A Future FOR THE Sport

OPEN CHAMPIONSHIPS BALL HARDNESS RESEARCH REPORT 2023

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SUMMARY

Since 2019, the United States Bowling Congress (USBC) Equipment Specifications staff has conducted updated research looking at how bowling ball hardness changes after use over time. These research reports demonstrated urethane shell balls drop in hardness the most after use. Reactive shell balls have less significant changes, showing little to no drop in hardness after use.

This 2023 report summarizes field testing of hardness at the 2023 USBC Open Championships. The Open Championships allowed the research team to test a larger sample size and balls that had a longer manufactured period than balls previously tested at professional events and in laboratory settings.

In this study, the USBC Equipment and Specifications team tested 751 bowling balls for hardness, including: 616 reactive balls and 135 urethane balls. The results aligned with previous research, confirming similar data trends with both types of balls in a larger population.

- Urethane balls measure expectedly softer after use.
- Reactive balls show little to no change with use.

This study reinforces the conclusion that urethane bowling balls get naturally softer with use and shows this has been the case for many years. USBC continues to not have a reason to justify removing used bowling balls from competition due to hardness changes from ordinary use.

PROCESS

The data was collected by receiving balls from bowlers in the squad room prior to competition at doubles and singles squads between the dates of April 17, 2023, and April 21, 2023. In this window of time, USBC tested 751 balls. The testing procedure called for no cleaning of the surface nor external heating to raise the temperature of the balls. Instead, the balls were received in an "as is" state and measured for both hardness and temperature. Then the balls were returned directly to their owners.

The technical testing SOP[1] can be found on BOWL.com.

TOOL MONITORING

To monitor the testing devices, four baseline bowling balls were at each station to be measured before and after each squad. These results were to establish a difference between the devices' measurements at USBC's laboratory and in the field, as well as monitoring the tool over the course of the event as environmental factors such as oil or polishes on the tested bowling balls were involved.

Prior to the event, each tool was tested in a laboratory setting to baseline the control balls. Prior to testing any balls at the event, the test balls were re-evaluated at the venue to measure the difference. Also using what is known about the relationship between hardness and temperature, we can calculate an expected difference in hardness for each ball. From previous research:

$$\textit{Reactive Hardness Change} \cong -0.10\ (D/(°F))$$

$$\textit{Urethane Hardness Change} \cong -0.22\ (D/(°F))$$

The following data tables are the hardness results of the test balls measured in our lab as well as the check at the event before the first squad.

[1] Testing SOP

Durometer	Location	Sample	Hardness (D)	Temperature (°F)
Tool 1	Lab	Test Ball 1	74.5	72.1
Tool 1	Lab	Test Ball 2	77.3	72.1
Tool 1	Lab	Test Ball 3	77.3	72.0
Tool 1	Lab	Test Ball 4	74.6	72.1
Tool 1	Pre-Squad 1	Test Ball 1	75.5	66.7
Tool 1	Pre-Squad 1	Test Ball 2	77.6	66.5
Tool 1	Pre-Squad 1	Test Ball 3	77.9	66.0
Tool 1	Pre-Squad 1	Test Ball 4	75.3	65.6

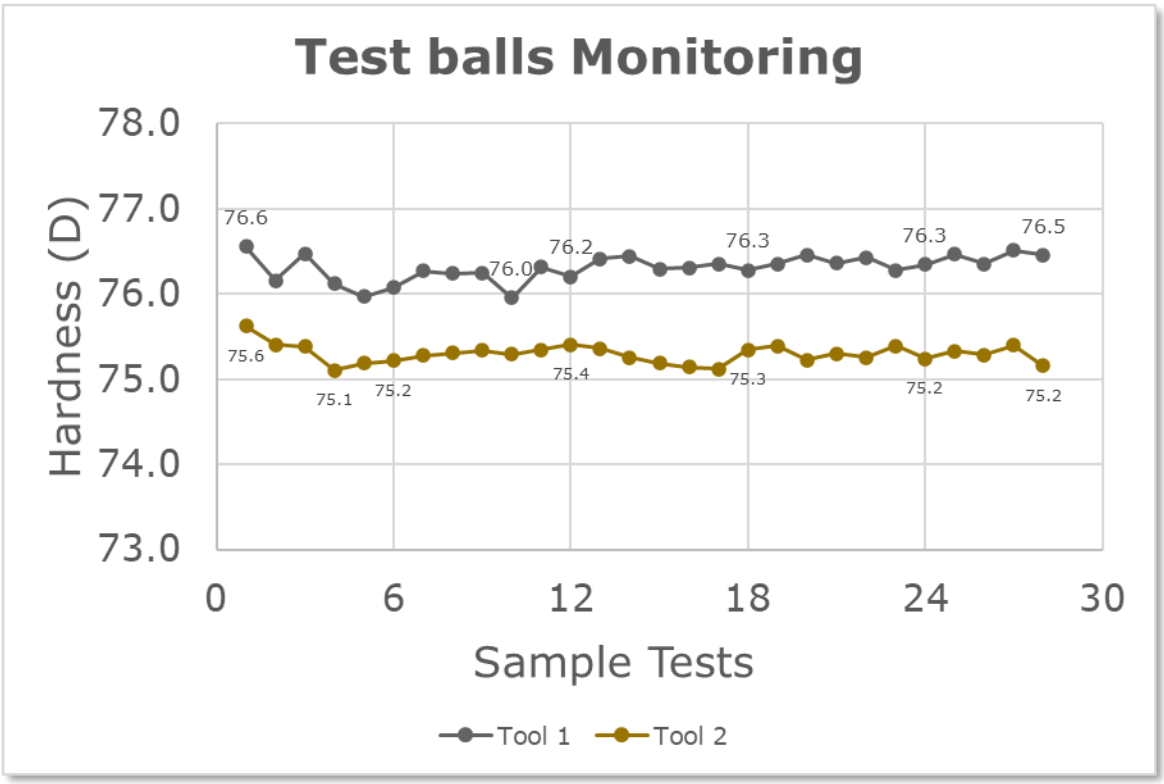
Difference	Exp. Difference	*Tool shift*
1.0	0.5	*0.4*
0.4	0.6	*-0.2*
0.6	0.6	*0.0*
0.7	0.6	*0.0*
	Average:	***0.1***

Durometer	Location	Sample	Hardness	Temperature
Tool 2	Lab	Test Ball 5	75.6	72.0
Tool 2	Lab	Test Ball 6	73.9	72.0
Tool 2	Lab	Test Ball 7	75.1	72.4
Tool 2	Lab	Test Ball 8	75.8	72.1
Tool 2	Pre-Squad 1	Test Ball 5	76.0	66.3
Tool 2	Pre-Squad 1	Test Ball 6	74.4	66.7
Tool 2	Pre-Squad 1	Test Ball 7	75.5	66.0
Tool 2	Pre-Squad 1	Test Ball 8	76.6	66.5

Difference	Exp. Difference	*Tool shift*
0.4	0.6	*-0.2*
0.5	0.5	*0.0*
0.4	0.6	*-0.2*
0.8	0.6	*0.2*
	Average:	***-0.1***

The results show the devices performed in the field within +/- 0.1 of how they performed in the lab, and the only differences measured in the test balls are directly in-line with their temperature differences.

Additionally, the test ball groups average hardness was monitored before and after each squad where testing occurred, showing that the devices performed consistently throughout the data collection within the normal fluctuations that were expected.



DATA ANALYSIS

The team gathered data on 751 unique bowling balls. 616 of these samples were balls classified as reactive balls, 135 were samples classified as urethane balls.

The reactive samples were reflective of 10 manufacturers across 22 brands. The urethane samples were reflective of eight manufacturers and 10 brands.

Summary of Reactive Hardness Results:

- Reactive balls tested: 616
- Minimum hardness tested: 72.2 D
- Average hardness tested: 75.1 D
- Maximum hardness tested: 80.1 D

A full data table[2] of all the measurements gathered on reactive balls can be found on BOWL.com.

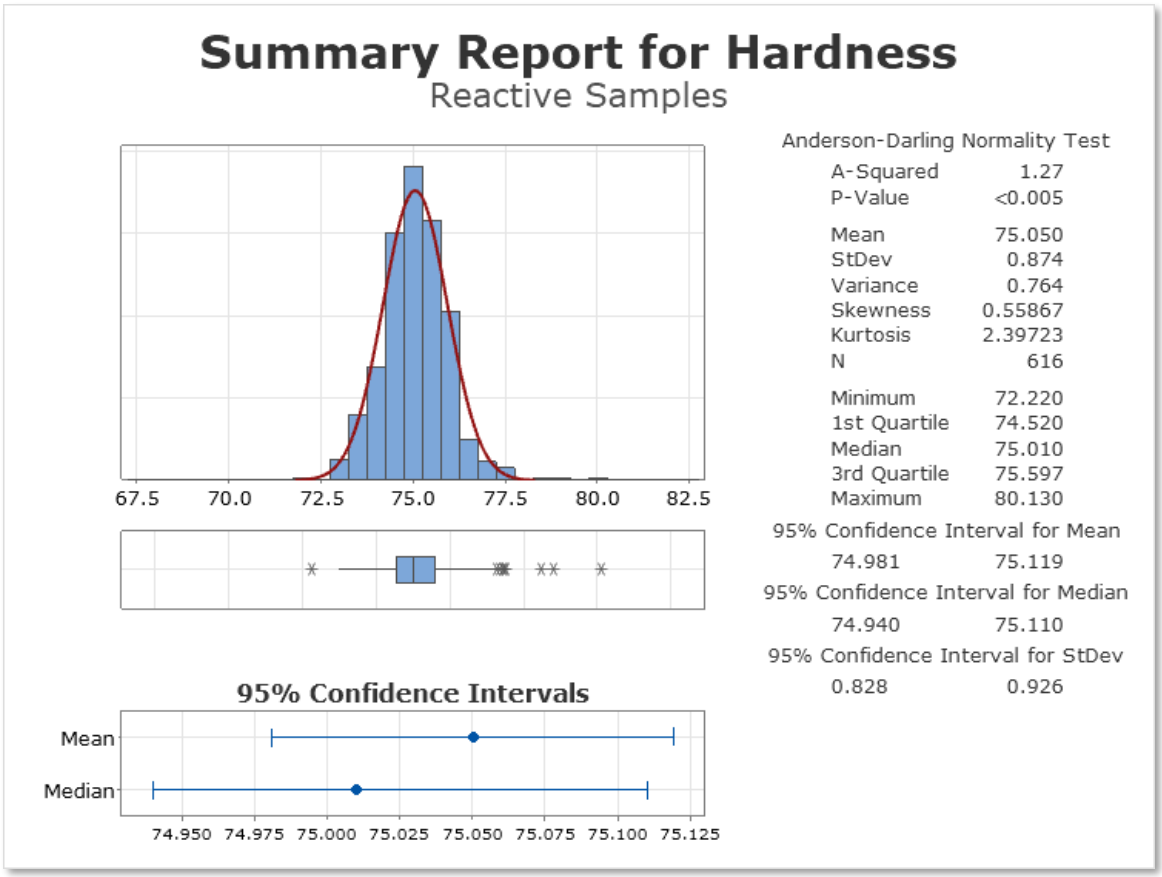
Summary of Urethane Hardness Results:

- Urethane balls tested: 135
- Minimum hardness tested: 67.6 D
- Average hardness tested: 74.5 D
- Maximum hardness tested: 82.4 D

[2]Reactive data

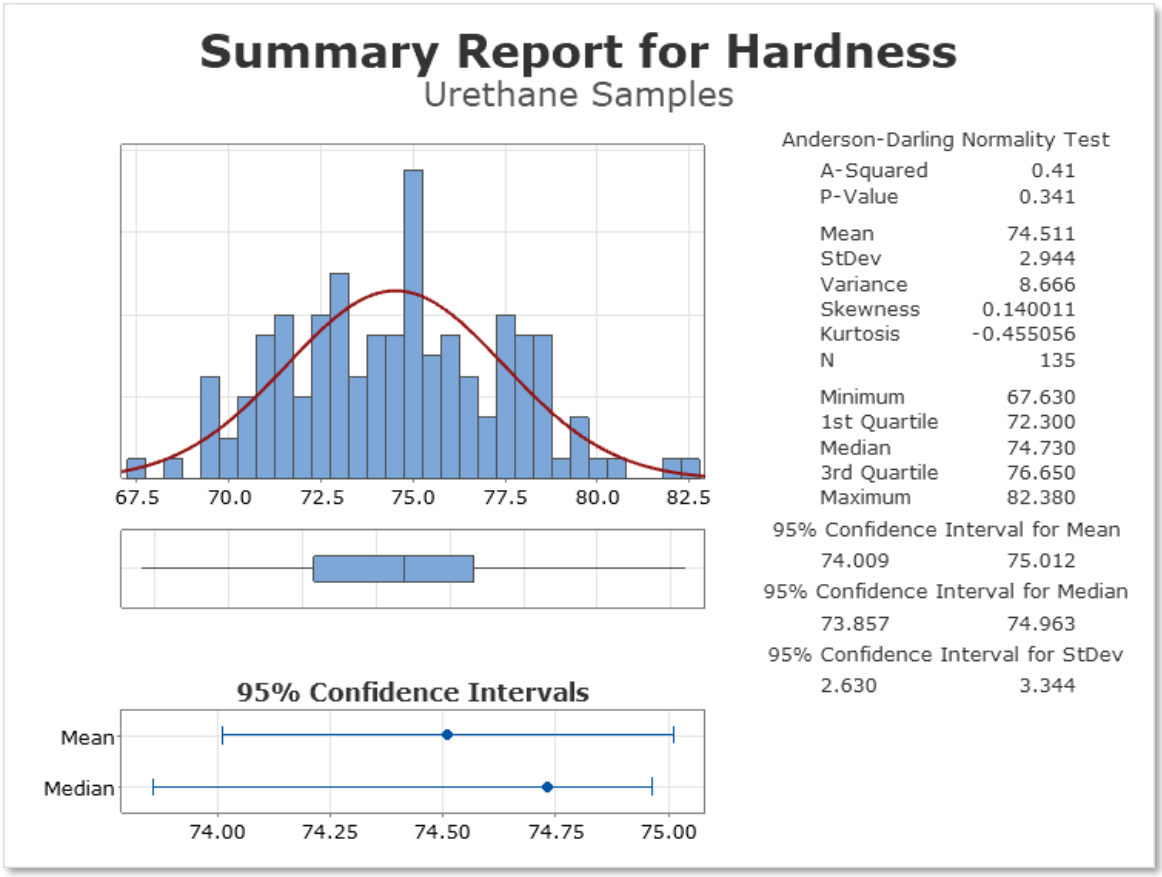
A full data table[3] of all the measurements gathered on urethane balls can be found on BOWL.com.

This chart summarizes the raw hardness data collected from each reactive ball in the test. In this data, we see an average of 75.0 D with samples anywhere from 72.2 D and 80.1 D (7.9 D range).



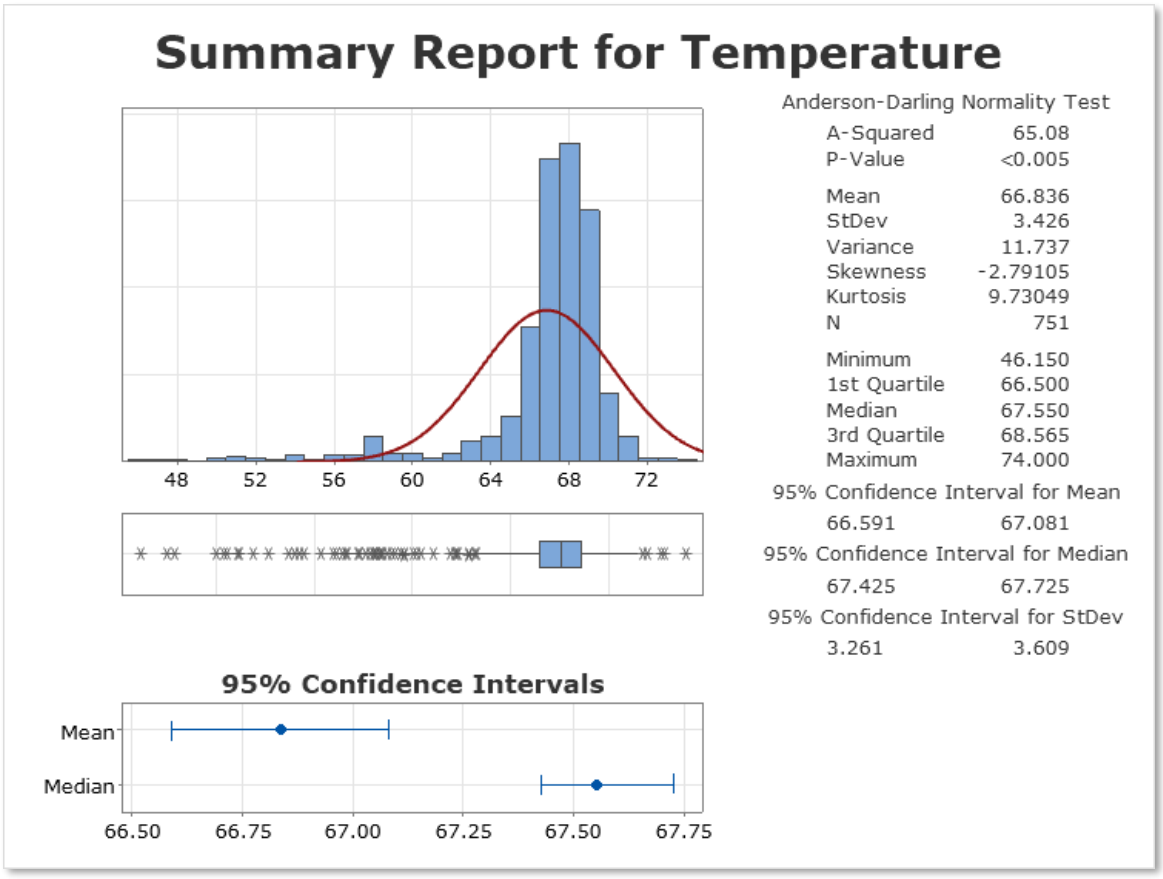
Similarly, the following chart showcases all the urethane sample data. This data shows a similar average at 74.5 D, but a much larger range from 67.6 D to 82.4 D (14.8 D range).

[3]Urethane data

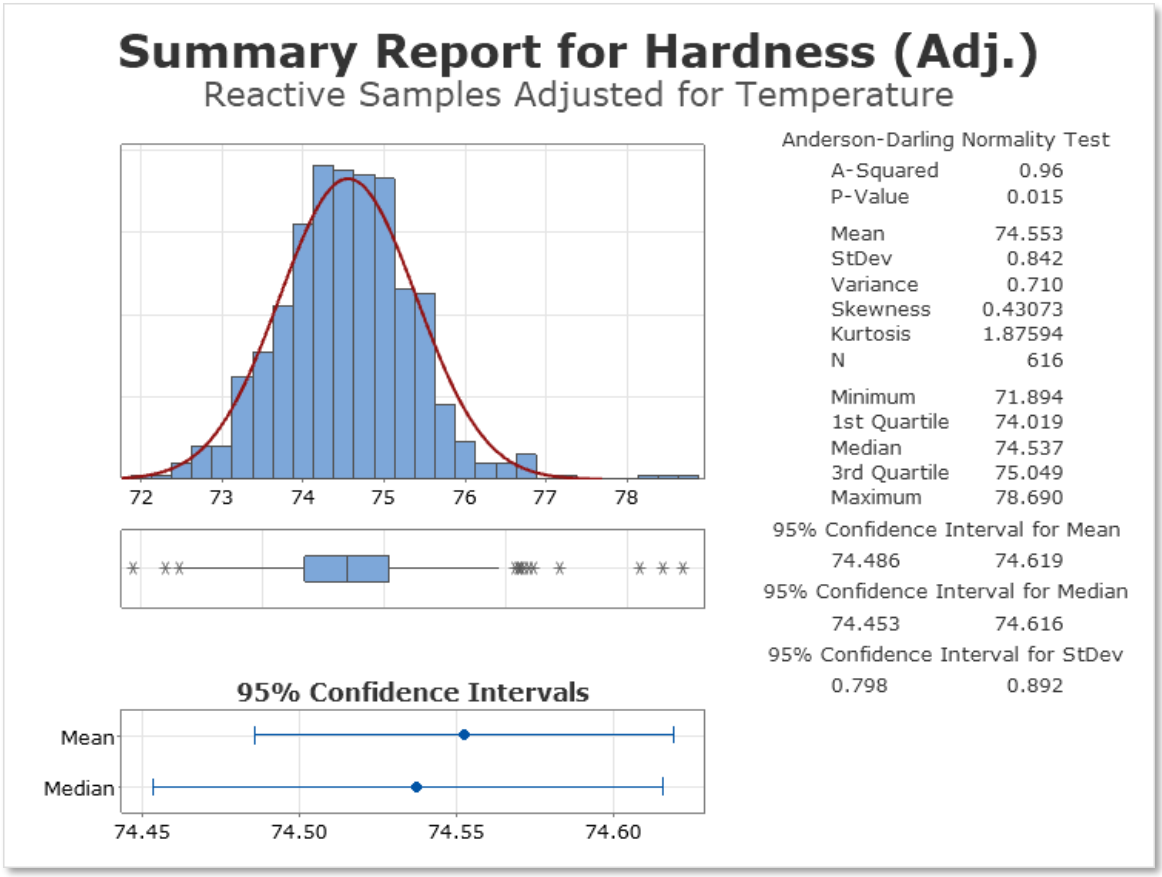


While testing at the Open Championships, we found that balls being used at the event varied significantly more in age than what was tested previously at professional tournaments. Of the samples whose age was discernable from the serial number, the ages ranged from less than one month old to more than 27 years old, with an average ball age of three years. Urethane balls made more than 10 years ago were made at higher hardness's than balls being produced today.

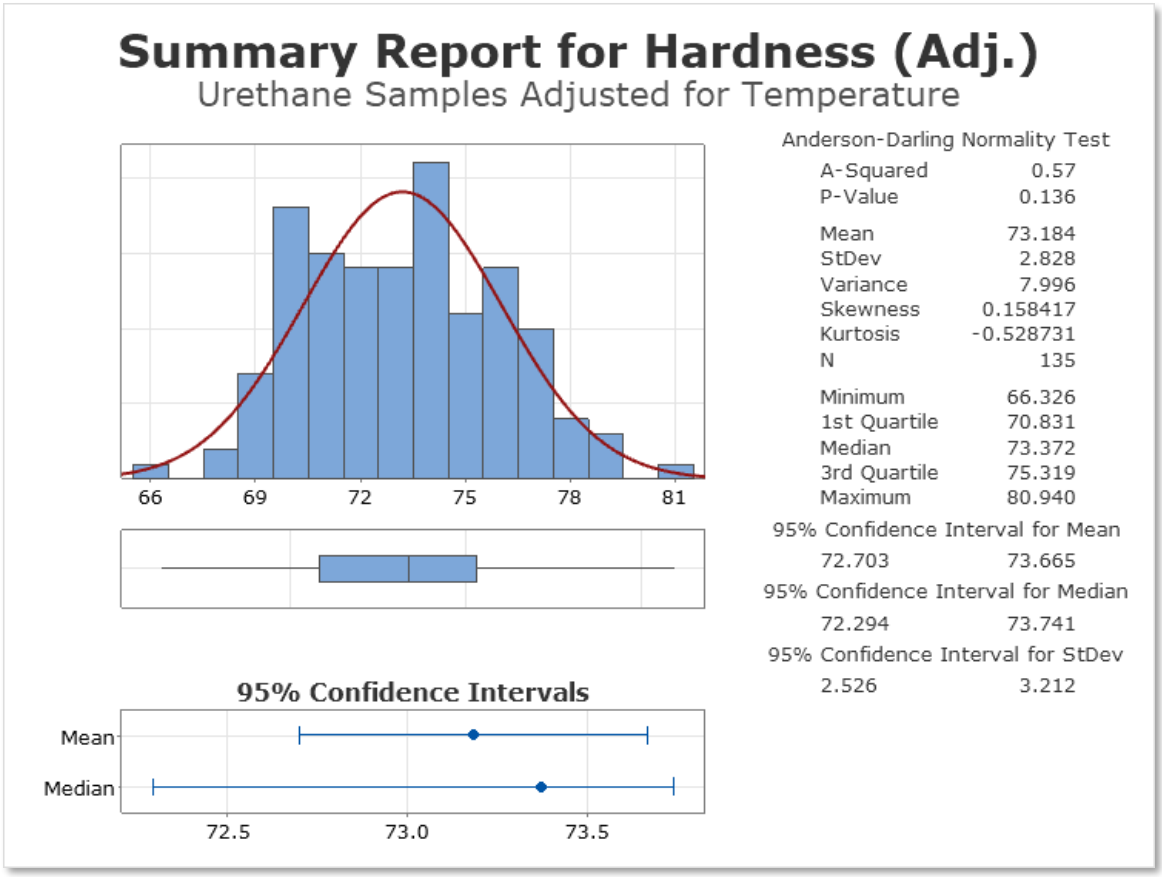
If we examine the temperatures of the balls being tested, we find that many were tested much cooler than the standard temperature range for testing. Ranging from balls as cold as 46.2 °F to as warm as 74 °F.



If we look at the data collected in this test alongside our known trends in hardness and temperature, the data converts as follows:

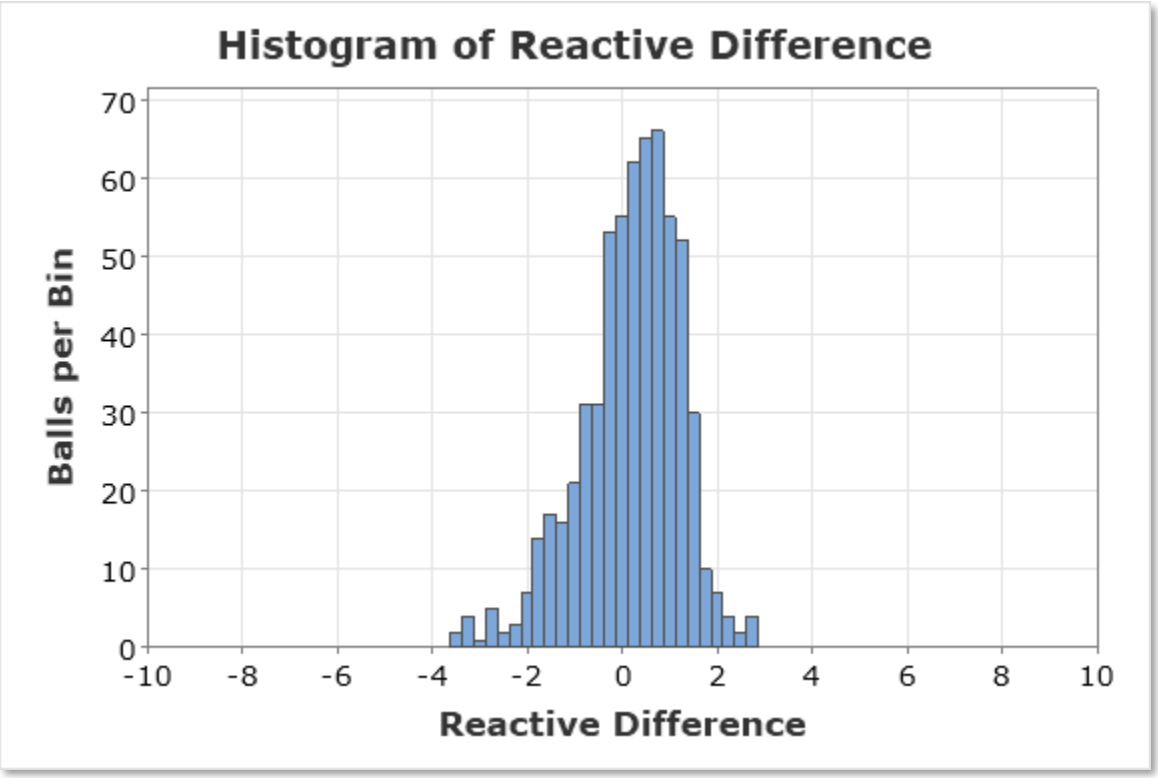


The reactive data once adjusted for temperature averages 74.5 D with a range from 71.9 D to 78.7 D.

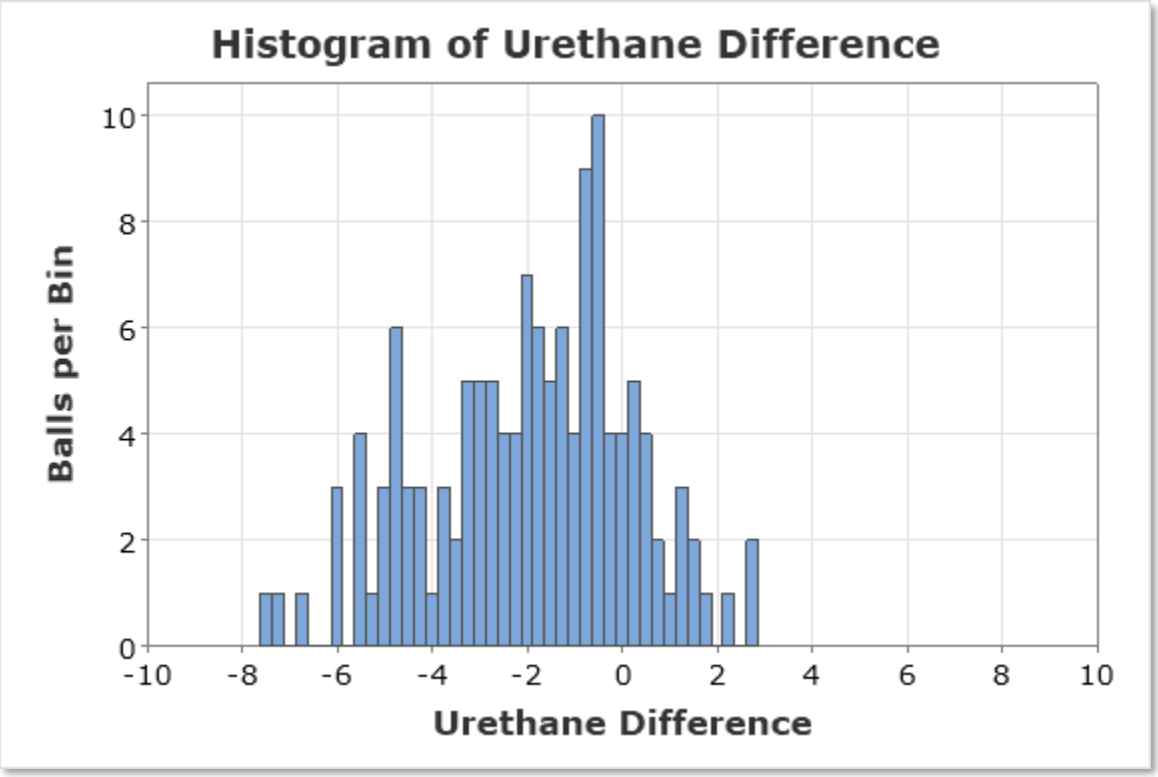


The urethane data averages 73.2 D with a range from 66.3 D to 80.9 D.

Having the data adjusted for temperature, and understanding the tools performance on test balls measured in the lab and on-site, allows us to reference all of these balls back to the values at which each of their respective models were approved. With reactive samples, we see the majority measure within plus or minus 2 points of the value of their approval samples, with an average difference of 0.3 D harder than approval.



Urethane balls continue to show loss in hardness compared to their unused approval samples. The largest observed variation from approval hardness was 7.6 D which aligns with changes we have seen in other field tests, as well as laboratory studies on hardness with use. The average drop in urethane hardness from approval in this study is 2.0 D.



KEY TAKEAWAYS

The data collected in this research study continues to show similar results.

- Hardness of reactive balls changes little to none with use. An observed difference of only 0.3 D harder than approval comparisons.
- Hardness of urethane balls decreases with use with varying amounts from ball to ball with changes as much as 7.6 D in this study.
- The data collected in this event aligned with results from previous testing.

This study reinforces the conclusion that urethane bowling balls get naturally softer with use and shows this has been the case for many years. USBC continues to not have a reason to justify removing used bowling balls from competition due to hardness changes from ordinary use.