TR-4
HDB/HDS/SDB/PDB/MRS
Listed Materials
6/20/2017

PPI Listing of
Hydrostatic Design Basis (HDB),
Hydrostatic Design Stress (HDS),
Strength Design Basis (SDB),
Pressure Design Basis (PDB) and
Minimum Required Strength (MRS) Ratings
For Thermoplastic Piping Materials or Pipe
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Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe

FOREWORD

This report lists thermoplastic piping materials with a Plastics Pipe Institute (PPI) recommended Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) or Minimum Required Strength (MRS) rating for thermoplastic piping materials or pipe.

These listings have been established in accordance with PPI TR-3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) or Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe". Copies are available from the PPI website.

Questions concerning any listing in this report should be referred to:

Plastics Pipe Institute, Inc.
105 Decker Court, Suite 825
Irving, TX  75062

www.plasticpipe.org

In the case of any deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB (Hydrostatic Stress Board) in consultation with the manufacturer.

The Plastics Pipe Institute (PPI) as a service to the industry has prepared this report. Reasonable efforts are made by PPI, its members and staff to ensure that the required methods, policies, standards and procedures have been followed and that the presented test data are reliable. PPI expressly disclaims any warranty, expressed or implied, regarding the HDB, SDB, PDB or MRS values derived from submitted information, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Each product manufacturer that lists compositions with the Hydrostatic Stress Board does so voluntarily and with the express agreement that PPI assumes no liability in regard to the lists, and that it will hold PPI harmless from any claims or liability in connection with its listed pipe compositions. PPI does not endorse the proprietary products or processes of any manufacturer, and assumes no responsibility for compliance with applicable laws and regulations.

PPI offers various technical reports, technical notes and statements to assist engineers, code officials, specifiers, installers and users in proper selection and application of plastics piping. Copies of this report, as well as other publications, are available for download from PPI on the website www.plasticpipe.org.

This report was first published in September 1967. This update was issued in March 2011.
NOTES TO THE READER
SOME RULES AND CONDITIONS

1. **Processing Techniques**: It is stressed that these policies and procedures are for development of recommended ratings for thermoplastics piping materials or pipe based on test data from good quality pipes (extruded or molded) made by specific processing techniques. These recommended ratings may or may not be valid for products made by differing processing techniques.

2. **Definitions and Acronyms**: Definitions and Acronyms are shown in the next section. The terminology of this report is in accordance with the definitions given in ASTM Standards D883, "Standard Definition of Terms Relating to Plastics," and F412, "Standard Terminology Relating to Plastic Piping Systems".

3. **Adjusting Recommended Ratings for Application-Specific Environments**: HDB/PDB/MRS/SDB recommended ratings issued by PPI are for conditions equivalent to those under which the test data were obtained, e.g., constant pressure, temperature and specific test environment. Various industry standards or regulations provide appropriate design factors or design coefficients to calculate the corresponding maximum allowable operating pressure for the piping system used in the desired application. Under some conditions, such as pressure cycling, higher temperature, more aggressive environment, or handling and installation quality, all of which may significantly reduce pipe durability, a more conservative design factor or design coefficient should be chosen. More information on design factors and design coefficients is given in PPI TR-9, "Recommended Design Factors and Design Coefficients for Pressure Applications of Thermoplastic Pipe Materials". Sustained pressure testing at elevated temperatures used to obtain these ratings may not be sufficient to fully evaluate either the thermal or oxidative stability performance of thermoplastic materials or pipe.

4. **Product Standards**: An HDB/PBD/SDB/MRS recommended rating has been shown, through both scientific procedures and historical experience, to be a useful indicator of the relative long-term strength of a thermoplastic material when tested under the conditions set out in test method ASTM D2837 or ISO 9080. The performance of a material (or a piping product made with that material) under actual conditions of installation and use is dependent upon a number of other factors and conditions, which are not addressed in this report. These other factors and conditions are properly governed by the relevant product standard. The usefulness and adequacy of an HDB/PDB/SDB/MRS as an indicator of the strength of a material or pipe for use in any particular application is reflected in its incorporation in the applicable product standard, along with other appropriate performance parameters for the product and its component material. The appropriateness of an HDB/PDB/SDB/MRS for a specific application is also determined by the decision of a private or governmental entity to adopt such a standard as part of its own requirements for the product. The term “50-year strength value,” as used in ASTM D2837, is a mathematical extrapolation that is useful in the context of developing an HDB. It does not necessarily constitute a representation that any material with such a value will perform under actual use conditions for that period of time.

5. **Sunlight (UV) Exposure**: These policies do not take into consideration the adequacy of a plastic composition's protection against sunlight exposure. Manufacturers may include in plastic pipe compositions suitable ingredients for the protection of properties against possible degradation by sunlight radiation during normal storage and use. The user should ensure that sufficient protection has been incorporated into the selected piping composition should the application involve extended sunlight exposure during storage and/or use.
6. **Recommended Ratings are Formulation Specific**: Each HDB/PDB/SDB/MRS issued by PPI is specific to that particular thermoplastic piping material formulation, including the procedure for mixing, which is represented by the data submitted to the HSB. Any changes in the mixing procedure, in the formulation, or in its ingredients, outside those permitted in TR-3 are considered to result in a new composition, which may have different long-term strength properties. The listed HDB/PDB/SDB/MRS does not apply to this new composition, unless the changes have been made, or validated, in accordance with one or more of the policies presented in this report; or have been ruled upon by the HSB as acceptable based on information provided to the HSB.

7. **Resin Changes**: An inherent assumption in the development of these policies and procedures is that the commercial pipe resin will be of equivalent chemical and molecular composition, insofar as these parameters influence long-term strength and durability, to the resin used in the composition on which the original long-term data supplied to PPI were obtained. Any modification of the resin composition is considered to result in a different material from the one on which the original listings were based. The Chairman of the HSB should be notified of such modifications and the applicable policy followed to maintain the listing. In the case of a change in manufacturing location of the resin used in a listed compound, the Chairman of the HSB should be notified and any applicable policy followed to maintain the listing. Also, in the case of any deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB in consultation with the manufacturer.

8. **Disclaimer**: While every effort has been made by the Plastics Pipe Institute to assure that these policies are sound, reasonable and prudent, PPI expressly disclaims any guarantee or warranty regarding their application. Each manufacturer who lists compositions in accordance with the procedures in TR-3 does so voluntarily and with the express agreement that PPI assumes no liability in regard to the listed compositions, and that the manufacturer will hold PPI harmless from any claims or liability arising in connection with its listed pipe compositions.

9. **Manufacturer’s Responsibility**: The manufacturer is responsible to insure that his product is continually manufactured in such a manner as to maintain the long-term strength and durability consistent with the long-term data supplied to the HSB. In the case of a deviation or circumstance not covered by a specific policy, a disposition will have to be made by the HSB in consultation with the manufacturer.

10. **Adoption of Policies and Procedures**: These policies and procedures have been adopted using standard letter ballot methods.

11. **Interpretations**: Questions pertaining to the interpretation of any policies in this report should be referred to the Chairman of the HSB, Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75063.

12. **Maximum Temperature for Listings**: The maximum temperature for which PPI will list an HDB/PDB/SDB/MRS for a material in accordance with the policies and procedures in TR-3 is 200°F (93°C). PPI listing for temperatures above 200°F may be requested as a “Special Case” (see note 13) for consideration by the HSB.

13. **Special Case Listings**: The policies and procedures in TR-3 are intended to cover HDB/PDB/SDB/MRS listings for most thermoplastic piping materials. PPI recognizes there may be unusual cases, issues or circumstances that are not covered in TR-3, and that may justify an exception to the standard policies. To allow manufacturers an opportunity to have their material(s) listed by PPI when this occurs, the HSB has provided a “Special Case” system. The manufacturer may present its “Case” to the HSB at one of their two annual meetings, usually in February and August, using the approved “Checklist for HSB Submissions” form in TR-3 Appendix A.1. All information provided to HSB in these special cases will be made available for review only by HSB members and PPI staff, and will be held by them in strict confidence, in accordance with PPI’s written confidentiality procedures (available from the HSB Chairman). There is a PPI fee for each
special case. You must contact the HSB Chairman well in advance of each meeting to arrange for your special case. A completed HSB submission form **must** be received at least two (2) weeks prior to the HSB meeting to permit HSB consideration at that meeting.
## Definitions and Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute 1430 Broadway New York, NY 10018</td>
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<tr>
<td>API</td>
<td>American Petroleum Institute 211 North Ervay Suite 1700 Dallas, TX 75201</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association 6666 West Quincy Avenue Denver, CO 80235</td>
</tr>
<tr>
<td>CSA</td>
<td>CSA, International 178Rexdale Boulevard Etobicoke, Ontario CANADA M9W 1R3</td>
</tr>
<tr>
<td>HSB</td>
<td>Hydrostatic Stress Board c/o Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, TX 75062</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization of Standardization Central Secretariat Geneva, Switzerland USA Contact: American National Standards Institute 1430 Broadway New York, NY 10018</td>
</tr>
<tr>
<td>NSF</td>
<td>NSF International 789 Dixboro Road Ann Arbor, MI 48113-0140 P. O. Box 5059 2600 GB Delft, Netherlands</td>
</tr>
<tr>
<td>PPI</td>
<td>Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, TX 75062</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
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<td>Brittle</td>
<td>A failure mode which exhibits no visible (to the naked eye) material deformation (stretching, elongation, or necking down) in the area of the break.</td>
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<td>Composite pipe</td>
<td>Pipe consisting of two or more different materials arranged with specific functional purpose to serve as pipe.</td>
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<td>CRS $\theta_{t}$</td>
<td>The Categorized Required Strength, CRS $\theta_{t}$, is the categorized lower prediction limit (LPL) of the long-term hydrostatic strength at a temperature ($\theta$) and a time ($t$) as determined in accordance with ISO 9080 and ISO 12162. CRS $\theta_{t}$, at 20°C and 50 years equals MRS.</td>
</tr>
<tr>
<td>Dependent Listing</td>
<td>A separate listing of a formulation that has previously been established as an independent listing under another owner's designation. Refer to Part D.3 of TR-3.</td>
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<tr>
<td>Ductile</td>
<td>A failure mode which exhibits material deformation (stretching, elongation, or necking down) in the area of the break.</td>
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<tr>
<td>E-X</td>
<td>The data level of an experimental grade listing where 'X' is the number of the grade level. e.g.: E-2 covers data out to at least 2,000 hours, E-8 covers data out to at least 8,000 hours, etc.</td>
</tr>
<tr>
<td>Experimental Grade (E)</td>
<td>A PPI HSB recommended rating that is valid for a limited duration, given to those materials covered by data that do not yet comply with the full requirements of the Standard Grade, but satisfy the applicable minimum preliminary data requirements that are detailed in TR-3. The owner of an experimental listing must understand there is a potential risk in commercial sale of an experimental product in case it does not meet all the TR-3 requirements for a standard grade.</td>
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<tr>
<td>HDB</td>
<td>The term HDB (Hydrostatic Design Basis) refers to the categorized long-term hydrostatic strength (LTHS) in the circumferential or hoop direction, for a given set of end use conditions, as established by ASTM Test Method D 2837, &quot;Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.&quot; Hydrostatic Design Basis (HDB) – one of a series of established stress values (specified in Test Method D 2837) for a plastic compound obtained by categorizing the long-term hydrostatic strength determined in accordance with ASTM Method D 2837.</td>
</tr>
<tr>
<td>Independent listing</td>
<td>A listing that has been established by a formulation owner under the provisions of Part A of TR-3.</td>
</tr>
<tr>
<td>LCL Ratio</td>
<td>The ratio of $\frac{LCL}{LTHS}$ expressed as a percentage. This ratio is a measure of the amount of scatter in the data and must be at least 85%.</td>
</tr>
<tr>
<td>LCL</td>
<td>Lower Confidence Limit - The lowest value of the LTHS, based on a statistical analysis of the regression data that can be expected at 100,000 hours.</td>
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<tr>
<td>LTHS</td>
<td>Long-term hydrostatic strength - the estimated tensile stress in the wall of the pipe in the circumferential orientation that when applied continuously will cause failure of the pipe at 100,000 hours. This is the intercept of the stress regression line with the 100,000-h coordinate.</td>
</tr>
</tbody>
</table>
**MRP**
Minimum Required Pressure – one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, etc.) obtained by categorizing the long-term hydrostatic pressure strength in accordance with ISO 9080.

**MRS**
The term MRS (Minimum Required Strength) refers to the categorized long-term hydrostatic strength in the circumferential, or hoop direction, for a given set of end use conditions, as established by ISO 9080, "Determination of Long-Term Hydrostatic Strength of Thermoplastic Materials in Pipe form by Extrapolation." Minimum Required Strength – one of a series of established stress values for a plastic compound obtained by categorizing the long-term hydrostatic strength determined by hydrostatic testing in accordance with ISO 9080 and ISO 12162.

**Multilayer pipe**
Multilayer is a type of composite

**TYPE 1:** A pressure rated pipe having more than one layer (bonded together) in which at least 60% of the wall thickness is polymeric material that has an HDB (Hydrostatic Design Basis) or MRS (Minimum Required Strength), from which the pressure rating of the pipe is determined.

**DISCUSSION:** An example of this is coextruded plastic pipe with an outer layer for barrier or color purposes. If this outer layer has the same HDB/MRS as the bulk wall, the entire wall thickness is used for pressure calculations; if not, only the bulk wall that has an HDB/MRS rating is used for pressure calculations.

**TYPE 2:** A pressure rated pipe having more than one layer (bonded together) where at least 60% of the wall thickness is polymeric material, where the pipe pressure rating is determined by pipe size and pipe wall construction, and this pipe rating is listed by a PDB (Pressure Design Basis) or MRP (Minimum Required Pressure).

**DISCUSSION:** An example of this is PEX/AL/PEX pipe.

**TYPE 3:** non-pressure rated pipe comprising more than one layer in which at least 60% of the wall thickness is polymeric material.

**NOTE:** the different layer(s) of multilayer pipe may provide color, barrier, stiffness or other properties according to the intended application.

**PDB**
The term PDB (Pressure Design Basis) refers to the categorized long-term pressure strength for multilayer pipes or other complex piping components, as established by ASTM Test Method D 2837, "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials." Pressure Design Basis – one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, etc.) obtained by categorizing the long-term hydrostatic pressure strength determined in accordance with an industry test method that uses linear regression analysis. Although ASTM D 2837 does not use “pressure values”, the PPI Hydrostatic Stress Board uses the principles of
ASTM D2837 in plotting log pressure vs. log time to determine a “long-term hydrostatic pressure strength” and the resulting “Pressure Design Basis” for multilayer pipe that is listed in PPI TR-4.

**PHR**
Parts by weight of a specified ingredient per hundred parts by weight of the base resin.

**PR**
Pressure Rating – the estimated maximum pressure that the medium in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

\[
PR = 2 \times (HDB) \times \text{design factor} / (SDR-1),
\]

\[
SDR = \text{Standard Dimension Ratio}
\]

\[
= \text{Average outside diameter} / \text{minimum wall thickness}
\]

Or

\[
PR = (PDB) \times \text{design factor}
\]

**Private Listing**
Manufacturer’s listing that is held privately within PPI and is not published in PPI TR-4.

**SDB**

NOTE: The SDB is used only for a material intended for molding applications. The SDB shall not be used for pipe applications.

**Standard Grade (S)**
A PPI HSB recommended rating that is valid for a five year period, given to those materials that comply with the full data requirements of TR-3.

**Substantiation**
A requirement of ASTM D 2513 for PE materials to show that extrapolation of the 73°F stress regression curve is linear to the 438,000-hour intercept.

**Thermoplastic**
A plastic that repeatedly can be softened by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion.

**TR**
Technical Report

**TR-X**
A PPI Technical Report where 'X' is the number of the report. e.g.: TR-3/2002 is the 2002 edition of TR-3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB) and Minimum Required Strengths (MRS) Ratings for Thermoplastic Piping Materials or Pipe".
UCL  Upper Confidence Limit - The highest value of the LTHS, based on a statistical analysis of the regression data that can be expected at 100,000 h.

UV  Ultra-Violet radiation from solar exposure.

Validation  The process of ensuring that, for those materials that exhibit a transition from ductile to brittle failure mode, this transition occurs after 100,000 h at the rated temperature.
<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CPVC</td>
<td>Chlorinated Poly (vinyl chloride)</td>
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<tr>
<td>PA</td>
<td>Polyamide (aka nylon)</td>
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<tr>
<td>PB</td>
<td>Polybutylene</td>
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<tr>
<td>PE</td>
<td>Polyethylene</td>
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<tr>
<td>PEX</td>
<td>Crosslinked polyethylene</td>
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<tr>
<td>PFA</td>
<td>Perfluoro (alkoxy alkane)</td>
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<tr>
<td>POM</td>
<td>Polyoxymethylene (aka polyacetal)</td>
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<tr>
<td>PP</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>PVC</td>
<td>Poly (vinyl chloride)</td>
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<tr>
<td>PVDF</td>
<td>Poly (vinylidene difluoride)</td>
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SECTION I

MATERIALS WITH PPI RECOMMENDED HYDROSTATIC DESIGN BASIS (HDB), MAXIMUM HYDROSTATIC DESIGN STRESS (HDS) OR STRENGTH DESIGN BASIS (SDB) ESTABLISHED IN ACCORDANCE WITH PPI TR-3 (ASTM D 2837).

PART A - MATERIALS EVALUATED FROM DATA DEVELOPED ON EXTRUDED PIPE SPECIMENS (HDB) – THESE MATERIALS MAY BE USED FOR EITHER EXTRUDED PIPE OR MOLDING APPLICATIONS

The tables that follow present PPI recommended HDB's in effect on the date of issue of this report. Information on subsequently listed materials may be obtained by contacting the Plastics Pipe Institute. Each table has been divided into dependent listings and independent listings. A resin manufacturer or pipe manufacturer may have an independent listing in which they provide all the stress rupture data required by TR-3. A resin manufacturer may transfer their listing to the pipe manufacturer using the protocol in TR-3. In this case, the pipe manufacturer has a dependent listing.

The listings of HDB's have been sub grouped in accordance with the material's standard pipe material designation code. In this designation system, which is widely used by major national product standards, the plastic is identified by its standard abbreviated terminology in accordance with ASTM D 1600, "Standard Terminology Relating to Abbreviations, Acronyms, and Codes for Terms Relating to Plastics", followed by a four or five digit number. The first two or three digits, as the case may be, code the material's ASTM classification (short-term properties) in accordance with the appropriate ASTM standard specification for that material. The last two digits of this number represent the PPI recommended HDS at 73°F (23°C) divided by one hundred. Three examples of this pipe material designation code are as follows:

- CPVC 4120 is a chlorinated polyvinyl chloride (the CPVC abbreviation is in accordance with ASTM D 1600) classified as Type 4, Grade 1 (in accordance with ASTM F 441) which has a 2,000 psi maximum recommended HDS utilizing a 0.5 design factor at 73°F (23°C) for water.

- POM 21110 is a polyoxymethylene (the POM abbreviation is in accordance with ASTM D 1600) classified as Group 2, Class 1, Grade 1 (in accordance with ASTM D 4181) which has a 1,000 psi maximum recommended HDS utilizing a 0.5 design factor at 73°F (23°C) for water.

- PE 3408 is a polyethylene (the PE abbreviation is in accordance with ASTM D 1600) classified as a grade PE 34 with a density cell class of 3 and a slow crack growth cell class of 4 (in accordance with ASTM D 3350). It has an 800-psi maximum recommended HDS utilizing a 0.5 design factor at 73°F (23°C) for water.
The standard pipe material designation codes covered by this report are:

<table>
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<tr>
<th>Pipe Material Designation Code</th>
<th>Maximum HDS at 73°F (23°C) psi</th>
<th>HDB at 73°F (23°C) psi</th>
<th>ASTM Specification</th>
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<tbody>
<tr>
<td>Polyvinyl Chloride (PVC)</td>
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<tr>
<td>PVC 1120</td>
<td>2,000</td>
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<td>D 1785</td>
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<tr>
<td>PVC 2116</td>
<td>1,600</td>
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<td>Chlorinated Polyvinyl Chloride (CPVC)</td>
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The following materials carry a recommended HDB of 4,000 psi and a maximum recommended HDS of 2,000 psi at 73°F (23°C) for water.

1. Pipe Listings Dependent on PPI Generic Range Composition

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### 2. Independent Listings – PVC 1120

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#### TABLE I.A.2 PVC 2116 MATERIALS

The following materials carry a recommended HDB of 3,150 psi and a maximum recommended HDS of 1,600 psi at 73°F (23°C) for water.

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TABLE I.A.3 - CPVC 4120 MATERIALS

The following materials carry a recommended HDB of 4,000 psi and a maximum recommended HDS of 2,000 psi at 73F (23°C) for water.

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2. Independent Listings – CPVC 4120

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2. Independent Listings – CPVC 4122

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2. Independent Listings – CPVC 23448

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NOTE1: CPVC 23448 represents the cell classification per ASTM D1784-11.

2. Independent Listings – CPVC 24448

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NOTE1: CPVC 24448 represents the cell classification per ASTM D1784-11.

TABLE IA.4 - PE 1404 MATERIALS

The following materials carry a recommended HDB of 800 psi and a maximum recommended HDS of 400 psi at 73°F (23°C) for water.

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The following materials carry a recommended HDB of 1250 psi and qualify for a 0.63 design factor to establish a maximum recommended HDS of 800 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 2406 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

### TABLE I.A.6. - PE 2708 MATERIALS

The following materials carry a recommended HDB of 1250 psi and qualify for a 0.63 design factor to establish a maximum recommended HDS of 800 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 2406 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

### 1. Dependent Listings – PE 2708

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2. Independent Listings – PE 2708

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2. Independent Listings – PE 3408

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TABLE I.A.8. - PE 3608 MATERIALS

The following materials carry a recommended HDB of 1600 psi and a maximum recommended HDS of 800 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 3408 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

1. Dependent Listings – PE 3608

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2. Independent Listings – PE 3708

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TABLE I.A.11- PE 4608 MATERIALS

The following materials carry a recommended HDB of 1600 psi and a maximum recommended HDS of 800 psi at 73° (23°C) for water. These materials also meet the requirements for PE 3408 as per ASTM D3350-02a. (*) – Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73° (23°C) regression is linear to 50 years.

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TABLE I.A.13 - PE 4710 MATERIALS

The following materials carry a recommended HDB of 1600 psi and qualify for a 0.63 design factor to establish a maximum recommended HDS of 1000 psi at 73°F (23°C) for water. These materials also meet the requirements for a PE 3408 as per ASTM D3350-02a. (*) - Indicates the material meets policy in TR-3 and ASTM D2837/D2513 requirement for substantiation. Stress rupture data confirm that the 73°F (23°C) regression is linear to 50 years.

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2. Independent Listings – PE 4710

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The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “0” indicates it does not meet this requirement or it has not been tested.

### 1. Dependent Listings – PEX 0006

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### TABLE IA.14A - PEX 0006 MATERIALS

The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “0” indicates it does not meet this requirement or it has not been tested.
<table>
<thead>
<tr>
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<th>Material Designation</th>
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<th>HDB (psi)</th>
<th>Grade</th>
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## 2. Independent Listings – PEX 0006

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</table>
The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “1” indicates the PEX tubing has been tested and meets the F 876 requirement for minimum chlorine resistance at the end use condition of 25% at 140°F (60°C) and 75% at 73°F (23°C). A digit “0” indicates it does not meet this requirement or it has not been tested.

1. Dependent Listings – PEX 1006

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2. Independent Listings – PEX 1006

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The following materials carry a recommended HDB of 1,250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F 2023. A digit “5” indicates the PEX tubing has been tested and meets the F 876 requirement for minimum chlorine resistance at the end use condition of 100% at 140°F (60°C).

### 1. Dependent Listings – PEX 5006

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2. Independent Listings – PEX 5006

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2. Independent Listings – PEX 5106

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<td>630</td>
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<td>12/31/2021</td>
</tr>
</tbody>
</table>
The following materials carry a recommended HDB of 1250 psi and a maximum recommended HDS of 630 psi at 73°F (23°C) for water. The first digit is for chlorine resistance tested in accordance with ASTM F2023. A digit “5” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 100% at 140°F (60°C). The second digit indicates the UV resistance as per ASTM F876. The digit “3” indicates a minimum 6 month UV exposure resistance.

1. Dependent Listings – PEX 5306

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### 2. Independent Listings – PEX 5306

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### 2. Independent Listings – PEX 0008

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2. Independent Listings – PA 32316

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2. Independent Listings – PA 42316

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TABLE I.A.20 - PVDF 2020 MATERIALS

The following materials carry a recommended HDB of 4000 psi and a maximum recommended HDS of 2000 psi at 73°F (23°C) for water.

<table>
<thead>
<tr>
<th>Company Name</th>
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<th>Temp °F</th>
<th>HDB (psi)</th>
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SECTION I

PART B – THESE MATERIALS MAY BE USED FOR MOLDING APPLICATIONS ONLY

TABLE I.B.1
Materials with recommended hydrostatic design basis (HDB) at 73°F (23°C) that have been established in accordance with TR-3 using:

Molded Specimens

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Material Designation</th>
<th>Designation Code</th>
<th>Temp °F</th>
<th>HDB (psi)</th>
<th>Grade</th>
<th>Expiration Date</th>
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</thead>
<tbody>
<tr>
<td>PolyOne</td>
<td>GEON 87431</td>
<td>PVC 1120</td>
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<td>4000</td>
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<td>12/31/2021</td>
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<tr>
<td>PolyOne</td>
<td>GEON M1200/M3200</td>
<td>PVC 2116</td>
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TABLE I.B.2
Materials with recommended hydrostatic design basis (HDB) at 73°F(23°C) that have been established in accordance with TR-3 using:

Extruded Pipe Specimens

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Material Designation</th>
<th>Designation Code</th>
<th>Temp °F</th>
<th>HDB (psi)</th>
<th>Grade</th>
<th>Expiration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axiall LLC</td>
<td>Axiall / Georgia Gulf 6907 BLUE 83</td>
<td>Extruded Pipe for Molding</td>
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<tr>
<td>Lubrizol Advanced Materials</td>
<td>TEMPRITE 3212 GRAY 245</td>
<td>Extruded Pipe for Molding</td>
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<td>4000</td>
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<td>12/31/2019</td>
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<tr>
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<td>12/31/2019</td>
</tr>
<tr>
<td>Lubrizol Advanced Materials</td>
<td>TEMPRITE 3235 BLUE 470</td>
<td>Extruded Pipe for Molding</td>
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<td>Extruded Pipe for Molding</td>
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TABLE I.B.3
Materials with recommended strength design basis (SDB) at 73°F(23°C) that have been established in accordance with TR-3 using:

Molded Plaque Specimens

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Material Designation</th>
<th>Designation Code</th>
<th>Temp °F</th>
<th>SDB (psi)</th>
<th>Grade</th>
<th>Expiration Date</th>
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<tr>
<td>JM Manufacturing dba JM Eagle</td>
<td>UAC-MFPA1</td>
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</table>
SECTION II

PIPPES WITH PPI RECOMMENDED PRESSURE DESIGN BASIS (PDB)
AND MAXIMUM PRESSURE RATINGS (PR) ESTABLISHED
IN ACCORDANCE WITH PPI TR-3 (ASTM D 2837).

This Section lists recommendations for the Pressure Design Basis (PDB) for composite pipes and pipes
of multilayer construction consisting essentially of two layers of thermoplastic material that sandwich a
thin layer of metallic reinforcement. Because the longer-term strength of pipes of such construction is
determined not only by the properties of each of the materials used but also by the specific
combination of materials and layer thicknesses, this Section differs from Section I in two important
respects:

♦ The long-term strength recommendations are presented in terms of a pressure design basis (PDB)
which represents the pipe’s estimated long-term hydrostatic pressure strength; and

♦ Each PDB recommendation is specific to the particular wall construction and pipe diameter that
are represented by the data upon which the PDB recommendation was established.

The PDB is the categorized estimated long-term hydrostatic pressure strength of a pipe. The
procedures for the estimating of the long-term hydrostatic pressure strength, and for its categorization
into preferred values, are the same as those used in Section I for the establishing of a material's
hydrostatic design basis (HDB).

The maximum pipe pressure ratings (PR’s) are obtained by multiplying the PDB by a 0.5 design factor.
The design factor is intended to take into consideration all the variables and degree of safety involved
on a particular application. The 0.5 value is without consideration to conditions such as aggressive
environments, cyclic stressing, localized stress concentrations, and temperature fluctuations which were
not present in the testing of the pipes but which could significantly affect long-term durability. Smaller
design factors (effectively, larger safety factors) should be considered to compensate for conditions not
adequately represented by the test protocol upon which the PDB's have been established. The pipe
manufacturer, appropriate pipe standards and codes, and relevant technical information should be
consulted for guidance.

The PDB’s listed in this Section have been developed under the same PPI TR-3 protocol as is used for
the establishing of the HDB’s that are listed in Section I of this report. The use of this protocol,
including the use of ASTM method D 2837, was deemed as appropriate for each of the listed pipe
constructions because their pressure versus time-to-rupture behavior exhibits the same kind of
regression with duration of loading as is exhibited by thermoplastic pipes of homogenous wall
construction. The Hydrostatic Stress Board excludes wall constructions that cannot be evaluated and
analyzed in accordance with ASTM D 2837 from consideration.

Experimental listings are also allowed.

There are indications that the long-term strength of a pipe of multilayer construction could be
expressed as some function of the tensile strength properties and relative thickness of each of the
separate material layers (Reference #1 and #2). Should this be confirmed for any of the listed material
combinations, then the recommended strength for each such combination will be reported in terms of
a material strength (i.e., and HDB), rather than a pipe strength (a PDB).

Reference #1 – Frank Furno, A New Concept in Plastics Piping, Proceedings of the Eleventh Plastic

Reference #2 – Jeremy Bowman, The Influence of Time and Temperature on the Strength of
Multilayered Pressure Pipe, Plastics Pipe VII Proceedings (September, 1992, Koningshooft, The
Netherlands) The Plastics and Rubber Institute.
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SECTION III

MATERIALS WITH PPI RECOMMENDED MINIMUM REQUIRED STRENGTH (MRS) AND CATEGORIZED REQUIRED STRENGTH (CRS) ESTABLISHED IN ACCORDANCE WITH ISO 9080 AND ISO 12162.

For classification purposes, the MRS is determined using ISO 9080 and the ISO 12162 standard conditions of 20°C (68°F). The CRS (θ, t) is the Categorized Required Strength value of σ_{ipl} determined and categorized for the selected temperature (θ) and required time (t) in accordance with ISO 9080 using the 3 or 4 coefficient stress rupture/time equation. These CRS (θ, t) values are listed in Table III.B.1. This current listing approach is under review by the Hydrostatic Stress Board.

The reader is advised that the MRS and CRS(θ, t) values listed in TR-4 represent an approximation of the likelihood that pipe specimens produced from these materials will not fail when placed in service and utilized in conjunction with the appropriate design coefficients. HDB values as determined in accordance with TR-3 policies include a stress reduction factor (design factor) to arrive at a recommended HDS. MRS and CRS(θ, t) designations, as determined in accordance with ISO 9080, do not include any stress reduction factors (design coefficients) that are required prior to its application for an intended service. As such, it is the responsibility of the design engineer to determine the appropriate design coefficients for the particular application when using MRS and CRS(θ, t). The reader is advised to consult the owner of the material designation for specifics regarding interpretation or use of the MRS and CRS(θ, t) values listed in TR-4.
### 2. Independent Listings – PE 80

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### TABLE III.A.2 - PE 100 MATERIALS

The following materials have a recommended MRS of 10.0 MPa (1450 psi) at 20°C (68°F).

1. Dependent Listings – PE 100

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APPENDIX

List of Manufacturer
Contacts

*use the Search Listing feature on the
PPI HSB web section

http://plasticpipe.org/hsb/searchlistings.html
APPENDIX

PPI Membership

Benefits
8 Reasons to Join the Plastics Pipe Institute

1. **Learn from the Experts – Your Industry Peers!**
   PPI offers unmatched opportunities to learn more about the plastics pipe industry from the experts in your industry – your peers. Learn about best practices, market opportunities, standardization issues, ongoing research and many other areas critical to your company’s success.

2. **Input into Industry Positions**
   PPI is recognized as the industry voice before North American and international standards setting organizations, code writing bodies, municipalities and other regulatory agencies. And we regularly provide industry positions to these groups. Help us develop positions that will benefit your interests.

3. **Networking**
   Membership allows you participation in all PPI forums and meetings. At these events, you will meet and learn from your peers in the industry. Our membership includes material and additive suppliers, pipe manufacturers, equipment manufacturers and distributors, giving you access to the complete supply chain. PPI’s Spring and Fall meetings are recognized throughout the industry as “must-attends” and are open to members only.

4. **Technical Credibility of PPI and the Use of the PPI Logo**
   PPI is recognized around the world as the technical expert on plastic piping issues. The use of our logos is available to members only, and provides unmatched credibility. Use the logo(s) on your literature, product packaging, website and business cards to show that you are part of the worldwide leader on plastic pipe issues.

5. **Links to Your Company from PPI’s Website**
   We provide links to all of our members through our website www.plasticpipe.org. PPI has thousands of visitors monthly, all looking for suppliers of piping products, or information about products. We provide a link for them to quickly get to you.

6. **Services of PPI’s Staff**
   Our technical, engineering and marketing staff are ready to answer your questions and help you grow your business. This knowledge base is available to members everyday, and is a benefit we encourage you to use. Call us today!

7. **Discounts on PPI Services & Products**
   PPI members get significant discounts on PPI’s products and services, including literature, certification program fees and product listing fees. These products and services will help your business succeed – and at a discount!

8. **50 + Years of Experience**
   PPI was founded in 1950, and through responsible and credible leadership, has established itself as the technical and marketing leader of the industry before a wide variety of stakeholders. Today, PPI is the voice of the plastics piping industry.