

## BLIND SPOTS EXPLAINED

Surrounding every moving vehicle is a circle of 360 degrees that can be defined as the operating environment of the vehicle. Within that environment can be other vehicles, people or other objects. The operator must be provided with information as to these items at all times while the vehicle is moving to be able to make sound decisions as to what action must be taken to avoid collisions.

## VISIBILITY IS CRITICAL

While driving the Operator Must SEARCH, EVALUATE and EXECUTE

Search for objects or conditions;

Evaluate the path ahead and alternate paths of travel and

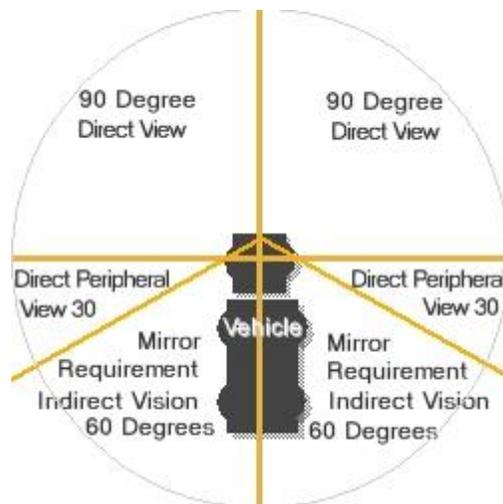
Execute any needed adjustment in speed or position in time to avoid collisions.

Two tools are available to provide the operator with the necessary information;

The eyes of the operator for both direct and peripheral vision, and  
Mirrors, for areas the eyes do not capture, referred to as indirect vision.

All of this can be summarized in an illustration:

Figure 1



To the extent that there is an interference with the operator's direct and/or indirect vision of the operating environment the extent of that interference is referred to as a "blind spot".

## COMMERCIAL VEHICLES ( BOTH ROAD AND OFF-ROAD VEHICLES) HAVE “BLIND SPOT” PROBLEMS

Over the years the custom has developed for road vehicles such as trucks and buses of using a flat glass mirror for clarity in backing the vehicle and a wide angle convex mirror to provide a wider field of view to better cover the operating environment. This continues today even though everyone knows this has not provided a solution for the “blind spot” problem and fatalities and injuries continue to be reported by operators of these vehicles.

For instance the Federal Motor Carrier Safety Administration Safety Progress Report as of 12-31-11 reports that for 2010 the following occurred in these areas:

3797	large truck fatalities
304	bus fatalities
64,338	large truck injuries
16,338	bus injuries

The Federal Government does not keep statistics about what percentage of these fatalities and injuries were caused by blind spots in the operator’s mirrors but they show their concern by the “NO ZONE” campaign begun in 1994 with a goal to increase awareness of the No Zones—danger areas such as blind spots around commercial vehicles, in which cars can disappear from the view of the truck or bus driver. As part of the campaign charts and graphs were prepared for the education of the driving public. Figure 2 presents an illustration of the Governments blind spots around the typical tractor-trailer combination.

Figure 2



Source: Federal Motor Carrier Safety Administration –No Zone Campaign

The Governments own chart shows the serious lack of coverage of the operators’ working environment but does not address the root cause of why these blind spots exist. Further there is no way to judge the effectiveness of such a program, but the Governments report of fatalities and injuries above quoted would seem to indicate

that the problem created by blind spots still exists and yet they have chosen to take no further action.

## SOURCE OF THE BLIND SPOT PROBLEM WITH COMMERCIAL VEHICLES

At M-C North America we decided to find the source of the problem and correct it.

As above stated a flat glass is commonly part of the mirror systems currently available and this glass is capable of producing no more than 20-30 degrees of view (averaging 5-10 degrees over many vehicles examined) which cannot be changed due to size limitations.

The convex mirror was added to increase this field of view, blind spots still exist, so the cause of the problem must be the convex mirror.

For the past 60 plus years mirror manufacturers have provided only one type of wide angle mirror, the single rate of curvature convex mirror. To create the single rate of curvature mirror, the glass is curved at a specific rate to create the wider view.

This mirror has the attribute of providing a wider field of view but has two distinct flaws for the use intended for these commercial vehicles.

### 1. FIELD OF VIEW LIMITED TO CONE SHAPE CONE OF VIEW CREATES A VERTICAL PLANE BLIND SPOT

The single rate of curvature convex mirror provides a field of view that commences at the face of the glass and expands as distance is placed between the face of the mirror to the rear of the vehicle until the cone widens enough to show the ground area. This leaves along the side of the vehicle 2 blind spots, one on a vertical plane, and one on a horizontal plane

This cone of view on the vertical plane causes problems when the vehicle is turning corners and objects near the side of the vehicle cannot be seen by the direct vision of the operator nor are they shown to the operator in the exterior mirrors.

This vertical plane can be illustrated by simply sitting in the seat and marking the spot where the ground is first shown in the mirrors on the side of the truck. On the following photo lines illustrating what is seen in the mirrors are imposed for the flat glass "west coast type" mirror with an 8 inch convex mirror mounted below the flat glass mirror on a tractor-trailer combination truck.

Figure3



The line at the bottom of the viewing area sets the upper limit of the vertical plane blind spot as the area along the side of the vehicle that is not seen in the rear view mirrors.

#### CONE OF VIEW PRODUCES A HORIZONTAL PLANE BLIND SPOT

When sitting in the seat of the vehicle and marking the view out from the side of the vehicle the blind spot illustrated is the horizontal plane blind spot. This is illustrated by the lines physically imposed on the photo attached as Figure 4.



Figure 4

The horizontal plane blind spot causes problems in lane changes and turning maneuvers and many truckers report that it forces them to turn the signal light on and start the lane change and continue to make the maneuver unless they hear a horn from the lane they intend to move into. Looking at many vehicles we estimate that the combination flat glass and convex glass provided the operator an average of 60 degrees and the combination of the door and window precluded any real help from the operators' peripheral view so the horizontal blind spot equaled about 30 degrees.

In Figure 5 below see the view out of the passenger side window of a typical tractor-trailer combination to illustrate how the view of the operators' peripheral vision is interfered with by the window structure and the view of the mirrors is even obstructed.



Figure 5

## 2. Distortion

The second problem introduced with the use of the single rate of curvature convex mirror is the problem of distortion. (Note in Figure 5 above the view in the round convex mirror of a truck that is actually parked at the immediate rear of the subject vehicle to illustrate the problem of actually determining where an object is with the standard convex mirror and note that all the while the operator is looking at the mirrors on the side of the truck the eyes of the operator are not on upcoming traffic to the front of the vehicle.) To create the standard convex mirror the glass must be curved to create the wider field of view. This type of mirror technology always produces images that are smaller in size than the actual object. This causes problems with the operator's perception of where the object actually is in relation to his/her vehicle and requires the operator to make mental calculations and/or judgments as to where the object is before maneuvering into the area and many times even requires the operator to actually turn to look into the area. (which is many times impossible-see Figure 5 above). Both of these actions require the operator to take the eyes off the road ahead and can result in a collision with upcoming traffic.

Further if a wider field of view is sought to correct the horizontal and vertical blind spots discussed above the glass must be curved more and this increases the factor of distortion until a point is reached where the mirror produces images so distorted that the driver cannot even look at the mirror while the vehicle is moving.

## LOCATION AND SIZE OF MIRRORS CAN ALSO COMPOUND THE EFFECT OF BLIND SPOTS

In Figure 6 we see a new case type mirror which is the prevailing type mirror now being used by the trucking industry.

Figure 6



The mirror is located on the door of the truck and as looked at by the view in Figure 6 shows the large blind spot that is created in the area behind the mirror. The better location for the mirror should be to the front of the windshield so the operator can just glance to the side and obtain the necessary information about what is in the area to the side of the truck and do so while keeping the eyes on the road ahead. The same age old technology of the single rate of curvature convex mirror is still being used. Placing the mirror on the door requires the operator to turn the head and the distortion factor requires the operator to still make mental calculations as to the exact location of any objects viewed and at the same time try and see any objects that may be behind the mirror itself and do all of this this while the eyes are not on the upcoming road. The end result is an 80,000 pound vehicle moving ahead at 65-70 mph on the freeway and the operator is forced to take the eyes off the upcoming traffic ahead in an attempt to make a lane change. If the eyes remain on the mirror configuration too long an accident with upcoming traffic is more than possible. This type of problem is also found in the transit industry with transit buses and becomes even more important because the object not seen behind the mirror is usually a pedestrian. The advice given to transit bus operators is to “bob and weave” or “rock and roll” in their seat while driving the bus to attempt to see people behind the mirrors in the blind spot created by the mirrors. Even assuming the transit bus person is physically able to continue these contortions over a period of 8 hours the problem would be better handled by moving the location of the mirrors to the front of the driver.

## OFF-ROAD VEHICLES

### CONSTRUCTION

Construction, agricultural, mining equipment and logging equipment are considered off-road equipment so the only Federal Requirement of mirrors for regular trucks and buses of a 7 x 7 inch flat glass (other requirements for school buses) to be placed upon the vehicle at the time the manufacturer delivers the vehicle to the purchaser do apply to such vehicles and other agencies responsible for these industries have never considered the importance of mirrors on these vehicles, although the Mine Safety and Health Administration (MSHA) has recognized the danger of blind spots on off road mining equipment, and has chosen to solve the problem with electronic methods such as video cameras. ( and, even though this approach has been advanced by the agency there is still no clear mandate from them that rear view mirrors are no longer required if cameras are placed in use). Electronic methods can fail more often than mirrors so a mirror system that works, provides a complete back-up system for the cameras. Here the same age old mirror technology as for road vehicles has been applied by manufacturers to these categories of equipment.

The approach historically has been placement of one convex type mirror on each side of the equipment. The convex rate of curvature decided upon is one that provides the maximum view with the least possible distortion, a compromise mirror. Here too the cone theory of view provides much the same blind spots along the sides of the vehicle as described above. The following figure is a front end loader showing the blind spot along the side of the vehicle.



Figure 7

This type of equipment can be found in use in construction, logging, agricultural and mining and is usually operated in close conjunction with other employees and the problem is that the operator of the equipment cannot see them. Reports of co-employees being injured or killed while working adjacent to the equipment are many and yet manufacturers continue to apply the old mirror technology, and government agencies continue to tally the fatalities and injuries without advancing serious thought about requiring manufacturers to correct the problem.

## FARMING

A review of the mirrors on a large farm tractor illustrates the same type of blind spot along the side of the vehicle, especially dangerous for small children, which is a particular problem of the family farm operator. Another area behind the vehicle that is especially dangerous, the area of the power take-off should be subject to view constantly, which can best be done by the installation of a camera on the back of the cab. Unfortunately the farm industry does not have any advocate organizations interested in trying to force safety measures other than publishing safety memos about avoiding the dangers.

Figure 8 with blind spot illustrated on photo



Figure 8

## MINING/QUARRY

The same type of result is found in the large equipment such as the mine/quarry articulated truck, the important area of the ground area is not shown to the operator by the currently employed mirror system.



and the rigid type haul truck

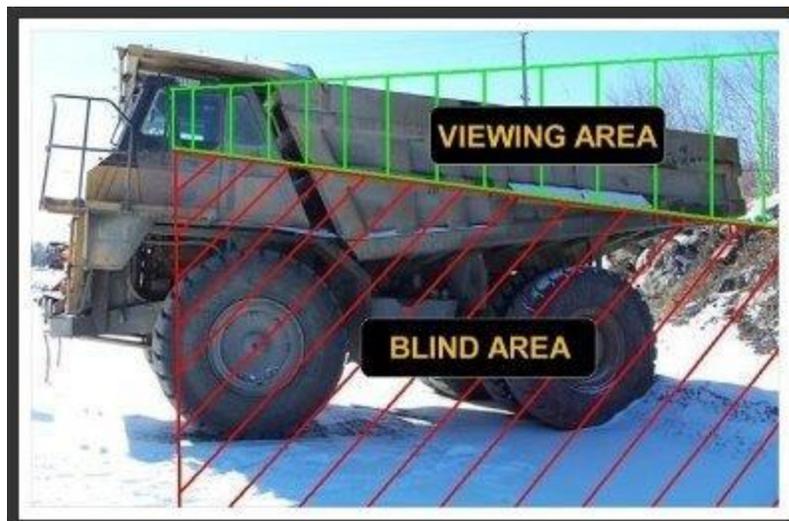


Figure 9

Blind spot accidents with these large vehicles can be very costly in lives lost and damages caused;



Figure 10

And results in continuing reports such as the following Alert from the Mine Safety and Health Administration will continue;

#### “Struck by” Accidents

“There has been an alarming trend of serious and fatal injuries involving miners who are being crushed, run over, pinned by, or struck by, moving mining equipment.”

MSHA Alert dated 6-4-12

In response to the above findings as to the state of mirroring vehicles of all types, M-C North America has developed a new wide angle mirror technology that has the ability to correct these deficiencies in the view of the operating environment of vehicles. We take our technology and make the mirror the proper size for the type of equipment.

Our goal to develop solutions using this technology located properly on the vehicle that provide the operator the view of the operators’ environment, that will allow safe operation of the vehicle whether it is being used on congested roadways or in other areas where co-workers may be present.

Go to our “ Industries Page”, select the type of equipment and review the current White Paper on that type of equipment to see the M-C Mirror Technology solution to the “Blind Spot” problem. If your equipment is not shown contact us and we will work with you to provide a solution.

Richard T. Ince  
Safety Director  
M-C North America Inc.