From:	Bruce Bailey
To:	Access Board Docket
Subject:	Docket ATBCB-2019-0002 request to testify remotely
Date:	Friday, September 13, 2019 10:46:32 AM
Attachments:	Smart OBW 027.png Smart OBW 029.png Smart OBW 048.png Smart OBW Concept.png

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From: Peter Axelson (PAX) <pax@beneficialdesigns.com>
Sent: Thursday, September 5, 2019 8:54 PM
To: Rose Marie Bunales <bunales@Access-Board.gov>
Cc: Bill Blythe <bill@beneficialdesigns.com>; Bill Botten <botten@Access-Board.gov>
Subject: RE: Docket ATBCB-2019-0002 request to testify remotely

Hi Rose Marie,
I have included my preliminary feedback and comments below that I would like to present and discuss on the 12th of September.
Peter Axelson
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Q1 and Q22
Not without a standards process involving aircraft lavatory designers and wheelchair designers and users.

Information on the Hamburg on-board wheelchair.
All smiles and celebration for the **Hamburg University of Applied Sciences (HAW):** the "Smart Onboard Wheelchair" concept won the "University" category, prevailing against two competitors from Delft University of Technology in the Netherlands. Thanks to a specially shaped seat, the wheelchair can be rolled directly over the on-board toilet, allowing the passenger to use the lavatory independently. The trophy was presented by Paul Estoppey, responsible for the hub airlines Austrian, Lufthansa and SWISS within the Lufthansa Group.

The design of an onboard wheelchair like the one depicted in the Hamburg video….
https://www.youtube.com/watch?v=iDn0BJGae3k

In this video it can be seen that the seat slides back to extend back over the toilet. This is only possible if the seat of the onboard wheelchair is physically supported by the platform around the toilet seat when it slides back. This means that the toilet seat would have to be designed with a flat surface or platform around it that can bear weight. If the bench area around the toilet seat would be able to bear weight on it there is a possibility to support an on-board wheelchair like the Hamburg design. The Hamburg on-board WC appears to have small rollers under the lateral aspect of the seat frame that roll back over the top surface of the platform on either side of the toilet seat. This requires the toilet structure to bear the weight of the wheelchair frame when occupied. This seems reasonable since aircraft toilets are designed for large passengers to sit on them.

To design on-board wheelchairs that work in the manner shown in the video, the toilet

seats and the structure around the toilet seat would need to be standardized across the airline industry. Depending on how tight the standard could be set for the toilet seat structure, the on-board wheelchair might have to be adjustable in height or built specifically to interface with each aircraft bathroom design.

If the height of the toilet seat platform on aircraft were precisely standardized at a very specific maximum height with a minus tolerance of 0.125 inches (3 mm) an on-board wheelchair could be designed and built with a sliding seat to slide back over the toilet structure provided it was designed to have linear areas where rollers could be supported across the flat surface laterally outside the width of the toilet seat.

This would also mean that the maximum width and height dimensions of the toilet seat would have to be restricted to allow the on-board wheelchair seat to be designed with the clearance to roll back in such a way that the rollers are supported on the flat surface outside with width of the toilet seat.

If an on board wheelchair has a cantilever design to roll back across the top of a toilet in the aircraft, a standards committee would need to be convened to develop a standard for the interface between the on-board wheelchair and the aircraft lavatory. This would require the cooperation of a standards development process between the designers or aircraft lavatories and the designers of wheelchairs.

Experts would be needed with the following areas of expertise.

Wheelchair manufactures
Wheelchair designers
Wheelchair test labs
Wheelchair users
Aircraft Lavatory and Toilet designers
Aircraft Designers
Persons who are non-ambulatory that use wheelchairs

For any type of on-board wheelchair to be effectively designed aircraft manufacturers and outfitters would have to agree to the establishment of standards related to the design of accessible lavatories. The aircraft manufacturers would also have to agree to a minimum clearance width on their center aisle ways. There does not currently appear to be a standard for this. This creates tremendous problems for the designers of aircraft boarding chairs that are often designed and built to be very narrow presenting dangerous conditions for passengers. Every single aisle aircraft with 3/3 seating in coach I have flown on has a clearance width of 18 in. of clear space in the center aisle. This is the same space that is provided for sitting on these aircraft. The seat cushion measures 18 inches. The clearance between the arm supports is typically 2 in. less because of the width of the arm support. The minimum clearance with on all aircraft aisle ways should be 18 inches. The bony hip structure on an adult is 16 in. without any soft tissue being considered. How should one expect persons to sit in a boarding or on board wheelchair and be rolled down the aisle without scraping the seats if the aisle width is less than 18 inches clear!

In a research project funded by the Paralyzed Veterans of America PVA, over 500 non-ambulatory passengers were surveyed. Over 12 percent of all travelers in have fallen over in boarding chairs and over 7 percent have fallen out of these narrow boarding chairs. Setting a minimum clearance width would allow designers of boarding chairs to design wider boarding chairs. This is because boarding wheelchairs are currently much less than 15 inches wide and they fall over in the jet way where there are slopes to get down to the aircraft.

Furthermore the WC industry should be asked to develop standards related to the design of on-board wheelchairs. Experts would have to work together to accomplish this task.

As an adaptive ski expert and wheelchair seating and design expert, I was involved in setting the standards for Ski lifts ANSI B-77 and the standards for Adaptive ski equipment RESNA ASE Vol. 1 to ensure that the two standards work in harmony with one another to allow safe and effective loading and unloading from chairlifts. The adaptive ski equipment must be high enough to load and unload form the lift. The lift must operate at a height that can be accessed by adaptive skiers.

Additional critical components of the bathroom include the minimum width of the doorway into the lavatory.
The minimum clear space inside the bathroom and the location of grab bars inside the lavatory is also important.

Once an interface standard is developed the specifications for the on-board wheelchair must be created.
This work should be left to a consensus standards body that operates like the RESNA Wheelchair standards committee.
Specifications should not be just pulled out of the air.

Q2
Of course with some assembly required potentially.

Q3
An expensive and time consuming standards process will be required as explained above.

Q4 and Q5
The strength requirements of an on-board wheelchair can be defined by existing RESNA Wheelchair standards test procedures. Static, impact and Fatigue test procedures already exist that can be used to verify the strength of an on-board wheelchair. The static stability and effectiveness of the brakes can also be verified using RESNA Wheelchair standards test procedures. It is not appropriate to impose arbitrary 5x factor of safety requirements on an on-board wheelchair for example. The static, impact and fatigue strength testing in RESNA Vol. 1 Section 8 takes care of the strength requirements on any type of wheelchair.

Q6 Q23
The standard adult wheelchair has an 18 wide by 16 inch seat depth. These are the same dimensions of aircraft seat cushions, which a usually shorter to accommodate shorter people. Lower leg length is really long for the 95th percentile.

Q7
I measure the aisle width on every aircraft I fly on when possible. Most 3/3 seating aircraft have 18 in. clear space in the aisle.
CRJs have only 16 in. at times which is too narrow. The clear space must be 18 in. Jogs in the seating require additional distance to deal with rolling from one aisle to another when they are not lined up.

Q8
Not enough questions are being asked to determine the possibility to create an on-board wheelchair that slides over the toilet seat. The width of the toilet seat and it height with the cover up and down must be known. The width of the support panel adjacent to the toilet seat must be known. How much clearance is there on either side of the toilet seat with the cover up or down. What is the depth of the toilet seat.

Q9
Samples of existing on-board wheelchairs need to be tested. Our firm has tested three different boarding wheelchairs in our wheelchair test lab.

Q10
The terms for the various maximum overall dimension and seating dimensions of wheelchairs should be used RESNA Section 5 and 7.

Q11
For the purpose of maneuvering an on-board wheelchair into an aircraft lavatory the use of 4 pivoting wheels would be desirable. However, being able to lock pivoting wheels is very difficult and requires additional width of the chair. For this reason, the design of the aircraft lavatory should consider use of a wheelchair that has 2 pivoting wheels and 2 fixed wheels. This is another issue that should be considered by meetings to standardize the interface between the aircraft lavatory and the on-board wheelchair.

Q12
Clear space should be provided in an ADA lavatory to bring an on-board wheelchair inside of it and close the door or curtain. The minimum clearance width on the door of the ADA lavatory should be 18 in. clear, same as the aircraft aisleway

Q14
An onboard wheelchair, when unoccupied, could easily be pushed on its wheels.

Q15 and Q16
On board wheelchairs currently fit into spaces that are specifically designed for them on commercial aircraft. The space designated for a passenger to store their personal

wheelchair when preboarded per the ACAA should not be used to store the on-board wheelchair.

Q17
On board wheelchairs should be tested for static stability using RESNA Volume 1 Section 1
Performance values should meet Group 2 performance requirements in my opinion with stability in all directions.
Six degrees would be the minimum in my opinion.

Q18 Q19
If the sliding feature of an onboard wheelchair were to become unlocked, the onboard wheelchair would tip over backwards.
Requiring the on-board chair to be pushed up against the front of the toilet seating area could be a way to create a safety feature that would prevent it from unlatching when not desired. This is another point that would have to be addressed during standardization. If the sliding feature remained extended when the front casters of the wheelchair slide forward the chair would tip rearward as well. There is often a way to defeat safety features that could cause a rearward stability problem.

Q20
All numbers are averages measured flying on commercial airlines, mostly United and American -
Seat heights in most 3/3 seating aircraft are 17 to 18 in. in height. The average was 17.4 in.
A CRJ the seat height was measured to be 17 in. with 18 in seat width
Seat width average measured was 17.5 (S80) all others 18.0 to 19.5. Average was 18.5 in.
Seat depth at the center is 18.125 average
Clearance width between arm supports is 17.5
Seat angle is 5.8 degrees at front and 7,3 degrees at the rear of seat
Back support angle 5.8 upper, 19.9 degrees mid back height, 7.4 degrees lower back
Back support height at the neck 20.7 in.
Head support height 24.8 – 25.3 in
Back support height 28 – 28.6 in.
Seat pitch 31 normal 34 extended legroom
Knee clearance 9 to 14.5 in. 12.7 avg.

Q21
unknown

Q22
Creating anything adjustable on a manual wheelchair increases the weight of the chair. Having the height of the on-board wheelchair adjustable in height while sitting in the wheelchair is complicated and typically requires a hydraulic component of some kind or a screw mechanism, often battery powered to adjust the seat height.
Assembly of a wheelchair to a different seat height might be possible with quick release pins.

Q23
See Q5

Q24
There should be a minimum clear space width of 18.0 in. of width on all aircraft for access by human beings ambulatory or non-ambulatory.

Q25
A seat width of 15 in. is reasonable understanding that many people will be hanging off the sides of the seat and soft tissue damage may occur to the user sitting in the 15 in. wide seat.

Q26
A 2.0 inch gap would be a minimum.

Q27
The minimum back width should be the same as the seat width, 15.0 in.

Q28
Some passengers require head and neck support. The head and neck support may have to be a separate part that is attached to the on-board wheelchair if needed.

Q29
The arm support will need to be able to fold up out of the way or be removable. The arm support will perform a postural stability function keeping the user centered on the back support at the height of the arm support. The arm support should be greppable for transfers. The length should be considered further.

Q30
9 by 12 should be the minimum. Users with larger feet or range of motion issues will need to be transported in reverse so their feet/shoes can drag if required.

Q31and Q32
A fold up design would be acceptable otherwise it would have to remove. A strap would help for may people to keep their feet in position when the on-board chair is moving.

Q33
0.75 in clearance should not be necessary. It only needs to clear the thresholds in the Aircraft by 0.25 in. loaded.

Q34 and Q35
Swivel locks take up lots of space and will reduce the lateral wheelbase of the on-board wheelchair. Most swivel lock mechanisms also lock the wheel at the same time. The size of the wheel should not be specified at this time to see what solutions can be developed for handling the requirements to have swivel and wheel locks. It might be very dangerous to specify a requirement for a 5 in. wheel from a stability point of

view. The environment the wheelchair is operating in is highly constrained, The chair will be in a narrow aisle width during transfer. Wheel locks do not prevent the chair from sliding on the surface. Operability of wheel locks on casters would be at the caster. This would be difficult for a user to reach.

Q39
Stability will decrease with all wheels swiveling since the lateral wheelbase will be less.

Q40
The front wheels should swivel for sure. This is what wheelchair users are used to when maneuvering.

Q41
The rear handles could fold.

Q42 and Q43
Front assist handles are on some wheelchairs to assist with transfers.
A front handle could attach to the foot support area of the wheelchair that could be removed.
Straps can be used to assist a wheelchair from the front.
This is how I have received assistance in my own personal on board wheelchair.

Q44
No

Q45
Yes with more weight

Q46
No restriction, Buckle that can easily be adjusted and released like an airline seat belt latch
In this way the same extender straps could be used that are used by the airline

207.1 Back support height of 26 in. seems restrictive – suggest 18 in. with a head and neck support that attaches separate.
209.3 A minimum clearance of 0.75 should be specified from the floor.

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