

Collaborating on Toll Plaza Safety

U.S. toll facilities play a vital role in meeting the nation's transportation needs. They also present common safety challenges for both motorists and toll workers.

To better understand toll safety, the Federal Highway Administration (FHWA) conducted a study of toll plaza safety in coordination with the International Bridge, Tunnel and Turnpike Association and the International Brotherhood of Teamsters.

The study's objectives were to identify toll safety best practices and share them as widely as possible.

The resulting report, *Strategies for Improving Toll Plaza Safety*, identifies nearly 100 safety strategies in use across America.



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Strategies for Improving Toll Plaza Safety



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of the innovative ideas in *Strategies
for Improving Toll Plaza Safety*.

CONCLUSIONS

The purpose of this study was to examine the safety of the facilities for toll collectors and other workers (such as maintenance workers) who work in and around the facilities, as well as for motorists traveling through toll plazas. Information was gathered through a survey, telephone interviews, and site visits, revealing nearly 100 separate strategies that are being used at toll plazas across the country that have the potential to improve safety for workers and motorists. These strategies span a wide range of issues and tackle a wide range of safety challenges.

In an effort to help readers to identify the strategies best suited for their needs, the report presented each strategy along with comments from practitioners on any concerns they may have seen with a particular strategy (e.g., cost), and any practical constraints that may exist (e.g., plaza design). In addition, each strategy was ranked in terms of effectiveness. These rankings were obtained from participants in a Toll Facility Safety Study Workshop, held in McLean, Virginia, in June 2007. Participants included both management and labor and represented 21 tolling agencies from across the country.

The report also provided information about two overarching strategies, training and a culture of safety, which address multiple safety issues rather than focus on one issue in particular such as speeding.

The report concluded with a discussion of ways to address safety while using open road tolling. As many agencies are making the move toward some form of open road tolling, many are also discovering some new safety challenges along the way. Some of the safety impacts that were uncovered through this study were also noted.

As the operating conditions, culture, etc., are different at each agency and even at each toll plaza in some cases, the strategies identified may not be applicable to all situations. The strategies in this report were therefore presented primarily as ideas for agencies to consider when seeking ways to improve safety for workers and motorists at their toll collection facilities.

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Another new safety challenge that hybrid-ORT has introduced is the issue of managing queue spillback onto the mainline from the cash payment plaza. Preventing this involves both design and operational solutions. For the Illinois Tollway, which recently converted all of its mainline plazas to hybrid-ORT facilities (a cash payment plaza separated from the mainline traffic by physical barriers), this has been a challenge that it has had to actively monitor and manage. At the planning stage, the agency modeled each of its plazas to estimate queue lengths at various times of the day and designed longer deceleration lanes at plazas where they expected longer queues. As an ongoing effort, it has been monitoring the number of cash transactions occurring at each plaza and performing targeted marketing to residents in areas near plazas with a high percentage of cash transactions in an effort to increase adoption of ETC, thereby reducing queues. The issue of queue spillback is expected to be less of a concern over time as more and more customers switch to electronic payment, but is likely to be an initial challenge for any agencies switching to ORT.

Another drawback noted by the Illinois Tollway is that the switch to hybrid-ORT has resulted in cash lanes having a higher percentage of inexperienced users. The agency feels that this may have increased the amount of erratic driving behavior at some of its plazas as the motorists who are less familiar with the facility can no longer "follow" the experienced motorists through the plaza.

A final challenge associated with hybrid-ORT is that vehicles that are not ETC-equipped may stop in travel lanes due to confusion over how to make payment. One agency that faced this challenge was the PANY/NJ, which recently changed the lower deck of the George Washington Bridge over to ETC-only during nighttime hours (the plaza is equipped with an automated enforcement system that charges customers by mail and the plaza is unstaffed at night), and the agency initially encountered a wide range of unsafe maneuvers (e.g., vehicles turning around, backing up, cutting across the plaza). To address these issues, PANY/NJ added signs at each booth that say "YOU WILL BE BILLED" and added an intercom system to provide customers access to supervisory staff on the staffed upper deck toll plaza. PANY/NJ also changed its signs to direct non-ETC customers to the right side of the plaza where they will pose less of a danger to other motorists in the event that they do come to a stop or attempt other erratic behavior. The sign that the agency has evolved to at the right side of the plaza reads "ALL OTHERS."

Safety Awareness Programs

One agency has a Toll Plaza Safety Awareness Program. This is a month-long program run twice a year by the agency together with its dedicated police force and the state police. Police perform various operations at the toll plaza, including seatbelt checks and ETC speed enforcement. Additional signs, such as portable changeable message signs, are used as needed. The agency reported that toll operations are not negatively impacted and that the program seems to reduce unsafe driving behaviors in the vicinity of plazas, but that the benefit is only short-term.

MAINTAINING SAFETY WHILE USING OPEN ROAD TOLLING

By a strict definition, open road tolling (ORT) refers to fully-automated electronic tolling in an “open road” environment, allowing vehicles to travel at highway speeds when passing through toll collection points. Under this definition, customers must either possess an electronic transponder, or be assessed toll charges via license plate recognition technology. By this strict definition, safety is improved as there is inherently lower exposure: there are fewer worker-vehicle interactions since there is no plaza, and fewer vehicle-vehicle conflicts since less traffic is traveling through a plaza; also, noise and emissions are lessened due to the reduction in vehicles starting and stopping.

Beyond this strict definition of ORT, a number of agencies have implemented what might best be termed hybrid ORT operations: that is, they include a combination of mainline, full-speed ETC lanes along with fully-separated cash lanes. Typically, cash-paying customers must exit the roadway or shift to a separated toll plaza in order to make cash payment at a traditional, staffed plaza. An example of this is shown in Figure 37 above. This type of arrangement can also present some new challenges that are worthy of discussion.

One potential safety-related drawback to ORT (both fully “open road” and hybrid-ORT) is equipment maintenance since, in most cases, repairs that take place over the roadway would require that all lanes be closed. However, the Florida Turnpike has addressed this concern with a unique overhead gantry design that allows maintenance workers access to equipment without closing lanes or disturbing traffic (Figure 38). The gantry provides an area large enough for maintenance employees to work above the roadway, and all ETC equipment is positioned on a lever that allows workers to pull the equipment up into the work area. Additionally, there is a screen shielding workers from passing motorists to avoid distraction, and there is a fine mesh material at the base of the gantry below the work area to prevent the danger of debris dropping onto the traffic below during maintenance activities.



Figure 37. Open-Road Tolling in Illinois



Figure 38. Florida Turnpike’s Overhead Gantry for ORT Allows for Maintenance Activities without Road Closure

Employee Safety Meetings

Several agencies have regular employee safety meetings, typically held on a monthly or quarterly basis. Topics of safety meetings include reminders about safety procedures for lane crossing and lane closing; procedures for handling robberies; procedures for emergency situations; information on preventing slips, trips, and falls; and information on stretches to prevent repetitive stress injuries. Several agencies take the opportunity at scheduled meetings to review a recent incident and to review the proper steps employees should take to prevent a similar incident from occurring again.

Safety Award Programs

Many toll agencies use award programs as part of their overall strategy to reduce worker injuries at toll plazas. Most awards are presented annually. One agency presents an annual "Plaza Award" to any plazas where no one has been injured over the past year and an annual "Turnpike Award" to any turnpikes that have had no employee injuries.

Another agency gives employees awards for preventing possible injuries. This same agency will also reprimand employees for not calling out safety concerns. For example, if one employee sees another employee crossing a lane without a vest and does not try to correct it, not only does the employee not wearing the vest receive a reprimand, but so does the employee who witnessed the violation and did nothing to correct it.

Safety Incentive Programs

Safety incentive programs are also a fairly common technique for promoting a culture of safety. These types of programs reward employees for passing safety audits and maximizing days without injury either with cash bonuses or with points that employees can use to purchase items out of catalogs (examples of this are shown in Figures 36 and 37). In some cases, the program works such that an entire plaza is rewarded as a group, thus introducing the factor of peer pressure to maintain good safety records. While successful, these programs are not without controversy. One concern is that they must be constantly re-invented to remain fresh and capture the imagination and interest of the staff. Another concern is that they may actually lead to under-reporting or treatment of legitimate injuries and/or safety violations and can present challenges to management-worker relations.

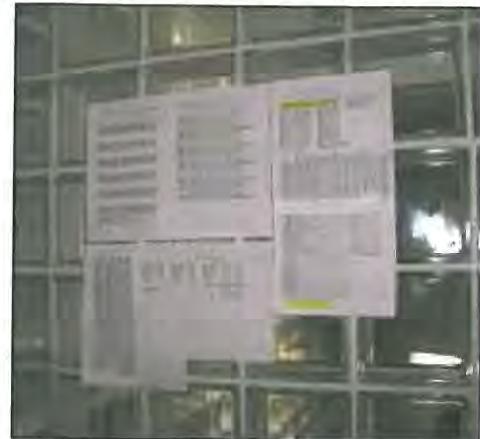


Figure 35. Tracking Employee Performance Publicly can Be an Incentive for Employees to Follow Safety Procedures



Figure 36. Sign in Plaza Office Reminds Employees about Safety Record

OVERARCHING SAFETY STRATEGIES

This section presents findings according to two major types of strategies that could be viewed as over-arching: *training*, and an overall *culture of safety*. This section provides examples of ways in which training and a strong safety culture have helped agencies improve safety at their facilities.

TRAINING

The use of training as a safety mitigation strategy varied widely from agency to agency. At one end of the scale were those agencies that offered short, on-the-job safety sessions taught as part of a general course focused primarily on revenue collection, with minimal to no re-training. At the other end of the scale were agencies that offered intensive safety training sessions upon hiring, used professional trainers and props such as safety videos, and undertook periodic refresher courses and annual “safety” or “toll training” days. One agency had undertaken a unique approach by offering web-based training that workers could access from break rooms. Another agency required all maintenance staff to go through work zone safety classes and flagging classes. Yet another agency requires crossing training for *all* workers (even vendors who put out ads at plazas).

In terms of safety training topics, most covered safety procedures at toll plazas including lane crossing, lane closing, hazardous materials, emergency situations, and robbery. Some agencies determine their safety training topics based on injury statistics from the previous year.

SAFETY CULTURE

The final set of mitigation strategies refer to something that was ever-present during the various site visits but almost intangible to quantify: a culture of safety. Establishing a safety culture involves both setting an overall tone of safety (e.g., by featuring safety as the first topic in annual reports), and undertaking a series of small, often changing actions (e.g., posting rotating safety reminders in break rooms, displaying safety reminders around the workplace such as the floor mat shown in Figure 34).

Focus on Safety for Maintenance Staff

One way that many agencies ensure that safety is a priority is that they place a higher priority on safety-related maintenance items than on other requests.

For example, one agency records such safety-related requests on red paper versus the regular white paper used for other requests.

Safety Committees

Most agencies that the team visited have some type of safety committee in place. Those that placed the greatest emphasis on these committees ensured representation from all spectrums of the workforce – from collectors to senior managers – and often established sub-committees at each plaza or for a small group of plazas.

Safety Audits

Two agencies that the team visited made use of random safety audits, with one using internal staff to conduct the audits and one using an outside firm (since plaza personnel were able to identify the internal auditors). Both of these agencies also supplemented the formal audits with more frequent “self-inspections” by plaza managers and supervisors.



Figure 34. Floor Mat in Plaza Building Reminds Employees to “Think Safety”

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹²	Concerns / Constraints
Install a PA system at unmanned booths to enable communication with drivers.	In order to address drivers that stop at unmanned booths some agencies have installed public address systems.	<ul style="list-style-type: none">Considered to be very effective by agencies that have implemented.Ranked 6th of 16 strategies considered by workshop participants for reducing driver confusion.	<ul style="list-style-type: none">May not be cost-effective.May not work very well in noisy environments.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹²	Concerns / Constraints
Conduct public education campaign to reduce electronic tag "wavers."	Use billing statements, advertising, etc. to warn people of the possibility that their toll will not register if they wave their ETC tags as opposed to using a proper windshield mount.	<ul style="list-style-type: none"> Agencies that have undertaken advertising question the effectiveness. Ranked near the bottom of solutions considered for reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> Advertising can be costly. General consensus that the patrons do not pay attention to such warnings.
		<p><i>Increasing Conspicuity of Facilities and Workers</i></p>	
Use signs to warn drivers about the potential for workers in the roadway.	Many agencies use signs such as "SLOW DOWN - PROTECT OUR WORKERS" or pedestrian crossing signs to protect workers.	<ul style="list-style-type: none"> Ranked 3rd of 30 solutions considered by workshop participants for reducing driver exposure. Collectors like them. 	<ul style="list-style-type: none"> Adds to visual clutter and driver confusion.
Use white strobe lights at plazas to highlight facilities during inclement weather.	A number of agencies use special lighting, such as strobe lighting, to increase the conspicuity of toll plazas, especially during inclement weather such as fog.	<ul style="list-style-type: none"> May be most effective in areas with severe weather such as fog. Ranked 9 of 16 (tied) strategies considered for reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> None identified.
		<p><i>Reducing the Incidence of Vehicles Stopping or Backing in High-Speed Lanes</i></p>	
Use a tall barrier wall to prevent motorists in high-speed lanes from stopping and crossing lanes to staffed booths.	Drivers who inadvertently enter ETC lanes or whose transponder malfunctions often exit their vehicles and cross lanes to reach staffed booths. The installation of taller barrier walls can help to cut down on this dangerous practice.	<ul style="list-style-type: none"> Agencies that have implemented this practice have found it to be very effective in preventing customers from both crossing lanes and from stopping in the first place. Ranked 2nd of 16 (tied with one other) strategies considered for reducing driver confusion by workshop participants. As a by-product, may cut down on rubber-necking. 	<ul style="list-style-type: none"> May limit ability to detect incidents and monitor ETC lanes. Questions as to effectiveness of approach. Some concerns about legislative consequences of not providing warnings of violation prosecution.
Eliminate violation warning signs.	Some agencies have eliminated or reduced the conspicuity of toll violation warning signs in ETC lanes to discourage non-ETC drivers from stopping and either backing up or exiting their vehicles to reach a staffed booth.	<ul style="list-style-type: none"> Ranked second last (tied) of all strategies considered for reducing driver confusion by workshop participants. Practice may help to reduce unsafe actions, but does not eliminate them. 	<ul style="list-style-type: none"> Doubts as to the effectiveness of such signs. Relatively low cost. Ranked 7th (tied) of 16 solutions considered for reducing driver confusion by workshop participants.
Post "STAY IN VEHICLE" signs at booths.	Such signs should help to prevent drivers from exiting their vehicles in ETC lanes and attempting to walk to staffed lanes.	<ul style="list-style-type: none"> Creates additional sign "clutter." Questions as to whether or not patrons actually read them. 	

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹²	Concerns / Constraints
Use digital signs in advance of plaza to indicate which lanes are currently ETC.	For plazas where lane configurations change throughout the day at least one agency has implemented the use of digital signs in advance of the plaza that indicate which lanes are ETC.	<ul style="list-style-type: none"> Ranked 2nd of 16 strategies considered for reducing driver confusion by workshop participants. Helps to move lane selection decision back to mainline lanes. 	<ul style="list-style-type: none"> Can create additional confusion. Must be actively updated. Added maintenance costs and issues.
Position maintenance trucks with flashing lights and flaggers at end of long queues.	Use high visibility maintenance trucks and / or flaggers at the end of long, unexpected queues that extend beyond the sight of the plaza.	<ul style="list-style-type: none"> Considered to be very effective when implemented, but ranked low by workshop participants. 	<ul style="list-style-type: none"> Resource-intensive.
Create a buffer lane between bi-directional traffic where physical barriers do not exist.	A number of plazas change the number of bi-directional lanes throughout the day and thus do not have physical separation between the travel directions. The use of a buffer lane (or unused lane) can help to separate these opposing traffic flows.	<ul style="list-style-type: none"> Felt to be an effective strategy if traffic demands and plaza capacity support taking one lane out of operation. Tied for 15th of the 16 strategies considered for reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> Many plazas do not have the excess capacity to support this.
<i>Informing Motorists of Lane Closures</i>			
Include signs on gates upstream of the plaza to convey to motorists when a lane is closed.	While a number of agencies use no more than a traffic cone to indicate lane closures, others use more conspicuous indicators such as STOP signs, LANE CLOSED signs, large red X signs, etc.	<ul style="list-style-type: none"> Signs are felt to work best in concert with physical gates. Strategy received the 5th highest (out of 16) number of votes for most effective strategies by workshop participants. 	<ul style="list-style-type: none"> Signs may be difficult to affix current gates. May be expensive to retrofit.
<i>Mitigating Sensory Overload</i>			
Determine sign messaging based on feedback from motorists.	Make use of surveys, focus groups and other formal feedback mechanisms to design and select sign messages.	<ul style="list-style-type: none"> Ranked last of the solutions considered for reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> Costly. Difficult to capture visitors' inputs.
Ban the use of advertisements on or near plazas.	Agencies have conflicting policies with regard to advertisements in and around toll plazas, with some even having ads on the booths themselves. This has created questions about information overload and caused a number of agencies to ban such signs.	<ul style="list-style-type: none"> Debates continue as to whether or not such advertisements contribute to unsafe conditions; however, the majority of agencies agree that having fewer signs contributes to increased safety. Ranked in the bottom 3rd of all strategies considered for their effectiveness in reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> Banning advertising reduces revenues.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹²	Concerns / Constraints
<i>Clearly Identifying ETC Lanes</i>			
Supplement brand name signs such as “SunPass” with generic signs such as “Pre-PAY ONLY” to label ETC lanes.	In areas with heavy visitor traffic there are concerns that many travelers may not be familiar with local ETC product names (such as EZ Pass or SunPass) and may inadvertently enter ETC lanes as a result.	<ul style="list-style-type: none"> Ranked 5th of 16 strategies considered for reducing driver confusion by workshop participants. 	<ul style="list-style-type: none"> Can add to information overload. Difficult to select the appropriate term, e.g., “Pre-PAY” may not be universally understood by drivers either.
Differentiate ETC lanes from cash or mixed lanes with special pavement markings.	A number of agencies, such as the NY State Thruway use unique pavement markings (such as purple paint) to differentiate ETC from cash or mixed lanes.	<ul style="list-style-type: none"> Strategy was ranked 4th out of 16 strategies considered to reduce driver confusion. Agencies that have implemented the approach feel that it is effective and have received positive customer feedback on the practice. 	<ul style="list-style-type: none"> Maintenance of paint / markings, especially in cold weather environments. Restricts ability to re-configure lanes.
Paint lane numbers on the pavement in advance of the plaza.	To provide drivers more time to maneuver towards the appropriate lanes within a plaza some agencies have undertaken the practice of painting lane numbers into the pavement along the approach to a plaza with corresponding numbers over the various booths.	<ul style="list-style-type: none"> Particularly effective in areas where site lines to plaza are compromised (e.g., along curves). Some agencies who have implemented the practice question its effectiveness; however, customers seem to like it (according to satisfaction surveys). Strategy was ranked in the middle of the pack (7th of 16 strategies considered for reducing confusion) by workshop participants. 	<ul style="list-style-type: none"> Concerns that it may lead to information overload.
<i>Informing Motorists of Changing Conditions</i>			
Use variable message signs (VMS) to inform drivers of plaza conditions.	An increasing number of agencies are using variable message signs on the mainline to inform drivers of unexpected traffic conditions (e.g., incidents, maintenance, etc.). Few agencies use these signs specifically for plaza conditions.	<ul style="list-style-type: none"> Effective method of informing travelers of unexpected conditions. Received the highest number of top three votes as an effective strategy for reducing driver confusion (out of 16 strategies considered). 	<ul style="list-style-type: none"> Requires active surveillance and management. Expensive to install and maintain.

¹² Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas. Note that at the workshop, the strategies discussed here were presented in a category entitled “Driver Confusion and Distraction.”

downstream of the plaza, the agency has implemented advance signing that directs drivers to the side of the toll plaza where they will need to be depending on their direction of travel downstream of the plaza. Since installing the lane designation signs, the agency has not experienced any accidents downstream of the plaza.

Increasing Conspicuity of Facilities and Workers

Some agencies are installing messages on signs and the pavement at the toll plaza to caution drivers about employee presence in the toll lanes. One agency has installed pedestrian crossing warning signs with flashing amber lights at the beginning of the toll island to caution drivers. Signs are also posted in holders on the front of the bullnose. One of the sign messages used is "SLOW DOWN - PROTECT OUR WORKERS."

Another agency has a program called "Give Them 10" that was started when ETC was introduced. The message is for drivers to slow down to 10 mph for the safety of toll plaza employees. White markings are installed in every lane each spring with the message 10 MPH.

Another innovative strategy reported by West Virginia Parkways was the installation of white strobe lighting on the canopies at all toll plazas to highlight the facilities during inclement weather. The agency feels that the strobe lighting has been helpful in ensuring that drivers will see the upcoming plaza in foggy driving conditions.

The same agency reported using maintenance trucks with flashing lights and qualified flagging personnel at the rear of traffic back-ups when the traffic volume stretches beyond sight of the plaza. This technique is used to prevent rear-end collisions at the end of the queue.

Reducing the Incidence of Vehicles Stopping or Backing in High-Speed Lanes

Some agencies have deployed mitigation strategies that are aimed at preventing vehicles from stopping in high-speed lanes. For example:

- Some agencies have installed a tall barrier wall to prevent motorists in high-speed lanes from stopping and crossing to staffed booths.
- Other agencies have removed their driver violation warning signs – feeling that it is better to lose the toll (or pursue the toll through automated enforcement) than to have a vehicle stop in the high speed lanes.
- A large number of agencies have added signs instructing drivers "DO NOT STOP" or "DO NOT BACK UP – STAY IN VEHICLE" (as shown in Figure 33).
- Others have gone so far as to add public address systems to communicate with drivers at unmanned booths so that staff can instruct motorists to stay in their vehicle and to keep moving. However, there is some debate as to the usefulness of this approach owing to noise and the impracticality of constantly monitoring the travel lanes for such situations.



Figure 33. "DO NOT BACK UP" Sign to Reduce Unsafe Motorist Behavior

Strategy Rankings, Effectiveness, and Constraints

Table 7 lists strategies for mitigating safety challenges associated with driver confusion and driver inattention, along with comments on effectiveness, concerns/constraints, and ranking.

Red X's or Green arrows to indicate lane closure status that can be changed remotely, thereby reducing worker exposure to vehicles.

Mitigating Sensory Overload

The final significant source of driver confusion identified in the site visits was simply sensory overload, or the challenge of reading, recognizing, and appropriately acting upon the multitude of messages and signs presented to a driver approaching a plaza. Among the solutions that sites have explored to combat this issue are:

- Efforts to minimize the number of signs.
- Movement towards the use of symbols (such as "\$," as in Figure 32) in lieu of, or in addition to, words (such as "cash only").
- Movement toward simplification of messages on signs.
- The placement of signs at eye level (as opposed to overhead or in-pavement).
- The use of focus groups to test different sign configurations and messages.
- The banning of advertising in the vicinity of plazas.

Mitigating Driver Inattention

In addition to the various sources of confusion inherent in the design, layout, and operations of plaza facilities, drivers also introduce their own activities that contribute to inattention and distraction. While not unique to toll plazas, many customers engage in cell phone conversations, read maps, and undertake a variety of activities that have been demonstrated to cause driver distraction and crashes on all roadway facilities, not just toll plazas. In addition, a subset of drivers, colloquially referred to as "wavers," undertakes a form of distraction that is unique to plaza facilities. These individuals fail to properly mount their ETC tags and instead hold them up to the windshield, out the window, etc. with little regard to traffic conditions around them. While there is not much that can be done to mitigate against the actions of these individuals, agencies have pursued strategies such as public education campaigns, providing warnings against the practice in billing mail-outs, and instructing toll collectors to look for and discourage the practice if possible.

Providing Advance Information to Motorists

All agencies use advance signing to warn drivers that they are approaching a toll plaza. Specific messages include "TOLL PLAZA AHEAD," "PAY TOLL AHEAD," etc. In addition to these warning signs, some agencies use lane designation signs in advance of the plaza. For example, one agency has a plaza where drivers can either take an Interstate or exit onto a local road immediately after passing through the plaza. After experiencing a number of vehicular accidents immediately



Figure 31. Gates in Use to Indicate that a Lane is Closed



Figure 32. One Option for Conveying that Cash Is Accepted in All Lanes

confusion typically center around providing improved traveler information. For example, an increasing number of agencies are employing the use of Variable Message Signs (VMS) upstream of the toll plazas that could be used to warn drivers of unexpected conditions such as incidents and maintenance activities. The New York State Thruway is experimenting with the use of digital signs upstream of the plaza indicating which lane numbers are currently accepting ETC and which are cash or mixed use (see Figure 29).

Another agency uses high visibility maintenance trucks and/or flaggers at the end of long, unexpected queues that extend beyond the sight of the plaza. This can be a very effective strategy, but is also resource intensive.

Finally, some agencies with bi-directional lanes that change throughout the day make use of buffer lanes (or unused lanes) between the directions of travel. This can be a cost-effective solution to movable barriers, but offers less protection and may not be feasible in high traffic areas (i.e., no lanes may be available to designate as buffers).

Informing Motorists of Lane Closures

Agencies use a variety of methods for conveying a closed lane to motorists. Some agencies simply close a lane with a traffic cone or gate (some examples are shown in Figures 30 and 31). While this creates a physical barrier to help discourage drivers from entering closed lanes, it can be dangerous for collectors to put the gate into place. In addition to this, some agencies have faced problems with motorists not seeing closed gates. To address this, one agency has installed unique three-foot high orange reflectors on its gates (similar to driveway markers). Since the addition of the reflectors, the agency reported that there has been a significant reduction in the gates being hit. Beyond this, many agencies have signs on their gates to further communicate to motorists that the lane is closed, and to draw attention to the gates. In terms of messages, some use a "LANE CLOSED" sign or a "DO NOT ENTER" sign. One agency used to use a "STOP" sign on a gate, but moved away from this after noticing cars approaching the gate and waiting for it to open. Other agencies have moved away from written signs entirely – feeling that they add to visual clutter and confusion – and now simply employ



Figure 29. Dynamic Signs Display Current ETC Lane Numbers at a NYS Thruway Plaza



Figure 30. Options for Conveying a Closed Lane to Motorists

REDUCING DRIVER CONFUSION AND DRIVER INATTENTION

THE CHALLENGE

Toll plazas are inherently confusing environments. A variety of elements at plazas can cause confusion including merging vehicles, unfamiliar messages on signs, inconsistent lane configurations, and a wide variety of competing visual inputs. These issues are exacerbated by the fact that conditions change from agency to agency, from plaza to plaza, and even by time of day at some plazas. Not surprisingly, during the site visits, driver confusion was frequently cited as one of the primary observed reasons for vehicular crashes. Such confusion contributes to side-swipe collisions, rear-end collisions, vehicle strikes upon plaza infrastructure, and close-calls or collisions with toll workers.

One of the biggest concerns related to driver confusion involves unfamiliar, non-ETC equipped drivers entering into and then stopping in high-speed ETC lanes. Drivers will stop, get out of their vehicles, and cross toll lanes in an attempt to pay the toll. While this situation has improved somewhat over time, it remains a large concern at each of the sites visited in the study.

Beyond this, driver inattention is a significant problem at plazas (e.g., motorists talking on cell phones while driving).¹¹

POTENTIAL MITIGATION STRATEGIES

Clearly Identifying ETC Lanes

Agencies have implemented a number of strategies that aim to direct non-ETC drivers away from ETC lanes in the first place. These include: implementing public education campaigns to familiarize drivers with the concept of ETC; adding signs – for example supplementing “brand” signs such as “SunPass” with generic signs such as “Pre-Paid Only”; and using specialized lane markings, such as differentiating high-speed ETC lanes with purple paint on the outside edges of the lane (as shown in Figure 28).

In addition to this, several agencies reported using pavement markings to assist drivers with lane selection at the toll plaza. Some agencies paint messages on the pavement in the lanes such as CASH ONLY, or the name of the ETC system (e.g., EZ PASS). Other agencies have painted lane numbers on the pavement to match the lane numbers on the canopy signs, to aid motorists in choosing the proper lane well in advance of the plaza.

Informing Motorists of Changing Conditions

As mentioned earlier, frequently changing conditions at toll plazas also contribute to driver confusion and distraction. These variable conditions include lane closures, changes in lane direction (at some facilities), changes in lane configuration (ETC versus mixed use), and the presence of maintenance activities (scheduled and otherwise). Strategies to combat these particular sources of driver



Figure 28. The Use of Pavement Markings To Identify Dedicated-ETC Lanes

¹¹ Teamsters Safety & Health Facts: Distracted Driving, Cell Phone Use, and Motor Vehicle Crashes
<http://www.teamster.org/sites/teamsters.prometheuslabor.com/files/cellphones.pdf>

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹⁰	Concerns / Constraints
Paint the speed limit on the pavement in advance of the plaza.	Some agencies reinforce the speed limit by painting it on the pavement in advance of the plaza.	<ul style="list-style-type: none"> Several workshop participants noted that this is a cost-effective solution. Mixed debate as to effectiveness. Some agencies who had tried this did not find it to be particularly effective while others found it to be quite effective. Was selected by only one workshop participants as among the top 3 most effective strategies for reducing speeding. 	<ul style="list-style-type: none"> Maintenance. May not be as effective in areas where weather issues cause problems (i.e., sanding or snow plowing). Must be accompanied by enforcement.
Use regulatory speed limit signs at plazas.	Some agencies have found that changing speed limit signs from advisory to regulatory (black on white) has made a difference in speed limit compliance.	<ul style="list-style-type: none"> 6 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing speeding. Several participants noted that they had tried this and that it works. One noted that speeds in their agency's ETC lanes were reduced by 1 mph, and the other noted that they saw a 70 percent reduction in speeders. One agency uses this strategy in its express lanes only (where the speed limit is posted at 45 mph) and has found it to be very effective. One workshop participant commented that their agency had tried a number of strategies, but it wasn't until the "Your Speed" indicator signs were installed that there was a noticeable drop in the number of speeders. Several participants noted that the signs are more effective when the agency uses temporary trailer-mounted signs and moves them around to different locations periodically. 	<ul style="list-style-type: none"> Some agencies have experienced issues with motorists speeding up when these signs are present to see how high of a speed the sign will display. Sign accuracy was a concern mentioned by a few workshop participants since motorists aren't always sure it is "their" speed that was shown. Sign overload was a concern mentioned by a few workshop participants. One workshop participant noted that placing the signs near a fixed speed limit sign caused confusion for motorists at their plaza.
Use digital signs displaying real-time speeds at the plaza.	Many agencies use temporary or permanent digital signs displaying real-time speeds to motorists. Some use these signs in the area upstream of the plaza while others use them at the plaza itself.		

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹⁰	Concerns / Constraints
Install rumble strips or saw cuts in pavement upstream of the plaza.	Rumble strips in advance of the plaza can be used to draw motorists' attention to their speed and can also provide toll collectors with an auditory warning that a vehicle is approaching.	<ul style="list-style-type: none"> 9 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing speeding, with 6 participants rating it as the most effective strategy. One workshop participant reported that thermoplastic rumble strips are somewhat expensive and that there are associated maintenance costs, but that they are still worthwhile since they are so effective. 	<ul style="list-style-type: none"> Noise can be an issue for nearby residents. Plastic rumble strips can pose problems with snow plow operations.
Make maintenance vehicles more visible.	The PANY/NJ has equipped its maintenance vehicles with red lights (i.e., amber on front, red on back) to give motorists the impression of enforcement presence.	<ul style="list-style-type: none"> The PANY/NJ feels that this has significantly lowered speeds around maintenance vehicles. 	<ul style="list-style-type: none"> Many state laws prohibit the use of red lights for anything other than emergency vehicles.
Other Mitigation Strategies			
Install transverse pavement markings in advance of the plaza.	Transverse yellow pavement markings with progressively closer spacing gives motorists the illusion that they are increasing speed when in fact they are traveling at a constant speed.	<ul style="list-style-type: none"> May become less effective over time as motorists become accustomed to the markings. 	<ul style="list-style-type: none"> One workshop participant noted that the pavement markings may lead to further driver confusion in that they may make the lines separating lanes less visible.
Ensure that speed limits at plazas are consistent with nearby toll authorities.	Some agencies have found that ensuring consistency in speed limits across agencies can help with speed limit compliance.	<ul style="list-style-type: none"> Most workshop participants felt that this is an important strategy as it maintains driver expectation. 	<ul style="list-style-type: none"> May not work in areas where plaza configuration and traffic patterns are quite different from one plaza to another. Interagency coordination can be critical to achieving this.
Post speed limits at each lane.	Some agencies post speed limits at each lane to remind motorists of the speed limit.	<ul style="list-style-type: none"> Especially helpful at plazas where the speed limit varies by lane. 	<ul style="list-style-type: none"> Sign overload was a concern expressed by some workshop participants.
Implement a public outreach campaign targeting speeders.	Some agencies employ targeted outreach to their customers to remind them of the dangers of speeding through plazas. This can be done cost-effectively through mailers to ETC customers.	<ul style="list-style-type: none"> Was not selected by any workshop participants as among the top 3 most effective strategies for reducing speeding. 	<ul style="list-style-type: none"> Can be costly depending on how it is done. Difficult in areas with high tourist traffic.

Strategies for Improving Safety at Toll Collection Facilities

Table 6. Potential Strategies to Mitigate Safety Challenges Associated with Speeding

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ¹⁰	Concerns / Constraints
Policies and Enforcement			
Implement an automated enforcement program.	A number of agencies use a combination of an automated video enforcement system to identify violators and a program to issue warning letters and suspend ETC for repeat violators.	<ul style="list-style-type: none"> Anecdotally, sites that employ this technique seem to have the lowest incidence of speeding. 16 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing speeding. 	<ul style="list-style-type: none"> Significant cost. Legislation may make this prohibitive in some states. Somewhat restrictive as most agencies are only able to revoke tags that they have issued.
Increase enforcement presence at plazas.	Some agencies have increased enforcement presence in the vicinity of their plazas in an attempt to reduce speeding through the plaza. In many cases agencies report that even the presence of an unattended patrol car is quite effective.	<ul style="list-style-type: none"> 11 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing speeding. Several of the workshop participants spoke very highly of this strategy from their experience. 	<ul style="list-style-type: none"> Can be costly depending on what arrangement the agency has with the police. Some plazas may not have sufficient space downstream of the plaza to safely pull over offenders.
Double fines for speeding in toll areas.	A number of agencies have worked to enact legislation allowing them to enforce double fines for speeding in toll areas.	<ul style="list-style-type: none"> 7 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing speeding. 	<ul style="list-style-type: none"> Must be accompanied by enforcement. Not feasible in states where legislation does not allow agency to enforce speeds around plazas.
Physical Treatments			
Install gates downstream of the plaza.	Depending on the configuration, gates downstream of the plaza can help control speeds. In most cases the gates lift automatically as an ETC vehicle approaches, so ETC customers can proceed safely through the plaza without stopping as long as they maintain a reasonable speed – typically below 15 miles per hour.	<ul style="list-style-type: none"> Most workshop participants agreed that gates are an effective way of controlling speeds. 	<ul style="list-style-type: none"> Not feasible at plazas where throughput is an issue. Maintenance can be an issue as gates can be hit by inattentive motorists. Inoperable gates can pose a safety hazard requiring toll collectors to exit their booth to lift the gate.

¹⁰ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas.

- Ensure that speed limits at plazas are consistent with nearby toll authorities.
- Some agencies post speed limits at each lane as reminder to motorists as shown in Figure 26. This is especially helpful in situations where the speed limit varies by lane.



Figure 26. Speed Limits Are Posted at Each Lane To Reinforce Speed Limits

- Some agencies have implemented a public outreach campaign targeting speeders. To do this cost-effectively, many agencies do this as part of their regular mailings to ETC customers. One agency has a program called "Give Them 10" that encourages motorists to maintain speeds below 10 mph in the vicinity of toll plazas.
- To reinforce the speed limit, some agencies paint the speed limit on the pavement in advance of the plaza as shown in Figure 27.
- Some agencies have noticed a reduction in speeds after switching from advisory speed limit signs to regulatory speed limit signs.
- Many agencies use temporary or permanent digital signs displaying real-time speeds of motorists. Some use these signs in the area upstream of the plaza while others use them at the plaza area itself.



Figure 27. Pavement Markings Reinforce the Speed Limit in Dedicated ETC Lanes

Strategy Rankings, Effectiveness, and Constraints

Table 6 lists each strategy identified for mitigating safety challenges associated with speeding and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.

force. Different tactics are used when enforcing traffic violations. In some cases police conduct speed enforcement using radar from their vehicle – either from the plaza parking lot or from the shoulder downstream of the plaza. Another speed enforcement tactic used by the police is to place an officer on the toll island with radar. When a speeder is identified, the officer calls the vehicle description out to a chase cruiser that is downstream of the plaza. The police also sometimes use decoys for speed enforcement by placing radar inside an inconspicuous vehicle, such as a dump truck, on the shoulder at the plaza. Some agencies reported that the police will also park unmanned police cruisers at the plaza to assist with speed reduction.

One agency reported that it has succeeded in reducing speeding by getting legislation passed that allows for doubled fines for speeding in toll areas. In this particular case, the legislation applies only to toll plazas where the speed at the plaza is reduced to 30 mph for ETC lanes. This agency has open road tolling where the speed limit is not reduced and increased fines for speeding do not apply at these areas.

Physical Treatments

Another measure that many agencies felt played a role in successfully controlling speeds – whether or not they were installed for this reason – was gates. Where gates are in use, all customers, including those with electronic payment, must wait for a gate to lift before proceeding through the plaza. Typically the gates lift automatically as an ETC vehicle approaches, so that ETC customers can proceed safely through the plaza without stopping as long as they maintain a reasonable speed – typically below 15 miles per hour. While effective in reducing speeds through toll plazas, doing so may be in contradiction with agency objectives to maximize throughput and mobility.

Some agencies have found it effective to use rumble strips or grooved pavement in the area just upstream of the plaza (typically in advance of the flare for the toll plaza) to draw motorists' attention to their speed and to provide toll collectors with an auditory warning that a vehicle is approaching (as shown in Figure 24).



Figure 24. Rumble Strips

Other Mitigation Strategies

Other observed speed mitigation strategies include:

- Excessive speeds also affect first responders and maintenance workers, and many agencies expressed concern about this. The PANY/NJ has combated this by equipping its maintenance vehicles with partial red lights (i.e., amber on front, red on back) to give motorists the impression of enforcement presence. The agency believes that this has been successful in lowering speeds around incidents and maintenance work.
- The New York State Thruway uses transverse pavement markings to lower speeds at one of its plazas (as shown in Figure 25). The transverse yellow pavement markings are spaced progressively closer together to give motorists the illusion that they are increasing speed even when they are maintaining a constant speed.



Figure 25. The Use of Transverse Pavement Markings to Reduce Speeding

REDUCING SPEEDING

THE CHALLENGE

The introduction of ETC lanes, and particularly of high-speed ETC lanes, has introduced a new concern at plazas: speeding. Prior to the advent of ETC, every customer was required to come to a complete stop in order to collect a ticket or pay a toll. Now a good portion of customers are not required to stop at all, and in some cases, they are able to maintain near highway speeds while passing through a plaza.

POTENTIAL MITIGATION STRATEGIES

Vehicles speeding through plazas present an obvious safety concern for workers and, as a result, many agencies have implemented strategies specifically targeted at combating speeding.

Policies and Enforcement

Of the facilities visited by the team, those that reported having the lowest incidence of speeding were two agencies that had an aggressive automated enforcement program: the New York State Thruway and the Port Authority of New York and New Jersey (PANY/NJ). Although there is no hard data to substantiate this observation, it seems plausible that their extensive automated speed enforcement programs may be the main success factor in keeping speeds under control at their plazas. Like most other agencies that have an automated enforcement program, cameras record violators and then the agency notifies violators by mail of the offense. What makes their program somewhat unique is that the agencies suspend ETC tags for a period of time for repeat or excessive violators, a practice that is particularly effective with trucking firms due to the toll discount associated with having a transponder.

Of those agencies that do have some form of automated enforcement, most choose to inform motorists that the toll plaza is photo enforced, and in most cases this is done with white on black regulatory signs.

Increasing enforcement presence at plazas is another way that some agencies combat speeding (Figures 22 and 23 show examples of how different agencies demonstrate enforcement to motorists). In fact, some agencies feel that it is critical to all safety programs – so much so that one workshop participant even noted that no strategy would be effective without a strong enforcement program. Increasing enforcement presence is obviously an easier feat for those agencies that have a dedicated police force or well established relationships with the local police



Figure 22. Sign Notifying Motorists that Plaza Is Photo Enforced



Figure 23. Enforcement Presence at an MTA Plaza

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Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁹	Concerns / Constraints
Use physical barriers to prevent vehicles in left-most lane from making unsafe maneuvers to reach downstream off-ramps.	<p>In situations where off-ramps are immediately downstream of a plaza, some authorities physically prevent vehicles in left-most lanes from merging across traffic to reach the off-ramp. Other authorities use striping and signs to try to enforce such restrictions; however, this was felt to be less effective than physical barriers.</p>	<ul style="list-style-type: none"> Felt to be effective only with physical barriers versus lane striping, barrels, cones, or delineators. Was only rated among the top 3 most effective strategies for mitigating merging incidents by 5 of the 20 workshops participants, with none rating it as the most effective strategy. 	<ul style="list-style-type: none"> Concerns that it may confuse patrons and cause them to back up.
Use high-visibility flexible delineators to separate traffic lanes.	<p>This method of separating traffic lanes makes use of physical delineators in the roadway that are less expensive to deploy and that do not provide the same physical separation as barriers. Over time agencies have evolved to increasingly higher visibility delineators such as wide sergeant stripe panels and arrangements of multiple delineators in bowling pin configurations.</p>	<ul style="list-style-type: none"> Considered more cost-effective to deploy than physical barriers. Was rated among the top 3 most effective strategies to mitigate merging incidents by 9 out of the 20 workshop participants, with 3 ranking it the most effective strategy. 	<ul style="list-style-type: none"> Agencies reported a number of concerns, associated with maintenance of delineators including cost and worker safety.
Use pop-up delineators to reduce worker exposure at plazas requiring lane changes throughout the day.	<p>Pop-up delineators are systems where the delineators reside in the pavement and can be automatically activated or raised to demark lanes or support lane closures.</p>	<ul style="list-style-type: none"> Only 4 of 20 workshop participants rated this strategy among the top 3 strategies for mitigating merging incidents. Those facilities that employed the technique, such as the NY State Thruway, were very pleased with their operation and felt that the use of the delineators helped to reduce the worker exposure that is necessitated by manual systems. 	<ul style="list-style-type: none"> Some concerns about operation in areas with snow and ice. However, the NY State Thruway's compressed air system appears to have overcome this operational challenge. Felt to be an expensive solution that introduces its own maintenance concerns.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁹	Concerns / Constraints
<i>Channelization of Traffic</i>			
Channelize traffic downstream of the plaza with delineators.	While many facilities actively separate traffic upstream of the plazas, a smaller number make use of delineators (and to a lesser extent physical barriers) to similarly maintain separation for some length downstream of the plaza.	<ul style="list-style-type: none"> Would be most effective if the delineated section extended far enough to allow vehicles from the cash and mixed lanes to accelerate to match the speeds of the ETC traffic. Rated among the top 3 most effective strategies to mitigate merging concerns by 8 of the 20 workshop participants, although none rated it as the most effective strategy. 	<ul style="list-style-type: none"> Many plazas simply do not have the space. As with all delineators, introduces worker safety issues associated with placement and maintenance.
Provide a buffer lane between ETC and cash customers.	A small number of agencies use buffer or unused lanes between ETC and cash or mixed lanes. As more and more customers move to ETC and fewer lanes are required at plazas, this is becoming more feasible.	<ul style="list-style-type: none"> Rated as the 2nd or 3rd most effective strategy to address merging by 5 out of the 20 workshop participants and as the most effective strategy by 1 participant. Felt to be more economical than the use of physical barriers. 	<ul style="list-style-type: none"> Many plazas simply do not have the space to support unused lanes. Violators may try to use the buffer lane in an attempt to bypass the toll. May confuse patrons. If used intermittently may create an unsafe situation for workers during buffer lane closing and opening.
Use physical barriers to separate approaching high-speed traffic from cash or mixed lanes.	A number of agencies use physical separation such as concrete barriers to separate high-speed ETC traffic from lower speed mixed or cash traffic. The length of separation and the type of barrier varies greatly among the facilities employing this technique.	<ul style="list-style-type: none"> 18 of the 20 workshop participants rated this strategy among the top 3 most effective for reducing merging incidents, with 15 of the participants ranking it as the most effective strategy. 	<ul style="list-style-type: none"> Barriers themselves could become safety hazards. Installation and maintenance costs are high. Customers may inadvertently become "trapped" in the wrong lane and try to back up. Implementation may be restricted by lane width considerations. May present challenges to snow removal.

Strategies for Improving Safety at Toll Collection Facilities

Table 5. Potential Strategies to Mitigate Safety Issues Associated with Merging and Lane-Changing Behavior

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁹	Concerns / Constraints
Plaza Configuration			
Position ETC lanes on both the right and the left side of plazas with nearby on or off ramps.	In situations where a plaza is quickly followed by an off-ramp, it can be dangerous for high-speed ETC traffic to have to quickly weave across multiple lanes of traffic to utilize the ramp. This is exacerbated in areas with high percentages of truck traffic.	<ul style="list-style-type: none"> There is considerable debate about this practice. While most consider that the practice will increase driver safety there are concerns that it can decrease worker safety – forcing collectors to cross high-speed lanes to reach staffed booths. Ranked among the top 3 most effective merging mitigation strategies by 8 of 20 workshop participants. 	<ul style="list-style-type: none"> In many locations the practice is prevented by physical constraints. Can lead to increased worker exposure to high-speed lanes. Concerns that it may be confusing to drivers. Requires additional signs. Additional ETC lane may be blocked by queues from cash lanes. Could create additional, unexpected weaving problems.
Select location of truck-only lanes at plaza based on feedback from truck drivers.	A number of agencies face difficulties with trucks having to merge from shoulder travel lanes to median lanes to access ETC and then merging back across traffic. To address this concern, the Illinois Toll Authority recruited a number of commercial truck drivers and asked them to drive the agency's facility and indicate where they would ideally like to access the plaza. Truck-only lanes were then situated based in part on these responses.	<ul style="list-style-type: none"> While workshop participants felt that the practice of situating truck-only lanes based on user feedback was effective, there were concerns about the use of truck-only lanes in general. Was rated among the top 3 strategies for mitigating merging incidents by only 3 of the 20 workshop participants. 	<ul style="list-style-type: none"> The constraints identified referred to the general practice of truck-only lanes and centered around limited space to implement such an operation.

⁹ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas. Note that at the workshop, the strategies discussed here were presented in a category entitled "Merging and Lane Changing."

Channelization of Traffic

One way to reduce last-minute lane changes is to channelize traffic well in advance of the plaza to reduce last-minute lane changes (as shown in Figure 20). Similarly, some agencies channelize ETC traffic downstream of the plaza to delay the merging of traffic (as shown in Figure 21). Some agencies even make it a policy to separate traffic until the slower traffic has accelerated to two-thirds of the normal operating speed.

Other agencies use a buffer lane between the ETC lanes and cash or mixed-use lanes. Others use physical separation (such as a concrete barrier), including the use of barriers to prevent vehicles in the left-most lanes (typically ETC lanes) from making unsafe maneuvers to reach off-ramps located just downstream of the plaza. However, physical barriers can be costly to install and costly to maintain. As a result, some agencies simply extend the longitudinal markings further upstream of the toll plaza to assist with lane delineation. Others use high-visibility flexible delineators to separate traffic at plazas. The Florida Turnpike has found it effective to use wide yellow sergeant-striped delineators in place of

the solid white delineators that it previously used to separate traffic. The agency also found that visibility was improved after positioning the delineators in a “bowling pin” configuration instead of in a straight line.

For those agencies that face the additional challenge of lane assignments changing throughout the day, pop-up delineators can be a solution. However, some agencies in colder climates have found that pop-up delineators do not perform so well during snowy and icy conditions. To address this, the New York State Thruway designed a new pop-up delineator in-house that operates off of air compression and survives the winters.

Strategy Rankings, Effectiveness, and Constraints

Table 5 lists each strategy identified for mitigating safety issues associated with merging and lane-changing behavior and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.



Figure 20. Concrete Barriers and Attenuators Physically Separate Traffic Upstream of an Illinois Tollway Plaza



Figure 21. Pavement Markings and Cones Delay Merging Downstream at the Port Authority of NY & NJ's Holland Tunnel Plaza

safety issues associated with merging and lane-changing behavior and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.

REDUCING UNSAFE MERGING AND LANE CHANGING

THE CHALLENGE

Toll plazas present unique challenges in terms of lane-changing behavior and merging. Many plazas operate much like a complex intersection (i.e., there are on-ramps or off-ramps in close proximity to the plaza creating excessive weaving maneuvers). In addition, speed variance between ETC and cash-paying customers is a safety challenge faced by all agencies with plazas accepting both electronic and cash payment. Often, last minute lane changes occur simply because motorists are seeking out the shortest line - motorists commit to a toll lane in advance of the plaza but then see a shorter line at the plaza and switch lanes. Additionally, many agencies face challenges in dealing with truck traffic and over-sized loads, particularly in regard to their "mixing" with automobiles.

POTENTIAL MITIGATION STRATEGIES

Plaza Configuration

Toll authorities across the country have tackled the challenge of lane changing in a variety of ways. Many agencies make it a standard practice to position their dedicated high-speed ETC lanes to the left side of their plazas (i.e., toward the center of the roadway), with the idea that the customer expects faster-moving traffic to primarily be to the left side of the roadway. This practice appears to be effective except in situations where there are on-ramps or off-ramps in close proximity to the plaza, in which case positioning the ETC lanes to the left side of the plaza can cause unnecessary weaving maneuvers. To reduce weaving in these situations, some agencies have taken to positioning dedicated-ETC lanes to both the left and right side of their plazas as shown in Figure 19.



Figure 19. Dedicated ETC Lanes Positioned at Both Sides of a Plaza

that trucks are prohibited from traveling in the left lane on many roadways, which can pose a weaving problem if the dedicated-ETC lanes and/or the truck-only lanes are located to the left side of the plaza. To address this concern, the Illinois Toll Authority solicited feedback from truck drivers on the best configuration for its truck lanes. The agency recruited a number of commercial truck drivers and asked them to drive the agency's facility and indicate where the truckers would ideally like to access the plaza. Truck-only lanes were then situated based in part on their responses.

Another strategy that some agencies feel works well is to keep the dedicated ETC lanes in the same location at a plaza even if that plaza is reconfigured throughout the day as traffic density changes. This assists ETC patrons with identifying the proper lane and knowing that it is always in the same place. Another agency which reconfigured its plaza to include dedicated ETC lanes reported that it was helpful to look at ETC usage across all lanes in order to determine which lane(s) would be best for the dedicated ETC lanes. Previously, cash and ETC were accepted in all lanes, so the agency had the ability to track usage.

Safety can be further compromised when truck traffic which normally travels in the right-most lanes seeks out ETC lanes. A common issue is

Strategies for Improving Safety at Toll Collection Facilities

Table 4. Potential Strategies to Mitigate Assault

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁸	Concerns / Constraints
Lock booth doors	Instruct collector to keep the booth door locked at all times when inside the booth.	<ul style="list-style-type: none"> Ranked 4th out of 8 strategies considered by workshop participants for reducing assault. 	<ul style="list-style-type: none"> May restrict collectors' ability to rapidly exit the booth in an emergency.
Have periodic cash drops during shifts.	May reduce the temptation for robbery.	<ul style="list-style-type: none"> Ranked 3rd out of 8 strategies considered by workshop participants for reducing assault with 4 out of the 20 participants identifying it as the number one strategy. 	<ul style="list-style-type: none"> None.
Install cameras in and around booths.	Provides both a deterrent and investigation tool.	<ul style="list-style-type: none"> Ranked 2nd out of 8 strategies considered by workshop participants for reducing assault, with 7 of out of the 20 participants identifying it as the number one strategy. 	<ul style="list-style-type: none"> Expensive to install and monitor.
Install bullet-resistant glass on booths.	Offers additional protection to collectors against assault and guns.	<ul style="list-style-type: none"> Limited effectiveness as collectors must keep at least part of the booth open to interact with the public. This was not selected among the top three strategies for reducing environmental impacts by any of the workshop participants. 	<ul style="list-style-type: none"> Very expensive.
Provide bullet-resistant vests to collectors.	One toll agency began offering collectors the option of wearing bullet-resistant vests after one of its collectors was shot.	<ul style="list-style-type: none"> This was not selected among the top three strategies for reducing environmental impacts by any of the workshop participants. 	<ul style="list-style-type: none"> Expensive. May be uncomfortable to wear.
Install covert panic alarms in all booths.	Allows for collectors to summon help either from nearby supervisor or law enforcement. Particularly helpful at remote locations with a single collector.	<ul style="list-style-type: none"> Ranked 1st out of all strategies considered by workshop participants for reducing assault. 	<ul style="list-style-type: none"> Potential issue with false alarms.

⁸ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas.

REDUCING WORKER RISK OF ASSAULT

THE CHALLENGE

Another concern related to toll worker safety is the possibility of physical assault, either by irate customers or in connection with a robbery. At each site the study team visited, the agencies cited examples of workers being spit upon, having objects thrown at them, and – in extreme cases – being shot at. Fear of armed robbery was particularly pronounced in locations where a lone worker might be present – such as at an exit ramp plaza.

POTENTIAL MITIGATION STRATEGIES

While little can be done to entirely eliminate these occurrences, a number of mitigation strategies have been adopted by agencies across the country. These include:

- Keeping doors locked while in the booth.
- Having periodic cash drops during shifts to minimize the amount of cash that a collector has on hand at any given time.
- Maintaining close relationships with local law enforcement.
- Having closed-circuit television (CCTV) cameras in and around the booths.
- Having bullet-resistant glass on the booths.
- Providing collectors with Kevlar vests.

Nearly all agencies that the team spoke with have a handset in the booth for collectors to communicate directly with other collectors at the plaza, with a supervisor at the plaza building or at a nearby plaza, or - in many cases – with a communications center that is open 24 hours a day, 7 days a week. In addition to this, most agencies that the team spoke with have covert panic alarms in their booths so that collectors can call for help in an emergency situation; some also issue cell phones to collectors as an additional means of being able to communicate during an emergency.

One agency has a “Toll Security Committee” that meets every few months to discuss any incidents that have occurred recently and to brainstorm ways to prevent these types of incidents in the future.

Strategy Rankings, Effectiveness, and Constraints

Table 4 lists each strategy identified for mitigating safety issues associated with assault and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁷	Concerns / Constraints
Booth Design			
Provide collectors with adjustable height terminals, cash drawers, and/or chairs.	Providing collectors with adjustable height equipment can reduce workplace injuries associated with reaching. Especially helpful for tall or short employees.	<ul style="list-style-type: none"> Ranked 3rd out of 9 strategies considered by workshop participants in the "ergonomics" category. 	<ul style="list-style-type: none"> Can be expensive.
Use bumped-out Dutch doors on booths.	Booths with a bumped-out door design can allow collectors to see oncoming traffic and to reach vehicles without having to lean quite so far out of the booth.	<ul style="list-style-type: none"> Ranked 2nd out of 9 strategies considered by workshop participants in the "ergonomics" category. 	<ul style="list-style-type: none"> Lane widths at older plazas may constrain the width of the booth.
Policies and Procedures			
Implement policies to reduce injury due to vehicles pulling into or away from the booth.	To reduce injuries due to pulled arms as vehicles pull away from the plaza, one agency has made it a policy that collectors perform validation as their last step in the transaction process so that the gate stays down until the transaction is complete. Another has implemented a policy that collectors are not allowed to place their hands outside of the booth until after the vehicle has come to a complete stop.	<ul style="list-style-type: none"> 8 of the 20 workshop participants rated this strategy among the top 3 most effective strategies in the "ergonomics" category. 	<ul style="list-style-type: none"> Practicality of the validation policy depends on treadle placement.

Strategies for Improving Safety at Toll Collection Facilities

Table 3. Potential Strategies to Mitigate Safety Issues Associated with Ergonomics

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁷	Concerns / Constraints
Equipment			
Provide collectors with ergonomic stools.	Nearly all agencies provide some sort of ergonomic stools to their collectors. Some have gone toward a "sit/stand" stool. Others have found that swivel chairs with surrounding foot rests are preferable to their collectors.	• 8 of the 20 workshop participants rated this strategy among the top 3 most effective strategies in the "ergonomics" category.	<ul style="list-style-type: none"> Difficult to find stools that suit all collectors. Avoid chairs with flexible backs as this encourages collectors to lean back and can result in serious injury.
Install shelving and hooks in the booths.	Many agencies expressed the importance of keeping the booth floor free of all items that can pose a tripping hazard for workers. Having sufficient shelving and clothing hooks in the booth can facilitate this.	<ul style="list-style-type: none"> Although none rated this strategy among the top 3 most effective strategies in the "ergonomics" category, most workshop participants commented that this was a low-cost, common sense strategy. Important to avoid blocking collector's view out of the booth. 	<ul style="list-style-type: none"> None.
Provide collectors with anti-fatigue mats in the booths.	Anti-fatigue mats in the booths can reduce fatigue caused by standing for long periods on a hard surface.	• 14 of the 20 workshop participants rated this strategy among the top 3 most effective strategies in the "ergonomics" category, with 5 participants rating it as the most effective strategy.	<ul style="list-style-type: none"> Can present a tripping hazard - important to ensure that the mat is securely fastened to floor and that the chair legs cannot puncture the mat.
Install convex mirrors on the side of booths.	A small convex mirror on the booth can allow collectors to monitor vehicles exiting the booth without turning.	• Most workshop participants commented that this was a low-cost strategy that made sense.	<ul style="list-style-type: none"> Could pose a problem with trucks and large vehicles hitting the mirror at facilities with narrow lanes.
Provide ergonomic training to collectors.	Providing ergonomic training to collectors can teach them how to reduce the likelihood of repetitive motion injuries.	• 8 of the 20 workshop participants rated this strategy among the top 3 most effective strategies in the "ergonomics" category.	<ul style="list-style-type: none"> Can be expensive.

⁷ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas.

weariness for workers who stand in one position for long periods of time.⁶

- Denver E-470 has found it helpful to add a convex mirror to the side of the booth as shown in Figure 16. The position of the convex mirror allows collectors to see vehicles exiting the plaza while they are facing oncoming traffic. Collectors reported that the mirror reduces twisting motions as they often need to watch vehicles exiting to ensure that the gate has lifted properly.
- Some agencies provide collectors with ergonomic training to reduce repetitive injuries.



Figure 16. Convex Mirrors Can Reduce Twisting and Turning for Collectors

Booth Design

Some agencies have implemented adjustable-height terminals, chairs, and/or cash drawers in an effort to reduce workplace injuries associated with reaching (an example of an adjustable-height terminal is shown in Figure 17). In many cases strains can be caused by leaning out of the booth to see oncoming or exiting traffic. Depending on the booth design, collectors sometimes noted that leaning was necessitated by advertisements or sunshades on the window making it difficult to see out, or simply by booth/plaza design



Figure 17. Denver E-470's Adjustable Height Terminal

(e.g., a pillar can sometimes block their view of oncoming traffic).

Some agencies have less of a problem with this as their booths have a bumped-out door design which allows the collector to see oncoming traffic and to reach vehicles more easily without having to lean quite as far (see Figure 18).



Figure 18. Bumped Out Dutch Doors Can Reduce Twisting and Turning for Collectors

Policies and Procedures

Nearly all agencies that the team spoke with indicated that they have experienced injuries resulting from collectors' arms being pulled by customers as they pass through the plaza. To reduce these injuries, one agency has instructed collectors never to place their hands outside of the booth until after the vehicle has come to a complete stop. Another agency now instructs collectors to validate payment as the last step in processing a transaction (which in most cases keeps the gate down) to reduce the chance that the vehicle will attempt to pull away before the transaction is complete.

Strategy Rankings, Effectiveness, and Constraints

Table 3 lists each strategy identified for mitigating safety issues associated with ergonomics and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.

⁶ Canadian Centre for Occupational Health and Safety. <http://www.ccohs.ca/oshanswers/ergonomics/mats.html>.

IMPROVING ERGONOMICS FOR WORKERS

THE CHALLENGE

Another workplace injury commonly mentioned was strains to various body parts such as the wrist, back, or shoulder. Strains are difficult to avoid given that the nature of the work requires the worker to stand for much of their shift and that it requires a good deal of reaching and twisting, but there are some mitigation strategies that agencies have implemented to reduce these issues.

POTENTIAL MITIGATION STRATEGIES

Agencies have worked to improve ergonomics for collectors in a number of different ways, including implementing new policies and procedures, modifying their booth design, and providing special equipment.

Equipment

The team saw a variety of equipment in use to reduce workplace injuries including:

- Nearly all of the agencies that the team visited provide a stool for collectors to use while in the booth. However, few collectors that the team spoke with indicated that they use the stool very often since they find it easier to perform their work while standing (this was particularly the case with those who work the busier shifts). Many agencies have looked into different options for stools, but most indicated that they have had difficulty getting collectors to agree on the best design. One agency represented at the workshop warned of the danger of selecting chairs with a flexible back as this design encouraged collectors to lean back, resulting in some serious injuries. One agency that the team spoke with has gone toward a sit/stand stool that allows collectors the support of a chair without requiring them to sit. Another agency indicated that after having numerous discussions with its collectors about their needs, it has found that foot rests are very important to collectors and, as a result, the agency has found that a chair with a foot rest surrounding the entire chair is preferable (as shown in Figure 14).
- A number of agencies spoke of the importance of keeping items off the floor in the booth to avoid tripping hazards and to maximize collector sight lines to outside their booths. To combat this many agencies do not allow collectors to bring any personal items into the booth when working. Others provide shelves and hooks in the booth to make certain that collectors have sufficient places to store items without introducing a tripping hazard.
- Nearly all agencies visited have anti-fatigue mats in their booths (as shown in Figure 15). Anti-fatigue mats are designed to reduce fatigue that is caused by standing for long periods on a hard surface. Fatigue-reducing mats can be made of various materials including rubber, carpeting materials, vinyl, and wood, and are used to decrease foot



Figure 14. Chair with Circular Foot Rest



Figure 15. Anti-Fatigue Mat

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁵	Concerns / Constraints
Add brightly-colored striping to the edges of stairs and curbs.	One way to reduce trips is to paint the edges of stairs and curbs to improve visibility and depth perception.	<ul style="list-style-type: none"> Ranked 6th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Must be maintained.
Install handrails on both sides of tunnel stairways to reduce falls.	New toll plazas are now consistently constructed with hand-rails on either side of any stairwell. Many existing facilities are being retrofitted to also meet this goal.	<ul style="list-style-type: none"> Consistently reported as a significant improvement during site visits Ranked 9th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Additional cost if retro-fitted.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁵	Concerns / Constraints
Reducing Slips, Trips, and Falls			
Issue safety shoes to toll collectors.	Many agencies issue collectors safety shoes (slip-resistant, steel-toe) to reduce slips and to reduce workplace injuries.	<ul style="list-style-type: none"> Ranked 4th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. Low-cost. 	<ul style="list-style-type: none"> None. Can be costly to retro-fit existing plazas. Does require maintenance.
Use grooved or textured pavement in the crossing areas to reduce slips.	Some agencies reported using some sort of skid-resistant surface (e.g., FlexCrete™) at their collector crossing areas to reduce slips.	<ul style="list-style-type: none"> Ranked 6th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Costly.
Install drain gates at the curb at crossing areas to avoid ponding water and icy conditions.	Some agencies reported problems with ponding water in crossing areas	<ul style="list-style-type: none"> Considered very effective and necessary in areas where icing can occur. Ranked 4th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Costly.
Ensure that all walkways are covered.	Covering walkways can protect workers from the elements and can reduce incidents of slips, trips, and falls from ice and slippery conditions	<ul style="list-style-type: none"> This was not selected among the top three strategies for reducing environmental impacts by any of the workshop participants. 	<ul style="list-style-type: none"> Costly.
Provide crampons to collectors to reduce slips on ice.	Denver E-470 has begun providing crampons to collectors to reduce slips on ice. Crampons are outdoor footwear that are worn on the bottom of boots or shoes and that use spikes to provide traction on snow and ice.	<ul style="list-style-type: none"> Relatively small number of workers use the available crampons; however, those that do swear by them. Ranked near the bottom of all strategies considered by workshop participants for reducing environmental impacts on toll collectors. Low-cost. 	<ul style="list-style-type: none"> Requires some instruction in use and advertising of availability.
Switch from cash drawers to cash bags.	Providing collectors with cash bags instead of cash drawers can facilitate hands-free crossing.	<ul style="list-style-type: none"> Ranked 4th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> May add time for employees to transfer cash from drawers to bags. May result in loss prevention concerns.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁵	Concerns / Constraints
<i>Mitigating Excessive Noise Levels</i>			
Periodically conduct noise testing in the booths.	Toll plazas are often very noisy environments, especially at facilities with high levels of truck traffic. Consequently, a number of agencies undertake periodic noise monitoring to identify problems and develop remediation strategies (such as earplugs, banning air brakes, and rotating employees from truck-only lanes).	<ul style="list-style-type: none"> Ranked 2nd out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> None.
Limit exposure time of workers at booths with high truck traffic.	Some agencies periodically rotate employees out of booths in truck lanes to reduce noise impacts.	<ul style="list-style-type: none"> This was not selected among the top three strategies for reducing environmental impacts by any of the workshop participants. 	<ul style="list-style-type: none"> None.
<i>Personal Protective Equipment</i>			
Provide ear plugs to collectors.	Toll plazas tend to be very noisy environments. In fact, a number of workers interviewed during the site visits reported having difficulty hearing for some time after their shift (similar to attending a concert). Consequently, a number of agencies offer the use of ear plugs to their employees.	<ul style="list-style-type: none"> The use of ear plugs offers mixed benefits. Some workers do like them and use them; however, most find it difficult to communicate with the customers while wearing ear plugs. Ranked second to last (tied) of all strategies considered by workshop participants for reducing environmental impacts. 	<ul style="list-style-type: none"> Limits ability for collectors to interact with the public.
Provide gloves to collectors.	Given the nature of the cash transactions and fears about disease, etc., gloves can help to protect collectors' hands. This issue became particularly relevant during the concerns over anthrax.	<ul style="list-style-type: none"> Many collectors choose not to wear gloves even when they are readily available. Ranked 9th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Need to be sensitive to latex allergies.

Strategies for Improving Safety at Toll Collection Facilities

Table 2. Potential Strategies to Mitigate Safety Issues Associated with the Worker Environment

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁵	Concerns / Constraints
<i>Mitigating Air Quality Issues</i>			
Install carbon monoxide (CO) monitors in booths or test for CO periodically.	A few agencies now have CO monitors in their booths.	<ul style="list-style-type: none"> Ranked 6th (tied) out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. Must be maintained and tested periodically. 	
Install positive air in all booths.	Positive air systems are designed to extract fresh air from outside of the immediate vicinity of the booth (e.g., above the toll booth structure) where the air is not contaminated with vehicle emissions or particulate matter such as dust, and delivering it to the booth at a pressure which allows for positive pressure within the booth, thereby ensuring that air is forced out of the toll booth window. Cold/heat stress can also be controlled by these systems.	<ul style="list-style-type: none"> 15 out of the 20 workshop participants rated this strategy among the top 3 most effective strategies for reducing environmental impacts for collectors, with 7 participants rating it as the most effective strategy. Expensive. 	
Install air conditioning in booths.	Install air conditioning in booths in warmer climates and consider having individual controls inside booths.	<ul style="list-style-type: none"> Ranked 3rd out of 15 strategies considered by workshop participants for reducing environmental impacts for collectors. 	<ul style="list-style-type: none"> Adds costs for installation and maintenance. Without individual controls it is difficult to calibrate the systems to individual preferences.

⁵ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas. Note that at the workshop, the strategies discussed here were presented in a category entitled "Environmental Issues."

For colder climates, ice and snow can present a challenge. One agency has made a point to position drain gates below the curb at all crossing areas to avoid ponding water, which can lead to icy conditions. Another agency ensures that all of its walkways are covered to help reduce snow and ice on the walkways. Denver E-470 has recently begun issuing collectors crampoms (shown in Figure 11) which can be worn on the outside of their shoes to provide better traction on snow and ice.

Finally, as previously mentioned, several agencies focus on hands-free crossing with the use of shoulder bags to carry belongings (with the idea that having both hands free will make it easier for collectors to catch themselves if they fall). One agency now issues collectors cash bags instead of cash drawers to facilitate hands-free crossing (as shown in Figure 12).



Figure 11. Crampoms Can Help Collectors Avoid Slips in Snowy and Icy Conditions



Figure 12. Cash Bags Can Facilitate Hands-Free Crossing

In an attempt to mitigate trips, some of the agencies visited use brightly colored striping on the edges of stairs and curbs (as shown in Figure 13) to improve visibility and depth perception. For those agencies with tunnels or overhead access to booths, many stressed the importance of having handrails on both sides of any stairways.

Strategy Rankings, Effectiveness, and Constraints

Table 2 lists the strategies for mitigating safety issues associated with the worker environment, with information on effectiveness, concerns, constraints, and ranking.



Figure 13. Brightly Colored Curbing in the Crossing Area Can Reduce Trips

REDUCING WORKER EXPOSURE TO THE ENVIRONMENT

THE CHALLENGE

Toll collectors are exposed to a range of environmental hazards on the job, such as excessive noise and automotive emissions. Beyond this, the work environment can pose physical hazards that can result in injuries such as slips, trips, and falls, which were commonly mentioned by agencies as the most prevalent workplace injury occurring at their plazas. Slips, trips, and falls can be caused by icy or snowy conditions, from the presence of debris or other substances on the pavement, from uneven pavement, or simply from carelessness by workers when climbing stairs or curbs.

POTENTIAL MITIGATION STRATEGIES

Mitigating Air Quality Issues

Through the site visits the team found that many agencies typically perform some combination of the following mitigation strategies to lessen the impact of air quality hazards for collectors:

- CO and emissions testing – Some agencies have carbon monoxide (CO) monitors in their booths while others perform periodic CO and/or emissions testing.
- Positive air pressure – Many agencies have positive air pressure in their booths, and all agencies retrofitting booths were adding positive air.
- Air conditioning – Agencies in warmer climates typically have air conditioning in their booths; some also provide collectors with individual controls in the booths.

Mitigating Excessive Noise Levels

Many agencies perform noise testing on a periodic basis and take measures to reduce noise if they find that it is at an unacceptable level. Some agencies limit the length of time that workers are permitted to work at booths with high volumes of truck traffic due to the excessive noise levels that can be associated with trucks.

In addition to this, some agencies provide ear plugs to collectors, although nearly all of the collectors that the team spoke with indicated that they do not wear ear plugs on the job since they can make it difficult to converse with customers.

Personal Protective Equipment

In terms of protective equipment to deal with environmental impacts, the most common equipment that the agencies issue to collectors for environmental reasons are gloves, although most collectors interviewed by the study team reported that they do not wear them very often on the job either due to negative public perception or due to the fact that gloves make it difficult to quickly perform work tasks. In addition to this, some agencies provide slip-resistant safety shoes to reduce the occurrence of slips, trips, and falls.

Reducing Slips, Trips, and Falls

In terms of strategies to mitigate slips, an obvious solution that most agencies reported is simply making it a priority to keep the crossing areas clear of debris and oil. Beyond this, many agencies use grooved or textured pavement in the crossing area to provide better traction (for example, the Golden Gate Bridge staff has recently begun using a material called FlexCrete™, a fiber-reinforced aerated concrete, in place of standard concrete at its crossing areas).

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁴	Concerns / Constraints
<i>Garments for Improved Worker Visibility</i>			
Consider higher visibility vests.	Use vests with battery-powered flashing lights.	<ul style="list-style-type: none"> Was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> Most plazas are well-lit, approach may not be cost-effective.
Consider 5-pt breakaway safety vests.	Use safety vests that have a 5-point breakaway system designed to come off with minor or no injury if the vest becomes hooked on an object.	<ul style="list-style-type: none"> Ranked low by workshop participants considering strategies to reduce worker exposure, with only one participant placing this strategy in their top three. 	<ul style="list-style-type: none"> Cumbersome to put on.
<i>Maintenance and Lane Closures</i>			
Instruct workers to look back over their shoulder every few steps after manually closing a gate.	Require workers to look back over their shoulder every few steps after manually closing a gate.	<ul style="list-style-type: none"> Mixed assessment of effectiveness, some concern about workers tripping. Was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> Concerns about tripping.
Require attenuator trucks for all maintenance work requiring a lane closure.	Some agencies require the use of attenuator trucks for all maintenance work requiring a lane closure.	<ul style="list-style-type: none"> Highly effective when implemented, but often not feasible. Ranked 3rd (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> Very expensive. Time consuming to wait for attenuator truck.
“Your Speed is...” signs on attenuator trucks.	Use digital “Your Speed is...” on the rear of attenuator trucks to protect maintenance workers.	<ul style="list-style-type: none"> Was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> Very expensive.
Require maintenance workers to use a “buddy” system.	Require maintenance workers to use a “buddy” system (i.e., no maintenance work is performed alone) so that one worker can watch for traffic.	<ul style="list-style-type: none"> Considered very effective, but may be cost prohibitive in certain situations. Ranked 9th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> Cost.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁴	Concerns / Constraints
Warnings to Employees			
Use ManSaver™ Bars to slow collectors down while crossing the plaza, possibly with chains at the sides of the crossing area to channelize workers.	These bars, patterned after those used on fire trucks, require a worker to stop and lift the bar to enter a lane but can easily be pushed to exit.	<ul style="list-style-type: none"> Ranked 7th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> Some concerns that they may be difficult to open when workers' hands are full. Chains may hinder a quick escape in the event of an emergency. Adding bar or chains may pose a hazard in that collectors' bags and/or clothing may snag as they are crossing.
Use visual cues to remind workers of the danger of crossing lanes.	Agencies use a variety of visual cues to remind workers of the danger of crossing lanes including:	<ul style="list-style-type: none"> May be most effective for newer employees. Ranked near the bottom of all strategies considered by workshop participants for reducing driver exposure. 	<ul style="list-style-type: none"> No real constraints except that workers may become complacent and ignore signs and markings over time.
Visually remind workers when they are entering ETC and mixed use lanes.	<p>Label ETC and mixed use lanes differently from cash only lanes to remind collectors that vehicles may not stop in these lanes (e.g., with purple lights).</p>	<ul style="list-style-type: none"> Ranked near the bottom of all strategies considered by workshop participants for reducing driver exposure. 	<ul style="list-style-type: none"> Concerns that this strategy may give workers a false sense of security when crossing the non-ETC lanes.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁴	Concerns / Constraints
Escort employees across lanes.	A small number of agencies have, or have considered, a police escort or crossing guard for crossing lanes.	<ul style="list-style-type: none"> • Effective at reducing worker risk, but very cost prohibitive. • One agency that has implemented this strategy reports that in 42 years, no employee has been hit while crossing a lane. • Was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> • Very cost prohibitive. • May expose another employee.
Crosswalks			
Strategically locate crosswalks.	Carefully consider the location of crosswalks to encourage workers to cross where most appropriate for the environment at that particular plaza (i.e., upstream of the booth to provide improved sight lines; downstream of the booth so that vehicles stop prior to crossing; or well downstream of the booth to allow for longer stopping distance).	<ul style="list-style-type: none"> • Two workshop participants selected this in their ranking of the top 3 most effective strategies for reducing worker exposure, placing the overall ranking of this strategy toward the middle of the 30 strategies considered. • Effectiveness is somewhat dependent on plaza configuration. 	<ul style="list-style-type: none"> • May be constrained by physical layout of plaza.
Paint pedestrian crosswalks at the plaza.	Designed to warn the public and to ensure that workers cross at the same dedicated location.	<ul style="list-style-type: none"> • Encourages collectors to cross at a consistent location. • Ranked 9th (tied) of 30 strategies considered by workshop participants for reducing driver exposure. 	<ul style="list-style-type: none"> • Need to be re-painted periodically. • May give the collector a false sense of security.

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁴	Concerns / Constraints
Require toll collectors to use stop paddles when crossing.	<p>Issue handheld STOP sign paddles to workers to hold while crossing lanes.</p> <ul style="list-style-type: none"> A number of agencies that have tried this have not found it to be effective. Ranked near the bottom of all strategies considered by workshop participants for reducing driver exposure. 	<ul style="list-style-type: none"> Requires workers to be properly trained. Difficult to hold paddle while also holding cash drawer. Can give workers a false sense of security. 	
Instruct workers to provide verbal cues to motorists when crossing.	<p>Instruct workers to give verbal cues to motorists when crossing (e.g., yell "I'm crossing!").</p> <ul style="list-style-type: none"> Considered moderately effective, effectiveness can be diminished by noisy environment. Ranked 13th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> May be too noisy to practically implement. 	
Promote hands-free crossing for workers.	<p>Require workers to have at least one hand free during crossing so that they can signal to drivers if need be.</p> <ul style="list-style-type: none"> Considered moderately effective. Ranked 13th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None. 	
Issue shoulder bags to workers to use when crossing.	<p>Issue shoulder bags to collectors for hands-free crossing, and consider high-visibility color such as orange.</p> <ul style="list-style-type: none"> Helps to keep hands free. Ranked 9th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None. 	
Instruct workers to use mutual support when crossing.	<p>Instruct workers to use mutual support when crossing lanes (i.e., the collector in the booth directs motorists to stop for the crossing collector).</p> <ul style="list-style-type: none"> Considered moderately effective. Is simply done as a matter of course (without formal instruction) at a number of facilities. Ranked 9th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None. 	

Strategies for Improving Safety at Toll Collection Facilities

Strategy	Description	Rankings from Workshop Participants ⁴ and Comments on Effectiveness ⁴	Concerns / Constraints
<i>Crossing Procedures</i>			
Require workers to make eye contact with motorists in approaching vehicles.	Require workers to make eye contact with drivers before crossing.	<ul style="list-style-type: none"> Considered very effective by agencies that have this rule. Was ranked as the number 1 strategy out of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None.
Require workers to wear safety vests at all times.	A number of agencies require workers to wear safety vests at all times while on shift. This is thought to reduce instances of workers failing to put on their vest when they exit a booth or break area.	<ul style="list-style-type: none"> Highly effective where enforced. Ranked 2nd (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None.
Prohibit workers from crossing any high-speed ETC lanes.	Many agencies prohibit workers from crossing any high-speed ETC lanes.	<ul style="list-style-type: none"> Effective, but may not always be practical. Ranked 7th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> There may be no other way for collectors to reach staffed lanes.
Prohibit workers from crossing in front of any vehicle larger than an SUV.	After experiencing a fatality when a collector crossed in front of a large truck that was not able to see the worker, one agency now prohibits workers from crossing in front of any vehicle larger than an SUV.	<ul style="list-style-type: none"> Highly effective, where practical. However, was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> May not be practical in truck lanes.
Require workers to signal intention to cross.	Require workers to signal their intention to cross to the approaching driver and to wait for acknowledgement from that driver.	<ul style="list-style-type: none"> Considered very effective. Ranked 3rd (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> None.
Prohibit workers from crossing BEHIND vehicles.	A number of agencies instruct their employees not to cross behind vehicles in case the vehicle backs up.	<ul style="list-style-type: none"> Common practice with a number of agencies, but not all. Was not selected as a top three strategy to mitigate worker exposure by any of the workshop participants. Ranked last (tied). 	<ul style="list-style-type: none"> None.

Strategies for Improving Safety at Toll Collection Facilities

Table 1. Potential Strategies to Mitigate Safety Issues Associated with Worker Exposure to Vehicles

Strategy	Description	Rankings from Workshop Participants and Comments on Effectiveness ⁴	Concerns / Constraints
<i>Providing Direct Access to Booths</i>			
Provide physical bypasses of toll lanes for collectors.	Use tunnels or bridges to reduce the need for workers to cross lanes.	<ul style="list-style-type: none"> Effective if used properly. However, ranked last (tied) of all solutions considered by workshop participants to reduce worker exposure. 	<ul style="list-style-type: none"> Very expensive. Tunnels present problems with flooding. Even when available many workers do not use them.
Provide break areas on either side of large plazas.	Some agencies with large numbers of plaza lanes or with staffed lanes on both outside lanes (with ETC in the middle) have placed break rooms on either side of the plaza to minimize the number of lanes that collectors must cross during their shift.	<ul style="list-style-type: none"> Considered highly effective (though costly) where appropriate. Due to uniqueness of requirements, was not selected by any workshop participants in their top three list of most effective strategies for reducing worker exposure. 	<ul style="list-style-type: none"> Expensive.
Locate all dedicated ETC lanes to the far left of the plaza so that collectors can avoid crossing these high speed lanes.	Locate all dedicated ETC lanes to the far left of the plaza so that collectors can avoid crossing these high speed lanes.	<ul style="list-style-type: none"> Highly effective where feasible. Ranked 3rd (tied) of 30 strategies considered by workshop participants for reducing worker exposure, with 4 of 20 participants selecting it as the most effective solution. 	<ul style="list-style-type: none"> Will not work where ETC lanes are required on the right side of the plaza to facilitate exiting on down-stream ramps close to plaza.
Eliminate all mixed mode lanes to reduce uncertainty of driver behavior.	Many toll collectors consider mixed-mode lanes (with both ETC and cash customers) to be more dangerous to cross than cash or ETC lanes because it is more difficult to predict driver behavior in these lanes. Consequently, some agencies have given consideration to eliminating these lanes.	<ul style="list-style-type: none"> Does increase worker safety, but may reduce throughput. Ranked 15th (tied) of 30 strategies considered by workshop participants for reducing worker exposure. 	<ul style="list-style-type: none"> May not be feasible at certain plazas due to space constraints, traffic volumes, mix of ETC and cash traffic. May cause increased weaving and lane changing behavior.

⁴ Within each strategy grouping, workshop participants were asked to select and rank the three strategies that they believed to have the greatest potential to improve safety for workers and customers at toll plazas. Note that at the workshop, the strategies discussed here were presented in a category entitled "Improving Safety Issues Associated with Worker Exposure to Vehicles".

management when the vests were being selected, and the breakaway vest that was selected has received a positive response by employees.

Three agencies reported that they are considering development of new uniforms that will have safety features built in, thereby eliminating the need for safety vests.

Maintenance and Lane Closures

Other mitigation strategies related to worker safety in travel lanes included:

- Requiring workers to look over their shoulder every few steps after closing barriers.
- Using attenuator trucks for all maintenance activities that require a lane closure.
- Placing “Your Speed Is” dynamic signs on the rear of attenuator trucks to slow down vehicles in the vicinity of maintenance activities.
- Using side-fire cameras to allow for maintenance work without closing a lane (i.e., cameras are mounted by the roadside instead of overhead).
- Requiring maintenance workers to use a “buddy” system, with one worker watching for unsafe traffic conditions.

Strategy Rankings, Effectiveness, and Constraints

Table 1 lists each strategy identified for mitigating safety issues associated with worker exposure to vehicles and provides comments from practitioners on strategy effectiveness and any concerns/constraints. The table also provides information on practitioner ranking results from the Toll Facility Safety Study Workshop.

Garments for Improved Worker Visibility

Vests are typical safety garments provided to toll plaza employees. Beginning in November of 2008, all workers within the right-of-way of a Federal-aid highway who are exposed to traffic or to construction equipment within the work area are required to wear high-visibility safety apparel, defined as personal protective safety clothing that is intended to provide conspicuity during both daytime and nighttime usage, and that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear."^{2 3}

In terms of variations on the standard vest, one agency has recently adopted a safety smock which is light-weight, has short sleeves, and is waist length. It is fluorescent yellow green with orange sections and retro-reflective strips (similar to that shown in Figure 9).



Figure 9. Safety Smock

Depending on the climate, some agencies issue collectors a retroreflective jacket (as shown in Figure 10). Another agency issues toll collectors a 3-in-1 coat. The coat is lined and fluorescent yellow-green. The sleeves can be unzipped and removed for spring and fall and the lining unzips so that it is more vest-like in the summer.

Another agency has gone to using battery-powered flashing vests for employees who work in the toll lanes, and still another reported moving toward a high visibility safety vest with five-point breakaway. The vests were ordered in response to

news reports that vests would get caught on passing vehicles and workers were being dragged several hundred feet. The vests are fluorescent yellow green and are supplied to each employee and replaced as needed. The agency reported that they gave their collectors the opportunity to provide input to



Figure 8. Various Signs and Markings Remind Collectors of the Dangers of Crossing Lanes



Figure 10. Retroreflective Jacket

² Federal Register / Vol. 71, No. 226 / Friday, November 24, 2006 / Rules and Regulations, Page 67792.
http://www.workzonesafety.org/files/documents/laws_regulations/federal/nov_24_06.pdf

³ Revised American National Standard for High-Visibility Safety Apparel and Headwear, ANSI/ISEA 107-2004.
<http://www.workzonesafety.org/node/1736>

Warnings to Employees

Related to crosswalks, many agencies have implemented some type of mitigation strategy to remind workers that they are crossing live lanes of traffic. At one end of the spectrum, some agencies make use of a device called a ManSaver™ Safety Bar. As shown in Figure 6, these are physical gates adapted from use on fire trucks that must be carefully opened to enter a travel lane (i.e., the worker must stop and pull the gate either upward or toward himself), but that can be easily pushed through to get out of the travel lane on the other side. To ensure that collectors cross at the ManSaver™ bar, one agency that the study team visited has begun using chains at the sides of the crossing area in effect to channelize workers to cross at the ManSaver™ bar.

At the other end of the spectrum, a number of agencies have simply stenciled or painted messages on the curbs abutting the travel lanes. These messages include "LOOK→" and "WATCH FOR TRAFFIC" (examples shown in Figures 7 and 8). Through conversations with collectors, the general consensus is that such messages tend to be effective for new employees or when first added, but that over time they become part of the background and are ignored.

Two agencies visited use signs at toll lane crossings to mark ETC lanes so that employees can easily identify lanes where traffic does not stop. One agency uses signs that read "E-Z LOOK," with eyes drawn into "LOOK" and an arrow pointing in the direction of oncoming traffic. The signs are metal and mounted on the side of the bullnose facing in toward the lane at crossing locations. The same agency also uses red on white signs that read "BE ALERT HIGH SPEED TRAFFIC." Another agency uses signs that are installed on the backs of booths and read "WARNING – EZ PASS TRAFFIC DOES NOT STOP."



Figure 6. ManSaver™ Safety Bar

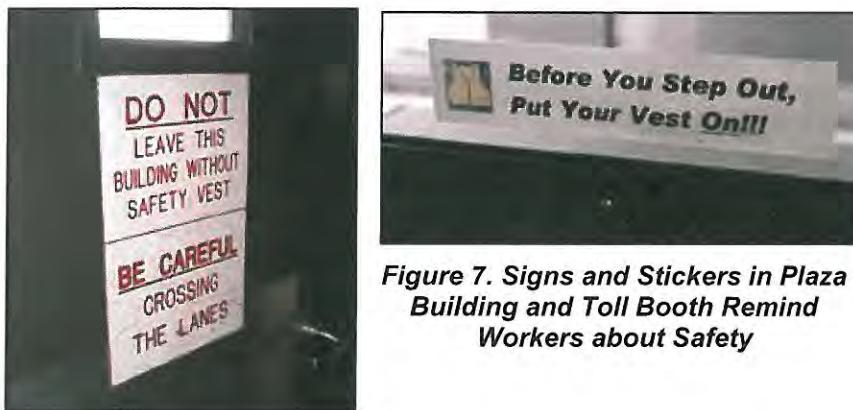


Figure 7. Signs and Stickers in Plaza Building and Toll Booth Remind Workers about Safety

- Workers at a number of agencies have adopted informal procedures of mutual support for lane crossing (i.e., the collector in the booth directs the motorist to stop for the crossing collector).
- One agency suggested that it might be a good practice to employ a person to escort workers while crossing lanes, much like a school crossing guard. Another agency, which has a dedicated police force, reported that the police escort all toll collectors across toll lanes. This agency commented that in 42 years an employee has never been hit while crossing a lane.

Crosswalks

One interesting finding from the study was the diversity in the location, demarcation, and setup of collector crosswalks. For the most part, crosswalks are located just downstream of the booth – minimizing the exposure time of the employee when walking from the crosswalk to the booth. However, a few agencies have alternative approaches. One places its crosswalks upstream of the booth. This reduces the issue of vehicles not being able to see collectors crossing behind booths (and collectors not being able to see vehicles around booths as shown in Figure 4). However, it also forces collectors to cross traffic lanes in an area where vehicles do not typically stop.

Another agency has its crosswalks positioned at a significant distance downstream of the booths. This provides collectors with somewhat better sight lines (e.g., so that they can see around the booth) and provides a greater distance between where the vehicle begins accelerating (at the booth) and the crossing point. However, it also means that collectors can have a more difficult time making eye contact with stopped vehicles and with fellow collectors in booths who may be able to offer mutual support.

There was also significant diversity in the methods used to demarcate the locations where collectors should cross. Most agencies use crosswalks painted on the pavement (as shown in Figure 5) and safety-shape barriers or railings (with openings at the crosswalks) to encourage workers to use the crosswalk. However, a small number of agencies are not as restrictive as to where collectors could cross – while they may still use painted crosswalks, they do not physically channel collectors to openings with gates, etc. for fear that these barriers could present dangerous obstructions if a collector was outside of the crosswalk area and needed to quickly get out of the travel lanes.



Figure 3. Clear Plastic Shoulder Bag for Collectors to Use when Crossing



Figure 4. Booths can Create a Visual Obstacle when Crossing



Figure 5. Painted Crosswalk for Workers

Two additional design strategies for minimizing worker exposure include:

- Locating all high-speed ETC lanes to the left of the facility (i.e., toward the middle of the roadway) and prohibiting employees from crossing these high-speed lanes.
- Eliminating all mixed-mode lanes, relying instead on dedicated ETC and cash lanes.

Crossing Procedures

For those cases where workers must still cross traffic lanes (either because a tunnel or bridge does not have an entrance to every lane, or because such a structure is not present), agencies have implemented a variety of different crossing procedures (both formal and informal). Nearly all agencies require workers to make eye contact with vehicles before crossing. However, this is the only procedure that appeared to be common to all agencies visited and interviewed. Crossing procedures that are employed by one or more agencies visited or interviewed, but that are not common to all, include the following:

- Most agencies require safety vests to be worn by workers at all times. Others require them to be worn only when outside of the booth.
- A number of agencies strictly prohibit workers from crossing any high-speed ETC lanes. Some agencies only allow supervisors to cross these lanes. Two agencies reported that employees are never allowed to cross active lanes of traffic – if an employee needs to cross a lane, it must first be shut down.
- Owing to an earlier incident that resulted in a fatality, one agency has a policy that workers are not allowed to cross in front of any vehicle larger than a sport utility vehicle (SUV), fearing that operators of large trucks simply cannot see a person immediately in front of their vehicles.
- Nearly all agencies require their workers to signal their intent to cross to drivers and to wait for confirmation from the driver.
- A number of agencies do not allow their workers to cross behind vehicles for fear that the vehicle may back up, a common occurrence at toll plazas.
- Employees of one agency are issued a small personal “stop paddle” (as shown in Figure 2) that is utilized by both the employee crossing an active lane of traffic and by the collector working in the adjacent toll booth.
- Some workers reported that they have taken to providing verbal cues to motorists (e.g., yelling “I’m crossing!”).
- Several agencies stress the importance of hands-free crossing. Having both hands free while crossing makes it easier for collectors to signal to oncoming traffic and to catch themselves if they fall. To facilitate hands-free crossing, a strategy that many agencies use is to issue collectors shoulder bags or backpacks – such as that shown in Figure 3 – in which they can carry their personal belongings (e.g., a sweater or a bottle of water) to the booth. In some cases the bag provided is a high-visibility color, such as orange, to make the collector more visible to motorists. One agency has even replaced its collectors’ cash drawers with cash bags that they can slip into a shoulder bag for completely hands-free crossing. Most collectors that the team talked with spoke favorably about using carry bags.



Figure 2. Handheld Stop Sign Aids Collector in Crossing Travel Lanes

IMPROVING WORKER SAFETY WHEN ACCESSING TOLL BOOTHS

THE CHALLENGE

When asked the one safety fear that kept them up at night, nearly every individual that the study team visited with or talked with gave the same response – a worker being struck by a vehicle. While such incidents are relatively rare, they have occurred, and the potential certainly exists for them to occur again. Among the factors that have contributed to such incidents in the past (or to more recent close calls) are the introduction of electronic toll collection (ETC) lanes, the uncertainty of driver actions in mixed-use lanes, the inability of operators of large trucks to see someone crossing directly in front of them, the dangers in closing a lane, and worker complacency.

POTENTIAL MITIGATION STRATEGIES

Given the level of concern surrounding this particular safety issue, it is perhaps not surprising that a large and varied number of mitigation strategies have been implemented across the country to address this problem.

Providing Direct Access to Booths

The most aggressive mitigation strategy to protect workers from vehicular traffic is the use of physical by-passes of toll lanes, such as tunnels or bridges (example shown in Figure 1), to provide access to booths without requiring workers to cross active traffic. Approximately half of the agencies visited by the study team have built such structures for their larger plazas. However, these structures rarely prevent all incidents of workers being in the roadway. Most of the structures do not have entrances for each and every lane; consequently workers are still typically required to cross two to three lanes. Even if collectors can avoid crossing a lane by using the structure, they still sometimes find themselves in live traffic – whether to pick up dropped monies, to assist customers having problems with their ETC transponders, or to close a lane. Further, the use of such structures by collectors is typically not mandated (even when present), and many of the agencies that have tunnels report that their usage remains quite low. The reasons for this are varied – workers avoid bridges without elevators because of the need to climb stairs, tunnels are often dark and the entrances slippery, and the use of both structures can take more time than simply walking across a lane.



Figure 1. Tunnels Provide Access to Booths without Exposure to Traffic

Another strategy for minimizing the number of lanes that a worker must cross is to provide break areas on either side of the plaza. Some agencies with large numbers of plaza lanes or with staffed lanes on both outside lanes (with ETC in the middle) have placed break rooms on either side of the plaza to minimize the number of lanes that a worker must cross during their shift. Agencies have found this to be an effective way to reduce exposure, but this approach can be costly and is often simply impractical given space limitations and lack of additional right-of-way.

Strategies for Improving Safety at Toll Collection Facilities

Following the presentation of individual strategies, this report presents information about two additional kinds of strategies (training and safety culture) that could be viewed as overarching in that they address multiple safety issues rather than focusing on one issue in particular, such as speeding.

Finally the report concludes with a discussion of maintaining safety while using open road tolling. As many agencies are making the move toward some form of open road tolling, many are also discovering some new safety challenges along the way. Some of these safety impacts that were uncovered through this study are discussed here as this will be an issue of interest to the industry moving into the future.

The complete findings of this study can be found in the document "Toll Facilities Workplace Safety Study Report to Congress" which is available online at www.fhwa.dot.gov/tolling/.

FOREWORD

Toll collection facilities present unique safety challenges both for the traveling public and for the workers who support the fare collection operation. A wide range of solutions have been developed to address these unique safety challenges. However, many of these solutions have been created by individual agencies that are geographically and institutionally isolated from one another. Consequently, while many of the techniques or strategies are quite innovative and might be applicable at other toll collection facilities, only a single agency is aware of the technique.

To address this problem, and in an effort to better understand the safety challenges that toll facilities face and how these challenges are being addressed within the industry, Congress called for a Toll Facility Safety Study to be conducted by the U.S. Department of Transportation.¹ This study involved gathering information on specific safety strategies directly from those who operate and who work in and around toll facilities. Information was gathered through an industry survey, telephone interviews, site visits and in-person interviews, and an industry workshop. Altogether, individuals from over 35 tolling authorities were consulted, and from discussions with these individuals, 94 strategies were identified that are currently in use across the country that may have the potential to improve safety at toll collection facilities elsewhere.

This report presents these 94 strategies. The strategies are presented according to some of the many challenges that agencies face with regard to worker and motorist safety:

- Improving Worker Safety when Accessing Toll Booths
- Reducing Worker Exposure to the Environment
- Improving Ergonomics for Workers
- Reducing Worker Risk of Assault
- Reducing Unsafe Merging and Lane Changing
- Reducing Speeding
- Reducing Driver Confusion and Driver Inattention
- Improving Safety through Overarching Strategies (e.g., training, a culture of safety, etc.)
- Maintaining Safety while Using Open Road Tolling

To guide readers in identifying strategies best suited for their needs, this report presents each strategy along with comments from practitioners on any concerns they may see with that particular strategy (e.g., cost), and any practical constraints that may exist (e.g., plaza design). In addition to this, each strategy is ranked in terms of effectiveness. These rankings were obtained from participants in a Toll Facility Safety Study Workshop, held in McLean, Virginia, in June 2007. Participants included both management and labor and represented 21 tolling agencies from across the country.

¹ Public Law 109-59: Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, Sec. 1403. Toll Facilities Workplace Safety Study. August 10, 2005.

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