

| PRODUCT AND MATERIAL SPECIFICATIONS | | |
|---|-------------------------------------|----------------|
| DATE OF PRINT JANUARY 3, 2005 | NON METALLIC RESOURCES, INC. | PAGE 1 of 5 |
| PP/AR® SEAMLESS PE and PP/FRP DUAL LAMINATE PIPE AND FITTINGS | | |

1. SCOPE

- 1.1 This specification provides design information applicable to patented NMR PP/AR and PE/AR (seamless dual laminate) piping products. These products include pipe spools, fittings, and fabrications.
- 1.2 This specification covers products with 150# flange drilling per ANSI 16.5 which are suitable for 150 PSI continuous service.
- 1.3 Flanged fittings are to ANSI 16.1 dimensions.
- 1.4 Products covered by this specification are suitable for continuous service temperatures to +212°F. (100°C) for PP/AR and 180°F (83°C) for PE/AR, unless otherwise specified.
- 1.5 Because of seamless, bonded liner construction these products can be designed for full vacuum service.

2. MATERIALS

- 2.1 Liner: PP (PE) liners are SEAMLESS. Only virgin PP (PE) is used in the extrusion of liners. This resin meets the requirements of ASTM D-1784 and may include less than 1% inorganic pigment for identification. A partial list of the physical properties is below:

| PROPERTY | PP VALUE | PE VALUE | TEST |
|------------------------|-----------|----------|------------|
| Specific Gravity | .90 - .91 | .955 | ASTM D-792 |
| Tensile Strength (PSI) | 4,500 | 3,500 | ASTM D-638 |

- 2.2 Bonding Layer: Using a patented process, woven or knit fiberglass cloth is melt bonded and partially mechanically embedded into the O.D. surface of the PP (PE) liner. Bond strength between the PP (PE) and glass:
 - a. Peel strength 25 PLI minimum.
 - b. Laminar Shear per ASTM D-2733-70 Method B Mod. PP (PE) material surface yields before bond between liner and casing reaches failure (1500 PSI minimum).
- 2.3 Outer Casing: The PP (PE) bonding layer composite is reinforced by hand lay-up or filament wound 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 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

- 3.1 Dimensional drawings included in paragraph 8 of this specification pertain to products listed in paragraph 1.
- 3.2 Flanges for pipe spools and fittings shall have bolt circle diameters, hole diameter and number of bolt holes in accordance with ANSI 16.5, unless otherwise specified.
- 3.3 Fittings shall have standard face to centerline dimensions for 150# ANSI 16.1, unless otherwise specified.

POLYPROPYLENE AND POLYETHYLENE
 SEAMLESS PE & PP/FRP DUAL LAMINATE PIPE AND FITTINGS

3.4 Pipe and fittings fabrication tolerances are as follows:

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

4. APPLICATION AND OPERATIONAL PARAMETERS

4.1 Temperature Range: PP/AR (PE/AR) is suitable for continuous operation to +212°F. (PE 180°F), unless otherwise specified.

4.2 Pressure Range: PP/AR (PE/AR) is suitable for continuous operation from full vacuum service to 150 PSI.

4.3 Thermal expansion and contraction of the PP/AR (PE/AR) systems is 1.7×10^{-5} in/in/°F.

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

- Mineral acids
- Alkalies
- Salt solutions
- Alcohols

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

4.5 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.

4.6 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/AR (PE/AR)'s vinyl ester casing material, no weep holes are required.

4.7 Heat Tracing: Heat tracing can be provided between structural casing and an exterior FRP casing taking advantage of the vinyl ester fiberglass casing's inherent insulating properties. Contact factory for details.

4.8 Insulation Qualities of Casing Material: fiberglass construction yields a heat conduction factor of $K=1.5 \text{ Btu/FT}^2/\text{hr}/^\circ\text{F}/\text{in}$. Check dimensional data for casing thickness.

POLYPROPYLENE AND POLYETHYLENE
SEAMLESS PE & PP/FRP DUAL LAMINATE PIPE AND FITTINGS

5. INSPECTION

- 5.1 All extruded liners are inspected prior to fabrication for pinholes, cracks, gouges, nicks or inclusion of foreign particles.
- 5.2 Completed fittings shall be subject to a 10,000 volt non-destructive electrostatic test to detect pinholes in the fittings which is cause for rejection. This test to be performed by factory only with properly controlled voltage and procedures.

6. HANDLING AND SHIPPING

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

7. INSTALLATION AND ASSEMBLY DATA

- 7.1 Supports: Hangers and supports may be ordered from NMR or supplied by customer. Supports should have a 1/8" thick rubber liner. Verify actual pipe outside diameter before ordering supports. See attached STD-300.

- 7.2 Support spacing:

MAXIMUM PIPE SUPPORT SPACING IN FEET AT PRESSURE RATING (PSI) PIPE SIZE

| PIPE SIZE | 25 | 50 | 75 | 100 | 125 | 150 |
|--------------|------|------|------|------|------|------|
| 1-1/2" | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 2" | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| 3" | 6.5 | 6.5 | 6.5 | 6.5 | 8.0 | 8.0 |
| 4" | 7.0 | 7.0 | 7.0 | 8.5 | 8.5 | 8.5 |
| 6" | 8.0 | 8.0 | 9.0 | 9.0 | 10.0 | 10.5 |
| 8" | 8.5 | 10.0 | 10.0 | 10.5 | 11.0 | 11.5 |
| 10" | 9.5 | 10.5 | 11.5 | 12.0 | 12.5 | 13.0 |
| 12" | 10.0 | 11.5 | 12.5 | 13.0 | 13.5 | 14.0 |

** Pipe Support spacing based on design conditions and can vary per service index

- 7.3 Assembly Bolt Torque

MAXIMUM BOLT TORQUE- FIBERGLASS FLANGES* -FOOT POUNDS OF TORQUE
INTERNAL PIPE PRESSURE RATING, PSIG, STANDARD

| PIPE SIZE | 25 | 50 | 75 | 100 | 125 | 150 |
|--------------|----|----|----|-----|-----|-----|
| 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 | 25 | 25 | 25 |
| 6" | 25 | 25 | 25 | 25 | 25 | 40 |
| 8" | 25 | 25 | 30 | 40 | 50 | 60 |
| 10" | 25 | 25 | 30 | 40 | 50 | 70 |
| 12" | 25 | 25 | 35 | 45 | 60 | 80 |

*The indicated bolt torque is required to seat gaskets of 70 durometer on full face flanges.

POLYPROPYLENE AND POLYETHYLENE
SEAMLESS PE & PP/FRP DUAL LAMINATE PIPE AND FITTINGS

7.4 Torquing of Bolts

- A. Grease all bolts and nuts with a suitable grease, finger tighten all nuts.
- B. With torque wrench, using a criss-cross method, tighten each bolt until 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.

7.5 GASKETS MUST BE USED IN NMR'S PP/AR (PE/AR) PIPING SYSTEM. Recommended gaskets are elastomeric materials of 55-70 durometer suitable for the intended chemical service.

7.6 Small SAE washers shall be used on all flanged fittings.

7.7 PP/AR (PE/AR) Installation Procedures

- A. Select gasket material of correct durometer and thickness (see 7.6).
- B. Use small SAE washers on all PP/AR (PE/AR) flanges.
- C. Lubricate all bolts before tightening.
- D. Tighten all bolts using criss-cross bolting method.
- E. Using a torque wrench, tighten bolts to bolt torques specified in section 7.3 of PP/AR (PE/AR) specification*.
- F. 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.

8. DIMENSIONAL DRAWINGS (ATTACHMENTS)

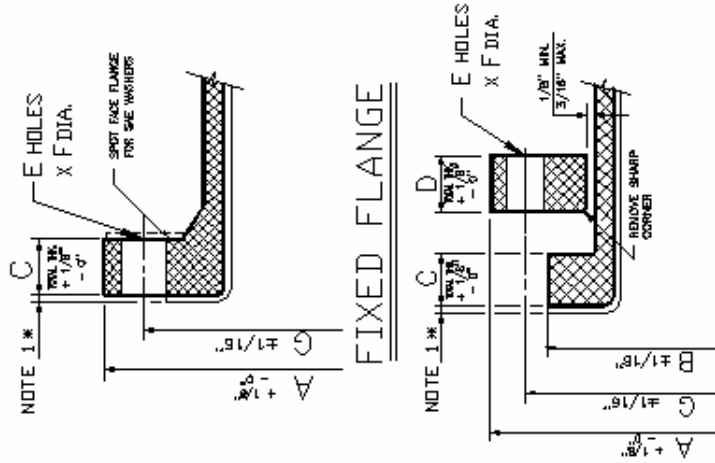
8.1 All dimensional drawings included in this paragraph are suitable for use in design pipe systems. Tolerances in paragraph 3.4 should be considered in design.

8.2 Non-Standard items will require customer approved prints prior to fabrication.

8.3 Dimensional drawings of standard PP/AR (PE/AR) products:

- SPEC-400 Piping Specification
- STD-101 Flange Dimensions
- STD-400 Pipe Dimensions, Pipe and Fitting Weights 1 1/2" - 12"
- STD-401 Fitting Dimensions
- STD-403 Pipe Dimensions, Pipe and Fitting Weights 14" - 24"
- STD-404 Fitting Dimensions 14" - 24"

POLYPROPYLENE AND POLYETHYLENE
SEAMLESS PE & PP/FRP DUAL LAMINATE PIPE AND FITTINGS




| NOM. SIZE | A O.D. FLANGE | B O.D. STUB END | C FLG./STUB THK. | D LAP JT. THK. | E NO. HOLES | F HOLE SIZE | G BOLT CIRCLE | BOLT SIZE SEE NOTE 1 * |
|-----------|---------------|-----------------|------------------|----------------|-------------|-------------|---------------|------------------------|
| 1 | 4 1/4 | 2 1/2 | 1 | 1 | 4 | 5/8 | 3 1/8 | 1/2 X 3 |
| 1 1/2 | 5 | 3 1/4 | 1 | 1 | 4 | 5/8 | 3 7/8 | 1/2 X 3 |
| 2 | 6 | 4 | 1 1/8 | 1 1/4 | 4 | 3/4 | 4 3/4 | 5/8 X 3 1/2 |
| 3 | 7 1/2 | 5 1/4 | 1 1/8 | 1 1/4 | 4 | 3/4 | 6 | 5/8 X 3 1/2 |
| 4 | 9 | 6 3/4 | 1 1/4 | 1 3/8 | 8 | 3/4 | 7 1/2 | 5/8 X 3 3/4 |
| 6 | 11 | 8 5/8 | 1 1/2 | 1 3/4 | 8 | 7/8 | 8 1/2 | 3/4 X 4 1/4 |
| 8 | 13 1/2 | 10 7/8 | 1 3/4 | 2 | 8 | 7/8 | 11 3/4 | 3/4 X 4 3/4 |
| 10 | 16 | 13 1/4 | 1 3/4 | 2 | 12 | 1 | 14 1/4 | 7/8 X 5 |
| 12 | 18 | 16 | 2 | 2 1/4 | 12 | 1 | 17 | 7/8 X 5 1/2 |
| 14 | 21 | 17 5/8 | 2 | 2 1/4 | 12 | 1 1/8 | 18 3/4 | 1 X 5 1/2 |
| 16 | 23 1/2 | 20 1/8 | 2 1/8 | 2 3/8 | 16 | 1 1/8 | 21 1/4 | 1 X 5 3/4 |
| 18 | 25 | 21 1/2 | 2 1/4 | 2 1/2 | 16 | 1 1/4 | 22 3/4 | 1 1/8 X 6 1/4 |
| 20 | 27 1/2 | 23 3/4 | 2 1/2 | 2 3/4 | 20 | 1 1/4 | 25 | 1 1/8 X 6 3/4 |
| 24 | 32 | 28 1/8 | 2 5/8 | 2 7/8 | 20 | 1 3/8 | 29 1/2 | 1 1/4 X 7 |

** FLANGE PRESSURE RATING: 150 PSI THRU 12"
100 PSI 14" - 24"

N O T E S

- FOR ALL PP/AR AND PE/AR ADD APPROPRIATE LINER THICKNESS (NMR STD-200/205) TO GET BOLT LENGTHS. *THICKNESS MAY VARY.
- FLARED POLYPROPYLENE AND POLYETHYLENE LINERS MAY NOT SEAT TO FACE OF FLANGE UNTIL BOLT UP.
- FOR BOLT LENGTHS WHEN USING LAP JOINT FLANGES, ADD LAP JOINT FLANGE THICKNESS TO LENGTH SHOWN.

LAP JOINT FLANGE

| | |
|--|--------------------------------|
|  engineered thermoplastics NMR METALLIC RESOURCES INC. MOBILE, ALABAMA | |
| IRAVN JES | STANDARD |
| DATE: 4-90 | FLANGE DIMENSIONS |
| CHK'D | JOB NO. P.D. NO. DWG. NO. REV. |
| DATE | STANDARD |
| SCALE | STD-10LP |
| NONE | 1 |

| NO | DATE | BY | DESCRIPTION | CRD |
|-----------|---------|-----|----------------|-----|
| 1 | 15-8-81 | BLS | GENERAL UPDATE | |
| REVISIONS | | | | |