Oklahoma State University

Stillwater, Oklahoma

Facilities Management - Energy Services

Central Plant, Bldg #0282 – 510 North Washington, Stillwater OK 74078

Distribution Systems
Utilities Distribution

Natural Gas System

Operations & Maintenance Manual

Revised 2022 - Contacts Updated 2024

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INTRODUCTION

The purpose of this OSU Natural Gas O&M Manual is to establish policies and procedures that conform to federal and state safety regulations for the installation, construction, maintenance, and operation of natural gas distribution facilities on the Oklahoma State University, Stillwater campus (OSU). This Manual contains the guidelines, practices, and procedures that assure OSU operates in compliance with accepted gas distribution and pipeline safety codes.

This manual is compiled from current federal and state regulatory documents for the exclusive use and application by OSU, Facilities Management (FM) personnel. Any use or application to gas operations at other locations will be at self-risk to the user.

The Natural Gas Pipeline Safety Act of 1968 required the United States Department of Transportation (USDOT) to develop and enforce minimum safety regulations for the transportation of gases by pipeline. These regulations are published in Title 49 of the Code of Federal Regulations (CFR), Parts 190 - 192. 49 CFR 192.605 states that operators shall prepare and follow a manual of written procedures for operation, maintenance, and emergency response and makes requirements for the manual. This manual is intended to meet such requirements for Oklahoma State University, Stillwater campus.

Although not required to, OSU has adopted the practices of the U. S. Department of Transportation's Pipeline and Hazardous Materials and Safety Administration's (PHMSA) Integrity Management (IM) rule, which defines the requirements for a utility's Distribution Integrity Management Program (DIMP). OSU uses a software package called "SHRIMP" (Simple Handy Rule-based Integrity Management Plan) for developing and managing its DIMP plan.

The *NG Pipeline Safety Act of 1968* applies to:

- gas utilities (private, public, and municipal),
- operators of housing developments and mobile home parks served by natural gas master meters,
- liquefied petroleum gas (LP-Gas) systems that supply 10 or more customers from a single source; and
- any portion of a LP-Gas system located in a public place, such as a highway.

The determination was made that OSU meets the definition of a Master Meter system and is required to follow the code. The pipeline safety code says that operators of all gas systems must:

- deliver gas safely and reliably to customers,
- provide training and written instruction for personnel,
- establish written procedures to minimize hazards resulting from gas pipeline emergencies, and
- keep records of inspection and testing.

Part 192.619 of CFR Title 49 requires that a *Maximum Allowable Operating Pressure* (MAOP) for the OSU system be established. With the aid of documentation from *Oklahoma Natural Gas Co.* (ONG), the MAOPs (Chapter 14) for seven OSU metering stations have been established as follows:

LOCATION	PSIG	EFFECTIVE APPROVAL DATE
Hall of Fame, West of Monroe Street	35 psig	05/08/1996
1300 Block of North-Western Road	35 psig	05/08/1996
Small Grains Complex	21 psig	05/23/1996
North Side of Power Plant	35 psig	04/13/2020
Beef Cattle Station, north side HWY 51	5.4 psig	10/1987
East side of Knoblock - south of McElroy	20 psig	09/27/2002
North side of 4th St. south of OSU McKnight Performing Arts Center	15 psig	01/26/2018

All gas piping installed after the dates stated in the table shall be based on a pressure test as described in Chapter 13, Leak Repairs - Construction.

It is imperative that OSU routinely meets its responsibilities under the Code because operators who do not comply may be subject to civil penalties, compliance orders, or both. If the hazards warrant, a "Hazardous Facility Order" may be issued that could shut down the OSU gas distribution system.

DEFINITIONS, TERMS, and ABBREVIATIONS

To understand this O&M Plan, one must know the meaning of some commonly used terms in the natural gas and LP- Gas industry. The following terms are commonly used in this arena.

CFR - Code of Federal Regulations include Title 49 a document that contains the actual regulations a natural gas operator must follow. The title number refers to a particular CFR volume.

CATHODIC PROTECTION - A procedure by which underground metallic pipe is protected against corrosion. It is a method for controlling the corrosion or deterioration of steel pipe and connected metallic equipment through the use of electrolysis.

CORROSION - The rusting of a metal pipe. This is caused by an electrochemical reaction that takes place between metallic pipe and its surroundings. As a result, the pipe deteriorates and will eventually leak. Underground corrosion can be retarded with cathodic protection.

CTS – copper tubing size

CUSTOMER METER - A device that measures the volume of gas transferred from an operator to the consumer.

DIMP - Distribution Integrity Management Programs

GAS OPERATOR - A person who engages in the transportation of gas. A gas operator may be a gas utility company, a municipality, or an individual operating a housing project, apartment complex, condominium, or a mobile home park served by a master meter. OSU is considered a gas operator.

IPS – iron pipe size

KEY VALVES - Are the valves needed to shut down the system, or part of the system, in case of an emergency.

LIQUIFIED PETROLEUM GAS (LP-GAS OR LPG) - Gas in a liquid state in the supply tank but vaporized at the tank's outlet then distributed in a gaseous state. LP gas expands when the temperature rises, and it is heavier than air.

MAIN - A gas distribution line that serves as a common source of supply for more than one service line.

MAOP - An abbreviation for maximum allowable operating pressure. This is established by design, past operating history, pressure testing, and pressure ratings.

MASTER METER SYSTEM – As defined by 49 CFR191.3, a pipeline system for distributing gas within, but not limited to, a definable area, such as a mobile home park, housing project, or apartment complex, where the operator (OSU) purchases metered gas from an outside source for resale through a gas distribution pipeline system. The gas distribution pipeline system supplies the ultimate consumer who either purchases the gas directly through a meter or by other means such as by rent. OSU's system has been determined to be a Master Meter System.

NATURAL GAS - A non-toxic, colorless fuel, about one third lighter than air. Gas burns only when mixed with air in the right proportion and ignited by a spark or flame. Gas in its natural state may not have an odor.

OPERATING and MAINTENANCE PLAN (O&M PLAN) - A plan required by the federal government and created by the system owner that outlines the procedures to be followed in operating and maintaining a safe system.

OVERPRESSURE PROTECTION EQUIPMENT - Equipment installed to prevent pressure in a system from exceeding the maximum allowed limit for operating the system safely.

PIPELINE - All parts of those physical facilities through which gas moves in transportation. This includes pipe, valves, and other items attached to pipe, meter stations, regulator stations, delivery stations, holders, or fabricated assemblies.

PRESSURE REGULATING/RELIEF STATION - Automatically reduces and controls the gas pressure downstream from a high-pressure source of gas into a system operating at a lower pressure. It includes any enclosures, relief devices, and ventilating equipment, and any piping and auxiliary equipment (such as valves, regulators, control instruments, and control lines.)

PSIG - An abbreviation for pounds per square inch gage pressure.

SERVICE LINE - A gas distribution line that transports gas from a common source of supply to a customer's meter, or to the connection to a customer's piping if the piping is farther downstream, or if there is no meter.

SERVICE REGULATOR - A device designed to reduce and limit the gas pressure to the consumer.

SERVICE RISER - The section of a service line which extends out of the ground and is often near the wall of a building. This usually includes a shut-off valve and a regulator.

SHRIMP - Simple Handy Rule based Integrity Management Plan - a software platform for developing and managing a DIMP plan

SHUT-OFF VALVE - A valve installed to shut off the gas supply to a building. The valve may be located ahead of the service regulator or below ground at the property line or where the service line connects to the main.

DR - STANDARD DIMENSION RATIO is the ratio of pipe diameter to wall thickness.

COMMONLY ABBREVIATED ORGANIZATIONS

AGA American Gas Association

ANSI American National Standards Institute, formerly the United States of America Standards Institute (USASI). All USASI issued standards and current standards issued by ASA have been re-designated as American National Standards (ANS) and continue in effect.

API American Petroleum Institute

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

DOT U. S. Department of Transportation

EHS Environmental Health and Safety - OSU

FM Facilities Management - OSU

ONG Oklahoma Natural Gas Co.

OSU Oklahoma State University, Stillwater campus

OQ Operator Qualified

MSS Manufacturers Standardization Society of the Valve and Fittings Industry

NACE National Association of Corrosion Engineers

NFPA National Fire Protection Association

RSPA Research and Special Programs Administration. This is the federal agency in DOT which is responsible for development and enforcement of the pipeline safety code.

CHAPTER 1 - Methods of Gas Leak Detection

Listed below are eight warning signs of a gas leak with descriptions of leak detection equipment and recommended methods for conducting surface and subsurface leak detection surveys.

WARNING SIGNS OF A LEAK

1. Odor. Gas is intentionally odorized so that the average person can perceive it at a concentration well below the explosive range--generally between ½ to 1% by volume or as local applicable codes dictate. Gas odor is the most common and effective indication of a leak. A report of gas odor should be investigated immediately, and the leak found and repaired. However, the odor of gas may be filtered out as the odorized gas passes through certain types of soil. It may be modified by passing through soil and into a sewage system containing vapors or fumes from other combustibles as well as the sewage odor itself. Therefore, odor is not always totally reliable as an indicator of the presence or absence of gas leaks.

2. Vegetation. Vegetation in an area of gas leakage may improve or deteriorate, depending on the soil, the type of vegetation, the environment, the climate, and the volume and duration of the leak. Vegetation surveys of changes in vegetation may indicate slow sub-soil leaks. Vegetation surveys should be supplemented with instrumentation.

3. Insects, (flies, roaches, spiders). Insects migrate to points or areas of leakage due to microbial breakdown of some components of gas. Some insects seem to like the smell of the gas odorant. Be aware of heavy insect activity, particularly near the riser, the gas meter, and regulator.

4. Fungus-Like Growth. Such growth in valve boxes, manholes, etc., indicates gas leakage. The color of the growth is generally white or grayish-white and looks like a coating of frost.

5. Sound. Listen for leaks. A hissing sound at a bad connection, a fractured pipe, or a corrosion pit hole is the usual indication of a gas leak.

6. Unaccounted for Gas. A possible leak is indicated when an off peak reading of a master meter, with a known average seasonal utilization rate, shows an unaccountably high usage rate. Periodic off-peak checks (preferably the summer months from midnight to three or four o'clock in the morning) can be averaged to provide data for comparison in future checks. Gas leaks served by a master meter system can be detected by comparing the total consumption registered on the customer meters with that registered on the master meter. If the master meter reading is greater than that recorded by adding all the unit meter readings, then a leak probably exists in the distribution system. This condition may also indicate a gas theft problem or a malfunctioning meter problem.

7. Soap Bubbles. A soap solution can pinpoint the location of a leak on an exposed pipe, on the riser, or the meter. The solution is sprayed onto the area in question and the location of bubbling indicates leakage.

8. Leak Detection Instruments. Gas leak indicators are sophisticated instruments that require regular care, maintenance, and calibration, and should be used only by trained personnel. OSU uses qualified outside vendors who are familiar with this equipment to perform annual leak surveys as noted in Appendix C of this document.

CHAPTER 2 - Reports and Plans Required by the Federal Government

The federal government requires every gas operator to report any incident and to follow and maintain records according to established Operating and Maintenance (O&M) and Emergency plans. This section provides an overview of these plans.

INCIDENT REPORT
See Emergency Plan

DISTRIBUTION INTEGRITY MANAGEMENT PLAN
On December 4, 2009, PHMSA published the final DIMP rule. The rule required each operator of a natural gas utility, master meter system or propane pipeline system to prepare and follow a written DIMP plan by no later than August 2, 2011. This rule required each operator to demonstrate:

- Knowledge of system infrastructure
- Identify threats
- Evaluate and prioritize risk
- Identify and implement measures to mitigate risks
- Measure performance, monitor results, and evaluate effectiveness
- Periodic Evaluation and Improvement
- Report results

Five years of data was entered into a database utilizing the SHRIMP tool, developed by the APGA Security and Integrity Foundation. Based on OSU's historical data, we identified no threats or risks to prioritize. This was an indication that the steps we defined in our O&M Manual were adequate and sufficient to maintain the integrity of and mitigate the potential for accidents in our jurisdictional gas system. OSU's intent is to continue to operate according to this manual and continue to evaluate any potential threats as additional information is compiled on a regular basis. Consistent with the exclusions in 49 CFR §191.9 (incident reports) and §191.11 (annual reports), operators of master meter and small LPG distribution systems need not report performance measures. Master meter systems in OK are no longer required to utilize the DIMP tool, as per OCC effective Summer 2021; however, OSU has decided to continue to utilize the DIMP tool as a guide to ensure best practices.

CHAPTER 3 – Materials Qualified for Use in Gas Systems

The federal regulations contained in 49 CFR Part 192 list many different materials qualified for gas service. The materials and specifications listed in this manual are those that are most commonly used in gas distribution systems installed in the early 1980's. Not all qualified materials or specifications listed in Part 192 are included in this chapter. The OSU Engineering Design Guidelines list acceptable materials and design methods for NG systems. The Guidelines can be found at:
https://fm.okstate.edu/energyservices/site-files/docs/engineeringguidelines/osu-engineering-guidelines.pdf

When purchasing material used in a gas system, it is extremely important to check the *marking* of the material. The marking on the material will help identify whether the material is qualified for gas service. An operator must select materials that are compatible with each other. This chapter covers the most common specifications and standards used by manufacturers for pipes, valves, flanges, regulators, and other equipment commonly used in gas distribution systems.

PIPE

Only steel and plastic pipe specifications are included in this chapter. (For other qualified pipe specs see Appendix A of 49 CFR - Part 192.)

STEEL PIPE

API 5L - Steel Pipe
ASTM A53 - Steel Pipe
ASTM A381 - Steel Pipe
ASTM Specification A671 - Steel Pipe
ASTM D2513 - Thermoplastic Pipe and Tubing

Guide for selecting the proper nominal wall thickness for steel pipe used in a gas distribution system. Measurement is in INCHES.

Nominal Pipe Size	Outside Diameter	Standard (Schedule 40) Wall Thickness	Minimum Wall Thickness after Threading
1/8	0.405	0.068	0.065
1/4	0.540	0.088	0.065
3/8	0.675	0.091	0.065
1/2	0.084	0.109	0.065
3/4	1.050	0.113	0.065
1	1.315	0.133	0.065
1 ¼	1.660	0.140	0.065
1 ½	1.900	0.145	0.065
2	2.375	0.154	0.075
3	3.500	0.216	0.098
3 ½	4.000	0.226	0.108
4	4.500	0.237	0.116
5	5.563	0.258	0.125
6	6.625	0.280	0.156
8	8.625	0.322	0.172
10	10.750	0.365	0.188
12	12.750	0.406	0.203

All new steel pipe manufactured under the above specifications with the above wall thickness have design pressure up to at least 152 psig. Operators are cautioned that the actual MAOP of a new or replacement pipe in a gas system is dependent upon the pressure test performed on the pipeline system before it is put in service. It is recommended that threaded pipe not be installed underground.

PLASTIC PIPE

When purchasing polyethylene (PE) plastic pipe, it is required that the pipe be marked ASTM D2513, and be IPS (iron pipe size), not DIPS (ductile iron pipe size) or CTS (copper tubing size). Plastic pipe with this marking is suitable for gas service.

At no time should the loading of the pipe cause the pipe section to lose its round shape. Plastic pipe and tubing should be stored and protected from damage by crushing, piercing, or extended exposure to direct sunlight.

All plastic pipe should be stored in accordance with the manufacturer's recommendations. In general, plastic pipe is to be stored inside and protected from direct sunlight. Direct sunlight can cause plastic pipe to become brittle. Pipe that has been stored in direct sunlight beyond what is allowed by the manufacturer is not suitable for installation in OSU's gas system. In recent years, the vast majority of natural gas companies have been installing ASTM D2513 PE pipe. Benefits of PE pipe are flexibility, good joining characteristics, durability, ease of installation, and cost. The PE designations most often used are PE 2306, PE 3306, PE 3406, and PE 3408.

Most PE pipe manufacturers subscribe to the *Dimension Ratio* (DR) method of rating pressure piping. The DR is the ratio of pipe diameter to wall thickness. A DR 11 means the outside diameter (OD) of the pipe is eleven times the thickness of the wall.

For high DR ratios the pipe wall is thin in comparison to the pipe OD. Given two pipes of the same OD, the pipe with the thicker wall will be stronger than the one with the thinner wall. High DRs have low pressure ratings; low DRs have high pressure ratings because of the relative wall thickness. Unlike Schedule pipe, all DR pipe with the same DR has the same pressure rating at all sizes.

This table below is intended to be a guideline. Personnel should check the manufacturer's specific pressure rating for each specific pipe.

PRESSURE RATING for PE PIPE (2406 and 3406) LISTED by ASTM D2513
DIMENSION RATIO (DR)

HYDROSTATIC DESIGN BASIS (HDB)										D2513
PSI	**6.0**	**7.3**	**9.0**	**11**	**13.5**	**17**	**21**	**26**	**32.5**	**Letter Code**
1600	200	160	125	100	80	64	50	40	32	G
1250	160	125	100	80	64	50	40	32	25	F
1000	125	100	80	64	50	40	32	25	20	E
800	100	80	64	50	40	32	25	20	16	D
630	80	64	50	40	32	25	20	16	12.5	C
500	64	50	40	32	25	20	16	12.5	10	B
400	50	40	32	25	20	16	12.5	10	8	A

Plastic pipe is purchased according to the *iron pipe size* (IPS).

Be aware that the actual MAOP of new extension or replacement pipe in a gas system is dependent upon design pressure of the pipe and components in the system, and the pressure test performed by the operator or their contractor on the piping system.

Before placing in service, OSU must test each disconnected service line in the same manner as a new service line (49 CFR 192.725). The pressure testing requirements for plastic and metallic service lines are listed under "Plastic Pipe Installation - Rule 9" and "Metallic Pipe Installation" found in Chapter 16.

PE pipe may be joined by either the heat fusion method (butt, socket, or electrofusion) or by a mechanical coupling. Personnel performing the joining procedure must be properly qualified for heat fusion, for each pipe material, or combination of materials being joined.

PE pipe that is not encased must have a minimum wall thickness of 0.090 inches. However, pipe with an OD of 0.875 (¾" nominal size) or less may have a minimum wall thickness of 0.062. PE is the only type of gas pipe qualified for use in the system by this document. Other materials may be approved by this system's operator of record and Energy Services Utilities Engineering organization however, any alternative gas pipe materials must be noted in the utility's Gas Book with documentation of approval attached.

VALVES

Each valve must meet the minimum requirements or the equivalent of API 6D. A valve may not be used under operating conditions that exceed the applicable pressure-temperature rating contained in the standard. The valve will be stamped with either the class (ANSI) or the maximum working pressure rating (PSIG). Never operate valves at pressures that exceed their rating.

The class of ANSI ratings on steel valves are ratings which specify the maximum working pressure for flanged-end and weld-end gate, plug, ball, and check valves.

Class Rating (ANSI) Maximum Working Pressure Rating (PSIG)

ANSI	150	300	400	600	900	1500	2500
PSIG	275	720	960	1440	2160	3600	6000

The maximum working pressure ratings are applicable at temperatures from -20°F > 100°F.

Metal valves will often be stamped with the symbols WOG. This means that they are suitable for service for water, oil, or gas. Sometimes just the letter G (for gas) appears.

The manufacturer's name or trademark will also be included on a valve. OSU installation personnel should maintain manufacturers' manuals that include installation, operation, and maintenance procedures for each different type of valve in the gas system. These manuals and procedures are to be maintained and accessible to system maintenance personnel at all times.

Plastic valves purchased for gas service should comply with industry standard ANSI B16.40. *Manually Operated Thermoplastic Valves in Gas Distribution Systems*. When buying plastic valves, record specifications and information on suppliers who are knowledgeable in the gas piping field.

FLANGES and FLANGE ACCESSORIES

Each flange or flange accessory (other than cast iron) must meet the minimum requirements of ANSI B16.5, MSS SP-44, or the equivalent. For cast iron, refer to 49 CFR 192.147 (c). For plastic fittings made of PVC or ABS plastic, refer to 49 CFR 192.91.

Installation personnel should verify that metal flanges purchased for the OSU system meet the above requirements. This can be done by checking the markings on the flange. The markings are similar to those on the valves.

REGULATORS and OVER PRESSURE PROTECTION EQUIPMENT

There are many different manufacturer models of gas regulators and over pressure equipment (relief valves) available for gas systems. Regulators and over pressure protection equipment must be properly sized so that over pressure or low-pressure conditions do not occur on the gas system. Manufacturers of gas regulators and

relief valves have manuals which contain formulas and charts for each of their specific models or types of equipment. These formulas and charts are necessary to size regulators and relief valves properly.

Obtain manufacturer operation and maintenance instructions for each individual type of regulator and relief valve in the OSU system. Normally, the manufacturer publishes a manual containing these instructions. These manuals are to be accessible at all times to system maintenance personnel.

CHAPTER 4 – Personnel Instructions

The following instructions cover operating and maintenance procedures which must be followed during normal operations and while making repairs (49 CFR 192.605(c)).

Normal Operations

1. Personnel shall observe caution when utilizing power equipment in and around aboveground gas distribution devices such as meters and regulators.

2. Welding and heat sources shall not be used adjacent to above ground gas distribution devices unless approved by the OSU EHS Director, and appropriate permitting is obtained.

3. Prior to working around natural gas devices, personnel shall make certain that there is adequate ventilation, and no leaks. Operator Qualified (OQ) OSU personnel shall check for gas and O_2 content of work site air and confirm safety of atmosphere. Installation personnel shall check for leaks. For added safety, fire extinguisher(s) shall be readily available during all work on gas lines.

4. Lock-out/tag-out procedures shall be used on all gas fired equipment and/or isolation valves when maintenance work being performed could result in an unintentional release of gas.

5. Any personnel who smell gas or observes problems with any gas distribution device or equipment shall report it immediately to their supervisor.

6. After hours problems shall be reported according to the NG OUTAGE COMMUNICATION TREE.

7. Any planned work in and around gas pipelines or devices where OSU owned ground needs to be opened requires an OSU Excavation Permit and confirmation that all relevant OSU and outside agencies have marked all known underground lines in the area. In addition, if work being performed is within 5-ft of a NG line, at least one approved OSU personnel must be available to witness work being performed. Locate requests begin by calling Oklahoma One-Call (OKIE) at 811. OKIE notifications are received by Energy Services personnel who then inform FM Work Control to process an Excavation Permit.

While making repairs

1. Any repair work on the gas distribution system that could result in the unintentional release of gas will require lock-out and tag-out of the line at the meter or nearest upstream valve.

2. All OSHA Safety Requirements shall be met when excavating to work on pipelines.

3. Only material qualified for use in gas systems may be utilized for repair purposes. Materials must meet requirements noted in Chapter 3 of this manual.

4. When a line is opened there must be no sources of ignition operating in the area. OQ OSU personnel shall monitor atmospheric conditions.

5. If any unsafe conditions develop, personnel shall vacate area immediately and contact the appropriate supervisor or emergency response personnel as dictated by the situation.

6. Work areas shall be responsibly safeguarded in order to keep students, staff, faculty, and all others at a safe distance from the work being performed.

7. All repairs are pressure tested to ascertain if they will hold up under operating pressures.

8. No person shall work on any part of the gas pipeline system unless such person is deemed qualified by OSU ES Utilities Distribution training records.

CHAPTER 5 – Line Marking Process

LINE MARKERS

1. All PE gas pipe installed underground shall be buried with a metal tracer wire to facilitate location when necessary.
2. Wire shall be No. 12 AWG copper clad steel wire or Copperhead brand or approved equal rated for direct burial application.
3. Insulation shall be yellow.
4. Wire shall be directly above and within 2" to 3" of the line but shall not contact the line at any point.
5. All gas pipes, regardless of material, are to be buried with a yellow marker tape approximately 12" above the line.

CHAPTER 6 – Patrolling and Continuing Surveillance

OSU patrols mains located in places or on structures where anticipated physical movement or external loading (weight, traffic) could cause failure or leakage (49 CFR 192.721). These places or structures include areas susceptible to earth subsidence (cave ins), or areas of construction activity. Patrolling can be done by walking along the pipeline and observing factors affecting safe operation. Patrolling of these mains is done annually and recorded on the Surveillance/Patrolling Form.

Patrolling also includes the annual inspection of regulators. Inspection assures proper operation of regulators, checks installation, and assures that vent screens are in place with no obstructions. Inspections are documented on the Surveillance/Patrolling Form.

The condition of the gas pipeline system is continually evaluated based on parameters entered into the DIMP database using the SHRIMP tool. Continuing surveillance is an ongoing process, and all personnel are instructed to constantly be vigilant for abnormal situations. If a threat is identified and ranked by the DIMP, OSU personnel must take appropriate action and ensure that necessary documentation is completed.

CHAPTER 7 – Gas Leak Surveys

A leakage survey of OSU's NG distribution system must be made as frequently as necessary, at intervals not exceeding 15-months, and at least once each calendar year (49 CFR 192.723). The survey shall be conducted on all exterior natural gas piping under OSU's authority.

Any leak that is found should be classified as soon as it is located. When a leak is discovered, it must be investigated to determine if a hazard exists. If a leak is deemed hazardous it must be repaired immediately and OSU must protect life and property until conditions related to the leak are no longer hazardous. All leak repairs – whether hazardous or not, are documented through the FM work order system.

NG system surveys are conducted annually during the growing season and may be conducted by meter readers or other maintenance personnel. All leaks discovered must be recorded. Document survey results on the appropriate form, whether or not leaks are found.

Specifications for the OSU STW NG Survey.

1. SURVEY SCHEDULE

The annual gas leak survey is performed by a qualified NG piping system leak testing business and coordinated by ES Utilities Engineering. The survey is scheduled to begin mid-June each year with a six-week allowed performance time ending July 31.

2. PROJECT DELIVERABLES

1. Daily Report - A summary of the day's survey result shall be provided to the accompanying OSU ES staff at the end of each day.

2. Annual Report – Due at completion of annual survey delivered to the ES Utilities Engineering Manager – *Includes results & findings from leak survey and odorant test.*
    a. Field Report
        i. A copy of the completed field report.
    b. Final Bound Report
        i. A bound final report for the NG system campus manager for their records.
    c. A final report in electronic format (on a thumb drive)

CHAPTER 8 – Shutdown and Abandonment of Facilities

SHUTDOWN

When it is necessary to shut down any area in the OSU natural gas system, personnel should go to the first available zone valve. If the area is looped, all lines serving the loop must be valved off. Steps are to be taken to minimize the number of affected buildings. Follow established tag-out procedures.

Once the need for the shutdown is past, reopen valves. When the system is back on-line, blow off any air that has accumulated in the pipeline and perform a sniff test.

ABANDONMENT

When an OSU gas main or service line is abandoned, it must be physically disconnected from the piping system and the open ends effectively sealed. In addition, personnel must determine the necessity of purging the line. All pipe 4" and larger shall be purged as follows.

a) When a pipeline or main full of air is placed in service, the air in it can be safely displaced with gas provided that a moderately rapid and continuous flow of gas is introduced at one end of the line and the air is vented out the other end. The gas flow should be continued without interruption until the vented gas is free from air. The vent should then be closed.

b) In cases where gas in a pipeline or main is to be displaced with air and the rate at which air can be supplied to the line is too slow to feasibly perform a procedure similar to, but the reverse of (a), then a slug of inert gas should be introduced to prevent the formation of an explosive mixture at the interface between gas and air. Nitrogen or carbon dioxide can be used for this purpose.

c) If a pipeline or main containing gas is to be removed, the operation may be carried out in accordance with (b), or the line may first be disconnected from all sources of gas and then thoroughly purged with air, water or with inert gas before any further cutting or welding is done.

In cases where the main and all the service lines connected to it are abandoned, the service line(s) must be capped at the customer's end. The abandoned main must be sealed at both ends.

Records must be kept on all abandoned facilities. This includes location, date, and method of discontinuing service (abandoning the facility). All information on any abandoned lines is reported as soon as possible to FM Energy Services, Utilities Distribution, and incorporated into the ES record of abandoned gas lines available in GIS.

When service to an OSU facility is temporarily or permanently discontinued, one of the following must be done:

a) The valve must be closed to prevent the flow of gas to the customer, and the valve must be secured with a lock or some other device to prevent opening of the valve by unauthorized people.

b) A mechanical device or fitting that will prevent the flow of gas must be installed in the service line or in the meter assembly.

c) The customer's piping must be physically disconnected from the gas supply and the open ends sealed (49 CFR 192.727).

For pipeline shutdowns, go to the first available workable zone valve to shut down the problem area. Isolate so as to minimize the number of buildings affected, making sure the entire loop (if applicable) is isolated. Use tag-outs on all valves used. After the shutdown work is completed, open all valves in the reverse order in which they were closed. Blow off any air that has accumulated in the line and do an odorant sniff test.

CHAPTER 9 – Preventing Accidental Ignition of Gas

Gas alone is not explosive but when it is mixed with air, it can ignite or explode with tremendous force. Every precaution should be taken by OSU personnel to prevent unintentional ignition of gas.

When venting gas into air, a fire extinguisher must be available (49 CFR 192.751), and all heat or ignition sources kept well away from the source of the venting.

CHAPTER 10 – Key Valves Maintenance

The key valves must be checked and serviced at intervals not exceeding 15-months, but at least once each calendar year. Records of this inspection must be maintained (49 CFR 192.747). Key valves are indicated on the Campus Jurisdictional Gas Map available in GIS.

Inspect and Service Valve

NOTE: Each distribution line valve that might be required during an emergency must be inspected and partially operated at intervals NOT exceeding 15-months, but at least once each calendar year. During valve inspection, any abnormal condition of valve or pipeline or existence of leakage must be documented and reported.

ABOVE GROUND INSPECTION:
Visually INSPECT for external damage.

1. VERIFY nameplate is visible and legible
2. INSPECT for leaks:
    a. Flange
    b. Bonnet joints
    c. Packing gland
3. INSPECT for:
    a. General condition
    b. Lubrication
    c. Freedom of movement
4. INSPECT for abnormal operating condition of valve or pipeline:
    d. Unintended pipe movement
    e. Corrosion
    f. Material defect
    g. Physical damage
5. IF ANY abnormal conditions are observed, NOTIFY the Supervisor

IF a leak is found, THEN:

1. IF practical, ATTEMPT to isolate or stop the leak and notify Supervisor
2. IF a serious leak is detected and presents a hazard to persons, follow NG Emergency Operations Plan procedures.

RECORD all results in AiM as directed.

SERVICING:

1. PERFORM servicing per manufacturer's specification
    a. For gate and ball valves:
        i. IF possible, WHILE valve is in CLOSED position, BLOW DOWN valve body
2. INSPECT for block and bleed capabilities
    a. IF body is capable of being blown down, but does not depressurize, THEN
        i. Indication is leakage by seats caused by valve not being fully closed
        ii. Indication is probable damage to seats or seating surfaces

NOTIFY Supervisor and/or other appropriate personnel

NOTE: Most ball and gate valves do not require lubrication except when needed to help seal damaged seats, gates, or balls.

LUBRICATION: CHECK manufacturer's specifications for lubrication.

1. LUBRICATE plug valve bodies with appropriate lubricant
    a. Hand wheel grease fittings
    b. Stem
    c. Packing gland studs
    d. Nuts
2. INSPECT packing glands on valve stems for leakage AND,
3. ADJUST or ADD packing, if required, to stop leak.

NOTE: Operate valves fully, when possible, otherwise, partial operation is acceptable. When operating the valve, take care to prevent disrupting service or over pressurizing the system

EVALUATE consequences of operating valve AND TAKE necessary precautions to minimize impact.

1. IF bypass piping and valves are present
    a. Unlock and open bypass before operating main line valve.
2. STROKE main line valve full travel, if possible, AND ensure valve operates freely with NO binding
3. RETURN main line valve to previous position AND shut and lock bypass valve
    a. If bypass piping and valves are <u>not present,</u> FOLLOW guidelines in NOTE box above.

INSPECTION: Underground poly valves:

1. Check area for AOC and note on inspection form.
2. Check valve lid for paint and ensure lid is marked GAS.
3. Remove lid from box and check riser for the presence of tracer wire. Remove any trash or dirt in the riser.
4. Place wrench on valve and turn 1/8 of a turn in the shut direction.
5. Re-open valve. Perform sniff test at riser opening to detect possible leakage.
6. Replace valve box lid and re-paint if needed.

<u>RECORD</u> Inspection results in AiM as directed.

CHAPTER 11 – Measuring and Odorization of Gas

49 CFR 192.625 requires that operators periodically sample combustible gas to verify that odor is readily detectable. The code specifically requires that Master Meter Systems obtain written verification of odorant from their supplier and conduct periodic "sniff" tests. To comply with these requirements, OSU conducts "sniff" tests using an odorometer as part of its regular leak testing efforts.

Note: Periodic *sniff tests* can be a guide in determining odorization levels even though they do not replace the need to maintain odorant usage records or perform odorometer tests. OSU maintenance personnel shall smell the gas at an open valve or gas oven burner during meter change-outs or other maintenance work. Records of sniff tests shall be maintained and, when possible, should be run at the ends of the system.

CHAPTER 12 – Corrosion Control

The OSU natural gas distribution system does not have cathodic protection. Records are insufficient to determine whether the remaining metallic pipe in the system was installed before or after August 1, 1971. OSU does not believe that initiating a corrosion control program at this time would be of benefit to the University. This view is based on the following:

- Since 1985, OSU has pursued an aggressive annual natural gas system leak survey program and plans to continue this annual survey, not only to conform with federal and state mandates, but also be proactive in its pursuit of safety in the gas system.

- The decision was made in the late 1980's to embark on a program for the replacement of underground metallic natural gas distribution lines with polyethylene material. Most known underground lines on OSU's Stillwater campus operating at the MAOP have been replaced in this program. It is the view of OSU that replacement of metallic lines with plastic is the best way of combating the corrosion problem that afflicts metallic lines. As underground metallic lines operating at the MAOP are discovered they shall be scheduled for replacement with polyethylene.

Above ground piping and below ground piping must be electrically separated by the use of anodeless risers. Above ground piping is protected by use of coatings (painting) of the pipe. This places a barrier between the pipe and the outside elements. This protection must be suitable to prevent corrosion caused by moisture, i.e., rain, fog, sprinklers, coolers, or any other source of moisture. All metallic above ground facilities must be evaluated for atmospheric corrosion at least once every three years and results documented in AiM as directed.

CHAPTER 13 – Leak Repairs and Construction

Repair, construction, and safety are based upon good common sense and sound engineering concepts. This chapter is designed to increase the safety of OSU's gas system by helping meet the construction and repair standards set by the pipeline safety code.

The manufacturers of pipe, valves, fittings, and other gas system components must design and test them to prescribed industry specifications. The specifications are incorporated into 49 CFR Part 192. Those meeting the requirements are qualified for gas service and marked with the *approved markings*. In addition, manufacturers usually develop procedures for joining their products and joining other materials to their products.

This chapter outlines construction, pipe handling, and pressure testing requirements that should be followed when installing a gas system. Plastic pipe fusion instructions and steel pipe welding and qualification procedures are

included in Chapter 16. These instructions and procedures explain the steps necessary to qualify a person to make pipe joints/welds for either plastic or steel pipe. They give directions for finding qualified persons to do the construction and repair work on the system. If a gas contractor is used to work on the system, it is OSU's responsibility to see that the contractor follows all requirements. However, it shall be OSU's policy that OSU trades and utilities personnel will, whenever possible, join all jurisdictional piping on projects involving outside contractors. In the event OSU cannot perform this service, the contractor will be required to follow all procedures and present all necessary documentation as mandated by 49 CFR Part 192 and outlined in OSU's Engineering Guidelines/NG Construction Standard.

PLANNING AHEAD

Before making modification or repair of a piping system, comprehensive plans should be made. It is essential that OSU installation personnel know the type of material and all the parts that make up the present gas piping system. The piping system consists of pipe, valves, fittings, regulators, relief devices, and meters. By knowing the type of material in the system, the proper fittings can be selected.

EXCAVATION

Before digging for gas line installation, repair, or replacement, the pipe network and other underground utility lines must be located on the property. Call OKIE to notify others who may have underground lines in the excavation area. Lines may be located by one or all of the following ways:

- Locate all underground utility lines on *as-built* or *corrected-for-construction* drawings. Maps or drawings of the location of the underground gas lines are very important. They can provide information to other utilities that must dig to repair or replace their utility lines. Any changes made in the system must be reported to FM Utilities Distribution so the drawings can be updated.
- Locate underground metallic utility lines with pipe locating instruments. Plastic pipe which was installed with an electrically conductive wire can also be located by this method. Pipe locating instruments are to be used in accordance with manufacturer's operating procedure; OSU personnel primarily use the Radiodetection RD 8100 (procedure for this unit located in Chapter 17 of this manual).
- Locate or verify locations of other underground utility lines serving the area. The line marking process is described in Chapter 5.

Be aware that service lines and mains built prior to the enactment of minimum depth requirements may be very shallow. Therefore, digging to expose gas lines for repair or replacement purposes should be carried out with hand tools (preferably made of brass or other non-sparking material) until the gas lines are located. Afterwards, power tools may be used.

When working on a leaking pipe, a stand-by worker should be ready to assist their partner in escaping from the hole in the event of an emergency. A fire extinguisher must be available during all such repairs.

PIPE INSTALLATION, REPAIR, AND REPLACEMENT: GENERAL COMMENTS

Gas service lines and mains are to be installed with a minimum of 24" of earth cover. Purging of new lines shall be accomplished in accordance with Abandonment of Facilities in Chapter 8.

Underground structures may prevent the installation of gas services or mains at minimum depths. The pipeline safety regulations allow a shallower depth of cover if adequate protection is provided (i.e., sufficient to withstand the anticipated external loads - e.g., heavier pipe, casing, concrete, etc.). In such cases, it is recommended that the gas line location be marked above ground. The area should be inspected frequently to ensure that the ground cover is intact and has not eroded (49 CFR 192.327 & 192.361).

OSU must document all leak repair data. Repairs should be done through the FM AiM work order system. Records must include leak reports received from customers.

METALLIC PIPE INSTALLATION

All the conditions listed below must be met when metallic pipe is installed. Although OSU intends to install PE pipe exclusively in the future, this material is included for reference purposes.

1. Make each joint in accordance with written procedures that have been proven by test or experience to produce strong gas tight joints.
2. Obtain and follow the manufacturer's recommendations for each specific fitting used.
3. Handle pipe properly without damaging the outside coating. Any gouges or scratches should be covered with an appropriate coating. If coating damage is not corrected, accelerated corrosion can occur in that area.
4. Coat or wrap steel pipe at all welded and mechanical joints before backfilling.
5. Pressure test new pipe for leaks before backfilling – as follows:

Mains operated at <1 psig	Test to at least 10 psig
Mains operated at 1 psig or > but < 10 psig	Test to at least 90 psig
Service lines operated at 1 psig but not more than 40 psig	Test at not less than 50 psig

6. Support the pipe along its length with proper backfill.
7. Make certain that backfill material does not contain stones, cinders, bottles, or cans that may damage or scratch pipe coating.
8. Cathodically protect steel pipes.
9. Electrically insulate dissimilar metals.
10. Make certain that compression type fittings that are intended to be electrically conductive have armored gaskets. Bond over insulating fittings to maintain electrical continuity for cathodic protection and for locating steel pipe.

If personnel must weld steel in the pipeline, they should review the pipeline safety requirements covered in Subpart E of 49 CFR Part 192, provide qualified welders to perform the welding, and follow the qualified welding procedures contained in Chapter 16. With the current material available for gas service (repair fittings, clamps, sleeves, tees, etc.), there should be little need to do much welding on a small gas distribution system for operation and maintenance purposes. The important things to remember are that welding must be performed in accordance with established written welding procedures that have been qualified and tested to produce sound ductile welds, and welding must be performed by welders who are qualified for the welding procedure to be used. Both the procedures and the personnel must be qualified for the type of weld performed.

OSU has adopted the qualified welding procedures for metallic pipe which is based on Section IX of the ASME Boiler and Pressure Vessel Code. OSU will qualify its on-staff welders to weld on the OSU steel gas system per provisions of 49 CFR 192.227 (b), Appendix C - Qualification of Welders for Low Stress Level Pipe and using the specifications of the procedure as contained in Chapter 16 of this manual.

PLASTIC PIPE INSTALLATION

Plastic pipe is now commonly used for distribution mains and services by the gas industry. The most common type of plastic pipe presently installed is polyethylene (PE). PE plastic pipe is the only acceptable plastic for LP-Gas piping and is recommended as the most suitable plastic pipe for natural gas piping. PE plastic pipe is manufactured according to ASTM D2513 and is marked with that number.

Plastic pipe may be buried directly in the ground. It may also be used to replace a deteriorated buried metal pipe. In these cases, a slightly smaller plastic pipe is generally inserted into the existing metal pipe.

Each plastic pipe joint must be made in accordance with written procedures that have been proven by test or experience to produce strong gas tight joints. Plastic pipe joining procedures must be qualified according to the

requirements contained in 49 CFR 192.283. The personnel who make the joints must meet the requirements contained in 49 CFR 192.285. OSU need not run the tests described in 49 CFR 192.283 themselves because most pipe and fitting manufacturers develop and qualify joining procedures for each specific product. Do not purchase the product if it cannot be certified that the manufacturer or supplier of the pipe or fitting has the joining procedures which meet the requirements of 49 CFR 192.283.

Manufacturers of both pipe and fittings have installation manuals, which describe the specific joining procedures required to make a strong, gas-tight joint. Manufacturers' procedures for each of the pipeline components that are used in the system must be easily accessible for OSU installation personnel.

49 CFR 192.273 requires that each joint be inspected before the gas line is put into service. Per 49 CFR 192.287, those who inspect these joints must be qualified to do so. OSU considers a person as qualified if they are also qualified to make such joints per 49 CFR 192.285. When a joint is inspected, documentation of the inspection is required and must be kept on file.

According to the safety standards (49 CFR 192.285), a person making joints must be qualified. 49 CFR 192.285 provides requirements for qualifying persons to make joints:

1. No person may make a plastic pipe joint unless that person has been qualified under the applicable joining procedure by:
    a. Appropriate training or experience in the use of the procedure; and
    b. Making a specimen joint from pipe sections joined according to the procedure that passes the inspection and test set forth in paragraph (b) of this section.
2. The specimen joint must be:
    a. Visually examined during and after assembly or joining and found to have the same appearance as a joint or photographs of a joint that is acceptable under the procedure; and,
    b. In the case of a heat fusion, solvent cement, or adhesive joint:
        i. Tested under any one of the test methods listed under 49 CFR 192.283(a) applicable to the type of joint and material being tested:
        ii. Examined by ultrasonic inspection and found not to contain flaws that would cause failure; or
        iii. Cut into at least 3-longitudinal straps, each of which is:
            1. Visually examined and found not to contain voids or discontinuities on the cut surfaces of the joint area; and
            2. Deformed by bending, torque, or impact, and if failure occurs, it must be initiated in the joint area.
3. A person must be re-qualified every 12-months (not to exceed 15-months) by the method indicated in (b) (ii) and (iii) above. Test strips and re-qualification documentation must be maintained on file.

The general rules to follow when installing plastic pipe are listed below:

Rule 1: Install plastic pipe manufactured under the ASTM D2513 specification. The pipe must have ASTM D2513 marked on it.

Rule 2: Make each joint in accordance with written procedures that have been proven by test or experience to produce strong tight joints. The manufacturer of the pipe or fitting should supply the procedures for his specific product in the manufacturer's manual. When installing the pipe, make certain that these procedures are followed (49 CFR 192.283). All joints must be made by a person qualified under 49 CFR 192.285.

Rule 3: Install properly designed valves in a manner which will protect the plastic material. Protect the pipe from excessive torsion (twisting) or shearing (cutting) loads when the valve is operated. Protect from any secondary stresses which might be induced through the valve or its enclosure.

Rule 4: Prevent pullout and joint separation. Plastic pipe must be installed in such a manner that expansion and contraction of the pipe will not cause pullout or separation of the joint. Operators unfamiliar with plastic pipe should have a qualified person perform all these procedures.

Rule 5: When inserting plastic pipe in a metal pipe, make a sufficient allowance for thermal expansion and contraction. Make an allowance at lateral and end connections on inserted plastic pipes, particularly those over 50' in length. End connections must be designed to prevent pullout caused by thermal contraction. It is desirable that fittings used should be able to restrain a force equal to or greater than the strength of the pipe. If not, the pipe should be restrained by anchoring, bracing, offset connection, or straps across the fitting. To minimize the stresses caused by thermal contraction, pipes inserted in the summer should be allowed to cool to ground temperature before tie-ins are made. Inserted pipes, especially those pulled in, should be relaxed, mechanically compressed, or cooled to avoid initial tensile stress.

Rule 6: Repair or replace imperfections or damages before placing the pipe in service.

Rule 7: Install all plastic mains below ground level (buried). Where the pipe is installed in a vault or other below-grade enclosure, it must be completely encased in gas-tight metal pipe with fittings that are protected from corrosion. (For service line, see Rule 8.) The plastic pipe installation must minimize shear and other stresses. Thermoplastic (PE) pipe for direct burial must have a minimum wall thickness of 0.090 inch. (Exception: pipe with an outside diameter of 0.875" (7/8") or less may have a minimum wall thickness of 0.062".) A plastic main that is not encased must have an electrically conductive wire or other means of locating the pipe while it is underground.

Rule 8: Install all plastic service lines below ground. A portion of the plastic service line may terminate above ground if it is protected against deterioration and external damage by a casing. The plastic must not be used to support external loads. There are many different manufacturers of anodeless risers. The primary advantage of an anodeless riser is that it does not have to be cathodically protected because the outside steel casing is not the gas carrier. The plastic inside the steel casing is the gas carrier. If anodeless risers are purchased, make sure they meet all DOT requirements. If steel risers are installed connected to plastic pipe by a transition fitting, make sure the steel riser is coated and cathodically protected.

Rule 9: Test installed plastic pipe at least at a level 150% of the maximum operating pressure or 50 psig, whichever is greater. However, the test pressure may not be more than three times the design pressure of the pipe. Repair pipe shall be pre-tested before it is placed in FM Stores. When pipe is received from the vendor, the joints or spools shall be subjected to the test pressures noted above. If the pipe passes the test, it shall be identified by markings as to date and pressure of test, documented, and placed in the FM Stores area. As pipe is used, it is charged to a work order which indicates the location of use. All testing is to be documented.

Rule 10: Take special care to ensure that plastic pipe is continually supported along its entire length by properly tamped and compacted soil.

Rule 11: If plastic pipe is laid where there has been digging and backfilling below the pipe, reinforce the pipe. To prevent any shear or other stress concentrations, use external stiffeners at connections to main, valves, meter risers, and other places where compression fittings might be used.

Rule 12: In the laying of plastic pipe, ensure adequate slack (snaking) in the pipe to prevent pullout due to thermal contraction.

Rule 13: Lay plastic pipe and backfill with material that does not contain any large or sharp rocks, broken glass, or other objects which could cut or puncture the pipe. Where such conditions exist, suitable bedding (sand) and backfill must be provided.

Rule 14: Take special care to prevent coal tar type coatings or petroleum base tape from contacting the plastic pipe; it can cause plastic pipe to deteriorate.

Rule 15: Static electricity can ignite a flammable gas-air atmosphere. When working with plastic pipe of any kind where there is (or there may be) the possibility of a flammable gas-air atmosphere, take the following precautions:

- Use a grounded wet tape conductor wound around, or laid in contact with, the entire section of the exposed piping.
- If gas is already present, wet the pipe starting from the ground end with a very dilute water and detergent solution. Apply tape immediately and leave it in place.
- Wet the tape occasionally with water. Where temperatures are below freezing (0°C/32°F), add glycol to the water to maintain tape flexibility. Ground the tape with a metal pipe driven into the ground.
- Do not vent gas using an ungrounded plastic pipe or tubing. Even with grounded metal piping, venting gas with high scale or dust content could generate an electric charge in the gas itself and an arc could result from the dusty gas cloud back to the pipe and ignite the gas. Vent gas only at a downwind location remote from people or flammable material.
- Note: Dissipating the static charge buildup with wet rags, a bare copper wire, or other similar techniques may not be as effective as the above procedure. In all cases, use appropriate safety equipment such as flame resistant and static free clothing, breathing apparatus, etc.

REPAIR METHODS - PLASTIC AND METAL

Replacement of gas lines and repair of leaks are highly specialized and potentially hazardous operations, persons with adequate training and certification only should attempt them. Only maintenance personnel with such training, experience, and certification should attempt repair of gas leaks or replacements of gas lines.

Leaks in service lines or mains may be repaired by cutting out a short length of pipe containing the leak and replacing it with a new segment of pipe. The pipe segment is attached to the existing line with couplings at each end. Remember that written procedures are required to be followed for each joint made. The proper procedures can be obtained from the manufacturer of the coupling.

Small leaks in steel service lines or mains, such as those resulting from corrosion pitting, are to be repaired with a steel band clamp applied directly over the leak. All bare metal pipe and fittings that are installed below ground must be properly coated and cathodically protected before backfilling. If several leaks are found and extensive corrosion has taken place, the most effective solution may be to replace the entire length of pipe that has deteriorated. The normal installation practices must be followed when performing more extensive repairs. They include priming and wrapping of all bare metallic piping and fittings, proper grading of lines to the main, cathodic protection, etc.

Leaking metal pipe can often be replaced by inserting PE pipe manufactured according to ASTM D2513 in the old line and making the appropriate connections at both ends. Again, operators are cautioned that allowance for thermal expansion and contraction must be made at lateral and end connections. Some of the PE pipe manufacturer's manuals include details for the proper techniques to install their products by insertion.

The most prevalent cause of breaks or leaks in plastic pipe is third-party damage. This is usually caused by an excavator breaking or cutting the pipe while digging. Plastic pipe is more vulnerable to such breaks than steel pipe. The lower strength of plastic pipe, however, is not necessarily a disadvantage. For example, if digging equipment hooks and pulls a steel pipe it may not break; however, the steel pipe may be pulled loose from a connection at some distance from the digging. The resulting leaks could go undetected for a period of time and may result in a serious incident. Although there is no assurance that the plastic pipe will not also pull out, it is more likely to break at the point of digging. Then the break can be easily detected and repaired.

After a leak has been repaired, a soap-bubble test must be conducted. Replaced main and services must be pressure tested for leaks.

Again, it should be emphasized that all sources of ignition should be kept away from the leak repair area. MATCHES SHOULD NEVER BE USED TO DETECT A GAS LEAK or to test the adequacy of a repair job.

PROPER LOCATION AND DESIGN OF CUSTOMER METER AND REGULATOR SETS

Before locating customer meters and regulators, these points must be considered:

1. accessibility,
2. protection of meter sets from damage, and
3. protection of people from release of gas at the meter set.

The next section gives the regulations covering location of meters and regulators. Guidelines are given for compliance with 49 CFR Part 192.

CUSTOMER METERS AND REGULATORS: LOCATION (49 CFR 192.353)

Install meters and service regulators in a readily accessible location. Protect the meters and regulators from corrosion and other damage. Install meters outside wherever possible.

If personnel install a service regulator in a building, put it as close as practical to the point of service entering the building. The regulator must be vented to the outside.

If a meter is installed in a building, it must be located in a ventilated place. It must be more than 3' from any source of ignition or any source of heat which might damage the meter.

It is best to locate the upstream regulator (in a series) outside the building. However, regulators may be located in a separate metering or regulating building.

CUSTOMER METERS AND REGULATORS: PROTECTION FROM DAMAGE (49 CFR 192.355)

Protection from vacuum or backpressure. If any customer's equipment might create either a vacuum or a backpressure, then a device must be installed to protect the gas system.

Service regulator vents & relief vents. The outside terminal of each service regulator vent & relief vent must be:

- rain and insect resistant
- located where gas from the vent can escape freely into the atmosphere. Vent it 3 feet or more away from any opening into the building; and
- protected from water damage in areas where flooding may occur. (Put it where it will not be under water in a flood.)

The meters and regulators must be installed in order to minimize stresses upon connecting piping. Each regulator that is designed to release gas in its operation must be vented to the outside atmosphere at least 3' from an opening into a building. Each pit or vault in a road, driveway, or parking area that houses a customer's meter or regulator must be able to support the vehicle traffic that could use that road, driveway, or parking area.

CUSTOMER METER INSTALLATIONS: OPERATING PRESSURE (49 CFR 192.359)

A meter may not be used at a pressure that is more than 67% of the manufacturer's shell test pressure (0.67 x shell test pressure).

Each newly installed meter manufactured after November 12, 1970, must have been tested to a minimum of 10 psig.

SERVICE LINES: LOCATION OF VALVES (49 CFR 192.365)

- Relation to regulator or meter. Each service-line valve must be installed upstream of the regulator. If there is no regulator, install the valve upstream of the meter.
- Outside valves. Each service line must have a shut-off valve in a readily accessible location that, if feasible, is outside of the building.
- Underground valves. Each underground service line valve must be located in a covered durable curb box or standpipe that allows ready operation of the valve. The box or standpipe must not be put stress on the service line.

Services should not be installed under buildings or mobile homes. If a service is installed under a building, it must be encased in a gas-tight conduit. This conduit must vent to the outside to a point where gas would not be a hazard and extend above ground, terminating in a rain and insect resistant fitting.

COMMON PROBLEMS TO WATCH FOR AT SERVICE RISER AND HOUSE REGULATORS

- Regulator vandalism or damage. This can be very hazardous. If the regulator fails to function for any reason, high-pressure gas may enter appliances. Tall flames at the burner or escape of gas could cause a fire or explosion.

- Obstructed vents. The vent on the regulator should be free of any obstructions. A wire screen installed at the vent should prevent the accumulation of dirt, the intentional insertion of foreign objects by children, or the build-up of insect nests (e.g., wasp nests). If the screen is removed, a new one must be inserted in its place. A non-functioning vent could cause regulator failure and thus present a serious fire hazard within the residential unit. The vent should be pointed down and away from windows and air intakes.

- Tenant move out. The valve on the meter riser should be equipped with a locking device to be controlled by authorized personnel only. The locking device on the shutoff valve also allows the repair of appliances without fear of the gas being accidentally turned on.

- Riser misuse. The tenants or customers should not be allowed to use the riser and its components for other purposes. Never use as an anchor for laundry lines, plant supports, or bicycle racks.

- Corrosion. Check for corrosion on the service riser at ground level.

CHAPTER 14 – Maximum Allowable Operating Pressure (MAOP)

The following items from ONG serve to document the Maximum Allowable Operating Pressures (MAOPs) of the OSU system.

OKLAHOMA NATURAL GAS

May 23, 1996

COPY

RECEIVED
OKLA. CORP. COMM.
MAY 28 1996
PIPELINE SAFETY DEPT.

Ms. Tracy Rowlett
Oklahoma Corporation Commission
Pipeline Safety Department, Room 681
Jim Thorpe Building
2101 North Lincoln Boulevard
Oklahoma City, OK 73105

Dear Ms. Rowlett:

OSU MAOP CONFIRMATION-SMALL GRAINS COMPLEX

I have provided you with the following:

- A copy of the Regulator and Relief Valve Selection (Form 761) for the measurement station at the OSU Small Grains Complex.
- A copy of the Regulator Installation or Removal (Form 502) for the installation of the Sprague CL-34 regulator. This document confirms the date of installation of the regulator.

As can be seen on the Form 761 the outlet set pressure of the Sprague CL-34 regulator is 10. 3 psig.

If you have questions regarding this matter, telephone me at (918) 588-7412.

Sincerely,

J. T. Wofford
Staff Engineer - Regulatory Compliance

Enclosures
c: R. L. Clymer w/o enclosures
R. L. Gambrell w/o enclosures

Appendix I-2

OKLAHOMA NATURAL GAS COMPANY
A DIVISION OF ONEOK Inc.
100 WEST FIFTH STREET, TULSA, OK 74103-4298
P.O. BOX 871, TULSA, OK 74102-0871
(918) 588-7000 • FAX (918) 588-7273

COPY

THIS FORM TO BE ATTACHED TO EACH FORM 432 AND/OR JOB ORDER FOR REGULATOR INSTALLATION

REGULATOR AND RELIEF VALVE SELECTION
FORM 761 (REV. 10-77)

JOB ORDER NUMBER

ATION DESCRIPTION: O.S.U. Small Grains
West 6th, Near Devon Rd.

TOWN: Stillwater
ATLAS PAGE
SEC ___ T ___ R ___

EXISTING REG. ☒
PROPOSED REG. ☐

REGULATOR INFORMATION

THIS SETTING IS: ☐ LINE REG. ☐ BORDER STA. ☐ DIST. REG. ☒ SERVICE LINE

LOAD DESCRIPTION: Commercial
12.7 MCFH

REGULATION IS ☒ UPSTREAM ☐ DOWNSTREAM OF METER(S)

Two Stage Setting: ☐ First Cut ☒ 2ND Cut

Monitor Setting: ☐ Monitor Reg. ☐ Control Reg.

Parallel Runs: ☐ Primary Reg. ☐ Stand-by Reg.

Regulator Supplies Isolated System ☒

NORMAL OPERATING RANGE DATA

	Maximum	Minimum
Hourly Load	12.7 Mcfh	3 Mcfh
Inlet Pressure	30 psig	30 psig
Outlet Pressure (1)	10.3 ~~oz.~~ - psig	10.3 ~~oz.~~ - psig
Regulating Capacity	15.4 Mcfh	15.4 Mcfh

Pressure of connecting lines

	Design (2)	MAOP
Inlet	60 psig	60 psig
Outlet	10.4 ~~oz.~~ psig	10.4 ~~oz.~~ psig

and Model No. Sprague C134-2 Body Size 2"

Orifice Size 5/8" Spring Size Main Orange — Pilot Black ~~Color~~ K Factor 700

RELIEF VALVE INFORMATION

☒ Relieves above regulator only
☐ Relieves ___ regulators in this setting

Regulator Failure: (14.4 + ___ (5)) (___ (6) = Cg) (1.29 (7)) = ___ (8) = Qf cfh

Capacity: (14.4 + 60 (5)) (700 (6) = K) / 2 OR = 26,040 (8) = Qf cfh

Less: Capacity of Internal Relief Valve, If any ___ cfh

Required Relief Valve Capacity ___ cfh

Maximum Relief Valve Inlet Pressure (3) 15 ~~oz.~~ psig

Relief Valve Set Pressure (4) 12 ~~oz.~~ psig

Make and Model: Fisher 289-H

Capacity 27,000 cfh Inlet and Outlet Size 1" X 1"

Type of loading: ☒ Spring ☐ Weight ☐ Lever & Weight ☐ Pilot

(6) Failure Capacity Formula: Pi x Cg x 1.29 = Qf OR KPI / 2 = Qf
Atmospheric Pressure & MAOP at Regulator Inlet in psi.
Regulator Valve Coefficient from Manufacturer's Data.
Factor to correct spec. grav. of air(1.0) to 0.6 Nat. Gas
Total cfh to be relieved at 100% open Reg. Failure

DISTRICT
B. Hall
Prepared By

Appendix I-3
Approved

STANDARD DATA

(1) Set pressure to be 5.333 oz. (9.236"wc) for all LP Service Regulators.
(2) Design pressure to be maximun of a range below.
LP.-2 to 8 oz.
M.P. (A)-Less than 12 psig
(B)-12 to 60 psig
I.P.-60 to 125 psig
HP. (A)-125 to 500 psig
(B)-500 to 800 psig
(C)-Over 800 psig

(3) Maximum build-up on outlet system must NOT EXCEED, for:
LP.-14 oz. (24.20" wc)
M.P. (A)-MAOP + 50%
(B)-MAOP + 6.0 psig
I.P.-MAOP + 10%
HP.-MAOP + 10% up to 75% of SMYS

(4) LP. Relief must begin at 12 oz. (20.76" wc)

General Office Approvals

	Initial	Date
Oper. Supt.		
Meas.		
Tech. Serv.		

COPY

Form 502 Rev. 3-63

REGULATOR INSTALLATION OR REMOVAL

Date of { Installation / Removal } _____ 19__

Location W. Hwy 51 - Small Grains Complex Station No. _____

Controls From C.P.M.P. Controls To Small Grains Complex

Inlet Pressure 30-45# Outlet Pressure 10# Site Size _____

Housing—Kind & Size Open - ON College property

Inlet Gauge Make _____ Ind. _____ Rec. _____ Range _____

Outlet Gauge Make _____ Ind. _____ Rec. _____ Range _____

By Pass Size 1" and 2" Type of Cutoff Stops

Safety Valve Make Fisher 289-H Type Spring (10-20# Size 1"

Set to Pop at 15# Leaks At 12# Pops At 15# Reseats At 12#

Location of Safety Valve ON inlet between regulator & Meter

Other Attachments, Describe

By Pass Stops Not Connected

2" Baker Valve under P.V (Locked)

From Stock At _____ Placed in Stock At _____

REGULATOR { JOB / WORK } ORDER No. _____

Complete Description of Regulator

Make Sprague C.L. 34-2 Type of Loading C.L. Pressure

Mfg Serial No. None Co. No. _____

Size Inlet 2" Size Outlet 2" Type Con. Sc. Flange Rating _____

Diameter Bolt Circle Inlet _____ No. Bolts _____ Size _____

Diameter Bolt Circle Outlet _____ No. Bolts _____ Size _____

Size Diaphragm Case Std Lever Length _____

Size Valves 5/8" Double _____ Single X Type Seat Soft

Rated Pressure Range 150# Inlet To 30-45# Outlet 10.4#

Safety Valve Make Fisher 289-H (5-14# Spring Rang

Type of Safety Valve Spring Size 1" Type & Size Dehydrator Pot _____

Other Descriptive Information

9-1-76 Removed Fisher 99 } ORange main Spring
Installed Sprague C.L. 34-2 } Black pilot spring. } 3-30-78
5/8" orifice. Set - 10.4#

Appendix I-4

{ Installation / Removal } Made By _____

OKLAHOMA NATURAL GAS

COPY

May 8, 1996

RECEIVED
OKLA. CORP. COMM.
MAY 13 1996
PIPELINE SAFETY DEPT.

Ms. Tracy Rowlett
Oklahoma Corporation Commission
Pipeline Safety Department, Room 681
Jim Thorpe Building
2101 North Lincoln Boulevard
Oklahoma City, OK 73105

Dear Ms. Rowlett:

OSU MAOP CONFIRMATION

I have provided you with the following:

- A copy of the Regulator and Relief Valve Selection (Form 761) for the Measurement Station 65-708.
- A copy of the Completion Report (Form 702) for construction on the rebuild of Measurement Station 65-708. This document confirms date of installation on the existing Rockwell regulator.
- A copy of the Regulator and Relief Valve Selection (Form 761) for the Measurement Station 91-631.

The Form 761 is the Oklahoma Natural Gas Company document of record regarding regulators and relief valves at commercial and industrial meter settings and at district regulator settings. As can be seen on the attached documents, the Form 761 lists the regulator and relief valve specifications such as size, inlet pressure, capacity, and outlet set points. By Oklahoma Natural procedures, if any component at a meter and regulator station is altered, or if there is an increase of the regulator inlet or outlet pressure, then a new Form 761 must be completed to reflect the changes. After researching our files, we are confident that the attached Form 761s are the most recent and no significant revisions have since been made to the regulators and relief valves.

Appendix I-5

OKLAHOMA NATURAL GAS COMPANY
A DIVISION OF ONEOK Inc.
100 WEST FIFTH STREET, TULSA, OK 74103-4298
P.O. BOX 871, TULSA, OK 74102-0871
(918) 588-7000 • FAX (918) 588-7273

COPY

Ms. Tracy Rowlett
Page 2
May 8, 1996

The attached Form 761 for Station 91-631 accurately reflects the current delivery pressure of 35 psig. However, the Form 761 for Station 65-708, listing the regulator outlet pressure as 35 psig, is no longer correct. Approximately, ten years ago the delivery pressure through this meter setting was reduced to its current level of 32 psig.

Prior to serving customers with elevated pressure, Oklahoma Natural personnel review the customer's piping system to ensure that materials and construction methods meet the appropriate standards. These safety inspections, in addition to the inspections performed by local building inspectors, were performed on the OSU piping systems prior to the initiation of service. The systems met Oklahoma Natural standards for customer piping and were approved to receive 35 psig. A survey of records and Stillwater area personnel indicates no subsequent safety problems on the OSU system. For these reasons, we recommend that the current pressures on the two systems be considered as the MAOP.

If you have questions regarding this matter, telephone me at (918) 588-7412.

Sincerely,

John T. Wofford

J. T. Wofford
Staff Engineer - Regulatory Compliance

Enclosures
c: R. L. Clymer w/o enclosures
R. L. Gambrell w/o enclosures

Appendix I-6

COPY Station # 65-708 1979

THIS FORM TO BE ATTACHED TO EACH FORM 432 AND/OR JOB ORDER FOR REGULATOR INSTALLATION

REGULATOR AND RELIEF VALVE SELECTION
FORM 761 (REV. 10-77)

JOB ORDER NUMBER

ATION DESCRIPTION: McGeorge, West of Monroe
O.S.U. Campus (Vet Village)

TOWN: Stillwater

ATLAS PAGE

SEC ___ T ___ R ___

EXISTING REG. ☒

PROPOSED REG. ☐

REGULATOR INFORMATION

THIS SETTING IS: ☐ LINE REG. ☐ BORDER STA. ☐ DIST. REG. ☒ SERVICE LINE

LOAD DESCRIPTION: (South Regulator) Residential & Commercial 47.1 MCFH

REGULATION IS ☐ UPSTREAM ☒ DOWNSTREAM OF METER(S)

Two Stage Setting: ☐ First Cut ☐ 2ND Cut

Monitor Setting: ☐ Monitor Reg. ☐ Control Reg.

Parallel Runs: ☒ Primary Reg. ☐ Stand-by Reg.

Regulator Supplies Isolated System ☒

NORMAL OPERATING RANGE DATA

	Maximum	Minimum
Hourly Load	47.1 Mcfh	20 Mcfh
Inlet Pressure	60 psig	50 psig
Outlet Pressure (1)	35 ~~oz.~~ - psig	35 ~~oz.~~ - psig
Regulating Capacity	148 Mcfh	113 Mcfh

Pressure of connecting lines

	Design (2)	MAOP
Inlet	60 psig	60 psig
Outlet	60 ~~oz.~~ psig	60 ~~oz.~~ psig

and Model No. Rockwell 441-575 Body Size 2"

ice Size 1.5" Spring Size 30-55# (Brown) ~~Cg~~ K Factor 4270

RELIEF VALVE INFORMATION

☒ Relieves above regulator only
☐ Relieves ___ regulators in this setting

Regulator Failure: (14.4 + ___ (5)) (___ (6) = Cg) (1.29) (7) = ___ (8) = Qf cfh

Capacity: (14.4 + 60 (5)) (4270 (6) = K) / 2 OR = 158,844 (8)' = Qf cfh

Less: Capacity of Internal Relief Valve, If any ___ cfh

Required Relief Valve Capacity 158,844 cfh

Maximum Relief Valve Inlet Pressure (3) 40 ~~oz.~~ psig

Relief Valve Set Pressure (4) 40 ~~oz.~~ psig

Make and Model American Axial Flow + 1"x1½" Farris 1875-R (187,345 CFH) (19,380 CFH)

Capacity 206,725 TOTAL cfh Inlet and Outlet Size 2" X 2"

Type of loading: ☒ Spring ☐ Weight ☐ Lever & Weight ☒ Pilot

Regulator Failure Capacity Formula: Pi x Cg x 1.29 = Qf OR KPI / 2 = Qf
(Pi = Atmospheric Pressure & MAOP at Regulator Inlet in psi.
Cg = Regulator Valve Coefficient from Manufacturer's Data.
1.29 = Factor to correct spec. grav. of air(1.0) to 0.6 Nat. Gas
(8)' = Total cfh to be relieved at 100% open Reg. Failure

DISTRICT
B. Holle
Prepared By

Approved

STANDARD DATA

(1) Set pressure to be 5.333 oz. (9.236"wc) for all LP Service Regulators.

(2) Design pressure to be maximum of a range below.
LP.-2 to 8 oz.
M.P. (A)-Less than 12 psig
(B)-12 to 60 psig
I.P.-60 to 125 psig
HP. (A)-125 to 500 psig
(B)-500 to 800 psig
(C)-Over 800 psig

(3) Maximum build-up on outlet system must NOT EXCEED, for:
LP.-14 oz. (24.20" wc)
M.P. (A)-MAOP + 50%
(B)-MAOP + 6.0 psig
I.P.-MAOP + 10%
HP.-MAOP + 10% up to 75% of SMYS

(4) LP. Relief must begin at 12 oz. (20.76" wc)

General Office Approvals

	Initial	Date
Oper. Supt.		
Meas.		
Tech. Serv.		

Appendix I-7

FORM 702

INSTALL J.O. NUMBER	REQUISITION NUMBER	LINE OR PLANT	REMOVAL J.O. NUMBER
515-36-44(73)		Stillwater	615-36-00(73)

SETTINGS	SERVICE MATERIAL	LINE FITTINGS	SIZE	WEIGHT	TYPE & GRADE	LINE PIPE INSTALLED	MATERIAL SUMMARY	REMOVED	ABAN'D
	42'		4½"	5.84#	1	42'	pipe, A-25 B&S C&W (.125)		
20'			3/8"	.1271#	1		tubing pressure		
	2	2	4"		1		ell, weld lt. wt. 90°		
		2	4"		ONG		bulge caps		
		1	17-D		1		anode galvopak		
1					1		meter and regulator setting per dwg. #385.1155.		
9			2"		ONG		bulge caps (fence)		
63'			2-3/8	3.00#	1		pipe, structural (fence)		
84'			1"	1.68#	1		pipe, A-25 P.E. (fence)		
42'			1"	1.68#	1		tubing pressure (fence)		
62"			5'		1		chain link fence 11 guage		
							16-M meter and regulator setting	1	

COPY

DESCRIBE WORK COMPLETED (SHOW BEGINNING AND ENDING POINTS AND LAY OF LINE OR PROPERTY LINE MEASUREMENTS.)

Installed 42' of 4½" C&W M-P service pipe beginning at a point 586' West and 36' South of the [center] of Monroe and McGeorge, at existing valve #319, thence south to a point 57' South [of t]he center of McGeorge then west to a point 57' South and 599' West of the center of Monroe and McGeorge where we installed 1- GT16 meter and regulator setting per dwg. #385.1155. Removed the 16M meter and regulator setting from Walnut and McElroy.

A double order was made on 1-2" axial flow valve and the 2" regulators. These items will be transferred to another job when the numbers are made available.

SEC. 15 TWP. 19N RGE. 2E COUNTY Payne S.D. 16 TWP. OR CITY Stillwater

MONTH OF LAST ENTRY AND/OR LIST OF OUTSTANDING ENTRIES: August, 1973

CONTRACTOR: | CONTRACT NO.:

ONG INSPECTOR OR FOREMAN: G. Casebolt & B. W. Holle

TYPE OF SOIL	PIPE SIZE PLASTIC	PIPE SIZE STEEL	FEET MACH DITCHED	FEET HAND DITCHED	FEET PLOWED	FEET BORED	COATING USED (CODE)
Clay		4½"	42'				EGPY

DEPTH OF LINE: 30"

SQ. YDS. PAVING CUTS:

CATHODIC PROTECTION APPLIED BY: G. Casebolt

REASONS FOR UNDER-OR OVERRUN:

RECEIVED AUG 6 1973 SERVICE CENTER ACCT.

TEST DATA

MEDIUM		PRESSURE		DURATION		LEAKS & FAILURES NO	TYPE	HOW REPAIRED
AIR	X	BEGIN 90 PSIG		9:30 A.M.	5-11-73 DATE			
GAS								
WATER		END 90 PSIG		11:30 A.M.	5-11-73 DATE			
[OTH]ER								

[TEST]ER'S NAME: M. P. Robison & J. Kates

PRESSURE TEST BY: G. Casebolt

PREPARED BY: Robert Knot DATE: 8-2-73

APPROVED BY: [signature] DATE:

	INSTALL JOB	REMVL JOB
DATE STARTED	5-7-73	5-11-73
DATE COMPLETED	7-27-73	7-27-73
MAN HRS. WORKED	185	36

Appendix I-8

RUE YNE 15 R-2-E STIL 515 615

REGULATOR AND RELIEF VALVE SELECTION AND RIS SYSTEM DATA
FORM 761 (11-92)

COPY

FORM DISTRIBUTION:
ORIGINAL-DISTRICT
COPY-G. O. MEASUREMENT--FILE

THIS FORM TO BE ATTACHED TO EACH FORM 432 AND/OR JOB ORDER FOR REGULATOR INSTALLATION

TATION INFORMATION

ATION NO.	MTR. & REG. TECH. NO.	TOTAL NO. REG. IN SETTING	TOTAL NO. RV IN SETTING
9111-6311	07017	04	00

JOB ORDER NO. 21532751112000001 | INSTALL DATE 020791

LOCATION DESCRIPTION: 1300 Block N. Western

QTR. 10 | SEC. 19 | TWP. N | RGE. 02E | TRANS. LINE NO. | TYPE SET ▶ [X] NEW [ ] EXIST | TOTAL CONNECTED LOAD-MCFH 155.1

TOTAL CONNECTED LOAD DESCRIPTION AND TYPE EQUIPMENT

1 - Boiler @ 25.1 mcfh Future Additional Boiler @ 30 mcfh

CITY LIMITS ▶ [X] INSIDE [ ] OUTSIDE | AD VALOREM REF NO.

TOWN: STILLWATER | ATLAS: 21 | NODE | NODE

REGULATOR INFORMATION | **REGULATOR POSITION**

REGULATOR IS [ ] UPSTREAM [X] DOWNSTREAM FROM METER(S). [ ] LINE [ ] DISTRICT [ ] CB [ ] SERVICE LINE

ACTUAL OPERATING RANGE DATA	MAXIMUM	MINIMUM	PRESSURES OF CONNECTING LINE	DESIGN	MAOP
HOURLY LOAD ①	155.1 MCFH	5 MCFH	INLET	275 PSIG	175 PSIG
INLET PRESS.	75 PSIG	75 PSIG	OUTLET	60 PSIG	60 PSIG
ET PRESS.	35 psiig	35 psiig			
REG. CAP	157.5 MCFH ②	157.5 MCFH	INITIAL REG. SET PRESSURE	35.0 OZ PSIG	

MINIMUM REGULATORY CAPACITY ② MUST EQUAL OR EXCEED MAXIMUM HOURLY LOAD ①

MULTI STAGE SETTING: SECOND CUT | MONITOR SETTING: CONTROL REGULATOR

PARALLEL RUNS: PRIMARY REGULATOR | REG. SUPPLIES ISOLATED SYS.: YES

REG. MAKE/MODEL NO.: MONI FLOW GRID | SERIAL NO.: 47991

REG. BODY SIZE: 2.000 | REG. ORIFICE SIZE: 50% CAP

REG. SPRING / SPRING COLOR / PRESSURE RANGE: | PILOT SPRING / COLOR / PRESSURE RANGE: BLUE

PILOT OVER-RIDE / PILOT SPRING / COLOR / PRESSURE RANGE: | REGULATOR SIZING CG ~~ORIFICE~~ FACTOR: 6210

REG. SEAT TYPE: SOFT | MAX. REG. PRESS. RATING: 285 PSIG

PILOT MAKE/MODEL: MONI SERIES 20 | TRIM: 50 %

CONTROLS FROM LINE: CPIP | CONTROLS TO LINE: UNIV MP

NOTE: *SEE REVERSE SIDE FOR RELIEF VALVE INFORMATION, REGULATOR FAILURE CAPACITY, AND STANDARD DATA INFORMATION.*

DISTRICT APPROVAL

PREPARED BY: Bill Holle

Appendix I-9

GENERAL OFFICE

OPERATING	MEASUREMENT	ENGINEERING

Oeee

DISTRIBUTION:
ORIGINAL – MEASUREMENT
COPY – DISTRICT

This Setting Installed as backup
FORM 502 (1-84) to College 32# System. Bh

REGULATOR INSTALLATION OR REMOVAL

Date of { Installation / ~~REMOVAL~~ } 8/21 19 97

Customer Name O.S.U. Campus
Location Washington and Hall of Fame Station No.
Controls From CP MP Controls To O.S.U. Campus
Inlet Pressure 50-60# Outlet Pressure 30# Site Size
Housing—Kind & Size Open
By Pass Size 2" Type of Valve P/V Lock: Yes ___ No X
Location of Relief Valve Inlet Riser - Up stream of Meter
Other Attachments, Describe
By Pass not connected.

From Stock At Placed in Stock At

REGULATOR { JOB / WORK } ORDER NO. ___

Complete Description of Regulator

Make Sprague CL34-2 Type of Loading C. L.
Mfg. Serial No. Co. No.
Size Inlet 2" Size Outlet 2" Type Con. Sc. Flange Rating
Size Diaphragm Case Std. Actuator Size
Size Orifice .625 ☐ Double ☒ Single Type Seat Soft ~~Cage~~ K 700
Rated Pressure Range 150# Inlet To 60# Outlet 30#
Relief Valve Make Fisher 289-H Type Spring Size 1" x 1"
Set to Relieve 42# Leaks At 37# Full Relief At 42# Reseats At 39#
Inlet Gauge Make Ind. Rec. Range
Outlet Gauge Make 0-50# V-P Ind. Rec. Range
Type of Pilot Sprague C. L. Press. Range 25-60# Set At 30#
Type and Size Dehydrator Pot
Other Descriptive Information

Orange Main Spring
Silver Pilot Spring.

{ Installation / ~~REMOVAL~~ } Made By Bill Holle

Appendix I-10

JLATOR AND RELIEF VALVE SELECTION
.D RIS SYSTEM DATA
AM 761 (7-93)

FORM DISTRIBUTION:
ORIGINAL-DISTRICT
COPY-G. O. MEASUREMENT--FILE

THIS FORM TO BE ATTACHED TO EACH FORM 432 AND/OR JOB ORDER FOR REGULATOR INSTALLATION

STATION INFORMATION

STATION NO.	MTR. & REG. TECH. NO.	TOTAL NO. REG. IN SETTING	TOTAL NO. RV IN SETTING	JOB ORDER NO.	INSTALL DATE
	0707	01	01	21537251240000 1	

LOCATION DESCRIPTION: Washington & Hall of Fame (West side of O.S.U. Power Plant Meter Building)

QTR.	SEC.	TWP.	RGE.	TRANS. LINE NO.	TYPE SET ▶	TOTAL CONNECTED LOAD-MCF
NE	15	19N	02E		XX NEW ☐ EXIST	2

TOTAL CONNECTED LOAD DESCRIPTION AND TYPE EQUIPMENT: 2 MCFH Commercial and Residential

CITY LIMITS ▶ XX INSIDE ☐ OUTSIDE — AD VALOREM REF NO. 6046516

TOWN	ATLAS	NODE	NODE
STILLWATER	7		

REGULATOR INFORMATION — REGULATOR POSITION 01

REGULATOR IS [X] UPSTREAM [ ] DOWNSTREAM FROM METER(S). [X] LINE [ ] DISTRICT [ ] CB [ ] SERVICE LI

OPERATING RANGE DATA	MAXIMUM	MINIMUM	PRESSURES OF CONNECTING LINE	DESIGN	MAOP
HOURLY LOAD ①	2.0 MCFH	0 MCFH	INLET	60 PSIG	60 PSI
INLET PRESS.	60 PSIG	50 PSIG	OUTLET	60 XX PSIG	60 XX PSI
SET PRESS.	30 psiig	30 psiig			
REG. CAP	212 MCFH ②	211 MCFH			

MINIMUM REGULATORY CAPACITY ② MUST EQUAL OR EXCEED MAXIMUM HOURLY LOAD ①

MULTI STAGE SETTING ____ CUT — MONITOR SETTING ____ REGULATOR

PARALLEL RUNS ____ REGULATOR — REG. SUPPLIES ISOLATED SYS. NO

REG. MAKE/MODEL NO. SPG CL 34-2 — SERIAL NO. ____

REG. BODY SIZE 2.000 — REG. ORIFICE SIZE .6250

REG. SPRING / SPRING COLOR / PRESSURE RANGE: ORANGE — PILOT SPRING / COLOR / PRESSURE RANGE: SILVER 25-60 psig

PILOT OVER-RIDE / PILOT SPRING / COLOR / PRESSURE RANGE: ____ — REGULATOR SIZING XXXXXXXX K FACTOR 7000

REG. SEAT TYPE: SOFT — MAX. REG. INLET PRESS. RATING 150 PSIG

PILOT MAKE/MODEL: SPG CL — MAX. REG. OUTLET CASING PRESSURE 80 PSIG

CONTROLS FROM LINE: CPMP — CONTROLS TO LINE: MP SERV — TRIM ____ %

NOTE: *SEE REVERSE SIDE FOR RELIEF VALVE INFORMATION, REGULATOR FAILURE CAPACITY, AND STANDARD DATA INFORMATION.*

DISTRICT APPROVAL: Dale S.

PREPARED BY: Bill Holle 4/96

GENERAL OFFICE	OPERATING	MEASUREMENT	ENGINEERING

Appendix I - 11

REGULATOR AND RELIEF VALVE SELECTION AND COMPLIANCE SYSTEM DATA

FORM DISTRIBUTION:

ORIGINAL: Region

Form 761 (12/2020)

THIS FORM TO BE ATTACHED TO EACH FORM 432 AND/OR JOB ORDER FOR REGULATOR INSTALLATION

STATION INFORMATION

Station Number 7-751-2- Maint No. Total No Of Regs: 01 Total No of RVs: 01

Job Order Number Installation Date

Location Description: OSU CITY GATE
MCELROY AND RAMSEY
STILLWATER, OK

QTR SW/4 SEC 11 T 19N R 02E Line No. Type of Setting: PROPOSED

Total Connected Load, 19.7 Mcf/h

Load Description and Type of Equipment

OSU DISTRIBUTION SYSTEM

City Limits INSIDE Ad Valorem Reference Number

Town STILLWATER Atlas Page 0000 Inlet Node 0000M Outlet Node 0000M

REGULATOR INFORMATION

REGULATOR POSITION 111

REGULATOR IS: DOWNSTREAM FROM METER(S) SETTING IS: CITY/TOWN GATE

OPERATING RANGE DATA

	MAXIMUM	MINIMUM
Hourly Load	19.7 Mcf/h (1)	1.0 Mcf/h
Inlet Pressure	55 psig	40 psig
Set Pressure	30 psig	25 psig
Regulator Cap'y	35.2 Mcf/h	22.2 Mcf/h (2)

Minimum Regulator Capacity (2) must equal or exceed maximum hourly load (1).

PRESSURE OF CONNECTING LINES

	DESIGN	MAOP
Inlet:	0060 psig	0060 psig
Outlet:	0060 psig	0035 psig

Multi-Stage Setting Cut

Parallel Runs Regulator

Regulator Make/Model FSH 299H

Reg Body Size 2.000 inches

Main Spring Size ZINC (14 TO 35 PSIG)

Reg Seat Type NITRILE

Trim %

Pilot Make/Model

Pilot Spring Size

Controls From Line HP To Line SVC

Monitor Setting Regulator

Regulator Serves Isolated System? NO

Serial Number

Reg Orifice Size 0.7500 inches

Reg Sizing Cg Factor 430.0 C1=31.0

Max Reg Inlet Pressure Rating 0150 psig

Max Reg Outlet Pressure Rating 0066 psig

Override Pilot Make/Model

Override Pilot Spring

Override Pilot Set Pressure psig

NOTE: SEE REVERSE SIDE FOR RELIEF VALVE INFORMATION, REGULATOR FAILURE CAPACITY, AND STANDARD DATA INFORMATION

REGIONAL APPROVAL

DIVISIONAL OFFICE

OPERATING	ENGINEERING

PREPARED BY

KRISTOPHER MENDOZA 10/11/2022

OVERPRESSURE PROTECTION (OPP) TYPE: Relief Valve

TYPE OF OVERPRESSURE ALARM: Full Capacity Relief Valve
SET PRESSURE: 35 psig

RELIEF VALVE INFORMATION | **RELIEF VALVE POSITION 111**

No. Regulators Relieved 01 RV Make and Model FSH 289P-6358B w/ RED (30 TO 100 PSIG) Spring
Inlet Size 1.00 Outlet Size 1.00 Serial No Type of Loading PILOT
Regulator Failure Cg Factor 430.0

*SIZED ON: MAOP

(5) ATMOSPHERIC PRESSURE + MAOP OR MOP (HP ONLY) AT REG INLET IN PSIG*
(6) REGULATOR FAILURE COEFFICIENT FROM MANUFACTURER'S DATA
(7) FACTOR TO CORRECT SPECIFIC GRAVITY FROM AIR (1.0) TO NATURAL GAS (0.6)
(8) TOTAL CF/H TO BE RELIEVED AT 100% OPEN REGULATOR FAILURE
FOR FACTORS OTHER THAN Cg OR K, REFER TO MFG'RS DATA OR DIVISIONAL ENG'RING

REGULATOR FAILURE CAPACITY:

Cg: (14.4 + 60.0) (430.0) (1.29) = 41301 ==> cf/h / 1000 = 41.3 Mcf/h
(5) (6) (7) (8)

K: (14.4 +) ( ) / 2 =

Cv: (14.4 +) ( ) / 2 =

Required Relief Valve Capacity		41.3	Mcf/h
Maximum Relief Valve Inlet Pressure	(3)	41	psig
Relief Valve Set Pressure	(4)	35	psig
Individual Relief Valve Capacity		47.1	Mcf/h
Total Setting Relief Valve Capacity		47.1	Mcf/h
Relief Valve Orifice Size		1.00	inches
Relief Valve Vent Size		1.00	inches
Relief Valve Inlet Pressure Rating		0083	psig
Relief Valve Outlet Pressure Rating		0066	psig

FOR MULTIPLE RELIEF VALVES

NO.	SET PRESSURE	CAPACITY
(1)	_____ psig	_____ Mcf/h
(2)	_____ psig	_____ Mcf/h
	TOTAL CAPACITY	**Mcf/h**

NOTE: ATTACH EXTRA DATA SHEET FOR EACH RELIEF VALVE

STANDARD DATA INFORMATION

(1) SET PRESSURE TO BE 5.3 OZ/SIG (9.2 in. WC) FOR ALL LP SERVICE REGULATORS
(2) DESIGN PRESSURE TO BE A MAXIMUM OF A RANGE BELOW:
LP - 14 OZ/SIG
MP A - LESS THAN 12 PSIG
B - 12 TO 60 PSIG
IP - 60 TO 100 PSIG
HP A - 100 TO 500 PSIG
B - 500 TO 800 PSIG
C - OVER 800 PSIG

(3) MAXIMUM PRESSURE ON OUTLET SYSTEM MUST NOT EXCEED, FOR:
LP - 14 OZ (24.26 IWC)
MP A - 1.5 x MAOP
B - MAOP + 6.0 PSIG
IP - 1.1 x MAOP
HP - 1.1 x MAOP, UP TO 75% OF SMYS
NOTE: MAOP = Maximum Allowable Operating Pressure

(4) LP RELIEF MUST BEGIN NO HIGHER THAN 12 OZ/SIG

*Maximum Allowable Operating Pressure (MAOP) of the line upstream of the regulator must also be used to determine the regulator failure capacity when sizing required relief valve capacities of regulator settings controlling pressure from I.P. to M.P., I.P. to L.P., and M.P. to L.P. systems.

Exceptions may be made to allow the use of actual Maximum Operating Pressure (MOP) in lieu of Maximum Allowable Operating Pressure (MAOP) on regulator setttings that are served from H.P. systems. These exceptions must be approved by the Divisional Engineering design section.

NOTE: when operating conditions change outside the original design conditions, the setting components must be reviewed by Divisional Engineering to ensure they are suitable for the new operating conditions.

VALVE INFORMATION

ON LP SYSTEMS, USE FULL PORT ISOLATION VALVE BELOW/RELIEF VALVE TO AVOID EXCESSIVE PRESSURE BUILD-UP/REDUCED VALVE CAPACITY.
FOR LP SYSTEMS ONLY, COMPLETE THE FOLLOWING INFORMATION REGARDING ISOLATION VALVING BELOW RELIEF VALVE.

MANUFACTURER:

VALVE TYPE (Ball, Plug, Etc.) :

SIZE:

MODEL/FIGURE NO:

CHAPTER 15 - NG Maintenance Forms

Various Natural Gas Maintenance and Inspection Forms

KEY VALVE INSPECTION FORM

KEY VALVE INSPECTIONS are completed once per calendar year.

DATE		
Valve Number	**Location**	**Smart Number**
Problem Noted:		
Action Taken:		

DATE		
Valve Number	**Location**	**Smart Number**
Problem Noted:		
Action Taken:		

DATE		
Valve Number	**Location**	**Smart Number**
Problem Noted:		
Action Taken:		

Operator (Print Name) _____ Operator Signature _____

I hereby certify that I have inspected this valve and found it to be Acceptable _____ Unacceptable _____

Inspection notes after correction of unacceptable findings: _____

Inspector (Print Name) _____ Inspector Signature _____

PIPE JOINING FORM

FUSION 1			
Type of Joint	Butt Fusion	Electrofusion	Metallic Weld
Items Joined			
Size and Material			
Start Time			
Electrofusion Info Only			
Fusion Time	Clamp Time	Voltage	

FUSION 2		
Items Joined		
Size and Material		
Start Time		
Electrofusion Info Only		
Fusion Time	Clamp Time	Voltage

FUSION 3		
Items Joined		
Size and Material		
Start Time		
Electrofusion Info Only		
Fusion Time	Clamp Time	Voltage

FUSION 4		
Items Joined		
Size and Material		
Start Time		
Electrofusion Info Only		
Fusion Time	Clamp Time	Voltage

_____ _____

Operator (Print Name) Operator Signature

I hereby certify that I have inspected this joint and found it to be Acceptable _____ Unacceptable _____

_____ _____

Inspector (Print Name) Inspector Signature

If joint is unacceptable, action taken to correct: _____

_____

I hereby certify that I have inspected this joint and found it to be Acceptable _____ Unacceptable _____

_____ _____

Inspector (Print Name) Inspector Signature

PRESSURE TEST FORM

DATE	
Test Station Location	
Test Station Length	
Pipe Material	**Pipe Size**
Test Medium	
Time Started	**Time Ended**
Pressure at Start	**Pressure at End**
Reason for any line loss that occurred:	
Repairs made to correct leakage:	
Insert sketch of piping layout or make one on reverse side of this form.	

Operator (Print Name)

Operator Signature

SNIFF TEST FORM

SNIFF TESTS are completed quarterly.

DATE:

West Campus (Small Grains)		
Specific Location		
Odor Noted	**YES**	**NO**
Action taken if no odor was detected.		

Main Campus		
Specific Location		
Odor Noted	**YES**	**NO**
Action taken if no odor was detected.		

North Campus		
Specific Location		
Odor Noted	**YES**	**NO**
Action taken if no odor was detected.		

Operator (Print Name)

Operator Signature

SURVEILLANCE and PATROLLING INSPECTION FORMS

Performed twice each year for entire system.
New form to be completed each day. Use back of sheet or multiple sheets if necessary.

Date _____

Vegetation and Insect Survey

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Above-Ground Corrosion Inspection

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Problem area: _____ Action taken: _____

Survey Results Notes:

_____

_____

_____

_____

_____

_____ _____

Operator (Print Name) Operator Signature

CHAPTER 16 – PE and Metallic Pipe Joining Procedures

PLASTIC PIPE FUSION INSTRUCTIONS

Designation: F2620 – 13

An American National Standard

Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings[1]

This standard is issued under the fixed designation F2620; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice describes procedures for making joints with polyethylene (PE) pipe and fittings by means of heat fusion joining in, but not limited to, a field environment. Other suitable heat fusion joining procedures are available from various sources including pipe and fitting manufacturers. This standard does not purport to address all possible heat fusion joining procedures, or to preclude the use of qualified procedures developed by other parties that have been proved to produce reliable heat fusion joints.

1.2 The parameters and procedures are applicable only to joining polyethylene pipe and fittings of related polymer chemistry. They are intended for PE fuel gas pipe per Specification D2513 and PE potable water, sewer and industrial pipe manufactured per Specification F714, Specification D3035, and AWWA C901 and C906. Consult with the pipe manufacturers to make sure they approve this procedure for the pipe to be joined (see Appendix X1).

NOTE 1—Information about polyethylene pipe and fittings that have related polymer chemistry is presented in Plastics Pipe Institute (PPI) TR-33 and TR-41.

1.3 Parts that are within the dimensional tolerances given in present ASTM specifications are required to produce sound joints between polyethylene pipe and fittings when using the joining techniques described in this practice.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 The text of this practice references notes, footnotes, and appendixes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the practice.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2513 Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

F1056 Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings

2.2 *PPI Documents:*

TR-33 Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene[3]

TR-41 Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping[3]

2.3 *AWWA Documents:*

AWWA C901 Standard for Polyethylene (PE) Pressure Pipe and Tubing, ½ in. (13 mm) through 3 in. (76 mm), for Water Service[4]

AWWA C906 Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1575 mm), for Water Distribution and Transmission[4]

3. Summary of Practice

3.1 The principle of heat fusion joining of polyethylene (PE) pipe is to heat two prepared surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion.

3.2 The heat-fusion procedures covered in this practice are socket fusion, butt fusion, and saddle fusion.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.20 on Joining.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

[4] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

*A Summary of Changes section appears at the end of this standard

3.2.1 *Procedure 1, Socket Fusion*—The socket-fusion procedure involves simultaneously heating the outside surface of a pipe end and the inside of a fitting socket, which is sized to be smaller than the smallest outside diameter of the pipe. After the proper melt has been generated at each face to be mated, the two components are joined by inserting one component into the other. See Fig. 1. The fusion bond is formed at the interface resulting from the interference fit. The melts from the two components flow together and fuse as the joint cools. Optional alignment devices are used to hold the pipe and socket fitting in longitudinal alignment during the joining process; especially with pipe sizes IPS 3 in. (89 mm) and larger. Automated socket fusion is not addressed in this procedure.

3.2.2 *Procedure 2, Butt Fusion*—The butt-fusion procedure in its simplest form consists of heating the squared ends of two pipes, a pipe and a fitting, or two fittings, by holding them against a heated plate, removing the heater plate when the proper melt is obtained, promptly bringing the ends together, and allowing the joint to cool while maintaining the appropriate applied force.

3.2.2.1 An appropriately sized butt fusion machine is used to clamp, align and face the pipe or fitting ends and to apply the specified fusion force. See Fig. 2.

3.2.3 *Procedure 3, Saddle Fusion*—The saddle-fusion procedure involves melting the concave surface of the base of a saddle fitting, while simultaneously melting a matching pattern on the surface of the pipe, bringing the two melted surfaces together and allowing the joint to cool while maintaining the appropriate applied force. See Fig. 3.

3.2.3.1 An appropriately sized saddle fusion machine is used to clamp the pipe main and the fitting, align the parts and apply the specified fusion force.

4. Significance and Use

4.1 The procedures described in Sections 7 – 9 are primarily intended for (but not limited to) field joining of polyethylene (PE) pipe and fittings, using suitable equipment and appropriate environmental control procedures. When properly implemented, strong pressure/leak-tight joints are produced. When these joints are destructively tested, the failure occurs outside the fusion joined area.

4.2 Melt characteristics, average molecular weight and molecular weight distribution are influential factors in establishing suitable fusion parameters; therefore, consider the manufacturer's instructions in the use or development of a specific fusion procedure. See Annex A1.

4.3 The socket fusion, butt fusion, and saddle fusion procedures in this practice are suitable for joining PE gas pipe and fittings, PE water pipe and fittings, and PE general purpose pipes and fittings made to PE product specifications from organizations such as ASTM, AWWA, API, and ISO that are used in pressure, low pressure and non-pressure applications. For gas applications, qualification of the procedure by testing joints made using the procedure in accordance with regulations from the authority having jurisdiction are required.

5. Operator Experience

5.1 Skill and knowledge on the part of the operator are required to obtain a good quality joint. This skill and knowledge is obtained by making joints in accordance with proven procedures under the guidance of skilled operators. Evaluate operator proficiency by testing sample joints.

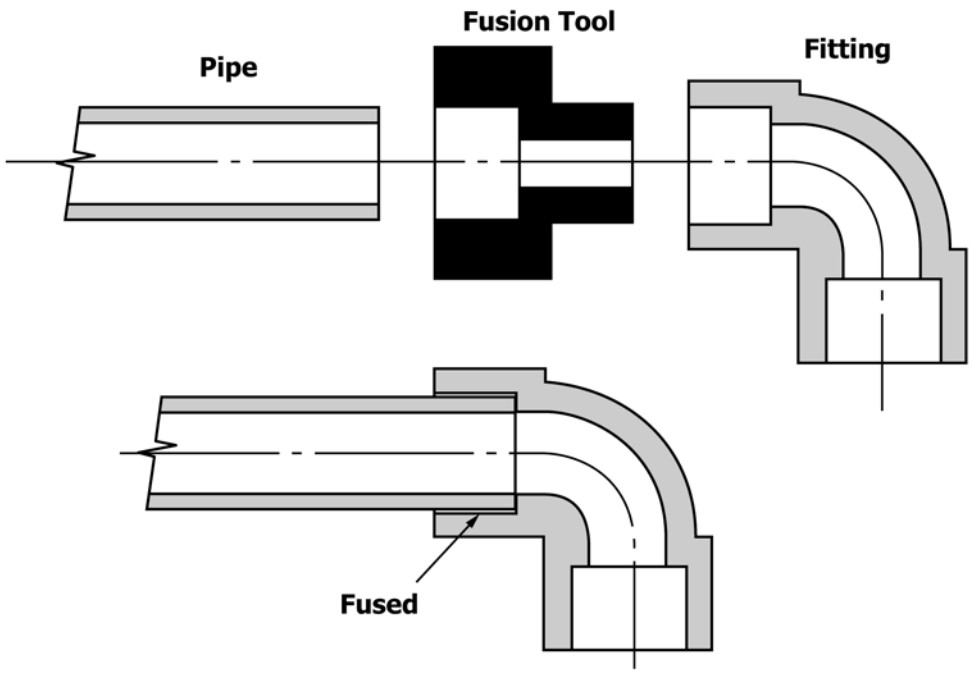


FIG. 1 Socket Fusion

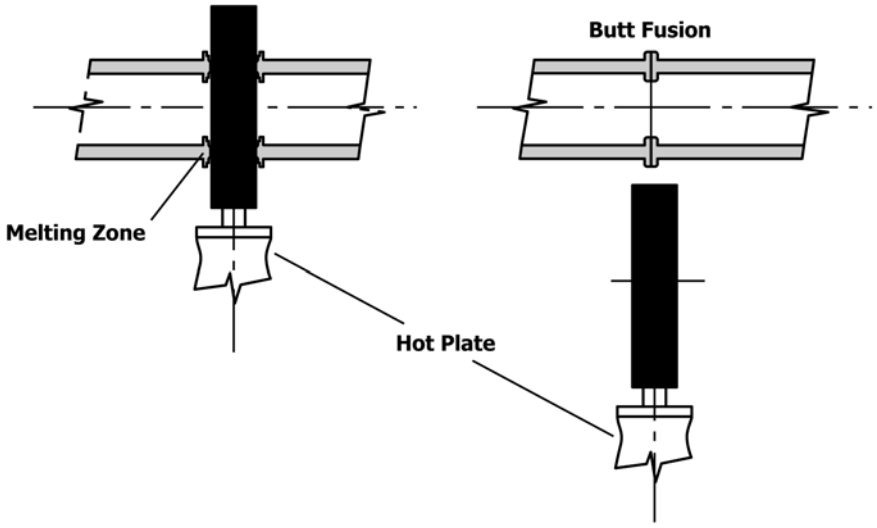


FIG. 2 Butt Fusion

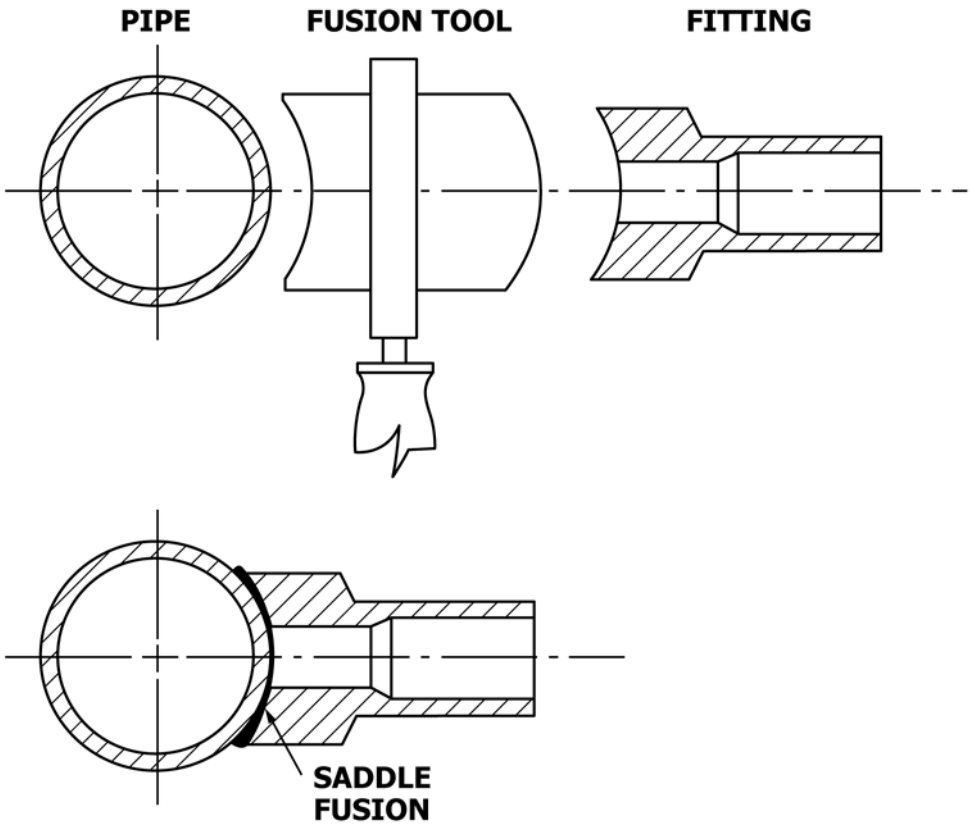


FIG. 3 Saddle Fusion

5.2 The party responsible for the joining of polyethylene pipe and fittings shall ensure that detailed procedures developed in conjunction with applicable codes and regulations and the manufacturers of the pipe, fittings, and joining equipment involved, including the safety precautions to be followed, are issued before actual joining operations begin.

6. Apparatus—General Recommendations

6.1 *Heating Tool*—Electric heating tools come in a variety of sizes that match the fusion machines capabilities. They are designed with enough wattage and electronic control to maintain the specified heater face temperature required in this procedure. The range of the heater control shall be larger than the heating temperature specification (the typical control range is 50°F (30°C) above and below the maximum and minimum required heating tool surface temperatures. Electric heating plates maintain consistent fusion temperatures when provided with an adequate power source.

6.2 *Heating Tool Faces*—Heating tools may be made from materials such as aluminum, stainless steel, copper, or copper alloys. Polyethylene material may stick to hot metal heating surfaces. This sticking may be minimized by applying a non-stick coating to the heating surfaces or by fitting a high-temperature, non-stick fabric over the heating surfaces. The heating plate surfaces, coated or uncoated, shall be kept clean and free of contaminants such as dirt, grease and plastic build-up, which may cause excessive sticking and create unsatisfactory joints. Most of these contaminants are removed from the hot tool surfaces using a clean, dry, lint-free, non-synthetic cloth such as cotton. Do not use synthetic fabrics which may char and stick to the fusion surface. Some pigments, such as carbon black, may stain a heating surface and probably cannot be removed; such stains will not contaminate the joint interface.

6.2.1 After a period of time in service, non-stick coatings or fabrics will deteriorate and become less effective. Deteriorated fabrics shall be replaced, and worn, scratched, or gouged non-stick coatings shall be re-coated when they lose effectiveness. Heat fusion quality may be adversely affected by deteriorated non-stick surfaces. Spray-on chemicals, such as non-stick lubricants or oils shall not be applied to heating iron surfaces as they will contaminate the joint.

6.3 *Temperature Indicator*—Heating tools shall be equipped with a thermometer or other built-in temperature indicating device. This device indicates the internal temperature of the heating iron, which is usually higher than temperature of the heating tool surfaces. Use a pyrometer, or other temperature measuring device, on the first joint of the day and periodically during the day to verify the temperature of the tool face surfaces within the pipe or fitting contact area. Select multiple checkpoints to ensure uniform surface temperature. An infrared pyrometer is calibrated by comparison to a calibrated surface pyrometer and adjusted to agree on each heating tool.

NOTE 2—A significant temperature variation, that is, cold spots, on the heating tool surfaces may indicate a faulty heating iron which may need to be serviced before it can be used.

7. Procedure 1—Socket Fusion

7.1 *Apparatus:*

7.1.1 *Socket Fusion Tools*—Socket fusion tools consist of a heating tool, heating tool faces, rounding clamps (cold rings), depth gage/chamfer tools, and pipe/fittings made to ASTM specifications.

7.1.2 *Heating Tool*—In order to obtain a proper melt, it is necessary for a uniform temperature to be maintained across the heating tool faces. An electrical tool shall have sufficient wattage and control to maintain the specified surface temperature of the tool faces.

7.1.3 *Heating Tool Faces*—Consisting of two parts, a male end for the interior socket surface and a female end for the exterior pipe surface. Both parts shall be made to such tolerances as to cause an interference fit. Heating tool faces are produced to Specification F1056 dimensions, and are coated with a non-stick material to keep melted pipe and fitting material from sticking to the face.

7.1.4 *Alignment Jig*—The alignment jig is an optional tool which consists of two sets of devices holding the components in alignment to each other. One set of holding devices is fixed, and the other allows longitudinal movement for making the joint.

7.1.5 *Rounding Clamps,* (cold ring) to maintain roundness of the pipe and control the depth of pipe insertion into the socket during the joining operation.

7.1.6 *Depth Gage,* for proper positioning of the rounding clamp on the pipe.

7.1.7 *Chamfering Tool,* to bevel the end of the pipe.

NOTE 3—The depth gage and chamfering tool may be combined into a single tool.

7.1.8 *Tubing Cutter,* to obtain a square end cut on the pipe.

7.1.9 *Fitting Puller,* an optional tool to assist in the removal of the fitting from the heating tool and to hold the fitting during assembly.

7.2 *Procedure:*

7.2.1 Attach the proper size heater faces to the heating tool, and bring the surface temperature of the tool faces to 490 to 510°F (254 to 266°C). Use a pyrometer, or other temperature measuring device, on the first joint of the day and periodically during the day to verify the temperature of the tool face surfaces within the pipe or fitting contact area. Select multiple checkpoints to ensure uniform surface temperature. Heating tool thermometers measure the internal temperature of the heating tool, which is typically higher than the surface temperature of the heating tool faces.

7.2.2 Cut the pipe end squarely, and clean the pipe end and fitting, both inside and outside, by wiping with a clean, dry, lint-free, non-synthetic cloth such as cotton. If this does not remove the contamination, refer to X1.7.1.

7.2.3 Chamfer the outside edge of the pipe end slightly and fix the rounding clamp about the pipe as determined from the depth gage. (See Note 4.)

7.2.4 Clean the heater adapters by wiping them with a clean, dry, lint-free, non-synthetic cloth such as cotton to remove any contamination from the surfaces. Push the socket fitting onto the preheated fitting tool face first, and then push the pipe into the pipe-side tool face until the rounding clamps make contact with the heating faces.

7.2.5 Heat the pipe end and the fitting socket for the time required in Table 1.

7.2.6 At the end of the heating time, simultaneously remove the pipe and fitting straight out from the tool, using a snap action. Immediately insert the pipe straight into the socket of the fitting so the rounding clamp is flush against the end of the fitting socket. Hold or block the joint in place to cool for the time specified in Table 1. (For ambient temperatures 100°F and higher, additional cooling time may be needed.)

7.2.7 Remove the rounding clamp, and inspect the melt pattern at the end of the socket for a complete impression of the rounding clamp in the melt surface. There shall be no gaps, voids, or un-bonded areas. Visually inspect and compare the joint against recommended appearance guidelines (see Appendix X2). Allow the joint to cool an additional five (5) minutes before exposing the joint to any type of stresses (that is, burial, testing or fusing the other end of the fitting.)

TABLE 1 Socket Fusion Time Cycles

	PE 2406/ PE 2708		PE 3408/ PE 3608/ PE 4710	
Pipe Size	Heating Time Seconds	Cooling Time Seconds	Heating Time Seconds	Cooling Time Seconds
½ in CTS	6-7	30	6-10	30
¾ in CTS	6-7	30	6-10	30
1 in. CTS	9-10	30	9-16	30
1 ¼ in. CTS	10–12	30	10-16	30
½ in . IPS	6–7	30	6-10	30
¾ in. IPS	8–10	30	8-14	30
1 in. IPS	10-12	30	15-17	30
1¼ in. IPS	12-14	45	18-21	60
1½ in. IPS	14-17	45	20-23	60
2 in. IPS	16-19	45	24-28	60
3 in. IPS	20-24	60	28-32	75
4 in. IPS	24-29	60	32-37	75

7.2.8 Allow for extremes in weather when making field joints. Heating times, dimensional changes, etc., are affected by extreme weather conditions.

NOTE 4— Some recommend using a 50-60 grit emery or garnet cloth to roughen the outside of the pipe and inside of the fitting as a means of minimizing any possible skin interface when making the fusion. Sandpaper is not recommended for this purpose, as it might disintegrate and contaminate the joint interface. If roughening is performed, first clean the surfaces before roughening with a clean cloth or water. Once the pipe or fitting surfaces have been roughened and clean material has been exposed, water cannot be used to clean the pipe surfaces. Clean dust and particles from the roughened surfaces afterwards by cleaning the pipe or fitting ends with a clean dry lint-free, non-synthetic cloth such as cotton.

8. Procedure 2—Butt Fusion

8.1 *Apparatus:*

8.1.1 *Heating Tool*—The heating tool shall have sufficient area to adequately cover the ends of the size of pipe to be joined. This electrical tool shall have sufficient wattage and control to maintain the specified surface temperature of the tool faces. It shall also be equipped with heater faces that are coated with a non-stick material to prevent sticking to the pipe surface.

8.1.2 *Butt Fusion Machine*—A Butt Fusion Machine has three basic parts: *(1)* a stationary clamping fixture and a movable clamping fixture for aligning and holding each of the two parts to be fused. This may or may not include the power supply to operate the machine; *(2)* a facer for simultaneously preparing the ends of the parts to be joined (Note 5); and *(3)* appropriate inserts for clamping different pipe sizes or fitting shapes. Butt Fusion Machines are operated manually or hydraulically. Some have their own power supply and some require a separate generator. They are available in a variety of sizes to fuse pipe and tubing produced to ASTM and other industry specifications.

NOTE 5—A facer is a rotating cutting device used to square-off the pipe or fitting ends to obtain properly mating fusion surfaces. If so equipped, facing should continue until a positive mechanical stop on the butt fusion machine is reached.

8.1.3 *Pipe Support Stands*—Optional pipe support stands or racks are used to support the pipe at both ends of the butt fusion machine to assist with pipe loading and alignment.

8.2 *Setup:*

8.2.1 Butt fusion machine setup parameters are prescribed in Table 2.

8.2.2 An interfacial pressure (IFP) of 60 to 90 psi (0.41 to 0.62 MPa) is used to determine the force required to butt fuse the pipe components. For manually operated fusion machines, enough force should be applied to roll the bead back to the pipe surface. A torque wrench may be used to apply the proper force. Manual fusion without a torque wrench has been used successfully by many gas utilities. For hydraulically operated

TABLE 2 Butt Fusion Machine Setup Parameters

Setup Parameter		Required Condition
Manual Butt Fusion Machine	Hydraulic Butt Fusion Machine	
Set heating tool temperature and heat to specified temperature		The surface temperature of heating tool faces must be 400 to 450°F (204 to 232°C). (See X1.1.) A pyrometer or other surface temperature measuring device should be used periodically to insure proper surface temperature of the heating tool faces.
Install inserts	Install inserts	Install inserts for the pipe OD or the fitting being fused.
Electric power supply	Electric power supply	Check field generator for adequate power supply and fuel sufficient to complete the fusion joint.
Manual pressure	Set facing pressure	As required. Observe butt fusion machine manufacturer's instructions for setting facing pressure.
Manual pressure	Set heating pressure	Observe the pipe and butt fusion machine manufacturer's instructions for setting heating pressures.
Manual pressure	Set fusion joining pressure	Determine fusion joining pressure for the pipe OD and dimension ratio (DR) using 60 to 90 psi (414 to 621 kPa) interface pressure. Observe pipe and butt fusion machine manufacturer's instructions to determine the theoretical fusion joining pressure.
	Determine drag pressure	Drag pressure is the amount of pressure required to get the carriage to move. Add this pressure to the theoretical fusion joining pressure to get the actual machine gage pressure to set.

fusion machines, the IFP is multiplied by the pipe area (A_P) to obtain the fusion force required in pounds. The fusion force required is then divided by the total effective piston area (TEPA) of the fusion machine carriage to obtain the theoretical fusion pressure (TFP) (See Eq 2). The drag pressure (P_D) is then added to the TFP to obtain the fusion machine gauge pressure (P_G) in psig required by the machine, see (Eq 1). (TFP and IFP are *not* the same value.) P_D is found by bringing the faced pipe ends within 2 in. (50 mm) of each other and increase the pressure on the carriage until it starts moving. Back off the pressure until the carriage is barely moving and record the drag pressure in psig. The equations used to calculate for the fusion machine gage pressure is shown below. These equations only apply when using a hydraulic fusion machine.

$$P_G = \text{TFP} + P_D \quad (1)$$

$$\text{TFP} = (A_p \times \text{IFP})/\text{TEPA} \quad (2)$$

$$A_p = (\text{OD} - t) \times t \times 3.1416 \quad (3)$$

where:

P_G = Fusion Machine Gauge Pressure, psig
TFP = Theoretical Fusion Pressure, psig
IFP = Interfacial Pressure, 60 – 90 psig
TEPA = Total Effective Piston Area, in^2 – Supplied by fusion machine manufacturer
P_D = Fusion Machine Drag Pressure, psig
A_p = Pipe Area, in^2
OD = Pipe Outside Diameter, in
t = Pipe Wall Thickness, in

NOTE 6—Interfacial pressure is used to determine butt fusion joining pressure settings for hydraulic butt fusion machines when joining specific pipe diameters and DR's. Interfacial pressure is *not* the gauge pressure. A slide rule or a gauge pressure calculator obtained from the machine's manufacturer can be used as a tool for the calculation.

8.3 *Procedure:*

8.3.1 Clean the inside and outside of the components (pipe or pipe and fitting) to be joined with a clean, dry, lint-free, non-synthetic cloth such as cotton. Remove all foreign matter from the piping component surfaces where they will be clamped in the butt fusion machine. If this does not remove the contamination, refer to X1.7.1.

8.3.2 If applicable, place pipe support stands at both ends of the butt fusion machine and adjust the support stands to align the pipe with the fusion machine centerline. Install the pipes or fittings being joined in the stationary and movable clamps of the butt fusion machine. Leave enough pipe protruding through the clamps to allow for facing and clamp the pipe or fitting in the machine.

8.3.2.1 Take care when placing pipe or fittings in the butt fusion machine. Pipes shall be aligned before the alignment clamp is closed. Do not force the pipe into alignment by pushing it against the side of an open butt fusion machine clamp. Pipes that are freshly cut and molded fittings generally do not have toe-in, and when mated to old-cut pipe or fabricated fittings, removing toe-in can ease adjustment for high-low alignment.

8.3.3 Face the piping component ends until the facer bottoms out on the stops and is locked between the jaws to establish clean, parallel mating surfaces between the pipe/fitting ends (see Note 5). Move the carriage to separate the pipe ends from the facer, remove the facer and all shavings and debris from the facing operation by brushing away with a clean, dry, lint-free, non-synthetic cloth such as cotton. Bring the pipe/fitting ends together at facing pressure. A visual inspection of this operation should verify a square face, perpendicular to the pipe centerline on each pipe end and with no detectable gap.

8.3.4 Check the pipe ends for high-low alignment and out-of-roundness. If adjustment is needed, adjust the high side down by tightening the high side clamp. Do not loosen the low side clamp or slippage may occur during fusion. Re-face the pipe or fitting ends if excessive adjustment is required (more than 180° rotation of the clamp knob) and remove any shavings from the re-facing operation with a clean, dry, lint-free, non-synthetic cloth such as cotton. The maximum OD high-low misalignment allowed in the butt fusion procedure is to be less than 10 % of the pipe minimum wall thickness.

8.3.5 Verify that the heater surface temperatures are in the specified temperature range 400 to 450°F (204 to 232°C). (See Appendix X1.) A pyrometer or other surface temperature measuring device should be used before the first joint of the day and periodically throughout the day to insure proper temperature of the heating tool face. All pyrometers are sensitive to usage techniques. Carefully follow the manufacturer's instructions for best results.

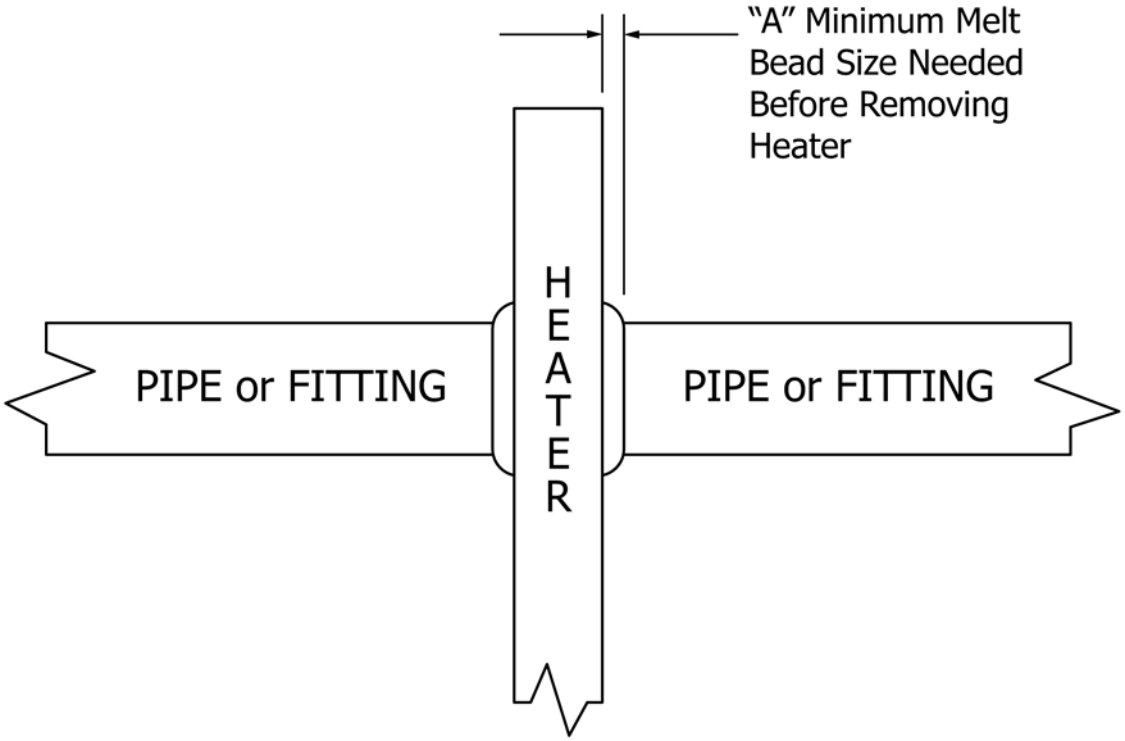
8.3.5.1 Clean the contact surfaces of the heating tool with a clean, dry, lint-free, non-synthetic cloth such as cotton. Place the heating tool in the butt fusion machine between the piping component ends and bring the pipe or fitting ends into full contact with the heating tool at fusion pressure. Briefly ensure full contact between piping component ends and the heating tool and then reduce the pressure to drag pressure but without breaking contact between the piping component ends and the heating tool. (On larger pipe sizes, (14 in. and larger) hold fusion pressure until a slight melt is observed around the circumference of the pipe or fitting before reducing pressure. This normally varies from about 10 s on 14 in. pipe to greater than 2 min on 36 and larger pipe sizes.)

8.3.5.2 Once the indication of melt is observed around the circumference of the pipe, begin the heat soak by reducing the pressure to maintain contact, without force, while a bead of molten polyethylene develops between the heater and the pipe or fitting ends. For 14 in. IPS pipe sizes and larger, maintain the heat soak for a minimum of 4.5 minutes for every inch (25.4 mm) of pipe wall thickness. (example: minimum heat soak time for a pipe with .50 in. (12.7mm) wall would be 2 min 15 s). Continue heating the pipe ends until the melt bead size has developed against the heater face per Table 3.

8.3.6 When the proper bead size is observed, quickly move the piping component ends away from the heating tool, remove the heating tool and quickly inspect the pipe ends.

8.3.6.1 Acceptable melt appears flat and smooth with no unmelted areas. Unacceptable melt appearance is any combination of a concave surface, unmelted areas, a bubbly pock-marked sandpaper-like surface or melted material sticking to heating tool surfaces (see Fig. X2.7). Low strength joints result from unacceptable melt appearance. Discontinue the joining

TABLE 3 Minimum Melt Bead Size



Pipe (OD) [Outside Diameter, in. (mm)]	"A" Minimum Bead Size, in. (mm)
< 2.37 (60)	1/32 (1)
≥ 2.37 (60) ≤ 3.5 (89)	1/16 (1.5)
> 3.5 (89) ≤ 8.62 (219)	3/16 (5)
> 8.62 (219) ≤ 12.75 (324)	1/4 (6)
> 12.75 (324) ≤ 24 (610)	3/8 (10)
> 24 (610) ≤ 36 (900)	7/16 (11)
> 36 (900) ≤ 65 (1625)	9/16 (14)

procedure, allow the component ends to cool completely and restart from 8.3.1. (See Appendix X2.)

8.3.6.2 The maximum time allowed for opening the machine, removing the heater and bringing the pipe ends together is shown in Table 4. For tubing sizes that are generally butt fused with mechanical fusion machines (not hydraulically controlled) (½ CTS to 1 ½ in. IPS), the maximum open/close time is 4 s. The quicker you can safely do this process, the better. See A1.4.3.1 for guidance on butt fusion in cold temperatures. Do not slam the pipe ends together.

NOTE 7—A concave melt surface is caused by unacceptable pressure during heating.

8.3.6.3 The correct fusion pressure rolls both melt beads over so that they touch the piping component OD surfaces. Do not use excessive or insufficient force (more than or less than the fusion interfacial pressure range). If the components are brought together with excessive force, molten material may be pushed out of the joint and cold material brought into contact forming a "cold" joint. If too little force is used, voids and weak bonded areas can develop in the joint as molten material cools and contracts.

8.3.7 Hold the molten joint immobile under fusion pressure until sufficiently cooled. Cooling under pressure before removal from the butt fusion machine is important in achieving

TABLE 4 Maximum Heater Plate Removal Times

NOTE 1—Fusion joints made in an enclosed and controlled factory fabrication environment will tolerate and may use longer maximum heater removal times.

Field Applications Pipe Wall Thickness, in. (mm)	Max. Heater Plate Removal Time Seconds
0.17 to 0.36 (5 to 9)	8
>0.36 to 0.55 (9 to 14)	10
>0.55 to 1.18 (14 to 30)	15
>1.18 to 2.5 (30 to 64)	20
>2.5 to 4.5 (64 to 114)	25

joint integrity. Maintain fusion pressure against the piping component ends for a minimum of 11 minutes per inch (25.4 mm) of pipe wall. For ambient temperatures 100°F and higher, additional cooling time may be needed. Avoid high stress such as pulling, installation or rough handling for an additional 30 min or more after removal from the fusion machine (only 10 minutes additional cooling time is required for IPS 1 in. and smaller pipe sizes). Do not apply internal pressure until the joint and surrounding material have reached ambient air temperature. (See Appendix X1.)

NOTE 8—Pouring water or applying wet cloths to the joint to reduce cooling time is not acceptable. Applying conditioned air is acceptable only as part of a controlled cooling cycle procedure where testing demonstrates that acceptable joints are produced using the controlled cooling cycle procedure.

8.3.7.1 Visually inspect and compare the joint against the butt fusion bead visual inspection acceptance guideline in Fig. 4. The v-groove between the beads should not be deeper than half the bead height above the pipe surface. When butt fusing to molded fittings, the fitting-side bead may display shape

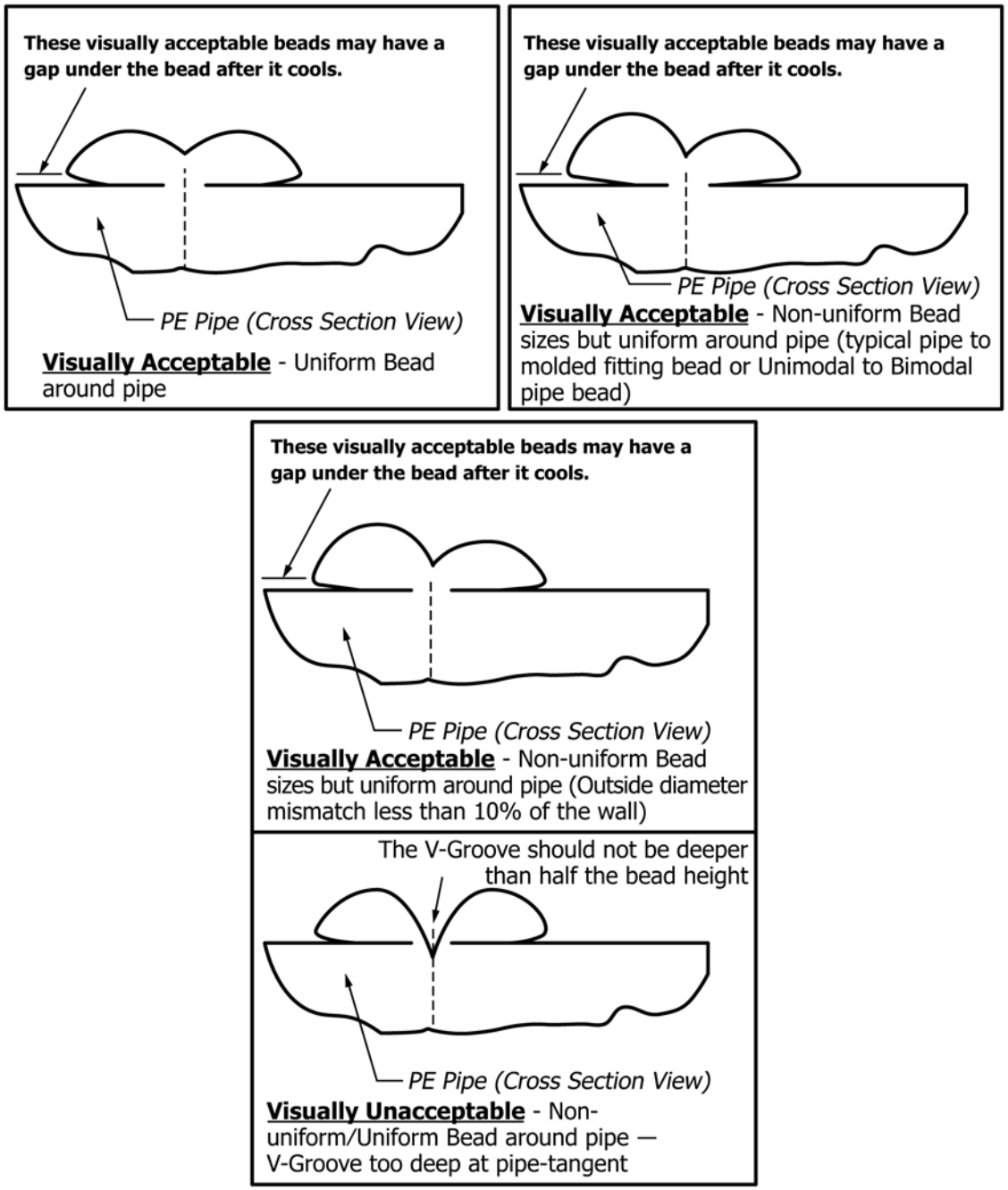


FIG. 4 Outside Diameter Butt Fusion Bead Guideline

irregularities such as minor indentations, deflections and non-uniform bead rollover from molded part cooling and knit lines. In such cases, visual evaluation is based mainly on the size and shape of the pipe-side bead. (See Appendix X2 for additional guidance.)

9. Procedure 3—Saddle Fusion

9.1 *Apparatus:*

9.1.1 *Heating Tool and Faces*—This electrical tool shall have sufficient wattage and control to maintain the specified surface temperature of the tool faces. The serrated or smooth faces are matched sets, by pipe size, of concave and convex blocks, which bolt or clamp onto a flat heating tool. The heating faces are coated with a non-stick material to prevent sticking to the pipe or fitting surfaces.

9.1.2 *Saddle Fusion Tool*—This tool clamps to the main, rounding and supporting the main for good alignment between the pipe and fitting. It holds the fitting, in correct alignment to the main. It also applies and indicates the proper force during the fusion process. A support or bolster is clamped to IPS 6 in. (168 mm) and smaller main pipe opposite the fitting installation area to support the main and assist in rounding the pipe.

9.1.3 *Optional Flexible Heat Shield*—A flexible heat resistant metal or insulated fabric pad used to help establish a melt pattern on larger mains before applying heat to the fitting.

9.2 *Saddle Fusion Terminology:*

9.2.1 *Initial Heat (Bead-up)*—The heating step used to develop an initial melt bead on the main pipe.

9.2.2 *Initial Heat Force (Bead-up Force)*—The force (lb) applied to establish an initial melt pattern on the main pipe. The Initial Heat Force is determined by multiplying the fitting base area ($in.^2$) by the initial interfacial pressure 60 ($lb/in.^2$).

9.2.3 *Heat Soak Force*—The force (lb) applied after an initial melt pattern is established on the main pipe. The Heat Soak Force is the minimum force (essentially zero pounds) that ensures that the fitting, heater and main stay in contact with each other.

9.2.4 *Fusion Force*—The force (lb) applied to establish the fusion bond between the fitting and the pipe. The fusion Force is determined by multiplying the fitting projected base area ($in.^2$) by the fusion interfacial pressure 30 ($lb/in.^2$).

9.2.5 *Total Heat Time*—A time that starts when the heater is placed on the main pipe and initial heat force is applied and ends when the heater is removed.

9.2.6 *Cool Time*—The time required to cool the joint to approximately 120°F (49°C). The fusion force must be maintained for 5 min on IPS 1¼ in. (42 mm) or 10 min for all other main sizes, after which the saddle fusion equipment can be removed. The joint must be allowed to cool undisturbed for an additional 30 min before tapping the main or joining to the branch saddle.

9.2.7 *Interfacial Area for Rectangular Base Fittings*—The major width times the major length of the saddle base, without taking into account the curvature of the base or sides, minus the area of the hole in the center of the base.

9.2.8 *Interfacial Area for Round Base Fittings*—The radius of the saddle base squared times π (3.1416) without taking into account the curvature of the base or sides, minus the area of the hole in the center of the base.

9.2.9 *Fitting Label*—The initial heat force, heat soak force and the fusion force will be listed on a fitting label in the lower right hand corner of the fitting for some manufacturer's saddle fusion fittings. This will eliminate the need to calculate the fusion forces in the field (for example, 180/0/90). If the label is not present, the heat and fusion forces need to be calculated.

9.3 *Setup:*

9.3.1 Select and install the proper heating tool faces to the heating tool based on the main size and fitting base size. Consult the pipe, fitting or equipment manufacturer's recommendations.

9.3.2 Plug in the heating tool and bring the heating tool face surfaces to 490 to 510°F (254 to 266°C) (see Table 5). A pyrometer or other surface temperature measuring device is used to determine and periodically check the heating tool surface temperature. Heating tool thermometers measure the internal temperature of the heating tool which is typically higher than the surface temperature of the heating tool faces.

9.3.3 Install the proper clamps in the Saddle Fusion Tool for the main size to be fused. Install the proper fitting clamp for the fitting to be joined. Consult the pipe, fitting or equipment manufacturer's recommendations.

9.4 *Procedure:*

9.4.1 *Preparation:*

9.4.1.1 Clean the inside and outside of the components (pipe or pipe and fitting) to be joined with a clean, dry, lint-free, non-synthetic cloth such as cotton. Remove all foreign matter from the piping component surfaces where they will be

TABLE 5 Generic Saddle Fusion Parameters

Heater Adapter Surface Temperature	500 ± 10°F (260 ± 6°C)
Initial Interfacial Pressure	60 ± 6 psi (4.14 ± 0.41 bar)
Heat Soak Interfacial Pressure	0 psi
Fusion Interfacial Pressure	30 ± 3 psi (2.07 ± 0.20 bar)
Total Heating Time on Main—1¼ in. IPS Pressure Main	15 s max
Total Heating Time on Main—2 in. IPS Pressure Main	25 to 35 s max
Total Heating Time on non-pressure 1¼ in. IPS, 2 in. IPS mains, and on pressure or non-pressure 3 in. IPS and larger mains.	Look for a 1/16 in. (1.6 mm) bead around the fitting base

clamped in the butt fusion machine. If this does not remove the contamination, refer to X1.7.1. Install the Saddle Fusion Tool on the main according to the manufacturer's instructions. The tool should be centered over a clean, dry location where the fitting will be fused. Secure the tool to the main. A main bolster or support is recommended under the pipe on IPS 6 in. (168 mm) and smaller main pipe sizes.

9.4.1.2 Abrade or scrape the surface of the main, where the fitting will be joined, approximately 0.007 in. (.178mm) deep to remove any oxidation or contamination. This can be done before or after the Tool is attached to the main. The abraded/scraped area must be larger than the area covered by the fitting base. It is important that the pipe surface be free from any type of contaminates that may be spread before the scraping or abrading process begins. Marks can be made on the outer surface of the pipe to aid in visual indication of abrading/scraping coverage, however the marks should be made with a non-petroleum based fast drying marker. After abrading/scraping, clean the pipe or fitting ends with a clean, dry, lint-free, non-synthetic cloth such as cotton. All markings on the pipe surface should be removed before beginning the heat cycle.

9.4.1.3 Abrade the fusion surface of the fitting with 50 to 60 grit utility cloth; remove all dust and residue with a clean, dry, lint-free, non-synthetic cloth such as cotton. Insert the fitting in the Saddle Fusion Tool loosely. Using the Saddle Fusion Tool, move the fitting base against the main pipe and apply about 100 lbf to seat the fitting. Secure the fitting in the Saddle Fusion Tool.

9.4.2 *Heating Procedure for Small Fittings (<2 in. IPS)* (see Table 5):

9.4.2.1 Clean the heating tool faces with a clean, dry, lint-free, non-synthetic cloth such as cotton. Place the heating tool on the main centered beneath the fitting base. Immediately move the fitting against the heater faces, apply the Initial Heat Force (see fitting label), and start the heat time. Apply the Initial Heat Force until melt is first observed on the crown of the pipe main (Initial Heat is the term used to describe the initial heating (bead-up) step to develop a melt bead on the main pipe and usually is 3 to 5 s) and then reduce the force to the Heat Soak Force (Bead-up force) (see fitting label). Maintain the Heat Soak Force until the Total Heat Time is complete. Total Heat Time ends:

(1) When the Total Heating Time expires for a pressurized IPS 1¼ in. (42 mm) or IPS 2 in. (63 mm) main, or

(2) When a melt bead of about 1⁄16 in. (2 mm) is visible all around the fitting base for a IPS 1¼ in. (42 mm) or IPS 2 in. (63 mm) non-pressurized main, or a larger pressurized or non-pressurized main, (see Table 5).

9.4.2.2 At the end of the Total Heat Time, remove the fitting from the heater and the heater from the main with a quick snapping action. Quickly check for a complete and even melt pattern on the pipe main and fitting heated surfaces (no unheated areas).

9.4.3 *Heating Procedure for Large Fittings (>IPS 3 in.) and Large Mains (>IPS 6 in.)* (see Table 5):

9.4.3.1 Place the heating tool on the main centered beneath the fitting base, and then place the Flexible Heat Shield between the heating tool and the fitting base. (This step usually requires an assistant to handle the Flexible Heat Shield).

9.4.3.2 Move the fitting against the Flexible Heat Shield, apply Initial Heat Force, and observe melt bead formation on the main all around the heating tool faces. When a melt bead is first visible on the main all around the heating tool faces, in a quick continuous motion, release the Initial Heat Force, raise the fitting slightly, remove the Flexible Heat Shield, move the fitting against the heating tool face, apply Initial Heat Force and start the heat time. When a melt bead is first visible all around the fitting base (usually about 3 to 5 s) immediately reduce applied force to the Heat Soak Force (usually zero). Maintain the Heat Soak Force until the Table 5 Total Heat Time ends.

NOTE 9—During heating, hold the heating tool in position by lightly supporting the heating tool handle. If not supported, the heating tool can slip out of position or displace the main or fitting melt and result in a poor joint.

9.4.3.3 At the end of the Total Heat Time, remove the fitting from the heater and the heater from the main with a quick snapping action. Quickly check for a complete and even melt pattern on the pipe main and fitting heated surfaces (no unheated areas). A mirror may be needed to check the bottom of the fitting.

9.4.4 *Fusion and Cooling* (see Table 5):

9.4.4.1 Whether or not the melt patterns are satisfactory, press the fitting onto the main pipe very quickly (within 3 s) after removing the heater and apply the Fusion Force (see the fitting label). Maintain the Fusion Force on the assembly for 5 min on IPS 1¼ in. (42 mm) and for 10 min on all larger sizes, after which the saddle fusion equipment may be removed. (Fusion Force adjustment may be required during Cool Time, but never reduce the Fusion Force during cooling.)

9.4.4.2 Cool the assembly for an additional 30 min before rough handling, branch joining or tapping the main. (If the melt patterns were not satisfactory or if the fusion bead is unacceptable, cut off the saddle fitting above the base to prevent use, relocate to a new section of main, and make a new saddle fusion using a new fitting.)

NOTE 10—These procedures are based on tests conducted under controlled ambient temperature conditions. Environmental conditions on a job site could affect heating and cooling times. Regardless of job site conditions or ambient temperature, the prescribed heating tool temperature is required. Do not increase or decrease the heating tool temperature. When saddle fittings are fused to pipes that are under pressure, it is important that the surface melt be obtained quickly without too much heat penetration with out exceeding the time guidelines in Table 5. Otherwise, too much heat penetration could result in pipe rupture from internal pressure.

9.5 *Visual Inspection:*

9.5.1 Visually inspect and compare the joint against visual inspection guidelines. There shall be three beads, a melt bead around the fitting base, a bead on the main from the edge of the heating tool, and a main pipe melt bead. The fitting and pipe melt beads should be rounded and about ⅛ in. (3 mm) wide all around the fitting base. The heating tool edge bead should be visible all around the fitting base, but may be separate from the main pipe melt bead.

9.5.2 The saddle fusion joint in unacceptable for use if visual bead appearance is unacceptable or if the melted surfaces were unacceptable. To prevent use, cut the fitting off at or just above the base. (See Appendix X2.)

NOTE 11—Look in the lower right hand corner of the fitting label for the forces required for that fitting in pounds force (Initial Heat Force/Heat Soak Force/Fusion Force) (for example, 180/0/90).

10. Keywords

10.1 butt fusion; fitting; heat fusion; joining; pipe; polyethylene; polyolefin; saddle fusion; socket fusion

ANNEX

(Mandatory Information)

A1. COLD WEATHER PROCEDURES

A1.1 *Cold Weather Handling*:

A1.1.1 Pipe shall be inspected for damage. Polyolefin Polyethylene pipes have reduced impact resistance in sub-freezing conditions. Avoid dropping pipe in sub-freezing conditions. When handling coiled pipe at temperatures below 40°F (4.44°C), it is helpful to uncoil the pipe prior to installation and let it straighten out. Gradually uncoil the pipe and cover it with dirt at intervals to keep it from recoiling. Always use caution when cutting the straps on coils of pipe because the outside end of a coil may spring out when the strapping is removed.

A1.2 *Preparation for Socket, Saddle, and Butt Fusion Joining*:

A1.2.1 *Wind and Precipitation*—The heating tool shall be shielded in an insulated container to prevent excessive heat loss. Shield the pipe fusion area and fusion tools from wind, snow, blowing dust, and rain by using a canopy or similar device.

A1.2.2 *Pipe and Fitting Surface Preparation*—The pipe and fitting surfaces to be "joined" or held in clamps shall be dry and clean and free of ice, frost, snow, dirt, and other contamination. Regular procedures for preparation of surfaces to be joined, such as facing for butt fusion and roughening for saddle fusion shall be emphasized. After preparation, the surfaces shall be protected from contamination until joined. Contamination of the area to be fused will likely cause incomplete fusion. Frost and ice on the surfaces of the pipe to be clamped in either a cold ring or alignment jigs may cause slippage during fusion. Inspect coiled pipe to see if it has flattened during storage, which could cause incomplete melt pattern or poor fusion. It may be necessary to remove several inches at the pipe ends to eliminate such distortion. Pipe may have a slight toe-in or reduced diameter for several inches at the end of the pipe. The toe-in may need to be removed before butt fusing to a freshly cut pipe end, or to a fitting.

A1.2.3 *Heating*—Work quickly once pipe and fitting have been separated from the heating tool, so that melt heat loss is minimized, but still take time (no more than 3 s) to inspect both melt patterns. Keep the heater dry at all times. Check the temperature of the heating tool regularly with a pyrometer or other surface temperature measuring device. Keep the heating tool in an insulated container between fusions. Do not increase heating tool temperature above the specified temperature setting. Gas-fired heating tools are used only in above freezing conditions.

A1.3 *Socket Fusion*:

A1.3.1 *Pipe Outside Diameter*—Pipe outside diameter contracts when cold. This results in loose or slipping cold rings. For best results, clamp one cold ring in its normal position adjacent to the depth gage. Place shim material (that is, piece of paper or rag, etc.) around the inside diameter of a second rounding ring and clamp this cold ring directly behind the first cold ring to prevent slippage. The first cold ring allows the pipe adjacent to the heated pipe to expand to its normal diameter during the heating cycle.

A1.3.2 *Fitting Condition*—If possible, store socket fittings at a warm temperature, such as in a truck cab, prior to use. This will make it easier to place the fitting on the heating tool because fittings contract when cold.

A1.3.3 *Heating*—At colder temperatures the pipe and fitting contract, thus the pipe slips more easily into the heating tool. At very cold outdoor temperatures (particularly with IPS 2, 3, and 4-in. pipe), the pipe may barely contact the heating surface. Longer heating times are used so that the pipe first expands (from tool heat) to properly contact the heating tool, then develops complete melt. The length of time necessary to obtain a complete melt pattern will depend not only on the outdoor (pipe) temperature but wind conditions and operator variation. Avoid cycles in excess of that required to achieve a good melt pattern. To determine the proper time for any particular condition, make a melt pattern on a scrap piece of pipe, using the heating time as instructed by the pipe manufacturer. If the pattern is incomplete (be sure rounding rings are being used), try a 3 s longer cycle on a fresh (cold) end of pipe. If the melt pattern is still not completely around the pipe end, add an additional 3 s and repeat the procedure. Completeness of melt pattern is the key. Keep the heater dry at all times. Check the temperature of the heating tool regularly and keep the heating tool in an insulated container between fusions.

A1.4 *Butt Fusion*:

A1.4.1 *Joining:*

A1.4.1.1 The fusion operator shall be aware of ambient weather conditions during the butt fusion of polyethylene pipe

and fittings and be ready and capable to make adjustments to the fusion procedure if ambient weather conditions change significantly.

A1.4.1.2 The qualified fusion procedure shall provide suitable measures for adjustment of fusion parameters, in particular the heating time, when the ambient temperature changes or during windy conditions. When the ambient temperature becomes colder, it will require a longer heating time to develop an indication of melt and the final bead size. The pipe wall thickness and pipe diameter are primary factors to consider when determining the necessary heating cycle time.

A1.4.1.3 The modifications to the fusion procedure require validation through the production of test fusions and their assessment by comparison to visual guidelines and bend testing.

A1.4.1.4 The specified heating plate temperature range shall not be exceeded to accommodate cold weather conditions.

A1.4.1.5 The fusion pressure must be maintained until a slight melt is observed around the circumference of the pipe or fitting before releasing pressure for the heat soak.

NOTE A1.1—Check for pipe slippage in the fusion machine in cold weather applications. The pipe is stiffer in cold temperatures and the OD of the pipe will shrink slightly, increasing the potential for slippage in the jaws.

A1.4.1.6 Do not apply additional pressure during the heat soak to accommodate cold weather conditions.

A1.4.1.7 Follow the minimum heat soak time for the wall thickness of pipe to be fused per 8.3.5.2. The melt beads formed against the heater surface during the heating soak shall be in accordance with Table 3. It is critical that the melt bead sizes specified in Table 3 be achieved.

A1.4.1.8 When the specified heat soak time and melt bead size has been achieved, the pipe and heater shall be separated in a rapid, snap-like motion. The melted surfaces shall then be joined as soon as possible, within the maximum times allowed in Table 4, so as to minimize cooling of the melted pipe ends. Cool the joint per 8.3.7.

A1.4.2 *Assessment*—Inspection assessment guidelines for fusion joints that are made under cold weather conditions are the same as for fusion joints made at warmer ambient temperatures. Key concerns affecting the quality of cold weather fusion joints are incorrect heating time and application of pressure during heating soak and moisture contamination that could generate a weak fusion joint. Therefore strict adherence to the butt fusion guidelines and adequate butt fusion process controls are the primary means to minimize this probability.

A1.4.2.1 Visual assessment of the finished bead is critical, since signs of incorrect heating, facing or joining force may be evident on the fusion bead. Correct shape of the finished bead, degree of bead rollover to the pipe surface and depth of the v-groove are key indicators (see Fig. 4 and Appendix X2.)

A1.4.3 *Joining in Adverse Weather:*

A1.4.3.1 *Cold Ambient Temperatures Below 32°F (0°C)*—Butt, Saddle or Socket, Fusion is generally not recommended below -4°F (-20°C) without special provisions such as a portable shelter or trailer or other suitable protective measures with auxiliary heating. When making a butt fusion joint with the ambient temperature is below 3°F(-16°C), the pipe ends shall be pre-heated using a heating blanket or warm air device to elevate the pipe temperature to improve the heating starting condition. With pipe mounted in the fusion machine, an alternate method of pre-heating is to stop the pipe ends within .25-.50 inches (6.4-12.7mm) of the heater plate face to allow the pipe ends to warm for 30 seconds to 2 minutes, depending on the pipe size and wall thickness. The use of direct application open flame devices, such as torches, for heating polyethylene pipe is prohibited due to the lack of adequate heating control and possibility of damage to the pipe ends. When fusing pipe under adverse cold weather or in windy field conditions with blowing dust is required, the provision of portable shelters or trailers with heating should be considered and are recommended to provide more consistent and acceptable working conditions. When fusing coiled pipe when the ambient temperature is below 32°F (0°C), it may be required to remove an end section of pipe from the coil and butt fuse on a straight section of pipe to enable correct pipe alignment. Completed joints shall be allowed to cool to ambient temperature before any stress is applied.

A1.4.3.2 *Wind*—Exposure of the fusion heater plate and pipe to wind can result in unacceptable temperature variations during butt fusions and possible joint contamination. When extreme wind conditions exist, the provision of a suitable shelter is required to protect the pipe and fusion heater plate to ensure a more consistent environment is provided. Wind conditions can develop through the pipe bore and cause unacceptable temperature variations during the heating process. Therefore, open pipe ends may require plugs or covers to prevent this condition. Note: Although wind conditions, during cold weather butt fusion, are the primary concern, wind conditions can affect butt fusion quality at all ambient temperatures by chilling the heated pipe surfaces during the heat soak. This increases the heat soak time to obtain the bead size against the heater surface.

A1.5 *Saddle Fusion*:

A1.5.1 *Surface Preparations*—Regular procedures for roughening the surfaces to be fused on the pipe and the fitting shall be emphasized. After the surfaces have been prepared, particular care shall be taken to protect against contamination.

A1.5.2 *Heating Time*—Make a trial melt pattern on a scrap piece of pipe. A clean, dry piece of wood is used to push the heating tool against the pipe. If the melt pattern is incomplete, add 3 s to the cycle time and make another trial melt pattern on another section of cold pipe. If the pattern is still incomplete, continue 3 s additions on a fresh section of cold pipe until a complete melt pattern is attained. Use this heating cycle for fusions during prevailing conditions. Regardless of the weather or the type of tools used, the important point to remember is that complete and even melt must occur on the fitting and the pipe in order to produce a good fusion joint. This requires pipe preparation to make it clean, straight, round, and well supported.

APPENDIXES

(Nonmandatory Information)

X1. JOINING

X1.1 *Parameters and Procedures*—These parameters and procedures in this practice are approved by the majority of pipe manufacturers for the majority of the solid wall polyethylene pipe materials on the market today. Consult with the pipe manufacturer to make sure they approve this procedure for the pipe to be joined. Other specific parameters and procedures, such as heater temperature variations, have been developed, tested and approved by some municipalities, utilities, and end users. They are not covered in this specification.

X1.2 *Quality Assurance Recommendations*—It is recommended that the following steps be followed to help insure quality fusion joints.

X1.2.1 Make sure the equipment or tooling used to make the fusion joints is in good working order and conforms to the equipment manufacturer's quality assurance guidelines.

X1.2.2 Make sure the operator of the equipment or tooling to be used has had the proper training in the operation of that equipment.

X1.2.3 If possible, use a datalogging device with hydraulic joining equipment to record the critical fusion parameters of pressure, temperature and time for each joint.

X1.2.4 Visually inspect each joint and. compare the datalogged records to this approved standard before burying the pipe. (See Appendix X2 for visual guidelines.)

X1.3 *Heating Polyethylene (PE) in a Hazardous Environment*—Electrically powered heat fusion tools and equipment are usually not explosion proof. When performing heat fusion in a potentially combustible atmosphere such as in an excavation where gas is present, all electrically powered tools and equipment that will be used in the combustible atmosphere shall be disconnected from the electrical power source and operated manually to prevent explosion and fire. For the heating tool, this requires bringing the heating tool up approximately 25°F (14°C) above the recommended maximum surface temperature in a safe area, then disconnecting it from electrical power immediately before use.

X1.4 *Butt Fusion of Unlike Wall Thicknesses*—The butt fusion procedure in this practice is based on joining piping components (pipes and fittings) made from compatible polyethylene compounds having the same outside diameter and wall thickness (PR) per ASTM or other industry product specifications. In some cases, butt fusion joining of pipes and fittings that have the same outside diameter but unlike wall thickness (different by one standard DR or more) is possible. The quality of butt fusion joints made between pipes of unlike wall thickness is highly dependent on the performance properties of the polyethylene compound used for the pipes or fittings being joined. Consult the pipe or fitting manufacturer for applicable butt fusion procedures for components with dissimilar wall thicknesses.

X1.5 *Butt Fusion of Coiled Pipe*—Coiled pipe is available in sizes up to 6 in. IPS. Coiling may leave a set in some pipe sizes that must be addressed in the preparation of the butt fusion process. There are several ways to address this situation:

X1.5.1 Straighten and re-round coiled pipe before the butt fusion process. (Specification D2513 requires field re-rounding of coiled pipe before joining pipe sizes larger than 3 in. IPS.)

X1.5.2 If there is still a curvature present, install the pipe ends in the machine in an "S" configuration with the print lines approximately 180° apart in order to help gain proper alignment and help produce a straight joint. See Fig. X2.15.

X1.5.3 If there is still a curvature present, another option would be to install a straight piece of pipe between the two coiled pipes.

X1.6 *Butt Fusion of Pipe with "Toe-In" on the End of the Pipe*:

X1.6.1 "Toe-In" is a slight reduction in diameter at the end from pipe extrusion. When butt fusing two extruded pipe segments, the toe-in is normally about the same and therefore the alignment is easily attained. When one end of the pipe is field cut, toe-in is temporarily removed which can affect high-low alignment when butt fusing to a pipe that has not been field cut. Trimming up to 2 in. off the end of the pipe that has not been field cut will usually correct difficulties with high-low alignment. This condition may also occur when joining pipe to molded fittings. In this circumstance as well, trimming up to 2 in. from the pipe end will usually correct difficulties with high-low alignment. For pipe that has been trimmed, toe-in will reoccur after several hours.

X1.7 *Contamination of Pipe before Fusion*—Introduction of contamination to the pipe can happen in a number of ways and should be avoided by following the precautions listed below:

X1.7.1 Before installing the pipe in the fusion machine, clean the OD, ID and ends with a clean, dry, lint-free, non-synthetic cloth such as cotton. If the contamination cannot be removed this way, wash the pipe with water and a clean cloth or paper towel to remove the contamination, rinse the pipe with water and dry thoroughly with a clean, dry, lint-free, non-synthetic cloth such as cotton or paper towel. If contamination, such as bar oil, was transferred to the pipe ends after cutting, use 90 % or greater isopropyl alcohol or acetone on a clean cloth or isopropyl alcohol wipes on the ends of the pipe to clean the contamination, then rinse with water and dry thoroughly on the pipe ends, ID and OD. It is important that

pipe ends be clean before installing in the fusion machine to avoid contaminating fusion machine parts that contact the pipe ends such as the facer and heater. If the facer or heater becomes contaminated, the contamination may be transferred back to the pipe ends, possibly compromising joint quality. Do not use the facer to remove contamination.

X1.7.2 After the pipe ends are faced and aligned, bring the pipe ends together to prevent dirt and other contaminates from blowing onto the fusion surfaces. Keep the pipe ends together until you are ready to install the heater for the butt fusion process.

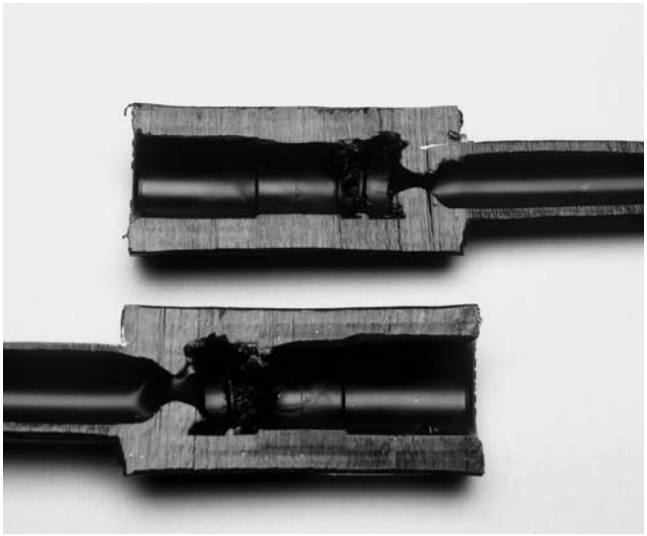
NOTE X1.1—Every effort should be made to make the joint perpendicular to the axis of the pipe. Visually mitered (angled, off-set) joints should be cut out and re-fused (see appearance guidelines in Appendix X2).

X2. HEAT FUSION VISUAL APPEARANCE GUIDELINE

Acceptable Visual Appearance

Melt bead flattened by cold ring.
No gaps or voids.
Good alignment between pipe and fitting.

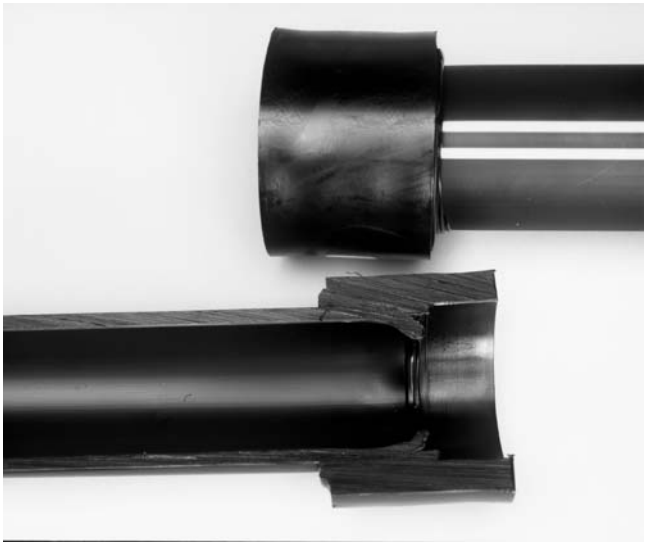
FIG. X2.1 Socket Fusion



Unacceptable Visual Appearance

Excessive heating.

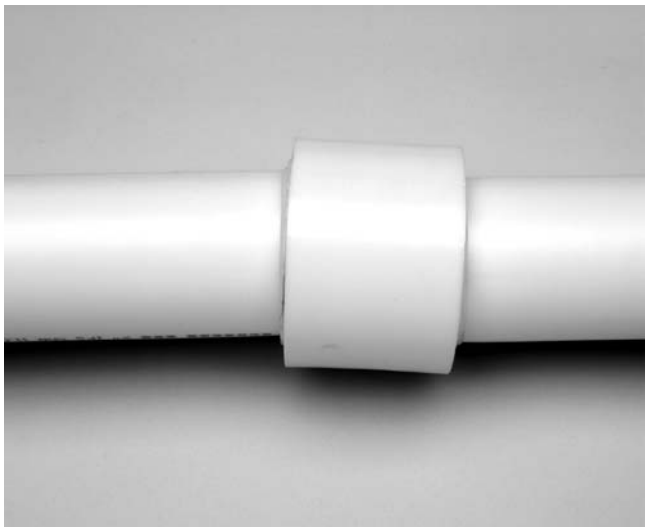
FIG. X2.2 Socket Fusion



Unacceptable Visual Appearance

Melt bead not flattened against the fitting/cold ring.
Improper insertion depth; no cold ring.
Excessive heating.

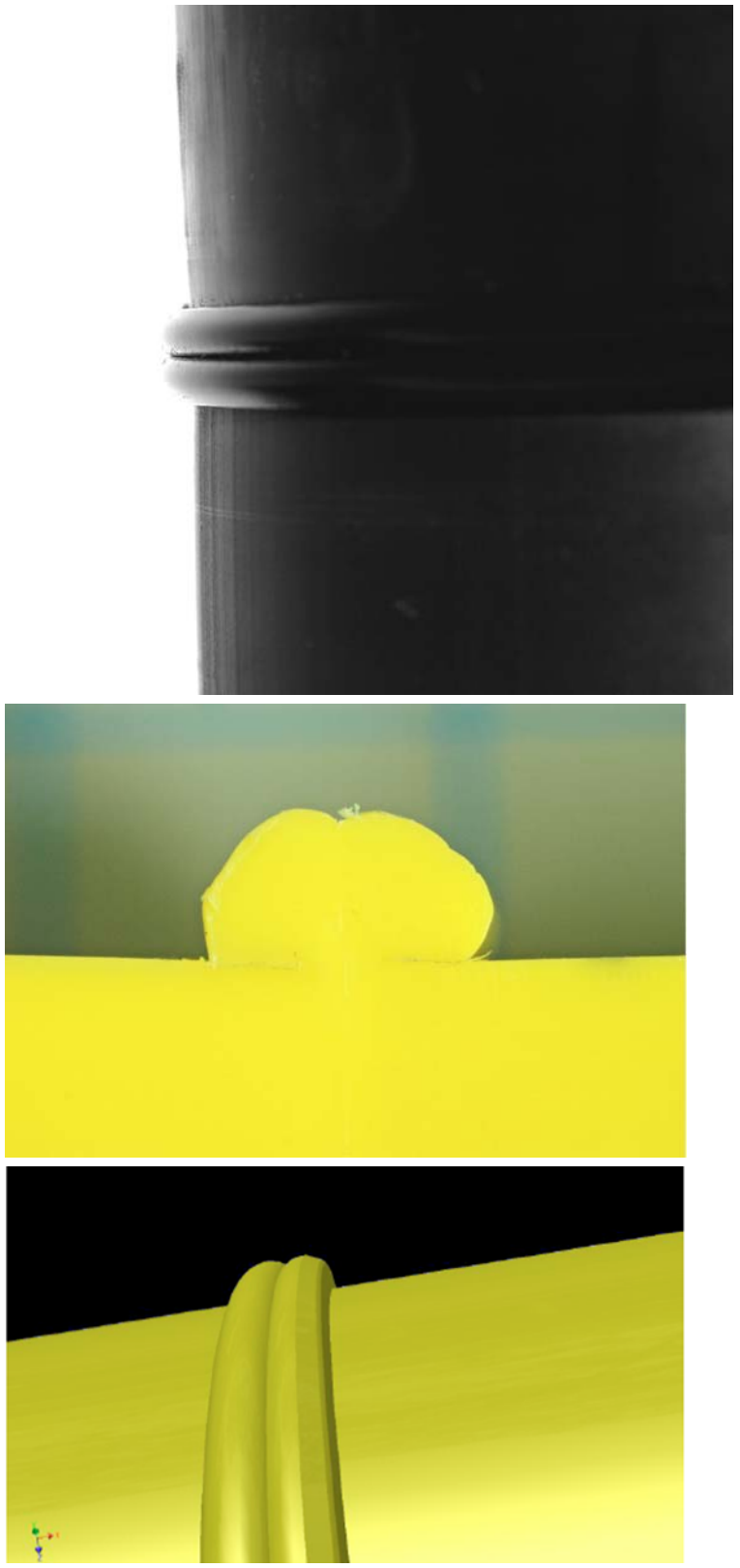
FIG. X2.3 Socket Fusion



Unacceptable Visual Appearance

Misalignment.

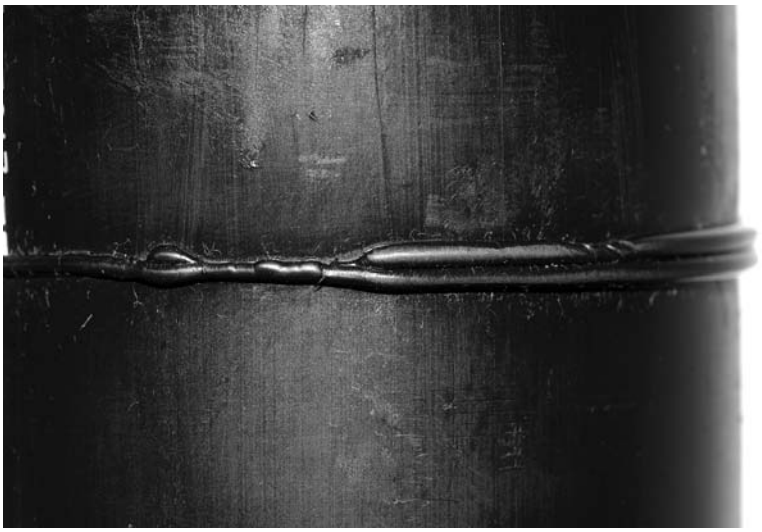
FIG. X2.4 Socket Fusion



Acceptable Visual Appearances

Proper double roll-back bead.
Proper alignment.

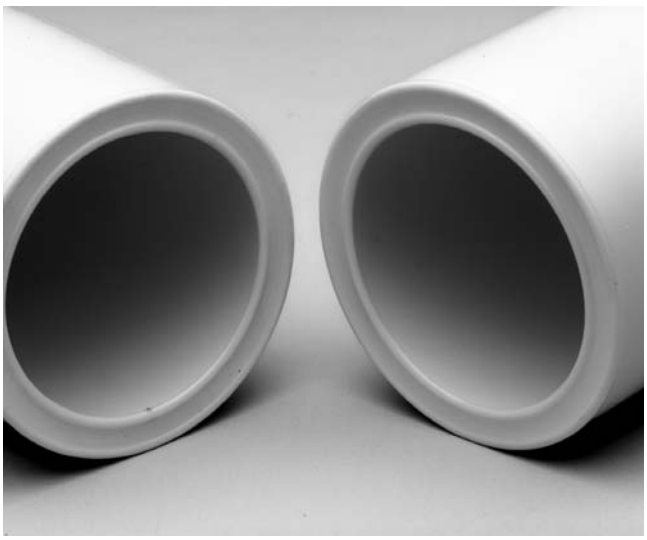
FIG. X2.5 Butt Fusion



Unacceptable Visual Appearance

Incomplete face-off.

FIG. X2.6 Butt Fusion



Unacceptable Visual Appearance

Unacceptable concave melt appearance after heating.
Possible over-pressurization during the heat cycle.

FIG. X2.7 Butt Fusion

Unacceptable Visual Appearance

Improper “high-low” pipe alignment.
Visually mitered joint.

FIG. X2.8 Butt Fusion

Unacceptable Visual Appearance

Improper alignment in fusion machine–mitered joint.

FIG. X2.9 Butt Fusion

Unacceptable Visual Appearance

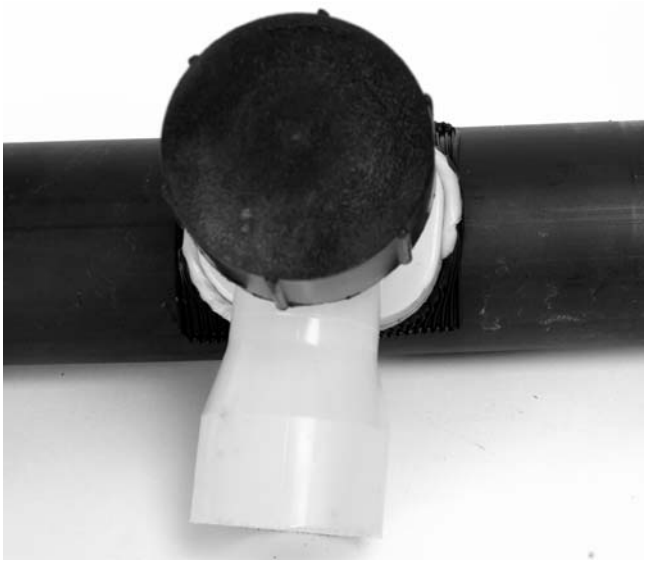
Contamination in joint.

FIG. X2.10 Butt Fusion

Acceptable Visual Appearance

Proper alignment, force and melt.
Proper surface preparation.

FIG. X2.11 Saddle Fusion Joint



Unacceptable Visual Appearance

Improper alignment.
Fitting offset from melt pattern.

FIG. X2.12 Saddle Fusion Joint

Unacceptable Visual Appearance

Over-melt of fitting and main.
Possible over-pressurization of fitting on main.

FIG. X2.13 Saddle Fusion Joint

Unacceptable Visual Appearance

Under-melt of fitting and main.
Fitting offset from melt pattern.
Possible under-pressurization of fitting on main.

FIG. X2.14 Saddle Fusion Joint

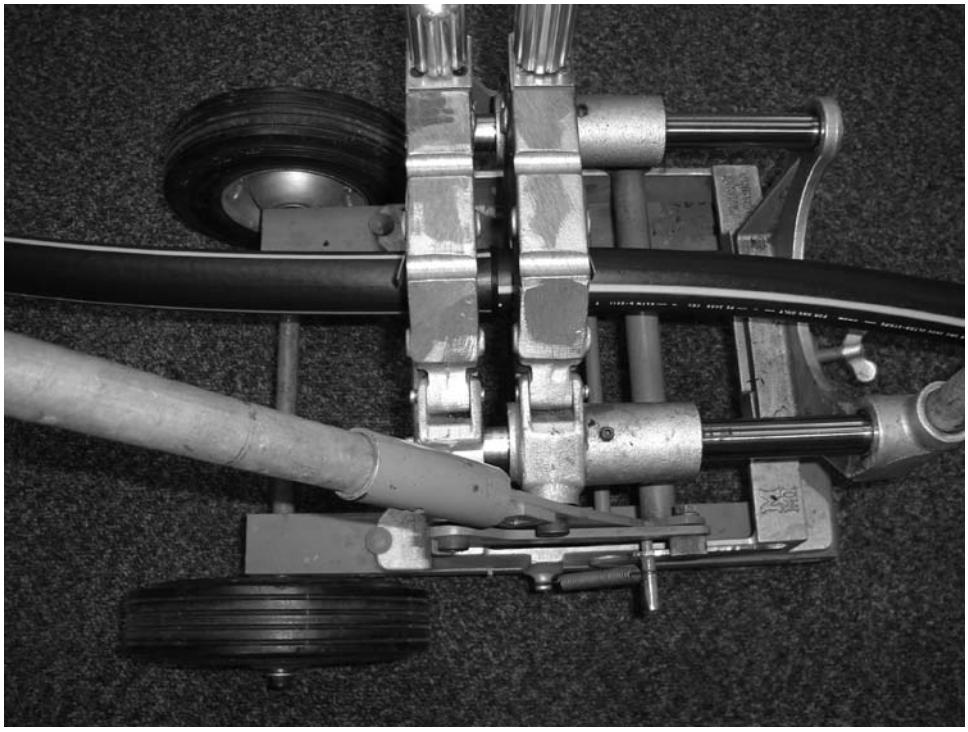


FIG. X2.15 Coiled Pipe Installation in Fusion Machine

X3. DETERMINING SADDLE FUSION FORCE IF LABEL IS NOT PRESENT

X3.1 When the saddle fusion fitting does not have a label to show the initial heat force (IHF) and the fusion force (FF), use the following formulas to determine the forces required.

X3.2 *Determining IHF and FF*:

X3.2.1 IHF is determined by multiplying the area of the saddle fitting base by 60 psi, the initial interface pressure. For rectangular base saddle fittings, the fusion area is the base length times the base width less the area of the outlet hole. Base curvature and corner radii are ignored. For round base saddle fittings, the fusion area is the area of the base outside diameter less the area of the outlet hole. Base curvature is ignored.

$$IHF = L \times W - \left(0.785 \times d^2\right) \times 60 \quad \text{(X3.1)}$$

$$IHF = 0.785 \times \left(D^2 - d^2\right) \times 60 \quad \text{(X3.2)}$$

where:

IHF = initial heat force, lb,
L = rectangular base length, in.,
W = rectangular base width, in.,
d = outlet hole inside diameter, in., and
D = round base outside diameter, in.

X3.2.2 *FF* is one-half of *IHF*:

$$FF = \frac{IHF}{2} \quad \text{(X3.3)}$$

X4. BEND BACK TESTING OF FUSED JOINTS

X4.1 It is possible to evaluate sample joints in order to verify the skill and knowledge of the fusion operator. Cut joints into straps, (see Fig. X4.1) and visually examine and test for bond continuity and strength. Bending, peeling, and elongation tests are useful for this purpose. These tests are generally conducted on smaller pipe sizes. For butt fusion test straps, limit the wall thickness of the pipe to 1in. (25mm) to prevent possible injury in conducting the test. Visually inspect the cut joint for any indications of voids, gaps, misalignment of surfaces that have not been properly bonded. Bend each sample at the fusion joint with the inside of the pipe facing out until the ends touch. The inside bend radius should be less than the minimum wall thickness of the pipe. In order to successfully complete the bend back, a vise may be needed. The sample must be free of cracks and separations within the fusion joint location. If failure does occur at the weld in any of the samples, then the fusion procedure should be reviewed and corrected. After correction, another sample fusion joint should be made per the new procedure and re-tested. Bend testing of pipes with a wall thickness greater than 1in. (25mm) could be dangerous and should be done with an approved bending fixture that supports and contains the pipe during the test or with another approved procedure.

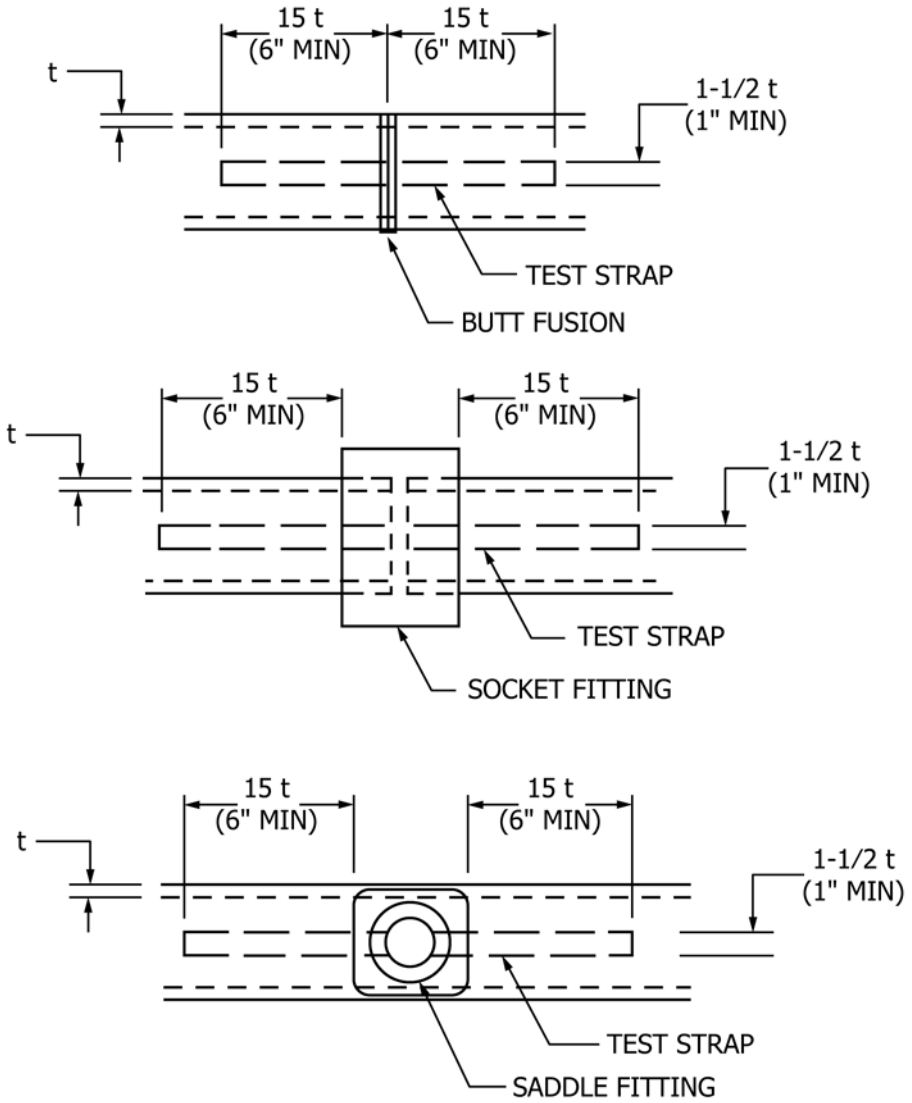


FIG. X4.1 Bent Strap Test Specimen

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2620–12) that may impact the use of this standard. (Approved Nov. 1, 2013.)

(1) 8.2.2 was revised.

Committee F17 has identified the location of selected changes to this standard since the last issue (F2620–11$^{\varepsilon 1}$) that may impact the use of this standard.

(1) Sections 6.2, 7.2.2, and 7.2.4 were revised.
(2) 7.2.7, and Note 4 revised.
(3) 8.3.4, 8.3.5.1 revised.
(4) 8.3.1 and Table 8.3.3 revised.
(5) Table 3 revised.
(6) Table 4 revised.
(7) Note 8 revised.
(8) Fig. 4 revised.
(9) Sections 9.2.9, 9.4.1.1, 9.4.1.3, 9.4.2.1 revised.
(10) Sections X1.6 and X1.7 added.
(11) Fig. X2.5 revised.

METALLIC WELDING and QUALIFICATION PROCEDURES

The qualification of OSU ES welders shall be done by a recognized independent testing entity conducted in accordance with Section IX, ASME Boiler and Pressure Vessel Code. Timing for certification is as follows.

After initial qualification, a welder may not perform welding unless:

1. Within the preceding 15 calendar months, the welder has re-qualified, except that the welder must re-qualify each calendar year, or
2. Within the preceding 7½ calendar months, but at least twice each calendar year, the welder has had a production weld cut out, tested, and found acceptable in accordance with the qualifying test.

Welder qualification procedures from the independent testing entity shall be kept on file.

GENERAL WELDING PROCEDURES

WELDING STEEL PIPE:

All welding shall conform to ASME Section 9, with a retest every 6 months.

1. Welder shall use position welding with the vertical down as the direction of welding.
2. Each joint shall be wire brushed or use other acceptable means to remove rust, dirt, mill scale or other foreign substances before being placed in alignment for welding.
3. The adjoining lengths of pipe shall be accurately aligned by the use of a suitable alignment clamp. The adjoining lengths of pipe shall be accurately spaced before welding. Under no circumstances shall metered pipe welds be allowed.
4. The root bead shall be applied completely around the circumference of the pipe and adequately cleaned of all scale and slag. The second bead (the hot pass) shall be applied immediately after this cleaning operation. Before the day's work is completed hot passes will be applied to all root beads. Under no circumstances will welded joints be accepted when such have been connected only by the root bead from the end of one day's work to the next. Each completed weld shall be thoroughly cleaned of slag, coating and scale. Welded sections of pipe will not be rolled off dollies until all affected welds have cooled.
5. In case of cold, rainy weather, or excessive winds, the operator shall provide for protection for the welders while at work and care will be taken to assure that welds are not subject to sudden changes in temperature until such welds are thoroughly cooled. Welding will not be carried on when, in the judgment of the operator; the weather is unsuitable for welding operations.
6. If upon inspection, a weld appears defective, the welder shall cut from the line a cylinder of pipe continuing such a weld and replace it with good pipe or shall have the weld repaired to the satisfaction of the Superintendent. The following limits apply:
    a. Cracks, regardless of their location, will not be repaired.
    b. Defects, except cracks, that are externally exposed in the cover pass may be repaired without prior approval from the Superintendent.
    c. Defects beneath the cover of the surface of the cover pass specifically defined, in the opinion of the Superintendent as slag inclusions, porosity or gas pockets may be repaired in compliance with API 1104 provided:
        i. The defect can be repaired without grinding complete through the weld.
        ii. No single area of the defect shall exceed 25 percent of the pipe circumference length. A given single area of defect may consist of one or more defects.
        iii. Adjacent areas of defects shall be separated by sound weld metal of a length not less than 7 percent of the pipe circumference length.

iv. Before such repairs are made, such defects shall be entirely removed to clean metal by grinding in a manner acceptable to the Superintendent. All slag and scale will be removed by wire bending.
v. Flame cutting and air carbon arc gouging will not be used for removing defects in production of tie-in welds. Air carbon arc may be used to remove defects in fabrication welds only.
vi. When preheating is required, an area of four inches on each side of the repair shall be preheated to a minimum of 200 degrees F. and maintained during repair welding. Temperature will be checked by using a temperature indicating crayon.
vii. All repair cavities will not be less than 2 inches in length. All repairs will be made with a minimum of two passes. The start and stop of repair passes will not be superimposed over the start and stop of the preceding repair pass.
viii. All repairs shall meet the Standard of Acceptable Nondestructive Testing.
ix. No further repairs will be made in these areas.

WELDING PRECAUTIONS:

The welder will take necessary precautions to ensure that no arcing occurs between the ground lead of the welding machine and the pipe of the fittings. Striking the arc on any point other than the welding grove will not be permitted. All arc burns on the pipe will be removed by cutting a cylinder of pipe continuing the arc burn and replacing it with good pipe.

Preheating will be used when welding fitting to fitting and pipe to pipe fittings, and when the internal pipe temperature is 45° or below. Preheating will also be used when the pipe, for any reason, is wet or damp. Such preheating will be accomplished by any means acceptable to the Superintendent and shall cover an area of at least four inches on each side of the weld. A minimum of 200° F. will be maintained during the welding process and will be checked by using a temperature indicating crayon.

During shutdown, the open ends of the pipe shall be securely closed, and all pipe ends raised to prevent the entrance of small animals, water or obstructions and shall not be reopened until work recommences. A suitable cover of about the same diameter as the pipe will be placed over the open ends of the tie-in sections or both ends of a long section. Any obstructions that occur must be removed by the welder to the satisfaction of the Superintendent. The line must be delivered entirely free from water, dirt, obstructions, or other foreign material.

No pup joints will be installed in the line that is less than 20" in length.

All construction tie-ins, other than those at road or stream crossings, will be made at a point level with the top of the trench, unless otherwise specified by the Superintendent.

WELDING OF SERVICE LINES:

Steel service lines are constructed with approved black pipe. The maintenance crews are provided with tools and components to cut and thread black pipe so that welding is not required for service lines except the tapping tees. Taps are welded onto the top surface of the mains. Welders who do any welding for OSU are to be tested in this type of welding.

Welding must not begin until there is enough space to allow the welder freedom of movement. The welding must not be performed during bad weather. Any flammable materials must be kept clear.

Visual inspection of all welds is expected of both the welder and any other crew members present who are qualified to visually inspect welds. A qualified welder is also considered qualified to inspect welds. The metal of the main where a branch is to be located, must be in good shape so that it will hold up under the increased stresses due to discontinuity in the pipe material. The area on the main close to the weld must be clean and dry. The weld, when complete, should be cleaned of weld slag so that it can be inspected for undercutting and so that rough spots or excessive reinforcement can be ground off. Runs of pipe for mains are welded. The welding procedure requirements that crew members should watch out for are outlined as follows:

1. The only person permitted to do the welding is the one qualified.
2. The welder is to be looked after during welding operations. Sometimes it is important that his instructions or requests are carried out quickly and correctly.
3. The other crew members are permitted to help with the set-up, cleaning, scraping, and grinding. However, anyone using power tools must wear safety glasses.
4. The metal in the weld must be clean and dry before any welding is done.
5. The alignment and pre-spacing must be maintained while the root bead is made.
6. The weld slag and rough spots must be chipped and cleaned before the second weld is started.
7. The second weld should be made shortly after the root bead is completed but not while the root bead is still hot.
8. The weld slag and rough spots must be chipped and ground away. If this is the final weld, a visual inspection must be made to make sure there is not any undercutting and that the proper amount of reinforcement exists. Additional welds are the same as the second weld for the purpose of these instructions.

CHAPTER 17 – Line Locator User Manual

USER GUIDE

RD8100™

MULTIFUNCTION PRECISION CABLE AND PIPE LOCATORS

90/UG104INT/01 ISSUE 1 07/2015

Radiodetection®

Preface

About this guide

CAUTION: This guide provides basic operating instructions for the RD8100 locator and transmitter. It also contains important safety information and guidelines and as such should be read in its entirety before attempting to operate the RD8100 locator and transmitter.

This guide is intended as a quick reference guide only. For detailed instructions, including the use of accessories, help with eCert™, CALSafe™, SurveyCERT™ and usage-logging please refer to the RD8100 locator operation, SurveyCERT and RD Manager™ manuals, which are available for download from www.radiodetection.com.

The online User Manual library also contains links to the SurveyCERT and RD Manager manuals.

⚠ WARNING! Direct connection to live conductors is POTENTIALLY LETHAL. Direct connections to live conductors should be attempted by fully qualified personnel only using the relevant products that allow connections to energized lines.

⚠ WARNING! The transmitter is capable of outputting potentially lethal voltages. Take care when applying signals to any pipe or cable and be sure to notify other technicians who may be working on the line.

⚠ WARNING! Reduce audio level before using headphones to avoid damaging your hearing.

⚠ WARNING! This equipment is NOT approved for use in areas where hazardous gases may be present.

⚠ WARNING! When using the transmitter, switch off the unit and disconnect cables before removing the battery pack.

⚠ WARNING! The RD8000 locator will detect most buried conductors but there are some objects that do not radiate any detectable signal. The RD8100, or any other electromagnetic locator, cannot detect these objects so proceed with caution. There are also some live cables which the RD8100 will not be able to detect in Power mode. The RD8100 does not indicate whether a signal is from a single cable or from several in close proximity.

⚠ WARNING! Batteries can get hot after prolonged use at full output power. Take care while replacing or handling batteries.

3 Year Extended Warranty

RD8100 locators and transmitters are covered by a 1 year warranty as standard. Customers can extend their warranty period to a total of 3 years by registering their products within 3 months of purchase.

Registration is carried out using the RD Manager PC software which can be downloaded from the Radiodetection website. Visit **www.radiodetection.com/RDManager**.

You can also register your product(s) by sending an email to **rd-support@spx.com**, including the following details:

- Serial number of each product to be registered
- Date of purchase
- Company name & address, including country
- Contact name, email address & telephone number
- Country of residence.

From time to time Radiodetection may release new software to improve the performance or add new functionality to its products. By registering, users will benefit from email alerts advising about new software and special offers related to its product range.

Users can opt-out at any time from receiving software and technical notifications, or just from receiving marketing material by contacting Radiodetection.

eCert and Self-Test

The RD8100 locator is safety equipment which should be regularly checked to ensure its correct operation.

eCert provides a thorough test of the RD8100's locating circuitry, and supplies a Radiodetection Calibration Certificate when a positive test result is obtained.

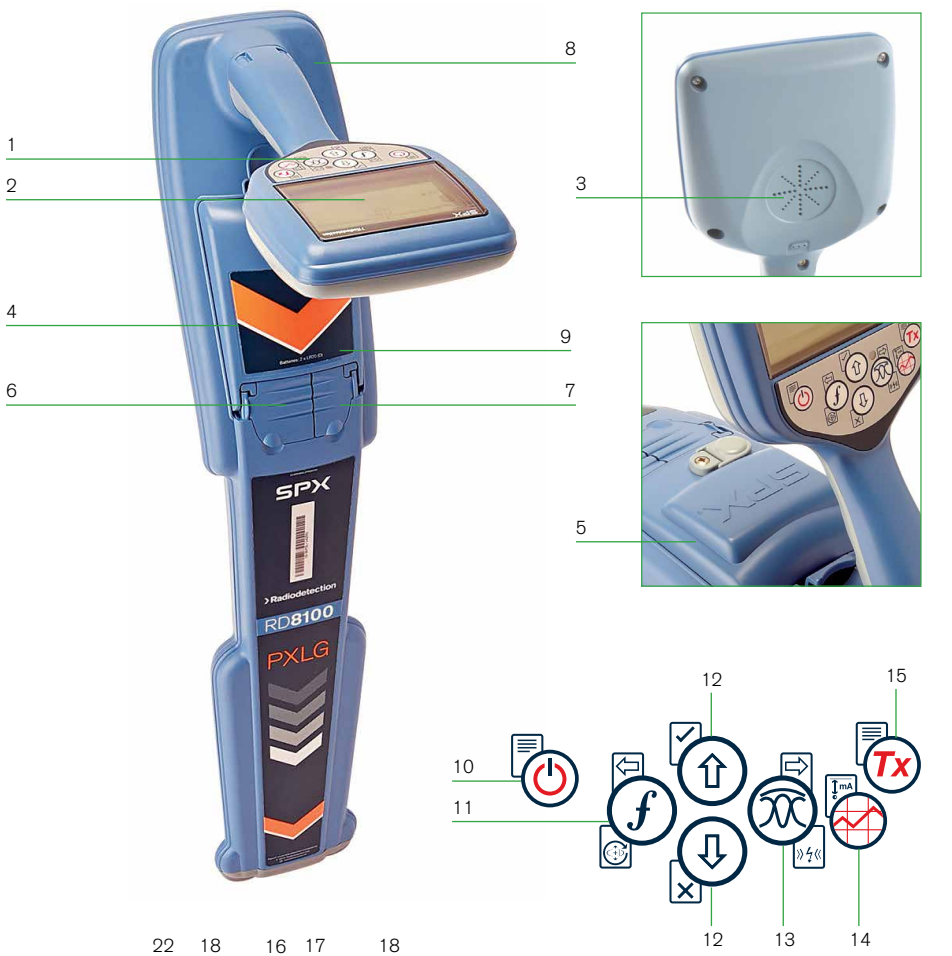
To run an eCert, the locator should be connected to an internet-enabled PC on which the RD Manager software is installed.

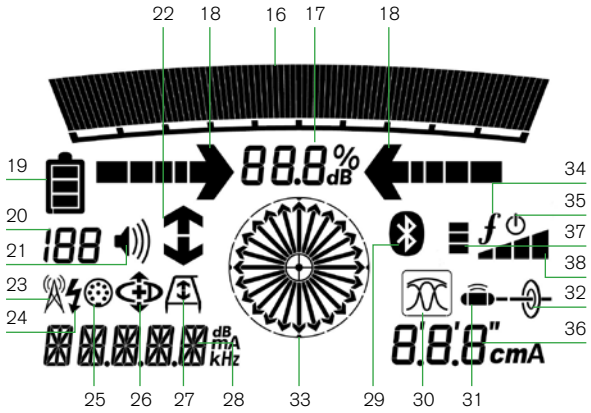
Refer to the RD Manager operation manual for further details. Additional purchase may be required.

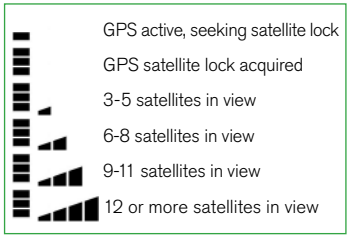
RD8100 locators incorporate an Enhanced Self-Test feature. In addition to the typical checks for display and power functions, the RD8100 applies test signals to its locating circuitry during a Self-Test to check accuracy and performance.

We recommend that a self-test is run at least weekly, or before each use.

RD8100 locator







Locator features

1. Keypad.
2. LCD with auto backlight.
3. Speaker.
4. Battery compartment.
5. Optional Lithium-Ion battery pack.
6. Accessory connector.
7. Headphone connector.
8. Bluetooth® module antenna.
9. USB port
   (inside battery compartment).

Locator keypad

10. Power key.
11. Frequency key.
12. Up and down arrows.
13. Antenna key.
14. Survey key.
15. Transmitter key.

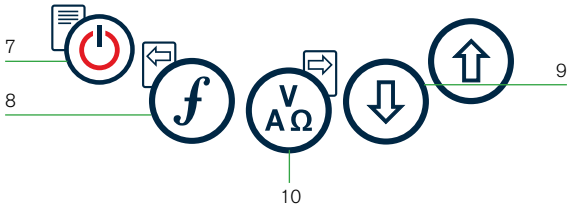
Locator screen icons

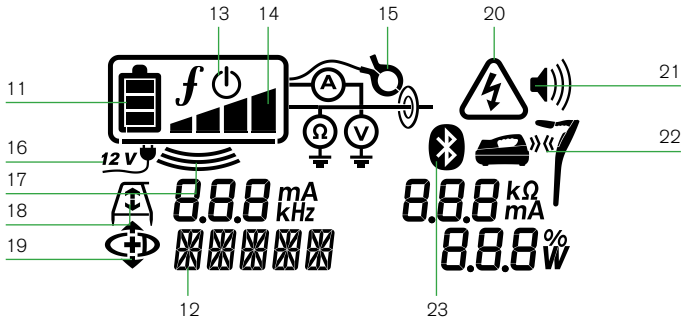
16. Signal strength bargraph with peak marker.
17. Signal strength readout.
18. Null / Proportional Guidance arrows.
19. Battery level.
20. Sensitivity readout / Log number.
21. Volume level.
22. Current Direction arrows.
23. Radio Mode icon.
24. Power Mode icon.
25. Accessory / Measurement icon.
26. CD Mode icon.
27. A-Frame icon.
28. Frequency / current / menu readout.
29. Bluetooth status icon:
    Flashing icon means pairing is in progress. Solid icon indicates a connection is active.
30. Antenna mode icon:
    Indicates antenna selection:
    Peak / Null / Single, Peak+ / Guidance.
31. Sonde icon: Indicates that a sonde signal source is selected.
32. Line icon: Indicates that a line signal source is selected.
33. Compass: Shows the orientation of the located cable or sonde relative to the locator.
34. Transmitter communication status – confirms successful iLOC™ communication.
35. Transmitter standby indicator.
36. Depth readout.

GPS equipped locators only:

37. GPS Status.
38. GPS Signal quality.

Tx-1, Tx-5 and Tx-10 transmitters





Transmitter features

1. Keypad.
2. LCD.
3. Removable accessory tray.
4. D-cell battery tray.
5. Optional Lithium-Ion battery pack.
6. Bluetooth module antenna.

Transmitter keypad

7. Power key.
8. Frequency key.
9. Up and down arrows.
10. Measure key.

Transmitter screen icons

11. Battery level indicator.
12. Operation mode readout.
13. Standby icon.
14. Output level indicator.
15. Clamp icon: Indicates when a signal clamp or other accessory is connected.
16. DC Power connected indicator.
17. Induction mode indicator.
18. A-Frame: Indicates when the transmitter is in Fault-Find Mode.
19. CD Mode: Indicates that the transmitter is in Current Direction Mode.
20. Voltage warning indicator: Indicates that the transmitter is outputting potentially hazardous voltage levels.
21. Volume level indicator.

iLOC Enabled transmitters only:

22. Pairing icon: Appears when the transmitter and locator are connected via iLOC.
23. Bluetooth icon: Indicates status of Bluetooth connection. Flashing icon means pairing is in progress.

Keypad actions and shortcuts

Switch the locator or transmitter on by pressing the ⏻ key. Once powered up, the keys function as follows:

Locator keys

KEY	● SHORT PRESS	▬ LONG PRESS
⏻	Enter the menu	Switch power off
ƒ	Scroll through locate frequencies from low to high	SideStep™ (see 'iLOC' section) When using Current Direction™: Perform a CD Reset
⟲	When using active frequencies: Toggles peak, peak+, null, broad peak and guidance antenna modes. In Power Mode: Scrolls through Power Filters™ for improved discrimination of parallel or strong power signals	In Peak+ antenna mode: Switch between Guidance and Null arrows
⇧ and ⇩	Increase and decrease gain. RD8100 automatically sets gain to mid-point when pressed	Rapidly increase and decrease gain steps in 1dB increments
📈	Take a Survey Measurement and send over Bluetooth if paired	–
Tx	Send an iLOC command to a paired transmitter	Enter the Transmitter power setting menu for use over iLOC

Transmitter keys

KEY	● SHORT PRESS	▬ LONG PRESS
⏻	Enter the menu	Switch Power off
ƒ	Scroll through locate frequencies from low to high	–
V Ω A	Take voltage and impedance measurements using the currently selected frequency	Take voltage and impedance measurements at a standardized frequency
⇧ and ⇩	Adjusts the output signal	Select standby ⇩ / maximum standard power ⇧

Tip: to scroll through frequencies from high to low, hold ƒ while pressing the ⇩ button (applies to both locators and transmitters).

Before you begin

IMPORTANT!
This guide is intended to be a quick reference guide. We recommend you read the full operation manual before you attempt to operate the RD8100 locator.

First use

The RD8100 locators and transmitters can be powered by D-cell alkaline batteries, D-cell NiMH batteries, or by an accessory Li-Ion (Li-Ion) battery pack.

To fit the D cell batteries in the locator, open the battery compartment and insert two D-Cell Alkaline or NiMH batteries, taking care to align the positive (+) and negative (-) terminals as indicated.

To fit the D cell batteries in the transmitter, unlatch the accessory tray. The battery compartment is located underneath the transmitter body. Use the turnkey to unlatch the battery compartment. Insert eight D-Cell Alkaline or NiMH batteries, taking care to align the positive (+) and negative (-) terminals as indicated.

Alternatively, you can power the transmitter from a mains or vehicle power source using a Radiodetection supplied optional accessory adapter.

Rechargeable battery packs

Lithium-Ion battery packs are available for both locators and transmitters, providing superior performance over traditional alkaline batteries. To fit these rechargeable packs, follow the instructions provided with each pack.

Checking your system software version

If you wish to check which version of software is running on your locator, press and hold the ƒ key when switching the locator on. This information may be asked for when contacting Radiodetection or your local representative for technical support.

Transmitters automatically show their software version on startup.

System setup

It is important that you set up the system according to regional / operational requirements and your personal preferences before you conduct your first survey. You can set the system up using the menus as described below.

Setting up your system

The RD8100 locator and transmitter menus allow you to select or change system options. Once entered, the menu is navigated using the arrow keys. Navigation is consistent on both the transmitter and the locator. When in the menu, most on-screen icons will temporarily disappear and the menu options will appear in the bottom left-hand corner of the display. The right arrow enters a submenu and the left arrow returns to the previous menu.

Note that when browsing the locator menu, the ƒ and keys act as left and right arrows. When browsing the transmitter menu, the ƒ and keys act as left and right arrows.

To navigate menus:

1. Press the key to enter the menu.
2. Use the or keys to scroll through the menu options.
3. Press the key to enter the option's submenu.
4. Use the or keys to scroll through the submenu options.
5. Press the key to confirm a selection and return to the previous menu.
6. Press the key to return to the main operation screen.

NOTE: When you select an option and press the key, the option will be enabled automatically.

Locator menu options

- VOL: Adjust the speaker volume from 0 (mute) to 3 (loudest).
- DATA: Delete, send or review saved SurveyCERT measurements and enable or disable the Bluetooth communication channel.
- BT: Enable, disable, reset or pair Bluetooth connections. Also defines the protocol used when connecting to a PC or PDA.
- GPS: Enable or disable the internal GPS module and enable/disable SBAS GPS augmentation (GPS models only) – or select an external GPS source.
- CDR: Perform a Current Direction (CD) Reset. (Alternatively press and hold the ƒ key when in CD mode).
- UNITS: Select metric or imperial units.
- INFO: Run a Self-Test, display the date of the most recent service recalibration (M CAL) or the most recent eCert calibration.
- LANG: Select menu language.
- POWER: Select local power network frequency: 50 or 60Hz.
- ANT: Enable or disable any antenna mode with the exception of Peak.
- FREQ: Enable or disable individual frequencies.
- ALERT: Enable or disable Strike*Alert*™.
- BATT: Set battery type: Alkaline, NiMH or Li-ION.
- COMP: Enable or disable display of the Compass feature.

Transmitter menu options

- VOL: Adjust the speaker volume from 0 (mute) to 3 (loudest).
- FREQ: Enable or disable individual frequencies.
- BOOST: Boost transmitter output for a specified period of time (in minutes).
- LANG: Select menus language.

- OPT F: Run SideStep*auto*™ to auto-select a locate frequency for the connected utility.
- BATT: Set battery type: ALK, NiMH or Li-ION and enable / disable Eco mode.
- MAX P: Set the transmitter to output its maximum wattage.
- MODEL: Match the transmitter setting to the model of your locator.
- MAX V: Set the output voltage to maximum (90V).
- BT: Enable, disable or pair Bluetooth connections (Bluetooth models only).

Examples of using the menu, selecting options and making changes:

Locator mains power frequency

To select the correct frequency (50 or 60Hz) for your country or region's power supply:

1. Press the key to enter the menu.
2. Scroll to the POWER menu using the or keys.
3. Press the key to enter the POWER menu.
4. Use the or keys to select the correct mains frequency.
5. Press the ƒ key twice to accept your selection and return to the main operation screen.

Batteries

It is important to set the system to match the currently installed battery type to ensure optimal performance and correct battery level indication.

To set your battery type:

1. Press the key to enter the menu.
2. Scroll to the BATT menu using the or arrows.
3. Press the key (locator) or the key (transmitter) to enter the BATT menu.
4. Scroll up or down to select the correct battery type (Alkaline, Nickel-metal Hydride or Lithium-Ion).
5. Press the ƒ key twice to accept your selection and return to the main operation screen.

Transmitter Eco Mode

When using alkaline batteries, Eco mode can be selected to maximize run time. When Eco mode is selected the transmitter automatically reduces its maximum power output as battery levels run low. Eco mode is switched off by default. To Enable Eco Mode:

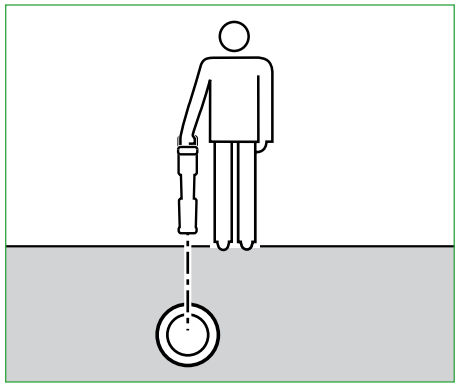
1. Press the key to enter the menu.
2. Scroll to the BATT menu using the or arrows.
3. Press the key to enter the BATT menu.

4. Select the ALK Battery type using the ⇧ or ⇩ arrows.
5. Press the V/AΩ key to enter the ECO sub menu
6. Select ECO using the ⇧ or ⇩ arrows.
7. Press the f key three times to accept your selection and return to the main operation screen.

Locating pipes and cables

For more detailed descriptions of using the locator and transmitter, and for detailed locate techniques, refer to the Operation Manual.

The RD8100 locator is designed to operate with the 'blade' of the locator perpendicular to the path of the cable or pipe being located.



Running a Self-Test

We recommend that a Self-Test is run at least weekly, or before each use. As the Self-Test tests the integrity of the locate circuity, it is important that it is carried out away from larger metallic object such as vehicles, or strong electrical signals. To run a Self-Test:

1. Press the ⏻ key to enter the menu.
2. Scroll to the INFO menu using the ⇧ or ⇩ arrows.
3. Press the ⦿ key to enter the INFO menu.
4. Select TEST using the ⇧ or ⇩ arrows.
5. Press the ⦿ key to select YES
6. Press the f key to begin the Self-Test
7. Once the Self-Test is completed, the result (PASS or FAIL) will be displayed.
8. Restart the locator using the ⏻ key

SideStep*auto*™

The transmitter can be used to recommend a general-purpose locate frequency for the intended locate task by measuring the impedance of the target cable or pipe. To run SideStep*auto*™, connect the transmitter to the target utility, then:

1. Press the ⏻ key to enter the menu.
2. Scroll to the OPT F menu using the ⇧ or ⇩ arrows.

3. Press the V/AΩ key to select 'START.
4. Press the f key to start the test. The transmitter will automatically select a general purpose frequency for use on the connected utility.

Locating with Active Frequencies

Active frequencies are applied to the target pipe or cable using the transmitter, and provide the most effective way of tracing buried pipes or cables.

Generally speaking, it is better to use a low frequency on larger, low impedance utilities, and move to a higher frequency on smaller, high impedance utilities.

The lowest power setting required to trace the target utility should always be used to minimize the risk of false trails.

The transmitter can apply a signal using three different methods:

Direct connection

In direct connection, you connect the transmitter directly to the pipe or cable you wish to survey using the red Direct Connect lead supplied. The black lead is generally connected to earth using the supplied ground stake.

The transmitter will then apply a discrete signal to the line, which you can trace using the locator. This method provides the best signal on an individual line and enables the use of lower frequencies, which can be traced for longer distances.

⚠ **WARNING! Direct connection to live conductors is POTENTIALLY LETHAL. Direct connections to live conductors should be attempted by fully qualified personnel only using the relevant products that allow connections to energized lines.**

Induction

The transmitter is placed on the ground over or near the survey area. You select the appropriate frequency. The transmitter will then induce the signal indiscriminately to any nearby metallic conductor. In induction mode, using higher frequencies is generally recommended as they are induced more easily onto nearby conductors.

Transmitter Clamp

An optional signal clamp can be placed around an insulated live wire or pipe up to 8.5" / 215mm in diameter to transfer the transmitter signal to the utility. This method of applying the transmitter signal is particularly useful on insulated live wires and removes the need to disconnect the supply to the cable.

⚠ **WARNING! Do not clamp around uninsulated live conductors.**

⚠ **WARNING! Before applying or removing the clamp around a power cable ensure that the clamp is connected to the transmitter at all times.**

Locating with Passive Frequencies

Passive frequency detection takes advantage of signals that are already present on buried metallic conductors. The RD8100 supports four types of passive frequencies: Power, Radio, CPS* and Cable TV (CATV)* signals. You can detect these frequencies without the aid of the transmitter.

*Model specific.

Power Filters

RD8100 locators allows operators to take advantage of the harmonic signals found on power networks. Once in Power Mode, press the key to switch out of Radiodetection's sensitive Power Mode and scroll through five individual Power Filters. This enables operators to establish if a single large power signal comes from one source or from the presence of multiple cables. The different harmonic characteristics of the detected lines can then be used to trace and mark their route.

Additionally the use of an individual harmonic can allow you to locate power lines in situations where the total signal would otherwise be too large.

Locate Modes

The RD8100 offers a choice of 5 locate modes, each of which is designed for specific uses, depending on what task is being carried out.

To scroll between locate modes, press the key.

PEAK: For accurate locating, the peak bargraph provides a visual readout of the signal strength. The peak signal is found directly over the buried utility.

PEAK+: Choose to combine the accuracy of the Peak bargraph with Null arrows, which can indicate the presence of distortion, or with proportional Guidance arrows for rapid line tracing – switch between them by holding the key.

GUIDANCE: Proportional arrows and a ballistic 'needle' combine with audio left/right indication for rapidly tracing the general path of a buried utility.

BROAD PEAK: Operating similarly to Peak mode, but giving a result over a wider area. Used to detect and trace very weak signals, for example very deep utilities.

NULL: Provides a quick left/right indication of the path of a utility. As Null is susceptible to interference, it is best used in areas where no other utilities are present.

Depth, current and compass readouts

WARNING! Never use the depth measurement readout as a guide for mechanical or other digging activity. Always follow safe digging guidelines.

The RD8100 locator can measure and display the utility depth, locate signal current and the relative orientation of the cable or pipe to the locator. This helps you to make sure that you are following the right cable or pipe, especially when other utilities are present.

The RD8100 locator features TruDepth™, a feature that helps you to ensure the accuracy of your locates or Survey Measurements. The depth and current are automatically removed from the display when the locator is at an angle of more than 7.5° from the path of the cable or pipe being located, or when the locator determines that signal conditions are too poor for reliable measurements.

Current Direction (CD)

The Tx-10(B) transmitter can apply a unique CD signal onto a pipe or cable. This signal can be used to identify an individual pipe or cable amongst a number of parallel utilities, ensuring operators follow the right line. A CD signal clamp or direct connection leads can be used to apply the unique signal to the pipe or cable and a CD locator clamp or CD stethoscope can be used to identify individual pipes or cables.

Using accessories

The locator and transmitter are compatible with a wide range of accessories. For detailed information on using any of the accessories below please refer to the RD8100 locator operation manual.

Transmitter signal clamps

When it is not possible to connect directly onto a pipe or cable, or induction mode is unsuitable, a transmitter signal clamp may be used. The clamp is plugged into the output of the transmitter and provides a means of applying a locate signal to an insulated live wire. This is particularly useful with live insulated cables as it removes the need to disable the power and break the line.

WARNING! Do not clamp around uninsulated live conductors.

WARNING! Before applying or removing the clamp around a power cable ensure that the clamp is connected to the transmitter at all times.

To locate or identify individual lines a locator signal clamp can be connected to the accessory socket of the locator and can be clamped around individual pipes or cables.

Stethoscopes and locator signal clamps

Locator clamps can be used to identify a target cable or pipe amongst a number of different cables by checking for the strongest locate signal. When cables are bunched or tightly packed, a stethoscope antenna can be used in place of a clamp.

To use a stethoscope or locator signal clamp, connect it to the locator's accessory socket. The locator will automatically detect the device and filter out location modes that are irrelevant.

Sondes, Flexrods and FlexiTrace

Sondes are battery powered transmitters that are useful for tracing non-metallic pipes. They can be fixed to Flexrods to allow them to be pushed through pipes or conduits, and some are suitable for blowing through ductwork. The RD8100 can detect a range of sonde frequencies, including those transmitted by GatorCam™4 or flexiprobe™ pushrod systems and P350 flexitrax™ crawlers.

For a detailed guide on locating sondes, please refer to the operation manual.

A FlexiTrace is a traceable fiberglass rod incorporating wire conductors with a sonde at the end. It is connected to the output of the transmitter and is typically used in small diameter, non-metallic pipes. The user has the option of locating the entire length of the cable or choosing to locate only the tip of the cable.

The FlexiTrace has a maximum power rating of 1W. When using the FlexiTrace with a Radiodetection Tx-5(B) or Tx-10(B) transmitter the output limit must be set to 1W in the MAX P menu and the output voltage limit set to LOW in the MAX V menu.

No additional settings are required for the Tx-1 transmitter.

Fault-finding with an A-Frame

The RD8100PDL and PTL models have the ability to detect cable or pipe insulation faults accurately using an A-Frame accessory. The Tx-5(B) and Tx-10(B) provide fault finding signals that can be detected by the A-Frame as a result of the signal bleeding to ground through damaged cable sheaths.

The Transmitter's multimeter function can be used to measure the impedance of the connected pipe or cable in order to characterize the fault.

For a detailed guide to fault-finding, please refer to the operation manual.

Plug / Live cable connector

The plug connector is connected to the output of the transmitter and is used to put a signal onto a line and trace it from a domestic mains plug to the service cable in the street.

The live cable connector can be used to apply a signal to a live cable. Only suitably qualified personnel should use this equipment.

Submersible antenna

This antenna is connected to the locator and used to locate pipes and cables underwater at depths of up to 300 feet / 100 meters.

⚠ WARNING: use of the submersible antenna should be by fully licensed and experienced personnel only, and only after fully reading the operation manual!

RD Manager PC Software

RD Manager is the RD8100 locator system PC companion, and it allows you to manage and customize your locator. RD Manager is also used to retrieve and analyze survey and usage data, run an eCert calibration, and to perform software upgrades.

You can use RD Manager to register your products to obtain an extended warranty, setup your locator by performing a number of maintenance tasks such adjusting date and time, activating and de-activating active frequencies, or by setting-up functions like CALSafe or Strike*Alert*.

RD Manager is compatible with PCs running Microsoft Windows XP, 7, 8 and 8.1. To download RD Manager, go to **www.radiodetection.com/RDManager**.

If you do not have internet access, or wish to receive RD manager on a CD-ROM, contact your local Radiodetection office or representative.

For more information about RD Manager refer to the RD Manager operation manual.

Bluetooth wireless connections

RD8100 locators feature a Bluetooth wireless module, as standard, providing the ability to connect to compatible devices such as transmitters (Tx-5B or Tx-10B models), PCs, laptops or handheld devices running a compatible application.

NOTE: The RD8100 locator wireless features may be subject to national and or local regulations. Please consult your local authorities for more information.

⚠ WARNING! Do not attempt any wireless connection in areas where such technology is considered hazardous. This may include: petrochemical facilities, medical facilities or around navigation equipment.

Switching Bluetooth on

By default RD8100 locators and Bluetooth enabled transmitters are shipped with the Bluetooth wireless connection module disabled.

1. Press the ⏻ key to enter the menu.
2. Scroll to the BT menu using the ⇧ or ⇩ keys.
3. Press the ⏦ key (locator) or the V/A/Ω key (transmitter) to enter the BT menu.
4. Scroll up or down to the ON option.
5. Press the ƒ key to switch Bluetooth ON and return to the previous menu.

You can switch Bluetooth off to conserve battery life, or to comply with regulations in areas where wireless communications are considered hazardous. To do this, follow the above process, selecting 'OFF' in the BT menus.

Pairing to a PDA or PC

Connection requirements:

- Any RD8100 locator.
- A compatible Bluetooth enabled PDA or Bluetooth enabled PC or Laptop.

NOTE: The procedure below describes the pairing process between a RD8100 locator and a PDA. Pairing to a PC follows the same steps for the RD8100 locator and similar steps for your PC or laptop. Consult your PC or laptop Bluetooth pairing instructions to pair with the RD8100 locator.

Pair the RD8100 locator to your PDA using your PDA's Bluetooth software.

NOTE: The procedure for pairing your PDA may differ depending on the PDA make and model. The following procedure should apply to most PDAs.

On the locator:

1. Press the ⏻ key to enter the menu.
2. Scroll to the BT menu using the ⇧ or ⇩ keys.
3. Press the key to enter the BT menu.
4. Scroll up or down to the PAIR menu.
5. Press the key to enter the PAIR menu.
6. Scroll up or down to the BT-PC option.
7. Press the ƒ key and the locator will attempt to pair with your PDA.

On your PDA:

8. From the PDA's **Start menu**, select **Settings** then select the **Connections Tab** followed by the **Bluetooth icon.**
9. Ensure the Bluetooth radio is switched on and make the PDA visible to other devices.
10. Select the Devices tab and scan for new partnerships.
11. Create a partnership with the RD8100_XXXX device.
12. If asked for a passkey, enter 1234.
13. Refer to the SurveyCert manual for advanced settings if required by your PDA.

Resetting connections

If you experience problems with the RD8100 Bluetooth features, Radiodetection recommends resetting the connection and then pairing your device again:

1. Press the ⏻ key to enter the menu.
2. Scroll to the BT menu using the ⇧ or ⇩ keys.
3. Press the key to enter the BT menu.
4. Scroll up or down to the RESET menu.
5. Press the ƒ key and the locator will purge all current connections.
6. Re-pair your devices.

Bluetooth error codes

If an error occurs when attempting to perform any Bluetooth command using the locator to the transmitter or the locator to a PC or PDA, the LCD will display a code to help you resolve the problem on the locator.

The codes are as follows:

BT CODE	DESCRIPTION
BT001	Bluetooth not configured for this unit
BT002	Internal Bluetooth error
BT003	Locator not paired with transmitter
BT004	Locator not paired with PC/PDA
BT005	Paired but connection attempt failed. Power cycling may be required
BT006	Corrupt response received from transmitter
BT007	Indeterminate response received from transmitter
BT008	No response received from transmitter
TX??	Transmitter unable to change to the requested frequency

Taking Survey Measurements

RD8100 locator models are capable of recording measurements at up to 1000 survey points, and optionally sending them to an external device using Bluetooth.

If the locator is a GPS model or if paired to a PDA with GPS that is running a compatible application such as SurveyCERT the locator will append positional information alongside time and date to the data, providing spatial context.

NOTE: The internal GPS module needs to be switched on and connected to the GPS satellite system.

Saving measurements

To save survey measurements, press the key.

To achieve accurate results the locator must be kept as still as possible during the saving process.

The locator will always save measurements to internal memory. If Bluetooth is switched on, paired to a device and BT-PC is enabled, the locator will also attempt to send the saved measurement to a paired PDA running SurveyCERT or to a PC running a compatible application.

Erasing measurements

The RD8000 locator allows you to delete all measurements. Erasing the log will wipe the RD8000 memory and is usually recommended when you begin a new survey.

⚠ WARNING! Erasing measurements cannot be undone!

1. Press the ⏻ key to enter the menu.
2. Press the ⇧ or ⇩ keys to select LOG menu.
3. Press the ⦿ key to enter the LOG menu.
4. Scroll up or down to select the DEL option.
5. Press the ƒ key to make the selection and return to the main menu.

To send stored data to a paired PDA or PC:

Stored data can be transferred wirelessly to a compatible PDA running Radiodetection's SurveyCERT app or a PDA or PC compatible application.

SurveyCERT

SurveyCERT is the PDA app from Radiodetection which makes utility mapping easier for surveyors in the field.

You can use SurveyCERT to store survey measurements taken from your locator in your PDA for later review. SurveyCERT for PDAs, and its operation manual are available as a free download from the Radiodetection website.

To send data to a paired PDA or PC:

1. Ensure your paired PDA is switched on and running the SurveyCERT app.
2. Press the ⏻ key to enter the menu.
3. Scroll to the LOG menu using the ⇧ or ⇩ keys.
4. Press the ⦿ key to enter the LOG menu.
5. Scroll up or down to the SEND option.
6. Press the ƒ key and the locator will attempt to send your stored survey data to your PDA.

Stored data can also be transferred using the USB connection to RD Manager to be analyzed by the software's built-in SurveyCERT capabilities. Refer to the RD Manager operation manual for more info on how to retrieve store survey data.

RD Manager's SurveyCERT functionality can be used for post survey analysis, interface to Google Maps® and easy export to GIS/mapping systems.

Automatic Usage-Logging

RD8100 locator models equipped with GPS offer a powerful data logging system which records all the instrument's critical parameters (including GPS position, if available) and warnings in its internal memory every second.

The automatic logging system is always active and cannot be disabled. It's memory is capable of storing at least 1 year's worth of normal usage data.

Logs can be retrieved using the RD Manager PC application for usage analysis and survey validation. Refer to the RD Manager operation manual for further information.

GPS

The RD8100 locator can be paired to an external GPS module or use it's internal GPS module (GPS models only) to be able to detect and store its latitude, longitude and accurate UTC time alongside its location data. This positional information can then be appended to Survey Measurements, or the automatic usage-logging system.

The presence of GPS data allows for the data to be mapped easily and to export and save the information directly into GIS systems.

GPS menu settings

There are 5 options in the GPS menu:

- INT: Select this to use the internal GPS if present.
- EXT: Select this to use the GPS from a compatible paired device.
- OFF: Select this to switch off the internal GPS module and save battery.
- SBAS: Set SBAS (Satellite-based augmentation systems) mode to improve GPS accuracy. When ON the GPS system will take longer to lock.
- RESET: Select YES to reset the internal GPS (GPS models only).

iLOC

iLOC lets you control the transmitter remotely using your RD8100 locator. With iLOC you can adjust the output frequency, power settings and use SideStep. iLOC commands are sent over a Bluetooth module that can operate at distances of up to 300m/1000ft in direct line of sight.

iLOC is a standard feature of all RD8100 locator models, and requires a Bluetooth equipped Transmitter (Tx-10B or Tx-5B).

NOTE: Operating in built up areas and in areas with high electromagnetic interference may reduce iLOC's performance.

Pairing to a transmitter

To pair to a transmitter you require a Bluetooth enabled model such as the Tx-5B or Tx-10B.

Before you begin, you should switch off all nearby Bluetooth equipment as they may interfere with the locator and transmitter's pairing process.

Preparing the locator:

1. Press the ⏻ key to enter the menu.
2. Scroll to the BT menu using the ⇧ or ⇩ keys.
3. Press the ⌘ key to enter the BT menu.
4. Scroll to the PAIR menu and press the ⌘ key to enter it.
5. Scroll to the BT-TX option.

NOTE: You must complete the pairing process within 90 seconds to prevent the locator's Bluetooth connection from timing out.

Preparing the transmitter:

6. Press the ⏻ key to enter the menu.
7. Scroll to the BT menu using the ⇧ or ⇩ keys.
8. Press the V/AD key to enter the BT menu.
9. Scroll to the PAIR option.

Starting the pairing process:

10. Press the ƒ key on the transmitter followed by the ƒ key on the locator.
11. The transmitter and the locator will now attempt to pair.

When pairing is in progress, the transmitter and locator will display a flashing Bluetooth icon. Pairing can take up to a minute. If the pairing process is successful, the transmitter will display the))((icon and the locator will display a persistent Bluetooth icon for the duration of the connection.

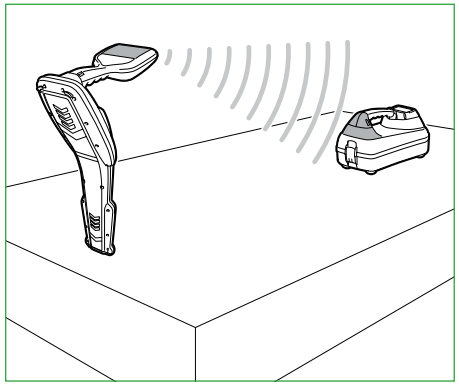
If pairing fails, ensure that any nearby Bluetooth devices are switched off or invisible then repeat the process.

Once the locator and transmitter have successfully paired you can use iLOC to change the transmitter's output frequency and power levels remotely from the locator.

Using iLOC

The locator and transmitter need to be paired to use iLOC. For optimum performance:

- Try to minimize obstructions in line of sight.
- If possible, raise the transmitter off the ground by 30-60cm (1-2ft).
- Face the rear end of the transmitter towards the locator.
- Point the screen of the locator towards the transmitter.



NOTE: If any iLOC commands fail, move closer to the transmitter and repeat the process.

Changing frequencies

Once the transmitter and the locator are paired, you can change the transmitter's output frequency remotely using the locator:

1. On the locator, select the frequency you want by pressing the ƒ key until the frequency is displayed on screen.
2. Press the Tx key to send the new frequency to the transmitter.
3. The locator will display SEND momentarily and then OK if the transfer is successful.
4. If the transfer is unsuccessful, the locator will display a bluetooth error code error code.

If the process fails, you may be out of range or there may be an error in the connection. Move closer to the transmitter and retry the procedure. If the connection continues to fail, return to the transmitter and reset the connection.

Adjusting power

iLOC lets you adjust the transmitter's power output remotely; you can also put the transmitter into standby mode and then wake it remotely.

1. Transmitter power options are located in the TXOUT menu on the locator. Press and hold the Tx key to display the TXOUT menu.
2. Press the ⌘ key to enter the power level menu.
3. Scroll up or down through the power output options using the ⇧ or ⇩ keys:
   - **STDBY:** Transmitter standby mode, the connection is still active but the output is disabled – use to prolong battery life.
   - **LOW:** Low power output.
   - **MED:** Medium power output.
   - **HIGH:** High power output.
   - **BOOST:** Temporarily boosts transmitter power output to its maximum level.
4. Once you have selected the mode you want, press the ƒ key to confirm.
5. Press and hold the Tx key to select the new setting and exit the menu.
6. Press the Tx key once to send the settings to the transmitter.

NOTE: When changing the transmitter frequency using iLOC, the chosen transmitter power setting will be retained.

SideStep

SideStep allows you to change the output frequency on the transmitter. SideStep changes the selected frequency by several Hertz and automatically sets the locator's locate frequency to match the transmitter's output frequency.

1. On the locator, select the frequency you want by pressing the ⓕ key until the frequency is displayed on screen.
2. To step the frequency, press and hold the ⓕ key until **STEP** appears on the LCD.
3. Press the Tx key to send the SideStep command to the transmitter.
4. If the command is sent successfully, an asterisk (*) will appear on the locator next to the frequency and STEP will appear on the transmitter below the frequency.
5. To return to the standard locate frequency, press and hold the ⓕ key. Once the asterisk (*) has been removed from the display, press the Tx key to send the command to the transmitter

CALSafe

GPS equipped RD8100 locators models are equipped with a system which can be enabled to force them to shut down once they are beyond the expected service / calibration date.

When the unit is within 30 days of the service due date the unit will display at startup the number of days left. The locator will stop functioning on the service due date.

CALSafe is disabled by default. You can enable the CALSafe feature and edit the CALSafe service / calibration due date using the RD Manager PC software. Refer to the RD Manager operation manual for further information.

Training

Radiodetection provides training services for most Radiodetection products. Our qualified instructors will train equipment operators or other personnel at your preferred location or at Radiodetection headquarters. For more information go to **www.radiodetection.com** or contact your local Radiodetection representative.

Care and maintenance

The RD8100 locator and transmitter are robust, durable and weatherproof. However you can extend your equipment's life by following these care and maintenance guidelines.

General

Store the equipment in a clean and dry environment.

Ensure all terminals and connection sockets are clean, free of debris and corrosion and are undamaged.

Do not use this equipment when damaged or faulty.

Batteries and power supply

Only use the rechargeable battery packs, chargers and power supplies approved by Radiodetection.

If not using rechargeable packs, use good quality Alkaline or NiMH batteries only.

Batteries should be disposed of in accordance with your company's work practice, and/or any relevant laws or guidelines in your country.

Cleaning

⚠ WARNING! Do not attempt to clean this equipment when it is powered or connected to any power source, including batteries, adapters and live cables.

Ensure the equipment is clean and dry whenever possible.

Clean with a soft, moistened cloth. Do not use abrasive materials or chemicals as they may damage the casing, including the reflective labels. Do not use high pressure jets of water to clean the equipment.

If using this equipment in foul water systems or other areas where biological hazards may be present, use an appropriate disinfectant.

Software upgrades

From time to time, Radiodetection may release software upgrades to enhance features and improve performance of the RD8100 locator or transmitter. Software upgrades are free of charge and provided through the RD Manager PC software

E-mail alerts and notification of new software releases are sent to all registered users. You can also check if your products are up-to-date or upgrade them by using the RD Manager software upgrade screen.

NOTE: To upgrade your product's software you need to have created an account using RD Manager and have a live internet connection. An optional Radiodetection power supply may be required to update your transmitter software.

Disassembly

Do not attempt to disassemble this equipment under any circumstances. The locator and transmitter contain no user serviceable parts.

Unauthorized disassembly will void the manufacturer's warranty, and may damage the equipment or reduce its performance.

Service and maintenance

Regularly check your equipment for correct operation by using the Self-Test function and eCert.

The locator and transmitter are designed so that they do not require regular recalibration. However, as with all safety equipment, it is recommended that they are serviced and calibrated at least once a year either at Radiodetection or an approved repair center.

NOTE: Service by non-approved service centers may void the manufacturer's warranty.

Details of Radiodetection offices and distribution partners can be found at **www.radiodetection.com**.

Radiodetection products, including this guide, are under continuous development and are subject to change without notice. Go to **www.radiodetection.com** or contact your local Radiodetection representative for the latest information regarding the RD8100 locator or any Radiodetection product.

Radiodetection®

CHAPTER 18 – NG System Earthquake Plan

Oklahoma State University

Stillwater, Oklahoma

Facilities Management - Energy Services

Central Plant, Bldg #0282 – 510 North Washington, Stillwater OK 74078

Distribution Systems
Utilities Distribution

Natural Gas System

Earthquake Plan

Revised Spring 2022

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1 – EARTHQUAKE PREPAREDNESS

DEFINITIONS

EARTHQUAKE
Earthquake is a term used to describe both sudden slip on a fault and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth.

FAULT
A fault is a fracture along which the blocks of crust on either side have moved relative to one another parallel to the fracture.

LIQUEFACTION
A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking.

AFTERSHOCKS
Aftershocks are earthquakes that follow the largest shock of an earthquake sequence. They are smaller than the main shock and within 1-2 rupture lengths distance from the main shock. Aftershocks can continue over a period of weeks, months, or years. In general, the larger the main shock, the larger and more numerous the aftershocks, and the longer they will continue.

MAGNITUDE
The magnitude is a number that characterizes the relative size of an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph. Several scales have been defined, but the most commonly used are (1) local magnitude (ML), commonly referred to as "Richter magnitude," (2) surface-wave magnitude (Ms), (3) body-wave magnitude (Mb), and (4) moment magnitude (Mw). Scales 1-3 have limited range and applicability and do not satisfactorily measure the size of the largest earthquakes. The moment magnitude (Mw) scale, based on the concept of seismic moment, is uniformly applicable to all sizes of earthquakes but is more difficult to compute than the other types. All magnitude scales should yield approximately the same value for any given earthquake.

Source: http://earthquakes.usgs.gov/learn/glossary/?alpha=S

2 – EARTHQUAKE RICHTER MAGNITUDE SCALE and CLASSES

EARTHQUAKE RICHTER MAGNITUDE SCALE

RICHTER MAGNITUDE	EARTHQUAKE EFFECTS	EST. NUMBER PER YEAR
2.9 of less	Usually not felt, but can be recorded by seismograph.	1,300,000
3.0 to 3.9	Often felt, but only causes minor damage.	130,000
4.0 to 4.9	Often felt, but only causes minor damage.	13,000
5.0 to 5.9	Slight damage to buildings and other structures.	1,319
6.0 - 6.9	May cause a lot of damage in very populated areas.	134
7.0 to 7.9	Major earthquake. Serious damage.	17
8.0 or greater	Great earthquake. Can completely destroy communities near the epicenter.	1

Source: http://neic.usgs.gov/neis/eqlists/eqstats.html

EARTHQUAKE RICHTER MAGNITUDE CLASSES

Earthquakes are also classified in categories ranging from minor to great, depending on their magnitude.

CLASS	RICHTER MAGNITUDE
Great	8 or more
Major	7 - 7.9
Strong	6 - 6.9
Moderate	5 - 5.9
Light	4 - 4.9
Minor	3 -3.9

3 – EARTHQUAKE PROTOCOLS

- When an earthquake occurs, there is no warning; the destruction from an earthquake depends on the magnitude of the quake and the design of structures. Aboveground structures will show various stages of damage reflecting the magnitude of the earthquake.
- What is not obvious is the damage underground facilities may sustain as a result of an earthquake.
- The following pages are minimal protocols that should are put in place after an earthquake has occurred in or near areas with underground facilities served by Oklahoma State University – Stillwater Campus.
- Actions to be taken and/or considered are determined by:
    1) the magnitude of the earthquake; and,
    2) the distance in miles to the nearest OSU Stillwater Facility.
- Depending on the underground piping (cast iron, plastic or steel) in or near the area of the earthquake, more stringent actions may need to be taken to assure underground facilities are safe.
- In the event of an earthquake in the OSU gas system service, the Earthquake Action Log will be completed for the event. The purpose of the Earthquake Action Log is to document the appropriate actions taken, based on the severity of the earthquake and its proximity OSU Stillwater facilities.

Natural Gas - Earthquake Protocol

Oklahoma State University - Stillwater Campus

Earthquake Magnitude	1 - 3	3.1 - 3.9				4.0 - 4.9				5.0 - 5.5				5.6 - 5.9			
Miles to Nearest Facilities	Any	0-10	10-30	30-100	>100	0-10	10-30	30-100	>100	0-10	10-30	30-100	>100	0-10	10-30	30-100	>100
* *Actions to be taken and considered*																	
No Action	x			x	x				x				x				x
Monitor Web, App & TV		x	x			x	x	x		x	x	x		x	x	x	
Notify UD Supervisor, UD On Call						x	x	x		x	x	x		x	x	x	
Notify FM Work Control						x				x	x			x	x		
Notify Distribution Manager						x				x	x			x	x		
Notify Energy Services Director						x				x	x			x	x		
Send Out UD Patrols						x				x	x			x	x		
Initiate Leak Survey														x	x		
Mobilize MEP/Zone On Call														x	x		
Notify EOC Commander						x								x	x		

Earthquake Magnitude	6.0 and Higher			
Miles to Nearest Facilities	0-10	10-30	30-100	>100
* *Actions to be taken and considered*				
No Action				
Monitor Web, App & TV	x	x	x	x
Notify UD Supervisor, UD On Call	x	x	x	x
Notify FM Work Control	x	x		
Notify Distribution Manager	x	x		
Notify Energy Services Director	x	x		
Send Out UD Patrols	x	x		
Initiate Leak Survey	x	x		
Mobilize MEP/Zone On Call	x	x		
Notify EOC Commander	x	x		
Request Mutual Assistance				

*** Definitions of Action to be Taken According to Earthquake Magnitudes**

1. OSU will not respond.
2. Utility crew will monitor webs, apps and TV.
3. Utility supervisor and on-call will be notified and determine action to be taken.
4. Utility supervisor will notify Work Control for support and awareness.
5. Utility supervisor will notify manager that a qualifying earthquake has been detected.
6. Utility manager will notify director that a qualifying earthquake has been detected.
7. Utility supervisor will send out Distribution crew to initiate patrolling.
8. Utilities supervisor will initiate the leak survey.
9. Utility supervisor will request MEP/Zone On Call Support.
10. Energy Services Director will notify administration for campus EOC support consideration.
11. Energy Services will request the support of mutual aid, ONG, PRC and contract crews.

4 – THE MODIFIED MERCALLI INTENSITY SCALE

The Modified Mercalli Intensity Scale

Earthquake Richter Scale

The Modified Mercalli Intensity Scale of 1931 is the basis for the U.S. evaluation of seismic intensity. Unlike earthquake magnitude, which indicates the energy a quake expends, Mercalli intensity denotes how strongly an earthquake affects a specific place. It has 12 divisions, using Roman numerals from I to XII.

MAGNITUDE	MERCALLI	INTENSITY DESCRIPTION
2	I	Usually not felt, but detected by instruments.
	II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
3	III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing truck.
	IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rock noticeably.
4	V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
5	VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
	VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motor cars.
6	VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
7	IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
	X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed over banks.
8	XI	Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and landslips in soft ground. Rails bent greatly.
	XII	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

5 – EARTHQUAKE ACTION LOG

EARTHQUAKE ACTION LOG

Date/Time of Notification

Date: **Time:**

Location: **Magnitude:**

Facilities Checked OSU Stillwater

1. **2.**

3. **4.**

5. **6.**

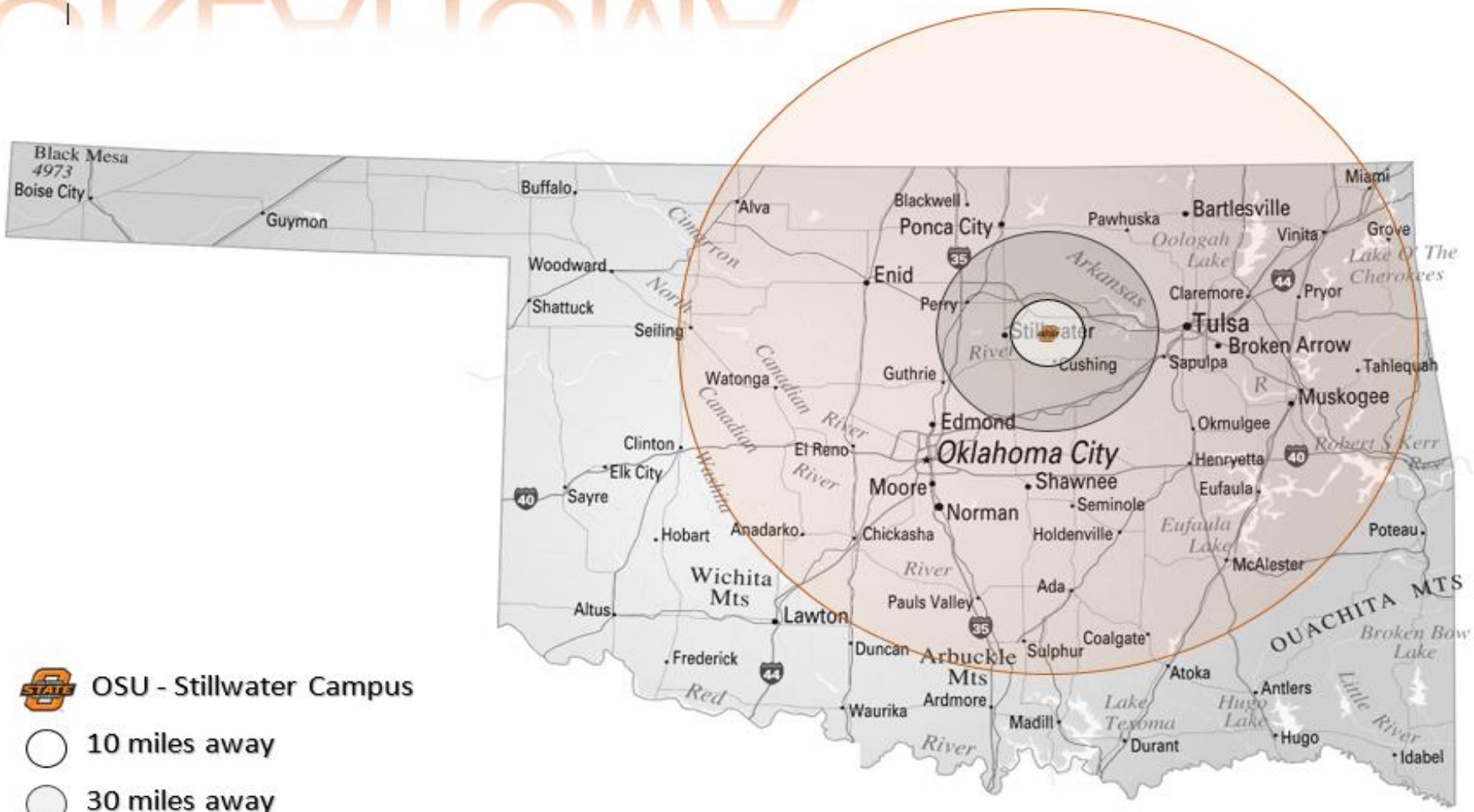
Person Sent to Check Facilities

Findings

Action Taken - If Any

Follow-Up Recommendations/Required

OKLAHOMA



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CHAPTER 19 – NG System Emergency Operations Plan

Oklahoma State University

Stillwater, Oklahoma

Facilities Management - Energy Services

Central Plant, Bldg #0282 – 510 North Washington, Stillwater OK 74078

Distribution Systems
Utilities Distribution
Natural Gas System
EMERGENCY PLAN

Table of Contents

EMERGENCY PLAN OVERVIEW

This Emergency Plan provides a guide for complying with the Federal and State requirements, assuring safety for the public and maintaining facilities in satisfactory condition.

An "emergency" condition exists when OSU management, or a responsible person, has determined that extraordinary procedures, equipment, manpower and supplies must be employed to protect the public safety or property from existing or potential hazard.

These hazards will include, but are not limited to, the following:

- Under pressure in the gas system
- Overpressure in the gas system
- Uncontrolled escaping gas
- Fire or explosion near or directly involving a pipeline facility
- Any leak considered hazardous
- Danger to major segment(s) of the system

The hazards also include:

- Natural disasters (floods, tornadoes, hurricanes, earthquakes, etc.)
- Civil disturbances (riots, etc.)
- Load reduction conditions (result in voluntary or mandatory reduction of gas usage)

EMERGENCY PROCEDURES

I - Incident Notification
In the event of a natural gas leak that has the potential to represent a hazard to persons or properties, move away from the site of the leak and notify 911 immediately.

- 911 Emergency--(911)
  911 dispatch will gather information from the caller and contact the following appropriate departments:

  - Stillwater Fire Department
  - OSU Campus Police
  - LifeNet EMS
  - OSU Facilities Management Work Control (405-744-7154)

Facilities Management Work Control
Work Control personnel (or evening ops), upon receiving the call from 911 dispatch, will immediately report the leak event to the following Oklahoma State University authorities:

Position Title	Name	Office Phone	Cell Phone
DIST SYS Supervisor	Norm Howard	405-744-4412	405-612-5287
DIST SYS Asst. Spvsr.	Josh Page	405-744-4395	321-368-5610
DIST SYS Manager	Greg McKnight	405-744-7288	405-334-7067
Energy Services Director	Brandon Neal	405-744-7149	405-747-4867
OSU Envr. Health & Safety	Kim Southworth	405-744-7241	

II - Incident Priorities and Criteria for Action

A. Priorities

1. The first priority of action for all incidents involving natural gas will be directed toward life safety first followed by property. Immediate care shall be given to any injured person(s).
2. Determine the Incident Level based upon criteria listed in this outline.
3. The surrounding area may be evacuated to reduce risk of additional casualties.

B. **Level 1 Incidents:** Leak classification and action criteria.

Level 1 Definition:
A leak that represents an existing or probable hazard to persons or property. Requires immediate repair or continuous action until the conditions are no longer hazardous.

Level 1 Action Criteria:
Requires prompt action to protect life and property, and continuous action until the conditions are no longer hazardous.

Prompt action in some instances may require one or more of the following (not necessarily in this order):

- Notifying police and fire departments by calling 911

- Implementation of OSU Emergency Plan
- Evacuating a suitable area based on size of the leak
- Blocking off an area
- Rerouting traffic
- Eliminating sources of ignition
- Venting the area
- Stopping the flow of gas by closing valves or other means

Examples:

1. Any leak which, in the judgment of operating personnel at the scene, is regarded as an immediate hazard.
2. Escaping gas that has ignited.
3. Any indication of gas that has migrated into or under a building or into a tunnel.
4. Any underground reading at the outside wall of a building or where gas would likely migrate to an outside wall of a building.
5. Any reading of 80% LEL or greater in a confined space.
6. Any reading of 80% LEL or greater in small substructures (other than gas-associated substructures) from which gas would likely migrate to the outside wall of a building.
7. Any leak that can be seen, heard, or felt, and is in a location that may endanger the general public or property.

C. **Level 2 Incidents -** Leak classification and action criteria.

Level 2 Definition
A leak that is recognized as being non-hazardous at the time of detection, but justifies scheduled repair based on probable future hazard.

Level 2 Action Criteria
Leaks should be repaired or cleared within one calendar year, but no later than 15-months from the date the leak was reported. In determining the repair priority, criteria such as the following should be considered:

- Amount and migration of gas
- Proximity of gas to buildings and sub-surface structures
- Extent of pavement
- Soil type and soil conditions (such as frost cap, moisture & natural venting)

Level 2 leaks should be reevaluated at least once every six months until cleared. The frequency of reevaluation should be determined by the location & magnitude of the leakage condition.

Level 2 leaks may vary greatly in degree of potential hazard. Some Level 2 leaks, when evaluated by the above criteria, may justify scheduled repair within the next 5-working days. Others will justify repair within 30-days. During the working day on which the leak is

discovered, these situations should be brought to the attention of the individual responsible for scheduling leak repair.

On the other hand, many Level 2 leaks, because of their location and magnitude, can be scheduled for repair on a normal routine basis with periodic re-inspection as necessary.

Examples:

1. Leaks requiring action ahead of ground freezing or other adverse changes in venting conditions. Any leak that, under frozen or other adverse soil conditions, would likely migrate to the outside wall of a building.

2. Leaks requiring action within 6-months.

    - Any reading of 40% LEL, or greater, under a sidewalk in a wall-to-wall paved area that does not qualify as a Level 1 leak
    - Any reading of 100% LEL, or greater, under a street in a wall-to-wall paved area that has significant gas migration and does not qualify as a Level 1 leak
    - Any reading less than 80% LEL in small substructures (other than gas-associated substructures) from which gas would likely migrate creating a probable future hazard
    - Any reading between 20% LEL and 80% LEL in a confined space
    - Any reading on a pipeline operating at 30% SMYS, or greater, in a class 3 or 4 location, which does not qualify as a Level 1 leak
    - Any reading of 80% LEL, or greater, in gas-associated substructures
    - Any leak that, in the judgment of operating personnel at the scene, is of sufficient magnitude to justify scheduled repair

D. **Level 3 Incidents** - Leak classification and action criteria

Level 3 Definition:
A leak that is non-hazardous at the time of detection and can be reasonably expected to remain non-hazardous.

Level 3 Action Criteria:
These leaks should be re-evaluated during the next scheduled survey, or within 15-months of the date reported, whichever occurs first, until the leak is re-graded or no longer results in a reading.

Examples:
Leaks requiring re-evaluation at periodic intervals:

- Any reading of less than 80% LEL in small gas-associated substructures
- Any reading under a street in areas without wall-to-wall paving where it is unlikely the gas could migrate to the outside wall of a building
- Any reading of less than 20% LEL in a confined space

III - Incident Responsibilities

1. The 1st Responder shall establish a unified command post (utilizing the Incident Command System) near the scene, when necessary or required, to coordinate the incident.

2. On-scene emergency personnel from LifeNet EMS shall provide immediate first aid to injured persons when it is safe to do so.

3. OSU Campus Police and Stillwater Fire Department shall conduct evacuations in the event of fire, explosion, natural disaster or other type of incident, when necessary, as directed by the Incident Commander.

4. OSU Campus Police, in conjunction with other supporting agencies, shall establish, maintain, and man all necessary incident perimeters and barricades as directed by the Incident Commander.

5. OSU Energy Services personnel shall isolate the incident area by shutting off the flow of any gas from feed lines into the impacted area, only after the determination that such action can be performed safely.

6. The City of Stillwater Fire Department shall manage any fire suppression needs and may assist LifeNet EMS in providing advanced emergency medical care and transportation of patients.

7. Manpower and equipment shall be provided by OSU's Facilities Management at the request of the Incident Commander.

IV - Response Procedures

In case of fire located near or directly involving a pipeline facility, explosion occurring near or directly involving a pipeline facility, natural disaster, or other emergency incident, the following response procedures will be followed:

Notification will proceed as designated on page-5 of this document.

The first responder(s) shall designate an incident commander and activate the incident command system (ICS). When necessary, an on-scene incident command post shall also be established.

The on-scene incident command post shall be located upwind and as close as practical to the incident site so that continual visual observations may be maintained of the incident area, and immediate response to changing conditions may be possible. The on-scene command post shall stay in communication with all responding agencies.

Responding agencies shall provide designated responsibilities as listed above, under the direction of the incident commander.

First aid and medical care will be provided by LifeNet EMS to injured persons as soon as possible.

Firefighting and fire suppression operations will be initiated and conducted by Stillwater Fire Department.

Gas valve shut off will be conducted as quickly as possible by OSU Energy Services department, once the determination is made that it is safe to do so.

Perimeter zone(s) around the affected area shall be established as directed by the incident commander in accordance with standard emergency scene practices.

Hazard Zone - The Hazard Zone is the area in which personnel are potentially in immediate danger from the hazardous situation. This zone shall be established by the incident commander. Access to this area will be rigidly controlled and only authorized personnel with proper protective equipment and an activity assigned by the Energy Services, Distribution Systems Manager or his representative and approved by the on-site incident command post shall be allowed to enter the incident area. OSU Campus Police personnel will be assigned to monitor entry and exit of all personnel from the Hazard Zone.

Evacuation Zone - The Evacuation Zone is the larger area surrounding the Hazard Zone, in which a lesser degree of risk to emergency personnel exists, but from which all civilians will be removed. The limits of this zone will be enforced by the OSU Campus Police and other agencies based upon distances and directions established by the incident commander. The area to be evacuated depends upon the nature and extent of the fire, explosion, natural disaster, or other emergency. All evacuations shall be ordered by the incident commander and shall be conducted in an orderly, expedient fashion.

Additional Perimeter Zones may be established as necessary. These may include **Hot Zone, Warm Zone, and Cold Zone** for gas incidents that may also involve hazardous chemicals, as well as a **Staging Area** for any major incident that may require large numbers of personnel and equipment.

Incident-specific circumstances will dictate other procedures that will be used to bring the emergency under control in accordance with the priorities of life safety first, followed by the protection and salvage of property.

V - POST Incident Management

A. Upon declaration of the Incident Commander that the incident is under control and the incident area is safe, Stillwater Fire Department personnel shall sweep the incident area searching for any additional casualties. Upon completion of the sweep, responsible personnel shall begin the cause and origin procedures. Upon completion of the investigation, repairs may be initiated.

B. Barriers shall remain intact, and any area vacated due to the incident shall remain vacated until repairs and any required tests are completed before restoring all systems back to normal operating conditions.

C. Repairs shall be initiated immediately and shall be expedited to restore normal service and to place OSU's gas distribution system into a normal and safe mode of operation.

D. Normal procedures shall apply to the emergency repairs:

1. Only qualified OSU personnel shall perform the repairs.
2. Only approved material as specified in the Guide for Small Gas Operators shall be utilized.
3. OSHA & OSU's safety procedures and guidelines shall be utilized.

E. Upon completion of repairs, and after the gas system has been successfully tested and restored to operation, the incident area may be released for normal operation.

1. A final inspection of the area shall be conducted by qualified personnel at the direction of the Incident Commander.
2. As directed the Incident Commander:
   - Barriers shall be removed
   - Personnel shall be allowed to return to the area
   - Emergency personnel shall be released upon direction by the Incident Commander

VI - <u>POST Incident Reporting</u>

A. The University Fire Marshal, shall, within 72-hours of the closure of the Level One incident, schedule and facilitate a debriefing with all agencies concerned, i.e., University, City, State, ONG, and National participants. This debriefing shall include, but not be limited to:
   1. Critique of the incident
   2. Problem areas identified
   3. Revisions to the emergency plan, if needed
   4. Factors that caused the incident

B. Upon completion of the debriefing, open discussion for questions and answers.
C. The University Fire Marshal issues the final report.

RESPONDING to GAS LEAK REPORTS

It is the responsibility of OSU Facilities Management to train its employees on policy and procedure concerned with gas leak calls and reports.

I. The Facilities Management (Work Control) employee receiving a report of a gas leak should get as much of the information as possible to fill out a leak report, or Facilities Management Work Request.
II. All reports of gas leaks on OSU property get assigned a high priority. Leaks inside a facility or building receive a Priority One.
III. Upon receiving pertinent information, and determining that a hazardous leak exists inside a building, the caller should be advised on the following:
   a. Do not operate (do not turn on or off) any electrical appliance or device.

b. Extinguish all open flames. Do not light any matches, cigarettes, etc.
c. Turn off the gas supply (only if the caller knows how to do so).
d. Evacuate the building to a safe distance. Be close enough to relay information to arriving emergency personnel.

IV. Dispatch necessary Facilities Management personnel to the location.

V. Duties of the first responsible University responder (Facilities Management employee or Campus PD) on the scene: *Take any corrective action necessary to ensure protection of life, then property*. It is the responsibility of the person in charge to:
a. Set up communication
b. Coordinate the operation
c. Make all decisions concerning closing emergency valves and isolating areas, as well as coordinate emergency personnel and equipment.

MINIMUM OPERATOR RESPONSE ACTIONS:

I. Leaks outside of buildings:

a. Assess danger to passersby, surrounding buildings and their occupants, and other property.
b. Extinguish all open flames.
c. If necessary, notify the Stillwater Fire Department.
d. Block the street(s)
e. Notify Supervisor or other responsible persons.
f. Check neighboring buildings for gas vapors, fumes, etc.
g. Implement Check List for major emergency (see page 14).
h. Repair leak
i. Upon completion of repairs, check the area using a Combustible Gas Indicator; if determined safe, allow occupants to return to building.

II. Leaks inside a building:

a. Evaluate the issue to determine hazard, concentration of gas, and source of the leak.
b. Evacuate the building if required.
c. Do not operate any light switches or electrical appliances.
d. Do not use the telephone; turn off pagers and cell phones.
e. Shut off the gas meter valve.
f. Ventilate the building.
g. Bar hole the area, especially around the foundation. Check water meter and other ground openings.
h. If ground is gas-free, and if the building is gas-free, turn on the meter valve. CHECK ALL GAS PIPING AND APPLIANCES FOR LEAKS.
i. Implement Check List for major emergency (see page 14).
j. Repair leak.
k. If leak cannot be repaired, notify Supervisor. Turn off the meter, lock it and tag it out.

III. Gas burning inside a building:
   a. Call 911.
   b. If fire is at appliance, shut off the gas appliance valve, if possible.
   c. If not possible, shut the gas off at the meter or appropriate valve.
   d. Implement Check List for major emergency (see page 14).

IV. Interruption in the gas supply
   An interruption in gas supply could be due to - freezing of the regulators, break in the line, sabotage, or ONG cut-off.
   a. Call OSU's supplier (ONG).
   b. Locate the leak; inform ONG of the location of the leak.
   c. Close appropriate valve in the system to isolate the break.
   d. Implement Check List for major emergency (see page 14).

NG EMERGENCY NOTIFICATION LIST

SYSTEM OWNER: Oklahoma State University

Norm Howard	ES UTIL Distribution Supervisor	405-744-4412	405-612-5287
Josh Page	ES UTIL Distribution Asst. Supervisor	405-744-4395	321-368-5610
FM Work Control		405-744-7154	
Greg McKnight	ES Distribution Systems Manager	405-744-7288	405-334-7067
Brandon Neal	ES Director	405-744-7149	405-747-4867
Jerry Petre	University Fire Marshal	405-744-1700	405-338-0224
Casey Romero	ES Asst. Director and Energy Management Manager	405-744-4628	

AVAILABLE EMERGENCY EQUIPMENT LIST

EQUIPMENT	AMOUNT	LOCATION	INSPECTION
Backhoe/front-end loader	2	Facilities Management	After 500 hours
Dump trucks	1	Facilities Management	Quarterly
Winch truck	1	Facilities Management	Quarterly
Mobile yard crane	1	Facilities Management	Quarterly
3210 DW Trencher	1	Facilities Management	Quarterly
Emergency generators	8	Facilities Management	Monthly
Emergency lights	15	Facilities Management	Monthly
Hand tools	various	Facilities Management	Monthly
Repair kits	2	Facilities Management	Monthly
Barricades/Barriers	numerous	Facilities Management	Monthly
Gas Detectors	7	Facilities Management	Weekly and before each use
Labor	as needed	Call Out	

NOTIFICATIONS LIST

AGENCY **TELEPHONE**

LOCAL:

Leon Jones, Chief Public Safety Officer 744-6528

Campus Police Dispatcher 744-6523

Stillwater Police Department 372-4171

Stillwater Fire Department 372-0497

Ambulance, Life-Net 707-0060

Emergency Response 911

Oklahoma Natural Gas 405-707-5621

STATE:

Oklahoma Corporation Commission 1-405-521-2258
Pipeline Safety 24 hours

Oklahoma Natural Gas 800-458-4251
24 hours

NATIONAL:

National Response Center 1-800-424-8802

CHECK LIST (MAJOR EMERGENCY)

- ❑ 1. Has 911 Emergency been called?
- ❑ 2. Have the occupants been evacuated to a designated area and the area secured?
- ❑ 3. Has the Police Department been notified by 911 dispatch?
- ❑ 4. Has Life-Net EMS been notified by 911 dispatch?
- ❑ 5. Has a repair crew been notified by Facilities Management Work Control?
- ❑ 6. Has the leak been shut off or brought under control by FM Energy Services?
- ❑ 8. Has the University call list been executed?
- ❑ 9. Has outside help been requested?
- ❑ 10. If an area has been cut off from a supply of gas, has the individual building been cut off?
- ❑ 11. Is the situation under control and has the possibility of recurrence been eliminated?
- ❑ 12. Has the surrounding area, including adjacent buildings and cross streets, been probed for the possibility of further leakage?
- ❑ 14. If applicable, has telephonic report been made to the State?
- ❑ 15. If applicable, has telephonic report been made to NRC/DOT?

REPORTING REQUIREMENTS

A. A telephone call from a senior University official MUST BE MADE TO THE U.S. DEPARTMENT OF TRANSPORTATION and OKLAHOMA CORPORATION COMMISSION for any leak where:

1. There is a release of gas from a pipeline.

AND

There is a death or personal injury requiring hospitalization or there is estimated property damage, including the cost of gas lost, by the operator or others, of $50,000 or more.

2. There is an event that is significant in the judgment of the operator, even though it was not described in A-1.

B. A telephone call MUST BE MADE TO THE OKLAHOMA CORPORATION COMMISSION for any leak where:

1. There is a release of gas from a pipeline.

AND

There is a death or personal injury requiring hospitalization or there is estimated property damage, including the cost of gas lost, by the operator or others, of $5,000 or more.

2. There is an event that is significant in the judgment of the operator, even though it was not described in B-1.

The telephone report to DOT and OCC should contain:

- OSU's address
- Name and phone number of individual reporting the incident.
- The location of the leak (city, county, state, and street address).
- The time of the leak (hour and date).
- The number of fatalities and personal injuries, if any.
- Type and extent of property damage.
- Description of the incident. (See DOT Incident Form, attached.)

A telephonic report should be made at the earliest practicable time following discovery **(within 2 hours).**

RESTORATION OF GAS SERVICE DUE TO OUTAGE

When the supply of gas has been cut off to an area, the gas should not be restored to the affected area until the individual gas services in a university building have been turned off.
In restoring service on the University to an affected area, all gas piping and meters must be purged and appliances re-lighted. Never turn gas on at a meter unless you have access to ALL appliances or equipment on the piping.

The OSU Facilities Management person in charge is to coordinate this operation and be responsible for same.

A complete record of the incident, including service restoration and drawings, if necessary, must be kept on file.

EDUCATION AND/OR TRAINING

Employee Training

OSU Facilities Management employees must be trained annually in emergency procedures that include but are not limited to:

1. Update of the emergency plan
2. Review of employee responsibilities in an emergency
3. Review of location and use of emergency equipment.
4. Review properties of natural gas.
5. Review the locations of:
    - Systems map
    - Main records
    - Service records
    - Valve records
    - Regulator station schematics
6. Take a hypothetical emergency situation and conduct a step-by-step review with employees on the action to be taken, including contact with public officials, Stillwater Fire Department, OSU & Stillwater Police, and ONG, etc.
7. Record keeping
8. Telephone reports (U.S. DOT, State agency, etc.)
9. Records shall be kept on file of attendance and items discussed.
10. Liaison with appropriate fire, police, and other public officials.

PUBLIC EDUCATION

Oklahoma State University will, through its Communications Office, enable faculty, staff, students, the general public and appropriate governmental organizations, to recognize a gas emergency. OSU will, through Residential Life, and other departments, instruct the concerned constituency in reporting gas odors, leaks and other emergencies to OSU Facilities Management Work Control, OSU Police, or ONG (Oklahoma Natural Gas).
The program material should include, but not be limited to:

- Information about gas properties
- Recognition of gas odors
- What to do and not do when there is a strong gas odor
- Notification of the University and gas company prior to making excavation-related activities.
- Telephone numbers for persons in the University to report gas leaks or odors or other information during both business and non-business hours.

This information may be conveyed to the University constituency by a number of means:

- Radio and television
- Newspaper
- Meetings
- Bill stuffers
- Mailings
- Hand-outs
- Posted on bulletin boards
- Employee newsletters
- Campus websites
- Apartment handbooks
- New-employee orientation
- Campus-wide email
- Facilities Management Website

The University will maintain records of the public information program and related activities.

LIAISON WITH PUBLIC OFFICIALS & LOCAL GAS UTILITIES

Environmental Health and Safety will establish liaison with fire, police, civil defense, and medical officials with respect to these emergency procedures. These officials include representatives of Stillwater Police and Fire Departments (911 dispatch management), Payne County Emergency Management and Oklahoma Natural Gas, Life-Net EMS and OSU Student Health Center, as well as OSU Facilities Management managers.

Liaison will consist of annual meetings to discuss what each agency can do for the other to control an emergency situation at the OSU facility. This meeting will be performed with face-to-face communication, at which time a copy of this Emergency Plan will be provided to each official.

Documentation must be kept of all meetings, training sessions, and other related activities, such as:

- Date of meeting, attendance, and titles of participants
- Training sessions on proper procedures to follow during a gas emergency
- Meetings to learn capabilities, responsibilities, and procedures respecting gas emergencies of each group.

INFORMATION TO THE NEWS MEDIA

During an emergency, refer all requests for information to the University's Communications Office (CO). The CO will coordinate emergency information with responsible OSU management. The OSU plan for public announcements includes:

- Calm the situation
- Do not make unwarranted comments
- Tell precisely what the public can do to help
- Tell specifically what OSU and ONG are doing about the incident.
- Give facts to prevent baseless rumors.
- Repeat most encouraging view of situation that facts will permit.
- Do not speculate regarding the situation in absence of facts.

ACCIDENT INVESTIGATION

OSU will proceed in analyzing accidents and failures, and at the minimum:

- Evaluate the situation
- Protect life and property
- Keep the area safe
- Conduct a leak survey
- Conduct pressure test of piping
- Perform meter and regulator checks
- Question persons on the scene
- Examine burn and debris patterns
- Request ONG test odorization level
- Record weather conditions
- Select samples of the failed facility or equipment or equipment for laboratory examination for the purpose of determining the causes of the failure and minimizing the possibility of recurrence
- Notify the appropriate Risk Management Office

TELEPHONIC REPORTS to the FEDERAL GOVERNMENT

Gas pipeline incidents that meet the reportable state requirements and have caused estimated damages in excess of $50,000 (total of operator's damage and damage to others and including cost of gas loss) must also be reported to the federal government.

TELEPHONE TOLL FREE	(800) 424-8802
WASHINGTON, D.C.	(202) 426-2675
24 HOURS EVERY DAY	

This telephonic report, if required, should also be made upon discovery, but in no case later than two hours after discovery. This telephonic report of a serious incident should include:

- Identity of reporting operator,
- Name and phone number of individual reporting the incident,
- The location of the leak (city, county, state, and street address),
- The time of the leak (date and time)
- The number of fatalities and personal injuries, if any,
- Type and extent of property damage, and
- Description of the incident.

EMERGENCY EQUIPMENT

We are responsible for the adequacy, availability, and condition of emergency equipment. Inspection of emergency equipment will be conducted quarterly, or as often as may be necessary, and records of these inspections will be kept on file.

CONTRACTOR EMERGENCY CALL LIST

Contractor's name: _____

Address: _____

24-hour telephone number: _____

FACILITY NAME: _____

EMERGENCY PLAN - STAFF TRAINING RECORD

Plans will be reviewed annually, and records of review and training shall be kept on file. Employees shall be trained in the operation/maintenance and emergency plan once each calendar year.

ANNUAL PLAN REVIEW	PERSONNEL TRAINING

INCIDENT REPORT – GAS DISTRIBUTION SYSTEM

Incident Report includes the following two pages.

S Department of Transportation Research and Special Programs Administration

INCIDENT REPORT -- GAS DISTRIBUTION SYSTEM

Date of Report

PART 1 - GENERAL REPORT INFORMATION

1. a. Operator's 5-digit identification number: / / / / / /
   b. Name of Operator _____
   c. _____ Number & Street
   d. _____ City,County,State,Zip Code
2. Location of incident
   a. _____ Number & Street
   b. _____ City & County
   c. _____ State and Zip Code
   d. Class Location ☐1 ☐2 ☐3 ☐4
   e. Incident on Federal Land? ☐Yes ☐No
3. Time and Date of Incident

   / / / / / hour / / / mo / / / day / / / year

4. Reason for Reporting

   ☐ Fatality Number / / / / persons
   ☐ Injury requiring inpatient hospitalization Number / / / / persons
   ☐ Property damage/loss Estimate $ _____
   ☐ Operator Judgment/Emergency Action
   ☐ Supplemental Report
5. Elapsed time until area was made safe: / / / hr / / / min.
6. Telephonic Report: / / / mo. / / / day / / / year
7. a. Estimated pressure at point & time of incident (PSIG)_____

   b. Maximum allowable operating pressure (MAOP) (PSIG)_____

   c. MAOP established by:

   (1) ☐ Test pressure (PSIG) _____

   (2) ☐ 49 CFR § 192.619(a)(3)

PART 2 - APPARENT CAUSE

☐ Corrosion *(continue in Part A)*
☐ Damage by Outside Forces *(continue in Part B)*
☐ Construction/Operating Error caused by operator *(continue in Part C) and/or C)*
☐ Accidentally *(continue in Parts B*
☐ Other_____

PART 3 - NARRATIVE DESCRIPTION OF FACTORS CONTRIBUTING TO THE INCIDENT

(Attach additional sheet(s) as necessary)

PART 4 - ORIGIN OF THE INCIDENT

1. Part of System Where Incident Occurred
   ☐ Main ☐ Meter Set Assembly
   ☐ Service Line ☐ Other_____
3. Material Involved:
   ☐ Steel ☐ Cast iron
   ☐ Polyethylene plastic ☐ Other plastic: _____
   ☐ Other_____
   NPS (Nominal Pipe Size) / / / / / in. Wall Thickness / / / / / in.
2. Component That Failed
   a. Part
   ☐ Body of Pipe ☐ Regulator/meter
   ☐ Valve ☐ Joint, type_____
   ☐ Fitting ☐ Weld--_____ (specify girth, longitudinal, fillet)
   ☐ Drip/Riser ☐ Other_____
4. Specification _____ Manufacturer _____ Year Manuf. / / / / / Year Installed / / / / /

PART 5 - ENVIRONMENT

Area of Incident

☐ Within/Under Building ☐ Under Pavement ☐ Above Ground ☐ Under Ground or Under Water ☐ Other _____

PART 6 - PREPARER AND AUTHORIZED SIGNATURE

_____ Preparer's Name & Title - PRINT

_____ Telephone Number

_____ Authorized Signature & Date

_____ Telephone Number

INCIDENT REPORT -- GAS DISTRIBUTION SYSTEM (continued)

PART A - CORROSION

1. Where did the corrosion occur?
   - ☐ Internally
   - ☐ Externally
2. Visual Description
   - ☐ Localized Pitting
   - ☐ General Corrosion
   - ☐ Other_____
3. Cause
   - ☐ Galvanic
   - ☐ Other_____
4. Pipe Coating Information
   - ☐ Bare ☐ Coated
5. Was corroded part of pipeline considered to be under cathodic protection prior to discovering incident?
   - ☐ Yes Year protection started / / / / /
   - ☐ No
6. Additional Information:

PART B - DAMAGE BY OUTSIDE FORCES

1. Primary Cause of Incident
   - ☐ Damage resulted from action of operator or his/her agent
   - ☐ Damage resulted from action by outside party/third party
   - ☐ Damage by earth movement
     - ☐ Subsidence
     - ☐ Landslide/Washout
     - ☐ Frost
     - ☐ Other_____
   - ☐ Damage by lightning or fire
2. Locating information (for damage resulting from action of outside party/third party)
   a. Did operator get prior notification that equipment would be used in the area?
      - ☐ Yes Date received / / / mo. / / / day / / / yr.
      - ☐ No
   b. Was pipeline location marked either as a result of notification or by markers already in place?
      - ☐ Yes ☐ Permanent Markers ☐ Temporary Stakes ☐ Other_____
      - ☐ No
   c. Does Statute or ordinance require the outside party to determine whether underground facility(ies) exist?
      - ☐ Yes
      - ☐ No
3. Additional Information:

PART C - CONSTRUCTION DEFECT

1. Cause
   - ☐ Poor workmanship during construction ☐ Operating procedures inappropriate ☐ Error in operating procedure application
   - ☐ Physical damage during construction ☐ Other _____
2. Additional information:

PART D - OTHER

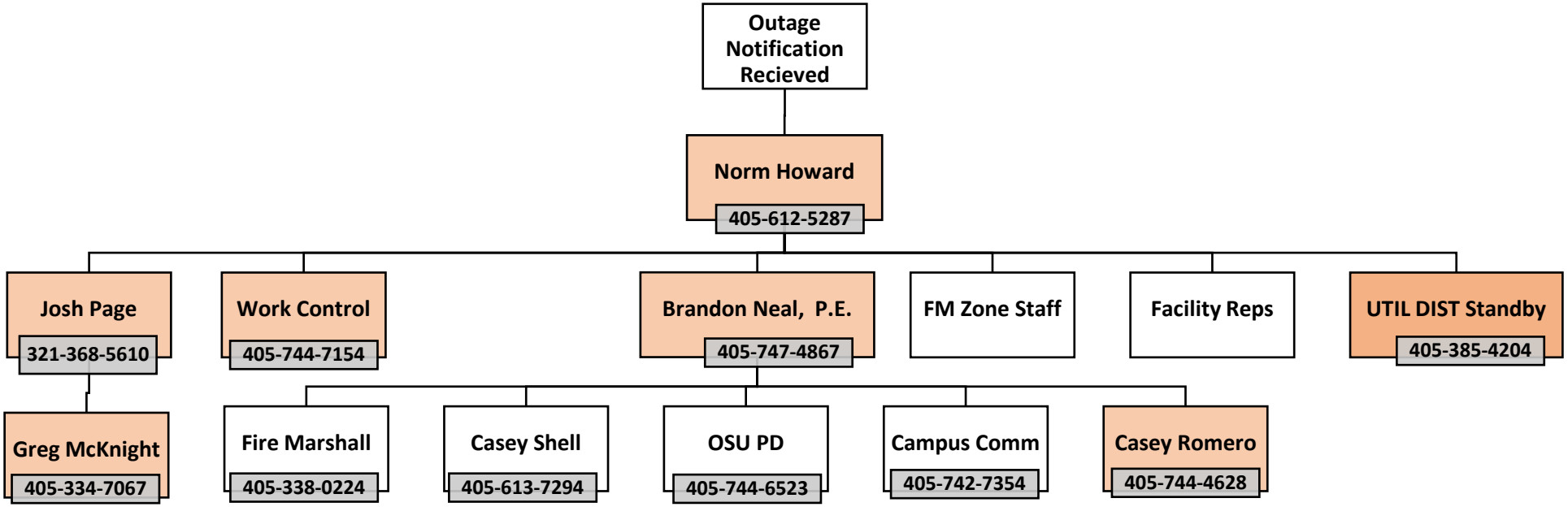
Brief Description:

NOTICE: This report is required by 49 CFR Part 191. Failure to report can result in a civil penalty not to exceed $1,000 for each violation for each day that such violation persists except that the maximum civil penalty shall not exceed $200,000 as provided in 49 USC 1678.

NG OUTAGE COMMUNICATION TREE

Natural Gas Distribution Failure / Sustained Outage

Communication Tree



Primary Roles (mandatory notification)

If the next person in a primary role cannot be reached, take responsibility to call the next level of primary roles.
If anyone in the middle of the tree receives the first notification, notify the primary role above and respective roles below.

CHAPTER 20 – OSU Stillwater Natural Gas MAP

AMERICA'S BRIGHTEST
ORANGE

2"-4" JOINT TRENCH

2" Riser

Emergency Generator

Legend

- Buildings
- Natural Gas Valve
- Natural Gas Riser

J Gas Valve

- J GAS Valve
- J GAS Key Valve
- J GAS Line
- Gas Line
- J GAS Annotation Note
- Gas Annotation Note
- Gas Line Note
- J GAS Line Note

Oklahoma State University Natural Gas System

Date: 10/19/2022

1 inch = 700 feet

0 405 810 1,620 2,430 3,240 Feet