

Post Week 0 Fuel Counter Assessment

Purpose

FIRST staff used the official REBUILT™ presented by Haas Week 0 event in New Hampshire on February 21, 2026, to test a variety of field behaviors. This document describes the testing done specifically on the Fuel Counters in the Hubs. FIRST staff were looking specifically for the following:

- Physical jam conditions of Fuel getting stuck in the Hub, anywhere from the funnel to the exit of the counter.
- Differences in counts between a post-event count of video recordings and the FMS (Field Management System) count from the event.
- Timing of the Fuel going through the system, from entering the funnel to the exit of the counter.

Methodology

For all of the tests, two cameras were set up off the field by the scoring table, one pointing at each Hub so that the funnel and exit could both be seen in one camera view. These cameras recorded every match from Week 0, which was 31 total matches. These videos were used to manually count all of the Fuel after the event, as well as to perform a time study with specially marked Fuel.

28 Fuel were marked with a variety of different colors and patterns using permanent markers. These markings allowed for a single Fuel to be followed while scored among other Fuel in a large group, when watching the videos back frame by frame. This was done to be able to observe how long an individual Fuel took to move through the entire Hub scoring system.

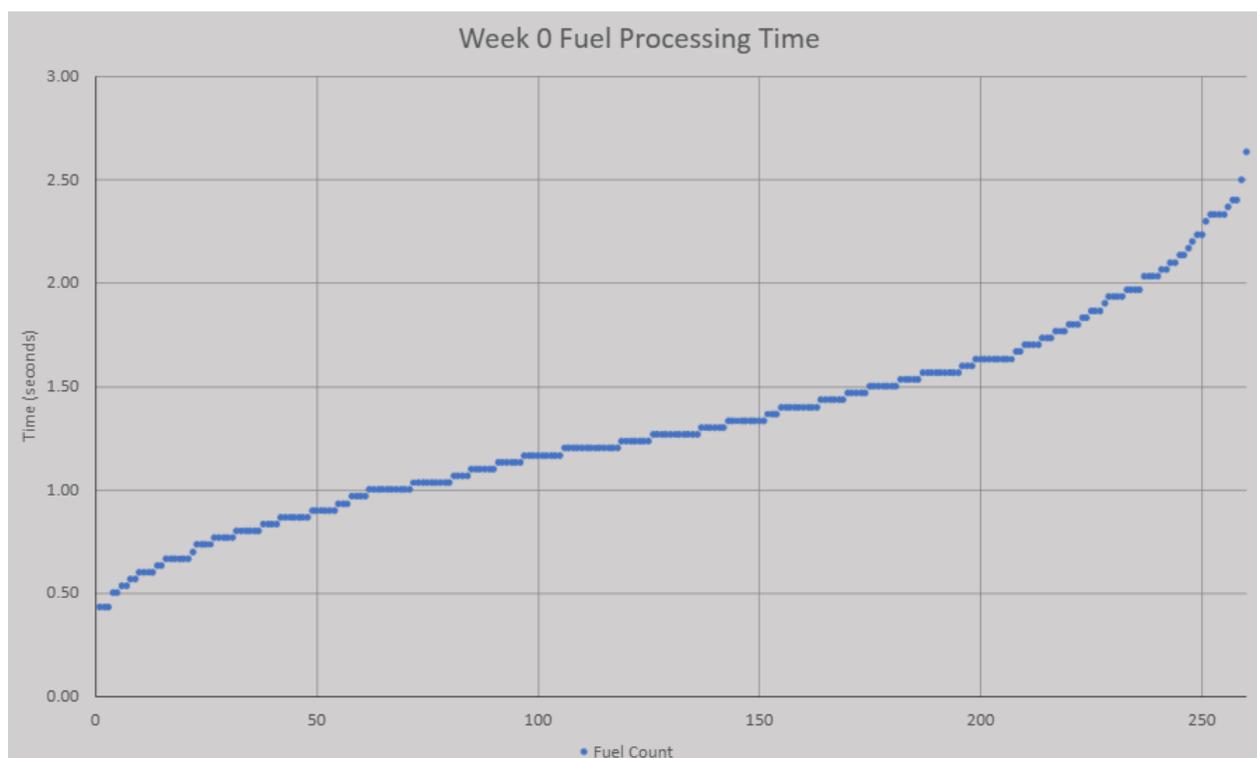
The automated counting system logged its total overall counts per Hub, and its total counts per lane per Hub every second. This data was used along with the video footage above to confirm every Fuel counted at Week 0.

Results

After 31 matches of REBUILT at Week 0, 6,741 Fuel were processed through the two Hubs, and the following positive results were noted:

- No Fuel got physically stuck or jammed between the funnel and the counter exit during match play
- All Fuel scored during the match were counted by the sensors in the Hub Counters during the assessment periods.
- All marked Fuel were processed in less than 3 seconds from when they entered the funnel until they were counted by the Fuel Counter, with an average processing time of 1.32 seconds (see Figure 1).

Figure 1: Week 0 Fuel Processing Time



There were a few notable issues from these tests:

1. Before Qualification Match 8, a count of 1 was found in one of the Hubs before the match started. This was caught by Field Staff and fixed before the match started.
2. At the end of Playoff Match 12, a single Fuel did not process through the Fuel Counter before it turned off 3 seconds after the match. This went unnoticed during the event, and that Fuel was immediately processed and counted at the beginning of Playoff Match 13.
3. There were 5 instances at Week 0 where Fuel was counted twice in the Hub (0.074% of Fuel scored). (see [this gif](#))

Conclusions

Overall, the results from Week 0 confirmed to *FIRST* staff that the Fuel Counters are generally behaving as expected. Every Fuel that was observed as scored within the match was processed within 3 seconds, and every Fuel was counted by the sensors. Every Fuel being processed within 3 seconds means that there will be no changes to the length of the post-shift and post-match assessment periods. Changes to address notable issues are outlined below:

Issue 1: Pre-match Fuel count

- **Cause:** This was caused by a hand from a volunteer triggering a sensor before Qualification Match 8 while checking something else in the Hub.
- **Mitigation:** This was an oversight in the software controlling the counting sensors. This has been fixed to prevent this issue at future events.

Issue 2: Single Unprocessed Fuel

- **Cause:** This was caused by a Fuel entering the Funnel after the buzzer and not having enough time to process within the 3 second post-match assessment period after the previous match. This caused the Fuel to process during the next Match immediately when the motors turned on.
- **Mitigation:** The solution we have implemented is to run the Hub motors for a few extra seconds after the post-match assessment period ends to clear all Fuel. Note that while the motors will run a few extra seconds, the scoring assessment period will not change, as extending it would allow Fuel thrown after the buzzer by Human Players to be counted.

Issue 3: Double counted Fuel

- **Cause:** *FIRST* Staff is confident that this was caused by Fuel briefly slowing down in the outer most exit paths of the Hub. This was observed to be happening in the outer exits only due to the outer exits having a deflector plate, which causes some Fuel to bounce around between the deflector plates and the frame of the Hub. These Fuel that were briefly stuck have already been counted correctly by the sensor, but their presence caused Fuel behind them to also slow down and sometimes bounce back through the sensor's path a second time causing a miscount
- **Mitigation:** After testing multiple options, the solution implemented is to remove the deflector plates from the outer exit paths of the Hub. More details are outlined below.

While double counts of Fuel only happened a few times, *FIRST* engineering team's goal is to count the Fuel as accurately as possible. There is also concern that this would become a more common issue as more Fuel are scored in shorter amounts of time as we get into higher levels of REBUILT match play.

FIRST staff does not take changing the field design, game dynamics, or rules lightly and investigated several solutions. After testing multiple options, removing the deflector plates proved to be the solution that best balanced solving the counting issue, while being plausible to implement at all events. These deflector plates were designed to ensure increase the width of Fuel dispersion across the Neutral Zone. [Testing on our test field after Week 0 shows that the change in spread from removing the deflectors is minimal](#), especially when other Fuel are already on the floor in the neutral zone.

Between these tests and watching the Week 0 match videos, *FIRST* staff feel confident that removing the deflector plates will be a minimal change to the match experience for teams, while ensuring the counters are giving accurate results. This change will be fully implemented in Team Update 15 on March 3rd and will be in place for our first official event in Istanbul, Türkiye.