mailed 1/73
14

SPI

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

250 PARK AVENUE • NEW YORK, NEW YORK 10017 • 212/687-2675

January 5, 1973

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE DIVISION

Dear Member:

Attached are six new test methods. They are:

1) Proposed Recommended Practice for Soot Accumulation on Polyethylene Bottles

2) Recommended Practice for Measuring Toughness of PVC Bottles by Drop Impact

3) SPI Compression Test for Water-Filled and Capped Plastic Bottles Initial Bottle Strength

4) SPI Dead Load Compressive Test for Water-Filled and Capped Plastic Bottles Bottle Time (Creep) Factor

5) SPI Compression Test for Corrugated Boxes and Inserts Initial Box Strength

6) SPI Stack Compression Test Stacking Pattern Factor Pallet Design Factor

Also attached is a ballot on which you can record your vote for each one of the proposed test methods. You are requested to have your ballot returned no later than January 31, 1973. This will enable us to review negative ballots in time for discussion at the Committee's annual meeting on February 15, 1973.

All negative ballots must be accompanies by an explanation to be valid.

Cordially,

Thomas J. McGrath
Director of Packaging Services

TJM/mm
att.

SPI-25590

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.
250 PARK AVENUE · NEW YORK, NEW YORK 10017 · 212/687-2675

BALLOT

PLEASE COMPLETE AND RETURN TO:

Mr. Thomas J. McGrath
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

TEST METHODS	VOTE AFFIRMATIVE	VOTE NEGATIVE
Proposed Recommended Practice for Soot Accumulation on Polyethylene Bottles		
Recommended Practice for Measuring Toughness of PVC Bottles by Drop Impact		
SPI Compression Test for Water-Filled and Capped Plastic Bottles Initial Bottle Strength		
SPI Dead Load Compressive Test for Water-Filled and Capped Plastic Bottles Bottle Time (Creep) Factor		
SPI Compression Test for Corrugated Boxes and Inserts Initial Box Strength		
SPI Stack Compression Test Stacking Pattern Factor Pallet Design Factor		

Signature____________________________

Name____________________________

Company____________________________

Date____________________________

PLEASE RETURN ALL BALLOTS BY JANUARY 31, 1973. ALL NEGATIVE BALLOTS MUST BE ACCOMPANIED BY AN EXPLANATION TO BE VALID!

PROPOSED RECOMMENDED PRACTICE FOR

SOOT ACCUMULATION ON POLYETHYLENE BOTTLES

1. SCOPE

1.1 This method describes a test procedure for determining the relative soot accumulation properties of polyethylene bottles.

2. SUMMARY OF METHOD

2.1 An electrostatic charge is generated on the bottle surface under controlled conditions. The charged samples are exposed in a chamber to soot created by burning toluene wetted filter paper. Soot accumulation is rated visually by comparing the amount of carbon particles accumulated on the bottle to that shown on a pre-established grading scale.

3. SIGNIFICANCE

3.1 This method provides a useful means for determining the relative soot accumulation properties of polyethylene bottles. In particular, the method has been found useful in evaluating antistatic additives or antistatic bottle surface treatments or both. Experience has shown that the behavior of bottles in this test can be related to dust and lint accumulation under actual use conditions.

3.2 The method provides a means of accelerating soot accumulation. However, the correlation of the results of this test to actual use conditions must be established for each application.

3.3 Although no formal Round Robin testing has been done on other types of plastics, this test method has been found useful for testing other than polyethylene plastics. (1)

---

(1) R.E. Schanzle, "New Test for Plastics Antistatics," Modern Packaging, May, 1964, pp 129, 130, 204.

4. APPARATUS

4.1 The apparatus shall consist of the following (alternate size chambers are acceptable provided they are satisfactorily correlated):

4.1.1. Standard soot test chamber [2] having a 66,200 cubic centimeter (2.3 $ft.^3$) testing volume essentially like that shown in Figure 1. The test chamber shall be equipped with:

4.1.1.1 Means for maintaining a 15 ± 5 per cent relative humidity.

Note 1 The test chamber described in this procedure provides for humidity reduction by means of chemical drying agent contained within the chamber. Satisfactory results require the distribution of the drying medium in the chamber be such that it does not impede the flow of air. However, satisfactory results have also been obtained by locating the chamber in a room maintained at 15 per cent humidity or by use of other air drying equipment.

4.1.1.2 A fan or blower for air circulation to meet requirement 8.1.2

4.1.1.3 Means for igniting toluene filter paper.

4.1.1.4 Removable 80 mesh wire screens covering test chamber inlet and outlet.

4.1.1.5 Filter paper holder (20 mesh screen of size slightly larger than filter paper.

(2) May be purchased from H. Jacob Company - Cincinnati, Ohio.

4.1.2 Tongs

4.1.3 Relative humidity indicator (3)

4.1.4 Hypodermic (syringe) capable of holding specified amount of toluene. (see footnote #8)

4.1.5 Brush (see 10.1).

4.1.6 Urethane foam pad. 2.5 x 2.5 x 1.7" nonrigid "Urethane" foam at a density of 1.66 lbs. per cubic ft.

5. MATERIALS

5.1 Trichloroethylene.

5.2 Toluene USP, NF or CP.

5.3 Calcium chloride or equivalent granules, 8 mesh.

Note 2 Not required when humidity reduction is obtained by other means.

5.4 Dry cloth (for cleaning chamber).

5.5 Paper towels (4).

5.6 Filter paper, 24 mm diameter, ashless type (5).

5.7 Clear lacquer spray.

6. SAFETY PRECAUTIONS

6.1 Use caution when handling toluene and trichloroethylene. Small quantities may produce noticeable bodily effects if inhaled, contacted or ingested. Have adequate ventilation. If burning of toluene is not complete, stop test, clear chamber of toluene vapor and start over.

6.2 Have fire extinguisher nearby when handling and igniting toluene.

---

(3) Abbeon Relative Humidity Indicator Model AB2 or equivalent has been found satisfactory for this purpose.

(4) Kaypee Industrial Wipes, Sorg Paper Co., Middletown, Ohio or equivalent Have been found satisfactory for this purpose.

(5) Filter paper no. 895E, Carl Schleicher & Schuell Co. or equivalent has been found satisfactory for this purpose.

SPI-25594

7. TEST SPECIMENS

7.1 The test specimens shall be a specified area (not to exceed the width of the urethane pad) of the plastic bottles under investigation. For accurate determination of relative soot accumulation properties, all of the bottles should be of the same configuration. The specimens shall be free from visible water and dirt. Surfaces to be judged for soot accumulation resistance properties shall not be handled either beforehand or during the performance of the test. A minimum of three specimens for each test variable is necessary. (Use statistical sample when precision is required.)

8. CALIBRATION AND STANDARDIZATION

8.1 Apparatus

8.1.1 Check for test chamber tightness by sealing off smoke entrance and exit screens, and generating smoke as indicated under 10.8 and inspecting for smoke leakage into test chamber.

Note 3 Two mil polyethylene film may be placed over the openings and held in place with pressure sensitive tape.

8.1.2 With Polyethylene film removed and the chamber smoke entrance and exit covered just by the screens, measure the time for the smoke cloud to cross the test chamber to the chamber outlet. Smoke cloud must cross test chamber in 7 $\pm$ 1 seconds.

8.1.3 Calibrate the humidity indicator for 15 per cent relative humidity by storing over a saturated solution of lithium chloride at 20 $\pm$ 1 C per P.&.G. test method. <u>It is necessary to alternate the indicator between the 15 per cent humidity and a higher humidity (40-50 per cent) several times to be certain that the</u>

indicator returns to the 15 per cent reading accurately.

8.1.4 Operation of the test chamber may be checked using bottles with known soot accumulation properties.

Note 4 White pigmented bottles made from polyethylene resin containing no antistatic additive [6] and bottles made from the same material but sprayed overall with an antistatic agent [7] can be used.

8.2 Reference Standards and Blanks

8.2.1 Reference standards in the form of standard samples or photographs should be established for each individual bottle size and design scale to which tested specimens may be compared. Bottles prepared under 8.1.4 may be used as extremes.

Note 5 The grading scale employed in Round Robin testing (Fig. 2) may be used as a guide.

8.2.2 Acceptability of the reference standards shall be agreed upon by the purchaser and supplier.

9. CONDITIONING

9.1 The test specimens shall be stored at room temperature 20 to 30 C (68 to 86 F) 24 hours prior to testing and record RH.

---

(6) A non-antistatic all purpose polyethelyne copelymer resin type 3 or 4 containing 0.5% TiO_2 pigment has been found satisfactory for this purpose.

(7) An Aqueous solution of 10% by volume of Arquad 2HT-75 (Armour Industrial Co.) in water or equivalent may be used.

10. PROCEDURE

10.1 Remove wire screens from chamber and clean them by brushing in trichloroethylene, Dry with a clean cloth. Wipe out chamber with clean dry cloth to remove all loose soot and remove any remaining bottles from previous tests.

10.2 For the apparatus shown in Figure 1. to achieve 15% RH ± 5% spread approximately 200 gms. of dried calcium chloride on the screen in the drying drawer. If chamber has been used previously check condition of calcium chloride drying agent in drying drawer and replace if chamber has been left open or if ambient humidity is extremely high. If not replaced sooner, replace calcium chloride after every ten tests.

10.3 Close and latch all chamber openings, start blower and reduce relative humidity in chamber to 15 ± 5 per cent.

10.4 When the chamber reaches the humidity level specified, turn blower off and charge the specified area of the bottle to be tested by rubbing with a paper towel supported by 1 inch thick urethane foam padding to equalize pressure. (Compress pad 1/2 way) Stroke bottle surface to be tested only ten times in one direction starting at the top of the bottle and contacting the full panel surface as the stroke is made to the bottom of the panel. Only one pre determined area should be stroked per bottle.

10.5 Immediately after charging, place each bottle in the chamber allowing no less than 5 cm. (2 in.) between bottles or between the chamber walls and the bottles. Keep the test chamber door closed except when opened to position a charged bottle in the chamber.

10.6 Use a new surface area of towel for each bottle

10.7 Latch chamber door. Start blower. Maintain chamber humidity at 15 ± 5 per cent for two hours.

10.8 Turn blower off. Wet a piece of filter paper held with tongs with 0.10 cc of toluene [8]. Immediately place the wetted filter paper convex side up on the holder in the combustion drawer, close the drawer and immediately ignite the toluene using the ignition system. CAUTION, A DELAY IN IGNITION COULD ALLOW SOLVENT VAPORS TO MIX WITH AIR IN THE CHAMBER CREATING A POSSIBLE EXPLOSION HAZARD. (See section 6) Allow the filter paper to burn for 15 ± 1 seconds, then immediately start the blower. Turn off blower after 7 ± 1 seconds.

Note 7 The time the blower is run should be sufficient to just carry the smoke cloud across the test chamber to the chamber outlet. The test is made less severe if the blower is allowed to run longer than the specified time after ignition because particles are carried past the bottles.

10.9 After 15 ± 1 minutes, open chamber door and immediately remove specimens for inspection.

Note 8 Bottle contact time with the smoke generated affects the severity of the test results. Less contact time reduces the soot collected on bottles while a longer contact time increases the amount of soot collected.

---

(8) A hypodermic syringe (Hamilton Co., Inc. Whittier, Calif. Microliter #725) has been found useful in accurately dispensing small amounts of toluene.

10.10 Bottles may be lightly sprayed with clear lacquer after inspection for preservation.

Note 9 Customer and supplier are to use same type of spray for reproducibility.

11. INTERPRETATION OF RESULTS

11.1 Subjectively rate the soot accumulation on the specimens by comparison with the grading scale established. Soot accumulation should be rated as 0 = none to 9 = severe.

12. REPORT

12.1 The report shall include the following:

12.1.1 Complete identification of the plastic bottles tested including source, manufacturer, type, form, date of manufacture (if internal antistatic agent employed) or date of surface treatment (if applicable), previous history, etc.

12.1.2 Purpose of test.

12.1.3 Atmospheric conditions during conditioning and testing

12.1.4 Bottle surface rubbed.

12.1.5 Degree of soot accumulation.

12.1.6 Date of test.

FIGURE 1

SOOT CHAMBER

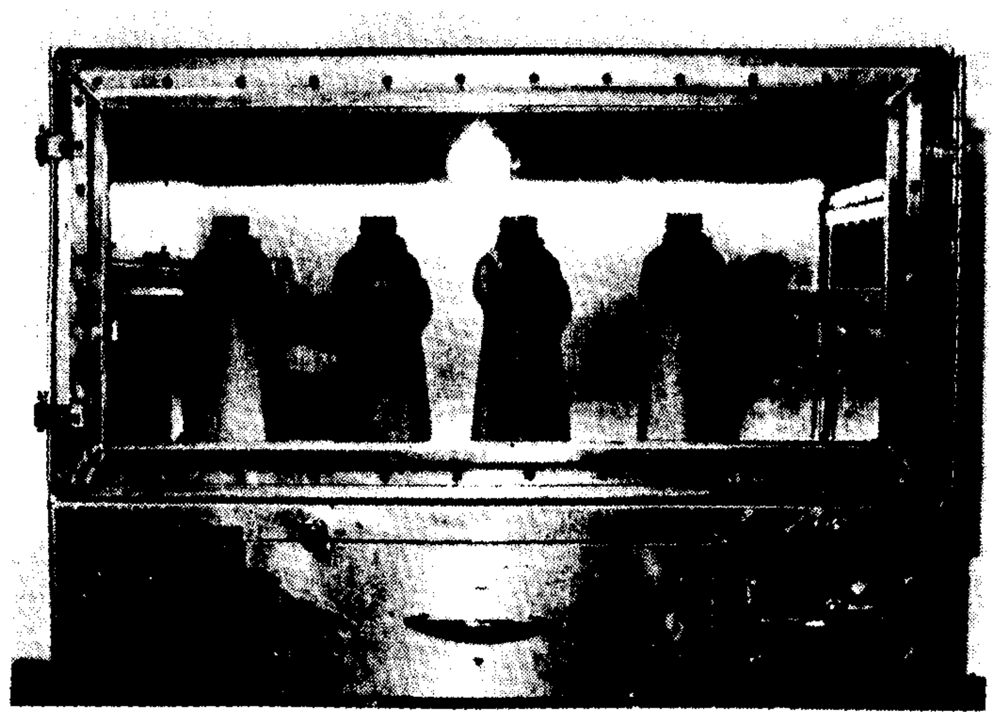
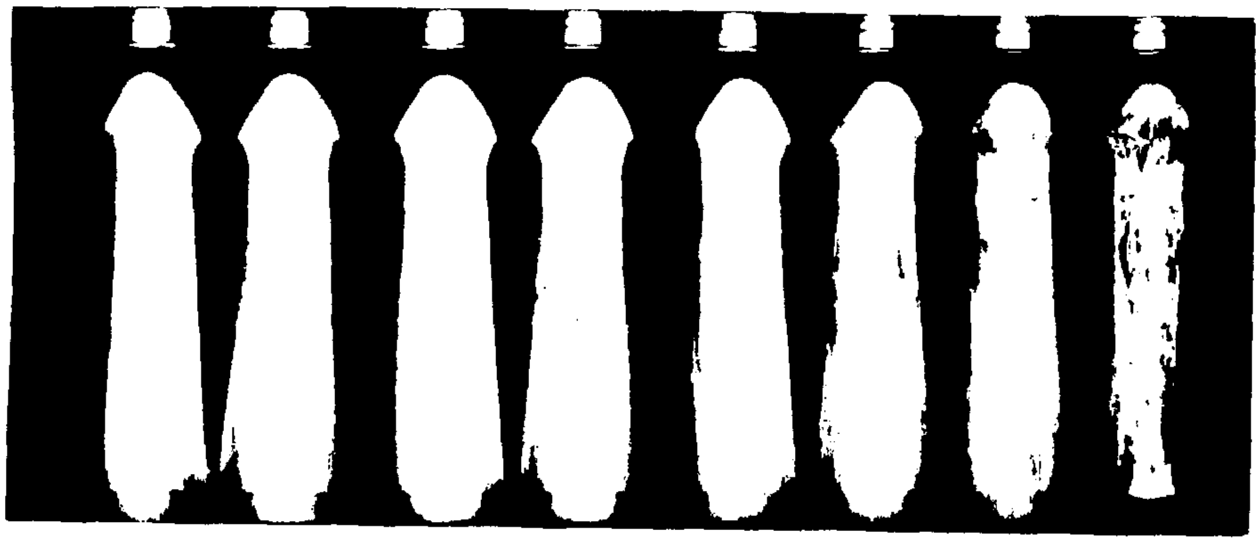


FIGURE 2

GRADING SCALE



0 1 2 3 4 5 6 7 8 9

REVISED

FINAL DRAFT

RECOMMENDED PRACTICE FOR MEASURING TOUGHNESS OF PVC BOTTLES BY DROP IMPACT

1. SCOPE

This recommended practice is designed to provide a procedure for measuring drop impact resistance of polyvinyl chloride bottles which are intended for use as containers. The procedure is not designed to evaluate the suitability of any particular bottle shape, PVC compound, or set of molding conditions and it is not intended to be a specification for PVC bottles. This procedure may be used, however, for setting requirements for performance of PVC bottles as agreed upon between buyer and seller.

2. SUMMARY OF PROCEDURE

The procedure consists of dropping sealed PVC chloride bottles, which have been filled with water, onto a steel surface from a prescribed height in one position (flat bottom drop). Each bottle is dropped once.

3. APPARATUS

A drop testing machine such as specified in ASTM D-2463-70, SPI Technical Bulletin PBD-4-1968 or equivalent shall be used.

4. TEST SAMPLES

A. Test bottles shall be selected by a suitable procedure to assure that the sample properly represents the lot being tested. The minimum sample size should not be less than 20 bottles, provided that each mold cavity is equally represented in the sample.

B. Closures which afford a good seal.

5. PROCEDURE

The test bottles should be filled to nominal capacity with water at 23°C ± 2°C then capped tightly and conditioned at 23°C ± 2°C for 24 hours. Prepare the drop testing apparatus so as to assure that bottles hit the impact surface squarely on their bottoms, following the procedure described in ASTM D-2463 paragraph 6 or equivalent. FN(1) Set the platform to the desired height. Flat bottom drop bottles once each. Examine each bottle for evidence of failure. Any visible rupture is a failure; any appearance of water on the outside of the container except leakage form the closure or an external source is a failure.

FN(1) Desired height would be that one agreed upon between buyer and seller.

6. REQUIREMENTS

Expectancy of impact survival based on above criteria; survival should be determined and agreed upon by buyer and seller.

7. REPORT

The report shall include the following:

A. Complete identification of the bottle tested including size, style, material, weight, date of manufacture and any other pertinent information.

B. Temperature at which test was run.

C. Number of bottles tested.

D. Type of drop (bottom).

E. Height of drop.

F. Number of bottles that failed, if any, and location of failures.

SPI COMPRESSION TEST FOR

WATER-FILLED AND CAPPED PLASTIC BOTTLES

INITIAL BOTTLE STRENGTH

SPI TEST METHOD 1

SCOPE

This method covers the procedure for determining the Initial Bottle Strength for plastic bottles. This term is the compressive load the bottle will support at a critical deflection level (appearance or performance defect) as determined by a laboratory compression test.

Initial Bottle Strength is a measure of the ability of the plastic bottle to support top-to-bottom compressive loads.

SUMMARY

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. One of the terms involved in this method (equation) is the Initial Bottle Strength, L_{bt}.

APPARATUS

A compression testing machine, Compression Test for Shipping Containers (ASTM designation D642)[1], of accepted design and capacity which will apply load at a speed of 0.5 inches per minute and record the load-deformation of the sample. The test machine shall be calibrated following the methods of verification of testing machines (ASTM designation: E4)[2].

1. Annual Book of ASTM Standards, Part 15
2. Annual Book of ASTM Standards, Part 30

The upper platen of the tester shall be locked parallel to the lower platen, that is, not equipped with a swivel joint.

TEST SPECIMENS

At least ten bottles or one bottle from each mold cavity.

CONDITIONING

Bottles shall be at least one week old.

PROCEDURE

1. Weigh and record weight of each bottle to the nearest tenth gram.
2. Fill bottles to rated fill level $\pm$ ½% with water at $23^{\circ} \pm 1^{\circ}$ C ($73.4^{\circ} \pm 1.8^{\circ}$ F). Cap with recommended torque using closure that would normally be used with bottle. (If air escapes, test is not valid unless vent-type closure is used). Bottles may be tested at other temperatures such as filling line temperatures or temperatures expected to be encountered in actual warehouse conditions.
3. Center filled and capped bottle on bottom platen of testing machine. Lower top platen to 1/8 inch above top of closure. Record this distance as zero deformation. Set autographic load-deformation recorder at zero.
4. Turn on machine and compress the bottle.
5. Record load at the critical bottle deflection.
6. Test all sample bottles in the same manner.

REPORT

The report shall include the following:

1. A complete description of the bottle and closure under test; its dimension (bottle print), making weight, resin type, and density.
2. A graph showing the load-deformation relation for each bottle test, together with observations which may assist in interpreting the results or aid in impro

the design of the bottle.

3. A composite graph showing the load-deformation relation for <u>all</u> bottle tests. This composite graph is the average of individual bottle loads at each 0.05 inch bottle deflection. The deflection scale of the graph shall be adjusted so that 0 inch deflection on the composite curve will correspond with the point that the average bottle begins to accept load. The composite graph will show the fail point as the average maximum load at critical deflection.

4. Temperature of water in the water-filled bottles.

5. A statement to the effect that all tests were made in full compliance with this method.

SPI DEAD LOAD COMPRESSIVE TEST

FOR WATER-FILLED AND CAPPED PLASTIC BOTTLES

BOTTLE TIME (CREEP) FACTOR

SPI TEST METHOD 2

SCOPE

This method covers the procedure for determining the Bottle Time (Creep) Factor for plastic containers. This term is the percentage of the Initial Bottle Strength, L_{bt}, (Test Method 1) that the bottle will support at a constant load for a given time before exceeding the critical bottle deflection.

SUMMARY

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. One of the terms involved in this method (equation) is the Bottle Time (Creep) Factor, R_{bt}.

APPARATUS

The apparatus shall be any mechanical means of uniformly applying a static (dead) load to water-filled and capped bottles. The apparatus will include a dial micrometer capable of reading to 0.001 inch, a timer, and may include a limit switch which will turn off the timer after a predetermined deflection value has been reached.

TEST SPECIMENS

A minimum of four bottles shall be used for each test. If the size of the apparatus permits, it is recommended that the same number of bottles be used in each test that would be packed in the shipping container.

A minimum of three (3) tests shall be conducted.

PROCEDURE

1. Prepare bottles for test, following procedure from Test Method 1.
2. Test shall be conducted in a temperature controlled environment. Standard conditions are 23 ± 1°C (73.4 ± 1.8°F). Tests may be conducted at other temperatures such as those expected to be encountered in actual warehouse conditions
3. Position the bottles on the lower platen so that the applied load will be distributed uniformly over the bottles.
4. Zero the dial micrometer just at the point the top platen contacts the tallest bottle.
5. Start timer and release upper platen to load bottles.
6. Read dial micrometer and record.
7. Record time required for bottles to compress (creep) to predetermined deflection value(s).

THEORY

The Load Ratio - time relation can be determined by two different methods. The first method determines the time required for bottles to reach the Critical Deflection level under several dead load weights. The Load Ratio is the ratio of dead load weight to the Compressive Strength of the bottle. If three or more sets of tests are performed at different Load Ratio, then their Load Ratio can be plotted against the measured times on semi-log paper to give the Bottle Creep Load Ratio curve.

The second method requires only one test set to determine the complete curve. The test set is run with a dead load weight of 15 to 20 percent of the Bottle Compressive Strength. The time required to meet five or six deflection points between initial deflection and the Critical Deflection point is measured. The load required to obtain these same deflection points is determined from the Compressive Strength test of the bottle.

The Load Ratios are the dead load weight divided by the compressive loads at each deflection point. The Bottle Creep Load Ratio Curve is prepared by plotting the Load Ratios against the time (semi-log scale) required to reach each deflection point in the dead load test.

REPORT

The report shall include the following:

1. A copy of the report from Test Method 1, Initial Bottle Strength.
2. The semilogrithmic R_{bt} versus time graph.
3. Temperature of test environment.
4. A statement to the effect that all tests were made in full compliance with this method.

SPI COMPRESSION TEST FOR

CORRUGATED BOXES AND INSERTS

INITIAL BOX STRENGTH

SPI TEST METHOD 3

SCOPE

This method covers the procedure for determining the Initial Strength of boxes. This term is the compressive load the box and insert will support within allowable deflection limits. In general, this value will be the deflection of the box and insert at maximum load.

Initial box strength is a measure of the ability of the box and insert to support top-to-bottom compressive loads.

SUMMARY

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. One of the terms involved in this method (equation) is the Initial Box Strength, L_{bx}.

APPARATUS

A compression testing machine, Compression Test for Shipping Containers (ASTM designation D642)[1], of accepted design and capacity which will apply load at a speed of 0.5 inches per minute and record the load-deformation of the sample. The test machine shall be calibrated following the Methods of Verification of Testing Machines (ASTM designation E4)[2].

1. Annual Book of ASTM Standards, Part 15
2. Annual Book of ASTM Standards, Part 30

The upper platen of the tester shall be locked parallel to the lower platen, that is not equipped with a swivel joint.

TEST SPECIMENS

At least five boxes properly closed with inserts positioned and restrained shall be tested.

CONDITIONING

Boxes and inserts shall be preconditioned at least 24 hours at less than 35% R. H. and then conditioned 48 hours at standard conditions, 50 ± 2% R.H. and 23 ± 2° C (73.4 ± 3.6° F). After closing, they will be conditioned an additional 24 hours at standard conditions prior to testing. Boxes and inserts may be tested at other RH and/or temperatures as may be encountered in warehouse storage.

SEALING CORRUGATED BOXES

Set up and square the box and then bend forward the short or inner flaps 90° and apply a uniform application of adhesive. Close the long or outer flaps by bending forward 90° to contact the glued inner flaps. Invert box onto a flat surface and weigh the flaps to insure a good seal.

When glue has sufficiently set, invert box and position inserts (partitions, H-divider, Z-pad, etc.) as described in the box specifications. The inserts must be restrained to remain properly positioned during test. This may be accomplished by inserting truncated bottles in the box. The restraining devices shall not contribute to the top-to-bottom compressive strength of the box.

Close and seal top flaps in the same manner as the bottom flaps applying only enough weight to the top of the box to hold the flaps in contact until glue has set.

PROCEDURE

1. Center the specimen on the bottom platen of the testing machine. Lower the top platen to 1/8 inch greater than the specified closed box height. Record this distance as zero deformation. Set autographic load-deformation recorder at zero.
2. Turn on machine and compress the box.
3. Record load-deformation until maximum load has been obtained.
4. Test all sample boxes in the same manner.

REPORT

The report shall include the following:

1. A complete description of the box and insert (copy of specification card) under test showing the position and explaining the method of restraining the insert.
2. A graph showing the load-deformation relationship for each test together with any observations which may assist in interpreting the results or aid in improving the design of the box and inserts.
3. A composite graph showing the load-deformation relationship for all tests. This composite graph is the average of individual box loads at each 0.05 inch deflection. The deflection scale of the graph shall be adjusted so that 0 inch deflection on the composite curve will correspond with the point that the average box begins to accept load The composite graph will show the fail point as the average maximum load at average deflection.

4. RH and temperature used for preconditioning and conditioning and actual tests.

5. A statement to the effect that all tests were made in full compliance with this method.

SPI STACK COMPRESSION TEST

STACKING PATTERN FACTOR

PALLET DESIGN FACTOR

SPI TEST METHOD 4

SCOPE

This method covers the procedure for determining the loss in compressive strength of boxes stacked one on top of another in actual warehouse stacking patterns, and the additional loss in stacking strength of boxes stacked on non-solid surfaces such as warehouse pallets.

SUMMARY

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. Two terms involved in this method (equation) are the Stacking Pattern Factor, SP and the Pallet Design Factor, PDF.

APPARATUS

A compression testing machine, Compression Test for Shipping Containers (ASTM designation D642)[1], of accepted design and capacity which will allow load at a speed of 0.5 inches per minute and record the load deformation of the stack. The test machine shall be calibrated following the methods of verification of testing machines (ASTM designation: E4)[2]

The upper platen of the tester shall be locked parallel to the lower platen, that is not equipped with a swivel joint.

1. Annual Book of ASTM Standards, Part 15
2. Annual Book of ASTM Standards, Part 30

CONDITIONING

'oxes and inserts shall be preconditioned at least 24 hours at less than 35% R. H. nd then conditioned 48 hours at standard conditions, 50 ± 2% R. H. and 23 ± 2° C 73.4 ± 3.6° F). After closing, they will be conditioned an additional 24 hours t standard conditions prior to testing. Boxes and inserts may be tested at other H and/or temperatures as may be encountered in warehouse storage.

EALING CORRUGATED BOXES

et up and square the box and then bend forward the short or inner flaps 90° and pply a uniform application of adhesive. Close the long or outer flaps by bend-ng forward 90° to contact the glued inner flaps. Invert box onto a flat surface nd weigh the flaps to insure a good seal.

hen glue has sufficiently set, invert box and position inserts (partitions, -divider, Z-pad, etc.) as described in the box specifications. The inserts ust be restrained to remain properly positioned during test. This may be ac-omplished by inserting truncated bottles in the box. The restraining devices hall not contribute to the top-to-bottom compressive strength of the box. lose and seal top flaps in the same manner as the bottom flaps applying only nough weight to the top of the box to hold the flaps in contact until glue has et.

UMBER OF TESTS

ach test shall be made on four tiers (layers) of boxes arranged in the actual arehouse stacking pattern. At least three tests shall be conducted.

ROCEDURE I

tacking Pattern Factor

. Center the first tier of boxes on the bottom platen of the test machine.

Build the second, third, and fourth tiers in the actual warehouse stacking pattern.

2. Lower the top platen to 1/8 inch greater than the maximum stack height. Record this distance as zero deformation. Set autographic load-deformation recorder at zero.

3. Turn on machine and compress the stack of boxes.

4. Record load-deformation until maximum load has been obtained.

Note: Occasionally, the stack compression test will not show a distinct yield point. When this happens, a good approximation of the maximum stack load can be made by comparing the average stack load with the composite graph from the individual box tests (Test Method 3)

5. Test all sample boxes in the same manner.

PROCEDURE II

Pallet Design Factor and Stacking Pattern Factor combined

A. Procedure II A is identical with Procedure I except the stack is built on the top of the warehouse pallet (PDF° Top).

B. Procedure II B, the stack is built under the warehouse pallet (PDF° Bottom).

REPORT

The report shall include the following:

1. Initial Box Strength, Test Method 3.

2. A graph showing the load-deformation relationship for each stack test together with any observations which may assist in interpreting the results or aid in improving the design of the box and inserts.

3. A composite graph showing the load-deformation relationship for all tests. This composite graph is prepared by:

   a. Averaging the stack load at each 0.20 inch deflection;

   b. Dividing the average stack load by the number of boxes per tier (average stack load per box);

   c. Dividing the deflection at each 0.20 inch level by four (four tiers per test); and

d. Plot the average stack load per box at each 0.05 inch deflection.

. Calculate the Stacking Pallet Factor (Procedure I) or the combined Pallet esign Factor and Stacking Pattern Factor, Procedure II A for PDF' Top and/or 'rocedure II B for PDF, bottom, by dividing the maximum stack load from 3d above y the maximum individual box load obtained from Test Method 3.

5. RH and temperature used for preconditioning and conditioning and actual tests.

5. A statement to the effect that all tests were made in full compliance with this method.

adv 7/9/73

SP

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

250 PARK AVENUE · NEW YORK, NEW YORK 10017 · 212/687-2675

July 6, 1973

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE DIVISION

Dear Member:

The Technical Committee has approved for balloting a supplement to the SP-400 finish of our technical bulletin PBD-2-1968.

Attached is a ballot which you are requested to return to me by August 10, 1973. Please note that negative ballots must be accompanied by an explanation to be valid.

Cordially,

Thomas J. McGrath
Director of Packaging Services

TJM/mm
att.

Proposed Supplement to SP-400 Finishes of PBO-2

Many two-piece child-resistant closures rely on a downward motion of the outer shell for their proper function. The SP-400 finishes do not necessarily provide physical space for this motion. The following specifications are recommended when an SP-400 finish is to be used with such a child-resistant closure.

Beadless finish: Increase min. H and max. H dimensions by at least .117" over the values listed on SP-400. Specifically, this means

mm size	min. H dimension
20 & 22	.473"
24 & 28	.502"
33, 38, & 45	.505"

Bead finish: Either increase H-dimension as on the beadless finish or, as an alternate, limit the max. bead diameter to the following dimensions:

mm size	max. bead diameter
20	.885"
22	.967"
24	1.049"
28	1.200"
33	1.377"
38	1.588"
45	1.853"

If the max. bead diameter is limited to these dimensions and the top of the bead is at least .117" above the bottle shoulder, the H-dimensions listed on SP-400 may be used without impeding the function of the child-resistant closure.

To avoid closure contact between adjoining packages during shipment, the bottle diameter should be no less than the following dimensions:

mm size	min. bottle diameter
20	1.060"
22	1.125"
24	1.200"
28	1.350"
33	1.530"
38	1.740"
45	2.000"

In specific applications, it is recommended to consult the manufacturer of the child-resistant closures.

May 1973
Dimensional Research Subcommittee
F. R. Homburger, Chairman

BALLOT

PLEASE COMPLETE AND RETURN TO:

Mr. Thomas J. McGrath
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

	AFFIRMATIVE	NEGATIVE
Supplement to SP-400 Finish of Technical Bulletin PBD-2-1968		

Signature________________________

Name____________________________

Company__________________________

Date_____________________________

PLEASE RETURN ALL BALLOTS BY AUGUST 10, 1973. ALL NEGATIVE BALLOTS MUST BE ACCOMPANIES BY AN EXPLANATION TO BE VALID!

SP THOMAS J. McGRATH

DUE TO LIMITED SUPPLY, COPY OF PRINT SENT TO BOTTLE BLOWER ONLY. -

SPI

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

250 PARK AVENUE · NEW YORK, NEW YORK 10017 · 212/687-2675

mailed 3/8/74
M

March 6, 1974

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE INSTITUTE

Dear Member:

Enclosed is a copy of our proposed finish SP-445 which was prepared by Ed Campbell of Continental Can Company.

Please review this and if you have any comments, please direct them to Ed Campbell with a carbon copy to me. His address is 2425 Touhy Avenue, Elk Grove Village, Illinois

Cordially,

Thomas J. McGrath
Director of Packaging Services

TJM/mm
encl.

SPI-25622

Minutes 3-3-74

SP

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

250 PARK AVENUE · NEW YORK, NEW YORK 10017 · 212/687-2675

March 11, 1974

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE INSTITUTE

Dear Member:

The following is a proposed note on our SP-400 finish.

> "Many child-resistant closures rely on dissimilar simultaneous motions for their proper function. The SP-400 finishes do not necessarily provide physical space for these motions. A special min. and max. H-dimension or, as an alternate, a max. bead diameter must then be specified. In addition, to avoid closure contact between adjoining packages during shipment, the bottle diameter should be no less than the largest diameter of the closure. Since these limiting specifications vary between types of child-resistant closures, any user should obtain them from the specific closure manufacturer."

Please return the attached ballot indicating whether you approve or disapprove of this addition to the PBD-2-1968. Please remember that negative ballots must be accompanied with an explanation to be valid.

You are requested to return the ballot by March 29, 1974.

Cordially,

Thomas J. McGrath
Director of Packaging Services

TJM/mm
att.

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

250 PARK AVENUE · NEW YORK, NEW YORK 10017 · 212 687-2675

BALLOT

Please Complete and Return to:
Mr. Thomas J. McGrath
Director of Packaging Services
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

	AFFIRMATIVE	NEGATIVE
Proposed note on SP-400 Finish of Technical Bulletin PBD-2-1968		

Signature ______________________

Name ______________________

Company ______________________

Date ______________

PLEASE RETURN ALL BALLOTS BY MARCH 29, 1974. ALL NEGATIVE BALLOTS MUST BE ACCOMPANIED BY AN EXPLANATION TO BE VALID!

The Plastic Bottle Institute
A Division of The Society of the Plastics Industry, Inc
250 Park Avenue New York, New York 10017
(212) 687-2675

August 30, 1974

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE INSTITUTE

Dear Member:

Attached are four new test methods. They are:

1) Vertical Compression Test.

2) Dead lead compressive test for water-filled and capped plastic bottles - bottle time(creep) factor.

3) Compression test for corrugated boxes and inserts-Initial box strength.

4) Stack compression test - stacking pattern factor pallet design factor.

Also attached is a listing of materials and apparatus. Please record your vote for each proposed test method. You are requested to have your ballot returned, no later than October 1, 1974.

All negative ballots must be accompanied by an explanation to be valid.

Cordially,

Thomas J. McGrath

Thomas J. McGrath
General Manager

TJM/mf
Att.

SPI-25625

B A L L O T

PLEASE COMPLETE AND RETURN TO:

Mr. Thomas J. McGrath
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

TEST METHODS	VOTE AFFIRMATIVE	VOTE NEGATIVE
Vertical Compression Test		
Dead Lead Compressive Test for water filled and capped plastic bottles		
Compression test for corrugated boxes and inserts-initial box strength		
Stack Compression Test - stacking pattern factor pallet design factor		

Signature________________________

Name________________________

Company________________________

Date________________________

PLEASE RETURN ALL BALLOTS BY OCTOBER 1, 1974. ALL NEGATIVE BALLOTS MUST VE ACCOMPANIED BY AN EXPLANATION TO BE VALID!

Mailed 9/3/74

The Plastic Bottle Institute
A Division of The Society of the Plastics Industry, Inc
250 Park Avenue New York, New York 10017
(212) 687-2675

August 30, 1974

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE INSTITUTE

Dear Member:

Attached are four new test methods. They are:

1) Vertical Compression Test.

2) Dead lead compressive test for water-filled and capped plastic bottles - bottle time(creep) factor.

3) Compression test for corrugated boxes and inserts-Initial box strength.

4) Stack compression test - stacking pattern factor pallet design factor.

Also attached is a listing of materials and apparatus. Please record your vote for each proposed test method. You are requested to have your ballot returned, no later than October 1, 1974.

All negative ballots must be accompanied by an explanation to be valid.

Cordially,

Thomas J. McGrath

Thomas J. McGrath
General Manager

TJM/mf
Att.

SPI-25627

B A L L O T

PLEASE COMPLETE AND RETURN TO:

Mr. Thomas J. McGrath
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

TEST METHODS	VOTE AFFIRMATIVE	VOTE NEGATIVE
Vertical Compression Test		
Dead Lead Compressive Test for water filled and capped plastic bottles		
Compression test for corrugated boxes and inserts-initial box strength		
Stack Compression Test - stacking pattern factor pallet design factor		

Signature_______________________________

Name___________________________________

Company________________________________

Date___________________________________

PLEASE RETURN ALL BALLOTS BY OCTOBER 1, 1974. ALL NEGATIVE BALLOTS MUST VE ACCOMPANIED BY AN EXPLANATION TO BE VALID!

SPI-25628

SPI VERTICLE COMPRESSION TEST

SCOPE

This is a test procedure for determining the compressive yield load of plastic container. Method A tests the bottle empty and vented and Method B tests the bottle filled and capped.

SIGNIFICANCE

The compression test provides valuable information as follows:

Method A - determines the ability of a container to support loads which may be encountered in filling and capping operations. It evaluates material and process variables for a specific container. It evaluates the design for a specific material. It is a source of information for the design of handling equipment and other related fields.

Method B - determines the ability of a container to support top loads in warehouse stacking. It determines the Initial Bottle Strength (L_{b_t}), which is the compressive load the bottle will support at the "Critical Deformation" (an appearance or performance defect). Initial Bottle Strength is used in the SPI Summary Report "Stacking Performance of Plastic Bottles in Corrugated Boxes" to predict the stacking height of plastic bottles in corrugated boxes.

DEFINITION OF TERMS

Compressive Yield Load - The compressive load at the first point in a compression test where compressive deformation of the specimen is increasing without increase in compressive load. Report load in pounds (kilograms).

SPI-25629

DEFINITION OF TERMS (cont'd)

"Critical Deformation" - The point at which the bottle is compressed to its yield point or deformed so that it is not acceptable from an appearance standpoint.

Deflection - The distance that the bottle is compressed. Report deflection in inches (centimeters)

APPARATUS

A compression testing machine, as described in ASTM D 642 (Compression Test for Shipping Containers)[1], ASTM D 2659 (Column Crush Properties of Blown Thermoplastic Containers), or equivalent of accepted design, which will apply load at constant speeds of 1.0 and 0.5 inches per minute (2.54 and 1.27 cm per minute) and record the load deflection of the sample with an accuracy of ± one (1) percent. The upper platen of the tester shall be locked parallel to the lower platen, that is, not equipped with a swivel joint. The top platen will have a small hole (s) provided (1/8 to 1/4 inch or 0.3 to 0.6 cm) to allow the air within the container to escape. The test machine shall be calibrated following the methods of verification of testing machines. (ASTM designation E 4)[2] A suitable weighing device, accurate to a tenth of a gram is necessary.

TEST SPECIMENS

At least twenty representative bottles are required including one bottle from each mold cavity.

Notes:

1. Annual Book of ASTM Standard Part 15
2. Annual Book of ASTM Standard Part 30

SPI-25630

3/15/7-

SPI VERTICLE COMPRESSION TEST

CONDITIONING - Method A

Containers are to be conditioned for a minimum of 24 hours in the same atmosphere as the test equipment. The atmosphere should be maintained throughout the test. Recommended test temperature is 23° ± 2° C. (73.4° ± 3.6° F.) However, if impossible to test at this condition, the test may be run at ambient temperature. All data shall be corrected to 23° C. base. (See calculation).

CONDITIONING - Method B

Bottles shall be at least one week old.

PROCEDURE - Method A

1. Weigh and record weight of each container to the nearest tenth gram.
2. Record temperature at which the test is made.
3. Set up testing machine so that the crosshead rate is a constant 1.0 inch per minute (2.54 cm per minute)
4. Place the container between the surfaces of the compression jig or plates so that the centerline of the bottle neck [illegible] with the centerline of compressive force and so that the air within the container will escape.

Note 1. In certain instances, it may be desirable to test containers in the non-vented condition. In those cases, adequate provisions should be made to insure that the containers are positively sealed.

5. Compress the container until compressive yield load has been passed. Record compressive yield load to the nearest pound (kilogram). Record the location of the failure, e.g. sidewall, shoulder, heel, etc., and any other unusual observation. (Refer to bottle drawing in SPI glossary.)

SPI-25631

PROCEDURE - Method A (cont'd)

Note 2. In certain instances it may be desirable to record and report deflection at compressive yield load. In such cases, a suitable means of measuring this distance shall be provided on the test equipment.

PROCEDURE - Method B

1. Set up testing machine so that crosshead rate is a constant 0.5 inch per minute (1.27 cm per minute).
2. Weigh and record weight of each bottle to the nearest tenth gram.
3. Fill bottles to rated fill volume $\pm$ 1/2 % with water at $23^\circ \pm 2^\circ$ C ($73.4^\circ \pm 3.6^\circ$ F). Cap with recommended torque using closure that would normally be used with bottle. (If air escapes, test is not valid) Bottles may be tested at other temperatures such as filling line temperatures or temperatures expected to be encountered in actual warehouse conditions.
4. Center filled and capped bottle on bottom platen of testing machine. Lower top platen to a position so that the distance between the two platens is 1/8 inch (0.3 cm) greater than the specified height shown on the bottle print plus closure height. Record this distance as zero deflection. Set autographic load deflection recorder at zero.
5. Turn machine and compress the bottle.
6. Record load (L_{bt}) and deflection at the critical bottle deformation.
7. Test all sample bottles in the same manner with the zero deflection position identical to test number one.

CALCULATIONS - Method A

1. All compressive yield load values are to be corrected to 23° C. Therefore, a temperature correction curve must be developed for the specific container being tested. This curve is obtained by plotting the compressive yield load versus temperature. The curve shall cover the range of temperatures to be encountered in testing.

2. Correct all individual values of compressive yield load to a base of 23° C by adding or subtracting, as appropriate, the increment as indicated by the correction curve.

3. The arithmetic mean shall be calculated by obtaining the sum of all corrected data and dividing this sum by the number of containers tested.

4. The range shall be indicated by reporting the highest and lowest corrected readings.

5. The standard deviation shall be calculated as follows and reported to two significant figures.

$$S = \sqrt{\frac{\Sigma x^2 - n\bar{x}^2}{n-1}}$$

Where:

S = estimated standard deviation

Σx^2 = sum of all the squares of each corrected observation

n = number of observations

$\bar{x}$ = arithmetic mean of the set of corrected observations

SPI VERTICLE COMPRESSION TEST

<u>REPORT</u> - Method A

(a) Identification

(1) of materials

(2) of container design

(3) manufacturer

(b) Method of sample selection

(c) Conditioning procedure

(d) Atmospheric conditions in test room

(e) Number of containers tested

(f) Relationship of centerline of bottle to the centerline of compressive force.

(g) Date of test

(h) Average bottle weight and range

(i) The arithmetic mean, range (highest and lowest), and the standard deviation for the compressive [illegible]

(j) Location (s) of failure

(k) Deflection when obtained

(l) A statement that all tests were made in full [illegible] with this method, or reporting deviations from [illegible] method.

SPI-25634

REPORT - Method B

The report shall include the following:

(A) A complete description of the bottle and closure under test; its height and maximum bottle dimension (from the bottle print), making weight, resin type and density.

(B) A graph showing the load deflection for each bottle test, together with observations which may assist in interpreting the results or aid in improving the design of the bottle.

(C) A composite graph showing the load deflection relation for all bottle tests. This composite graph is the average of individual bottle loads at each 0.05 inch (0.127 cm) bottle deflection. The deflection scale of the graph shall be adjusted so that Zero deflection on the composite curve will correspond with the point where the average bottle begins to accept load. The composite graph will show the fail point (L_{bt}) as the average maximum load at critical deformation.

(D) Temperature of water in the water-filled bottles at time of test.

(E) A statement that all tests were made in full compliance with this method, or reporting deviations from this test method.

SPI DEAD LOAD COMPRESSIVE TEST

FOR WATER-FILLED AND CAPPED PLASTIC BOTTLES

BOTTLE TIME (CREEP) FACTOR

SPI TEST METHOD PBD-_____

SCOPE

This is a test procedure for determining the Bottle Time (Creep) Factor for plastic containers. This term is the percentage of the Initial Bottle Strength, L_{bt}, (Test Method PBD-3) that the bottle will support at a constant load for a given time before exceeding the "Critical Deformation".

SUMMARY OF METHOD

The Load Ratio - Time relation can be determined by two different methods. The first method determines the time required for bottles to reach the "Critical Deformation" under several dead load weights. The Load Ratio is the ratio of dead load weight to the Compressive Strength of the bottle. If three or more sets of tests are performed at different Load Ratio, then their Load Ratio can be plotted against the measured times on semi-log paper to give the Bottle Creep Load Ratio Curve.

The second method requires only one test set to determine the complete curve. The test set is run with a dead load weight of 15 to 20 percent of the Bottle Compressive Strength. The time required to meet five or six deflection points between initial deflection and the "Critical Deformation" is measured. The load required to obtain these same deflection points is determined from the Compressive Strength test of the bottle.

The Load Ratios are the dead load weight divided by the compressive loads at each deflection point. The Bottle Creep Load Ratio Curve is prepared

SPI-25636

by plotting the Load Ratios against the time (semi-log scale) required to reach each deflection point in the dead load test. (Experience indicates the second method is the preferred technique.)

SIGNIFICANCE

SPI SUMMARY REPORT: STACKING PERFORMACE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. One of the terms involved in this method (equation) is the Bottle Time (Creep) Factor, R_{bt}.

DEFINITION OF TERMS

Compressive Yield Load - The compressive load at the first point in a compression test where compressive deformation of the specimen is increasing without increase in compressive load. Report load in pounds (kgms).

"Critical Deformation" - The point at which the bottle is compressed to its yield point or deformed so that it is not acceptable from an appearance standpoint.

Deflection - The distance that the bottle is compressed. Report deflection in inches (cms).

APPARATUS

The apparatus shall be any mechanical means of uniformly applying a static (dead) load to water-filled and capped bottles. The apparatus will include a dial micrometer capable of reading to 0.001 inch (0.0025 cm), a timer and may include a limit switch which will turn off the timer after a predetermined deflection value has been reached. (See Materials and Apparatus section)

SPI TEST METHOD

TEST SPECIMENS

A minimum of four representative bottles shall be used for each test. If the size of the apparatus permits, it is recommended that the same number of bottles be used in each test that would be packed in the shipping container. A minimum of three (3) tests shall be conducted.

PROCEDURE

1. Prepare bottles for test, following procedure from Test Method PBD-3.
2. Test shall be conducted in a temperature controlled environment. Standard conditions are 23 $\pm$ 2° C (73.4 $\pm$ 3.6° F). Tests may be conducted at other temperatures such as those expected to be encountered in actual warehouse conditions.
3. Position the bottles on the lower platen so that the applied load will be distributed uniformly over the bottles.
4. Zero the dial micrometer at the point the top platen contacts the tallest bottle.
5. Start timer and release upper platen to load bottles.
6. Read dial micrometer and record.
7. Record time required for bottles to compress (creep) to predetermined deflection value (s).

REPORT

The report shall include the following:

1. A copy of the report from Test Method PBD-3, Initial Bottle Strength.
2. The semilogarithmic R_{bt} versus time graph.
3. Temperature of test environment.
4. A statement that all tests were made in full compliance with this method, or reporting deviations from this test method.

SPI-25638

SPI COMPRESSION TEST FOR

CORRUGATED BOXES AND INSERTS

INITIAL BOX STRENGTH

SPI TEST METHOD PBD-____

SCOPE

This method covers the procedure for determining the Initial Strength of boxes. This term is the compressive load the box and insert will support within allowable deflection limits. In general, this value will be the deflection of the box and insert at maximum load.

Initial box strength is a measure of the ability of the box and insert to support top-to-bottom compressive loads.

SIGNIFICANCE

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. One of the terms involved in this method (equation) is the Initial Box Strength, L_{bx}.

APPARATUS

A compression testing machine, Compression Test for Shipping Containers (ASTM designation D642)[1], of accepted design and capacity which will apply load at a speed of 0.5 inches (1.27 cm) per minute and record the load-deflection of the sample. (See Materials and Apparatus section) The test machine shall be calibrated following the Methods of Verification of Testing Machines (ASTM designation E4)[2].

1. Annual Book of ASTM Standards, Part 15

2. Annual Book of ASTM Standards, Part 30

SPI-25639

The upper platen of the tester shall be locked parallel to the lower platen, that is, not equipped with a swivel joint.

TEST SPECIMENS

At least five boxes properly closed with inserts positioned and restrained shall be tested.

CONDITIONING

Boxes and inserts shall be preconditioned at least 24 hours at less than 35% R. H. and then conditioned 48 hours at standard conditions, 50 $\pm$ 2% R.H. and 23 $\pm$ 2° C (73.4 $\pm$ 3.6° F). After closing, they will be conditioned an additional 24 hours at standard conditions prior to testing. Boxes and inserts may be tested at other RH and/or temperatures as may be encountered in warehouse storage.

PROCEDURE

Set up and square the box and then bend forward the short or inner flaps 90° and apply a uniform application of adhesive. Close the long or outer flaps by bending forward 90° to contact the glued inner flaps. Invert box onto a flat surface and weigh the flaps to insure a good seal. When glue has sufficiently set, invert box and position inserts (partitions, H-divider, Z-pad, etc.) as described in the box specifications. The inserts must be restrained to remain properly positioned during test. This may be accomplished by inserting truncated bottles in the box. The restraining devices shall not contribute to the top-to-bottom compressive strength of the box.

Close and seal top flaps in the same manner as the bottom flaps applying only enough weight to the top of the box to hold the flaps in contact until glue has set.

PROCEDURE (Cont.)

1. Center the specimen on the bottom platen of the testing machine. Lower the top platen to a position so that the distance between the two platens is 1/8 inch (0.3 cm) greater than the specified closed box height. Record this distance as zero deflection. Set autographic load-deflection recorder at zero.
2. Turn on machine and compress the box.
3. Record load and deflection until maximum load has been obtained.
4.. Test all sample boxes in the same manner with the zero deflection position identical to test number one.

REPORT

The report shall include the following:

1. A complete description of the box and insert (copy of specification card) under test showing the position and explaining the method of restraining the insert.
2. A graph showing the load-deflection relationship for each test together with any observations which may assist in interpreting the results or aid in improving the design of the box and inserts.
3. A composite graph showing the load-deflection relationship for all tests. This composite graph is the average of individual box loads at each 0.05 inch (0.10 cm) deflection. The deflection scale of the graph shall be adjusted so that 0 inch (cm) deflection on the composite curve will correspond with the point that the average box begins to accept load. The composite graph will show the fail point (L_{bx}) as the average maximum load at average deflection.
4. RH and temperature used for preconditioning and conditioning and actual tests
5. A statement that all tests were made in full compliance with this method, or reporting deviation from this test method.

SPI-25641

SPI STACK COMPRESSION TEST

STACKING PATTERN FACTOR

PALLET DESIGN FACTOR

SPI TEST METHOD PBD-____

SCOPE

This method covers the procedure for determining the loss in compressive strength of boxes stacked one on top of another in actual warehouse stacking patterns, and the additional loss in stacking strength of boxes stacked on non-solid surfaces such as warehouse pallets.

SIGNIFICANCE

SPI SUMMARY REPORT: STACKING PERFORMANCE OF PLASTIC BOTTLES IN CORRUGATED BOXES outlines a method to predict the stacking strength of plastic bottles in corrugated boxes. Two terms involved in this method (equation) are the Stacking Pattern Factor, SP and the Pallet Design Factor, PDF.

APPARATUS

A compression testing machine, Compression Test for Shipping Containers (ASTM designation D642)[1], of accepted design and capacity which will apply load at a speed of 0.5 inches (1.27 cm) per minute and record the load-deflection of the stack. (See Materials and Apparatus section) The test machine shall be calibrated following the Methods of Verification of Testing Machines (ASTM designation: E4)[2]

The upper platen of the tester shall be locked parallel to the lower platen, that is, not equipped with a swivel joint.

1. Annual Book of ASTM Standards, Part 15
2. Annual Book of ASTM Standards, Part 30

SPI-25642

C-1

3/8/82

TEST SPECIMENS

Each test shall be made on four tiers (layers) of boxes arranged in the actual warehouse stacking pattern. At least three tests shall be conducted.

CONDITIONING

Boxes and inserts shall be preconditioned at least 24 hours at less than 35% R. H. and then conditioned 48 hours at standard conditions, 50 $\pm$ 2% R.H. and 23 $\pm$ 2° C (73.4 $\pm$ 3.6° F). After closing, they will be conditioned an additional 24 hours at standardconditions prior to testing. Boxes and inserts may be tested at other RH and/or temperatures as may be encountered in warehouse storage.

PROCEDURE

Set up and square the box and then bend forward the short or inner flaps 90° and apply a uniform application of adhesive. Close the long or outer flaps by bending forward 90° to contact the glued inner flaps. Invert box onto a flat surface and weigh the flaps to insure a good seal. When glue has sufficiently set, invert box and position inserts (partitions, -divider, Z-pad, etc.) as described in the box specifications. The inserts must be restrained to remain properly positioned during test. This may be accomplished by inserting truncated bottles in the box. The restraining devices shall not contribute to the top-to-bottom compressive strength of the box. Close and seal top flaps in the same manner as the bottom flaps applying only enough weight to the top of the box to hold the flaps in contact until glue has set.

METHOD A: Stacking Pattern Factor

1. Center the first tier of boxes on the bottom platen of the test machine. Build the second, third, and fourth tiers in the actual warehouse stacking pattern.

SPI-25643

2. Lower the top platen to 1/8 inch (0.3 cm) greater than the maximum stack height. Record this distance as zero deflection. Set autographic load-deflection recorder at zero.

3. Turn on machine and compress the stack of boxes.

4. Record load-deflection until maximum load has been obtained.

   Note: Occasionally the stack compression test will not show a distinct yield point. When this happens, a good approximation can be made as follows:

   1. Determine the deflection at yield of the individual box (Test Method__).

   2. Multiply this deflection by the number of layers in the stack.

   3. Read the stack compression at the total deflection as calculated.

5. Test all sample boxes in the same manner.

METHOD B: Pallet Design Factor and Stacking Pattern Factor Combined

A. Method B - 1 is identical with Method A except the stack is built on the top of the warehouse pallet (PDF° Top).

B. Method B - 2 the stack is built under the warehouse pallet(PDF° Bottom).

REPORT

The report shall include the following:

1. Initial Box Strength, Test Method____.

2. A description of stacking pattern and pallet used in the test.

3. A graph showing the load-deflection relationship for each stack test together with any observations which may assist in interpreting the results or aid in improving the design of the box and inserts.

4. A composite graph showing the load-deflection relationship for all tests. This composite graph is prepared by:

   a. Averaging the stack load at each 0.20 inch (5.0 cm) deflection;

   b. Dividing the average stack load by the number of boxes per tier (average stack load per box);

   c. Dividing the deflection at each 0.20 inch (5.0 cm) level by four (four tiers per test); and

d. Plot the average stack load per box at each 0.05 inch (0.10 cm) deflection.

5. Calulate the Stacking Pallet Factor (Procedure I) or the combined Pallet Design Factor and Stacking Pattern Factor, Procedure II A for PDF° Top and/or Procedure II B for PDF, bottom, by dividing the maximum stack load from 3d above by the maximum individual box load obtained from Test Method 3.

6. RH and temperature used for preconditioning and conditioning and actual tests.

7. A statement that all tests were made in full compliance with this method, or reporting deviations from this test method.

MATERIALS AND APPARATUS LIST

PBD-3 SPI VERTICLE COMPRESSION TEST

Item I Compression Testing Machine

Gaynes Engineering Co.
1642-52 W. Fulton St.
Chicago, Ill. 60612
PH (312) HA 1-5257

Testing Machines Inc.
400 Bayview Ave.
Amityville, NY 11701
PH (516) 842-5400

L.A.B. Corp.
P.O. Box C
Skaneateles, NY 13152
PH (315) CY 5-[illegible]

PBD- DEAD LOAD COMPRESSION TEST

Item I Dead Load Compression Tester

Gaynes Style DLT
Gaynes Engineering Co.
1642-52 W. Fulton St.
Chicago, Ill. 60612
PH (312) HA 1-5257

PBD- INITIAL BOX STRENGTH

Item I Compression Testing Machine

Gaynes Engineering Co.
1642-52 W. Fulton St.
Chicago, Ill. 60612
PH (312) HA 1-5257

Testing Machines Inc.
400 Bayview Ave.
Amityville, NY 11701
PH (516) 842-5400

L.A.B. Corp.
P.O. Box C
Skaneateles, NY [illegible]
PH (315) [illegible]

PBD- STACKING PATTERN [illegible] PALLET DESIGN [illegible]

Item I Compression Testing Machine

Gaynes Engineering Co.
1642-52 W. Fulton St.
Chicago, Ill. 60612
PH (312) HA 1-5257

Testing Machines Inc.
400 Bayview Ave.
Amityville, NY 11701
PH (516) 842-5400

L.A.B. Corp.
P.O. Box C
Skaneateles, NY [illegible]
PH (315) CY 5-[illegible]

SPI-25646

Thalick 10/31/74

The Plastic Bottle Institute
A Division of The Society of the Plastics Industry, Inc
250 Park Avenue · New York, New York 10017
(212) 687-2675

New Telephone Number (212) 573-9400

October 25, 1974

TO: MEMBERS OF THE TECHNICAL COMMITTEE
OF THE PLASTIC BOTTLE INSTITUTE

Dear Member:

Enclosed is a draft copy of our technical bulletin entitled "Visual Color Evaluation of Clear Rigid PVC Bottles - Recommended Practice."

Please review the technical bulletin and complete and return the ballot no later than November 15, 1974.

All negative ballots must be accompanied by an explanation to be considered valid.

Cordially,

Thomas J. McGrath
General Manager

TJM/mm
att.

The Plastic Bottle Institute
A Division of The Society of the Plastics Industry, Inc
250 Park Avenue New York, New York 10017
(212) 687-2675

BALLOT

Please Complete and Return to:

Mr. Thomas J. McGrath, General Manager
The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

Test Method	Affirmative	Negative
Visual Color Evaluation of Clear Rigid PVC Bottles - Recommended Practice	/____/	/____/

Signature____________________

Name____________________

Company____________________

Address____________________

PLEASE RETURN ALL BALLOTS BY NOVEMBER 15, 1974. ALL NEGATIVE BALLOTS MUST BE ACCOMPANIED BY AN EXPLANATION TO BE VALID!

SPI-25648

D R A F T

VISUAL COLOR EVALUATION OF CLEAR RIGID PVC BOTTLES - RECOMMENDED PRACTICE

SCOPE

This recommended practice is designed to provide a method for evaluating the color tint of clear polyvinyl chloride bottles. This recommended practice is intended for use in determining the acceptability of bottle color as agreed upon between buyer and seller.

SIGNIFICANCE

The significance of this recommended practice is limited to the visual determination of whether or not a bottle is within predetermined acceptable color tint limits.

SUMMARY OF PRACTICE

This recommended practice consists of evaluating the color tint of clear PVC bottles when compared to standard shades of blue, green, scarlet, violet and/or yellow solutions (singly or in combination) in distilled water.

APPARATUS

1. Specimen Holder (See attached sketch).
2. Macbeth Light - Model No. BBX-526 or equivilent.
3. Predetermined Color Limit Samples in 200ml test tubes (sealed).

MATERIALS

1. Lightfast water soluble dyes.

   A. American Cyanamid

      (1) Calcomine Blue 7GSL
      (2) Calcocid Alizarine Blue SAPG
      (3) Calcocid Crocein Scarlet
      (4) Calcocid Violet 3BLF
      (5) Calcocid Fast Yellow 3G EX, Conc.

(continued)

B. GAF

(1) Alizarine Supra Sky RA
(2) Alizarine Cyanine Green GIN Conc.
(3) Alizarine Geranol B (Violet)
(4) Alizarine Irisol RD (Violet)
(5) Fast Light Yellow D-3GA Ex.

2. Distilled Water

TEST SAMPLES

Clear rigid PVC bottles of any size, weight or shape may be tested. No set number of bottles is required. Sufficient bottles should be evaluated to be reasonably certain that the results obtained represent the lot or production run from which bottles were taken.

PROCEDURE

1. Prepare standard solutions in glass containers by completly dissolving the water soluble dyes (approximately 0.5mg/liter) in distilled water to produce the required color shades.

2. Fill the clear PVC sample bottle (s) to be evaluated with distilled water.

3. Place the filled PVC sample bottle between the two color limit standard solutions in the specimen holder. Place specimen holder in Macbeth Light for evaluation.

REPORT

The report shall include the following:

1. Complete identification of the bottle evaluated including size, style, material, method of processing, weight, date of manufacture and any other pertinent information.

2. Number of bottles evaluated and date.

3. Report whether bottles evaluated were within limits and any other comments, as required.

RLH/ls
6-28-74

SPECIMEN HOLDER