Common Covered Task 501
Conduct a Pressure Test

Directions

This training guide is to be used by a Veriforce Authorized Evaluator/Trainer and Trainee during on-the-job training (OJT) or prior to an evaluation as a resource. (S) Indicates a demonstration or skill task; (K) indicates a knowledge task.

OJT Reminder

OJT is an active hands-on process. Practice should be as similar to the actual job task as possible. However, if the training is being provided on an actual job site while a covered task is actually being performed, the Evaluator either needs to be qualified on that covered task or be assisted by someone who is qualified on the covered task. The Evaluator should closely monitor the Trainee's practices to ensure safe and correct task performance. At no time should a non-qualified individual perform, or train for, a covered task unless directed and observed by a qualified individual. However, if the ***"span of control"*** for that particular covered task is "1:0" (requiring only qualified individuals to perform the covered task), the training must be simulated. Training is simulated by "walking through" the task and simulating all actual manipulations (valves, switches, tools, etc.) an individual would use during the performance of a covered task. Simulating includes the use of safety and administrative requirements as if the task were being performed live. Refer to the Veriforce Evaluator Training Program for more on how to conduct formal OJT.

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Recommended Student Training or Resources:

- DOT 49 CFR 192.328(d)
- DOT 49 CFR 192.505
- DOT 49 CFR 192.506
- DOT 49 CFR 192.507
- DOT 49 CFR 192.512
- DOT 49 CFR 195.304
- DOT 49 CFR 195.305
- DOT 49 CFR 195.306

Knowledge: Explain what is required prior to performing this task.

Pipeline Operator-Approved Procedures and Appropriate Equipment/Material

Prior to performing this task, you will need to have the pipeline operator-approved procedures as well as the appropriate equipment and materials. The procedures will outline requirements for performing this task that are specific to the pipeline operator. Operators may also have specific requirements regarding the type of equipment that can be used to perform this task.

Therefore, it's important to follow the specific requirements of the procedures and only use operator-approved equipment. Doing so can ensure the task is performed correctly and according to the pipeline operator's standards.

Knowledge: Identify common test mediums.

Before identifying common test mediums, it is important to understand the pipeline regulations.

In accordance with regulation **49 CFR 192.503 (Transportation of Natural and Other Gas By Pipeline: Minimum Federal Safety Standards – Test Requirements),** the test medium must be liquid, air, natural gas, or inert gas (such as nitrogen) that is compatible with the material of which the pipeline is constructed; relatively free of sedimentary materials; and, except for natural gas, nonflammable.

In accordance with regulation **49 CFR 195.306 (Transportation of Hazardous Liquid By Pipelines – Pressure Testing),** the test medium must be water, except in the following situations:

- *Liquid petroleum that does not vaporize rapidly may be used as the test medium, if the requirements of 195.306(b) are met. This does NOT apply to offshore pipelines.*
- *Carbon dioxide pipelines may use inert gas (such as nitrogen) or carbon dioxide as the test medium, if the requirements of 195.306(c) are met.*
- *Air or inert gas may be used as the test medium in low-stress pipelines.*

The most common test mediums for conducting a pressure test to substantiate MAOP/MOP are:

- Water
- Inert gas
- Natural gas / Product

Of the three most common test mediums mentioned, the preferred method is water.

A liquid (such as water) is incompressible and does not fill a volume by expanding into it. The molecules simply can't be forced any closer to each other than they already are.

A gas (such as air or natural gas), on the other hand, is compressible and expands to fill any volume containing it.

During a pressure test, energy (or internal pressure) is applied to stress the test section. If the medium is a compressible gas, such as air or nitrogen, then the gas is compressed and absorbs energy while applying stress to the pipeline.

If a failure occurs, both the pipeline stress energy and the gas compression energy are suddenly released.

When water (an incompressible liquid) is used as the test medium, the energy release is limited to the pipeline stress energy.

As a result, water is the preferred medium for testing because less energy is released in the event of a failure.

A simple experiment to illustrate the difference between gas and water is to fill two balloons – one with water and the other with air - and then tie the ends closed.

Take a sharp object and pop each balloon.

You will find that the balloon filled with water will either leak through the hole or break open, letting the water flow out with minimal force.

The balloon filled with air will immediately "pop," releasing both the energy in the balloon and the compressed air.

Knowledge: Describe considerations when water is used a test medium.

As stated previously, water is the preferred medium for conducting pressure tests of the pipeline.

Water is also the only medium that can be used for spike testing per the Code of Federal Regulation 192.506.

A spike test is a hydrostatic test where the line is pressured to either 1.5 times the maximum allowable operating pressure (MAOP) or 100% specified minimum yield strength (SMYS), whichever is less, for at least 15 minutes.

Spike tests are conducted when there is a concern that latent, or dormant cracks, might grow due to a phenomenon known as "pressure reversals."

A pressure reversal is the occurrence of a defect that fails at a pressure level lower than the highest pressure it was previously exposed to during a hydrostatic test.

While water is considered safer than air or gas when conducting pressure tests, there are some considerations that must be taken into account when using water as a test medium.

Such considerations include local, state, and federal environmental laws as well as weather conditions.

Regulations require that the operator ensure that the test medium is disposed of in a manner that will minimize damage to the environment.

To prevent any contamination to the environment during discharge of the medium and ensure compliance with all laws and requirements, proper planning and preparation must be taken.

In order to determine the method used for discharge of the test medium, you will need to take a pre- and post-sample reading of the water.

The pre-sample serves as a "starting point" and is used to determine what materials are present in the medium prior to introducing it to the pipeline.

This sample is taken from the water source, which can be from many areas such as a stream, river, lake, municipality, etc.

Some of the main contaminants that the water is tested for are mercury, lead, and metal levels that can pose a problem to the environment and affect pipeline integrity.

The post-sample test is completed after the water is introduced into the pipeline.

The purpose of this test is to determine if any contaminants were increased or introduced to the water after the pressure test.

The test results, along with local, state, and federal requirements, will determine the disposal method of the test medium.

When collecting samples of water for testing ensure that care is taken not to introduce any outside contaminants and that the container is properly secured and labeled.

Each pipeline operator and laboratory will have specific requirements for labeling the samples. However, at a minimum, you need to ensure you are in compliance with any laws and requirements for proper labeling, handling, and shipping of samples that are potentially hazardous waste.

There are several methods used for treating the medium, both prior to the water entering the pipeline and after the test is complete.

Many times, water used for testing is pumped from lakes, rivers, and streams. Prior to water entering the pipeline, it is filtered through an in-line filtration system that removes any sediment and contaminants in the water. This is helpful in ensuring pipeline integrity as well as aiding with cleaning and drying of the pipeline after the test.

Depending on the results of the pre- and post-sample tests, including any variances, the pipeline operator will determine which dewatering method is required.

If the water is deemed environmentally safe, the operator may decide to dewater directly from the pipeline back into the ground.

Even if the water is deemed safe and approved for dewatering by local laws, care must be taken when doing this to prevent flooding and ground erosion.

Common methods used to filter the water and prevent flooding and erosion when dewatering back into the ground are the use of:

- Splash plates
- Hay bales
- Filter socks

These methods work as filters to collect sediments when discharging water. They also help prevent erosion and flooding of the nearby landscape.

If the water is deemed unsafe for the environment and/or dewatering into the ground is not an option, the pipeline operator will be required to dispose of the water in accordance with local and federal environmental laws.

Unlike the procedures for discharging the water into the ground, contaminated or unsafe water is drained from the pipeline directly to a water containment system, such as a frac tank.

The frac tank is then transported to a water treatment facility where the test water is properly cleaned.

Another consideration that must be taken into account when using water is the ambient temperature. This is important to monitor due to the effects temperature has on water.

If the water freezes while it is in the pipeline, it will expand, cause damage, and jeopardize pipeline integrity

In addition to potential pipeline damage, freezing can also damage test needles, dead weight lines, and other test equipment.

It's also important to note that any amount of freezing of the test lines will cause incorrect test readings and could be a potential hazard.

For example, if the line (or even a small portion of the line) is frozen, pressure readings will only show what the pressure is in the test line up to the blocked point, and not the actual pipeline pressure.

This could cause you to increase pipeline pressure to levels that exceed the test parameters. It could also cause a false reading of a pressure hold, when in fact there could be a pipeline pressure decrease.

While we cannot control the weather, we can plan and take proper protective measures to eliminate freezing of water while using it as a test medium.

To alleviate potential freezing in the test equipment, it is common to use a lubricating oil, such as Marvel Mystery oil or any glycol-based antifreeze, in your testing lines.

Another method that is also used (in addition to an antifreeze fluid) is to insulate the testing lines and connections.

To prevent freezing of water in the pipeline, you may need to add a non-toxic antifreeze to the test water. In some cases, the pipeline operator may also require the construction of a temporary cover of any exposed pipe, including manifolds.

In order to determine if measures are needed to prevent water from freezing, you will need to constantly monitor and record the ambient and water temperatures. Doing otherwise would be to blindly trust the elements, which could cause an inaccurate test or have catastrophic results.

Knowledge & Skill: Describe and simulate required preparation for conducting a pressure test.

The pipeline operator is responsible for developing a plan and establishing test parameters for the pressure test. A great deal of time, thought, effort, and coordination is put into developing the plan, along with ensuring that all regulatory requirements are met. The plan encompasses every aspect of the pressure test from start to finish.

Prior to beginning the test, you will need to obtain the plan and ensure that you follow every aspect of it. You must also be qualified on the covered task performed and be competent with any equipment you will be using.

As stated previously, the plan contains every aspect of the pressure test. Therefore, it is important to understand the parameters outlined by the pipeline operator, including the following:

- Specify safety precautions

The pipeline operator will outline any additional PPE requirements as well as any specific safety measures that may be needed because of weather conditions or location.

- Equipment needed

This will encompass any and all equipment needed to conduct the pressure test.

- Test medium being used

As previously discussed, depending on the pipeline operator requirements and regulatory guidelines, the operator may use various test mediums.

- Pressure and test times

This will include any hoop stress and all pressure hold times.

- Recording times

Recording times vary by job, location, and pipeline operator requirements. The operator will outline their specific recording times, which could range from every 15 minutes to every 30 minutes to every hour.

- Target test pressures

This will be the pressure range (minimum and maximum limits) that takes into account current pipeline status, maximum operating pressure (MOP), and maximum allowable operating pressure (MAOP).

Other parameters outlined by the pipeline operator in the plan include:

- Location of manifolds, flanges (based on their ratings), and pressure relief devices that may need to be removed or isolated.
- The duration of the test and any applicable pressure holds
- Procedures for discharge and proper disposal of the test medium

Once you have read and understand the procedures, you will need to ensure all applicable equipment is in good, serviceable condition. You also need to ensure all safety, pre- and post-check procedures are followed.

After you have determined which type of testing equipment is to be used, you must confirm that all required calibration reports and certifications are available and current. Recertify any test equipment as required.

Some examples of test equipment requiring calibration are:

- Deadweights
- Pressure monitors/recorders
- Certified test gauges

When checking the calibration of the equipment, you should take into account the duration of the testing process. If the equipment you are using is due to expire or close to the scheduled test date, you should consider obtaining a spare.

This proper planning will alleviate the potential of causing any downtime waiting for calibration.

Confirm that any existing or temporary piping and subsequent components that will be introduced to the test meet or exceed the test pressure specified in the testing plan.

For example, if you are testing a pipeline at a pressure of 1600psig, you will need to ensure all subsequent components (such as valves, manifolds, and pipe) have pressure ratings that meet or exceed 1600 psig.

If required, ensure all affected valves have been blown down or drained.

In addition, you must also confirm that all fittings, flanges, unions, and threaded joints are tight and properly sealed.

As previously mentioned, there are hazards associated with pressure testing.

Safety measures must be taken into account when selecting the site for your testing equipment.

There are several factors to consider when selecting the location of your testing equipment.

Care must be taken to protect the testing equipment and the qualified operator running the equipment, while also taking into consideration any geographical constraints.

You should place all testing equipment as far as possible from the facility being tested and at the opposite side of any exposed seams.

As a rule of thumb, you will want to stage the equipment in a position that is protected by a barrier.

It is also important to minimize exposure of the testing area to those not involved in the test itself.

Once you have selected the site for your testing equipment, you should set up and ensure all equipment is serviceable. You also need to have a clear understanding of all equipment being used. This includes, but is not limited to:

- Deadweights (electronic and mechanical)
- Pressure monitors/recorders
- Temperature recorders
- Hoses and fittings
- High- and low-pressure pumps
- Stroke counters

To ensure accurate readings, you should verify that the recording gauges are level and plumb.

If a recording pressure gauge is not available, obtain and record readings from an approved and suitable substitute, such as a spring gauge or deadweight gauge. Manual recordings of readings should be taken at prescribed intervals that have been established by the pipeline operator.

Calibrated deadweights are extremely accurate and can be used to calibrate other equipment.

Prior to using pressure gauges, you should verify their accuracy or calibrate them with a deadweight.

You should also do this after the test to verify the accuracy of the gauge and document any variations found.

Any temperature changes can affect the test pressure and the overall test results due to expansion or compression of the water molecules.

Therefore, it is important to monitor and record ambient temperatures prior to and during the test.

Even though you can implement and adhere to all safety measures, you can never eliminate all of the potential hazards of an operation because there will always be something out of your control.

Pressure in a sealed pipe can be hazardous and should always be respected (regardless of the medium used). Therefore, it is important to ensure control measures are in place to limit personnel from entering the testing area.

After all the pre-test preparation and safety measures have been accomplished, you will begin to fill the test segment with the test medium.

Knowledge & Skill: Describe and simulate activities required to conduct test.

If a recording chart is used, ensure you place the static pressure recording chart and pen at the correct time when the test begins.

After the pressure stabilizes to the required pressure prescribed by the pipeline operator, you should begin the test.

During the test, you need to ensure the pressures remain within the test parameters that were outlined in the test plan by the pipeline operator.

There are a lot of factors that can change the test pressure readings during the test. Some of these key factors are temperature and elevation.

To ensure that the test is accurate, you must monitor and record test temperatures and elevations.

As water heats up, its molecules move faster and bounce farther apart, making it less dense. This expansion causes a pressure increase when the water is contained, such as in a sealed pipeline.

As water cools, the molecules slow down and move closer together, making it more dense. This causes pressure to decrease when water is contained in a pipeline.

The sun can cause the water to heat or cool, causing either an increase or decrease of the pressure.

In order to determine an accurate reading of the pressure test, you will need to monitor and factor in the temperature effects of the water caused by the sun.

Another key factor that affects pressure variances is elevation.

To figure elevation effects on pressure, you will need to find the difference between the high and low points. To do this, you will need to know the elevation of the pipeline that you are testing. The elevation is documented on plot maps and in the pipeline operator's plan.

The math formula for factoring elevation effects on pressure is as follows:

Multiply each foot of elevation difference by .4331.

This will give you the pressure variance between your low point and your high point.

As you can see, there are a lot of different conditions that can cause variations in pressure while conducting a pressure test. Any one of the conditions mentioned has the potential to drastically affect the results of the test.

Therefore, ensure that you are closely monitoring and documenting any changes in pressure as well as the causes and any mitigating factors.

In addition to monitoring and documenting pressure variances caused by temperature and elevation, you will also need to properly record the pressures, temperatures, pump stroke readings, and pressure hold times at the operator's prescribed recording times as outlined in the test plan.

The operators and engineers use all the data recorded to determine and validate the results of the test.

Therefore, properly documenting the test in accordance with the test plan is important. The test must be performed exactly as outlined to ensure the test is valid and accurate.

Knowledge & Skill: Describe and simulate steps involved in depressurizing.

Once you have completed the test in accordance with the pipeline operator's test plan, you will give all documented data to the operator's authorized representative.

Ensure acceptance of the test by the operator's representative prior to beginning depressurization.

After you have confirmed acceptance of the test by the pipeline operator, you will begin to relieve pressure in the pipeline.

When relieving pressure from the pipeline, you must follow the procedures outlined in the plan.

Once you have verified that the pressure in the pipeline has been relieved, you can begin to remove the test medium.

As previously stated, methods for dewatering are determined from the results taken from testing the medium for environmental contaminants.

When performing dewatering, ensure the flow end of the pipeline is prepared properly.

A great deal of time goes into planning a pressure test, from factoring wall thickness, SMYS, class locations, pressures, hoop stress, and pressure times to determining test medium volumes and dewatering plans. The plan

is all inclusive of the test from start to finish and takes into account all requirements set forth by the DOT, EPA, and numerous other governing bodies.

It is imperative that you understand your role during the pressure testing process and that you adhere to all aspects set forth by the pipeline operator.

Conducting pressure testing on a pipeline encompasses a great deal of different factors, and no one pressure test mirrors another.

Critical thinking and diligent reactions are key to both safety and the overall success of a test. Monitoring and running equipment used to conduct the test require specialized skill as well as knowledge gained through a complete understanding of the entire operation.

Additionally, there are several types of testing equipment used in the field. While the result of the equipment is the same, the mechanics may vary drastically. Ensure you are fully competent on the equipment that you will be working with.

Lastly, there is no substitute for hands-on training and direct trainer involvement. With that said, this training is not intended to substitute for any hands-on training.

Abnormal Operating Conditions (AOCs)

Candidates are required to possess the ability to **RECOGNIZE** and **REACT** to the listed AOCs for each task. Be prepared to answer questions concerning additional AOCs that may be relevant. Evaluators may ask questions about AOCs throughout the evaluation.

An AOC is defined in **49 CFR §§ 192.803** and **195.503** as:

A condition identified by the pipeline operator that may indicate a malfunction of a component or deviation from normal operations that may:

- Indicate a condition exceeding design limits; or
- Result in a hazard(s) to persons, property, or the environment.

Recognize: Unintentional releases, vapors, or hazardous atmosphere could be signs that an abnormal operating condition has occurred. Examples could include, but are not limited to:

- Blowing gas if natural or inert gas is medium
- Leaking component

React/Respond: Proper reactions/responses to take in the event of an Unintentional releases, vapors, or hazardous atmosphere on or near the pipeline include the following:

- Eliminate potential ignition sources.
- Move to a safe location.
- Notify emergency response personnel, as appropriate.
- Notify the designated pipeline operator representative.

Recognize: An unintended fire and/or explosion on or near the pipeline is an abnormal operating condition.

React/Respond: Proper reactions and/or responses to take in the event of an unintended fire and/or explosion on or near the pipeline include the following:

- Leave immediate area.
- Protect the public, property, and environment.

- Notify emergency response personnel, as appropriate.
- Notify the designated pipeline operator representative.

Recognize: Failure or malfunction of pipeline component(s) is an abnormal operating condition. Examples could include, but are not limited to:

- Material defects
- Valve
- Manifold
- Fittings
- Gasket failure

React/Respond: Proper reactions and/or responses to take in the event of a failure or malfunction of pipeline component(s) that has impaired or is likely to impair the serviceability of the pipeline include the following:

- Stop the activity.
- Protect the public, property, and environment.
- Notify the designated pipeline operator representative.

Glossary

AOC
abnormal operating condition

CFR
Code of Federal Regulations

CCT
common covered task

DOT
Department of Transportation

MAOP
Maximum allowable operating pressure

SMYS
Specified minimum yield strength