



Standard Operating Procedure: SOP-BALL-1

## Radius of Gyration (RG) of Asymmetrical Bowling Balls

<u>Rev</u>	<u>Date</u>	<u>Staff Member</u>	<u>Purpose</u>
7	11/13/19	A. Stanton	Added calibration/verification procedures
6	2/18/19	J. Milligan	Change Logo, clarify alignment of ball
5	1/22/14	E. Troutman	Edited for clarification
4	07/03/12	N. Mours	Added repeat if 0.08 seconds difference in swing time for any one axis
3	12/10/10	N. Mours	Removal of cradle alignment holder
2	03/12/09	N. Mours	Addition of pictures & use of PSA
1	02/11/09	N. Mours	rewrite for clarification
Origination date: 10/29/07		Originator: T. Robben	



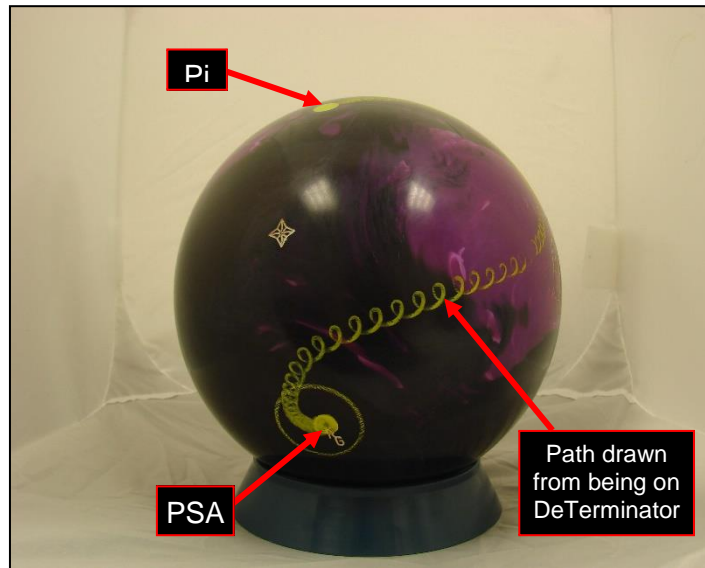
**Purpose:** To determine the RG about the X, Y and Z axes of asymmetrically marked bowling ball.

**Materials:**

- Ball cup
- Bowling ball to be tested with asymmetrical core markings
- Bowling Ball Radius of Gyration Worksheet which should include calibration information for the RG Swing being used
- Grease Pencil
- MoRich DeTerminator
- RG Swing with timing mechanism and electric eye counter
- Bowling ball total weight scale
- Turbo 2-N-1 Pro Sect

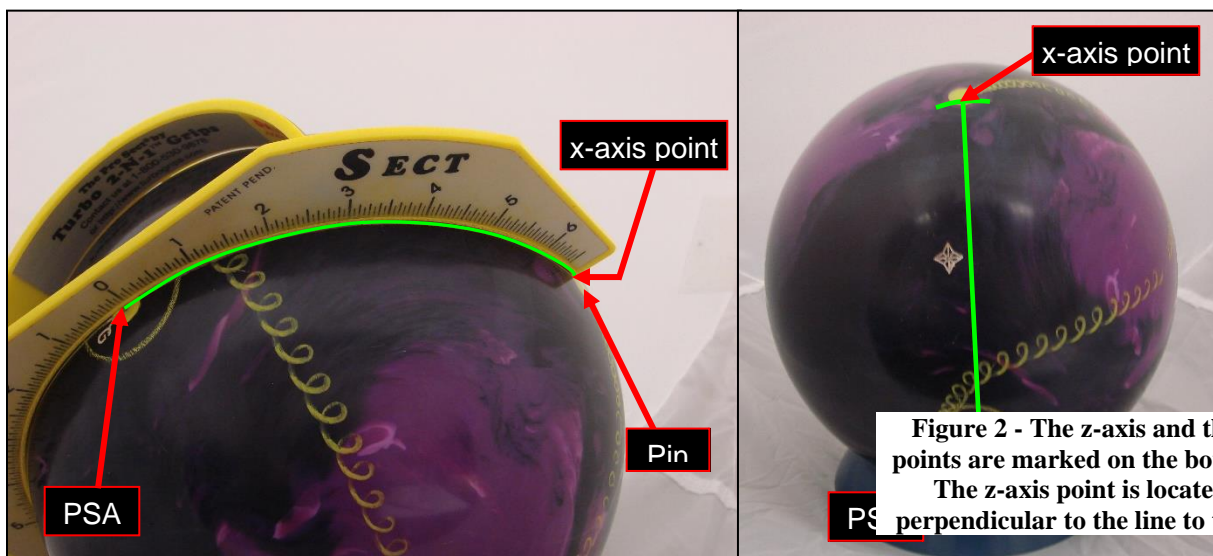
**Procedure:**

1. Using SOP-BALL-4, find the total weight of the bowling ball.
2. Record the total weight of the bowling ball on the “Bowling Ball Radius of Gyration Worksheet.”
3. Place the bowling ball in the DeTerminator with the manufacturer’s pin pointing directly through the eyehole of the side arm, with the CG toward the direction of rotation.
4. Energize the DeTerminator and allow the ball to spin up to a consistent speed.
5. Place the point of the grease pencil through the eyehole of the side arm on the DeTerminator until it is touching the ball surface and allow the grease pencil to draw a path on the bowling ball as it spins.
6. Wait until the bowling ball is spinning around about a point and the grease pencil has clearly marked that point indicating the PSA (Preferred Spin Axis) on the bowling ball.
7. Switch off the DeTerminator.
8. Remove the bowling ball from the DeTerminator and place in a ball cup. See Figure 1 which displays the marked PSA and shows the grease pencil path drawn on the bowling ball from step 6.



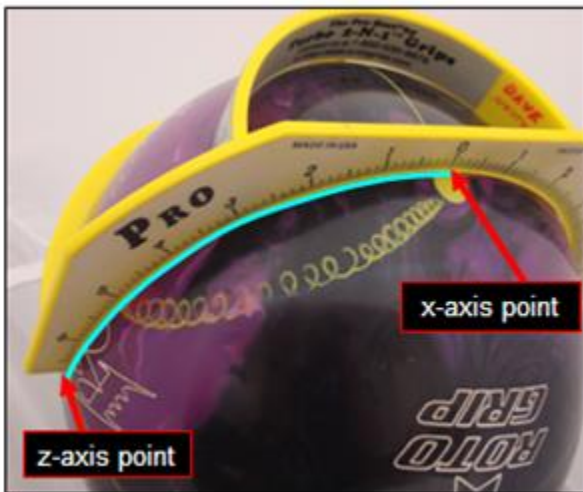
**Figure 1 - Asymmetrical bowling ball just after being spun on the DeTerminator**

9. Align the Pro Sect on the bowling ball so the “0” mark is on the PSA and the end is going through or towards the pin of the bowling ball.
10. Draw a line, using the grease pencil, from the PSA on the bowling ball through or towards the pin. This line is shown in green in Figure 2. Mark the point  $6\frac{3}{4}$ ” from the PSA towards the pin. This mark characterizes one end of the x-axis of the bowling ball. Figure 2 shows the marked PSA and the line drawn  $6\frac{3}{4}$ ” from the PSA towards the pin of the bowling ball.

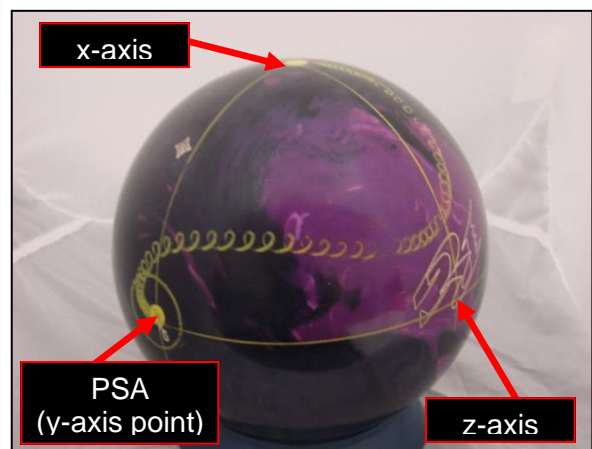


**Figure 2 - The z-axis and the x-axis points are marked on the bowling ball. The z-axis point is located  $6\frac{3}{4}$ ” perpendicular to the line to the x-axis.**

**Figure 3 – The green line drawn 6 ¾” from the PSA towards the pin locates one end of the x-axis of the bowling ball (the low RG).**  
 drawn in step 10 and highlighted in green in Figure 2 by placing the “0” mark of the Pro Sect on the x-axis marking. Mark one end of the z-axis by making a mark with the grease pencil 6 ¾” away from the x-axis point along the line that is perpendicular to the line drawn in step 10. Figure 3 shows the z-axis point 90 degrees away from the x-axis. The z-axis point is also mutually perpendicular to the y-axis point (PSA) and the x-axis point which is further illustrated in Figure 4.



**Figure 4 - The z-axis and the x-axis points are marked on the bowling ball. The z-axis point is located 6 ¾” perpendicular to the line to the x-axis.**



**Figure 5 - X-axis point, PSA and z-axis point labeled relative to each other.**

12. Supply power to the RG Swing timing mechanism and electric eye counter. Wait for the display to stop flashing.
- 13.
14. Place the bowling ball in the RG Swing cradle with the x-axis at the very top pointing up through the string on the RG Swing. To assist with centering the bowling ball, align the line from the x-axis to the PSA (y-axis) with the side bar of the cradle on the RG swing that is nearest to you.
15. Rotate and hold the left side of the RG Swing cradle towards you so the left side of the cradle is in front of the timing and counting sensor (approximately rotated to the left corner of the base of the RG swing nearest you). Continue to hold the cradle and push the “R” button on the timing and counting display so the display reads zero.
16. Carefully release the cradle so it rotates smoothly with as little wobble as possible.



17. Allow the bowling ball to “swing” for 5 periods (the timing mechanism and counter will stop once it reaches 11).
18. Once the timer stops, record the time for 5 periods on the “Bowling Ball Radius of Gyration Worksheet” for the axis being tested.
19. Reset the timing mechanism and electric eye counter without stopping the bowling ball from swinging. The RG swing should be on the same side of the counter as it was in step 14.
20. Repeat steps 16-17.
21. If the two swing times recorded for the x-axis have a difference of greater than 0.06 seconds, repeat steps 14-19. If not, continue.
22. Stop the bowling ball from swinging and rotate the bowling ball so y-axis point, or PSA is now at the very top pointing up through the string on the RG Swing. To assist with centering the bowling ball, align the line from the PSA (y-axis) to the z-axis with the side bar of the cradle on the RG Swing that is nearest to you.
23. Repeat steps 14-19.
24. If the two swing times recorded for the y-axis have a difference greater than 0.06 seconds, repeat steps 14-19 and then step 23. If not, continue.
25. Stop the bowling ball from swinging and rotate the bowling ball in the cradle of the RG Swing so the z-axis point is now at the very top pointing up through the string on the RG Swing. To assist in centering the bowling ball, align the line from the z-axis to the x-axis with the side bar of the cradle on the RG Swing that is nearest to you.
26. Repeat steps 14-19.
27. If the two swing times recorded for the z-axis have a difference greater than 0.06 seconds, repeat steps 14-19 and then step 26. If not, continue.
28. Once 2 swing times for each axis have been recorded on the “Bowling Ball Radius of Gyration Worksheet,” the RG values for each axis, the total differential and the intermediate differential will be displayed on the worksheet in inches.



**If ball results indicate the RG or Differential is out of spec:**

1. Test that the RG swing is operating correctly by running the official calibration block on all three axes. See SOP-BALL-13 “Bowling Ball RG Device Calibration” for test procedure.
2. If test results are within  $\pm 0.001$  of the expected values, the swing is operating correctly, and the original results will be reported in the test sheet.
3. If test results are not within  $\pm 0.001$  of the expected values, recalibrate the RG Swing using SOP-BALL-13 and retest the ball with the new calibration coefficients.

**Calibration**

All RG swings are to be recalibrated **quarterly** throughout the year (March/June/September/December) using the official calibration block. See SOP-BALL-13 for calibration procedures.

If any test ball presents values outside of the RG or differential specifications, the swings used must be checked for calibration. Please see previous section.