

**PPI TR-3
HDB/HDS/PDB/
SDB/MRS/CRS
Policies**

May 1, 2024

Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe



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FOREWORD

This report presents the policies and procedures used by the HSB (Hydrostatic Stress Board) of PPI (Plastics Pipe Institute, Inc.) to develop recommendations of long-term strength ratings for commercial thermoplastic piping materials or pipe. Recommendations are published in PPI TR-4, "PPI Listing of Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe", a regularly updated document.

PPI is a trade association dedicated to promoting the effective use of plastics piping systems. Since the 1950s, the PPI HSB has worked as a volunteer group under PPI's auspices to issue listings and continually evaluate and update procedures for long-term strength forecasting.

Listings are developed from stress rupture data submitted to the PPI HSB by the manufacturer. The general method used to evaluate the data is given in ASTM D2837, "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials," for HDB, SDB and PDB listings. For MRS listings, the data is evaluated using ISO 9080 Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation and classification is in accordance with ISO 12162 Thermoplastics materials for pipes and fittings for pressure applications – Classification, designation and design coefficient. All design basis must comply with the additional requirements delineated in this report. Many important national and international thermoplastic pipe standards, including those issued by ASTM International (American Society for Testing and Materials), ISO (International Standards Organization), NSF International (National Sanitation Foundation), AWWA (American Water Works Association), ANSI (American National Standards Institute), ASME (American Society of Mechanical Engineers) and the API (American Petroleum Institute), reference the long-term strength recommendations listed with the PPI HSB.

This report was prepared by PPI HSB as a service to the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but is offered “as is” without any express or implied warranty, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Each product manufacturer that lists compositions with the PPI HSB 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.

Additional information may be needed in some areas, especially with regard to unusual or special applications. Consult the manufacturer or material supplier for more detailed information. PPI does not endorse the proprietary products or processes of any manufacturer, and assumes no responsibility for compliance with applicable laws and regulations.

Questions, comments, and problems of interpretation should be referred to the the PPI HSB Chair, Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75062. Copies of this report, as well as other publications, are available from the PPI website: www.plasticpipe.org.

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SUMMARY OF CHANGES

SECTIONS	REVISIONS
2024 Version	
NOTES TO READER	HSBTG4-0214: Harmonization of the PPI TR-3 and PPI TR-4 Notes to Reader.
DEFINITIONS	HSBTG25-0219: The terms “commercially produced pipe” and “laboratory extruded pipe” were defined. PPI TR-3/2023 uses both terms but the actual definition was not included. PPI TR-3/2024 includes the actual definitions.
Part A.1.4 Acceptance of Data Policy	HSBTG7-0315: This new policy details acceptance requirements for the sustained pressure test data generated in accordance with ASTM D1598 or ISO 1167. The below deadlines have been communicated since May 2021: ▪ ISO 17025 laboratories: Data started after EOY2023 and submitted for a PPI HSB listing, must comply with the policy. ▪ In-House laboratories: Data started after EOY2024 and submitted for a PPI HSB listing, must comply with the policy.
Part J. UNPLASTICIZED POLYAMIDE (PA) SPECIFIC POLICIES, PRACTICES AND PROCEDURES	POTG16-0815: This new policy details requirements for initial listing unplasticized polyamide (PA) pressure pipe grades. This first policy is specific to PA-11 and PA-12 grades.
2023 Version	
Experimental Grade Levels	Editorial revision: Revised format "E-X" to harmonize with the Experimental Grade levels shown Part A.1.2.1 Table. Minimum Distribution of Data Points.
Par A.1.2.1	Editorial Revision: Added label for the Table of Contents "Experimental Grade Progression to Standard Grade Requirements"
Part A.1.2.2 Renewal Requirements for Standard Grade Independent Listings	Editorial revision: In Part A.1.2.2.4, removed mention of "or PDB" as those policies are specific to HDB listings. PDB renewal policies are detailed in Part A.1.2.2.8.
Part A.1.3 Listing Request Packet Required Information	HSBTG23-0817: This new policy details listing request packet requirements.
Part B. Grades of Recommendations and Data Requirements for MRS and CRS _{0,t}	HSBTG23-0817: The existing Part B. policy references the new policy, Part A.1.3 Listing Request Packet Required Information.

2023 Version	
Part C. Strength Design Basis (SDB)	Editorial revision: Mentions of ASTM F 2018 now reference the last active version of the standard, which was 2000. The mentions are revised to "ASTM F 2018-00".
PVC policy: Part E.5.2 To establish a range with greater component variability	Editorial revision: Mentions of "b, c and d" in E.5.2.1 were revised to "E.5.2.2, E.5.2.3 and E.5.2.4".
CPVC policy: Part H.5.2 To establish a range with greater component variability	Editorial revision: Mentions of "b, c and d" in H.5.2.1 were revised to "H.5.2.2, H.5.2.3 and H.5.2.4".
Checklists (PVC and non-PVC Compounds)	Editorial revision: Removed both checklists from PPI TR-3 and included mention of their availability on the PPI HSB web pages. This approach harmonizes with that taken for the request letter templates.
Document	Editorial revision: Harmonized the layout in all sections.
2021 Version	
Term/ Definition: commercially produced pipe	HSBTG25-0219: Revised the language to reflect the term and definition for "commercially produced pipe". This replaces terms such as "commercially extruded pipe", "extruded on commercial equipment" and the other variations seen in PPI TR-3. Note, the HSB IRC document details all mentions that were replaced with "commercially produced pipe".
Part A.4 HDB Validation of 180°F HDB PE Compound	POTG11-0819: The policy is revised to include validation requirements for the 180°F (82°C) HDB PE compound listings. Note, the HSB IRC document records the previous and revised language.
Part A.8 Stress Rating of Thermoplastic Pipes with Barrier Layers	CMPTG6-0819: Reference to PPI TN-23 was removed as the policy language is being included in PPI TR-3. In addition, the word "pressure" was revised to "stress" as this reflects the policy. Note, the HSB IRC document records the previous and revised language.
Part F.4.5.2 ISO 9080 Based Method for Validation of 180°F (82°C) HDB	POTG13-0220: The policy is revised to include use of ISO 11357-3 DSC method to determine the melting point for a PE compound. The ramp rate and sample sized are specified. Note, the HSB IRC document records the previous and revised language.

Part G.1 PEX Initial Listing Policy	POTG10-0816: A new policy provides guidance on the initial listing requirements for PEX compounds and pipe. – Part G.1.1: Policy for PEX Material Designation Codes – Part G.1.2: Listing Requirements for PEX Pipe Compounds and HDB Recommendations – Part G.1.3: Listing Requirements for PEX Pipe HDB Recommendations with a polymeric barrier layer. – Part G.1.4: Listing Requirements for PEX Dependent Listings. Note, the HSB IRC document records the previous and revised language.
2020 Version	
All pages, where needed	Editorial revision: Added headers throughout the document.
All pages, where mentioned	Editorial revision: Reformatted “5 year” to “5-year” to match the formatting elsewhere in the document.
All pages, where mentioned	Editorial revision: Reformatted “50 year” to “50-year” to match the formatting elsewhere in the document.
All pages, where mentioned	Editorial revision: Editorial revision: “Chairman of the HSB” to “PPI HSB Chair”.
Table of Contents	Editorial revision: Added all marked headers and page numbers.
Foreword	Editorial revision: Updated the foreword
Summary Of Changes	Editorial revision: Moved after the Foreword.
Notes To Reader	Editorial revision: Corrected typo “insure” to “ensure”.
Definitions	Editorial revision: Formatted into a table.
Acronyms	Editorial revision: Formatted into a table.
Part A.1.2. Duration and Renewal of Recommendations	Editorial revision: Part A.1.2.2.13: Separated the two provisions.
Part A. HDB Requirements	Editorial revision: Formatted to tables.
Part E.4.Substitution of Resin in Poly (Vinyl Chloride) PVC Plastic Pipe Formulations	Editorial revision: Formatted resin properties into a table.
Part E.5 Allowable Formulation Variability for PVC Pipe and Fittings Compounds	Editorial revision: Formatted allowed variations into a table.
Part H.4 Substitution of Resin in Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Formulations	Editorial revision: Formatted resin properties into a table.
APPENDIX: X.1.2, X.1.3, X.1.4, X.1.5	Editorial revision: Separated from Appendix X.1 and placed in new appendix X.2 SUPPLEMENTAL INFORMATION ON LISTINGS. – X.2.1 Additional Information – X.2.2 Release of Recommendations – X.2.3 Appeals of HSB Actions – X.2.4 Confidentiality – X.2.5 Request Templates

APPENDIX: Request Letter Templates	Editorial revision: Removed the older request templates and added mention in new X.2.5 Request Templates, that these are available online.
APPENDIX X.3	Editorial revision: Added title "CONVERSION OF PHR TO WEIGHT PERCENT" and reformatted.
APPENDIX X.4 PPI Membership	Editorial revision: Removed PPI membership information as the PPI HSB provides a service to the industry. Also, a PPI membership is not required to list with the PPI HSB.
Part G.3 Policy on Establishing Equivalence of Modified PEX Pipe Compositions	Editorial revision: Formatted test requirements into a Table.
PE Compounds with a Recommended HDB at 180°F	Existing policy is now labeled for PE compounds with a recommended HDB up to 140F: – Part F.1.1: Substitution of Thermal Stabilizers – Part F.2.1: Variation in the Amount of Stabilizer – Part F.3.1: Substitution of Ultraviolet Light Stabilizers in Non-Black PE Compounds
	NEW policy is included for PE compounds with a recommended HDB up to 180F: – Part F.1.2: Substitution of Thermal Stabilizers – Part F.2.2: Variation in the Amount of Stabilizer – Part F.3.2: Substitution of Ultraviolet Light Stabilizers in Non-Black PE Compounds – Part F.4.5: ISO 9080 Based Method for Validation of 180°F (82°C) HDB
	New language is added to direct the reader to policies applicable to the 180F HDB PE compounds in these parts: – Part F.4: PE Validation (2nd paragraph) – Part F.5: PE Substantiation (1st paragraph) – Part F.6: PE Modifications (1st paragraph).
Part F.6.3 Test requirements to establish equivalence	Editorial revision: Formatted test requirements using bullet points.

2018 Version	
Definitions	- Added a definition for solid wall pipe. - Removed the previous definition for Multilayer pipe based on Type 1, Type 2 and Type 3. Replaced previous definition of composite pipe with the new ones: - Group 1 (Helically Wrapped Reinforced Thermoplastic Pipe (RTP)) - Group 2 (Dispersed Reinforcement) - Group 3 (Multilayer (non-helically wrapped)) which comprises: - Barrier; - Reinforced; - Coextruded thermoplastic compounds.
Part E.3. FULFILLING CERTAIN PPI TR-3 REQUIREMENTS BY UTILIZING AN ALTERNATE METHOD OF ANALYZING STRESS - RUPTURE DATA FOR PVC - Part E.3.1.2.4	New language to state that one lot of pipe is needed to qualify a substituted PVC resin.
Part E.4. SUBSTITUTION OF RESIN IN POLY (VINYL CHLORIDE) PVC PLASTIC PIPE FORMULATIONS - Part E.4.2.1	Hydrostatic design stress was revised to HDB
Part E.4. SUBSTITUTION OF RESIN IN POLY (VINYL CHLORIDE) PVC PLASTIC PIPE FORMULATIONS - Part E.4.3.1	The previous regression requirements were revised to a full E-2 in accordance with Part A.1.2.1. Note, E.4.3.2 was removed and Note 3 was revised.
Part F.6.3.2 MRS Equivalence	Corrected typo in second bullet to reference F.6.3.1
Part G.1. POLICY FOR PEX MATERIAL DESIGNATION CODES	This is now a policy for PEX material designation codes.
Part G.2. POLICY ON FORMULATION MODIFICATIONS FOR PEX HDB LISTINGS	The percentages in Parts G.2.3.1.3 and G.2.3.2 were revised to state as a weight percent.

2017 Version	
PART A.1 GRADES OF RECOMMENDATIONS AND RENEWALS	Updated to include the Five Year Renewal Policy for PPI TR-4 HDB and PDB Independent Listings at Standard Grade.
PART B.1 GRADES OF RECOMMENDATIONS AND RENEWALS	Updated to include the Five Year Renewal Policy for PPI TR-4 MRS and CRS Independent Listings at Standard Grade.
PART C.1 GRADES OF RECOMMENDATIONS AND RENEWALS	Updated to include the Five Year Renewal Policy for PPI TR-4 SDB Independent Listings at Standard Grade.
2017a Version	
PART A.1.2.2.4 Hydrostatic pipe testing for any HDB or PDB listed product	Updated to explicitly state validation as a requirement for PE compounds holding a HDB listing.
2016 Version	
PART F. POLICY ON ESTABLISHING EQUIVALENCE OF MODIFIED PE PIPE COMPOUNDS	Language clarified in Part F.6
APPENDIX X.1	Language clarified in X.1.1 Checklist
2012 Version	
Document title	Title – Added “CRS”
PART A. GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR HDB and PDB	Addition of Part A.10 Recommended HDB AND PDB Ratings Using ASTM D2992
PART B. GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR MRS AND CRS _{0,t}	- Part B.2 was removed. - Sections were renumbered.
PART D. GENERAL POLICIES, PRACTICES AND PROCEDURES - D.1 POLICY ON COLORANT CHANGES	Edits to clarify TR-3 language related to Colorant Ranges: - Parts D.1.1.12: D.1.1.2.1, D.1.1.2.2 and D.1.1.2.3
PART E.2. POLICY ON SUBSTITUTION OF AN APPARENTLY IDENTICAL INGREDIENT IN A PVC COMPOSITION	Addition of Part E.2.1
PART F.6. POLYETHYLENE SPECIFIC POLICES, PRACTICES AND PROCEDURES	Addition of - F.6.1: HDB Equivalence - F.6.2: MRS Equivalence
PART G. PEX Specific Policies, Practices and Procedures	Addition of - G.1: Protocol for PPI Listing of PEX Pipe in PPI TR-4 - G.2: Policy on Formulation Modifications for PEX HDB Listings - G.3: Policy on Establishing Equivalence of Modified PEX Pipe Compositions
PART H. POLICY ON SUBSTITUTION OF AN APPARENTLY IDENTICAL INGREDIENT IN A CPVC COMPOSITION	Addition of Part H.2.1

NOTES TO THE READER

SOME RULES AND CONDITIONS

1. **Processing Techniques:** It is stressed that these policies and procedures are for development of HDB/HDS/PDB/MRS/CRS/SDB recommended ratings issued by the PPI HSB for conditions equivalent to those under which the test data were obtained from good quality extruded pipes or machined or injection molded specimens. These HDB/HDS/PDB/MRS/CRS/SDB 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 standards: ASTM D883, "Standard Definition of Terms Relating to Plastics"; ASTM F412, "Standard Terminology Relating to Plastic Piping Systems"; ISO 9080, "Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation"; and ISO 12162, "Thermoplastics materials for pipes and fittings for pressure applications - Classification, designation and design coefficient".
3. **Adjusting Recommended Ratings for Application-Specific Environments:** It is the current policy of the PPI HSB to provide recommendations of the HDB's and HDS's at 73°F and elevated temperature HDB's for water for thermoplastic piping compounds. The recommended ratings, HDB/HDS/PDB/MRS/CRS/SDB, issued by the PPI HSB are based upon conditions under which the test data were obtained, e.g., constant pressure, temperature, and hydrostatic test environment. Various industry standards, codes, or regulations can utilize the application of appropriate design factors or design coefficients to calculate the maximum allowable operating pressure for the piping system for the desired application(s). Under certain conditions, such as pressure cycling, elevated temperature excursions, aggressive internal or external environments, live and dead loads, notch sensitivity of the buried pipe, or handling and installation concerns, the long-term pipe performance may be significantly reduced. Thus, a more conservative design factor or design coefficient may apply. Further, sustained hydrostatic pressure testing at elevated temperatures used to obtain some recommendations may not be sufficient to fully evaluate either the thermal or oxidative stability of the pipe compound.
4. **Recommendation of Hydrostatic Design Basis (HDB) and Hydrostatic Design Stress (HDS):** The Hydrostatic Design Stress (HDS) is the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when the internal hydrostatic water pressure is applied. The HDS is determined by reducing the HDB by a Hydrostatic Design Basis Factor (DF_{HDB}) which is a number less than 1.00. This design factor is used to reduce the HDB into an engineering design stress taking into consideration the variables and margin of safety involved in a properly installed thermoplastic pressure pipe system. The PPI HSB recommended DF_{HDB} are for sustained water pressure at 73°F.

5. **Hydrostatic Design Stress (HDS):** HDS recommended ratings issued by the PPI HSB are maximum recommended values for conditions equivalent to those under which the test data were obtained, e.g., constant pressure, temperature and specific test environment. Maximum HDS values are arrived at in the PPI HSB policies by multiplying the HDB by a design factor of 0.50 unless otherwise stated in this PPI TR-3.
6. **Product Standards:** Scientific procedures and historical experience support that an HDB/HDS/PDB/MRS/CRS/SDB recommended rating, based on test method ASTM D2837, ISO 9080 or ASTM F2018-00, is a useful indicator of the relative long-term strength of a thermoplastic piping compound. The actual long-term performance of a thermoplastic piping compound (or a piping product made with that thermoplastic piping compound) may be different because of factors and conditions that are not addressed in ASTM D2837, ISO 9080, ASTM F2018-00 or this report. These other factors and conditions, not addressed in ASTM D2837, ISO 9080, ASTM F2018-00 or this report, need to be considered and should be addressed in the relevant pipe product standard. The appropriateness of an HDB/HDS/PDB/MRS/CRS/SDB recommended rating for a specific application is the responsibility of the end user or the appropriate/governing regulatory entity. 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.
7. **Sunlight (UV) Exposure:** These policies do not take into consideration the adequacy of protection against sunlight exposure in any thermoplastic piping compound. Manufacturers may include suitable ingredients for the protection of properties against possible degradation by sunlight radiation during normal storage and use. Product standards may also specify requirements for UV protection.
8. **Recommended Ratings are Formulation Specific:** Each HDB/HDS/PDB/MRS/CRS/SDB recommended rating issued by the PPI HSB is specific to that particular thermoplastic piping material compound formulation, including the procedure for mixing, which is represented by the data submitted to the PPI HSB. Any changes in the mixing procedure, in the formulation, or in its ingredients, outside those permitted in the PPI TR-3 policies are considered to result in a new compound, which may have different long-term strength properties. The listed HDB/HDS/PDB/MRS/CRS/SDB does not apply to this new compound, unless the changes have been made, or validated, in accordance with one or more of the policies presented in PPI TR-3, or have been considered by the PPI HSB and deemed acceptable based on information provided to the PPI HSB.

9. **Resin Changes:** An inherent assumption in the development of these policies and procedures is that the commercial thermoplastic compound will be of equivalent chemical and molecular composition, insofar as these parameters influence long-term strength and durability, to the thermoplastic compound used in the composition on which the original long-term data supplied to PPI HSB were obtained. Any modification of the thermoplastic compound is considered to result in a different material from the one on which the original HDB/HDS/PDB/MRS/CRS/SDB recommended ratings were based. Unless the modification is otherwise covered in a PPI TR-3 policy, the PPI HSB Chair 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 thermoplastic compound, the PPI HSB Chair 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, the determination under these policies will have to be made by the PPI HSB in consultation with the manufacturer.
10. **Disclaimer:** While every effort has been made by the PPI HSB to assure that these policies are sound, reasonable and prudent, PPI HSB expressly disclaims any guarantee or warranty regarding their application. Each manufacturer who lists thermoplastic compounds or composite pipe in accordance with the procedures in PPI TR-3 does so voluntarily and with the express agreement that PPI assumes no liability in regards to the listed thermoplastic compounds or composite pipe, and that the manufacturer will hold PPI harmless from any claims or liability arising in connection with its listed thermoplastic compounds or composite pipe.
11. **Manufacturer's Responsibility:** The manufacturer is responsible to ensure that their 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 PPI HSB. In the case of a deviation or circumstance not covered by a specific policy, the manufacturer may consult the PPI HSB. .
12. **Adoption of Policies and Procedures:** These policies and procedures have been adopted using standard letter ballot methods.
13. **Interpretations:** Questions pertaining to the interpretation of any policies in this report should be referred to the PPI HSB Chair, Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75062.
14. **Maximum Temperature for Listings:** The maximum temperature for which PPI HSB will list an HDB/HDS/PDB/MRS/CRS/SDB for a material in accordance with the policies and procedures in PPI TR-3 is 200°F (93°C). For listing at temperatures above 200°F, a "Special Case" (See Note 15) may be requested for consideration by the PPI HSB.

15. **Special Case Listings:** The policies and procedures in PPI TR-3 are intended to cover HDB/HDS/PDB/MRS/CRS/SDB recommended ratings for most thermoplastic piping materials. The PPI HSB recognizes there may be cases, issues or circumstances that are not covered in PPI TR-3, and that may justify an exception to the standard policies. To allow manufacturers an opportunity to have their compounds or composite pipe listed by PPI HSB when this occurs, the PPI HSB has provided a “Special Case” process. The manufacturer may present its “Case” to the PPI HSB at one of their two annual meetings, usually in February and August, using the approved “Checklist for the PPI HSB Submissions” form in PPI TR-3 Appendix X.1. All information provided to the PPI HSB in these special cases will be made available for review only by the PPI 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 PPI HSB Chair). There is a fee for each special case. A company or individual interested in presenting a special case to the PPI HSB should contact the PPI HSB Chair well in advance of the meeting. A completed submission form must be received at least 30-days in advance of the PPI HSB meeting to permit the PPI HSB consideration at that meeting.

ACRONYMS

ANSI	American National Standards Institute 1430 Broadway New York City, New York 10018
API	American Petroleum Institute 211 North Ervay Suite 1700 Dallas, Texas 75201
ASTM	ASTM International 100 Barr Harbor Drive West Conshohocken, Pennsylvania 19428
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, Colorado 80235
CSA	CSA International 178 Rexdale Boulevard Toronto, Ontario Canada M9W 1R3
HSB	Hydrostatic Stress Board c/o Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, Texas 75062
ISO	International Organization for Standardization. Secretariat: Netherlands Normalisatie-instituut (NNI) P. O. Box 5059 2600 GB Delft, Netherlands USA Contact: American National Standards Institute 1430 Broadway New York City, New York 10018
NSF	NSF International 789 Dixboro Road Ann Arbor, Michigan 48113-0140
PPI	Plastics Pipe Institute, Inc. 105 Decker Court, Suite 825 Irving, Texas 75062

DEFINITIONS

Brittle	A failure mode which exhibits no visible (to the naked eye) material deformation (stretching, elongation, or necking down) in the area of the break.
Commercially produced pipe	Pipe made by a pipe producer on commercial production equipment
Composite pipe	This pipe is defined by the following Groups 1, 2 and 3. NOTE: The regression must have a negative slope. Group 1: Helically Wrapped Reinforced Thermoplastic Pipe (RTP): The case in which the reinforcement elements are applied such that they have the shape or form of a helix (spiral) and additional non-helical elements are acceptable. Group 2: Dispersed Reinforcement: Solid wall pipe with reinforcement dispersed by compounding in the polymer matrix. Group 3: Multilayer (non-helically wrapped): A pressure rated pipe having more than one layer and does not rely exclusively on a reinforcement for its strength. i. Barrier: a pipe identified with distinct layers of dissimilar materials such as polymer/metal/polymer (PEX/AL/PEX) or polymer/non-stress rated polymer/polymer (PEX/EVOH/PEX). ii. Reinforced: a pipe identified with distinct layer(s) such as metal mesh, foamed or a layer with dispersed fillers. iii. Coextruded thermoplastic compounds: a pipe identified with distinct layers of thermoplastic compounds such as MDPE with a HDPE, PP with PE, natural plastic with a pigmented layer or others other coextruded structure.
$CRS_{q,t}$	The Categorized Required Strength, $CRS_{q,t}$, is the categorized lower prediction limit (LPL) of the long-term hydrostatic strength at a temperature (q) and a time (t) as determined in accordance with ISO 9080 and ISO 12162. $CRS_{q,t}$ at 20°C and 50-years equals MRS.
(C)	Design Coefficient - a number greater than 1.00 that takes into consideration the variables and degree of safety involved in a properly installed thermoplastic pressure piping installation. For purposes of this document, a design coefficient recommended for use with an MRS category is designated C.

(DF)	Design Factor - a number less than 1.00 that takes into consideration the variables and degree of safety involved in a properly installed thermoplastic pressure piping installation. For purposes of this document, a design factor recommended for use with an HDB category is designated DF.
Dependent listing	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.
Ductile	A failure mode which exhibits material deformation (stretching, elongation, or necking down) in the area of the break.
E-X	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.
Experimental Grade (E)	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.
HDB	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, "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials." 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.
HDS	Hydrostatic Design Stress – the recommended maximum hoop stress that can be applied continuously with a high degree of certainty that failure of the pipe will not occur.
Independent listing	A listing that has been established by a formulation owner under the provisions of Part A of TR-3.
Laboratory produced pipe	Pipe produced that does not fulfil the requirements of commercially produced pipe.
LCL Ratio	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%.

LCL	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.
LTHS	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.
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.
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. (See Appendix X. 3)

Pressure Rating (PR)	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. $PR = 2 (HDB) \times (\text{design factor}) / (SDR-1)$ where SDR = Standard Dimension Ratio = average outside diameter/ minimum wall thickness Or $PR = (PDB) (\text{design factor})$
Private listing	Manufacturer's listing that is held privately within PPI and is not published in PPI TR-4.
SDB	Strength Design Basis – one of a series of established stress values (specified in Test Method D2837) for a plastic molding compound obtained by categorizing the long-term strength determined in accordance with ASTM Test Method F 2018-00. The term SDB (Strength Design Basis) refers to the categorized long-term strength for a plastic molding compound obtained by ASTM F 2018-00, “Standard Test Method for Time-to - Failure of Plastics Using Plane Strain Tensile Specimens.” NOTE: The SDB is used only for a material intended for molding applications. The SDB shall not be used for pipe applications.
Solid Wall Pipe	The pipe wall is composed entirely of a single extruded layer of a single compound
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 D2513 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-3/2011 is the 2011 edition of TR-3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) 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.

COMMON PLASTICS ABBREVIATIONS

CPVC	Chlorinated Poly (vinyl chloride)
PA	Polyamide (aka nylon)
PB	Polybutylene
PE	Polyethylene
PEX	Crosslinked polyethylene
PFA	Perfluoro (alkoxy alkane)
POM	Polyoxymethylene (aka polyacetal)
PP	Polypropylene
PVC	Poly (vinyl chloride)
PVDF	Poly (vinylidene difluoride)

PART A. GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR HDB and PDB

A.1 GRADE OF RECOMMENDATIONS AND RENEWALS

A.1.1 Three grades of recommended hydrostatic design basis (HDB), hydrostatic design stress (HDS) and pressure design basis (PDB) are issued by PPI. These recommended grades are either publicly listed in PPI TR-4 or privately listed within PPI:

A.1.1.1 The **Standard Grade recommendation** is for a five-year period for those materials that comply with the full data requirements of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, and all the pertinent additional data requirements which are detailed in Sections that follow.

A.1.1.2 The **Experimental Grade recommendation** is for a limited duration and is for 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 the Sections that follow. **The owner of an experimental grade 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. The 85% LCL requirements, and all other requirements in D 2837 applies to experimental grades except as noted in TR-3.**

A.1.2 Duration and Renewal of Recommendations

A.1.2.1 Experimental Grade Progression to Standard Grade Requirements

An **Experimental Grade recommendation** must be periodically advanced through certain specified data levels until the full data requirements of the Standard Grade are satisfied. **Failure to make a required advance of an Experimental Grade recommendation will cause the recommendation to expire.** The recommendation level and temperature determine the data requirements. The experimental point distribution requirements for each test lot vary according to the test data level as follows:

Experimental Data Level	Covers Data for at Least (hrs)	Total Min. number of test points	MINIMUM DISTRIBUTION OF DATA POINTS					
			Less than 1000 (hrs)	Over 2000 (hrs)	Over 4000 (hrs)	1000-6000 (hrs)	Over 6000 (hrs)	Over 8000 (hrs)
E-2	2,000	10	6	1	---	---	---	---
E-4	4,000	10	6	1	1	---	---	---
E-6	6,000	12	6	---	---	3	1	---
E-8	8,000	15	6	---	---	3	1	1
E-10	10,000	18	(Consult latest issue of ASTM D2837 for data distribution requirements)					

A.1.2.2 Renewal Requirements for Standard Grade Independent Listings

The **Standard Grade recommendation** is for a five-year period. The owner of such recommendations may request a continuation for another five-year period within 4 1/2 and 5-years after the initial listing. This renewal procedure may be repeated. (**PPI TR-3 Parts A.1.2.2.1 – A.1.2.2.13** details the Five-Year Renewal Policy for Independent Listings at Standard Grade level).

A.1.2.2.1 **The Five-Year Renewal** shall apply only to Independent Listings at Standard Grade level. Dependent Listings which are covered by PPI TR-3 Part D.3, are excluded from this requirement.

A.1.2.2.2 **Any data submission** must be on a current lot of the compound produced within the most recent 5-year listing period and not from any previously listed lot of the compound.

A.1.2.2.3 **All Independent Listings** must verify that all the compound cell classification requirements of the originally listed compound are met on one lot per A.1.2.2.2, in accordance with the current version of the appropriate ASTM, ISO or other appropriate product standard.

A.1.2.2.4. **Hydrostatic pipe testing for any HDB listed product** requires the testing of the same lot of the compound as per A.1.2.2.3;

- a. To the initial experimental grade level for the maximum temperature in the original listing per PPI TR-3 Part A.
- b. Submission of the hydrostatic test data using the PPI TR-3 submittal checklist in appendices X as was done for the initial listing. Please see applicable sections in TR-3.
- c. Hydrostatic test data on either laboratory or commercially produced pipe may be submitted.
- d. PE compounds listed with an HDB shall include validation requirements.

A.1.2.2.5 **Hydrostatic pipe testing for any MRS listed products** requires the testing of the same lot of the compound as per A.1.2.2.3 by the MRS equivalence procedure in F.6.2 or as follows:

- a. For PE-100 products: 20°C @ 12 MPa for ≥ 100 hours and 11.1 MPa for ≥ 2,500 hours and 80°C @ 5.4 MPa for ≥ 165 hours and 4.9 MPa for ≥ 2,500 hours.
- b. For PE-80 products: 20°C @ 10 MPa for ≥ 100 hours and @ 9.1 MPa for ≥ 2,500 hours; @80°C @ 4.5 MPa for ≥ 165 hours and @ 3.9MPa for ≥ 2,500 hours.
- c. Three pipes at each condition shall meet or exceed the time requirement.
- d. Hydrostatic test data on either laboratory or commercially produced pipe may be submitted.

A.1.2.2.6 **If a product has both an HDB and MRS listing**, the listing holder can choose which test to conduct from A.1.2.2.4 or A.1.2.2.5

A.1.2.2.7 **SDB listed products** requires the testing of the same lot of the compound as per A.1.2.2.3 as follows:

- a. SDB data of E-2 at 73°F, and E-6 at the highest listed temperature is needed to the same SDB level as the original listing.

A.1.2.2.8 **Material Specific Requirements**

- a. **PEX pipe** including those with barrier layers must confirm that the gel level per ASTM D2765 is not lower than the original listed compound.
 - i. ASTM D2765 testing shall include testing of colored PEX with barrier layer at maximum thickness, if such a pipe is manufactured.
 - ii. In the instance, that no colored pipe with a barrier layer is manufactured, then a colored PEX construction may be tested.
 - iii. In the instance that neither barrier layer piping nor colored piping is manufactured, then a natural piping material may be tested.
- b. **Multilayer pipes:** Specimens of one structure representing the severe case pipe size are to be tested. The severe case pipe size is that size with the highest strain energy in the pipe wall. Rationale must be presented with the listing request to support the “severe case” analysis.
- c. **Hydrostatic pipe testing for any thermoplastic pipes with barrier layers different from above** requires the testing of the same lot of the compound as per A.1.2.2.3 as follows:
 - i. The specific construction of the product shall be supplied and verified to have not changed from the originally submitted product.
 - ii. Submission of stress rupture data of E-2 at 73°F, and E-6 at the highest listed temperature and the thinnest wall manufactured (i.e. the pipe which has the barrier layer at the highest percentage of the overall wall thickness). The total thickness of the barrier layer shall be the same, $\pm 10\%$, for all pipe sizes to be manufactured under this listing. Data must result in the same HDB as the original thermoplastic stress rupture data.

A.1.2.2.9 In cases where the same base resin is used in multiple Independent Listings:

- a. The Listing Owner may satisfy the renewal requirements for all these listings by submitting test data from just one of these compounds, provided all of the common listings are of the same HDB(s). Thus, all Independent Listings shall be considered either by testing or by association to a family of products which has had a representative lot of the compound tested.

NOTE: For example, listings established via equivalency are considered part of the family of products based on the “parent listing”.

- b. It is the responsibility of the Independent Listing Owners to communicate the product family to the PPI HSB Chair in this regard.
- c. The renewal is not base resin manufacturing location specific.

A.1.2.2.10 Standard Grade Recommendations are renewed if they meet or exceed the minimum performance capability in the original listing.

A.1.2.2.11 This renewal policy is not compound manufacturing location specific.

A.1.2.2.12 Products that are not renewed or not in the process of renewal will be delisted from PPI TR-4 in the subsequent year. Companies may appeal to the PPI HSB Chair or provide a special case to the HSB until the appeal is resolved.

A.1.2.2.13

- a. The HSB Chairman shall have the authority in situations where most or all of the 5-year renewals are in a single year or in only a 2-year period to stagger the workload over the 5-year time period.
- b. The Chairman shall also have the authority to waive the 5-year renewal testing of compounds based on the same base resin in the case where said base resin has undergone full standard grade level testing for a new listing in the 5-year period.

A.1.3 Listing Request Packet Required Information

For a recommendation in PPI TR-4 or PPI TR-2, the manufacturer shall include the following information in the request packet.

A.1.3.1 A cover letter detailing the request and a completed checklist.

NOTE: Checklist templates are available in the PPI HSB web section.

A.1.3.2 If regression data was generated, the laboratory report(s) shall be included in the request packet.

A.1.3.2 In addition to fulfilling all the applicable requirements of the data analysis standard (D2837 or ISO 9080/ ISO 1167), the laboratory report shall report the following for the regression data.

- a. Whether the point was used in or excluded from the analysis. A reason shall be noted for points excluded from the analysis.

b. At any and all test temperatures, the hoop stress (psi or MPa) and the time (hours) for each failed test specimen or the time on test for non-failure specimens and if testing for the specimen was stopped or if it is still on test.

c. The nature or type of the failure mode, for example ductile or brittle.

NOTE: Other failure mode terms can be found in ASTM standards F412, D1598, D2837 and ISO 1167.

d. The electronic regression data.

NOTE: Pipeson or Excel format work best.

A.1.3.3 Cell classification data in accordance with the applicable material classification standard (e.g., ASTM D3350, D1784, D6779).

A.1.3.4 Applicable characterization data for the piping material, for example %crosslink, inherent viscosity, predefined properties for an ingredient listing in PPI TR-2.

NOTE: The request letter and checklist templates detail characterization data to include with the request packet.

A.1.4 Acceptance of Data Policy

A.1.4.1 All HDB, PDB or MRS test data submitted for listing to the Plastics Pipe Institute Hydrostatic Stress Board (PPI HSB) shall be in conformance with the applicable scope of testing in ASTM D1598 or ISO 1167, using a pipe testing environment of water in/ water out or water in/ air out for the pipe specimens, and generated in one of the qualified laboratories detailed in Part A.1.4.2.

A.1.4.2 Acceptance of the data is based on compliance and conformance as further described below:

A.1.4.2.1 Acceptable demonstration of compliance and conformance by a **Commercial Laboratory (CL)**:

- a. The laboratory is accredited in accordance with the latest version of ISO 17025 and whose accreditation includes the applicable scope of testing as stated and defined in A.1.4.1.
- b. The ISO 17025 accreditation of the laboratory shall be granted by an Accreditation Body (AB) listed by the International Laboratory Accreditation Cooperation (ILAC), International Accreditation Forum (IAF) or European Co-Operation for Accreditation (EA).
- c. The laboratory generating test data as defined in A.1.4.1, shall provide evidence of valid accreditation during the time that the data was generated and collected. This evidence shall be included in the submittal request.

NOTE 1: Commercial Laboratories (CL) are test facilities for hire.