

## CONSIDER the WIGGLE-FACTOR

Over the past several years, I have been asked to do an ASTM F-2291 “Patron Containment Analysis” for ride manufacturers and for Authorities Having Jurisdiction. Recently I was doing a containment analysis for a ride that had a specially modified shoulder restraint system that was supposed to fit a patron with a minimum height of 44 inches.

Based on my analysis it appeared that a youth with a height of 44 inches (5 ½ years old) was too young for the dynamic forces on this ride no matter what restraint design was applied. The minimum height of a patron, accompanied by a “responsible companion” was set to 48 inches and the unaccompanied height was set at 52 inches. Not being satisfied by the theoretical calculations I asked if we could find a typical 48 inch patron so we could actually test the restraint system.

The owner of the ride manufacturing company went to the local school and asked parents waiting for their children to come out of school if they would participate in the experiment. The idea was to have the child sit in the seat and then try to get out without any motion from the ride. I was happy that the volunteer was just a bit short of 48 inches and was actually 7 years old. Our volunteer had a younger brother who was 39 inches tall who was also at our test.

The young girl who was our primary test subject was asked to try every way she could think of to get out of the modified restraint system.



No matter which way she turned and wiggled she could not get out. The shoulder restraint-to-seat horn gap was less than  $\frac{3}{4}$  inch. The spread of the shoulder restraint prevented escape between the side of the seat and the restraint. Her legs were contained by the red added horizontal bar at the bottom of the restraint.

Little brother (39 inches) was eager to do the same test as his big sister. We agreed to give him an opportunity to be a volunteer. With the modified shoulder restraint he was unable to twist or wiggle out of the restraint system. The ultimate test came when we removed the restraint modification. The following pictures show an interesting event.



With the added red horizontal restraint bar removed, our 39 inch volunteer proudly did his escape act using the following sequence of events:

TUCKED HIS FEET UNDER HIS BOTTOM

STOOD UP

PUT HIS SHOULDERS THROUGH THE UPPER PART OF THE RESTRAINT

STEPPED OUT

What was more amazing about this escape is that was totally un-coached or even suggested. It was almost a natural response when we asked our young volunteer to try to get out of the restraint.

To me this was even more of a surprise. I had investigated a ride accident where a child was alleged to have come out of a restraint and fell out of the ride. During the investigation, we also conducted a test of the restraint system. In that case, the volunteer was the same age and height as the child involved in the accident.

With the shoulder restraint at the most open but safely locked and the secondary restraint down and locked, we asked our young volunteer to try and get out of the restraint. No matter how hard he tried to slide out from under the restraint he could not. We then asked him to try and get out any way he could. He paused for a few minutes and then got a sly smile on his face. He kicked off his shoes and: - -

TUCKED HIS FEET UNDER HIS BOTTOM

STOOD UP

PUT HIS SHOULDERS THROUGH THE UPPER PART OF THE RESTRAINT

STEPPED OUT

The startling similarity of a natural response to the “try to get out of the restraint” request is amazing. I now have to take into consideration the “Wiggle-Factor” when I do a patron containment analysis. I am now incorporating testing of a containment system as part of my containment analysis. I think more ride designers and inspectors need to know about and take into consideration the “Wiggle-Factor”.

I would be most interested in finding out if anyone else has observed similar escape behavior with children on amusement rides.

AS an aside, I have recently filed a patent application for a locking restraint system for amusement rides that adds an extra measure of containment for patrons on “Family” rides where there is a combination of patron sizes and shapes. The new locking restraint system will fit the smallest rider as well as the 95<sup>th</sup> percentile rider.

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