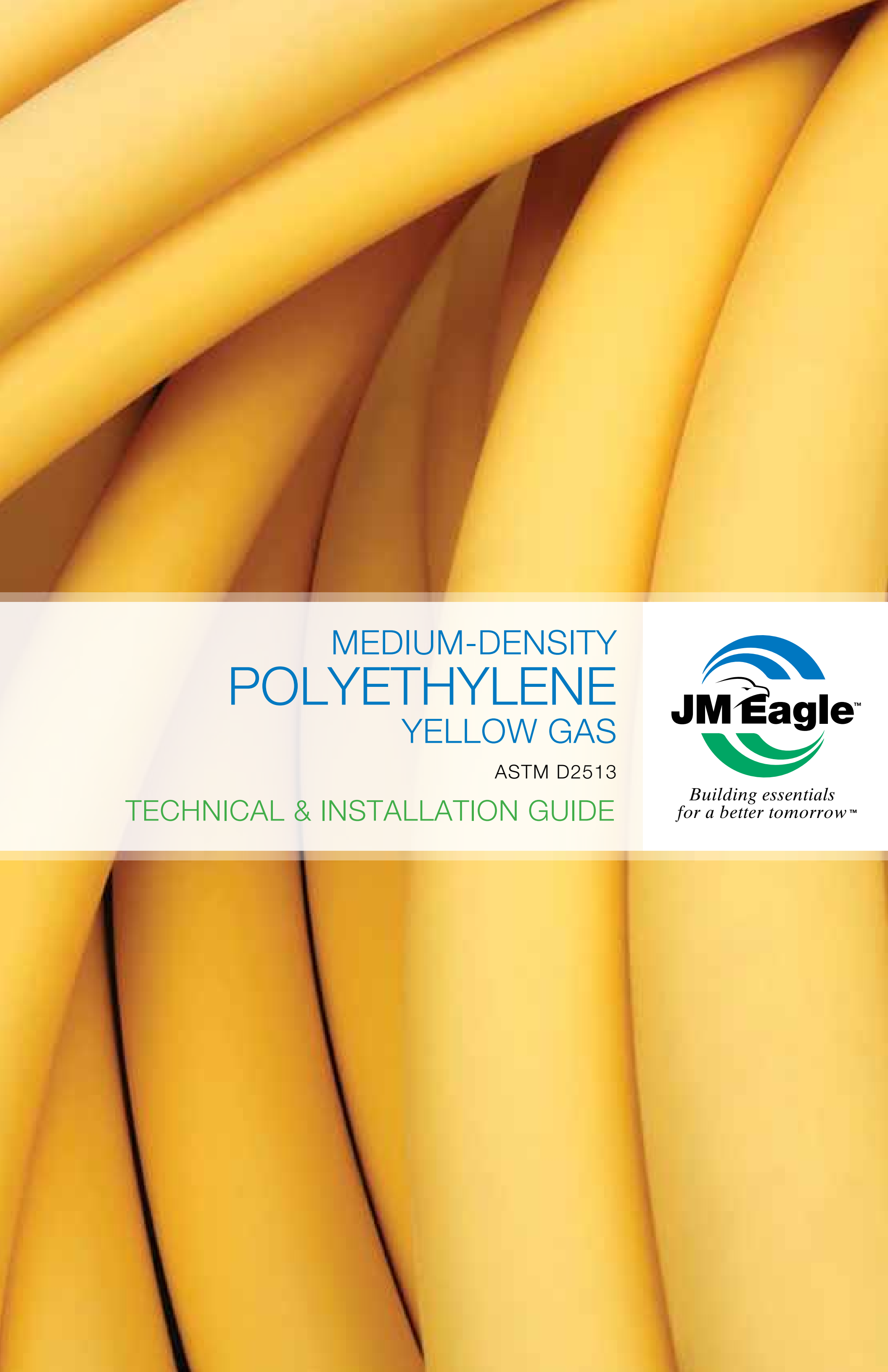

MEDIUM-DENSITY POLYETHYLENE YELLOW GAS

ASTM D2513

TECHNICAL & INSTALLATION GUIDE

JM Eagle™

Building essentials for a better tomorrow™

MEDIUM-DENSITY POLYETHYLENE YELLOW GAS

CONTENTS

WARRANTY

J-M Manufacturing Company Inc. (JM Eagle™) warrants that its standard polyvinyl chloride (PVC), polyethylene (PE), conduit/plumbing/solvent weld and Acrylonitrile-Butadiene-Styrene (ABS) pipe products ("Products") are manufactured in accordance with applicable industry specifications referenced on the Product and are free from defects in workmanship and materials. Every claim under this warranty shall be void unless in writing and received by JM Eagle™ within 30 days of the date the defect was discovered, and within one year of the date of shipment from the JM Eagle™ plant. Claims for Product appearance defects, such as sun-bleached pipe etc., however, must be made within 30 days of the date of the shipment from the JM Eagle™ plant. This warranty specifically excludes any Products allowed to become sun-bleached after shipment from the JM Eagle™ plant. Proof of purchase with the date thereof must be presented to the satisfaction of JM Eagle™, with any claim made pursuant to this warranty. JM Eagle™ must first be given an opportunity to inspect the alleged defective Products in order to determine if it meets applicable industry standards, if the handling and installation have been satisfactorily performed in accordance with JM Eagle™ recommended practices and if operating conditions are within standards. Written permission and/or a Return Goods Authorization (RGA) must be obtained along with instructions for return shipment to JM Eagle™ of any Products claimed to be defective.

The limited and exclusive remedy for breach of this Limited Warranty shall be, at JM Eagle's sole discretion, the replacement of the same type, size and like quantity of non-defective Product, or credits, offsets or combination of thereof, for the wholesale purchase price of the defective unit.

This Limited Warranty does not apply for any Product failures caused by user's flawed designs or specifications, unsatisfactory applications, improper installations, use in conjunction with incompatible materials, contact with aggressive chemical agents, freezing or overheating of liquids in the Product and any other misuse causes not listed here. This Limited Warranty also excludes failure or damage caused by fire stopping materials, tread sealants, plasticized vinyl products or damage caused by the fault or negligence of anyone other than JM Eagle™, or any other act or event beyond the control of JM Eagle™.

JM Eagle's liability shall not, at any time, exceed the actual wholesale purchase price of the Product. The warranties in this document are the only warranties applicable to the product and there are no other warranties, expressed or implied. This Limited Warranty specifically excludes any liability for general damages, consequential or incidental damages, including without limitation, costs incurred from removal, reinstallation, or other expenses resulting from any defect. IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY DISCLAIMED AND JM EAGLE™ SHALL NOT BE LIABLE IN THIS RESPECT NOTWITHSTANDING JM EAGLE'S ACTUAL KNOWLEDGE THE PRODUCT'S INTENDED USE.

JM Eagle's Products should be used in accordance with standards set forth by local plumbing and building laws, codes or regulations and the applicable standards. Failure to adhere to these standards shall void this Limited Warranty. Products sold by JM Eagle™ that are manufactured by others are warranted only to the extent and limits of the warranty of the manufacturer. No statement, conduct or description by JM Eagle™ or its representative, in addition to or beyond this Limited Warranty, shall constitute a warranty. This Limited Warranty may only be modified in writing signed by an officer of JM Eagle™.

1.0 INTRODUCTION

The UAC 2000 product line is manufactured from a yellow PE 2406/PE 2708 material. The UAC 2000 system can be joined by socket fusion, butt fusion, saddle fusion, mechanical fittings or electrofusion. All methods are reliable means of joining the UAC 2000 piping system. Generally, the choice of which joining method to use is at the discretion of the individual gas company.

Installer training for the proper use and installation of polyethylene pipe is a critical factor in its long-term performance. The UAC 2000 system has ample safety factors included in its design for providing reliable long-term performance in gas distribution service, if the system is properly installed and operated at design pressures. The importance of proper training and re-training in the installation and operation of plastic piping systems cannot be overemphasized. Installation and operating recommendations are included in this bulletin to help gas companies develop effective training programs.

The Code of Federal Regulations (CFR) Title 49, Subchapter D-Pipeline Safety, should be consulted for specific guidance regarding installation recommendations and requirements. The American Gas Association (AGA) periodically publishes a “Plastic Pipe Manual for Gas Service” which also contains useful suggestions on installation. In addition, other publications by the AGA, the American Society for Testing and Materials (ASTM), and the Plastics Pipe Institute (PPI) can be helpful. Proper use of this information will minimize the potential for failure resulting from improper installation practices.

2.0 PRODUCT & TECHNICAL INFORMATION

2.1 CODE COMPLIANCE

UAC 2000 pipe and fittings are manufactured from polyethylene resin which meets ASTM D2513, Standard Specification for Polyethylene Plastic Pipe and Fittings. The polyethylene (PE) Material Designation Code is PE 2406/PE 2708 and the cell classification according to ASTM D3350, is PE 234373E.

All UAC 2000 pipe and fittings meet the requirements specified in ASTM D2513 which in turn is incorporated, by reference, in Appendices A and B of Part 192, Title 49 of the CFR, “Transportation of Natural and Other Gas by Pipeline: Minimum Safety Standards.” All socket and butt fusion fittings also meet the requirements of ASTM D2683 and D3261, respectively.

2.2 PHYSICAL PROPERTIES

Table 1 lists general physical properties of UAC 2000.

PHYSICAL PROPERTY DATA FOR UAC 2000 POLYETHYLENE PIPE		
PROPERTY	**ASTM TEST METHOD**	**NOMINAL VALUE**
Density	D1505	0.943/cc
Melt Index	D1238	0.2 g/10 min.
Yield Strength	D638	2800 psi
Ultimate Elongation	D638	> 800%
Environmental Stress (PENT)	F1473	> 1000 hrs.
Crack Resistance		
F0 hrs (Molded Plaque)	D1693	> 5000 hrs.
F0 hrs (Compressed Ring)	F1248	> 5000 hrs.
Flexural Modulus	D790	100,000 psi
Vicat Softening Point	D1525	248°F
Brittleness Temperature	D746	< -130°F
Hardness, Shore D	D2240	63
Thermal Expansion	E831	$9x10^{-5}$ in/in/°F

Table 1

2.3 LONG-TERM STRENGTH

The industry standard for establishing the design basis for polyethylene gas distribution systems is ASTM D2837, "Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials." This standard assigns the long-term strength of the pipe based on hydrostatically tested samples at a range of pressures which result in creep rupture failures over a period of 10,000 hours or more. A regression analysis of these burst data is made to project the failure curve to 100,000 hours establishing the Long-Term Hydrostatic Strength (LTHS). Based on this, a Hydrostatic Design Basis (HDB) is assigned for each standard temperature tested.

The pressure rating and associated ASTM D2513 designation for two temperatures are summarized in Table 2.

TEMPERATURE, °F	HYDROSTATIC DESIGN, BASIS CATEGORY, PSI	ASTM D2513 DESIGNATION
73	1250	PE2406/PE2708
140	1000	CE

Table 2

2.4 PIPE PRESSURE RATING

Design pressure ratings for UAC 2000 pipe can be calculated by using the following formula given in the Department of Transportation (DOT), Minimum Federal Safety Standards for Gas Lines, Subpart C, Section 192.121:

$$P = 2S/(SDR-1) \times 0.32$$

Where:
P = Design pressure in psi gage
S = Hydrostatic Design Basis Category, psi
SDR = Standard Dimension Ratio

Table 3 lists the calculated design pressure ratings based on HDB at 73 degrees F and 140 degrees F.

Section 192.123 of the DOT Minimum Federal Safety Standards for Gas Lines permits use of polyethylene pipe and tubing at temperatures up to 140 degrees F.

In meter riser use, the tubing should not touch the casing wall and there should not be any fusion joints in tubing operated at temperatures above 100 degrees F. Use of plastic pipe in above ground meter riser applications is discussed in a report issued by the PPI (TR-30).

DESIGN PRESSURE RATING (PSIG) FOR UAC 2000 PIPE AND TUBING		
SDR	**73°F**	**140°F**
7.0	100	100
9.3	96	77
10.0	88	71
11.0	80	64
11.5	76	61
12.5	69	55
13.5	64	51
21.0	40	32

Table 3

2.5 EFFECT OF ENVIRONMENTAL EXPOSURE ON PHYSICAL PROPERTIES

2.5.1 CHEMICAL RESISTANCE

UAC 2000 polyethylene pipe has good resistance to most solvents and chemicals which it is likely to encounter in natural and manufactured gas distribution services. Examples are odorants (mercaptans), fogging oils, antifreezes (glycols and other alcohols) and the many constituents of natural and synthetic gas. UAC 2000 pipe meets the chemical resistance specifications outlined in ASTM D2513. Chemical resistance data for polyethylene pipe can be found in the PPI's Technical Report TR-19, "Chemical Resistance" or through your JM Eagle™ sales representative.

2.5.2 WEATHER RESISTANCE

UAC 2000 pipe has a stabilizer system to protect it from ultraviolet degradation when exposed to direct sunlight. The recommended outdoor storage is generally limited to three to five years from the date of manufacture. In general, JM Eagle™ recommends the use of a first-in first-out inventory procedure.

2.5.3 INSTALLATION TEMPERATURES

UAC 2000 pipe can be installed at any ambient temperature condition in which normal installation operations would continue. In cold weather, however, special procedural recommendations, as outlined in this bulletin, should be followed.

2.5.4 THERMAL EXPANSION AND CONTRACTION

The coefficient of thermal expansion for UAC 2000 pipe is 9×10^{-5} inch per inch per degrees F. This translates to an easy rule of thumb: the pipe changes in length 1 inch per 10 degrees F change in temperature per 100 feet of pipe length.

The effect of expansion and contraction must be considered when using compression type fittings. The fitting must possess sufficient pull-out resistance to counteract the thermal stress forces generated by the pipe or tubing. In addition, the fitting must comply with DOT regulations, as stated in Title 49, CFR Part 192, which requires that joints be as strong as the pipe. Use and installation of compression fittings is the responsibility of the user.

2.5.5 PERMEATION

All types of plastics are permeable by gases to varying extents. The constituents of natural gas are somewhat permeable through polyethylene pipe, but not enough to have any detrimental effects on function in gas distribution service.

Because methane is the primary constituent of natural gas, it may be of interest to know its rate of permeation through UAC 2000 pipe. The AGA "Plastic Pipe Manual" lists the permeability rate of methane through PE 2406/PE 2708 as :

$$4.2 \times 10^{-3} \quad \frac{\text{Ft}^3 \text{ of gas-mils of wall thickness}}{\text{Ft}^2 \text{ pipe area} \times \text{day} \times \text{pressure in atmospheres}}$$

Using this value, the volume of methane lost through permeation in 1 mile of 2-inch SDR 11 pipe operating at 60 psig with 100 percent methane inside is only 0.27 ft^3/day.

The rates of permeation for other constituents of natural gas, except hydrogen, are generally equivalent to, or less than, that for methane. Even though the value for hydrogen is five times that of methane, considering its relatively low concentration in most natural and synthetic gas, it is apparent that the actual amount that could permeate is normally so low as to be insignificant.

2.5.6 EFFECT OF EXTERNAL LOADING STRESSES

Consideration must be given to the installation of all plastic piping systems, including the UAC 2000 piping system, to avoid failures caused by excessive external stress. Field experience has shown that excessive externally induced stresses can act independently or together with internal pressure to exceed material strength and cause failure. Because polyethylene is subject to "crack propagation" under excessive stress conditions, such failures may not occur until after several years of use. Excessive installed bending in plastic piping systems particularly at joints, can exceed stress limits and result in failure. Pipe where joined to fittings should be laid true to line and grade and backfilled carefully to prevent differential settlement, and thus excessive bending. Protective sleeves and proper backfilling and compaction techniques for service branches combine to alleviate bending stress problems. See Permanent Minimum Bending Radius Limits, pg. 20.

Excessive stresses and failure of plastic pipe can also result from impact, indentations or deflection. Avoid excessive compaction forces and particularly avoid installation of the pipe against a source of point loading. The bed for the pipe and fill materials around the pipe, must be free of rocks, blocking materials or other sources of point loading or deflection. Heavy machine compaction, as by roller or hydrohammer, should be used only for consolidation of final backfill with a minimum of 24 inches of previously layered and compacted backfill.

ASTM D2774, "Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping," provides additional backfilling information.

2.5.7 PLASTIC PIPE DAMAGE & REPAIR

Industry surveys indicate the primary causes for repair of plastic gas distribution piping are from third-party damage and poor workmanship in the initial installation. Repair can be minimized by using careful mapping and location methods and by proper training and inspection procedures. When repair is required, an advantage of UAC 2000 polyethylene pipe is its capability of being squeezed to control gas flow quickly and localize system shutdown.

Recommended procedures for repair are outlined in the Gas Piping Technology Committee of the AGA Guide, as well as the AGA "Plastic Pipe Manual."

Squeeze-off in sections of pipe, which are to be left in the system, should only be done using approved techniques and properly designed equipment to minimize pipe damage. Procedures for squeezing-off UAC 2000 are provided in the squeeze-off section of this bulletin.

An Electrofusion System and the MetFit Mechanical Fitting System are useful in making repairs to polyethylene gas pipe.

2.5.8 MIXED SYSTEMS – JOINING DIFFERENT POLYETHYLENES

The Plastics Pipe Institute has warned that "indiscriminate mixing without consideration of inherent differences between polyethylenes can produce faulty joints subject to failure in service." Substantial differences in melt viscosities between polyethylenes may require use of unequal heating times, pressures and temperatures to achieve optimal joining conditions. The complexities of intermixed joining make it difficult to use effectively in a field environment. Additionally, the gas company must qualify and train personnel in the special joining procedures.

UAC 2000 is fusion compatible with other fractional melt index piping systems. Information concerning which polyethylene resins have been tested is available through your JM Eagle™ sales representative. An Electrofusion System and the MetFit Mechanical Fitting System are effective methods for joining dissimilar polyethylenes with different melt viscosities.

2.5.9 PRODUCT DISPOSAL

At present, most polyethylene is disposed of by landfill. UAC 2000 polyethylene pipe is quite stable and poses no health hazards in properly operated landfill situations.

In some instances, polyethylene refuse is burned. Under conditions of good combustion, such as is found in forced draft incinerators, polyethylene is converted to carbon dioxide and water. Incomplete combustion results in the generation of volatiles that are the same as those produced during high temperature processing operations. Carbon monoxide and acrolein are believed to be the most toxic fume components produced under poor combustion conditions.

The combustion of polyethylene is discouraged where large amounts of oxygen cannot be maintained. Such situations include open burning or dump fires and pit burning. When the oxygen supply during burning is limited, the smoke produced should be considered toxic and not inhaled. The same is true for smoke produced from wood and paper burned under poor combustion conditions. Applicable regulations should be considered in the disposal of solid waste.

3.0 INSTALLATION GUIDELINES

3.1 HANDLING

UAC 2000 pipe is a tough flexible product which is able to withstand normal installation handling. However, unusually rough handling of UAC 2000 pipe can result in damage to the pipe wall. Care should be taken to avoid pushing or pulling UAC 2000 over or around sharp projections. UAC 2000 pipe is subject to impact damage when dropped from excessive heights or when heavy objects are dropped upon it, particularly during cold weather. Kinking or buckling should be avoided and any section of pipe which has been damaged in this manner should be cut out. Based on pipe pressure tests, a good rule of thumb in determining if a scratched piece of pipe should be cut out of the piping system is: if the scratch depth is greater than 10 percent of the pipe wall thickness, then the section should be removed or repaired.

3.2 UNLOADING AND LOADING

When unloading or loading a shipment of UAC 2000 pipe, forklift operators should be cautioned against damaging the pipe with the fork or tines of the lift truck. Coils of pipe are strapped or palletized for easy unloading or loading. When unloading or loading straight sticks of pipe, allow for some bending in the middle of the lift. Position forklift tines as far apart as possible to reduce the amount of bending. This will enable operators to lift the load without raising the forks to excessive heights which risks dropping the load.

It is recommended that pipe be unloaded according to the guidelines outlined in the PPI Material Guide. This publication is available for download at www.plasticpipe.org/publications/index.html

Pipe unloaded by hand from a truck bed should be rolled down inclined planks to keep damage to a minimum. It should not be dropped to the ground. Never drop the pipe onto hard pavements or rocky terrain from truck beds. This is particularly important when unloading pipe at temperatures of 40 degrees F or below; under these conditions, the pipe is stiffer and more susceptible to damage from impact.

WARNING: When breaking down bulk packs, take care to stand clear of pipe while strapping is being cut. Coiled HDPE pipe may contain energy as in a spring. Uncontrolled release, i.e., cutting of straps, can result in dangerous uncontrolled forces. All safety precautions and proper equipment is required.

3.3 STRINGING

Reel trailers can be helpful when stringing out coiled pipe for direct burial, plow-in, pull-in or insertion renewal. It is helpful when handling coiled pipe to string the pipe out on the ground upon arrival at the job site. This allows time for the coil set to relax, and will simplify handling and emplacement of the pipe.

When uncoiling pipe by hand, only cut those straps on the coils which are necessary to uncoil outer rolls; cut internal bands whenever necessary as the coil is unrolled.

If silo packs are not to be transshipped and individual coils are used, it is advisable to cut the large steel bands which tie the silo pack to the pallet. If the pallet strapping has caused any deformation of pipe, this releasing of tension will allow such deformed areas to recover to normal shape. Any sections of pipe which are severely damaged should be cut out before installation.

Always inspect the pipe as it is being uncoiled and during installation to make sure no damage to the pipe has occurred during shipment and subsequent handling at the job site.

3.4 STRAIGHTENING

Whenever making saddle fusions on freshly uncoiled pipe, make sure the pipe is straightened in the area where the fusion will be made. Application tools are designed to provide straightened and supported sections of recently coiled pipe to help make satisfactory saddle fusions.

3.5 DRAGGING

Occasionally, when long strings of pipe are joined together, it is necessary to drag the pipe to where it will be installed. When the pipe must be dragged over rocky terrain or hard pavement, take precautions to protect the pipe from abrasion. Sand bags, used tires, or short logs may be used to support the pipe and prevent hard contact with sharp rocks or hard pavement.

3.6 CUTTING

UAC 2000 pipe should be cut with pipe and tubing cutters designed for plastic pipe. These tools easily provide the square cut ends which are necessary to provide satisfactory fusion joints. If carpenter or hack saws are used to cut the pipe, special care must be taken to ensure square cut ends and to clean the resultant sawdust from inside the pipe.

WARNING: Before cutting coiled pipe, restrain both sides of cut. Pipe is under tension. Unrestrained pipe can spring back forcibly while being cut and could cause personal injury.

3.7 COLD WEATHER HANDLING

Polyethylene is a tough piping material; yet colder temperatures can reduce resistance to damage from mechanical abuse, such as impact. Avoid dropping the pipe, especially in cold weather. Although the recommended method of unloading is to use a forklift or crane, an alternate method would be to roll the sticks of pipe down inclined planks. In all cases the pipe should be inspected for damage.

When handling coiled pipe at temperatures below 40 degrees F, it is helpful to uncoil the pipe that is to be installed and let it straighten out prior to making the installation. This can be done by gradually uncoiling the pipe and covering it with dirt at intervals to keep it from coiling up again. Always be careful when cutting the straps on coils of pipe because the outside end of a coil may spring out when the strapping is removed.

In cold weather conditions, more effort will be required to uncoil the pipe and piping will spring back more forcibly if the ends are not anchored or restrained. Carefully follow equipment manufacturer's recommendations and guidelines for cold weather conditions.

3.8 OTHER HANDLING PRECAUTIONS

During the transport of pipe, it should be continuously supported in a manner so as to minimize movement between the pipe and its support. Any practice of carrying supplies or equipment on top of plastic pipe should be avoided because of damage from sharp edges and other projections.

Care should be taken to protect the pipe from excessive heat. Be particularly careful of open flames. Do not lay an open flame or torch across pipe surfaces.

3.9 TRENCHING

For direct burial of UAC 2000 pipe, trench bottoms should be relatively smooth, continuous and free of rocks and other debris. When ledge rock, hardpan or boulders are encountered, the bottom of the trench should be padded with sand or other fine grained fill materials. The trench should be wide enough to allow: (a) fusion in the ditch if required, (b) snaking of the pipe along the bottom of the trench if needed, and (c) filling and compaction of side fills. Minimum trench widths can be utilized in most instances by joining the pipe before lowering it into the trench.

Minimum burial depth is regulated by federal, state and local codes. Generally, sufficient cover must be maintained to provide reasonable protection against anticipated external stress loads. Service lines in areas of light overhead traffic should have a minimum of 18 inches of cover while main sizes should be installed at a minimum depth of 24 inches.

3.10 PIPE PLACEMENT IN TRENCHES

UAC 2000 pipe can be joined either above ground or in the ditch as the situation dictates. Though most joining can be accomplished above ground, joining which must be done in the ditch should be well planned to ensure that enough space is available and that proper alignment is achieved. Care should be taken to avoid buckling, gouging, and other mechanical damage when lowering UAC 2000 pipe into the ditch.

Align all pipe and fitting joints true to line and grade. Additionally, protective sleeves should be installed at all service branches to protect against bending and shear forces. As mentioned earlier, extremely cold weather makes UAC 2000 pipe less flexible and increases the likelihood of impact damage.

UAC 2000 pipe should be buried far enough away from steam lines, hot water lines, power lines and other sources of heat to avoid temperature pressure combinations in excess of those permitted by the pressure rating formula defined in the Department of Transportation, Minimum Federal Safety Standard for Gas Lines, Subpart C, Sections 192.121 and 192.123.

Because plastic pipe contracts as it cools, it is desirable in warm weather to snake the pipe in the bottom of the trench. This provides for "slack" in the pipeline to be taken up as the pipe cools and contracts in the ditch prior to backfilling.

3.11 VALVE INSTALLATION

The CFR Title 49, Part 192.193 states: "Each valve installed in plastic pipe must be designed so as to protect the plastic material against excessive torsional or shearing loads when the valve or shut-off is operated and from any other secondary stresses that might be exerted through the valve or its enclosure."

3.12 PIPE LOCATING

A standard method for locating plastic pipe requires that an electrical conductor (such as metallic wire or metallic tape) be installed with the pipe to permit location with electronic detectors.

The AGA (2006 Edition) provides the following information on the use and placement of such electrical conductors: “Companies have reported that current surges (such as developed by lightning strikes) have followed the tracer causing physical damage to plastic pipe. Where practical, a separation of wire and pipe may be beneficial. However, separation may lead to difficulty in precise location of the plastic pipe. The engineer must consider the relative importance of locating the pipe versus the possibility of current surges.”

3.13 BACKFILLING & COMPACTION

Backfilling and compaction of emplaced UAC 2000 pipe must be accomplished so as to avoid induced bending stresses both as a result of the backfilling itself and from differential settling of fill materials subsequent to the backfilling operation. Additionally, care should be taken to avoid mechanical damage to the pipe from the fill material itself. Attention to careful emplacement, filling and compaction procedures will prevent such induced stresses and mechanical damage.

UAC 2000 mains and services should be continuously supported beneath their entire lengths by clean and firm backfill materials (no rocks). Intermittent blocking should not be used to support pipe or services across excavated sections.

Relatively compactible and clean fill materials should be used to bed newly emplaced mains and services with particular attention to filling voids beneath transitions and service connections. Side fill compaction should be utilized to develop lateral passive soil forces when backfilling larger diameter thin wall pipes. The first layer of fill material around and about 12 inches over the pipe should be free from rocks or frozen chunks that could damage the pipe. This layer should be well compacted by hand. Successive layers should be spread uniformly to fill the trench completely. Large rocks, frozen earth and decomposable debris such as wood should not be included in the backfill.

Heavy rollers and large mechanical tampers such as hydrohammers should only be used to consolidate the final backfill and even then there should be a minimum of 24 inches of layered and previously compacted cover.

3.14 PERMANENT MINIMUM BENDING RADIUS LIMITS

The permanent minimum bending radius at fusions (butt, socket, saddle, electrofusion) in the UAC 2000 system should be 90 times the pipe diameter. UAC 2000 pipe without fusions can accommodate a permanent bending radius of 20 times the pipe diameter. Tighter bends down to 10 times the pipe diameter can be made if they are temporary, such as in the plowing or the insertion method of installation.

3.15 INSERTION RENEWAL

When inserting UAC 2000 pipe, avoid damage to the pipe both during installation and from shear forces caused by earth loading after the system is installed. The CFR Title 49, Part 192.321 (f) states: “Plastic pipe that is being encased must be inserted into the casing pipe in a manner that will protect the plastic. The leading end of the plastic must be closed before insertion.” The suggestions that follow should aid in meeting the requirements of this federal regulation.

To protect encased UAC 2000 mains and services against damage from bending and shear stresses due to earth loads:

1. Any portion of exposed plastic piping which spans disturbed earth should be protected by adequate consolidation and compaction of backfill beneath and around the exposed section or by bridging between casing ends.
2. The inserted pipe must be padded where it emerges from the casing to prevent it from bearing on the end of the casing.
3. When holes in the casing must be cut for installation of services it is desirable to remove only the top part of the casing to insure continuous support for the inserted UAC 2000 main.

4. The same care in backfilling and compaction around service connections that applies for direct burial applications also applies for insertion service connections.

To protect UAC 2000 mains and services against damage during the insertion procedure:

1. A starter ditch of sufficient length must be opened to allow UAC 2000 to be inserted without buckling or excessive bending.
2. The casing pipe should be prepared to the extent necessary to prevent any sharp edges, projections or abrasive material from damaging the plastic pipe during or after insertion. This can often be accomplished with pigs or reamers. It is advisable to pull a test piece of the same size UAC 2000 pipe through the casing for examination prior to the actual insertion.
3. The edge of the casing opening should be shielded to prevent shaving or gouging of the pipe being inserted.
4. If UAC 2000 pipe is to be pulled through the casing pipe, the tensile loading should not exceed half the tensile strength of the inserted pipe. "Weak links" made from smaller sizes of UAC 2000 pipe can be fabricated to protect the inserted pipe from damage due to excessive pulling stress.
5. The federal regulation requires that the leading end of the plastic be closed before insertion. Fabricated nose cones of wood, metal or UAC 2000 end caps can be used for this purpose. A straight length on the lead end of a coiled pipe will often aid insertion, especially in cold weather.

A newly inserted main or service line must be allowed to contract while cooling to ground temperature prior to tie-in. Tie-in or coupling of inserted mains or services can be accomplished using standard heat fusion, electrofusion or compression type fittings. When compression fittings are used to join inserted mains, a precaution, such as anchoring, may be required to ensure against pull-out due to earth settlement and thermal contraction of the plastic. The plastic pipe should be anchored close to the tie-in point against movement relative to the joint.

3.16 PRESSURE TESTING AND LEAK DETECTION

The CFR Title 49, Part 192.513 lists the test requirements for plastic pipelines:

a. Each segment of a plastic pipeline must be tested in accordance with this section.
b. The test procedure must ensure discovery of all potentially hazardous leaks in the segment being tested.
c. The test pressure must be at least 150 percent of the maximum operating pressure or 50 psig, whichever is greater.
d. During the test, the temperature of thermoplastic material must not be more than 140 degrees F.

Pressure test duration is often dictated by state and local codes as well as utility standards. Generally, test duration should be determined by consideration of the volumetric content of the test section and the instrumentation used to ensure discovery of all leaks. Air or inert gas are standard test mediums.

Pressure testing of UAC 2000 pipe should not be initiated until about 20 minutes after the final heat fused joint is made. It is generally desirable to pressure test new installations prior to backfilling so that soap bubble checks of joints can be used to locate leaks, if they occur. The test section should be tied down at intervals to prevent whipping of the pipeline should sudden pressure release occur. This is particularly important when pressure testing sections of pipe on top of the ground prior to insertion.

When using expandable caps or compression type couplings as test heads, adequate pull-out resistance of the mechanical connector must be demonstrated. Additional methods such as anchoring, sandbagging, staking, strapping or other means of restraint should be used for safety. Many utilities use transition fittings with welded on closure caps as test heads.

When using air compressors to pressure test sections of UAC 2000 pipe, care should be taken to minimize contamination of the pipe with excessive amounts of oil or other agents. Oil has the effect of plasticization of UAC 2000 pipe that results in a small decrease in strength in regions where high concentrations of oil are absorbed by the plastic. For this reason, traps or filters should be used on the discharge side of the compressor to minimize the amount of contamination. Also, the temperature of the air from the compressor must be low enough so as not to allow the test temperature to exceed the maximum allowable 140 degrees F.

When time testing large volume sections of UAC 2000 pipe, the operator should be aware of the creep characteristics of plastic pipe and the effects of temperature change. After initial pressurization, polyethylene pipe may continue to expand slightly, causing a noticeable drop in gauge reading which will stabilize after a few minutes. A long term reading should be initiated when the stabilization point has been reached

It is occasionally necessary to use gaseous leak detection tracers to locate leaks in a buried system. Commercial odorants in liquid form should not be injected directly into a UAC 2000 system because they can temporarily affect the strength of polyethylene. Odorants should be vaporized prior to injection. When barholes are sunk to provide a path to the surface for the tracers, care should be taken to avoid puncturing the buried pipeline.

3.17 SAFETY AND FIELD PRECAUTIONS

1. **WARNING:** Treat electrical tools as potential sources of ignition and follow standard safety procedures for working in explosive atmospheres.
2. **WARNING:** Only properly trained and qualified personnel should make fusions.
3. **WARNING:** Wear suitable gloves and eye protection.
4. **WARNING:** Temperature of fusion tools should be checked to be sure that they conform to the recommended operating temperature range.
5. **WARNING:** When breaking down bulk packs, take care to stand clear of pipe while strapping is being cut. Coiled HDPE pipe may contain energy as in a spring. Both the straps and the pipe may spring outward when the strap is cut and could cause severe injury. All safety precautions and proper equipment is required.
6. **WARNING:** Before cutting coiled pipe, restrain both sides of cut. Pipe is under tension. Unrestrained pipe can spring back forcibly while being cut and could cause personal injury.
7. **WARNING:** Understand and follow all equipment manufacturer's recommendations and guidelines.

3.18 HEATING TOOL MAINTENANCE

Clean heater adaptors carefully before and after each fusion. Remove any residual polyethylene using a clean non-synthetic cloth. Never use metal objects to clean heater adaptors because they can damage the surface.

The heating tool temperature recommendations shown in this bulletin represent the temperature on the surface of the heater adaptors which actually contact the pipe or fitting. This temperature should be monitored daily to ensure compliance with recommendations.

The operator can usually expect the tool thermometer to indicate a higher temperature than specified in order to achieve the correct surface temperature. In addition, the operator will normally encounter variations in heater adaptor temperature due to different adaptor configurations. In these cases, the adaptor having the lower temperature should be set at the recommended temperature.

4.0 FUSION PROCEDURES

WARNING: Understand and follow all equipment manufacturer's recommendations and guidelines.

4.1 SOCKET FUSION

4.1.1 EQUIPMENT

1. Pipe or tubing cutter
2. Cold ring
3. Depth gauge
4. Chamfering tool (for 1.25 inches through 4 inches)
5. Heating tool
6. Female and male heater adaptors
7. Fitting puller
8. Clean non-synthetic cloth

4.1.2 PROCEDURES

1. Cut the pipe squarely with a pipe or tubing cutter.
2. Chamfer pipe sizes 1.25-inch IPS through 4-inch IPS using a chamfering tool.
3. Clean the end of the pipe with a clean non-synthetic cloth.
4. Install the depth gauge and cold ring. Remove depth gauge once cold ring is secured. Ensure pipe is sufficiently round once cold ring is installed.
5. Place a fitting puller on couplings, caps and reducers 2-inch IPS through 4-inch IPS.
6. Check the heater adaptor faces for proper joining temperature 500 degrees F (±10 degrees F).
7. Place the fitting on the tool and then the tool on the pipe. Push the tool, pipe and fitting together with even pressure.
8. When the fitting is against the tool and the tool against the cold ring, begin the heating cycle shown in Table 4.
9. Count the time by saying one thousand one, one thousand two, one thousand three, etc., or use a stopwatch.
10. When you have counted off the proper cycle time, remove the fitting from the tool with a quick snap action. Then remove the tool from the pipe in the same way. *Note:* For service sizes, pull the tubing out of the tool first.
11. Quickly inspect the melt pattern on the pipe and fitting. If an incomplete pattern is obtained, repeat steps 1 to 10 using a longer heating cycle and new fitting.
12. Within 3 seconds, carefully line up and push the fitting onto the pipe until it bottoms against the cold ring on the pipe. Do not twist or rotate the fitting.
13. Hold the joint firmly together without movement for the recommended holding time shown in Table 4. After an additional 3 minutes release the cold ring and fitting puller.
14. Inspect the entire circumference of the fused joint to be sure there are no open gaps in the pipe to fitting juncture, and that the melt is pressed against the coupling all the way around. If a gap is found or the joint is not aligned properly, cut it out and repeat the procedure. See a properly made socket fusion joint appearance in Figure A. Only accept joints that meet these requirements. Never allow a questionable joint to be installed.
15. Wait an additional 10 minutes prior to pressure testing or burial.

SOCKET FUSION TIME CYCLES		
PIPE SIZE	**HEATING TIME** (sec)	**HOLDING TIME** (sec)
½" CTS	6-7	20
1" CTS	9-10	20
1¼" CTS	10-12	20
½" IPS	6-7	20
¾" IPS	8-10	20
1" IPS	10-12	30
1¼" IPS	12-14	30
1½" IPS	14-17	30
2" IPS	16-19	30
3" IPS	20-24	40
4" IPS	24-28	40

Table 4

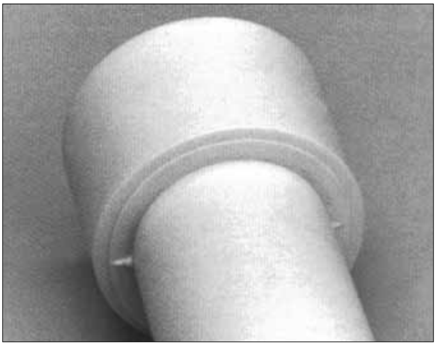

Figure A

4.1.3 COLD WEATHER CONSIDERATIONS (BELOW 55ºF)

- Carefully remove (by light tapping or scraping) the ice and frost from the fusion areas and the areas to be clamped. Otherwise, ice will melt when exposed to the heating tool and spot chill the polyethylene. This could cause incomplete fusion.

- If possible, store fittings at room temperature (such as in truck cab) prior to use. This will reduce fitting contraction and make placing fitting on heater adaptor easier.
- Cold weather also causes pipe contraction which can result in a loose or slipping cold ring. For best results, clamp one cold ring in its normal position behind the depth gauge. Place shim material (i.e., a piece of paper or rag) around the inside diameter of a second cold ring and clamp this cold ring directly behind the first cold ring to prevent slippage.
- Shield the heating tool and fusion area from the wind, snow and freezing rain.
- Ensure heater adaptor faces maintain a temperature of 500±10 degrees F.
- The length of cycle necessary to obtain a complete melt pattern will depend not only on the outdoor temperature, but also on wind conditions, pipe contraction and operator technique. The maximum heating cycle times shown in Table 4 should be used as a starting point for determining the exact heating cycle time for the particular installation conditions.

  Determining the exact heating cycle time can be accomplished by making a test melt pattern on a piece of cold scrap pipe. If the initial melt pattern is incomplete try a 5 second longer cycle on another cold piece of scrap pipe. Continue this process until a complete melt pattern is obtained. Avoid cycles in excess of that required to achieve a good melt pattern.

  Once the optimum heating cycle is established, begin fusion by placing the female adaptor on the pipe. Start counting the heating cycle once the pipe is completely seated. The socket fitting should then be pushed on the male adaptor. There should be no problem with melt development in the fitting since the fit will be snug.
- Work quickly once pipe and fitting have been removed from the heating tool so that melt heat loss is minimized. But, still take time (2 to 3 seconds) to inspect both melt patterns.

4.2 BUTT FUSION

In addition to the following procedure, JM Eagle™ also has tested and endorses TR-33, the generic fusion procedure that is available from PPI at www.plasticpipe.org.

WARNING: Understand and follow all equipment manufacturer's recommendations and guidelines.

4.2.1 HEATING TIME

The heating time for virtually all large diameter pipe is determined by visually observing the melt bead during heating. For sizes 8 inches and larger, a bead width of 3⁄16 inch of an inch to ¼ of an inch is recommended.

4.2.2 INTERFACIAL PRESSURE

The interfacial pressure for butt joints has been expanded to 60 to 90 psi. For hydraulic machines, the fusion force is determined by multiplying the interfacial pressure times the calculated pipe end area. The gauge pressure is theoretical; the internal and external drag needs to be added to this figure to obtain the actual fusion pressure required by the machine. Contact the machine manufacturer for set-up details.

4.2.3 HOLDING & COOLING TIME

The molten joint must be held immobile under pressure until cooled adequately to develop its strength. Due to the heavy weight of large diameter, heavy (lower SDR number) wall pipe, the newly made joint must be able to withstand the added stress of pipe removal from the machine. The fusion force should be held in the machine until the surface of the bead is cool to the touch. Ambient field conditions may require a cooling time of 30 to 90 seconds **per inch of pipe diameter** to achieve the cool temperature for removal from the machine. Pulling, installation, or rough handling of the pipe should be avoided for an additional 30 minutes.

4.2.4 EQUIPMENT

1. Pipe cutter
2. Butt fusion machine
3. Clean non-synthetic cloth

4.2.5 PROCEDURES:

1. Install appropriate shell clamp.
2. Select and control heating tool temperature. A 440 degrees F (±10 degrees F) tool temperature is preferred. However, 500 degrees F (±10 degrees F) or 400 degrees F (-25degrees F) may be used as alternates.
3. The pipe must be clean and dry. Wipe the inside and outside of pipe to be joined with a clean cloth. Make sure all foreign matter is removed. Cut off damaged or flattened pipe ends.
4. Swing facing unit into place and lock.
5. Retract movable shell back and lock.
6. Position longer lengths of pipe in stationary shell clamp by placing pipe end lightly against the facing unit plate so that a sufficient amount of pipe end will be removed during facing. Close shell and tighten sufficiently to prevent slippage. Position shorter pipe or fitting in movable shell in similar manner. In the case of coiled pipe, print lines should be 180 degrees apart to form an “S” configuration in the pipe. If the pipe is out-of-round, wait two minutes for pipe relaxation and retighten the shells.
7. Turn on facer motor and advance the pipe (fitting) ends against the facer cutters using enough pressure to cut a continuous ribbon. Continue facing until stops are reached and both ends are completely parallel and smooth. Remove facing unit per butt fusion machine manufacturer’s instructions.
8. Remove the shavings from pipe ends and facer base. Faced pipe ends should be kept clean and free of dust, water oil or anything that might contaminate the fusion area.
9. Check the ends of the faced pipe. If either pipe is not completely faced, go back to Step 3. Facing should be occasionally checked by carefully placing a straight edge across a faced pipe end to insure that the entire surface is level for complete contact of the pipe with the heating tool.
10. Bring the faced pipe ends together quickly and smartly to ensure that the pipe will not slip in the shells. There should be no misalignment greater than 15 mils for 2-inch pipe and 30 mils for larger sizes. Shells can be retightened to correct for some misalignment. There should be no gaps greater than 5 mils between the ends. If the pipe ends are not aligned or if gaps are present, adjust the pipe in the shells and go back to Step 3.

11. Retract the shells and position the heating tool between the pipe ends.
12. Move the pipe and/or the fitting ends against the heating tool firmly to assure complete contact; then relax to slight contact pressure only.
13. Heating guidelines shown in Table 5 should develop a Final Bead Width of the size shown in Table 6 under normal conditions. Heating cycle starts when a complete, uniform bead of molten material is visible around the entire circumference of both ends. It is optional to develop melt based on Visual appearance provided that Final Bead Width guidelines shown in Table 6 are attained. To assist operators in obtaining the proper Final Bead Width, guidelines are also provided in Table 6 for Melt Bead Width while heating.
14. At the end of the heating cycle, quickly retract the pipe shell clamps to snap the heater away from the pipe ends. Remove the heater without touching the pipe (if melted material is pulled off the pipe ends, allow the pipe to cool and then repeat the entire procedure). Bring the melted ends together rapidly (do not slam) to develop a double roll back of each bead onto the pipe. Use only enough pressure to form a double rollback bead. This operation should take no longer than three seconds.

Note: Hydraulic butt fusion machines should be set using an interfacial pressure of 60 to 90 psi. Refer to butt fusion machine manufacturer's recommendation for specific machine settings.

15. Maintain pressure for the "Holding Time Cycle" shown in Table 5.
16. Release pressure and allow joint to cool in the machine for an additional 3 minutes. Open shells and remove the pipe from the machine handling it with care.
17. Inspect the entire circumference of the fused joint for uniformity in size and shape. Each bead width should be the dimensions shown in Table 6. See Figure B for properly made butt fusion joint. Only accept joints meeting these requirements. Never allow a questionable joint to be installed.
18. Visually mitered joints (angled, offset) should be cut out and re-fused.
19. Allow further cooling for the time prescribed in Table 5 before subjecting the pipe to rough handling.

BUTT FUSION TIME CYCLES (440°, 500°F)				
440°F PIPE SIZE	**500°F HEATING TIME** (sec)	**HOLDING HEATING TIME** (sec)	**COOLING TIME** (sec)	**TIME FOR ROUGH HANDLING** (min)
½" CTS*	12-14	6-7	40	10
1" CTS*	16-19	10-12	40	10
1¼" CTS*	18-22	12-14	40	10
½" IPS*	14-17	8-10	40	10
¾" IPS*	16-19	10-12	40	10
1" IPS*	18-22	12-14	40	10
1¼" IPS	25-30	14-17	60	10
2" IPS	40-48	16-19	60	20
3" IPS	50-60	20-24	75	20
4" IPS	55-66	24-29	90	20
6" IPS	90-108	40-48	180	30
8" IPS & larger	Visual	Visual	Cool to touch	Cool to touch

* Socket Fusion recommended for these sizes.

Table 5

BEAD WIDTH GUIDELINES (400°, 440°, OR 500°F)		
PIPE SIZE	**MELT BEAD WIDTH**	**FINAL BEAD WIDTH**
1¼"- 2"	approximately 1⁄16"	1⁄16" - ⅛"
3" - 4"	1⁄16" - ⅛"	⅛"
6"	⅛" - 3⁄16"	3⁄16"
8" IPS & larger	3⁄16" - ¼"	¼"

Table 6

Figure B

Properly Made Butt Fusion Joint

4.2.6 COLD WEATHER CONSIDERATIONS (BELOW 55 DEGREES F)

- Carefully remove (by light tapping or scraping) the ice and frost from the fusion areas and the areas to be clamped. Otherwise, ice will melt when exposed to the heating tool and spot chill the polyethylene. This could cause incomplete fusion.
- Shield the heating tool and fusion area from the wind, snow and freezing rain.
- Ensure heating tool maintains temperature.
- Normally, the shell clamps are more than adequate to prevent pipe slipping in the liner. However, contraction in the pipe OD (because of low temperature) may, on occasion, result in pipe slippage in the shell. A shim layer (pressure sensitive tape or metal shim, etc.) can be placed on the liner ID to provide clamping restraining to the pipe.
- Follow the standard procedure with particular attention to the fusion steps. The timed cycles remain the same, but it may take longer to develop the initial melt bead completely around the pipe ends. Do not increase pressure. Quickly snapping the pipe from the heater and immediate closing of the shells to minimize melt cooling is important.

4.3 SADDLE FUSION

In addition to the following procedure, JM Eagle™ also has tested and endorses TR-41, the generic fusion procedure that is available from PPI at www.plasticpipe.org.

WARNING: Understand and follow all equipment manufacturer's recommendations and guidelines.

4.3.1 EQUIPMENT

1. Application tool
2. Heating tool
3. Appropriate size saddle heater adaptors
4. 50- or 60-grit emery cloth
5. Clean non-synthetic cloth

An application tool must be used when making saddle fusion joints. Application tools should perform the following functions:

- The tool must be able to straighten, round and support the main during the heating, joining and holding steps.
- The saddle area of the fitting must be uniformly supported when heating, joining and cooling.
- The tool should allow good alignment of the fitting saddle with the main when heating, joining and cooling. It should place the fitting on the center line of the main.
- The opening/closing mechanism used must be fast enough to prevent undue melt cooling.
- Joining pressure should be sufficient to roll the melt bead back all around the base of the fitting. It should be capable of maintaining constant pressure during cooling.

4.3.2 PROCEDURES

1. Clean main with clean cloth. Secure application tool to main according to manufacturers' instructions. Ensure it is centered over location where fitting will be fused.
2. Install correct heater adaptors on heating tool and set heater adaptor face temperature to 500 degrees F (±10 degrees F).
3. Insert fitting in application unit and place fitting base on pipe. When proper alignment is obtained, secure fitting tightly in unit.
4. Retract the fitting from the main and roughen the pipe and fitting

surfaces to be fused with 50- or 60-grit emery cloth. Wipe residue from fusion area with a clean, non-synthetic cloth.

5. Place heating tool on main centered under fitting. Position fitting against heating tool. Apply force shown in Table 7 during heating cycle. The heating tool may be rocked slightly, about 2 degrees, so that it can seek its own alignment on the main, but it should not be allowed to slide between the fitting and the main. Note that the timed heating cycles in Table 7 are guidelines for obtaining the appropriate melt beads. Weather conditions may require longer or shorter heating cycle times. The key to selecting the heating cycle time is obtaining a complete melt pattern on the main and fitting. *Note:* Consult tool manufacturer for recommended machine settings to achieve forces shown in Table 7. Heating cycle begins after pipe and fitting are seated firmly against heating tool. Heat for time shown in Table 7 or until Melt Bead Width shown in Table 8 is visible on crown of pipe.
6. Smartly remove the fitting from the heating tool and heating tool from the main, insuring no melt has stuck to the adaptors. Make sure the heater adaptor corners do not dig into the pipe wall.
7. Quickly inspect both melt patterns before fusing the fitting to the main. If the patterns are complete, press the fitting on the main very quickly (within 3 seconds) with firm pressure until a Final Bead Width of the size in Table 8 is developed around the entire base of the fitting. If either pattern is incomplete, fuse the fitting onto the main and cut off the outlet or stack to prevent its use. Abandon the fitting and begin another fusion at a new location.
8. Hold pressure on the fitting for the time Shown in Table 7. Allow an additional 3 minutes for cooling prior to removing the application unit.
9. Inspect the fusion to be sure that melt has squeezed out completely around the edge of the saddle base. Check to be certain that the saddle fitting is entirely within the pipe melt pattern. Properly made tapping tee and branch saddle fusions are shown in Figure C and D, respectively. Only accept joints meeting these requirements. Never allow a questionable joint to be installed.
10. For tapping tees and service saddles, allow an additional 15 minutes cooling before pressure testing and tapping. For branch saddles, allow an additional 30 minutes.

SADDLE FUSION TIME CYCLE GUIDELINES					
FITTING	**PIPE SIZE**	**HEATING TIME CYCLE** (sec)	**HEATING FORCE** (lbf)	**FUSION/ COOLING FORCE** (lbf)	**HOLDING TIME CYCLE** (sec)
Tapping Tees and Service Saddles	1" - ¼"	40 (ftg.)	60 - 80	40 - 90	60
		25 (pipe)[2]	60 - 80	40 - 90	60
	2" - 8"	40	60 - 80	40 - 90	60
	12"	40 (ftg.)	60 - 80	40 - 90	60
		55 (pipe)[3]	60 - 80	40 - 90	60
High Volume Service Punch Tees	2"	40 - 50	120 - 140	60 - 80	120
	3"	70 - 80	120 - 140	80 - 100	120
	4"	70 - 80	120 - 140	90 - 120	180
	6"	80 - 90	120 - 140	90 - 120	180
	8"	80 - 100	120 - 140	120 - 140	180
Branch Saddles Rectangular Base	2" x 2"	45 - 50	120 - 140	60 - 80	120
	3" x 2"	70 - 80	120 - 140	80 - 100	120
	4" x 2"	70 - 80	120 - 140	90 - 120	180
	6" x 2"	80 - 90	120 - 140	90 - 120	180
	8" x 2"	80 - 100	120 - 140	120 - 140	180
	3" x 3"	60 - 70	180 - 190	80 - 100	120
	4" x 3"	60 - 70	180 - 190	80 - 100	120
	4" x 4"	110 - 120[4]	295 - 305	120 - 140	210
	6" x 4"	180 - 190[4]	180 - 190	120 - 140	210
	8" x 4"	180 - 190[4]	180 - 190	120 - 140	210
	6" x 6"	240 - 260	285 - 330	120 - 140	240
	8" x 6"	240 - 260	285 - 330	120 - 140	240

Table 7

[1] Use of Serrated heating irons may reduce heating times.
[2] Use heat shield between main and heater for first 15 seconds of heating cycle.
[3] Use heat shield between fitting and heater for first 15 seconds of heating cycle.

NOTE: *It should be emphasized that these heating/fusion recommendations are strictly guidelines. This is true of all saddle fusion procedures. Certain conditions will almost always exist which result in longer or shorter heating times. The most important guideline is to achieve a complete pipe and fitting melt pattern.*

[4] If it is thought that these conditions develop too much fitting melt, a pipe pre-heat of 60 seconds followed by a combined pipe/fitting heat of 120-13 seconds for 6" x 4" and 8" x 4" branch saddles can be used. Heating forces and fusion/cooling forces should remain the same.

4.3.3 COLD WEATHER CONSIDERATIONS (BELOW 55ºF)

- Carefully remove (by light tapping or scraping) the ice and frost from the fusion areas and the areas to be clamped. Otherwise, ice will melt when exposed to the heating tool and spot chill the polyethylene. This could cause incomplete fusion.
- Shield the heating tool and fusion area from the wind, snow and freezing rain.
- Ensure heater adaptor faces maintain a temperature of 500 degrees F (±10 degrees F)
- The length of cycle necessary to obtain a complete melt pattern will depend not only on the outdoor temperature, but also on wind conditions, pipe contraction and operator technique. The heating cycle times shown in Table 7 should be used as a starting point for determining the exact heating cycle time for the particular installation conditions.

Determining the exact heating cycle time can be accomplished by making a test melt pattern on a piece of cold scrap pipe. If the initial melt pattern is incomplete, try a 5-second-longer cycle on another cold piece of scrap pipe. Continue this process until a complete and uniform melt pattern is obtained on the fitting and pipe. Avoid cycles in excess of that required to achieve a good melt pattern.

BEAD WIDTH GUIDELINES		
PIPE SIZE	**MELT BEAD WIDTH**	**FINAL BEAD WIDTH**
1"- ¼"	1/32"	1/16"
2"	1/16"	⅛"
3" & larger	⅛"	larger than ⅛"

Table 8

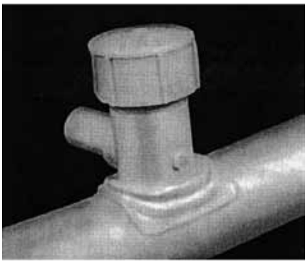

Figure C

Properly Made Tapping Tee Fusion

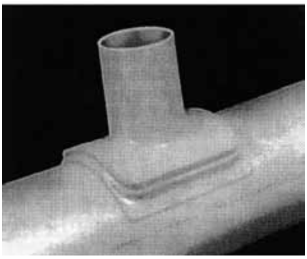

Figure D

Properly Made Branch Saddle Fusion

4.4 TAPPING PROCEDURES

4.4.1 TAPPING TEE

1. Slip the protective sleeve over the service line and then fuse the line to the outlet. Tighten the cap and pressure test for leaks around the saddle and outlet fusions. If a leak occurs, release pressure, cut off the outlet or stack and abandon the tee. If it passes the pressure test, release the pressure in preparation for tapping.
2. Remove cap. It is important to keep both the cap and seal areas free of dirt.
3. Insert the hex shank of the tap tool[1] all the way into the hex socket portion of the punch. Using the tap tool, turn the punch down until the appropriate tool mark (dependent on pipe size) is flush with the top of the stack.

For 10 -inch SDR 13.5 and 12-inch SDR 13.5 mains, tapping is complete when the 8-inch mark is 0.25-inch below the top of the stack (i.e., four additional turns).

CAUTION: Turning the punch down appreciably beyond the above mentioned tool marks could result in dropping the punch into the main.

4. Raise the punch until the top of the punch is flush with the top of the stack. It should never extend above the top of the stack. Gas leak-by may occur through the stack internal threads between the time of the tap and cap sealing.
5. Replace cap and tighten. Turn cap down by hand until base of cap just contacts shoulder on body. Some resistance to turning may be felt a couple turns prior to the cap reaching its final position. This is normal; the o-ring seal is being compressed. Excessive tightening does not improve sealing performance but may cause unnecessary stress on the fitting.

4.4.2 SERVICE SADDLE AND BRANCH SADDLE

Once the service saddle or branch saddle fitting has been fused to the main, it is ready to be tapped. Be certain that the tapping tool used has the following features:

- A cutter of an appropriate size so that it will not damage the inside of the fitting.
- Built-in stops to prevent damage to the inner wall of the main opposite to the hole cut in the pipe.
- Coupon retention.
- Safety chain for hot taps.
- Pressure test valve for hot taps.

When there is no pressure in the main, tapping is accomplished with a cold tapping tool. If there is pressure in the main, tapping is accomplished with a hot tapping tool.

4.5 HEAT FUSION QUALIFICATION

UAC 2000 socket, butt and saddle fusion joints made according to procedures described in this bulletin have been tested by JM Eagle™ using ASTM test methods given in Table 9 and meet the requirements of DOT Regulation Section 192.283.

The Office of Pipeline Safety (OPS) has stated that results of tests properly performed by a manufacturer of pipe and fittings may be adopted by a gas utility to qualify socket, butt, and saddle fusion procedures pursuant to DOT Regulation Section 192.283. The regulations provide, however, that “it is still the operator who is responsible for compliance of his pipeline.”

ASTM TEST METHODS		
TEST	**ASTM NO.**	**REQUIREMENT**
Short term rupture strength (hoop stress)	D1599	Ductile failure
Test for tensile properties	D638 (1)	> 25%
Time for failure under constant internal pressure (1320 psi hoop stress)	D1598	> 1000 hours
Knock-off resistance of saddle fusions	F905	No joint failure

Table 9

DOT Regulations for Procedures and Personnel Qualification

NOTE: (1) As applied to machined specimens of Polyethylene Pipe Joints (Socket and Butt Fusion) at a strain rate of 0.5 inches/min.

The DOT has ruled that, effective July 1, 1980, Part 192 of Title 49 of the Code of Federal Regulations is amended as follows (for heat fusion joints):

Section 192.283 Plastic Pipe; Qualifying Joining Procedures

a. **Heat Fusion**

Before any written procedure established under Section 192.273(b) is used for making plastic pipe joints by a heat fusion method, the procedure must be qualified by subjecting specimen joints made according to the procedure to the following tests –

1. The burst test requirements of Paragraph 6.6 (Sustained Pressure Test) or Paragraph 6.7 (Minimum Hydrostatic Burst Pressure) of ASTM D2513 ([2])

NOTE: ([2]) Updated references to paragraphs in 2000 edition of ASTM D2513 are 5.5 and 5.7 respectively.

2. For procedures intended for lateral pipe connections subject a specimen joint made from pipe sections joined at right angles according to the procedure to a force on the lateral pipe until failure occurs in the specimen (ASTM F905). If failure initiates outside the joint area, the procedure qualifies for use; and
3. For procedures intended for nonlateral pipe connections, follow the tensile test requirements of ASTM D638, except that the test may be conducted at ambient temperature and humidity. If the specimen elongates no less than 25 percent or failure initiates outside the joint area, the procedure qualifies for use.

Section 192.285 Plastic Pipe; Qualify Persons to Make Joints

No person may make a plastic pipe joint unless that person has been qualified under the applicable procedure by:

1. Appropriate training or experience in the use of the procedure, and
2. Making a specimen joint from pipe sections joined according to the procedure that passes the inspection test and set forth below.

The specimen joint must be:

1. 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
2. In the case of a heat fusion… joint
   a. Tested under Section 192.283
   b. Examined by ultrasonic inspection and found not to contain flaws that would cause failure
   c. Cut into at least three longitudinal straps, each of which is:
      I. Visually examined and found not to contain voids or discontinuities on the cut surface area
      II. Deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area.

4.5.1 PROCEDURES FOR HEAT FUSION QUALIFICATION

1. Prepare fusion joint as described previously in the "Fusion Procedures" section of this Manual. Allow joint to cool one hour.
2. Compare the outside appearance of joint with photograph illustrating the correct procedure.
3. Section the joint axially into at least three straps (1 inch wide) to expose the bond area. Leave approximately 8 inches of pipe on both sides of the joint.
4. Inspect the fusion to verify:

Socket Fusion

- Complete melt development
- No gaps or voids
- External melt pressed against coupling
- Bond length
- Alignment

Saddle Fusion

- Complete pipe melt pattern
- No gaps or voids
- Complete melt development around base of fitting
- Fitting placed in pipe melt pattern
- Properly prepared pipe surface

Butt Fusion

- Complete and uniform melt beads
- Melt bead rolled back to pipe
- No gaps or voids
- Alignment
- Complete facing
- Visually mitered joints (angled, offset) should be cut out and re-fused

5. Using the sectioned joint from Step #3, perform the bend test as shown in Figures F, G and H. Hold the ends of the strap in the bent position and inspect the fusion area. If there are any gaps or voids evident, the joint should be rejected. The sectioned joint must be free of gaps or voids.
6. If the joint is not representative of the photographs shown in this guide, determine the incorrect procedure step taken and make another joint.

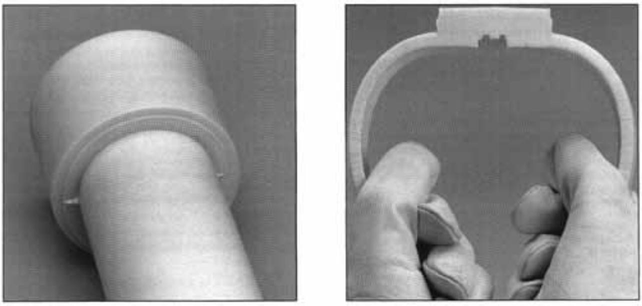

Figure E

Correctly Made Socket Fusion Joint

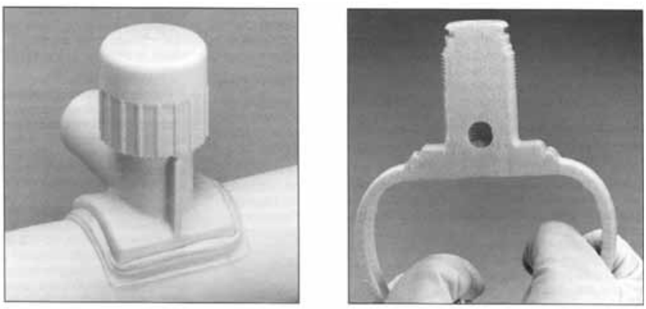

Figure F

Correctly Made Saddle Fusion Joint

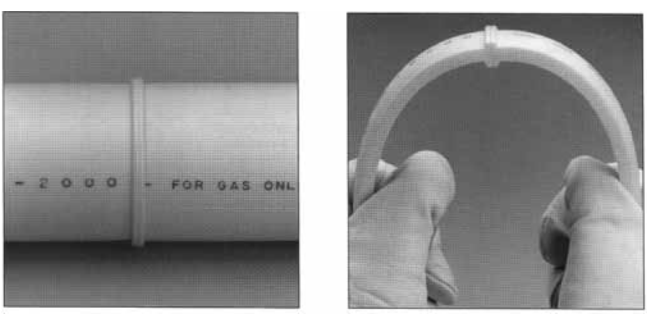

Figure G

Correctly Made Butt Fusion Joint

5.0 SQUEEZE-OFF

WARNING: Understand and follow all equipment manufacturers' recommendations and guidelines.

Effective flow control is a basic requirement in gas distribution systems. This is accomplished in the UAC 2000 polyethylene piping system in two ways. The primary method of flow control should be those installed system valves that are available. Secondly, squeeze-off using suitable equipment can be used to control flow or isolate a section of pipe. Also, squeeze-off is frequently used to control flow for emergency repairs or during certain pipe line or branch extension operations.

This section describes equipment and explains proper procedures and precautions for effectively and safely squeezing off UAC 2000 pipe for flow control. The pressure rating of the pipe is retained if the recommended procedures and equipment are used.

5.1 TOOLS

Squeeze units suitable for use on UAC 2000 pipe consist of steel bars and a mechanical or hydraulic means of forcing the bars together. These units are designed to squeeze UAC 2000 pipe until the inside surfaces meet. This adequately controls gas flow although a bubble tight seal is not always obtained. A positive locking mechanism should be available.

CAUTION: To assure flow control, yet prevent damage to the pipe, tools have mechanical stops to limit the minimum gap between the squeeze bars. Recommended minimum gaps between the squeeze bars for UAC 2000 pipe are based on the formula:

Min.gap=(2) (max wall thickness) x (0.7)

In addition to observing the minimum gap distances between bars, the bars themselves should be rounded to prevent pipe damage.

The user also may want to consult the "Standard Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing," Designation F1041, issued by the ASTM.

5.2 PRECAUTIONS FOR SQUEEZE-OFF

Certain precautions should be taken to prevent damage to the squeeze tools or to UAC 2000 pipe during squeeze-off in recognition of the large forces required for flow control, particularly in large main sizes. Damage to the pipe from improper squeeze-off procedures may cause eventual failure.

- Make certain the pipe is centered and squared in the squeeze tool. It is important that the pipe be free to spread as it flattens. Failure to do so may prevent flow control or result in damage to the pipe or the tool.
- Locate the squeeze point at least three pipe diameters away from the nearest fitting or butt-fused joint. Failure to do so may result in damage to the fittings or joints.
- Squeeze-off UAC 2000 pipe only once in the same place. It is possible for scale or other metal particles contained within the gas flow to become trapped at the squeeze point. A second squeeze in the immediate area of the first could force these particles to penetrate into or through the pipe wall.
- Always use a squeeze tool with gap stops to limit the amount of squeeze and use the proper gap stops for the pipe size being squeezed. Using smaller gap stops or otherwise over squeezing the pipe may result in damage to the pipe or tool.
- A bubble tight flow control will not always be obtained through squeeze-off. If more complete flow control is required, a valve should be used or additional squeeze tools used in series to supplement each other.
- Close the squeeze tools until flow is controlled or until the gap stops make contact. Do not use extension levers or "cheater bars," or otherwise abuse the tools in trying to effect a squeeze-off. Such abuse may overstress the tool and result in failure of the tool and release of the gas flow. Any damaged tool should be repaired or replaced before use for squeeze-off of UAC 2000 pipe.
- Squeeze UAC 2000 pipe slowly or use momentary pauses in the operation to allow for pipe relaxation and reduction in resistance to closure. This is particularly helpful in larger diameters or when the pipe becomes stiffer in cold weather.

- A release rate of 0.5 inches/minute or less is recommended by ASTM F1041 based on a GRI/Battelle Study, “Effect of Squeeze-Off Practices and Parameters on PE Gas pipe Damage.”

5.3 STATIC ELECTRICITY

WARNING: Treat electrical tools as potential sources of ignition and follow standard safety procedures for working in explosive atmospheres.

Emergency flow control situations requiring squeeze-off may involve working in the vicinity of flowing gas. The possibility and potential hazard of static electricity should be considered and the company standards on bell hole safety followed.

Because static electricity can build up on any non-conductor such as plastic pipe, there is a possibility of a spark discharge of sufficient energy to cause ignition if the proper air/gas mixture is present. It is also possible for repair crews to receive shocks even though ignition does not occur. Therefore, a study was made with a major gas utility to define the nature of static charge buildup on polyethylene pipe. The results of that study indicated that:

1. Potential for ignition is present if all three of the following conditions are present: (a) there is sufficient gas flow to cause extensive turbulence; (b) rust particles or other foreign particles are present in the gas; (c) the charge is present at a point where a combustible air/gas mixture is present.
2. During the study, voltages over 30,000 volts were generated, but no ignitions occurred. The location of the measured charge (on the inner wall of the pipe several inches from the opening) was such that there is some doubt that it is present at a point where the combustible air/gas mixture is also present.
3. Although ignition was not obtained, it is clear that under certain conditions high static charges can be developed and static discharge is a possible ignition source.

Some utilities have taken precautions to dissipate the charge and minimize the possibility of an ignition and maximize the personal safety of the crew. The objective is to provide a path to ground for any static charge.

These precautions have included:

- Before personnel are permitted in the bell hole, a fine water spray is applied over the entire area including all exposed pipe and dirt.
- The pipe is kept wet during the squeeze-off procedure until squeeze-off is complete.
- A wet rag is applied to the pipe surface to provide dissipation of static charge to ground.
- In freezing weather, a 50/50 solution of antifreeze and water is sometimes necessary.

Squeezing the pipe causes an increase in the velocity of flowing gas and thus possible increase in static charge development. Therefore, it is suggested that squeeze-off be done in a separate bell hole remote to the leak whenever possible.

Additional information on static electricity is summarized in the report, "Static Electricity Considerations in Repair of Polyethylene Pipe Systems," available from JM Eagle™ sales representatives, and in the AGA "Plastic Pipe Manual for Gas Service."

Gas pipe products (previously produced by US Poly) are currently manufactured by JM Eagle™.

UAC 2000 pipe and tubing conform to the requirements outlined in ASTM D2513 specifications for "Thermoplastic Gas Pressure Pipe, Tubing and Fittings," and to Department of Transportation Title 49, Part 192, "Transportation of Natural and Other Gas by Pipe Line — Minimum Safety Standards." JM Eagle™ manufactures gas distribution pipe and tubing from polyethylene resin, which meets ASTM specifications.

This guide is meant as an explanatory supplement to the materials above on how to install JM Eagle™ Yellow gas pipe under normal or average conditions so as to comply with Standard Laying Specifications. Any discrepancies between the above standards and the written information contained herein, should be brought to the attention of Product Assurance immediately for resolution, prior to any actions by either contractor, engineer, or municipality.

This guide is not intended to supply design information nor to assume the responsibility of the engineer (or other customer representative) in establishing procedures best suited to individual job conditions so as to attain satisfactory performance.

Engineers, superintendents, contractors, foremen, and laying crews will find out much to guide them. This booklet will also be of help in determining pipe needs when ordering.

NOTES:

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