



Future Truck Program Position Paper: 2015-1

360° Driver Awareness Expectations

Developed by the Technology & Maintenance Council's (TMC)
360° Driver Awareness Task Force

ABSTRACT

Vehicle crashes are greatly impacted by a driver's knowledge of what exists around his or her vehicle. The term "360° Driver Awareness" describes technologies and devices that improve safety by increasing a driver's knowledge of what is around his or her vehicle. This paper serves as a request for manufacturers and suppliers to share their plans for products that will be marketed within the next 10 years (or as soon as possible) to allow equipment users to better assess and implement the technology in their operations. It also serves to outline equipment user expectations for such technologies as used in commercial vehicle operations.

PURPOSE AND SCOPE

In 2012, TMC's Future Truck Committee established a 360° Driver Awareness Task Force to promote and advance the development of technologies that give the driver a complete 360° awareness of objects in and around a commercial vehicle. This position paper lists these technologies and their effectiveness in order to give equipment users a better idea of their value within their various operations.

As part of its mission, this Task Force has:

- Challenged the vehicle manufacturers, system suppliers, and/ or academic organizations to declare their advanced technology development plans capable

of achieving — or in combination with other technologies — the goals of TMC's 360° driver awareness initiative.

- Challenged technology and product developers to declare the estimated availability of future technologies to supplement products currently available along with the awareness and vision percentage of improvement covered by each technology.
- Encouraged all vision awareness technology providers to use the standard measurement techniques and objectives defined in TMC RP 428, *Guidelines for Vision Devices*, and the Society of Automotive Engineers' SAE J1750, *Describ-*

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ing and Evaluating the Truck Driver's Viewing Environment.

- Emphasized the urgent need to demonstrate solutions to vehicle “blind spots” in the front of the tractor and at rear of the trailers, including the operations of longer combination vehicles (LCVs) — e.g., twins, triple trailers — as they change lanes, merge into traffic, backup, etc.
- Solicited definitive approaches to define acceptable levels of visibility and clarity of vision (COV).
- Requested these technologies communicate with onboard vehicle systems to improve reaction time but not override the driver’s control of the vehicle.
- Discouraged the use of additional hard wiring between vehicles within the vehicle train, as such is not acceptable to equipment users. That being said, any wireless communications used must not interfere with other wireless communications onboard or between vehicles.
- Worked to ensure the use of these technologies does not increase driver workload or distraction in an attempt to improve driver awareness.

BACKGROUND

The need for the driver to see all around the vehicle — i.e., 360° driver awareness — in order to make safe driving decisions was first defined by TMC’s Future Truck Committee in *TMC’s Future Truck Committee Position Paper 2004-3—Future Driver Vision: Equipment User Expectations for Vision When Driving Heavy Trucks*. This paper also challenged industry to define vision targets as a measurement tool and assessment technique.

Since 2004, some progress has been made in this area. For example:

- SAE responded by revising SAE J1750, adding targets and defining zones around trucks; however, it did not include acceptance criteria.

- TMC’s S.4 Cab & Controls Study Group revised RP 428 to define how to use J1750 in documenting a vision score for comparison of alternate products or approaches. RP 428 also defined specific minimum acceptance targets for key driving maneuvers.

NOTE: The revised document — RP 428A — did not make Rear of Trailer targets mandatory since known viable products, technologies or procedures were not currently available then for tractor and trailer combination units. TMC will continue searching for such solutions, however.

DISCUSSION

Commercial vehicle maneuverability is particularly challenging, especially when moving to the adjacent lane to the right of the truck. Poor vision areas at both the front of the tractor and the rear of the trailer are problems.

RP 428A defines targets that address the front blind spot as mandatory but was forced to leave the rear targets as optional since at the time of its approval there was no known viable product on the market available to “see” or “sense” the targets without adding a cable between the tractor and trailer or using wireless systems that are vulnerable to “cross-talk” (i.e., a camera from one vehicle feeding the signal to another unintended vehicle).

The SAE J560 and SAE J2394 connectors/cables are the technology of choice for the interconnections between the tractors, dollies, and trailers. Equipment users have stated in other papers that no additional hard wire connectors or cables are acceptable. The COV remains an open issue because the tendency is for government and manufacturers to define an area where vision is required. Viewing this area can be technically achieved by decreasing the radius of a convex mirror increasing the field of view (FOV). Unfortunately the decreased

radius diminishes the size of the object in the mirror and can make the image of no practical benefit. An image in a mirror with a nominal radius of curvature less than 300 mm is judged to be too small an image to be meaningful to the driver in making decisions in typical driving conditions. But as noted in Appendix D of SAE J1750, this limitation is not intended to imply that a mirror with radius greater than 300 mm is adequate – only that anything below 300 mm is clearly inadequate.

An industry standard for measuring COV has not been established. TMC's RP 428A suggests using "A" to "B" images as an interim technique. The Task Force will recommend this technique until an industry standard for measuring clarity objectively and consistently is developed. Also, the definition of clarity should be defined with all technologies such as mirrors, video, etc. in all environments per SAE J1455.

Equipment users will not adopt technologies that do not make economic and operational sense to their given operation, unless compelled to do so. For an adequate assessment, fleets must be able to plan future purchase on a five-year or longer cycle.

Such plans cannot be effectively made in this area using the present day knowledge of current technologies. Advances in vehicle technologies not only affect the type of vehicles that will be purchased, but it can and often does change the way a company operates throughout its various departments. By working together, fleets and manufacturers can improve the direction that monies are spent on research and development and speed up the acceptance of the technologies into the market place.

Making future technologies known today will also help industry develop standards to ensure compatibility with presently designed vehicles. Industry can also develop performance mea-

surements as to a product's true ability to perform as expected within a given vocation. This will help to eliminate the shock of disappointment caused by purchasing technologies that do not meet expectations within a given application.

COMMUNICATION CONSIDERATIONS

At the time of this writing, it has been proven that a hacker with a laptop and Bluetooth capability can take control of automobiles equipped with Bluetooth-controlled components. While there have not been any known occurrences of this happening in the field, our industry cannot take this chance with vehicles that haul hazardous materials.

The communication systems of these vehicles must be as secure as possible. While there are many communication methods being developed, it must be remembered that vehicles in use today could be in service for more than 20 years; therefore, any new vehicles built with these new technologies should be backward compatible or neutral in effect.

Information can and should be exchanged between vehicles on the same road. However, there cannot be any chance of unintended cross communication interfering with the operation of another vehicle. Additional hard wire connections between connected units within a vehicle train must be avoided for maintenance and operational reasons. There also must be an automatic handshake between units as they are connected to make up a vehicle train. Electronic unit acknowledgement should be broken whenever units are removed from the overall vehicle train, and this needs to be communicated to the driver at the time of connection and any time that a driver requests this information.

There are many types of hard wire connections being used in the communication industry but very few can reliably be used with heavy

duty vehicles. Most are not meant to be exposed to the harsh environmental operations of heavy-duty commercial vehicles. Current connections, cables, and terminals need to be reviewed and improved by those who know the needs of the transportation industry. TMC's S.1 Electrical Study Group, along with SAE and the Institute of Electrical and Electronics Engineering (IEEE) are examples of technical groups that do have the ability to review and modify current standards. They can also write new performance standards when current standards do not meet the needs for future technologies. TMC's S.1 Study Group should take this project on and consult other global groups for their knowledge of current design and performance standards that may be used.

DRIVER AWARENESS CONSIDERATIONS

Driver attention is very important to safe vehicle operation. While there are many products being produced to supply information to the driver, many use proprietary communications systems and require the driver to take his or her eyes off of the road to check the supplied information. While this information can help raise a driver's awareness of his or her surroundings, news of impending danger should not add to driver workload/distraction.

Unnecessary information may distract the driver from viewing the road. The needed information may be delivered by a visible screen, visible warning device, audible directional warning, or a vibration delivered to the driver's body. TMC suggests that the developers and manufacturers of these systems work together to set standard methods for supplying information to the driver. TMC also suggests that they use TMC RP 401C, *Location and Operation of Instruments and Controls In Motor Truck Cabs* to locate any visible aids inside the cab. For other methods, TMC's S.4 Cab & Controls Study Group should be consulted for establishing the best location for such warning notification devices.

SAE J1750 and TMC RP 428A should be used as methods for measuring the effectiveness of visible technologies such as mirrors and cameras. SAE J1750 establishes three alternate methods for describing and evaluating the truck driver's viewing environment:

- Target Evaluation,
- Polar Plot, and;
- Horizontal Planar Projection.

The Target Evaluation describes the field of view volume around a vehicle, allowing for ray projections, or other geometrically accurate simulations, that demonstrate areas visible or non-visible to the driver. The Target Evaluation method may also be conducted manually, with appropriate physical layouts, in lieu of computer assisted drafting methods.

The Polar Plot presents the entire available field of view in an angular format, onto which items of interest may be plotted, whereas the Horizontal Planar Projection presents the field of view at a given elevation chosen for evaluation.

TMC RP 428A goes a step farther by establishing a minimum performance level for these visible devices. TMC recommends that these three industry practices — TMC RP 428A, TMC RP 401C and SAE J1750 — be used for testing any direct vision devices.

These test methods, however, should be updated to include a means of testing and evaluating indirect vision devices, which allow the driver to "see" areas around the vehicle that cannot be seen using direct vision or image reflecting devices such as mirrors. Indirect vision or supplemental information devices are needed to inform the driver of conditions behind the vehicle, trailer or between and behind multiple trailers. The capability to check behind and between units of a combination vehicle will greatly increase the need for global communication standards.

NEED FOR ADDITIONAL STANDARDS

In order to develop meaningful standards for increasing the knowledge and awareness of the driver's surrounding, the trucking industry must have greater knowledge of the human eyes' ability to find and focus on objects that may be a danger to vehicle operation. The contrast in colors between background and focus objects will be a big factor in a human's ability to pick out these objects on a monitor screen. This problem can escalate if the driver is color blind. Speed of movement also needs to be addressed so that movement on a monitor can be accessed quickly and accurately by the driver.

Clarity

Standards are needed to measure the COV and position judgment that a driver receives from mirrors or displays from cameras. Industry cannot measure the value of a product or technology without a standard to measure against. As shown in various reports on visual cognition [1], there are human factors that can greatly affect how a driver responds to information or warnings, such as age, size, health, stress, information overload and environment. Clarity of interpretation by the brain along with clarity of understanding or other forms of clarity must be studied in order to make sure that guidelines and standards are comparable with human abilities. This will require that the trucking industry consult and work with other groups that can supply information on these human factors. This will help ensure that technology

[1] For further information on eye movements in visual cognition, TMC suggests the following references:

- http://www.scholarpedia.org/article/Eye_movements
- Findlay and Gilchrist (2003) "Active Vision -- The Psychology of Looking and Seeing". Oxford: Oxford University Press.
- Henderson, J. M., & Ferreira, F. (2004). *The Interface of Language, Vision, and Action: Eye Movements and the Visual World*. New York: Psychology Press.

and product design standards consider these human factors for improving the ability of drivers to safely operate their vehicles.

Windshields

There currently is no standard to measure the clarity of a used windshield that has small pits (sand pits) from highway use. These pits are small chips and cracks that capture water and oil which the wipers cannot remove. When a driver is trying to see on a rainy night in a high traffic area these sand pits cause a higher level of glare that diminish the clarity of vision for the driver. They also greatly diminish the driver's view when driving into the raising or setting sun light. This is made even worse if the oncoming vehicle is using extra bright lights or lights that are aimed too high. A standard that rates the effects of pitted windshields on driver's visibility is needed to assist users in maintaining safe operating conditions of their vehicles. Once a standard is set then tools can be made to measure the effects of these pits on driver vision.

NOTE: The following information report, *S.4 Cab & Controls Study Group Information Report: 2013-1—Mirror Obscuration During Inclement Weather*, may be of interest.

Lights

Headlights have advanced greatly but the regulations that control these lights have not protected those that are meeting the vehicles on the road. Brighter headlights give drivers a greater and clearer field of vision from the driver's seat. Unfortunately, the drivers that are meeting these oncoming bright lights find that vision is greatly reduced, making for a potentially hazardous condition for both vehicles and their passengers. This matter should be addressed by TMC's S.1 Study Group for ways to improve both safety and eye comfort as well as the field of vision for both vehicles.

The lighting industry has ways of curing or greatly improving this problem but laws and

cost are getting in the way of safety. For an example of one method, visit <https://www.youtube.com/watch?v=X2LiSBghbJY>. The lenses of today's vehicles' headlights are subject to ultraviolet (UV) light damage and cleaning solutions that are not compatible with the lenses. This damage diminishes the light needed for clear vision by the driver. New materials need to be developed for the lenses that will not be affected by UV rays or the cleaning solutions in use today. Equipment users need a way to ensure their vehicles' headlamps will last the typical service life expected by the vehicle's first owner, as defined in TMC RP 171, *High-Performance Coatings for Forward Lighting On Commercial Trucks*.

Electronic Communication

The trucking industry must review the current data communication standards used worldwide by various groups in order to find the best ones for global use and thereby reduce the number of proprietary standards. The use of proprietary communication standards can greatly reduce the ability to mix equipment within a fleet. In a global market, they can also serve to block competition between manufacturers by freezing out smaller manufacturers. TMC's S.12 Onboard Vehicle Electronics Study Group should address this issue. The trucking industry should work together to determine the best non-proprietary industry communication standards to use.

SUMMARY OF REQUESTED ACTIONS

The following is a summary of actions TMC believes the trucking industry should take pertaining to 360° driver awareness.

1. All new technology should allow equipment to be backward or neutral compatible for a period of 20 years.
2. Data communication from one vehicle or vehicle system cannot interfere with the safe operation of another vehicle or its components.
3. Driver awareness technologies should not require the need for additional hard

wire connections between the connected units within a combination vehicle.

4. There must be an automatic handshake between units as they are connected within a combination vehicle. This electronic acknowledgement of units should be broken when the units are removed from the overall vehicle train.
5. The hand shake connection or disconnect needs to be communicated to the driver at the time of connection/disconnect and at anytime the driver requests this information.
6. The trucking industry should work together to determine the best non-proprietary industry communication standards to be used.
7. Current connections, cables, and terminals need to be reviewed and improved by those groups which know the needs of the transportation industry, such as TMC's S.1 Electrical Study Group, SAE and IEEE. They can also write new performance standards when current standards do not meet the needs for future technologies.
8. Only information of impending danger should be given to the driver while traveling in excess of a certain threshold speed (as yet to be determined) to avoid driver distraction and information overload.
9. TMC suggests that the developers and manufacturers work together to set standard methods for supplying information to the driver.
10. It is also suggested that they use TMC Recommended Practice 401C to locate any visible aids inside the cab. For other methods Study Group S-4 should be consulted for establishing the best location for the warning notification device.
11. SAE J1750 and TMC RP 428A should be used for measuring the effectiveness of visible technologies such as mirrors and cameras.
12. TMC recommends that TMC RP 428A, TMC RP 401C and SAE J1750 be used

for testing any direct and reflected vision devices. These test methods, however, should be updated to include a means of testing and evaluating indirect vision devices, which allow the driver to “see” areas around the vehicle that cannot be seen using direct vision or image reflecting devices such as mirrors.

14. There is a need to search or develop standards that can be used to measure the clarity of view, speed of focus, target movements and position as well as the correctness of judgment when a driver receives images from mirrors, camera monitors and other sensors.
15. Clarity of interpretation by the brain along with clarity of understanding or other forms of clarity must be studied in order to make sure that guidelines and standards are comparable with human abilities.
16. Indirect vision or supplemental information devices are needed to inform the driver of conditions behind the vehicle, trailer or between and behind multiple trailers. The capability to check behind and between units of a combination vehicle will greatly increase the need for global communication standards.
17. A standard that rates the effects of pitted or other damage to windshields on driver’s visibility is needed to help users maintain the safe operating condition of their vehicles.
18. The issue of headlight glare should be explored by TMC’s S.1 Study Group to improve safety and eye comfort as well as the field of vision for drivers of both meeting vehicles.
19. The trucking industry must review the current data communication standards used worldwide by various groups in order to find the best ones for global use and thereby reduce the number of proprietary standards. TMC’s S.12 Study Group should help lead this effort.
20. Manufacturers, academia, and devel-

opers of 360° awareness technologies should make their technology known to industry as soon as possible so that standards and testing methods can be developed in a timely fashion.

21. Third party, non-biased testing should be used to report on the true value of a technology or finished product within a specified type of operation.

CONFIDENCE IN REPORTED VALUES TO EQUIPMENT USERS

In order to give equipment users a greater level of confidence in manufacturers’ reports of the value of their technologies, TMC is currently assembling a library of third-party testing reports for any type of technology that is connected with the trucking industry. Connections are being made for the third-party testing of the technologies or products in order to verify the performance level of devices to be tested with TMC RP 428A and SAE J1750. These connections involve some of the leading universities in North America, dealing with the results of those tests that report on driver awareness.

TMC will accept any credible third-party verification report that the manufacturers wish to have reported to fleets requesting the information. If for some reason the manufacturer does not wish to have the results of the verifying test reported, they should not supply the results to TMC. Each test will be conducted based on agreements between the product owner and the third-party tester. TMC will not get involved in the negotiations for any testing. TMC will not accept any test results generated by manufacturers or their private testing parties. TMC does not consider for-profit testing companies to be non-biased. Because products are not necessarily tested by manufacturers in the typical type of operation that the product will be used, equipment users are often unable to get the expected benefits that are claimed by the manufacturer. Non-biased, third-party testing should give a truer picture of what equipment users should expect to achieve in the field.

