Interpreting wheelchair seat cushion performance standards...

A guidance on how to interpret performance measures obtained from ANSI/RESNA WC-3 and ISO 16840 Wheelchair Seating standards for wheelchair seat cushions intended to manage tissue integrity.
This test measures the ability of a cushion to maintain tissue integrity by its ability to immerse and envelop the buttocks.

**Loaded Contour Depth**

**Metrics & Result Ranges**

- **Loaded contour depth (mm):** The depth of immersion of the basepoints (ITs) of a cushion loading indenter
  - Observed Range: 13–77 mm

- **Overload Deflection 1 (mm):** The additional immersion from the nominal load with a 33% increase in load
  - Observed Range: 2–8 mm

- **Overload Deflection 2 (mm):** The additional immersion from the nominal load with a 66% increase in load
  - Observed Range: 5–14 mm

**Guidance**

**Immersion:** The depth a person sinks into the cushion.

A higher **Loaded contour depth** indicates more immersion into the cushion and distribution of pressure on the soft tissue.

Cushions with higher additional immersion under the **overload** conditions have higher margins of safety against bottoming out.

*Result Ranges declared herein were measured in testing to date and are not a defined range that results must fall within.*
Envelopment

**Guidance**

Envelopment: The ability to conform to the contour of the body

The pressure averages at each of the four elevations provide information on the cushion’s ability to redistribute forces. Similar pressure values at each elevation indicate good envelopment. Lower pressure at the lowest elevation (E1) representing the ITs is also desirable.

The higher the immersion values the more the buttocks sink in and pressure is distributed.

**Metrics & Result Ranges**

**Pressure at 4 Elevations (mmHg):** Average pressure at each of 4 elevations (E1 - E4) of the indenter under standard and overload conditions.

- Depth of immersion of the basepoints (ITs) of a cushion loading indenter
- Observed Ranges:
  - E1: 44-137 mmHg
  - E2: 14-236 mmHg
  - E3: 61-160 mmHg
  - E4: 0-237 mmHg

**Immersion**

**Standard (mm):** The depth of immersion of the basepoints (ITs) of the indenter at standard load

- Observed Range: 31-81 mm

**Overload (mm):** The depth of immersion of the basepoints (ITs) of the indenter at overload

- Observed Range: 35-84 mm

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**This test characterizes a wheelchair cushion’s ability to envelop and immerse the buttocks.**

Two sizes of dual semi spherical indenters and two loads are applied to assess the ability of the cushion to adjust to changes in size and weight.

*Values for large (255 mm) indenter at standard load (425 N)*
This test indicates the ability of a wheelchair cushion to reduce impact loading on tissues and help to maintain postural stability when performing tasks such as going off a curb.

Metrics & Result Ranges*

Impact 1 (m/s²):
The magnitude of the acceleration of the initial impact of a cushion loading indenter
Observed Range: 20-36 m/s²

Impact 2 to Impact 1 Ratio (%):
The ratio of the second to the initial impact as a percentage
Observed Range: 23-58 %

Guidance

A lower Impact 1 indicates better comfort and postural stability.

A lower Impact 2 / Impact 1 Ratio indicates better absorption of energy after initial contact, decreasing tissue loads and reducing bouncing.

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This test indicates a cushion’s ability to consistently provide support during a cycle of loading and unloading.

**Guidance**

The larger the hysteresis, the lower the ability of the cushion to maintain support during loading and unloading, or the greater the tendency to conform to the user and maintain the contour shape.

**Metrics & Result Ranges**

- **250N Hysteresis (%):**
  - The difference between cushion thickness at 250 N during loading and unloading expressed as a percentage of loaded thickness
  - Observed Range: 3-43%

- **500N Hysteresis (%):**
  - The difference between cushion thickness at 500 N during loading and unloading expressed as a percentage of loaded thickness
  - Observed Range: 4-24%

*Result Ranges declared herein were measured in testing to date and are not a defined range that results must fall within.*
This test characterizes the cushion’s response to slight horizontal movements in the forward direction, indicating stability and risk to soft tissue due to shear.

Metrics & Result Ranges*

Peak Force (N):
The maximum horizontal force required to displace a cushion loading indenter 10 mm
Observed Range: 63–288 N

Force at 60 sec (N):
The final force achieved during the 60 sec settling time after movement
Observed Range: 42–229 N

Guidance

A higher Peak or Final Force, or a higher horizontal stiffness, may offer more stability but also an increased chance of tissue deformation due to shear forces between seat cushion and buttocks.

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Sliding Resistance

This test’s measurement provides an indication of the slipperiness, or the tendency to slide off of the cushion.

**Metrics & Result Ranges**

Slip Force (N):
The maximum horizontal force required for the cushion loading indenter to first displace or “slips” on the cushion
Observed Range: 7-254 N

**Guidance**

High **Slip Force** = Less Slippery
Low **Slip Force** = More Slippery

A more slippery cushion may increase tendency to slide out of position and compromise the users’ pressure distribution and posture, but it may also make transfers easier.

*Result Ranges declared herein were measured in testing to date and are not a defined range that results must fall within*
This test indicates the cushion’s ability to return to its pre-loaded shape and dimensions following a period of loading.

**Guidance**

The closer the **recovery ratio** is to 1, the faster the cushion returns to its pre-loaded shape and dimensions.

A recovery ratio closer to 0 may be indicative of fatigue or a viscoelastic material that conforms to the user and takes significant time to return to original shape.

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**Metrics & Result Ranges***

- **25s Recovery Ratio (%):** The ratio of the cushion thickness at the IT location 25s after a load is removed to the original thickness
  - Observed Range: 0.6–1%
- **1200s Recovery Ratio (%):** The ratio of the cushion thickness at the IT location 1200s after a load is removed to the original thickness
  - Observed Range: 0.9–1%

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For more information visit: wheelchairstandards.pitt.edu

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