

**Table 20HV.E3.1A
(Series 20HV, 20HV-C, 20HV(FDA), 20HV(FDA)-C)
Mechanical Specifications**

| Temp (F) | Pipe Strengths (psi) | | | | | Pipe Moduli (psi) | | | | |
|----------------|----------------------|--------------|-------------|------------|-------------|-------------------|--------------|-------------|------------|-------------|
| | Axial Tensile | Hoop Tensile | Axial Flex. | Hoop Flex. | Axial Comp. | Axial Tensile | Hoop Tensile | Axial Flex. | Hoop Flex. | Axial Comp. |
| Ambient | 8,400 | 26,400 | 16,800 | N/A | 18,000 | 1,400,000 | 2,200,000 | 1,400,000 | 2,200,000 | 1,500,000 |
| 150 | 8,400 | 26,400 | 16,800 | N/A | 18,000 | 1,400,000 | 2,200,000 | 1,400,000 | 2,200,000 | 1,500,000 |
| 175 | 6,300 | 19,800 | 12,600 | N/A | 13,500 | 1,050,000 | 1,650,000 | 1,050,000 | 1,650,000 | 1,125,000 |
| 200 | | | | | | | | | | |
| 225 | | | | | | | | | | |
| 250 | | | | | | | | | | |

ASTM D4024 / D5421 Flange Codes

| | |
|---|--------------------------|
| 2" - 6" Flanges, 200psi | RTR-111D-445; CM-B4I |
| 8" Flanges, 200psi | RTR-111D-446; CM-B4I |
| 10" - 12" Flanges, 200psi | RTR-111D-447; CM-B4I |
| 14" - 24" Flanges, 150psi | RTR-111C-337; CM-B4IF-66 |
| All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange. The grade epoxy is interpreted to include epoxy vinyl esters. ASTM D5421 does not have ratings above 150psi. | |

ASTM D2310 / D2996 Pipe Codes

| | |
|--|-----------------|
| 2" - 3" Pipe | RTRP-12ET1-1112 |
| 4" Pipe | RTRP-12ET1-1113 |
| 6" Pipe | RTRP-12ET1-1114 |
| 8" and larger Pipe | RTRP-12ET1-1116 |
| All materials are filament wound, polyester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included). Short term hoop strength > 10,000psi; long. tensile strength > 8,000psi; Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size. Replace 'T' with 'Q' for the HDB rating of joints. | |

ASTM F1173 / ISO15840 Codes

| |
|---|
| Type I, Resin 3, Class B, Rating Method 1 |
|---|

ASTM D5685 Fittings Codes

| | |
|--|------------|
| 2" - 12" Fittings, 200psi | RTRF 52E4E |
| Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 200psig rating | |
| 14" - 24" Fittings, 150psi | RTRF 52E4D |
| butt & strap joint, 150psig rating | |

Other Properties

| | |
|--|-----------|
| Density (lb/cu in.) | 0.06 |
| Shear Modulus (psi) | 1,400,000 |
| Thermal Expansion Coefficient (in./in./F) | 0.00001 |
| Thermal Conductivity (BTU-in./ft^2-hr-F) | 1.3 |
| Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$ | 0.55 |
| Major Poisson's Ratio, $E_a/E_h * \nu_{ha} = \nu_{ah}$ | 0.35 |
| Hazen Williams Coefficient | 150 |
| Specific Roughness (in.) | 0.0002 |

Notes:
 1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.
 2. Blank areas are Not Recommended.

Table 20HV.E3M.1A (Metric)
(Series 20HV, 20HV-C, 20HV(FDA), 20HV(FDA)-C)
Mechanical Specifications

| Temp (C) | Pipe Strengths (MPa) | | | | | Pipe Moduli (GPa) | | | | |
|----------------|----------------------|--------------|-------------|------------|-------------|-------------------|--------------|-------------|------------|-------------|
| | Axial Tensile | Hoop Tensile | Axial Flex. | Hoop Flex. | Axial Comp. | Axial Tensile | Hoop Tensile | Axial Flex. | Hoop Flex. | Axial Comp. |
| Ambient | 57.9 | 182.0 | 115.8 | N/A | 124.1 | 9.7 | 15.2 | 9.7 | 15.2 | 10.3 |
| 65.6 | 57.9 | 182.0 | 115.8 | N/A | 124.1 | 9.7 | 15.2 | 9.7 | 15.2 | 10.3 |
| 79.4 | 43.4 | 136.5 | 86.9 | N/A | 93.1 | 7.2 | 11.4 | 7.2 | 11.4 | 7.8 |
| 93.3 | | | | | | | | | | |
| 107.2 | | | | | | | | | | |
| 121.1 | | | | | | | | | | |

ASTM D4024 / D5421 Flange Codes

| | |
|---|--------------------------|
| 2" - 6" Flanges, 200psi | RTR-111D-445; CM-B4I |
| 8" Flanges, 200psi | RTR-111D-446; CM-B4I |
| 10" - 12" Flanges, 200psi | RTR-111D-447; CM-B4I |
| 14" - 24" Flanges, 150psi | RTR-111C-337; CM-B4IF-66 |
| All materials are contact molded (closest definition to filament wound in D4024), epoxy vinyl ester resin, integrally molded flange. The grade epoxy is interpreted to include epoxy vinyl esters. ASTM D5421 does not have ratings above 150psi. | |

ASTM D2310 / D2996 Pipe Codes

| | |
|--|-----------------|
| 2" - 3" Pipe | RTRP-12ET1-1112 |
| 4" Pipe | RTRP-12ET1-1113 |
| 6" Pipe | RTRP-12ET1-1114 |
| 8" and larger Pipe | RTRP-12ET1-1116 |
| All materials are filament wound, epoxy vinyl ester resin, reinforced liner, HDB of > 5,000psi for joints, > 10,000psi for pipe (axial loads included). Short term hoop strength > 10,000psi; long. tensile strength > 8,000psi; Long. tensile modulus > 1,000,000psi; stiffness factor varies with pipe size. Replace 'T' with 'Q' for the HDB rating of joints. | |

ASTM F1173 / ISO15840 Codes

| |
|---|
| Type I, Resin 3, Class B, Rating Method 1 |
|---|

ASTM D5685 Fittings Codes

| | |
|--|------------|
| 2" - 12" Fittings, 200psi | RTRF 52E4E |
| Contact molded fittings, epoxy vinyl ester resin, reinforced liner, butt & strap joint, 200psig rating | |
| 14" - 24" Fittings, 150psi | RTRF 52E4D |
| butt & strap joint, 150psig rating | |

Other Properties

| | |
|--|----------|
| Density (g/cu cm) | 1.7 |
| Shear Modulus (GPa) | 9.7 |
| Thermal Expansion Coefficient (mm/mm/C) | 0.000018 |
| Thermal Conductivity (W-cm/cm ² -C) | 0.0019 |
| Minor Poisson's Ratio, $\nu_{min} = \nu_{ha}$ | 0.55 |
| Major Poisson's Ratio, $E_a/E_h * \nu_{ha} = \nu_{ah}$ | 0.35 |
| Hazen Williams Coefficient | 150 |
| Specific Roughness (cm) | 0.0005 |

Notes:
 1. Axial flexural is also termed bending; hoop flexural is also termed circumferential.
 2. Blank areas are Not Recommended.

**Table 20HV.E3.5A
(Series 20HV, 20HV-C, 20HV(FDA), 20HV(FDA)-C)
Stress Analysis Data**

Material Properties

| | | |
|---------------------------------|---------------------------|-----------------------|
| C_t | 0.000010 in./in./F | 0.000018 mm/mm/C |
| $E_a = E_x$ | 1,400,000 psi | 9.7 GPa |
| $\nu_{min} = \nu_{ha}$ | 0.55 | 0.55 |
| E_h | 2,200,000 psi | 15.2 GPa |
| rho | 0.060 lb/in. ³ | 1.7 g/cm ³ |
| $E_a/E_h * \nu_{ha} = \nu_{ah}$ | 0.35 | 0.35 |

UKOOA Data

| | | |
|----------------------|---|-----------|
| SH, $f_1 * LTHS$ | 10,000 psi | 68.95 MPa |
| R, Sa(0:1) / Sa(2:1) | 0.64 | 0.64 |
| f_2 - sustained | 0.67 | 0.67 |
| f_2 - thermal | 0.83 | 0.83 |
| f_2 - occasional | 0.89 | 0.89 |
| K | Mean temperature change multiplier, 0.85 for liquids, 0.8 for gases, 1.0 for amb. temp changes. | |

BS7159 Data

| | | |
|------------------------|---|-----------|
| SH, $\epsilon_d * E_a$ | 2,520 psi | 17.38 MPa |
| | (based on 0.0018 design strain) | |
| E_h/E_a | 1.57 | 1.57 |
| K | Mean temperature change multiplier, 0.85 for liquids, 0.8 for gases, 1.0 for amb. temp changes. | |
| Kn | Fatigue factor, 1.0 for static applications | |

ISO14692 Data

| | | |
|----------------------|---|---------------|
| al(0:1) | 2,722 psi | 18.8 MPa |
| al(2:1) | 4,278 psi | 29.5 MPa |
| hl(2:1) | 8,556 psi | 59.0 MPa |
| Qs-bends | 4,850 psi | 33.4 MPa |
| r-bends | 1.9 | 1.9 |
| Eh/Ea-bends | 1.0 | 1.0 |
| Qs-joints | 4,104 psi | 28.3 MPa |
| r-joints | 2.0 | 2.0 |
| A1 | 1.0 up to 150F | 1.0 up to 65c |
| System design factor | 0.67-sustained, 0.83-thermal, 0.89-occasional | |
| Thermal factor, k | Same as UKOOA | |

| D | tr,min |
|-----|--------|
| 1 | 0.25" |
| 1.5 | 0.25" |
| 2 | 0.25" |
| 3 | 0.25" |
| 4 | 0.25" |
| 6 | 0.31" |
| 8 | 0.38" |
| 10 | 0.44" |
| 12 | 0.50" |
| 14 | 0.44" |
| 16 | 0.50" |
| 18 | 0.56" |
| 20 | 0.63" |
| 24 | 0.75" |

| D | tr,min |
|-----|--------|
| 25 | 6.4mm |
| 40 | 6.4mm |
| 50 | 6.4mm |
| 80 | 6.4mm |
| 100 | 6.4mm |
| 150 | 7.9mm |
| 200 | 9.5mm |
| 250 | 11.1mm |
| 300 | 12.7mm |
| 350 | 11.1mm |
| 400 | 12.7mm |
| 450 | 14.3mm |
| 500 | 15.9mm |
| 600 | 19.1mm |

Caution should be used when selecting ISO14692 as a design code in some software. The inability to adjust the biaxial stress ratio for tees and the inability to select Type 2 laminate construction for elbows may have an effect on the results. UKOOA as a design code may be a better selection even though this code does not offer the ability to adjust f_2 for the various loading cases.

**Table 20HV.E3.4A
(20HV, 20HV-C, 20HV(FDA), 20HV(FDA)-C)
ISO 14692 Part 3 - Annex D Calculations**

Stress Intensification Factors (SIFs), Flexibility Factors (Kappa), Pressure Stress Multipliers (PSMs)
(BS7159, Type 2 Laminate, 0.0012 design strain)

| Size (in.) | Series 20HV, 20HV-C, 20HV(FDA) | | | | | | |
|-------------------|--------------------------------|-------------------|----------|------------------|-----|------|-----|
| | Elbows | | | | | Tees | |
| | Flexibility Factor | Axial bending SIF | | Hoop bending SIF | | SIF | PSM |
| | In-plane | Out-of-plane | In-plane | Out-of-plane | | | |
| 2 | 1.3 | 1.1 | 1.2 | 1.9 | 1.7 | 1.1 | 1.0 |
| 3 | 1.9 | 1.5 | 1.6 | 2.5 | 2.2 | 1.3 | 1.0 |
| 4 | 2.5 | 1.7 | 1.8 | 2.5 | 2.5 | 1.5 | 1.0 |
| 6 | 2.9 | 1.9 | 2.1 | 2.5 | 2.5 | 1.7 | 1.0 |
| 8 | 2.8 | 1.9 | 2.0 | 2.5 | 2.5 | 1.7 | 1.0 |
| 10 | 3.0 | 2.0 | 2.1 | 2.5 | 2.5 | 1.8 | 1.0 |
| 12 | 2.9 | 1.9 | 2.1 | 2.5 | 2.5 | 1.7 | 1.0 |
| 14 | 3.0 | 2.2 | 2.4 | 2.5 | 2.5 | 2.0 | 1.0 |
| 16 | 3.0 | 2.1 | 2.3 | 2.5 | 2.5 | 1.9 | 1.0 |
| 18 | 3.0 | 2.3 | 2.4 | 2.5 | 2.5 | 2.0 | 1.0 |
| 20 | 3.0 | 2.3 | 2.4 | 2.5 | 2.5 | 2.1 | 1.0 |
| 24 | 3.0 | 2.3 | 2.5 | 2.5 | 2.5 | 2.1 | 1.0 |
| 30 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.3 | 1.0 |
| 36 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.3 | 1.0 |
| 42 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.3 | 1.0 |
| 48 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.3 | 1.0 |

Note: Tees that are qualified according to ISO14692 have a PSM of 1.0. Tees that are not qualified will typically have PSMs ranging from 1.8 to 3.0. Reducing tees will have slightly different SIFs than tees; however, it is acceptable to use the same values as the same-size tees. e.g., a 6"x2" reducing tee or outlet would have the same SIF as a 6" tee.