

Applications

- Chemical Processing Liquids
- Food Processing Liquids
- Potable Water
- Cooling Water
- Condensate Return
- Industrial Wastewater
- Mildly Corrosive Liquids
- Crude Oil & Gas
- Produced Water
- Saltwater
- CO₂

Materials and Construction

Red Thread HP16 pipe is manufactured by the filament winding process using aromatic amine-cured epoxy thermosetting resin to impregnate strands of continuous glass filaments. The pipe is rated up to 435 psig in accordance with API 15LR, 20 year design life at 200°F (93°C), serviceable up to 210°F (99°C) by applying a derating factor of 0.92 to all component ratings.

ASTM D-2996 Classification: RTRP-11AW1-3110 for static design basis.

Fittings

Fittings are manufactured with the same chemical and temperature capabilities as the pipe. Depending on the configurations and size, the fittings construction method will be compression molded, contact molded, fabricated or filament wound. Fittings details are in two documents. Use CI1350 for sizes 2"-16" (50-400 mm) and CI1351 for 18"-42" (450-1050 mm). All fittings may not have the same pressure rating as the pipe. System rating is governed by the lowest rated component used.

Joining System

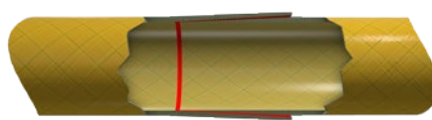
- **T.A.B.™** - In sizes 2"-6", pipe and couplings are supplied with a threaded and bonded (T. A. B) joining system. Double-lead threads provide quick secure adhesive connections during installation.
- **Bell & Spigot** - The pipe and fittings are joined using the bell and spigot connection. Pipe is supplied with one end belled (integral bell or factory-bonded coupling) and one end tapered in sizes 8"-42". For 8"-42" sizes, the matched tapered joining method is used and the pipe is available in random 12 meter (40 feet) lengths.

Epoxy adhesive available from NOV Fiber Glass Systems is used to secure the joint.
- **Flanged** - Flanged connections are available for all components and diameters.

View of Joint Illustrations



T.A.B.



Bell & Spigot



Flanged

Nominal Dimensional Data

| Pipe Size | | Inside Diameter | | Outside Diameter ⁽⁴⁾ | | Reinforced Wall Thickness | | Weight | | Capacity | |
|-------------------|------|-----------------|------|---------------------------------|------|---------------------------|-------|--------|--------|----------|-------|
| in | mm | in | mm | in | mm | in | mm | lbs/ft | kg/m | gal/ft | l/m |
| 2 ⁽¹⁾ | 50 | 2.24 | 57 | 2.35 | 60 | 0.058 | 1.47 | 0.4 | 0.54 | 0.20 | 2.5 |
| 3 ⁽¹⁾ | 80 | 3.36 | 85 | 3.54 | 98 | 0.086 | 2.18 | 0.8 | 1.20 | 0.46 | 5.7 |
| 4 ⁽²⁾ | 100 | 4.36 | 111 | 4.53 | 115 | 0.083 | 2.11 | 1.0 | 1.52 | 0.78 | 9.7 |
| 6 ⁽²⁾ | 150 | 6.41 | 163 | 6.65 | 169 | 0.122 | 3.10 | 2.2 | 3.21 | 1.68 | 20.9 |
| 8 | 200 | 8.36 | 212 | 8.61 | 219 | 0.127 | 3.23 | 2.9 | 4.35 | 2.85 | 35.4 |
| 10 | 250 | 10.36 | 263 | 10.67 | 271 | 0.156 | 3.96 | 4.5 | 6.62 | 4.38 | 54.4 |
| 12 | 300 | 12.28 | 312 | 12.65 | 321 | 0.185 | 4.70 | 6.3 | 9.31 | 6.16 | 76.4 |
| 14 | 350 | 14.03 | 356 | 14.51 | 369 | 0.238 | 6.05 | 9.2 | 13.70 | 8.03 | 99.7 |
| 16 | 400 | 16.03 | 407 | 16.57 | 421 | 0.272 | 6.91 | 12.0 | 17.90 | 10.50 | 130.0 |
| 18 | 450 | 17.82 | 453 | 18.38 | 467 | 0.277 | 7.04 | 13.6 | 20.20 | 13.00 | 161.0 |
| 20 | 500 | 19.83 | 504 | 20.40 | 518 | 0.286 | 7.26 | 15.6 | 23.30 | 16.00 | 199.0 |
| 24 | 600 | 23.83 | 605 | 24.50 | 622 | 0.334 | 8.48 | 21.9 | 32.60 | 23.20 | 288.0 |
| 30 ⁽³⁾ | 750 | 30.03 | 763 | 30.89 | 785 | 0.430 | 10.92 | 35.6 | 52.90 | 36.80 | 457.0 |
| 36 ⁽³⁾ | 900 | 36.03 | 915 | 37.05 | 941 | 0.510 | 12.95 | 50.6 | 75.30 | 53.00 | 658.0 |
| 42 ⁽³⁾ | 1050 | 42.03 | 1068 | 43.23 | 1098 | 0.600 | 15.24 | 69.4 | 103.00 | 72.10 | 895.0 |

- ⁽¹⁾ Reinforced wall thickness exceeds the requirement for 232 psig and may be operated up to 435 psig.
- ⁽²⁾ Reinforced wall thickness exceeds the requirement for 232 psig and may be operated up to 362 psig.
- ⁽³⁾ Qualified for 232 psig, see fittings ratings in CI1351 for exceptions.
- ⁽⁴⁾ Outer diameter is for use in flexibility analysis. Consult factory representative for OD tolerances.

Supports

The following engineering analysis must be performed to determine the maximum support spacing for the piping system. Proper pipe support spacing depends on the temperature and weight of the fluid carried in the pipe. The support spacing is calculated using continuous beam equations and the pipe bending modulus derived from long-term beam bending tests. The following tables were developed to ensure a design that limits beam mid-span deflection to 1/2 inch and bending stresses to less than or equal to 1/3 of the ultimate bending stress. Any additional weight on the piping system such as insulation or heat tracing requires further consideration. Restrained (anchored) piping systems operating at elevated temperatures often result in guide spacing requirements that are more stringent than simple unrestrained piping systems. In this case, the maximum guide spacing will dictate the support/guide spacing requirements for the system. Pipe support spans at changes in direction require special attention. Supported and unsupported fittings, at changes in direction are considered in the following tables and must be followed to properly design the piping system.

Support Spacing vs. Specific Gravity

| Specific Gravity | 2.00 | 1.50 | 1.25 | 1.00 | 0.75 |
|------------------|------|------|------|------|------|
| Multiplier | 0.85 | 0.91 | 0.95 | 1.00 | 1.06 |

Example: 18" pipe @ 75°F (23.9°C) with 1.5 specific gravity fluid, maximum support spacing = 35.2 x 0.91 = 32.0 ft. (9.76 m)

Maximum Support Spacing for Uninsulated Pipe⁽¹⁾

| Size | | Continuous Spans of Pipe ⁽²⁾ | | | |
|------|------|---|-------|--------|------|
| | | feet | | meters | |
| in | mm | 75°F | 200°F | 24°C | 93°C |
| 2 | 50 | 14.0 | 10.1 | 4.3 | 3.1 |
| 3 | 80 | 17.1 | 12.4 | 5.2 | 3.8 |
| 4 | 100 | 18.2 | 13.2 | 5.6 | 4.0 |
| 6 | 150 | 22.1 | 16.0 | 6.7 | 4.9 |
| 8 | 200 | 24.0 | 17.4 | 7.3 | 5.3 |
| 10 | 250 | 26.6 | 19.3 | 8.1 | 5.9 |
| 12 | 300 | 29.0 | 21.0 | 8.8 | 6.4 |
| 14 | 350 | 31.8 | 23.1 | 9.7 | 7.0 |
| 16 | 400 | 34.0 | 24.7 | 10.4 | 7.5 |
| 18 | 450 | 35.2 | 25.5 | 10.7 | 7.8 |
| 20 | 500 | 36.5 | 26.5 | 11.1 | 8.1 |
| 24 | 600 | 39.7 | 28.8 | 12.1 | 8.8 |
| 30 | 800 | 44.8 | 32.5 | 13.7 | 9.9 |
| 36 | 900 | 49.0 | 35.5 | 14.9 | 10.8 |
| 42 | 1050 | 53.0 | 38.4 | 16.2 | 11.7 |

- ⁽¹⁾ For Sg=1.0, consult manufacturer for heavier insulated pipe support spans. Span recommendations include no provision for weight of (fittings, valves, etc.) or thrusts at branches and turns. Heavy valves and other appurtenances must be supported separately.
- ⁽²⁾ Calculated spans are based on 1/2" mid-span deflections to ensure good appearance and adequate drainage. Total system stresses should always be taken into account by the system design engineer when determining support spans.

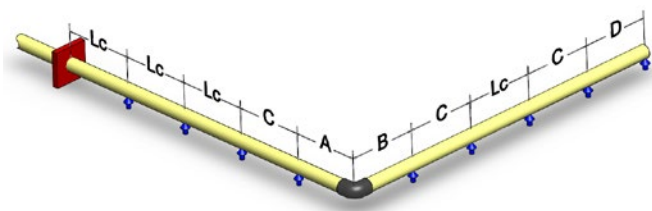
There are seven basic rules to follow when designing piping system supports, anchors, and guides:

1. Do not exceed the recommended support span.
2. Support valves and heavy in-line equipment independently.
This applies to both vertical and horizontal piping.
3. Protect pipe from external abrasion.
4. Avoid point contact loads
5. Avoid excessive bending. This applies to handling, transporting, initial layout, and final installed position.
6. Avoid excessive vertical run loading. Vertical loads should be supported sufficiently to minimize bending stresses at outlets or changes in direction.
7. Provide adequate axial and lateral restraint to ensure line stability during rapid changes in flow.

Adjustment Factors for Various Spans With Unsupported Fitting at Change in Direction

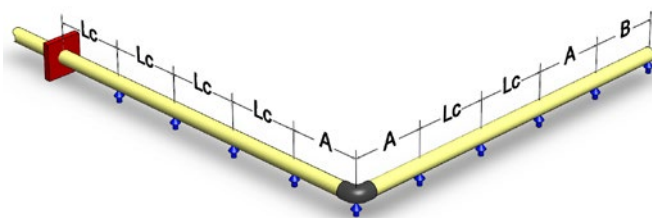
| Span Type | Factor | |
|-----------|---|--------|
| Lc | Continuous interior or fixed end spans | 1.00 |
| C | Second span from supported end or unsupported fitting | 0.80 |
| A+B | Sum of unsupported spans at fitting | ≤0.75* |
| D | Simple supported end span | 0.67 |

*For example: If continuous support is 10 ft. (3.04 m), A+B must not exceed 7.5 ft.(2.28 m) (A=3 ft. (0.91 m) and B=4.5 ft. (1.37 m)) would satisfy this condition.



Adjustment Factors for Various Spans With Supported Fitting at Change in Direction

| Span Type | Factor | |
|-----------|--|------|
| Lc | Continuous interior or fixed end spans | 1.00 |
| A | Second span from simple supported end or unsupported fitting | 0.80 |
| B | Simple supported end span | 0.67 |



Thermal Expansion

The effects of thermal gradients on piping systems may be significant and should be considered in every piping system stress analysis. Pipe line movements due to thermal expansion or contraction may cause

high stresses or even buckle a pipe line if improperly restrained. Several piping system designs are used to manage thermal expansion and contraction in above ground piping systems. They are listed below according to economic preference:

1. Use of inherent flexibility in directional changes.
2. Restraining axial movements and guiding to prevent buckling.
3. Use expansion loops to absorb thermal movements.
4. Use mechanical expansion joints to absorb thermal movements.

To perform a thermal analysis the following information is required:

1. Isometric layout of piping system
2. Physical and material properties of pipe
3. Design temperatures
4. Installation temperature (Final tie in temperature)
5. Terminal equipment load limits
6. Support movements

A comprehensive review of temperature effects on fiberglass pipe may be found in NOV Fiber Glass Systems' Engineering and Piping Design Guide, Section 3.

| Change in Temperature | | Pipe Change in Length | |
|-----------------------|------|-----------------------|----------|
| °F | °C | in/100 ft | cm/100 m |
| 25 | 13.9 | 0.32 | 2.67 |
| 50 | 27.8 | 0.64 | 5.35 |
| 75 | 41.7 | 0.96 | 8.02 |
| 100 | 55.6 | 1.28 | 10.7 |

Testing

Hydrostatic testing is recommended to evaluate the integrity of all new piping installations. For systems operating below the system rating, a test pressure of 1.5 times the system operating pressure is recommended; however, the maximum test pressure must not exceed 1.3 times the lowest pressure rated fiberglass component in the piping system.

The hydro test pressure should be repeated up to ten cycles from 0 psig to the test pressure to provide a high degree of confidence in the piping system. The final pressurization cycle should be allowed to stabilize for 15-30 minutes, then inspected for leaks. Do not attempt to repair leaks while system is pressurized. The hydro test should be repeated after any re-work is performed.

When hydro testing, open high-point vents (if used) to prevent entrapment of air in the lines as the system is slowly filled with water, then close the vents and slowly pressurize to the test pressure. Upon completion of hydro test, relieve the pressure on the system slowly, open vents and any drains to allow for complete drainage of the system.

Water Hammer

Piping systems may be damaged by pressure surges due to water hammer. The use of soft start pumps and slow actuating valves will reduce the magnitude of surge pressures during operation and are highly recommended.

Typical Mechanical Properties

| Pipe Property | 75°F | 24°C | 200°F | 93°C | Method |
|--|-------------------------|--------|-------------------------|---------------|--------------------------|
| | psi | MPa | psi | MPa | |
| Axial Tensile | | | | | |
| Ultimate Stress | 9,530 | 65.7 | 6,585 | 45.4 | ASTM D2105 |
| Modulus of Elasticity | 1.68 x 10 ⁶ | 11,584 | 1.42 x 10 ⁶ | 9,791 | ASTM D2105 |
| Poisson's Ratio, $v_{ah} (v_{ha})^{(1)}$ | 0.35 (0.61) | | | | |
| Axial Compression | | | | | |
| Ultimate Stress | 12,510 | 86.3 | 8,560 | 59.0 | ASTM D695 |
| Modulus of Elasticity | 0.677 x 10 ⁶ | 4,668 | 0.379 x 10 ⁶ | 2,613 | ASTM D695 |
| Beam Bending | | | | | |
| Modulus of Elasticity (Long Term) | 2.6 x 10 ⁶ | 17,927 | 0.718 x 10 ⁶ | 4,951 | ASTM D2925 |
| Hydrostatic Burst | | | | | |
| Ultimate Hoop Tensile Stress | 40,150 | 277 | 36,480 | 252 | ASTM D1599 |
| Hydrostatic Hoop Design Stress | | | | | |
| Static 20 Year Life | LTHS - 95% LCL | - | 18,203 - 14,689 | 125.5 - 101.3 | ASTM D2992 - Procedure B |
| Static 50 Year Life | LTHS - 95% LCL | - | 16,788 - 13,142 | 115.7 - 90.6 | ASTM D2992 - Procedure B |
| Parallel Plate | | | | | |
| Hoop Modulus of Elasticity | 3.02 x 10 ⁶ | 20,822 | - | - | ASTM D2412 |
| Shear Modulus | 1.36 x 10 ⁶ | 9,343 | 1.15 x 10 ⁶ | 7,895 | - |

Typical Physical Properties

| Pipe Property | Value | Value | Method |
|----------------------|----------------------------------|----------------------------------|-----------|
| Thermal Conductivity | 0.23 BTU/hr•ft•°F | 0.4 W/m°C | ASTM D177 |
| Thermal Expansion | 10.7 x 10 ⁻⁶ in/in/°F | 19.3 x 10 ⁻⁶ mm/mm/°C | ASTM D696 |
| Absolute Roughness | 0.00021 in | 0.00053 mm | |
| Specific Gravity | 1.8 | | ASTM D792 |

⁽¹⁾ v_{ha} = The ratio of axial strain to hoop strain resulting from stress in the hoop direction.
 v_{ah} = The ratio of hoop strain to axial strain resulting from stress in the axial direction.
⁽²⁾ The differential pressure between internal and external pressure which causes collapse.
⁽³⁾ A 0.67 design factor is recommended for short duration vacuum service. A full vacuum is equal to 14.7 psig (0.101 MPa) differential pressure at sea level.
⁽⁴⁾ A 0.33 design factor is recommended for sustained (long-term) differential collapse pressure design and operation.

Ultimate Collapse Pressure

| Size | | Collapse Pressure ^(2,3,4) | | | |
|------|------|--------------------------------------|-------|------|------|
| | | psig | | MPa | |
| In | mm | 75°F | 200°F | 24°C | 93°C |
| 2 | 50 | 177 | 133 | 1.22 | 0.92 |
| 3 | 80 | 171 | 129 | 1.18 | 0.89 |
| 4 | 100 | 69 | 51 | 0.48 | 0.35 |
| 6 | 150 | 69 | 51 | 0.48 | 0.35 |
| 8 | 200 | 29 | 20 | 0.20 | 0.14 |
| 10 | 250 | 27 | 20 | 0.19 | 0.13 |
| 12 | 300 | 27 | 20 | 0.19 | 0.14 |
| 14 | 350 | 45 | 33 | 0.31 | 0.23 |
| 16 | 400 | 45 | 33 | 0.31 | 0.23 |
| 18 | 450 | 31 | 23 | 0.22 | 0.16 |
| 20 | 550 | 23 | 16 | 0.16 | 0.11 |
| 24 | 600 | 20 | 14 | 0.14 | 0.10 |
| 30 | 750 | 21 | 15 | 0.14 | 0.10 |
| 36 | 900 | 21 | 15 | 0.14 | 0.10 |
| 42 | 1050 | 21 | 15 | 0.14 | 0.10 |

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