Wheelchair Cushion Testing Methodology

There are two testing methods that may be used to document wheelchair seat cushion criteria: the simulation method and the human subject method. Simulation tests are used to measure loaded contour depth and bottoming out. Human subject tests are used to measure peak interface pressure.

**Simulation Tests** Simulation tests use standardized models of the human buttocks known as cushion-loading indentors (CLIs). There are two CLIs that are used for simulation testing, a 25 mm CLI and a 40 mm CLI.

Loaded contour jig- 40 mm version schematic

![Loaded contour jig- 40 mm version schematic](https://via.placeholder.com/150)

The webbing is pulled taut over the cylinders & runs under the trochanter buttons for securement.

Loaded contour depth stand & jig in use

![Loaded contour depth stand & jig in use](https://via.placeholder.com/150)
Test method for determining 25 mm and 40 mm of contour depth

• Place the test cushion on a flat, horizontal surface. Cushions with curved bases must be stable during contour measurement testing.
• Align the CLI so that it is centered from the sides of the cushion and so that the ischial tuberosities of the models are 11-15 cm from the rear edge of the cushion. The ischial tuberosity portion of the CLI should be aligned with the analogous portion of the test cushion.
• Load the CLI to 140 Newton’s (31 pounds) & wait 5 minutes.
• Contact of the lateral buttons indicates that the cushion has contoured to 25 or 40 mm depending on the CLI used.
• Repeat the test two times waiting 5 minutes between trials

A cushion must pass the respective contour test during all trials to meet the minimum criteria specified in the cushion definition section.

Overload test method for measuring bottoming out

• Record the height of the CLI from the horizontal surface at the end of the loaded contour depth test described above.
• Add 47 Newton’s (10 pounds) to the CLI and record the height from the horizontal surface after 1 minute.
• Subtract the height at overload (#2) from the height at standard load (#1).
• Round the value in #3 to the nearest 5mm.
• Remove the overload weight and repeat the test twice, measuring the height in #1 and #2 each time. Wait period is same as above—at each test the first weight is applied, then the overload weight and then the whole thing is removed, wait 5 minutes and repeat.
• Determine the median of the three values recorded in #4. This is the “overload deflection”.

If the overload deflection is greater than or equal to 5mm, then the cushion is determined not to have bottomed out during the overload test.

Simulated use testing

There must be simulation of 12 or 18 months of use of the cushion (depending on the cushion type – see Definitions section). Following simulated use, the measurements for loaded contour depth and overload as described above must be repeated.

Test report

There must be a report of the tests which includes:
• The name and address of the facility performing the tests and the date(s) of the tests; and
• The manufacturer and brand name/number of the test cushion; and
• The weight of the cushion to the nearest 250 gm; and
• The width and length of the cushion; and
• The temperature and relative humidity of the room where the tests are conducted; and
• Identification of which CLI was used (25 mm or 40mm); and
• The results of the three loaded contour depth tests and the overload deflection test prior to simulated used testing; and
• A description of the method used to simulate cushion use;
• A statement specifying the number of months of use that were simulated; and
• Measurements as described in #7 obtained after simulated use testing; and
• A statement attesting that the testing methodology described in this policy was followed; and
• The printed name and signature of the person performing or supervising the tests and the signature date.

Human Subject Tests
The ability to demonstrate that there is an important reduction in interface pressure in comparison with a standard reference cushion when tested with human subjects is the basis for this approach. Human subject tests must be performed by an entity that has received human subject testing approval from an Institutional Review Board approved by the US Department of Health and Human Services.

Ten (10) wheelchair users must be studied, at least five of which must be clinically insensate on the body surface contacting the cushion. Interface pressure measurements are taken with each subject seated on the cushion being tested as well as on a standardized reference cushion (see below). The measurements are obtained with a transducer placed on top of the cushion.

Subjects must be seated on the cushion and interface pressure transducer for at least 60 seconds before data is collected. The subject should be positioned in their typical posture as determined by query and independent facility judgment. Three measurements are taken on each subject on each cushion separated by a complete unloading of the cushion for at least 60 seconds.

The standard reference cushion must be an uncovered 75 mm thick foam slab with a 25% indentation force deflection (IFD) of 41-49 pounds and a density of 2.5-3.0 pounds/cubic ft.

There must be a report of the tests which includes:
• The name and address of the facility performing the tests and the date(s) of the tests; and
• The manufacturer and brand name/number of the test cushion; and
• Information about the interface pressure measurement device utilized:
  • Manufacturer and brand name
  • Date of most recent calibration
  • Percent error of measurement at 50 and 100 mm Hg pressure; and
• Actual 25% IFD and density of the reference cushion (obtained from the foam manufacturer or supplier) and actual thickness of the reference cushion (for contoured cushions, report the thickness of the cushion portion in contact with the ischial tuberosities based on standard placement of the cushion); and
• Information on each subject (coding subjects to preserve confidentiality) including:
  • Age
  • Height
  • Weight
  • Disability
• Buttocks sensation status; and
• Interface pressure measurements for each subject on the test cushion and on the reference cushion:

If the transducer covers the entire seating area, the entire map showing the pressure in each cell must be submitted. The anatomical locations (as determined by palpation) of the right and left ischial tuberosities and the sacrum/coccyx must be identified on each map. (Data can be submitted as a hard copy map or utilizing the device software.) or,

If the transducer only covers a portion of the seat surface, measurements must be taken at the following three locations (as determined by palpation): right and left ischial tuberosities and sacrum/coccyx. The report must identify the anatomical location of each set of measurements. The report must list the pressure in each cell at each specified location. The values for the three locations are considered a single test; and The Peak Pressure Index (PPI) for each subject on the test cushion and on the reference cushion.

The PPI is determined as follows:

For each test, identify the cell in the sacro-ischial zone with the highest pressure; Determine the greatest sum of pressures in the identified cell and the adjacent cells in a 9-10 square centimeter area. If there are multiple cells with the same “highest pressure”, consider all of them in the determination of the “greatest sum”. [Note: A 3 cm by 3 cm square or a 3.5 cm diameter circular area are examples of a 9-10 sq cm area. For example, if using an interface pressure-sensing array with a cell size of 1 sq cm, 9 cells (a 3 by 3 array) are used and if using a sensing array with a cell size of 2.5 sq cm, 4 cells (a 2 by 2 array) are used.];

For each test, calculate the average of the cells with the greatest sum of pressures; Calculate the average of the results obtained in step (e) for the 3 tests on the test cushion and the 3 tests on the reference cushion. These values are the PPIs for the subject on each cushion.

A statement attesting that the testing methodology described in this policy was followed; and the printed name and signature of the person performing or supervising the tests and the signature date must be submitted with the coding application.

To determine if the minimum performance characteristics specified in the Definitions section for a particular type of cushion have been met, calculate the average PPI for the 10 subjects on the test cushion and the average PPI for the 10 subjects on the reference cushion. Divide the average PPI on the test cushion by the average PPI on the reference cushion and multiply the value by 100 to give the percentage comparison of Peak Pressure Indexes. If the comparative pressures are less than the specified values (125% or 85% depending on the cushion), then the minimum performance characteristics with respect to pressure have been met.
Sources of Additional Information


