Superior
Dual Laminate Products

Contents

Introduction to Dualaminate Piping

Dualaminate Piping Program in Conformance with ASME B 31.3 Thermoplastic Lined FRP Piping Systems

A. Advantages of Dualaminates

CPF Dualam Inc. is a diversified custom fabricator of corrosion resistant process piping and equipment and specializes in severe chemical services which require that our systems be specific to each application.

B. What is Dualaminate and why is it better?

A dual laminate bonded pipe is one where the FRP has been bonded to the liner to overcome vacuum and the different coefficients of thermal expansion. Our bonded DUALAM system, by preventing the concentration of stresses, eliminates the potential of mechanical damage due to expansion differential. In addition, the thermoplastics' temperature and pressure handling capabilities are enhanced due to the FRP bonding as shown on the following chart.

C. Available Materials of Construction

THERMOPLASTIC LINER	MAXIMUM TEMPERATURE THERMOPLASTIC ONLY	RESIN TEST METHOD	SERVICE TEMPERATURE DUALAMINATE
1. PVC	60˚C (143˚F)	ASTM D1784	80˚C (190˚F)
2. CPVC	90˚C (195˚F)	ASTM D2848	100˚C (212˚F)
3. Polypropylene	90˚C (195˚F)	ASTM D4101	95˚C (205˚F)
4. PVDF	140˚C (280˚F)	ASTM D3222	121˚C (250˚F)
5. ECTFE	180˚C (350˚F)	ASTM D3275	121˚C (250˚F)
6. MFA	260˚C (500˚F)	ASTM D6314	121˚C (250˚F)
7. FEP	205˚C (400˚F)	ASTM D3368	121˚C (250˚F)

Disclaimer: The maximum service temperature of each individual Thermoplastic is increased with Professional FRP Dualamination (Vinylchlorides and Polyolefins) but the Chemical Resistance above that temperature should be checked with CPF Dualam Inc..

D. Advantages over plastic lined carbon steel, straight frp, and thermoplastic pipe

Inadequacies of metals in severe chemical applications led to the development of plastic lined steel. However, without any bonding to the steel, the normal characteristics of plastics such as creep, high thermal contraction and expansion, plastic memory and lower strength leads to the mechanical failure of the lining.

1. Replacing lined steel piping
   - A. DUALAM piping can be used in full vacuum and at higher temperatures
   - B. DUALAM piping will not externally corrode from exposure to industrial environments as steel does
   - C. DUALAM weighs 75% less than lined steel

2. DUALAM compared to FRP piping
   - A. DUALAM pipe is not nearly as prone to impact cracking or crazing during handling and installation
   - B. DUALAM piping has a far broader range of corrosion resistance and is more abrasion resistant
   - C. All structural fibers are isolated from process fluid stream
   - D. DUALAM pipe can be fusion welded. This minimizes flange connections.

3. Replacing thermoplastics pipe
   - A. DUALAM retains the pressure rating even with temperature increase.
   - B. DUALAM is not nearly as subject to brittle fracture at low temperatures.
   - C. Allowable support spacings can be easily doubled.

E. Technical Advances in Fusion & Bonding Techniques

With the advent of pipe and sheet butt fusion and the glass backing impregnation of thermoplastic sheet, the Canadian DUALAM dual lamination processes have become as reliable and as cost effective as any plastic lined steel or straight Fiberglass systems. We will detail the situation and response methods in our individually specific Technical Literature.

F. Proof Testing Available in Accordance with ASME B 31.3 Chapter 7, Part 9.

Expansion and Contraction of Plastic Pipe (Thermoplastic Only)

Calculating Dimensional Change

Plastics, like other piping materials, undergo dimensional changes as a result of temperature variations above and below the installation temperature. The extent of expansion or contraction is dependent upon the piping material of construction and its coefficient of linear expansion which, for convenience, is listed below for several materials in units of inches of expansion per 10°F temperature change per 100 feet of pipe. It is also listed in the more conventional form of inches of expansion per inch of length.

Expansion Coefficient

MATERIAL	-IN/IN/°F X 10^{-5}	Y-IN/10°F/100 FT.
PVC	4.0	.360
CPVC	3.8	.456
PP	8.0	.600
PVDF	7.0	.948

The degree of thermal expansion or contraction is also dependent upon the system temperature differential as well as the length of pipe run between changes in direction and it can be calculated using the following formula:

$$\Delta L = \frac{Y(T1 - T2)}{10} \times \frac{L}{100}$$

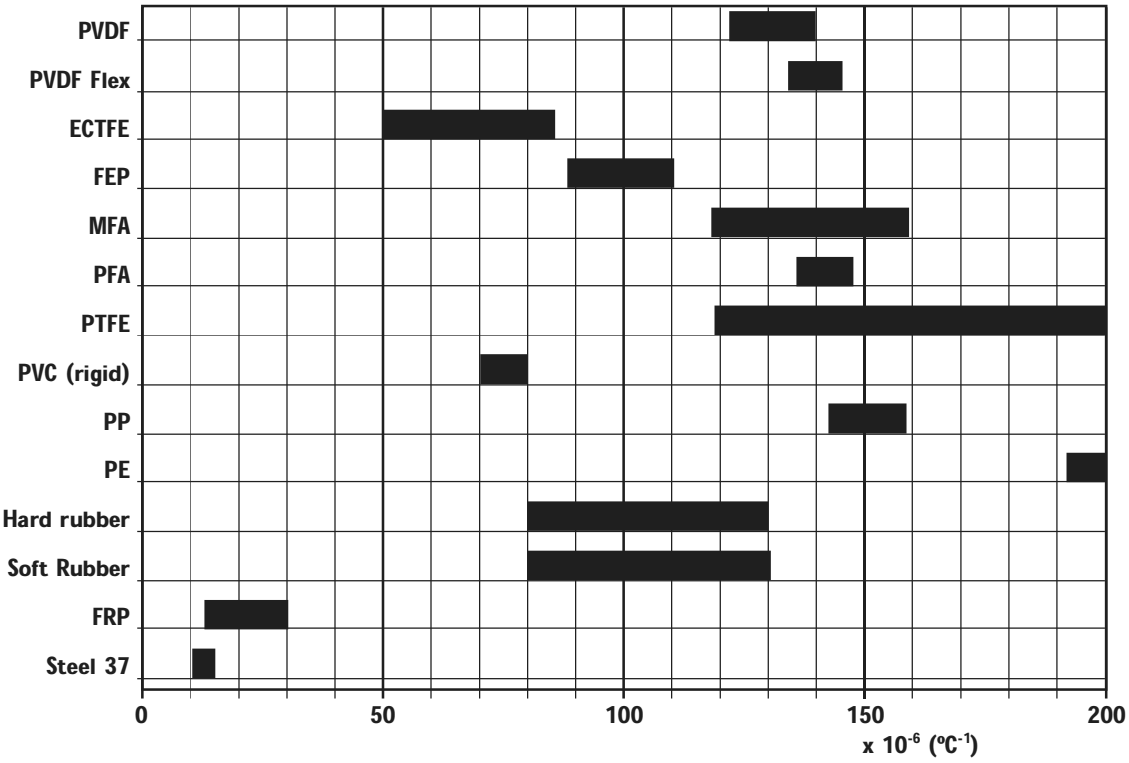
ΔL = Dimensional change due to thermal expansion or contraction (in.).

Y = Expansion Coefficient (See Table above). (in/10°F/100 ft)

$(T1 - T2)$ = Temperature Differential between the installation temperature and the maximum or minimum system temperature, which provides the greatest differential (°F).

L = Length of pipe run between changes in direction (ft).

Comparison of Linear Thermal Expansion Coefficients



DUALAM PVC/FRP and CPVC/FRP

Product and Material Specifications

PRODUCT SPECIFICATIONS #APP 1961
CHLOROLAM-CLASS P PIPING (PVC/FRP) AND CHLOROLAM-CLASS C (CPVC/FRP)

A. Advantages of Chlorolam-Class P & Chlorolam-Class C

PVC and CPVC are used as the basic chemical resistant liner for a very wide range of acids and alkalies at a relatively low cost. They are resistant to most inorganic compounds and to a great many oxidants up to 80°C (PVC:FRP) and 100°C (CPVC:FRP). They are also resistant to most organic compounds except chlorinated solvents and aromatics.

B. Applications of Chlorolam-Class P & Chlorolam-Class C

At a moderate extra cost, PVC:FRP and CPVC:FRP dual laminates offer better chemical resistance and longer service than Fiberglass. Like all thermoplastics, their abrasion resistance is better. With the advantage of using a wide range of PVC & CPVC resins, the bulk chemical businesses such as Sodium Chlorate, Chlorine and Caustic manufacturing have found very good success with these materials.

Other areas where these systems have been extensively used are in Zinc & Copper leaching processes using Sulphuric acid. Also Chlorine Dioxide manufacturing processes in Pulp & Paper bleaching are a major user.

Specifications

PVC and CPVC Laminates
CHLOROLAM-CLASS P and CHLOROLAM-CLASS C

Special Fabrications – Chlorolam-Class UPVC (EN) and Chlorolam-Class PVC-C:

CPF Dualam specializes in Dekadur Red UPVC (EN) unplasticized fabrications and Dekadur PVC-C fabrications. Contact CPF Dualam Engineering for custom systems.

1. Scope

The following design information applies to CHLOROLAM-CLASS P and CHLOROLAM-CLASS C dual laminate or armoured thermoplastic piping products. This covers all piping, spooling, fittings and special fabrications.

Pressure Ratings

Dual Laminate DUALAM piping is available with pressure ratings of 50, 100 and150 psi.

Temperature Ratings

For continuous service operations, the maximum service temperatures should not exceed
CHLOROLAM-CLASS P: — <180°F
CHLOROLAM-CLASS C: — <210°F

Thermal Expansion

Care should be exercised to compensate for thermal expansion & contraction forces, but for unreinforced thermoplastics, the co-efficient is higher.

CHLOROLAM-CLASS P
CHLOROLAM-CLASS C
} 1.7×10^{-5}/inch/inch/°F

Bonding Procedure for CHLOROLAM-CLASS P and CHLOROLAM-CLASS C

The success of the DUALAM Piping System lies with the chemical bond for PVC and CPVC bond between the specific thermoplastic and the heterogenous fiberglass structural reinforcement. This bond is achieved by very careful preparation of the thermoplastic by sanding prior to applying the primary bonding agent. This is let cure for max. 24 hours. Subsequent to that, the fiberglass overlay is machine wound or custom contact moulded to achieve $7 N/mm^2$ in accordance with DIN Test Method 53769 Part 1 for Shear strength and ASTM D-1781-98 for Peel strength.

The general quality requirement is detailed in DIN 16964.

Vacuum Service

The bond strength and the fiberglass overlay allows DUALAM piping to be made to accept full vacuum.

2. Materials

Only virgin pipe or sheet is used for thermoplastic liner. The thermoplastic resin will meet ASTM D-1784 requirements. A partial list of physical properties is shown below:

PROPERTY	PVC	CPVC	TEST METHOD
Specific Gravity	1.38-1.40	1.52	ASTM D-792
Tensile Strength, psi	7,700	8,200	ASTM D-638

The fiberglass structural shall be made of either premium grade vinyl ester or polyester resin with the glass reinforcing applied by filament winding or by hand layup. The outer coating shall consist of a veil with a resin rich UV stabilized resin glaze coat. Where required, fire retardant resins can be used.

3. Dimensional Data

All socket fittings shall conform to ASTM D-2467, all flanged fittings are to be in accordance with ANSI B 16.0 for dimension and ANSI B 16.5 for standard 150 lb drilling. Socket fittings shall comply with ASTM D-2467 for face to centerline dimensions.

Tolerances

Pipe and fitting tolerances are as follows:

DESCRIPTION	DIMENSION	TOLERANCES
Pipe spools	Length	± 1/8"
	Flange alignment	± 1/16"
Flanges	All data to comply except thickness	ANSI B 16.5
Fittings	Face to centerline	± 1/8"
	Alignment	± 3/64"
	Flange I.D. radius	1/4" ± 1/16"

4. Corrosion Resistance

Thermoplastic liner

The acid and alkali resistance of CHLOROLAM-CLASS P or CHLOROLAM-CLASS C is excellent. For specific data, consult CPF Dualam.

Structural reinforcement

The chemical resistance of the vinylester or polyester resins to corrosive atmospheres does not normally require any additional protection. This structural FRP casing also allows for direct burial. For specific environments, consult CPF Dualam.

Additional Services

DUALAM piping can be heat traced. Consult with CPF Dualam. Without heat tracing and additional insulation, the insulating properties are approximately K=1.5 BTU/ft/hr/°F/in.

5. Fabrication

Thermoplastic liner

All connections, flanges and fittings shall be joined to the pipe using hand welding and welding rod of the same resin quality. Butt fusion is permitted, where feasible. Where standard moulded fittings are used, they shall be cemented to the pipe using proper thermoplastic procedures. All fittings shall be backwelded min. 24 hours after cementing. Any fabricated pipe shall be fused along the length, where feasible, using modern automatic fusion machinery.

Fiberglass

All hand lay-up fiberglass fabrication shall be in general accordance with NBS PS-15-69 for the structural reinforcement. FRP reinforcements shall be made either by hand or via filament winding and comply with the required pipe pressure requirements. All thermoplastic fittings having an end lip, such as moulded connections, shall have a putty radius applied to allow a smooth FRP overlay.

Permeation

Permeation is not a problem with DUALAM as it is with metal clad plastics. No weep holes are needed as the FRP resin will allow condensation to migrate safely.

6. Approximate Weights of Chlorolam-Class P/Chlorolam-Class C Pipes and Fittings (in lbs.):

PIPE SIZE	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Weight/Ft.	1.75	2.05	3.75	4.34	7.05	11.16	16.25	22.07
Flanged 90° ELL	3.5	4.5	8.1	12.5	23.7	40.7	60.6	98.8
Flanged 45° ELL	2.7	3.7	6.6	10.4	18.3	29.8	42.8	69.2
Flanged Tee	4.5	6.0	11.2	16.9	32.5	53.5	80.0	126.7
Flanged Cross	6.0	8.0	15.0	22.6	43.4	71.4	106.7	169.0
Flanged 45° Lateral	4.9	6.6	12.1	19.0	37.2	64.1	95.3	158.2
Flange 1.0	1.3	2.4	3.8	6.3	10.2	13.7	21.8	

Based on Filament Wound pipe. Flanges and fittings are contact moulded.

7. For all fittings and dimensional drawings, such as 90° Elbows, 45° Elbows and Concentric Reducers, Contact CPF Dualam Engineering.

Dualam-PP/ Dualam-PE Product and Material Specifications

PRODUCT SPECIFICATIONS #APP 1967
POLYLAM-PP PIPING (PP/FRP) AND POLYLAM-PE PIPING (PE/FRP)

A. Advantages of Polylam-PP/Polylam-PE

Polyolefins such as Polypropylene and Polyethylene have been widely used in industry as a dualaminate liner due to a combination of high chemical resistance and good abrasion resistance. Widely used in severe chemical environments and Hydrometallurgy it is chemically resistant to virtually all inorganic chemicals except for strong oxidizing agents and free chlorine.

It is also resistant to most organic compounds (unlike PVC or CPVC) except strong or chlorinated solvents.

One additional advantage of Polypropylene and Polyethylene is that it is non-toxic and meets U.S.F.D.A. regulations for foodstuffs and Pharmaceuticals. The non-stick surface aids cleaning for hygiene reasons. At a moderately higher cost POLYLAM-PP/POLYLAM-PE offers much better chemical resistance than S.S.316 or FRP.

B. Applications of POLYLAM-PP/POLYLAM-PE

Used in areas where abrasion is evident such as slurries in mining e.g. strong acid storage – HCl H_2SO_4, HF. Zinc, Copper and Uranium leaching is an excellent application where Sulphuric Acid is used in a slurry.

Widely used in steel pickling acid tanks and piping for its corrosion resistance it will handle temperatures too high for PVC. Also, food manufacturing and pure water manufacturing are two industries relying on Polypropylene.

CPF Dualam recommends the use of PP-H 2222 Block Co-Polymer for the Hi-purity membrane caustic in Chlor-Alkali due to its superior corrosion resistance in the pipe liner and particularly the Hot gas bead welding used for long term exposure at 95˚ C.

The preferred Resin for Hydrometallurgy for transfer of Sulphuric acid bearing ores such as Zinc, Copper and Uranium is the PP-R, Random Co-Polymer because of the better malleability of the liner joint fusion, which allows it to stretch before breaking on hot or cold thermal cycling.

1. Scope

This specification provides design information applicable to patented POLYLAM-PP/POLYLAM-PE Laminate piping products. These products include pipe spools, fittings and fabrications.

This specification covers products with flange drilling per ANSI B16.5 which are suitable for 150 PSI continuous service.

Butt fusion system fittings to DIN 16962. Flanged fittings are to ANSI B 16.1 dimensions.

Products covered by this specification are suitable for continuous service temperatures to PP 195˚F (PE 195˚F) unless otherwise specified.

Because of bonded liner construction these products can be designed for full vacuum service.

2. Materials

Liner

Polypropylene Homopolymers, Random Co-Polymers and Block Co-Polymers are used in the extrusion of liners. This resin meets the requirements of ASTM D-4101 and may include less than 1% inorganic pigment for identification. A partial list of the physical properties is below:

PROPERTY	PP	PP	TEST
Specific Gravity	.90 – .91	.9555	ASTM D-792
Tensile Strength (PSI)	4,500	3,500	ASTM D-638

Bonding Procedure

Using a CPF Dualam process, a knit glass cloth is melt bonded to 50% mechanical embedding as per DIN 16964 to 3.5N/mm^2. It has been tested in accordance with DIN Test Method 53769 Part 1 for Shear Strength and ASTM D-1781-98 for Peel Strength.

Outer Casing

The outer casing is rated for 50 PSI to 150 PSI and full vacuum, using a premium grade vinyl ester resin with glass reinforcement and UV stabilized exterior gel coat.

3. Design and Fabrication Details

Flanges for pipe spools and fitting shall have bolt circle diameters, hole diameter and number of bolt holes in accordance with ANSI B 16.5, unless otherwise specified.

Pipe fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
Flanges	All dimensions except thickness	ANSI B 16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
I.D. Radius Flanges		1/4" ± 1/16"

4. Applications and Operational Parameters

Temperature Range: PP/PE is suitable for continuous operation upto 205˚ F, unless otherwise specified.

Pressure Range is suitable for continuous operation from full vacuum service to 150 PSI.

Thermal expansion and contraction of the Dualam PP/Dualam PE systems is 1.7 X 10^{-5} in/in/˚F.

Chemical Resistance (liner): PP (PE) liner is chemically inert to the following broad general commercial chemicals: PP (PE) – mineral acids, alkalies, salt solutions, alcohols.

Chemical Resistance (outside casing): The inherent resistance of the vinyl ester casing to chemical plant corrosive atmospheres normally requires no additional protection. This casing also allows direct burial without additional protection. For specific environments, consult factory. Casing does contain UV stabilizer and fire retardant protection is available.

Permeation: The gas permeation if present through PP (PE) occurs faster through the vinyl ester casing eliminating the condensation between liner and casing which occurs in lined steel pipe. Since these gases are not trapped by the PP/PE vinyl ester casing material, no weep holes required.

Heat Tracing: Internal heat tracing can be provided between liner and casing taking advantage of the vinyl ester fiberglass casing's inherent insulating properties. Consult factory for specifics.

Insulation Qualities of Casing Material: Fiberglass construction yields a heat conduction factor of K = 1.5 Btu/ft/hr/˚F/in. Check dimensional data for casing thickness.

5. Approximate Weights of Polylam-PP/Polylam-PE Pipe and Fittings: (in lbs.)

PIPE SIZE	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Weight/Ft.	1.9	2.03	3.27	4.3	7.3	11.6	17.9	26.7
Flanged 90° ELL	3.5	4.5	8.1	12.5	23.7	40.7	60.6	98.8
Flanged 45° ELL	2.7	3.7	6.6	10.4	18.3	29.8	42.8	69.2
Flanged Tee	4.5	6.0	11.2	16.9	32.5	53.5	80.0	126.7
Flanged Cross	6.0	8.0	15.0	22.6	43.4	71.4	106.7	169.0
Flanged 45° Lateral	4.9	6.6	12.1	19.0	37.2	64.1	95.3	158.2
Flange 1.0	1.3	2.4	3.8	6.3	10.2	13.7	21.8	

Based on Filament Wound pipe. Flanges and fittings are contact moulded.

6. For all fittings and dimensional drawings, such as 90˚ Elbows, 45˚ Elbows and Concentric Reducers, Contact CPF Dualam Engineering.

Dualam-PV (PVDF/FRP) Product and Material Specifications

PRODUCT SPECIFICATIONS #APP 1972
DUALAM-PV (PVDF/FRP) FLUOROLAM-CLASS PV PIPING

A. Advantages of Dualam-PV

PVDF or Kynar is a fluorinated polymer similar to PTFE Teflon. Its excellent chemical resistance lends itself to a wide range of inorganic and organic chemicals including solvents. One of the important factors of PVDF is its 121˚C (250˚F) temperature range. It is also non toxic and meets U.S. F.D.A. regulations for foodstuffs and pharmaceuticals. The non-stick surface aids cleaning for hygienic applications and resists abrasion. PVDF is virtually inert and does not age.

B. Applications of Dualam-PV

PVDF is used mainly in applications where its resistance to acids and organics rules out most other Thermoplastic Linings. In the pulp and paper industry it is used for Sulphuric and HCl handling and storage as well as Sodium Chlorate and Chlorine Dioxide. In the bulk chemical manufacturing it is used in Nitric and Sulphuric production, Liquid Bromine handling, Organic Insecticides and Chlorinated Solvents such as Vinyl Chloride.

PVDF is also one of the best materials for Ultra-Pure water manufacture for biological research and high purity acid manufacturing for the Microelectronic Industry.

C. Standard Grade PVDF LIners

The chemical resistance is good up to a pH of 11 with good dimensional stability from -40˚C up to 150˚C without compression. It is good for abrasion resistance as well as having good aging stability.

Standard grade PVDF is resistant to UV degradation and has very good dielectric and piezoelectric properties.

D. Special Grade PVDF Liners

For special situations, PVDF Liners are available for such applications where explosion hazard exists, in an antistatic form (black in colour).

PVDF Liners also are available for Dualamination with a synthetic veil or glass veil backing impregnated for improving bond to the structural FRP, or chemically etched HV Liners.

Co-Polymers of PVDF are now being used mainly for flexibility of parts and for higher purity.

1. Scope

This specification provides design information applicable to FLUOROLAM CLASS-PV Dual Laminate piping products. These products include pipe spools, fittings and fabrications.

This specification covers products with flange drilling per ANSI B 16.5 which are suitable for 150 PSI continuous service.

Flanged fittings covered by these specifications are to ANSI B 16.1 dimensions.

Products covered by this specification are suitable for continuous service temperatures to 250˚F unless otherwise specified. (In Dualaminate, temperature is limited by vinylester resin used.)

Because of bonded liner construction these products can be designed for full vacuum service.

2. Materials

Liner

Homopolymer and Co-Polymer PVDF (polyvinylidene fluoride) resins are used in the manufacture of PVDF linings for pipe and fittings. This resin meets the requirements of ASTM D-2116 Type III. A partial list of the physical properties is shown below:

PROPERTY	VALUE	TEST
Specific Gravity	1.76 – 1.78	ASTM D-792
Tensile Strength (PSI)	6,500 - 7,100	ASTM D-638
Elongation	40%	ASTM D-638

Bonding Procedure

Using a CPF Dualam process, a knit glass cloth is embedded to 50% depth obtaining a shear bond strength of 5N/mm as per DIN 16964. It has been tested in accordance with DIN Test Method 53769 Part 1 for Shear Strength and ASTM D-1781-98 for Peel Strength.

Outer Casing

The PVDF liner is bonded to a structural laminate composed of HLU or FW fiberglass vinyl ester construction yielding a totally bonded laminate. This specification indicates filament wound thicknesses. Hand lay-up construction when performed is per

Product Standard NBS PS-15-69. A premium grade vinyl ester resin is used with glass reinforcement and UV stabilized exterior gel coat.

3. Design and Fabrication Details

Dimensional drawings included in paragraph 8 of this specification pertain to products listed in paragraph 1.

Flanges for pipe spools and fitting shall have bolt circle diameters, hole diameter and number of bolt holes in accordance with ANSI B 16.5 unless otherwise specified.

Fittings shall have standard face to centreline dimensions for 150 lb. ANSI B 16.1, unless otherwise specified.

Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
Flanges	All dimensions except thickness	ANSI B 16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
I.D. Radius Flanges		1/4" ± 1/16"

4. Application and operational parameters

Temperature Range: PVDF is suitable for continuous operation upto 280˚F (250˚ F in Dualaminate) unless otherwise specified.

Pressure Range: Dualam PV is suitable for continuous operation from full vacuum service to 150 PSI.

Thermal expansion and contraction of the Dualam PV system is 1.7 X 10^{-5}in/in/˚F.

Chemical Resistance (liner): PVDF liner is chemically inert to the following broad general commercial chemicals:

- All acids including hydrofluoric, hydrochloric, sulphuric and aqua regia
- All chlorides — organic and inorganic
- All sulfates — organic and inorganic
- All bleach solutions
- All solvents, All caustic, All phenols, All peroxides

For specific corrosion resistance data, consult corrosion chart or factory.

Chemical Resistance (outside casing): The inherent resistance of the vinyl ester casing to chemical plant corrosive atmospheres normally requires no additional protection. This casing also allows direct burial without additional protection. For specific environments, consult factory. Casing does contain UV stabilizer and fire retardant protection is available.

Permeation: The gas permeation if present through PVDF occurs faster through the vinyl ester casing eliminating the condensation between liner and casing which occurs in steel lined pipe. Since these gases are not trapped by the PVDF's vinyl ester casing material, no weep holes required.

Heat Tracing: Internal heat tracing can be provided between liner and casing taking advantage of the vinyl ester fiberglass casing's inherent insulating properties. Consult factory for specifics.

Insulation Qualities of Casing Material: Fiberglass construction yields a heat conduction factor of K=1.5 Btu/ft/˚F/in. Check dimensional data for casing thickness.

5. Approximate weights of Fluorolam-Class PV Pipe and Fittings:

PIPE SIZE	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Weight/Ft.	2.6	3.05	4.85	6.37	9.37	13.08	17.65	27.33
Flanged 90° ELL	3.5	4.5	8.1	12.5	23.7	40.7	60.6	98.8
Flanged 45° ELL	2.7	3.7	6.6	10.4	18.3	29.8	42.8	69.2
Flanged Tee	4.5	6.0	11.2	16.9	32.5	53.5	80.0	126.7
Flanged Cross	6.0	8.0	15.0	22.6	43.4	71.4	106.7	169.0
Flanged 45° Lateral	4.9	6.6	12.1	19.0	37.2	64.1	95.3	158.2
Flange 1.0	1.3	2.4	3.8	6.3	10.2	13.7	21.8	

Based on Filament Wound pipe. Flanges and fittings are contact moulded.

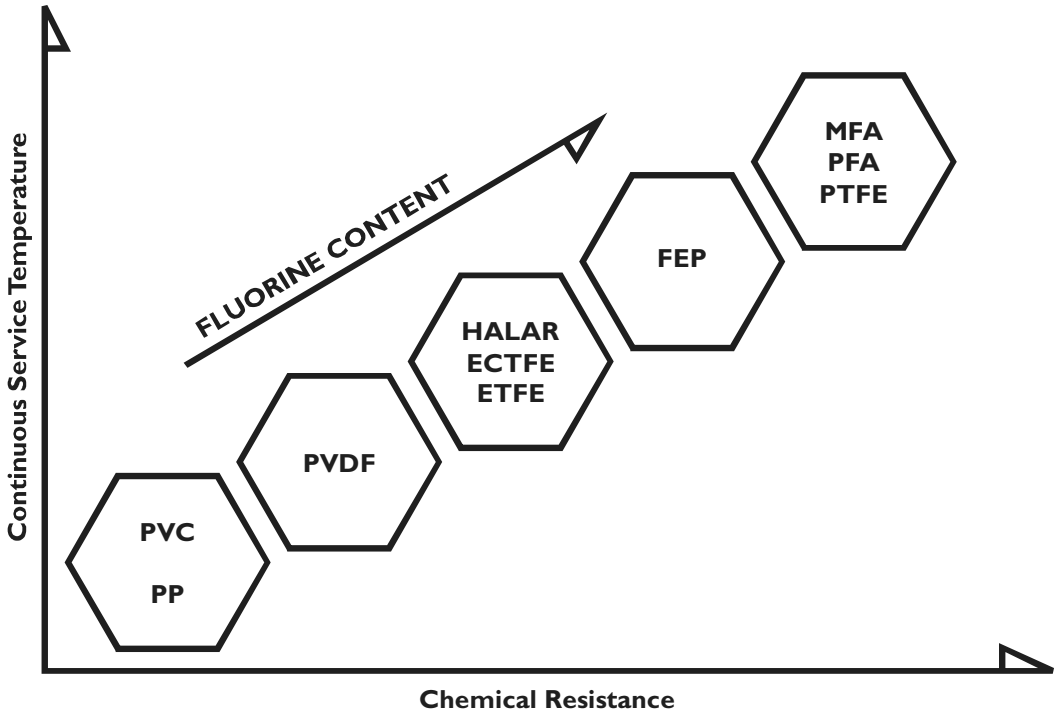
6. PVDF Installation Procedures

A. Select gasket material of correct durometer and thickness.
B. Use a spacer when bolting PVDF flanges to flanges of dissimilar material.
C. Use Type A Narrow SAE washers on all PVDF flanges.
D. Lubricate all bolts before tightening.
E. Tighten all bolts using criss-cross bolting method.
F. Using a torque wrench, tighten bolts to bolt torques specified.
G. Allow bolts to seat for 24 hours and recheck bolt torques.
* On flanges <4", tighten in increments of 5 ft. lbs.
* On flanges >6", tighten in increments of 10 ft. lbs.

7. For all fittings and dimensional drawings, such as 90° Elbows, 45° Elbows and Concentric Reducers, Contact CPF Dualam Engineering.

Thermoplastic Products

Service Temperature versus Chemical Resistance



Dualam-Halar (ECTFE/FRP) Product and Material Specifications

PRODUCT SPECIFICATIONS #APP 1977
DUALAM ECTFE/FRP (FLUOROLAM-CLASS E) PIPING

A. Advantages of Fluorolam-Class E

Process changes required by environmental regulations have resulted in increasingly corrosive plant conditions, situations in which highly inert fluoropolymers excel. Unlike metals, fluoropolymers are not sensitive to changes in pH, moisture, and strong oxidizers, and are not attacked by a broad variety of chemicals. The three characteristics which lead to the inertness of fluoropolymers include:

(a) very strong interatomic bonds between the carbon and fluorine atoms,
(b) the almost perfect shielding of the polymer's carbon backbone by fluorine atoms, and
(c) long polymer chain length.

HALAR ECTFE is a true thermoplastic that can be melt extruded and fabricated by traditional methods for use in mechanical systems including piping, tanks and scrubbers. Extruded surfaces of ECTFE exhibit extraordinary surface smoothness, which reduces or eliminates particle generation and inhibits or prevents biofilm growth. HALAR ECTFE is transparent in thin sections or can be pigmented and supplied with polyester or glass backing for Dualaminate applications. It has a maximum service temperature of 250˚F (121˚C).

B. Typical Chemical Industry Applications of Fluorolam-Class E

ECTFE/FRP has become a favorite material in the recent expansions of Sodium Chlorate manufacturing for pulp and paper bleaching, where the process requires high temperatures, extreme corrosion and the ability to avoid any current due to electrical reduction.

Some Chemical Plant uses include free or nascent Chlorine production, Bromic Acid (HBr) production and many scrubbing applications and filter housings where a mixture of caustic, hydrogen or chlorine are evident.

FLUOROLAM-CLASS E is an excellent system for storage of Hydrogen Peroxide used in many new pulp and paper chemical systems and specialty manufacturing processes which use HCl, H_2SO_4 and Hydrofluoric Acid. In fact, HALAR is not dissolved by any known solvent to 300˚F.

ECTFE/FRP has recently been proven by the Swedish Corrosion Institute to be superior to FEP/FRP in corrosion and permeation to Wet Chlorine Gas at 80˚C – 85˚C. This lends itself to major new uses in the North American, European and Japanese markets for Chlor Alkali membrane technology use for Anolyte and Wet/Nascent Chlorine Gas.

Recent welding improvements for ECTFE pipe butt fusion to DVS 2207 Part 15 and hand welding to AWS G1.10 and new modified Co-Polymers of ECTFE to make it more malleable, combined with the fact it is 30 times less permeable and 1/3 of the cost of FEP, make it an industry workhorse.

C. Typical High Purity Industry Applications of Fluorolam-Class E

In the high purity processing industry (semiconductor), HALAR fluoropolymers are widely used because they are exceptionally pure (low extractables) and have a very smooth surface which reduces or eliminates particle generation and inhibits or prevents biofilm growth.

- High purity chemical storage tanks and process equipment
- High purity chemical transport containers
- High purity piping systems.

1. Scope

This specification provides design information applicable to FLUOROLAM-CLASS E Dual Laminate piping products. These products include pipe spools, fittings and fabrications.

This specification covers products with flange drilling per ANSI B 16.5 which are suitable for 150 PSI continuous service.

Flanged fittings covered by these specifications are to ANSI B 16.1 dimensions.

Products covered by this specification are suitable for continuous service temperatures from 250˚F (121˚C) to -20˚F (-29˚C), unless otherwise specified.

Because of bonded liner construction these products can be designed for full vacuum service.

2. Materials

Liner

Only Solvay Co-Polymer (ECTFE) resins are used in the manufacture of FLUOROLAM - CLASS E linings for pipe and fittings. This resin meets the requirements of ASTM D-3275. A partial list of the physical properties is shown below:

PROPERTY	VALUE	TEST
Specific Gravity	1.68	ASTM D792
Tensile Strength (PSI)	6600 – 7000	ASTM D638
Elongation	200 – 300	ASTM D638

Bonding Layer

Using a melting process, a woven or knit fiberglass cloth is melt bonded and partially mechanically embedded into the O.D. surface of the ECTFE liner. Bond strength between ECTFE and glass:

A. Shear Strength as per DIN 53769 Part 1.
B. Peel Test as per ASTM D-1781-98.

Outer Casing

The ECTFE liner with bonding layer is reinforced with a hand lay-up or filament wound structural laminate. Hand lay-up construction, is as per standard NBS PS-15-69. A premimum grade vinyl ester resin is used with glass reinforcement and UV stabilized exterior gel coat.

3. Design and Fabrication Details

Dimensional drawings included in paragraph 8 of this specification pertain to products listed in paragraph 1.

Flanges for pipe spools and fitting shall have bolt circle diameters, hole diameter and number of bolt holes in accordance with ANSI B 16.5 unless otherwise specified.

Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
Flanges	All dimensions except thickness	ANSI B 16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
I.D. Radius Flanges		1/4" ± 1/16"

4. Application and Operational Parameters

Temperature Range: FLUOROLAM - CLASS E is suitable for continuous operation from 250˚F (121˚C) to -20˚F (-29˚C), unless otherwise specified.

Pressure Range: FLUOROLAM - CLASS E is suitable for continuous operation from full vacuum service to 150 PSI.

Thermal expansion and contraction of the FLUOROLAM - CLASS E system is 1.7 X 10^{-5}in/in/˚F.

Chemical Resistance (liner): ECTFE liner is chemically inert to the following broad general commercial chemicals:

- All acids including hydrofluoric, hydrochloric, sulphuric and aqua regia
- All chlorides — organic and inorganic
- All sulfates — organic and inorganic
- All bleach solutions, wet Chlorine Gas/Anolyte
- All solvents, All caustic, All phenols, All peroxides

For specific corrosion resistance data, consult corrosion chart or factory.

Chemical Resistance (outside casing): The inherent resistance of the vinyl ester casing to chemical plant corrosive atmospheres normally requires no additional protection. This casing also allows direct burial without additional protection. For specific environments, consult factory. Casing does contain UV stabilizer and fire retardant protection is available.

Permeation: The gas permeation if present through ECTFE occurs faster through the vinyl ester casing eliminating the condensation between liner and casing which occurs in steel lined pipe. Since these gases are not trapped by the ECTFE's vinyl ester casing material, no weep holes required.

Heat Tracing: Internal heat tracing can be provided between liner and casing taking advantage of the vinyl ester fiberglass casing's inherent insulating properties. Consult factory for specifics.

Insulation Qualities of Casing Material: Fiberglass construction yields a heat conduction factor of K=1.5 Btu/ft/˚F/in. Check dimensional data for casing thickness.

5. Approximate weights of Fluorolam-Class E Pipe and Fittings:

PIPE SIZE	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Weight/Ft.	2.76	3.27	6.2	9.01	11.10	15.2	19.8	27.9
Flanged 90° ELL	3.5	4.5	8.1	12.5	23.7	40.7	60.6	98.8
Flanged 45° ELL	2.7	3.7	6.6	10.4	18.3	29.8	42.8	69.2
Flanged Tee	4.5	6.0	11.2	16.9	32.5	53.5	80.0	126.7
Flanged Cross	6.0	8.0	15.0	22.6	43.4	71.4	106.7	169.0
Flanged 45° Lateral	4.9	6.6	12.1	19.0	37.2	64.1	95.3	158.2
Flange 1.0	1.3	2.4	3.8	6.3	10.2	13.7	21.8	

Based on Filament Wound pipe. Flanges and fittings are contact moulded.

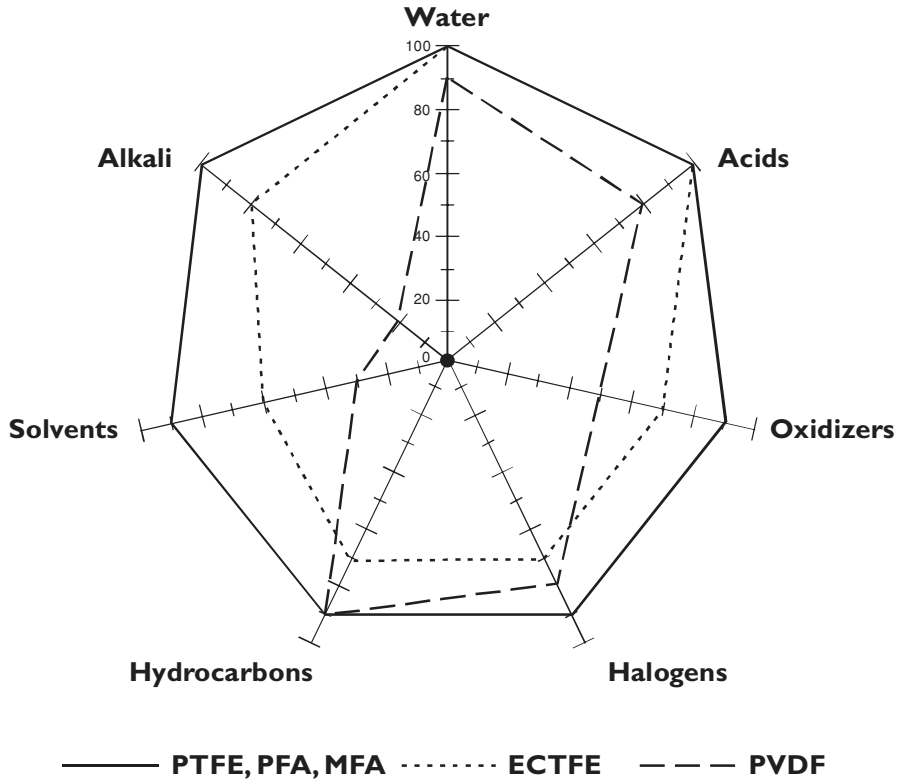
6. Fluorolam-Class E Installation Procedures

A. Select gasket material of correct durometer and thickness.
B. Use a spacer when bolting FLUOROLAM-CLASS E flanges to flanges of dissimilar material.
C. Use small SAE washers on all FLUOROLAM-CLASS E flanges.
D. Lubricate all bolts before tightening.
E. Tighten all bolts using criss-cross bolting method.
F. Using a torque wrench, tighten bolts to bolt torques specified in Section 8..
G. Allow bolts to seat for 24 hours and recheck bolt torques.
* On flanges <4", tighten in increments of 5 ft. lbs.
* On flanges >6", tighten in increments of 10 ft. lbs.

7. For all fittings and dimensional drawings, such as 90° Elbows, 45° Elbows and Concentric Reducers, Contact CPF Dualam Engineering.

Fluoropolymer Chemical Resistance

Fluoropolymers within their Temperature Rating



Dualam MFA/FRP Product and Material Specifications

PRODUCT SPECIFICATIONS #APP 1998
DUALAM (MFA/FRP) AND FLUOROLAM-CLASS M PIPING

A. Advantages of MFA

Hyflon MFA fluoropolymers offer the highest temperature rating and broadest chemical resistance of all melt processable fluoropolymers. They are an ideal choice for extreme thermal and chemical environments. Hyflon MFA is designed to give much better physical properties than FEP, lower creep, and improved stress cracking resistance, and has a 50˚C higher temperature rating. Hyflon grades are also lower in permeation than comparable competitive products.

Because its structure is based on PFA chemistry, Hyflon MFA offers an excellent balance of properties for lining applications. The unique chemistry of MFA allows for a very cost competitive product, giving PFA type performance with improved economics. It combines the best properties of both FEP and PFA while maintaining a cost similar to FEP. Upper temperature rating is high, 260˚C, like PFA, surface is extremely smooth (much smoother than PFA), low temperature mechanical properties are similar to FEP and better than PFA. MFA's excellent thermal stability has allowed its use in semiconductor high purity chemical applications where traditionally high purity PFA was used. All things considered, MFA offers the best balance of properties for lining applications than any other melt processible perfluoropolymer.

Easily extruded for pipe, tubing and injection moulded for fittings, CPF Dualam believes MFA the best new material in Dualaminate construction for beyond the year 2003.

B. Applications of MFA

Hyflon MFA is the first new fluoropolymer to the plastics industry in over 20 years and, since its introduction in 1995, has gained rapid acceptance in the chemical processing, pulp and paper, and high purity processing industries. Hyflon MFA is resistant to virtually all chemistries, even the most extreme, including acids, bases, oxidizing acids, mineral acids, metal salt solutions, peroxides and more.

- Scrubbing towers handling sodium chlorate and hydrogen gas
- Waste stripping columns
- High purity chemical storage tanks and process equipment
- Chemical transport containers
- High purity piping systems (thermoplastic and Dualaminate).

C. Other Fluoropolymers Available

For special applications, CPF Dualam will use FEP, PFA or ETFE (Tefzel) in Dualaminate pipe construction. Contact CPF Dualam Engineering for details.

1. Scope

This classification provides design information applicable to FLUOROLAM - CLASS M Dual Laminate piping. These products include pipe spools, fittings and fabrications.

2. Materials

Liner

Solvay Co-Polymer MFA resins are used in the manufacture of linings from pipe fittings. The resin meets the requirements of ASTM D 6314.

PROPERTY	VALUE	TEST
Specific Gravity	2.12 – 2.17	ASTM D792
Tensile Strength (PSI)	2700 – 3600	ASTM D638
Elongation	300 – 360	ASTM D638

Bonding Layer

Using a melting process a knit fiberglass cloth is melt bonded and partially mechanically embedded into the O.D. surface of the MFA liner. Bond strength between MFA and fiberglass is:
A. Shear Strength as per DIN Test Method 53769 Part 1.
B. Peel Strength as per ASTM D-1781-98.

Outer Casing

The MFA liner with bonding layer is reinforced with a hand lay up or filament wound structural laminate. Hand lay up construction is as per standard NBS PS-15-69. A premium Vinylester grade resin is used with glass reinforcement and U.V. stabilized gel coat.

3. Design and Fabrication Details

Dimensional drawings included in paragraph 8 of this specification pertain to products listed in paragraph 1.

Flanges for pipe spools and fitting shall have bolt circle diameters, hole diameter and number of bolt holes in accordance with ANSI B 16.5 unless otherwise specified.

Pipe and fittings fabrication tolerances are as follows:

ITEM	DIMENSION	TOLERANCES
Pipe spools	Length	± 1/8"
	Bolt hole alignment	± 1/16"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
Flanges	All dimensions except thickness	ANSI B 16.5
Fittings	Face to centerline	± 1/8"
	Flange alignment	± 1/32" (1" thru 4")
	(with theoretic pipe centreline)	± 3/64" (> 6")
I.D. Radius Flanges		1/4" ± 1/16"

4. Application and operational parameters

Temperature Range: FLUOROLAM - CLASS M is suitable for 250˚F to - 20˚F unless otherwise specified.

Pressure Range: Continuous operation from full vacuum to 150 PSI.

Thermal expansion and contraction: 1.7 x 10^{-5}/in/in/˚F

Chemical Resistance (liner): MFA is chemically inert to all concentrated acids, alkalies, many organics.

Chemical Resistance (outside casing): Premium Grade Vinylester to contain UV protection and fire retardant if required.

Permeation: Superior to FEP, PVDF and PTFE. For specifics, contact CPF Dualam.

Heat Tracing: Internal heat tracing can be provided between liner and casing taking advantage of the vinyl ester fiberglass casing's inherent insulating properties. Consult factory for specifics.

Insulation Qualities of Casing Material: Fiberglass construction yields a heat conduction factor of K=1.5 Btu/ft/˚F/in. Check dimensional data for casing thickness.

5. Approximate weights of Fluorolam-Class M Pipe and Fittings:

PIPE SIZE	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Weight/Ft.	2.76	3.27	6.2	9.01	11.1	15.2	19.8	27.9
Flanged 90° ELL	3.5	4.5	8.1	12.5	23.7	40.7	60.6	98.8
Flanged 45° ELL	2.7	3.7	6.6	10.4	18.3	29.8	42.8	69.2
Flanged Tee	4.5	6.0	11.2	16.9	32.5	53.5	80.0	126.7
Flanged Cross	6.0	8.0	15.0	22.6	43.4	71.4	106.7	169.0
Flanged 45° Lateral	4.9	6.6	12.1	19.0	37.2	64.1	95.3	158.2
Flange 1.0	1.3	2.4	3.8	6.3	10.2	13.7	21.8	

Based on Filament Wound pipe. Flanges and fittings are contact moulded.

6. MFA Installation Procedures

A. Select gasket material of correct durometer and thickness.

B. Use a spacer when bolting FLUOROLAM - CLASS M flanges to flanges of dissimilar material.

C. Use Type A Narrow SAE washers on all FLUOROLAM - CLASS M flanges.

D. Lubricate all bolts before tightening.

E. Tighten all bolts using criss-cross bolting method.

F. Using a torque wrench, tighten bolts to bolt torques specified in Section 8..

G. Allow bolts to seat for 24 hours and recheck bolt torques.

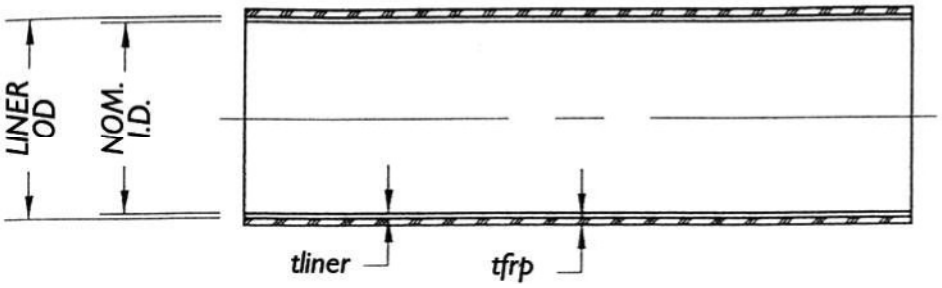
* On flanges <4", tighten in increments of 5 ft. lbs.
* On flanges >6", tighten in increments of 10 ft. lbs.

7. For all fittings and dimensional drawings, such as 90˚ Elbows, 45˚ Elbows and Concentric Reducers, Contact CPF Dualam Engineering.

Standard Dimensions of Dualam Piping

DUALAM PVC/FRP and CORZAN® CPVC/FRP

PRODUCT AND MATERIAL SPECIFICATIONS: **FILAMENT WOUND** PRESSURE PIPE (CHLOROLAM-CLASS P, CHLOROLAM-CLASS C)



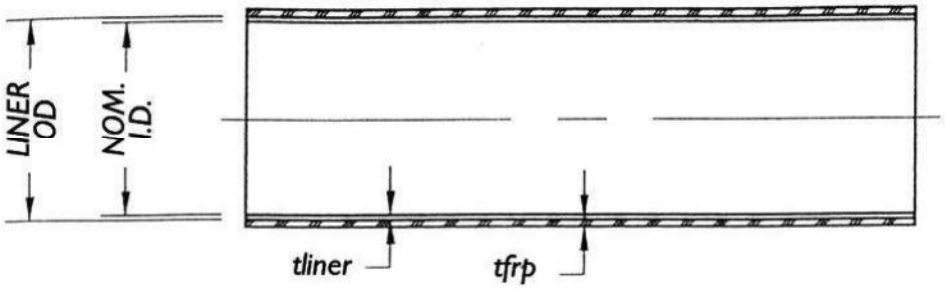
NOMINAL DIA. (inch)	ACTUAL I.D. LINER (inch)	OD LINER (inch)	MINIMUM tliner (inch)	THICKNESS FRP (tfrp)			VACUUM RATING		
				50 PSI (INCH)	100 PSI (INCH)	150 PSI (INCH)	50 PSI (psi)	100 PSI (psi)	150 PSI (psi)
1	0.935	1.315	0.179	0.10	0.10	0.10	14.7	14.7	14.7
1 1/2	1.476	1.90	0.200	0.10	0.10	0.10	14.7	14.7	14.7
2	1.913	2.375	0.218	0.10	0.10	0.10	14.7	14.7	14.7
3	2.864	3.50	0.300	0.10	0.10	0.10	14.7	14.7	14.7
4	3.998	4.50	0.237	0.10	0.10	0.15	8.3	8.3	14.7
6	6.031	6.625	0.280	0.10	0.15	0.20	2.5	8.3	14.7
8	7.943	8.625	0.322	0.10	0.15	0.25	1.0	3.5	14.7
10	9.976	10.75	0.365	0.10	0.20	0.30	.5	4.2	14.3
12	12.41	12.75	0.172	0.15	0.20	0.35	1.0	2.4	13.2
14	13.66	14.0	0.172	0.15	0.25	0.40	0.6	3.0	12.4
16	15.66	16.0	0.172	0.15	0.30	0.45	0.4	3.5	11.8
18	17.66	18.0	0.172	0.20	0.35	0.50	0.7	3.9	11.4
20	19.60	20.0	0.199	0.20	0.35	0.55	0.5	2.8	11.0
24	23.54	24.0	0.230	0.25	0.45	0.65	0.6	3.5	10.5

Notes:

Thermoplastic Liner: PVC/CORZAN® CPVC sheet or tube with chemical bonding
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass Continuous Filaments (F.W.)
Outer Surface: Resin containing paraffin wax and UV inhibitors
Vacuum ratings are based on a 5 to 1 safety factor for unstiffened pipe
Pressure ratings are based on a strain of 0.014 in/in for unstiffened pipe
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PP/PE,AGRU PVDF,AGRU ECTFE, DEKADUR EN, DEKADUR PVC-C, SYMALIT MFA, SYMALIT ETFE, SYMALIT FEP, SYMALIT PFA

PRODUCT AND MATERIAL SPECIFICATIONS: **FILAMENT WOUND** PRESSURE PIPE (POLYLAM-CLASS PP, POLYLAM-CLASS PE, FLUOROLAM-CLASS PV, FLUOROLAM-CLASS E, FLUOROLAM-CLASS M, CHLOROLAM-CLASS UPVC (EN), CHLOROLAM-CLASS PVC-C)



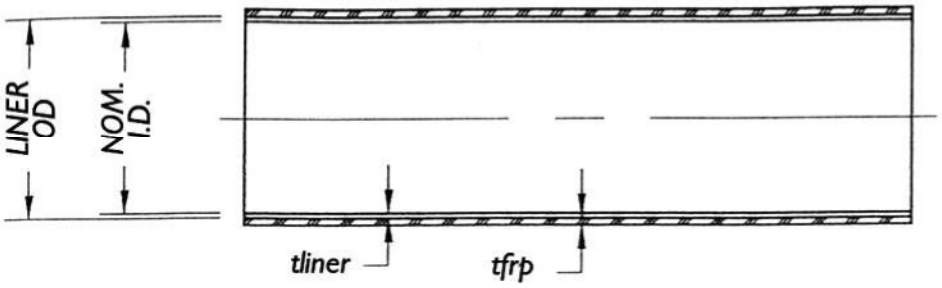
NOMINAL DIA. (inch)	MAXIMUM I.D. LINER (mm)	T PLASTIC OD LINER (mm)	MINIMUM tliner (mm)	THICKNESS FRP (tfrp)			VACUUM RATING		
				50 PSI (INCH)	100 PSI (INCH)	150 PSI (INCH)	50 PSI (psi)	100 PSI (psi)	150 PSI (psi)
1	27	32	2.4	0.10	0.10	0.10	14.7	14.7	14.7
1 1/2	35	40	2.4	0.10	0.10	0.10	14.7	14.7	14.7
2	56	63	2.4	0.10	0.10	0.10	14.7	14.7	14.7
3	84	90	2.8	0.10	0.10	0.10	14.7	14.7	14.7
4	104	110	3.0	0.10	0.10	0.15	8.3	8.3	14.7
6	154	160	3.0	0.10	0.15	0.20	2.5	8.3	14.7
8	194	200	3.0	0.10	0.15	0.25	1.0	3.5	14.7
10	244	250	3.0	0.10	0.20	0.30	0.5	4.2	14.3
12	310	315	* 2.3	0.15	0.20	0.35	1.0	2.4	13.2
14	345	350	* 2.3	0.15	0.25	0.40	0.6	3.0	12.4
16	395	400	* 2.3	0.15	0.30	0.45	0.4	3.5	11.8
18	445	450	* 2.3	0.20	0.35	0.50	0.7	3.9	11.4
20	495	500	* 2.3	0.20	0.35	0.55	0.5	2.8	11.0
24	595	600	* 2.3	0.25	0.45	0.65	0.6	3.5	10.5

Notes:

Thermoplastic Liner: PP/PE,UPVC (EN),PVC-C,PVDF, ECTFE, MFA, ETFE, FEP, PFA sheet or tube with embedded cloth (mechanical bonding)
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass Continuous Filaments (F.W.)
Outer Surface: Resin containing paraffin wax and UV inhibitors
Vacuum ratings are based on a 5 to 1 safety factor for unstiffened pipe
Pressure ratings are based on a strain of 0.014 in/in for unstiffened pipe
* PP/PE/EN/PVC-C 4.0 mm, PVDF 3.0 mm, ECTFE/MFA/ETFE/FEP/PFA 2.3 mm
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PVC/FRP and CORZAN® CPVC/FRP

PRODUCT AND MATERIAL SPECIFICATIONS: **HLU** PRESSURE PIPE (CHLOROLAM-CLASS P, CHLOROLAM-CLASS C)



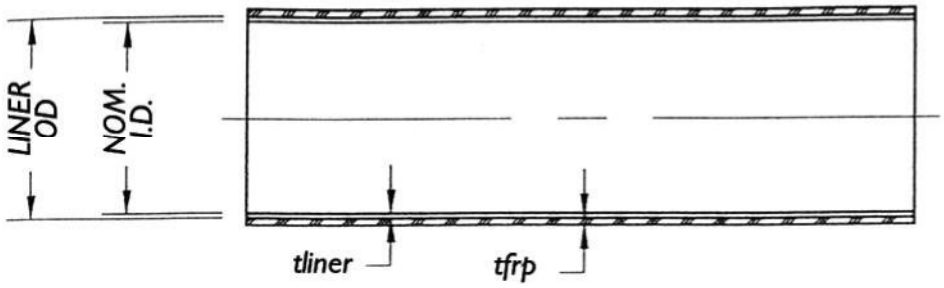
NOMINAL DIA. (inch)	ACTUAL I.D. LINER (inch)	OD LINER (inch)	MINIMUM tliner (inch)	THICKNESS FRP (tfrp)			VACUUM RATING		
				50 PSI (INCH)	100 PSI (INCH)	150 PSI (INCH)	50 PSI (psi)	100 PSI (psi)	150 PSI (psi)
1	0.935	1.315	0.179	0.18	0.18	0.18	14.7	14.7	14.7
1 1/2	1.476	1.90	0.200	0.18	0.18	0.18	14.7	14.7	14.7
2	1.913	2.375	0.218	0.18	0.18	0.18	14.7	14.7	14.7
3	2.864	3.50	0.300	0.18	0.18	0.25	14.7	14.7	14.7
4	3.998	4.50	0.237	0.18	0.25	0.25	14.7	14.7	14.7
6	6.031	6.625	0.280	0.18	0.25	0.38	10.5	14.7	14.7
8	7.943	8.625	0.322	0.25	0.31	0.43	13.2	14.7	14.7
10	9.976	10.75	0.365	0.25	0.38	0.50	6.8	14.7	14.7
12	12.41	12.75	0.172	0.25	0.43	0.62	3.9	14.7	14.7
14	13.66	14.0	0.172	0.31	0.50	0.75	4.7	14.7	14.7
16	15.66	16.0	0.172	0.31	0.56	0.80	3.1	14.7	14.7
18	17.66	18.0	0.172	0.38	0.62	0.91	4.4	14.7	14.7
20	19.60	20.0	0.199	0.38	0.69	1.0	3.2	14.7	14.7
24	23.54	24.0	0.230	0.38	0.81	1.22	2.7	14.7	14.7

Notes:

Thermoplastic Liner: PVC/CORZAN® CPVC sheet or tube with with chemical bonding
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M) } Option: All mat on small diameter
E Glass 24 oz/sq. yd. WOVEN ROVING (WR)
Outer Surface: Resin containing paraffin wax and UV inhibitors
Vacuum ratings are based on a 5 to 1 safety factor for unstiffened pipe
Pressure ratings are based on a strain of 0.014 in/in for unstiffened pipe
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PP/PE,AGRU PVDF,AGRU ECTFE, DEKADUR EN, DEKADUR PVC-C, SYMALIT MFA, SYMALIT ETFE, SYMALIT FEP, SYMALIT PFA

PRODUCT AND MATERIAL SPECIFICATIONS: **HLU** PRESSURE PIPE (POLYLAM-CLASS PP, POLYLAM-CLASS PE, FLUOROLAM-CLASS PV, FLUOROLAM-CLASS E, FLUOROLAM-CLASS E, FLUOROLAM-CLASS M, CHLOROLAM-CLASS UPVC (EN), CHLOROLAM-CLASS PVC-C)



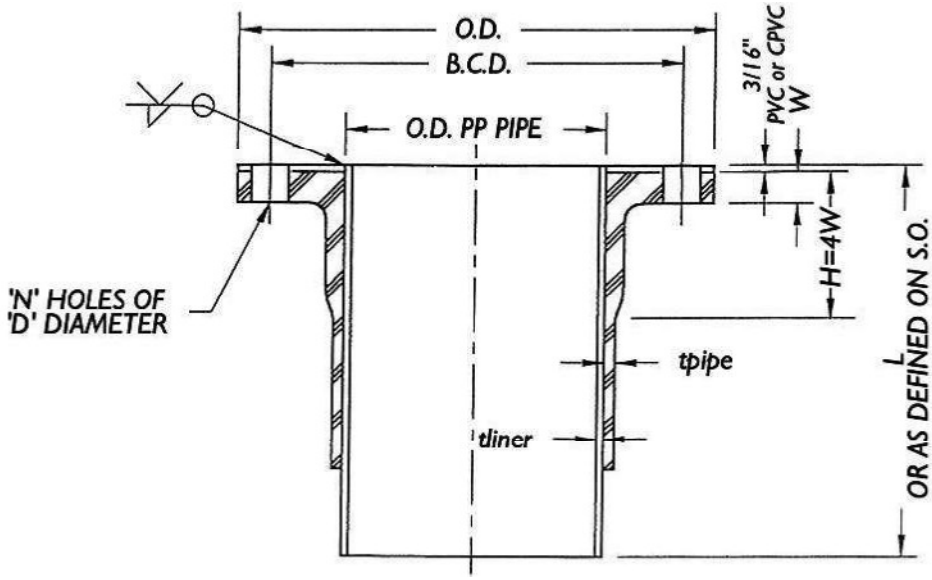
NOMINAL DIA. (inch)	MAXIMUM I.D. LINER (mm)	T PLASTIC OD LINER (mm)	MINIMUM TUBE LINER (mm)	THICKNESS FRP (tfrp)			VACUUM RATING		
				50 PSI (INCH)	100 PSI (INCH)	150 PSI (INCH)	50 PSI (psi)	100 PSI (psi)	150 PSI (psi)
1	27	32	2.4	0.18	0.18	0.18	14.7	14.7	14.7
1 1/2	35	40	2.4	0.18	0.18	0.18	14.7	14.7	14.7
2	56	63	2.4	0.18	0.18	0.18	14.7	14.7	14.7
3	84	90	2.8	0.18	0.18	0.25	14.7	14.7	14.7
4	104	110	3.0	0.18	0.25	0.25	14.7	14.7	14.7
6	154	160	3.0	0.18	0.25	0.38	10.5	14.7	14.7
8	194	200	3.0	0.25	0.31	0.43	13.2	14.7	14.7
10	244	250	3.0	0.25	0.38	0.50	6.8	14.7	14.7
12	310	315	* 2.3	0.25	0.43	0.62	3.9	14.7	14.7
14	345	350	* 2.3	0.31	0.50	0.75	4.7	14.7	14.7
16	395	400	* 2.3	0.31	0.56	0.80	3.1	14.7	14.7
18	445	450	* 2.3	0.38	0.62	0.91	4.4	14.7	14.7
20	495	500	* 2.3	0.38	0.69	1.0	3.2	14.7	14.7
24	595	600	* 2.3	0.43	0.81	1.22	2.7	14.7	14.7

Notes:

Thermoplastic Liner: PP/PE, UPVC (EN),PVC-C,PVDF, ECTFE, MFA, ETFE, FEP, PFA sheet or tube with embedded cloth (mechanical bonding)
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M) } Option: All mat on small diameter
E Glass 24 oz./sq. yd. woven roving (WR)
Outer Surface: Resin containing paraffin wax and UV inhibitors
Vacuum ratings are based on a 5 to 1 safety factor for unstiffened pipe
Pressure ratings are based on a strain of 0.014 in/in for unstiffened pipe
* PP/PE/EN/PVC-C 4.0 mm, PVDF 3.0 mm, ECTFE/MFA/ETFE/FEP/PFA 2.3 mm
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PVC/FRP and CORZAN® CPVC/FRP

PRODUCT AND MATERIAL SPECIFICATIONS: 50 PSI, 100 PSI, 150 PSI FULL FACE FLANGES
(CHLOROLAM-CLASS P, CHLOROLAM-CLASS C)



Note:
"H" and "W" do not include the thermoplastic.

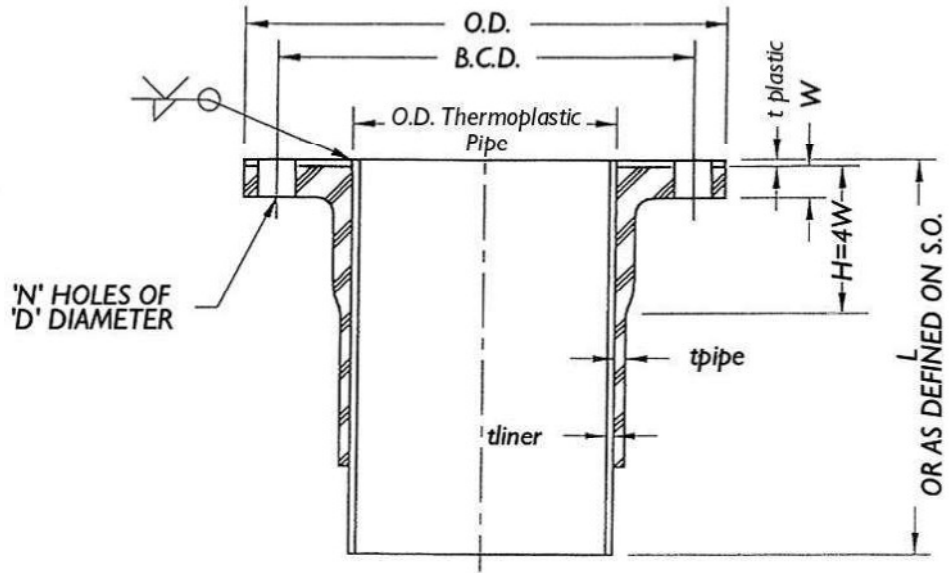
NOMINAL DIA. (inch)	ACTUAL LINER I.D. (inch)	PVC/CPVC LINER O.D. (inch)	PVC/CPVC tliner (inch)	L. (inch)	50 PSI frp tpipe (inch)	50 PSI frp flg. W (inch)	100 PSI frp tpipe (inch)	100 PSI frp flg. W (inch)	150 PSI frp tpipe (inch)	150 PSI frp flg. W (inch)	FLANGE O.D. (inch)	B.C.D. ANSI (inch)	HOLE DIA. "D" (inch)	NO. OF HOLES N
1	0.935	1.315	0.119	6	0.18	1/2	0.18	1/2	0.18	5/8	4-3/8	3-1/8	5/8	4
1 -1/2	1.475	1.9	0.20	6	0.18	1/2	0.18	9/16	0.18	11/16	5-1/2	3-7/8	5/8	4
2	1.913	2.375	0.22	6	0.18	1/2	0.18	9/16	0.18	11/16	6-1/2	4-3/4	3/4	4
3	2.864	3.5	0.300	6	0.18	1/2	0.18	11/16	0.25	13/16	8	6	3/4	4
4	3.998	4.5	0.237	8	0.18	9/16	0.25	13/16	0.25	15/16	9-1/2	7-1/2	3/4	8
6	6.031	6.625	0.280	8	0.18	5/8	0.25	7/8	0.38	1-1/16	11-1/2	9-1/2	7/8	8
8	7.943	8.625	0.322	8	0.25	3/4	0.31	1	0.43	1-1/4	14	11-3/4	7/8	8
10	7.976	10.75	0.365	10	0.25	7/8	0.38	1-3/16	0.50	1-7/16	16-1/2	14-1/4	1	12
12	12.41	12.75	0.172	10	0.25	1	0.43	1-7/16	0.62	1-3/4	19-1/2	17	1	12
14	13.66	14.0	0.172	12	0.31	1-1/16	0.50	1-1/2	0.75	1-7/8	21-1/2	18-3/4	1-1/8	12
16	15.66	16.0	0.172	12	0.31	1-3/16	0.56	1-5/8	0.80	2-1/16	24	21-1/4	1-1/8	16
18	17.66	18.0	0.172	12	0.38	1-1/4	0.62	1-3/4	0.91	2-1/4	25-1/2	22-3/4	1-1/4	16
20	19.6	20.0	0.199	12	0.38	1-5/16	0.69	1-7/8	1.00	2-7/16	28	25	1-1/4	20
24	23.54	24.0	0.230	12	0.43	1-1/2	0.81	2-1/8	1.22	2-13/16	32-1/2	29-1/2	1-3/8	20

Notes:

Thermoplastic Liner: PVC/CORZAN® CPVC sheet or tube chemically bonded
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M) } Option: All mat on small diameter
E Glass 24 oz./sq/ yd. Woven Roving (WR)
Outer Surface: Resin containing paraffin wax and UV inhibitors
All flange bolt holes to straddle centerlines
Flange back face to accomodate ANSI Type B plain washers
Flanges drilled to ANSI B16.1, Class 150 hole patterns
Also available in DIN or JIS bolt hole pattern
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PP/PE,AGRU PVDF,AGRU ECTFE, DEKADUR EN, DEKADUR PVC-C, SYMALIT MFA, SYMALIT ETFE, SYMALIT FEP, SYMALIT PFA

PRODUCT AND MATERIAL SPECIFICATIONS: 50 PSI, 100 PSI, 150 PSI FULL FACE FLANGES (POLYLAM-CLASS PP, POLYLAM-CLASS PE, FLUOROLAM-CLASS PV, FLUOROLAM-CLASS E, FLUOROLAM-CLASS E, FLUOROLAM-CLASS M, CHLOROLAM-CLASS UPVC (EN), CHLOROLAM-CLASS PVC-C)



Liner Thickness
PP/PE 4.0 mm
PVDF 3.0 mm
ECTFE 2.3 mm
MFA 2.3 mm
Dekadur UPVC (EN) 4.0 mm
Dekadur PVC-C 4.0 mm
ETFE 2.3 mm
FEP 2.3 mm
PFA 2.3 mm

Note:
"H" and "W" do not include the thermoplastic.

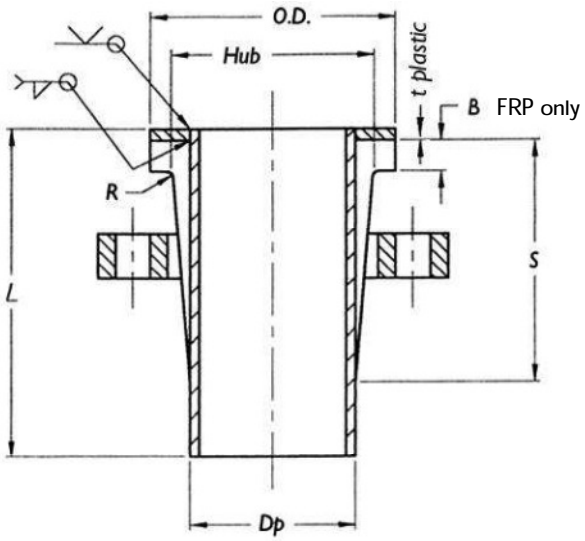
NOMINAL DIA. (inch)	MAX. LINER I.D. (mm)	T PLASTIC LINER O.D. (mm)	T PLASTIC tliner (mm)	L. (inch)	50 PSI frp tpipe (inch)	50 PSI frp flg. W (inch)	100 PSI frp tpipe (inch)	100 PSI frp flg. W (inch)	150 PSI frp tpipe (inch)	150 PSI frp flg. W (inch)	FLANGE O.D. (inch)	B.C.D. ANSI (inch)	HOLE DIA. "D" (inch)	NO. OF HOLES N
1	27	32	2.4	6	0.18	1/2	0.18	1/2	0.18	5/8	4-3/8	3-1/8	5/8	4
1 -1/2	35	40	2.4	6	0.18	1/2	0.18	9/16	0.18	11/16	5-1/2	3-7/8	5/8	4
2	56	63	2.4	6	0.18	1/2	0.18	9/16	0.18	11/16	6-1/2	4-3/4	3/4	4
3	84	90	3	6	0.18	1/2	0.18	11/16	0.25	13/16	8	6	3/4	4
4	104	110	3	8	0.18	9/16	0.25	13/16	0.25	15/16	9-1/2	7-1/2	3/4	8
6	154	160	3	8	0.18	5/8	0.25	7/8	0.38	1-1/16	11-1/2	9-1/2	7/8	8
8	194	200	3	8	0.25	3/4	0.31	1	0.43	1-1/4	14	11-3/4	7/8	8
10	244	250	3	10	0.25	7/8	0.38	1-3/16	0.50	1-7/16	16-1/2	14-1/4	1	12
12	310	315	* 2.3	10	0.25	1	0.43	1-7/16	0.62	1-3/4	19-1/2	17	1	12
14	345	350	* 2.3	12	0.31	1-1/16	0.50	1-1/2	0.75	1-7/8	21-1/2	18-3/4	1-1/8	12
16	395	400	* 2.3	12	0.31	1-3/16	0.56	1-5/8	0.80	2-1/16	24	21-1/4	1-1/8	16
18	445	450	* 2.3	12	0.38	1-1/4	0.62	1-3/4	0.91	2-1/4	25-1/2	22-3/4	1-1/4	16
20	495	500	* 2.3	12	0.38	1-5/16	0.69	1-7/8	1.00	2-7/16	28	25	1-1/4	20
24	595	600	* 2.3	12	0.43	1-1/2	0.81	2-1/8	1.22	2-13/16	32-1/2	29-1/2	1-3/8	20

Notes:

Thermoplastic Liner: PP/PE, UPVC (EN),PVC-C,PVDF, ECTFE, MFA, ETFE, PFA, FEP sheet or tube with embedded cloth (mechanical bonding)
All welds to be coated with conductive graphite filled resin
FRP:
Resin: Premium grade vinylester resin
Cure System: MEKP/CoNAP-DMA-CHP/CoNAP
Reinforcement:
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M) } Option: All mat on small diameter
E Glass 24 oz./sq/ yd. Woven Roving (WR)
Outer Surface: Resin containing paraffin wax and UV inhibitors
All flange bolt holes to straddle centerlines
Flange back face to accomodate ANSI Type B plain washers
Flanges drilled to ANSI B16.5, Class 150 hole patterns
Also available in DIN or JIS bolt hole pattern
* PP/PE/EN/PVC-C 4.0 mm, PVDF 3.0 mm, ECTFE/MFA/ETFE/FEP/PFA 2.3 mm
Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM PP/PE,AGRU PVDF,AGRU ECTFE, SYMALIT MFA, DEKADUR EN and DEKADUR PVC-C

PRODUCT AND MATERIAL SPECIFICATIONS: STUB FLANGES COMPLETE WITH DUCTILE IRON (EPOXY COATED OR GALVANIZED BACK UP RINGS) ANSI B 16.5 BOLT PATTERN



Liner Thickness

PP/PE 4.0 mm
PVDF 3.0 mm
ECTFE 2.3 mm
MFA 2.3 mm
Dekadur UPVC (EN) 4.0 mm
Dekadur PVC-C 4.0 mm
ETFE 2.3 mm
FEP 2.3 mm
PFA 2.3 mm

NOMINAL DIA. (inch)	MAX. I.D. (mm)	RATING (PSI)	Dp (mm)	O.D. (mm)	Hub (mm)	B min. (mm)	R (mm)	S (mm)	L (mm)
1	25	150	32	63	46	13	3	110	229
1 1/2	33	150	40	82	62	13	3	110	229
2	56	150	63	101	80	13	3	110	229
3	80	150	90	133	108	14	3	130	229
4	102	150	110	171	133	16	4	135	229
6	152	150	160	219	192	19	4	135	229
8	192	150	200	276	247	22	4	150	229
10	242	150	250	336	288	26	4	175	229

NOMINAL DIA. (inch)	MAX. I.D. (mm)	Dp (mm)	O.D. (mm)	Hub (mm)	B min. (mm)			R (mm)	S (mm)	L (mm)
					50 PSI	100 PSI	150 PSI			
12	307	315	406	339	19	27	33	6	250	300
14	342	355	447	396	20	29	35	6	250	300
16	392	400	511	453	22	31	38	6	250	300
18	442	450	546	503	23	34	41	6	250	300
20	492	500	603	559	23	34	41	6	250	300
24	592	600	714	672	25	36	44	6	250	300

Notes:

For backing ring dimensions or custom flanges, contact CPF Dualam Engineering.
Also available in DIN or JIS bolt hole pattern.

CPF DUALAM / TROY MANUFACTURING
FIBERGLASS REINFORCED PLASTIC (FRP)
Product and Material Specifications
SPECIFICATIONS: ASME / ANSI PS-15-69, CANADA 41-GP-22

A. Material and Properties

FRP PIPING (1"-24")	
Corrosion Barrier Pipe	0.10" / 0.25" / 0.50"
Pipe Structure	Hand Lay-up, Filament Wound, Orthowound
Flange	Laminated
Resin System	Viny Ester / Premium Vinyl Ester (Epoxy Novolac) / Bisphenol A / Isophthalic
Fire Retardance	Optional
Joint Types	Butt & Wrap
Pressure Rating	25 - 150 psi
Typical Applications:	Chlorine & Custom applications, Caustic, Brine, Aeros

GENERAL PHYSICAL PROPERTIES - TROY FRP PIPE & FITTINGS*

Coefficient of Thermal Expansion	1.2 to 1.7 x 10^{-5} in./in./deg. F.	2.2 to 3.0 x 10^{-5} mm/mm/deg. C.
Thermal Conductivity	1.3 BTU in./ft.^{2} /deg. F/hr.	188 (W-mm)/(m^2 deg. C)
Density	0.058 lb/in.^{3}	1.61 g/cm^3
Hazen William's Flow Coefficient	150	
Manning's Flow Coefficient	0.009	

* These are approximate values if exact values are required consult TROY ENGINEERING.

MECHANICAL PROPERTIES - FILAMENT WOUND PIPING - Structural Layers

	HELICAL ± 55° angle		ORTHOWOUND	
Ultimate Tensile & Compressive Strength				
Hoop	40,000 psi	(276 Mpa)	45,000 psi	(310 Mpa)
Axial (due to pressure)	20,000 psi	(138 Mpa)	25,000 psi	(172 Mpa)
Tensile & Compressive Modulus of Elasticity				
Hoop	3.0 x 10^6 psi	(20,690 Mpa)	3.5 x 10^6 psi	(24,132 Mpa)
Axial	1.5 x 10^6 psi	(10,335 Mpa)	1.9 x 10^6 psi	(13,100 Mpa)
Poisson's Ratio				
Change in axial strain caused by hoop stress	0.6			
Change in hoop strain caused by axial stress	0.4			

MECHANICAL PROPERTIES - HAND LAY-UP PIPING - Structural Layers

Ultimate Tensile & Compressive Strength		
Hoop / Axial (laminates<1/4" thick*)	12,000 psi	(83 Mpa)
Hoop / Axial (laminates≥1/4" thick**)	20,000 psi	(138 Mpa)
Tensile & Compressive Modulus of Elasticity		
Hoop / Axial (laminates<1/4" thick*)	1.2 x 10^6 psi	(8,276 Mpa)
Hoop / Axial (laminates≥1/4" thick**)	1.7 x 10^6 psi	(11,742 Mpa)

Poisson's Ratio, hoop / axial & axial / hoop 0.34*, 0.25**
*Indicates "all mat" construction **Indicates mat and woven roving

MECHANICAL PROPERTIES - CORROSION BARRIER

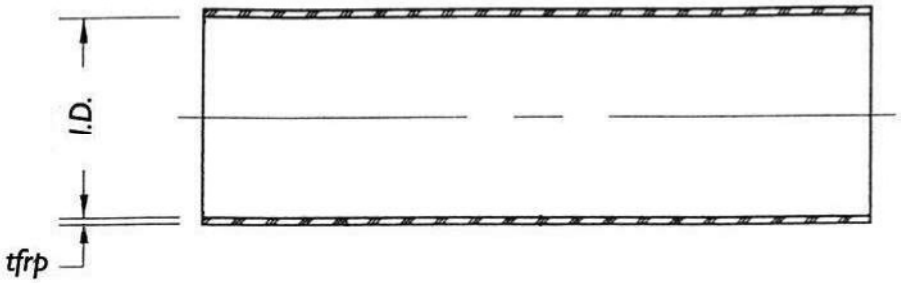
Ultimate Tensile & Compressive Strength		
Hoop / Axial	10,000 psi	(69 Mpa)
Tensile & Compressive Modulus of Elasticity		
Hoop / Axial	1.0 x 10^6 psi	(6,897 Mpa)

Poisson's Ratio, hoop / axial & axial / hoop 0.34

Standard Dimensions of FRP Piping

Fiberglass Reinforced Plastic (FRP)

PRODUCT AND MATERIAL SPECIFICATIONS: **FILAMENT WOUND** PRESSURE PIPE

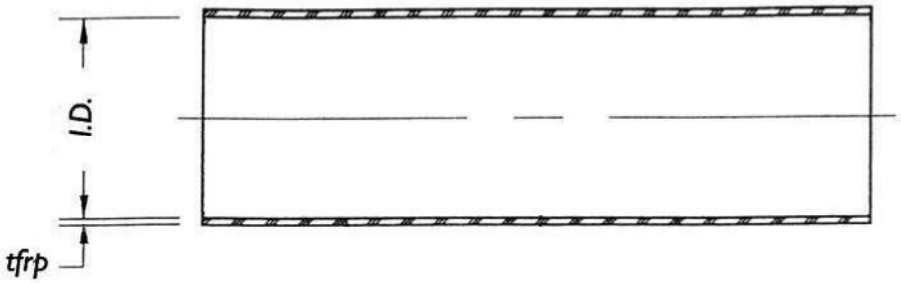


NOMINAL DIA. (inch)	ACTUAL I.D. (inch)	THICKNESS tfrp (inch)	PIPE LENGTH (max.)
2	2	3/16	20'-0"
3	3	1/4	20'-0"
4	4	1/4	20'-0"
6	6	1/4	20'-0"
8	8	1/4	20'-0"
10	10	5/16	20'-0"
12	12	3/8	20'-0"
14	14	7/16	20'-0"
16	16	7/16	20'-0"
18	18	1/2	20'-0"
20	20	1/2	20'-0"
24	24	5/8	20'-0"

Notes:

Liner: FRP
Resin: DERAKANE 411 OR HETRON 922 FOR CORROSION LINER AND STRUCTURAL LAYER
Color: NATURAL (UNPIGMENTED)
Reinforcement:
NEXUS Veil (NV)
'C' Glass Surfacing Veil 'CV'
'Chopped Stand Mat 'M'
E/Ecr Glass Continuous Filaments (F.W.)
Outer Surface: Resin containing UV inhibitors

Sales order or fabrication drawing shall be followed when differing from the above notes



NOMINAL DIA. (inch)	ACTUAL I.D. (inch)	THICKNESS tfrp (inch)	LENGTH (max.)
1	1	3/16	20'-0"
1 1/2	1 1/2	3/16	20'-0"
2	2	3/16	20'-0"
3	3	1/4	20'-0"
4	4	1/4	20'-0"
6	6	1/4	20'-0"
8	8	1/4	20'-0"
10	10	5/16	20'-0"
12	12	3/8	20'-0"
14	14	7/16	20'-0"
16	16	7/16	20'-0"
18	18	1/2	20'-0"
20	20	1/2	20'-0"
24	24	5/8	20'-0"

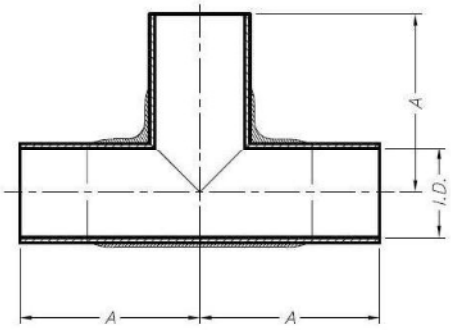
Notes:

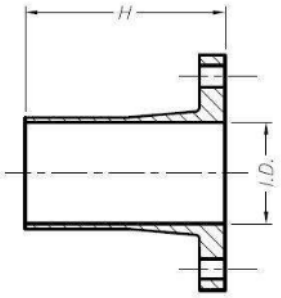
Liner: FRP
Resin: DERAKANE 411 OR HETRON 922 FOR CORROSION LINER AND STRUCTURAL LAYER
Color: NATURAL (UNPIGMENTED)
Reinforcement:
NEXUS Veil (NV)
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M)
E Glass 24 oz./sq. yd. woven roving (WR) } Option: All mat on small diameter
Outer Surface: Resin containing UV inhibitors

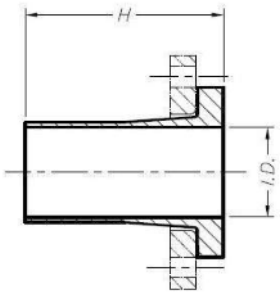
Sales order or fabrication drawing shall be followed when differing from the above notes

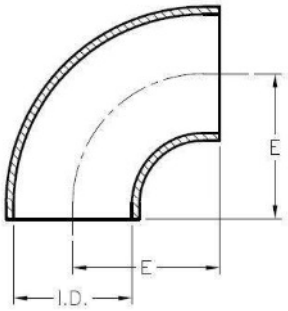
Fiberglass Reinforced Plastic (FRP) Fittings

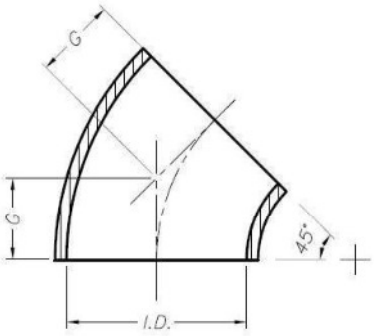
PRODUCT AND MATERIAL SPECIFICATIONS: ADAPTED AMERICAN STANDARD











FRP FITTING DIMENSIONS					
NOM. SIZE (inch)	I.D. (inch)	A (inch)	E (inch)	G (inch)	H (inch)
1	1	3	2	13/16	6
1 1/2	1 1/2	4	3	1 1/4	6
2	2	6	4	1 5/8	6
3	3	7	6	2 1/2	6
4	4	8	6	2 1/2	6
6	6	10	9	3 3/4	8
8	8	12	12	5	8
10	10	14	15	6 1/4	10
12	12	16	18	7 1/2	10
14	14	18	21	8 3/4	12
16	16	20	24	10	12
18	18	21	27	11 1/4	12
20	20	22	30	12 1/2	12
24	24	24	36	15	12

Notes:

Liner: FRP
Resin: DERAKANE 411 OR HETRON 922 FOR CORROSION LINER AND STRUCTURAL LAYER
Color: NATURAL (UNPIGMENTED)
Reinforcement:
NEXUS Veil (NV)
'C' Glass Surfacing Veil 'CV'
E/Ecr Glass 1 1/2 oz/sq. ft. MAT (M)
E Glass 24 oz./sq. yd. woven roving (WR) } Option: All mat on small diameter
Outer Surface: Resin containing UV inhibitors

Sales order or fabrication drawing shall be followed when differing from the above notes

DUALAM Metric DIN Standards

Dualam DIN 16965 Type B Piping

A. Material and Properties

Dualam DIN Type B Composite Pipes combine the high mechanical and thermal strength of the GRP materials with the excellent chemical resistance of a thermoplastic liner. Depending on the application the following linings: UPVC, PVC-C, PP, PE, PVDF, ECTFE or MFA are used. Pipes and fittings correspond to DIN Standard Type B and combine synthetic reaction resins with glass fibres to give an economical solution for each application.

Resins used include: polyester resins on a bisphenol A base, neopentl glycol, isophthalic acid, HET acid etc. and vinylester.

Pipes and fittings are produced by winding with glass fibre products of quality grades E- and C-glass, E-CR glass and others.

Project-specific pressure and size alternatives not listed here can also be supplied; contact CPF Dualam Engineering.

Winding laminate for pipes: reference values for 20˚C.

Tensile Strength:	
circumferentially	360 N/mm^2
longitudinally	180 N/mm^2
Modulus of elasticity, tensile:	
circumferentially	> 17 000 N/mm^2
longitudinally	> 10 000 N/mm^2
Flexural strength:	
circumferentially	> 360 N/mm^2
longitudinally	> 180 N/mm^2
Modulus of elasticity, flexural:	
circumferentially	> 16 000 N/mm^2
longitudinally	> 8 000 N/mm^2
Shear modulus:	2 500 N/mm^2
Thermal expansion coefficient:	25 - 30 • 10^{-6} K^{-1}
GRP density:	1.8 g/cm^3
Thermal conductivity	
thermoplastic resin	0.16 - 0.25 W/mK
GRP	0.27 W/mK
Roughness of the internal surface:	0.007mm

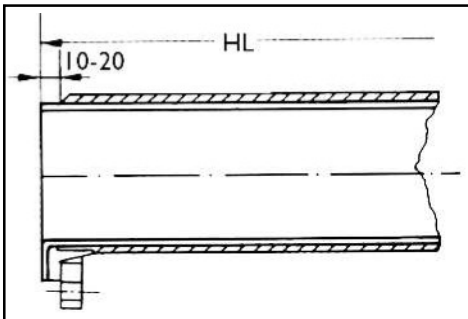
B. Installation Notes

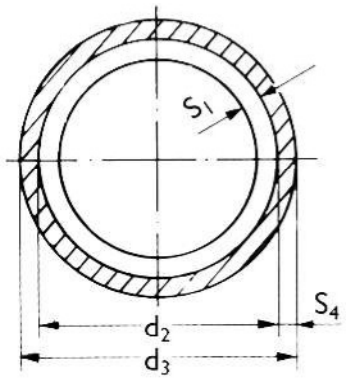
REFERENCE VALUES FOR DISTANCE BETWEEN SUPPORTS [M] FOR PIPES WITHOUT THERMAL INSULATION

NOM. DIA.	PN 6 - bar				PN 10 - bar				PN 16 - bar			
DN	Gas	Liquids			Gas	Liquids			Gas	Liquids		
	$\rho_{fil} = 0$	$\rho_{fil} = 1.0$	$\rho_{fil} = 1.5$	$\rho_{fil} = 1.8$	$\rho_{fil} = 0$	$\rho_{fil} = 1.0$	$\rho_{fil} = 1.5$	$\rho_{fil} = 1.8$	$\rho_{fil} = 0$	$\rho_{fil} = 1.0$	$\rho_{fil} = 1.5$	$\rho_{fil} = 1.8$
25	see PN 16				see PN 16				2.3	2.1	2.0	2.0
32									2.5	2.3	2.2	2.1
40									2.8	2.4	2.3	2.2
50									3.1	2.6	2.4	2.4
65									3.3	2.7	2.6	2.5
80									3.6	2.9	2.7	2.6
100									4.0	3.0	2.8	2.7
125									4.3	3.1	2.9	2.8
150	see PN 10				4.8	3.4	3.1	3.0	4.9	3.5	3.2	3.1
200					5.3	3.6	3.3	3.2	5.7	3.9	3.6	3.5
250	5.9	3.8	3.5	3.4	6.1	3.9	3.6	3.4	6.6	4.4	4.0	3.9
300	6.5	4.0	3.7	3.5	6.9	4.4	4.0	3.8	7.4	4.9	4.5	4.3
350	7.1	4.2	3.9	3.7	7.6	4.7	4.3	4.1	8.2	5.2	4.8	4.6
400	7.5	4.4	4.0	3.8	8.3	5.0	4.5	4.4	8.8	5.6	5.1	4.9
500	8.9	5.1	4.7	4.5	9.5	5.6	5.1	4.9	10.0	6.2	5.7	5.5
600	10.0	5.8	5.4	5.2	10.0	6.2	5.7	5.4	10.0	6.8	6.3	6.1

DUALAM Metric DIN Standards

Pipes to DIN 16 965, Part 2





Dimensions in mm

HL manufactured length (m)
S_1 thickness of the liner
s_4 GRP wall-thickness
d_2 liner o.d.
d_3 GRP o.d.
g_1 liner weight (kg/m)
g_4 GRP weight (kg/m)

Nom. Pressure PN	Operating pressure (gauge)*) to DIN 16 867: Pipe	
	-20°C to +50°C	>50°C to +80°C
16	A 16	B 10
10	A 10	B 6
6	A 6	B 4

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10

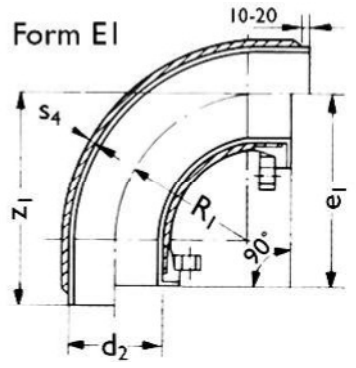
Application range –A– to DIN 16867 ≤50°C

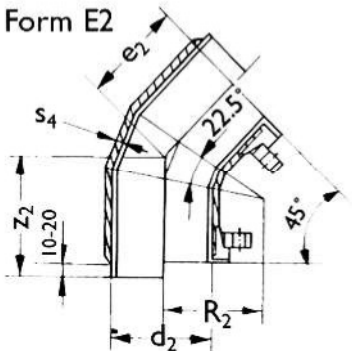
NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
PN 16	S_4 1)	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.2	3.7	4.4	5.3	5.8	6.4	7.8	9.1
	d_3 min.	38	46	56	69	81	96	116	131	167	208	259	326	367	413	516	619
	g_4	0.5	0.7	0.8	1.0	1.2	1.4	1.6	2.0	2.8	4.0	6.0	9.1	11.2	13.9	21.2	29.6
PN 10	S_4 1)									2.9	2.9	3.1	3.7	4.0	4.4	5.2	6.1
	d_3 min.									166	206	257	322	363	409	511	613
	g_4									2.5	3.1	4.2	6.3	7.7	9.5	14.0	19.8
PN 6	S_4 1)											2.9	2.9	2.9	3.1	3.6	4.1
	d_3 min.											256	321	361	407	508	609
	g_4											4.1	5.0	5.9	7.1	10.3	14.0
Liner Dia.	d_2	32	40	50	63	75	90	110	125	160	200	250	315	355	400	500	600
UPVC	S_1	3.6	4.5	3.7	4.7	3.6	4.3	5.3	3.7	4.7	4.0	4.9	6.2	7.1	5.0	4.0	5.0
	HL	5.0	5.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	4.8	4.8	4.8	4.8
	g_1	0.5	0.7	0.8	1.3	1.2	1.7	2.6	2.1	3.4	4.2	5.7	9.0	11.4	14.5	9.4	13.6
PVC-C	S_1	2.4	3.0	3.7	4.7	3.6	4.3	5.3		7.7	4.0	4.9	6.2		3.2	5.6	
	HL	4.8	4.8	4.8	4.8	4.8	4.8	4.8		4.8	4.8	4.8	4.8		4.8	4.8	
	g_1	0.4	0.7	1.0	1.6	1.4	2.1	3.1		6.1	4.7	6.4	9.9		6.8	14.2	
PP	S_1	3.5	3.7	4.6	5.8	4.3	5.1	6.3	7.1	6.2	4.9	6.1	7.7	8.7	9.8	8.0	5.0[2])
	HL	5.0	5.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0[4])	6.0[4])	6.0[4])	6.0[4])	6.0[4])	5.8[4])	5.8[4])
	g_1	0.3	0.4	0.7	1.0	1.0	1.4	2.0	2.6	2.2	2.7	4.2	7.3	9.3	9.5	12.5	11.6
ECTFE/ MFA	S_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[3])	3.0[3])	3.0[3])	3.0[3])	3.0[3])
	HL	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
	g_1	0.3	0.4	0.7	1.1	1.0	1.4	2.0	1.5	2.5	3.1	4.8	7.5	9.5	12.1	12.0	9.0
PVDF	S_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[3])	3.0[3])	3.0[3])	3.0[3])	3.0[3])
	HL	5.0	5.0	5.0	5.8[4])	5.8[4])	5.8[4])	5.8[4])	5.8[4])	5.8[4])	5.8[4])	5.8[4])	5.8	5.8	5.8	5.8	5.8
	g_1	0.4	0.5	0.8	1.0	1.4	1.5	2.0	2.2	2.9	3.6	4.5	5.3	6.0	6.7	8.4	10.0

1) Glass content 60 ± 5%
2) Stripwound pipe
3) Sheet material
4) Alternatively: manufactured length = 4.8 m with flanged ends

DUALAM Metric DIN Standards

Elbows to DIN 16 966, Part 2





Dimensions in mm

e_1 overall length with collar (90°)
z_1 overall length without collar (90°)
d_2 outside dia. of liner
e_2 overall length with collar (45°)
z_2 overall length without collar (45°)
s_4 min. GRP wall-thickness
R_1/R_2 radius
g_1/g_2 weight without flange (kg/unit)

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 867: Elbow			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10
Pipe measurements as page_____

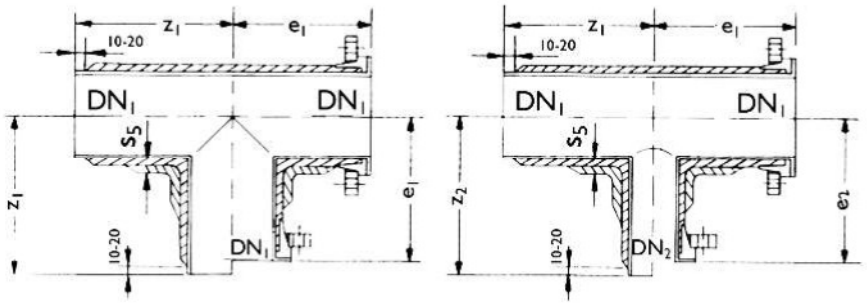
Application range –A– to DIN 16867 ≤50°C

NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
	d_2	30	40	50	63	75	90	110	125	160	200	250	315	355	400	500	600
Wall thickness s_4	PN 16	2.9	2.9	2.9	2.9	2.9	2.9	3.2	3.7	4.4	5.3	6.4	7.8	8.6	9.6	11.8	14
	PN 10					2.9	2.9	2.9	2.9	3.2	3.7	4.4	5.3	5.8	6.4	7.8	9.1
	PN 6										2.9	2.9	3.7	4.4	4.4	5.3	5.8
	PN 4													2.9	3.2	3.7	4.4
	PN 2.5																2.9
Elbow 90°	e_1	110	130	150	180	140	165	205	245	285	365	450	525	600	680	830	950
	z_1	130	150	170	200	165	190	230	280	315	400	490	555	635	725	865	950
Elbow 45°	e_2	70	80	90	105	85	100	115	135	150	190	225	260	290	325	390	430
	z_2	90	100	110	125	110	125	140	170	180	225	265	290	325	370	425	430
Elbow 90° R_1	UPVC	30	40	50	73	85	105	135	160	190	275	250	300	350	400	500	620
ECTFE/MFA/PP		30	40	50	63	75	90	110	140	155	195	250	300	350	400	500	600
	PVC-C	25	32	40	70	65	80	100	130	150	200	250	300	350	400	500	620
	PVDF	25	32	40	70	65	80	100	125	150	200	250	300	350	400	500	620
Elbow 45° R_2	UPVC	40	50	63	63	85	90	110	130	190	275	260	310	360	410	520	620
ECTFE/MFA/PP		30	40	50	63	75	90	110	125	160	200	250	277	350	400	500	600
	PVC-C	26	33	42	50	65	80	100	125	150	200	260	310	360	410	520	620
	PVDF	25	32	40	50	65	80	100	125	150	200	260	310	360	410	520	620
Weight 90°	g_1	0.2	0.3	0.4	0.8	0.6	0.9	1.7	2.4	3.7	7.7	12.2	20.6	23.7	41.0	43.0	
45°	g_2	0.1	0.2	0.3	0.5	0.4	0.9	1.4	1.5	2.1	3.9	6.9	11.0	12.0	21.2	22.1	32.8

Elbow 90°/45° UPVC DN 125 and between DN 250 and 600 of mitred construction
Elbow 90°/45° PP, ECTFE, MFA DN 350-600 of mitred construction
Elbow 90°/45° PVC-C, PVDF all nom. dia.of mitred construction
For 90° elbows in PP, ECTFE, MFA without mitres the cylindrical ends are polished
For 45° elbows without mitres the cylindrical ends are polished

DUALAM Metric DIN Standards

T-pieces and Branches to DIN 16 966, Part 4



Dimensions in mm

e_1 overall length with collar
e_2 overall length with collar
s_5 min. GRP wall-thickness
z_1 overall length without collar
z_2 overall length without collar

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 867: T-piece, branch			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10
Pipe sizes as page_____

Application range –A– to DIN 16867 ≤50°C

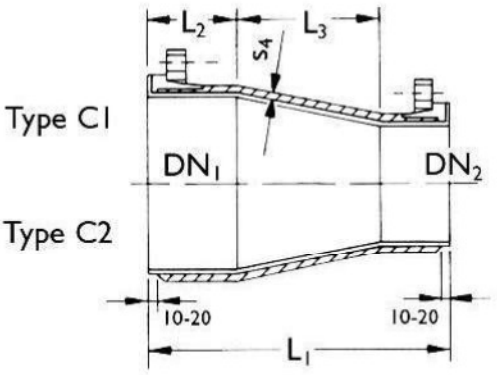
DN_1 → DN_2		e_1	z_1	e_2	z_2	wall-thickness s_5				
						PN 16	PN 10	PN 6	PN 4	PN2.5
25	25	110	130	–	–	4.4				
32	25	130	150	175	190	5.8				
	32	130	150	–	–	5.1				
40	25			180	200	5.8				
	32	150	170	180	200	5.8				
	40			–	–	6.1				
50	25					5.8				
	32	180	200	185	205	5.8				
	40					6.2				
	50			–	–	7.3				
65	32						5.8			
	40	140	165	195	215		5.8			
	50						5.8			
	65			–	–		5.6			
80	40				220		5.8			
	50	165	190	200	220		5.8			
	65				225		5.8			
	80			–	–		6.3			
100	50				230		5.8			
	65	205	230	210	235		6.1			
	80				235		6.8			
	100			–	–		7.8			
125	65						6.6			
	80	245	280	270	295		7.1			
	100						7.7			
	125			–	–		8.8			
150	80			240	265		8.0			
	100	285	315	240	265		8.8			
	125			290	325		9.4			
	150			–	–		11.0			

DN_1 → DN_2		e_1	z_1	e_2	z_2	wall-thickness s_5				
						PN 16	PN 10	PN 6	PN 4	PN2.5
200	100			260	285			8.0		
	125	365	400	310	345			9.0		
	150			310	340			9.9		
	200			–	–			11.6		
250	125				375			8.1		
	150	450	490	340	370			8.9		
	200				375			10.0		
	250			–	–			11.6		
300	150			360	390			10.1		
	200	525	555	365	400			11.1		
	250			415	455			12.4		
	300			–	–			14.4		
350	200			395	430				8.7	
	250	600	635	455	485				9.7	
	300			455	475				10.6	
	350			–	–				11.3	
400	250			470	510				10.3	
	300	680	725	470	500				11.5	
	350			520	555				12.1	
	400			–	–				13.0	
500	300			525	555				12.8	
	350	830	865	575	610				13.9	
	400			575	620				14.7	
	500			–	–				16.3	
600	350			620	655					10.4
	400	950	950	620	665					11.0
	500			670	705					12.3
	600			–	–					13.6

Other branch combinations possible.
Contact CPF Dualam Engineering for details.

DUALAM Metric DIN Standards

Reducing Adapters, Concentric to DIN 16 966, Part 5



L_1 overall length
L_2 Nozzle length
L_3 Cone length
s_4 min. GRP wall-thickness

Dimensions in mm

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 867: Reducing adapter			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10
Pipe dimensions see page_____

Application range –A– to DIN 16867 ≤50°C

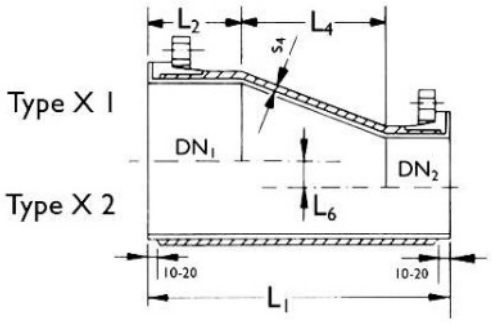
DN_1 → DN_2		L_1	L_2	L_3	wall-thickness s_5				
					PN 16	PN 10	PN 6	PN 4	PN2.5
32	25	180	85	20	2.9				
40	25	205	85	45	2.9				
	32	200	85	25	2.9				
50	25	235	85	80	2.9				
	32	230	85	60	2.9				
	40	205	85	35	2.9				
65	32	260	85	90		2.9			
	40	235	85	65		2.9			
	50	210	85	30		2.9			
80	40	275	85	105		2.9			
	50	245	85	70		2.9			
	65	210	85	40		2.9			
100	50	325	110	95		2.9			
	65	285	110	90		2.9			
	80	250	110	50		2.9			
125	65	350	110	130		2.9			
	80	310	110	90		2.9			
	100	285	110	40		2.9			
150	80	375	110	180		3.5			
	100	350	110	130		3.5			
	125	310	110	90		3.5			

DN_1 → DN_2		L_1	L_2	L_3	wall-thickness s_5				
					PN 16	PN 10	PN 6	PN 4	PN2.5
200	100	495	127	230			2.9		
	125	430	127	195			2.9		
	150	370	127	105			2.9		
250	125	575	143	320			3.3		
	150	510	143	230			3.3		
	200	400	143	130			3.3		
300	150	655	158	360			4.0		
	200	540	158	255			4.0		
	250	435	158	130			4.0		
350	200	665	150	400				3.3	
	250	550	150	270				3.3	
	300	440	150	140				3.3	
400	250	695	166	385				3.5	
	300	580	166	255				3.5	
	350	450	166	115				3.5	
500	300	865	191	515				4.1	
	350	730	191	375				4.1	
	400	615	191	255				4.1	
600	350	980	181	630					3.3
	400	865	181	515					3.3
	500	630	181	260					3.3

Other reducing combinations possible.
Contact CPF Dualam Engineering for details.

DUALAM Metric DIN Standards

Reducing Adapters, Eccentric to DIN 16 966, Part 5



L_1 overall length
L_2 Nozzle length
L_4 Cone length
L_6 offset
s_4 min. GRP wall-thickness

Dimensions in mm

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 967: Reducing adapter				
	-20°C to +50°C		>50°C to +80°C		
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10
Pipe dimensions see page_____

Application range –A– to DIN 16867 ≤50°C

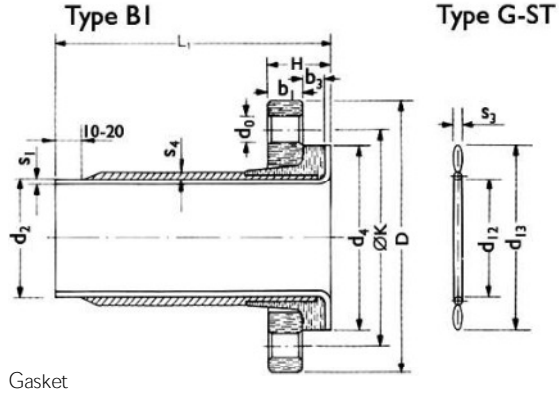
DN_1 → DN_2		L_1	L_2	L_4	L_6	wall-thickness s_5				
						PN 16	PN 10	PN 6	PN 4	PN2.5
32	25	180	85	20	4.0	2.9				
40	25	205	85	45	9.0	2.9				
	32	200	85	25	5.0	2.9				
50	25	235	85	80	15.5	3.3				
	32	230	85	60	11.5	3.3				
	40	205	85	35	6.5	3.3				
65	32	260	85	90	17.5		2.9			
	40	235	85	60	12.5		2.9			
	50	210	85	30	6.0		2.9			
80	40	275	85	100	20.0		3.2			
	50	245	85	65	13.5		3.2			
	65	210	85	40	7.5		3.2			
100	50	325	110	90	23.5		4.4			
	65	285	110	85	17.5		3.7			
	80	250	110	50	10.0		3.7			
125	65	350	110	125	25.0		4.0			
	80	310	110	85	17.5		4.0			
	100	285	110	40	7.5		4.0			
150	80	375	110	175	35.0		4.9			
	100	350	110	125	25.0		4.9			
	125	310	110	85	17.5		4.9			

DN_1 → DN_2		L_1	L_4	L_6	L_6	wall-thickness s_5				
						PN 16	PN 10	PN 6	PN 4	PN2.5
200	100	495	127	225	45.0			3.9		
	125	430	127	185	37.5			3.9		
	150	370	127	100	20.0			3.9		
250	125	575	143	310	62.5			4.7		
	150	510	143	225	45.0			4.7		
	200	400	143	130	25.0			4.7		
300	150	655	158	345	77.5			6.3		
	200	540	158	245	57.5			6.3		
	250	435	158	125	32.5			6.7		
350	200	665	150	385	77.5				4.5	
	250	550	150	260	52.5				4.5	
	300	440	150	135	20.0				3.7	
400	250	695	166	370	75.0				5.0	
	300	580	166	245	42.5				5.0	
	350	450	166	110	22.5				5.0	
500	300	865	191	495	92.5				5.6	
	350	730	191	360	72.5				6.0	
	400	615	191	245	50.0				6.0	
600	350	980	181	605	122.5					4.7
	400	865	181	495	100.0					4.7
	500	630	181	245	50.0					4.7

Further reducing combinations possible.
Contact CPF Dualam Engineering for details.

DUALAM Metric DIN Standards

Nozzle with Bonded Collar and Backing Flange to DIN 16 966, Part 6



Gasket
Shore-A hardness approx. 60° Dimensions in mm

L_1 overall length
d_2 liner o.d.
s_1 liner thickness
s_4 GRP wall-thickness

Sealing surfaces welded:
UPVC, PP,
ECTFE/MFA: ≥ DN 500
PVC-C: ≥ DN 400
PVDF: ≥ DN 200

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 967: Nozzle, flange			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10

Application range –A– to DIN 16867 ≤50°C

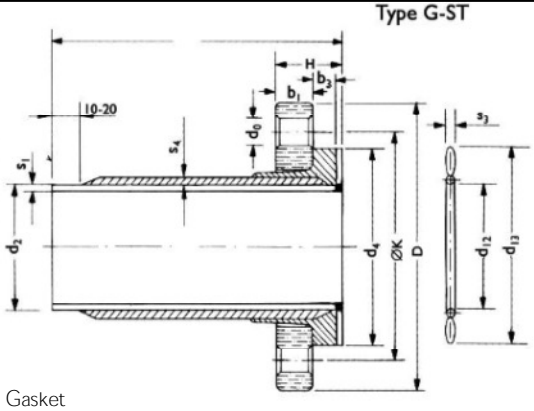
NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
	L_1	200	200	200	200	200	200	200	200	200	200	250	250	300	300	350	375
s_4 GRP PN 16/PN 10		2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.1	3.7	4.0	4.4	5.2	6.1
Liner	d_2	32	40	50	63	75	90	110	125	160	200	250	315	355	400	500	600
UPVC	s_1	3.6	4.5	3.7	4.7	3.6	4.3	5.3	3.7	4.7	4.0	4.9	6.2	7.1	5.0	4.0	5.0
PVC-C	s_1	2.4	3.0	3.7	4.7	3.6	4.3	5.3	–	7.7	4.0	4.9	6.2	–	3.2	5.6	–
PP	s_1	3.5	3.7	4.6	5.8	4.3	5.1	6.3	7.1	6.2	4.9	6.1	7.7	8.7	9.8	8.0	5.0[1]
ECTFE/MFA	s_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]
PVDF	s_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]
Collar PN 16	b_3 + 2.0	12	14	14	14												
PN 10	b_3 + 2.0					15	16	18	20	22							
PN 6	b_3 + 2.0										25	28	30				
PN 4	b_3 + 2.0													32	35	38	
PN 2.5	b_3 + 2.0																45
	d_4	68	78	88	102	122	138	158	188	212	268	320	370	430	482	585	685
Flange GRP	b_1	14	15	16	18	20	22	24	27	30	32	34	36	38	42	47	56
steel	b_1	–	–	–	–	–	–	–	–	–	20	22	26	28	32	38	36
	D	115	140	150	165	185	200	220	250	285	340	395	445	505	565	670	780
	Δ K	85	100	110	125	145	160	180	210	240	295	350	400	460	515	620	725
	d_0	14	18	18	18	18	18	18	18	22	22	22	22	22	26	26	30
Bolt	qty	4	4	4	4	4	8	8	8	8	8	12	12	16	16	20	20
	thread	M12	M16	M16	M16	M16	M16	M16	M16	M20	M20	M20	M20	M20	M24	M24	M27
Clamping length	H[4]	30	33	35	38	39	43	48	54	60	62	68	74	79	87	93	106
G-ST flange	d_{12}	35	43	49	61	77	90	115	141	169	220	274	325	368	420	520	620
gasket	d_{13}	70	82	92	107	127	142	162	192	218	273	330	378	438	490	595	695
	s_3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	7
Bolt tightening torques 4)	Nm	8	14	18	18	20	12	20	24	38	32	32	44	28	44	52	52

1) Stripwound pipe
2) Sheet material
3) Minimum quantity: 200 m / option: s = 5.0 mm (stripwound pipe)
4) GRP loose flange

DUALAM Metric DIN Standards

Connector with Integral Collar and Floating Flange to DIN 16 966, Part 6

Type G-ST



L_1 overall length
d_2 liner o.d.
s_1 liner thickness
s_4 GRP wall-thickness

Sealing surfaces welded

Gasket
Shore-A hardness approx. 60° Dimensions in mm

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 967: Nozzle, flange			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10

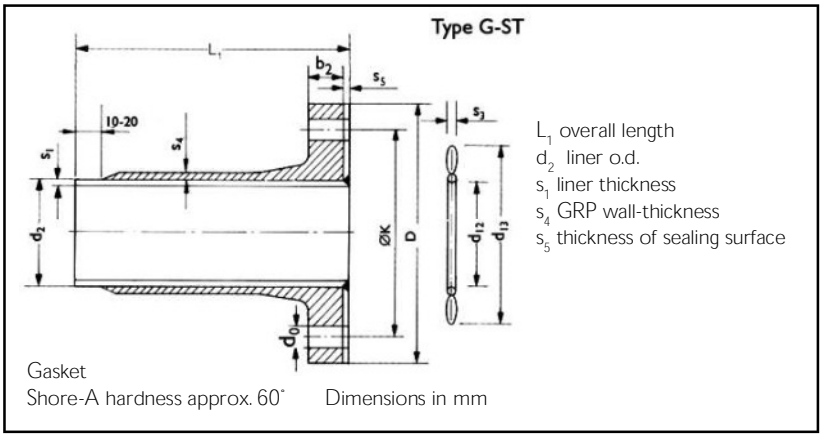
Application range –A– to DIN 16867 ≤50°C

NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
	L_1	200	200	200	200	200	200	200	200	200	200	250	250	300	300	350	375
s_4 GRP	PN 16	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9								
	PN 10									2.9	2.9						
	PN 6											2.9	2.9	2.9	3.1	3.6	4.1
Liner		Dimensions see page 34 (Nozzle with Bonded Collar)															
Collar	PN 16 b_3 + 2.0	12	14	14	14												
	PN 10 b_3 + 2.0					15	16	18	20	22							
	PN 6 b_3 + 2.0										25	28	30				
	PN 4 b_3 + 2.0													32	35	38	
	PN 2.5 b_3 + 2.0																45
	d_4	68	78	88	102	122	138	158	188	212	268	320	370	430	482	585	685
Flange GRP	b_1	14	15	16	18	20	22	24	27	30	32	34	36	38	42	47	56
steel	b_1	–	–	–	–	–	–	–	–	–	20	22	26	28	32	38	36
	D	115	140	150	165	185	200	220	250	285	340	395	445	505	565	670	780
	Δ K	85	100	110	125	145	160	180	210	240	295	350	400	460	515	620	725
	d_0	14	18	18	18	18	18	18	18	22	22	22	22	22	26	26	30
Bolt	qty	4	4	4	4	4	8	8	8	8	8	12	12	16	16	20	20
	thread	M12	M16	M16	M16	M16	M16	M16	M16	M20	M20	M20	M20	M20	M24	M24	M27
Clamping length	H[1])	30	33	35	38	39	43	48	54	60	62	68	74	79	87	93	106
G-ST flange	d_{12}	35	43	49	61	77	90	115	141	169	220	274	325	368	420	520	620
gasket	d_{13}	70	82	92	107	127	142	162	192	218	273	330	378	438	490	595	695
	s_3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	7
Bolt tightening																	
torques 1)	Nm	8	14	18	18	20	12	20	24	38	32	32	44	28	44	52	52

1) GRP loose flange

DUALAM Metric DIN Standards

Connector with Integral Fixed Flange to DIN 16 966, Part 6



L_1 overall length
d_2 liner o.d.
s_1 liner thickness
s_4 GRP wall-thickness
s_5 thickness of sealing surface

Gasket
Shore-A hardness approx. 60° Dimensions in mm

Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 867: Fixed flange			
	-20°C to +50°C		>50°C to +80°C	
16	A	16	B	10
10		10		6
6		6		4
4		4		2.5
2.5		2.5		1.6

*) Recommended loading for components installed in pipe systems = 70-95%
Flange connection measurements DIN 2501, PN 10

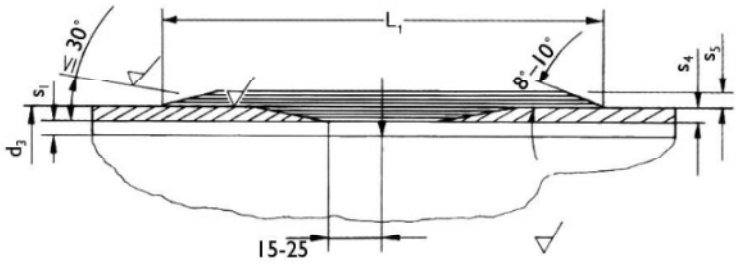
Application range –A– to DIN 16867 ≤50°C

NOM. DIA.		DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
		L_1	200	200	200	200	200	200	200	200	200	200	250	250	300	300	350	375
s_4 GRP		PN 16	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9								
		PN 10									2.9	2.9						
		PN 6											2.9	2.9	2.9	3.1	3.6	4.1
Liner		d_2	32	40	50	63	75	90	110	125	160	200	250	315	355	400	500	600
	UPVC	s_1	3.6	4.5	3.7	4.7	3.6	4.3	5.3	3.7	4.7	4.0	4.9	6.2	7.1	5.0	4.0	5.0
	PVC-C	s_1	2.4	3.0	3.7	4.7	3.6	4.3	5.3		7.7	4.0	4.9	6.2		3.2	5.6	
	PP	s_1	3.5	3.7	4.6	5.8	4.3	5.1	6.3	7.1	6.2	4.9	6.1	7.7	8.7	9.8	8.0	5.0[1]
	ECTFE/MFA	s_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]
	PVDF	s_1	2.4	2.4	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0[2]	3.0[2]	3.0[2]	3.0[2]	3.0[2]
		s_5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Flange	PN 16	b_2 + 2.0	14	15	16	18												
	PN 10	b_2 + 2.0					20	22	24	27	30							
	PN 6	b_2 + 2.0										33	37	42				
	PN 4	b_2 + 2.0													40	44	49	
	PN 2.5	b_2 + 2.0																49
		D	115	140	150	165	185	200	220	250	285	340	395	445	505	565	670	780
		Δ K	85	100	110	125	145	160	180	210	240	295	350	400	460	515	620	725
		d_0	14	18	18	18	18	18	18	18	22	22	22	22	22	26	26	30
Bolt		qty	4	4	4	4	4	8	8	8	8	8	12	12	16	16	20	20
		thread	M12	M16	M16	M16	M16	M16	M16	M16	M20	M20	M20	M20	M20	M24	M24	M27
G-ST flange		d_{12}	35	43	49	61	77	90	115	141	169	220	274	325	368	420	520	620
gasket		d_{13}	70	82	92	107	127	142	162	192	218	273	330	378	438	490	595	695
		s_3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	7
Bolt tightening torques [1]		Nm	8	14	18	18	20	12	20	24	38	32	32	44	28	44	52	52

1) Stripwound pipe
2) Sheet material
3) Minimum quantity: 200 m / option: s = 5.0 mm (stripwound pipe)

DUALAM Metric DIN Standards

Laminated Joints to DIN 16 966, Part 8



Dimensions in mm

L_1 covering laminate length
s_4 GRP pipe wall-thickness
s_5 covering laminate thickness
s_1 liner thickness

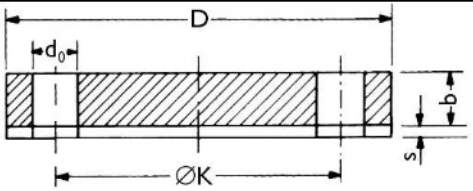
Nom. Pressure PN	Operating pressure (gauge)* to DIN 16 867:	
	-20°C to +50°C	>50°C to +80°C
16	A 16	B 10
10	A 10	B 6
6	A 6	B 4

*) Recommended loading for components installed in pipe systems = 70-95%
Pipe dimensions see page ––––––––

Application range –A– to DIN 16867 ≤50°C

NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
PN 16	L_1	110	110	110	110	110	120	140	175	210	280	345	415	460	550	685	745
	s_5	4	4	4	4	4	4	4.5	5.5	6.5	8.5	10.5	12.5	15	17	21	25
	s_4	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.2	3.7	4.4	5.3	5.8	6.4	7.8	9.1
PN 10	L_1									130	165	205	250	290	330	410	480
	s_5									4	5.5	6.5	8	9	10.5	13	15.5
	s_4									2.9	2.9	3.1	3.7	4.0	4.4	5.2	6.1
PN 6	L_1											125	150	170	200	240	290
	s_5											4	5	5.5	6.5	8	9.5
	s_4											2.9	2.9	2.9	3.1	3.6	4.1

Blank Flanges with Thermoplastic Lining



b GRP flange thickness
s lining thickness
g weight

Dimensions in mm

NOM. DIA.	DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500	600
	PN	16	16	16	16	10	10	10	10	10	6	6	6	4	4	4	2.5
s_4 GRP	b GRP	16	16	16	18	20	22	28	30	30	33	37	42	40	44	49	50
	b steel	DIN 2527 Type B									20	22	22	22	22	24	28
	s	thermoplastic thickness 4 mm min.															
Liner	D	115	140	150	165	185	200	220	250	285	340	395	445	505	565	670	780
Collar	Δ K	85	100	110	125	145	160	180	210	240	295	350	400	460	515	620	725
	d_0	14	18	18	18	18	18	18	18	22	22	22	22	22	26	26	30
	Quantity	4	4	4	4	4	8	8	8	8	8	12	12	16	16	20	20
	Thread	M12	M16	M16	M16	M16	M16	M16	M16	M20	M20	M20	M20	M20	M24	M24	M27
	g GRP	0.3	0.5	.06	0.7	0.9	1.1	1.9	2.7	3.4	5.0	7.5	10.8	13.2	18.2	28.5	39.5
	g steel										17	24	31	41	50	75	110

Blank steel flanges: Material No. 10110 (USt 37-1); Type B, DIN 2527
Flange connection measurements DIN 2501, PN 10

DUALAM JIS Standards (Japanese Industrial Standard)

10 Kg/cm² Full Face Flanges

NOMINAL I.D. (inch)	FLANGE O.D. (mm)	B.C.D. JIS (mm)	No. of Holes	Hole Dia. (mm)	Size of Bolt Nominal
1	125	90	4	19	m16
1 1/2	140	105	4	19	m16
2	155	120	4	19	m16
3	185	150	8	19	m16
4	210	175	8	19	m16
6	280	240	8	23	m16
8	330	290	12	23	m20
10	400	355	12	25	m22
12	445	400	16	25	m22
14	490	445	16	25	m22
16	560	510	16	27	m24
18	620	565	20	27	m24
20	675	620	20	27	m24
24	795	730	24	33	m30

Notes:

1) When the nominal size of bolt is under m16, the bolt hole shall conform to Class 3 in JIS B 1001.
2) The dimensional tolerance shall conform to JIS B 2203.

References to International Standards

1. DIN 16965 Part 2: Type B Pipes Dimensions
2. DIN 16964: General quality requirements and testing
3. DIN 53769 Part 1: Determination of the adhesive shear strength of Type B pipeline components
4. DIN 16966 Part 2, DIN 16966 Part 4, DIN 16966 Part 5
5. DIN 16966 Part 8: Laminated joints dimensions for Type B piping
6. BS 6464:1984 – British Standard specification for reinforced plastics pipes, fittings and joints for process plants
7. PRN 88: Swedish pressure piping code plastics
8. DIN 16962 Part 4–12: Polypropylene pipe and fittings, dimensions, fusion and general quality requirements
9. DIN 16963 Part 4–10: Polyethylene pipe and fittings, dimensions, fusion and general quality requirements
10. DVS 2207 Part 15: Heating element butt welding of PVDF and ECTFE pipe and fittings
11. CGSB 41–GP–22: Canadian Standard for: Process equipment; Reinforced polyester; Chemical resistant, custom contact moulded pipe and fittings (NBS PS–15–69 American equivalent)
12. ASME B 31.3–1996: Process piping, ASME Code for pressure piping, B 31
13. ASTM C1147–95: Standard practice for determining the short term tensile weld strength of chemical resistant thermoplastics
14. ANSI/AWS G1.10: 2000 – Guide for the evaluation of hot gas and heated tool thermoplastic welds
15. CEN 13067 STD: 2002 – European Committee for Standardization approval testing of welders for thermoplastic welded assemblies

Typical Physical Properties of Most Engineered Thermoplastics

		HDPE	PP		PVC	CPVC	PVDF		ECTFE	ETFE	FEP	TFE	PFA	MFA
			Homo-polymer	Copolymer (unfilled)			Homo-polymer	Copolymer (unfilled)						
Density	g/cm^3	0.95-0.97	0.91	0.88-0.91	1.38	1.5	1.75-1.79	1.76-1.79	1.68	1.70	2.12-2.17	2.2-2.3	2.12-2.17	2.12-2.17
Mechanical Properties														
Tensile Break Strength	MPa	22.1-31.1	31-41	27.6-38.0	41-52	47-62	31-48	24-41	46-54	45	19-21	14-19	28-31	24-30
ASTM D-638	Kpsi	3.2-4.5	4.5-6.0	4.0-5.5	6.0-7.5	—	4.5-7.0	3.5-6.0	6.6-7.8	6.5	2.7-3.1	2.0-2.7	4.0-4.5	3.5-4.4
Tensile Modulus	MPa	1070-1090	1139-1553	897-1242	2415-4140	2353-3278	1380-5520	—	1656	828	345	400-552	483	689
ASTM D-638	Kpsi	155-158	165-225	130-180	350-600	341-475	200-800	—	240	120	50	58-80	78	100
Elongation ASTM D-638	%	10-1200	100-600	200-500	40-80	4-100	12-600	—	200-300	100-400	250-330	200-400	300	300-360
Yield Strength	MPa	26.2-33.1	31-37	20.7-29.7	41-45	41-55	20-57	20-38	31-34	49	—	12	14	—
ASTM D-638	Kpsi	3.8-4.8	4.5-5.4	3.0-4.3	5.9-6.5	6-8	2.9-8.3	2.9-5.5	4.5-4.9	7.1	—	1.7	2.1	—
Thermal Properties														
HDT at 0.46 Mpa	C	79-91	107-121	54-60	57	102-119	132-150	93-110	90	104	70	221	75	62
(66psi) ASTM D-648	F	175-196	225-250	130-140	158	215-247	270-300	200-230	194	220	158	250	166	145
Linear Coefficient of Expansion	per °C x 10^{-5}	10.6-19.8	14.6-18.0	12.2-17.1	5.0-10.0	11.2-14.0	12.6-25.6	—	14.4	10.6	8-11	12.6-22	25-38	12-20
ASTM D-696	per °F x 10^{-5}	5.9-11.0	8.1-10	6.8-9.5	2.7-5.6	6.2-7.8	7.0-14.2	—	8.0	5.9	—	2.0-12	14-21	7-11
Thermal Conductivity	W/m K	0.39-0.43	0.1	0.16	0.16-0.18	0.12	0.09-0.11	0.16	0.14	0.20	0.21	0.21	0.21	0.20
ASTM C-177	BTU/ft^2 - hr - F/in	76-83	0.7	1.1	1.1-1.23	0.81	0.59-0.76	1.11	0.97	1.40	1.48	1.48	1.48	1.48

Notes:

Properties are at room temperature unless otherwise stated. Properties are typical values and are not to be used for design purposes.

This pipe installation manual describes the general requirements for shipping and handling of dual laminate piping. It provides general guidlines for installation of piping on-site and joining methods. All infomation provided is subject to change without notice. CPF Dualam should be contacted for specific applications and recommendations.

Storage and Handling of Dual Laminate Piping

Dual laminate piping requires special storage and handling. At the locations where a pipe or spool rest on a truck bed or ground, the pipe should be wrapped with foam to avoid damage. A board of 2 4" should also be placed approximately every five feet under each layer of pipe to support and evenly distribute the load. The pipe should also be braced on either side or strapped to the wood bracing to prevent unnecessary pipe movement.

Avoid placing CPF Dualam pipe or spools on sharp edges, narrow supports or other objects which can cause damage to the pipe wall. Where possible, the pipe or spool should be left in the original shipping container until ready for use.

CPF Dualam Inc. takes precautions to prevent damage when shipping or moving spools, but damage can occur when the piping is dropped. The piping should never be thrown or dropped and must be protected from all types of impact.

All flanges and openings should be covered with corrugated plastic or hardboard to prevent damage or debris from entering the pipe if it is not shipped in a closed container.

Upon receiving, perform a visual inspection of all parts for shipping damage, especially flange faces and pipe ends. Possible evidence of shipping damage are scuff marks on the outside which can result in damage of the thermoplastic liner.

When storing piping prior to installation. All parts should be kept in a dry place and a controlled temperature.

For small diameter piping from 1" to 12", a minimal amount of equipment is required for handling due to the light weight of the piping. If the piping is more than 20 feet, use at least two support points.

For large diameter piping from 12" to 48", piping should be lifted with wide fabric straps or belts. Do not allow chains or cables to contact the pipe during shipping and handling.

Extra care must be taken when transporting piping in cold weather, since the thermoplastic liner can become more brittle and sensitive to mechanical shock as temperatures decrease. Avoid moving or storing dual laminate piping below the following temperatures:

PIPE SYSTEM	MATERIAL	TEMPERATURE (°F)	TEMPERATURE (°C)
Chlorolam-Class P	PVC/FRP	14°F	-10°C
Chlorolam-Class C	CPVC/FRP	14°F	-10°C
Fluorolam - F	FEP/FRP	-4°F	-20°C
Polylam-Class PE	PE/FRP	-40°F	-40°C
Polylam-Class PP	PP/FRP	-40°F	-40°C
Fluororolam-Class PV	PVDF/FRP	32°F	0°C
Fluororolam-Class E	ECTFE/FRP	-4°F	-20°C
Fluororolam-Class M	MFA/FRP	-4°F	-20°C

When transporting of CPF Dualam piping in cold weather is required and falls below the temperatures listed above for the appropriate material, it should be in an enclosed and heated van or truck.

Pipe Supports and Hangars

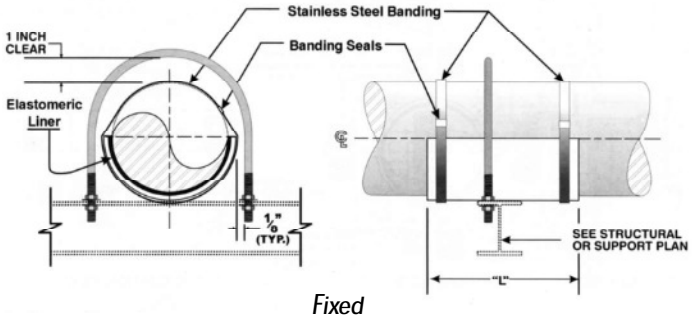
Fabricated steel hangars, supports and anchors should be manufactured to fit the outside of the dual laminate piping being used. It is usually necessary to fabricate custom standard hangars and supports, and anchors. CPF Dualam recommends that all hangars and supports be lined with an elastomeric pad (Shore 'A' hardness 50 - 70) to conform to any surface irregularities and to provide uniform bearing support.

All installations of CPF Dualam piping should be reviewed for proper locations and fit of all supports, hangars and anchors. Contact CPF Dualam's Engineering department for the outside diameter of the piping and design information that is required for your application.

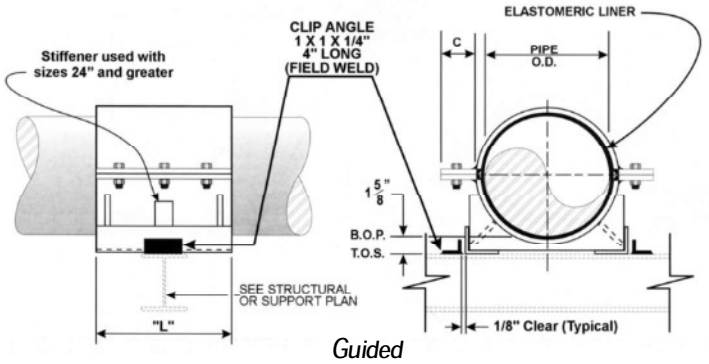
CPF Dualam can also supply all types of hangars, supports, anchors and clamps for your dual laminate piping system. These are available in a wide variety of materials and painted or galvanized to meet the project specifications.

Pipe Saddle Supports

Pipe support saddles may be either fixed or guided as required for the piping system design. Piping saddles usually consist of two 180° halves with the fixed saddles bolted to the supporting steel, while the guide supports allow for axial or lateral movement due to thermal expansion.



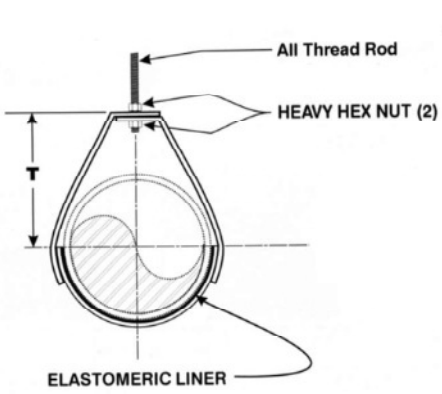
Fixed

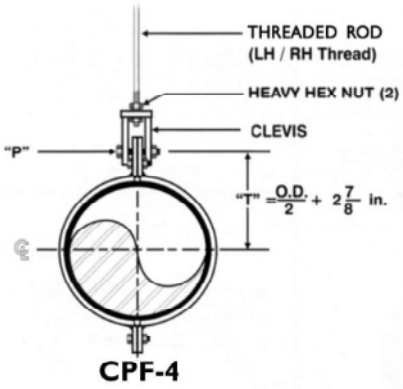


Guided

Pipe Hangers

Pipe hangers are usually available in several basic configurations such as a sling, clamp or clevis hanger. These hangars only guide the pipe, they do not restrain axial or lateral movement.





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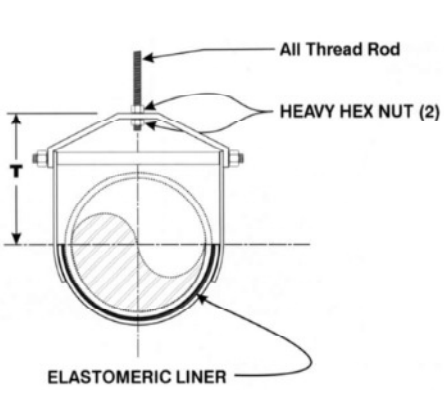
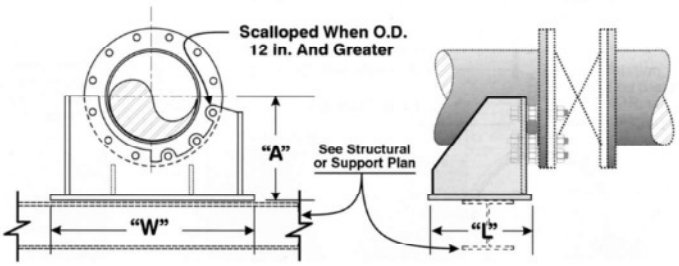


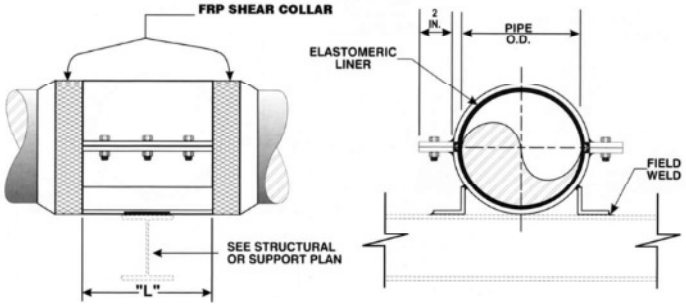
Pipe Anchors

Pipe anchors restrain the movement of pipe against thrust loads and thermal expansion. Thrust collars are laminated to the dual laminate pipe on either side of the anchor support to restrain movement of the pipe. Ideally, the collars are installed in the shop to minimize cost when the collar location is known, but they can also be installed in the field.



Valves and Flanged Component Supports

Valves and any flanged components that are used in dual laminate piping should be independently supported to prevent overstressing of the pipe or fitting. A common method is to use a flange hanger or support.



Typical Inspection, Handling and Shipping, and Pipe Support Spacing

1. Inspection

1. Prior to any fabrication, all thermoplastic liners/pipe are fully inspected for total integrity. No cracks, pinholes occlusions etc. are permitted.
2. Fabricated fittings are electrostatically tested to max. 15,000 volts for integrity.
3. Fiberglass outer reinforcement is checked for flaws, colour mismatch and for total curing of the resin used.

2. Handling and Shipping

The gasket face of each spool or fitting shall be protected by end plates or other suitable protective means.
All spools and fittings shall be suitably packed to provide necessary protection during handling, shipping and storage.

3. Pipe Support Spacing

Recommended support spacing for filament wound pressure pipe is shown in the table below. Table is based on the following assumptions:

Contact CPF Dualam for support width design.
Simple support conditions
180° F maximum temperature
Maximum deflection = span/360
Wind and seismic effects are not considered.

Specific gravity of contents, 1.2

Sp. Gr.	Multiplier
1.0	1.10
1.2	1.00
1.4	0.93
1.6	0.87
1.8	0.81

FILAMENT WOUND DUAL LAMINATE PRESSURE PIPE

DIA.	FRP WALL THICKNESS 0.20	0.25	0.30	0.36	0.41	0.46	0.51	0.56	0.62	0.67	0.72
2	8.0	8.5	9.0	9.5							
3	9.5	10.0	11.0	11.5							
4	10.0	11.0	12.0	12.5	13.0						
6	10.5	11.5	12.5	13.5	14.5						
8	10.5	11.5	13.0	14.0	15.0	15.5					
10	10.5	12.0	13.0	14.0	15.0	16.0	17.0				
12	10.5	12.0	13.0	14.5	15.5	16.0	17.0				
14	10.5	12.0	13.0	14.5	15.5	16.5	17.0	18.0			
16	10.5	12.0	13.0	14.5	15.5	16.5	17.5	18.0	19.0		
18	10.5	12.0	13.5	14.5	15.5	16.5	17.5	18.0	19.0	20.0	
20	11.0	12.0	13.5	14.5	16.0	16.5	17.5	18.5	19.5	20.0	21.0
24	9.5	12.5	13.5	15.0	16.0	17.0	17.5	18.5	19.5	20.0	21.0

Dia. and thicknesses are in inches. Span is in feet.

CONTACT MOLDED DUAL LAMINATE PRESSURE PIPE

DIA.	FRP WALL THICKNESS 0.18	0.25	0.29	0.37	0.41	0.49	0.56	0.64	0.68	0.76	0.80	.88	.95	1.00	1.10
2	7.0	9.0	9.5	11.0											
3	8.0	10.5	11.0	12.5											
4	8.0	11.5	12.5	14.0	14.5										
6	8.5	12.0	13.0	15.5	16.0	17.5									
8	8.5	12.0	13.0	16.0	16.5	18.0									
10	8.5	12.0	13.0	16.0	17.0	18.0	19.5								
12	9.0	12.0	13.5	16.0	17.0	18.5	19.5	20.0							
14	9.0	12.0	13.5	16.0	17.0	18.5	19.5	21.0	21.5						
16	9.0	12.0	13.5	16.0	17.0	18.5	20.0	21.0	21.5	23.0	23.0				
18	8.0	12.0	13.5	16.5	17.0	18.5	20.0	21.0	22.0	23.0	23.5	24.0			
20		10.0	13.0	16.5	17.0	19.0	20.0	21.0	22.0	23.0	23.5	24.0	25.5	26.0	
24		8.5	11.0	15.0	17.0	19.0	20.0	21.5	22.0	23.0	25.0	25.0	26.0	27.5	29.0

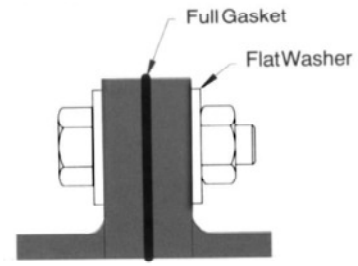
Dia. and thicknesses are in inches. Span is in feet.

Flanged Connections

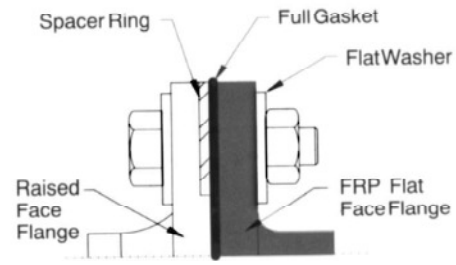
Pipe flanges are available in two styles, flat face or stub ends with backing flanges. Whichever style is used, the proper installation of he flange is critical to a leak free installation of the piping system. Flat face flanges MUST be bolted to a companion flat face flange with a full face gasket. If a dual laminate flat face flange must be connected to a raised face flange of a different material, a spacer ring must be added to provide an even distribution of the stresses on the full face flanges. Cracking of the flat face flange can occur if a spacer ring is not used.

Stub ends with backing flanges can be bolted directly to a raised face flange; however, they cannot be bolted to a flat face flange. Ring gaskets should be used with dual laminate stub ends.

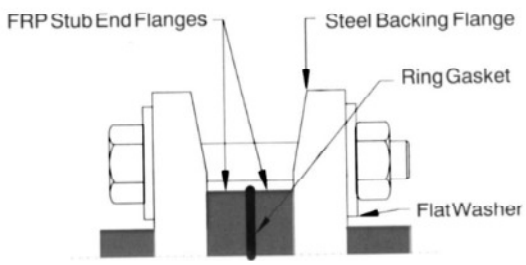
Flat Face Flange Connection



Raised Face to Flat Face Flange Connection



Stub Ends with Backing Flanges

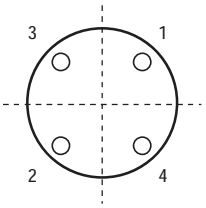


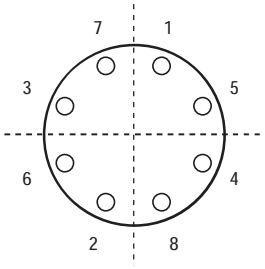
Proper gasket selection is crucial to a leak free installation of a flanged dual laminate piping system. The gasket type should have a Shore A durometer of 50–65 with a minimum thickness of 1/8 inch. The use of gaskets higher than a shore A durometer of 65 required higher bolt torques to seal the flange and can result in cracking of the flange. Typical gasket materials include neoprene, EPDM, EPDM Peroxide Cure, red rubber, Viton, and PTFE.

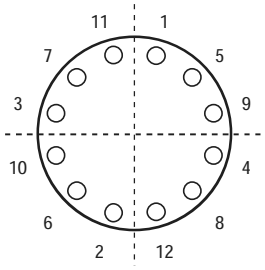
All bolts should be properly tightened in a criss cross fashion using thread lubricant, except Teflon coated bolts. Plain washers of ANSI Type B should be used with dual laminate flanges.

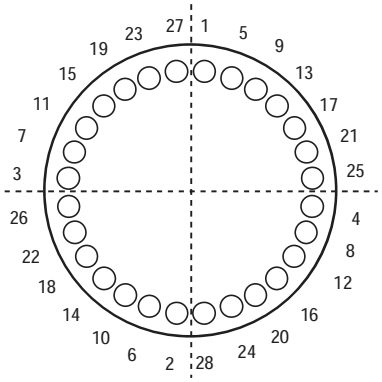
Bolts should be tightened to 50% of the required bolt torque, and retightened in the same criss cross fashion until a required torque is achieved. For low pressure applications, the sealing torque can be less than the published maximum bolt torque.

Bolt Tightening Sequence









Maximum Bolt Torque - Dual Laminate Flanges*

FOOT POUNDS OF TORQUE

NOMINAL	INTERNAL PIPE PRESSURE RATING, PSIG, STANDARD					
DIAMETER	25	50	75	100	125	150
1"	15	15	15	15	15	15
1 1/2"	15	15	15	15	15	15
2"	25	25	25	25	25	25
3"	25	25	25	25	25	25
4"	25	25	25	30	30	30
6"	30	30	30	30	30	40
8"	30	30	35	40	40	40
10"	30	30	35	40	40	40
12"	30	30	40	40	40	45
14"	35	35	40	50	50	50
16"	35	35	40	50	50	50
18"	35	35	40	50	50	50
20"	35	35	40	50	60	60
24"	45	45	45	60	65	65

** The indicated bolt torque is required to seat gaskets of 65 durometer on full face flanges, based on a nut factor K=0.2.*

Torque of Bolts

A. Grease all bolts and nuts with a suitable grease, finger tighten all nuts.
B. With torque wrench, using a crisscross method, tighten each bolt until the torque for each bolt falls within the range listed above.
C. After 24-30 hours or a temperature cycle or a pressure cycle, torque for each bolt shall be checked and those below the minimum are to be re-torqued to the range listed above.

Auxiliary neoprene gaskets and spacers must be used when flanging dual laminates of dissimilar material. Recommended gaskets to be 55 – 70 durometer.

Type A Narrow SAE washers shall be used on all flanged fittings.

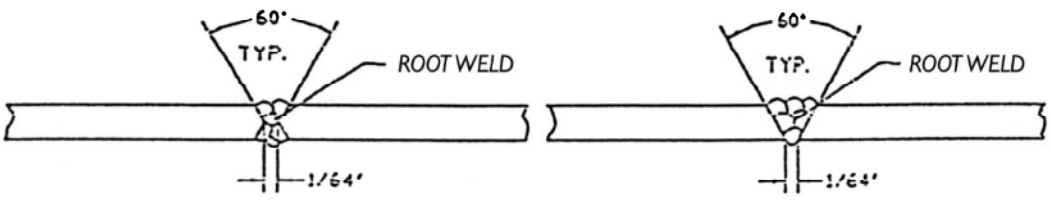
Butt Joints

Butt joints should only be performed by trained personnel meeting CPF Dualam's requirements. A dual laminate butt and strap joint can be performed using a butt fusion machine or hot gas hand welding for the joining of the thermoplastic liner. The structural fiberglass layer is applied similar to a standard fiberglass pipe after the thermoplastic liner is spark tested where accessible.

Before any fusing or welding of pipe ends can be performed, preparation of the ends to remove any impurities, grit, and dirt must be performed.

A butt joint performed with a butt fusion machine achieves the most reliable and consistent joint in the field. This is because the temperature and pressure at which the joint is fused is carefully regulated. However, the operation of the butt fusion machine must be by trained personnel and to up to date standards DIN 16962, DUS 2207 Part 15.

An alternative to butt fusion is hot gas hand welding. The disadvantage of hot gas hand welding is that it relies much more on the personnel performing the welding. A hand weld is performed with a hot air welding gun with a welding rod. A typical hand weld profile is a 'V' groove butt weld. The two pipe ends are tacked welded in place to the proper position and then a root bead pass is performed on the entire butt joint. The root bead is allowed to complete cool, and then subsequent weld passes are performed until the recommended number of welds is completed for the particular thermoplastic lining. For fluoropolymer liners, nitrogen gas should be used for hot gas welding since the heated fluoropolymer reacts with air and inhibits a proper weld. A diagram of a typical 'V' weld is shown below.



For all thermoplastic welding, it is very important that the personnel know the welding characteristics of the material since the welding temperature and safety requirements vary with each material. Extreme care must be taken when welding fluoropolymer liners such as ECTFE, MFA, PTFE, ETFE, FEP, PFA because toxic fumes are released when these materials are welded.

Before the structural fiberglass joint layer is applied, the thermoplastic weld should be spark tested where possible. This is done by inserting a wand with steel wool on the end or conductive blanketing material down the pipe to the location of the field weld. With the conductive material in place on the inside of the pipe, a spark tester is run along the weld from the outside and any pinholes in the weld result in electrical spark. If this occurs, the joint need to be re-welded and re-tested.

When the welding is complete, depending on the material, the thermoplastic liner in the vicinity of the weld should be stress relieved. This can be done by wrapping an electrical thermal blanket around the pipe and stress relieving the weld at the appropriate temperature as recommended by the thermoplastic manufacturer or CPF Dualam.

After the welding is finished, tested and stress relieved as necessary, the liner needs to be prepared for fiberglassing. For materials such as PVC and CPVC that do not have a fabric or glass backing, the thermoplastic lining needs to be coated with a bonding resin (Ashland M7392). The resin is let cure and the structural fiberglass can be applied.

A fiberglass field joint kit will include glass reinforcing material, laminating resin, surfacing resin, and catalyst (MEKP – Lupersol DDM-9 or BPO). If the resin is not promoted, an accelerator (DMA) and promoter (6% Cobalt Napthanate) will also be required. The glass material should be pre-cut and the glass wet out with resin on a flat surface overlaid with cardboard. Make sure the field wrap areas do not have any surface coating that will prevent improper bonding of the joint before applying the fiberglass material. After the reinforcing material has been properly applied, let the laminate cure and cool, and then apply the surface coat which should contain UV inhibitors and paraffinated wax. A typical diagram of a dual laminate butt and strap joint is shown on back page.

Wherever possible, the field wraps should be performed in a controlled environment with the temperature and humidity remaining as constant as possible. The ideal conditions are between 15 to 20°C (60°F to 68°F) and a relative humidity of less than 60%.

All personnel performing the field wraps should read and understand the Material Safety Data Sheets prior to working with these materials.

CPF Dualam Inc. can supply all materials for purchase; butt fusion machines or hot gas welding equipment for rental or purchase; and personnel for installation. CPF Dualam can also train people for welding CPF Dualam piping products.

Heat Tracing

Depending on the location of the dual laminate piping, it may be necessary to protect the piping with heat tracing. This is particularly important for piping located outdoors which is subject to freezing or temperatures which are below the cold brittle temperature of the thermoplastic. When installing heat tracing with insulation there are several important things to remember.

a) Use an electrical tape system that is self-regulating.
b) The maximum temperature capability of the heat tracing should not be greater than the maximum temperature rating of the pipe.
c) The average pipe wall temperature must not exceed the temperature rating of the pipe.
d) The insulation, usually 2 to 3 inches thick should be properly installed to reduce heat loss.
e) Heat tracing should not be applied only down one side of the pipe, since this causes uneven heating and differential stress leading to bowing of the pipe. The heat tracing should be spiral wrapped or run in two parallel lines down opposite sides of the pipe.

Hydrostatic Field Testing

Hydrostatic testing may be accomplished either at the shop or in the field after the entire piping system has been installed. Do not hydrostatic test the piping until all anchors and supports are in place. Do not use pressurized gas to perform a pressure test.

CPF Dualam will be notified before any pressure tests are performed. The recommended test pressure varies since CPF Dualam custom designs its piping systems for individual projects. Typically, the test pressure should be between 125% and 150% of the internal design pressure.

When testing the piping, the line must be filled with water such that all air is vented prior to pressurization. Limit the initial pressure to 50% of the design pressure for approximately 10 minutes to seal all flanged gasket joints. Gradually increase the pressure to the specified test pressure and then blank off and observe the line for approximately 30 minutes. After 30 minutes, the line pressure should not have dropped by more than 5 psig and no significant leakage should have occurred.

After completing the pressure test, empty the line and thoroughly inspect the piping.

The above test procedure is NOT recommended for vent or gas lines.