



STRING PINSETTER RESEARCH REPORT

2023

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OVERVIEW

USBC has concluded a comprehensive research study on string pinsetters. The USBC Equipment Specifications Committee has approved the final specifications based on the research. The final specifications reduce the string length to a minimum limit of 54 inches. This length allows for improved scoring and split conversion rates compared to free-fall.

- USBC's lab data indicates strike percentage on string pin bowling under the final specifications will be 7.1% less than in free-fall.
- This could result in average differences as large as 10 pins or more.
- Unusual spare conversion rates have been nearly eliminated.
- Additional bowler tests are needed to better determine if a conversion between string pinsetter competition and free-fall is reasonable.

Therefore, as next steps:

- USBC will certify string pinsetters and string pin bowling as an independent category of equipment and competition, separate from free-fall machines effective August 1, 2023, for the 2023/2024 season.
- USBC will conduct additional bowler tests with the objective of determining whether string averages can be used the same as free fall or whether a conversion can be created.
- USBC will provide an update on the additional testing and potential for conversion in advance of the 2024/2025 season.

Background

For the past two years, the USBC equipment specifications staff has been conducting research into the use of string pinsetters and how they affect the sport of bowling. At the end of 2021, USBC released its initial findings along with a list of preliminary specifications for the string pinsetter manufacturers to target with the goal of better aligning string pinsetters with free-fall pinsetters.

This year USBC has begun receiving string pinsetters designed to meet the preliminary specifications. The machines are being put through testing to evaluate the strike pocket, as well as their tendency to allow pins to rebound from the pit to convert challenging spares. The following summarizes the findings:

- Strike pocket is more aligned with free-fall than the original phase of testing.
- String-related strike occurrences are down to less than 1% of shots.
- Pins rebound much less often to convert challenging splits than in the original phase of testing.
- Preliminary specifications have resulted in some challenges with higher tangle rates.
- Additional research showed shorter string lengths than the proposed specifications reduce the tangle rate and maintain most of the scoring improvements.
- Data collected shows adding inserts to the pins had little to no impact on their performance.

NEW STRING PINSETTERS

At the end of 2021, USBC released the results of its initial phase of research on string pinsetters along with preliminary specifications that were developed to help promote similarity between the performance of the different pinsetters and more closely align with free-fall performance.

The preliminary specifications were:

Specification	Min	Max
String Length	65"	None
Ball Cushion Distance	35"	None
Pin Curtain Distance	14"	18"
Kickback Thickness	Match Free Fall, 2.75" on both sides	

String length refers to how long the string is when it becomes tight as measured from where the string exits the machine to the top of the pin. Ball cushion distance is the distance from the end of the lane to the cushion that stops the bowling balls. Pin curtain distance is the location of the hanging curtain that slows down the pins to help prevent them from rebounding.

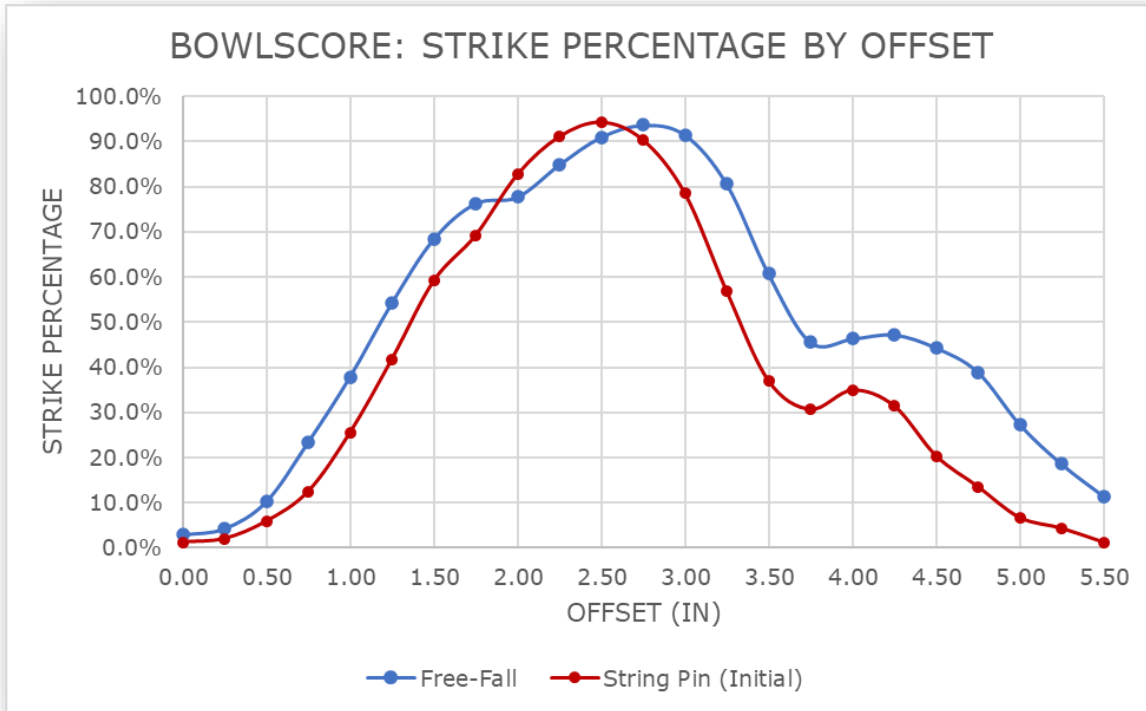
After the announcement of the preliminary specifications on December 7, 2021, USBC began testing machines submitted by manufacturers that were made according to the preliminary specifications.

Strike Pockets

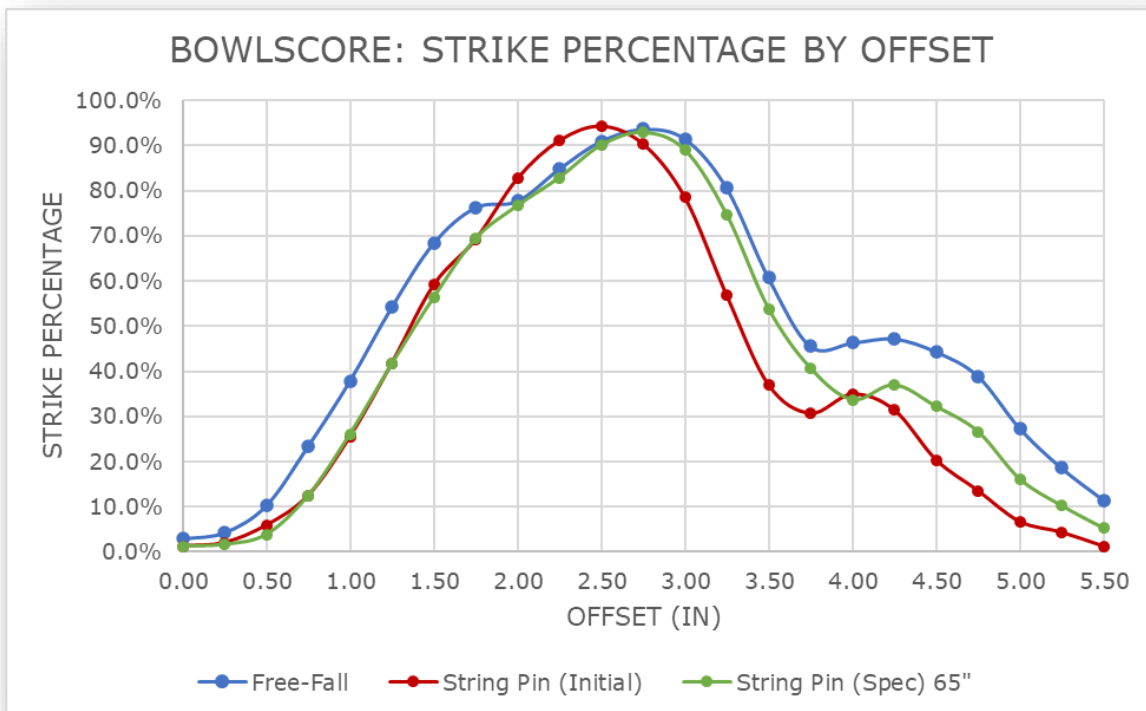
Bowlscore¹, our automated ramp that rolls the ball into the pin deck at controlled angles and offsets, is our main research tool for studying strike percentages. It can deliver the ball into the pin deck with anywhere from zero to 10 degrees of entry angle, at any offset from 0 inches (directly into the headpin) to 5.5 inches (very light hit). In short, it attacks the pocket from every angle a bowler could, and then some.

We can assess whether a product affects strike percentage by evaluating which shots in Bowlscore strike versus those that do not. In the following charts, we plot strike percentage by offset averaging all the entry angles together.

¹ [Bowlscore](#)



In our original testing, we saw offsets where strings struck more, and offsets where they struck less. Cumulatively we saw approximately a 10% decrease in striking when going from free-fall to strings.



Applying the same analysis to the data from the new machines that meet the preliminary specifications, we still see a reduction in striking on the very high and low ends of the pocket. Overall, the data has moved closer to the behavior of our free-fall control set. The previous difference of 10.7% has been reduced to 7.1% -- a percentage difference of about 34% closer to free fall.

Due to Bowlscore being confined to one lane, it is important for us to also evaluate strikes with E.A.R.L.² to ensure there are no left-to-right lane differences with the new machines. Previously, we saw asymmetric kickback thickness and string lengths between lanes on a single pair. Implementing a uniform wall thickness and string length requirement resulted in both lanes on the pair scoring the same in strike testing with E.A.R.L.

Lane 17 X%	Lane 18 X%	Difference
45.1%	44.9%	-0.2%

We observed a difference between lanes of 0.2% which is smaller than the minimum detectable difference in our testing.

Split Conversions

In the first phase of testing, we saw that corner pins that did not have enough string length tended to bounce out of the pit more than normal. We saw the distance the pin can travel before the string gets tight could easily allow a rebound out of the pit. A ball would strike the pins and the pins would ricochet off another boundary in the pit and swing into the remaining pins.

A combination of preliminary specifications on the string length, pin curtain distance and ball cushion distance was designed to eliminate this phenomenon. And this was mostly accomplished.

One of the new machines tested was designed with a change in material for the hanging pin curtain. This lighter-weight curtain did not take enough energy away from the pins and still allowed for more rebounds. However, while the machines were still in testing the manufacturer supplied a new pin curtain material that prevented all rebounds. This was useful learning.

Pinsetter	2-7-8-10	4-6-7-10
Type	Conversions	Conversions
Free-Fall	0 / 90	0 / 90
String Pin	0 / 90	0 / 90

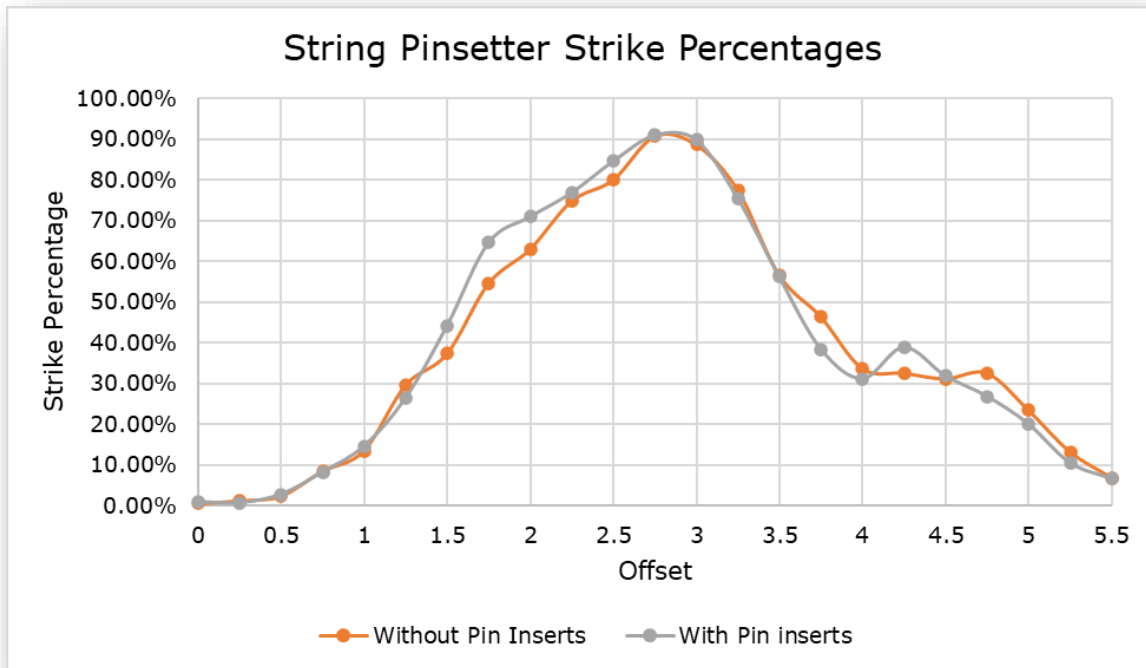
The observation that pins can still rebound quite often when the preliminary specifications were met confirmed there will need to be a test of pin rebounds at the approval state of these products to ensure their pin curtains are adequate.

Pin Specifications

During the first phase of tests, it was discovered that drilling the holes in the pins that are needed to attach the pin to a string were causing the pins' radius of gyration (RG) to go out of specification. To combat this, the manufacturers designed inserts that are either attached to the pin or the string to add mass back to the pin near the location of the drilled holes. The manufacturers were able to supply many designs that returned the pins to within specification.

Pins were tested with and without the pin inserts to evaluate their effectiveness in altering the pin performance.

² [E.A.R.L.](#)



The results showed that bowling with or without the pin inserts resulted in little to no change in the pin performance. Additionally, some of the metal inserts wore down on the strings to the point that the strings would break during testing.

With data that supports that the pin inserts have no effect on the flight of the pins, there is no reason to mandate the use of inserts that introduce metal, additional costs and additional steps into these machines. Instead, it is more reasonable to allow the use of drilled pins without inserts provided:

- The diameter of the hole in the top of the pin does not exceed 9/32" (0.281").
- The hole that receives the knot does not exceed 11/16" (0.687").
- Hole depths do not continue past where they intersect with other holes.
- An extension of the side hole is allowed to come out the opposite side of the pin for a tool to be used to help install the string. The diameter of this hole must not exceed 9/32" (0.281").

These requirements are aligned with how string pins are already drilled.

NEW FINDINGS

During the initial phase of testing, we observed that the pins strings can tangle, causing play to stop until they can be untied and the pins reset. With no frame of reference (since we were working with these machines for the first time), these occurrences seemed to be happening at a tolerable rate and were not tracked.

After the machines were modified to meet the preliminary specifications, the tangle rate seemed much higher than in previous testing and therefore we began tracking it for each machine. Collectively we saw 237 tangles in 30,360 shots.

Shots	Tangles	Tangle Rate	Shots per Tangle
30,360	237	0.8%	128

At first glance, tangle rates of 1% may not appear relevant, but when viewed as 100 shots per tangle, it becomes meaningful. In a league session with four-bowler teams, if we give each bowler 11 frames per game, there are:

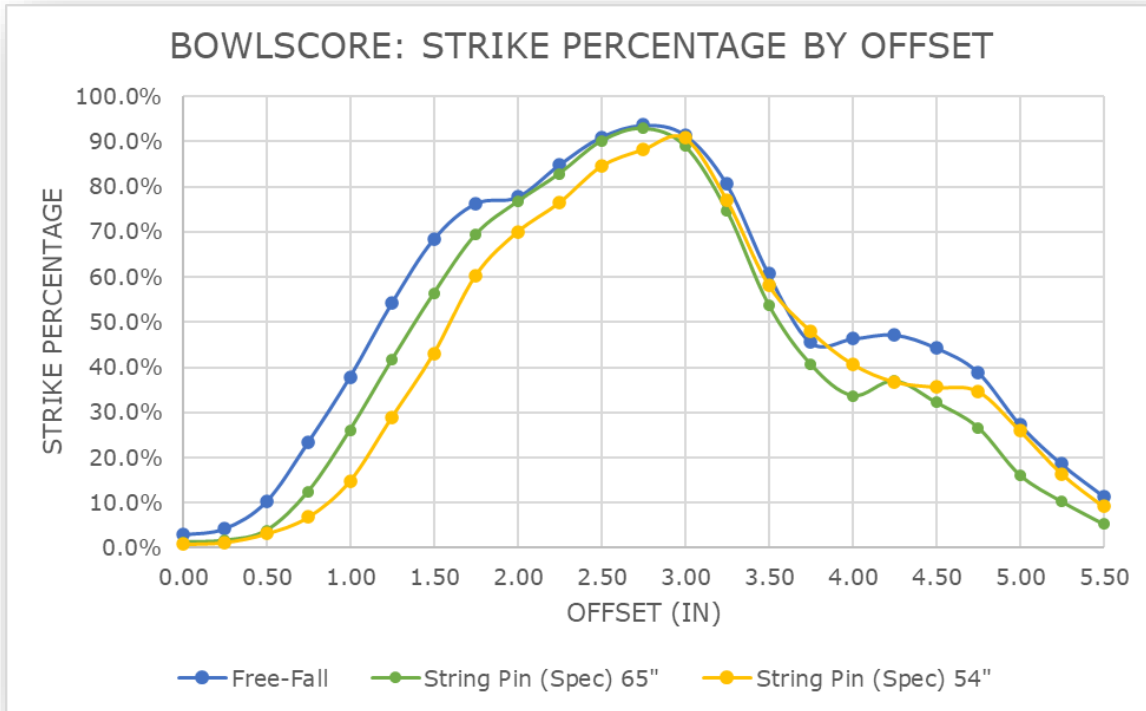
$$Frames = \left(\frac{4 \text{ bowlers}}{\text{team}}\right) \left(\frac{11 \text{ frames}}{\text{bowler game}}\right) \left(\frac{2 \text{ teams}}{\text{pair}}\right) \left(\frac{3 \text{ games}}{\text{session}}\right) = 264 \frac{\text{frames}}{(\text{pair})(\text{session})}$$

So, in a full 20-lane (10 pair) center, there would be approximately 2,640 frames per session. At a tangle rate of 1%, that is approximately 26 tangles per 3-game block. While tangles for the most part are a simple stop for a staff member to clear (typically untying a standard half-knot), this many tangle stops were a usability concern from the preliminary specs that was affecting all three pinsetters similarly.

Additional Research

The preliminary specifications were successful with regard to achieving scoring results closer to free-fall. However, we were concerned the tangle rate would be considered undesirable product performance.

USBC communicated the findings with the participating manufacturers to receive their input. The feedback moved the research towards looking at string lengths between what we originally saw – as short as (46" / 32.5") – to what was proposed 65". The manufacturers feedback suggested 54" was a desirable starting point, closer to the mid-point of 46" and 65". The goal is to conduct additional research in the hopes of identifying string length that would allow for lower tangle rates, while maintaining the scoring results closer to free fall achieved at 65".



We can see that shortening the strings from 65" to 54" in our Bowlscore testing minimally impacted the striking profile of the pinsetters. This was expected, as the first-ball cycle has typically been less affected by the string lengths than the second-ball cycle.

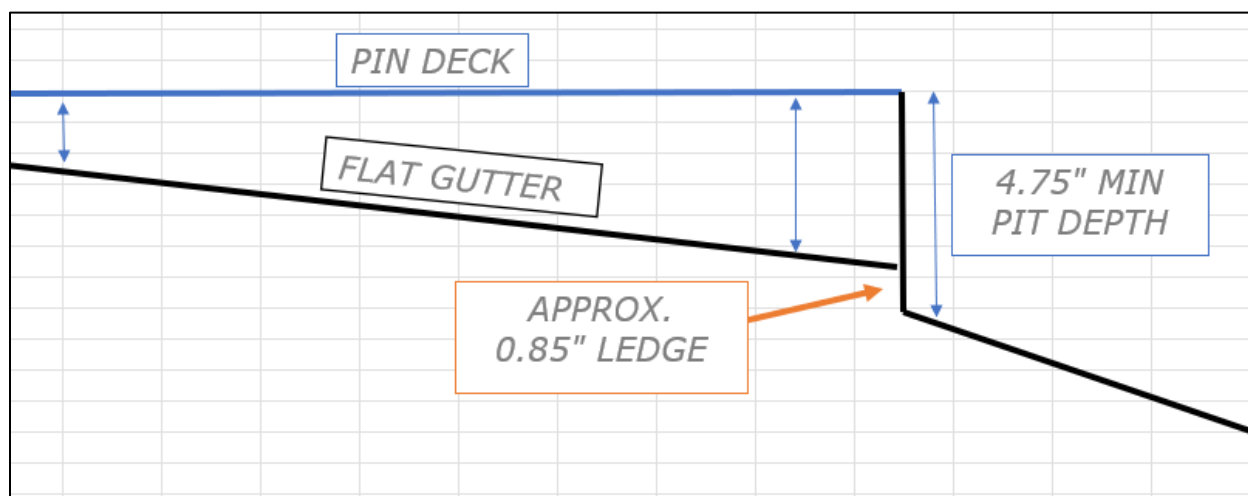
54" Split Testing

Pinsetter Type	2-7-8-10	4-6-7-10
	Conversions	Conversions
Free-Fall	0 / 90	0 / 90
String Pin	0 / 90	0 / 90

Split testing at 54" showed us a promising result. In our previous research, we saw conversion rates of the 7-10 split as high as 20%. But, in the retesting, we did not convert any. The key difference lies in ensuring the pin decks, flat gutters and pit floors meet specifications.

In the original tests, the machines were installed as originally designed prior to the proposed specifications. The pit floor of the machine in which we conducted our original experiment for string length versus split conversions, had a near-flush transition from the flat gutters to the pit floor. This allowed the strings to get tight and swing the 10-pin around, slide it up the 7-pin side flat gutter and the string would convert the 7-10 split.

Ensuring the flat gutters, pin decks and pit floors meet specifications causes there to be a natural ledge between the pit floor and the flat gutters that makes it more challenging for the pin to return up the flat gutter.



It is important to note that, during the retesting, we came exceptionally close to having the 10 pin return up the flat gutter on the 7-pin side. But, so far in our additional testing, we have not converted any challenging splits due to rebounds.

Tangles With 54"

Shots	Tangles	Tangle Rate	Shots per Tangle
27,770	50	0.2%	555.4

Reducing the string lengths to 54" greatly improved the tangle rate from roughly 100 shots per tangle to more than 550 shots per tangle on average.

Combining all of this together:

- Reducing the length had a negligible impact on the first-ball cycle results.
- Reducing the length did not result in challenging split conversions.
- Reducing the string length vastly reduced the observed tangle rate.

String Scoring Pace

Despite the improvements, the laboratory data still suggests that the strike percentage on string pin bowling will be 7.1% less than what we see in free-fall. Based on data collected so far this could result in average differences as large as 10 pins or more. USBC is going to continue the research into the scoring pace of String Pinsetters versus Free-Fall.

USBC estimates that by using a sample of 350 diverse bowlers bowling 4 games on each pinsetter type, we will be able to accurately determine if string pin bowling averages 3 or more pins different than free-fall bowling.

Testing will continue to evaluate scoring differences in advance of the 2023-24 season to make a final determination of whether averages need to be separated from free-fall, if there is a possible conversion, or if they can reasonably be considered the same.

SUMMARY

The USBC Equipment Specifications Committee has approved the final specifications based on the

research. The final specifications reduce the string length to a minimum limit of 54 inches. This length allows for improved scoring and split conversion rates compared to free-fall.

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