Flexpoint Sensor Systems Pedestrian Impact Detection (PID) Sensor

Environmental Chamber and Impact Testing Results

Report Number 88-9-078

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FLEXPOINT
flexible sensor systems

Section 1 - Introduction

Impact and Environmental Testing Evaluation Results
Flexpoint Bend Sensor® Pedestrian Impact Detection (PID) Sensor

Iteration 1 – 5 Pin, 4 Segment Construction Only

Test Report # 88-9-078

We are pleased to provide the following report on the performance of the Bend Sensor® PID sensors through environmental and impact testing. The purpose of this testing is to narrow down the large number of construction possibilities to one or two design types so we can proceed with further confirmation testing. It was decided to begin with the 5 Pin, 4 Segment design. This design was then tested using Polyester overlaminate (PEOL) and Polyimide overlaminate (PIOL).

Section 2 – Impact Testing

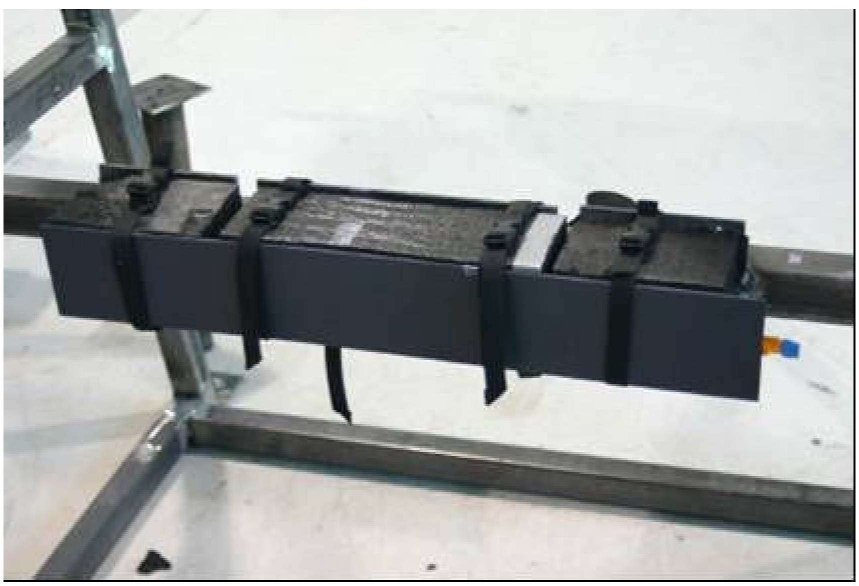
Test Set-Up: (see pictures below)

- **Leg Form.** The leg form was constructed following the EEVC guidelines as described on page 68. (European Enhanced Vehicle-safety Committee, Working Group 17 dated December 1998 with September 2002 updates). The leg was constructed only from the knee joint down.
- **Steel Post.** The steel post was constructed using the same 70mm diameter tube and weighted to be equal with the leg form.
- **Bumper Block.** The bumper block is an EPP foam with a density of 1.9 pounds per cubic foot.
- **Fuβball/Soccer Ball.** For these impacts a standard inflatable #5 soccer ball was used.
- **Bumper Fascia.** The fascia is 0.125" (3mm) thick ABS plastic.
- **Pendulum.** The pendulum is a steel "A" frame construction with an arm length of 127" from the pivot to the impact zone of the bumper. Based on potential versus kinetic energy equations this gives us the possibility of a 40 km/h collision. Our current tests are conducted at approximately 25 km/h and 40 km/h.
- **Membrane switch.** In order to determine the reaction time of the Bend Sensor® a membrane switch was attached to the front fascia to trigger the moment the post touched the bumper. Using two channels on the oscilloscope one monitored the switch and the other channel monitored the Bend Sensor®. The time interval was then observed.
- **The Bend Sensor®.** Electrically the sensor has 4 discreet elements.
- **Voltage divider for sensor measurement.** The test circuit is a voltage divider with the Bend Sensor® and a resistor connected to 5VDC. An increase in sensor resistance is reflected in an increased sensor voltage up to the limit of 5VDC.

Leg Form

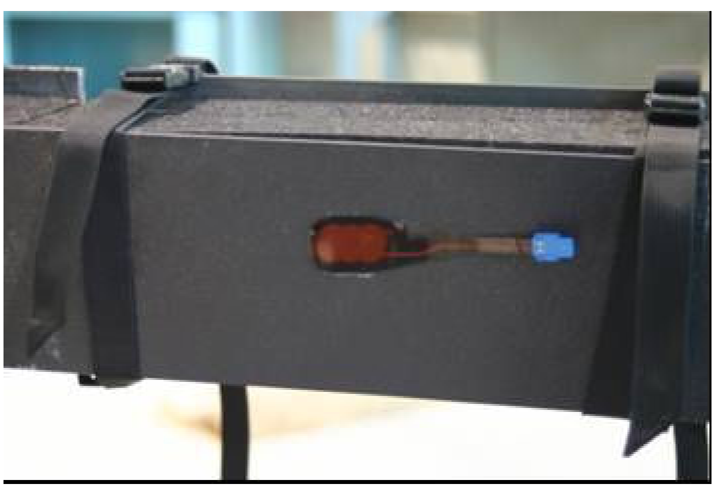
Steel Post

Bumper Block



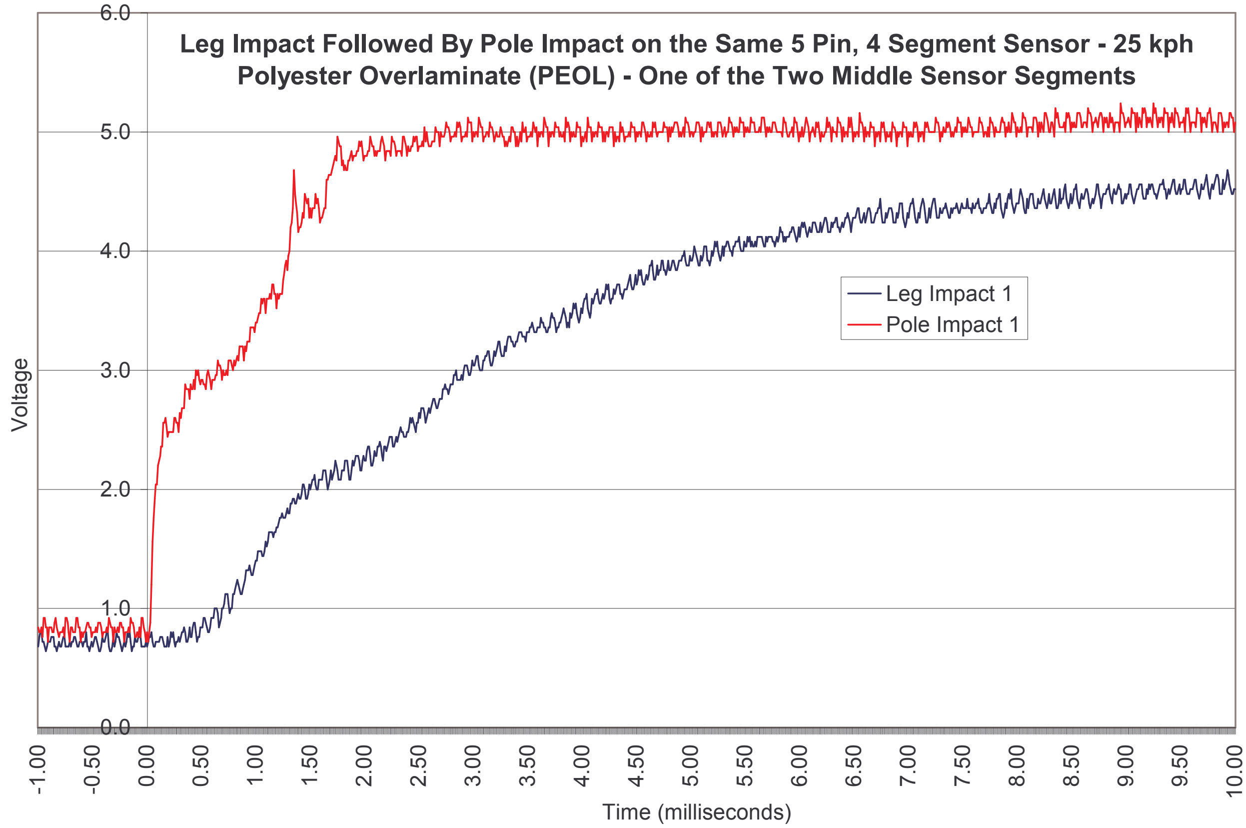
Bumper fascia with Bend Sensor® mounted to the reverse side

Pendulum as described. Overall height of approximately 13 feet



Membrane switch attached to the bumper fascia, and located directly in the contact zone of the steel post

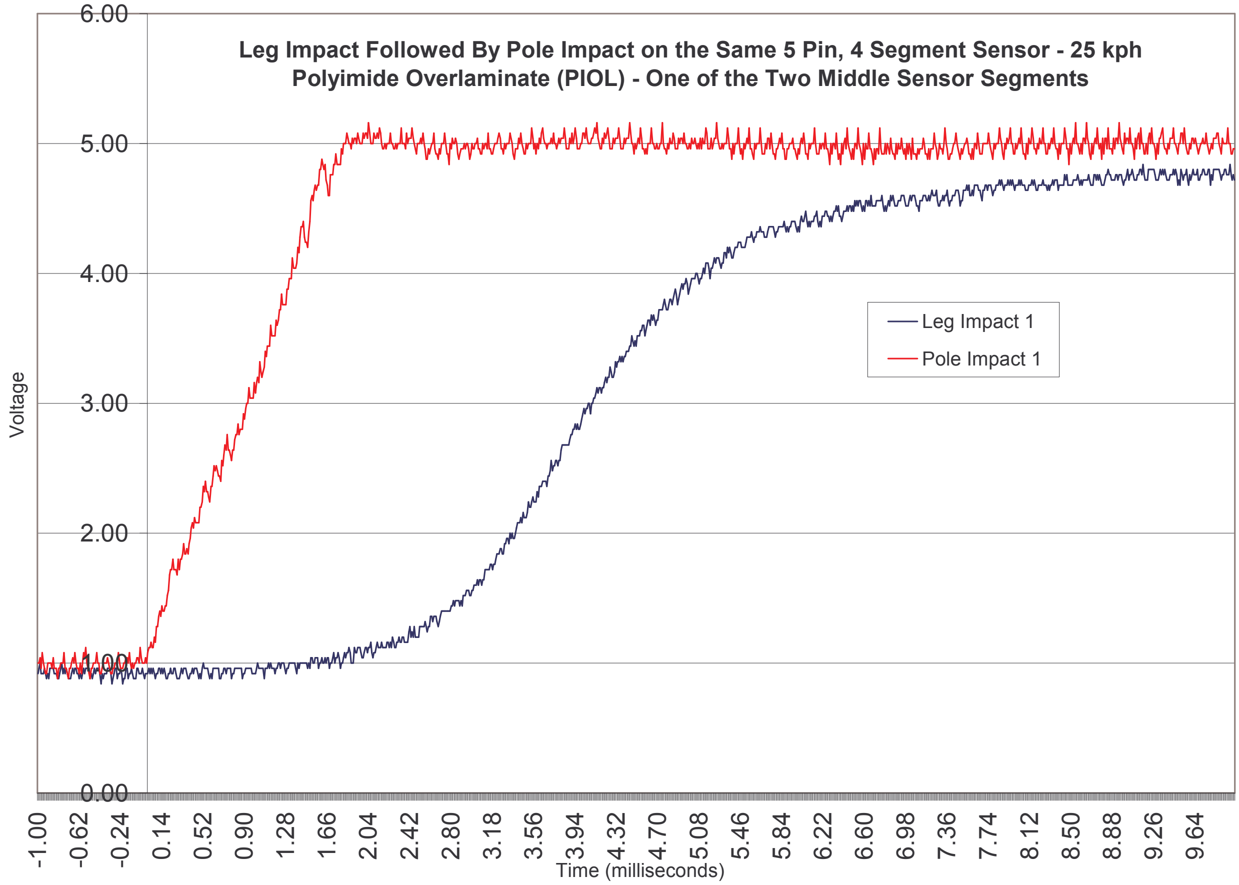
Leg Impact Followed By Pole Impact – PEOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact.

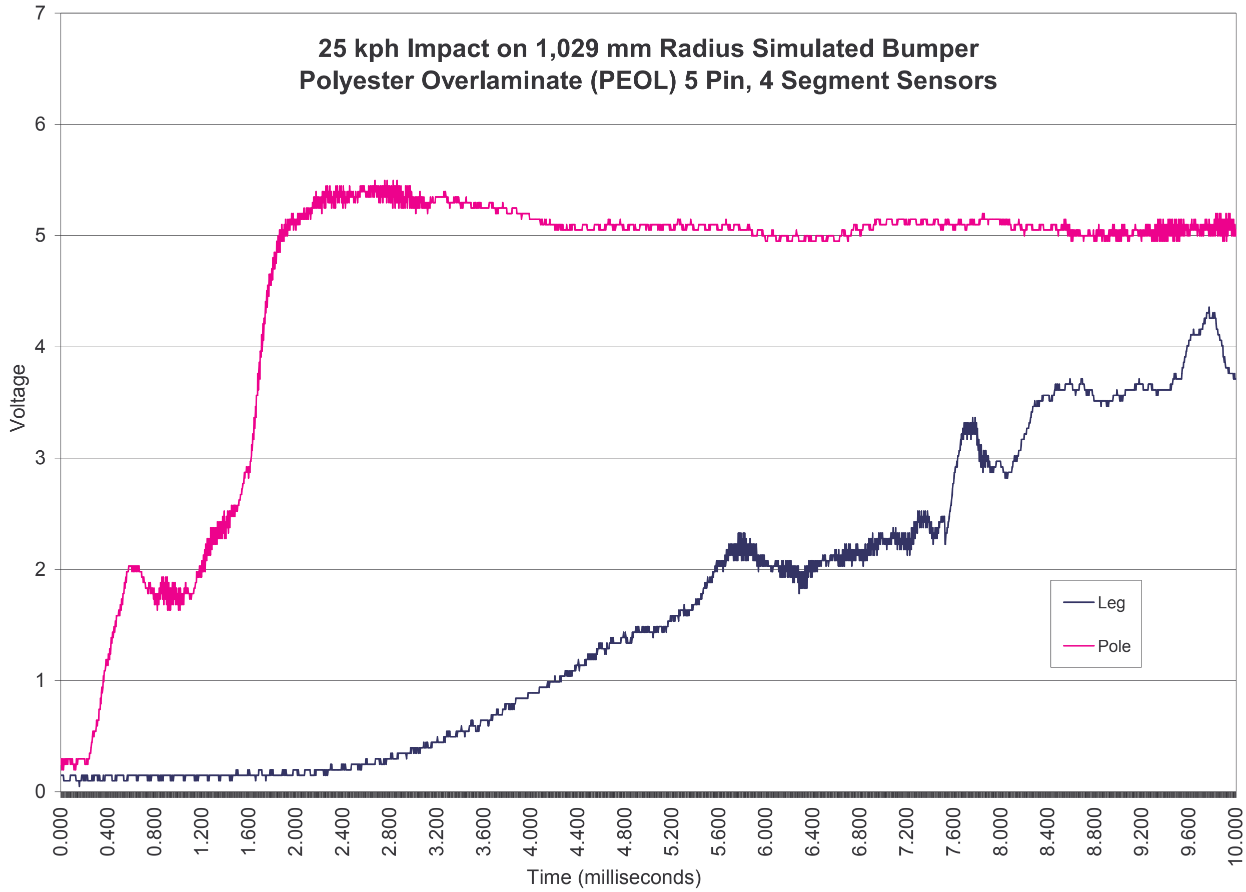
Leg Impact Followed By Pole Impact – PIOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact.

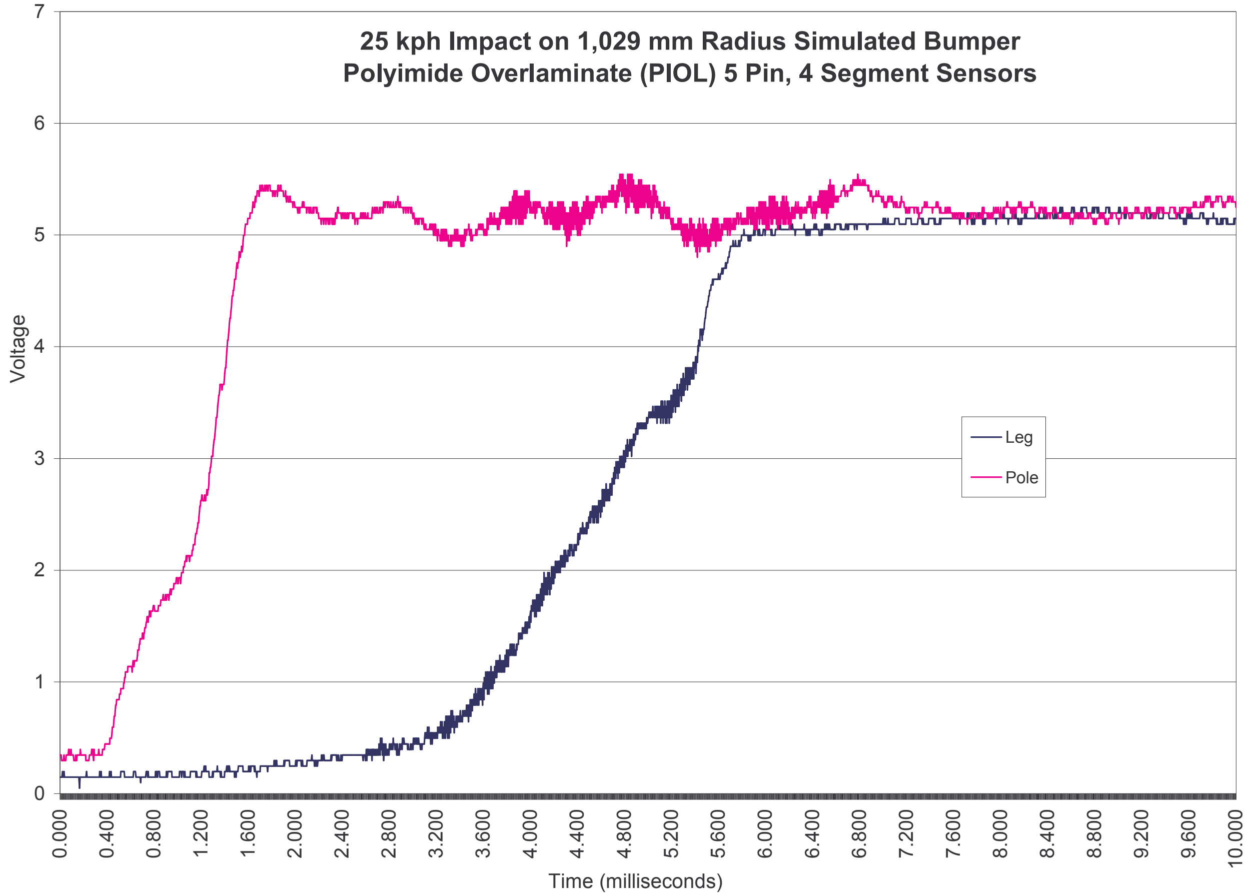
Impact on Larger Radius (1,029 mm) – PEOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact. The difference can be seen on a flat surface or on this radiused surface.

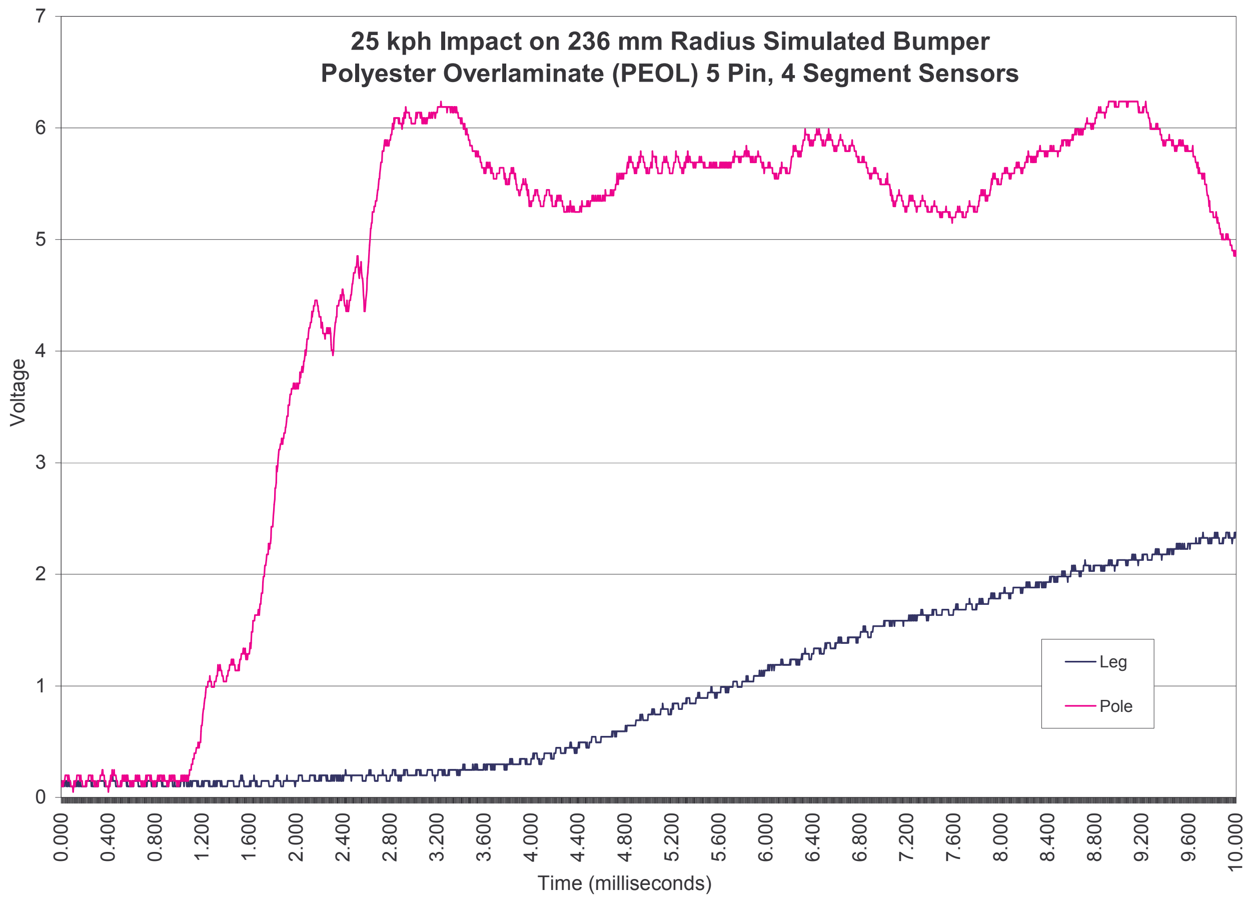
Impact on Larger Radius (1,029 mm) – PIOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact. The difference can be seen on a flat surface or on this radiused surface.

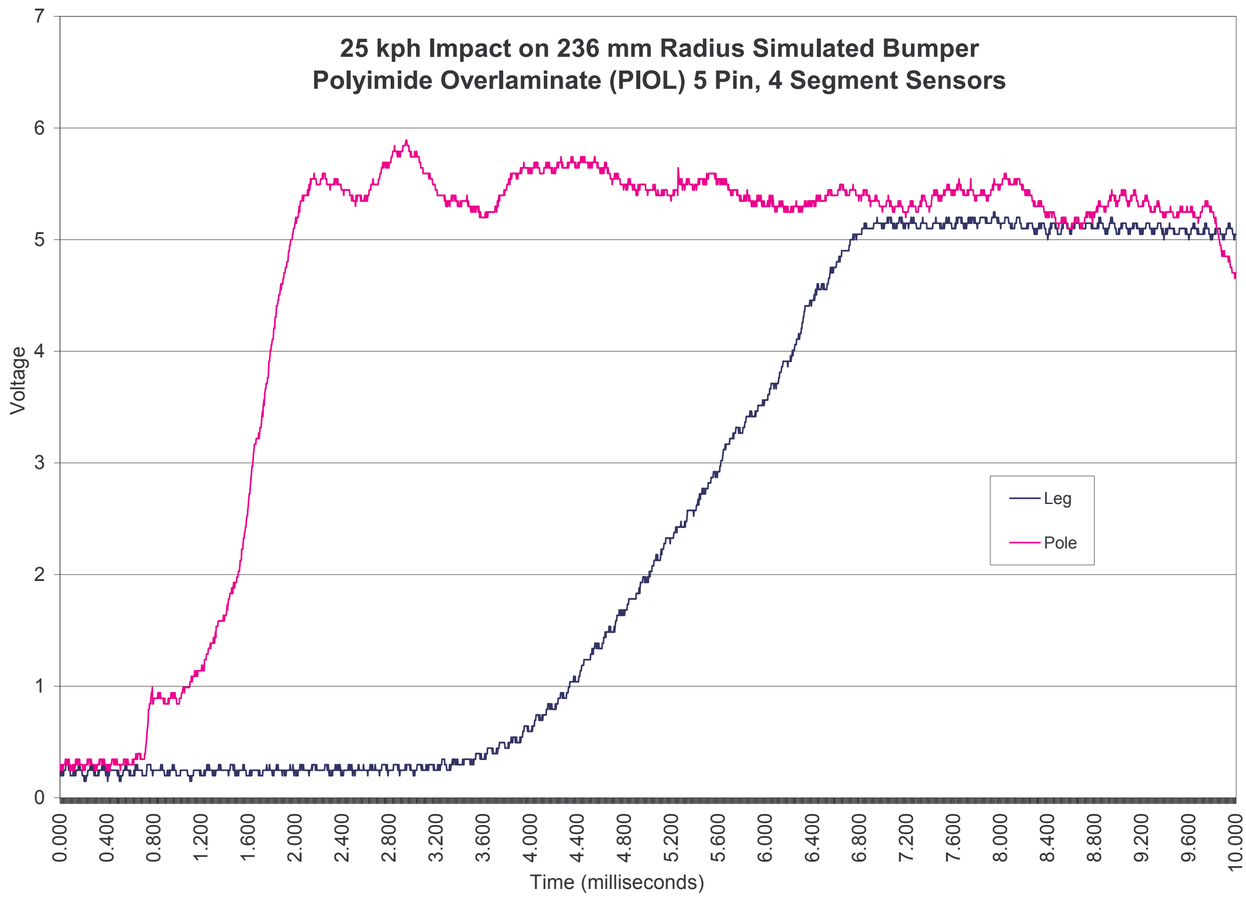
Impact on Tighter Radius (236 mm) – PEOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact. The difference can be seen on a flat surface or on this radiused surface.

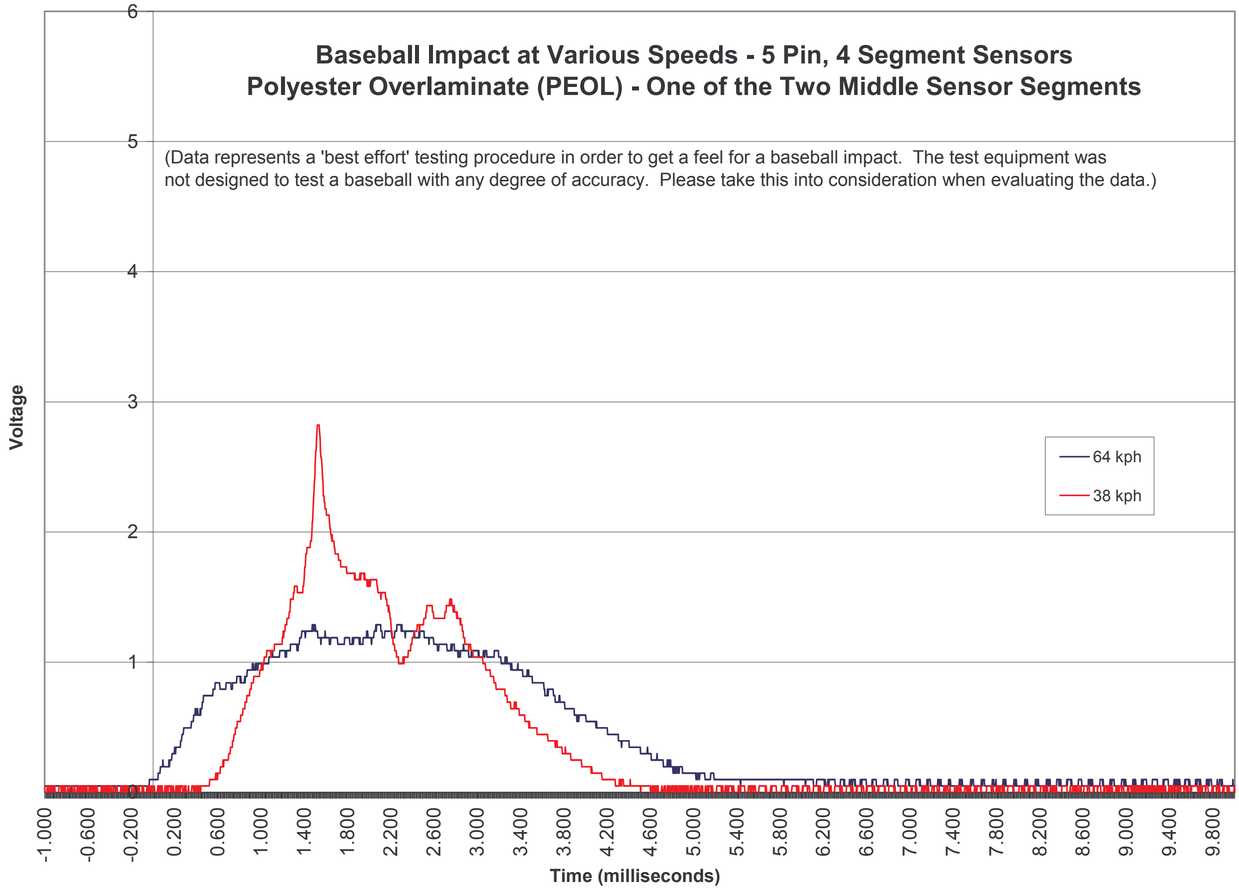
Impact on Tighter Radius (236 mm) – PIOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish the pole impact from the leg impact. The difference can be seen on a flat surface or on this radiused surface.

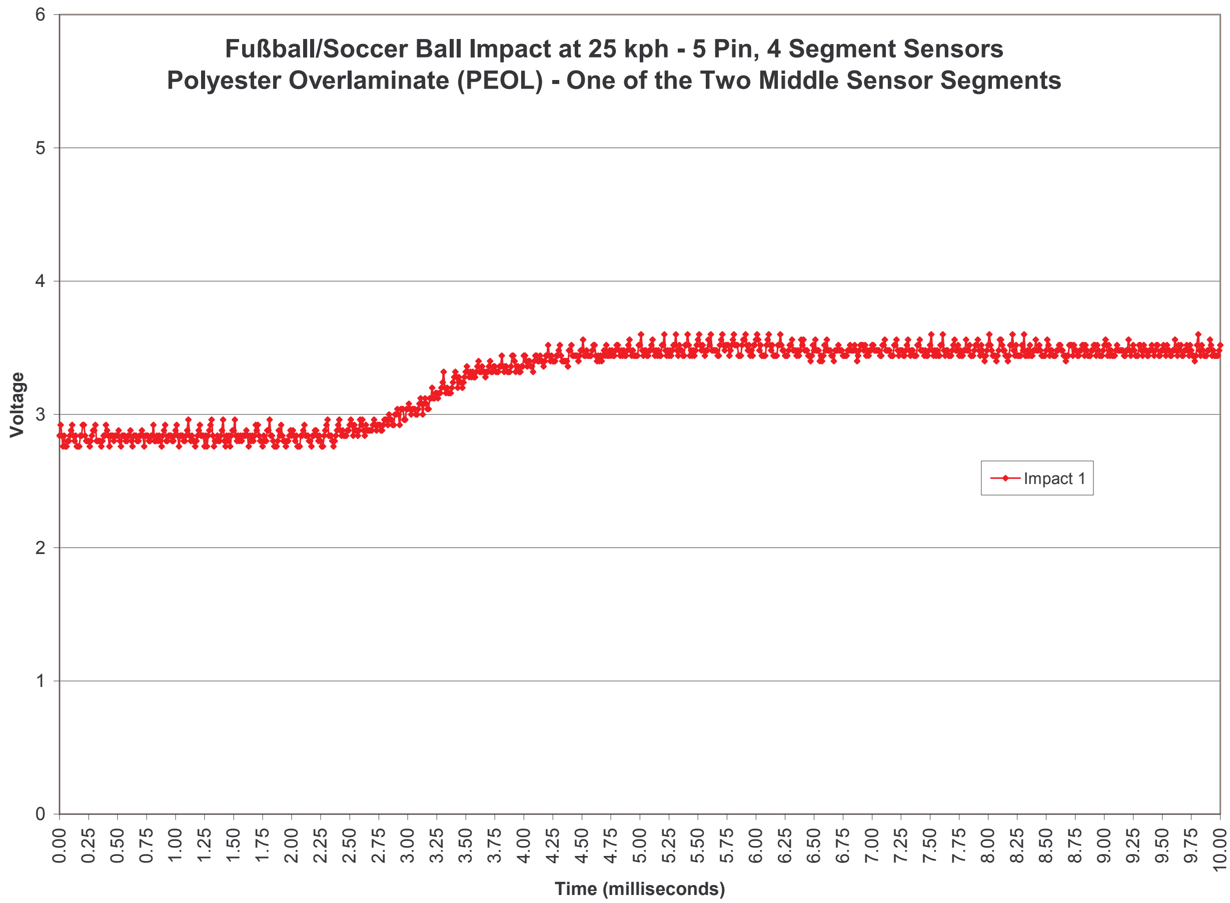
Baseball Impact – PEOL:



Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish a baseball impact from a leg or pole impact.

Futbol/Soccer Ball Impact – PEOL:

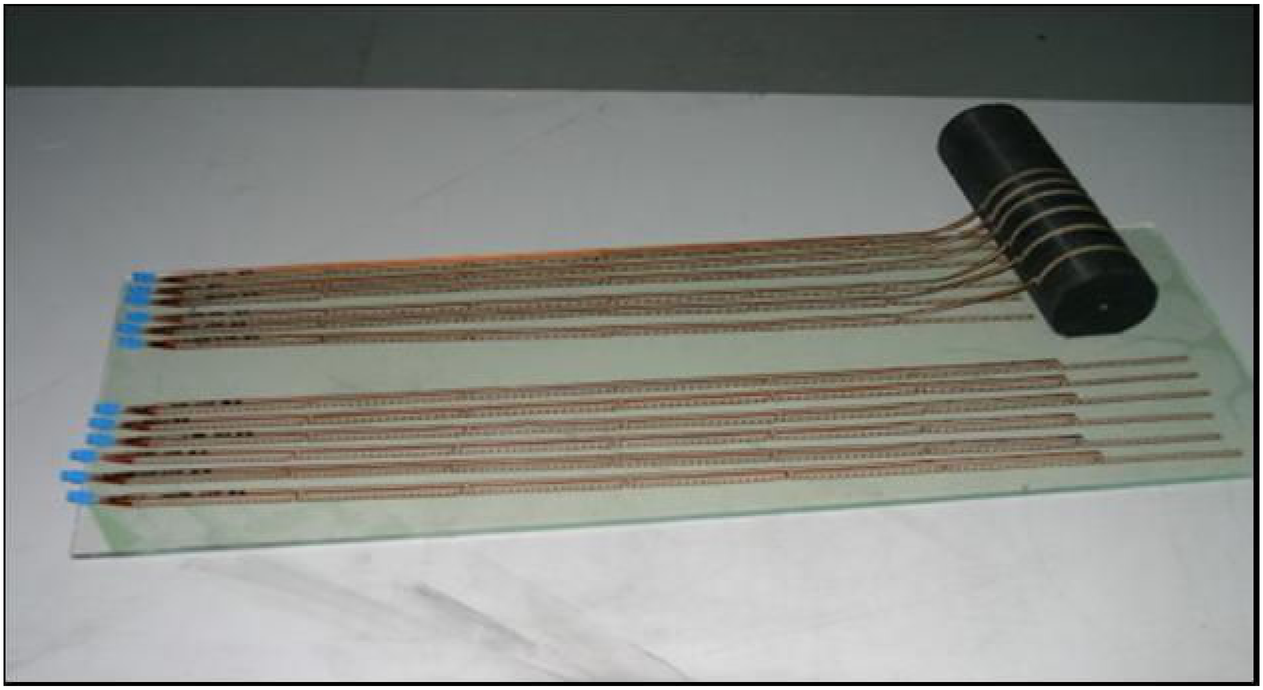


Conclusions:

The rate-of-change and the amount of change during the first few milliseconds after impact clearly distinguish a basketball impact from a leg or pole impact.

Section 3 – Environmental Testing

Test Set-Up: The 5 pin, 4 segment sensors were adhered to a plastic sheet. Each construction was tested in both a flat and bent configuration (see photo below).



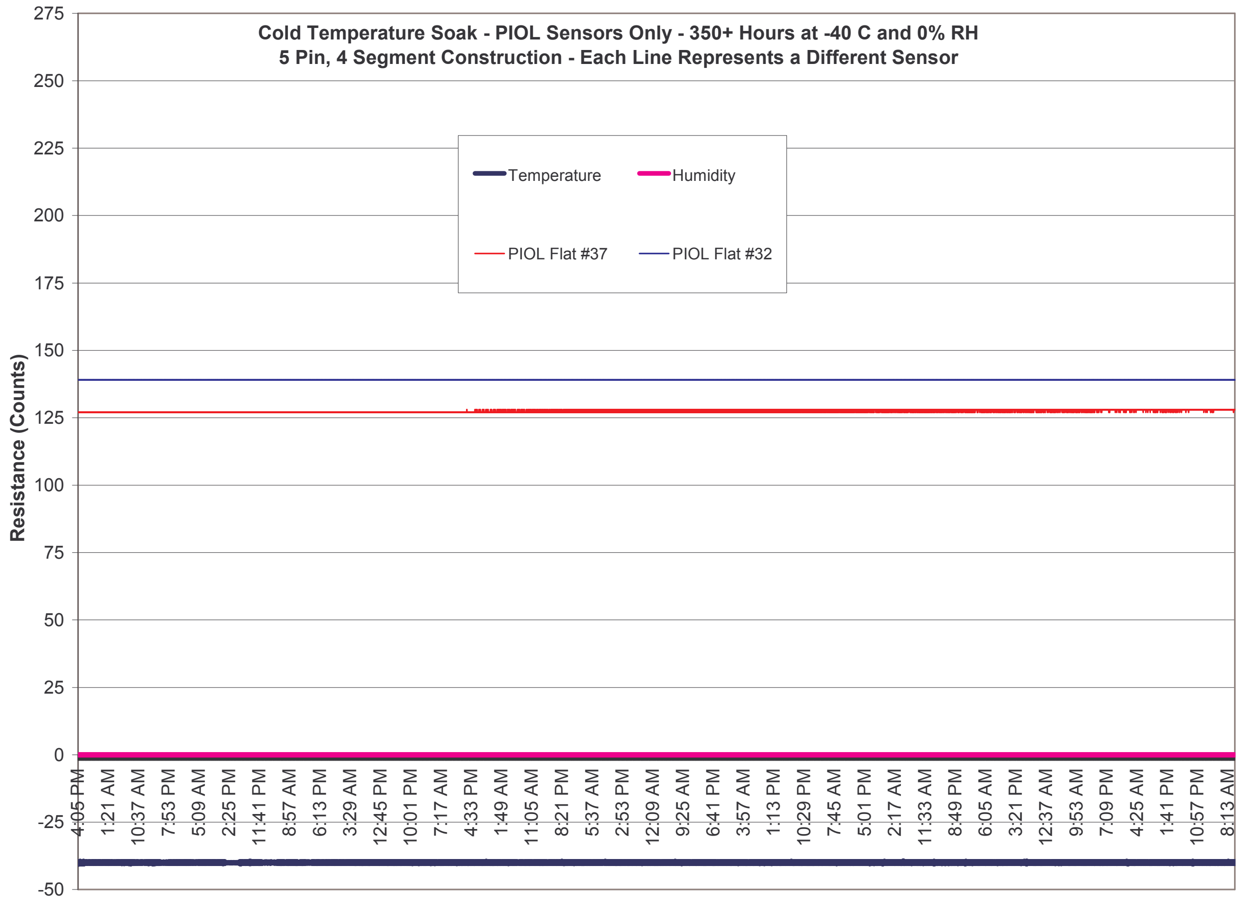
Each construction type described in the introduction was tested with two sensors in the flat position. Therefore, the graphs represent 2 completely 'different' sensors.

The sensors were constantly being measured and a recording of the sensor count values took place once per minute during the time of the test. The same type of recording of data took place for the chamber temperature and humidity values. These files were both date and time stamped, allowing the files to be merged at the conclusion of each test.

The following tests were completed for each construction:

- High Temperature Soak: 95 C and 0% RH (minimum of 100 hours)
- Cold Temperature Soak: -40 C and 0% RH (minimum of 100 hours)
- Humidity Soak: 23 C and 85% RH (minimum of 100 hours)

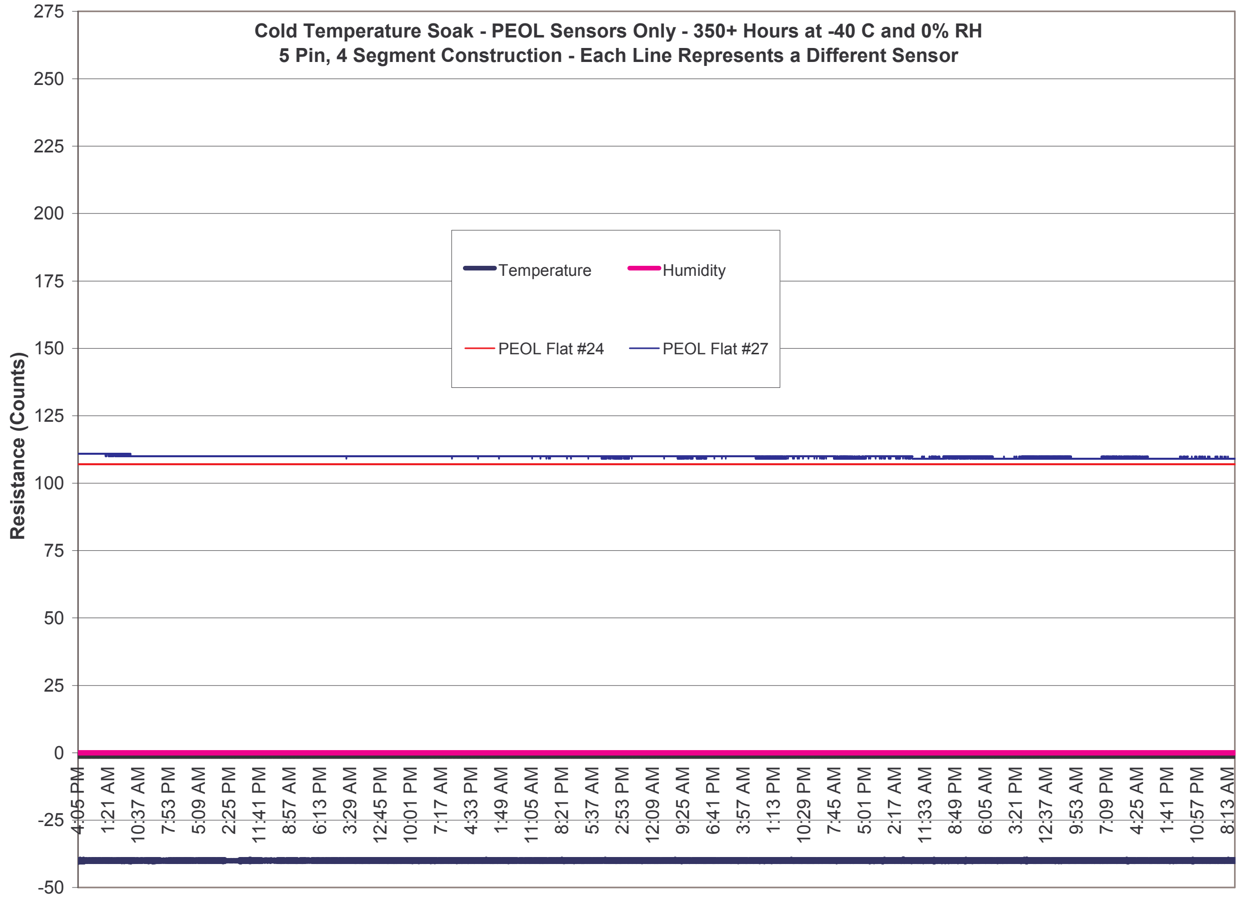
Cold Temperature Soak – PIOL:



Conclusions:

The count values stabilize during Cold Temperature Soak, regardless of construction type.

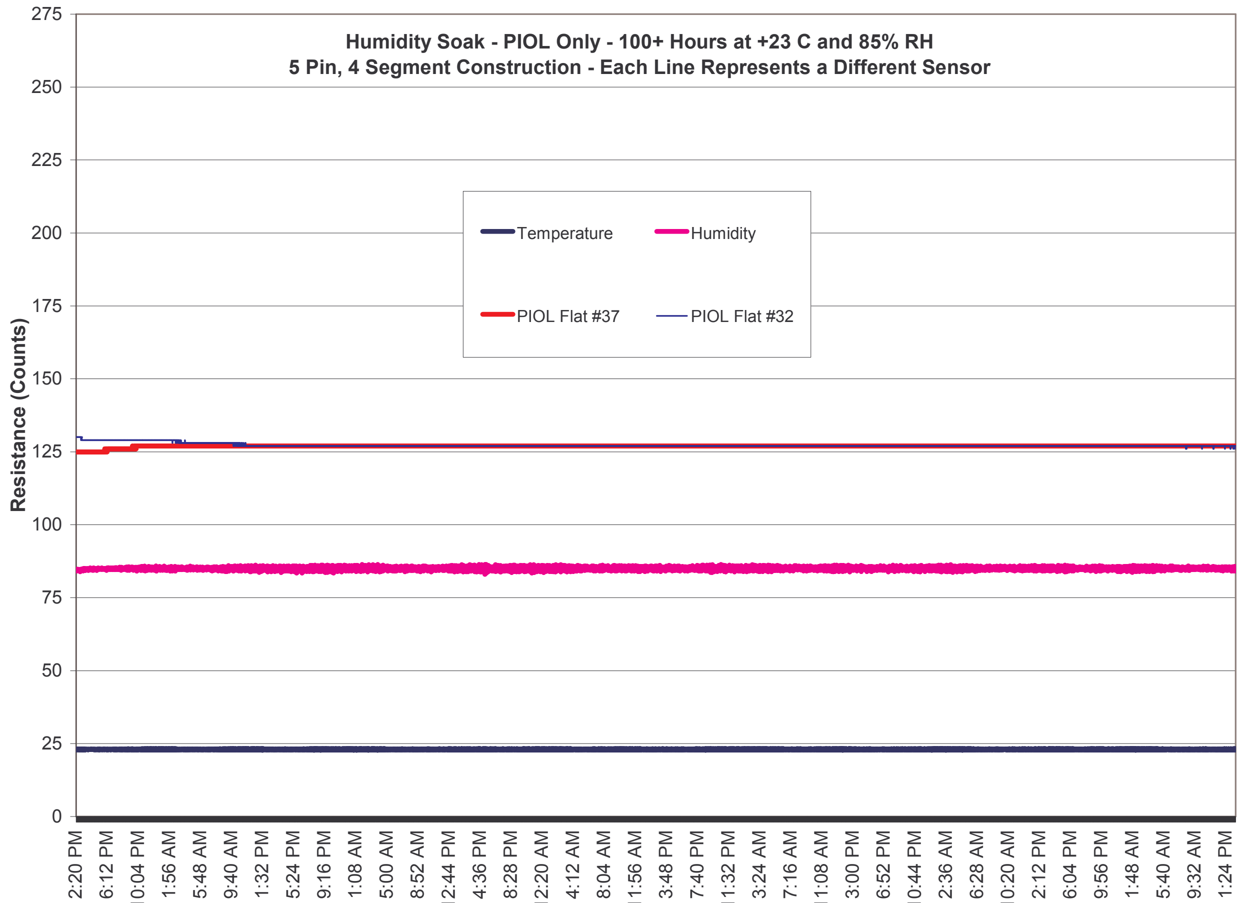
Cold Temperature Soak – PEOL:



Conclusions:

The count values stabilize during Cold Temperature Soak, regardless of construction type.

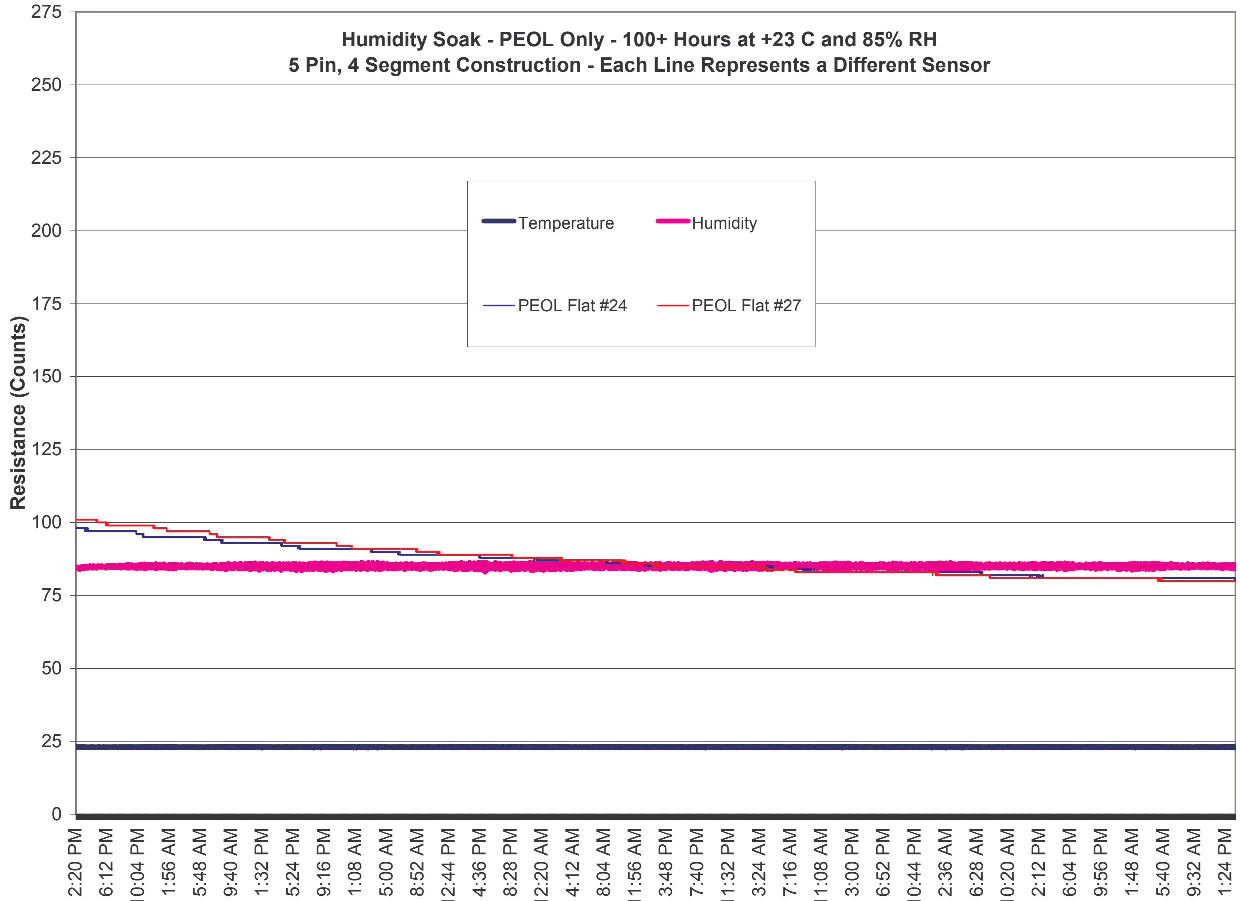
Humidity Soak – PIOL:



Conclusions:

The count values stabilize during Humidity Soak Testing.

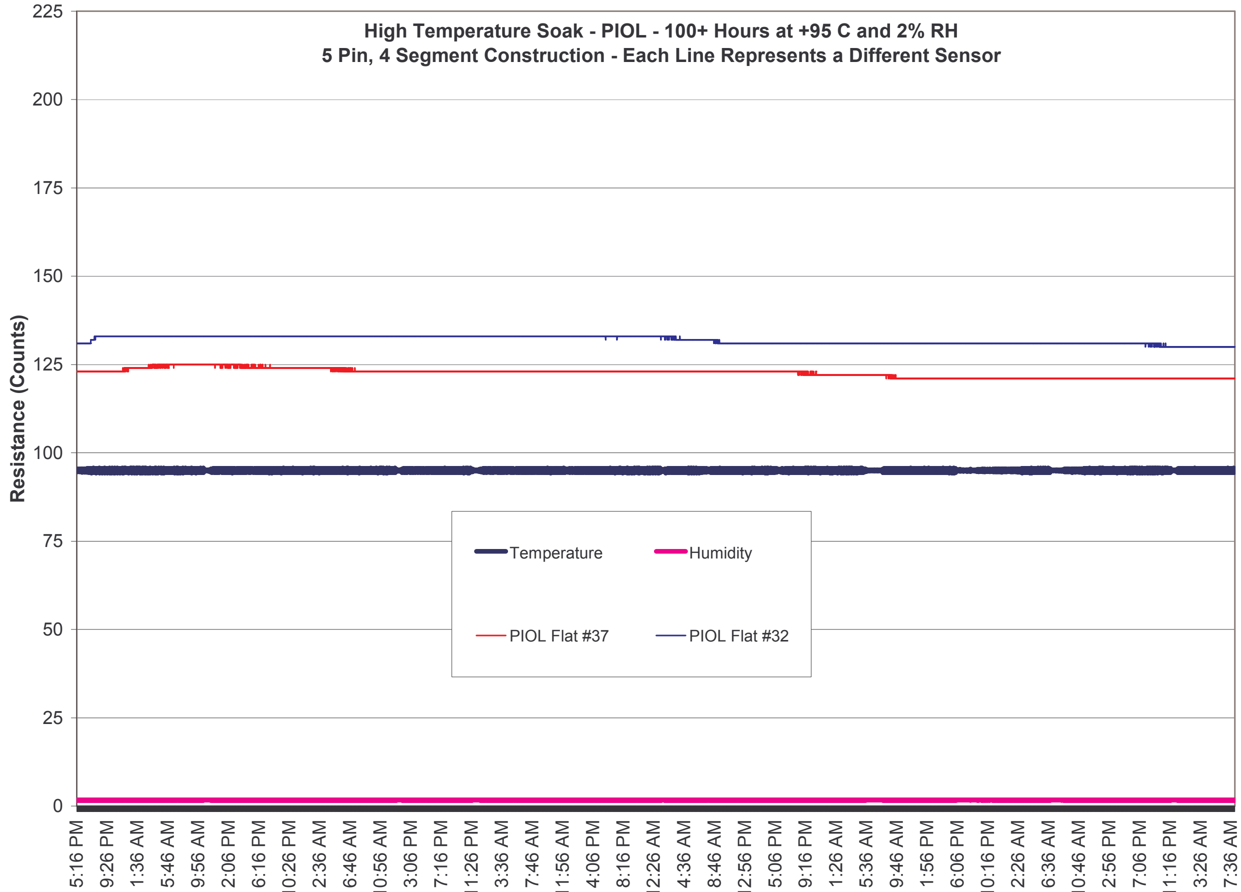
Humidity Soak – PEOL:



Conclusions:

There is a slight drop in the count value over the course of this test. This type of count change (humidity effect) is easily discernible, and does not resemble (amount, and rate of change) an impact graph.

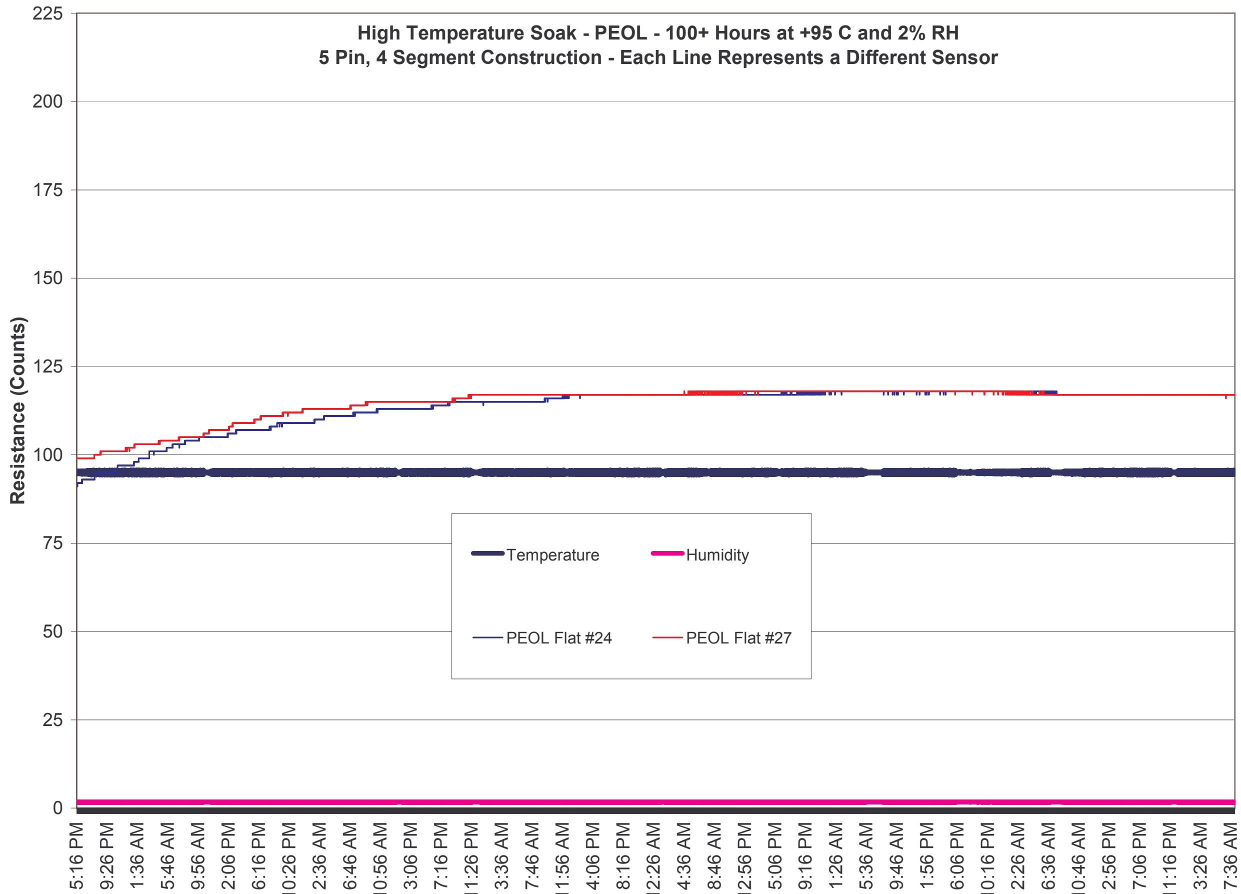
High Temperature Soak – PIOL:



Conclusions:

- The count values stabilize during High Temperature Soak, regardless of construction type.

High Temperature Soak – PEOL:



Conclusions:

The count values stabilize during High Temperature Soak, regardless of construction type.

Section 4 – Overall Conclusions:

Impact Testing –

- Response times are typically better than 1 to 2 milliseconds.
- Examining the amount of voltage change and the rate-of-change of the voltage make it clear to see the differentiation between the leg form and the pole or the balls.
- Both PEOL and PIOL constructions differentiate between the leg form and the pole extremely well.

Environmental Chamber Testing –

- All of the constructions are fairly stable in constant soak environments.
- The PIOL constructions appear to be even more stable than the PEOL constructions.
- Neither of the overlaminates (PEOL, PIOL) exhibited any delamination from the various tests. All of the sensors went through a minimum of 3 of the tests. The PIOL is more robust, but the PEOL did not show any visual problems. Additional testing may be needed if PEOL is the chosen construction.