

**TR-3/2004**  
**HDB/PDB/SDB/MRS**  
**Policies**

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



# TABLE OF CONTENTS

FOREWORD

NOTES TO THE READER

ABBREVIATIONS AND DEFINITIONS

PART A: GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR HDB AND PDB

- A.1 Grades of Recommendation
- A.2 Requirements for Grades at 73°F (23°C)
- A.3 Requirements for Grades at 140°F (60°C)
- A.4 Requirements for Grades at 180°F (82°C)
- A.5 Requirements for Grades at 200°F (93°C)
- A.6 Recommended HDB for New Materials
- A.7 Recommended PDB Ratings for Multilayer and Composite Pipes

PART B: GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR MRS

PART C: GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR SDB

PART D: GENERAL POLICIES, PRACTICES AND PROCEDURES

- D.1. Policy on Colorant Changes for HDB (Formerly Part D)
- D.2. Policy for Determining Long-Term Strength (LTHS) by Temperature Interpolation (Formerly Part E)
- D.3. Policy on Dependent Listings (Formerly Part F)
- D.4. Changes Between Two Percentages of a Compounding Ingredient (Formerly Part H)
- D.5. Measurement Variability (Formerly Part I)
- D.6. Requirements for Fittings Materials (Formerly Part J)

PART E: PVC SPECIFIC POLICIES, PRACTICES AND PROCEDURES

- E.1 Standard Industry Practice of High Intensity Mixing of PVC Pipe Compounds (Formerly Part A.2)
- E.2 Policy on Substitution of an Apparently Identical Ingredient in a PVC Composition (Formerly Part C)
- E.3 Fulfilling Certain PPI TR-3 Requirements by Utilizing Alternate Method of Analyzing Stress-Rupture Data for PVC (Formerly Part M)
- E.4 Substitution of Resin in Poly (vinyl chloride) PVC Plastic Pipe Formulations (Formerly Part S)

- E.5 Allowable Formulation Variability for PVC Pipe and Fittings Compositions (Formerly Part T)
- E.6 Substitution of Thermal Stabilizers in PVC Pipe Compositions (Formerly Part U)

## PART F. POLYETHYLENE SPECIFIC POLICIES, PRACTICES AND PROCEDURES

- F.1 Substitution of Thermal Stabilizers in PE Plastics Pipe Compounds (Formerly Part K)
- F.2 Variation in Amount of Stabilizer in PE Plastics Pipe Compounds (Formerly Part L)
- F.3 Substitution of Ultraviolet Light Stabilizers in Non-Black PE Plastics Pipe Compounds (Formerly Part V)
- F.4 Determination and Validation of the Hydrostatic Design Basis (HDB) for Polyethylene Piping Materials (Formerly Part X)
- F.5 Hydrostatic Design Basis Substantiation for PE Materials
- F.6 Policy on Establishing Equivalence of Modified PE Pipe Compositions (Formerly Part Z)

## PART G PEX SPECIFIC POLICIES, PRACTICES AND PROCEDURES

- G.1 Protocol for PPI Listing of Effect of Chlorine on PEX Pipe in PPI TR-4 (Formerly Part G)
- G.2 Policy on Formulation Modifications for PEX HDB Listings (Formerly Part AA)
- G.3 Policy on Establishing Equivalence of Modified PEX Pipe Compositions (Formerly Part BB)

## APPENDICES

### X.1 TEST DATA REPORT REQUIREMENTS

- X.1.1 Checklist for HSB Submissions
- X.1.2 Additional Information
- X.1.3 Release of Recommendations
- X.1.4 Appeals of Hydrostatic Stress Board Actions
- X.1.5 Confidentiality

### X.2 SUGGESTED LETTERS/FORMATS

- X.2.1 Letter from Owner of Independent Listing (For Part D.1.2)
- X.2.2 Letter from Intended Receiver of Independent Listing (For Part D.1.2)
- X.2.3 Resin Substitution in PVC Compositions

### X.3 PPI MEMBERSHIP APPLICATION

# **POLICIES AND PROCEDURES FOR DEVELOPING HYDROSTATIC DESIGN BASIS (HDB), PRESSURE DESIGN BASIS (PDB), STRENGTH DESIGN BASIS (SDB) and MINIMUM REQUIRED STRENGTH (MRS) RATINGS FOR THERMOPLASTIC PIPING MATERIALS OR PIPE**

## **FORWARD**

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 early 1960s, 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 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, or in ISO 9080 for MRS listings, with additional requirements delineated in this report. Many important national and international thermoplastic piping standards, including those issued by ASTM, ISO (International Standards Organization), NSF International, AWWA (American Water Works Association), ANSI (American National Standards Institute), ASME (American Society of Mechanical Engineers) and the API (American Petroleum Institute), reference these HSB/PPI listed long-term strength recommended ratings.

This report was prepared by PPI 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 without any warranty, expressed or implied. 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 Chairman of the HSB, Plastics Pipe Institute, 1825 Connecticut Ave. NW, Suite 680, Washington, DC 20009. Copies of this report, as well as other publications, are available from PPI on the website [www.plasticpipe.org](http://www.plasticpipe.org). Please ask for the current literature catalog.

This report was updated January 2004.

## 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 insure 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, 1825 Connecticut Ave N.W., Suite 680, Washington, DC 20009.
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 X.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

ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
API	American Petroleum Institute 211 North Ervay Suite 1700 Dallas, TX 75201
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
CSA	CSA, International 178Rexdale Boulevard Etobicoke, Ontario CANADA M9W 1R3
NSF	NSF International 789 Dixboro Road Ann Arbor, MI 48113-0140
PPI	Plastics Pipe Institute, Inc. 1825 Connecticut Ave. NW Suite 680 Washington, DC 20009
HSB	Hydrostatic Stress Board c/o Plastics Pipe Institute, Inc. 1825 Connecticut Ave. NW Suite 680 Washington, DC 20009
ISO	International Standards Organization Secretariat: Netherlands Normalisatie-instituut (NNI) P. O. Box 5059 2600 GB Delft, Netherlands  USA Contact: American National Standards Institute 1430 Broadway New York, NY 10018
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, <i>"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"</i> .
UV	Ultra-Violet radiation from solar exposure.
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.
Ductile	A failure mode which exhibits material deformation (stretching, elongation, or necking down) in the area of the break.
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.
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.
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.
Independent listing	A listing that has been established by a formulation owner under the provisions of Part A of TR-3.
Private Listing	Manufacturer's listing that is held privately within PPI and is not published in PPI TR-4.
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. <b>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.</b>

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.
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.
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.
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.
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%.
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.
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.

SDB

Strength Design Basis – one of a series of established stress values (specified in Test Method D 2837) for a plastic molding compound obtained by categorizing the long-term strength determined in accordance with ASTM Test Method F 2018. The term SDB (Strength Design Basis) refers to the categorized long-term strength for a plastic molding compound obtained by ASTM F 2018, “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.

CRS ( $\theta$ , t)

The CRS ( $\theta$ , t) is the Categorized Required Strength value of  $\sigma_{pl}$  determined and categorized for the selected temperature ( $\theta$ ) and required lifetime (t) in accordance with ISO 9080 using the 3 or 4 coefficient stress rupture/time equation.

Multilayer pipe

(In the US and Canada, sometimes multilayer pipe is referred to as composite pipe).

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.

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.

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.

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

SDR = Standard Dimension Ratio

= Average outside diameter / minimum wall thickness

or

$$PR = \text{(PDB) (design factor)}$$

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 Grades of Recommendation

A.1.1 Two grades of recommended hydrostatic design basis (HDB) 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.**

## A.1.2 Duration and Renewal of Recommendations

A.1.2.1 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:

Experi- mental 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 D 2837 for data distribution requirements)					

A.1.2.2 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.

**A.2 Requirements for Grades at 73°F (23°C):**

A.2.1 The Experimental Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except that the submitted test data need only meet the requirements given in the following table:

Level of Recommendation	Time of Data Submission	Minimum Data Required	
		Lots	At Level
E-2	Initial	One	E-2
E-4	Initial or, Within 6 months after level 2	One	E-4
E-6	Initial or, Within 6 months after level 4	One	E-6
E-8	Initial or, Within 6 months after level 6	One	E-8

An additional requirement for the Experimental Grade for polyethylene (PE) pipe compositions is successful validation of at least one test lot in accordance with Part F.4 of this document.

A.2.2 The requirements of the Standard Grade shall be met within six months after those of E-8 Level Experimental Grade are met.

A.2.3 The Standard Grade shall meet the requirements of the latest revision of "Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, for at least one lot and the minimum requirements of the E-2 level of the Experimental Grade for each of at least two additional lots. At least one of these three lots of pipe shall be made by a pipe producer on commercial production equipment.

An additional requirement for the Standard Grade for PE compositions is successful validation, in accordance with Part F.4 of this document, which is to be established on each of two lots of pipe, one of which is to be the same as that tested through at least 10,000 hours for the purpose of determining the LTHS. A pipe producer shall make one of the two tested lots on commercial equipment.

A.2.4 The Standard Grade recommendation listing will expire five years after the initial listing date. The owner of the listing may request a continuation within 4 1/2 and five years after the initial listing date for another five years. This renewal procedure may be repeated.

**A.3. Requirements for Grades at 140°F (60°C):**

A.3.1 The Experimental Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except for the following requirements:

A.3.1.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the E-2 level or higher.

A.3.1.2 Not less than the following test data shall be available at 140°F (60°C):

<b>Level of Recommendation</b>	<b>Time of Data Submission</b>	<b>Lots</b>	<b>At Level</b>
<b>E-6</b>	<b>Initial</b>	<b>One</b>	<b>E-6</b>
<b>E-8</b>	<b>Initial or, Within 6 months after level 6</b>	<b>One</b>	<b>E-8</b>

A.3.2 An additional requirement for the Experimental Grade for Polyethylene (PE) pipe compositions is successful validation of at least one test lot in accordance with Part F.4 of this document.

The requirements of the Standard Grade shall be met within six months after those for the E-8 level are met.

A.3.2.1 PPI will grant an E-2 Experimental Grade at 140°F (60°C) based on presentation to the HSB Chairman of acceptable E-2 stress rupture data at both 140°F (60°C) and 176°F (80°C). The owner of this E-2 listing shall submit E-6 stress rupture data at 140°F (60°C) to PPI within six months to retain this special listing.

A.3.3 The Standard Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis of Thermoplastic Pipe Materials," ASTM D 2837, except for the following requirements:

A.3.3.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the Standard Grade.

A.3.3.2 Test data shall be available at 140°F (60°C) for at least one lot, meeting the requirements of the test method (10,000 hours minimum).

A.3.3.3 Test data shall be available at 140°F (60°C) meeting the E-6 level (minimum of 6,000 hours and 12 points) on at least two additional lots of pipe.

A.3.3.4 At least one of the lots in items 3.3.2 or 3.3.3 shall be made by a pipe producer on commercial production equipment.

A.3.4 The Standard Grade recommendation listing will expire five years after the initial listing date. The owner of the listing may request a continuation within 4 1/2 and five years after the initial listing date for another five years. This renewal procedure may be repeated.

An additional requirement for the Standard Grade for PE compositions is successful validation, in accordance with Part F.4 of this document, which is to be established on each of two lots of pipe, one of which is to be the same as that tested through at least 10,000 hours for the purpose of determining the LTHS. A pipe producer shall make one of the two tested lots on commercial equipment.

**A.4. Requirements for Grades at 180°F (82°C):**

A.4.1 The Experimental Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except for the following requirements:

A.4.1.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the E-2 level or higher.

A.4.1.2 Test data shall be available at 180°F (82°C) as follows:

<b>Level of Recommendation</b>	<b>Time of Data Submission</b>	<b>Lots</b>	<b>At Level</b>
<b>E-6</b>	<b>Initial</b>	<b>One</b>	<b>E-6</b>
<b>E-8</b>	<b>Initial or, Within 6 months after level 6</b>	<b>One</b>	<b>E-8</b>
<b>E-10</b>	<b>Initial or, Within 6 months after level 8</b>	<b>One two</b>	<b>E-10 and E-6</b>

A.4.1.3 PPI will grant an E-2 Experimental Grade at 180°F (82°C) based on presentation to the HSB Chairman of acceptable E-2 stress rupture data at both 180°F (82°C) and 200°F (93°C). The owner of this E-2 listing shall submit E-6 stress rupture data at 180°F (82°C) to PPI within six months to retain this special listing.

A.4.2 The requirements of the Standard Grade shall be met within 18 months after those for the E-10 level.

A.4.3 The Standard Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except for the following requirements:

A.4.3.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the Standard Grade.

A.4.3.2 a. Test data shall be available at 180°F (82°C) for at least one lot for not less than 16,000 hours, or:

b. Test data shall be available (1) at 180°F (82°C) for at least one lot for not less than 10,000 hours, and (2) at 200°F (93°C) for at least one lot for not less than 4,000 hours.

A.4.3.3 Test data shall be available at 180°F (82°C) on at least two additional lots which meet the full requirements of test method ASTM D 2837.

A.4.4 The Standard Grade recommendation listing will expire five years after the initial listing date. The owner of the listing may request a continuation for another five-year period within 4 1/2 and 5 years after the initial listing date.

**A.5 Requirements for Grades at 200°F (93°C):**

A.5.1 The Experimental Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except for the following requirements:

A.5.1.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the E-2 level or higher.

A.5.1.2 Test data shall be available at 200°F (93°C) as follows:

<b>Level of Recommendation</b>	<b>Time of Data Submission</b>	<b>Lots</b>	<b>At Level</b>
<b>E-6</b>	<b>Initial</b>	<b>One</b>	<b>E-6</b>
<b>E-8</b>	<b>Initial or, Within 6 months after level 6</b>	<b>One</b>	<b>E-8</b>
<b>E-10</b>	<b>Initial or, Within 6 months after level 8</b>	<b>One two</b>	<b>E-10 and E-6</b>

A.5.2 The requirements of the Standard Grade shall be met within 18 months after those for the E-10 level.

A.5.3 The Standard Grade shall meet the requirements of the latest revision of "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials", ASTM D 2837, except for the following requirements:

- A.5.3.1 The pipe material shall have a PPI recommended hydrostatic design stress at 73°F (23°C) at the Standard Grade.
- A.5.3.2
  - a Test data shall be available at 200°F (93°C) for at least one lot for not less than 16,000 hours, or:
  - b. Test data shall be available at 200°F (93°C) on at least two additional lots that meet the full requirements of method ASTM D 2837 (minimum of 10,000 hours and 18 points).
- A.5.3.3 Test data shall be available at 200°F (93°C) meeting the requirements of the test method (minimum of 10,000 hours and 18 points) on at least two additional lots of pipe.
- A.5.4 The Standard Grade recommendation listing will expire five years after the initial listing date. The owner of the listing may request a continuation for another five years within 4<sup>1</sup>/<sub>2</sub> and 5 years after the initial listing date. This renewal procedure may be repeated.

## **A.6 Recommended HDB for New Materials:**

- A.6.1 The following are the requirements for the development of recommended hydrostatic design basis for new plastic pipe materials which, for this purpose, are those for which there is no standard pipe material designation included in the latest edition of ASTM specifications that cover plastic pressure pipe (for example, PVC 1120 is not a new material, but PVC 1125 would be a new material):
  - A.6.1.1 Material Classification: The base material or compound shall be identified by classification in an ASTM material specification or in a proposed ASTM specification that has been submitted to at least an ASTM Committee letter ballot.
  - A.6.1.2 Time-Strength-Creep Characteristics
    - A.6.1.2.a. Experimental Grade: Satisfactory hydrostatic E-6, or higher level test data for at least one lot, and E-2, or higher level, test data for each of two or more additional lots shall be supplied. This recommendation shall be limited to one year, after which period the requirements for the Standard Grade shall be met to continue the recommendation.
    - A.6.1.2.b. Provisional Standard Grade: Satisfactory hydrostatic E-10 or higher level for at least one lot, and E-2 or higher level test data for each of two or more additional lots shall be supplied. At least one of these lots of pipe shall have been made by a commercial pipe extruder. This provisional Standard Grade recommendation shall

be limited to one year after which the recommendation will be reviewed in depth by the HSB in conjunction with a representative of the manufacturer. After this review the Board will take one of the following actions:

- extend for another year the Provisional Standard Grade recommendation;
- change the recommendation to the regular five-year Standard Grade; or,
- withdraw the recommendation.

A.6.2 Additional information: Data and information on the aging characteristics and on any unusual properties that may be helpful in evaluating the time-stress behavior of the material in pipe form in service shall be submitted to the Board for study before the Standard Grade recommendation is made.

#### **A.7 Recommended PDB Ratings for Multilayer and Composite Pipes:**

TR-4 Section II lists recommendations for the Pressure Design Basis (PDB) for 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, these PDB ratings differs from HDB ratings 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 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 TR-4 Section II 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 TR-4. The use of this protocol, including the use of ASTM method D2837, Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials, 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 D2837 from consideration.

For a Standard grade rating, the PPI Hydrostatic Stress Board requires three pipe lots for the largest pipe size at the highest listed temperature and at the lowest listed temperature. For intermediate listed temperatures and the largest pipe size, only one lot is required, and this is to be an E-10. For the smaller pipe sizes that are to be listed, only one lot is required for each size and each temperature. For this one lot, the longest time is required – for example, E-10 at 73°F and E-16 at 180°F, at the highest and lowest listed temperatures. For intermediate temperature listings of the smaller pipe sizes, an E-6 is required. 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 Fuel Gas Pipe Symposium (October 1989, San Francisco, CA), American Gas Association.

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

## **PART B. GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR MRS**

### **B.1 Grades of Recommendation**

B.1.1 Only the Standard Grade is recommended for the Minimum Required Strength (MRS) at this time. The experimental grade may also become available through a special case hearing of the Hydrostatic Stress Board.

B.1.2 The Standard Grade recommendation is for a five-year period for those materials that comply with the full data requirements of ISO 9080 "Determination of Long-Term Hydrostatic Strength of Thermoplastic Materials in Pipe form by Extrapolation." These MRS ratings are listed in PPI TR-4.

B.2 At this time changes to the composition of a material with an MRS listing are not allowed, except through a special case hearing of the Hydrostatic Stress Board. As PPI gains more experience with this rating method, substitutions that are permitted for various ingredients as outlined in the different parts of TR-3 for HDB listings may also be allowed for MRS listings.

## **PART C. GRADES OF RECOMMENDATIONS AND DATA REQUIREMENTS FOR SDB**

### **C.1 Grades of Recommendation**

C.1.1 The Strength Design Basis (SDB) is a method of obtaining a long-term strength rating for thermoplastic materials intended for molding applications. This method is not applicable for fiber-filled thermoset materials.

C.1.2 Only the Standard Grade is recommended for the Strength Design Basis (SDB) at this time. The experimental grade may also become available through a special case hearing of the Hydrostatic Stress Board.

The Standard Grade recommendation is for a five-year period for those materials that comply with the full data requirements of ASTM F 2018 "Standard Test Method for Time-to-Failure of Plastics Using Plane Strain Tensile specimens". These SDB ratings are listed in PPI TR-4.

C.2 At this time changes to the composition of a material with an SDB listing are not allowed, except through a special case hearing of the Hydrostatic Stress Board. As PPI gains more experience with this rating method, substitutions that are permitted for various ingredients as outlined in the different parts of TR-3 for HDB listings may also be allowed for SDB listings.

- C.3 The SDB rating for a molding material may not be used to determine the pressure rating of a fitting. This rating is for the material only and is intended to satisfy industry requirements for a molding material to have an established long-term strength rating.

## **PART D. GENERAL POLICIES, PRACTICES AND PROCEDURES**

### **D.1. POLICY ON COLORANT CHANGES FOR HDB (Formerly Part D)**

#### **D.1.1. Permitted Colorant Changes Without Need for Additional Testing**

##### **D.1.1.1. Formulations With a Recommended HDB Which Has Been Established Based on a Specified Colorant Content**

D.1.1.1.1 The amount of colorant in a plastic pipe compound with a PPI recommended HDB may be changed from the amount specified for the base composition by as much as 0.5 parts per hundred parts of resin without the need to submit additional hydrostatic strength data, provided the colorant is neither a liquid nor includes a liquid component at ambient temperature conditions.

D.1.1.1.2 Any type colorant that is used in the base composition may be substituted in part or in whole, by any other colorant of similar physical nature (see Note 2) provided the substituted colorant is limited to a maximum of 0.5 parts per hundred parts of resin.

D.1.1.1.3 The compound with a colorant change does not become a new base compound to which additional formulation changes can be made.

##### **D.1.1.2 Formulations With a Recommended HDB That Has Been Established Based on a Specified Range of Colorant Content**

D.1.1.2.1 Whenever data have been developed to qualify a plastic pipe compound at two different colorant levels, and thereby establishing a colorant range, then no additional hydrostatic strength data are required for any variations in the amount of colorant within this established range.  
For PE formulations, one of the range limits may be qualified by conducting tests in accordance with the requirements of Part F.5 of this report.

D.1.1.2.2 Any type colorant that is used in the colorant range formulation may be substituted in part or in whole by any other colorant of similar physical nature (see Note 2) provided the total content of colorant remains within the minimum/maximum limits specified in the colorant range formulation.

- D.1.1.2.3 The compound with a colorant change does not become a new base compound to which additional formulation changes can be made.

## **D.1.2. Colorant Changes Which Require Additional Testing**

- D.1.2.1. For all colorant changes that exceed the 0.5 parts per hundred parts of resin permitted under Section 1.A above, or that fall outside the range limits established under Section 1.B above, satisfactory test data developed in accordance with Part F (for PE pipe compositions) or in accordance with Part E (for PVC pipe composition) are required.
- D.1.2.2. General – Acceptance of colorant changes that do not meet the above criteria may sometimes be obtained by making a petition to the HSB. Sufficient data are required to provide adequate assurance that the contemplated change will not compromise the HDB (or HDB's if they have been issued for more than one temperature) of the original formulation. The HSB may be consulted in advance to establish an acceptable test protocol.

- Note 1. The manufacturer should make adequate tests to assure users that the colorant changes do not adversely affect performance properties other than long-term hydrostatic strength, such as aging and weather resistance.
- Note 2. A colorant of similar physical nature is one that is generally accepted to be within the same chemical family, of the same approximate pigment particle size and particle size distribution, exhibits non-reactive properties with the base resin and remains solid over the intended application range.

## **D.2 POLICY FOR DETERMINING LONG-TERM STRENGTH (LTHS) BY TEMPERATURE INTERPOLATION (Formerly Part E)**

- D.2.1. The HDB (Hydrostatic Design Basis) for a PPI standard listing temperature (73, 100, 120, 140, 160, 180, or 200°F) may be established on the basis of an LTHS that has been interpolated from LTHS values obtained for one higher and one lower temperature. The data used for this interpolation method must be in compliance with the applicable Parts of PPI TR-3. The following additional policies shall also apply in such cases:

- D.2.1.1 The Grade of the HDB recommendation established from the interpolated LTHS shall be based on the minimum Grade for which the higher or lower temperature data would qualify.
- D.2.1.2 The higher temperature data shall also be sufficient to qualify the subject material for at least the minimum Experimental

Grade at that temperature. If this higher test temperature is not one of the PPI standard listing temperatures, then the minimum data requirements of the higher PPI standard listing temperature shall apply.

- D.2.1.3 Data sets used in determining an interpolated LTHS do not need to be from the same lot. However, these lots used to determine an interpolated LTHS may not be used again for subsequent lots required by PPI TR-3.

Use the following equation to determine a temperature interpolated LTHS:

$$S_T = S_L - \frac{(S_L - S_H) \left( \frac{1}{T_L} - \frac{1}{T_T} \right)}{\left( \frac{1}{T_L} - \frac{1}{T_H} \right)}$$

Where:  $S_T$  = LTHS at interpolation temperature (psi)  
 $S_L$  = LTHS at the lower temperature (psi)  
 $S_H$  = LTHS at the higher temperature (psi)  
 $T_T$  = interpolation temperature (K)  
 $T_L$  = lower temperature (K)  
 $T_H$  = higher temperature (K)

### **D.3 POLICY ON DEPENDENT LISTINGS (Formerly Part F)**

#### **D.3.1. Establishing Dependent Listings:**

A PPI listing for a recommended HDB or MRS that has been established under the provisions of Part A and Part B (henceforth known as the independent listing) may be used to establish a separate listing for the same formulation but under another owner's designation (hence known as the dependent listing). The value of the HDB or MRS for the dependent listing is, but for the exception given in this Part, the same as that for the independent listing. A dependent listing may be established when the following requirements are satisfied (See Appendix X.2 for suggested information transmittal letters):

##### **D.3.1.1. By the owner of the Independent Listing:**

The owner of an independent listing wishing to establish thereupon a dependent listing shall provide the Chairman of the HSB with the following information in writing:

- D.3.1.1.1. The identification of the compound with the independent listing and the identification by which the formulation is to be listed as a dependent compound;
- D.3.1.1.2. Identification of the organization receiving the formulation and the HDB or MRS dependent listing;
- D.3.1.1.3. An assertion that the organization receiving the formulation has been provided with the names of suppliers of the ingredients, and all pertinent information and know-how required to produce, mix, and process the dependent formulation as an equivalent to the independent formulation, or, for cases in which there may be some reason to question complete equivalence (See Note 1) the recommended reduction, if any, of the level of the HDB or MRS for the dependent listing from that assigned to the independent listing.

NOTE 1: It is generally recognized that the equipment and conditions employed in the mixing and processing of a thermoplastic pipe composition will influence the composition's long-term strength characteristics. For example, the same pipe formulation that in one case is premixed prior to pipe extrusion, but in another depends entirely on the extrusion process for proper dispersion of its ingredients, may not yield the same long-term strength under both conditions. Accordingly, it is considered prudent for those cases in which there might be some reason to question complete equivalence to limit the duration and the level of the HDB or MRS recommendations until more definitive data have been obtained on pipe made under the different sets of processing conditions. It is the responsibility of those presenting requests for establishing dependent listings to ensure, as best as possible, the equivalence of the processing conditions under the independent and dependent listings.

- D.3.1.1.4 That permission has been given to the recipient of the formulation to reference the test data supplied on behalf of the independent listing.

**D.3.1.2. By the intended owner of the Dependent Listing:**

The intended owner of the dependent listing shall provide the Chairman of the HSB with the following information in writing:

- D.3.1.2.1 The identification by which the independent formulation is listed;
- D.3.1.2.2 The identification by which the resultant dependent formulation is to be listed;

- D.3.1.2.3 Confirmation that the owner of the independent formulation has made available the names of the ingredient suppliers, and all pertinent information and know-how required to prepare, mix and process the dependent compound as an equivalent to the independent formulation; or, if this is not the case, in accordance with the recipe established by the owner of the independent formulation;
- D.3.1.2.4 A statement that it is intended to prepare, mix and process the dependent compound in accordance with the above;
- D.3.1.2.5 That permission has been received from the owner of the independent listing to use test data supplied on behalf of the independent formulation;
- D.3.1.2.6 That any limitation on the HDB or MRS that may have been recommended by the owner of the independent listing is an acceptable condition for obtaining the dependent listing.

**D.3.2. Duration and Level of Recommendation for Dependent Listings:**

- D.3.2.1. Unless otherwise requested by the owner of the independent listing and except when the listing is covered by the provision in 2.C of this Part, a recommendation for a dependent listing will be for the same level as that of the referenced independent listing.
- D.3.2.2. But for the exception presented in 2.C of this Part, a recommendation for a dependent listing will have the same expiration date as that of the referenced independent listing.
- D.3.2.3. In the case of dependent pipe formulations that are to be mixed and converted into pipe by different processing than that represented by the pipe on which the independent listing was obtained (e.g., as when the dependent formulation essentially relies on the extrusion process for homogenization of ingredients whereas the independent formulation was precompounded prior to pipe extrusion), or with any processing conditions by which the quality of homogenization may be suspect (See Note 1 on previous page), the recommended HDB or MRS shall be set in accordance with the recommendation of the holder of the independent listing and be in effect for only six months unless one of the following occurs prior to the end of the six-month period:
  - D.3.2.3.1 Test data obtained in accordance with Part A and B shall be presented on at least one lot of pipe that has been made in the commercial production equipment of the owner of the dependent listing. The data that are developed in accordance with Part A shall cover not less than the E-2 data level and shall support the recommended HDB or MRS assigned the dependent formulation. Continuance of the recommendation requires that it be advanced

through the progressive steps outlined in Part A until a Standard Grade recommendation is established.

- D.3.2.3.2 The holder of the dependent listing advises the Chairman of the HSB that he accepts a permanent recommended HDB or MRS of 80 percent of the value established for the referenced independent formulation.

### **D.3.3. Substitutions in Dependent Listings:**

A formulation change accepted for the independent listing is also acceptable for the dependent listing. This may be explained by a general example as follows:

EXAMPLE: Company A has a compound listed and gives the formulation, the suppliers of the ingredients, and the mixing and handling know-how to Company B along with permission for Company B to use the test data submitted by Company A. Company B agrees to follow strictly the information supplied by Company A to mix the equivalent that they designate under another name. When Company A has a formulation change accepted for this listing, then this formulation change is also acceptable for the equivalent compound under the Company B listing

## **D.4 CHANGES BETWEEN TWO PERCENTAGES OF A COMPOUNDING INGREDIENT (Formerly Part H)**

The percent of a specific compounding ingredient may be varied without further testing over the range between the percentages given in two listings that differ only in the percent of this ingredient so long as both listings are maintained. In the case of stabilizers, both referenced listings shall be at the Standard Grade level. If it is desired that a compound with an intermediate percentage be listed, it will be at the grade level of the lower of the two listings.

## **D.5 MEASUREMENT VARIABILITY (Formerly Part I)**

Because of the differing precisions of measuring devices and the normal variations inherent even in good handling techniques and processing equipment, the small variations in the amount of an ingredient in a compound are not considered to be changes in the formulation provided (a) the norm is set at the percentage given in the formulation and (b) variations over a reasonable number of batches are small and about equal on the average on the plus and minus side of the norm.

## **D.6 REQUIREMENTS FOR MOLDING MATERIALS (Formerly Part J)**

- D.6.1 Materials intended for molding only must be evaluated in accordance with this part. Materials intended for both extrusion and molding may be evaluated in accordance with this Part or Part A.
- D.6.2 The test specimens shall be injection-molded tubes with knit lines that result from either a side gate or an end gate. The tube wall of each specimen should be as uniform in thickness as is technically possible.

NOTE 1 For some materials this molding process can have an effect on the long-term hydrostatic strength. The molding conditions used to mold these pipe specimens should be consistent with molding conditions used for that material in actual end use applications.

- D.6.3 These specimens shall be tested in the same manner as extruded pipe specimens. The exposed length of the specimen between end enclosures shall be at least five times the specimen outside diameter.
- D.6.4 The policies and procedures shall be the same as those used for developing recommended hydrostatic design stresses for thermoplastic pipe materials except that the report shall include complete information about the specimen configuration.
- D.6.5 The resultant HDB recommendations for molding materials shall identify whether the data were obtained on extruded or molded specimens and, if molded, the gating design.

## **PART E: PVC SPECIFIC POLICIES, PRACTICES AND PROCEDURES**

### **E.1 STANDARD INDUSTRY PRACTICE OF HIGH INTENSITY MIXING OF PVC PIPE COMPOUNDS (Formerly Part A.2)**

#### **E.1.1. Equipment**

High Intensity Mixers: Characterized by a closed bowl or vessel containing motor driven plows or blades. The blades typically run between 500 and 800 rpm, with a tip speed of 30 to 40 meters per second. These blades are designed to homogenize the resin and other ingredients through intensive mixing and frictional heat that they develop.

Low Intensity Coolers: Characterized by a closed bowl or vessel containing motor driven plows or blades. The blades typically run between 50 and 100 rpm with a tip speed around 6 meters per second. These blades are designed to assist in the cooling of the compound through aeration and the action of throwing the compound against the walls of the cooler. Coolers can be water-jacketed and/or air injected.

#### **E.1.2. Single Batching**

Resin is dumped into the mixer with the blades turning. The other ingredients are added to the resin at the same ratio as specified by the formulation. The material is mixed until an approximate temperature between 190°F and 245°F is reached. The blended compound is dumped into the cooler and cooled. The material is transferred to storage.

#### **E.1.3. Double Batching**

Resin is dumped into the mixer with the blades turning. The other ingredients are added to the resin at a higher ratio than specified by the formulation. This ratio does not exceed 2:1. The material is mixed until an approximate temperature between 190°F and 245°F is reached. The blended concentrate is dumped into the cooler and resin is added to make a blended compound with proportioned ingredients at the ratios specified by the formulation. The blended compound is cooled and then transferred to storage.

Note: Words like "typical" and "approximately" were chosen intentionally, as this procedure does not pretend to be perfectly precise, but only describes common industry practice.

It should also be noted that the description is as concise as possible and limited to variables that are likely to have the potential to impact HDB results. For example, a cooler dump temperature range was intentionally omitted because this temperature is more of a material-conveying question than a HDB question.

It is recognized that the method of mixing affects dispersion of ingredients in compounds and potentially the quality of pipe. Therefore when qualifying new chemically equivalent ingredients to the current *PPI Range Formula* the method of mixing is to be described.

It is recognized that the method of mixing affects dispersion of ingredients in compounds and potentially the quality of pipe. Therefore when qualifying new ingredients that are not chemically equivalent to currently listed ingredients or extending a range in the PPI Range formulation the first data set submitted for qualification must be derived from pipe made from compound that was doubled batched at a 2:1 ratio per the *Standard Industry Practice of High Intensity Mixing of PVC pipe Compounds*.

## **E.2. POLICY ON SUBSTITUTION OF AN APPARENTLY IDENTICAL INGREDIENT IN A PVC COMPOSITION (Formerly Part C)**

- E.2.1. A manufacturer who has a PVC pipe compound with a PPI Standard Grade recommended HDB for 73°F (23°C) may substitute an apparently identical ingredient from a different supplier with no change in amount for an ingredient that is present in no more than 5 parts per hundred parts (by weight) of resin provided the least squares regression line for the substituted compound obtained with test data for at least 15 points including at least one point beyond 2,000 hours produces: (1) a 100,000-hour hydrostatic strength that is not less than required to give the same hydrostatic design basis as that recommended for the base compound and, (2) a 50-year strength value that is not less than 85 percent of the 50-year strength value of the base compound (to assure that the slope for the substituted compound is approximately the same as that for the base compound). In this case the substituted formulation will be considered to be identical to the original formulation in regard to the hydrostatic design stress. The manufacturer shall make available to the Chairman of the HSB, on a confidential basis, the results of the evaluation studies undertaken to show apparent material identity.
- E.2.2 The HSB shall be consulted for minimum data requirements for other formulation modifications and stress recommendations at temperatures other than 73°F (23°C).

Note 1. Consult Part E.3 (Formerly Part M) for an alternate method for analyzing stress-rupture data for PVC.

### **E.3. FULFILLING CERTAIN PPI TR-3 REQUIREMENTS BY UTILIZING AN ALTERNATE METHOD OF ANALYZING STRESS - RUPTURE DATA FOR PVC (Formerly Part M)**

The use of this method is optional and its inclusion here does not in any way preclude the use of the procedures that are published elsewhere in TR-3.

#### **E.3.1. Applicability:**

- E.3.1.1. This procedure may be applied in the evaluation of stress-rupture data developed for PVC compounds.
- E.3.1.2. This procedure may be used in evaluating the stress-rupture data for:
  - E.3.1.2.1. Second and third lots of pipe required in Part A to obtain a Standard Grade rating.
  - E.3.1.2.2. Lots of pipe used to demonstrate the effects of substitution of "apparently identical ingredients" as described in Part E.2.
  - E.3.1.2.3. Lots of pipe used to show the effects of changes in the level of compounding ingredients (excluding stabilizers) up to  $\pm 50$  percent from the levels contained in a compound with an established recommended hydrostatic design stress.

#### **E.3.2. Alternate Method:**

As soon as five or more stress-rupture data points are developed, compute the long-term hydrostatic strength (LTHS), the 95 percent upper (UCL) and lower (LCL) confidence levels, and the lower confidence level ratio ( $R_{LCL} = LCL/LTHS$ ) (Note 1). Check these results against the following requirements:

- E.3.2.1. If the  $R_{LCL}$  is 0.85 or greater, evaluate data in accordance with 2.2, 2.3, or 2.4 below. If  $R_{LCL}$  is less than 0.85, incorporate additional data points as they become available and recompute until  $R_{LCL} \geq 0.85$ .
- E.3.2.2. If the 100,000-hour LCL stress value is greater than 4,000 psi, this lot will always exceed the present 3,830-psi long-term hydrostatic strength requirements (Note 2). This test work can be stopped and the data can be submitted to fulfill the requirements listed in B.1., B.2, or B.3. above.
- E.3.2.3. If the 100,000-hour UCL stress value is less than 3,830 psi, this lot will not attain the required long-term hydrostatic strength (Note 2). The tests should be stopped.
- E.3.2.4. If the 100,000 hours UCL stress value is more than 3,830 psi, and the 100,000 hour LCL stress value is less than 3,830 psi, the test should be

continued to obtain more data points (Note 2). As additional data points are developed, re-compute and re-examine data to see whether it meets the requirements. Continue testing until the lot qualifies or fails either under this method or another part of PPI TR-3.

NOTE 1. Calculate the lower confidence level (LCL), and the lower confidence level ratio ( $R_{LCL}$ ) in accordance with ASTM D 2837 (see Section 5.2.3.3 of the 1990 edition). Consult any standard treatment on analysis of regression equations for the calculation of the upper confidence level (UCL).

NOTE 2. The 3,830-psi value is the minimum long-term hydrostatic strength that qualifies for a 4,000 psi HDB category. Minimum required long-term hydrostatic strengths for other HDB categories are given in ASTM D 2837.

NOTE 3. As an approximation, the UCL may be estimated from the LCL by the following equation:

$$\text{Log UCL} = \log \text{LTHS} + (\log \text{LTHS} - \log \text{LCL})$$

#### **E.4. SUBSTITUTION OF RESIN IN POLY (VINYL CHLORIDE) PVC PLASTIC PIPE FORMULATIONS (Formerly Part S)**

Consent of the Chairman of the HSB is required to substitute an alternate resin (resin B) in a PVC pipe formulation for the original resin (resin A). Such consent shall be awarded when the following conditions are satisfied:

E.4.1 The listing for the subject formulation is for the Standard Grade (per 1.2 of Part A) at 73°F (23°C).

E.4.2 The Chairman of the HSB shall be advised in writing (See Note 1) by the owner of the "independent" listing (per D.3) that the proposed resin substitution has been determined to be an acceptable formulation variation on the basis of established requirements that the owner has set for that formulation and upon demonstrated compliance to the following:

E.4.2.1 Resin B is an originally specified resin in at least one PVC compound formulation that carries a Standard Grade hydrostatic design stress recommendation at 73°F (23°C) of the same value as that of the subject compound;

E.4.2.2 Resin B satisfies all of the property requirements established by its manufacturer for the use of the resin in pressure rated PVC pipe compounds;

E.4.2.3 The cell classification, when determined in accordance with ASTM D 1784, "Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds", or D 3915, "Standard Specification for Poly(Vinyl Chloride) (PVC) and Related Plastic Pipe and Fitting Compounds for Pressure Applications", of the compound made from the subject formulation, is the same with resin B as when using resin A; and,

E.4.2.4 Both resin A and resin B satisfy the following property requirements:

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>REQUIREMENT</b>
<b>Type of Material</b>	-----	<b>PVC Homopolymer</b>
<b>Inherent Viscosity</b>	<b>ASTM D1243</b>	<b>0.88 - 0.96</b>
<b>Heat Loss (water); % by weight</b>	<b>1 Hr @ 221°F (105°C)</b>	<b>0.5 max</b>
<b>Apparent Bulk Density, gm/cc</b>	<b>ASTM D1895</b>	<b>0.46 - 0.62</b>
<b>Compacted Bulk Density, gm/cc</b>	-----	<b>0.54 - 0.72</b>
<b>RVCM</b>	-----	<b>10 ppm max</b>

E.4.3. Results of hydrostatic rupture tests at 73°F (23°C) shall be submitted to the Chairman of the HSB which demonstrate, when evaluated in accordance with ASTM D 2837 but with the exceptions herein given, that the long-term hydrostatic strength, the lower confidence limit, and the 50-year intercept of pipe made on commercial equipment from the formulation using the substitute resin (resin B) continue to satisfy the D 2837 requirements established on pipe made from the original formulation. The exceptions to D 2837 are that circumferential expansion tests need not be made and minimum data point and test requirements are relaxed to the following:

E.4.3.1 For initial approval (experimental grade )for the use of the substitute resin (resin B), the test data shall consist of not less than nine data points, representing one or more extrusion lots, which shall cover a range of failure times, in hours, spanning at least three log cycles (i.e., from 0.05 to 50 hours, or from 1 to 1,000 hours).

E.4.3.2 For final approval (standard grade) for the use of the substitute resin (resin B), additional test data shall be provided within six months of the granting of the initial approval consisting of at least six additional data points representing not less than three different extrusion lots. The failure time for these points shall be not less than 10 hours with at least two points over 2,000 hours. These additional data may be evaluated either in combination with, or separately from, those supplied for the initial approval (See Note 2).

This policy is intended only to cover the alternative use in PVC formulations of PVC resins that are judged by the criteria herein presented as sufficiently similar in nature to

produce pressure pipes that are essentially the same in performance. The requirements given are not to be considered as specifications or standards that describe the requirements for all the PVC resins suitable for PVC pressure pipes. Proposed substitution of PVC resins not meeting the requirements of this policy may be evaluated in accordance with other policies and procedures in TR-3.

NOTE 1. The Appendix includes a suggested letterform that may be used to transmit to the Chairman of the HSB the information required in Part E.4.

NOTE 2. The intention of the Board is to eventually drop this requirement and change initial and final approval, after it has been demonstrated, as expected, that the longer time data per this requirement confirm the 'initial' approval results.

### **E.5. ALLOWABLE FORMULATION VARIABILITY FOR PVC PIPE AND FITTINGS COMPOUNDS (Formerly Part T)**

The content of one or more ingredients of PVC pipe and fittings compositions may be varied without changes in the recommended HDB for 73°F (23°C) provided the formulation variations and the procedures for establishing the recommendation comply to provisions given herein:

#### **E.5.1 Allowable formulation variation for a fixed composition formulation:**

E.5.1.1 The formulation shall have a Standard Grade recommended design stress at 73°F (23°C) per section 1.2 of Part A.

E.5.1.2 The originally specified content of any number of the following components may be adjusted within the given limits provided each adjusted component meets the indicated property requirements and the resultant formulation can be processed into pipe of acceptable quality:

<b>COMPONENT</b>	<b>MAXIMUM COMPONENT VARIATION FROM ORIGINAL SPECIFIED CONTENT (PERCENT)*</b>	<b>MAXIMUM ALLOWABLE CONTENT OF COMPONENTS IN ADJUSTED FORMULA</b>
Titanium dioxide	± 20	No Limit
Calcium stearate	± 10	No Limit
Calcium Carbonate	± 20	5.0 phr
Paraffin Wax	± 10	No Limit
Polyethylene Wax	± 20	0.3 phr
Colorant	± 20	No Limit

<b>Process Aid</b>	<b>± 20</b>	<b>No Limit</b>
<b>Stabilizer</b>	<b>± 20, but not to exceed ± 0.2 phr</b>	<b>No Limit</b>

\* As specified for original formulation - no variance allowed.

+ The designation  $\pm$  means plus, or minus.

### **E.5.2 To establish a range with greater component variability:**

Select the maximum and minimum levels for one or more ingredients, and proceed as follows:

- E.5.2.1 Test data shall be provided as required by Part A of PPI TR-3 for both the compound when prepared with all additives (all ingredients except resin) at the specified maximum level (maximum range formula) and when prepared with all additives at their minimum level (minimum range formula). To assist in the processing of the data, the maximum and minimum range formulas shall be treated as separate entities until the requirements given in b, c and d below are fulfilled. As long as both the maximum and minimum formulas carry a recommendation of the HSB for the same design stress, and other requirements herein stipulated are satisfied, any formula of that compound which lies within the maximum/minimum range also enjoys that recommendation. For range formulas, the provisions for formulation variation for "fixed" composition formulas do not apply; component content beyond that indicated by the maximum/minimum range is not permitted.
- E.5.2.2 Stress-rupture data obtained on pipe made from the maximum range formula shall be provided for at least one lot in accordance with the schedule given in Part A of PPI TR-3 until the full requirements of ASTM D 2837 are satisfied.
- E.5.2.3 Stress-rupture data obtained on pipe made from the minimum range formula shall be provided for at least one lot for the E-2 level of Part A.
- E.5.2.4 To advance the recommendation for the range formula combination to the Standard Grade, in addition to the above, E-2 level data shall be provided for one other lot of pipe extruded on commercial production equipment that is made from any formula lying within the maximum/minimum range. The Standard Grade recommendation for the range formula shall be granted upon each of all the submitted data lots qualifying for the same hydrostatic design basis per ASTM D 2837.

Formulation changes outside these guidelines, including those for recommended HDB at temperatures beyond 73°F (23°C), may be evaluated in accordance with other policies and procedures in TR-3.

## **E.6. SUBSTITUTION OF THERMAL STABILIZERS IN PVC PIPE COMPOSITIONS (Formerly Part U)**

This policy presents conditions under which stress-rupture data at the E-2 level per Part A are acceptable in demonstrating that the recommended HDB that has been assigned to a PVC pipe composition are not compromised by the use in that composition of a new, or modified, stabilizer (stabilizer B) as a substitute for the original stabilizer (stabilizer A). Under this policy, consent from the Chairman of the HSB is required before the so-modified composition can be accepted under the recommended values assigned the original, or base, composition. Such consent shall be available provided the following conditions are met:

- E.6.1 The composition under consideration is either an independent listing, or is dependent upon an independent listing that carries a Standard Grade recommended value for the temperature in question.
- E.6.2 If the composition is a dependent listing, then the owner of the independent listing shall advise the Chairman of the HSB in writing that the proposed stabilizer substitution is an acceptable formulation variation.
- E.6.3 Both the original stabilizer (stabilizer A) and the substitute stabilizer (stabilizer B) shall be identified along with the use levels of each. (This information shall be kept administratively confidential by the Chairman of the HSB.).
- E.6.4 The substitute stabilizer (stabilizer B) shall be an originally specified stabilizer in at least one PVC compound that carries a Standard Grade hydrostatic design stress recommendation.
- E.6.5 The cell classification, when determined in accordance with ASTM D 1784 or D 3915, shall be the same for the composition when made with stabilizer B as was established when made with stabilizer A.
- E.6.6 The stabilizer level in the compound must be within the range from 0.3 to 1.0 parts per hundred parts of resin and the amount cannot be varied more than allowed by PPI formulation variability policy (See Part E.5). In the case of a range formulation, only the highest usage level of stabilizer must be tested.
- E.6.7 Pipe manufactured under commercial production conditions from a compound made with stabilizer B shall, when subjected to hydrostatic testing per ASTM D 1598, yield stress rupture data that when evaluated in accordance with ASTM D 2837, with the exceptions given herein, produces calculated values of the long-term hydrostatic strength, the lower confidence limit and the 50-year intercept that satisfy the ASTM D 2837 requirements for the hydrostatic design basis assigned the compound when formulated with stabilizer A. The exceptions to ASTM D 2837 are that circumferential expansion tests need not be made and

the test data only need satisfy the E-2 level requirements of Part A. These tests are to be carried out for each temperature for which recommended HDB equivalence is being established.

Proposed substitutions outside these guidelines may be evaluated in accordance with other policies and procedures in TR-3.

## **PART F: POLYETHYLENE SPECIFIC POLICES, PRACTICES AND PROCEDURES**

### **F.1. SUBSTITUTION OF THERMAL STABILIZERS IN PE PLASTICS PIPE COMPOUNDS (Formerly Part K)**

Thermal stabilizers designed for use in polyethylene (PE) compounds may be used interchangeably in a PE plastic pipe formulation that has a recommended HDB without having to submit additional long-term strength test data provided:

- F.1.1 Thermal stability requirements in ASTM Standard D 3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials", are met;
- F.1.2 The total content of the stabilizer package in the formulation is less than 0.5 parts per 100 parts of resin;
- F.1.3 The quantity of the substituted stabilizer is within  $\pm 50$  percent of the level of the stabilizer in the original formulation.
- F.1.4 The quantity of the substituted thermal stabilizer does not exceed 0.25 parts per 100 parts of resin.

The compound with the stabilizer change does not become a new base compound to which additional changes can be made.

Proposed substitutions outside these guidelines may be evaluated in accordance with other policies and procedures in PPI TR-3.

### **F.2. VARIATION IN AMOUNT OF STABILIZER IN POLYETHYLENE PLASTICS PIPE COMPOUNDS (Formerly Part L)**

In the case of a polyethylene (PE) pipe compound with a recommendation at the E-6 Grade or higher, the amount of stabilizer may be changed up to  $\pm 50$  percent from the specified amount for the base composition without the need to submit additional

hydrostatic strength data, provided the so altered composition satisfies the thermal stability requirements in ASTM Standard D 3350, "Standard Specification for Polyethylene Plastics Pipe and Fitting Materials".

The compound with the stabilizer change does not become a new base compound to which additional formulation changes can be made.

### **F.3. SUBSTITUTION OF ULTRAVIOLET LIGHT STABILIZERS IN NON-BLACK POLYETHYLENE PLASTICS PIPE COMPOUNDS (Formerly Part V)**

Ultraviolet (UV) light stabilizers designed for use in non-black polyethylene (PE) compounds may be used interchangeably in a polyethylene plastic pipe formulation that has a recommended HDB without the submission of additional long-term strength test data provided:

1. The total content of the UV stabilizer package in the formulation is less than 0.75 parts per 100 parts of resin;
2. The quantity of the substituted stabilizer does not exceed 0.75 parts per hundred.

The compound with the stabilizer changes does not become a new base compound to which additional changes can be made.

Proposed substitutions outside these guidelines may be evaluated with other policies and procedures in PPI TR-3. No consideration is given to the effectiveness in UV light protection in that this characteristic of the compound is not considered by PPI nor ASTM pipe standards and is between the purchaser and seller.

### **F.4. DETERMINATION AND VALIDATION OF THE HYDROSTATIC DESIGN BASIS (HDB) FOR POLYETHYLENE PIPING MATERIALS (Formerly Part X)**

#### **F.4.1 Standard Method - Determination and Validation of Elevated Temperature HDB**

Develop data in accordance with Part A for the temperature at which an HDB is desired.

**If a brittle failure occurs before 10,000 hours, this standard method is not applicable and the Alternate Method in section F.4.2 shall be used.**

- F.4.1.1 Analyze the data to determine the linear regression equation. Extrapolate this equation to 100,000 hours to determine the LTHS. If the 97.5% LCL at 100,000 hours is less than 90% of this LTHS, consider the data unsuitable for use by this method. If all conditions are satisfied, use Table 1 of ASTM D 2837 to determine the HDB category at this temperature.
- F.4.1.2 When the HDB category has been determined by section F.4.1.1, use tables F.4.1.1 or F.4.1.2 to define the time and stress requirements needed to validate this HDB.

Test at least six specimens at the stress level determined by the tables. These specimens must have a minimum log average time exceeding the value shown in the table to validate the HDB. For example, to validate an HDB of 1000 psi at 140°F, this required time is 3800 hours at 193°F (90°C)/690 psi or 11,300 hours at 176°F (80°C)/775 psi.

If a temperature/stress condition in the tables results in a premature ductile failure for a particular PE material, the stress at that temperature may be lowered by 15%. The corresponding required time for this lowered stress is then six times the value in the table. For example, when validating an HDB of 1600 psi at 73°F, if testing at 80°C/825 psi results in ductile failures, lower the stress to 700 psi and retest. The required time to validate using this condition is now 1200 hours. If ductile failures still occur, the stress may be lowered to 595 psi and the corresponding time is increased to 7200 hours.

If a temperature/stress condition in the tables results in a premature ductile failure for a particular PE material, the stress at that temperature may also be lowered by less than 15%. In this case, consult with the HSB Chairman to determine the appropriate required time at the selected stress level.

**Table F.4.1.1: Validation of 73°F (23°C) HDB**

HDB to be Validated (psi)	193°F (90°C)		176°F (80°C)	
	Stress (psi)	Time (hrs.)	Stress (psi)	Time (hrs.)
1600	735	70	825	200
1250	575	70	645	200
1000	460	70	515	200
800	365	70	415	200
630	290	70	325	200
500	230	70	260	200

**Table F.4.1.2: Validation of 140°F (60°C) HDB**

HDB to be Validated (psi)	193°F (90°C)		176°F (80°C)	
	Stress (psi)	Time (hrs.)	Stress (psi)	Time (hrs.)
1250	860	3800	970	11300
1000	690	3800	775	11300
800	550	3800	620	11300
630	435	3800	490	11300
500	345	3800	390	11300
400	275	3800	310	11300

Note: When an elevated temperature HDB is validated by this standard method, all lower temperature HDB's are considered validated for that material.

**F.4.2. Alternate Method - Determination of Elevated Temperature HDB When Brittle Failures Occur Before 10,000 hours.**

If the standard method outlined in section F.4.1 is not appropriate for the material and test data, then use this alternate method to determine the HDB.

- F.4.2.1 Develop data in accordance with Part A for the temperature at which an HDB is desired.

Using only the ductile failures, determine the linear regression equation. The failure point data must be spread over at least two log decades and meet the LCL requirements of section 1.1. The stress intercept at 100,000 hours using this equation is the "ductile" LTHS.

- F.4.2.2. To determine the brittle failure performance, solve for the three coefficients of the rate process equation using steps 1-4 of Procedure I in ASTM D 2837, or another recognized rate process method protocol. All failures must be in the brittle mode. Data developed under ASTM D 2837 to validate a 73°F HDB can be used to solve for the three-coefficient equation as long as all specimens at the three conditions were tested to failure and resulted in brittle type failures. Use the failure points at the three conditions to solve for the three unknown coefficients.

Using this brittle failure model, calculate the stress intercept value at 100,000 hours for the temperature at which an HDB is desired. This resulting stress intercept is the "brittle" LTHS.

F.4.2.3 The LTHS used to determine the HDB category as per Table 1 in ASTM D 2837, shall be the lower value of the ductile failure LTHS from section 2.1 or this brittle failure LTHS.

Rate Process Equation:

$$\text{Log } t = A + B/T + C (\log S)/T$$

Where:  $t$  = time (hours)  
 $T$  = absolute temperature (K)  
 $S$  = Hoop stress (psi)  
 $A, B, C$  = constants

Note: The ISO TR/9080 four-coefficient model may be used if it has a better statistical fit to the data, subject to review of the HSB Chairman.

### F.4.3 ISO 9080 Method - Validation of Elevated Temperature HDB based on Ductile Regression at Higher Temperature

F.4.3.1 Develop data in accordance with Part A for the temperature at which an HDB is desired. Analyze the data to determine the linear regression equation. Extrapolate this equation to 100,000 hours to determine the LTHS. If the 97.5% LCL at 100,000 hours is less than 90 % of this LTHS, consider the data unsuitable for use by this method.

**Note: If a brittle failure occurs before 10,000 hours, this method is not applicable and the Alternate Method in section F.4.2 shall be used.**

F.4.3.2 Develop a regression based on *ductile* stress-rupture data at either 80° or 90°C. Use Table F.4.3.2 to determine the appropriate data level for the temperature to be validated. The regression data must satisfy the following requirements:

F.4.3.2.1 The 97.5% LCL ratio for these data must be greater than 90%.

F.4.3.2.2 Non-failed specimens at the longest running times may be included in the regression, provided their inclusion does not decrease the LTHS (See ASTM D2837, section 5.2.2).

F.4.3.2.3 The log average of the five highest times (used in the regression) must exceed the minimum time  $t_{max}$  indicated in Table F.4.3.2.

**Table F.4.3.2**

Temperature to be Validated (°F)	193°F (90°C) Regression		176°F (80°C) Regression	
	Data Level <sup>1</sup>	Min. $t_{max}$ <sup>2</sup>	Data Level <sup>1</sup>	Min. $t_{max}$ <sup>2</sup>
140 (60°C)	E-6	5500	E-10+	17,000
<sup>1</sup> Per data interval requirements <sup>2</sup> $t_{max}$ = log average of 5 longest times (included in regression)				

**EXAMPLE:**

140°F (60°C) regression data are determined in accordance with Part A and support an HDB of 1000 psi. No brittle failures are obtained within 10,000 hours.

According to Table F.4.3.2, minimum data requirements for a 193°F (90°C) regression are an “E-6” data level (Part A) and a  $t_{max}$  of 5,500 hours. The following data are obtained:

Stress	Failure Time	Failure Mode
760	71	Ductile
755	102	Ductile
745	514	Ductile
740	693	Ductile
740	717	Ductile
735	908	Ductile
730	1478	Ductile
730	1726	Ductile
725	2155	Ductile
720	2943	Ductile
720	4087	Ductile
715	4382	Ductile
710	5207	Ductile
705	5928	Ductile
700	6174	Ductile
700	7000	Non-Failure

LCL Ratio = 98.4% (> 90%)

Longest 5 times:

4382

5207

5928

6174

7000

**Log Avg. 5667**

[5,667 > 5,500]

**HDB is validated.**

## **F.5: Hydrostatic Design Basis Substantiation for PE Materials**

When it is desired to show that a PE material has additional ductile performance capacity than is required by validation of the 73°F (23°C) time/stress curve to 100,000 hours, the following procedure may be used to further substantiate that the stress regression curve is linear to the 438,000-hour intercept.

F.5.1 Use the twelve data points from Condition I and II obtained from Procedure I of ASTM D 2837, along with the 438,000-hour intercept, to solve for the three-coefficient rate process extrapolation equation. Then using this new model, calculate the mean estimated failure time for Condition III. When the log average time for six specimens tested at Condition III has reached this time, linear extrapolation of the 73°F (23°C) stress regression curve to 438,000 hours is substantiated.

F.5.2 When Procedure II of ASTM D 2837 is used to validate the 73°F (23°C) HDB, linear extrapolation of the stress regression curve to 438,000 hours is substantiated when the log average failure time of the test specimens at 176°F (80°C) surpasses 6000 hours at a stress of no more than 100 psi below where all failures are ductile. A ductile failure reference stress shall be established by 3 specimens all failing in the ductile mode at the same temperature.

Note: The Long-Term Hydrostatic Strength (LTHS) at 50 years is not to be used for pressure rating calculations. The MAOP is still calculated using the HDB obtained from the LTHS at 100,000 hours.

PE materials meeting this additional substantiation of the 73°F (23°C) extrapolation shall be denoted by an asterisk (\*) in PPI TR-4.

## **F.6. POLICY ON ESTABLISHING EQUIVALENCE OF MODIFIED PE PIPE COMPOSITIONS (Formerly Part Z)**

A manufacturer who has a polyethylene pipe compound with a PPI Standard Grade recommended HDB may modify that compound provided that 1) the changes are minor, as herein defined, or 2) adequate testing is performed to confirm that the modified material has at least an equivalent HDB to the original PPI listed material at each temperature. Minor modification(s) in PE compounds that require no testing and reporting to the HSB are covered in the following sections of TR-3:

Colorant changes	Part D.1
Thermal Stabilizer Substitution	Part F.1
Stabilizer Variations	Part F.2

Other modifications to the composition of a piping compound could significantly affect its long-term service life. Accordingly, such changes will require certain hydrostatic pressure testing to confirm the modified compound has the same HDB as the original listed compound. Examples of possible composition modifications include:

Changes in color concentrate:

A change in pigment level not covered in Part D, and/or a change in the concentrate carrier resin - The concentrate carrier resin is not considered to have changed if the nominal melt index and density, and the process technology, the catalyst system, and the comonomer used in its manufacture are nominally the same as that of the carrier resin used in the original composition.

Changes in the manufacturing specifications for the PE resin.

Changes in either PE resin or PE pipe compound manufacturing process.

It is recognized that a change in process conditions will generally, but not always, result in no adverse change in long-term strength characteristics provided the material is made to the same manufacturer's product specifications. The determination of which process change could affect long-term strength has to be determined by the listing company using the best judgment. Past experience can be a guide. Whenever there is reasonable suspicion, testing, as described below, should be conducted to confirm that the material's long-term strength characteristics have remained unchanged. Some examples of process changes that should be considered during the decision making process include:

Changes in the type of manufacturing process.

The start-up of new reactors at existing or new plant sites.

Changes in the type of compounding equipment used in the pelletization process.

Modifications in color concentrate, material manufacturing specifications, and in manufacturing process as described above, will require certain minimum confirmatory stress-rupture testing and validation in accordance with Parts A and F.4 of this report. Test data on one (1) lot of the modified compound shall be developed to confirm that all the HDB's assigned to the original compound are maintained.

The minimum levels of data required are, E-2 per Part A at 73°F and E-2 at the highest other listed temperature, if any. In addition, validation at the highest listed temperature is also required.

In the case of materials with a listing at more than one temperature, the requirements given above for the highest listed temperature are sufficient to establish equivalence for all listed temperatures.

Modifications that are not within the scope of those defined in this Part are considered to result in new materials subject to the full testing requirements of Part A, and Part F.4. However, the HSB has the authority, on a case-by-case basis, to recommend different testing requirements upon review of the proposed modification.

## **PART G: PEX SPECIFIC POLICES, PRACTICES AND PROCEDURES**

### **G.1. PROTOCOL FOR PPI LISTING OF EFFECT OF CHLORINE ON PEX PIPE IN PPI TR-4 (Formerly Part G)**

- G.1.1 PEX pipe producer initially contacts HSB Chairman to obtain TR-4 HDB listing for their product. HSB Chairman outlines for the pipe producer all the requirements for this HDB listing along with listing the chlorine resistance when tested in accordance with ASTM test method F 2023. The pipe producer may either privately list this chlorine resistance for their product with PPI or publicly list it for publication in PPI TR-4.
- G.1.2 PEX pipe producer obtains chlorine stress rupture data in accordance with ASTM test method F 2023.
- G.1.3 PEX pipe producer submits stress rupture chlorine data to HSB chairman for analysis and calculations for the conditions defined in ASTM F 2023.
- G.1.4 HSB chairman sends letter to PEX pipe producer summarizing calculation results. PPI will publish results in a categorized manner in its new chlorine resistance section of TR-4 if requested by the pipe manufacturer. The TR-4 listing will include the specific test conditions of pH, chlorine and ORP, along with the categorized failure time in accordance with the appropriate PEX pipe standard.
- G.1.5 This listing by PPI is for the PEX pipe product rather than for the PEX material or compound. HSB will consider if transfer of a listing from the material supplier (independent listing) to a pipe producer (dependent listing) per the TR-4 protocol should be available when more data are developed using ASTM F 2023.
- G.1.6 Deviations from this policy would be heard by the HSB as a special case.

## **G.2 POLICY ON FORMULATION MODIFICATIONS FOR PEX HDB LISTINGS (Formerly Part AA)**

The following formulation modifications to cross-linked polyethylene (PEX) compounds may be made without having to submit additional long-term strength test data provided:

1. The formulation changes fit within the guidelines below;
2. The required additional supporting data detailed below is provided;
3. The Gel content of the new compound as determined according to ASTM D2765, "Standard Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics" is not lower than that for the original compound for which the recommended HDB was obtained.

### **G.2.1 Colorant Changes:**

Colorant changes as detailed in Part D.1 of PPI TR-3.

### **G.2.2 Thermal Stabilizers:**

#### **A. Thermal Stabilizer Substitution:**

Thermal Stabilizers for use in PEX compounds may be used interchangeably in a PEX plastic pipe formulation provided:

- A.1. The requirements for Stabilizer Validation in Section 6.8 of ASTM Standard F876, "Standard Specification for Crosslinked Polyethylene (PEX) Tubing", are met;
- A.2. The total content of the stabilizer package in the formulation is less than 0.75 parts per 100 parts of resin;
- A.3. The quantity of substituted stabilizer is within  $\pm 50$  percent of the level of the stabilizer in the original formulation;
- A.4. The quantity of the substituted thermal stabilizer does not exceed 0.75 parts per 100 parts of resin.

#### **B. Change in Amount of Thermal Stabilizer:**

The amount of thermal stabilizer may be changed up to  $\pm 50$  percent from the specified amount for the base composition. An increase in thermal stabilizer does not require testing. If the level of thermal stabilizer is decreased the new compound must satisfy requirements for Stabilizer Validation in Section 6.8 of ASTM Standard F876, "Standard Specification for Crosslinked Polyethylene (PEX) Tubing"

### **G.2.3 Addition of UV Light Stabilizers:**

Ultraviolet (UV) light stabilizers designed for use in crosslinked polyethylene (PEX) compounds may be used interchangeably in a PEX plastic pipe formulation provided:

- A. The total content of the UV stabilizer package in the formulation is less than 0.75 parts per 100 parts of resin;
- B. The quantity of the substituted stabilizer does not exceed 0.75 parts per hundred of resin.

No consideration is given to the effectiveness in the UV light protection in that this characteristic of the compound is not considered by PPI or ASTM standards and is between the purchaser and seller.

### **G.2.4 Catalyst Changes:**

For PEX pipe manufacturing processes that utilize a catalyst to accelerate the crosslinking process, the level of this catalyst may be changed up to  $\pm 50$  percent from the specified amount for the base composition.

The type of catalyst may also be changed provided the same carrier fluid or resin is utilized. Also, the level of the substituted catalyst must be within  $\pm 50$  percent of the original catalyst level.

### **G.2.5 Carrier Resin Changes:**

Carrier resins for the addition of additives to the PEX formulation may be used interchangeably provided:

- A. The substituted Carrier Resin has the same Cell Classification according to ASTM D3350, " Specification for Polyethylene Plastics Pipe and Fittings Materials";
- B. The addition level of the Carrier Resin including additives is below 6% of the total formulation.
- C. The level of substituted resin is the same as for the original base formulation.

Note 1: Due to the chemical nature of the PEX manufacturing process changes to formulations may result in an interference with the crosslinking process or the crosslinking process may interfere with the functioning of the additive. The manufacturer should make adequate tests to assure users that the formulation changes do not adversely affect the performance properties other than long-term hydrostatic strength.

Note 2: The compound to which any one of the above mentioned formulation change is made does not become a new base compound to which additional changes can be made.

Proposed substitutions outside these guidelines may be evaluated with other policies and procedures in PPI TR-3.

### **G.3 POLICY ON ESTABLISHING EQUIVALENCE OF MODIFIED PEX PIPE COMPOSITIONS (Formerly Part BB)**

A manufacturer who has a crosslinked polyethylene (PEX) compound with a PPI Standard Grade recommended HDB may modify that compound provided that the changes are minor, as herein defined, or adequate testing is performed to confirm that the new material has an equivalent HDB to the original PPI listed material at each of the temperatures for which the material is listed. Minor modification(s) in PEX compounds that require no testing and reporting to the HSB are covered in TR-3 Part G.2.

Other modification to the composition of a piping compound could significantly affect its long-term service life. Accordingly such changes will require certain hydrostatic pressure testing to confirm the modified compound has the same HDB as the original listed compound. Examples of possible compound modifications include:

For PE Base resin (prior to crosslinking):

- Changes in the manufacturing specifications for the PE resin
- The start-up of new reactors at existing or new plant sites for PE base resin manufacture
- Changes in PE base resin manufacturing process

Changes such as those outlined above will require certain minimum confirmatory stress-rupture testing and validation in accordance with Parts A and B of this report. Test data on one (1) lot of the modified compound shall be developed to confirm the same HDB as the original compound. The levels of data required are:

<b><u>Listing Temperature</u></b>	<b><u>Minimum Data Requirement for Listed Temperature</u></b>
73 °F (23 °C)	E-2 per Part A
Highest Rated Temperature	E-6 at highest rated temperature

In addition to the above stress-rupture testing, data shall be supplied to confirm that the Gel content of the modified PEX composition as determined according to ASTM D2765, "Standard Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics", is not lower than that for the original compound for which the recommended HDB was obtained.

In the case of materials with a listing at more than one temperature, the requirements given above for the highest listed temperature are sufficient to establish equivalence for all listed temperatures.

Modifications that are not within the scope of those defined in this Part are considered to result in new materials subject to the full testing requirements of Part A. However, the HSB has the authority, on a case-by-case basis, to recommend different testing requirements upon review of the proposed modification.

## **APPENDICES**

## APPENDIX X.1 TEST DATA REPORT REQUIREMENTS

### X.1.1 Checklist for HSB Submissions

The minimum information required by PPI's HSB to develop recommendations of HDB/PBD/SDB/MRS for specific thermoplastic pipe and fitting materials is summarized in the following two submission checklists (one for PVC and one for non-PVC materials). The HSB may require additional information for certain cases.

Complete all sections, then send to the HSB Chairman, along with the signed certification below:

#### CERTIFICATION TO ACCOMPANY SUBMISSIONS TO THE HSB

I do hereby certify that the data and other information included with this submission are truthful and accurate; that the data are derived from testing actually performed on the samples identified in the submission by (INSERT NAME OF COMPANY OF OUTSIDE LABORATORY THAT CONDUCTED THE TESTING \_\_\_\_\_); that the data do not, in any way, misrepresent the performance or other characteristics of the material covered by the submission; and that this submission does not omit any data or information known to my company (including that derived from any testing summarized in this submission) which would be material to an HSB decision on the action requested.

Signed: \_\_\_\_\_

Authorized Representative

Print Name: \_\_\_\_\_

Title: \_\_\_\_\_

Company: \_\_\_\_\_



# CHECK LIST FOR HSB SUBMISSIONS NON - PVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date: \_\_\_\_\_

## 1 - Owner of Proposed PPI Listing

Manufacturer: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 Phone: ( ) \_\_\_\_\_ Fax: ( ) \_\_\_\_\_  
 Contact: \_\_\_\_\_

## 2 - Data Submission:

Compound Designation: \_\_\_\_\_  
 Compound is Intended for  Extrusion Only  
 Molding Only  
 Either Extrusion or Molding  
 Data Submission is for a:  New Formulation  
 Modified Formulation  
 ↪ Base, (or Parent), Formulation is: \_\_\_\_\_  
 ↪ \_\_\_\_\_  
**Description of Modification**

## 3 - Type of Request:

Routine Request: The data and other information herewith presented are in full compliance with PPI TR-3 requirements for the requested level, (E2, E4, E6, etc.) of PPI listing.

Special Case: Some of the information, as follows, is not in full compliance with the TR-3 requirements:

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Notwithstanding this, it is believed that the data presented are sufficient for granting the request listing based on the following reasons:

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**(Note: Special Cases are referred to the HSB for adjudication)**



# CHECK LIST FOR HSB SUBMISSIONS NON - PVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date:

## 4 - Requested Action:

Based on this data submission the following action is requested:

A listing of the subject formulation (see Note) for the listing level, (Standard, E2, E4, E6, etc.) of \_\_\_\_\_, for a recommended \_\_\_\_\_ psi, HDB/PDB/SDB/MRS of \_\_\_\_\_ for a temperature of \_\_\_\_\_ °F (or °C, specify), and external environment of \_\_\_\_\_.

Acceptance of the subject formulation as equivalent to the base formulation. It is requested that this equivalent formulation be listed under:

Its own identification, which is: \_\_\_\_\_

or

The Base formulation.

**(Note: Consult PPI TR-3, Parts A & B for listing grades, conditions and requirements)**

## 5 - Other Data or Listings:

Does this material have a PPI listing at other temperatures or conditions?

No

Yes (Provide the details)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Are there stress-rupture data available for other temperatures?

No

Yes - Have been previously submitted (List the temperatures in °C or °F)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Yes - Are now being submitted via separate data submissions (List the temperatures in °C or °F)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



# CHECK LIST FOR HSB SUBMISSIONS NON - PVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date: \_\_\_\_\_

**6 - Pipe or Fitting Material Designation and Classification:**

ASTM Standard: \_\_\_\_\_

Cell Classification or Material Identification \_\_\_\_\_

Actual Values (indicate the units):

<u>Physical Property</u>	<u>Test Method</u>	<u>Average Value, or Range</u>
Tensile strength, psi or MPa	ASTM D638	_____
Flexural Modulus, psi or MPa	ASTM D790	_____
Izod Impact Strength, ft•lb/in or J/m	ASTM D256 Method A	_____
Deflection temperature under load °F or °C	ASTM D648	_____
[264 psi (1.82 MPa) load]		_____
Others:	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**7 - Compound Mixing:**

Material is:     Pre-Compounded    or     Blended In-Plant

**8 - Hydrostatic Stress/Time Data:**

8.1 - Use the form in Section 10 to provide the stress, time and failure mode for each lot of pipe that was tested (make copies if necessary). All data points must be reported even though they may not be considered appropriate for the calculation. The reason for the latter is to be given.

8.2 - Indicate the Mode of Failure in Section 10, using the following codes:

- |                       |                    |
|-----------------------|--------------------|
| N - Non-failure point | B - Brittle        |
| S - Shatter           | ? - Other, Specify |
| D - Ductile           |                    |



# CHECK LIST FOR HSB SUBMISSIONS NON - PVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date:

## 8 - Hydrostatic Stress/Time Data (cont'd):

8.3 - Is Creep the controlling factor?

(See Paragraph 5.3, "Circumferential Expansion", of ASTM D2837 for details on data requirements for evaluating creep as a potential limiting factor. Based on historical data, PPI's HSB recognizes the following materials as having long term strengths which are not limited by the ASTM D2837 creep criterion: PVC, medium and high density PE, CPVC, PA & PB.)

**No** Present the basis for this conclusion if the material is other than those listed above.

**Yes** Present the circumferential expansion data summary and resultant calculations on a separate data sheet.

8.4 - Calculate the 100,000-h LTHS, 50-year intercept, LCL and LCL Ratio and show these results in Section 10.

8.5 - Computer printouts of the data and calculations are acceptable if they provide the information requested in Section 10 in an easy to read format.

8.6 - Polyethylene materials, which are to be listed with an HDB at 73°F and at higher temperatures, must also undergo supplemental validation of the long-term hydrostatic strength in accordance with Clause 5.6 of ASTM D2837, or Part F.4 of TR-3.

Remember to submit these validation data on a separate data sheet.

8.7 - For crosslinked polyethylene (PEX) pipe data, what is the measured level of crosslinking?

\_\_\_\_\_

What is the measurement method? \_\_\_\_\_

The listed HDB/MRS for this PEX pipe will be based on this crosslink level.

## 9 - Hydrostatic Stress Summary (indicate the units)

HDB/PDB/SDB/MRS requested:

psi or MPa



# CHECK LIST FOR HSB SUBMISSIONS

## PVC and CPVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date: \_\_\_\_\_

### 1 - Owner of Proposed PPI Listing

Manufacturer: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 \_\_\_\_\_  
 Phone: ( ) \_\_\_\_\_ Fax: ( ) \_\_\_\_\_  
 Contact: \_\_\_\_\_

### 2 - Data Submission:

Compound Designation: \_\_\_\_\_  
 Submission is a:  New PVC Formulation (see 6.1.1)  
 New Compound (See 6.1.3),  PPI Range Formulation  
 for:  Private Formulation  
 (check one of the following:)  Other component not  
 PVC Resin (6.1.2) complying  
 Process Aid to the guidelines of PPI TR-  
 Heat Stabilizer 3:  
 Commercial Designation \_\_\_\_\_  
 of the new Component: Specify \_\_\_\_\_  
 (Attach Physical Property Data  
 Sheet)  
 Special Case (Attached an explanation of why it should be  
 considered)

### 3 - Compound Mixing:

Equipment:  High Intensity Mixer  Low Intensity Cooler  
 or  \_\_\_\_\_ or  \_\_\_\_\_  
 Describe Other Describe Other  
 Procedure:  Double Batching or  Single Batching  
 Description: \_\_\_\_\_  
 (Describe the procedure \_\_\_\_\_  
 followed in preparing \_\_\_\_\_  
 the compound. See Note \_\_\_\_\_  
 7 of TR-3) \_\_\_\_\_

# CHECK LIST FOR HSB SUBMISSIONS

## PVC and PVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date: \_\_\_\_\_

<b>4 - Fabrication Process:</b>		
4.1 - Extrusion: <input type="checkbox"/>	<input type="checkbox"/> Laboratory Equipment and Conditions	
Extrusion was done on:	or	<input type="checkbox"/> Production Equipment and Conditions
4.1 - Molding: <input type="checkbox"/>	Type of Mold <input type="checkbox"/> Side Gate	or <input type="checkbox"/> End Gate
Specimen Dimensions, in or mm (Indicate Units):		
Outside Diameter: _____	Wall Thickness: _____ / _____	Length: _____
Average	Minimum      Average	Average

<b>5 - Resin and/or Compound Properties:</b>				
5.1 - Resin Properties:				
(Only required if <b>PVC Resin</b> box was checked in Section 2)		<b><u>Lot 1</u></b>	<b><u>Lot 2</u></b>	<b><u>Lot 3</u></b>
		— (if required) —		
Inherent Viscosity	ASTM D1243	_____	_____	_____ (0.88 - 0.96)
Heat Loss (water) % by wt.	1 hr @ 221°F (105°C)	_____	_____	_____ (0.5 max.)
Apparent Bulk Density, g/cc	ASTM D1895	_____	_____	_____ (0.46 - 0.62)
Compacted Bulk density, g/cc	ASTM D1895 (Method C)	_____	_____	_____ (0.54 - 0.72)
RVCM	ASTM D3749	_____	_____	_____ (10 ppm max.)
5.1 - Compound Properties:				
Cell Classification per ASTM D1784:		_____		
Actual Values (indicate units):				
Base Resin			PVC	
Izod Impact Strength, ft-lb/in or J/m	ASTM D256 Method A	_____	_____	
Tensile strength, psi or MPa	ASTM D638	_____	_____	
Modulus of elasticity, psi or MPa	ASTM D638	_____	_____	
Deflection temperature under load, °F or °C [264 psi (1.82 MPa) load]	ASTM D648	_____	_____	

# CHECK LIST FOR HSB SUBMISSIONS

## PVC and CPVC COMPOUNDS

Consult PPI TR-3 for Definitions, etc.

Date:

### 6 - Hydrostatic Stress/Time Requirements

6.1 - Data Required:

6.1.1 - New PVC Formulation:

Provisional Listing

≥ E2  
followed by ≥ E4, E6,  
etc.  
every 6 months.

Standard Listing

E10 on one lot  
plus ≥ E2  
on two additional  
lots.

6.1.2 - New PVC Resin::

(stabilizer and calcium carbonate must be at the maximum of range).

Provisional Listing

≥ E6  
followed by ≥ E8, etc.  
every 6 months.

Standard Listing

E10 on one lot  
plus ≥ E2  
on two additional  
lots.

6.1.3 - New Component:

(subject component must be at the maximum of range).

Provisional Listing

≥ E6  
followed by ≥ E8, etc.  
every 6 months.

Standard Listing

E10 on one lot  
plus ≥ E2  
on two additional  
lots.

6.1.4 - Special Case:

(what protocol is proposed?)

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### 6.2 - Stress/Time Data:

6.2.1 - Use the forms in Section 8 to provide the stress, time and failure mode for each lot of pipe that was tested. All data points must be reported even though they may not be considered appropriate for the calculation. The reason for the latter is to be given.

6.2.2 - Indicate the mode of failure using the following codes:

N - Non-failure point

B - Brittle

S - Shatter

? - Other, Specify

D - Ductile

6.2.3 - Calculate the 100,000-h LTHS, 50-year intercept, LCL and LCL Ratio and show these results in Section 8.

6.2.4 - Computer printouts of the data and calculations are acceptable if they provide all the information requested in Section 8 in an easy to read format.

### 7 - Hydrostatic Stress Summary: (Indicate the units)

HDB/PDB/SDB/MRS requested

psi or MPa



### **X.1.2. Additional Information**

Supplemental information useful in the development of new or improved policies and in enhancing the quality of correlation, interpretation and extrapolation of stress-rupture data is welcomed by the HSB. For example, data obtained on poor quality pipe (i.e., pipe that does not meet the latest standards and/or specifications), will be helpful and will be used to study the method and other auxiliary procedures used to develop recommended HDB/PDB/SDB/MRS values and in preparing effective product specifications. The sources of such data and the detailed data itself will be kept confidential if those submitting such data so request. For this purpose, the material identification may be omitted from the report. Data in this category will not be used as a basis for developing recommendations for hydrostatic design stresses for plastic pipe materials. It should be noted that design stresses cannot be recommended for pipe materials that do not meet current standards and specifications.

The submission of results of research and development studies on the stress rupture behavior of thermoplastic pipe and field experiences on the effect of changes in formulations are also requested. Such data are helpful in determining whether or not changes in or additions to these policies and procedures should be made, thereby improving plastic pipe engineering.

### **X.1.3. Release of Recommendations**

The HSB will not issue any recommendations for HDB/PDB/SDB/MRS values for specific commercial materials without the written approval of the manufacturers of the materials.

Data and other information should be sent to:

Stephen Boros, Chairman  
Hydrostatic Stress Board  
Plastics Pipe Institute, Inc.  
1825 Connecticut Ave. NW, Suite 680  
Washington, DC 20009-1301

### **X.1.4. Appeals of HSB Actions**

It is PPI's hope that a thorough understanding of the policies and procedures for developing recommended HDB/PDB/SDB/MRS values for thermoplastic piping materials will minimize any disputes or disagreements regarding HSB actions on requests for recommendations. However, if a manufacturer disagrees with an action taken by the HSB in regard to his product, he may request that the HSB review its initial determination. The action on any request for review will be subject to approval by PPI's President and Counsel.

A request by a manufacturer for review of a disagreement with the HSB must be in writing and contain a complete description of the manufacturer's original proposal and sufficient information to accurately explain the nature of the disagreement and the

decision or action sought by the manufacturer. Upon receipt by the HSB, the Board will consider the matter and reply in writing to the manufacturer within thirty (30) days. The manufacturer may, if he so chooses, request a conference call with, or appear before the Board to discuss the issue. If necessary, the HSB may request any additional information needed to reach a decision.

**X.1.5. Confidentiality**

Neither PPI staff, PPI members, nor any member of the HSB will make any public comment on the status of a particular manufacturer's products or test results, except to note whether the product is publicly listed in PPI's TR-4.

## **APPENDIX X.2**

### **SUGGESTED LETTERS FOR TRANSMITTING THE INFORMATION REQUIRED BY VARIOUS PARTS OF THIS REPORT**

## FOR PART D.3 - ESTABLISHING DEPENDENT LISTINGS:

### X.2.1 Letters from owner of independent listing:

- A. Covering condition of complete equivalence of mixing and processing of the independent and dependent formulation. (For example, when premixing and extrusion of dependent formulation uses basically the same equipment and conditions as used for independent formulation.)

Dear \_\_\_\_\_

(Chairman of HSB):

Our (give independent formula designation) is presently listed by PPI as a (give PPI material designation, e.g., PVC 1120). The following recommended hydrostatic design basis (HDB) or Minimum Required Strength (MRS) has been established by PPI on the basis of the data we provided: (list the HDB/MRS for each temperature for which an HDB/MRS recommendation has been granted).

We have supplied (give name and address of the intended receiver of this formulation) the formulation for this composition, and the specification requirements and source of supply for all required ingredients. In addition we have furnished them with all pertinent information, including equipment description and mixing and processing details, such that their processing of this composition can be equivalent, and yield a product that is equivalent, to that represented by the data we supplied on behalf of (give name of independent formula designation).

Therefore, we request, and grant permission, for the test data developed for (give independent formula designation) to be used for the transfer of the above HDB/MRS recommendations to the (give name of company receiving transfer) who will be preparing this composition, and listing it, under their designation (give dependent formula designation).

\* \_\_\_\_\_ agrees to hold the Plastics Pipe Institute (PPI) harmless and indemnify PPI for any and all liability, loss, damage, cost and expense which PPI may suffer, incur, or be put to by reason of any claim, suit or proceeding for personal injury, property damage or economic loss on account of the failure or alleged failure of the compound listed (or pipe produced from the compound) to conform to specifications on which the listing is based, or based on the HDB or MRS assigned to the compound, and \* \_\_\_\_\_ further agrees to defend PPI at \* \_\_\_\_\_'s expense, against any and all suits, claims or proceedings.

Yours very truly,

\*Give company name

- B. Covering condition where complete equivalence mixing and processing cannot be assured (see 1.1.3 of D.3). (For example, when a melt homogenized compound was used to prepare pipe under the independent listing but the dependent listing will depend solely on the extrusion process to effect proper mixing.)

Dear (Chairman of HSB):

Our (give independent formula designation) is presently listed by PPI as a (give PPI material designation, e.g., PVC 1120). The following recommended HDB or MRS has been established by PPI on the basis of the data we provided: (list the HDB/MRS for each temperature for which an HDB/MRS recommendation has been granted).

We have supplied (give name and address of the intended receiver of this formulation) the formulation for this composition and the specification and source of supply for all required ingredients. In addition we have furnished them with all pertinent information, including equipment description and mixing and processing details, such that their processing of this composition can be equivalent, and yield a product that is equivalent, to that represented by the data we supplied on behalf of (give name of independent formula designation).

However, because of certain apparent differences between the processes by which (give name of independent formula designation) was prepared and that by which it will be prepared by (name of intended receiver), we cannot establish with reasonable certainty complete equivalence between the two processes.

Accordingly, we request that in accordance with D.3 of TR-3 the test data we developed on behalf of (give independent formula designation) be used for the transfer, for a maximum period of six months, of the HDB/MRS recommendations referenced in the first paragraph. Prior to the end of this period confirmatory data shall be supplied by us (or by intended receiver).

{An alternate to this last paragraph is the following.}

Therefore, we request that in accordance with D.3 of TR-3 the test data we developed on behalf of (give independent formula designation) be used for the transfer of the HDB/MRS recommendations referenced in the first paragraph, after they are first reduced by a factor of 0.80.

\* \_\_\_\_\_ agrees to hold the Plastics Pipe Institute (PPI) for any and all liability, loss, damage, cost and expense which PPI may suffer, incur, or be put to by reason of any claim, suit or proceeding for personal injury, property damage or economic loss on account of the failure or alleged failure of the compound listed (or pipe produced from the compound) to conform to specifications on which the listing is based, or based on the HDB or MRS assigned to the compound, and \* \_\_\_\_\_ further agrees to defend PPI at \* \_\_\_\_\_'s expense, against any and all suits, claims or proceedings.

Yours very truly,

\*Provide Company Name

## X.2.2 Letter from intended receiver of independent listing:

Dear \_\_\_\_\_

(Chairman of HSB)

We have received from (give name and address of owner of independent listing) the formulation, and the specification requirements and the source of all required ingredients, for their (give PPI material designation, e.g., PVC 1120) composition (give independent formula designation). In addition we have been furnished with all pertinent information, including equipment description and mixing and processing details, to allow us to process this composition as an equivalent to that represented by the data that was supplied by the HSB (give name of owner of independent formula) on behalf of this composition. It is our intention to exactly reproduce this composition, which we will designate as (give dependent composition designation), and to process it in accordance with this information.

Accordingly, we request that the data supplied on behalf of (give name of independent formulation) be used for the transfer of the HDB or MRS recommendation for the composition to (give dependent composition designation). We accept any time limitation and data requirements or stress reduction established by (give name of owner of independent formulation) for this transfer.

\* \_\_\_\_\_ agrees to hold the Plastics Pipe Institute (PPI) harmless and indemnify PPI for any and all liability, loss, damage, cost and expense which PPI may suffer, incur, or be put to by reason of any claim, suit or proceeding for personal injury, property damage or economic loss on account of the failure or alleged failure of the compound listed (or pipe produced from the compound) to conform to specifications on which the listing is based, or based on the HDB or MRS assigned to the compound, and \* \_\_\_\_\_ further agrees to defend PPI at \* \_\_\_\_\_'s expense, against any and all suits, claims or proceedings.

Yours very truly,

\*Provide Company Name

**X.2.3 FOR PART E.9: RESIN SUBSTITUTION IN PVC COMPOSITIONS**

Dear \_\_\_\_\_  
 (Chairman of HSB):

Presently, our PVC pipe formulation (give formula designation) carries a HSB recommended hydrostatic design basis (HDB) or Minimum Required Strength (MRS) of {give value(s) and temperature(s)}. We request the consent of the HSB for the use of alternate PVC resin (description of alternate resin) in addition to the originally specified PVC resin (designation of originally specified resin). The proposed alternate resin has been determined by us to be an acceptable substitute for the original resin on the basis of our requirements for this compound as well as the following criteria proposed by the HSB:

- (in case this is a dependent formulation) the owner of this formulation has established that this proposed resin substitution is acceptable and communications in this regard has been sent to you by him.
- the alternate resin is an originally specified material in at least one other PVC pipe formulation carrying a Standard Grade recommendation from the HSB.
- the use of the alternate resin has been determined not to result in any change of the ASTM material cell classification of the originally formulated compound. Supporting data are included with this letter.
- both the alternate and the original resins satisfy the following property requirements:

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>REQUIREMENT</b>
<b>Type of Material</b>	-----	<b>PVC Homopolymer</b>
<b>Inherent Viscosity</b>	<b>ASTM D 1243</b>	<b>0.88 - 0.95</b>
<b>Heat Loss (water); by wt.</b>	<b>1 Hr. @ 221°F (105°C)</b>	<b>0.5 max.</b>
<b>Apparently Bulk Density gm/cc</b>	<b>ASTM D 1895</b>	<b>0.46 - 0.62</b>
<b>Compacted Bulk Density, gm/cc</b>	-----	<b>0.54 - 0.72</b>
<b>RVCM</b>	-----	<b>10 ppm max.</b>

Stress rupture data demonstrating that the long-term strength category of the formulation is unaffected by the use of the alternate resin are enclosed. These data support an initial approval from the HSB for this proposed formulation modification and we request that such approval be granted.

\* \_\_\_\_\_ agrees to hold the Plastics Pipe Institute (PPI) harmless and indemnify PPI for any and all liability, loss, damage, cost and expense which PPI may suffer, incur, or be put to by reason of any claim, suit or proceeding for personal injury, property damage or economic loss on account of the failure or alleged failure of the compound listed (or pipe produced from the compound) to conform to specifications on which the listing is based, or based on the HDB or MRS assigned to the compound, and \* \_\_\_\_\_ further agrees to defend PPI at \* \_\_\_\_\_'s expense, against any and all suits, claims or proceedings.

Yours very truly,  
 \*Provide Company Name

**FOR PART E.12: PPI PVC GENERIC RANGE FORMULATION:**

To: HSB, Plastics Pipe Institute

We wish to list with PPI, under our commercial designation \_\_\_\_\_, the pre-qualified PVC range compound as defined in Part E of PPI TR-3. We would also like to have this listing published in PPI TR-4, and the National Sanitation Foundation notified of your acceptance of this listing. We understand and agree that this listing is given subject to the policies and procedures set forth in PPI TR-3.

We understand that this PVC compound is pre-qualified for a 4,000 psi hydrostatic design basis, and a maximum hydrostatic design stress of 2,000 psi, for water at 73°F (23°C), provided that only the specified materials are used, the blend of these materials is suitably homogenized prior to extrusion, and the extrusion into pipe is so conducted as to satisfy all the requirements of the applicable and current ASTM, AWWA, API, or other product standards.

We also understand that we shall be periodically advised, by the issuance of the update to PPI TR-3, of any approved changes in composition and approved components of this compound to which we shall comply.

In addition, we reserve the right to modify this composition for public, or our own private use, in accordance with the stipulations given in Part E.7.

\* \_\_\_\_\_ agrees to hold the Plastics Pipe Institute (PPI) harmless and indemnify PPI for any and all liability, loss, damage, cost and expense which PPI may suffer, incur, or be put to by reason of any claim, suit or proceeding for personal injury, property damage or economic loss on account of the failure or alleged failure of the compound listed (or pipe produced from the compound) to conform to specifications on which the listing is based, or based on the HDB or MRS assigned to the compound, and \* \_\_\_\_\_ further agrees to defend PPI at \* \_\_\_\_\_'s expense, against any and all such suits, claims or proceedings.

\*Provide Company Name

## **APPENDIX X.3**

### **PPI Membership Application**

## Membership Application

### **Plastics Pipe Institute, Inc.** **Membership Year 2004**

#### Guidelines

PPI dues are based on company sales within specific markets, as well as the approved annual budgets for each PPI division. *All information submitted will be kept strictly confidential.*

- **Reporting Sales To Markets Covered by the PPI:**

**Please use the following guidelines when completing the sales form attached for each of the PPI divisions. (Note: PPI bylaws require that members with sales in markets covered by PPI divisions must join those PPI division(s) and will be billed for the market division(s) fee(s).)**

1. Report all 2003 plastic pipe related sales to customers within North America (United States, Puerto Rico, Canada and Mexico). Freight costs shall not be included in reporting sales.
2. Report 2003 plastic pipe related sales from one or more of the following categories:
  - Pipe and/or fittings manufactured by the member. If pipe and/or fittings are manufactured from resin that is purchased from a company that is a member of the PPI, total net sales may be calculated as pipe/fittings sales **less** resin cost for those sales. If the resin company is not a member of the PPI, you may not deduct resin cost.
  - Pipe and/or fittings manufactured by the member from resin purchased from a source under the same PPI membership as the member. In this case, total net sales are calculated as pipe and fitting sales **including** resin cost for those sales.
3. Report 2003 sales of all resin manufactured by the member.
4. Report 2003 sales of all system components (i.e. risers, transition fittings, valves, mechanical fittings, etc.), fabricating or installing equipment manufactured by the member.
5. Report 2003 sales of all resin additives manufactured by the member.

## Confidential Member Sales Report Membership Year 2004

1.

<b>Company Name:</b>		
Representative's Name:		
Title:		
Address:		
City:	State:	Zip:
Phone:	Fax:	e:mail:

2. **We manufacture** (check all that apply):  Pipe, Fittings, Valves  Resin, Additives  
 Joining Equipment  Manufacturing Equipment  Other \_\_\_\_\_

3. **Voting Membership** – Available to manufactures of pipe, fittings, resin, additives, joining equipment, manufacturing equipment or other related products. Please complete the following table.

**North American Company Sales** (estimated) to plastic pipe markets for the calendar year ending December 31, 2003 are as follows (check all appropriate boxes)<sup>1</sup>:

Sales Range	Sales to Municipal & Industrial Markets	Sales to Fuel Gas Markets	Sales to High Temperature Markets	Sales to the Plastic Conduit Markets	Sales to the Corrugated Polyethylene Pipe Markets
\$ .1 - \$1million	\$2,450	\$920	\$1,450	\$1,250	Pipe Mfg: \$3,650 Matl. Supplier: \$2,450 Equip/Other: <sup>2</sup> \$2,625
1.1 - \$2 million <sup>2</sup>	\$4,900	\$1,840	\$2,900	\$2,500	Pipe Mfg: \$3,650 Matl. Supplier: \$2,450 Equip/Other: <sup>2</sup> \$2,625
\$2.1 – \$5 million	\$9,800	\$3,680	\$5,800	\$5,000	Pipe Mfg: \$3,650 Matl. Supplier: \$2,450 Equip/Other: <sup>2</sup> \$2,625
\$5.1 – \$10 million	\$14,700	\$5,520	\$8,700	\$7,500	Pipe Mfg.: \$7,300 Matl. Supplier: \$2,450 Equip/Other: \$7,875
\$10.1 - \$15 million	\$14,700	\$5,520	\$8,700	\$7,500	Pipe Mfg: \$10,950 Matl. Supplier: \$4,900 Equip/Other: \$7,875
\$15.1 – \$20 million	\$19,699	\$7,360	\$11,600	\$10,000	Pipe Mfg: \$14,600 Matl. Supplier: \$4,900 Equip/Other: \$7,875
\$20.1 - \$25 million	\$19,600	\$7,360	\$11,600	\$10,000	Pipe Mfg: \$18,250 Matl. Supplier: \$4,900 Equip/Other: \$7,875
\$25.1 - \$50 million	\$24,500	\$9,200	\$14,500	\$12,500	Pipe Mfg: upon request Matl. Supplier: upon request Equip/Other: upon request
\$50.1 - \$100 million	\$29,400	\$11,040	\$17,400	\$15,000	Pipe Mfg: upon request Matl. Supplier: upon request Equip/Other: upon request

<sup>1</sup>PPI Bylaws require all members with sales represented by a division to join that division. Also, a company may not join a division in which it does not have sales.  
<sup>2</sup>All voting manufacturing members must join at least one division at this level.

**4. Non-Voting Membership** – Available to consultants, testing labs, foreign affiliates and retired individuals.

Professional

Individual

Foreign Affiliate

*\$1,500 per year per company*

*\$250 for each division*

M&I Division

Fuel Gas Division

High Temp. Division

Conduit Division

CPPA Division

*\$200 per year per individual*

*\$70 for each division*

M&I Division

Fuel Gas Division

High Temp. Division

Conduit Division

CPPA Division

*\$2640 per year per company*

*\$180 for each division*

M&I Division

Fuel Gas Division

High Temp. Division

Conduit Division

CPPA Division

**5. Distributor Membership** – Any corporation, partnership, or sole proprietorship which purchases plastics piping systems for resale.

Distributor Membership

*\$1,250 per year*

**6. Certify To the Accuracy of This Statement:**

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Please return this form by fax or mail to:  
Rich Gottwald, President, Plastics Pipe Institute, Inc.

## 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](http://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. 52 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.