test commensurate with an appropriate test pressure ratio that provides the desired reassessment interval. The reassessment interval is a function of the pipe wall thickness, the maximum size of possible remaining cracks, and the estimated crack-growth rate.

c) Manufacturing threats, such as fatigue susceptible seam flaws that grow due to pressure cycling, are typically managed with the use of a spike test and/or a strength test commensurate with an appropriate test pressure ratio that provides the desired reassessment interval. The reassessment interval is a function of the pipe wall thickness, the maximum size of possible remaining cracks, the estimated crack growth rate, and the operating pressure cycles.

d) Materials and construction threats are typically managed with the use of a spike test and/or a strength test. These time independent or stable threats do not require reassessment to establish their integrity, provided conditions that could adversely affect the specific manufacturing or construction-related threats do not occur later in service.

4.1.4 Safety

The operator should consider the following safety items when planning and conducting the pressure test.

a) Outline safety precautions and provide procedures for personnel who perform the test (hot work permits, confined space entry, personal protective equipment, lock-out/tag-out procedures, etc.).

b) Conduct hazard assessment and safety meetings.

c) Require that all personnel conducting a hydrostatic test comply with all local, state, and federal environmental and safety standards as a minimum.

d) Identify precautions and procedures to minimize risk to the public and the environment, especially when a test medium other than water is to be used and during the removal of the test medium.

e) Consider measures necessary to restrain temporary piping and hoses used during filling of the line with the test medium, during the pressure test and during the removal of the test medium.

f) Consider additional measures to respond to possible test failures.

4.1.5 Communications

The operator should consider the following communication items.

a) A written site-specific test procedure with all pertinent details associated with the project should be developed as part of the pressure test planning process. The written plan should be distributed to appropriate company personnel, contractors, and others directly involved with the test for review and comment during the early stages of the planning process.

b) Prior to the test, the operator should notify the proper authorities, governmental agencies, potential emergency response personnel and landowners along the right-of-way.

c) Prior to the test, the operator should secure applicable permits.

d) The operator should clearly outline the roles of the various personnel involved in the pressure testing process. This includes the following:

   i) operating personnel,

   ii) contractor and/or maintenance personnel,

   iii) person(s) responsible for certifying the results of the pressure test.

4.1.6 Pipeline Operating Conditions

The operator should consider the following pipeline operating conditions.

a) The current and future maximum steady state hydraulic grade line for pipelines transporting hazardous liquids or carbon dioxide.

b) The maximum pressure profile during surges for pipelines transporting hazardous liquids or carbon dioxide.

c) Lowest and highest required operating pressure limit within the test section.

d) The length of time the test section can remain out-of-service during the testing period.

4.1.7 Types of Pressure Tests

4.1.7.1 General

There are three basic types of pressure tests. They may be performed separately or in combination in order to determine the integrity of a pipeline and/or to meet applicable company, regulatory, or code requirements. The three types of pressure tests differ by their respective purposes and test pressure ratios. The operator should determine the appropriate test(s) based on the purpose of the test. A brief description of each type of pressure test is as follows.

4.1.7.2 Spike Test

A spike test is used to verify the structural integrity of pipelines with time dependent anomalies. For spike tests, the test pressure ratio is typically greater than 1.25. Spike test durations are typically longer than 5 minutes but shorter than 1 hour in order to minimize the subcritical enlargement of anomalies that are too small to fail during the test. Spike test durations should be long enough to allow any transients in the test medium caused by the pressurization process to stabilize. Spike tests are determined to be successful if no pipe ruptures occur as per the established acceptance criteria.

4.1.7.3 Strength Test

A strength test is used to establish the operating pressure limit of a pipeline segment. Typically, the test pressure ratio is 1.25 and the duration is 4 hours or longer, but these values may differ depending on applicable codes and/or regulations. Strength tests are determined to be successful if no pipe ruptures or leaks occur as per the established acceptance criteria.

4.1.7.4 Leak Test

A leak test is used to determine that a pipeline segment does not show evidence of leakage. Typically, the test pressure ratio is less than 1.25 and the duration is 2 hours or longer, but these values may differ depending on the situation, company procedures, and applicable codes and regulations. In general, the duration of a leak test must be long enough for the operator to determine if the test meets the established acceptance criteria. Leak tests are determined to be successful if all pressure variations can be explained as per the established acceptance criteria. It is important to note that under certain conditions, leak tests on gas pipelines may be performed by surveillance of the line with flame ionization equipment or other leak detection equipment after the line has been repressurized with gas.

4.1.8 Maximum Test Pressure

An operator should consider the following when determining test pressure.

a) The maximum developed hoop stress to be created within the test segment [for pressure levels near the specified minimum yield strength (SMYS) of the pipe, consideration should be given to using a pressure–volume plot during pressurization to monitor for possible yielding and to document pressurization; see 5.4].

b) Location, elevation, and characteristics (size, wall thickness, grade, and seam type) of each type of pipe and pipe fittings (elbows, tees, reducers) in the test section.

c) Location, elevation, and pressure rating of equipment (strainers, vents, pumps, closures, etc.) within the test section.

d) Location, elevation, and rating of components (flanges and valves) within the test section.

e) Competing against the need to increase the test pressure to the maximum level possible is the risk of test failure or multiple failures. Consideration should be given in the planning process to how many test failures the operator is willing to tolerate before reducing the test pressure and ultimately the operating pressure limit.

4.1.9 Historical Engineering and Operations Documentation

Prior to conducting the pressure test, the following engineering and operations documents should be reviewed to make sure that the pressure test is appropriate and feasible.

a) Previous hydrostatic test reports.

b) Previous in-service or out-of-service pipe failures.

c) The results of past in-line inspection (ILI) surveys. [Prior ILI results can be useful to determine if existing flaws need to be examined prior to the test. The reason for requesting recent ILI results prior to the pressure test is to ensure that all other potential anomaly types (i.e. corrosion, gouges, dents, etc.) have been discovered and investigated.]

d) Mill test reports for piping and fittings.

e) Past cathodic protection surveys.

f) Previous maintenance and inspection records.

4.1.10 Pipeline Characteristics

The following pipeline characteristics should be established when designing the pressure test.

a) Test section boundaries and segmenting of the pipeline.

b) Location of appurtenances within the test section (valves, flange sets, taps, stopples, sleeves, patches, etc.).

c) Location of isolation points (valves) within the test section boundaries.

d) Timing of the test (time of day and/or year).

e) Location of the pressure and temperature sensing device(s) within the test section.

f) Test medium injection location.

g) Test medium disposal location.

h) Condition of right-of-way.

i) Obstructions impairing access to the pipeline.

j) Elevation profile of the test segment.

k) The amount of exposed pipe within the test section. Particular care should be taken to prevent freezing of the exposed piping during cold weather. Large amounts of exposed piping can result in large temperature related pressure changes, making a stable test difficult to achieve.

l) Identification of joint connections within the test section:

   i) consider exposing all threaded, bolted, or flanged fittings within the test segment prior to the test for visual inspection during the test;

   ii) consider replacing any gaskets within the test section prior to conducting the pressure test.

4.1.11 Target Test Pressure and Pressure Test Duration

Determination of the target test pressure of a pipe segment should take the following into consideration.

a) Elevation differences within the test section.

b) Current operating pressure limit of the pipe segment.

c) Past hydrostatic test pressures (mill test pressure, if known).

d) Desired operating pressure limit for each point within the pipeline segment.

e) Maximum allowable piping stress levels to be created by the pressure test.

f) Lowest ANSI appurtenance rating.

g) Past failure history (in-service and pressure test).

h) Presence of people, structures, or environmentally sensitive areas within the test section boundaries that would possible be impacted by a test failure.

i) Mainline valve locations.

j) Results of past ILI and other assessments.

k) Evaluation of mill test data.

Testing to higher pressures will eliminate some flaws that would survive if tested at lower pressures. The test duration at the maximum test pressure should be designed to minimize any potential flaw growth. The pressure test subjects the pipe to a high level of stress with the goal of removing, through failure, any flaws that are greater than the critical size for the stress level imposed. With an increased test pressure ratio, surviving flaws are smaller, the safety factor is greater, and the time to failure and reassessment intervals for time dependent flaws is greater (see Figure 1).

Figure 1 illustrates the relationship between flaw depth (a) divided by pipeline wall thickness (t), flaw length, and test pressure for a typical pipeline. The shaded areas represent the population of flaws eliminated by a strength pressure test (pink) and a spike pressure test (green). Relatively larger flaws remain after a strength pressure test conducted at 90 % of the SMYS than the spike pressure test conducted at 100 % SMYS. Larger flaws do not have to propagate as far or deep as smaller flaws to reach the critical length/depth where they are likely to fail at 79.2 % SMYS (72 % SMYS plus 10 % overpressure protection set point).

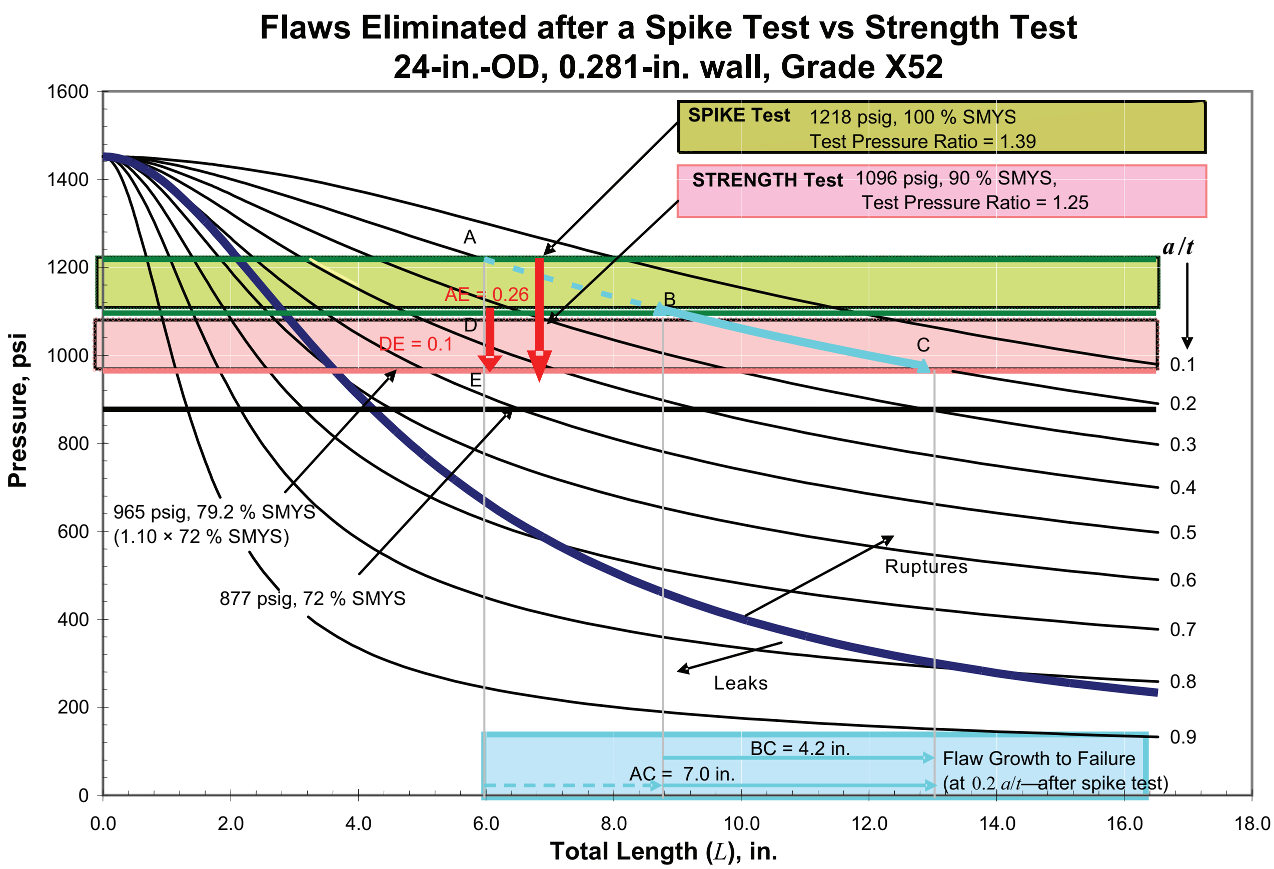

Figure 1—Impact of Test Pressure on Margin of Safety

For example, the required flaw extension to failure at 79.2 % SMYS (72 % SMYS plus 10 % overpressure protection set point) after a spike pressure test for a 6-in. long (L = 6 in.), 20 % deep flaw is illustrated by the blue lines connecting points "A" and "C" ($\overline{AC}$ = 7.0 in.; a/t = 0.2). This is 1.66 (AC/BC = 7/4.2 = 1.66) times the extension required for failure for the same depth flaw remaining after a strength pressure test. The required flaw depth propagation for 79.2 % SMYS (72 % SMYS plus 10 % overpressure protection set point) after a spike pressure test for a 6-in. long, 20 % deep flaw is illustrated by the red lines connecting points "A" and "E" ($\overline{AE}$ = 0.26). This is 1.86 (AE/DE = 0.26/0.14 = 1.86) times the growth required for the same length flaw to extend to failure 79.2 % SMYS (72 % SMYS plus 10% overpressure protection set point) after a strength pressure test.

In this case, the flaw growth required to fail at 79.2 % SMYS (72 % SMYS plus 10 % overpressure protection set point) is increased by 66 % to 86 % by adding a short duration pressure spike to the pressure test (spike pressure test). Fracture mechanics principles were used to generate Figure 1. The characteristics of the pipeline to be pressure tested must be evaluated in the same manner to determine the additional benefit derived from a spike pressure test.

Repeated tests within the same section should be avoided since restressing pipe and pipeline components may cause flaws to grow to unexpected lengths without failing. Repeated tests may lead to a lower pressure where subsequent failures may occur (pressure reversal). There should be a balance between test duration, test pressure, and the probability of repeated failures as opposed to how many test failures the operator is willing to tolerate before reducing the test pressure and ultimately the operating pressure limit.

The operator should determine the specified test pressure range based on the target test pressure. The specified test pressure range will vary depending on the type of pressure test conducted and field conditions.

The operator should establish the duration of the pressure test based on the applicable codes or regulations, the type of pressure test being conducted, and whether or not the test segment can be visually examined for leaks during the test. When the required duration of a pressure test is not listed in applicable codes or regulations (such as pressure tests for integrity assessment purposes), guidance in this RP should be followed.

4.1.12 Pressure Test Failures

The operator should establish a plan for dealing with the possibility of a pressure test failure including the following.

a) Availability of equipment, personnel, materials, and inspection required for repair and environmental response activities.

b) Methods for preserving the fractured surfaces on the failed specimens of pipe for further analysis.

c) Test failure cause should be determined by laboratory examination, if not known or readily apparent.

4.1.13 Pressure Test Acceptance Criteria

Each operator should establish pressure testing acceptance criteria in order to verify that the pressure test was completed without evidence of leakage of the test medium (see 5.8 for additional guidance).

4.2 Pressure Test Medium

4.2.1 Test Medium Considerations

When considering the liquid to be used as the test medium for a pressure test, the following should be considered.

a) Primary and makeup sources of the test medium.

b) Need of a corrosion inhibitor or other treatment (pH neutralization, etc.) to be added to the test medium.

c) State and local codes should be reviewed to determine if there are any permits and/or regulatory requirements for obtaining a source of the test medium.

d) The volume of test medium required to fill the test segment plus failure contingency.

e) The test medium injection point into the test segment.

f) The need for storage of the clean test medium prior to the pressure test, if required.

g) The need for use of biocides to treat the line segment that comes in contact with the test medium, if required.

h) Fill rate and pressure of the test medium into the test segment.

i) The anticipated temperature of the test medium, atmosphere, ground, and test medium stabilization period.

j) The anticipated quality of the test medium including determination of the need for filters and a time frame for the settling of solids.

k) Sampling procedure to ensure (and to document) test medium quality before the test section is filled, while the test section is being filled, and before a failure or ultimate disposal occurs.

l) The need for storage of used test medium prior to disposal, if required.

m) State and local codes should be reviewed to determine if there are regulatory permits and/or requirements for disposal of the test medium.

n) Disposal location and method, for test medium.

o) Procedures and materials used for assisting in leak detection and locating, such as dyes or detectable gases, if required.

4.2.2 Special Considerations for Test Mediums Other Than Water

A pressure test should be conducted with water; however, liquid petroleum having a Reid vapor pressure of less than 7 pounds per square inch absolute (psia) may be used as the test medium if all of the following conditions are met.

a) The pipeline or piping segment to be tested is not part of an offshore pipeline or offshore piping facility.

b) The pipeline or piping segment to be tested is not located where a release could adversely impact any environmentally sensitive areas.

c) The pipeline or piping segment to be tested (rated for operation above 275 psig) is outside of cities and/or other highly populated areas.

d) Every building located outside of the operators' piping facility, but within 300 ft (92 m) of the pipeline or piping segment to be tested, is unoccupied while the test pressure is greater than or equal to a pressure that produces a hoop stress of 50 % of the SMYS.

e) The pipeline or piping segment to be tested is kept under surveillance by pipeline personnel equipped with portable radios or similar equipment to provide continuous communication with the person in charge.

f) Suitable contingency response equipment and personnel for spill cleanup are strategically placed near the pipeline or piping segment to be tested.

g) Test procedures meet all applicable local, state, or federal government regulations.

4.3 Pressure Test Equipment and Materials

Equipment for a pressure test should be carefully selected and be in working order. The measurement equipment should be appropriate for the pressures expected during the pressure test. The following equipment may be required for a pressure test.

a) A high-volume pump and associated piping to fill the line that provides adequate pressure to overcome static head, maintains sufficient velocity to move displacers/pigs and any debris in the pipeline, and ensures turbulent flow in the pipeline in order to minimize the interface between the test medium and any hazardous liquids in the pipeline.

b) A test medium supply line filter that ensures a clean test medium.

c) An injection pump that introduces corrosion inhibitors, leak detection dyes or gases, or other chemicals into the test segment if their use is desired.

d) A meter for measuring line fill or a comparable means of measuring it.

e) A variable speed, positive displacement pump that pressurizes the line to a suitable or appropriate level that meets or exceeds the specified test pressure. The pump should have a known volume per stroke and should be equipped with a stroke counter. (A constant-speed pump with a variable flow rate control may be used in lieu of the above if the liquid test medium injected into the pipeline is measured during pressurization.)

f) The equipment used for volume measurement during pressurization should have an accuracy better than 1 % of the volume added with a sensitivity of 0.1 % of the calculated volume of the liquid added after line filling to produce the required test pressure in the test section.

g) A relief valve may be required to prevent overpressure of the test segment while the line is being filled with the test medium, during pressurization and during the test.

h) A portable tank or transport into which excess test medium can be discharged and from which makeup volumes can be drawn.

i) A pressure sensing and display device that has the pressure range and increment divisions necessary to indicate anticipated test pressures.

j) A deadweight tester or an equivalent pressure sensing device that is capable of measuring in increments of less than or equal to one (1) psig (6.7 kPa). The device should have a certificate of calibration that is not more than one year old at the start of testing.

k) A continuous-recording pressure measurement device (such as a chart recorder) that provides a permanent record of pressure versus time. This device should be calibrated immediately before each use with the deadweight tester.

l) A test medium temperature sensing and display instrument that is properly calibrated to a range suitable for anticipated test temperatures. Temperature instrument accuracy should be within 1 °F of actual temperature. Temperature instrument sensitivity should be within 0.1 °F.

m) A continuous-recording temperature measurement device that provides a permanent record of test medium temperature versus time. This device should be calibrated immediately before each use with a certified thermometer.

n) An ambient temperature sensing and display instrument that is properly calibrated to a range suitable for anticipated ambient temperatures.

o) A continuous-recording temperature measurement device that provides a permanent record of ambient temperature versus time.

p) Facilities that protect all instrumentation from weather extremes.

q) Electronic pressure/temperature monitoring and recording systems that assist in the analysis of test data. Such systems can be used in lieu of the components listed above provided that the individual pressure sensors included in the systems have a level of sensitivity and can be field calibrated in a manner similar to those instruments listed above.

r) Pigs, scrapers, spheres, and similar devices that clean the test segment and facilitate the removal of air, hazardous liquids, or gas from the line during filling operations and similar suitable devices for test medium removal/displacement.

s) Temporary manifolds and connections, as needed.

t) Equipment, materials, and fluids that are needed to introduce and displace the test medium from the test segments.

u) Communication equipment that is adequate for coordinating test activities.

v) Equipment that isolates line segments for leak determination and facilitates repair.

w) Replacement pipe, valves, gaskets, etc. that can be used to replace those that may fail during pressure test.

x) Test medium sampling equipment.

y) Vacuum truck to recover test medium spills from ruptures or leaks (if environmental permit limits are exceeded).

z) Test medium disposal filtration equipment.

aa) Excavation equipment to expose failure sites.

ab) Appropriate placards for vacuum trucks and frac tanks used to store test medium or product.

ac) Information or product data sheets for all chemicals used or collected during the test.

ad) Gas/oxygen detecting equipment.

ae) Grounding straps for static electricity.

af) Test medium containment material (spill boom, absorbent pads, drip pans, etc.).

ag) Air patrol of pipeline test segment to help locate possible failure locations.

ah) Pig tracking equipment to track pigs used for gas, product, or test medium displacement.

ai) Tie-downs for all temporary hoses and piping.

Caution—If freeze plugs are used to isolate line segments, special handling techniques should be used to ensure personnel safety. Consideration should be given to nondestructive examination for flaws, toughness, and the ductile-to-brittle transition temperature when selecting the joint for the freeze.

4.4 Location and Use of Test Measuring Equipment

Volume changes in the test section are sensitive to the effects of temperature. As temperature rises or falls, corresponding pressure and volumes changes will occur. This relationship requires that the measurement of pressure and temperature be precise and representative of the test section.

Test pressures can be measured and determined for the test section with a high degree of certainty. The use of appropriate instrumentation at multiple measuring points or an elevation profile in conjunction with a measurement point provides an accurate representation of the test pressures along the pipeline. Unlike pressure, temperature is potentially more difficult to determine and carries with it a component of uncertainty. This becomes readily apparent for long test section where varying burial depths and multiple ground environments may be encountered leading to temperature variations within the test section. The precise temperature of the test medium and the pipeline throughout the test section may not be known. It is not practical to measure every location where a temperature difference may exist. However, the number and location of temperature measurement points should be evaluated and carefully selected to adequately characterize the test section. It is also important to allow the test medium temperature in the pipeline to stabilize before pressure testing begins.

Instrumentation should be commensurate with the measurement needs for both the pressure and temperature measuring instruments. A degree of uncertainty will exist due to the number and accuracy of the instrumentation and this uncertainty should be taken into account when establishing the acceptance criteria.

5 Pressure Test Implementation

5.1 General

The operator should develop a site-specific test procedure including detailed information regarding test pressures and the duration of the pressure test. This procedure may be a combination of this section of the RP and the operator's standard operating practices and a typical "test plan" detailing the specifics for the pipeline system being tested.

5.2 Qualification of Contractor and Operator Personnel

Qualifications of contractor and operator personnel for conducting pressure tests will vary based on certification requirements by regulation, code, or operator standards and procedures.

Operator personnel and contractors involved with designing, planning, conducting, or approval of a pressure test should be qualified by both training and experience. Each operator is responsible for establishing these qualifications. In determining qualifications, the following factors should be considered.

a) Performance of applicable calculations and interpretation of test data and results.

b) Knowledge of code requirements and regulations.

c) Qualification requirements of governing authority to conduct or witness testing.

d) Governmental or operator requirements to certify test results.

e) Familiarity with equipment and pressure test setup.

f) Familiarity with test procedures.

5.3 Line Fill and Cleaning

The line fill operation typically accomplishes several functions, such as clean the line, displace product, and introduce the necessary test medium into the test segment. It should be noted that pigging operations normally will not remove all hydrocarbons from the piping segment. Residual product, gases, or vapors may remain in the test segment. Consideration should be given to performing a nitrogen displacement ahead of the medium, especially if additional work will be performed on the pipeline prior to the test. Before the actual line filling operation, consideration should be given to run a sizing pig, caliper, or deformation tool in an effort to identify any geometric abnormalities that may exist in the line prior to the test. Additionally, consideration should also be given to running a batch/train of cleaning pigs to remove sediments, paraffins, and so forth from those pipeline segments that are not under a normal pigging program.

Many of the same safety concerns in 5.9 also apply to the use of temporary piping and couplings in the line filling and cleaning process. Temporary piping should be properly anchored and adequately secured from movement. Pipe couplings should have safety devices or restraints to limit movement due to unexpected separation of the piping.

Pigs or spheres are usually inserted to separate the test medium from the contents in the remainder of the pipeline. Locators may be inserted in the pigs to track them during the filling process and to ensure that the pigs are in the correct location.

The fill pump should be sized so that the pigs will travel at a speed that will maintain a good seal with the pipeline. This will reduce the risk of introducing air or other compressible mixtures behind the pigs. Air or compressible mixtures in the test water may occur when the pipeline is empty or filled with an inert gas or a gas mixture prior to line filling. A minimum of 2 mph to 3 mph is a suggested starting point for the velocity of the pigs. High velocities may cause excessive wearing of the pigs and may cause the displaced product, air, or gas mixture to mix with the test medium. Unless the line fill is occurring with some form of backpressure, as pigs travel down the line and down a slope, the weight of the column of fluid could cause the pig to travel faster than the filling operation would allow, thus introducing product, air, or gas behind the pig.

The quality and source of the test water should be determined. Water that contains sediment, non-neutral pH levels, or is high in salinity may be detrimental to the pipe, valves, and equipment and should not be used unless it is filtered or treated. The possible deleterious effect of additives or corrosion inhibitors on the processing of gas or hazardous liquids to be transported should be investigated.

A flow meter should be placed in the line to monitor and maintain the planned design rate of fill. The meter will allow the test personnel to make adjustments as necessary as pressure builds and fill rates drop as the line pack progresses. It will also assist in matching the actual fill volume with the calculated fill volume. To a lesser extent, tank level or tank gauging equipment may also be used for this purpose.

Air and gas mixtures should be bled during the filling process to minimize the time for line pressure stabilization. Additionally, air or gases in the test medium may affect the sensitivity of the leak test. Limits may be established for the amount of air entrapment. The amount of trapped or residual air in the test section may be determined from preparation of a pressure–volume plot. The nonlinear portion of the pressure–volume plot at the beginning of pressurization represents the residual air in the pipeline as shown in Figure 2. For test pressures greater than 290 psig (2000 kPa), it is preferable for the total amount of residual air in the test section to be less than 0.2 % of the volume of the test section. Except from a possible safety standpoint, the effects of residual air in the test section are not significant if the straight-line section of the pressure–volume plot (see Figure 2) begins at a pressure that is less than 50 % of the test pressure and the test pressure is greater than 290 psig (2000 kPa). However, the total amount of residual air in the test section should not exceed 5 % of the volume of the test section. When the air content is significant and could affect the accuracy of the test, the air content should be determined and accounted for during the evaluation of the test results.

The temperature of the fill water should be recorded as it is introduced into the pipeline. This will aid in the determination of line temperature stability. Additionally, the flow rates and pressures should also be recorded or monitored to protect the pipeline from an over pressure situation.

A portable tank is used to make up the difference between the actual water supply and the high volume fill pumps. This may not be necessary if the fill pumps have a direct supply, such as a river.

If possible, excavated segments should be backfilled prior to the initial pressurization. The sensor on each temperature recording device should be installed so that it is in contact with the pipeline at a point where it has normal cover. Additionally, it should be at a distance far enough from the injection point so that the effect of the exposed piping and makeup injection(s) on temperature is minimized. The backfill around the recording temperature device sensor should be tamped. Insulation, if appropriate, should be used on the capillary lines to the temperature recorder, and the temperature recorder should be installed in an insulated box. Large centrifugal pumps and storage tanks will

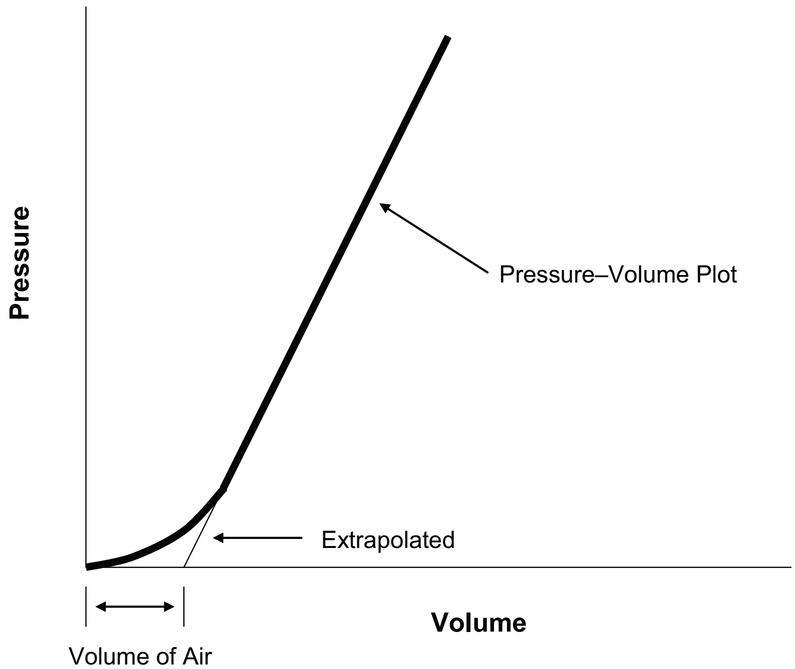

Figure 2—Pressure–Volume Plot with Residual Air

affect the temperature of the test medium. The temperature of the buried line should be recorded until the pressure test is completed.

5.4 Initial Pressurization

Keep safety in mind at all times! Pipe maintained at high pressure is potentially dangerous. Established safety guidelines should be followed at all times.

Personnel conducting the test should maintain continuous surveillance over the operation to ensure that it is carefully controlled. Test personnel should be located at a safe distance from the test section. All temporary piping and test heads should be adequately secured before the pressurization process is started.

The initial pressurization of the section of pipe to be tested begins once the segment is full of fluid and the appropriate measures have been taken to bleed any and all air; in other words, the line segment is "packed." Pressurization involves bringing the section of pipe to be tested up from the static pressure after the fill process to the desired test pressure.

Initial pressurization of the section should occur at a controlled rate to avoid surging the pipeline. The site-specific test procedure should determine the pressurization rate up to the target test pressure (the pressurization rate is typically 10 psig/min or lower).

Pipe connections should be periodically checked for leaks during the pressurization process. The flow rate should be monitored and logged for preparation of a pressure–volume plot, if applicable. Calculations indicating the amount of the test medium that is required to increase the pressure from the fill pressure to the test pressure should be made prior to the pressure test and made available to test personnel. This information aids in determining the tightness of the segment and assists in determining, along with the pressure–volume plot, if leaks have occurred or if the pipe has yielded.

If it is determined that air is trapped in the pipeline, it may be necessary to add vents or taps at the high elevation points in order to bleed the air from the pipeline.

It is preferable for a pressure–volume plot to be initiated at the start of the pressurization process and continue until the test pressure is reached. The lower end of the pressure–volume plot can be used to determine the total amount of residual air in the test section. The upper end of the pressure volume plot can be used to determine if any pipe in the test segment may have reached its elastic limit. ASME B31.8:2007, Appendix N, Section N-5 provides information associated with the various methods that can be used to determine the pipeline pressure required to produce yielding.

Once 80 % to 90 % of the target test pressure is reached, the rate of pressurization should be reduced, especially when the pressure is at or near 100 % of the target test pressure. Prior to the start of the test, it may be desirable to have a stabilization period, which would allow both the temperature and pressure to stabilize. Once the temperature and pressure have stabilized, the test pressure can be reduced by removing some of the test medium into a graduated cylinder for measurement purposes. The reduction in pressure and the volume of the removed test medium can be used to determine the amount of residual air in the test section. Furthermore, this information along with the temperature of the test medium throughout the test section can be used to determine the actual change in volume associated with a change in pressure for the entire test section in order to verify the accuracy of any theoretical acceptance criteria calculations that may be performed during the test. Once the desired test pressure is reached, the pressurization equipment should be stopped and isolated from the section.

NOTE Pressure charts, sensors, and displays only show an approximation of the actual pressure. The charts provide proof of the continuity of the test. The deadweight tester or electronic equipment provides the actual pressure to be recorded.

5.5 The Test Period

When the test pressure is reached, pressurization should cease and all valves and connections to the line should be inspected for leakage. After inspecting for leakage, test personnel should verify that the specified test pressure is being maintained. Pressure transients may occur during the pressurization process and residual air may go into solution. A period of temperature stabilization may be required before the start of the test. The time required for thermal stabilization is dependent on the temperature of the test medium at the time of filling, heat capacity of the test medium, pipe diameter, depth of pipe burial, and the ground temperature. The test period shall begin after the temperature of the test medium, pipe temperature, and ground temperature has stabilized. When this stabilization process has been completed, the injection pump should be isolated from the test section.

The duration of the test period for the pressure test should be specified in the site-specific test procedure and be in accordance with ASME B31.4, ASME B31.8, any regulations from a governmental agency with jurisdictional authority, and/or the operator's established test procedures.

Pressure and temperature should be continuously monitored during the test, and all of the pressure and temperature readings should be recorded. Deadweight tester comparisons with pressure recorder readings should be made at the beginning of the test, periodically during the test, and at the end of the test. The results of the deadweight tester checks and temperature readings should be recorded on the pressure and temperature logs for the predetermined intervals during the pressure test. Typically, temperature and pressure data are recorded every $^1/_2$ hour throughout the duration of the test. Weather changes, such as the development of rain or clouds, that could affect the pressure and temperature should be documented on the test log. The volume or pressure of any added or subtracted test medium should be documented on the test log, as well as the temperature and pressure at that time and be accounted for in the assessment of the results of the pressure test. It is mandatory that the volume of any test medium added or removed be accounted for to determine if the pressure test has been completed without evidence of leakage for any pressure test of piping that cannot be 100 % visually checked for leaks.

Minor or gradual pressure changes during the test can be a result of residual air in the segment, temperature effects, or leaks through loose connections. Extending the test duration may be necessary to demonstrate that air and temperature effects have been accounted for.

5.6 Pressure Test Failures

The site-specific test procedure should specify the preferred method(s) for locating leaks or failures. The operator may choose to fly, drive, and/or walk the pipeline right-of-way to visually check for evidence of leaks during the pressure test. The operator should develop contingency plans for locating large and small leaks in areas of difficult terrain or in the event of inclement weather. A visual inspection is usually performed on all fabricated assemblies.

Pipe, valves, fittings, and test components that fail during a pressure test should be investigated to determine the cause and to minimize the possibility of a recurrence. Any leaks or failures of the pipeline should be properly documented in the test report as per Section 6. Proper documentation will be vital to subsequent investigations and follow up activities.

The mode or manner of failure will be important and will guide any subsequent actions taken by the operator.

a) If a rupture or a substantial leak occurs, the test should be stopped to determine the cause and the necessary steps taken to repair the source of leak or area of failure. If possible, the cause of failure should be understood before proceeding with repairs and repressurization of the test segment. Initial findings may indicate that changes should be made to test pressures or test procedures. Pipe or other failed components should be preserved for further examination and failure analysis if necessary. Once repaired the test should be restarted with a new hold period.

b) If a small leak occurs, the pressure should be reduced to an appropriate level while locating the leak. After repairs, the test should be restarted with a new hold period for either a strength (for liquid pipelines) or leak test. For a strength (for gas pipelines only) or spike test, the test can be continued if the injection pump is capable of maintaining test pressure during the test period.

If leaks are discovered the line should be depressurized and temporary or permanent repairs made. The line may be repressurized following the repairs. Temporary repairs may be used for the test if allowed by company procedures. Permanent repairs should be made prior to starting or returning the pipeline to service. The operator should confirm that there is no evidence of leakage by performing an additional leak test or conducting a leak survey.

Although it is not desirable, it is important to note that a small amount of leakage from ancillary piping and/or the test equipment may be acceptable if the piping/equipment will not be part of the final pipeline system and if it is allowed by the governing regulations and/or design codes. Any leakage from ancillary piping and/or the test equipment should be accurately measured and accounted for as part of the acceptance criteria calculations.

5.7 Searching for Leaks

Locating leaks can be a difficult and time-consuming process. Various methods and techniques may be used to improve the operator’s ability to find leaks during a pressure test including the following.

a) Sectioning or segmenting the pipeline and monitoring the pressure of each section. Closing mainline block valves will isolate the pipeline into smaller segments. Freeze plugs may also be used to isolate sections of the pipeline for evaluation.

b) Dyes may be used in the test water to improve visual indication of the leak area.

c) Acoustical monitoring equipment may be employed to narrow the search area.

d) Odorants or tracers introduced into the test medium during the filling process will allow the operator to detect leaks with sensing equipment.

5.8 Pressure Test Acceptance Criteria

5.8.1 General

Pressure test acceptance criteria should be established prior to conducting a pressure test. Governments or entities with jurisdictional authority may establish additional acceptance criteria by rule or regulation.

5.8.2 Strength and Spike Test

A strength pressure test or spike pressure test is acceptable if the test pressure can be maintained for the test period. Evidence of a leak does not invalidate the test. If the test pressure cannot be maintained throughout the test section, the damaged components should be repaired and the test repeated.

5.8.3 Leak Test

A pressure change is directly related to a volume change in the test section. The change in volume may be the result of a leak, a temperature change, the effects of air in the test section, or a combination of these factors. Pressure variations during a leak test are acceptable if it can be shown that the changes are caused by factors other than a leak.

Volume differences between the start and the end of the test period should be determined. The volume differences are attributable to four components as follows.

a) Injections and withdrawals.

b) Changes in calculated volume due to temperature changes.

c) Dissolution of air or gases into the test medium.

d) Test medium released through a relief valve.

Trapped air or gases will slowly go into solution. Small amounts of air will not significantly affect the test results. Large volumes of air may affect test results and should be accounted for in the evaluation of volume differences.

Changes in volume due to temperature and pressure should be determined by the use of appropriate calculations. A set of calculations that provide volume corrections to account for temperature and pressure changes that occurred during the test period (start and stop) should be developed or adopted. The effect of temperature varies with the pipe diameter, D/t ratio (outside pipe diameter/wall thickness), volume of residual air, and the test liquid. The use of test calculations to evaluate volume deviations is not necessary when tested components are visually inspected and checked for leakage.

Volume losses above the uncertainty of measurement accuracy should be explained. Unexplained losses indicate an unknown leak or leaks in the test section. For liquid pipelines, unaccounted leakage of the testing medium is not permitted during the entire testing period for both the strength and/or leak test. Although codes or regulations may allow continuation or acceptance of a pressure test with a possible leak, operators should strive for a leak-free test.

The ability to identify leaks with confidence against the uncertainty of measurement accuracy is the fundamental basis of the leak test acceptance criteria. A volume difference in which there is no rational or analytical explanation to adequately account for the changes indicates the possibility of a leak. Extending the test period may increase leak sensitivity.

In addition to volume accountability, other factors may also be considered in determining a pressure test as valid. The trending correlation between temperature and pressure changes may be used. These changes may be evaluated by the use of a plot of the pressure and temperature over time. Observation, experience, and engineering judgment may also be employed to determine acceptability of the test.

Generally, more than one factor is used to evaluate and determine acceptability of a pressure test. The application of engineering principles and analytical evaluation of all test data is necessary to determine the acceptability of a pressure test.

Several different methodologies are available in technical literature that may be used to assist in determining the volume change in a pipeline during a pressure test as it relates to a change in the temperature and/or pressure of the test medium. These methodologies include Appendix C of AS/NZS 2885.5:2012.

5.8.4 Quality Assurance

Pressure test data should be evaluated by use of operator-established acceptance criteria. These criteria should be in accordance with appropriate codes and regulatory requirements. Qualified individuals should be used to determine acceptance. Operators should establish requirements for qualified individuals who determine the acceptability of pressure tests.

5.9 Depressurization, Displacement, and Disposal of the Test Medium

As part of the site-specific procedure for removal of the test medium from the test section, test medium release rates, velocity, and hydrodynamic forces should be considered in the design of the test medium removal system and the potential environmental impacts caused by erosion, drainage, and flooding. Test medium removal lines should be properly anchored and compatible with the service pressures expected during the removal of the test medium. Significant and sudden variations in pressure often occur within the main pipeline and temporary test medium removal lines. These variations can be caused by changes in pig velocity as it passes through bends in the pipeline or changes in pig and test medium velocity due to changes in pipeline elevation. Compressed air, nitrogen, or other gases escaping around the pig, which can combine with air already present in the main pipeline at high spots in the pipe, can also create a source for stored energy within the main pipeline. These sudden pressure changes produce surges that are transferred from the main pipeline to the temporary test medium removal line. This can result in movement of the temporary test medium removal line, as the pressures can easily exceed the working pressures and bending capabilities of the temporary test medium removal piping system, or when the entire test medium removal manifold is inadequately designed for the stresses that can be imposed while removing the test medium. See additional safety considerations listed in 5.2 of this document.

Once testing has been completed, depressurization should follow a control plan outlined in as part of the pressure test procedure. The control plan should indicate the number of locations to bleed off pressure. Release points should be monitored. When water is used as the test medium, it should be disposed of in accordance with all applicable environmental regulations. It should also be tested, filtered, and/or treated per the conditions of the discharge permit or applicable regulations. Prior to its discharge, water should be free of solids, acids, oils, and other products detrimental to the environment. The test medium may also need to be stored for treatment prior to disposal.

Once the line is depressured, the test medium may be displaced with liquid petroleum, air, or inert gas. The test medium may be displaced with spheres, squeegees, or other pigging devices. Product quality or internal corrosion control requirements may dictate that a pipeline drying regimen be conducted after the test medium is displaced. Free water, if used as the test medium, may be removed from the pipeline by running multiple test medium removal pigs propelled by compressed air if the pipeline is gas free or contains no residual hydrocarbon vapors. Nitrogen is recommended if the line is not gas free or contains residual hydrocarbon vapors, which can occur if the pipeline was in gas or hazardous liquid service prior to the pressure test. If air or inert gas is to be used, consideration must also be given to the amount of energy stored in the compressed gas.

When used as the test medium, water should be removed from valve bodies, dead legs, drips, headers, fabricated assemblies, and other parts of the pipeline, where normal dewatering is not effective. Once the pipeline has been dewatered the drying operations may commence if necessary. Additionally, a biocide train may be used to minimize bacteria growth prior to drying or returning the line to service.

5.10 Drying Operations

Pipelines may require drying due to moisture limitations in the product specifications. Air compressors with an after cooler may be used to remove the bulk of the moisture from the air and to reduce air temperatures. Foam swabs are typically used at periodic intervals to drive down the dew point per any operator requirements. Dry nitrogen can be used to complete the drying process for low dew point requirements. Methanol may also be used to assist in the drying process and may be separated or removed by charcoal filters. When the appropriate dew point has been reached, the pipeline should be isolated to preserve the pipeline condition before it is returned to service.

6 Pressure Test Records and Drawings

6.1 General

As per company procedures, applicable codes, and regulations, pressure test records may be used to demonstrate the operating pressure limit of a discrete point within a pipeline system and/or demonstrate compliance with pipeline integrity management requirements. As a result, each operator should retain pressure test records for the useful life of the pipeline.

6.2 Pressure Test Records

Pressure test record keeping requirements may differ depending on the type of facility tested and the purpose of the pressure test (i.e. a profile drawing may not be necessary for a fabricated assembly). Pressure test records should include the following information.

a) Name of the operator company.

b) Name of the pressure testing contractor (if applicable).

c) Sketch or drawing of the pipe or pipeline being tested (especially for station piping).

d) Profile drawing of the pipe or pipeline being tested (especially for pipeline segments).

e) Name, line number, or description of the tested pipe or pipeline.

f) Diameter(s) of the pipe in the test segment.

g) Wall thickness(es) of the pipe in the test segment.

h) Grade or SMYS of the pipe in the test segment.

i) ANSI rating for applicable pipeline components in the test segment.

j) Location and elevation of the test segment endpoints.

k) Location and elevation of the pressure test recording equipment.

l) Description of the test medium.

m) Source of the test medium.

n) Description of any additives injected into the test medium.

o) Description of the pressure test equipment/apparatus.

p) Serial number(s) of pressure test equipment/apparatus.

q) Certifications and calibration data for the pressure test equipment/apparatus.

r) Date and time of the start of the pressure test.

s) Date and time of the end of the pressure test.

t) Duration of each portion of the pressure test.

u) Straight-line plot of pump strokes per increment of pressure rise during pressurization.

v) Continuous chart showing test pressure versus time.

w) Log of test pressure versus time.

x) Minimum test pressure and the location of the minimum test pressure in the test segment.

y) Maximum test pressure and the location of the maximum test pressure in the test segment.

z) Physical description and location of the pressure-limiting component in the test segment.

aa) Explanation of any pressure discontinuities.

ab) Description and volume of any repressurizations and/or bleed-offs.

ac) Continuous temperature chart showing pipe or test medium temperature versus time.

ad) Log of pipe or test medium temperature versus time.

ae) Continuous temperature chart showing ambient temperature versus time.

af) Log of ambient temperature versus time.

ag) Description of the weather during the test (including any changes).

ah) Pressure test acceptance criteria calculations.

ai) Name, signature, and title of the person responsible for performing the pressure test.

aj) Name, signature, and title of operator company's witness.

ak) Name, signature, and title of personnel certifying/approving pressure test (including approval stamp, if required).

al) Leak or failure information including location, description, cause (if known), method of repair, and disposition of failed pipe or components.

am) Other records as determined by the operator or required by regulation or law.

6.3 Pressure Test Drawings

When plan and profile drawings are developed and used, the following information should be identified on the drawings in the format appropriate to the operator (i.e. mile post, as-built survey station, *XY* coordinate, etc.).

a) Name, line number, and/or physical description of the tested pipeline.

b) Description of the test segment and the test segment number (if applicable).

c) Total length of the test segment.

d) Description of the physical location of each pressure test endpoint.

e) Elevation of each pressure test endpoint.

f) Description of the physical location of the pressure recording equipment.

g) Elevation of the pressure recording equipment.

h) Description of the physical location of the highest pipeline elevation in the test segment.

i) Elevation of the highest pipeline elevation in the test segment.

j) Description of the physical location of the lowest pipeline elevation in the test segment.

k) Elevation of the lowest pipeline elevation in the test segment.

l) Description of the physical location of the pressure-limiting component in the test segment.

m) Elevation of the pressure-limiting component in the test segment.

n) Location of any valves and/or appurtenances in the test segment.

o) Location of any river crossings, road crossings, and/or other permanent features in the test segment.

Bibliography

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[2] ASME B31.4:2009 [2], Section 400.2

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