



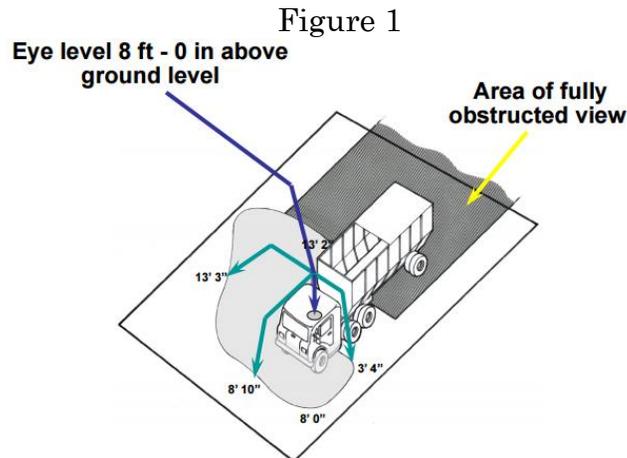
## BLIND SPOTS AND THE TRASH TRUCK

Trash trucks come in many different styles, the front loader, the rear loader, the side loader, pneumatic collection trucks and grapple trucks. They can range in length of 30 to 40 feet, and are expected to travel on smaller streets and alleys, make extremely sharp turns, and are in regular contact with pedestrians and bicyclists. Stop and Go is common. Fully loaded they can cause great damage to anything they come in contact with. Concerning their safety record, John J. Rich in his article “Creating a Safer Waste Truck Environment” states’

“The BLS (Bureau of Labor Statistics) also show that waste collection is the fourth most hazardous occupation in the U.S., and more than 10 times the average rate for all occupations in the country.” and

“One insurance underwriter who has specialized in analyzing the loss data for the waste industry for more than 20 years maintains that for every 10 waste vehicles in a fleet there will be two accidents annually, and one of every nine collisions will involve bodily injury to the other party.”

An general illustration of the blind spots existing on the trash truck is found in Massachusetts Occupation and Health Division “No-See Zones”:

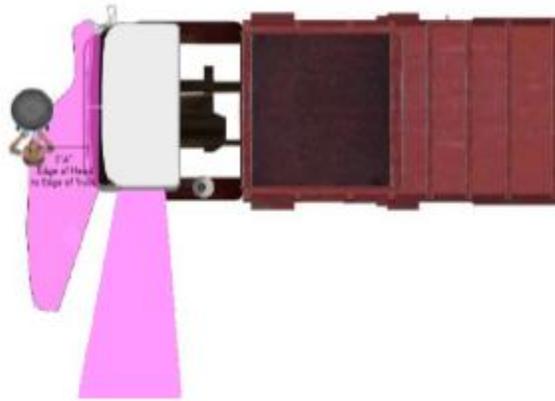


## Refuse Truck

(Note the drivers eye level is over 8 feet from ground level and the areas to the rear are fully obstructed from the operators’ view. This is an illustration of the problem with no mirrors or cameras.

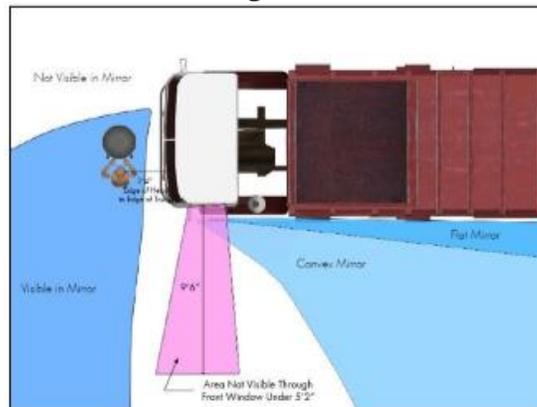
Looking at the cab view on the drivers' side illustrates the view from the window and the front of the truck. Blind areas are shown in pink.

Figure 2



When a standard west coast mirror with an 8 inch convex is attached to the door and a convex mirror is placed on the right pillar the area viewed is shown as follows:

Figure 3



(Source of both illustrations SAE Paper 2007-01-4232)

With this photo two items of concern should be remembered. Note the view provided by both the flat glass and the convex glass on the door starts as the face of the mirror and opens up at distance to the rear of the truck is introduced and the view out the drivers' window does not see the ground until well over 9 feet from the side of the truck.

Since there is such a variety of trash trucks, the problem of blind spots can only be analyzed in a general manner.

1. The operator must tend to the operation of the vehicle.
2. The smaller streets and alleys means the vehicle is operated in close proximity objects such as cars, garages etc.
3. The Stop and Go requirement means constant pulling away from the curb and entering the traveled lanes of the roadway.

4. The Stop and Go requirement means that every time the vehicle is moved the area may have changed while the vehicle is stopped by a pedestrian traffic or a cyclist entering the area.
5. The operator must be aware of what is happening in the loading area of the Truck.
6. Special configurations of the vehicle must be taken into consideration, such as front loaders, grapple trucks or other attachments.
7. The operator must be provided with a view of the immediate front of the truck.

## UNDERSTANDING THE PROBLEM

### EXTERIOR MIRRORS ARE PLACED UPON THE VEHICLE TO REDUCE BLIND SPOTS WHICH ARE DEFINED AS AREAS NOT VISIBLE BY DIRECT VIEW.

Two considerations for exterior mirror systems are field of view and clarity of view. Does the view provided cover the area and is the view provided with clear images that do not require the operator to take time to make mental judgements.

Currently mirror manufacturers provide two types of mirrors: Flat Glass Mirrors that provide a clear view but one that does not provide a wide field of view, and Convex mirrors to supplement the flat glass mirror by providing a wider field of view. The flat glass and the convex mirror are either presented by two separate mirrors or by both glasses encompassed in a single case.

### WHAT AID DO EXISTING MIRROR SYSTEMS PROVIDE THE OPERATOR

The wide angle mirror technology used in the Convex mirrors is a single rate of curvature mirror. Flat glass is curved at a constant rate to make the convex mirror, which widens the field of view but introduces into the mirror two physical characteristics that will always be present. These are

1. the field of view starts at the face of the mirror and widens as distance from the mirror face to the rear of the vehicle is introduced until somewhere near the rear of the vehicle the envelope has opened up enough to show the ground. This generally is described as the "Cone Theory of View" and is illustrated by the diagram in Figure 3 above. What is neglected by most mirror users is the Cone Shaped view provided by the mirrors out from the side of the vehicle (horizontal) is also present in the vertical field of view provided. This creates a vertical blind spot along the side of the truck can be illustrated by the following photo. Figure 4

Figure 4



This vertical blind spot is many times referred to as the “kill zone” because a pedestrian or cyclist hit in this area generally ends up under the rear wheels. Many advocate the placement of side guards as a solution to keep people from ending up under the rear wheels. This solution may reduce fatalities by being run over by the rear wheels but turns the fatality into an injury. A better solution would be to eliminate the blind spot by providing the operator a view of this danger area.

2. The second physical characteristic of the single rate of curvature is that bending the flat glass introduces “minification” of objects. Images of objects are smaller than they would appear in the flat glass mirror. An example of this characteristic can be illustrated by the attached photo:

Figure 5



If the object is only visible to the operator in the convex mirror mental calculations have to be made as to where the object is in relation to the vehicle operated. Any time needed to make the calculation is time the eyes are not on the road ahead.

## THE M-C NORTH AMERICA INC. SOLUTION

We broke the solution down into attaining 3 goals:

1. develop a mirror technology that can provide a wider view without the distortion prevalent in the current convex mirrors being used.
2. develop a solution to the problem of the cone field of view provided by current mirror systems.
3. develop a proper location of the mirrors on the vehicle to maximize the aid the mirrors provide for operator.

### Distortion

As stated above the primary problem with the single rate of curvature mirrors is “minimication” of images presented to the operator. The objects appear smaller than if viewed in a flat glass, and to the eye this presents a distortion element, which requires the operator to determine where the object actually is before the necessary reaction can be executed. If the operator takes action before a careful consideration is made the result can be accident. The time taken, varies for each individual, but no matter how much time taken the eyes are not on the road ahead. Our solution here was the creation of a new wide angle mirror technology(US Patent No. 8,172,411) which is a multi-radius approach that allows us have better control over the size of the images so the distortion factor is eliminated allowing the operator to use the information presented without taking time to determine where the object actually is instead of guessing where it is with current convex mirror technology. Our mirror glass provides clarity of view.

### Eliminating the effect of the Cone theory of View

Mirror manufacturers working with the single rate of curvature mirror do not have the ability to join various rates of curvature into one piece of glass because of the distortion factor. Our technology by removing the distortion factor on the wide angle mirror glass means we can join together in one mirror different rates of curvature. We can join a flatter

portion for backing, a more convex portion on the side to see out from the vehicle for lane changes and turning maneuvers, and a more convex portion on the bottom of the mirror to see the ground closer to the placement of the mirror on the vehicle. The blind spot from the mirrors location on the vehicle to the rear of the vehicle created by the Cone theory is eliminated.

Proper location of the exterior mirrors on the vehicle.

Historically exterior mirrors have been placed on the door or frame of the door. This placement requires the operator to turn the head to view the passenger side mirror and takes the eyes off the road ahead, and also the mirror itself creates a blind spot in the operators' view. A proper placement of the mirrors should be to the front of the windshield, 18 inches out and at eye level, so that the main eye contact is to the front of the vehicle for oncoming traffic, and allows the operator to see all that is necessary along the sides of the vehicle with just a glance of the eyes. This can only be accomplished by removing the distortion in the wide angle glass, and allows the full field of view of the mirrors to be available for the operator, and can in such a situation offer some aid to the view of the front of the vehicle. Location of the mirror on the door of the passenger size of the trash truck can be illustrated by the following photo:

Figure 6



Mounting the mirror on the door or pillar on the opposite side from the driver may result in obstruction by factors such as wing windows or other construction elements, requires the head to be turned to view the mirror and creates a blind spot for the area behind the mirror.

Proper location of the exterior mirror is illustrated by the attached photo:  
Figure 7



Mirror placement in this location allows the operator to see all information along the side of vehicle operated with just a glance, maintaining major eye contact with the road ahead.

For the immediate front of the vehicle we recommend cross-over mirrors (not the type of cross-over mirrors presently being used because the rate of curvature is so great that the distortion factor makes them useless) but mirrors that clearly show the operator the necessary information (presently under development with our mirror technology) or cameras as needed and for the rear of the vehicle the camera is the only solution. As is shown by the fact that many manufactures are offering the rear view camera as a standard.

At M-C North America Inc. we do not just sell mirrors and cameras, we sell solution that solve a problem.

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