Guidance on interpretation of performance standards for wheelchair seat cushions

The table below provides 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

Performance Test	Performance measures	Observed Ranges of Results	Guidance
LOADED CONTOUR DEPTH AND OVERLOAD DEFLECTION The test measures the ability of a cushion to maintain tissue integrity by its ability to immerse and envelop the buttocks.	**Loaded contour depth (mm):** The depth of immersion of the basepoints (ITs) of a cushion loading indenter **Overload deflection 1 (mm):** The additional immersion from the nominal load with a 33% increase in load **Overload deflection 2 (mm):** The additional immersion from the nominal load with a 66% increase in load	**Loaded Contour Depth:** 13 – 77 mm **Overload deflection 1:** 2 – 8 mm **Overload deflection 2:** 5 – 14 mm	*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.
ENVELOPMENT 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.	***Envelopment:*** **Pressure at Four Elevations [E1, E2, E3, E4] (mmHg):** Average pressure at each of 4 elevations of the indenter under standard and overload conditions ***Immersion:*** **Standard (mm):** The depth of immersion of the basepoints (ITs) of the indenter at standard load **Overload (mm):** The depth of immersion of the basepoints (ITs) of the indenter at overload	***Envelopment:*** **E1 (ITs):** 44 – 347 mmHg **E2:** 14 – 236 mmHg **E3:** 61 – 160 mmHg **E4 (Trochanters):** 0 – 237 mmHg ***Immersion:*** **Standard:** 31 – 81 mm **Overload:** 35 – 84 mm * Values for large (255 mm) indenter at standard load (425 N)	*Envelopment*: The ability to conform to the contour of the body The **pressure** averages at each of the four elevations provides information on the cushion's ability to redistribute forces. Similar pressure values at each elevation indicates 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.
IMPACT DAMPING This measurement 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.	**Impact 1 (m/s^2):** The magnitude of the acceleration of the initial impact of a cushion loading indenter **Impact 2 to Impact 1 Ratio (%):** The ratio of the second to the initial impact as a percentage	**Impact 1:** 20 - 36 m/s^2 **Impact 2 to Impact 1 Ratio:** 23 – 58 %	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.

HYSTERESIS This test measures of the cushion's ability to consistently provide support during a cycle of loading and unloading.	**250 N Hysteresis (%):** The difference between cushion thickness at 250 N during loading and unloading expressed as a percentage of loaded thickness **500 N Hysteresis (%):** The difference between cushion thickness at 500 N during loading and unloading expressed as a percentage of loaded thickness	**250 N Hysteresis:** 3 – 43 % **500 N Hysteresis:** 4 – 24 %	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
HORIZONTAL STIFFNESS This measurement characterizes the response of the cushion to slight horizontal movements in the forward direction, indicating stability and risk to soft tissue due to shear.	**Peak Force (N):** The maximum horizontal force required to displace a cushion loading indenter 10 mm **Force at 60 sec (N):** The final force achieved during the 60 sec settling time after movement	**Peak Force:** 63 - 288 N **Force at 60 sec:** 42 - 229 N	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.
SLIDING RESISTANCE This measurement provides an indication of the *slipperiness*, or the tendency to slide off of the cushion.	**Slip Force (N):** The maximum horizontal force required for the cushion loading indenter to first displace or "slips" on the cushion	**Slip Force:** 7 - 254 N	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.
RECOVERY The recovery characteristic of a seat cushion indicates the ability of the cushion to return to its pre-loaded shape and dimensions following a period of loading.	**25s Recovery Ratio (%):** The ratio of the cushion thickness at the IT location 25 sec after a load is removed to the original thickness **1200s Recovery Ratio (%):** The ratio of the cushion thickness at the IT location 1200 sec after a load is removed to the original thickness	**25s Recovery Ratio:** 0.6 – 1 **1200s Recovery Ratio:** 0.9 – 1	The closer the ratio is to 1, the faster the cushion returns to its pre-loaded shape and dimensions. A 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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