

**Otto Bock®**

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**OBSS Cushion Human Volunteer  
Heat and Water Vapour Testing**

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## **1. BACKGROUND:**

- 1.1. This test characterizes the heat and humidity retention/dispersion properties of the OBSS cushions during human use. Three volunteers were used to perform this testing. Two different cushion configurations were tested: the Standard OBSS cushion with Dartex cover, and the vented OBSS cushions with Spacer cover.

## **2. EXECUTIVE SUMMARY:**

- 2.1. The temperature measured no statistically significant difference between the vented and unvented OBSS cushions.
- 2.2. The relative humidity decreased by 17 percent with use of the vented OBSS cushion with spacer cover instead of the unvented OBSS cushion with the Dartex cover.
- 2.3. Across the board, all volunteers who performed the perceived comfort survey indicated that the vented OBSS cushion with spacer cover was dryer and cooler than unvented OBSS cushion with Dartex cover.
  - 2.3.1. A total of six volunteers performed the perceived comfort survey.

## **3. REFERENCES:**

- 3.1. EC Service Protocol 800.010: Heat & Humidity Test Procedure.
- 3.2. Crane, B; Holm, M.B; Hobson, D; Cooper, R.A; Reed, M.P; and Stadelmeier, S. (2004) Development of a consumer-driven Wheelchair Seating Discomfort Assessment Tool (WcS-DAT). *International Journal of Rehabilitation Research*. 27(1) 85-90. - modified for OBSS cushion use.
- 3.3. Tool for Assessing Wheelchair disComfort by Barbara Crane; (Email see Appendix).

## **4. MATERIALS:**

- 4.1. **Samples provided by customer:**
  - 4.1.1. OBSS vented cushion carved for volunteer. Refer to Figure 1, below.
    - 4.1.1.1. Otto Bock Serial Number: 2010040219.
    - 4.1.1.2. ECS Receipt Number: 049-10.
  - 4.1.2. OBSS cushion Spacer Fabric cover for volunteer. Refer to Figure 2, below.
    - 4.1.2.1. ECS Receipt Number: 049-10.
  - 4.1.3. OBSS unvented cushion carved for volunteer. Refer to Figure 3, below.
    - 4.1.3.1. Otto Bock Serial Number: 2010040219.
    - 4.1.3.2. ECS Receipt Number: 049-10.
  - 4.1.4. OBSS cushion Dartex cover for volunteer. Refer to Figure 4, below.
    - 4.1.4.1. ECS Receipt Number: 049-10.

**Figure 1 – OBSS vented cushion**



**Figure 3 – OBSS unvented cushion**



**Figure 2 – OBSS cushion spacer cover**



**Figure 4 - OBSS cushion dartex cover**



#### **4.2. Human Heat and Water Vapour Test:**

- 4.2.1. 6 volunteers participated in the comfort survey through setup and trials. 3 of volunteer's data was used in data calculations. Volunteer data was not gathered.
- 4.2.2. Office chair, removed cushion.
  - 4.2.2.1. Model number: Hon Alarais 4220 Series.
  - 4.2.2.2. ECS Receipt number: 029-10.
- 4.2.3. 5/8" plywood mounting board. Dimensions 16" x 16-1/2". Die-ply from TruCut.
  - 4.2.3.1. ECS receipt number: 041-10.
- 4.2.4. 11 Modified Dickson humidity and temperature loggers. Dickson Part number: TK150, ECS Calibration Due Date: 15-Aug-2011.
  - 4.2.4.1. Sensor modifications include the addition of an 18" ribbon cable with sensor attached externally to cable. The sensor was shielded from hazardous contaminants by inserting into Gore membrane sleeves. The sleeves allow for moisture vapour transpiration, but protect from foreign contaminants damaging the sensor. See Figure 5, below.
- 4.2.5. 11 Gore membrane sleeves.

- 4.2.5.1. Gortex Membrane – Taffetta 2L HAL Navy #2059. WL Gore Part Number: WAAZ100000K, Lot Number: 03023475AC.
- 4.2.5.2. ECS receipt number: 017-10
- 4.2.6. DicksonWare Version 16.3.0. Used to download data from the sensors into .txt format.
- 4.2.7. Dickson Logger Calibration Software, Version 6.8.0.
- 4.2.8. USB to mini-USB cable for Dicksonware data transfer.
- 4.2.9. Computer to analyze results.
  - 4.2.9.1. Microsoft Windows XP Professional Version 2002 – Service Pack 3
  - 4.2.9.2. Intel Celeron CPU E1400@ 2.00 GHz, 960 RAM
- 4.2.10. Microsoft Excel 2002 SP3.
- 4.2.11. Five x 5/16”x1-1/2” Hex Head Lag Screws. Purchased from the Home Depot.
- 4.2.12. Five x 5/16” Machine Washers. Purchased from the Home Depot.

**Figure 5** – Dickson temperature and humidity logger, modified model TK150.



## 5. TEST ENVIRONMENT:

- 5.1. No environment specifications were required. The testing environment consisted of uncontrolled office areas. Ambient recordings were recorded for each trial.

## 6. CUSHION INSTALLATION:

- 6.1. Each volunteer had two cushions carved: an unvented OBSS cushion and a vented OBSS cushion.
  - 6.1.1. The traditional Dartex OBSS cushion cover was used for the unvented OBSS cushion.

- 6.1.2. The breathable Spacer OBSS cushion cover was used for the vented OBSS cushion.
- 6.2. In order for the volunteers to go about their normal routines, the OBSS cushions were secured to an office chair platform, allowing the cushion height to be adjustable and easily maneuverable.
- 6.3. The office chair was modified such that the installed cushion was replaced with the mounting board embedded with Tee-nuts (for securing arms, back, and base of office chair) and mounting holes for OBSS cushions.
- 6.3.1. The purpose of the mounting board is to provide a stable surface in which the OBSS cushions can be secured to the chair assembly. The chair arms, back, and base are secured to the mounting board. Refer to Figure 6, below.
- 6.4. The hole pattern was translated to the bottom face of the OBSS cushions and the bottom of the cushion was pre-drilled.
- 6.5. The OBSS cushions were fixed to the modified office chair assembly by five 5/16"x1-1/2" Lag Screws.
- 6.6. The use of lag screws allowed for easy change over of cushions for different trials.
- 6.7. Refer to Figure 7, below.

**Figure 6** – Mounting board with attached back and base.



**Figure 7 – OBSS chair assembly with breather holes.**



## **7. METHOD:**

### **7.1. Cushion Set Up:**

7.1.1. The OBSS cushion tested was secured to modified office chair using the following conditions:

- 7.1.1.1. For testing of the OBSS unvented cushion, the Dartex cover was used.
- 7.1.1.2. For testing of the OBSS vented cushion, the Spacer Fabric cover was used.

7.1.2. The cushion was instrumented with two Dickson heat and humidity loggers.

- 7.1.2.1. A sensor was placed at the right and left ischial tuberosities.
- 7.1.2.2. Special care was taken during the wire routing to allow adequate wire translation upon volunteer loading without accumulating build up of wiring in one spot. Small amounts of masking tape were used to hold the positioning of the wire during loading. Refer to Figure 8, below.
- 7.1.2.3. The loggers were routed over the corresponding sides and folded up under the cover flap on the bottom side of the cushion.

**Figure 8 – OBSS Cushion testing, logger positioning.**



## **7.2. Testing:**

7.2.1. The Dickson heat and humidity loggers were cleared.

7.2.1.1. The loggers were set up to record the temperature and humidity once every 30 seconds.

7.2.2. A logger was placed in an ambient condition near the volunteer, but far enough away not to be influenced by the volunteer, direct sunlight, computers, or other equipment which produced heat. Typically, the ambient sensors were placed on a desk nearby.

7.2.2.1. For multiple volunteers within the same room, one ambient sensor was allowed. Volunteers testing in separate rooms were asked to use a separate ambient logger.

7.2.3. The trial began by having the volunteer sit on the OBSS cushion. A timer was started for three hours when the volunteer sat on the cushion.

7.2.3.1. The volunteer was asked not to stand up or shift around in the cushion during that time. Refer to Figure 9, below.

**Figure 9 – Volunteer sitting trial.**



- 7.2.4. At the end of the three hour time period, the volunteer was asked to stand up for 45 seconds.
- 7.2.5. At the end of the 45 seconds of standing, the volunteer was asked to sit back down into the cushion for an additional 15 minutes.
- 7.2.6. At the end of the 15 minute re-loading period, the trial was over.
- 7.2.7. The cushion was left to equilibrate for one hour prior to starting another trial.
- 7.2.8. The loggers were either downloaded at the end of each trial, at the end of each day, or at the completion of a three trial period.
- 7.2.9. The volunteer repeated steps 7.2.3 through 7.2.6 for a total of three trials per cushion condition.
- 7.2.10. Steps 7.2.1 through 7.2.8 were repeated such that one volunteer performed six trials: three trials on the unvented (dartex cover) OBSS cushion and three trials on the vented (spacer fabric cover) OBSS cushion.
- 7.2.11. All data was recorded. Filepath:  
\\Ecservers1\files\EC Service\Production\0360- OBSS retest with modified sensors\Testing and Analysis\Feb-2011 Data

## **8. RESULTS:**

- 8.1. Table 1, shown below, displays the average temperature values of the three volunteers for both cushion types at various time intervals.
- 8.2. Figure 10, shown below, displays a graphical representation of the average temperature values shown in Table 1 at various time intervals.

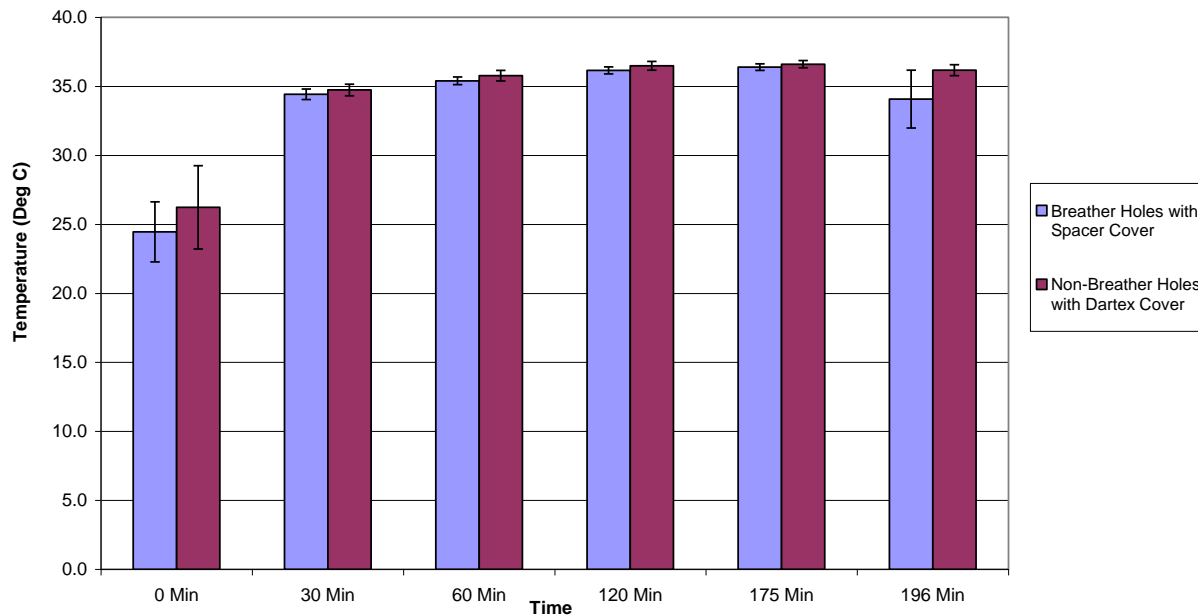
**Table 1** – Temperature comparison of OBSS cushion with breather holes and OBSS cushion without breather holes.

Time	Average Temp C° - Breather Holes	Confidence Interval*	Average Temp C° - Non-Breather Holes	Confidence Interval*	Difference
0 Min	24.5	2.2	26.2	3.0	1.8
30 Min	34.4	0.4	34.7	0.4	0.3
60 Min	35.4	0.3	35.8	0.4	0.4
120 Min	36.2	0.3	36.5	0.3	0.3
175 Min	36.4	0.2	36.6	0.3	0.2
196 Min	34.1	2.1	36.2	0.4	2.1

\*90% Confidence

**Figure 10** – Temperature comparison of OBSS cushion with breather holes and OBSS cushion without breather holes.

**Average Temperature Difference between Cushion Types**



\*\*\*90% Confidence

8.3. Table 2, shown below, displays the average relative humidity values of the three volunteers for both cushion types at various time intervals.

8.4. Figure 11, shown below, displays a graphical representation of the average relative humidity values shown in Table 2 at various time intervals.

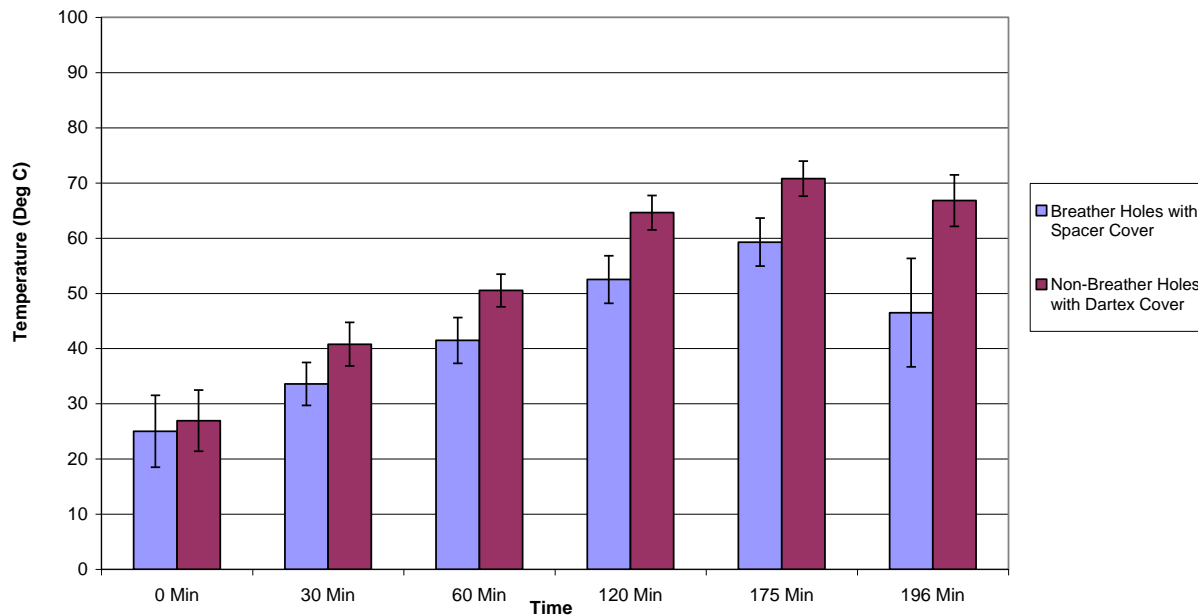
**Table 2 – Relative Humidity comparison of OBSS cushion with breather holes and OBSS cushion without breather holes.**

Time	Average %RH - Breather Holes	Confidence Interval*	Average %RH - Non-Breather Holes	Confidence Interval*	Difference
0 Min	25	7	27	6	2
30 Min	34	4	41	4	7
60 Min	41	4	51	3	9
120 Min	53	4	65	3	12
175 Min	59	4	71	3	12
196 Min	47	10	67	5	20

\*90% Confidence

**Figure 11 – Relative Humidity comparison of OBSS cushion with breather holes and OBSS cushion without breather holes.**

**Average Relative Humidity Difference between Cushion Types**



\*\*\*90% Confidence

- 8.5. After each of the two cushion types, each volunteer was asked to fill out a comfort survey. The comfort survey can be seen in the Appendix.
- 8.6. Table 3 displays the discomfort values for each volunteer of the OBSS cushion without breather holes.
- 8.7. Table 4, below, displays the discomfort values for each volunteer of the OBSS cushion with breather holes.

**Table 3 – Volunteer perceived discomfort score for OBSS cushion without breather holes.**

	General Discomfort Score	Discomfort Intensity	Total Score
<b>Volunteer 1</b>	50	18	<b>68</b>
<b>Volunteer 2</b>	38	26	<b>64</b>
<b>Volunteer 3</b>	54	43	<b>97</b>
<b>Volunteer 4</b>	24	14	<b>38</b>
<b>Volunteer 5</b>	59	31	<b>90</b>
<b>Volunteer 6</b>	56	20	<b>76</b>
		Average	<b>72</b>
		Confidence*	14

\*90% Confidence

**Table 4 – Volunteer perceived discomfort score for OBSS cushion with breather holes.**

	General Discomfort Score	Discomfort Intensity	Total Score
<b>Volunteer 1</b>	40	12	<b>52</b>
<b>Volunteer 2</b>	33	24	<b>57</b>
<b>Volunteer 3</b>	51	35	<b>86</b>
<b>Volunteer 4</b>	14	9	<b>23</b>
<b>Volunteer 5</b>	44	3	<b>47</b>
<b>Volunteer 6</b>	41	25	<b>66</b>
		Average	<b>55</b>
		Confidence*	14

\*90% Confidence

## 9. CONCLUSIONS:

- 9.1. The comfort survey indicates that the OBSS cushions with breather holes are significantly more comfortable, both in temperature and moisture.
- 9.2. The relative humidity measurements show a significant reduction in relative humidity of 17% with the OBSS cushions with breather holes.
- 9.3. The temperature measurements show a non-significant reduction of 1°C with the OBSS cushions with breather holes.
  - 9.3.1. This may be a cumulative effect; a larger data set is required to measure significant difference.

## 10. STATEMENT OF UNCERTAINTY:

- 10.1. All confidence intervals were calculated to a 90% confidence level.
- 10.2. The average non-breather OBSS cushion with dartex cover:
  - 10.2.1. Average relative humidity at 175 minutes into the test was 71% ± 3%.
  - 10.2.2. Average temperature at 175 minutes into the test was 36.6°C ± 0.3°C.

- 10.2.3. The discomfort score from the perceived comfort surveys measured an average of  $72 \pm 14$ .
- 10.3. The average breather OBSS cushion with spacer cover:
  - 10.3.1. Average relative humidity at 175 minutes into the test was  $59\% \pm 4\%$ .
  - 10.3.2. Average temperature at 175 minutes into the test was  $36.4^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$ .
  - 10.3.3. The discomfort score from the perceived comfort surveys measured an average of  $55 \pm 14$ .

- END -

# APPENDIX

## **General Information about the Tool for Assessing Wheelchair disComfort (TAWC)**

Thank you for your interest in using the Tool for Assessing Wheelchair disComfort (TAWC). Here is a copy of the assessment tool as developed and validated at the University of Pittsburgh to assess wheelchair seating discomfort. Here is some general information about use of this tool and scoring methods. The final two pages indicate the scoring methodology used in my study.

When used in my dissertation research, I generated two discomfort scores – the General Discomfort Assessment (Part II) and the Discomfort Intensity Score (Part III). I asked individuals in my study to rate their levels of discomfort and to answer all questions in the tool based on the previous 4-hour period. I had them complete an assessment every 4 hours throughout the day. In a clinical setting, it might be more useful to have the person answer the questions based on an average day, or based on the previous day, etc. Just be sure the requested time period is short enough so that the person's memory will be valid. I found that discomfort develops particularly after 4 – 6 hours of sitting, so an assessment within the first 4 hours probably will not be a true assessment of long-term seating discomfort.

The GDA score is derived by scoring the boxes with 1 – 7 scores, as indicated in the scoring key at the end of this document, then totaling all scores for the items.

The DIS score is derived by adding "1" to each of the scores in part III, with the exception of the final score if it is left blank, then totaling these scores.

I hope to have several publications out for this tool in the near future, the first of which is in Press in the International Journal of Rehabilitation Research. If you are using this for research purposes and would like to have the references, email me and I will send along whatever I have.

Feel free to email me if you have any other questions or concerns.

Barbara Crane  
Barb.crane@cox.net

## **OBSS Cushion with Ventilation Holes Comfort Survey**

### **Introduction and directions:**

This questionnaire has been developed as a way of determining the level of discomfort you experience while you are sitting in your wheelchair with each of the two sets of cushions.

There are three parts to this questionnaire:

- Part I asks you to provide general information that is important in evaluating seat discomfort.
- Part II asks you to rate your level of agreement with several statements about comfort and discomfort.
- Part III asks you to assign a number on a scale from 0 to 10 to describe a discomfort level for each region of your body.

## OBSS Cushion with Ventilation Holes Comfort Survey

### Part I: General Information:

1. What were the times that you first transferred into your wheelchair?

Day\_\_\_\_ \_\_\_\_ am/pm

Day\_\_\_\_ \_\_\_\_ am/pm

Day\_\_\_\_ \_\_\_\_ am/pm

2. Were you positioned properly in you chair when you began the study?

\_\_\_\_\_ yes \_\_\_\_\_ no

Describe problems if any occurred (anything out of the ordinary):

---

3. What time did you it get out of the chair on each of the days?

Day\_\_\_\_ \_\_\_\_ am/pm

Day\_\_\_\_ \_\_\_\_ am/pm

Day\_\_\_\_ \_\_\_\_ am/pm

4. During the times that you sat in the chair, did you change your position in your wheelchair?

\_\_\_\_\_ yes \_\_\_\_\_ no

5a. If yes, how many times did you change your position? \_\_\_\_\_

5. What types of activities did you do in your wheelchair during the study?

(check all that apply)

\_\_\_\_\_ Answered Phones

\_\_\_\_\_ Tasks at desk

\_\_\_\_\_ went to the copy machine or printer

\_\_\_\_\_ wheeled from one desk to another

\_\_\_\_\_ Other \_\_\_\_\_

6. How many car lengths would you say you drove your wheelchair during the study?

\_\_\_\_\_

(a typical car is 12 feet long)

## Tool for Assessing Wheelchair disComfort (TAWC)

Think about how you have felt while seated in your wheelchair:

### Part II: General Discomfort Assessment

Please rate your answer on the following scale: (place a mark in the appropriate box)	Strongly disagree	Disagree	Partly disagree	Neither agree nor disagree	Partly agree	Agree	Strongly agree
<b><i>While seated in my wheelchair...</i></b>							
...I feel poorly positioned							
...I feel like I have been in one position for too long							
...I feel like I need to move or shift my position							
...I feel aches, stiffness, or soreness							
...I feel pressure in some part or parts of my body							
...I feel too hot or cold or damp							
...I feel sweaty in the seat							
...I seek distraction to relieve discomfort							
...I feel uncomfortable							
...I feel no pain							
...I feel stable (not sliding or falling)							
...I feel comfortable							
...I feel good							
...I feel able to concentrate on my work or activities							

### Part III: Discomfort Intensity Rating

On a scale of 0 to 10, **0 being no discomfort** and **10 being severe discomfort**, please **RATE and DESCRIBE** the amount of discomfort you feel for each body area listed below.

**This rating should reflect the intensity of your discomfort for the time you were in your wheelchair:**

Body Areas	<u>Rating:</u>	<u>Please describe</u> the discomfort (for example: aching, burning, pressure, instability, or others)
Back		
Neck		
Buttocks		
Legs		
Arms		
Feet		
Hands		
Seat Temperature		
Overall Discomfort Level (General discomfort level)		
Other areas? Please list:		

# Quality Checklist

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|---|---|
| <ul style="list-style-type: none"> <li>• Project number labeled</li> </ul>  | Initials: <u>vbs</u> Date: <u>3/17/2011</u> |
| <ul style="list-style-type: none"> <li>• Date report submitted</li> </ul>   | Initials: <u>vbs</u> Date: <u>3/17/2011</u> |
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| <ul style="list-style-type: none"> <li>• References are accurate (i.e., correct Protocol listed)</li> </ul>   | Initials: <u>vbs</u> Date: <u>3/17/2011</u> |
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| <ul style="list-style-type: none"> <li>• Conclusions make sense and are clear and concise</li> </ul>  | Initials: <u>vbs</u> Date: <u>3/17/2011</u> |
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