



REAR-FACING WHEELCHAIR SECUREMENT FINDINGS AND BENEFITS SUMMARY

WHITE PAPER

**Q'STRAIT
FEBRUARY 12, 2016**



A Look at Rear-facing Wheelchair Securement

Rear-facing wheelchair passenger securement, already used on buses throughout Europe and Canada, could be on the verge of wider acceptance in the United States. That's because bus rapid transit (BRT) — the modern transportation alternative being explored or implemented in many localities — needs a faster and easier securement system than the traditional 4-point tie-down that has been the U.S. standard for many years.

BRT promises to speed daily commutes with higher capacity vehicles, restricted lanes and fewer stops. Rail-like features such as off-vehicle fare collection, platform-level boarding and multiple entry and exit doors can increase efficiency and keep dwell times to 1 or 2 minutes. But if a vehicle operator leaves the seat to perform a 4-point wheelchair securement, stop times can stretch to 4 minutes or more.

Rear-facing Securement Meets the Needs of BRT

Rear-facing securement, as implemented in Europe and Canada, is intended to reduce or eliminate operator intervention — though it must be noted some approaches don't achieve that goal. In the usual design, wheelchair passengers position themselves in a securement station where they face the rear of the bus and back their chair as close as possible against a padded backrest. As typically deployed, there are no belts or other chair restraints, though these can be provided. The backrest keeps the chair from rolling to the front of the vehicle, while wall-mounted handrails or retractable straps and aisle-side stanchions or foldable armrests are among the equipment provided to keep the chair within the station during normal vehicle maneuvers. The chair's own brakes are expected to keep the chair from sliding within the securement area.

In the U.S., the Americans with Disabilities Act already allows rear-facing wheelchair securement systems on buses over 22 feet long, provided these are in addition to a forward-facing 4-point system. But the law also specifies that both forward- and rear-facing securement systems must limit wheelchair movement to no more than 2 inches during normal operating conditions. This is a technical challenge — and, as we'll see later, a safety challenge as well — in widespread use of rear-facing securement in U.S. BRT systems, but not an insurmountable obstacle.

Real Benefits to Transit Systems and Passengers Alike

In its 2003 publication *Use of Rear-Facing Position for Common Wheelchairs on Transit Buses (TCRB Synthesis 50)*, a comprehensive review of research, engineering tests and on-the-road experience, the Federally-sponsored Transit Cooperative Research Program identified multiple benefits of rear-facing securement for both transit systems and wheelchair passengers.

Benefits for the transit system result primarily from there being *less need for operators to leave their seat*:

- Shorter dwell time at stops – the rear-facing securement process can take less than a minute
- Little or no involvement of bus operators
- Less likelihood of operator injury
- Fewer instances of operators being placed in awkward working positions
- Reduced maintenance costs through less replacement of straps

Benefits for wheelchair passengers derive primarily from their needing less help from others:

- Independent and dignified use of the transit system
- Faster boarding and disembarking
- Less delay caused to other passengers – and less resulting embarrassment for the wheelchair user
- Reduced need for physical contact with other persons
- No need for special attachment hardware on the chair to use the securement station
- Less damage to the chair or scooter from the securement system

But one of the most important benefits of the rear-facing approach is passenger safety. With the back panel using the vehicle's mass to absorb the forces of severe braking or a frontal collision, a *properly secured* rear-facing position is far safer than front-facing. This is same reason that laws or guidelines around the world require infants and small children to ride in rear-facing car seats.

Rear-facing Securement Still Has Room for Improvement

While transit system experience to-date confirms that rear-facing securement is fast enough to help keep buses on time, full-scale testing funded by the Transportation Research Board's Transit IDEA Program dramatically demonstrated that proper implementation of such a system is key to passenger safety. After testing several types of manual wheelchair, power wheelchair and scooter in three rear-facing securement station configurations in six types of buses, here's what researchers wrote in their 2005 report *Assessment of Rear Facing Wheelchair Accommodation on Bus Rapid Transit*:

“During normal driving, the manual chair would rotate during turns, the three-wheel scooter would tip during the stronger turns, and the power wheelchair was stable under all normal conditions. During extreme maneuvers, ***all three types of wheelchairs could be made to tip over if provided with a backrest or wall on only one side*** (emphasis added). The wheelchair would tip over during extreme turns when rear facing and during a panic stop when side facing. The three-wheel scooter would tip during turns when rear facing and during a panic stop when side facing. The power wheelchair would tip over backwards during an extreme turn when side facing.”

While the researchers concluded that rear-facing securement with a backrest and aisle-side armrest will prevent catastrophic motion for all types of wheelchairs under all driving conditions in which no collision is involved, they did note that “during normal driving conditions, users of manual wheelchairs and three-wheel scooters ***must expect some normal movement of their wheelchairs***” (emphasis added).

As for securing the rear-facing position to eliminate movement, neither the European grab bar approach nor Canada's use of compartmentalization stanchions or flip down arms satisfy current U.S. ADA requirements. U.S. transit systems that have experimented with Canadian style rear-facing compartments have found that the wider ADA minimum clear space for wheelchairs (30 inches vs. 27) results in a loss of seating from having to place the securement stations on the same side of the aisle and near the center door. Adding a stanchion or flip down arm creates impassable obstacles for other passengers when two wheelchairs are present side-by-side. Or the stanchion becomes the first stop for ambulatory passengers, interfering with flow at subsequent stops.

All of this is consistent with the TCRB's findings that “one remaining issue is that there still is no ideal solution to prevent the mobility aid from tipping or moving into the aisle within the rear-facing system.”

The Ideal Solution Arrives

More recently, researchers at the Rehabilitation Engineering Research Center in the University of Pittsburgh's Department of Rehabilitation Science and Technology compared the usability, comfort, and independent use by wheelchair passengers of a prototype automated rear-facing wheelchair securement system against a 4-point tie-down system.

Developed by Q'Strait together with the University of Pittsburgh, the prototype system featured a passenger-activated aisle-side arm attached to the backrest and a wall-mounted cushion plate, both of which moved laterally to secure the wheelchair in place. To disengage the system and exit the bus, the wheelchair passenger activates a wall-mounted switch.

Participants responded positively to the automated rear-facing system, scoring it higher than the 4-point tie-down system on safety and security, stability during the ride and ease of use. Passengers found the automated system to be quicker, easier and more independent to use than the 4-point tie-down system. Quantum, Q'Strait's refined and fully developed version of that automated rear-facing securement station, is now available to — and seeing adoption in — transit systems worldwide.

Conclusion

In tests and real-world experience, rear-facing wheelchair securement has been proven to deliver benefits to transit systems and passengers alike, especially in enabling wheelchair users' independent use of public transportation and in minimizing the delays, costs and risks of operator intervention.

But prevailing rear-facing securement stations do not maximize passenger safety. Both in countries where rear-facing is already common practice and in the U.S. where this approach provides an attractive solution for emerging BRT, advanced automated rear-facing securement technology can help BRT cut commuting times while assuring wheelchair passengers of a safe ride.

Further Reading

- *Assessment of Rear Facing Wheelchair Accommodation on Bus Rapid Transit*, Dr. Katharine Hunter-Zaworski and Dr. Joseph R. Zaworski, Oregon State University, Corvallis, OR. Published by Transportation Research Board, Transit IDEA Program, 2005.
- *Use of Rear-Facing Position for Common Wheelchairs on Transit Buses: A Synthesis of Transit Practice*; *TCRP Synthesis 50*; Transportation Research Board, Transit Cooperative Research Association; 2003.
- *User Evaluation of Three Wheelchair Securement Systems In Large Accessible Transit Vehicles*; Linda van Roosmalen, PhD; Patricia Karg, MS; Douglas Hobson, PhD; Michael Turkovich, MS; Erik Porach, BS; Department of Rehabilitation Science and Technology, Rehabilitation Engineering Research Center on Wheelchair Transportation Safety, University of Pittsburgh, Pittsburgh, PA; Published in *Journal of Rehabilitation Research & Development*, Volume 48 Number 7, 2011.



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