TECHNICAL ASSISTANCE REPORT

ENGINEERING AND TECHNOLOGY MEASURES TO IMPROVE LARGE TRUCK SAFETY: STATE OF THE PRACTICE IN VIRGINIA

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EXECUTIVE SUMMARY

In response to a request by Frank S. Wolf and Jo Ann Davis of the U.S. House of Representatives, Governor Mark Warner formed a Special Task Force on Truck Safety in the fall of 2002. The objective of the task force was to examine ways to reduce the number of crashes involving large trucks on Virginia's roads. One of the goals of this task force was to identify engineering and technology measures that have the potential to improve large truck safety.

The task force charged the Virginia Transportation Research Council with identifying engineering and technology measures that offer the potential to improve large truck safety. A literature review of these areas was conducted, and a survey of personnel in the Virginia Department of Transportation (VDOT) was also carried out (1) to determine what measures have been implemented in Virginia, and (2) to solicit ideas for additional improvements. Traffic control improvements, geometric design changes, and intelligent transportation systems that improve truck safety are summarized in this report, and survey respondents' recommendations for potential initiatives in engineering, enforcement, and education are also presented.

The research showed that VDOT has already taken many actions to improve large truck safety issues and that further action could be taken in several areas:

1. VDOT's Mobility Management Division (MMD) should consider encouraging the use of dynamic truck speed advisory systems on freeway ramps where there are large numbers of rollover crashes.

2. VDOT's Location & Design Division should examine whether current design standards are adequate for the current truck fleet.

3. The MMD should consider developing guidelines for providing advance warning of the start of the red phase at intersections with limited sight distance.

4. The MMD should reexamine whether the truck lane restrictions are producing safety improvements.

In addition to these measures, VDOT should continue to pursue the initiatives that are already underway, for example, the rumble strip program and measures to improve traveler information.

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INTRODUCTION

In response to a request by Frank S. Wolf and Jo Ann Davis of the U.S. House of Representatives, Governor Mark Warner formed a Special Task Force on Truck Safety in the fall of 2002. The objective of the task force was to examine ways to reduce the number of crashes involving large trucks on Virginia's roads. Members of the Virginia Department of Transportation (VDOT), the Virginia Department of Motor Vehicles, the Virginia State Police, and the Virginia Trucking Association served on the task force. The task force was asked to perform a comprehensive examination of (1) the causes of large truck crashes and (2) potential solutions that could address these causes. One of the goals of the task force was to identify engineering and technology measures that have the potential to improve large truck safety. This report documents the results of that work.

PURPOSE AND SCOPE

The task force charged the Virginia Transportation Research Council (VTRC) with identifying engineering and technology measures that offer the potential to improve large truck safety. Specifically, the task force asked VTRC to:

1. Identify engineering and technology measures that other states have used to improve large truck safety.

2. Determine what measures VDOT has implemented in Virginia.

3. Solicit ideas from VDOT personnel for new truck safety initiatives.

Due to the tight schedule of the task force, less than 2 weeks was available to compile this information. As a result, it is possible that additional information is available, but time constraints made conducting a more detailed search impossible.

METHODOLOGY

Data on engineering and technology measures that could improve truck safety were collected in two ways. The VTRC Library, the University of Virginia Library, and the Internet

were used to identify studies of the effectiveness of engineering and technology measures on large truck safety. A survey was also sent to VDOT personnel to determine (1) what measures are being used by VDOT to improve truck safety and (2) what additional initiatives would help improve truck safety in the Commonwealth. The survey was sent to the following groups:

- district maintenance engineers
- district traffic engineers
- smart traffic center administrators
- representatives of the Location & Design Division
- representatives of the Mobility Management Division.

The survey instrument and a list of the survey respondents are included in the appendix.

LITERATURE REVIEW

The literature was reviewed to determine innovative methods that have been used across the United States to address the issue of large truck safety. The specific areas examined included:

- intelligent transportation system (ITS) solutions
- traffic control solutions
- geometric design solutions.

Time constraints prohibited a detailed literature review of these items, so each countermeasure is briefly described here.

ITS Solutions

Transportation agencies have used ITS in an attempt to improve safety for large trucks. For the most part, the systems that have been deployed have been geared toward providing drivers with additional information about potentially hazardous conditions. This section summarizes some of the research in these areas.

Truck Speed Advisory Systems

Truck speed advisory systems offer a direct way to influence truck safety. These systems detect truck speeds using radar or in-pavement detectors and alert truck drivers if they are

traveling too fast for current conditions.[1] The two most common applications of truck speed advisory systems are on freeway exit ramps where the risk of rollovers is high and on steep downgrades where trucks may accelerate to very high speeds. Truck speed advisory systems provide a dynamic warning that is targeted to a specific vehicle, potentially creating a safety improvement over static signs.

Virginia, Maryland, and Pennsylvania have installed truck speed advisory systems on freeway ramps to reduce the risk of rollover crashes.[2] These systems use parameters such as speed, deceleration, truck weight, radius of curvature, and superelevation to determine whether a truck's speed is excessive. Variable message signs or flashing beacons are activated to encourage the truck driver to slow down. These truck speed advisory systems have been installed at four high-crash sites in these three states. Data collected at these sites indicated that no rollover crashes were observed the 6 years following installation of the system.

A truck speed advisory system was also tested in Colorado on a 10-mile downgrade that averaged –6 percent.[3] The system provided a speed advisory that varied according to the weight of the truck. Again, a sign was used to alert drivers that they should slow down. The researchers found that the system reduced speeds an average of 8 mph on this downgrade and substantially improved speed limit compliance.

Improved Traveler Information

Traveler information can also potentially improve safety for large trucks. If truck drivers have information on traffic congestion or weather conditions, they could have the opportunity to alter routes or departure times so that they would not be exposed to potentially hazardous situations.[4] Traveler information can be distributed through variable message signs, highway advisory radio, 511 services, or the Internet.

In-Vehicle ITS Systems

Considerable research is being performed with in-vehicle ITS systems. Developments in commercial vehicle ITS systems do have the potential to improve large truck safety, but the cost to implement these systems can be significant. Some of ITS features that could improve truck safety are briefly described here.[5]

- *Collision avoidance technology.* Collision avoidance systems can provide early warning to truck drivers of an impending collision. These systems use sensors to determine the positional relationship between the vehicle and the surrounding environment. If a hazard is detected, the system can either sound a warning or take control of the vehicle by applying the brakes or accelerating.

- *Driver condition warning systems.* Driver fatigue is a factor in 3 to 6 percent of all fatal crashes involving large trucks and in 18 percent of single-vehicle, large-truck fatal crashes.[5] Driver condition warning systems can detect driver fatigue by

monitoring driver eye movement or steering maneuvers. A warning is sounded to alert the driver to pull over and take a break.

- *Fleet management systems/driving log recorders.* Systems that track and record a vehicle's current position and hours of service are available. These systems could be used to enforce hours of service regulations or identify the location of hazardous materials.

- *Safety systems.* Systems are being developed that can determine the condition of tires, braking systems, and other safety-critical components of a large truck. These systems will provide advance warning to the truck driver when it appears that a component is about to fail.

Geometric Design Solutions

As a matter of practice, engineers must consider the maneuvering characteristics of large trucks when developing the geometric designs for roads. The turning radii and acceleration/deceleration characteristics of large trucks are much different than those of passenger cars, causing engineers to use large trucks as design vehicles for most facilities. There are accepted standards that govern the design of roads to accommodate large trucks, so they are not discussed here.[6] Geometric standards do not offer precise guidance or may have become outdated in a number of areas, however. This section discusses these situations.

Truck Escape Ramps

Many states have provided truck escape ramps so that truck drivers have a controlled place to leave the roadway in the event of a braking system malfunction. There are no standard guidelines in the United States for determining when to provide escape ramps, although most states do agree that the following issues tend to drive the decision regarding whether to create an escape ramp:[7]

- crash experience at the site
- length of downgrade
- percent grade
- percentage of trucks
- conditions at the bottom of the grade.

Since no standard guidelines exist, the use of escape ramps can vary considerably among states.

Improvements to Parking Facilities

As noted earlier, driver fatigue is a major factor in many crashes involving large trucks. Improvements to truck parking facilities could potentially reduce fatigue-related crashes by providing drivers with more opportunities to take breaks. Increasing the number of parking facilities and improving the information available to truckers about parking availability could create a safety benefit. A study performed in Kentucky identified the following possible improvements that could reduce fatigue-related crashes:[4]

- Provide additional parking facilities, possibly by encouraging the use of weigh stations for parking.
- Publicize the locations of current parking facilities and the hazards of parking on shoulders.
- Restrict parking and enforce parking limits on shoulders.

Road Safety Audits

Road safety audits have also been used to help improve safety during the design process. A road safety audit is a systematic and independent assessment of a road's safety, and its purpose is to make a road as safe as possible before traffic ever travels on the road.[8] Road safety audits are used by many countries internationally and are beginning to be used in the United States. Road safety audits offer the opportunity to consider safety issues prior to construction, potentially eliminating problems before they can affect the motorist.

Traffic Control Solutions

Traffic control is often used to advise drivers of large trucks about specific restrictions or hazards. For example, truck rollover and speed advisory signing is included in the federal *Manual on Uniform Traffic Control Devices* (MUTCD).[9] Use of these signs should be standard practice and is not discussed here. Devices or techniques that go beyond what is required by the MUTCD are of interest, and several options have created improvements in large truck safety or operations.

Use of Rumble Strips

Centerline and shoulder rumble strips have been used across the nation as a countermeasure to reduce fatigue-related crashes. The use of rumble strips can offer a safety improvement not only to trucks, but also to all vehicles on the road. The documented results in some of the states that use rumble strips were:

- *California.*[10] Caltrans saw a 49 percent reduction in run-off-the-road crashes in the first 7 years after they implemented rumble strips on the shoulders of a rural highway.

- *Delaware.*[11] Centerline rumble strips were installed on a two-lane rural highway, and the total number of crashes on these highways declined by more than 25 percent in the 2 years following installation.

- *New York.*[11] The New York State DOT had installed more than 3,000 miles of shoulder rumble strips by 1998, and they have seen a 65 percent reduction in run-off-the-road crashes on sections of highway with rumble strips.

- *Virginia.*[12] More than 1,750 miles of roadway in Virginia have milled shoulder rumble strips. Run-off-the-road crashes have decreased 51.5 percent where the rumble strips have been implemented. VDOT estimates that installation of continuous milled rumble strips has saved 1 life for every 17 miles of rumble strips.

Lane Restrictions

Truck lane restrictions have been implemented in several jurisdictions in an attempt to improve safety and operations. In these cases, transportation officials believed that removing trucks from the passing lane would reduce conflicts between trucks and cars, potentially improving safety. The results of some deployments of truck lane restrictions are summarized here.

- *Broward County, Florida.*[13] Trucks were restricted to the right two lanes of a three-lane section, and crash data for 9 years were analyzed. The number of crashes involving a truck declined 38.4 percent, and the number of injury crashes involving a truck declined 56.8 percent.

- *Fort Worth-Weatherford, Texas.*[14] Trucks were restricted from the left lane on a three-lane directional section, and operational measures were analyzed. Trucks complied with the new restriction, with only 3 percent of trucks traveling in the restricted lane.

- *Houston.*[15] Trucks were restricted from the left lane on an 8-mile freeway section in Houston. The researchers examined crash data from a 36-week period and found that crashes had declined 68 percent from the prior year when restrictions were not present. This may be biased based on the small period of crash data available. A user survey found that the lane restrictions were widely supported, with 85 percent of respondents indicating that they supported the use of lane restrictions.

- *Chicago Area and Wisconsin.*[16] Truck lane restrictions were evaluated at two sites in suburban Chicago where trucks were restricted from the left lane on a three-lane section and on a rural Wisconsin roadway where trucks were restricted from the left lane on a two-lane section. The researchers found that fewer trucks impeded traffic

once the lane restrictions were installed, and the length of the queues of traffic unable to pass trucks declined. There was no adverse impact on the speed differential between the restricted and unrestricted lanes. Noncompliance with the truck restriction was extremely high at the Wisconsin site.

- *Northern Virginia.*[17] A study of the effectiveness of lane restrictions was performed on the Capital Beltway in Virginia. The study examined crash data from 2 years before to 2 years after the implementation of truck lane restrictions in 1984. The researchers found that the crash rate increased 13.8 percent after the implementation of the lane restrictions. A subsequent analysis of I-95 in 1988 revealed similar trends.

Signal Phasing

A recent research project examined ways to reduce the potential for large trucks to run red lights at high-speed, rural, isolated intersections.[18] The green phase was extended for up to 16 seconds in order to allow a truck to proceed through an intersection without stopping. This had the effect of reducing delays to trucks and minimized the potential for trucks to have a rear-end collision with stopped traffic or to run through the red light. It also decreased pavement wear in the area around the signal.

VDOT SURVEY RESULTS

VDOT personnel were surveyed to determine what measures were currently being used in Virginia to improve large truck safety. The survey (see Appendix A) was divided into four general areas:

1. ITS initiatives
2. geometric design improvements
3. traffic control improvements
4. organizational/coordination improvements.

The survey also asked the respondents to propose new initiatives that could improve truck safety. Responses were received from eight districts, two smart traffic centers, and three divisions. This section briefly summarizes the responses of the survey.

Existing Initiatives In Virginia

This section describes existing efforts in Virginia to improve safety through the use of ITS or engineering. This information summarizes the survey responses that were received from VDOT personnel.

ITS Initiatives

In general, VDOT uses ITS either to provide better traveler information to truck drivers about potential routes or to provide dynamic warnings to drivers that they are performing an unsafe action. The practices in use in Virginia are summarized here.

Permanent Variable Message Signs (VMSs) and Highway Advisory Radio (HAR)

VMSs and HAR are two readily available ways to provide information to truck drivers. The permanent VMSs operated by VDOT are used to provide traveler information to cars and trucks. They can be used to warn of weather conditions and incidents or to direct traffic to alternate routes. HAR is also being used to provide advisories to truckers. Truckers could be advised of construction, weather conditions, or congestion through the use of HAR.

I-81 Truck Fleet Alert

The I-81 Truck Fleet Alert Program was created as a way to provide travel information to commercial vehicle operators on the I-81 corridor. The program has been in development since 1999 and is an offshoot of Travel Shenandoah.[19] This system could be used to provide advisories on congestion, road conditions, weather, incidents, and current travel speed advisories. This system could potentially be expanded other major trucking corridors or the entire state.

511

Virginia's 511 service currently covers the area around the I-81 corridor and provides information on travel conditions and traveler services.[20] Users can get information on traffic alerts, construction information, current weather conditions, and motorist services. The 511 service provides information that can be used by drivers of large trucks for trip planning and could be expanded to provide more information that is applicable to large trucks, such as parking availability information.

Virginia Operational Information System (VOIS)

VOIS allows all users, including the trucking industry, to view and track roadway conditions, incidents, and work zones throughout the state. This could allow truck drivers to plan a route to minimize exposure to hazardous conditions. One planned improvement to VOIS is a broadcast e-mail function. Users who request to receive e-mails will receive an automated alert when road conditions change.

CB Wizard System

The CB Wizard system is similar to an HAR, but it broadcasts over the CB band. VDOT owns several of these systems, and they can be used to broadcast up to an 18-second message. The advantage of the CB Wizard System is that it can be used to target information to drivers of large trucks. It also does not require that a truck driver tune to a specific radio station since messages are usually broadcast over bands that truck drivers use regularly.

Automatic Truck Rollover Warning System (ATRWS)

Two ATRWSs have been deployed in VDOT's Northern Virginia District, and one is operating in the Salem District. These systems determine the potential for truck rollovers as a function of vehicle type, weight, and speed. If a truck is traveling too fast, a sign will be activated to advise the driver to reduce speeds. A summary of this system's effectiveness was presented earlier in this paper.[2] Engineers from the Northern Virginia District indicated that this system was very effective in reducing rollover crashes.

Dynamic Over Height Detectors

Over height detectors determine whether an approaching vehicle exceeds the height of a bridge or tunnel. The detectors activate a dynamic warning sign that alerts the truck driver that the vehicle is too large to proceed through the bridge or tunnel. Over height detectors are in place in Williamsburg, at the Hampton Roads Bridge Tunnel, and along I-95 in Southampton County. An additional detector will be installed on I-81 near Abingdon in 2003.

Fog and Wind Detection and Warning System

A project to construct a fog and wind detection and warning system is nearing completion on I-77 near Fancy Gap. This system will provide real-time information to motorists about weather conditions through VMSs and 511.

Weigh-in-Motion (WIM) Systems

WIM systems are in place in several locations around the Commonwealth. The WIM systems do not require that trucks slow down to be weighed, potentially reducing merging conflicts and deceleration conflicts in the areas around weigh stations. This could improve safety in those areas.

Commercial Vehicle Information and Systems Network (CVISN)

CVISN is an advanced system that integrates a collection of databases that support commercial vehicle operations. It combines different databases maintained by government and private carriers in order to perform electronic screening, exchange safety information, and handle credentialing. Virginia was one of two states participating in the CVISN prototype deployment. Once the CVISN system is deployed nationally, truck drivers will rarely need to be stopped at weigh stations, for credential inspection, or for safety inspections. This should have the effect of improving safety by reducing the number of times that trucks enter or leave the traffic stream.

Geometric Design Improvements

Truck Climbing Lanes

The use of truck climbing lanes should reduce conflicts between slow-moving trucks and faster passenger vehicles. The climbing lanes allow passenger cars to travel at a faster speed by

eliminating slower trucks from some of the travel lanes. The American Association of State Highway and Transportation Officials (AASHTO) has defined criteria for providing climbing lanes on two-lane roads and multilane highways.[6] AASHTO indicates that the following criteria should be satisfied before considering installing climbing lanes on a multilane highway:

- If the running speed of low-performance trucks is more than 10 mph below the average running speed of traffic, a climbing lane should be considered.
- Generally, a climbing lane should not be considered unless Level of Service D is exceeded.
- Because of economic reasons, climbing lanes are usually not warranted on four-lane highways when directional volumes are below 1,000 vehicles per hour per lane .

The addition of climbing lanes can provide a significant operational and safety improvement on upgrades. Climbing lanes allow passenger cars to pass slow-moving trucks and should also reduce the conflicts that can occur between traffic flowing at the prevailing operating speed and slower trucks. Truck climbing lanes are in place in a number of VDOT districts in the more mountainous regions of the state, and the engineers responding to the survey indicated that they have very positive effects on operations and safety.

Truck Escape Ramps

Truck escape ramps are provided in two of the more mountainous districts to provide a way for truck drivers to leave the road in a controlled manner. The Bristol District has two truck escape ramps. Their traffic engineer noted that the ramps have been used in the past but there is no record of how frequently they have been used. The Staunton District identified four escape ramps but did not know how frequently they were used.

Improvements to Ramp Geometry

The Salem District's traffic engineer noted that they have recently extended many acceleration and deceleration lanes along I-81. These extensions provide more space for trucks to accelerate or decelerate. This should allow trucks to enter or leave the I-81 mainline more smoothly and reduce the potential for conflicts with other vehicles on I-81.

Traffic Control Improvements

Rumble Strips

As noted earlier, VDOT has installed more than 1,750 miles of continuous shoulder rumble strips.[12] These rumble strips have reduced run-off-the-road crashes by more than 50 percent. Several of the survey respondents indicated that they believed this was one of the most effective measures that could be implemented to improve safety.

Truck Lane Restrictions

Truck lane restrictions are in place along several portions of freeway in Virginia. An example of the signing for a truck lane restriction is shown in Figure 1. Many of the survey respondents had positive comments about the effectiveness of the lane restrictions. One respondent noted that these restrictions are particularly effective when dealing with truck climbing lanes or other three-lane directional sections that ascend a steep grade.

Truck lane restrictions are also in place on several primary roads. The Lynchburg District restricts trucks to the right lane of U.S. 29 through the Madison Heights area of Amherst County. The district traffic engineer noted that this has improved flow on the corridor and increased safety. The Richmond District is currently considering commercial vehicle lane restrictions to improve the level of service on a primary corridor. The vertical alignment, number of traffic signals, and level of congestion are driving this effort.

As noted earlier, data are limited on the effectiveness of these truck restrictions. The only documentation located was from studies performed in Northern Virginia in the mid- to late 1980s. The data from these studies showed that the crash rate actually increased following the implementation of truck lane restrictions on the Beltway and I-95.[17] These results are contrary to the opinions of the survey respondents that truck restrictions offer a positive safety benefit.

Figure 1. Truck Lane Restriction Sign

Static Warning Signs

VDOT districts have installed a number of warning and regulatory signs to warn truck drivers of the potential for rollover crashes. An example of a static sign is shown in Figure 2. Generally speaking, the traffic engineers responding to the survey felt that these signs were very

Figure 2. Static Truck Rollover Sign

effective. Usually static signs are installed first, and signs with continuous hazard beacons are then installed if there is still a problem with rollovers after the static signs have been tried.

Passive advanced warning signs have also been implemented for low clearance structures. In the Fredericksburg District, they have used standard and enhanced low clearance signing on the Route 632 approach to a CSX railroad overpass. Special overhead structures with chains are hung at the low clearance height on the approaches. The breakaway chains serve as a physical warning that if a truck strikes the chains it will hit the overpass.

Dynamic Traffic Signal Ahead Warnings

The Lynchburg District has implemented dynamic warning systems on the approaches to all primary road intersections in the district where a SIGNAL AHEAD sign is needed. In these cases, the district has installed SIGNAL AHEAD: WHEN FLASHING BE PREPARED TO STOP signs where amber flashing lights are activated 7 seconds prior to the end of the green phase. This provides warning to oncoming traffic that the signal is either about to turn red or is already red. This could reduce the number of rear-end crashes and the number of instances where a red light is run. The Salem District is also using these systems for new installations on high-speed roadways or when only minimum sight distance is available.

Red Light Strobe Indications

The Fredericksburg District noted that they use red-indication flashing strobe lights on isolated traffic signals and in instances where a traffic signal is the first traffic control device encountered in a significant distance. These devices heighten the visibility of the traffic signal during the red phase and could reduce instances of running the red light or rear-end collisions.

Placement of Traffic Control Devices

The Fredericksburg District stated that they try to use overhead traffic control devices whenever possible to create a less cluttered view for truck drivers. It was felt that ground-mounted traffic control is sometimes difficult to see from the higher vantage point of the truck driver and overhead mounting reduces the "background noise" that may interfere with a truck driver reading and reacting to a sign.

Organizational/Coordination Improvements

The Fredericksburg District has created a quarterly report on truck issues in the district. This report is forwarded to VDOT's Mobility Management Division so that they can discuss the contents of the report with the Virginia Trucking Association. The goal of this effort is to get the trucking industry involved before a situation becomes controversial. These quarterly reports include information on complaints about truck speeds, volumes, and noise levels. Requests for through truck restrictions are also summarized.

Suggested Initiatives From Survey

This section summarizes the suggestions that survey respondents had for further improving large truck safety in Virginia. The suggestions are grouped by number of responses under each category. These are the raw suggestions provided in the survey. In some cases, proposed initiatives are contradictory or may not be feasible within the current legal framework.

ITS Initiatives

4 Responses

- Implement real-time speed advisory systems at areas with known crash problems, such as steep downhill grades or curves, when static signs and continuous hazard identification have not improved safety.

1 Response

- Implement roadway weather information systems at areas where recurring dangerous weather is known to exist. This information could be distributed through highway advisory radio, advanced traveler information systems, or fleet alert systems.

- Provide ITS systems to better notify truck drivers about whether parking is available at truck stops or rest areas.

- Examine the feasibility of using in-vehicle ITS systems in conjunction with "readable" pavement marking materials in order to detect or warn of lane drops.

- Examine over-height detection systems for problem areas.
- Continue to improve the availability of traveler information systems.
- Install more VMSs on major trucking corridors.
- Increase the use of CB Wizards on major trucking corridors.
- While in-vehicle ITS systems offer a lot of potential to improve safety, there is often no incentive for trucking companies to spend the money to install these devices. The state should recognize these systems as part of a company's safety program and offer tax incentives to companies that install these devices.
- Consider using automated speed enforcement cameras. This will probably require enabling legislation.
- Mandate the use of collision avoidance technology in large trucks.
- Require the use of vehicle tracking systems and electronic hours of service logs.
- Use overhead VMSs to provide advance warning of the end of queue entering construction or maintenance zones.
- Consider providing graphics-capable VMSs that could be used to alert drivers of special conditions, such as high winds on overpasses. European nations use graphics enabled VMSs to provide this type of information.
- Implement automated tracking of trucks carrying hazardous material on highways.
- Use ITS systems to provide warnings on bridges with low clearances.
- Use ITS to provide low ground clearance warnings at railroad grade crossings.

Geometric Design Initiatives

6 Responses

- When the opportunity is available, increase the length of acceleration and deceleration lanes to better accommodate the performance of trucks.

4 Responses

- Make wider use of truck climbing lanes. Climbing lanes are needed on I-81, and in urbanized areas with large percentages of commuter traffic.

3 Responses

- Many interchanges in Virginia were designed to meet older AASHTO standards. As the size of trucks has increased, these designs can be overly restrictive to modern trucks. Truckers can have problems maintaining control of their vehicle in the sharp curves on older interchanges. These curves also force trucks to reduce their speed significantly, making it more difficult to merge onto a highway. The radii of these curves need to be increased to enable truck drivers to safely navigate these curves.

2 Responses

- VDOT should be proactive in identifying crash-prone areas and then identifying countermeasures to correct problems. A statewide study to determine whether truck safety is a real or perceived problem should be conducted. Conduct a statewide analysis of truck crash characteristics to determine if any roadway geometry has an impact on crash frequency.

- Consider providing a separated right of way for commercial vehicles on major corridors.

1 Response

- Increase shoulder width to provide additional room for disabled vehicles or vehicles that stray from the travel lane.

- If there is a more focused push toward allowing larger trucks, VDOT needs to revise the Geometric Design Standards to take into account the larger weight/power ratio to determine the critical length of grade. A different design vehicle will also be necessary.

- If truck lane restrictions are implemented, the truck lanes should be wider than the non-truck lanes to help prevent trucks from "drifting" over the lane lines.

- Sometimes when more lanes are added to a limited access facility, the loop ramps are not improved. There are cases where rollover signing had to be put in place after a project was completed due to a new problem with trucks losing their loads.

- At the project scope phase, the area beyond the immediate intersection or interchange should always be considered when identifying problem areas. Intersections are much too close to interchange ramps, and this can create problems for trucks.

- Geometric design issues tend to occur more on primary and secondary highways. A local community will sometimes approve a zoning change to commercial or industrial, and the existing primary and secondary highways accessing the property are not designed to handle large volumes of trucks. When these situations occur, VDOT needs to consider upgrading the road to better accommodate the large trucks.

- Create more parking for large trucks at rest areas.

- More pull-off areas are needed on primary roads so that State Police can pull trucks over and safety perform inspections.

- When designing an intersection, engineers need to do a better job considering the turning radii of large trucks if trucks will use the intersection regularly.

- Provide more truck escape ramps, especially in rolling terrain.

- In order to save money, many older alignments that were four-laned were not improved to modern standards. This has created sections of highway where the crown is in the center of the pavement and where superelevation is substandard on curves. Both of these conditions can be very hazardous for large truck drivers who do not expect them.

- There are "broken-back" curves in the state that have multiple turning radii on the same curve. This deviates from driver's expectations, and can create safety problems.

- Unimproved vertical curves can create significant acceleration difficulties for large trucks on vertical climbs, increasing the potential for rear-end conflicts.

- Unpaved shoulders can create a safety hazard for all vehicles. Rutting of the shoulder can create a hazardous situation for vehicles that drift off of the edge of pavement and attempt to overcorrect to get back on the pavement. Shoulders should be paved whenever possible in order to increase recovery area, protect pavement structure and markings, and satisfy public expectations.

- It is often difficult for trucks to negotiate site designs in developed areas. This causes the trucks to decelerate to extremely low speeds in order to access these sites. Consultants need to do a better job designing access for large trucks in site plans.

- While neo-traditional design can help create well-defined neighborhoods, it is often very difficult for large trucks to access these developments due to the tight turning radii and narrow streets. Developers need to consider how moving trucks, garbage trucks, fire trucks, and school buses will negotiate these developments.

Traffic Control Initiatives

1 Response

- Install centerline rumble strips.

- Provide differential speed limits for passenger cars and trucks to reduce the variance in speeds of trucks on the I-81 corridor.

- Prohibit large trucks from passing on the left during heavy rains. The truck overspray can decrease visibility for the vehicles being overtaken, and can create a safety issue. Signing and enforcement would be problematic for this strategy.

- Prohibit large trucks from attempting to overtake vehicles on up-grades along interstate highways.

- Continue to support incident management programs related to quicker response and clearance.

- Increase the height of signal heads so that drivers behind large trucks can see the signal.

- Do not implement differential speed limits for trucks and cars.

- Use red-indication strobe lights to improve visibility of traffic signals at isolated intersections or at the first signal in a developed area where there have been no signals for a significant distance preceding the signal.

- Consider variable truck restrictions that are only in place during non-congested periods. During congestion, restricting trucks from the left lane could increase conflicts with merging and diverging traffic.

Legislative, Enforcement, or Education Initiatives

The survey respondents believed that the following initiatives would help improve large truck safety in Virginia.

5 Responses

- Increase funding for Virginia State Police to provide greater enforcement coverage on major trucking corridors.

- Increase funding for truck safety inspections.

3 Responses

- Increase penalties for safety violations.

- Provide funding for educational and public awareness campaigns about "No See Zones." This could potentially involve providing information at major tourism destinations, at gas station chains, at visitors' centers, or through public service announcements.

- Provide more education to the public about how large trucks handle, for example, emphasizing the difference in turning radii between a pickup truck and a tractor-trailer.

1 Response

- Until the physical geometry of I-81 can be improved, the speed limit should be decreased to 60 mph and the entire I-81 corridor should be heavily enforced.

- Evaluate how effectively Virginia is inspecting truck permits, licenses, driving logs, etc.

- Perform random on-road testing for substance abuse.

- Revise the police accident report to include the type of truck involved, the type of load/commodity being transported, and whether the load was permitted or not.

- Evaluate the effectiveness of §46.2-809 [of the *Code of Virginia*]: Regulation of truck traffic on secondary highways.

- Evaluate the effectiveness of §46.2-803.1 [of the *Code of Virginia*]: Commercial vehicles limited to use of certain lanes of certain interstate highways.

- Require "trailer skirts" for all trailers to reduce water spray.

- Introduce legislation to fund a study to compare load weights and braking distances.

- Introduce legislation that would require and enforce strict regulations on inspections of truck operating systems.

- Impose stronger fines for drivers found guilty of causing crashes due to a violation of in-service regulations.

- Do not permit triple trailers in Virginia.

- There is a large problem with overheight trucks going through some tunnels in Hampton Roads. Penalties should be applied for repeat offenders. This would help reduce delays and congestion.

- Change the maximum speed limit for all trucks to 55 mph.

- Create legislation that will mandate the rapid clearance of incident sites, even if it results in additional damage to vehicles or spilled loads.

- Require side brake warning signals.

- The trucking industry is expanding very quickly, which means that there are large numbers of inexperienced drivers on the road that make the same mistakes.

- General driver education/public service announcements need to emphasize that motor vehicles are not toys. Current advertising and entertainment presents a distorted view of how people should operate motor vehicles.

CONCLUSIONS

The literature review and survey identified a number of potential alternatives that could improve truck safety in Virginia. These alternatives can be classified into three categories:

1. areas of consensus
2. areas of conflicting opinions and evidence
3. areas where more research is needed.

Areas of Consensus

1. *ITS speed advisory systems.* Past deployments of these systems have produced significant safety improvements or speed reduction.[2,3] Several systems are being used in Virginia with good results.

2. *Improved traveler information.* These systems can provide information that allows truck drivers to perform more efficient trip planning. The specific safety benefits of these systems are difficult to quantify, but there is a great deal of agreement that they are beneficial. Traveler information is available from a variety of sources in Virginia, including the Internet, 511, and VMSs.

3. *Rumble strips.* A number of states have documented that shoulder and centerline rumble strips effectively reduce run off the road crashes.[10,11,12] Virginia has significant reductions in run-off-the-road crashes after the implementation of shoulder rumble strips.

4. *Climbing lanes.* Climbing lanes are used nationwide,[6] and they can offer safety and operational improvements by reducing speed differentials between cars and trucks. Climbing lanes are in use in many areas of Virginia.

5. *Truck escape ramps.* Truck escape ramps are used nationwide and offer a controlled way for drivers to leave the highway when brakes malfunction. Truck escape ramps were reported in two VDOT Districts.

6. *Improved geometric design of interchanges.* There was a great deal of agreement among VDOT engineers that interchanges need to be brought up to current design guidelines or possibly over-designed to allow truck drivers to enter the flow of traffic on a freeway more smoothly.

7. *Advance warning of the start of the red phase.* Several VDOT districts use these systems, and they offer the potential to reduce rear-end collisions and instances of running red lights.

8. *Increased enforcement.* There was a great deal of support for increased speed and safety enforcement and increased fines for violations.

9. *Increased driver education.* There was a lot of support for providing better education to the general public about the limitations of trucks with respect to handling, acceleration, and deceleration.

Areas of Conflicting Opinions and Evidence

1. *Lane restrictions.* There is conflicting evidence on the safety effect of truck lane restrictions. The study on I-495 showed an increase in crashes,[17] whereas other studies around the nation have shown crash reductions.[13,15]

2. *Differential speed limits.* Although engineers agree that large differentials in speeds between cars and trucks are undesirable, there was some disagreement about whether differential or uniform speed limits for cars and trucks should be used to achieve this.

Areas Where More Research Is Needed

1. *In-vehicle ITS systems.* These systems are still in development and have not been deployed on in large enough numbers to determine actual safety benefits.

2. *WIM or CVISN systems.* Although these systems would intuitively offer improved safety by decreasing merging and diverging conflicts, more data are needed to determine their actual effect.

RECOMMENDATIONS

The research showed that VDOT has already taken many actions to improve large truck safety issues, and that further action could be taken in several areas:

1. VDOT's Mobility Management Division (MMD) should consider encouraging the use of dynamic truck speed advisory systems on freeway ramps where there are large numbers of rollover crashes.

2. VDOT's Location & Design Division should examine whether current design standards are adequate for the current truck fleet.

3. The MMD should consider developing guidelines for providing advance warning of the start of the red phase at intersections with limited sight distance.

4. The MMD should reexamine whether the truck lane restrictions are producing safety improvements.

In addition to these measures, VDOT should continue to pursue the initiatives that are already underway, for example, the rumble strip program and measures to improve traveler information.

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APPENDIX

SURVEY OF VDOT PERSONNEL

November 7, 2002

TO **Administrators, Smart Traffic Centers**
District Maintenance Engineers
District Operations Engineers
District Traffic Engineers
Nancy Berry
Jon DuFresne
Ilona Kastenhofer
Dan Liston
Mohammad Mirshahi
J. R. Robinson

FROM: **Governor Warner's Truck Safety Task Force**

SUBJECT: **Engineering and Technology Countermeasures to Improve Large Truck Safety**

In response to a request by Representatives Frank Wolf and Jo Ann Davis, Governor Warner has formed a Large Truck Safety Task Force. This task force has been given the task of determining ways to reduce crashes involving large trucks on Virginia's roads. One of the goals of this task force is to identify engineering and technology measures that have the potential to improve large truck safety.

The task force has charged the Virginia Transportation Research Council (VTRC) with identifying engineering and technology measures that offer the potential to improve large truck safety on Virginia's roads. As VDOT engineers, you are in a unique position to know both the problems related to large truck safety and possible solutions to these problems. VTRC is seeking your input to:

(1) help identify how VDOT is currently dealing with issues related to large truck safety and
(2) identify innovative measures that are not currently being used in Virginia that could offer substantial safety benefits.

The task force has developed a very aggressive timeline for producing a report for Governor Warner. We would like to ask you to complete the attached survey by **November 13, 2002**. The information you provide will help the task force develop recommendations that will be considered by the Governor. Please e-mail your responses to **Michael.Fontaine@VirginiaDOT.org** or fax them to (434) 293-1990. If you have any questions about the survey, please contact Mike Fontaine at (434) 293-1909.

Truck Safety in Virginia:
Engineering and Technology Solutions

The Governor's Truck Safety Task Force has asked the Virginia Transportation Research Council to identify engineering and technology measures that could improve truck safety in Virginia. This survey will gather information on countermeasures that are in place or planned in Virginia, as well as identify areas where VDOT personnel believe there is room for improvement. Please contact Mike Fontaine at (434) 293-1909 or **Michael.Fontaine@VirginiaDOT.org** if you have any questions.

Please return the survey by **November 13, 2002** to Mike Fontaine. The survey can be returned via e-mail to **Michael.Fontaine@VirginiaDOT.org** or faxed to (434) 293-1990. Thank you for your help.

CONTACT INFORMATION

Name:_____

Title:_____

Phone:_____

E-mail:_____

District/Division:_____

Part I: Legislative Initiatives

1. Are there any legislative changes that you would like to see that directly impact large truck safety?

Part II: Intelligent Transportation Systems (ITS)

1. Are you aware of any ITS initiatives within your district/division that are specifically targeted at improving safety for large trucks? Possible examples could include weigh-in-motion (WIM) systems, speed advisory systems on curves to prevent rollover crashes, or other roadside countermeasures. Please describe the number and location of the systems, and identify how effective the system has been to date.

2. Are there any ITS improvements that could improve large truck safety that you believe VDOT should consider using on Virginia's roads that are not currently being used?

3. Are there any in-vehicle ITS countermeasures that you believe offer the opportunity to improve large truck safety? What are the potential barriers to implementation of these systems? Possible examples might include drowsy driver technology, collision avoidance systems, or electronic systems to record hours of service.

Part III: Geometric Improvements

1. The performance and handling characteristics of large trucks can dictate many of the design features of a road. Do you believe that there are any areas where VDOT does not adequately design for large trucks? Explain

2. Have you made any innovative geometric improvements in order to better accommodate large trucks? Please describe the improvements and their effectiveness. This does not include standard design elements, or features like truck climbing lanes that are standard practice.

3. Are there any innovative geometric techniques that you think VDOT should consider in the future to improve large truck safety? An example would be providing a separated right-of-way for commercial truck traffic on I-81.

Part IV: Traffic Control

1. Do you have any situations where trucks are restricted to certain lanes on freeways in your district? Have you found this restriction to have a positive impact on operations or safety?

2. Have you made any innovative traffic control improvements in your district to improve truck safety? Please describe the treatment and its effectiveness. Possible examples might include improvements to signal timings to reduce the number of stops by large trucks, consideration of the different visibility needs of truck drivers at night, etc.

3. Are there any traffic control solutions that could improve truck safety in Virginia that you would like to see deployed? Explain.

Part V: General Comments

If you have any general comments on the issues of large truck safety, including observed problems or possible education or enforcement solutions, please write them here.

SURVEY RESPONDENTS

- Robb Alexander, Richmond Smart Traffic Center
- Nancy Berry, Central Office Location & Design
- Travis Bridewell, Richmond District Traffic Engineer
- Jimmy Chu, Northern Virginia Smart Traffic Center
- Gregory Cross, Rural ITS Planning
- J.B. Diamond, Staunton District Traffic Engineer
- William P. Harrell, Northern Virginia Assistant District Traffic Engineer
- Jeff Hores, Fredericksburg District Traffic Engineer
- Ronnie Hubble, Bristol District Traffic Engineer
- Ray Khoury, Mobility Management Division Administrator
- Dan Liston, State Maintenance Engineer
- B.C. Pierce, Lynchburg District Traffic Engineer
- Stephen Read, Safety Analysis Program Manager, Mobility Management Division
- J.R. Robinson, ITS Director
- Cyndi Ward, Director Special Operations
- Bob Yates, Salem District Traffic Engineer