



M-C North America Inc. CUSTOM MIRRORS

All vehicle mirror manufacturers use a single rate of curvature mirror technology when producing wide angle glass. This type of mirror is generally referred to as a convex mirror and it is used by mirror manufacturers in conjunction with a flat glass mirror. The flat glass mirror provides images as they appear in real time so they can aid the driver in driving and backing the vehicle because they show objects where they actually are in relation to the vehicle being operated. Unfortunately the field of view they provide is very limited so the convex mirror is used to increase the field of view for the operator. The problem is that to get this increased field of view the convex glass introduces the concept of distortion which is simply a way of saying the images produced are always smaller than they would appear in the real time or in the flat glass. When an operator sees the image the object appears to be further away than it really is so the operator is required to make mental judgements as to whether it will interact with the vehicle being driven. Because of this fact the government agencies have always maintained that there must be some sort of separation between the flat glass and the convex glass to prevent driver confusion. The result is that the driver usually has a flat glass mirror and a convex mirror on each side of the vehicle, providing a view as follows:



Some objects may be shown in one mirror and not the other so the operator of the typical commercial vehicle is required to scan all 4 mirrors, and with some vehicles 6 mirrors, while continuing to operate the vehicle. You add congested city streets, where activity in the proximity of the vehicle is continually occurring and the operators' full time job is to keep looking in the mirrors, instead of maintaining the eyes on the road ahead.

The problem with this system of 4 or more mirrors to review is compounded by the fact that every mirror currently in use leaves large blind spots caused by the cone theory of view, which means simply that the field of view of any mirror starts at the face of the mirror and opens up as distance to the rear of the vehicle is introduced to a point where it opens up enough to include a view of the ground. This blind spot exists along the side of every vehicle and varies in length, depending the type of convex mirror used. Other mirror manufacturers could make a mirror that would show the ground earlier but the rate of curvature would have to be so severe that the distortion factor would make the mirror unusable for driving.

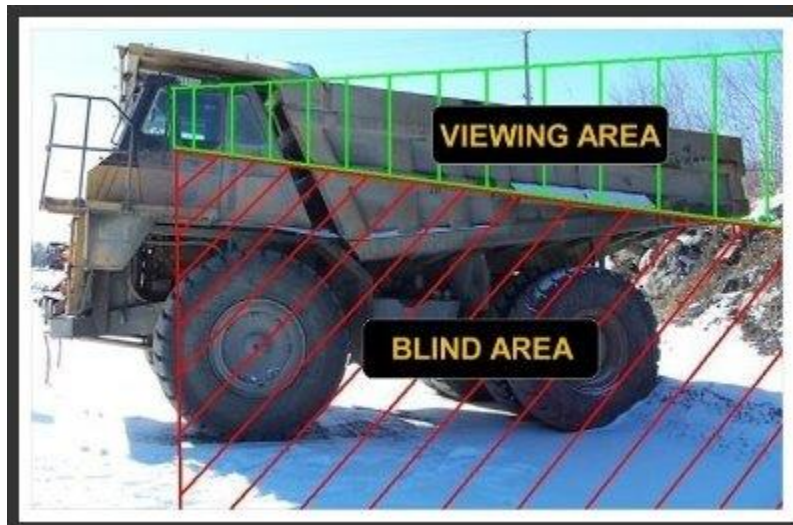
It is within this context that we began to develop our series of CUSTOM MIRRORS . We felt that the added stress of more mirrors would be counter-productive and this includes the use of electronic systems favored by the federal government that raise the question of adding to the drivers workload by providing monitors that must be watched, are much more costly than mirrors, have reliability issues, and have driver acceptance issues. For instance, with all the present reliance on electronic systems we have not seen one study that concluded it is better to have the operator of the vehicle looking at a monitor rather, that having the eyes on the road ahead is the best safety approach. We reached the conclusion, that reduction of the number of mirrors should be the major priority issue because the major focus of the drivers' eyes should be on the road ahead, and equally important the mirror selected must show the ground close to the location of the mirror on the vehicle, thus eliminating the blind spot on the side of the vehicle. The field of view must be considered out from the side of the vehicle to aid the operator in lane changes and turning maneuvers. And finally, the mirror should present images without distortion so the information they present can be obtained with just a glance giving the operator time to react as fast as possible to take corrective action. Current mirror systems fail in all these requirements. OUR CUSTOM MIRRORS ANSWER ALL THE QUESTIONS.

We approached the problem of developing a single side mirror for each side of the vehicle, by selecting a type of vehicle, testing the vehicle by sitting in the operator's seat to determine the blind spot along the side of the vehicle, the view out from the side of the vehicle, interviewed operators as to what they deemed important to see along the sides of the vehicle and

determining what we thought they should see. We knew that with the M-C North America multi-radius mirror technology, that produced a wide angle glass with no distortion, something that no other mirror manufacturer could offer, allowed us to join in one piece of glass various rates of curvature of glass to accomplish what we wanted the mirror to produce.

Then we started addressing vehicles of every type. We include 100 ton mine truck as illustrative of how we approached all vehicles. With the mine truck we learned, first that the mirrors on the passenger side were too small as a general rule. And no one had taken into account how far from the mirror the operator is sitting, and we would need a mirror that could be seen and acted upon by the operator, secondly we measured the distance from the mirrors location on the truck to the ground. Next we measured the extent of the blind spot along the side of the vehicle and superimposed our findings on the attached photo:

Exhibit A



The diagram shows the extent of the blind spot along the side of the vehicle as the ground cannot be seen until well behind the vehicle i.e. the cone of view. The blind spot along the bottom side of the vehicle would place the operator of coming into contact with persons or objects near the vehicle and importantly the driver was unable to see if after loading, debris was left that could do damage to the rear tires. Our replacement mirror must clearly show back for regular driving and backing, down to see the ground near the front tires and out from the side of the vehicle.

M-C Multi-radius technology allowed us to join various rates of curvature with other rates of curvature to produce a single mirror that accomplished our purpose. Thus, we incorporated a flat portion of the glass for backing and driving with a more convex portion, a radii of curvature that showed us the ground area by the front wheels and a more convex portion

along the outside of the glass to see out from the body of the truck all of which could not be accomplished the wide angle glass currently being offered by all other mirror manufacturers.

For mine/quarry trucks of 100 tons or less a mirror of 15 x 25 inches, incorporating different rates of curvature could and did produce a view along the side of the 100 ton mine truck as illustrated below:

Exhibit B



Compare this picture with the picture above (Exhibit A) and you can see how we cover the entire blind area listed and note the clarity of the images. The driver obtains all the information needed with just a glance.

Our next consideration was the use this technology to produce mirrors providing the same type of view on mine trucks in excess of 100 tons. (175-500 tons). The bigger size necessitated a larger size mirror and more consideration of the driver's distance from the passenger side mirror. We knew that we could satisfactorily join various rates of curvature with our M-C mirror technology so the project became one of selecting a proper size and proper radii of curvature for the various parts of mirror.

Our final result was for the passenger side of these vehicles we needed a 20 x 35 inch mirror and the resulting glass produced a view as shown by the following photo: Exhibit C



For the driver's side of the truck, because of the nearness of the operator to the actual mirror we used the same approach but found that the only difference had to be in the size of the mirror. We found that a 20 x 25 inch mirror was the correct size.

PHOTOS ILLUSTRATING OUR CUSTOM MIRRORS IN USE

15 X 25 INCH CUSTOM MIRROR ON A 60 TON ARTICULATED TRUCK

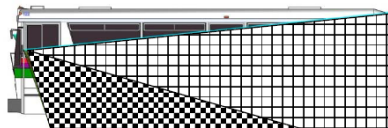


20 X 35 INCH CUSTOM MIRROR BEING INSTALLED ON A 240 TON MINE TRUCK

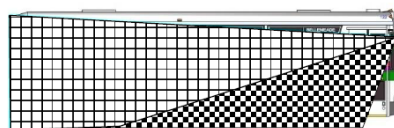


SINCE THE MIRROR INDUSTRY USES THE SAME SINGLE RATE OF CURVATURE WIDE ANGLE GLASS IN EVERY OTHER PIECE OF MOBILE EQUIPMENT AND THE PROBLEM OF BLIND SPOTS ALONG THE SIDE OF THE VEHICLE EXIST IN EVERY APPLICATION, EQUIPMENT SUCH AS TRANSIT BUSES, PARA-TRANSIT BUSES, SCHOOL BUSES, FRONT END LOADERS, SKID STEERS, ROLLERS, COMPACTORS, STREET SWEEPERS, STRAIGHT TRUCKS OF ALL TYPES, BOX TRUCKS, POST OFFICE VEHICLES, LIGHT RAIL, TROLLIES, FARM EQUIPMENT, ALL MILITARY VEHICLES, AND ANY OTHER TYPE OF EQUIPMENT UPON WHICH MIRRORS ARE NECESSARY ALL HAVE THE SAME BLIND SPOT ALONG THE SIDE OF THE EQUIPMENT AND FURTHER, THE CONE THEORY OF VIEW ALSO PRESENTS A LIMITED FIELD OF VIEW OUT FROM THE SIDE OF THE EQUIPMENT PROVIDING A VIEW THAT IS NOT ACCEPTABLE FOR LANE CHANGES AND TURNING MANEUVERS, SO THAT OPERATORS' ARE FORCED TO TAKE THE EYES OFF THE ROAD AHEAD TO TURN AND LOOK INTO THE AREAS WHILE MAKING THESE MANEUVERS.

The blind spot can be illustrated by the attached photo of a transit bus;



(c) Driver side view



(d) Passenger side view

The blind spot is illustrated by the small checks and extends from the point where the mirror is placed upon the vehicle and extends to where the mirror first shows the operator the ground, and the view out from the side of does not extend out far enough for safe lane changes and turning maneuvers.

For such equipment we have designed a series of mirrors composed of a 10 X 10 inch (254 X 254 mm), a 10 X 15 inch (254 x 381mm) and a 10 x 18 inch (254 x 457mm)

As with mine truck we examine the equipment and confer with Safety and Drivers to determine what must be seen and select the proper size. All of the mirrors are designed to provide a necessary view in one piece of glass, doing away with the 2 side mirrors now placed on equipment. A typical view can be illustrated by the following photo of our 10 x 15 mirror:



All mirrors contain a flat portion for driving and backing, a portion of the mirror for view of the ground at the location of the mirror on the vehicle and a portion of the mirror to see out from the side of the vehicle for safe lane changes and turning maneuvers (approximately 2 ½ lanes)

We will work with your people to eliminate the blind spot problem, and provide your operators the view necessary to safely operate the equipment.

Norm Smith

President/CEO

M-C North America Inc.

