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Docket Management Facility
U.S. Department of Transportation
1200 New Jersey Avenue SE
West Building Ground Floor, Room W12-140
Washington, D.C. 20590-0001

**RE: Docket No. NHTSA-2018-0021**

The Truck and Engine Manufacturers Association ("EMA") hereby submits comments on the Advance Notice of Proposed Rulemaking ("ANPRM") titled: *Federal Motor Vehicle Safety Standard No. 111, Rear Visibility,* that the National Highway Traffic Safety Administration ("NHTSA" or the "Agency") recently published in the Federal Register. See, 84 Fed. Reg. 54,533 (October 10, 2019).

EMA represents the world's leading manufactures of heavy-duty engines and commercial motor vehicles with the gross vehicle weight rating ("GVWR") greater than 10,000 pounds. EMA member companies manufacture highly customizer medium- and heavy-duty vehicles to perform a wide variety of commercial functions including interstate trucking, regional freight shipping, local parcel pickup and delivery, refuse hauling, and construction. The vehicles that EMA member companies produce utilize rearview mirrors in compliance with Federal Motor Vehicle Safety Standard (FMVSS) No. 111 – *Rear Visibility*. Additionally, EMA member companies are developing Camera Monitor Systems (CMS) for use on medium- and heavy-duty trucks. Accordingly, EMA and its member companies have a direct and significant stake in the FMVSS No. 111 ANPRM and in any resulting changes to the rear visibility requirements in the standard.

When considering CMS for commercial vehicle, it is important to note that for trucks with a GVWR of 11,340 kg (25,000 pounds) or more FMVSS No. 111 currently requires nothing more than a small, 323 $cm^2$ (50 $in^2$), rearview mirror of unit magnification installed on each side of the vehicle. All heavy truck manufacturers currently provide on each side of the vehicle rearview mirrors of unit magnification that are at least twice that size, plus convex mirrors to provide the driver a still greater field of view (FOV). Additionally, truck manufacturers provide optional hood-mounted convex mirrors and door-mounted look-down convex mirrors. In sum, today's trucks significantly exceed the requirements in FMVSS No 111 with their standard mirrors, and manufacturers provide many additional optional mirrors.

EMA member companies have been conducting extensive evaluations of CMS on test trucks in real-world operation in the U.S., and some are selling trucks in Europe with systems

that comply with UNECE Regulations No. 46. Compared to rearview mirrors, CMS has the potential to significantly improve both the safety and fuel efficiency of heavy trucks. CMS provides a wider FOV than mirrors, CMS cameras don't block the driver's direct view as do mirrors and their mounting structures, and the view from a CMS view can be further expanded with automatic trailer panning and manual panning. CMS monitors provides a clearer image, and cameras are less likely to be subject to environmentally-caused obstructions, and when the small camera lens does get dirty the driver can clean it much easier and more quickly than mirrors. In addition to those important safety benefits, CMS provides a unique opportunity reduce the aerodynamic drag of a heavy-duty tractors, thereby enabling a significant improvements in the fuel efficiency of long-haul tractor-semitrailer combination vehicles. For those reasons, we strongly support allowing CMS as an alternative in FMVSS No. 111to outside rearview mirrors on heavy trucks.

## SAE International Comments

EMA member company representatives are members of SAE International's CMS Test Protocols and Performance Requirements Task Force. The SAE task force is developing a Recommended Practice (RP) on test protocols and performance requirements for CMS on passenger cars and medium- and heavy-duty trucks. We believe that the Agency could use the RP as a basis for alternative certification requirements for CMS in FMVSS No. 111. The EMA member company representatives on the SAE task force participated in preparing the comments that SAE submitted on the ANPRM, and we concur with and endorse SAE's comments.

## Responses to Specific Requests for Input

Following are responses to specific requests for comment in the ANPRM, with the Agency's request for comment shown in *italics*:

Existing Industry Standards

*Are the physical properties of mirrors necessary to meet the stated purpose of FMVSS No. 111 to provide a ''clear and reasonably unobstructed view?''*

Camera monitor systems can be specified with the following features:

- Trailer Panning. The FOV can automatically follow the trailer in a turn, ensuring that the side of the trailer and the trailer tires are always in the view of the driver. Dynamic adjusting the FOV will result in larger fields of view that what can be obtained with a conventional mirror system, even when considering the driver's head movements.

- Manual FOV Panning. Controls that allow the driver to manually pan the FOV.

- FOV Optimized for Slow Speed Maneuvering. Based on vehicle speed, the FOV could automatically switch over to one that is more appropriate for slow speed precision maneuvering.

- Augmented Driver Assistance. Distance guidelines on the back of the trailer can indicate to the driver how close traffic is to the rear of a trailer or truck body. This feature improves situation awareness and assists the driver with lane changes.

- Night Vision. CMS can improve night vision using methods such as infrared illuminations or digital augmentation.

Though CMS lack true stereoscopic vision to support depth perception, truck manufacturers' over-the-road evaluations have shown this is not a significant problem for two reasons. First, the driver's mind uses the size of other objects in the view to infer depth perception. Second, currently available CMS have on-screen visual aids in the form of colored lines, to assist the driver in determining the relative position of other vehicles, loading docks and objects.

CMS for heavy-duty tractors currently have trailer tracking features that pan the displayed FOV to keep the rear of the trailer in view as much as possible while turning, which is a significant improvement over conventional mirrors. Additionally, CMS for tractors can change the displayed view while backing, to optimize what the driver can see.

System Field of View and Related Test Procedures

*We seek comment on whether and, if so, why minimum field of view requirements for CMS should differ from the current minimum field of view requirements for mirrors under FMVSS No. 111.*

CMS provides an expanded FOV compared to state-of-the-art rearview mirrors on heavy trucks, and significantly greater FOV when compared to the rearview mirror requirements in FMVSS No. 111. Following is a FOV analysis of a heavy-duty tractor depicting the following:

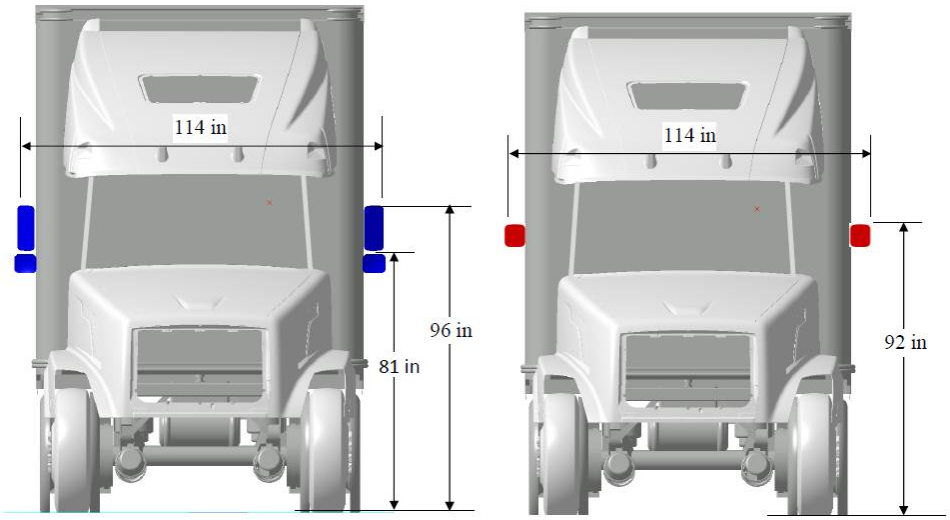
- Mirrors meeting the minimum reflective area as specified by FMVSS No. 111 (indicated by red boundary)

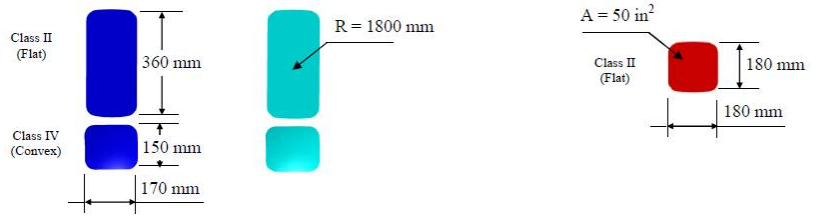
- Typical current mirrors with an expanded view compared to FMVSS No. 111 (indicated by navy blue boundary)

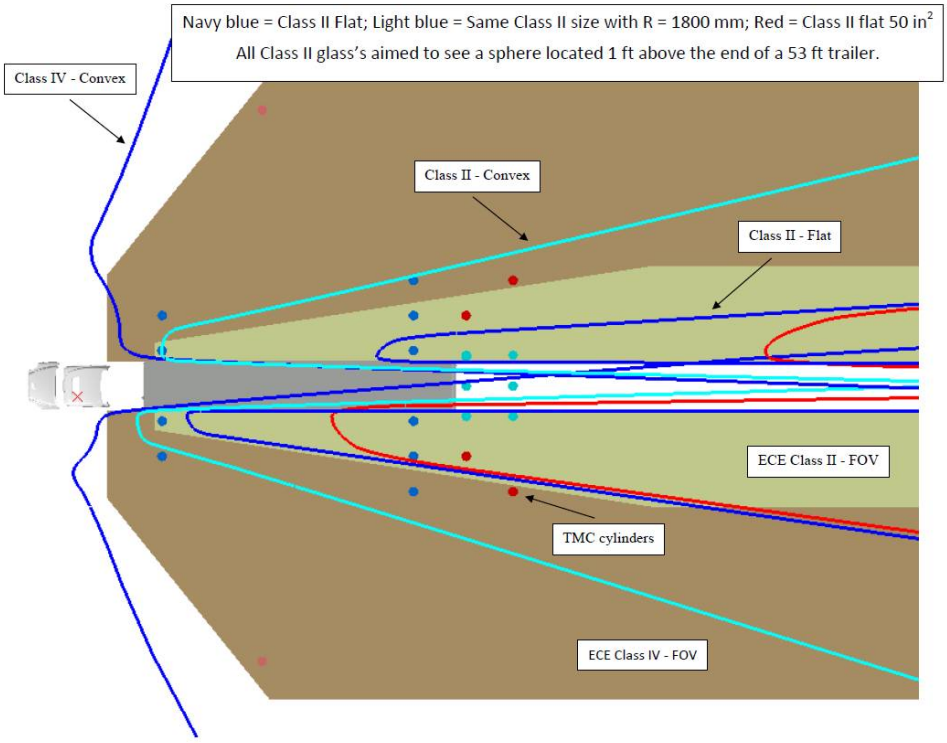
- UNECE Regulation No. 46 mirrors (indicated by light blue boundary)

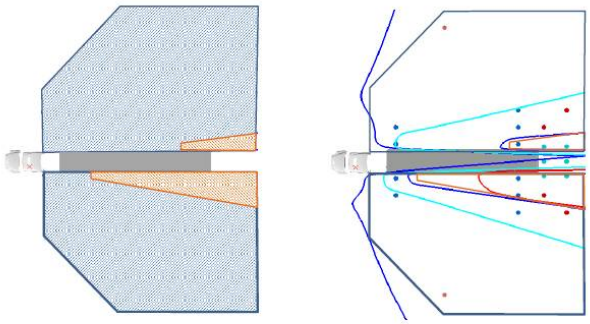
- UNECE Regulation No. 46 Class II and Class IV fields of view that are available with current heavy truck CMS.

- Cylinders per TMC RP 428, *Guidelines for Vision Devices*.

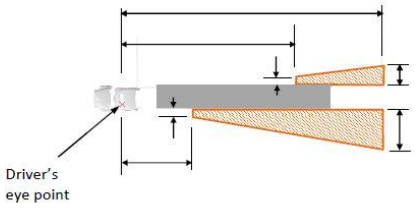

114 in
96 in
81 in
114 in
92 in


Class II
(Flat)
360 mm
Class IV
(Convex)
150 mm
170 mm
R = 1800 mm
A = 50 in2
Class II
(Flat)
180 mm
180 mm

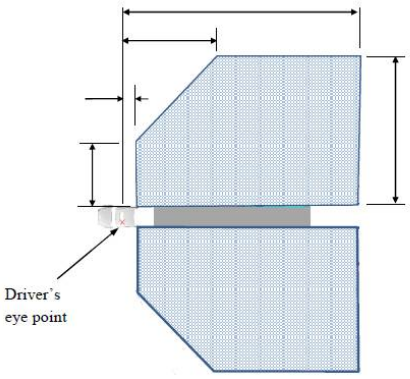

Navy blue = Class II Flat; Light blue = Same Class II size with R = 1800 mm; Red = Class II flat 50 in2
All Class II glass's aimed to see a sphere located 1 ft above the end of a 53 ft trailer.
Class IV - Convex
Class II - Convex
Class II - Flat
ECE Class II - FOV
TMC cylinders
ECE Class IV - FOV



Field of view Class II and Class IV – ground level




Field of vision Class II mirrors – ground level




Field of vision Class IV mirrors – ground level

An EMA member company conducted a static study comparing the FOV of typical conventional mirrors and CMS. They found that driver head and torso movement increased the FOV for conventional mirrors when compared to no head or torso movement. Additionally, they evaluated the FOV of one currently available CMS and determined it still had a significantly larger FOV even when driver head and torso movement are included.

*We seek comment on whether NHTSA should permit CMSs that use multiple cameras to provide multiple fields of view to the driver in the same image display area.*

Heavy trucks typically have two sets of main mirrors that display two separate fields of view. The upper flat mirror displays a narrow FOV, and the lower convex mirror displays a wider field of view. The two fields of view provide valuable information that drivers use to operate heavy trucks. Therefore, any alternative certification in FMVSS No. 111 should permit multiple cameras to provide multiple fields of view to the driver in the same image display area. Doing so will provide heavy truck manufacturers with the flexibility to offer two separate fields of view in the same monitor; the top portion of the display would display main view and bottom section would display the wide-angle view. The main and wide-angle views could be obtained with just one camera or two cameras. Such an arrangement would be similar to what drivers are used to on current mirrors, and it would help minimize driver confusion and the learning curve associated with CMS.

Image Quality and Related Test Procedures

*We seek comment on what disruptive display aberrations (blooming, etc.) should be addressed if the agency were to develop a CMS performance standard.*

EMA member company over-the-road evaluations of currently available CMS has shown blooming is not a major concern; however, the industry is still working to reduce it further. CMS manufacturers have significantly reduced the disruptive display aberrations over the last several years.

Side Rearview Image Display Locations, Driver Acclimation, and Related Test Procedures

*We seek comment on whether and how placing the CMS displays in non-traditional locations (e.g., in the center console) would affect vehicle safety, as compared to placing the displays close to where the outside rearview mirrors would be mounted near the A-pillars.*

EMA member company representatives are participating on SAE's CMS Test Protocols and Performance Requirements Task Force that is developing Recommended Practice J3155, *Camera Monitor Systems Test Protocols and Performance Requirements*. Following are draft requirements for CMS monitor positioning in heavy trucks. The draft requirements would minimize driver confusion in heavy trucks by taking into consideration factors such as viewing angles, glare, neck rotation angles, and gaze behavior.

- The regions on the monitor faces that display the required main and wide-angle views should not be obscured from the reference eye point.

- Obstruction of the driver's direct view caused by the installation of a device for indirect vision shall be restricted to a minimum.

- The monitors for the camera monitor systems shall not obscure the view to any of the mirrors on the vehicle.

- The installation of the monitor should be optimized for the viewing direction.

- The effects of glare, reflections (on the windshield and window panes), and ambient light should be considered when positioning monitors in the cab.

- The monitor may be adjustable by the driver in optimize viewing direction and image quality. In that case, the adjustment shall be possible without any tool.

- The arrangement of each monitor inside the vehicle shall be convenient to the driver. Thus, the image of the right-side field of view shall be presented to the right of the longitudinal vertical plane through the ocular reference point. The image of the left side field of view shall be presented to the left of the longitudinal vertical plane through the

reference eye point. Non-continuous images on a monitor shall be clearly separated from each other.

- The center of each monitor shall not be below a plane passing through the driver's reference eye point and declined 30° below.

- Monitor positions should be chosen to minimize eye movements both from the most common straightforward line of sight and from direct vision through the side windows in certain driving conditions. Both needs for horizontal and vertical eye movements should be considered.

Truck manufacturer on-road testing and computer modeling have both shown mounting the mirrors to the A-pillars in commercial vehicles dramatically reduces the outward viewing obstruction due to the elimination of the conventional mirrors. Drivers found the location to be intuitive and did not require a significant amount of time to retrain the muscle memory. Many drivers commented on the increased FOV due to the elimination of the direct vision obstruction of conventional mirrors and their mounting structure, especially during city driving and at intersections.

*We seek comment on whether research has been performed concerning the impacts of glare from sunlight and other vehicles' headlights on the CMS display, and whether test procedures have been developed to measure glare.*

Truck manufacturers have found that currently available CMS outperform conventional mirrors systems during a sunrise or sunset occurs behind the vehicle. The conventional mirrors occasionally produce a blinding reflection where the CMS inherently blocked out the extremely high intensity light. Additionally, when the truck was being overtaken by a vehicle with extra bright lights or misadjusted lights, the CMS limited the amount of blinding light transmitted to the driver's eyes.

*We seek comment on the anticipated lifespan of the electronic visual display and camera components that would be installed in a typical CMS.*

Like most key safety systems and other components and systems of a commercial vehicle, CMS reliability requirements should be defined by the truck manufacturer in conjunction with its suppliers. Product reliability, functionality and deterioration must be considered when defining those requirements while operating in all types of environmental conditions. Commercial trucks are business tools and the trucking fleets who purchase them have a great deal of experience determining the vehicle specifications that are best for a given application. When it comes to purchasing optional equipment (such as CMS), trucking fleets will typically buy a few vehicles with the new technology and evaluate it before purchasing the option on more trucks. Therefore, there is significant pressure on a heavy truck manufacturers to only offer options that will meet the needs of their customers and that includes ensuring that key safety systems (such as CMS) are reliable and durable.

Camera Durability, Reliability, and Related Test Procedures

*We seek comment on whether and, if so, how a CMS can be weatherproofed to prevent condensation, or large water droplets, forming inside the camera enclosure, which could reduce image clarity.*

Further, many automotive electronic components must be sealed to prevent contamination and internal condensation such as back up cameras, headlights, radar transmitters, ultrasonic proximity sensors, etc. Heavy truck manufacturers have been successful designing sealed systems for many years thus don't anticipate it to be an issue with CMS.

Heavy truck camera enclosures can be designed to the IP69K rating. An IP69K rating ensures protection from close-range high pressure, high temperature spray downs. This rating offers the highest level of protection from the harmful effects of water ingress in the Ingress Protection (IP) code. The test procedure for determining IP69K conformance is documented in ISO 20653 Road Vehicles-Degrees of protection (IP code).

*Depending on the mounting location, cameras may be subject to environmentally-caused lens obstructions (e.g., dirt, ice, rain drops). We seek comment on how to prevent or mitigate such lens obstructions.*

EMA member companies have conducted over-the-road testing of CMS in several worst-case scenarios that have shown the CMS to be less susceptible to soiling than conventional mirrors. Conventional mirrors are subject to visual degradation from soiling on both the mirror surface and the side window. However, CMS eliminates the primary environmentally-caused obstruction by eliminating the effects of side window soiling. Soiling of the camera lens was observed and resulted in a loss of displayed image sharpness, but the image was never deemed unusable. Furthermore, cleaning the camera lens was also much quicker and easier than rearview mirrors and thus drivers were more likely to clean them more frequently. Most of the drivers observed would just swipe their thumb across the lens to clean it; cleaning did not require the use of a cleaning solvent and rags or squeegees. Production versions of CMS would likely incorporate features into the camera housing to further refine the air flow around the lens further reducing potential soiling.

System Availability When Vehicle Ignition is Off

*Although it is not one of the primary safety purpose of rearview mirrors, drivers often use the outside rearview mirrors after turning off the ignition and preparing to exit the vehicle to determine whether it is safe to open the vehicle door when parked alongside a traffic lane. We seek comment on whether NHTSA consider requiring that a CMS be capable of serving this function by being operational in some capacity either at all times or for a specified period of time after opening the driver's car door.*

Functionality of the CMS when the ignition is off is important feature, particularly so with large commercial vehicles where the driver may have limited means of viewing alongside a tractor-semitrailer combination vehicle. All modern CMS currently include functionality that

allows the driver to initiate and use the system when the ignition is tuned off.

Miscellaneous

*We seek comment on the potential short-term and long-term economic impacts of CMS.*

Heavy trucks are not just big cars. When a trucking company purchases a heavy truck, it is making a significant capital investment in a piece of business equipment that it expects to return a profit. Accordingly, trucking fleets are showing great interest in CMS because it can improve visibility and thus help drivers avoid crashes. Additionally, removing the external mirrors can significantly enhance the aerodynamic performance of a heavy truck. In the case of long-haul tractor-semitrailer combination vehicles, fuel efficiency is of paramount importance to the profitability of the fleet operation, and reducing aerodynamic drag translates directly into improved fuel efficiency.

Aerodynamic performance and fuel efficiency have always been extremely important to long-haul trucking companies and therefore truck manufacturers constantly strive to improve both aspects of their products. On top of the marketplace pressures, NHTSA and the Environmental Protection Agency (EPA) are requiring more improvements in the aerodynamic performance and fuel efficiency of heavy trucks with the groundbreaking greenhouse gas/fuel efficiency (GHG/FE) regulations. The first phase of the GHG/FE rules became effective in 2014, with further reductions required in 2017. The second, more stringent, set of rules (GHG/FE Phase 2) will first become effective in 2021, with increased stringency in 2024, and still further improvements required in 2027.

As anyone can see when driving on the highways, modern trucks are much sleeker, and thus more aerodynamic, than those built in the past. The pressure on truck manufacturers to continuously redesign their tractors to refine aerodynamic performance comes from their customers' desire for improved fuel efficiency and the steadily increasing pressure of complying with the GHG/FE rules. Since the overall size of the tractor is dictated by the fixed dimensions of the trailer, truck designers are forced to find miniscule incremental aerodynamic improvements by refining the contours of the tractor. One significant opportunity for aerodynamic improvement lies in the rearview mirrors, and their support structures, that must be mounted on the exterior of each side of the cab. While installing only the minimum 323 $cm^2$ (50 $in^2$) flat-glass mirrors required by FMVSS No. 111 would improve aerodynamics, all manufacturers instead choose to install state-of-the-art flat-glass and convex mirrors that are two to three times larger than the minimum required. The obvious reason that manufacturers choose to install those larger, less aerodynamic, mirrors is to provide the driver the enhanced visibility that is crucial to the safe operation of a large truck.

Allowing truck manufacturers to install CMS in lieu of rearview mirrors would unlock a unique opportunity to make a consequential step forward in the aerodynamic performance of heavy-duty tractors. Based on input from all EMA tractor manufacturers, removing the current rearview mirrors and installing CMS would provide between 2.2 and 3.8 percent improvement in aerodynamic performance. That reduction in aerodynamic drag would directly translate into from 0.8 to 2.0 percent improvement in fuel efficiency performance for long-haul tractor-

semitrailer combination vehicles. If a single long-haul tractor consumes 20,000 gallons of fuel per year, the change from rearview mirrors to CMS could save the trucking company between 160 and 400 gallons of fuel – from just a single tractor in one year. Multiplying that improvement over many trucks in year-over-year operation, the fuel efficiency benefits of CMS would provide enormous financial returns to trucking fleets, not to mention the significant corresponding environmental benefits of reduced criteria pollutant and greenhouse gas emissions.

## Conclusion

EMA looks forward to working with the Agency to develop minimum performance standards for alternative certification requirements for CMS on heavy trucks in FMVSS No. 111. If there are any questions, or we could provide any additional information, please do not hesitate to contact Timothy Blubaugh at (312) 929-1972, or tblubaugh@emamail.org.

Respectfully submitted.

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MANUFACTURERS ASSOCIATION

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