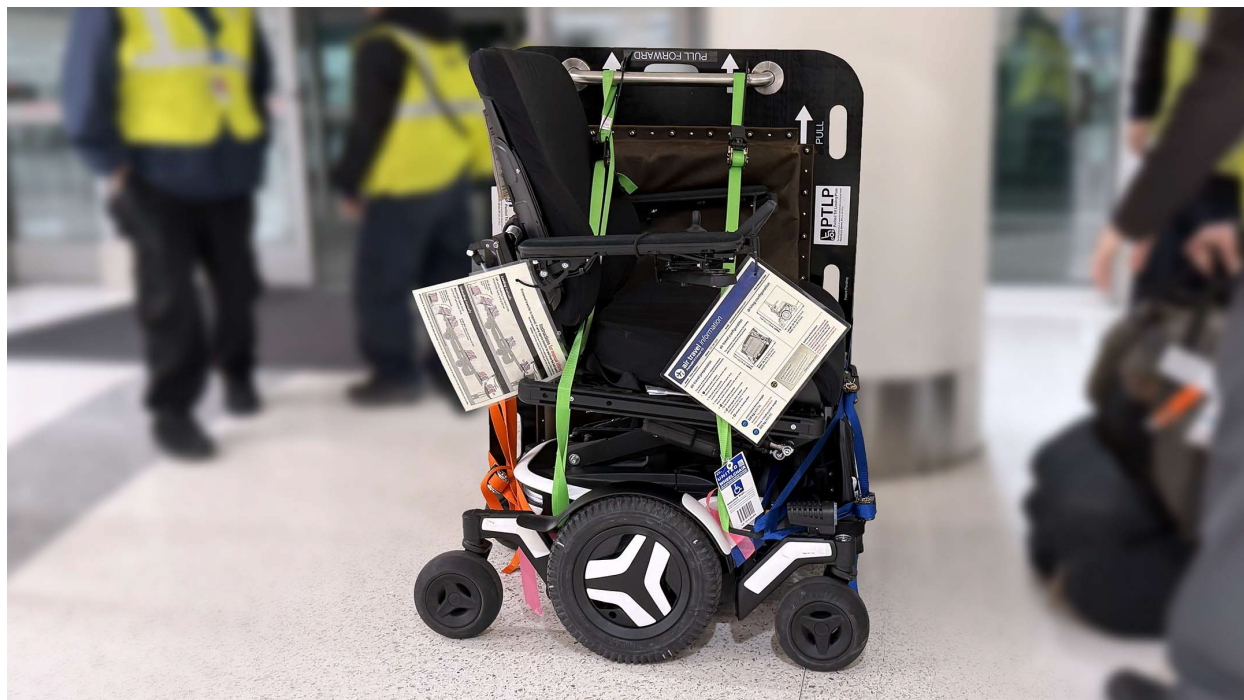


Solution to Safely Tip Powered Wheelchairs for Air Travel

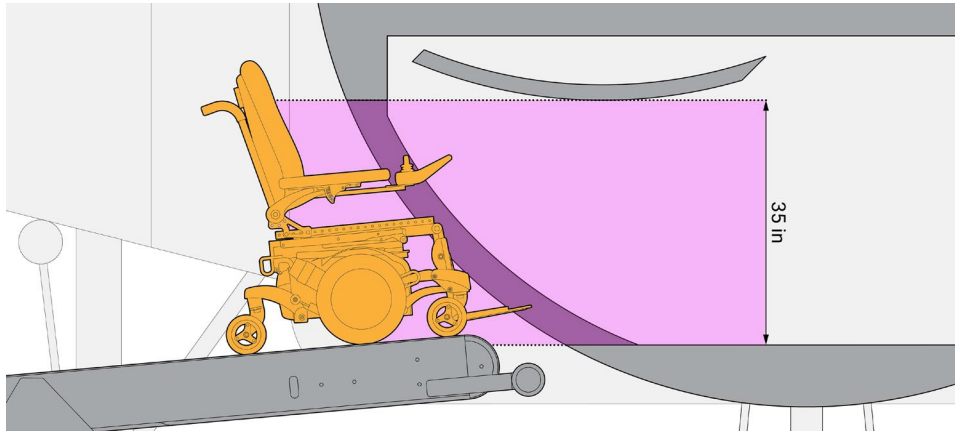


Abstract

Many people with disabilities require the use of powered wheelchairs that cannot reduce in height to fit through small aircraft cargo doors. Over the last 40 years, airlines have tipped such powered wheelchairs on their sides at the top of the belt loader and maneuvered the heavy devices into the cargo hold without any protection. Due to the damage caused to some wheelchairs during this process, some airlines are now denying all taller powered wheelchairs for air travel, leaving many passengers excluded from air travel on aircraft such as the Boeing 737. **However, a new tipping securement and protection system has been designed and tested to mitigate this problem. A Padded Tipping Plate should be adopted by air carriers to ensure equal access to air travel for passengers with disabilities.**

Fitting powered wheelchairs into aircraft

Powered wheelchairs provide essential mobility for many Americans. Such devices are custom-designed for the health and safety of the user and can often exceed the price of a car. Without one's personal wheelchair, many people are immobile and in danger of serious, life-threatening injury if they are unable to sit in their custom-molded seating system. A powered wheelchair is an expensive, heavy (typically 300–450 lb), and essential medical device that deserves proper care and handling during transport.



Cross section of a Boeing 737 showing that a powered wheelchair is unable to enter the cargo hold in the upright position

However, most powered wheelchairs will not fit into aircraft cargo holds while sitting upright on over half of US flights. For example, the popular Boeing 737 is designed with a cargo door that provides only 35 inches of vertical clearance, which may be further reduced by airline working clearance policies. Therefore, most powered wheelchairs must be tipped on their side to be maneuvered into these shorter cargo holds. Depending on the method of tipping, this can present challenges to both air carriers and passengers who must travel with their powered wheelchairs

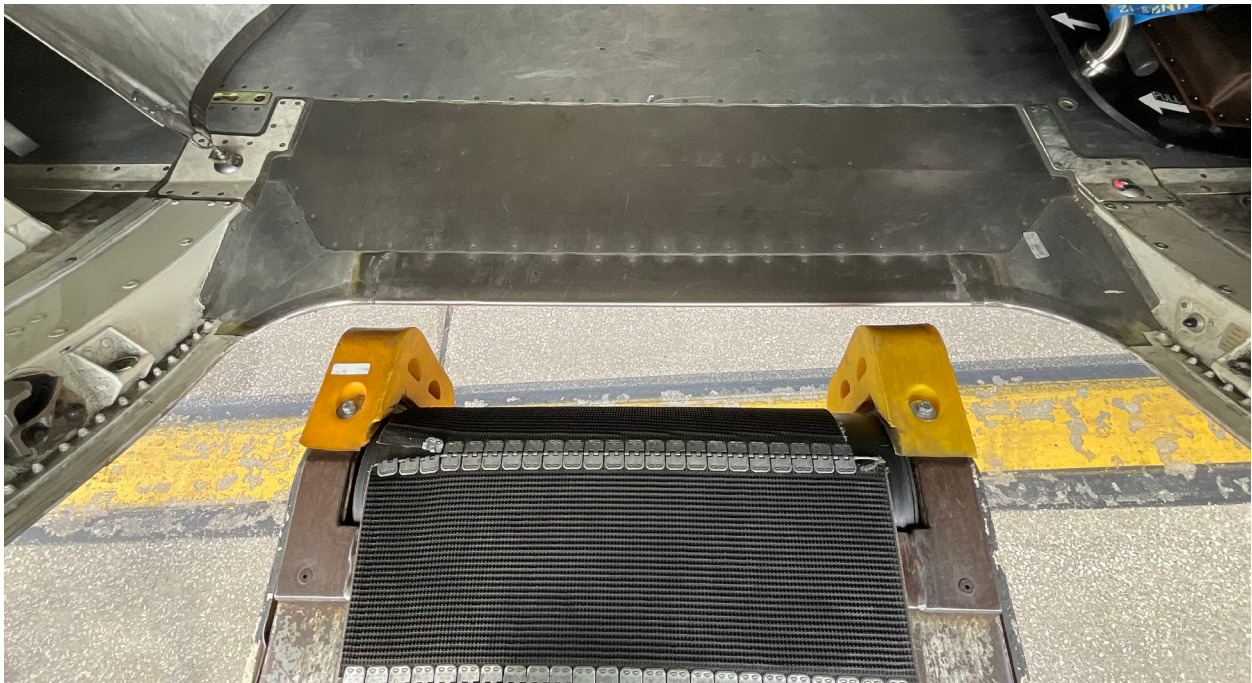
Faulty methods

Existing procedures for maneuvering heavy powered wheelchairs in and out of aircraft such as the Boeing 737 have not significantly changed over the past 40 years. Typically, either four ground crew agents transfer a powered wheelchair to the belt loader by manually lifting the heavy device or by using a mechanical lift, such as the KCI wheelchair trailer lift. Such lifts reduce damage caused by manual lifting of heavy powered wheelchairs. These lifts also contain an inner tray to carry the wheelchair onto and up the belt loader, as shown below, and have already reduced the number of falls from the belt loader when loading powered wheelchairs upright. Such trays also bridge the gap between the belt loader and the cargo hold.



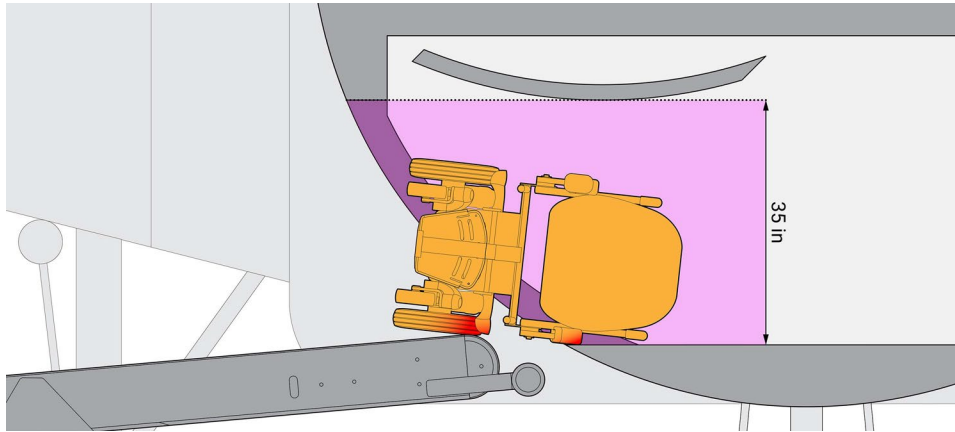
Example of a KCI powered wheelchair trailer lift barge being transferred onto belt loader

However, if the upright powered wheelchair is positioned on the belt loader without any type of loading tray, the tires of the wheelchair sit on the belt, which is often narrower than the wheel base of the powered wheelchair. When the belt starts moving, this configuration can cause the wheelchair to twist and fall off the belt loader, destroying the expensive medical device. At the top of the belt loader, the wheelchair must cross a wide gap between the belt loader and the cargo door sill, which can potentially cause damage for wheelchairs in any position.



Belt loader positioned at Boeing 737 rear cargo door sill

If the upright wheelchair is taller than the cargo door, the device is then tipped onto its side at the top of the belt loader. The wheelchair is then maneuvered across the gap between the belt loader and cargo door and into the cargo hold, where it may need to remain tipped on its side if the cargo hold ceiling is shorter than the device in its upright configuration.



Cross section of a Boeing 737 showing a tipped powered wheelchair being transferred from the belt loader into the cargo hold without any protection for the wheelchair or the aircraft

Without any protection, the weight of the tipped wheelchair is not evenly distributed and specific components on the wheelchair are overloaded. In addition, without proper securement, weaker components, such as the seating system or plastic shrouds, often bear significant loads during handling, similar to trying to move a parked car by lifting the body of the car, rather than lifting the frame underneath. The wheelchair may also potentially fall into the gap between the belt loader and cargo door, potentially damaging both the wheelchair and the aircraft.

Decades of tipping powered wheelchairs for air travel has resulted in damage to some wheelchairs. Although high rates of damage to luggage is not a new problem to the airline industry, the repercussions of damage to wheelchairs can be more serious. The owner of the damaged wheelchair faces challenges in mobility and transportation, as well as the potential for injury without their customized seating system. Air carriers are burdened with fines and the cost to repair or replace the damaged powered wheelchair.

Due to the lack of proper handling procedures, some air carriers are now reluctant to tip heavy powered wheelchairs.

The real problem

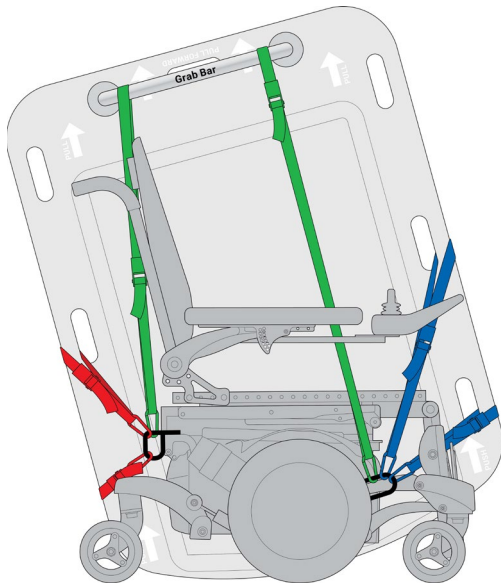
Tipping a powered wheelchair is not the problem; the existing wheelchair tipping procedures are the problem. While airlines have designed solutions to protect upright powered wheelchairs for air travel, such as wheelchair lifts and trays to safely transfer powered wheelchairs between tarmac, belt loader, and aircraft, nothing has been done to enable powered wheelchairs to be safely tipped for loading into 737 and other aircraft with lower height baggage doors. Despite the potential danger of current tipping methods, powered wheelchairs are strong and capable of being tipped and moved on their sides when protected. All powered wheelchairs have gone through rigorous strength and durability testing. **Ultimately, damage to powered wheelchairs does not occur because a powered wheelchair is not strong enough to travel when tipped on its side, but is due to poor handling procedures that do not protect the tipped wheelchair.**

A solution to the problem of faulty tipping methods must take into account the actual problems. Damage occurs to tipped powered wheelchairs during air travel as a result of the following issues:

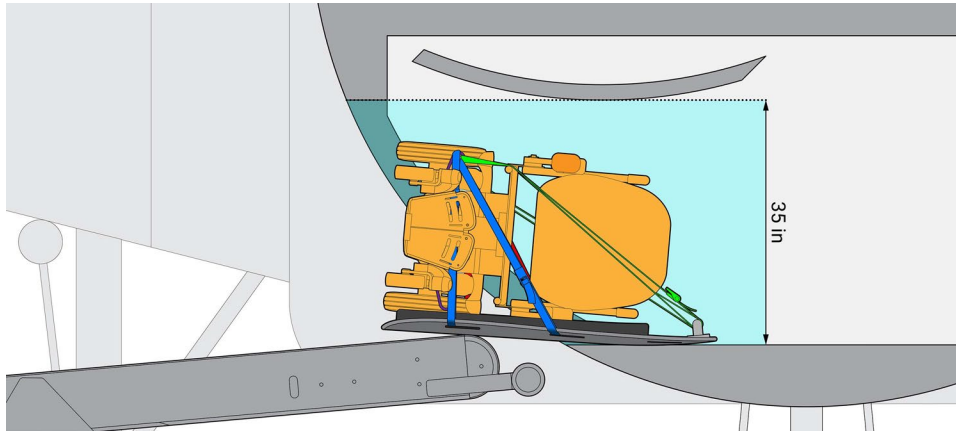
1. The tipped wheelchair is not protected
2. The tipped wheelchair is pulled or pushed using the seating system
3. The tipped wheelchair falls from the belt loader
4. Weaker removable components are not removed from the wheelchair prior to tipping and are thus broken or lost during transit

Restricting air travel only to passengers whose powered wheelchairs can fit through a cargo door when sitting upright is unnecessary, ignores the real issues, and will significantly reduce the number of available flights and destinations for people who require the use of taller wheelchairs. A better solution that addresses the real problem is needed. **Providing equal access to air travel for people with disabilities requires a safe and simple procedure to load and unload powered wheelchairs in the tipped configuration.**

A better solution



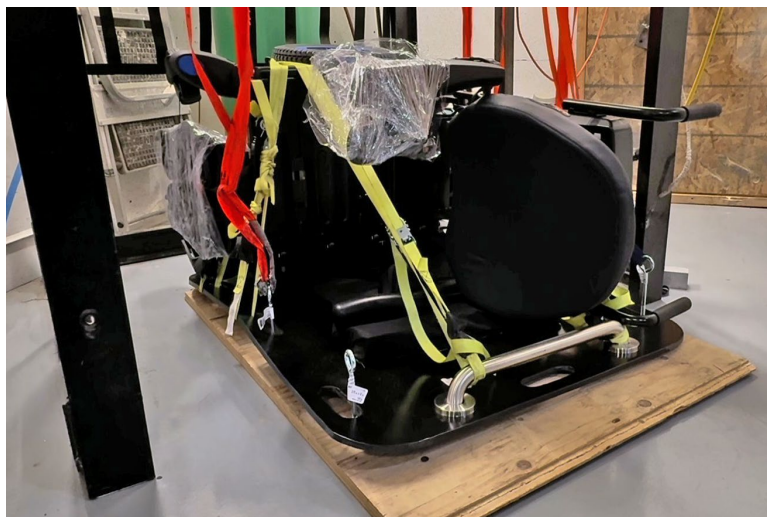
Beneficial Designs has designed a solution to provide securement, protection, and maneuverability for powered wheelchairs that must be tipped on their side to fit into aircraft cargo holds. The new **Padded Tipping Plate (PTP)** technology holds onto and supports the strong power base and seat frame structure of a powered wheelchair at its intended securement locations, enabling the device to be safely tipped onto its side and transported while in the tipped position. Along with the PTP, the strong structure of the chair is capable of bearing the weight of the wheelchair while tipped on its side.



Cross section of a Boeing 737 showing a tipped powered wheelchair being transferred from the belt loader into the cargo hold using a Padded Tipping Plate

Lab tested

Testing has validated this new device as an effective technology to protect and safely handle heavy powered wheelchairs tipped on their sides during air travel. The Beneficial Designs ANAB-accredited wheelchair test laboratory has conducted standard RESNA wheelchair standards drop testing on heavy powered wheelchairs from multiple manufacturers in the tipped position, while attached to a Padded Tipping Plate. The 6,667-cycle RESNA drop test in the upright position with a full-weight test mannequin simulates 5 years of normal wear and tear and is the most rigorous testing procedure currently applied to every powered wheelchair. **When each tipped powered wheelchair and Padded Tipping Plate package was dropped at the same 2-inch height for 6,667 cycles, along with all pre and post-test procedures, the wheelchair remained protected without a scratch.**



Drop testing a tipped 389 lb. powered wheelchair attached to the PTP

Batteries

Installed batteries are also able to be tipped on their sides. Non-spillable wheelchair batteries meeting IATA requirements are tested in all orientations. As required by RESNA and IATA, non-spillable batteries have been required to be installed in powered wheelchairs for over 27 years. These non-spillable batteries may be safely tipped using the PTP. Any other type of battery may be removed according to DOT requirements and the wheelchair can be tipped with a PTP.

Secured and protected

Tipping any powered vehicle requires holding onto the frame structure of the vehicle for securement and protection. Automobiles are regularly transported when secured by holding onto the frame structure. A powered wheelchair is designed with four anchor points that are connected to the strong frame structure. These anchor points are designed for securement in motor vehicles and are crash tested to 20-g test loads while the powered wheelchair remains occupied with a weighted test mannequin. The flexible Padded Tipping Plate is strapped and secured to the two anchor points on the side of the powered wheelchair opposite the joystick. Prior to final tightening of the straps and tipping, the wheelchair can continue to be driven wherever necessary.



Figure 1 Padded Tipping Plate attached to a powered wheelchair

Once the straps are fully tightened and secured, one person can safely tip the heavy powered wheelchair. High-tech padding provides cushioning between the Padded Tipping Plate and the powered wheelchair, distributing the weight of the wheelchair and protecting the drive wheel, frame, arm support, and back support while tipped, as demonstrated by the extensive RESNA drop testing.

The Padded Tipping Plate eliminates damage that could result from lifting or moving the powered wheelchair using the seating system or other weaker components by enabling efficient movement of the tipped wheelchair. The sides and front of the Padded Tipping Plate flex upwards off the ground, creating a movable tray or “sled” that facilitates safe and easy sliding and pivoting over uneven surfaces. As a result, the tipped side of the powered wheelchair is prevented from contacting any surfaces during movement, while the full seating system remains safe within the perimeter of the Padded Tipping Plate.



The front and sides of the PTP flex upwards

Loading safely

Rather than tipping the powered wheelchair on the belt loader, the Padded Tipping Plate allows tipping to occur prior to loading onto the belt loader. Once tipped, the powered wheelchair remains safe and ready to be loaded. The tipped powered wheelchair attached to the PTP can be manually or hydraulically lifted to a baggage trolley, from which the package can be easily moved onto the belt loader.



Tipped PWC-PTP package ready to be transferred from baggage trolley to belt loader

Once on the belt loader, the package can ascend with little to no guidance up to the cargo door and into the cargo hold. The low center of mass and evenly distributed surface of the tipped powered wheelchair-PTP package resists rolling or tipping, keeping the powered wheelchair safe and stable on the belt loader.



Tipped PWC-PTP package ascending belt loader

The package then easily transitions across the gap between the belt loader and the cargo door, sliding safely into the cargo hold. The moving belt helps to move the device, while ground crew members can push on the strong base frame or wheels of the wheelchair and pull on the grab bar at the front of the tipped package.



Belt loader pushes PWC-PTP package into a Boeing 737 cargo hold



Loading the PTP-PWC package into a CRJ-200

Once inside the aircraft, the tipped powered wheelchair-PTP package is rotated for positioning and securement, using the PTP hand holds or the securement straps. As a result, ground crew members no longer have to handle parts of a powered wheelchair that are not designed to move the weight of the device.



Ramp agents position the PWC-PTP package for air travel in a Boeing 737 cargo hold

Unloading safely

The unloading process is similar to the loading process as the powered wheelchair-PTP package transitions onto the belt loader, where it descends and is then transferred to a baggage trolley or a hydraulic lift. The powered wheelchair-PTP package can be manually or hydraulically lowered to the ground into the upright position for disassembly and preparation of the wheelchair for use.



Unloading the PWC-PTP package from a Boeing 737



Manually lowering the PWC-PTP package to the ground from a baggage trolley and a KCI wheelchair trailer lift



Using a KCI wheelchair trailer lift to transfer the PWC-PTP package

Field tested

The Padded Tipping Plate has been successfully used to transport a 389 lb. powered wheelchair and a 440 lb. powered wheelchair across the United States on multiple Boeing 737 aircraft, as well as in the upright configuration on an Airbus A319. This new technology was also tested with United Airlines at O'Hare International Airport and was successfully loaded into and out of a Boeing 737 and a CRJ-200.

A RESNA AT-1 Section 4 air travel configuration card was attached to the wheelchair along with an image of the battery label verifying IATA compliance, while a PTP instructional card provided ground crew members illustrated steps to follow for the loading and unloading procedures. Using standard powered wheelchair loading equipment or baggage trolleys, carrier agents experienced no problems loading and unloading the powered wheelchair-PTP package. After each flight, ground crew members met us in the baggage area with the powered wheelchair in order to ask more questions about the Padded Tipping Plate, telling us how the PTP made handling of a heavy powered wheelchair much easier.

Carrying the PTP

The Padded Tipping Plate may be mounted and strapped to the backside of a powered wheelchair to carry to and from the airport. The plate rests on the rear casters and the straps attach to the front of the seat frame. The user of the powered wheelchair may sit in and drive the wheelchair while the PTP is attached to the back.



The PTP rests upright on the rear casters of a powered wheelchair



Top and bottom straps hold the PTP against the rear side of the powered wheelchair

Moving forward

Damage to tipped powered wheelchairs during air travel has occurred because of inadequate and inefficient procedures. Powered wheelchairs are strong enough to be transported on their sides during air travel when properly secured to and handled with a Padded Tipping Plate. This new technology is necessary to ensure safe and proper wheelchair handling procedures for ground crew and equal access to air travel for passengers who require the use of a powered wheelchair. Damage to wheelchairs during air travel will significantly decrease as a result of this better solution. **Beneficial Designs is ready to test additional powered wheelchairs if necessary to verify that all powered wheelchairs will be able to successfully travel in the tipped configuration when protected with a Padded Tipping Plate.**