FOODSERVICE PACKAGING INSTITUTE®

Operating Procedure
FPI Rigidity Tester

Updated January 23, 2015

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1 Purpose/Scope

1.1 This method is for determining the rigidity (resistance to buckling and bending) of single-service paper and plastic plates, bowls, platters, and trays. The method uses the FPI plate rigidity tester to measure the force required to deflect the rim 0.5 inches while the product is supported at its geometric center.

1.2 If wet (simulated use) rigidity is desired for the single-service plates, bowls, platters, and trays, use an appropriate procedure to simulate actual use of the product with water or high moisture foods, remove the food or food simulant and conduct the rigidity test in the same manner as for dry products.

2 Apparatus/Materials

2.1 Foodservice Packaging Institute (FPI) Plate Rigidity Tester, motorized, available from:

Foodservice Packaging Institute, Inc. (www.fpi.org)
email: fpi@fpi.org

2.2 Foodservice Packaging Institute (FPI) Plate Rigidity Tester and Calibration Gauge technical assistance and service available from:

Peerless Machine & Tool Corporation (www.peerlessmachine.com)
1804 West Second Street
Marion, IN 46952
tel: (765) 662-2586
fax: (765) 662-6067
email: peerless@peerlessmachine.com

2.3 Transducer Techniques Load Cell Model MDB-5-C and Load Cell Display DPM-3, available from:

Transducer Techniques (www.transducertechniques.com)
42480 Rio Nedo
Temecula, CA 92590
tel: (800) 344-3965
fax: (951) 719-3900
email: tti@ttloadcells.com

Load Cell Display, Adapter and Cable Specification:

- Model #MDB-5-C with option CAL-TEDS-CUS / grams force, positive in compression, with DPM-3-OPT-C (Relay Option – Alarms and Setpoints) and DPM-3-OPT-T (RS232 Interface)
- Range 0 to 5.0 lbs (1260 grams), accurate to 0.05% (1.1 grams).
- Cal-Teds Plug and Play Smart Sensor Option (IEEE 1451.4 compliant).
- Positive readout in compression, calibrated in grams.
- Safe Overload: 150% of Full Load or 7.5 lbs. DO NOT exceed the safe overload or damage to the load cell will occur.
- *** Note: Cable and load cell are a matched set (same serial numbers). They must be used together or the rigidity readings will not be correct.
- DMP-3-AD9 (9 pin external adapter) and DPM-3-RJ11AD9 (RJ11 to 9 pin RS232 serial cable)

Load Cell Troubleshooting Guide available at:
www.transducertechniques.com/Troubleshooting-guide1.cfm

Operating and Serial Communication Manuals are available at:
http://www.transducertechniques.com/online-manuals.cfm

3 Training / Safety

3.1 The Primary Person Responsible (PPR) trains operators for this method.

4 Product Preparation

4.1 Condition all samples at least 24 hours prior to testing at 23° C (73° F), 50% RH. The samples should be separated from each other so that they are spaced out / not in a stack during conditioning. Where facilities are available, pre-condition the samples at 20-30% RH prior to conditioning at 50% RH so as to approach equilibrium moisture from the low side. All subsequent preparation and testing should be performed at 23° C, 50% RH. Reference:

TAPPI T402 os-70 ASTM: D685-93

4.2 Any deviation from the above should be noted on the report.

4.3 Rigidity of foam products will change during their initial aging period. Any testing of these products during the first 7 days after formation should include the age of the sample.

4.4 The number of tested samples should be statistically representative of the production lot, product population, process study, or other "lot" of interest.

Each data point should be the average value resulting from tests of no fewer than five (5) replicate samples.

Summary statistics should include all "n" data points.

The test report must indicate the size of the lot represented in the test summary statistics, and the number of data points included in the summary statistics.

4.5 Samples should only be tested once. Repeated testing of the same sample may result in lower strength / rigidity results.

5 Maintenance/Calibration

5.1 The PPR maintains the apparatus in proper working condition and ensures that there are no defects with the tester that may affect its operation or results.

5.2 A ¾" diameter, flat-bottomed load cell probe should be used for the testing.

5.3 The left and right side platens of the centering assembly, which the guide posts are placed into, are preset at manufacture to be equally distant from the center support assembly. This is required to properly locate the product at its geometric center for testing. DO NOT adjust the position of the left or right side centering assembly platens.

5.4 The load cell is a delicate electronic measurement device. DO NOT exceed the 7.5 lb overload limit (3400 grams) or damage to the load cell may occur.

5.5 Periodically, the tester operation should be checked to verify that the measurement process is stable and in control by testing the three cantilever spring steels on the calibration gauge / test fixture and comparing against standard measurement values. Statistical control chart systems may be used to determine if the measurement process is in control.

Each of the cantilever spring steels on the calibration gauge have been accurately tested on the "Gold Standard" FPI Plate Rigidity Tester at Peerless Machine & Tool Corp. and labeled with the standard measurement values. The standard measurement values are labeled, in grams, as a range (minimum and maximum), for each individual spring steel on the calibration gauge. The minimum and maximum values were determined by applying a ± 4% tolerance around each individual spring steel average. It should be noted that each calibration gauge will have different

standard measurement values. The differences are a result of slight spring steel material and mounting variations.

DO NOT disassemble, drop or otherwise damage the calibration gauge or cantilever spring steels, otherwise a shift in the standard measurement values will result.

The average readings for each cantilever spring steel on the calibration gauge should be within the standard measurement values. If the average readings are outside of this range, investigate the cause (tester or calibration gauge setup, load cell operation/calibration, load cell display/setup, etc.).

If required, the calibration gauge can be returned to Peerless Machine & Tool Corp. and retested on the "Gold Standard" FPI Plate Rigidity Tester to confirm or update the standard measurement values.

5.5.1 Turn on FPI Rigidity Tester power. The load cell will rise to a home or initial start point position. A 15 minute warm-up period is recommended for the electronics.

5.5.2 Open the centering assemblies left and right side platens wide enough to admit the calibration fixture by turning the centering assembly crank clockwise.

5.5.3 Place the calibration fixture on top of the round bar attached to the center support assembly. Position the calibration fixture so that the lower strength cantilever spring steel beam extends towards the load cell probe foot.

5.5.4 Adjust the centering assembly so that the load cell probe foot is centered over the spring steel button head located at the end of the cantilever.

The calibration fixture may need to be slid towards or away from the operator to locate the spring steel button head directly under the load
cell probe foot. *Note: Make sure that the load cell probe will only contact the spring steel / NOT the main fixture platen, otherwise load cell damage may occur.* In this position, one calibration fixture bottom pad will rest on the top of the centering assembly left side platen.

5.5.5 Lower the hold-down clamp on the left side of the unit until the clamp rests on top of the calibration fixture and firmly holds it level in a horizontal plane.

5.5.6 Lower the load cell / probe assembly using the raise / lower switch on the control box so that the probe foot is positioned just above the spring steel button head (about 1/8" to 1/4"). Positioning the probe foot starting point just above the spring steel button head will shorten the test cycle.

5.5.7 Push the black start button or depress the foot pedal switch to test the strength / rigidity of the lower strength cantilever spring steel. Compare to the lower strength cantilever

spring steel standard measurement values. Repeat this step if necessary to double check the strength reading. The average of the readings should be within the labeled minimum and maximum range.

5.5.8 Repeat steps 5.5.2 to 5.5.6 with the medium strength cantilever spring steel. Compare to the medium strength cantilever spring steel standard measurement values. Repeat this step if necessary to double check the strength reading. The average of the readings should be within the labeled minimum and maximum range.

5.5.9 Repeat steps 5.5.2 to 5.5.6 with the higher strength cantilever spring steel. Compare to the higher strength cantilever spring steel standard measurement. Repeat this step if necessary to double check the strength reading. The average of the readings should be within the labeled minimum and maximum range.

5.6 Alternatively or in addition the calibration test fixture steps detailed in 5.5, conditioned plate samples with consistent and known rigidity properties may be tested by use of the following procedure and compared to standard measurements or control charted. A large batch of the plate samples should be maintained for this method of tester calibration checks.

6 Procedure

6.1 Turn on FPI Rigidity Tester power. The load cell will rise to a home or initial start point position. A 15 minute warm-up period is recommended for the electronics.

6.2 Mark the rims of the products to be tested to indicate A and B test positions.

6.2.1 For non-compartmented round, oval and rectangular products, mark the highest point or surface of the rim of each product to be tested at two places A and B 90° apart (see Diagrams 1, 2, 3). The marked places should correspond to the machine direction (A) and the cross-machine direction (B) on products produced with materials with identifiable directionality.

6.2.2 For compartmented round and oval products, place one mark at A on the highest point or surface of the rim where the short rib intersects the edge, and place a second mark at B on the rim 90° from this point or surface (see Diagrams 4 and 5)

6.2.3 For compartmented rectangular products, place one mark at A on the highest point or surface of the rim in the center of the long side and place a second mark at B on the rim in the center of the short side which is farthest away from the small compartment (see diagram 6).

6.3 If compartmented plates are being tested, place the auxiliary platform on top of the round bar attached to the top of the center support assembly, and secure the platform with two setscrews (see figure 3).

6.4 Open the centering assembly left and right platens wide enough to admit the product. Place two guide posts into the predetermined test hole positions (A, B, C, D or E) of the centering assembly left side platen.

If the correct guide post test hole positions are not known, complete steps 6.4.1 through 6.4.8, otherwise proceed to step 6.5.

Note: The goal of the guide post placement is to 1) locate the test product on the support at its geometric center and 2) position the probe foot so that its bottom surface will contact the highest point or surface of the rim of the product throughout the full ½" deflection. The guide post placement into the test hole positions will depend upon the size, profile and style of the product. The holes are identified as A thru E with the A being the innermost holes and E being the outermost holes (see Figure 2).

6.4.1 To determine the guide post test hole positions, open the centering assembly left and right platens wide enough to admit the product. Place two guide posts into matching test hole positions on the centering assembly left side platen per the following general guideline for round plates and bowls.

5 to 12oz bowls (5" to 6" diameter) – Position A (innermost holes)
6" and 7" plates or 20oz bowls (7-1/4" diameter) – Position B
9" plates – Position C
10" and 11" plates – Position D

For oval, rectangular and other shaped containers, chose two matching guide post test holes and complete steps 6.4.1 through 6.4.8.

See Table 1 for a summary of guide post positions for a variety of known plate, bowl, dish and tray products. Please note that this is a preliminary set of guide post positions. Additional entries can be added as necessary.

6.4.2 Place an extra test product on the round bar and/or auxiliary platform so that mark A (or MD direction) is parallel to the tester base platen and directly below the load cell probe foot.

6.4.3 Squeeze and lower the hold-down clamp on the left side of the unit until the clamp rests on top of the product and holds it level in a horizontal plane. A small line level style gauge or equivalent should be placed on the center of the product during the adjustment of the hold-down clamp. Remove the line level gauge.

6.4.4 Place two guide posts into the matching test hole positions on the centering assembly right side platen as used in 6.4.1. All four guide posts should be positioned into matching test hole positions (A, B, C, D or E).

6.4.5 Adjust the centering assembly left and right platens by turning the centering assembly crank counterclockwise so that all four guide posts lightly touch the outer edges of the product without distorting its shape. The product is now located on the support at its geometric center.

6.4.6 Lower the load cell / probe assembly using the raise / lower switch on the control box so that the probe foot is positioned just above the product (about 1/8" to 1/4"). Positioning the probe foot starting point just above the product will shorten the test cycle. Adjust this position, if necessary, so that the load cell / probe will not interfere with the insertion or removal of the product.

6.4.7 Note the position of the ¾" diameter flat-bottomed probe foot in relation to the highest point or surface of the rim of the product.

If the probe foot is too far inward towards the center of the product, move the four guide posts inward to matching lower letter test hole positions (move from positions C to B for example). If the probe foot is too far outward towards the outer edge of the product, move the four guide posts outward to matching higher letter test hole positions (move from C to D for example). Repeat steps 6.4.5 and 6.4.6.

6.4.8 Remove the two guide posts on the centering assembly right side platen and return them to the storage holes in the tester base platen. Depress the foot pedal switch or black start button to begin the test. Note the location of the probe foot throughout the entire test cycle.

If the probe foot's bottom surface does not contact the highest point or surface of the rim of the product throughout the full ½" deflection, move the four guide posts inward or outward per 6.4.7 and repeat this step.

6.4.9 Record / tabulate the guide post test holes used for this product for future use. Dispose of the extra test product. Do not record its strength value since it may have been tested more than once per direction.

6.5 Place the product on the round bar and/or auxiliary platform so that mark A (or machine direction) is parallel to the tester base platen and directly below the load cell probe foot.

6.6 Squeeze and lower the hold-down clamp on the left side of the unit until the clamp rests on top of the product and holds it level in a horizontal plane. A small line level style gauge or equivalent can be placed on the center of the product during the adjustment of the hold-down clamp. Remove the line level gauge.

6.7 Place two guide posts into the matching test hole positions on the centering assembly right side platen. All four guide posts should be positioned into matching test holes positions (A, B, C, D or E) on the centering assembly left and right platens.

6.8 Adjust the center mechanism by turning the centering assembly crank counterclockwise so that all four guide posts lightly touch the outer edges of the product without distorting its shape.

Note: The product is now located on the support at its geometric center. The probe foot is positioned so that its bottom surface will contact the highest point or surface of the rim of the product throughout the full ½" deflection.

6.9 After the product has been properly centered, remove the two guide posts on the centering assembly right side platen and return them to the storage holes in the tester base platen. It will not be necessary to re-center the tester for continued testing of the same size and style product.

6.10 If necessary, lower the load cell / probe using the raise / lower switch on the control box until the probe foot is just above the product (about 1/8" to 1/4"). The probe will automatically return to this pre-test position between each test. Positioning the probe foot starting point just above the product will shorten the test cycle. Adjust this position, if necessary, so that the load cell / probe will not interfere with the insertion or removal of the product.

6.11 Check the product to make sure it still contacts both left side guide posts on the centering assembly left side platen and the hold down clamp.

6.12 Push the black start button or depress the foot pedal switch to begin the test cycle. The rigidity tester will:

- Reset the last peak force value on the display.
- Automatically lower until the probe foot touches the product rim and applies 3.0 to 3.7 grams of preload force. Note: The downward moving probe will initially pass the 3.7 gram reading, but return to it on a secondary upward movement.
- Travel vertically downward 0.5 inches, after the preload force/deflection is obtained, deflecting the product. Return upward to its pre-test position.
- Show the peak force in grams on the control box display. The peak force in grams can be obtained by a computer thru a RS-232 serial cable attached to the control box for data acquisition / logging. (See appendix for additional information on serial communication format and data acquisition.)

6.13 Record the peak force in grams. A computer data acquisition system may be set up and used to obtain the peak force value.

6.14 Turn the product 90° so that it lightly touches the left side guide posts and the second mark B (or CD direction) is directly below the load cell probe foot. Repeat steps 6.12 through 6.14. The hold down clamp should not need to be adjusted. The right side guide posts should also not need to be used.

6.14.1 For oblong products (trays, platters, etc.) center the product in the first marked direction A and take all those measurements at one time. Next, center the product in the second marked direction B and take all those measurements at one time.

6.15 Repeat steps 6.6 through 6.15 for all products to be tested. For products in the batch of the same size and style, the hold down clamp should not need to be adjusted (skip step 6.7), and the right side guide posts should not need to be used (skip steps 6.8 through 6.11).

6.16 Repeat steps 6.1 through 6.16 when changing product size or style.

7 Report

7.1 For each sample, report the individual and overall test averages, standard deviations, minimums and maximums to the nearest 1.0 gram and the number of replicates for each principal direction.

7.2 Clearly state any deviations from the standard procedure, and note any unusual features or characteristics of a sample.

8 References/Additional Information

8.1 It is recommended that the load cell be calibrated on a periodic basis. Transducer Techniques can recalibrate the load cell at their facility.

8.2 The peak force in grams can be obtained by a computer thru a RS232 serial cable connected to the control box for data acquisition. A proper communication interface needs to be established between the computer and display meter (See appendix). Please refer to the DPM3-Comm Manual or contact Transducer Techniques for more information on computer to display meter communication setup.

8.3 FPI Rigidity Tester developed for FPI and industry by Georgia-Pacific Corporation, Dixie® National Quality Assurance (Easton, Pa.) and Dixie® R&D (Neenah, Wis.). FPI Rigidity Testers produced for FPI by Peerless Machine & Tool Corporation (Marion, Ind.).

8.4 Operating procedure also developed for FPI and industry by Georgia-Pacific Corporation from Single Service Institute Operating Procedure – Single Service Rigidity Tester, dated November 7, 1983, and Georgia-Pacific Corporation, Neenah Technical Center Standard Test Method TM-4669B-om (Plate Rigidity, SSI Tester) dated March 1, 2001 – Revision 1

9 Document Revision History

9.1 May 19, 2005: Preliminary document developed for FPI by Georgia-Pacific Corp.

9.2 October 11, 2006: Preliminary document updated for FPI by Georgia-Pacific Corp. detailing operation with final Peerless Machine & Tool Corp. tester.

9.3 January 26, 2007: Final document developed for FPI by Georgia-Pacific.

9.4 April 3, 2008: Document revised for clarification and completeness. Calibration gauge spring steel standard values now recorded as a range (minimum and maximum) for each individual spring steel. Appendix added detailing RS232 serial communication, data acquisition – general information, DPM-3 Display Meter Tare/Reset and setup parameters.

9.5 April 22, 2009: Part 4.4 updated, reviewed by FPI Foodservice Packaging Standards Council and approved.

10 Appendix

10.1 RS232 Serial Communication Format:

Please refer to the DPM3-Comm Manual or contact Transducer Techniques, if necessary, for more information on computer to display communication setup.

Mode:	Full Duplex
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200 selectable by DPM-3 front panel menu item "Ser 1" X**X**X
	Note: Baud rate for FPI Rigidity Tester is set at 9600, or "Ser 1" X**5**X.
Parity:	None
Word Length:	8 data bits
Stop Bit:	1

10.2 Data Acquisition – General Information:

Please refer to the DPM3-Comm Manual or contact Transducer Techniques, if necessary, for more information on command mode data acquisition (Section 5.2).

The peak value on the DPM-3 meter display can be imported into a computer, using the RS232 serial cable and a compatible data acquisition / logging software system.
The software needs to send a "·1B2" parsing code requesting the DPM-3 peak value, after completion of each test. (Section 5.2.2)

10.3 DPM-3 Display Meter:

Please refer to the DPM3-Manual or contact Transducer Techniques, if necessary, for more information on display meter setup.

10.3.1 Tare/Reset Functions:

- The Tare/Reset key on the display face is not active since the display is in peak mode after the completion of each test.

- The display value can be Tared to zero, if desired, by pressing "reset " and "menu" on the display face at the same time.

  Note: The display may show a small residue value in grams (typically less than 1 gram) between tests. This residue value will not greatly influence the final test result. Taring the display value to zero is not necessary between tests. The display value should be Tared though if the residual value is greater than 1 gram.

10.3.2 Display Meter Setup Parameters:

Please refer to the DPM3- Manual or contact Transducer Techniques, if necessary, for more information on the Display Setup Parameters.

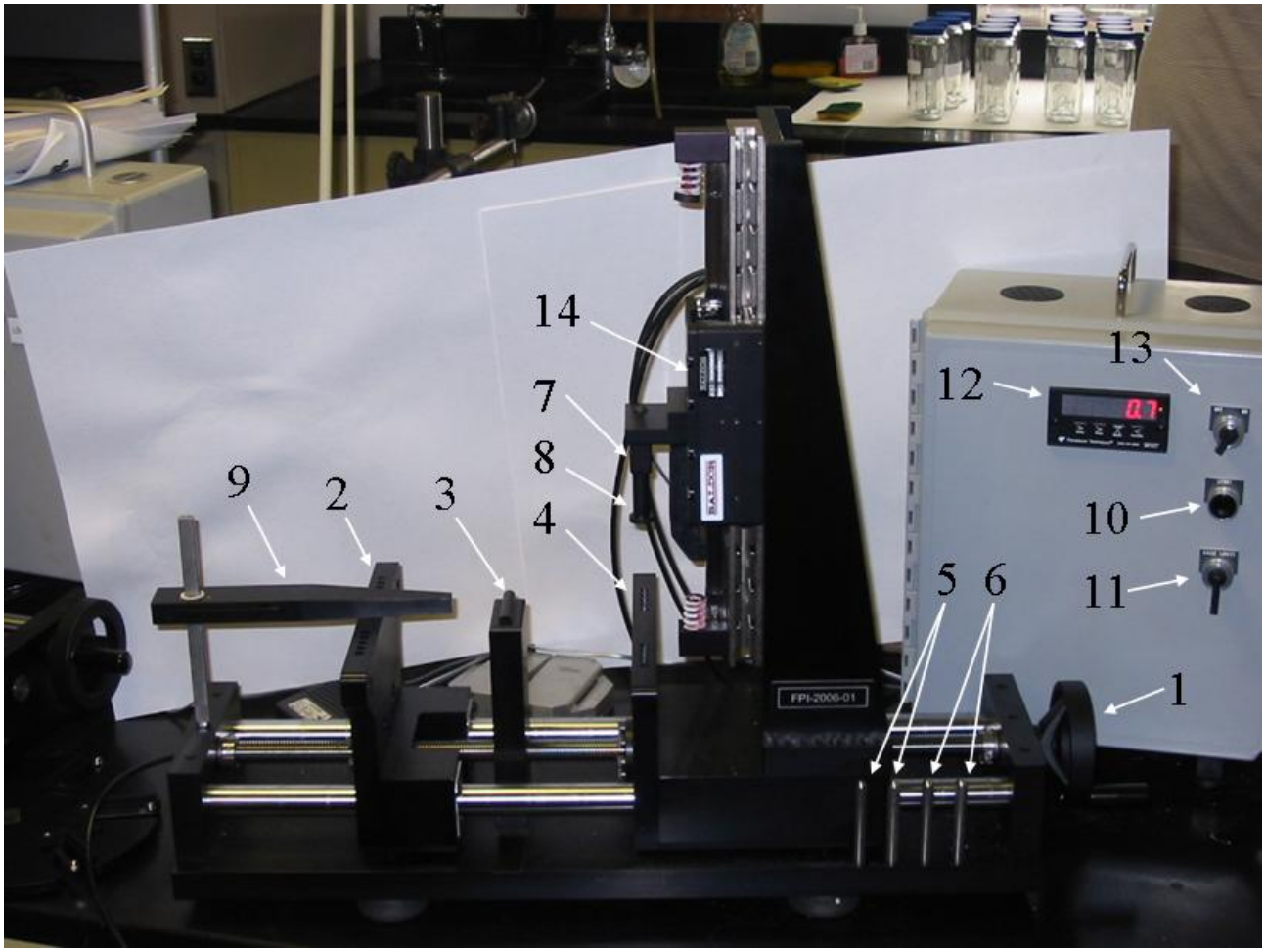
The following is a summary of the default display setup parameters. These values should not be changed.

The parameters can be accessed by pressing "Menu" on the display front panel, and values viewed by pressing "Peak." Press "Menu" to view the next parameter. Continue to press "Menu" until "Reset" appears on the display.

Setup: _0_ _ 1
ConFG: _ 0 0 _ _ *OR* ConFG: _0 1_ _ (if reading a negative value)
FiLtr: 1 1 1 0 0
DEC.Pt: d d d d . d
ALSEt: 0 0 1 4 0

tArE: 0 0 0 0
Ser 1: 1 5 1
Ser 2: 0 0 1 1
Ser 3: 0 0 0 0 0
Ser 4: 0 0 0
Ser no: Transducer serial number (no action required)
UnitS: g
CAL dAt: Transducer calibration date (no action required)
CAL InL: Initials of individual that performed the transducer calibration (no action required)
CAL Per: 3 6 5
M-Id: b r d g – A
Loc 1: 1 0 0 1 1
Loc 2: 0 0_ 0
Loc 3: 0 0 0 0
Loc 4: 0 0 0 0 0
Alarm 1: -10.0
Alarm 2: 3.7

Figure 1 – FPI Plate Rigidity Tester



1. Centering Assembly – Crank
2. Centering Assembly – Left Side Platen
3. Center Support Assembly
4. Centering Assembly – Right Side Platen
5. Guide Posts – Two For Left Side Platen
6. Guide Posts – Two For Right Side Platen
7. Load Cell
8. Probe Foot
9. Hold Down Clamp
10. Start Test Button (Or Can Use Foot Switch Not Shown)
11. Raise / Lower Probe Foot Switch
12. Preload / Peak Force Display
13. On/Off
14. Linear Motor

Figure 2 – Guide Post Test Hole Positions (A-E)

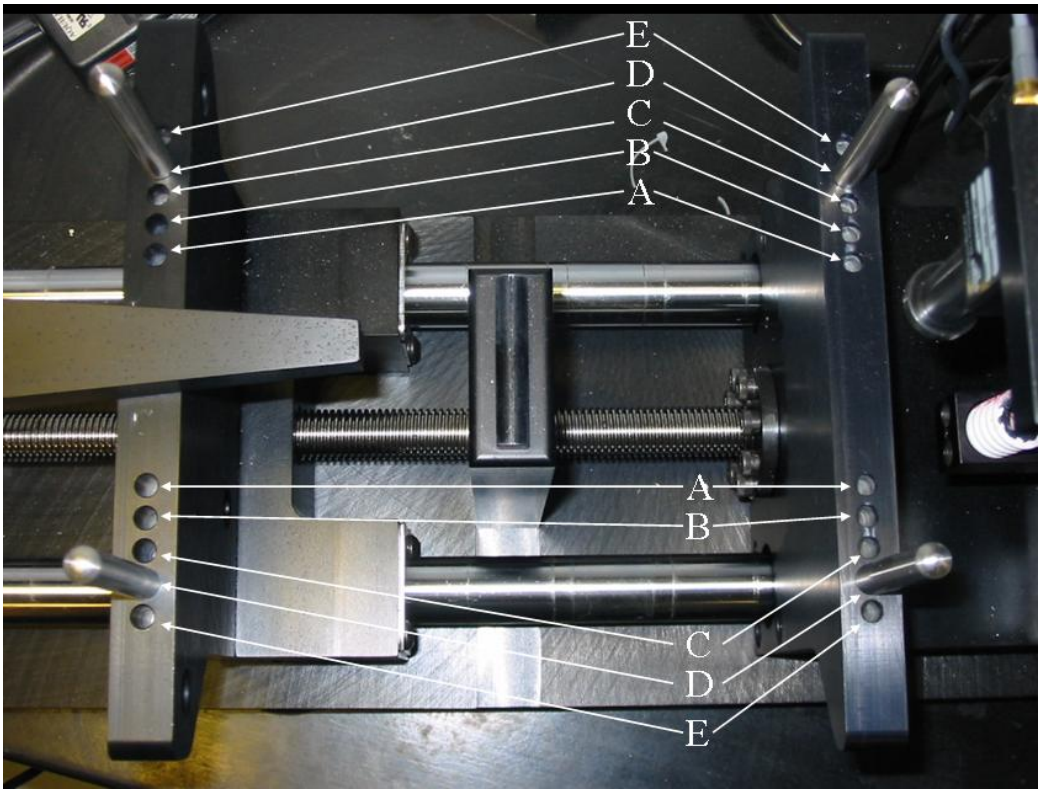


Figure 3 – Auxiliary Platform Placement for Compartmented Plates

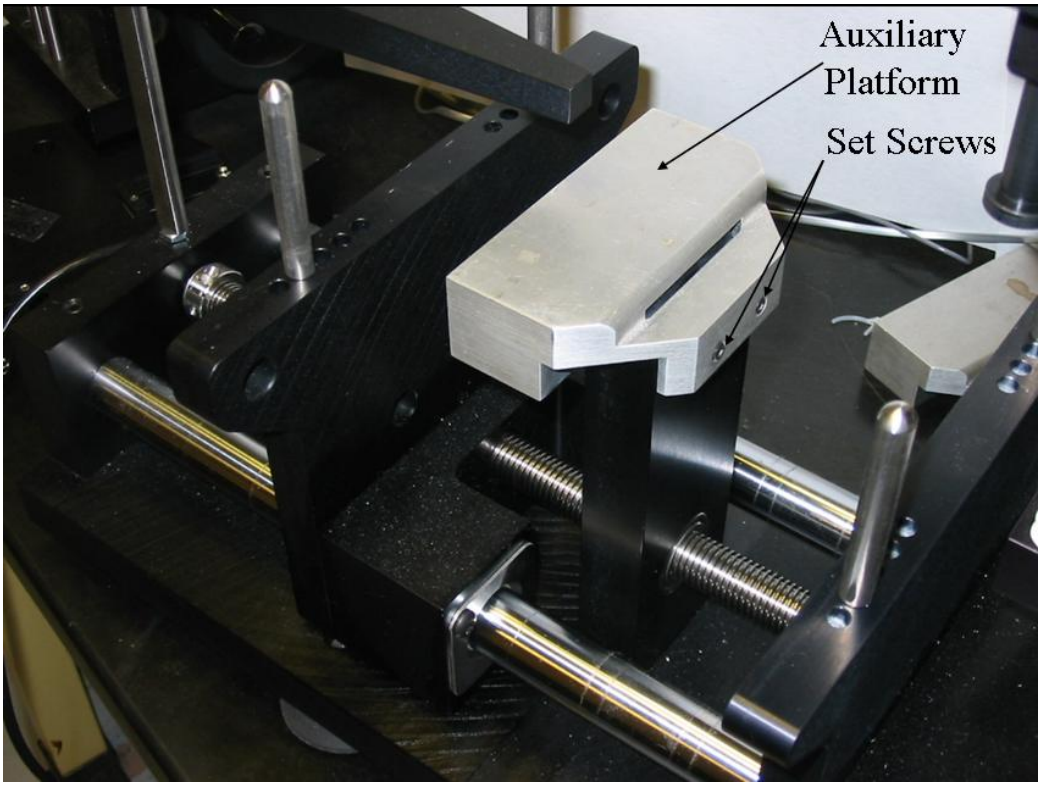
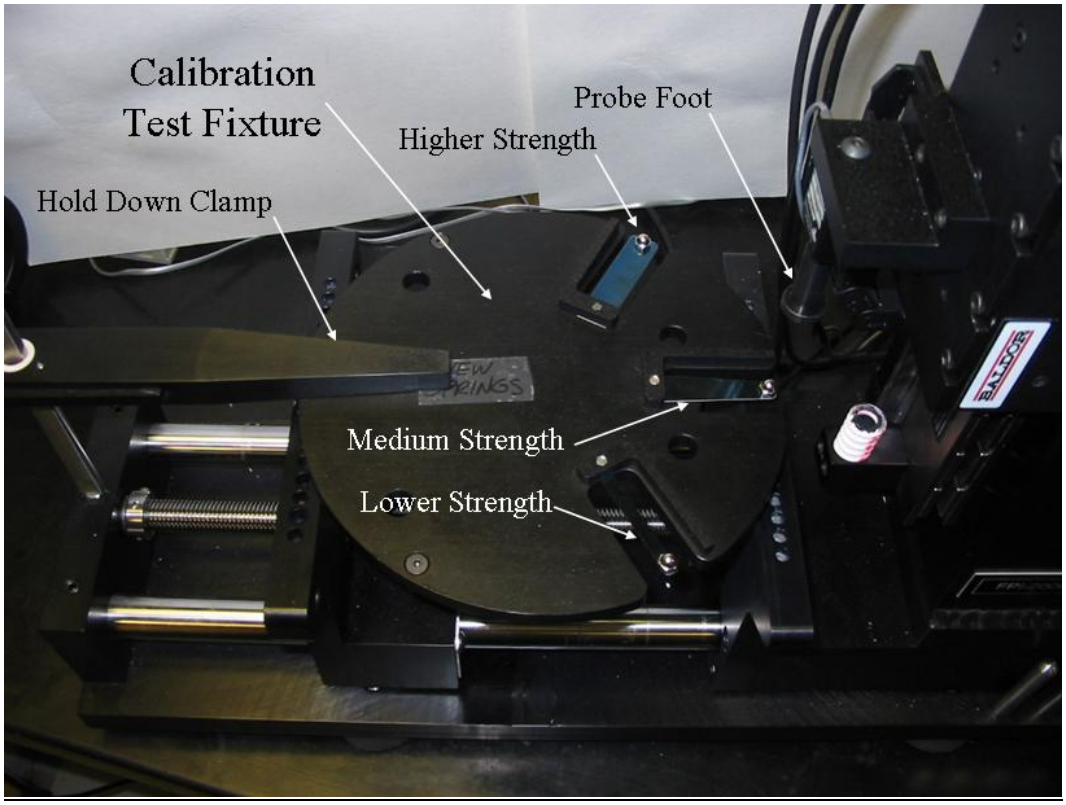


Figure 4 – Calibration Test Fixture with Three Spring Steel Beams



Diagrams 1-6 – A and B Test Positions on Product Rims

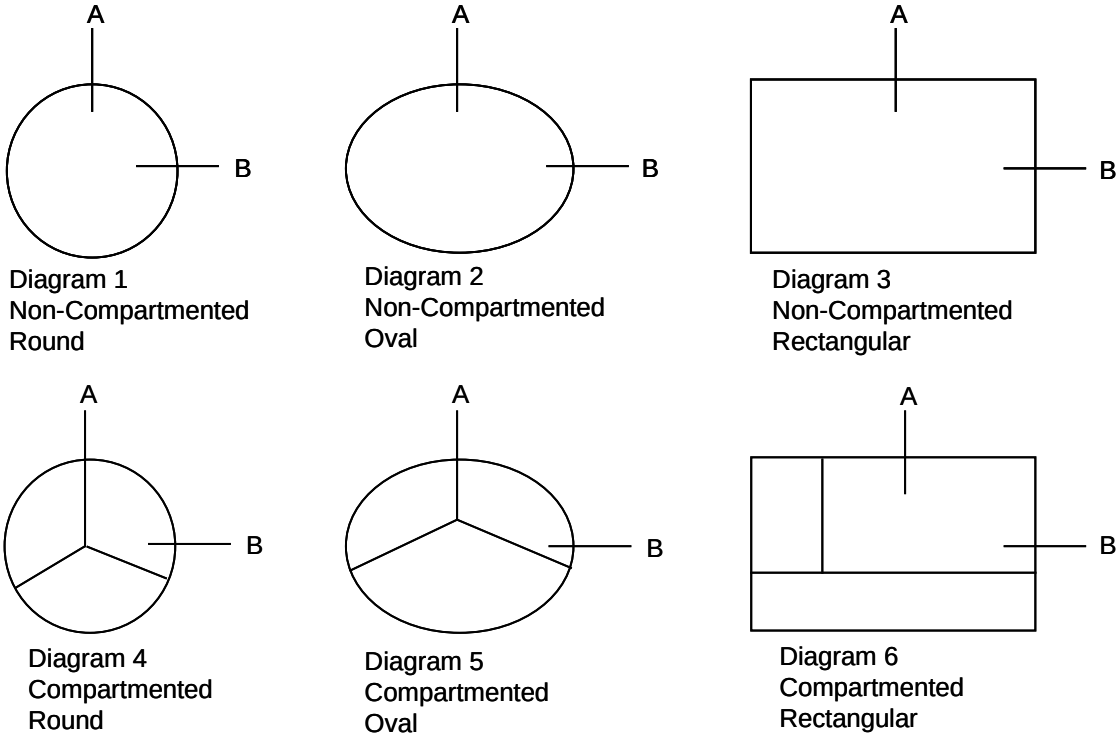


Table 1.

Summary of guide post positions for a variety of known products

Product Type	Company Name	Nominal Product Size	Substrate Type	Product Name	Guide Post Test Hole Positions
Round Plates	Georgia-Pacific	6"	Paper	Dixie / Heavy Duty	B
	Georgia-Pacific	7"	Paper	Dixie / Heavy Duty	B
	Georgia-Pacific	9"	Paper	Dixie / Heavy Duty	C
	Georgia-Pacific	9"	Paper	Dixie Ultra / Superware	C
	Georgia-Pacific	9"	Plastic	Stoneware	C
	Georgia-Pacific	10"	Paper	Dixie / Heavy Duty	D
	Georgia-Pacific	10"	Paper	Dixie Ultra / Superware	D
	Georgia-Pacific	10"	Plastic	Stoneware	D
	Georgia-Pacific	11"	Paper	Dixie Ultra / Superware	D
	Chinet	9"	Paper	All Occasions / Classic White	C
	Chinet	10"	Paper	Classic White	C
	Chinet	10" Compart.	Paper	Classic White	D
	Solo	9"	Plastic	Party	C
	Solo	10"	Plastic	Party	D
	Solo	9"	Foam		B
	Hefty	9"	Foam		B
	Generic	9"	WNP Paper	White No Print (WNP) Fluted Plate	B
Round Bowls	Georgia-Pacific	5oz	Paper	Dixie Superware	A
	Georgia-Pacific	12oz	Paper	Dixie Ultra / Superware	A
	Georgia-Pacific	20oz	Paper	Dixie Ultra / Superware	B
Oval Trays	Georgia-Pacific	7"x9"	Paper	Dixie Superware	B/D (major/minor)
	Georgia-Pacific	9"x11"	Paper	Dixie Superware	C/E (major/minor)
	Georgia-Pacific	10"x12-1/2"	Paper	Dixie Superware	D/E (major/minor)
Other					

Preliminary April 26th, 2005