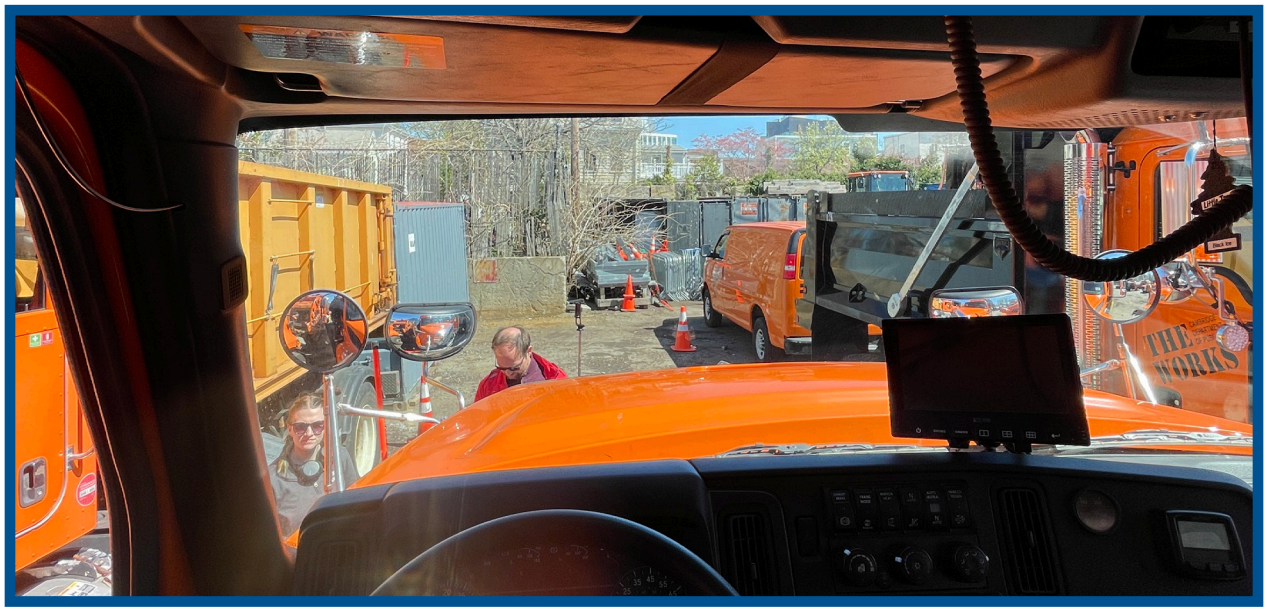
City of Cambridge, MA

Direct Vision Report Card



The Lab @ MassDOT

2024

City of Cambridge, MA

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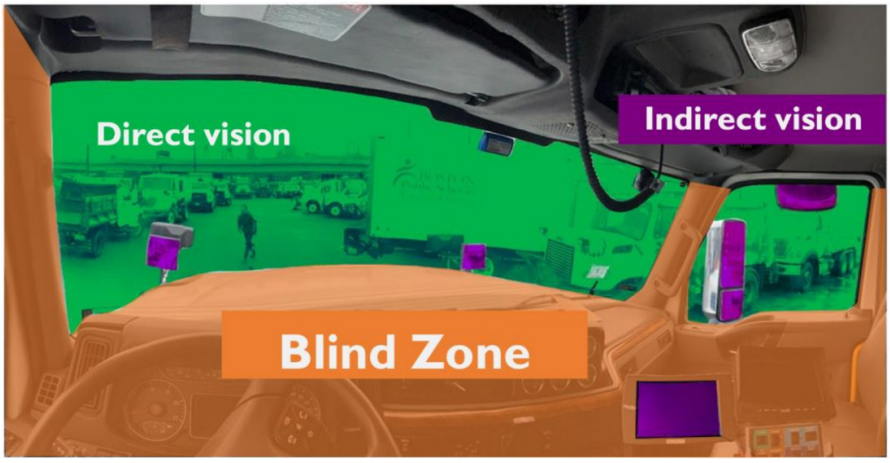
Overview

What is Direct Vision?

Direct Vision is what the driver of a vehicle can see without the aid of mirrors, cameras, or other sensors. Because they are so large, many fleet vehicles have blind zones that obscure objects and people close to the vehicle. When these vehicles share the road with pedestrians and cyclists, this becomes a major safety concern. Good direct vision for a driver means pedestrians and cyclists are more visible, driver reaction times are quicker, and everyone is safer.



What are the Results of the Measurements We Took?

For each of the vehicles we measured, we got a better understanding of:

1. Front and Passenger View Visibility — the nearest distance at which an adult and an elementary-school child are visible to a vehicle operator both directly in front of the vehicle and to the passenger side; and
2. The "Blind Zone Polygon" — the percentage of area that a vehicle operator cannot see in a 20-meter (65.6-foot) radius.

We've also applied the 5-star rating system developed by US Volpe Center to all of the vehicles measured to add some context to these measurements. We hope these results help you understand the direct vision of vehicles in your fleet and how they compare to other vehicles we measured across the state.

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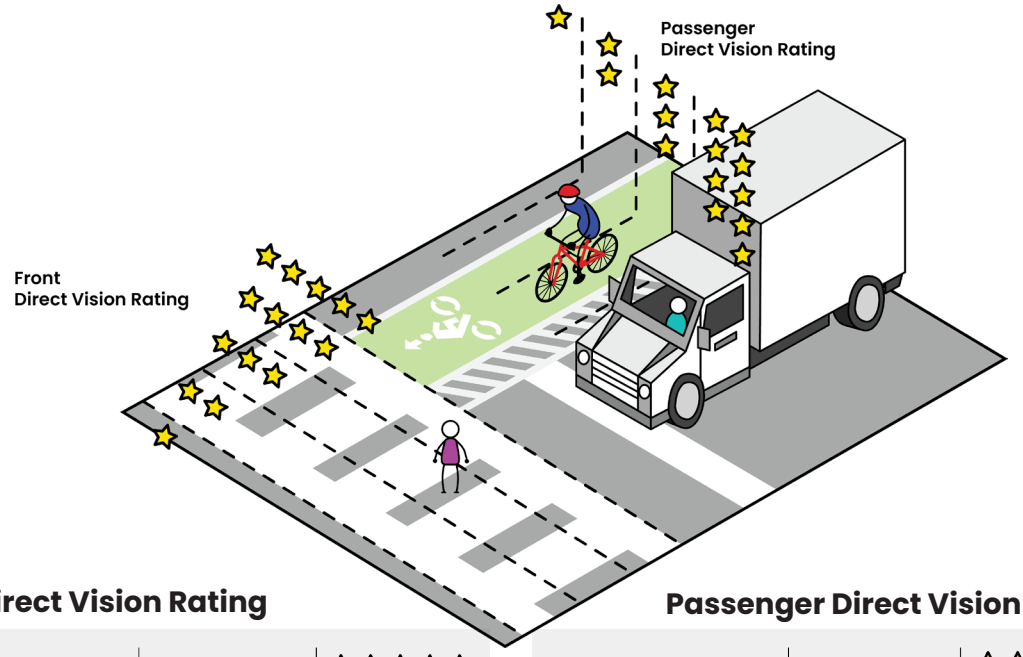
The 5-Star Rating System

The 5-star direct vision (DV) rating system developed by US Volpe Center gives us a way to quickly compare direct vision between vehicles, as well as an idea of where other road users — such as cyclists and pedestrians — are invisible to a vehicle operator in common scenarios on the road.



Front Direct Vision Rating

Child first visible	< 4 ft	★★★★★
	4-6 ft	★★★★
	6-8 ft	★★★
	8-10 ft	★★
	> 10 ft	★

Passenger Direct Vision Rating

Child first visible	< 3 ft	★★★★★
Adult first visible	< 3 ft	★★★★
	3-6 ft	★★★
	6-8 ft	★★
	> 8 ft	★

The rating system for the **front view** of a vehicle is based on the ability to see an elementary school child standing directly in front of the vehicle in a crosswalk at an intersection[1].

The rating system for the **view of the passenger-side** of a vehicle is based on the ability to see a cyclist directly next to the passenger-side door in a separated bike lane[2]. 1-Star through 4-Star ratings are based on the ability to see an adult cyclist, while a 5-Star rating is based the ability to see a child cyclist.

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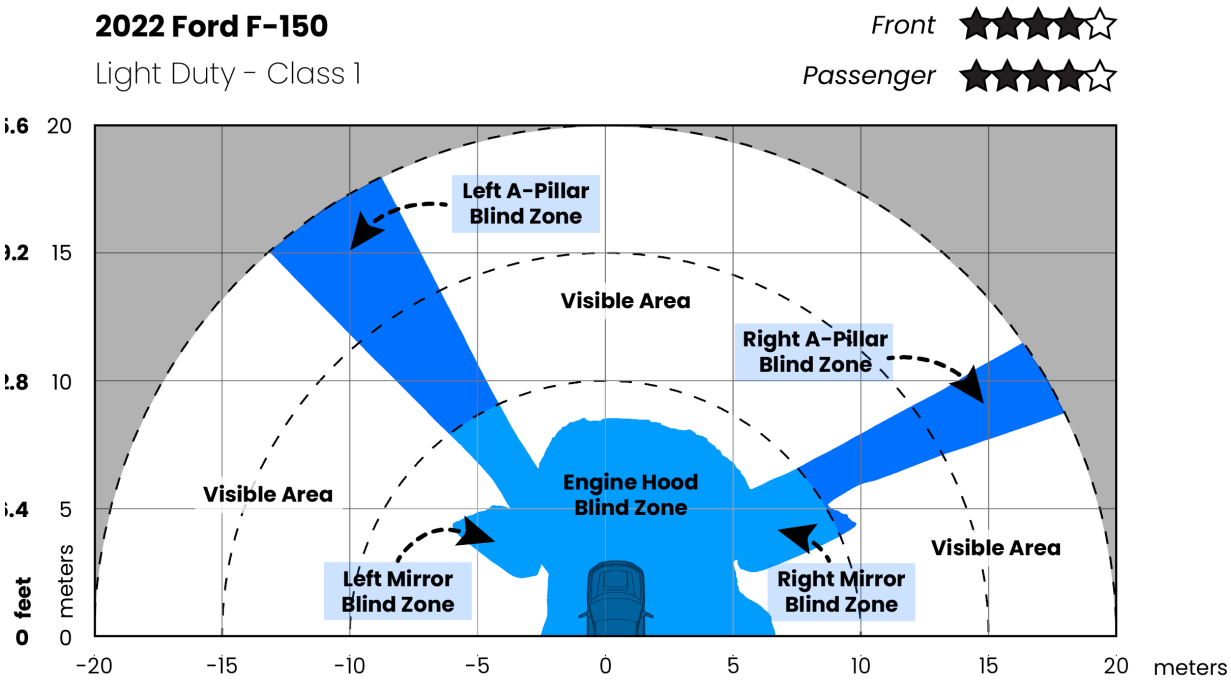
The Vehicle Blind Zone

The measurements we took also allowed us to calculate the area of the driver blind zone in these vehicles according to a standardized measurement methodology and data processing method. This gives us another way to compare the direct vision between different vehicles.



Ground-level blind zone polygon for a 2022 Ford F-150. Driver eyepoint is located at the origin (0,0).

For each of the measured or similar vehicles in your fleet, we used the measurements to generate an image showing the driver's eyepoint[3] direct vision blind zones in a 20-meter radius. Areas in blue represent the ground-level blind zones.

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Direct Vision in Your Fleet

We took measurements of these vehicles in your fleet:

Weight Class	Year / Make / Model	Front DV Rating	Passenger DV Rating	%Visible Area (10m radius)	%Visible Area (20m radius)
Heavy	2021 International HV607	★☆☆☆☆	★☆☆☆☆	30.57%	68.68%
	2023 Mack Granite GR42F	★☆☆☆☆	★☆☆☆☆	25.18%	66.78%

We also took measurements of vehicles in other fleets. Based on the fleet list you provided, we saw that vehicles in your fleet might be similar to these vehicles:

Weight Class	Year / Make / Model	Front DV Rating	Passenger DV Rating	%Visible Area (10m radius)	%Visible Area (20m radius)
Light	2019 Ford F-250	★★★★☆	★★★☆☆	30.01%	64.66%
	2021 Ford Transit 250	★★★★★	★★★★☆	63.37%	82.82%
Medium	2017 Ford F-350	★★★★☆	★★★★☆	29.77%	68.42%
	2016 Ford F-450	★★★☆☆	★★★★☆	31.14%	70.12%
	2020 Ford F-450	★★★☆☆	★★★★☆	29.26%	64.46%
	2024 Ford F-450	★☆☆☆☆	★★★☆☆	24.40%	59.30%
	2019 Ford F-550	★★☆☆☆	★★★☆☆	25.20%	60.62%
	2022 Ford F-550 Super Duty	★★☆☆☆	★★★☆☆	25.21%	61.73%
	2023 Ford F-550	★★☆☆☆	★★★☆☆	24.56%	58.27%
	2017 International 4300	★★★★☆	★★☆☆☆	47.23%	68.30%
Heavy	2019 International 7400	★☆☆☆☆	★☆☆☆☆	30.58%	63.90%
	2015 Peterbilt 348	★★☆☆☆	★★☆☆☆	42.35%	69.09%

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Your Fleet in the Study

The following pages' bar charts show the front and passenger direct vision ratings for the vehicles measured in our study, grouped into light-duty, medium-duty, and heavy-duty vehicles.

Light-Duty

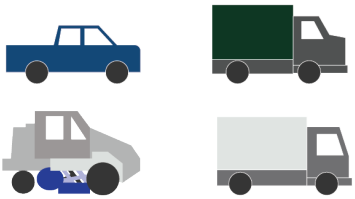
Class 1 & 2
GVWR: < 10,000 lbs.

Includes vehicles such as: Ford F-150, Chevrolet Silverado, Ford Transit, Chevrolet Express

Medium-Duty

Class 3 - 6
GVWR: 10,000 - 26,000 lbs.

Includes vehicles such as: Elgin Pelican, Ford F-350, International MV607



Heavy-Duty

Class 7 & 8
GVWR: > 26,000 lbs.

Includes vehicles such as: Freightliner 108SD, International Workstar 7400

Vehicles that were measured in your fleet are highlighted in red, and vehicles in your fleet that are similar to those we measured in other fleets are highlighted in striped red.

	MEASURED IN STUDY	MEASURED IN YOUR FLEET	IN YOUR FLEET, MEASURED IN STUDY
Elementary School Child			
Adult			

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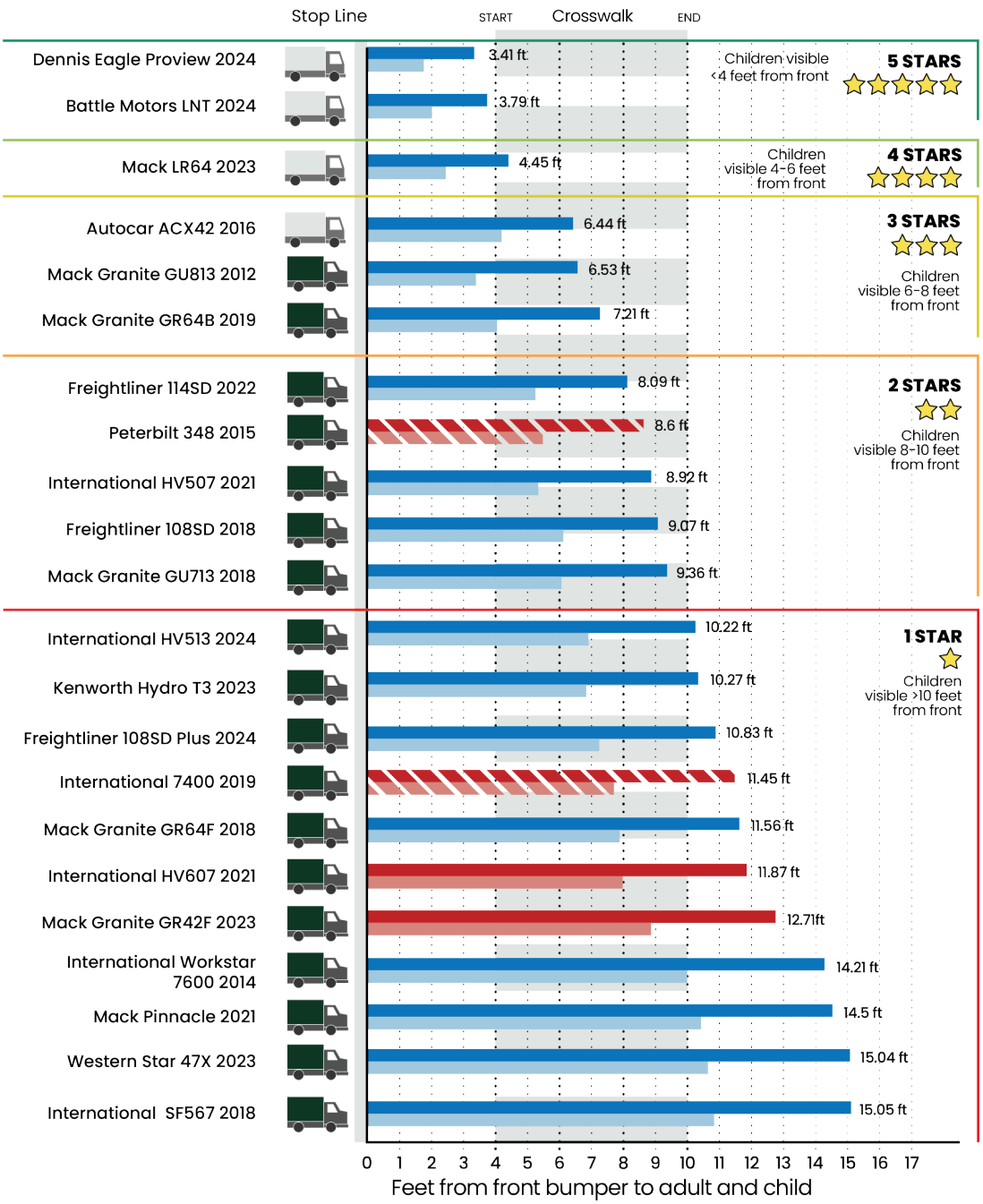
Front Direct Vision Ratings - Heavy Duty Vehicles



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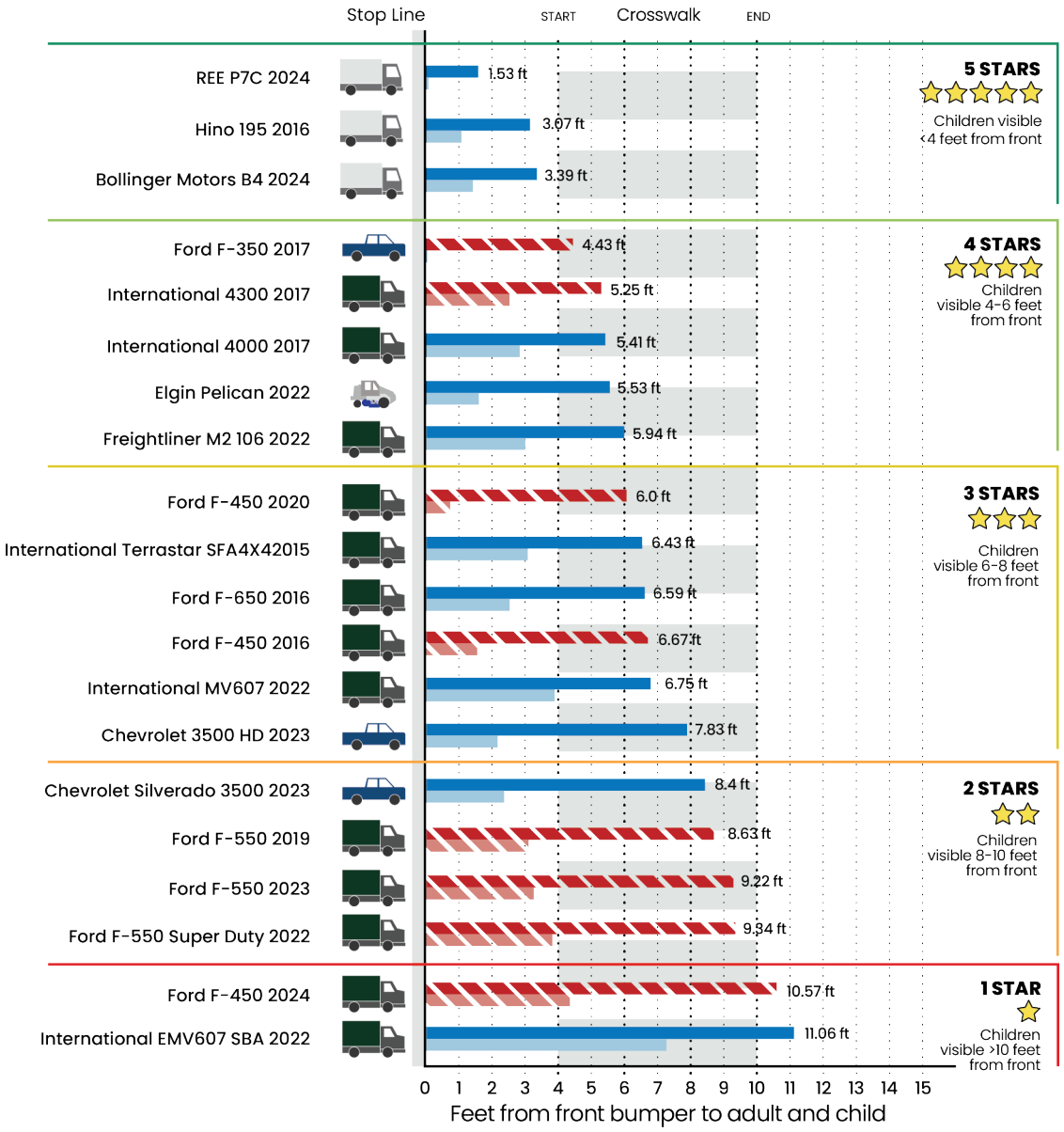
Front Direct Vision Ratings - Medium Duty Vehicles



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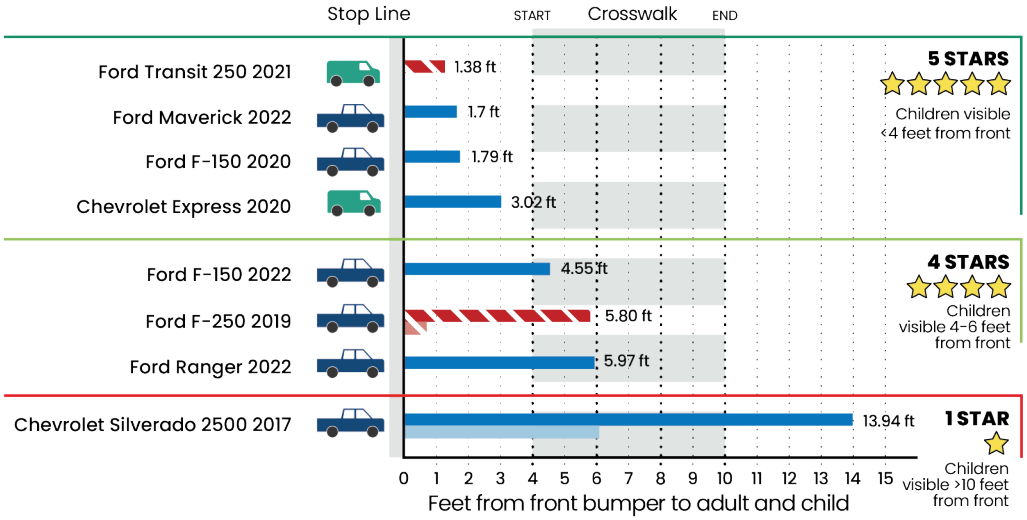
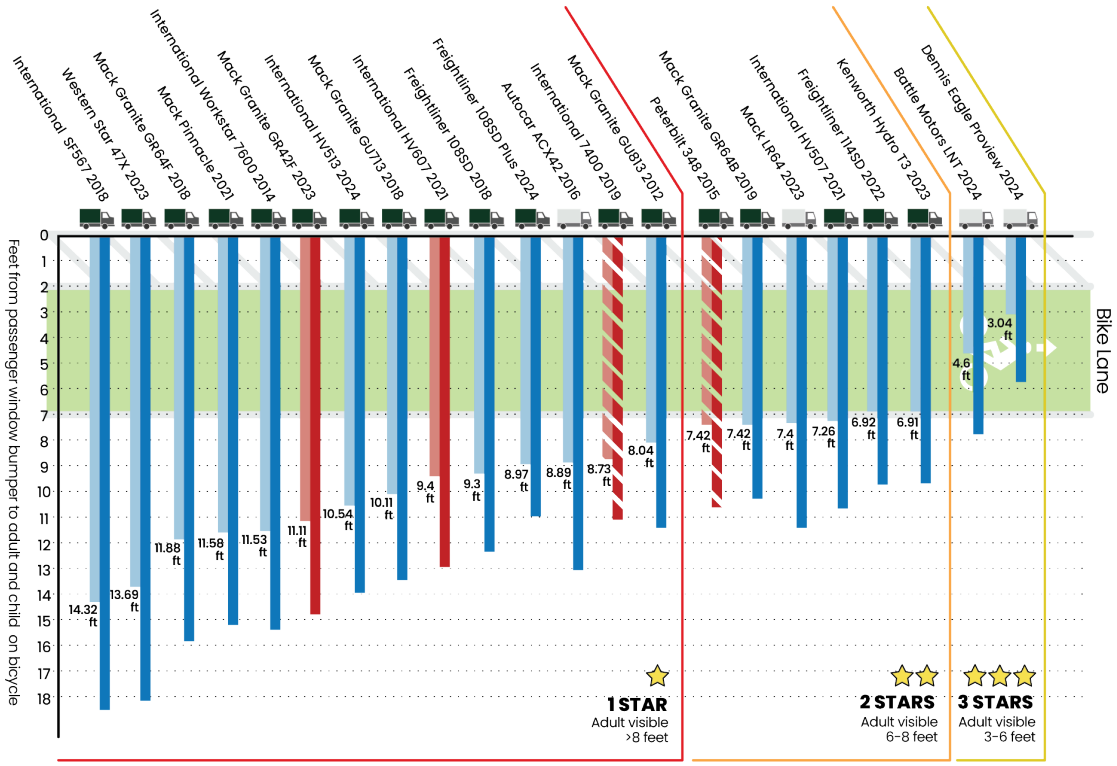
Front Direct Vision Ratings - Light Duty Vehicles



Passenger Direct Vision Ratings - Heavy Duty Vehicles



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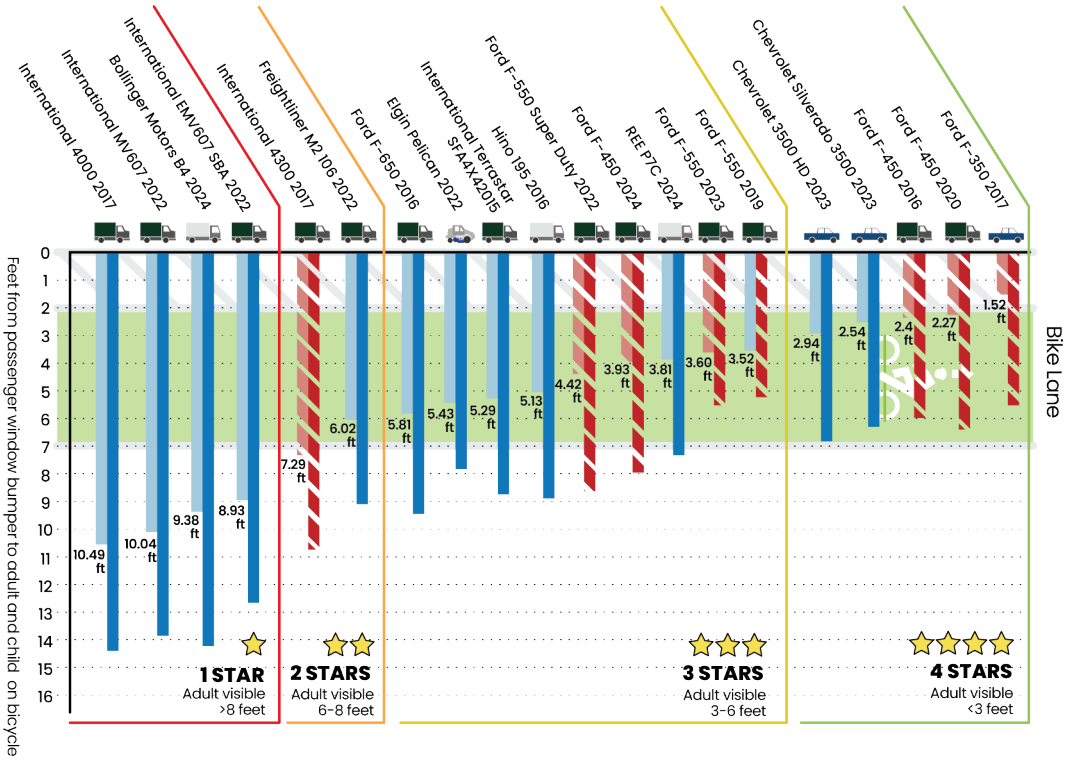
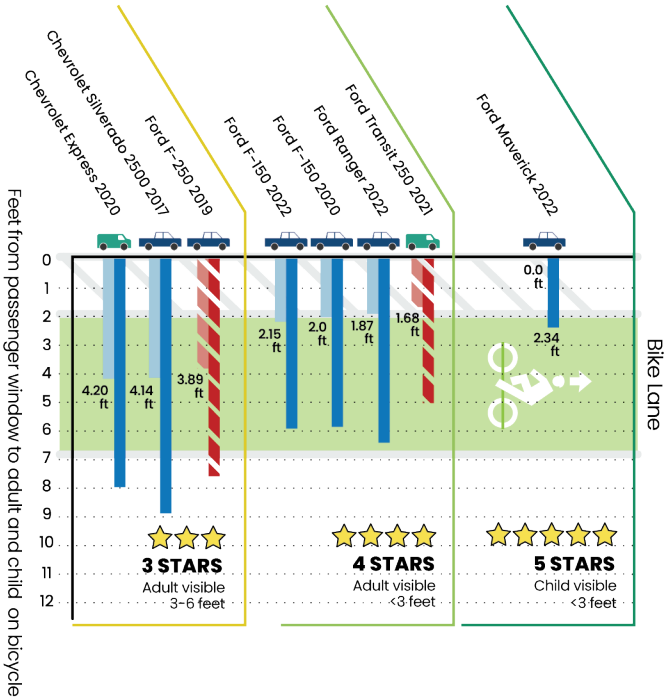
Passenger Direct Vision Ratings - Medium Duty Vehicles



Passenger Direct Vision Ratings - Light Duty Vehicles



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Now What?

Study Limitations

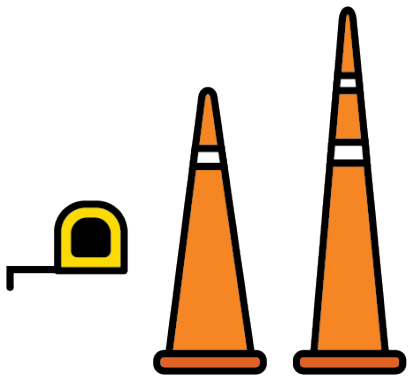
We've been using national averages to approximate where a driver's eyepoint is and to assess and rate direct vision. However, people come in all shapes and sizes, so each vehicle operator's field of direct vision is going to be a little different — as will the distance at which they can first see a child from the front or passenger side of the vehicle.

Provided next is a do-it-yourself method which gives measurements and direct vision ratings tailored to individual drivers and the vehicles they operate.

Measuring Your Fleet

We've captured measurements for some of your fleet — and you have the power to measure the rest on your own! This method can also help vehicle operators individually understand what visibility looks like when they're in the driver's seat.

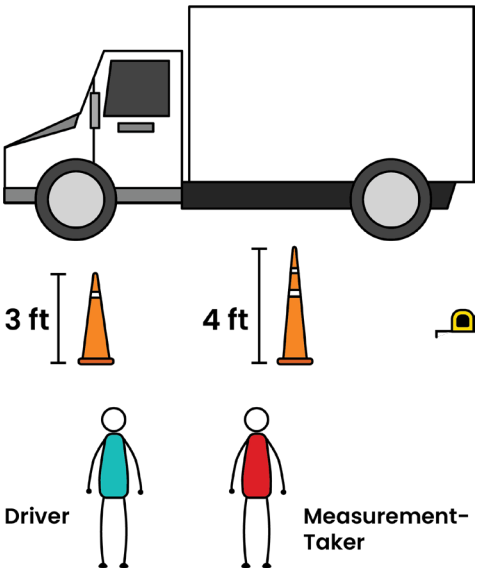
The instructions on the following pages will guide you step-by-step through how to assess your own fleet vehicles.



Measuring Your Fleet: the Cone Method

What You'll Need:

- The vehicle you are measuring
- A 3-foot cone
- A 4-foot cone
- Measuring tape
- Two people:
  - A person to sit in the driver's seat (preferably the vehicle operator!)
  - A person to take the measurements and move the cones



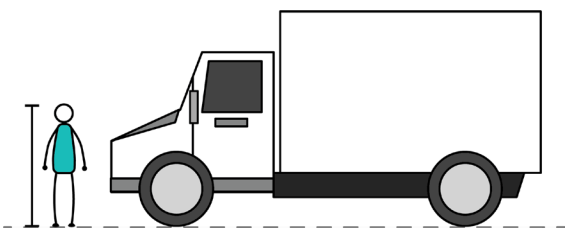
Measurement Card*

Visual Guide**

Feel free to check out the resources put together by Together for Safer Fleets to help you take direct vision measurements of vehicles in your fleet!

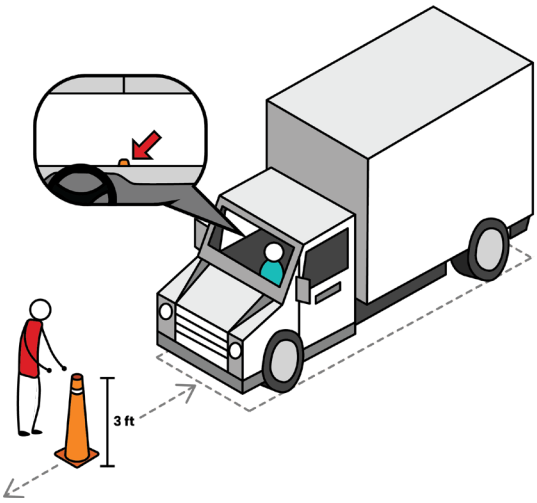
* https://tinyurl.com/tsr-dv-measurement-card
** https://tinyurl.com/tsr-dv-rating-guide

Instructions

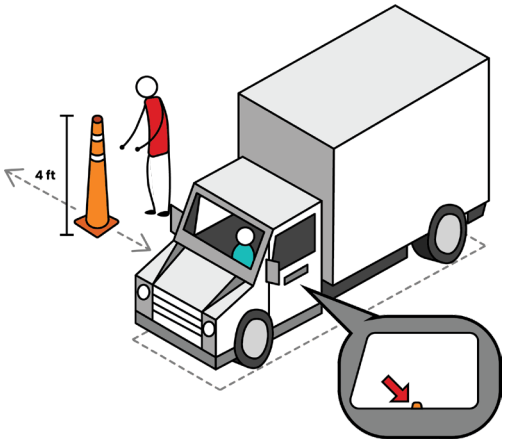


1. Park the vehicle in a reasonably flat area.
2. Take the height measurement of the driver.
3. Seat the driver in the vehicle with the seat in their normal operating position.

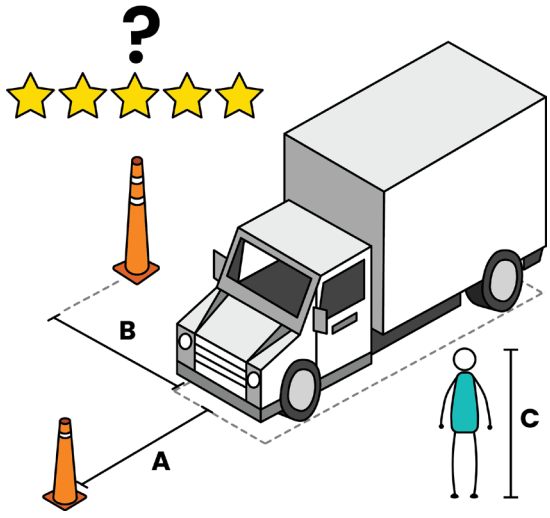
continued ⟶



4. Align the 3-foot cone with the center of the front bumper of the vehicle and place it on the ground directly in front of the truck.
5. Move the cone away from the vehicle in a straight line until the person sitting in the driver's seat can just barely see the cone. Record the distance in feet from the cone to the front bumper of the vehicle.



6. Align the 4-foot cone with the center of the passenger door and place it on the ground directly next to the vehicle.
7. Move the cone away from the vehicle in a straight line until the person sitting in the driver's seat can just barely see the cone. Record the distance in feet from the cone to the passenger side door of the vehicle.



You're done! Check to see where each of the measurements rank on the 5-star Direct Vision scales!*

* Driver height measurement (C) is for your reference, not a rating!

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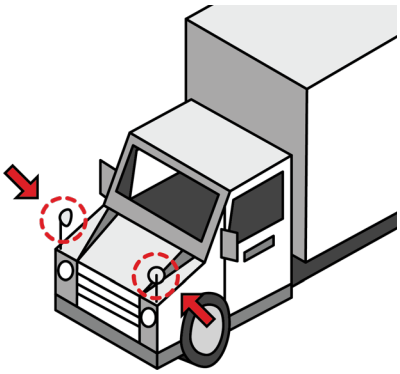
Now What? (continued)

Supplementing with Indirect Vision & Side Guards

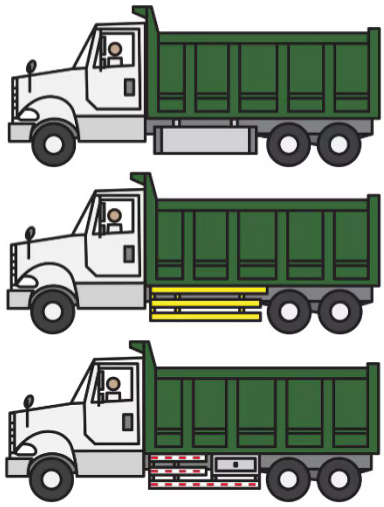
Although having a vehicle with high direct vision is ideal, it is not always feasible in the near-term to replace low direct vision vehicles. There are a number of aftermarket add-ons that can help improve visibility and reduce the blind zone of the vehicle, some of which you may already have equipped in your fleet. These include:

- Cross-over Mirrors
- Back-up or Surround Cameras
- Back-up Sensors, Pedestrian Turn Warnings, White-Noise Back Up Alarms
- Blind Spot Information Systems (BSIS) and Moving Off Information Systems (MOIS)
- Lateral Protective Devices (LPDs) - Side Guards and Toolboxes

You know your fleet best! We recommend taking stock of which vehicles in your fleet have add-ons supplementing their visibility with indirect vision, and where the blind zones still exist. **If a vehicle in your fleet rates below two stars for either front or passenger direct vision, we strongly recommend addressing those vehicles.**



Cross-over Mirrors



Different kinds of LPDs

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Recommendations from the Study

There are a few takeaways from the direct vision study that we hope you'll keep in mind as you evaluate direct vision in your fleet, and moving forward as you replace or add vehicles in your fleet.

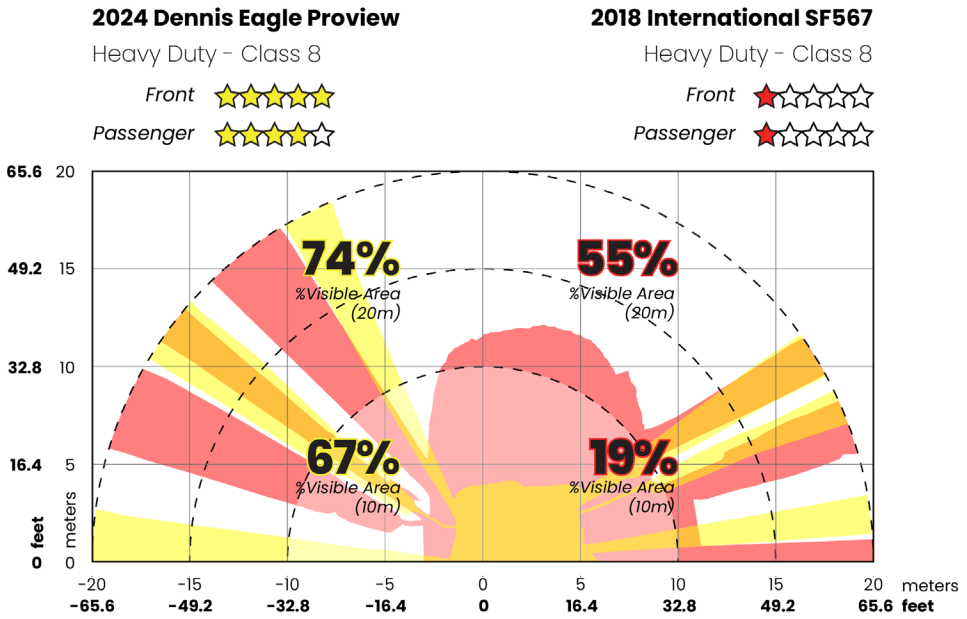
Downsizing

Can a smaller vehicle be used for the same job? Smaller vehicles are one of the most sure-fire ways to improve direct vision in vehicles. Of the vehicles measured in our study, the majority of light and medium class vehicles have front and passenger direct vision ratings of at least 3-stars. On the other hand, only 6 out 22 heavy-duty vehicles we measured had a front direct vision rating of 3-stars or above, and only 2 out of 22 heavy-duty vehicles we measured had a passenger direct vision rating of 3-stars or above.

Weight Class	% of Vehicles with a Front Direct Vision Rating of 3+ Stars	% of Vehicles with a Passenger Direct Vision Rating of 3+ Stars
Light	87.5% *(7/8 vehicles)*	100% *(8/8 vehicles)*
Medium	70% *(14/20 vehicles)*	70% *(14/20 vehicles)*
Heavy	27% *(6/22 vehicles)*	9% *(2/22 vehicles)*

Cab-forward or Cab-Over > Conventional

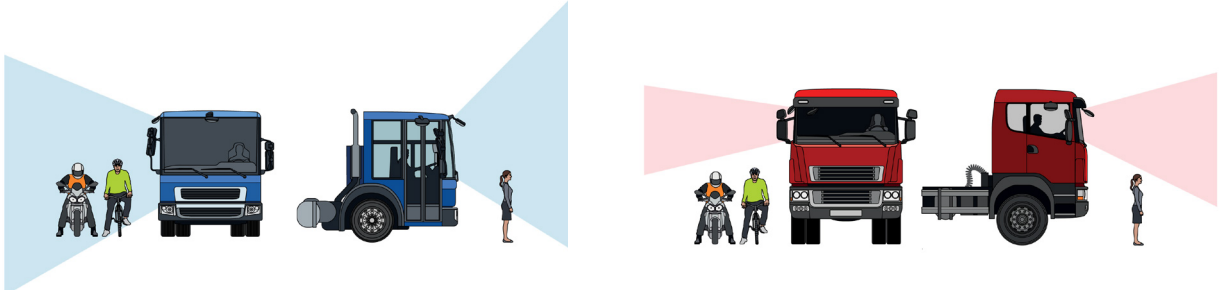
Cab-forward and cab-over vehicles consistently have better direct vision than conventional vehicles. They also make the truck cab more maneuverable than those of conventional vehicles.



The Dennis Eagle Proview is a cab-forward truck model, while the International SF567 is a conventional truck model. Both the star ratings are significantly better for the cab-forward model, and there is much more visible area in both the 10m and 20m radius.

Lower Ride Height and Cab Entry

Having a lower ride height and cab entry is another way to increase direct vision. It is also easier on drivers who might need to constantly enter and exit the vehicle on the job.



LEFT : Low ride height vehice and driver vision. RIGHT : High ride height vehicle and driver vision. Images from Transport for London's Direct Vision Standard: Guidance for Operators.

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Additional Resources

Commonwealth of Massachusetts Direct Vision Study

This is the study done in collaboration with US DOT Volpe Center that your fleet information contributed to. It couldn't have been completed without you!

https://tinyurl.com/MA-dv-study

City of Boston Direct Vision Study

This was the first study in Massachusetts with US DOT Volpe Center that investigates direct vision. It took its measurements from the City of Boston municipal fleet.

https://rosap.ntl.bts.gov/view/dot/68730

Optimizing Large Vehicles for Urban Environments

US DOT Volpe Center Studies

Learn more about the differences in safety (or lack thereof) between cab-overs and conventional trucks in Appendix B of the 'Downsizing' report.

https://nacto.org/optimizing-large-vehicles/

Exploring the Road Safety Benefits of Direct vs Indirect Vision in Heavy Goods Vehicle (HGV) Cabs

Transport for London Study

A study investigating benefits of direct vision over indirect vision.

https://tinyurl.com/tfl-direct-vs-indirect

The Lab @ MassDOT Direct Vision

Landing page for the Direct Vision project at The Lab @ MassDOT. Find more information and resources regarding our work on direct vision in large vehicles here.

https://www.mass.gov/info-details/direct-vision-study

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Notes

(From page 2)

[1] The reference height of an elementary school child is the 5th percentile shoulder height of a seven-year-old female (37 inches). Standard distances at an intersection were used, based on the Federal Highway Administration guidance on distances between stop lines and crosswalks. This guidance calls for a minimum of 4 feet between the stop line and a crosswalk, and a crosswalk that is at least 6 feet in width.

[2] The reference height used for an adult cyclist is based on the 5th percentile shoulder height of a female adult (47 inches), and the reference height used for a child cyclist is based on the 5th percentile shoulder height of a seven-year-old female (35 inches). Bike lane dimensions used are those recommended by the MassDOT Separated Bike Lane Planning & Design Guide. This guide recommends that a separated bike lane has a painted buffer that is at least two feet wide and a lane that is at least five feet wide.

(From page 3)

[3] In our study, the driver's eyepoint refers to the field of vision of a driver who is 5ft. 9in. tall (50th percentile male height). A more in-depth explanation of the methodology behind these images can be found in Section 2 of the Commonwealth of Massachusetts Direct Vision Study.