
Pipeline Repair**ENGINEERING PROCEDURE**

- 1 **Purpose** - This procedure provides guidelines for repairs on aboveground and buried pipelines.
- 2 **General** - Any time that a pipeline is determined to be leaking, an immediate temporary repair will be made to insure public safety, minimize damage to property and avoid damage to the environment.
- 3 **References:**
 - 3.1 API 1104 Welding of Pipelines and Related Facilities
 - 3.2 API 1107 Pipeline Maintenance Welding Practices
 - 3.3 ASME B31.8 Gas Transmission and Distribution Piping Systems
 - 3.4 ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquid
- 4 **Definitions:**
 - 4.1 CGI - Combustible Gas Indicator
 - 4.2 HVL -Highly Volatile Liquid
 - 4.3 LEL - Lower Explosion Level
 - 4.4 MAOP - Maximum Allowable Operating Pressure
 - 4.5 MSDS - Material Safety Data Sheet

Approved: _____ **Date:** _____
Manager Safety, Health, and Environment

Approved: _____ **Date:** _____
Environmental Manager

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5 Safety - PUBLIC AND PERSONNEL SAFETY AT THE REPAIR LOCATION IS OF PRIMARY IMPORTANCE.

- 5.1** At the leak location, the material that is being released should be treated as highly toxic and highly flammable until Operations or other responsible personnel have determined the appropriate response for the material.
- 5.2** Individuals making pipeline repairs shall have received at least the following training:
 - 5.2.1** Southwest Louisiana Safety Council Training
 - 5.2.2** Company Safety Training
 - 5.2.3** Specific Training for the Operating Unit Involved
- 5.3** All LCCC and Operating Unit specific Safety Procedures shall be strictly observed.
- 5.4** Permits are required for all work performed on Company pipelines and associated equipment. Permits must be obtained from the Operating Unit where the pipeline originates.
 - 5.4.1** Work Permit - for work performed that cannot produce an ignition source. All equipment used is intrinsically safe.
 - 5.4.2** Hot Work Permit - for work that may produce an ignition source. Work performed with equipment that is not intrinsically safe.
 - 5.4.3** Hot Tap Permit - Required anytime a pipeline is penetrated while in service. Refer to the Hot Tap Procedure for more detail. Hot Taps require the approval of the Safety , Health and Environmental Supervisor.
 - 5.4.4** Excavation Permit - for work performed that requires excavation.
 - 5.4.5** Confined Space - Any enclosed area that is difficult to enter or leave, is difficult to ventilate, and may have contained toxic, flammable, or oxygen deficient atmospheres.

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- 5.5 During a scheduled pipeline repair, the MSDS for the pipeline product shall be consulted and a list of personal protective equipment specific to the material or chemical being handled shall be provided by the person in charge of the repair.
- 5.6 Safety equipment listed in the table below is the minimum equipment that is required. Additional equipment may be required in specific situations and will be determined by the Company Safety Officer.

Material or Chemical	Safety Equipment Required
Ethylene Hydrogen VCM Vapors VCM Liquids Kerosene Ethylene Dichloride Natural Gas	Fire Extinguisher Combustible Gas Indicator Fire Retarding Clothing Eye Goggles Ear Plugs Full Face Mask Supplied Air Face Mask with Egress Bottle Slicker Suits and Boots Non-Sparking Tools

- 5.7 Prior to welding in or around a structure or in area containing gas facilities (including pipelines), a thorough check shall be made to determine the possible presence of a combustible gas mixture. Welding shall begin only when safe conditions are indicated.
- 5.8 Safety checks and test performed by Operations or Safety, Health and Environmental units as part of the requirements for the issuance of a hot work permit does not relieve the maintenance craftsman of his responsibility to insure a safe work place.
- 5.9 Warning signs advising the right-of-way users of the potential danger of the work in progress shall be posted at the entrances of the right-of-way during repair work.

6 Procedure

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6.1 Leak Repairs

Any indication of an unscheduled release of Gas or HVL shall be investigated immediately. The primary concern, from the time of the indication until the release is under control, is safety of the public and company or contractor employees, protection of property and protection of the environment.

6.1.1 Leak Classification

6.1.1.1 This section establishes a procedure for grading and isolating indications of flammable gas or HVL. When evaluating any leak indication, the preliminary step is to determine the perimeter of the leak area. When this perimeter extends to a building wall, the investigation should continue into the building.

6.1.1.2 Leak Grading - Based on an evaluation of the location or magnitude of a leak, or both, one of the following leak grades shall be assigned, thereby establishing the leak repair priority:

6.1.1.2.1 Grade 1 is a leak that represents an existing or probable hazard to persons or property, and requires immediate repair or continuous action until the conditions are no longer hazardous.

6.1.1.2.2 Grade 2 is a leak that is recognized as being nonhazardous at the time of detection, but requires scheduled repair based on the probable future hazard.

6.1.1.2.3 Grade 3 is a leak that is nonhazardous at the time of detection and can be reasonably expected to remain nonhazardous.

6.1.2 Pinpointing the Leak - Aboveground Gas and HVL

6.1.2.1 Leaks that cannot be detected visually shall be located using a CGI and/or soap bubble test.

6.1.3 Pinpointing the Leak - Underground Gas and HVL

6.1.3.1 Determine the migration of gas by establishing the outer boundaries of the indications. This will define the area in which the leak will normally be located. These tests should be made

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with a CGI without expending excessive effort providing sample points.

- 6.1.3.2** Locate all gas lines to narrow the area of search, giving particular attention to the location of valves, fittings, tees and stubs. Connections have a relatively high probability of leakage. Caution should be exercised to prevent damage to other underground structures during barring or excavating.
- 6.1.3.3** Identify foreign facilities in the area of the search, look for evidence of recent construction activities that could have contributed to the leakage. Gas may also migrate and vent along a trench provided for other facilities.
- 6.1.3.4** Make evenly spaced bar or test holes over the suspected leaking gas line and trace the gas to its source by identifying the holes with the highest readings on the CGI. All bar holes should be of equal depth and diameter, and down to the pipe depth necessary to obtain consistent and meaningful readings. All CGI readings should be taken at equal depth. Only the highest sustained reading should be used.
- 6.1.3.5** High readings are frequently found in more than one adjacent test hole. If this occurs, more readings are required. Normally, the reading more distant from the leak will decline over time. The test holes where the readings that decline the least over time are the closest to the leak.
- 6.1.3.6** Once the underground leak has been identified, additional holes of greater depth should be made to bracket the leak area. For example, if the initial test holes are spaced 6 feet apart, the bracketing holes should be between the two holes with the highest reading and should be 12 inches apart.
- 6.1.3.7** Finally use the following techniques to pinpoint the leak:
 - 6.1.3.7.1** Listen for gas escaping from the hole.
 - 6.1.3.7.2** Feel for gas passing from the hole with a sensitive part of the skin.

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6.1.3.7.3 Use a Manometer to detect pressure build up in the hole.

6.1.3.7.4 Look for dust particles blowing from the hole.

6.1.3.7.5 When gas is found in an underground conduit, tests at available openings may be used to isolate the source.

6.1.3.7.6 When the pattern of the CGI readings has stabilized, the bar hole with the highest reading will usually pinpoint the gas leak.

6.1.3.8 Once the pipe has been exposed a soap bubble test may be used to locate small leaks.

6.1.4 Excavation

6.1.4.1 Prior to excavation the following task shall be performed:

6.1.4.1.1 The area shall be probed and tested for combustible gas in accordance with the LCCC plant safety requirement as defined in Company Safety Procedures.

6.1.4.1.2 Pipe shall be precisely located using an electronic pipe locator or a probe prior.

6.1.4.1.3 Prior to excavating with power equipment, Louisiana One Call should be contacted so that other owner-users of the right-of-way may locate their pipelines and associated equipment in the area.

6.1.4.2 The excavation site shall be monitored with a CGI on a continuous basis and work should be stopped if a gas concentration above the LEL is observed.

6.1.4.3 Power excavation equipment shall not be used within one foot of the pipe.

6.1.4.4 The opening around the pipe shall be a minimum of two feet and shall allow easy access for the repair crew.

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6.1.4.5 The ditch shall be stepped one foot horizontal for each four feet of vertical rise. If stepping is impractical, the ditch may be shored. Shored ditches must be wide enough to accommodate a ladder.

6.1.4.6 A confined space entry permit is required prior to entry into the ditch.

6.1.4.7 Anyone entering the ditch must be informed of the confined space entry permit and its requirements.

6.1.5 Precautions

6.1.5.1 Unusual situations that are unlikely but possible, may complicate these techniques. For example, multiple leaks can give confusing data. To eliminate this potential complication, the area should be rechecked after repairs are completed.

6.1.5.2 Sewers and landfills may generate detectable gases.

6.1.5.3 When pinpointing leaks in pipelines for gases that are heavier than air, the gas will normally stay low near the pipe level but may flow down hill. Heavy gases usually do not diffuse rapidly or migrate widely in the soil so that the leak is usually close to the indication.

6.1.6 Evaluate the failure using the types of defects described below. Additional information about corrosion evaluation can be found in ASME/ANSI B31.4 appendix L. Failure types are:

6.1.6.1 External general corrosion - large area of the pipe is corroded on the outside.

6.1.6.2 External pitting corrosion - small area of corrosion with the remainder of the external pipe surface undamaged.

6.1.6.3 Internal corrosion - external of pipe appears to be sound with a corrosion leak from inside.

6.1.6.4 Crack in pipe base metal - crack in the pipe due to an imperfection in the steel.

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6.1.6.5 Crack in a weld - crack in a weld due to an imperfection in the weld.

6.1.6.6 Tear in the pipe - tear due to over stress of the pipe.

6.1.6.7 Gouges and grooves - Mechanical damage that does not penetrates the wall.

6.1.7 Initial Leak Arrest

6.1.7.1 Only personnel authorized by the Operating Unit Supervisor or the Maintenance Superintendent may make an initial leak arrest by plugging the line.

6.1.7.2 Hydrogen lines shall not be plugged.

6.1.7.3 An initial leak arrest may be made on corrosion pits by driving a non-sparking plug into the hole with a non-sparking hammer.

6.1.7.4 Tools used during the leak arrest should be made of non-sparking materials such as brass.

6.1.7.5 Plugs should never be driven into cracks, tears or gouges.

6.1.8 Methods of Repair - Corroded Areas

6.1.8.1 Plugs used to arrest a leak must be removed prior to making a permanent repair.

If feasible, the pipeline shall be taken out of service and repaired by cutting out a cylindrical piece of pipe and replacing it with a pipe of equal or greater design strength.

6.1.8.2 Hydrogen and ethylene lines shall not be welded on while in service.

6.1.8.3 Pipelines not in hydrogen or ethylene service and that can not shutdown, shall be repaired by using one of the following methods:

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6.1.8.3.1 A small leak may be repaired by welding a nipple over the leak to vent the gas while welding and then installing an appropriate fitting on the nipple.

6.1.8.3.2 A corrosion pit may be repaired by installing a properly designed bolt on leak clamp.

6.1.8.3.3 Corroded pipe made of material not exceeding 40,000 psi specified minimum yield strength may be repaired using a properly designed patch of similar material with rounded corners. The patch may not exceed one half of the circumference of the pipe.

6.1.8.3.4 Other corrosion leaks may be repaired with a properly designed full encirclement welded split sleeve.

6.1.9 Leak Repair - non-corrosion related

6.1.9.1 Cracks and tears are unstable and every effort should be made to take the line out of service and make the repair by replacing the section of pipe containing the defect.

6.1.9.2 Hydrogen and ethylene lines shall not be welded on while in service.

6.1.9.3 If the line cannot be removed from service, the pressure in the line should be reduced to a pressure that produces a stress of less than 20% of the specified minimum yield strength of the pipe material.

6.1.9.3.1 Using visual and non-destructive inspection methods, determine the condition of the pipe adjacent to the leak.

6.1.9.3.2 If the adjacent pipe is sound, the ends of the crack should be drilled and the pipe tested using nondestructive testing to determine if the ends of the crack have been removed.

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6.1.9.3.3 Once the crack tips have been removed, repair the pipe by installing a properly designed full encirclement welded split sleeve.

6.1.9.3.4 Welding shall not be performed until the crack tips have been removed, since the heat from the welding process will cause the crack to grow.

6.1.9.3.5 The pipeline shall not be returned to normal operating pressure until the Unit Manager has evaluated the repair and determined that the pipeline is safe to operate.

6.1.10 Leak Repair - Gouges, grooves and dents

6.1.10.1 Gouges, grooves and dents that are leaking shall be repaired by removing the line from service and removing a cylindrical section of the pipe containing the defect and replacing it with a new section of pipe of similar strength and composition.

6.1.10.2 Hydrogen and ethylene lines shall not be welded on while in service.

6.1.10.3 Pipelines that have gouges, grooves and dents and cannot be removed from service shall be operated at a pressure such that the hoop stress will not cause the internal pressure to exceed 20% of specified minimum yield strength of the pipe.

6.1.10.4 If the pipeline cannot be removed from service and cannot be operated at a reduced pressure, the pipe shall be repaired using one of the following methods:

6.1.10.4.1 Gouges, grooves and dents may be repaired by installing a properly designed full encirclement welded split sleeve.

6.1.10.4.2 Gouges, grooves and dents may be repaired by installing a full encirclement welded hot top sleeve providing the entire defect can be removed with the hot tap coupon.

6.2 Reconditioning of pipe

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6.2.1 Pipelines that can be removed from service shall be reconditioned using one of the following methods:

6.2.1.1 Any defect may be repaired by removing the cylindrical section of pipe containing the defect and replacing it with a pipe section of similar strength and material composition .

6.2.1.2 Cracks in welds made with filler metal may be repaired by grinding the defect out and replacing the weld metal using an approved welding procedure. Grinding should start in front of the crack tip and proceed back to the crack.

6.2.1.3 Small corroded areas may be repaired by weld metal overlay.

6.2.1.4 Corrosion pits may be repaired using a properly designed patch with rounded corners and made of metal with similar strength and composition. The patch may not be larger than one half of the pipe circumference.

6.2.1.5 Large corroded areas may be repaired by replacing the corroded section of pipe with a pipe section made of material of similar strength and composition.

6.2.1.6 Large corroded areas may be repaired by installing a properly designed full encirclement welded split sleeves over corroded areas provided the sleeve extends at least one pipe diameter into sound pipe.

6.2.1.7 Gouges and grooves deeper than 10% of the wall thickness must be repaired. Repairs may be made by grinding the area smooth and installing a properly designed full encirclement welded split sleeve of material of similar strength and composition.

6.2.1.8 Dents deeper than 1/4" on pipe up to 12" NPS or more than 2% of the diameter on pipe greater than 12" NPS must be repaired.

6.2.1.9 Dents that effect the curvature of the pipe at a weld or that have gouges shall be repaired by removing a cylindrical section of pipe containing the defect and replacing it with a section of pipe of material of similar strength and composition.

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6.2.1.10 Dents may be repaired by filling the dent with a hardening filler and installing a properly designed full encirclement welded split sleeve of material of similar strength and composition.

6.2.2 Pipelines that cannot be removed from service can be reconditioned using one of the following methods:

6.2.2.1 Hydrogen and ethylene lines shall not be welded on while in service.

6.2.2.2 Small corroded areas may be repaired by weld metal overlay.

6.2.2.3 Corrosion pits may be repaired using a properly designed patch with rounded corners and made of metal with similar strength and composition. The patch may not cover more than one half of the pipe circumference.

6.2.2.4 Large corroded areas may be repaired by installing a properly designed full encirclement welded split sleeves over corroded areas provided the sleeves extends at least one pipe diameter into sound pipe.

6.2.2.5 Weld defects in circumferential butt welds can be ground and repaired providing the pressure in the pipeline is reduced to level such that the hoop stress does not produce a stress that exceeds 20% of the specified minimum yield strength of the pipe material and the remaining wall thickness after grinding is not less than 0.125 “.

6.2.2.6 If a gouge, groove or dent occurs in a submerged arc welded seam (or manufacturing defect is found in such a weld) or if a gouge, groove or dent occurs in a circumferential butt weld, a full encirclement welded split sleeve shall be installed.

6.2.2.7 Gouges and grooves may be repaired by grinding the area smooth and installing a properly designed full encirclement welded split sleeve of similar strength and composition.

6.2.2.8 Dents may be repaired by filling the dent with a hardening filler and installing a properly designed full encirclement welded split sleeve of similar strength and composition.

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- 6.2.2.9** Gouges, grooves and dents may be repaired by installing a full encirclement welded hot top sleeve providing the entire defect can be removed with the hot tap coupon.

6.3 Initial inspection

- 6.3.1** The soundness of the pipe adjacent to the defect must be determined prior to work commencing.
- 6.3.2** The external surface of the pipe may be inspected using one of the following methods:
- 6.3.2.1** Visual inspection of pipe exterior aided with a pit gage if needed.
 - 6.3.2.2** Magnetic Particle inspection of the pipe external if cracking is expected.
 - 6.3.2.3** Ultrasonic inspection of pipe wall thickness.
 - 6.3.2.4** Radiographic inspection of the pipe interior.

6.4 Welding

- 6.4.1** Welds made on hydrogen lines shall be hardness checked and shall have a hardness that is less than or equal to BHN 235.
- 6.4.2** Welding Procedures
- 6.4.2.1** All weld repairs made by Company employees shall be performed using CONDEA Vista Welding Procedure Specification (WPS) 1.2.
 - 6.4.2.2** All weld repairs made by Contract employees shall be performed using Company approved welding procedure provided by the Contractor.
- 6.4.3** Welder Qualifications

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6.4.3.1 Company employees that make welds during pipeline repairs shall be qualified to the Company welding procedure being used on the repair.

6.4.3.2 Contract employees that make welds during pipeline repairs will be qualified to the Contractor welding procedure being used on the repair.

6.4.4 Burn through control

6.4.4.1 Burn through during welding is not expected when welding parameters do not exceed 20 volts and 100 amperes, if the remaining wall thickness is greater than 0.320 inches (Refer to ASME/ANSI B31.8, paragraph 851.43f). Welding performed outside these parameters must be approved by the Plant Maintenance Manager.

6.5 Coating repair

6.5.1 Pipe coating damaged during pipeline repair shall be repaired in accordance with the original coating manufacturers recommendations.

6.6 Testing and inspection

6.6.1 Pipe sections being installed as replacement spools shall be hydrotested to 1.5 times the maximum allowable operating pressure prior to installation. Pressure test shall be held for four hours.

6.6.2 100% of all field welds shall be non-destructively tested using the best method for the configuration of the weld.

6.6.3 Weld defects shall be graded and repaired in accordance with API 1104 and API 1107 requirements.

6.7 Documentation

6.7.1 Leak reports shall include the location of the leak, location class, grade of the leak and action taken.

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- 6.7.2** Repair reports shall be added to the original equipment file, the inspection file and the DOT coordinators file.
- 6.7.3** The DOT Coordinator shall determine if the leak is classified as an incident that requires reporting to the regulatory authorities.