CERTIFICATE

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By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

Document Name: PPI TR-3: Policies and Procedures for Developing Hydrostatic Design Bases (HDB), Pressure Design Bases (PDB), and Minimum Required Thermoplastic Piping Materials (Section E Only)

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APPROVED

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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 though 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^{o}F (23^{o}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^{o}F (23^{o}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:

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

E.4.3. Results of hydrostatic rupture tests at 73^{o}F (23^{o}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^{o}F (23^{o}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^{o}F (23^{o}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:

COMPONENT	MAXIMUM COMPONENT VARIATION FROM ORIGINAL SPECIFIED CONTENT (PERCENT)*	MAXIMUM ALLOWABLE CONTENT OF COMPONENTS IN ADJUSTED FORMULA
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**

Process Aid	**± 20**	**No Limit**
Stabilizer	**± 20, but not to exceed ± 0.2 phr**	**No Limit**

* As specified for original formulation - no variance allowed.
+ The designation ± 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^{o}F (23^{o}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 ±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 ± 50 percent from the specified amount for the base composition without the need to submit additional