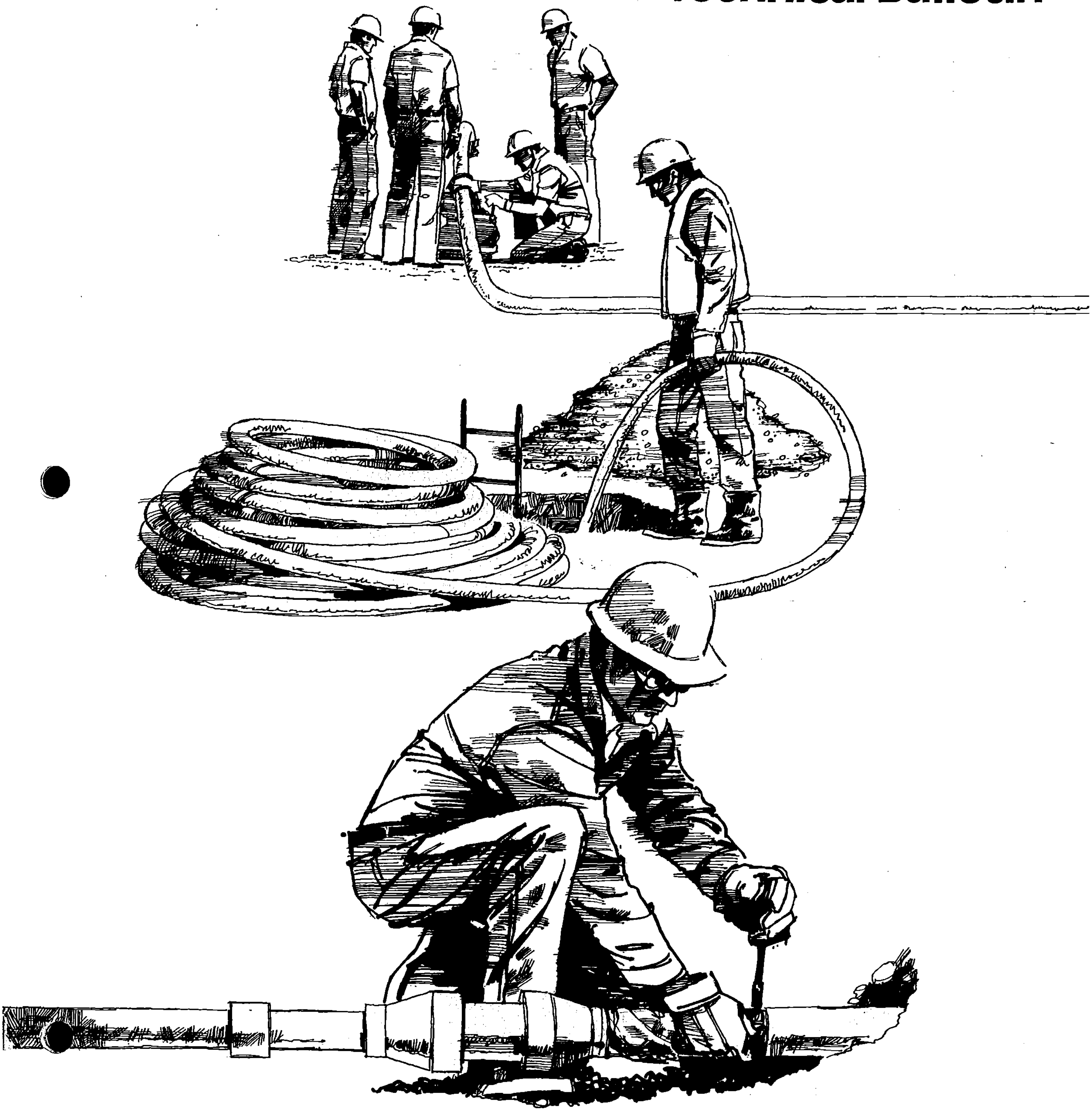
ALDYL* "A"
Polyethylene Piping Systems
Product and Technical Bulletin



* Registered U. S. Patent and Trademark Office for Du Pont's polyethylene pipe and fittings.

DU PONT
REG. U.S. PAT & TM OFF

The ALDYL* "A" System

The ALDYL "A" piping system has been providing gas utilities with corrosion free, highly reliable and cost effective service since 1965. It is the most thoroughly tested, carefully manufactured and technically supported polyethylene piping system in the gas industry. No other system is as widely used or has a longer record of efficient service.

ALDYL "A" system components are custom designed for natural gas service and are manufactured from a Du Pont ALATHON* polyethylene resin specifically developed to optimize those properties critical to safe and efficient gas distribution.

The ALDYL "A" piping system is the number one choice throughout the world in both direct burial and insert replacement of mains and services for the distribution of natural gas.

The Plastic Pipe Institute (PPI) has designated ALDYL "A" as a PE 2406 pipe material. Additionally, ALDYL "A" system components are a distinctive tan and are indent printed to assure easy and long term identification.

ALDYL "A" pipe is manufactured in accordance with dimensions and tolerances of ASTM Specification D2513, "Specifications for Thermoplastic Gas Pressure Piping, Tubing and Fittings". ALDYL "A" pipe and fittings meet the requirements of THE DEPARTMENT OF TRANSPORTATION, MINIMUM FEDERAL SAFETY STANDARDS. The design of Du Pont fittings is based on comprehensive stress analysis using accepted principles on assignment of allowable stresses in keeping with the requirement of minimum federal standards.

A complete system of tools for joining ALDYL "A" system components and for other field operations is available from a number of manufacturers. Installation bulletins describing all aspects of handling and installing ALDYL "A" systems are available to answer questions about ALDYL "A" and provide you with up-to-date information about installation techniques.

Since first introducing ALDYL "A" in 1965, Du Pont has made many improvements. Those improvements are a result of ongoing research and development in response to the needs expressed by the gas distribution industry.

Most recently, Du Pont has been able to improve resistance to bending at fusion joints, without altering the ease of fusion and handling characteristics required by the industry. The result is increased long-term reliability and more resistance to secondary load forces without a sacrifice in other attributes of the ALDYL "A" system.

The improvement is based on increased toughness of ALDYL "A" in resisting crack initiation and crack growth. The superior toughness comes from improved molecular tie chain efficiency**. This is accomplished by a unique proprietary process developed by Du Pont scientists.

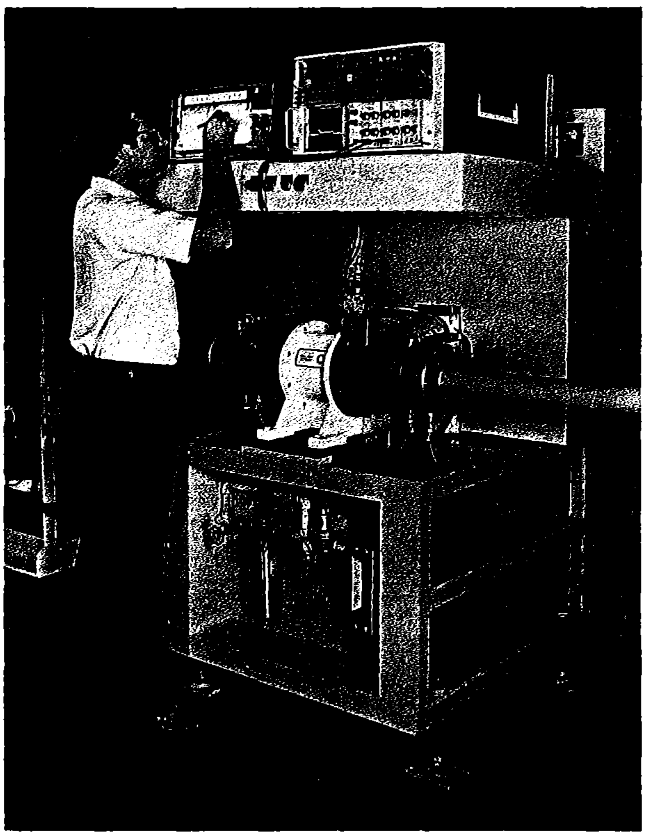
*Registered U.S. Patent and Trademark Office

**See "The Molecular Mechanism of Slow Crack Growth in Polyethylene" by A. Lustinger of Battelle.

Quality

No other supplier produces polyethylene piping system components for gas distribution to quality standards as exacting as those imposed by Du Pont. In addition to meeting or exceeding all industry standards, ALDYL pipe and fittings must satisfy the requirements of Du Pont's quality assurance program. This program covers the entire manufacturing process for ALDYL pipe and fittings from producing the specialized resin to designing and manufacturing system components.

100% Rota-Sonic* Inspection



Only Du Pont uses Rota-Sonic Scanners to inspect every inch of pipe sold to the gas industry. These electromechanical instruments detect random flaws that thin the wall of a pipe by as little as 10%. All such pipe is rejected and destroyed. To our knowledge, no other flaw detection system is as precise, reacts as rapidly and leaves no part of the pipe "uninspected".

Statistical Fitting Analysis

Depending on size, ALDYL "A" fittings are statistically inspected by either X-ray or fluoroscopic equipment. These measures are taken as a safeguard against voids or occlusions that can occur in fittings, during the molding process.

*Registered trademark of Sonic Instruments, Inc.

Documented Quality

A certificate of quality is issued with every shipment of ALDYL "A" pipe verifying compliance to the requirements of ASTM specification D2513. Additionally, customers receive a document containing size specifications for each shipment and something available from no other supplier, a record of the lot number that is permanently indent printed over the total length of every ALDYL component. This lot number permits future correlation between field installations, utility maps and Du Pont records describing the manufacturing conditions for components made under each lot number.

We know of no manufacturer of polyethylene piping systems for gas distribution other than Du Pont that uses Rota-Sonic scanning, or X-ray and fluoroscopic analysis, or Systems Testing by Rate Process or permanent quality documentation. When you consider that Du Pont uses all these techniques, it is clear that quality becomes the leading feature of ALDYL "A" piping systems.

Installation Advantages of ALDYL "A"

ALDYL "A" pipe is available in straight lengths and in coils, both of which can be installed by conventional trenching procedures. In addition, coils are ideal for plow-in or insertion installations.

Can Reduce Installation and Maintenance Costs

Several advantages of ALDYL "A" pipe can make significant cost reductions compared to steel pipe installation and maintenance: rapid joining by heat fusion, light weight and easy handling, availability in coils, and lower original cost. Additionally, polyethylene pipe is corrosion free, which eliminates the need for cathodic protection of installed ALDYL "A" systems.

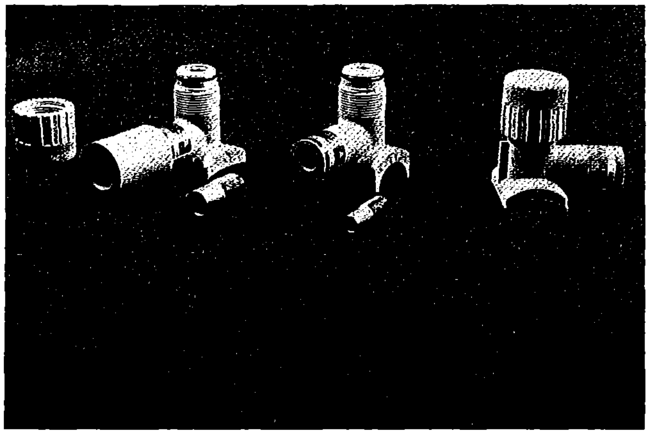
Insertion Renewal

Because of its flexibility and availability in long lengths, ALDYL "A" is widely used for both service and main insert replacement. Significant savings have been realized using this technique because of reduced digging and paving costs. In addition, natural gas customers are not inconvenienced because digging and trenching is greatly reduced.

Fast, Positive Joining

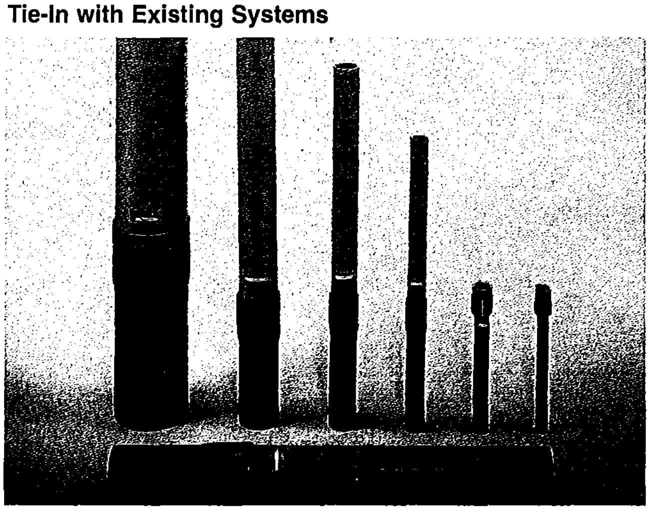
ALDYL "A" pipe is joined by either butt or socket heat fusion techniques, which reliably produce fast, permanent, and leak-free joints. Du Pont manufactures a full line of socket fittings up through 4" IPS in addition to butt fused fittings for 2" IPS and larger pipe sizes. Detailed procedures on joining ALDYL "A" pipe and fittings are contained in other bulletins.

Adding Services and Branches.



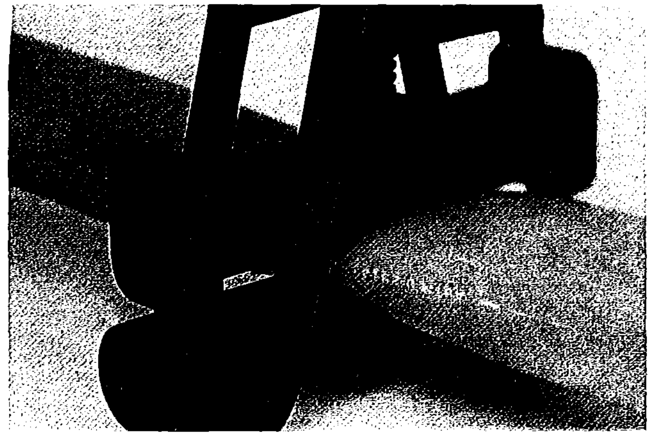
Safe, reliable self-tapping service punch tees are saddle fused to ALDYL "A" mains and are used to make hot taps at operating pressures. Multisaddle and branch saddle fittings can also be hot tapped using hot tapping tools. Detailed information on adding services and branches is available in other bulletins.

Tie-In with Existing Systems



ALDYL "A" is easily connected to existing steel pipe and valves by using specially-designed transition fittings available from Du Pont.

Repair and Pressure Control



An emergency shut-off can be made anywhere in an ALDYL "A" system by squeezing the pipe shut. Properly done, this procedure does not affect the pressure rating of the pipe. Standard repair clamps and gaskets can be used for temporary repairs. For permanent repair, damaged sections should be removed and new pipe installed using heat fused joints. Separate bulletins provide detailed instructions on repair and pressure control by squeeze-off.

The Importance of Training

Du Pont believes that complete training in the proper use and installation of plastic pipe is a critical factor in the long-term performance of any plastic piping system. The ALDYL "A" system has ample safety factors included in its design to provide reliable long-term performance in gas distribution service if the system is properly installed. The importance of proper training and retraining in the installation and operation of plastic piping systems cannot be overemphasized.

A complete set of installation and operating bulletins and training aids have been developed by Du Pont for the ALDYL "A" piping system to help utilities establish effective training programs. In addition, Du Pont Marketing and Technical Representatives are available to assist utilities in the development of such training programs.

The installation procedure bulletins and operation training aids available from Du Pont are listed below:

Installation Bulletins

- 100—General Installation Procedures
- 101—Socket Fusion
- 102—Butt Fusion
- 103—Saddle Fusion
- 104—Flow Control by Squeeze-Off
- 105—Steel-to-Plastic Transitions
- 106—Repair Procedures
- 107—Flange Adaptors

Training Aids

- Training Slides and Script
- Heat Fusion Installer Qualification Manual
- Fusion Procedures (Tip Cards)

Product Description

PIPE AND TUBING

Coiled

	Nominal Size	SDR*	PIPE DATA: Outside Diam. Average (in.)	Outside Diam. Tolerance	Wall Thickness Minimum	Wall Thickness Tolerance	Weight Lb./Ft.	PACKAGING DATA: Feet/Coil	Silo Packs Coils/Pack	Silo Packs Feet/Pack
Copper Tubing Size	½" (⅝"OD)	7	.625	±.004	.090	+.006 −.000	0.063	1,000	12	12,000
Copper Tubing Size	1" (1⅛" OD)	11.5	1.125	±.005	.099	+.008 −.000	0.13	500	7	3,500
Copper Tubing Size	1" (1⅛" OD)	12.5	1.125	±.005	.090	+.008 −.000	0.12	500	7	3,500
Copper Tubing Size	1¼" (1⅜" OD)	15.3	1.375	±.005	.090	+.008 −.000	0.15	500	6	3,000
Iron Pipe Size	½" IPS	9.3	0.840	±.004	.090	+.020 −.000	0.093	1,000	7	7,000
Iron Pipe Size	¾" IPS	11	1.050	±.004	.095	+.021 −.000	0.13	500	7	3,500
Iron Pipe Size	1" IPS	11	1.315	±.005	.119	+.026 −.000	0.20	500	6	3,000
Iron Pipe Size	1¼" IPS	10	1.660	±.005	.166	+.026 −.000	0.34	500	12	6,000
								1,500	4	6,000
Iron Pipe Size	2" IPS	11	2.375	±.006	.216	+.026 −.000	0.63	250	12	3,000
								500	7	3,500
								1,500	2	3,000
Iron Pipe Size	3" IPS	11.5	3.500	±.008	.307	+.035 −.000	1.33	240	6	1,440
								500	4	2,000
								1,000	2	2,000

40′ Straight Lengths

Nominal Size	SDR*	PIPE DATA: Outside Diam. Average (in.)	Outside Diam. Tolerance	Wall Thickness Minimum	Wall Thickness Tolerance	Weight Lb./Ft.	PACKAGING DATA: Bulk Packs Feet/Pack	Bulk Packs Number of Lengths/Pack
3" IPS	11.5	3.500	±.008	0.307	+.035 −.000	1.33	2,000	50
3" IPS With Coupling	11.5	3.500	±.008	0.307	+.035 −.000	1.35	2,000	50
4" IPS	11.5	4.500	±.009	0.395	+.040 −.000	2.19	1,080	27
4" IPS With Coupling	11.5	4.500	±.009	0.395	+.040 −.000	2.24	1,080	27
6" IPS	11.5	6.625	±.011	0.581	+.069 −.000	4.75	960	24
6" IPS	21	6.625	±.011	0.316	+.038 −.000	2.70	960	24
8" IPS	11	8.625	±.013	0.785	+.094 −.000	8.32	560	14
8" IPS	21	8.625	±.013	0.410	+.049 −.000	4.58	560	14

* SDR Standard Dimension Ratio is calculated by dividing the average OD of the pipe by the minimum wall thickness, as described in ASTM D-2513, par. 3.3.

FITTINGS

SOCKET FUSION

	CTS			IPS						
	½"	1"	1¼"*	½"	¾"	1"	1¼"	2"	3"	4"
Couplings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
90° Ells	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tees	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Caps	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reducers		½" CTS ¾"	1" CTS	½" CTS	½" CTS ½"	½" CTS 1" CTS ½" ¾"	1" CTS 1"	1" CTS 1¼"CTS* 1" 1¼"	2"	2" 3"

*Available by special order only

SADDLE FUSION[1]

	Main Size IPS						Outlet Size							
							CTS			IPS				
	1¼"	2"	3"	4"	6"	8"	½"	1"	1¼"*	½"	¾"	1"	1¼"	2"
Service Punch Tee Packs (¼" punch)	✓	✓	✓*	✓	✓*	✓*	✓			✓*	✓*			
Service Punch Tee Packs (½" punch)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		
Service Punch Tee Packs (¾" punch)		✓	✓	✓	✓	✓		✓	✓			(2)		
High Volume Service Punch Tee Packs (1¼" punch)		✓	✓	✓	✓	✓		✓	✓			✓	✓	(3)
Multisaddle Packs	✓	✓	✓	✓	✓		✓			✓	✓	✓		
High Volume Multisaddle Packs		✓	✓	✓	✓	✓		✓					✓	
Branch Nipples		✓	✓	✓										
Branch Fittings		x2"	x2" x3"	x2" x4"	x2" x4"	x4"								

(1) Punch tee and multisaddle packs include a protective sleeve.
(2) Socket or SDR 7.0 butt fused outlet; butt fused outlet used with 1" SDR 7.0 reducers only.
(3) Socket or SDR 11 butt fused outlet.
* Available by special order only.

BUTT FUSION

	SDR 7.0	SDR 10.0[6]	SDR 11/11.5			SDR 11/21	
	1"[5]	1¼"	2"	3"	4"	6"	8"
Caps		✓	✓	✓	✓	✓	✓
Tees		✓	✓	✓	✓	✓	✓
45° Ells				✓	✓	✓	✓
90° Ells		✓	✓	✓	✓	✓	
Flange Adaptors[4]			✓	✓	✓	✓	✓
Reducers	½" CTS ¾" CTS 1" CTS 1¼" CTS	1¼" CTS	1¼"	2"	3" 2"	4"	6" SDR 11 6" SDR 21

(4) With and without O-rings.
(5) 1" reducers are for use with 1" butt fused service punch tee only.
(6) Can be used with SDR 10.0 and SDR 11 pipe.

REQUIRED TOOLS

Available From Tool Manufacturers

Socket Fusion Joining Kits
- ½" CTS through 4" IPS

Socket and Saddle Fusion Heating Irons

Saddle Fusion Heater Faces
- multi-saddle/service punch tee
- combination saddle/socket heater faces
- high volume multi-saddle/high volume service punch tee
- branch saddle

Tapping Tools

Butt Fusion Machines

Squeeze-Off Tools (½" CTS through 8")

Saddle Fusion Assist Tools

MISCELLANEOUS

RIPPLE GRIP TRANSITION FITTING PACKS

CTS		IPS								
½"	1"	½"	¾"	1"	1¼"	2"	3"	4"	6"	8"
¾" IPS	¾" IPS	¾" IPS	¾" IPS	¾" IPS 1" IPS	1" CTS 1¼" IPS	2" IPS	3" IPS	4" IPS	6" SDR 11.5 and 21	8" SDR 11 and 21

TRAINING FITTINGS

Type	Saddle Size Main	Service Outlet
Multisaddle	1¼", 2", 3", 4" or 6"	½" CTS, ½" IPS or ¾" IPS
Overcap SPT Body	1¼", 2", 3" or 4"	½" CTS

4" and 6" CROSS FITTINGS - FOR FOUR-WAY INTERSECTIONS

PROTECTIVE SLEEVES

SERVICE PUNCH TEE REPAIR KIT

2" REPAIR FITTING

General Technical Information

Code Compliance and Quality Assurance

ALDYL "A" pipe and fittings are made from a proprietary grade of Du Pont ALATHON* polyethylene resin which meets ASTM Specification D1248 (for Grade P24) referenced in ASTM Specification D2513, "Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing & Fittings". This resin was developed specifically for use in natural gas service, to provide the balance of strength, handling, heat fusion, performance, and long-term retention of these properties, to meet the construction and operating needs of the industry.

Du Pont certifies that all ALDYL "A" pipe and fittings sold for gas distribution use meet the material and testing requirements specified in ASTM D2513 which in turn is incorporated, by reference, in Appendices A and B of Part 192, Title 49 of the Code of Federal Regulations, "Transportation of Natural and Other Gas by Pipelines: Minimum Federal Safety Standards".

Table 1 lists general physical properties of ALDYL "A" pipe and the resin used in its manufacture.

TABLE 1

PHYSICAL PROPERTY DATA ALDYL "A" POLYETHYLENE PIPE

Property	ASTM Test Method	Value
Melt Index	D3350-81	1.1 g./10 min
Base Resin Density	D3350-81	.937 g./cc
Thermal Expansion	E831-81	9 x 10^{-5} in./in/°F
Yield Strength	D3350-81	2800 psi
Ring Tensile Strength	D2290-76	2800 psi
Modulus of Elasticity	D638-82	100,000 psi
Thermal Conductivity	C177-76	1.8 BTU/hr/sq ft/°F/in.
Deflection Temperature @ 66 psi	D648-78	140°F
Vicat Softening Point	D1525-76	250°F
Impact Brittleness	D746-79	<-150°F
Flammability	D635-81	1 in./min
Flexural Modulus	D3350-81	90,000 psi
Elongation	D638-82	>900%

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 (normally ductile) over a period of 10,000 hours or more (see Figure 1). 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 (see Table 2).

The long-term hydrostatic strength line for ALDYL "A" at 73°F is shown in Figure 1.

ALDYL "A" pipe has also qualified for hydrostatic design basis category ratings at 100°F, 120°F and 140°F. The rating and associated ASTM D2513 designation for each temperature are summarized in Table 2 and are printed on all ALDYL "A" pipe.

TABLE 2

Temperature °F	Hydrostatic Design Basis Category, psi	ASTM D-2513 Designation
73	1250	PE 2406
100	1250	AF
120	1000	BE
140	800	CD

Pipe Pressure Rating

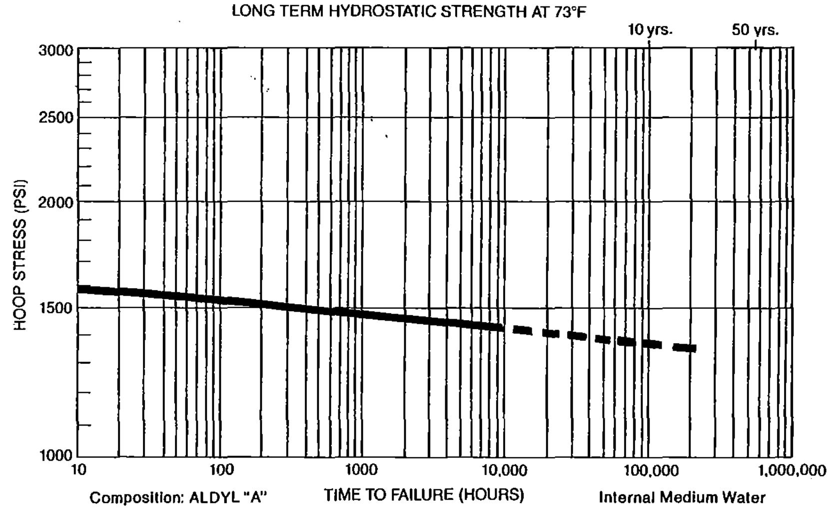
Design pressure ratings for ALDYL "A" pipe can be calculated by using the following formula given in Department of Transportation, Minimum Federal Safety Standards for Gas Lines, Subpart C, Section 192.121:

$$P = 2S \frac{t}{(D-t)} \times 0.32$$

where:
P = design pressure in psi gage
S = Hydrostatic Design Basis Category, psi
D = nominal OD, inches
t = minimal wall thickness, inches

FIGURE 1

LONG TERM HYDROSTATIC STRENGTH AT 73°F



*Reg. U.S. Pat & TM. Off.

The following calculations illustrate the application of this formula for determining design pressure ratings in Table 3.

Example (a), 2" IPS ALDYL "A" pipe for use at temperatures up to 100°F:

$$P = \frac{2 \times 1250 \times .216}{2.375 - .216} \times .32 = 80 \text{ psig}$$

Example (b), 1" CTS tubing (SDR 11.5) for use at temperatures up to 120°F:

$$P = \frac{2 \times 1000 \times .099}{1.125 - .099} \times .32 = 61.75 \text{ psig}$$

TABLE 3

Design Pressure Rating (psig) at Various Temperatures for ALDYL® "A" Pipe and Tubing

SDR	100°F	120°F	140°F
7	100	100	86
9.3	96	76	61
10	88	71	56
11	80	64	51
11.5	76	61	49
12.5	69	55	44
15.3	56	45	36
21	40	32	25

The use of ALDYL "A" in gas distribution at temperatures above 100°F is limited to meter riser tubing which goes above ground to the meter and is exposed to ambient temperatures. Section 192.123 of the Dept. of Transportation Minimum Federal Safety Standards for Gas Lines permits use of polyethylene pipe and tubing at temperatures up to 140°F.

In meter riser use, the tubing should not touch the casing wall nor should there be any fusion joints in tubing operated at temperatures above 100°F which can occur in above ground encasement. Use of plastic pipe in above ground meter riser application is discussed in a report issued by the Plastic Pipe Institute.

System Operating Pressure

Federal regulations permit use of the ALDYL "A" piping system up to pressure and temperature limits determined by the above standard formula. However, this formula considers pipe performance only. We can now determine this pressure capability for the entire system, including fittings and joints, by the Rate Process Method (RPM).

Based on comprehensive RPM testing of ALDYL "A" system components, the maximum recommended operating pressure is 60 psig (40 psig for SDR 21) at ground temperatures that do not exceed 100°F. While RPM testing supports higher pressures for internal loads only, this recommendation provides an increased safety margin to allow for the effects of external loads on the system. However, the maximum operating pressure can be increased to 80 psig for SDR 11 pipe if the need arises.

Effect of External Loading Stresses

External pressures on properly buried pipe in the gas distribution size range are normally quite low. Du Pont calculations and experiments show that ring deflections of ALDYL "A" pipe in normal installations do not exceed maximum allowable values and collapse from external pressure is unlikely.

Externally imposed bending stresses which result from improper installation procedures, and improper backfilling including exposed pipe at inserted system tie in points are a matter of primary concern. The importance of these factors cannot be overemphasized in any consideration of plastic pipe installation and performance.

Field experience has shown that excessive externally induced stresses can act independently or together with internal pressure to exceed material strength and cause failure. Such stresses can result from deflection (bending), impact, or indentations from point loading. Because polyethylene is subject to "creep rupture"under excessive stress conditions, such failures may not occur until after several years of use. Du Pont believes that these failures can minimized by adherence to sound installation procedures including the use of protective sleeves which are discussed in many industry standards and guides, including the *ASME Guide for Gas Transmission and Distribution Piping System—1980,* The AGA Plastic Pipe Manual, and ASTM D2774, "Underground Installation of Thermoplastic Pressure Piping". Du Pont also provides a "General Installation Procedures" bulletin for reference by ALDYL "A" system users.

Gas Flow

The calculation of gas flow is an important consideration in the design of gas distribution systems. Du Pont can provide charts and tables which describe flow and pressure drop under various operating conditions through the various components of the ALDYL "A" system. These charts are available through ALDYL Piping Systems sales offices and marketing representatives.

Effect of Environmental Exposure on Physical Properties

- CHEMICAL RESISTANCE

Du Pont ALDYL "A" 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. ALDYL "A" meets the chemical resistance specifications outlined in ASTM D2513.

Exposure to the gaseous hydrocarbon environments encountered in normal gas distribution service has no measurable effect on the strength of ALDYL "A" pipe. Tests performed on polyethylene pipe in gas distribution service for periods exceeding 20 years show no change in the physical properties of the pipe.

Testing and field experience have shown that some liquid chemicals normally encountered in gas distribution environment can plasticize ALDYL "A", but none will degrade it. The absorption into the pipe materials of certain aromatic and aliphatic hydrocarbons when in their liquid state can result in softening of the polyethylene and moderate loss of strength. This effect is, however, reversible as the liquids evaporate and the pipe "dries out". Because the softening is temporary and the strength loss is slight and reversible, exposure to such chemicals has not been proven detrimental to the long-term performance of ALDYL "A" in the gas distribution environment.

- WEATHER RESISTANCE

ALDYL "A" pipe has a unique UV stabilizer system to protect it from degradation due to exposure to sunlight. This system protects ALDYL "A" from damage for up to several years depending on the intensity of sunlight in the particular part of the country. In any case, the pipe can be stored outdoors by utilities up to two years from date of manufacture. In general, Du Pont recommends the use of a first-in, first-out inventory procedure.

- INSTALLATION TEMPERATURES

ALDYL "A" pipe can be installed at any ambient temperature condition in which normal installation operations would continue. In colder weather conditions, however, special procedural recommendations, as outlined in the installation bulletins and training slides, should be followed.

- THERMAL EXPANSION AND CONTRACTION

The coefficient of thermal expansion for ALDYL "A" is 9×10^{-5} inch per inch per degree F. This translates to an easy rule of thumb: the pipe changes 1 inch per 10 degrees F per 100 ft.

The effect of expansion and contraction must be considered when using compression type fittings because thermal stress forces can be generated greater than the pull-out resistance of the fitting. Use and installation of compression fittings is the responsibility of the user.

D.O.T. regulations, as stated in Title 49, C.F.R. Part 192, require that a joint be as strong as the pipe. There are mechanical fittings available in which pull-out resistance sufficient to achieve compliance is inherent in their design. The Du Pont "ripple grip" transition fitting is an example, and its use is recommended for connection ALDYL "A" to steel. While fusion is the preferred technique for joining polyethylene to polyethylene, several manufacturers offer for this purpose mechanical couplings which they represent as having pull-out resistance inherent in their design and sufficient to make a joint as strong as the pipe itself. A user of such fittings should satisfy himself of their adequacy by measures such as tests and consultation with the fitting manufacturer. Some compression couplings do not provide adequate pull-out resistance for compliance with the D.O.T. regulations. The user can enhance pull-out resistance of such fittings by appropriate anchoring. However, he should assure himself of the adequacy of these fittings and the manner in which they should be used in his specific situation by tests and consultation with the manufacturer.

Permeation

All types of plastic are permeable by gases to varying extents. The constituent gases of natural gas are somewhat permeable through polyethylene pipe, but not enough to have any apparent 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 ALDYL "A" pipe. The American Gas Association (AGA) Plastic Pipe Manual lists the permeability value of methane through PE2306 Pipe as:

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

This value agrees with values determined experimentally for ALDYL "A" by Du Pont. Using this value, the volume of methane lost through permeation in one mile of SDR 11 pipe operating at 60 psig with 100% methane inside is only 0.26 ft^3/day.

The rates of permeation for other constituents of natural gas with the exception of 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.

Plastic Pipe Damage & Repair

Industry surveys indicate the primary causes for repair of plastic gas distribution piping are mechanical or third party damage and poor workmanship in the initial installation. These causes for repair can be minimized by use of careful mapping and location methods and by proper training and inspection procedures respectively.

When repair is required, an advantage of ALDYL "A" polyethylene pipe is its capability of being squeezed off to control gas flow quickly and localize system shutdown. Recommended procedures for repair are outlined in the ASME Guide as well as the AGA Plastic Pipe Manual.

Procedures that are used for repairing damaged polyethylene pipe have been summarized in a recent paper. In addition, Du Pont provides a repair bulletin which outlines many of the procedures which have been used and the precautions which should be taken when repairing the ALDYL "A" system.

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 the likelihood of pipe damage. Procedural and equipment guidelines are outlined in the "Flow Control by Squeeze-Off" bulletin available from Du Pont.

Mixed Systems—Joining Different Polyethylenes

The Plastic Pipe Institute has warned that "indiscriminate mixing without consideration of inherent differences between polyethylenes can produce faulty joints." Substantial differences in melt viscosities between polyethylenes 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 utility must qualify the intermixed joints and train personnel in the special joining procedures.

The best joining practice is to use pipe and fittings from the same resin and manufacturer. There is no confusion on the part of operators by unusual joining procedures, and therefore less likelihood of error. Du Pont recommends that ALDYL® "A" not be intermixed with other polyethylene pipes having different melt viscosities.

However, Du Pont recognizes that mixed system joining may be unavoidable in unusual circumstances, and that ALDYL "A" can be joined to other PE systems. The utility must design appropriate procedures to adjust for material differences. The special procedures must be fully qualified under DOT regulations and operators trained and qualified in their use.

Socket Fusion or Butt Fusion

Du Pont's ALDYL "A" system can be joined by either socket fusion or butt fusion. Both methods have proven reliable over the years as means of joining polyethylene piping systems.

Generally, the choice of which system to use, socket or butt fusion, is up to the individual utility and is based on their particular preferences or certain technical considerations. Du Pont offers both socket fusion fittings from ½" CTS through 4" and butt fused fittings for 2" and larger sizes as part of the ALDYL "A" system.

Product Disposal

At present, most polyethylene is disposed of by landfill. Du Pont ALDYL "A" 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. When the oxygen supply during burning is limited, the smoke produced should be considered toxic and should not be 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.

Polyethylene Pipe Reference Material

A useful reference for information on polyethylene pipe is the *AGA Plastic Pipe Manual for Gas Service.* Topics discussed in this manual include properties, design, installation, testing, operation, and procurement considerations. In addition, the American Gas Association sponsors an annual Distribution Conference and occasional Plastic Pipe Symposiums at which papers are presented on the use of polyethylene pipe.

Specific references on polyethylene pipe properties and applications include the following:

"Determination of Stresses and Structural Performance in Polyethylene Gas Pipe and Socket Fittings due to Internal Pressure and External Soil Loads", by William B. Allman, *American Gas Association Distribution Conference,* Los Angeles, CA, May, 1975.

"Pull-Out Forces on Joints in Polyethylene Pipe Systems", by Karel G. Toll, *American Gas Association Distribution Conference,* New Orleans, LA, May, 1977.

"Crack Stability Under Load and the Bending Resistance of MDPE Piping Systems", by C. G. Bragaw, *Sixth Plastic Pipe Symposium,* Columbus, Ohio, April, 1978.

"Repair Methods for Damaged Polyethylene Piping—A State of the Art", by C. Frank Riddick, George J. Green, and John L. Husted, *American Gas Association Distribution Conference,* Denver, CO, May, 1978.

"Thermoplastics Fuel Gas Piping/Investigation of Maximum Temperatures Attained by Plastics Pipe Inside Service Risers", Plastics Pipe Institute, Technical Report PPI-TR 30, May 1978.

"Techniques for Predicting the Service Life of Polyethylene Gas Piping Systems", by C. G. Bragaw, *The Proceedings of the Seventh Plastic Fuel Gas Pipe Symposium,* New Orleans, LA, November 1980.

"Rapid Crack Propagation in Medium Density Polyethylene Pipe", by C. G. Bragaw, *The Proceedings of the Seventh Plastic Fuel Gas Pipe Symposium,* New Orleans, LA, November 1980.

"Rate Process Method as a Practical Approach to a Quality Control Method for Polyethylene Pipe", by E. F. Palermo, *Eight Plastic Pipe Symposium,* New Orleans, LA, November 1983.

"Weathering of Plastic Pipe", by I. K. DeBlieu and E. A. Zerlant (DSET), *American Gas Association Distribution Conference,* San Francisco, CA, 1984.

"Aging of Polyethylene Pipe in Gas Distrubution," by E. F. Palermo and I. K. DeBlieu, *American gas Association Distribution Conference,* Houston, TX, May 1983.

"Service Rating of Polyethylene Piping Systems by the Rate Process Method", by C.G. Bragaw, *Eight Plastic Pipe Symposium,* New Orleans, LA, November 1983.