

Contract Deliverable to the Center for Disease Control and
Prevention

Contract 200-2002-00563

“Construction Vehicle and Equipment Blind Area Diagrams”

Caterpillar Inc.

Final Report

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June 2, 2003

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Introduction

Recent studies have confirmed that highway and street construction workers are at a significant risk of fatal and serious nonfatal injuries while working in and around a street/highway construction jobsite. The hazard has been clearly defined as the “risk of injury from movement of construction vehicles and equipment within the work zones, as well as from passing motor vehicle traffic.” In analyzing the data collected on fatalities and serious nonfatal injuries occurring from 1992-1998 researchers from the National Institute for Occupational Safety and Health (NIOSH) have concluded that traffic control devices and jobsite management techniques alone will not completely eliminate the risks to workers. Furthermore, collision occurrences have been attributed in part to limited visibility around the equipment. Therefore, new technology is needed to help detect the presence of people in the direct path of construction equipment and then warn the operator of the impending collision.

In order to better help direct the development of the new technology, it is important to understand where current visibility limitations are around typical construction equipment. With this information, researchers can better perform worker exposure assessments across the different types and makes of construction equipment. Worker exposure data can then be used to help select the appropriate technologies such as radar systems, radio signal detection systems etc. that can help minimize the risk to workers.

The Center for Disease Control and Prevention awarded Caterpillar Inc. a contract to “obtain diagrams of the blind areas around 24 different vehicles or machines that are used in the construction industry” (Contract Award 200-2002-00563). This document is the draft final report for the contract and includes descriptions, pictures, and blind area diagrams for the vehicles and machines tested. Physical measurements were made for 20 of the machines and computer simulation was used for 4. The test procedures used are included as an appendix.

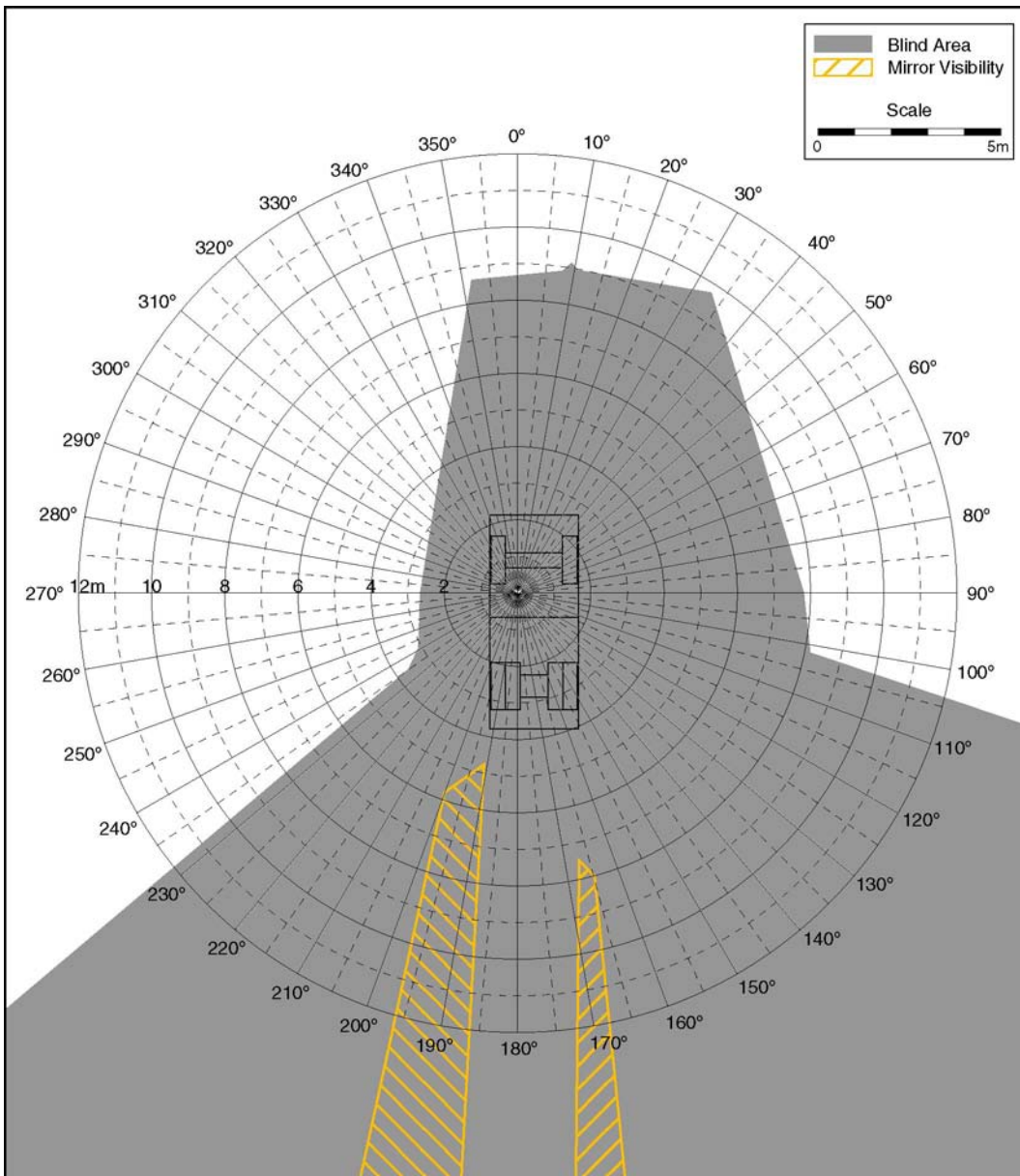
Blind Area Diagrams and Machine Descriptions

2-axle, front steer, rear dump trucks

GMC 7000
Sterling Acterra 7500
GMC 4500HD
GMC 3500HD

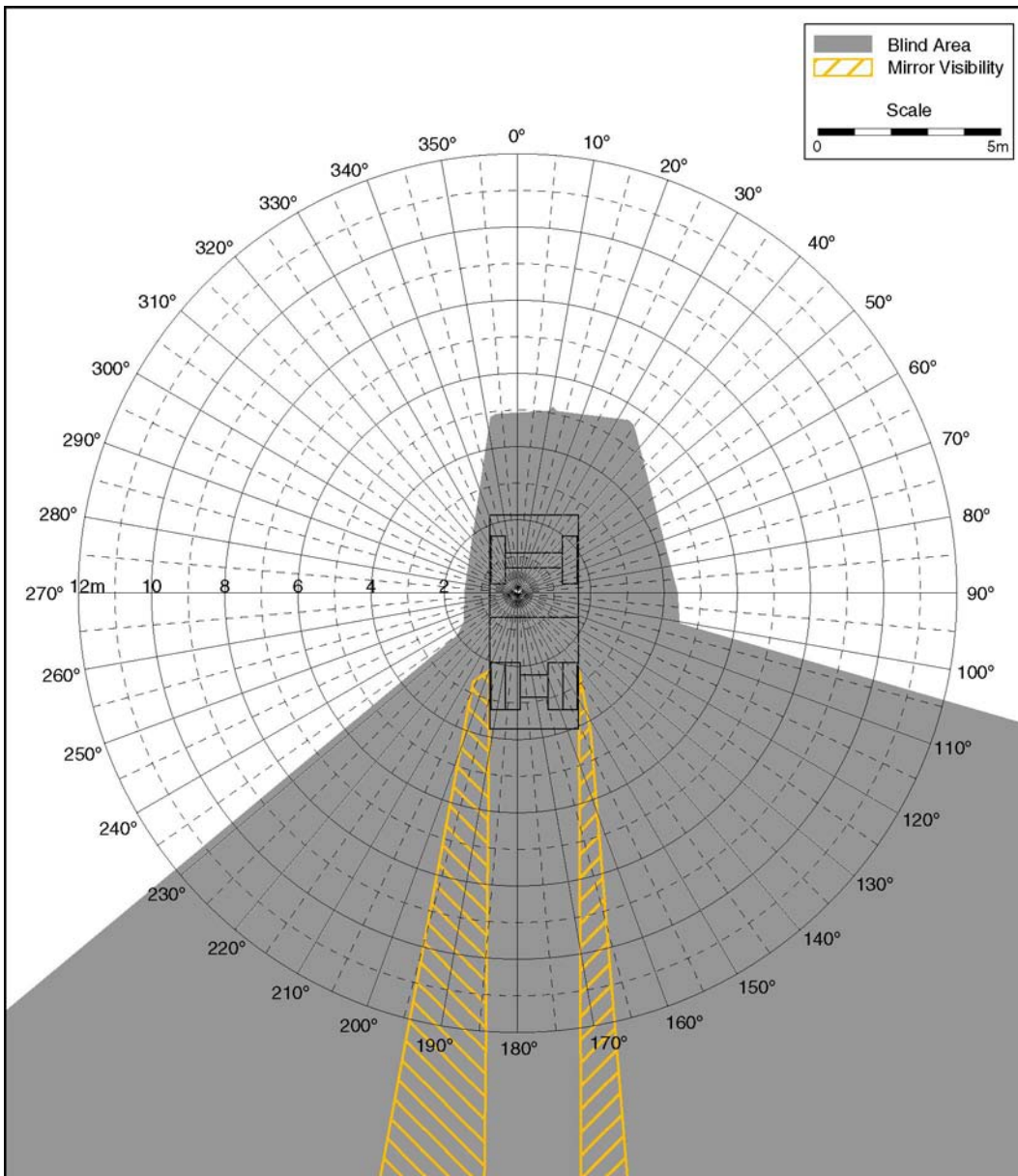
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	GMC 7000
GVW	28,000 lb
Serial #	1GDL7D1B7KV500643
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



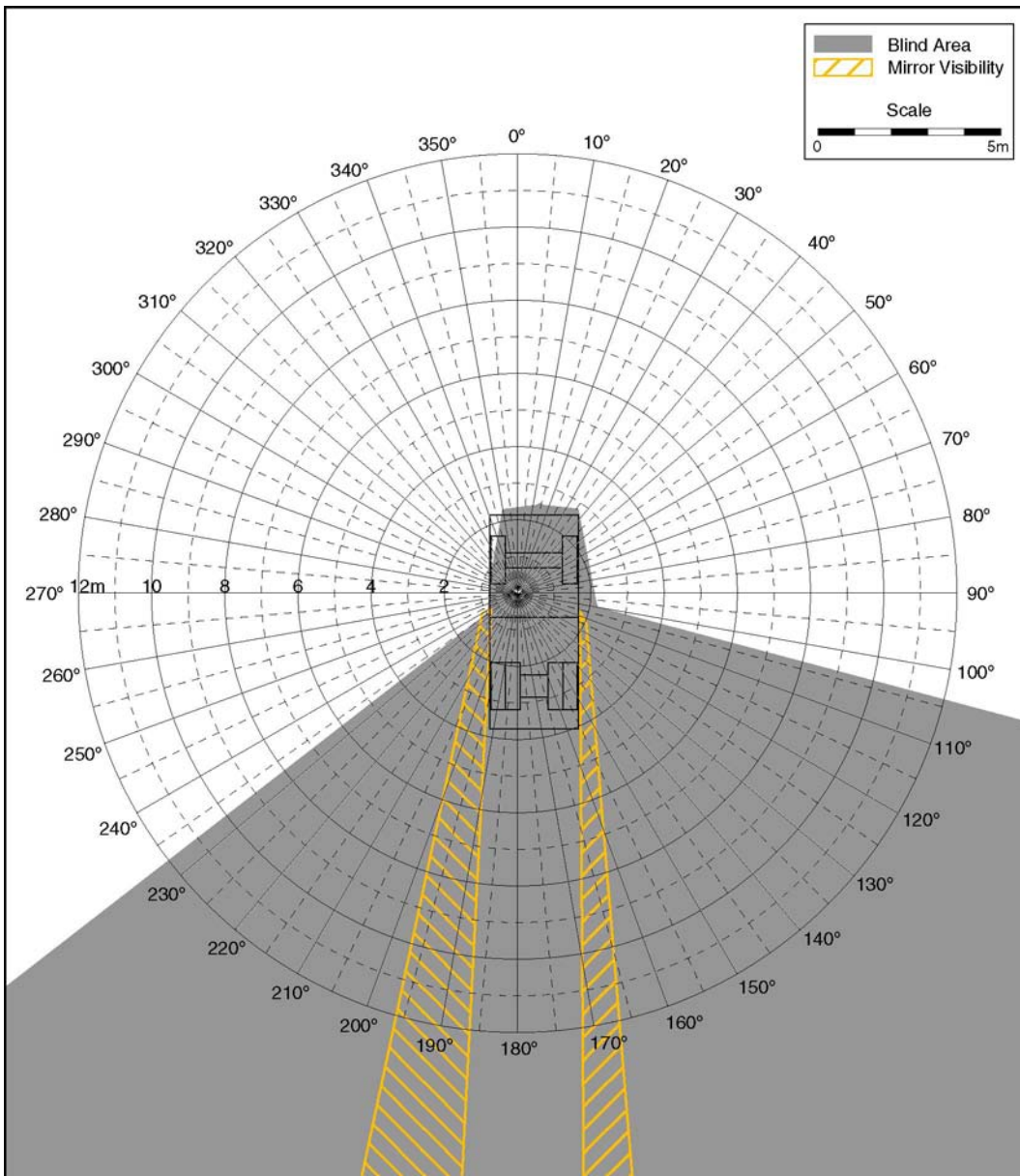
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	GMC 7000
GVW	28,000 lb
Serial #	1GDL7D1B7KV500643
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



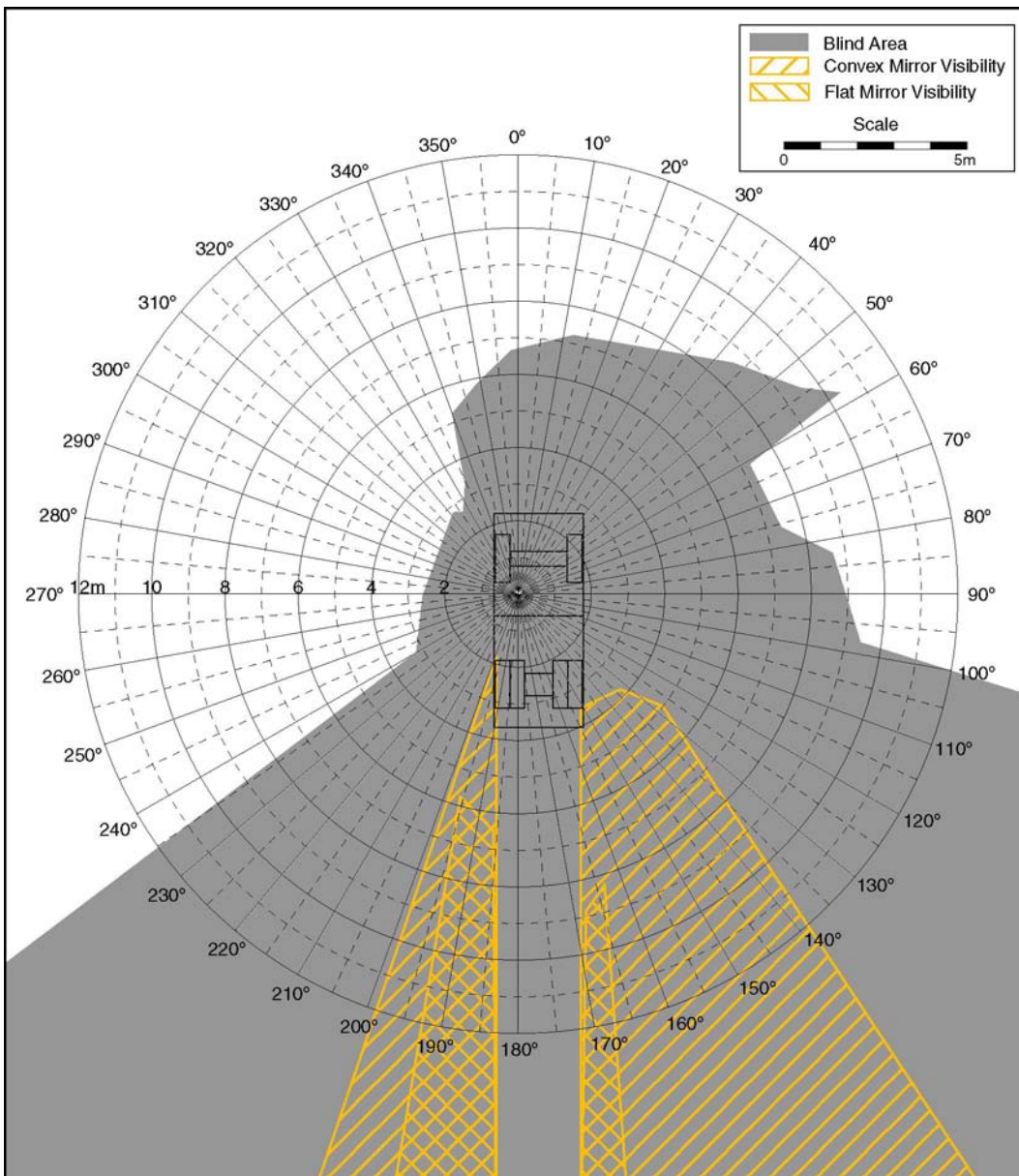
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	GMC 7000
GVW	28,000 lb
Serial #	1GDL7D1B7KV500643
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



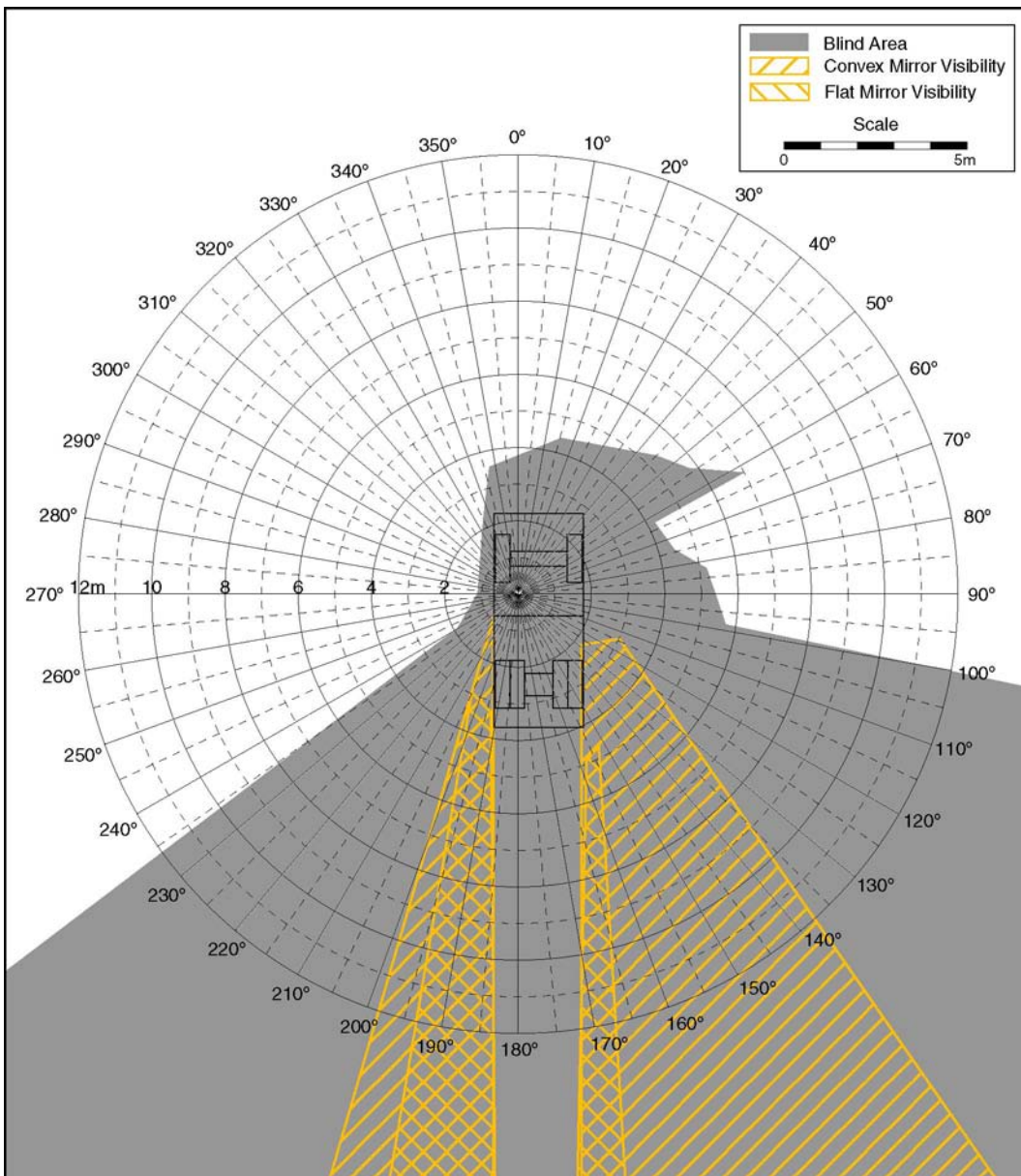
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	Sterling Acterra 7500
GVW	25,500 lb
Serial #	2FZAAHCTX1AH85404
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



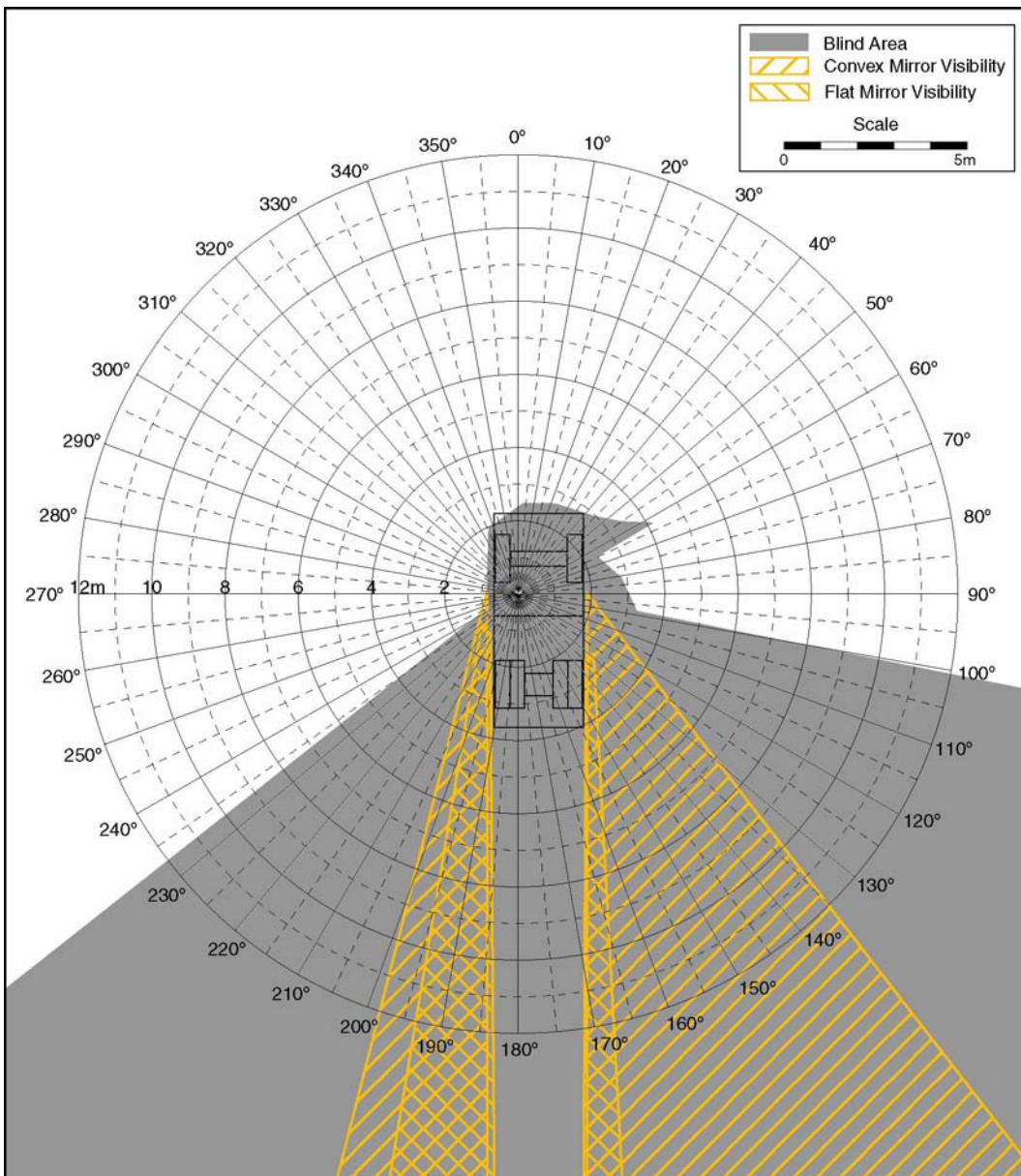
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	Sterling Acterra 7500
GVW	25,500 lb
Serial #	2FZAAHCTX1AH85404
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Attachments	None
Other Information	None
Measurement Technique	Physical



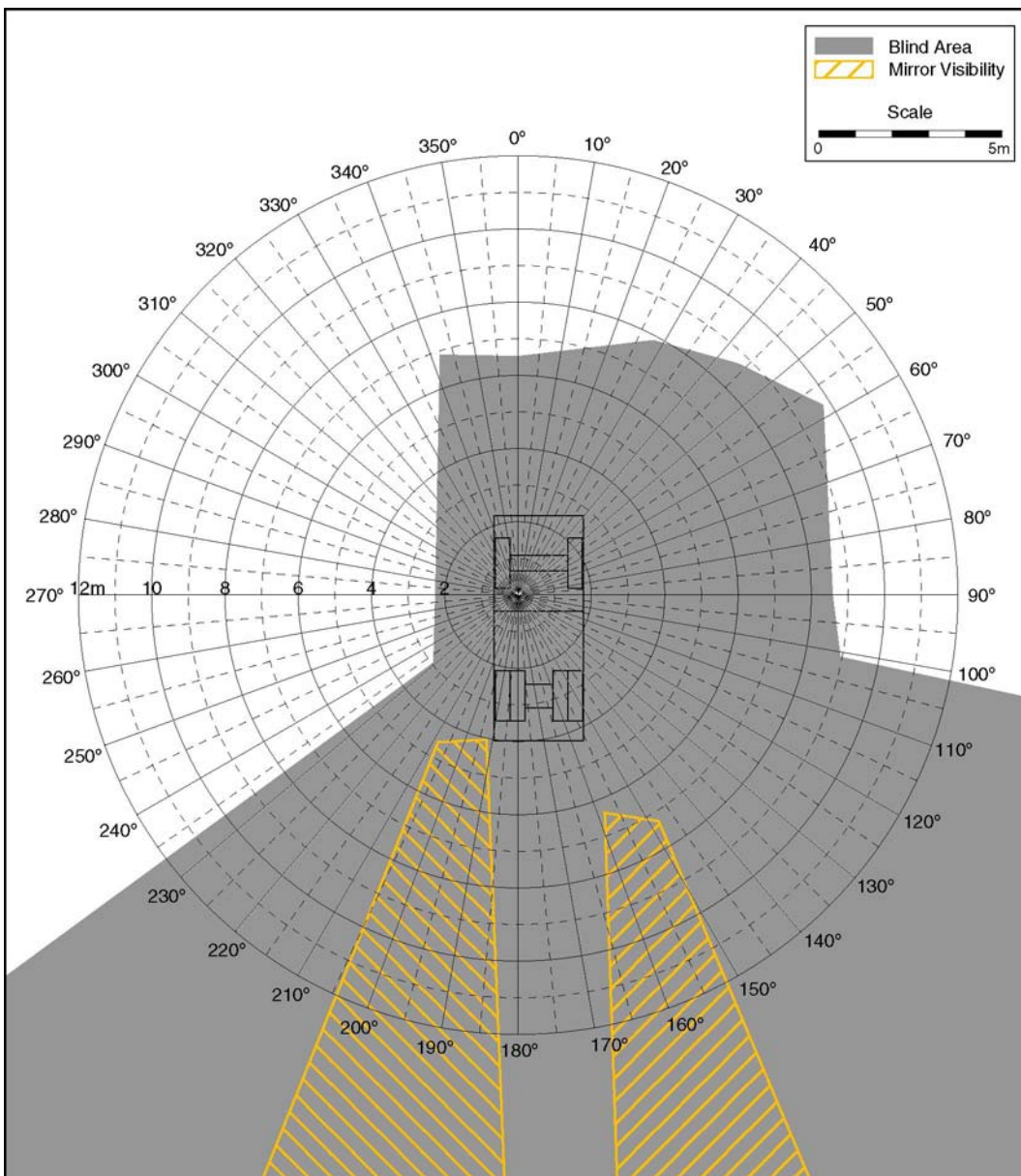
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	Sterling Acterra 7500
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Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



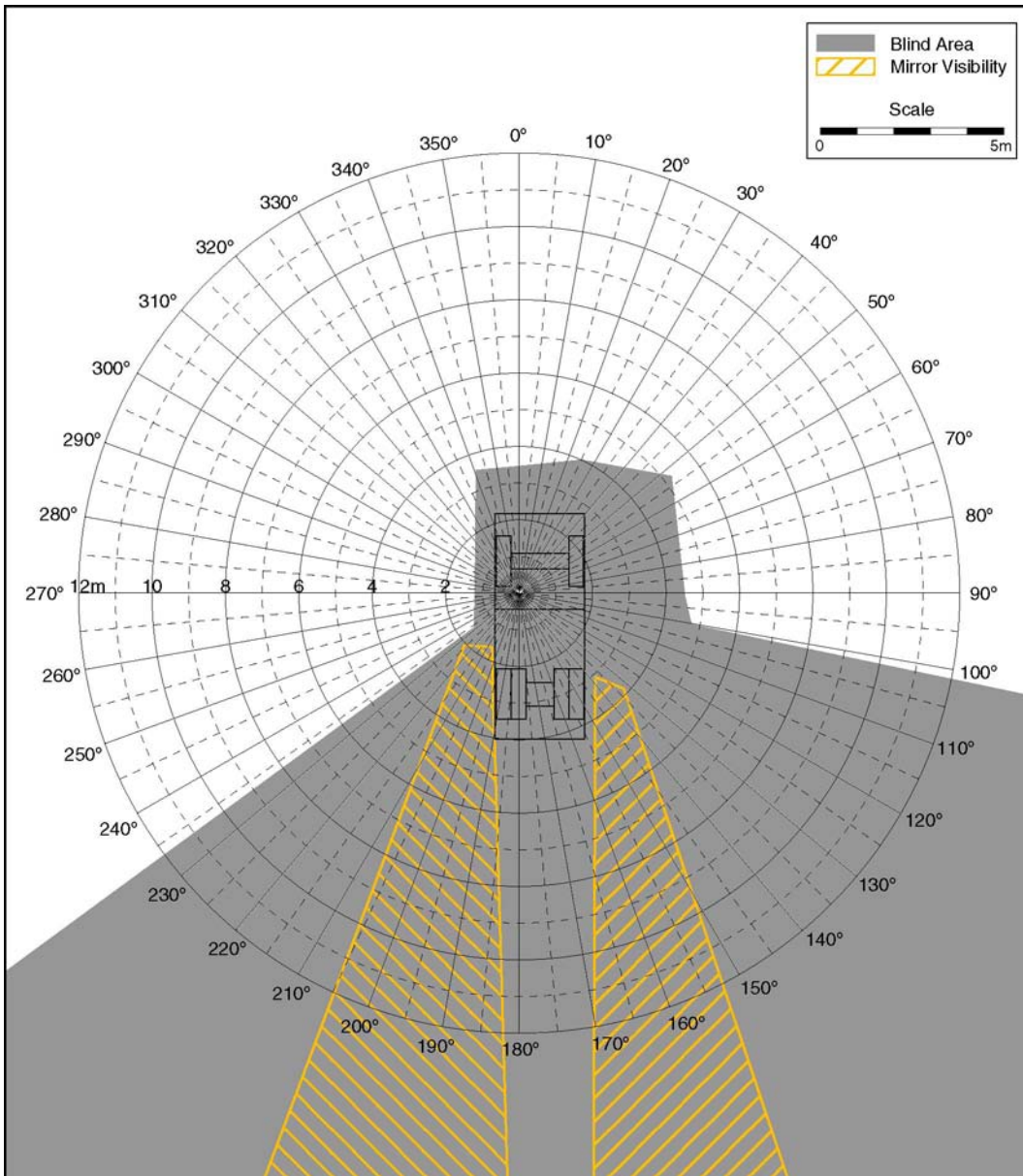
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	GMC 4500HD
GVW	16,000 lb
Serial #	1GBC4E1173F500877
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	Salt Spreader
Other Information	None
Measurement Technique	Physical



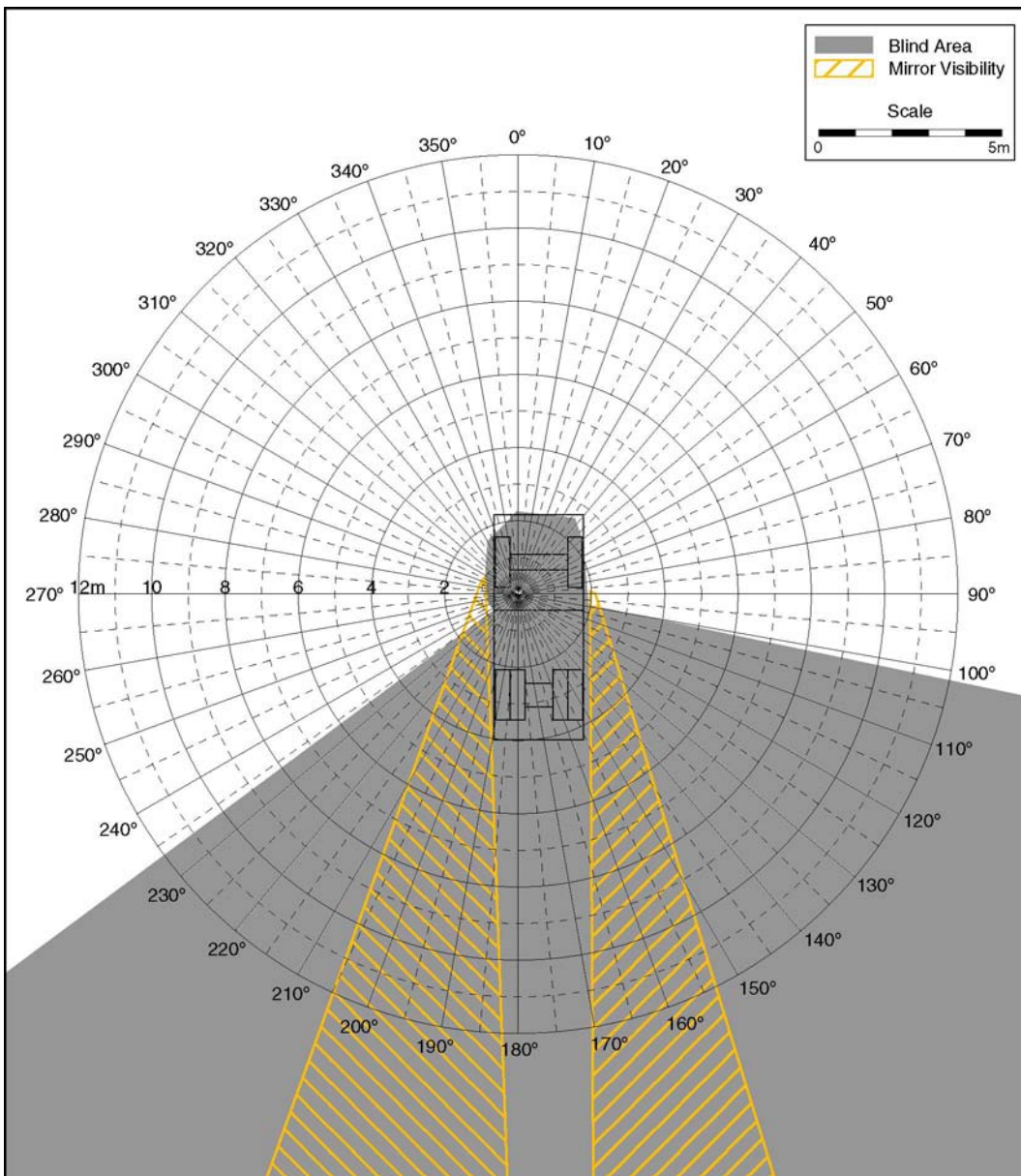
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	GMC 4500HD
GVW	16,000 lb
Serial #	1GBC4E1173F500877
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
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Other Information	None
Measurement Technique	Physical



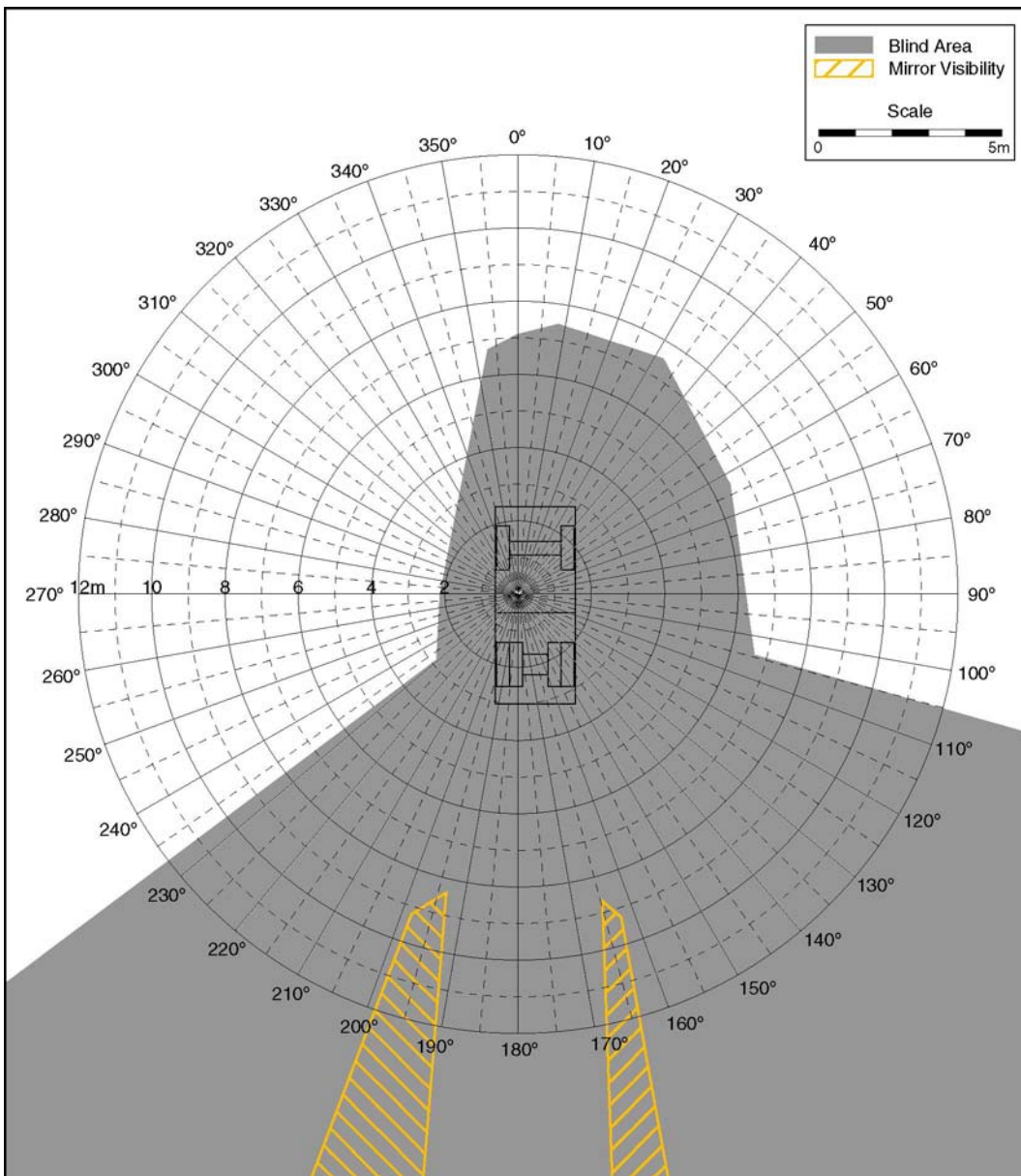
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	GMC 4500HD
GVW	16,000 lb
Serial #	1GBC4E1173F500877
Machine Dimensions	96" wide 230" long
Operator Enclosure	Closed ROPS
Attachments	Salt Spreader
Other Information	None
Measurement Technique	Physical



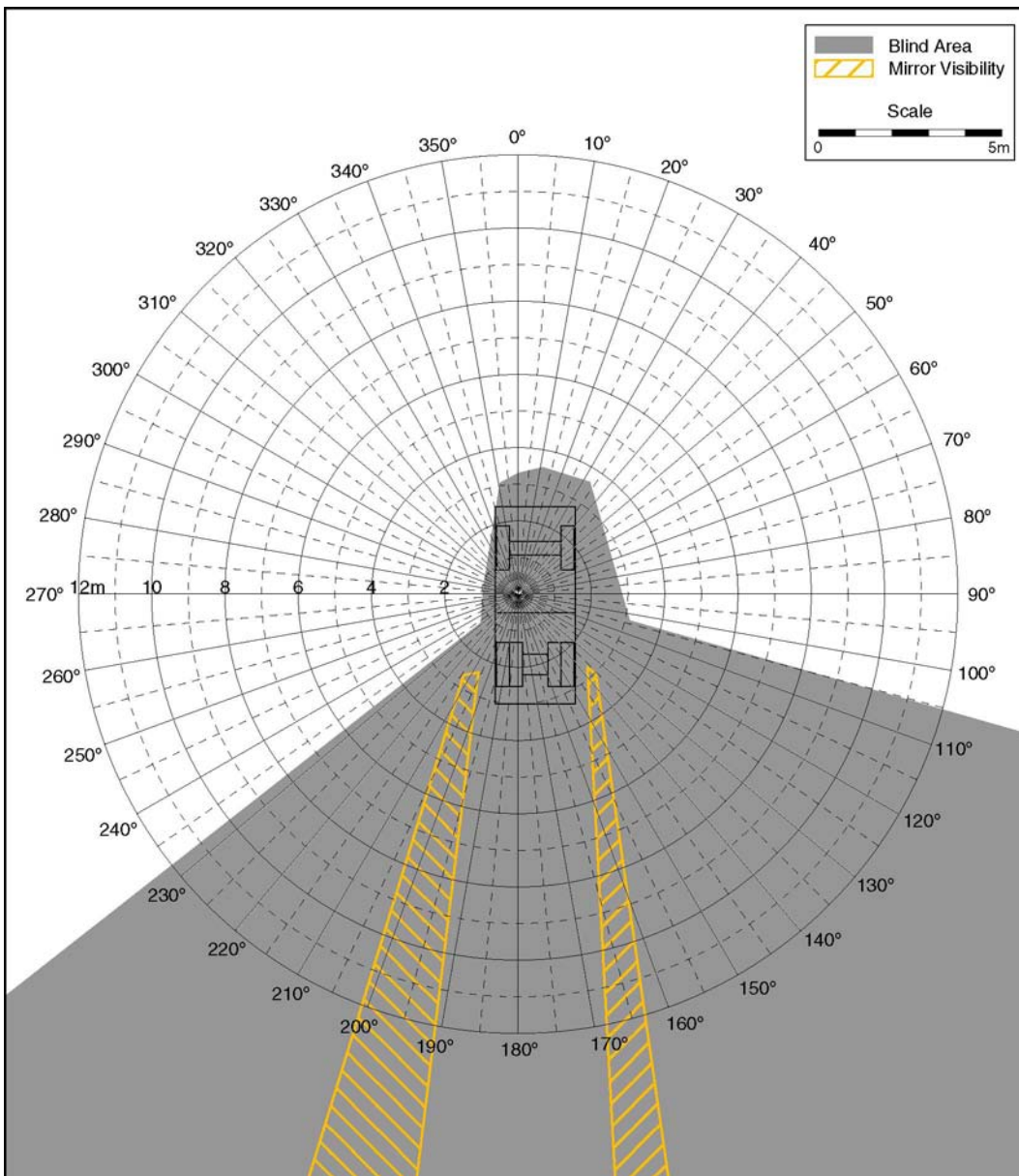
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	GMC 3500HD
GVW	15,000 lb
Serial #	3GBKC34G11M100295
Machine Dimensions	86" wide 212" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



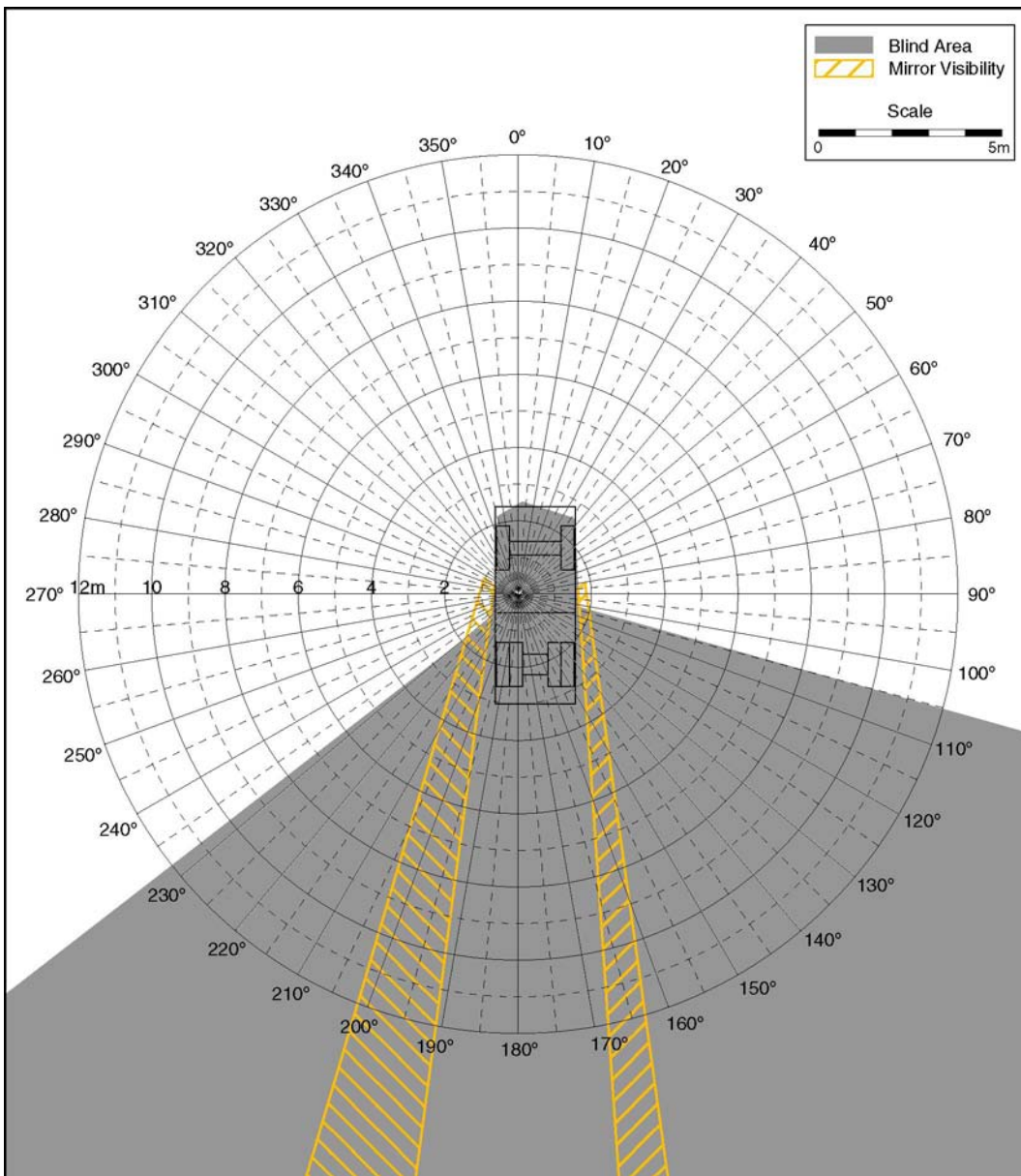
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	GMC 3500HD
GVW	15,000 lb
Serial #	3GBKC34G11M100295
Machine Dimensions	86" wide 212" long
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Attachments	None
Other Information	None
Measurement Technique	Physical



Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	GMC 3500HD
GVW	15,000 lb
Serial #	3GBKC34G11M100295
Machine Dimensions	86" wide 212" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical

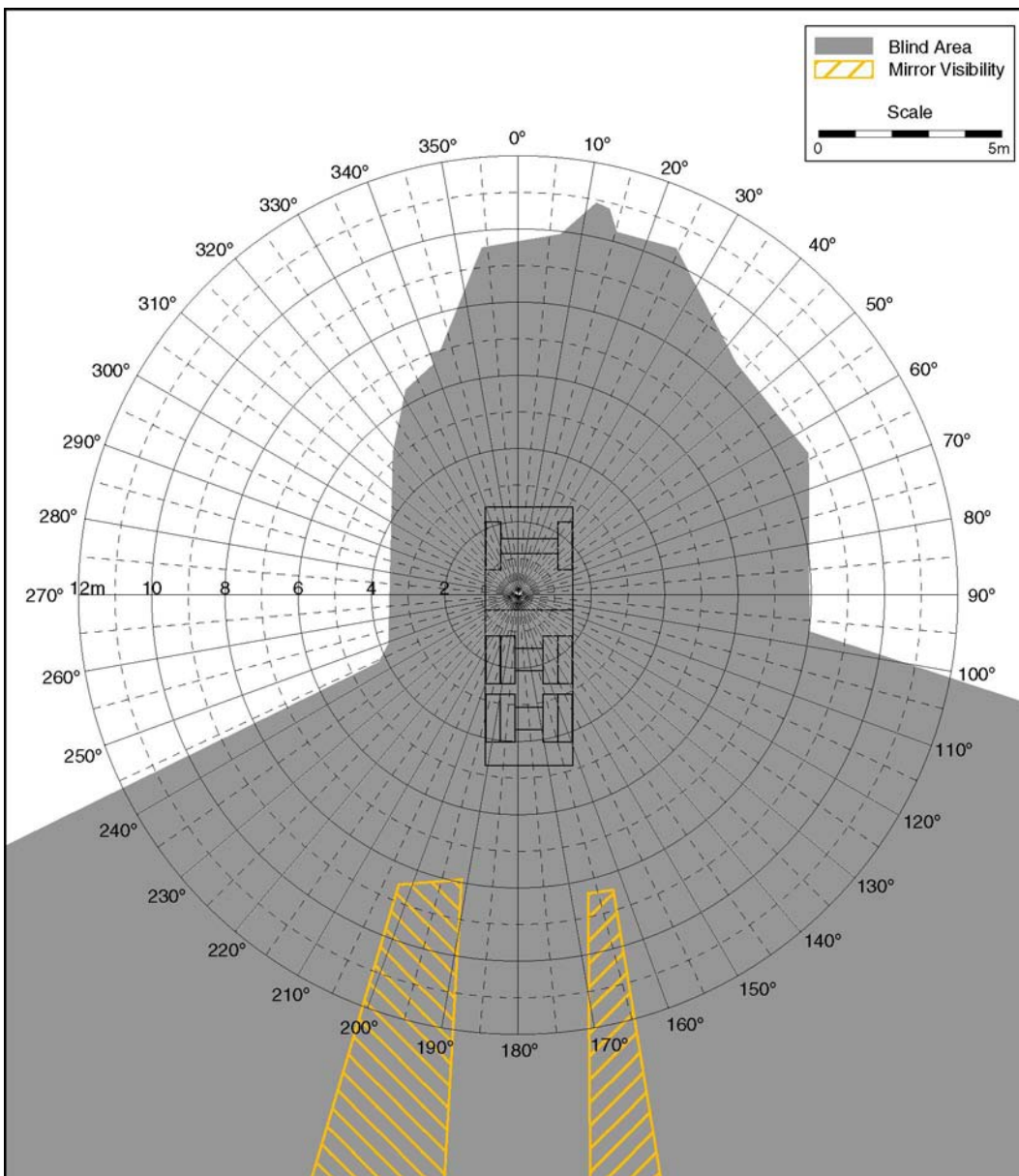


3-axle, front steer, rear dump trucks

Ford 880
Sterling LT7501
Sterling 9511
Ford LT9511

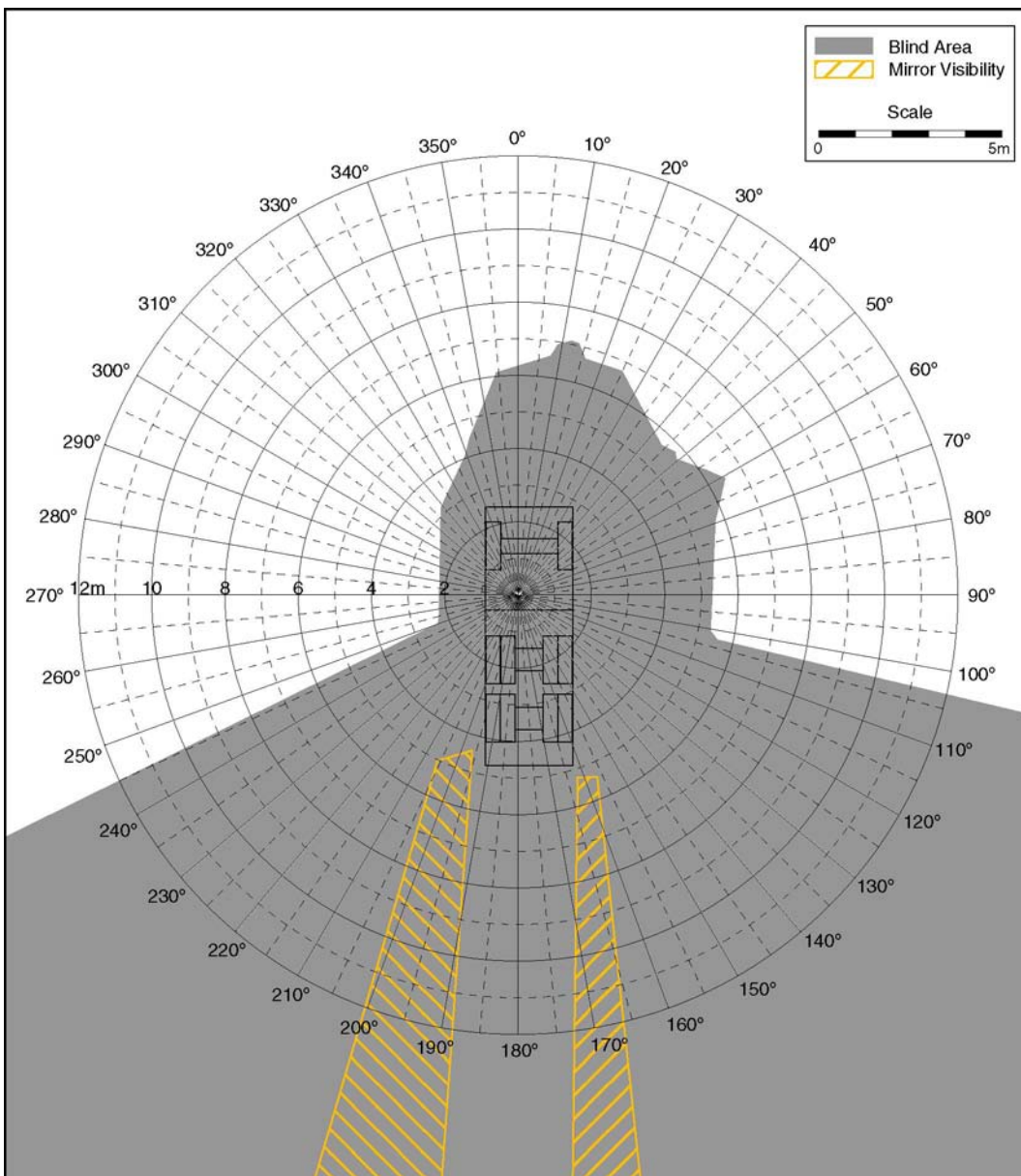
Blind Area Diagram for Construction Vehicle - Ground Plane

Dump Truck (Manufacturer and Model)	Ford 880
GVW	54,000 lb
Serial #	V00131
Machine Dimensions	7' 10" wide 23' 2" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



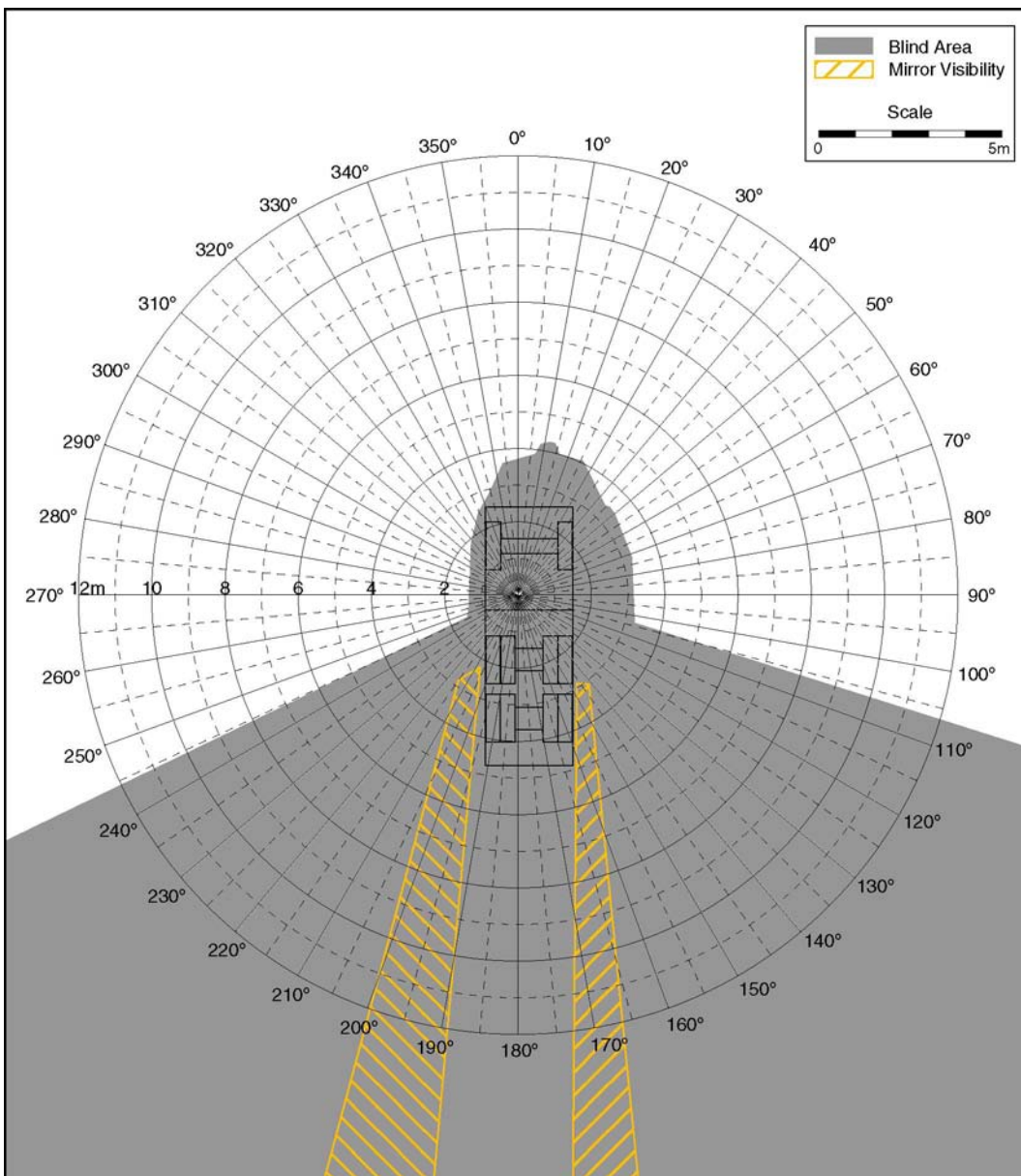
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	Ford 880
GVW	54,000 lb
Serial #	V00131
Machine Dimensions	7' 10" wide 23' 2" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



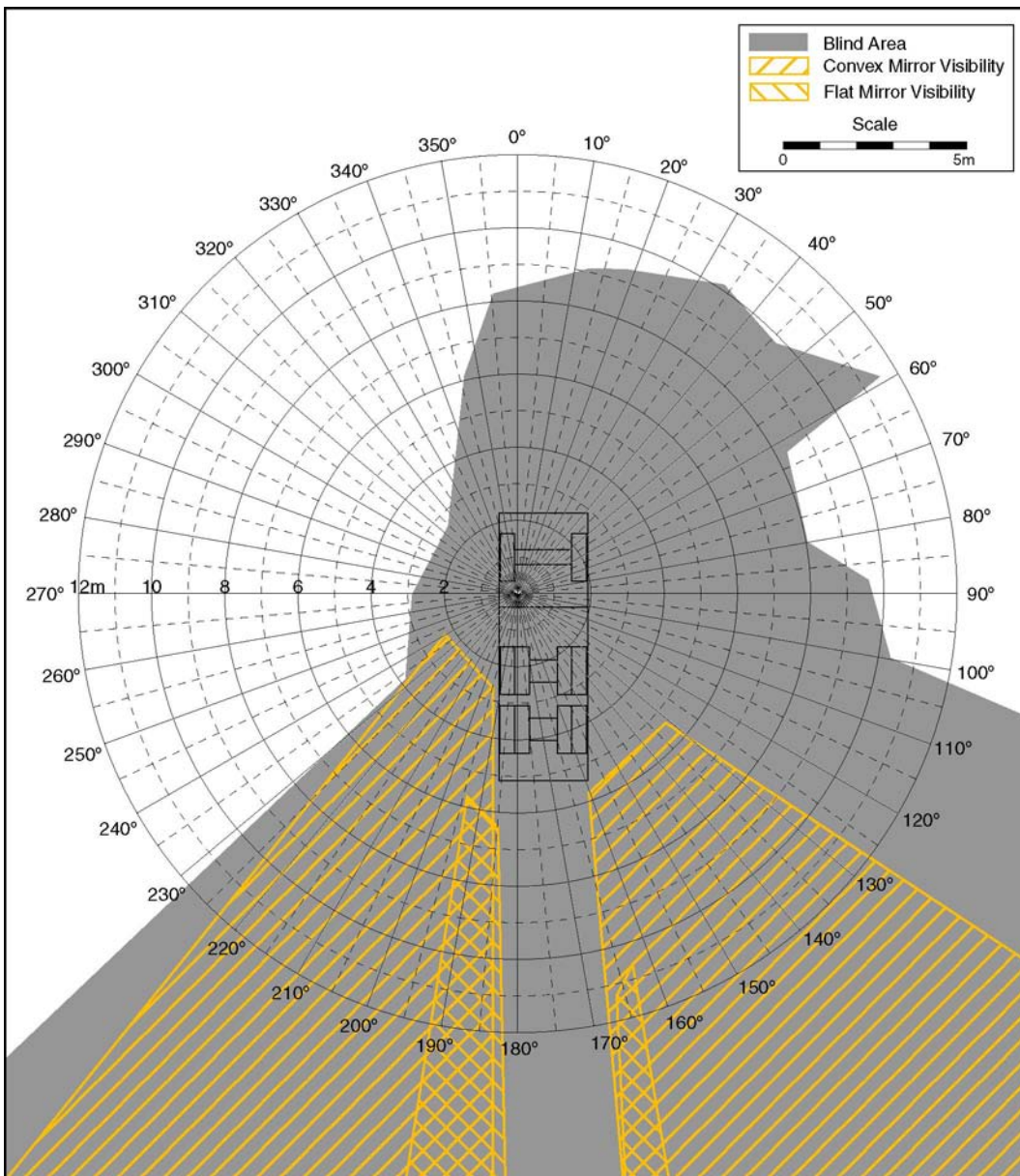
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	Ford 880
GVW	54,000 lb
Serial #	V00131
Machine Dimensions	7' 10" wide 23' 2" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



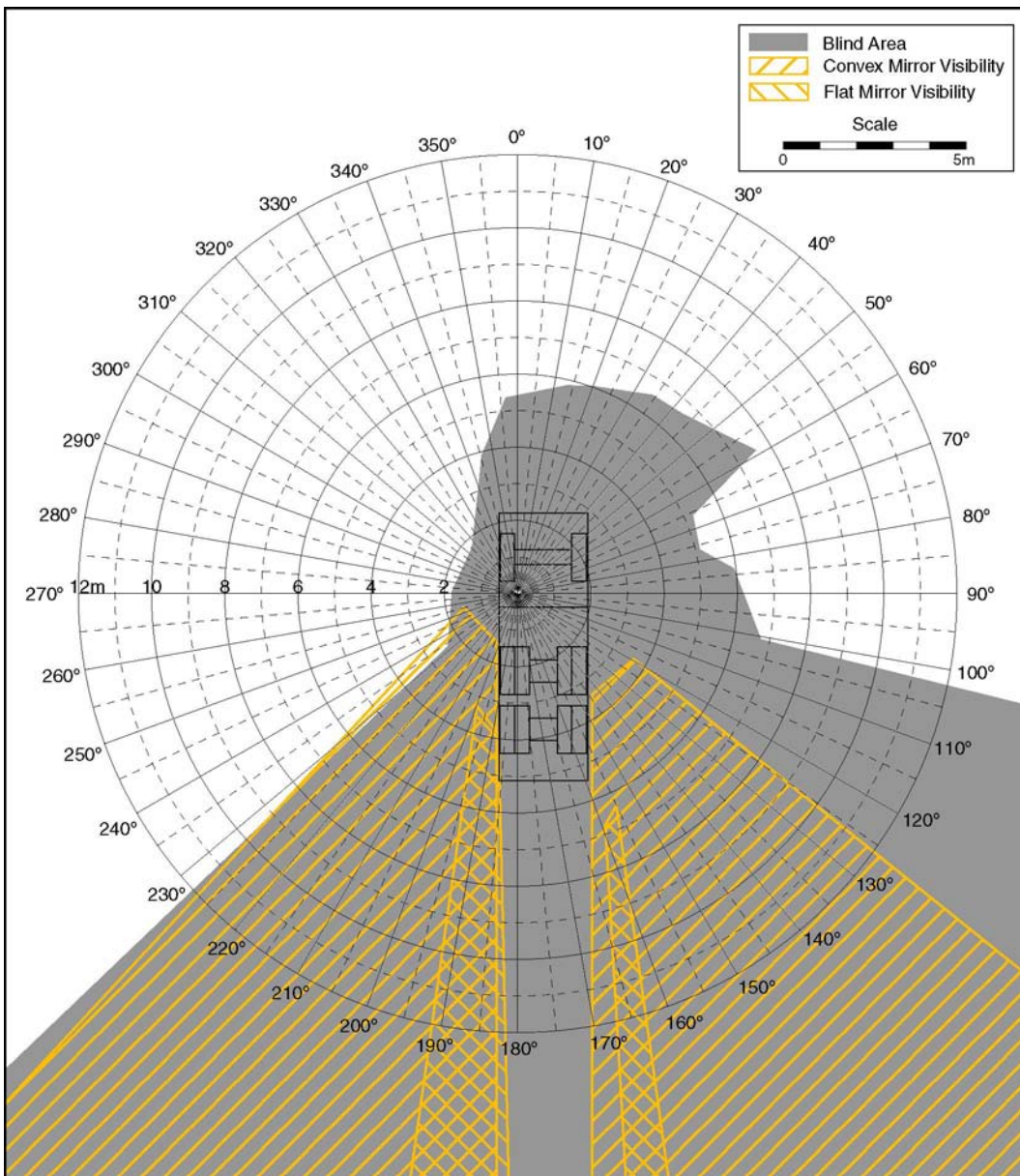
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	Sterling LT7501
GVW	58,000 lb
Serial #	2FZHATAK72AK12258
Machine Dimensions	96" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



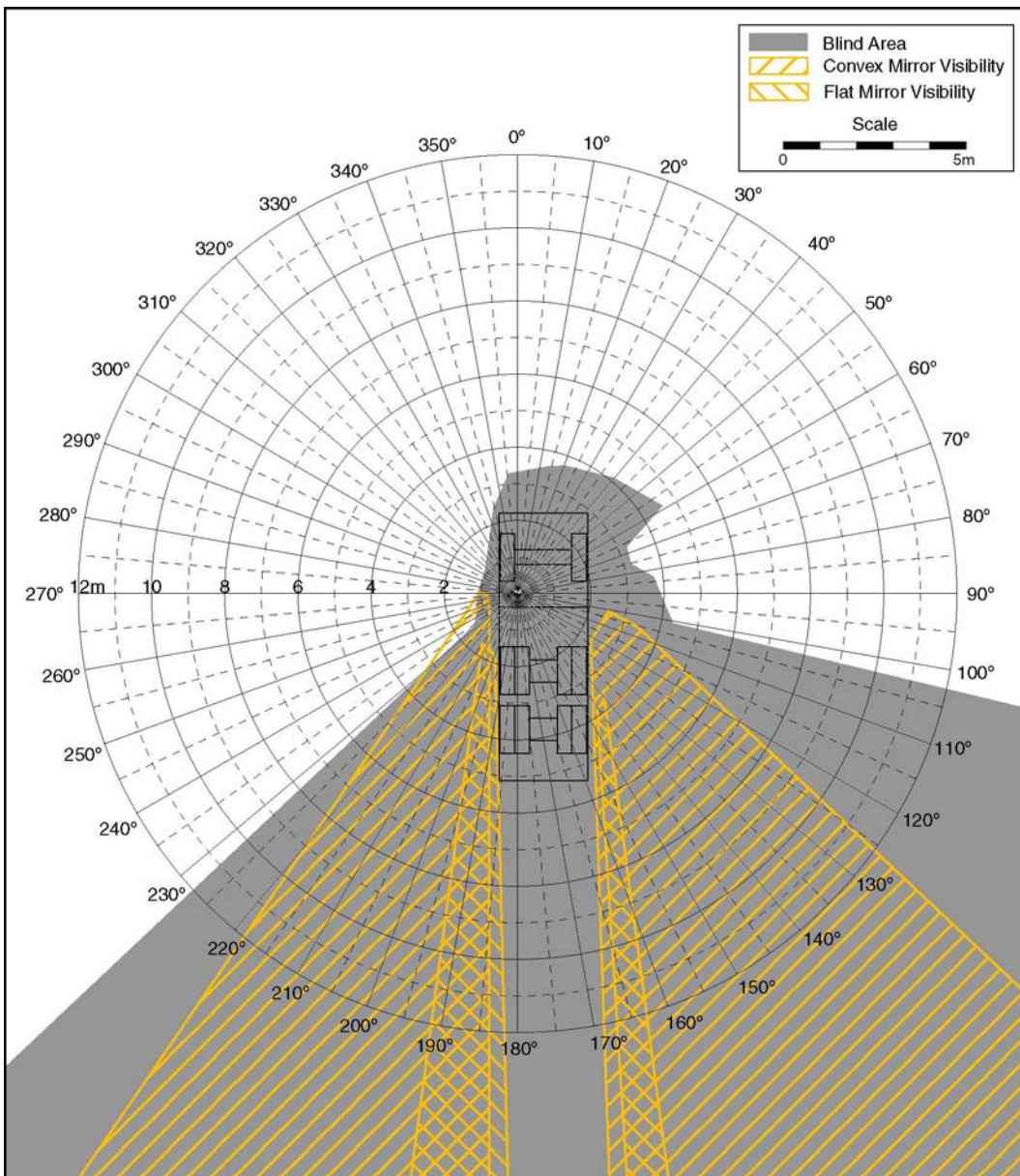
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	Sterling LT7501
GVW	58,000 lb
Serial #	2FZHATAK72AK12258
Machine Dimensions	96" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



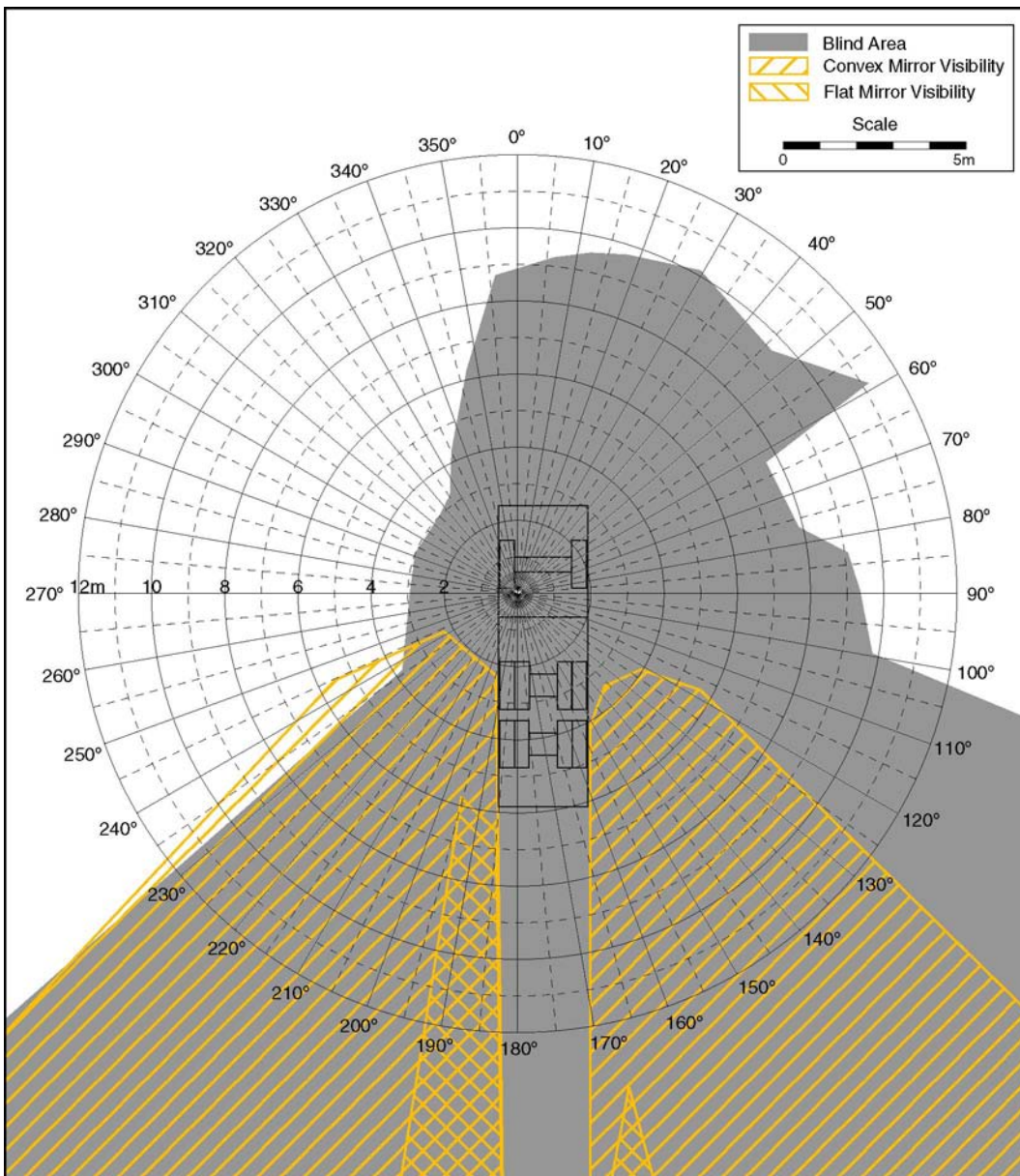
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	Sterling LT7501
GVW	58,000 lb
Serial #	2FZHATAK72AK12258
Machine Dimensions	96" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



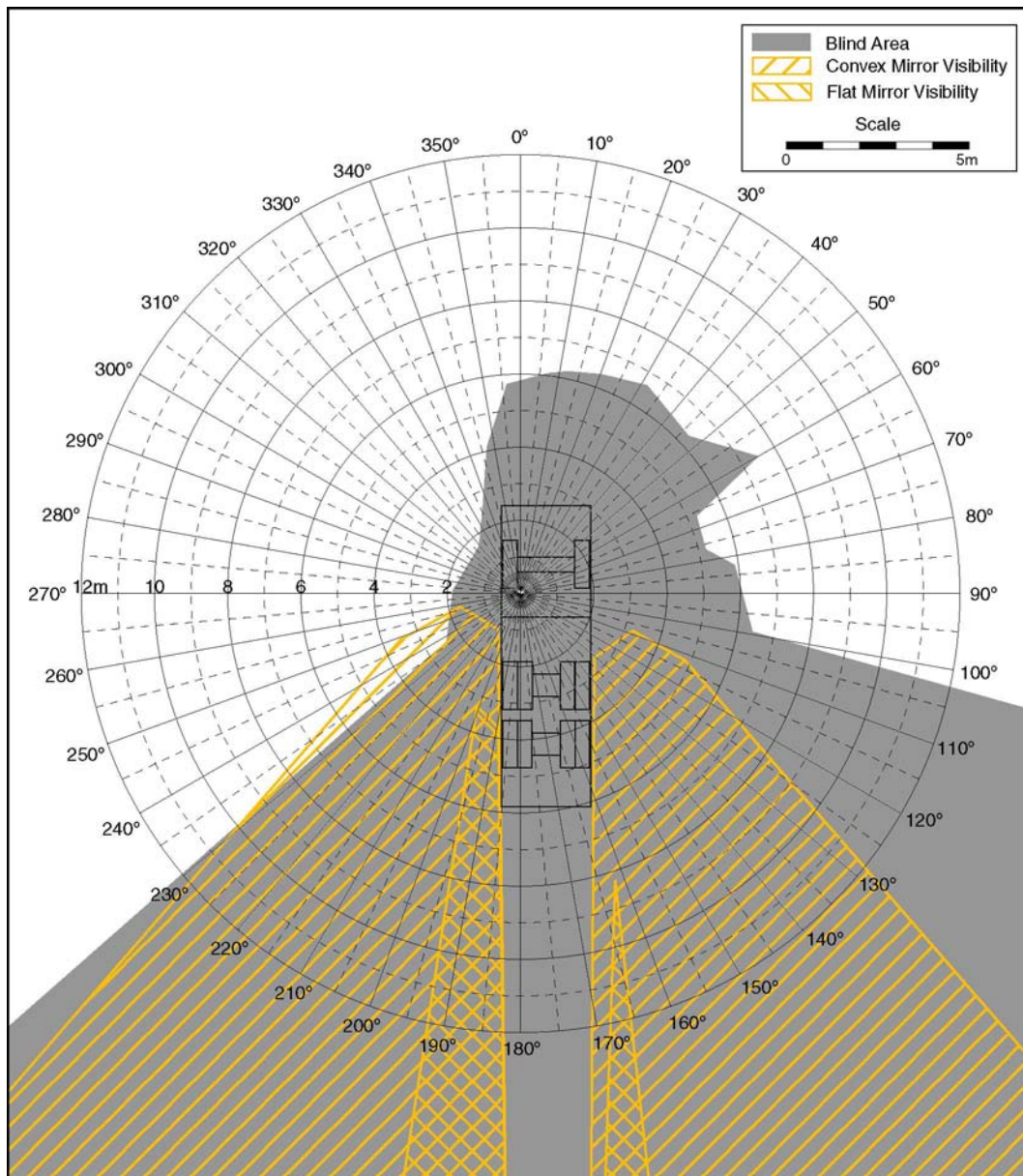
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	Sterling 9511
GVW	58,000 lb
Serial #	2FZNNWYB8XA982166
Machine Dimensions	96" wide 27' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



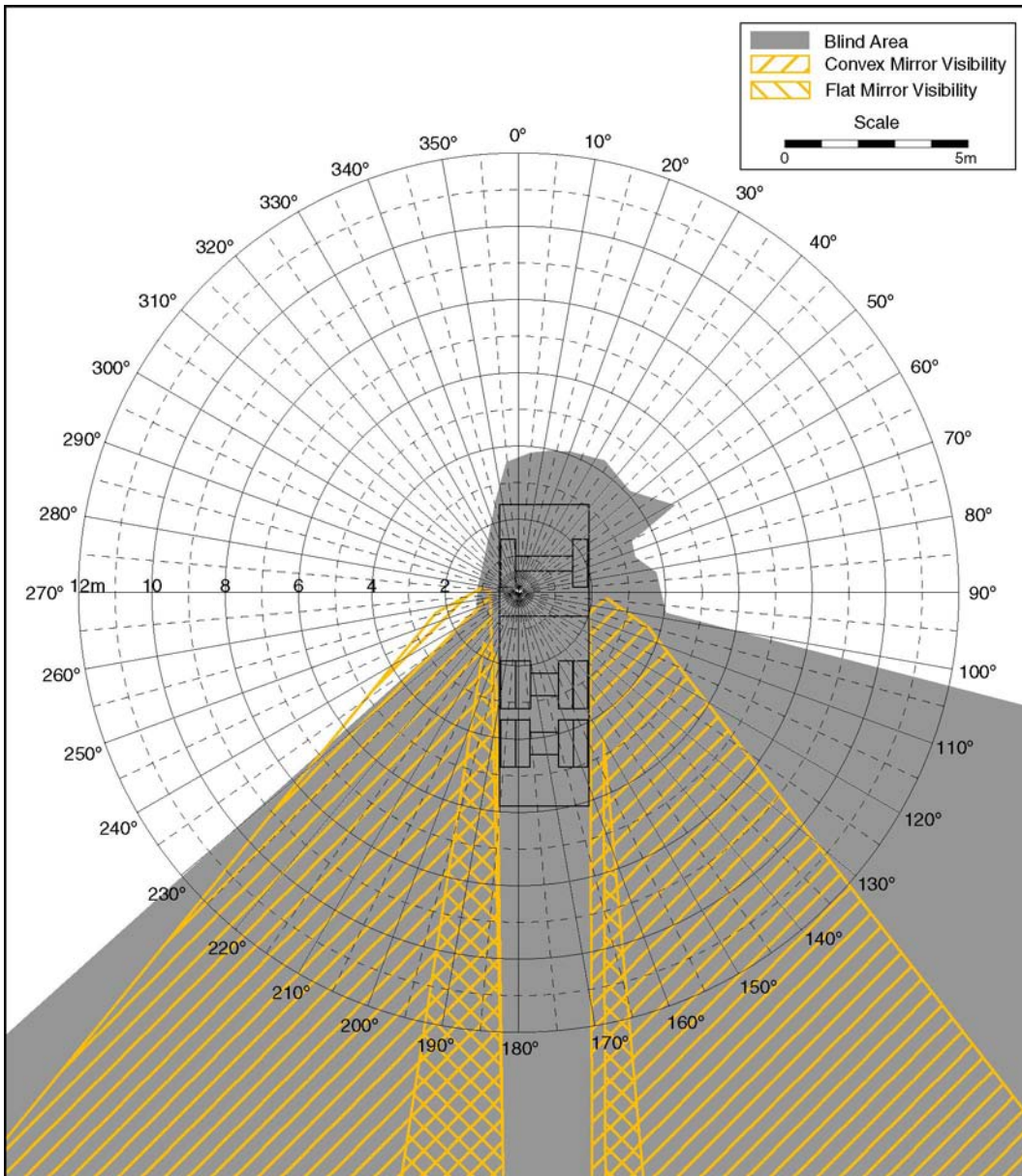
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	Sterling 9511
GVW	58,000 lb
Serial #	2FZNNWYB8XA982166
Machine Dimensions	96" wide 27' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



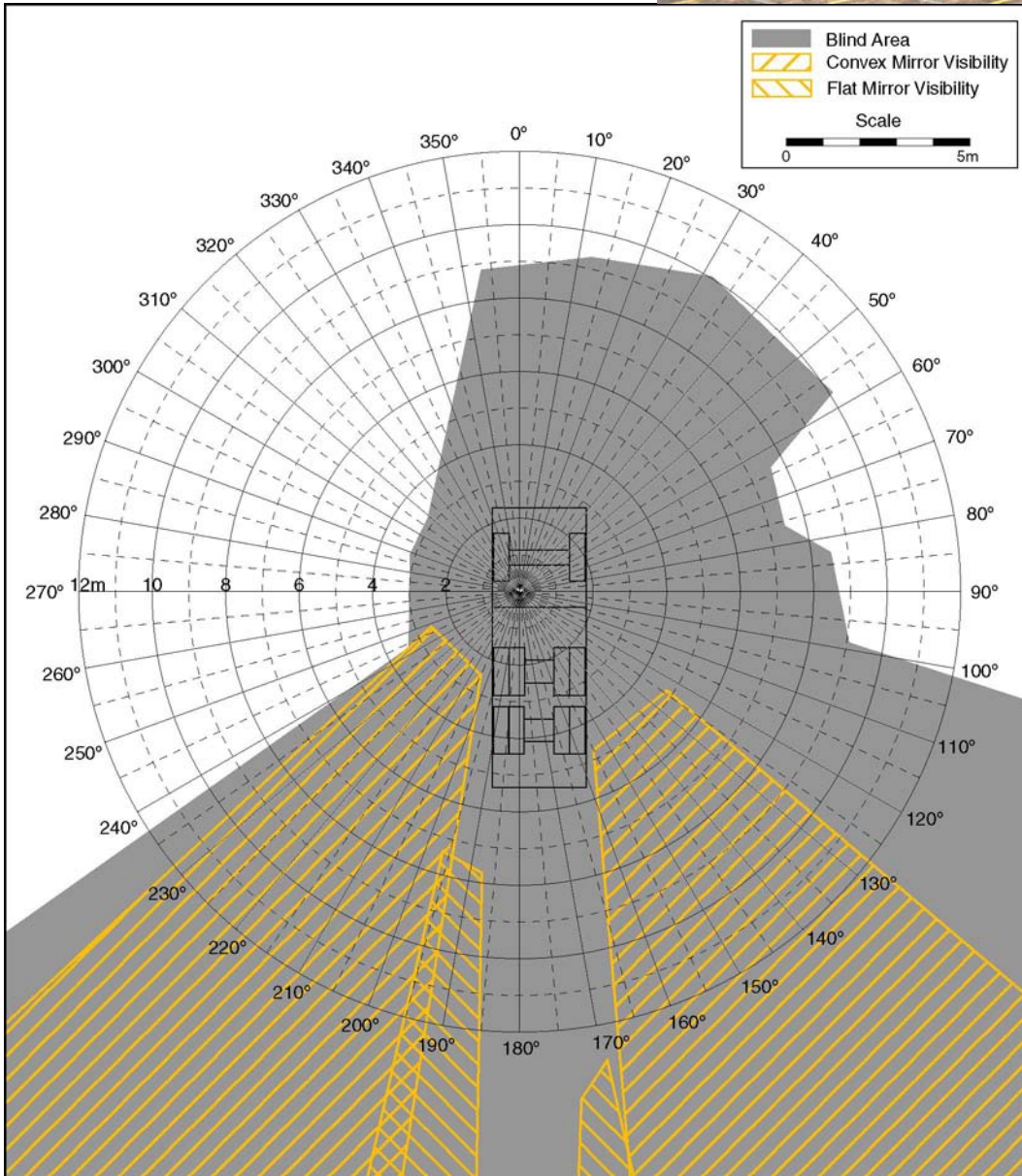
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	Sterling 9511
GVW	58,000 lb
Serial #	2FZNNWYB8XA982166
Machine Dimensions	96" wide 27' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



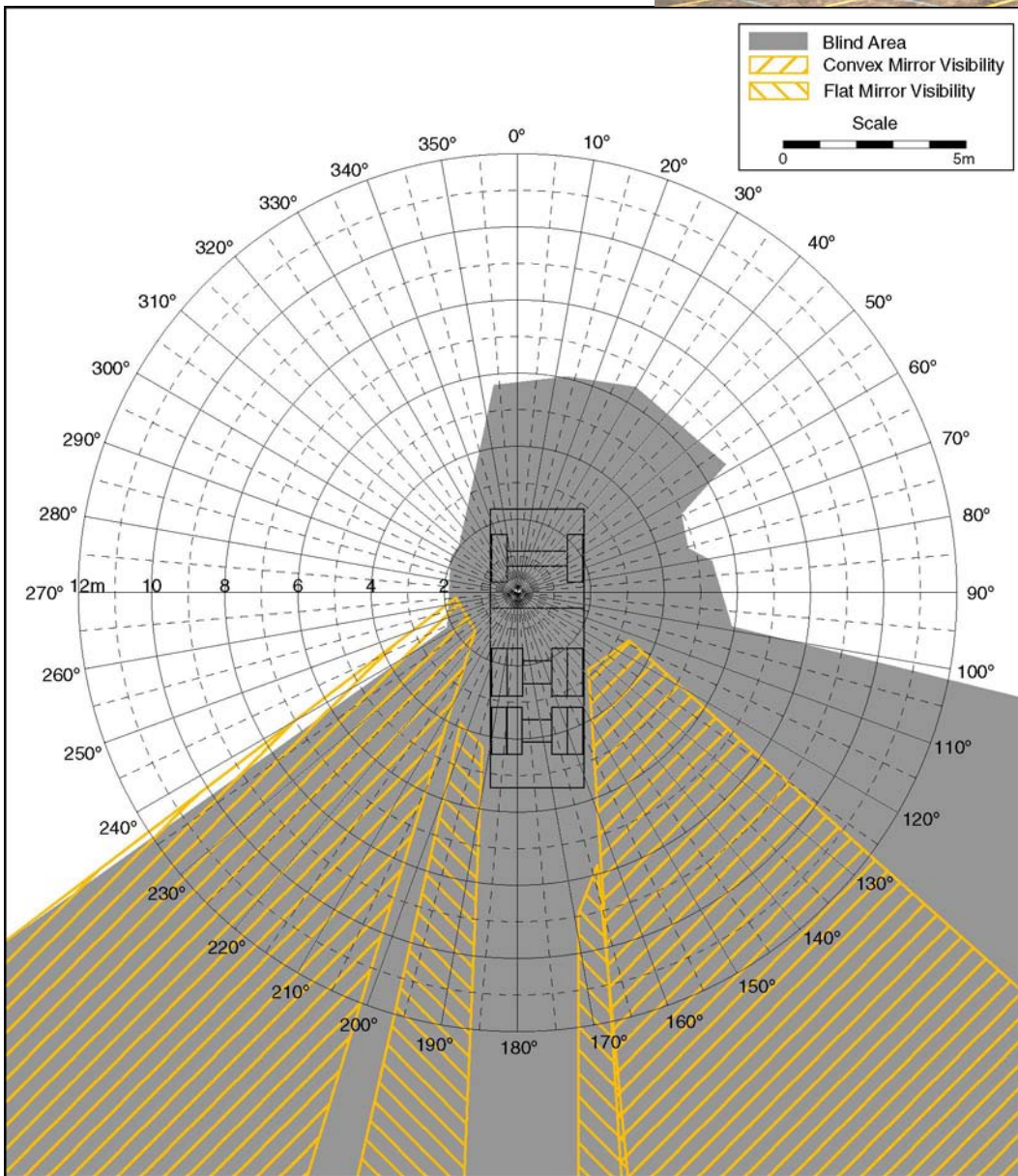
Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	Ford LT 9511
GVW	58,000 lb
Serial #	1FDZZ96KZWVA41330
Machine Dimensions	101" wide 25' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



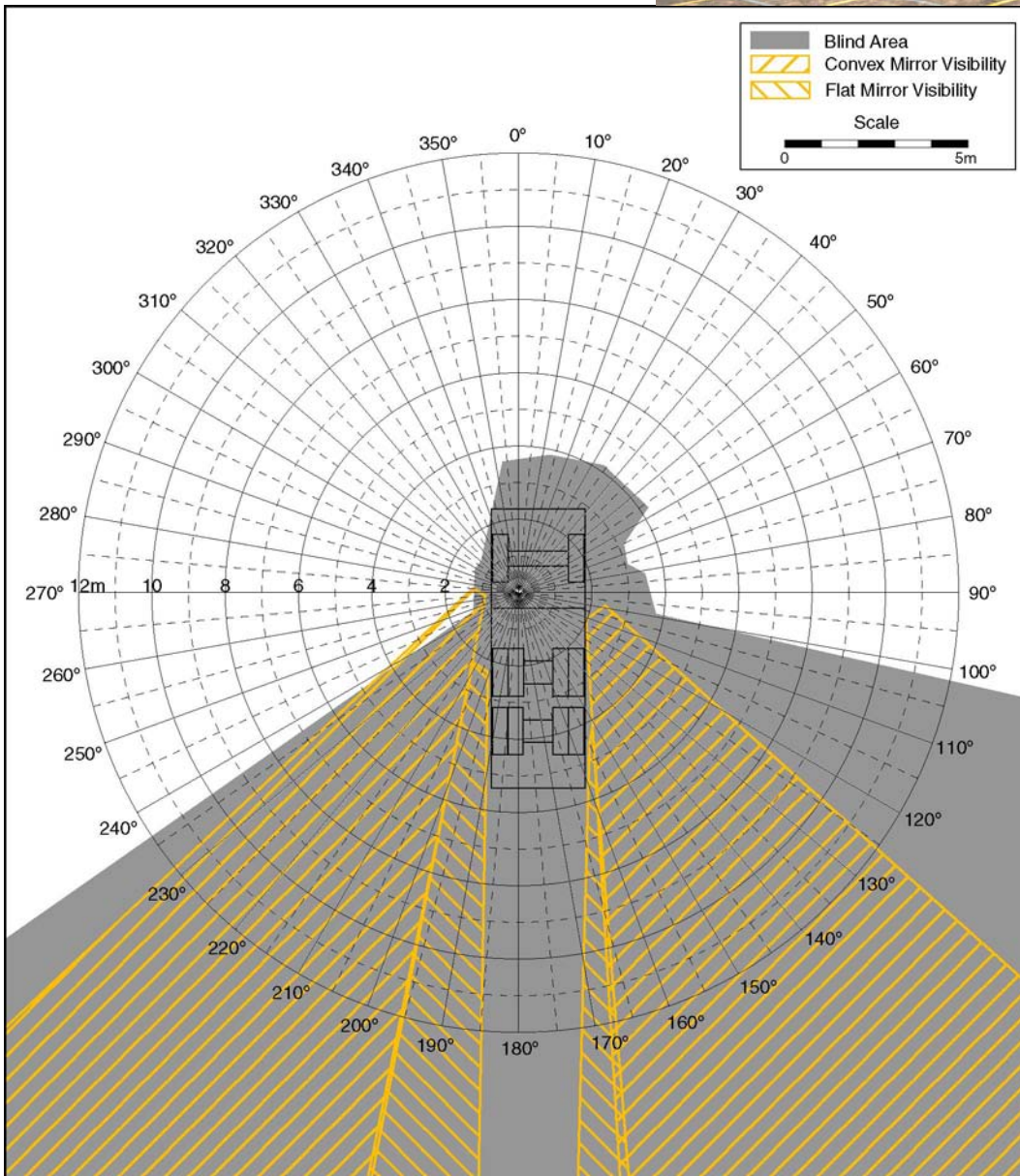
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Dump Truck (Manufacturer and Model)	Ford LT 9511
GVW	58,000 lb
Serial #	1FDZZ96KZWVA41330
Machine Dimensions	101" wide 25' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Dump Truck (Manufacturer and Model)	Ford LT 9511
GVW	58,000 lb
Serial #	1FDZZ96KZWVA41330
Machine Dimensions	101" wide 25' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



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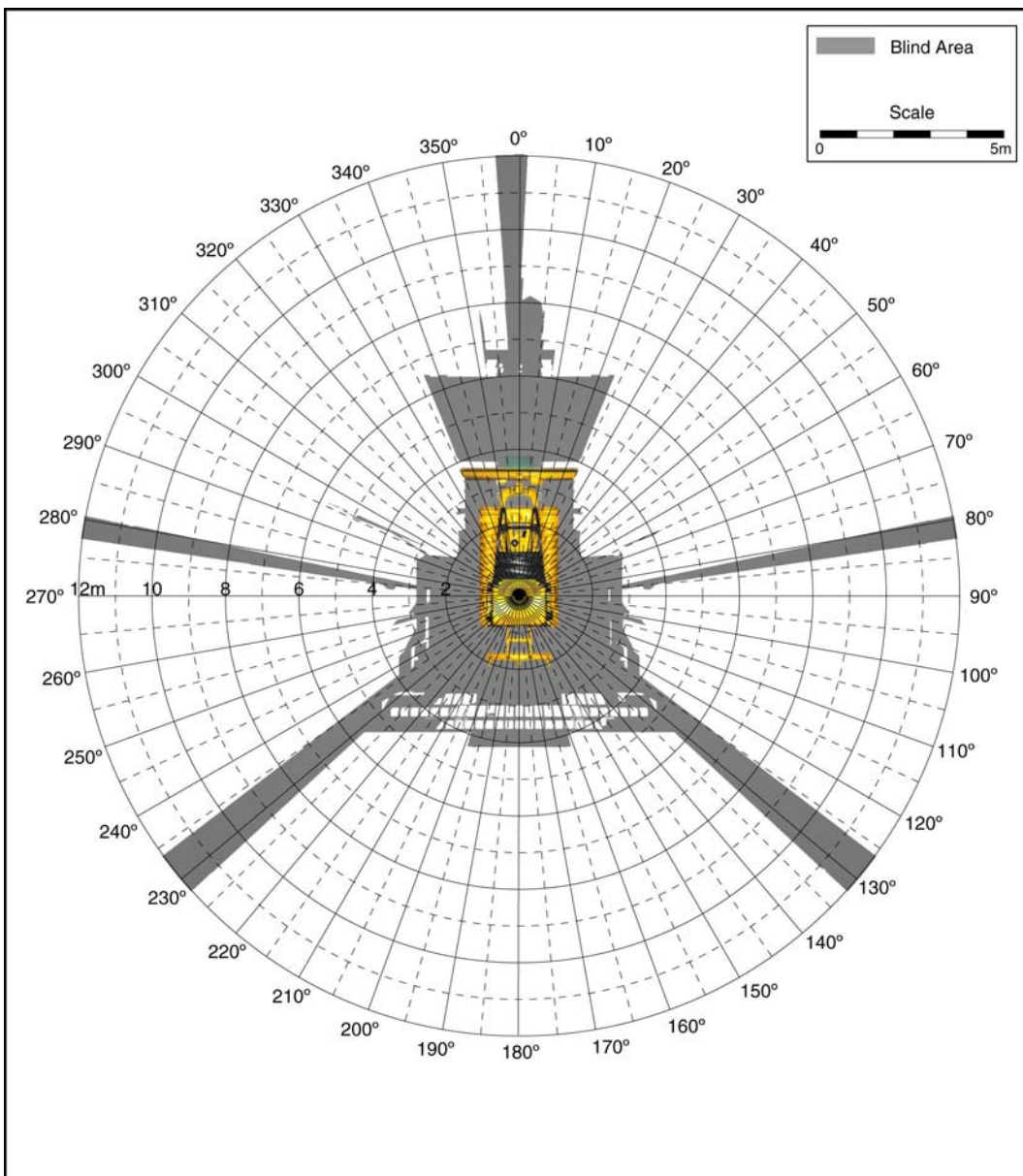
Contract # 200-2002-00563

Dozers

Cat D5G
Komatsu 41P
Cat D6R-LGP
Cat D7R

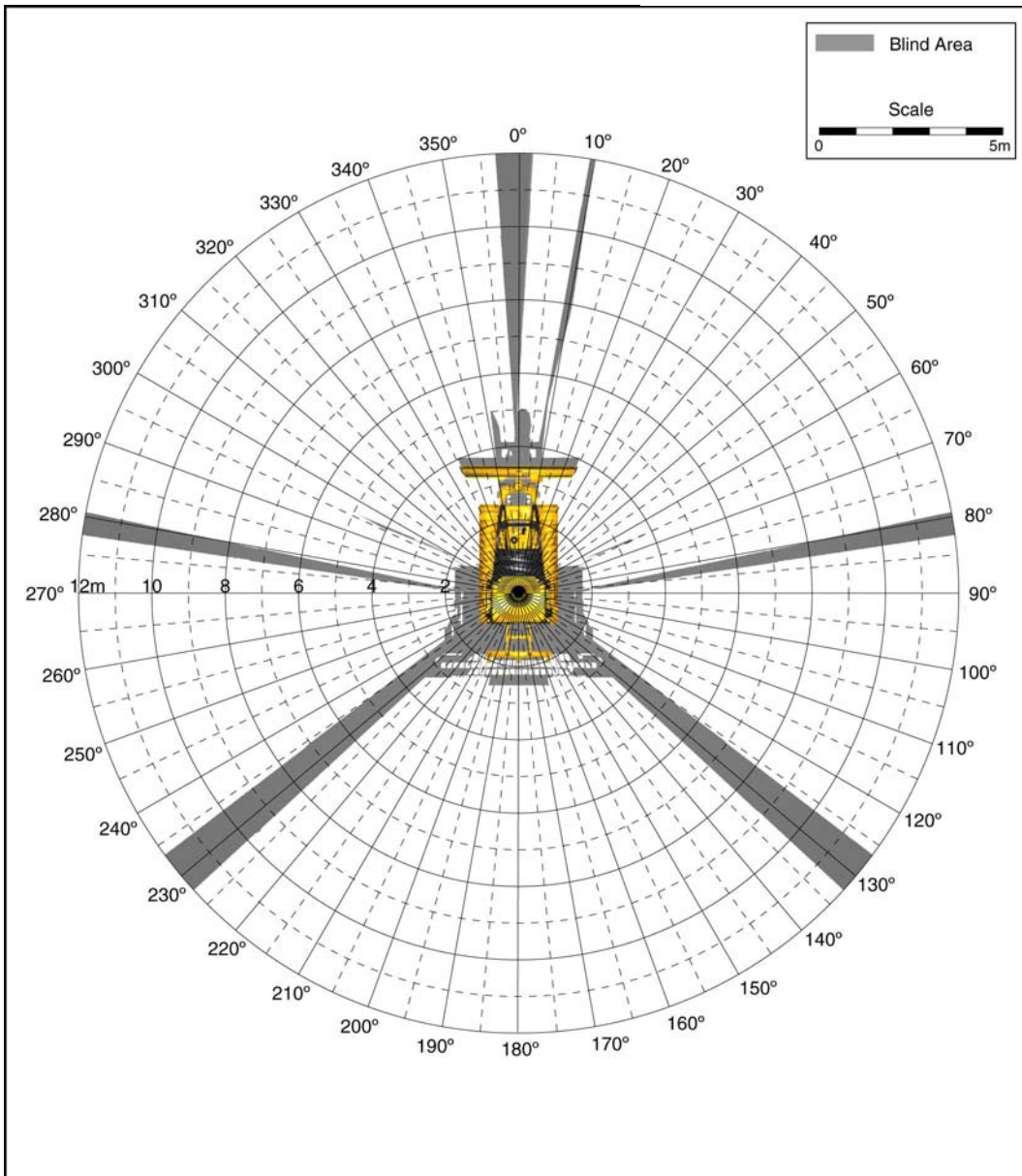
Blind Area Diagram for Construction Machine – Ground Plane

Dozer (Manufacturer and Model)	Cat D5G
GVW	19,630 lb
Serial #	FDWxxxxxx
Machine Dimensions	5' 1" wide 14' 2.7" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	10' 8" wide 3' 6" high Power Angle & Tilt Blade
Other Information	None
Measurement Technique	Computer



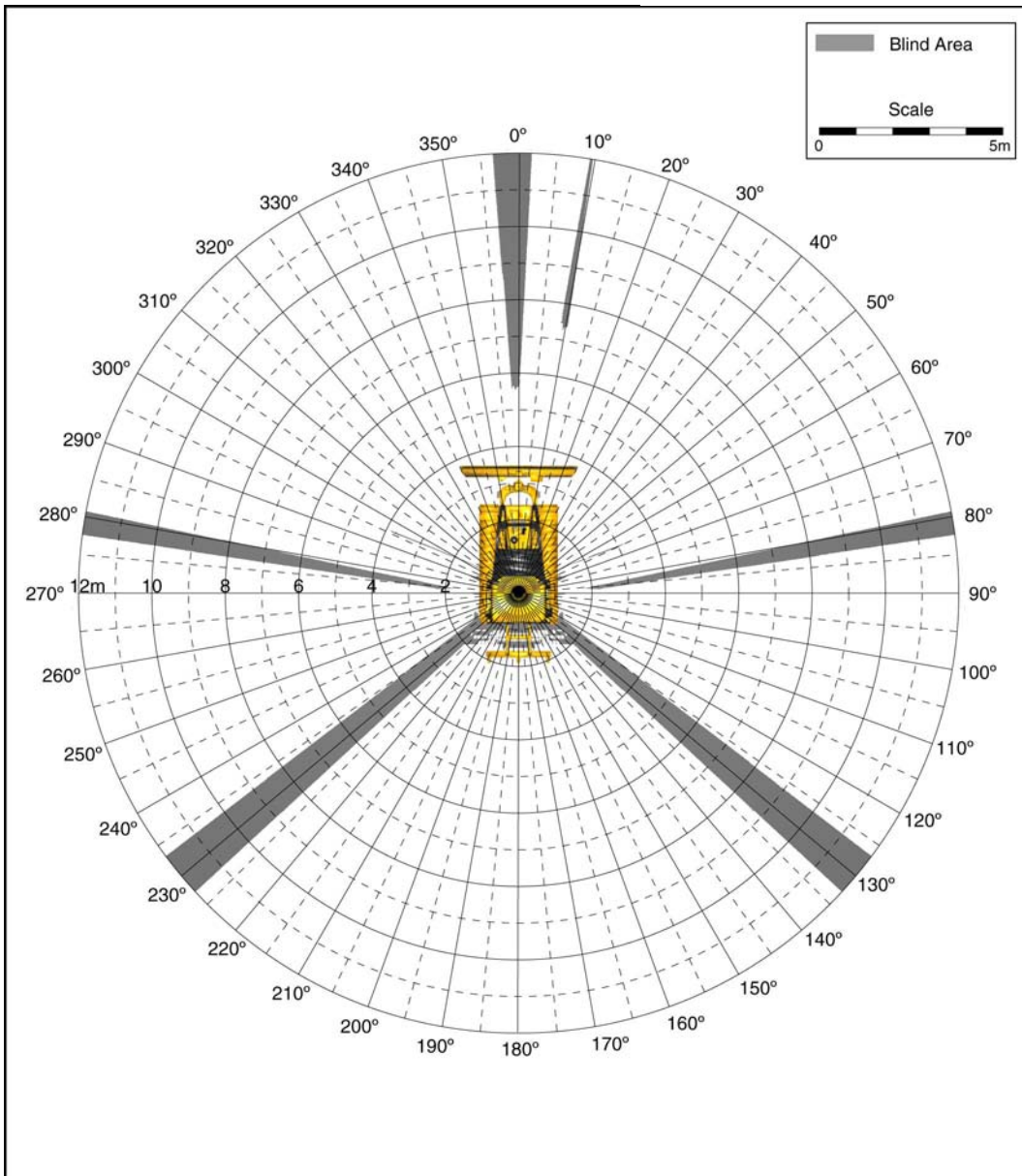
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Other Information	None
Measurement Technique	Computer



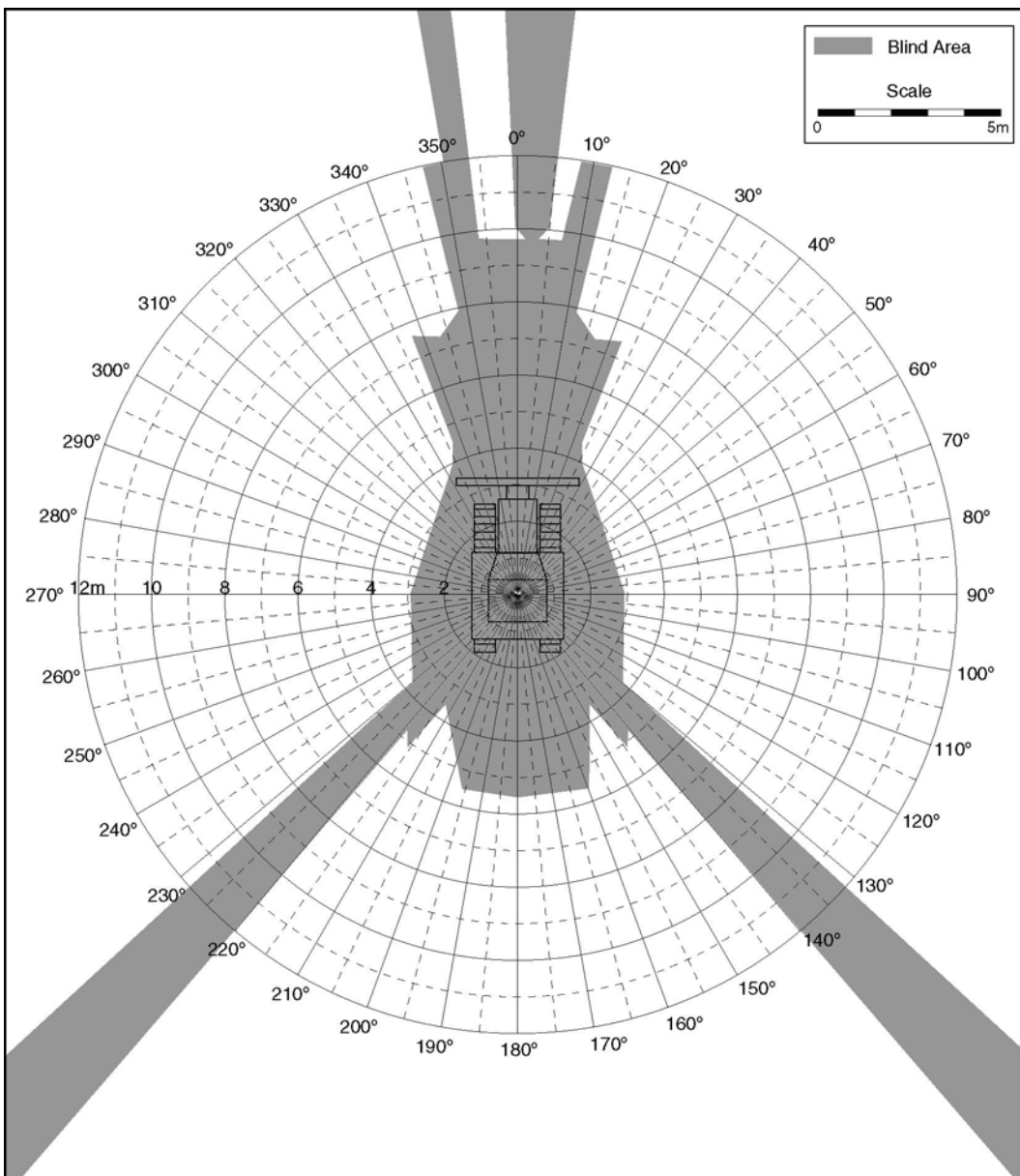
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GVW	19,630 lb
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Other Information	None
Measurement Technique	Computer



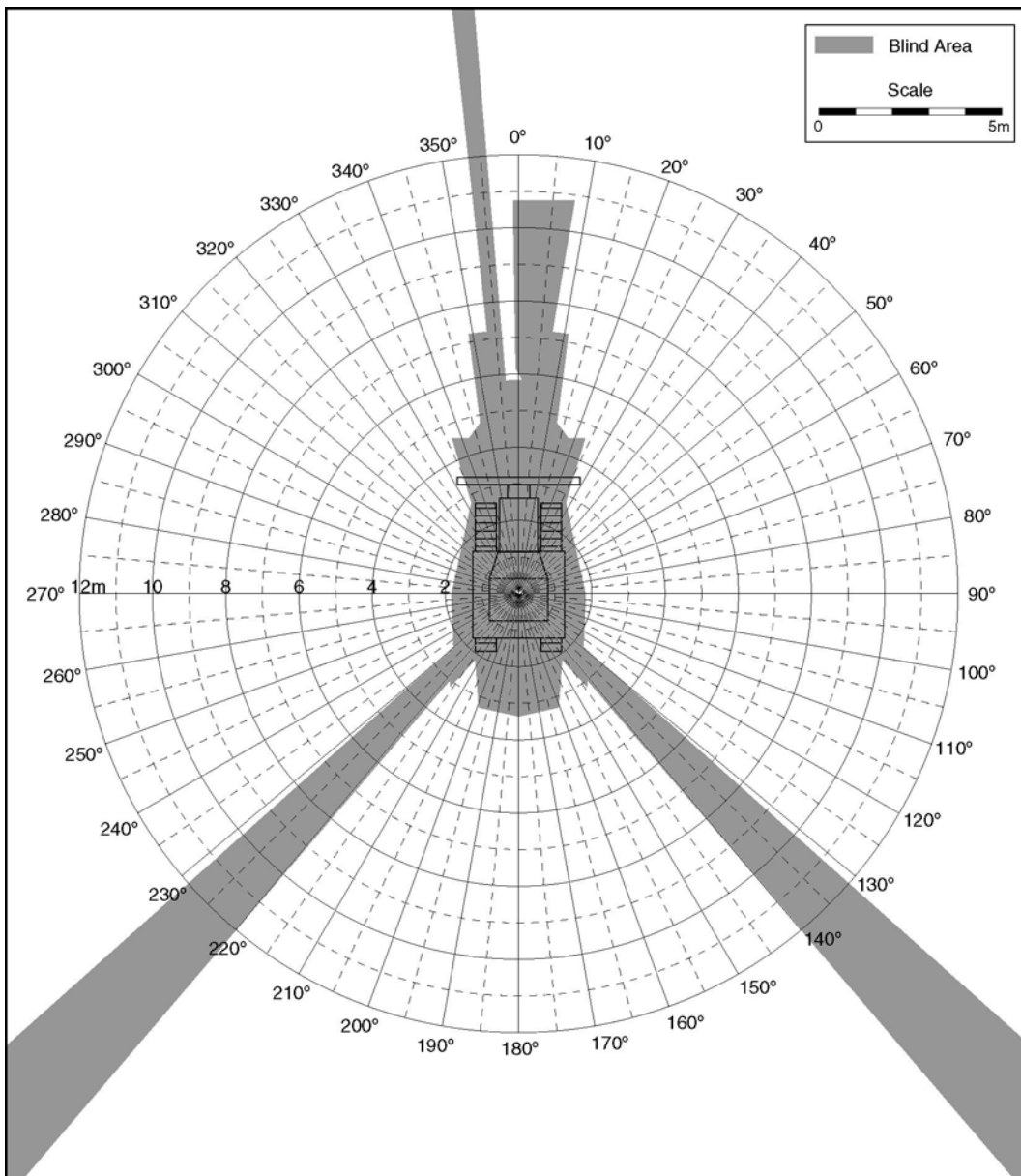
Blind Area Diagram for Construction Machine – Ground Plane

Dozer (Manufacturer and Model)	Komatsu 41P
GVW	25,000 lb
Serial #	B30105
Machine Dimensions	10' wide (blade) 16' long
Operator Enclosure	Closed ROPS
Attachments (Blade)	10' wide 3' 6" high Power Angle & Tilt Blade
Other Information	None
Measurement Technique	Physical



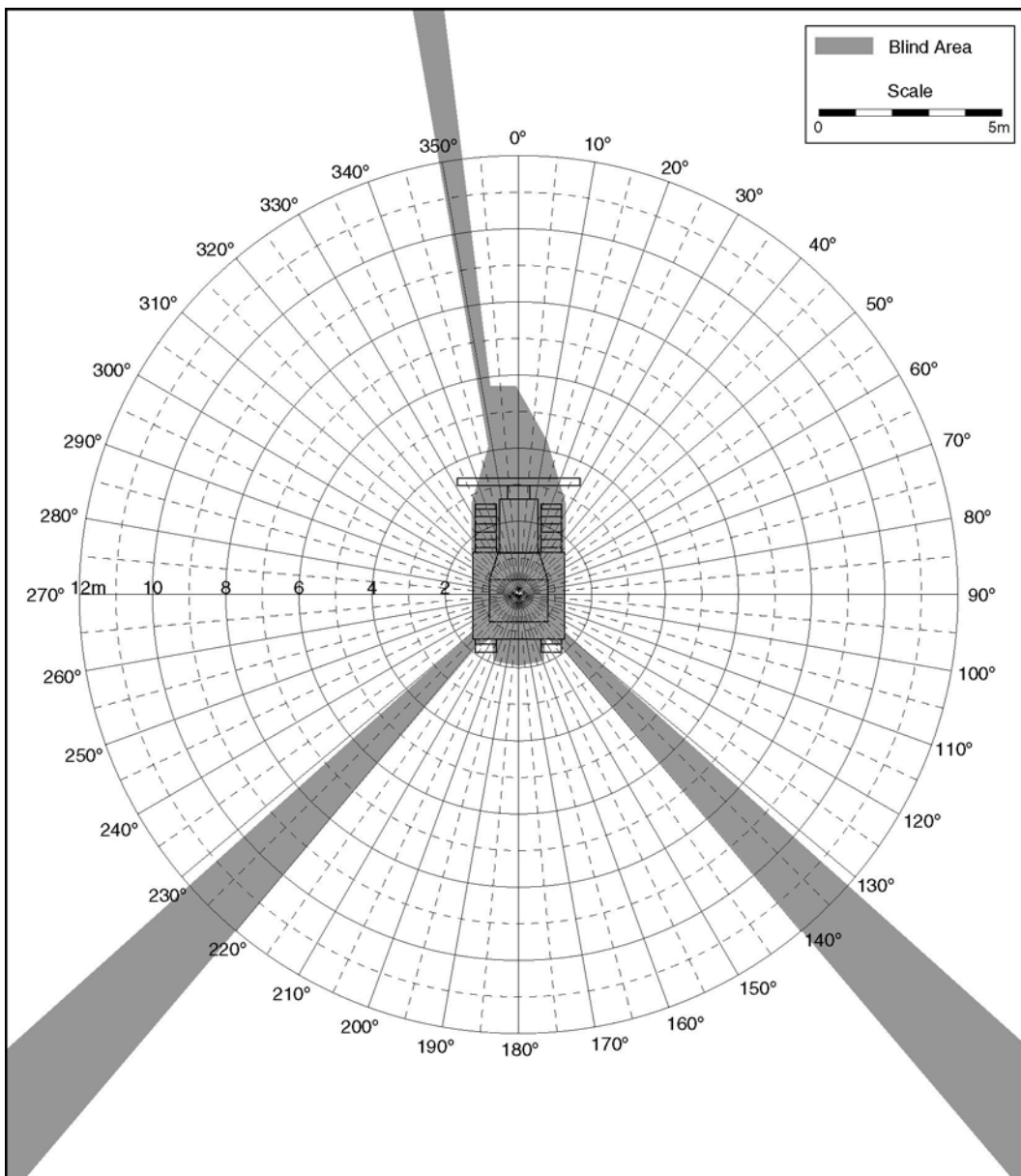
Blind Area Diagram for Construction Machine – 900 mm Plane

Dozer (Manufacturer and Model)	Komatsu 41P
GVW	25,000 lb
Serial #	B30105
Machine Dimensions	10' wide (blade) 16' long
Operator Enclosure	Closed ROPS
Attachments (Blade)	10' wide 3' 6" high Power Angle & Tilt Blade
Other Information	None
Measurement Technique	Physical



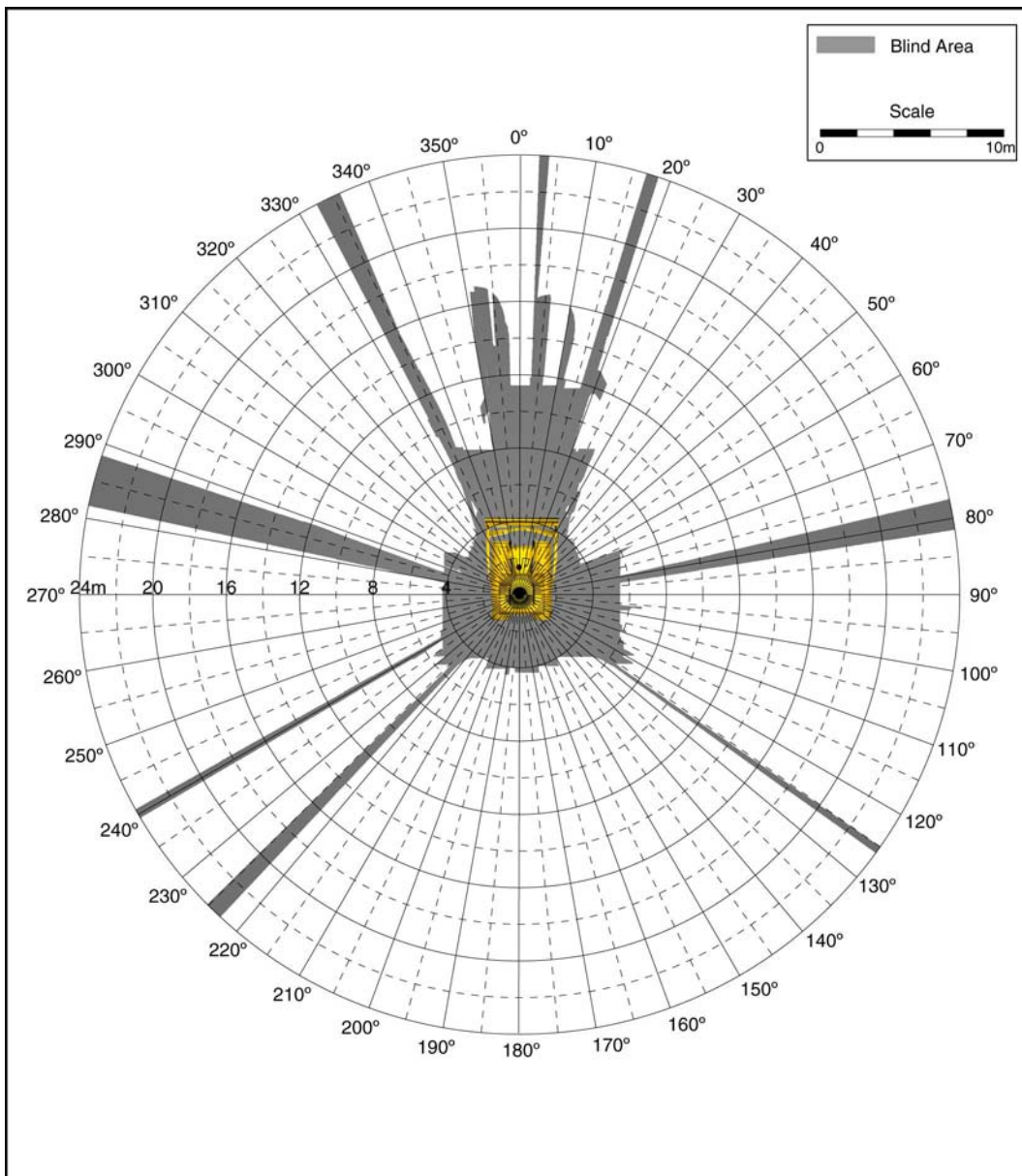
Blind Area Diagram for Construction Machine – 1500 mm Plane

Dozer (Manufacturer and Model)	Komatsu 41P
GVW	25,000 lb
Serial #	B30105
Machine Dimensions	10' wide (blade) 16' long
Operator Enclosure	Closed ROPS
Attachments (Blade)	10' wide 3' 6" high Power Angle & Tilt Blade
Other Information	None
Measurement Technique	Physical



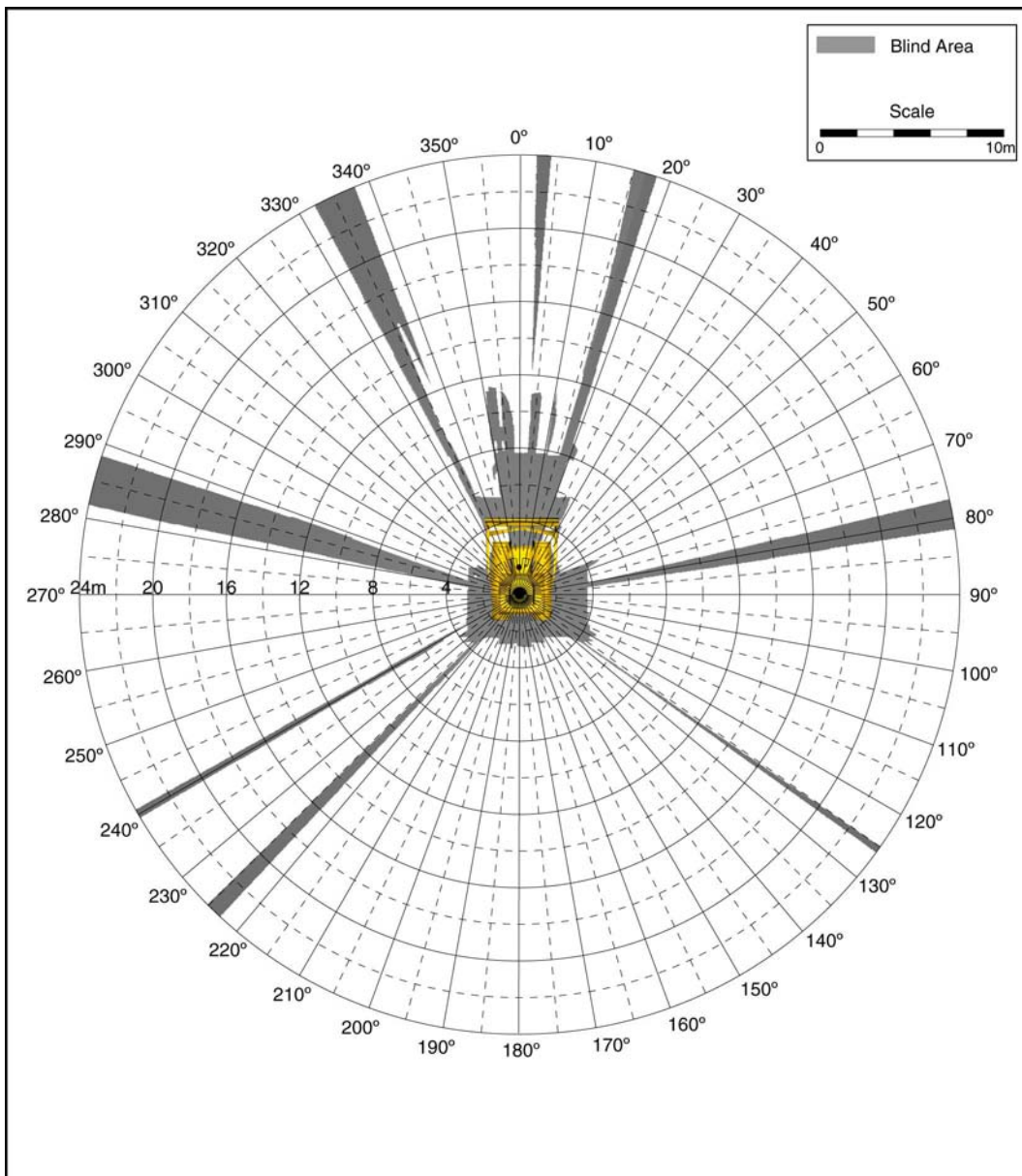
Blind Area Diagram for Construction Machine – Ground Plane

Dozer (Manufacturer and Model)	Cat D6R - LGP
GVW	45,600 lb
Serial #	FDTxxxxxxx
Machine Dimensions	8' 8" wide 13' 11" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	13' wide 3' 8" high Semi-U Blade
Other Information	None
Measurement Technique	Computer



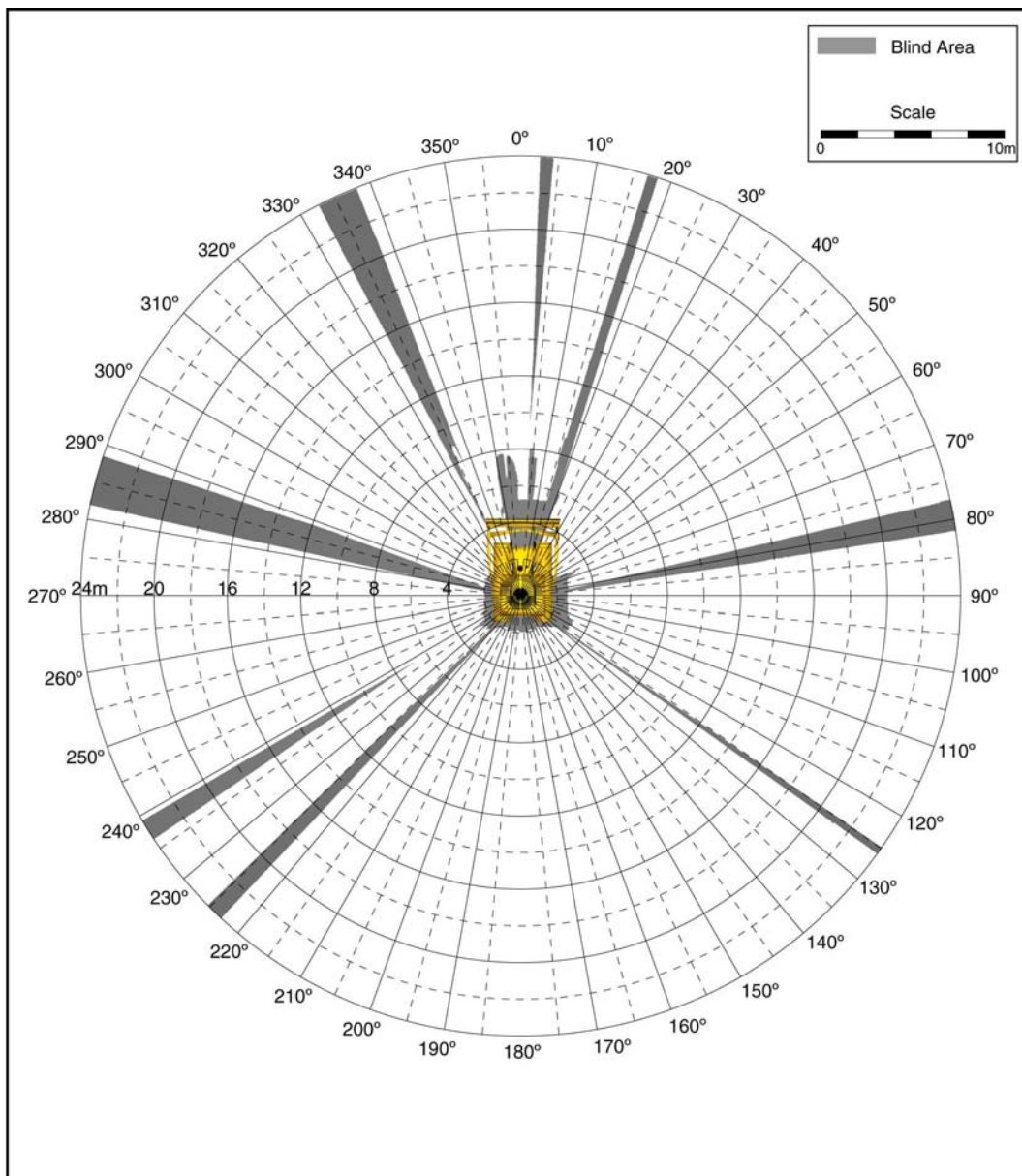
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Dozer (Manufacturer and Model)	Cat D6R - LGP
GVW	45,600 lb
Serial #	FDTxxxxxxx
Machine Dimensions	8' 8" wide 13' 11" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	13' wide 3' 8" high Semi-U Blade
Other Information	None
Measurement Technique	Computer



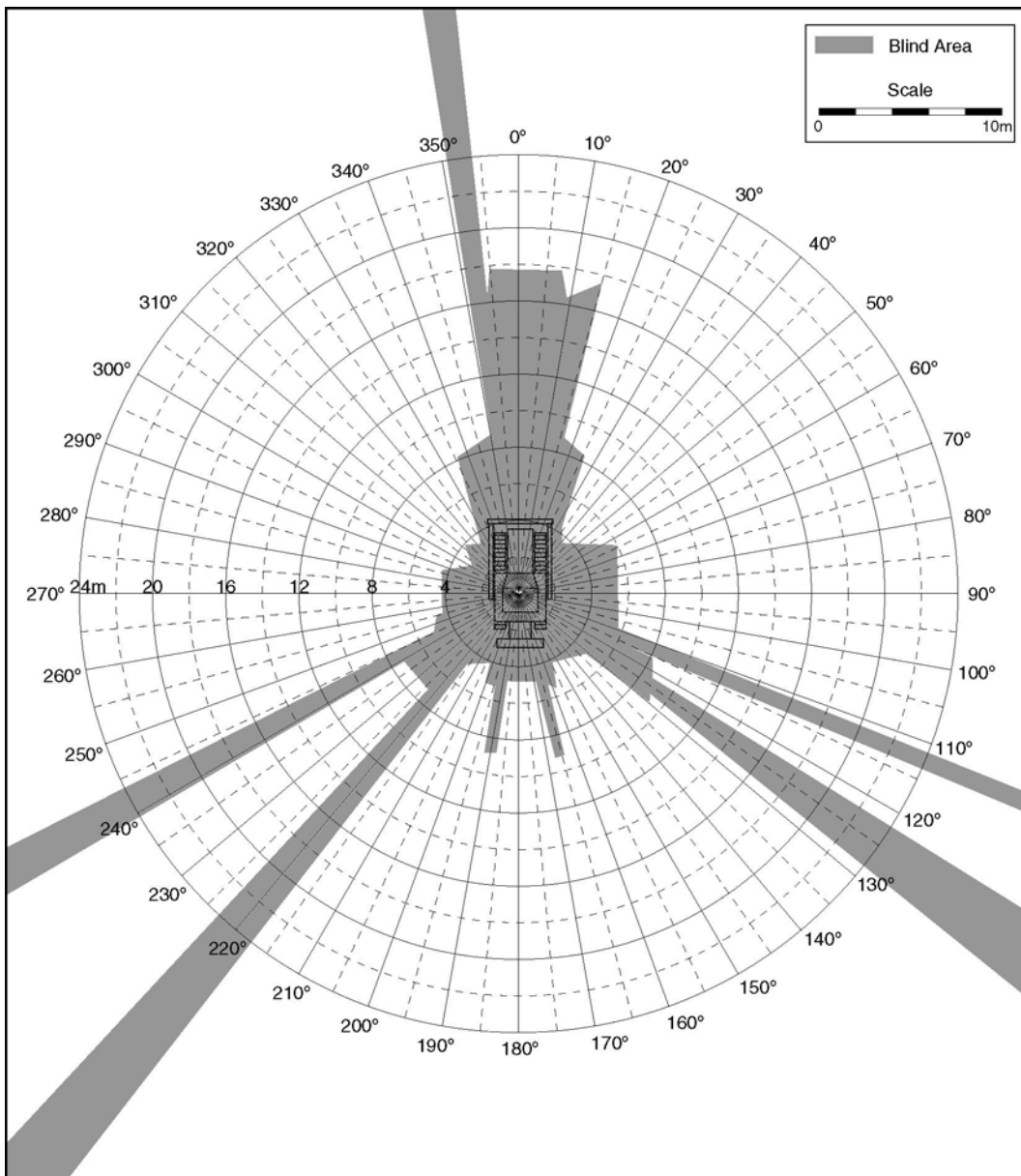
Blind Area Diagram for Construction Machine – 1500 mm Plane

Dozer (Manufacturer and Model)	Cat D6R - LGP
GVW	45,600 lb
Serial #	FDTxxxxxx
Machine Dimensions	8' 8" wide 13' 11" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	13' wide 3' 8" high Semi-U Blade
Other Information	None
Measurement Technique	Computer



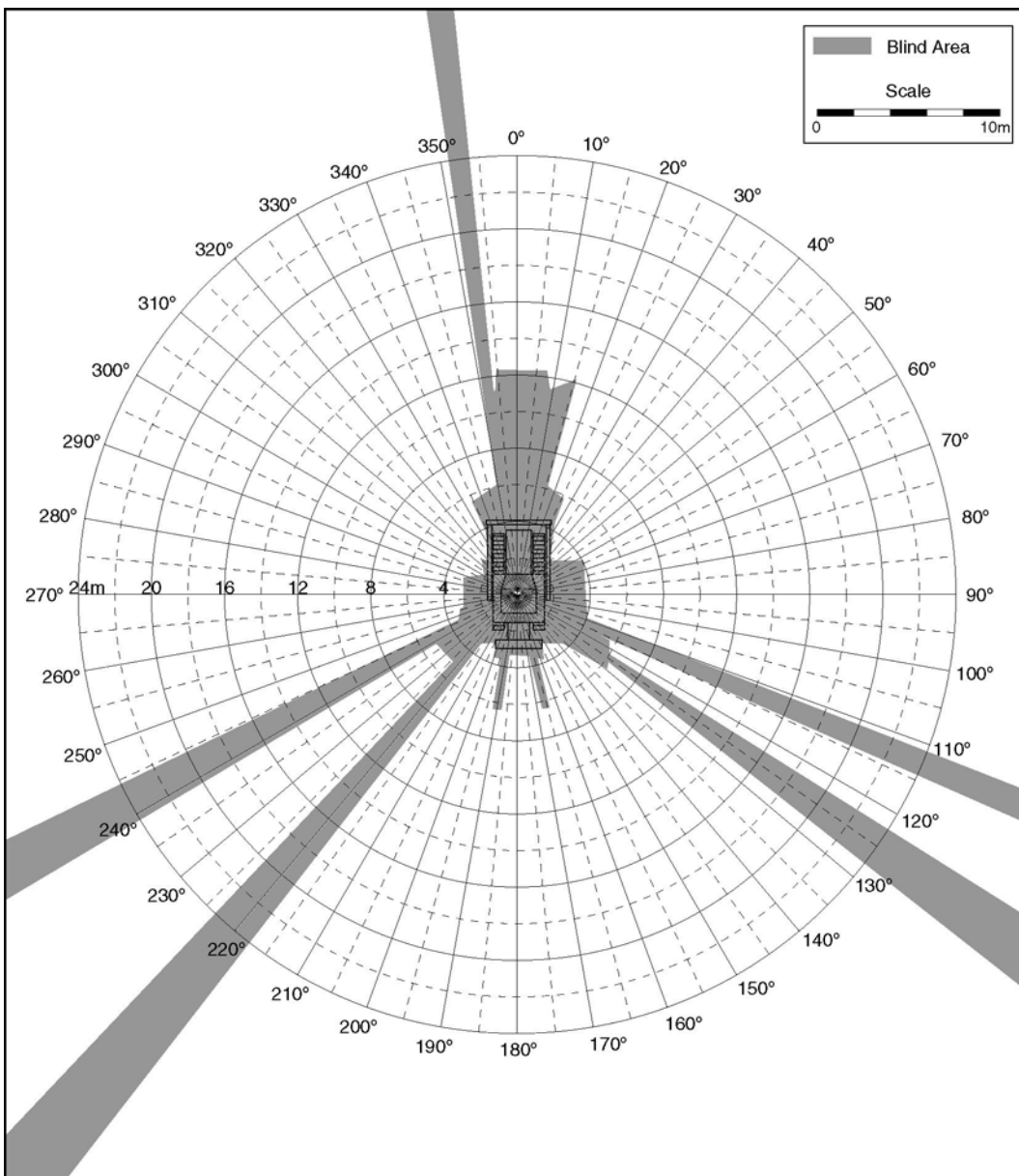
Blind Area Diagram for Construction Vehicle – Ground Plane

Dozer (Manufacturer and Model)	Cat D7R
GVW	61,336 lb
Serial #	1A11913
Machine Dimensions	9' 5" wide 15' 6" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	12' 1" wide 5' high Semi-U Blade
Other Information	None
Measurement Technique	Physical



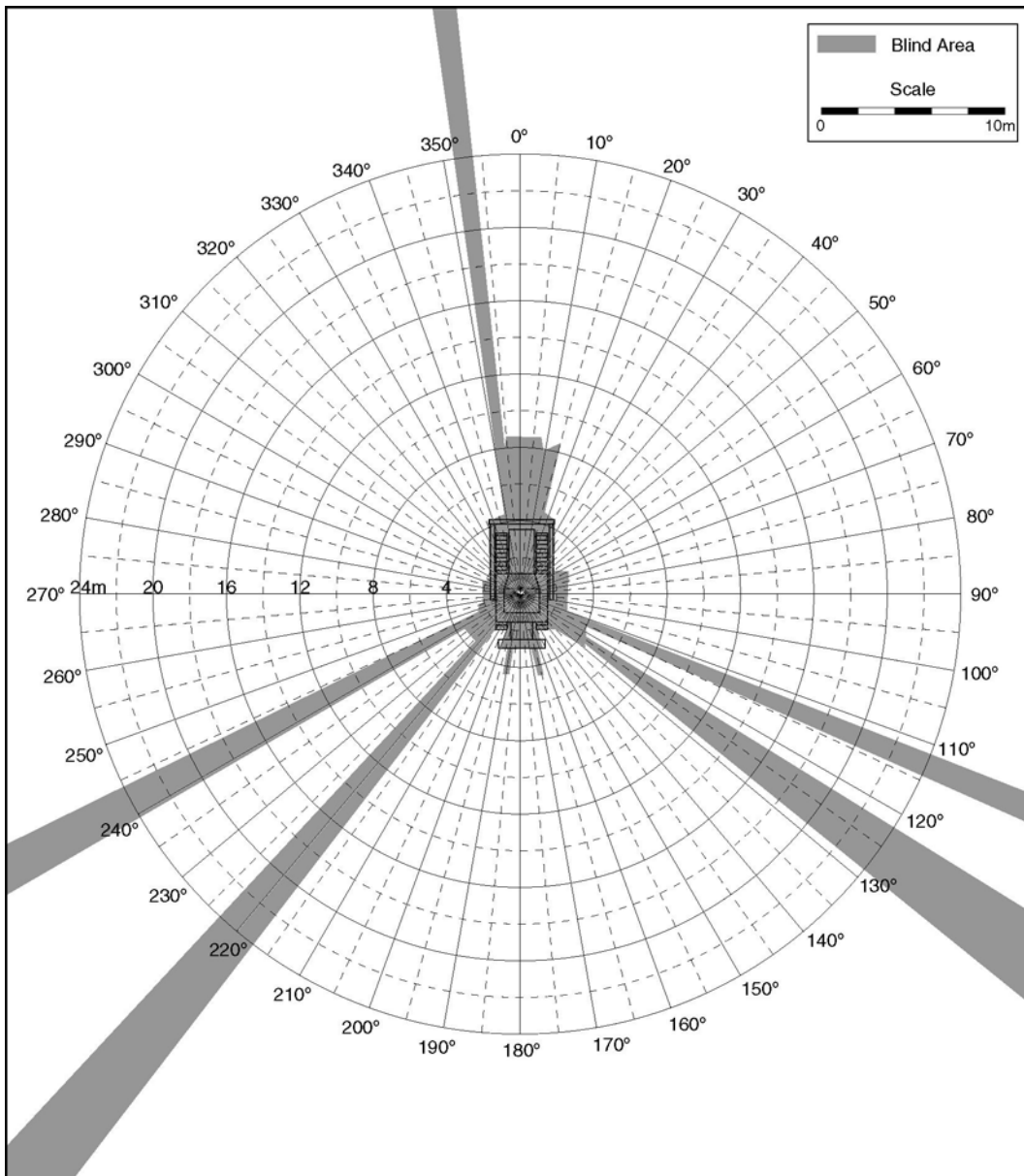
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GVW	61,336 lb
Serial #	1A11913
Machine Dimensions	9' 5" wide 15' 6" long
Operator Enclosure	Closed ROPS
Attachments (Blade)	12' 1" wide 5' high Semi-U Blade
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Blind Area Diagram for Construction Vehicle – 1500 mm Plane

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GVW	61,336 lb
Serial #	1A11913
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Operator Enclosure	Closed ROPS
Attachments (Blade)	12' 1" wide 5' high Semi-U Blade
Other Information	None
Measurement Technique	Physical



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PO Box 1875
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Contract # 200-2002-00563

Loaders

Komatsu WA480

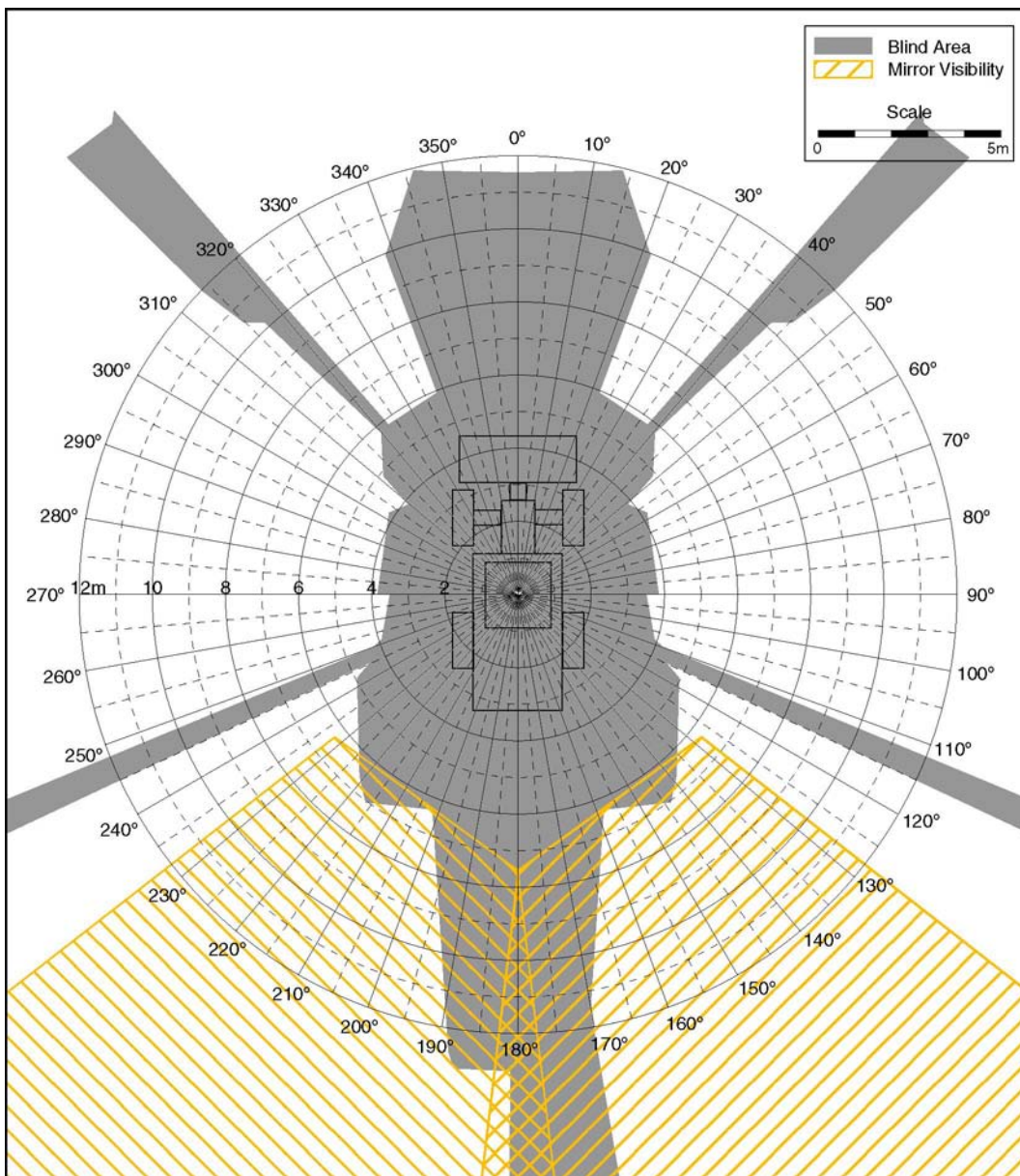
Cat 966G

Cat 938

Cat 950G

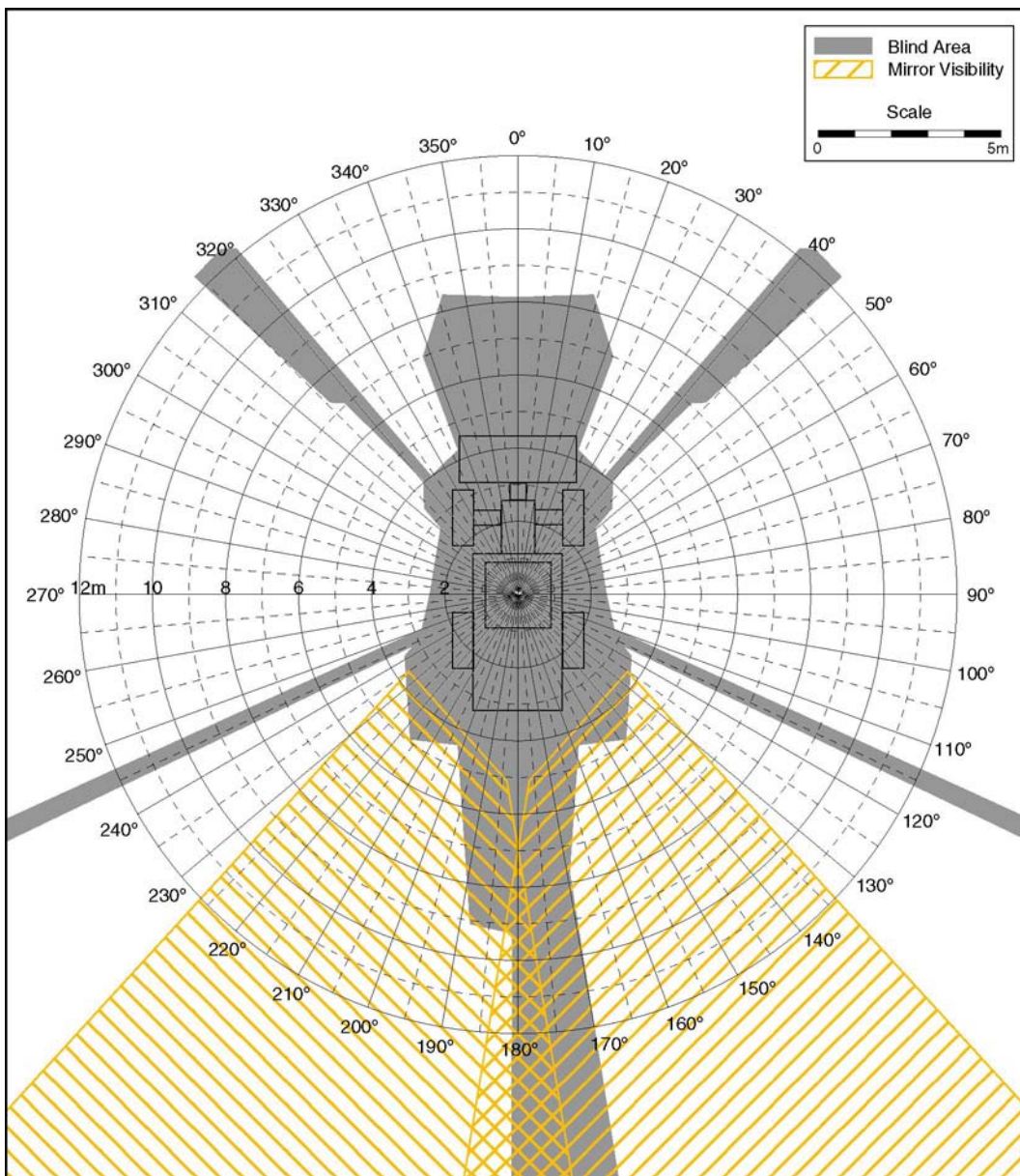
Blind Area Diagram for Construction Vehicle – Ground Plane

Loader (Manufacturer and Model)	Komatsu WA 480
GVW	54,980 lb
Serial #	WA480 H50074
Machine Dimensions	10' 5" wide 30' 0" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



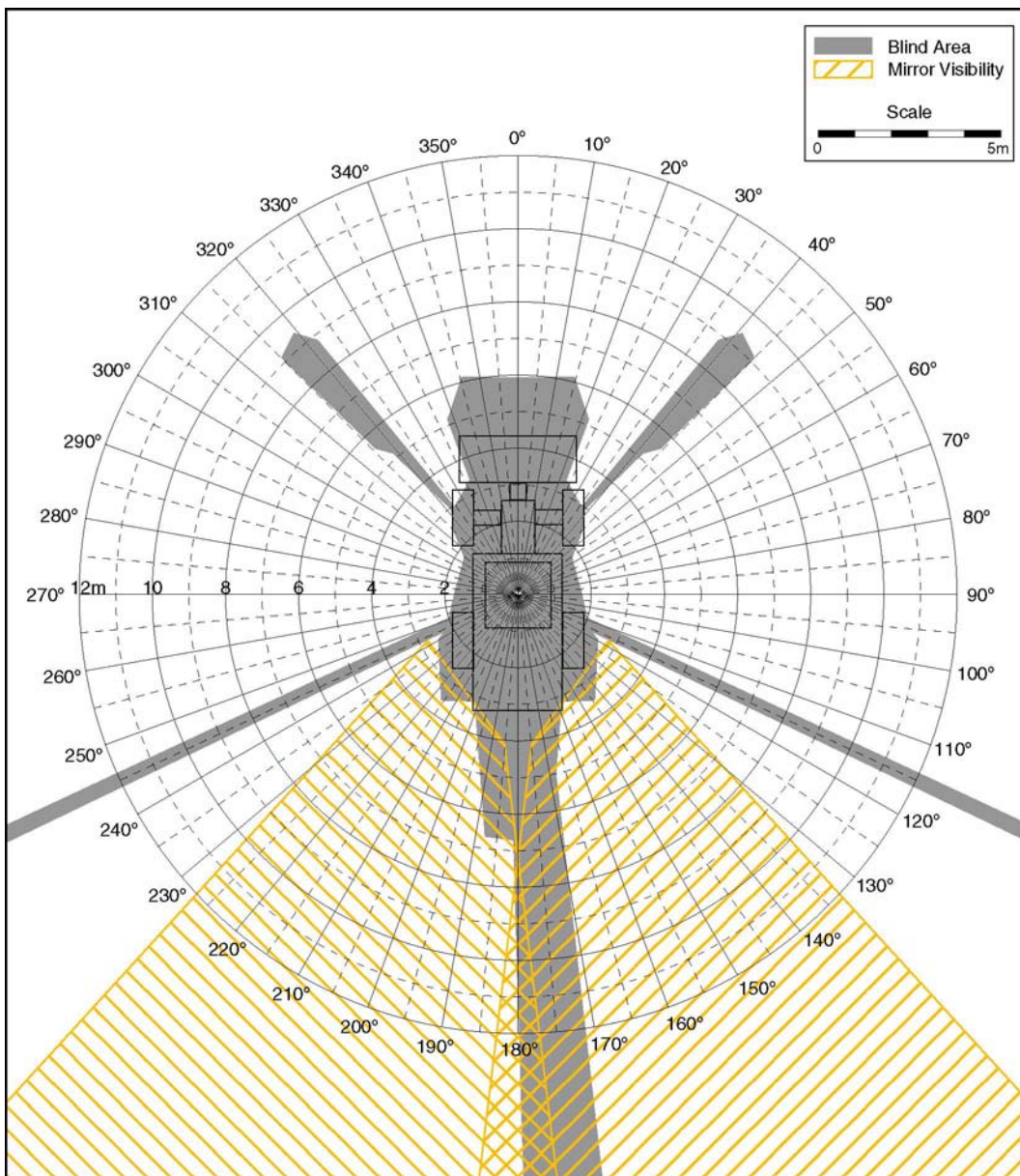
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Loader (Manufacturer and Model)	Komatsu WA 480
GVW	54,980 lb
Serial #	WA480 H50074
Machine Dimensions	10' 5" wide 30' 0" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



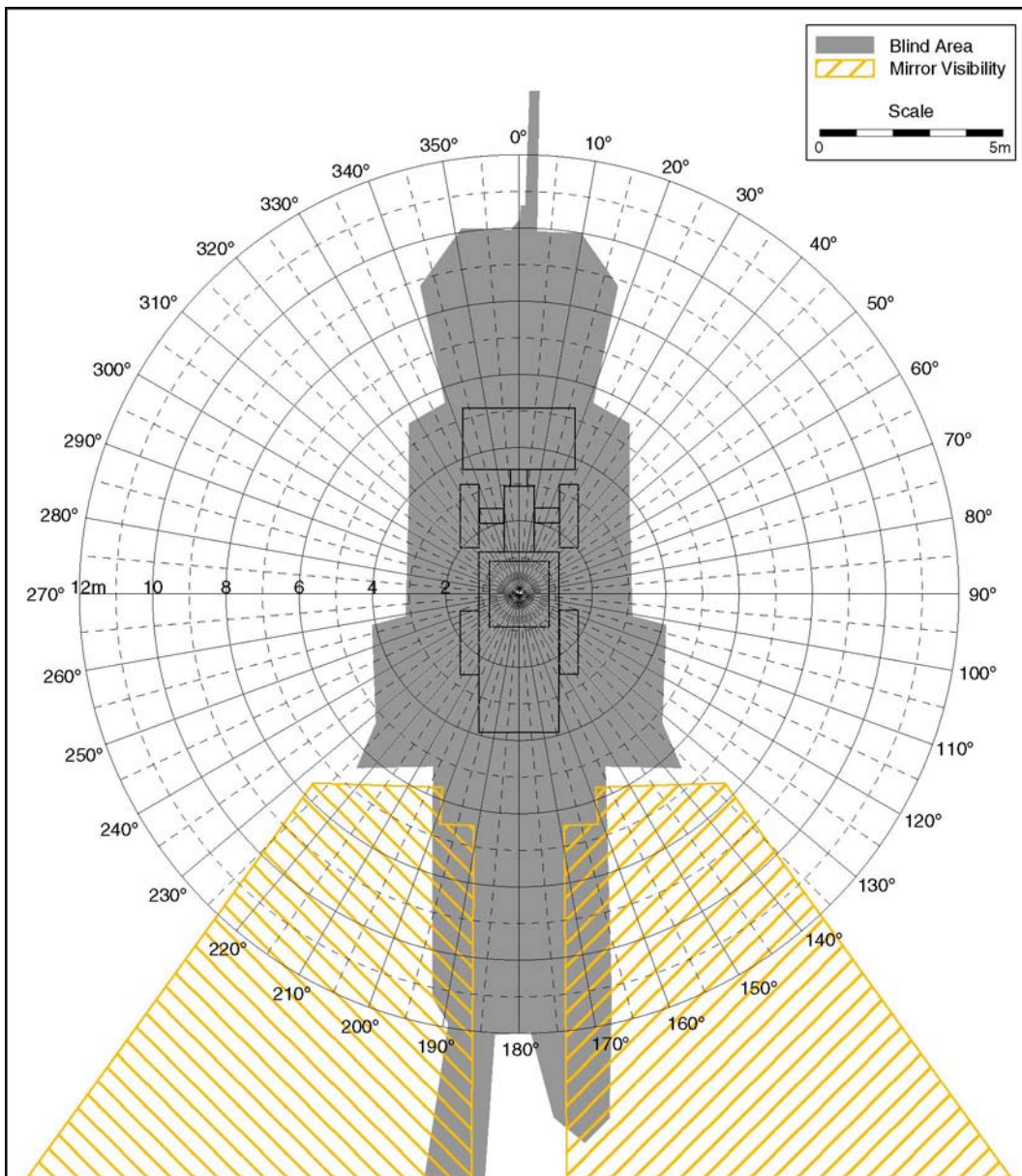
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Loader (Manufacturer and Model)	Komatsu WA 480
GVW	54,980 lb
Serial #	WA480 H50074
Machine Dimensions	10' 5" wide 30' 0" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



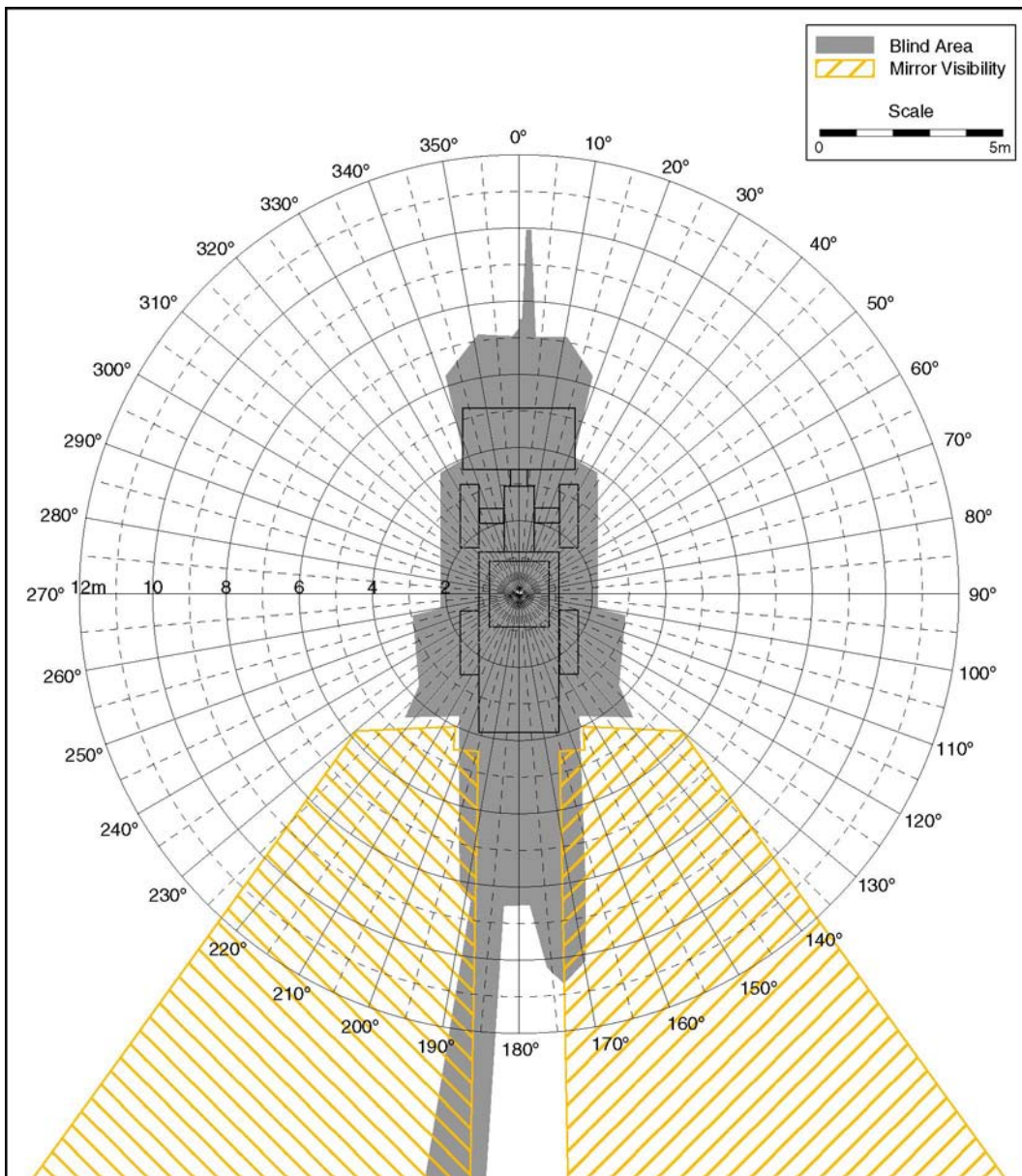
Blind Area Diagram for Construction Vehicle – Ground Plane

Loader (Manufacturer and Model)	Cat 966G
GVW	50,410 lb
Serial #	CAT0966GEANZ00277
Machine Dimensions	10' 6" wide 29' 1" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



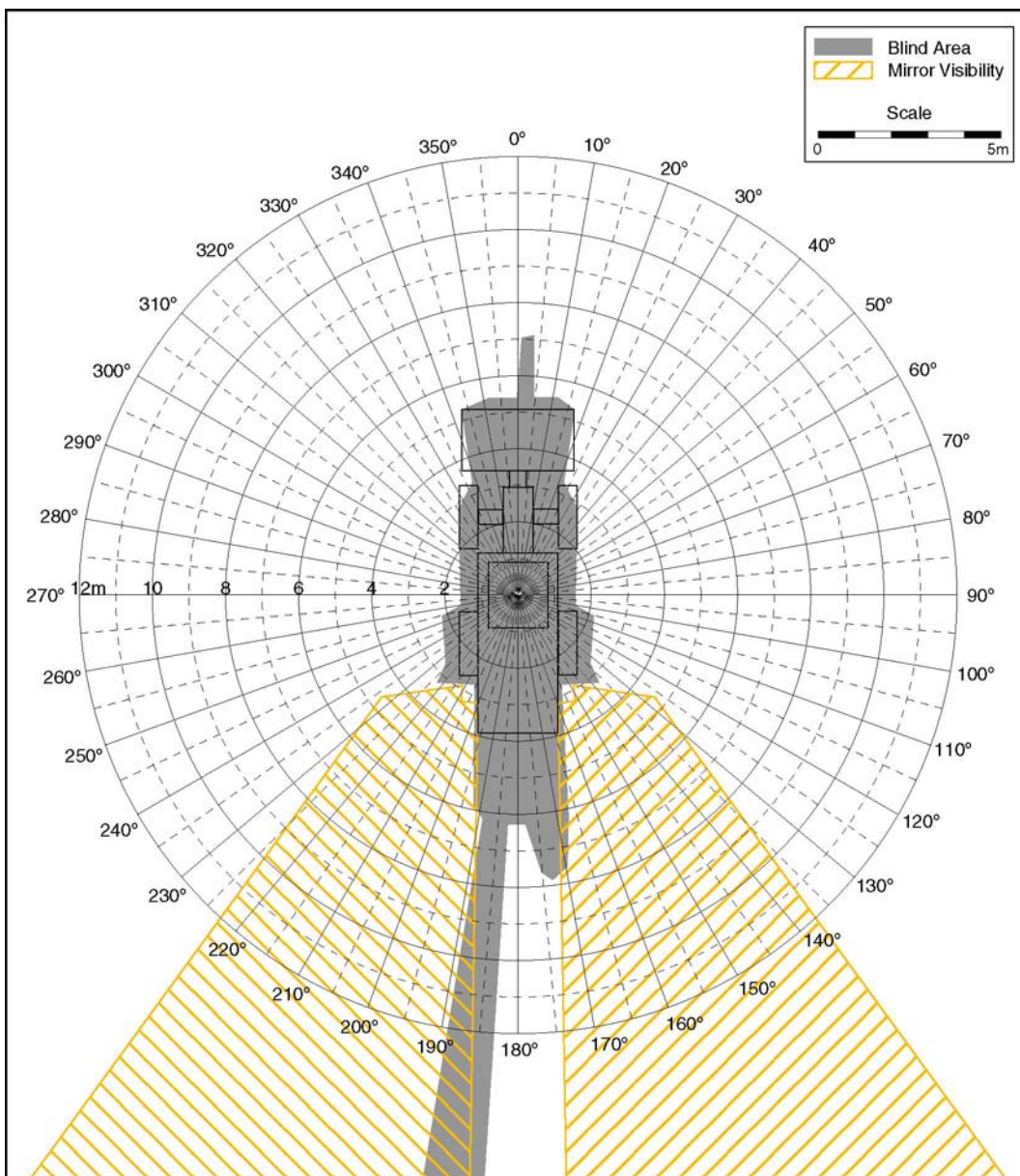
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Loader (Manufacturer and Model)	Cat 966G
GVW	50,410 lb
Serial #	CAT0966GEANZ00277
Machine Dimensions	10' 6" wide 29' 1" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



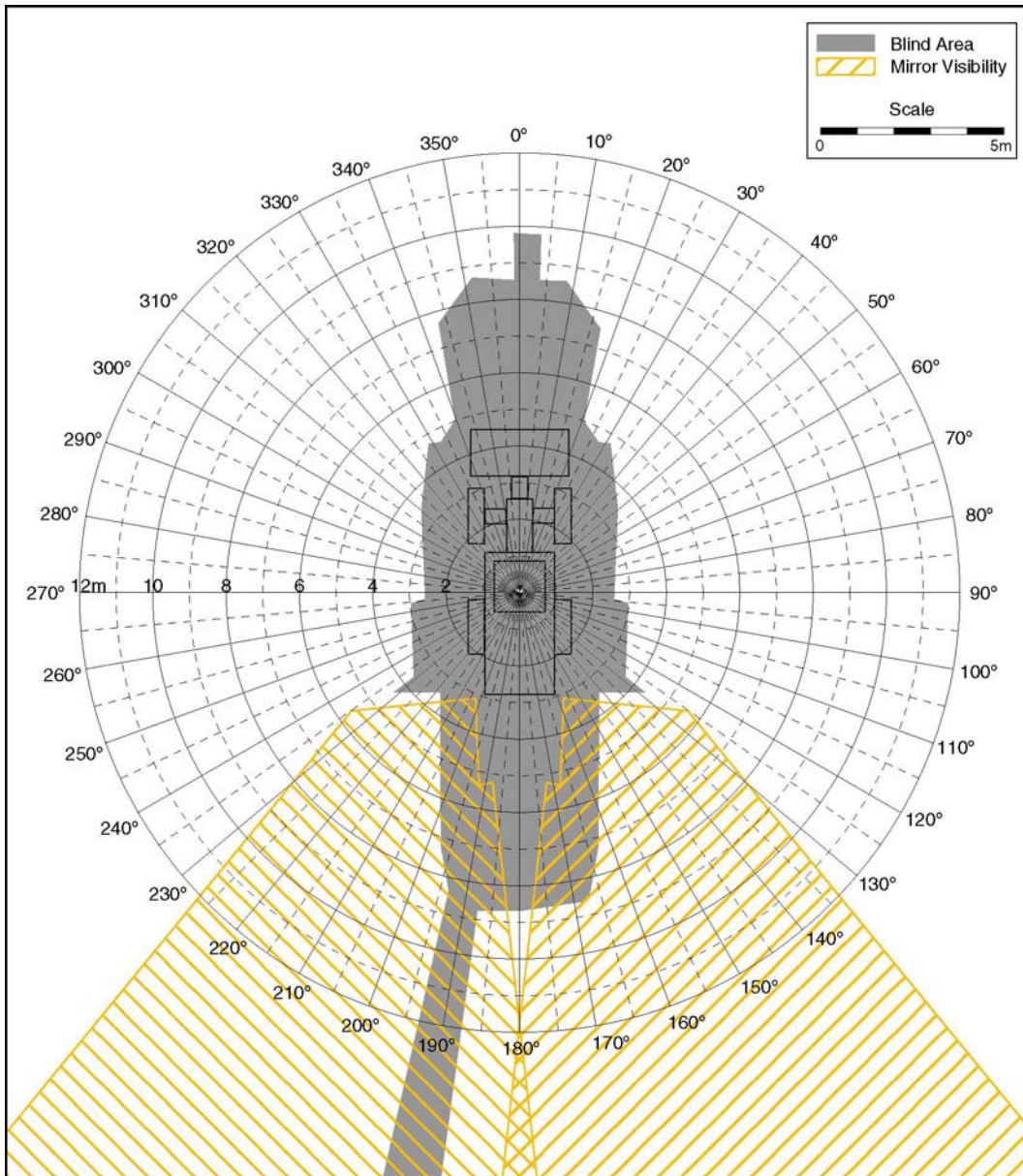
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Loader (Manufacturer and Model)	Cat 966G
GVW	50,410 lb
Serial #	CAT0966GEANZ00277
Machine Dimensions	10' 6" wide 29' 1" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



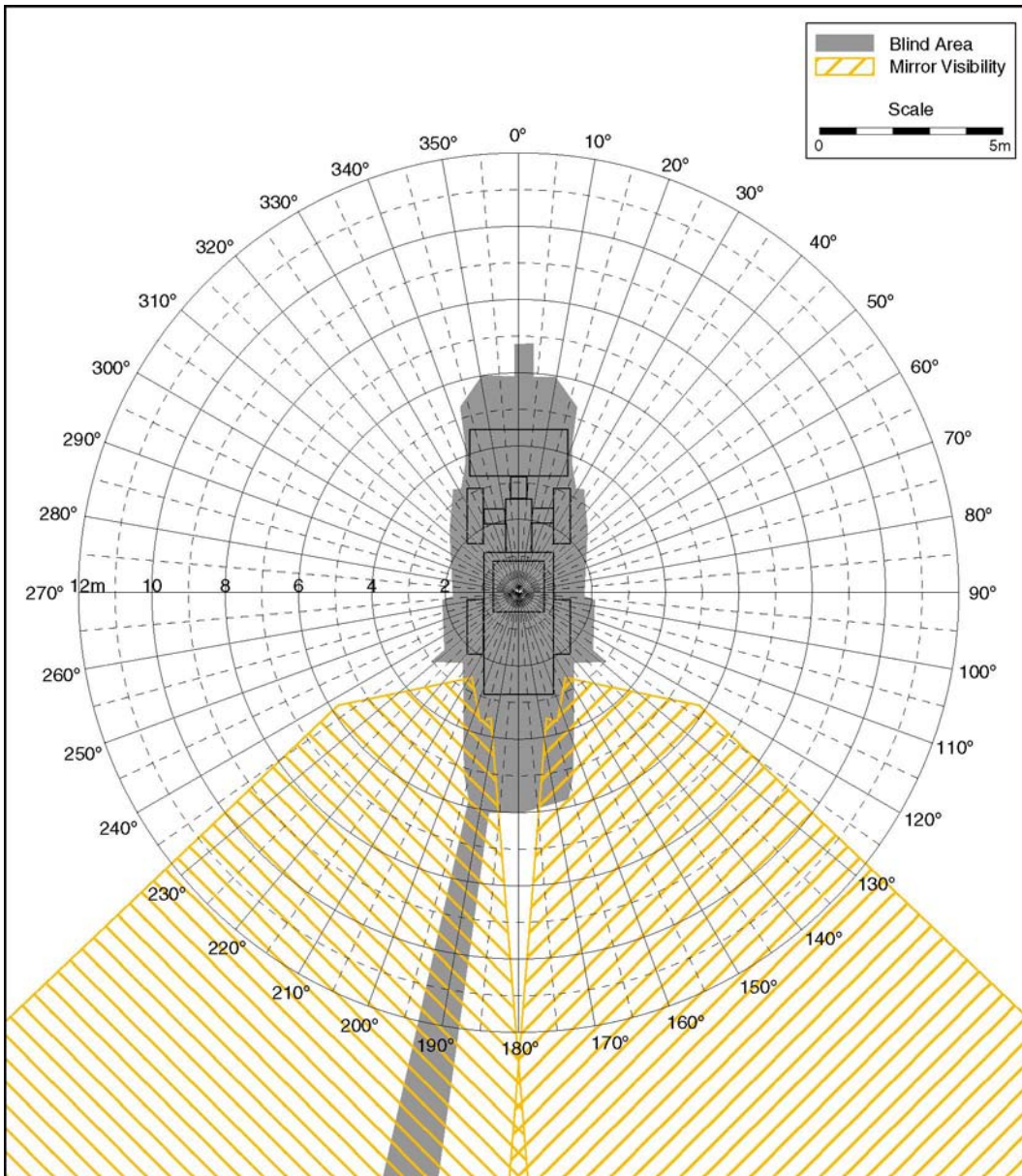
Blind Area Diagram for Construction Vehicle – Ground Plane

Loader (Manufacturer and Model)	Cat 938
GVW	29,060 lb
Serial #	CRD00274
Machine Dimensions	9' 1" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



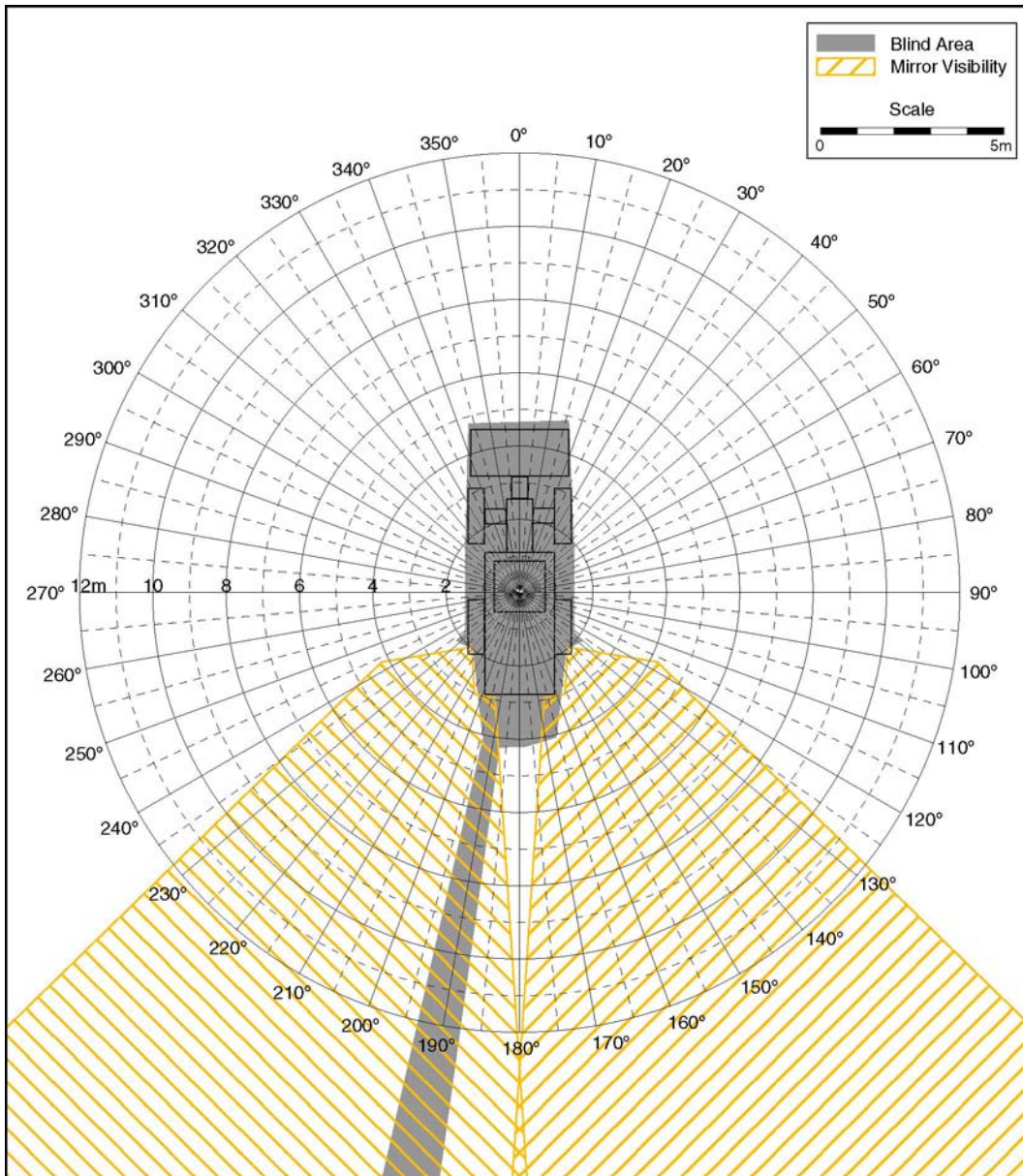
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Loader (Manufacturer and Model)	Cat 938
GVW	29,060 lb
Serial #	CRD00274
Machine Dimensions	9' 1" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



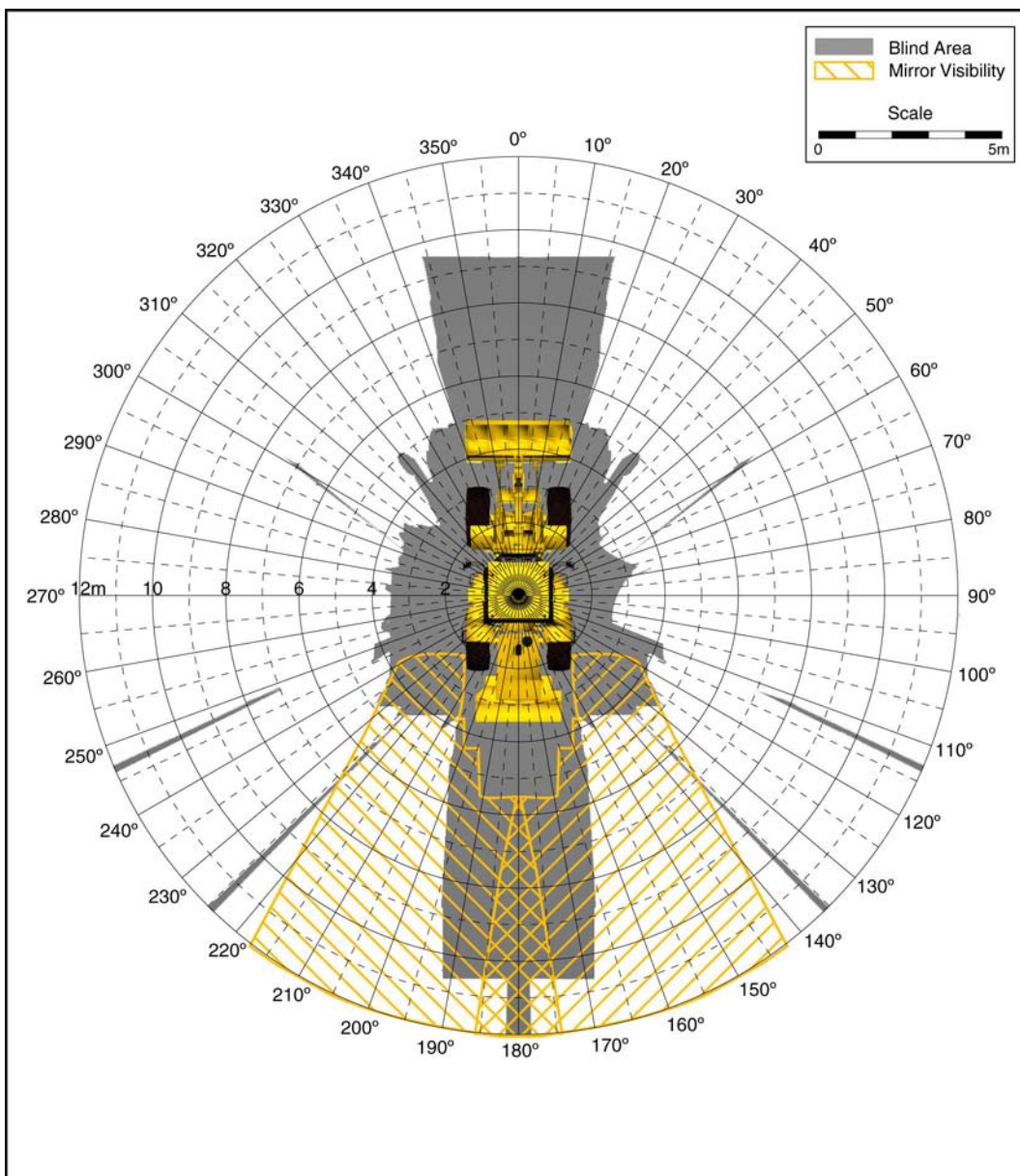
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Loader (Manufacturer and Model)	Cat 938
GVW	29,060 lb
Serial #	CRD00274
Machine Dimensions	9' 1" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



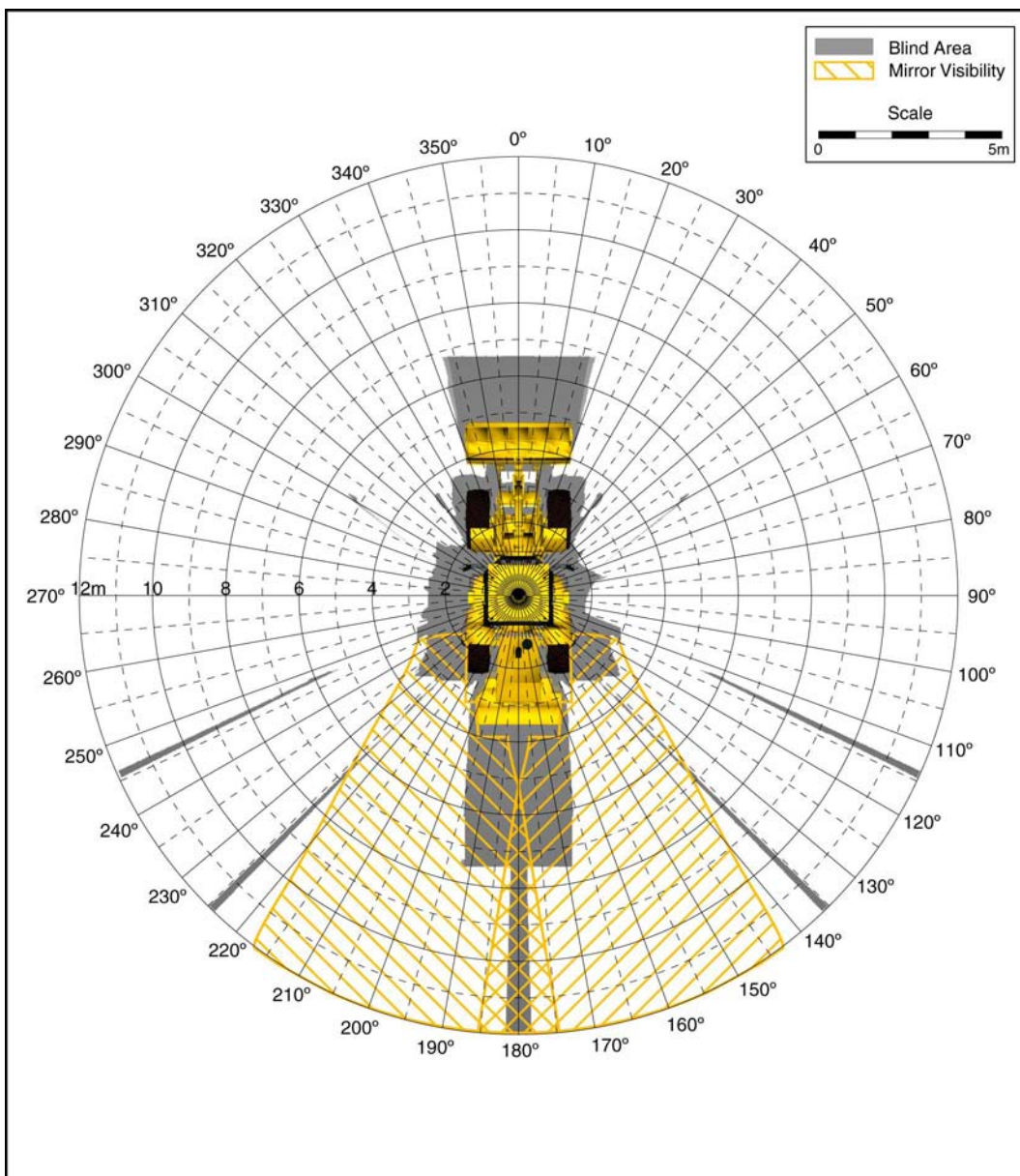
Blind Area Diagram for Construction Vehicle – Ground Plane

Loader (Manufacturer and Model)	Cat 950G
GVW	39,300 lb
Serial #	BAAXxxxxxx
Machine Dimensions	9' 10" wide 26' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer



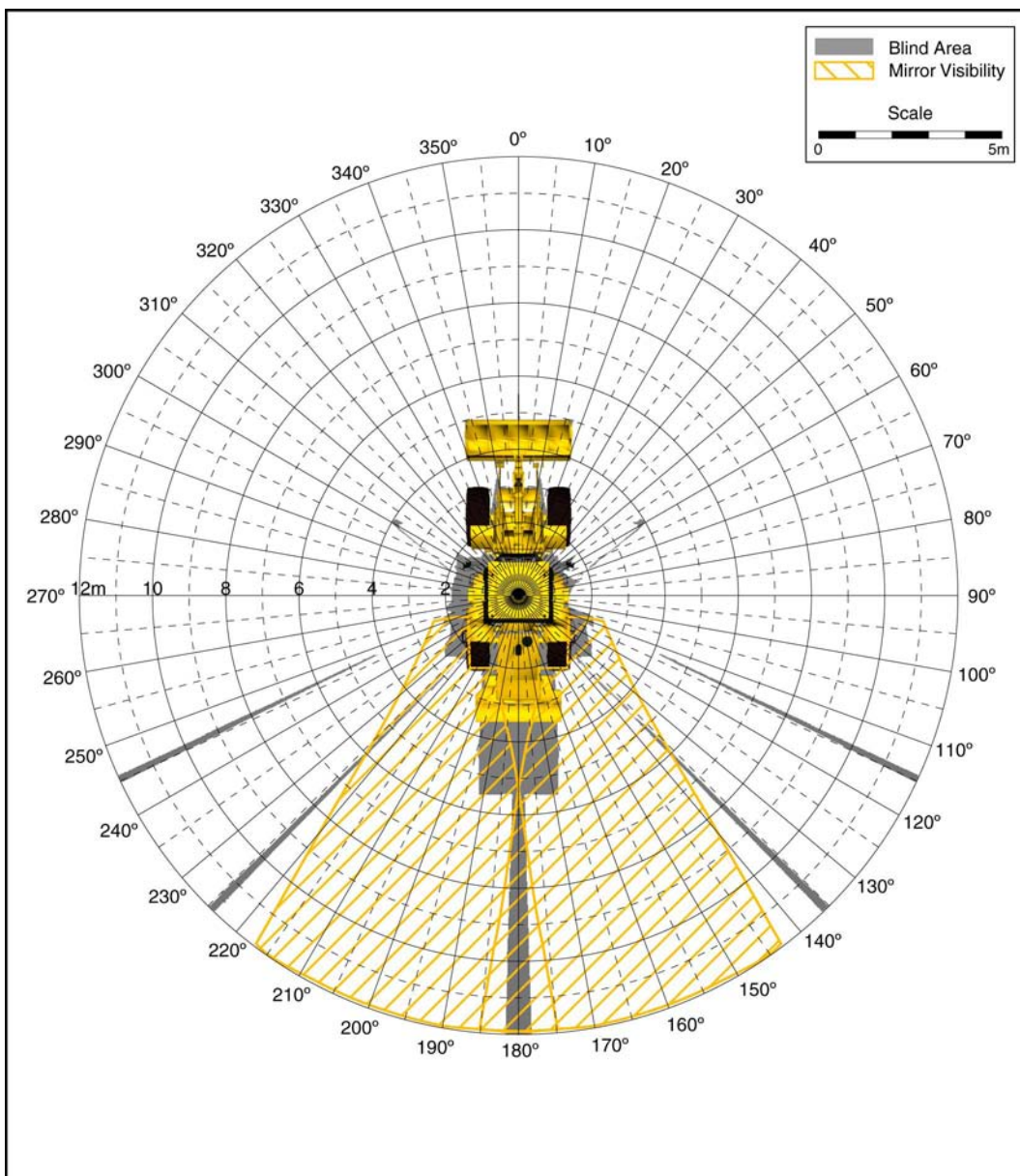
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Loader (Manufacturer and Model)	Cat 950G
GVW	39,300 lb
Serial #	BAAXxxxxxx
Machine Dimensions	9' 10" wide 26' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer



Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Loader (Manufacturer and Model)	Cat 950G
GVW	39,300 lb
Serial #	BAAXxxxxxx
Machine Dimensions	9' 10" wide 26' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer

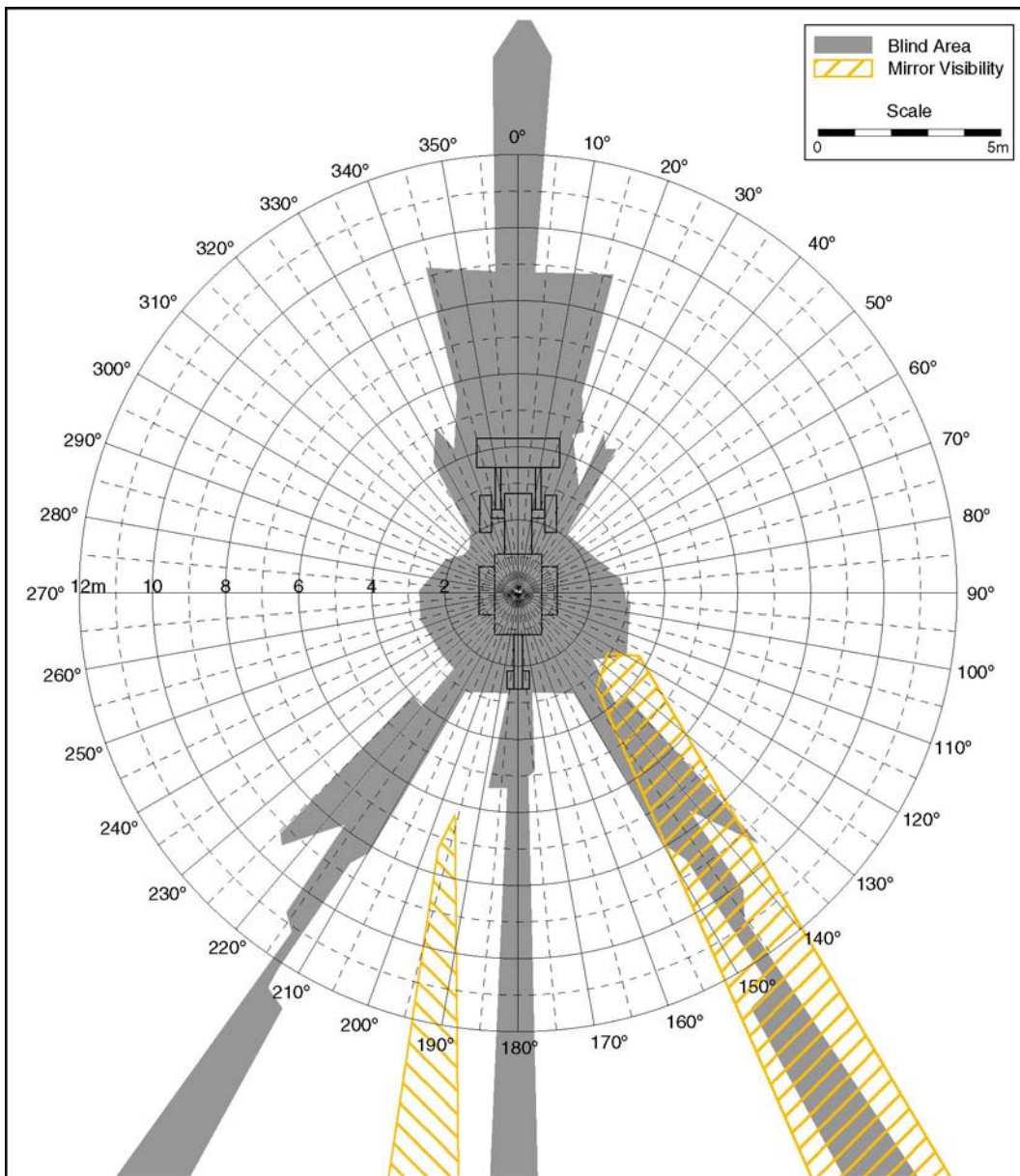


Backhoe loaders

Terex TX760
Cat 430D
Cat 416C
Cat 446B

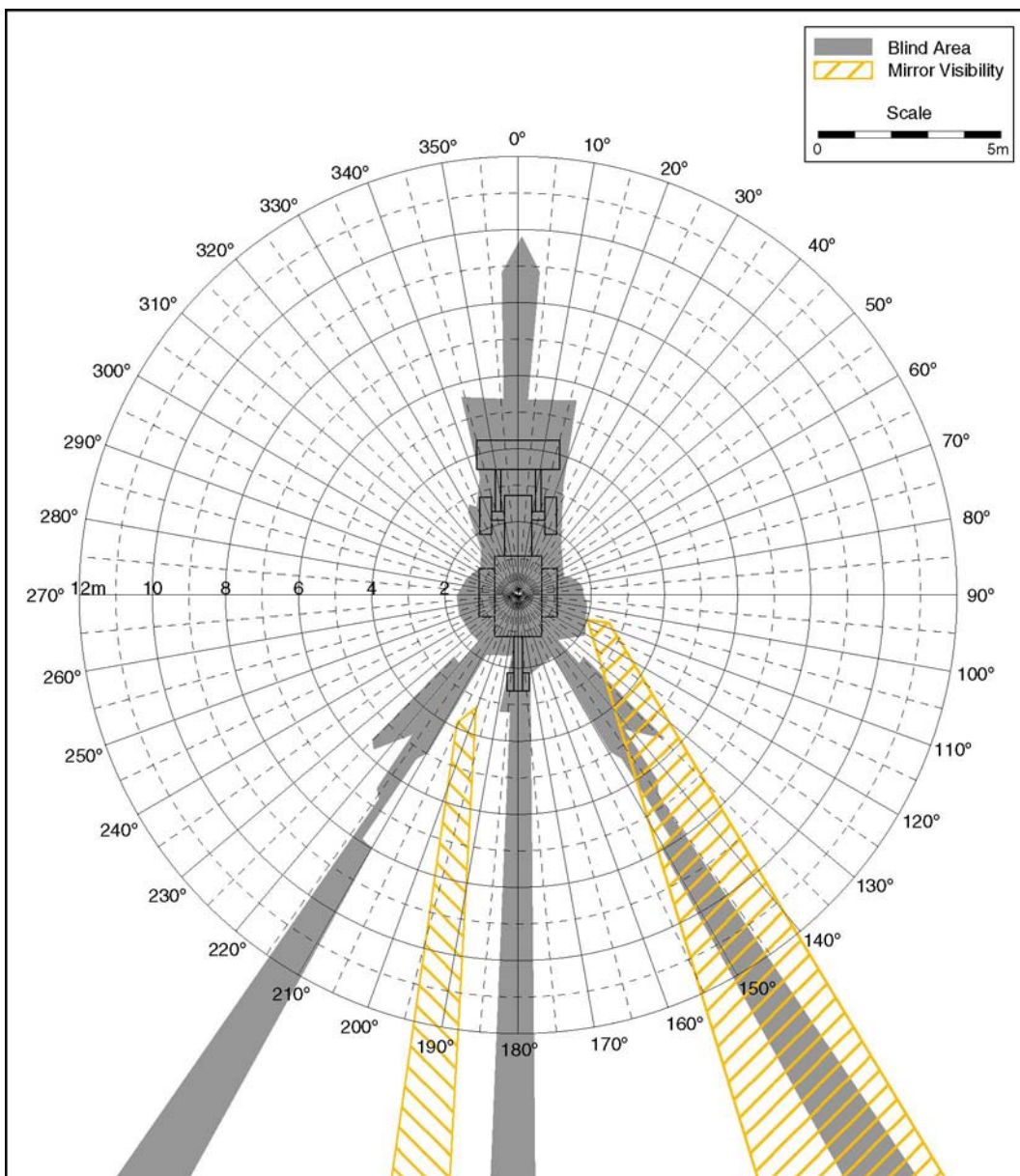
Blind Area Diagram for Construction Vehicle – Ground Plane

BHLoader (Manufacturer and Model)	Terex TX760
GVW	15,820 lb
Serial #	J02144
Machine Dimensions	7' 7" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



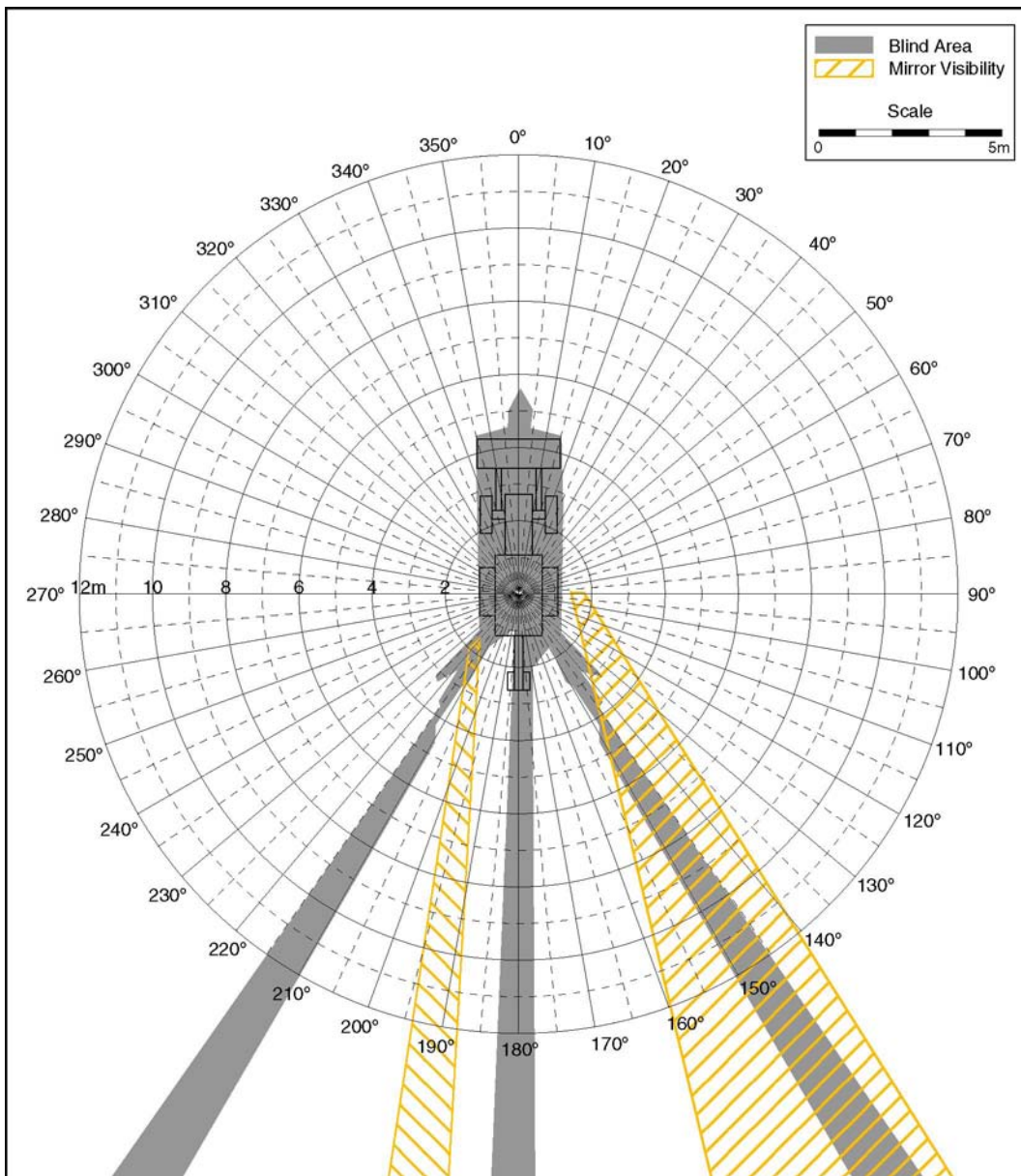
Blind Area Diagram for Construction Vehicle – 900 mm Plane

BHLoader (Manufacturer and Model)	Terex TX760
GVW	15,820 lb
Serial #	J02144
Machine Dimensions	7' 7" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



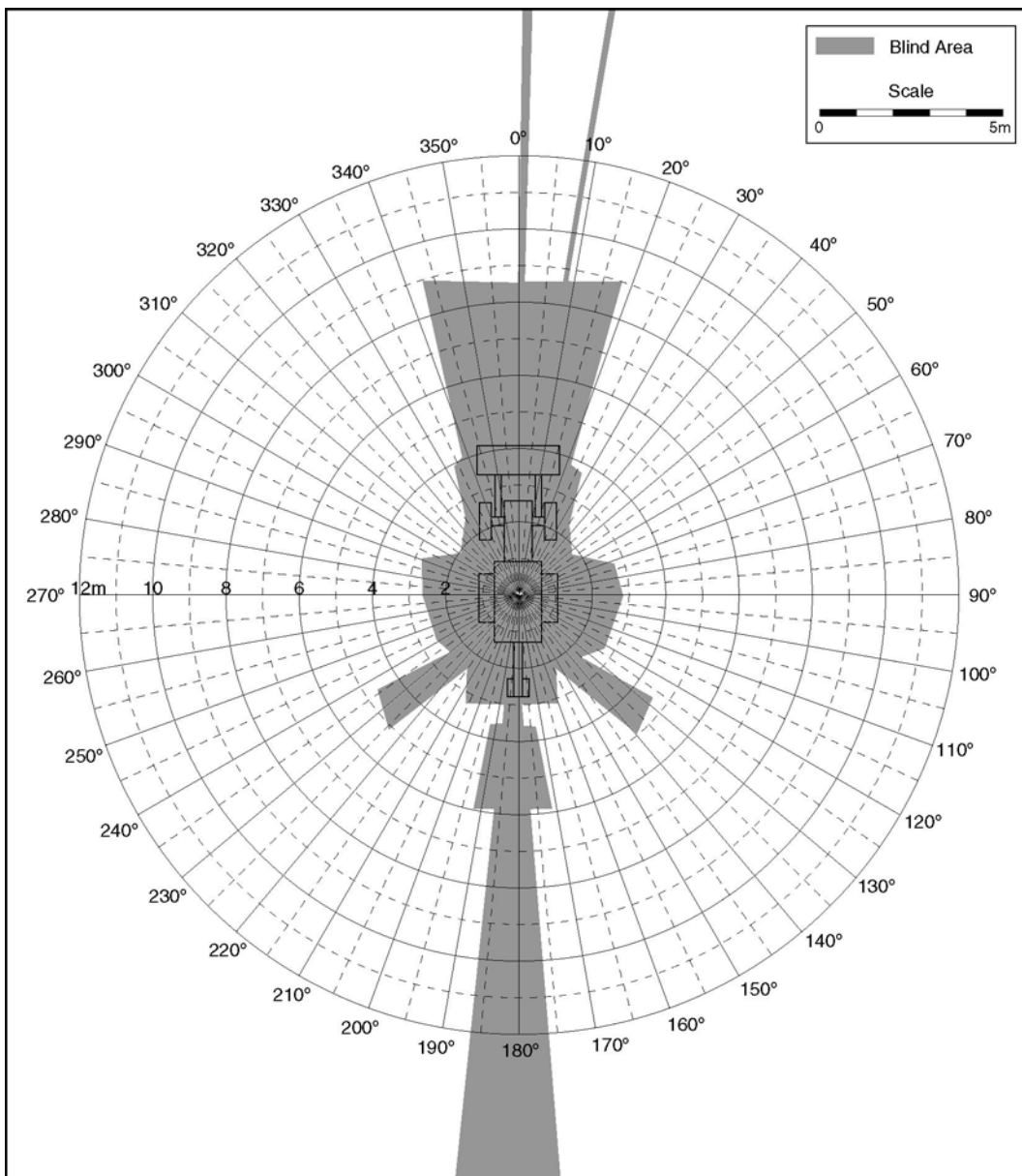
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

BHLoader (Manufacturer and Model)	Terex TX760
GVW	15,820 lb
Serial #	J02144
Machine Dimensions	7' 7" wide 23' 8" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



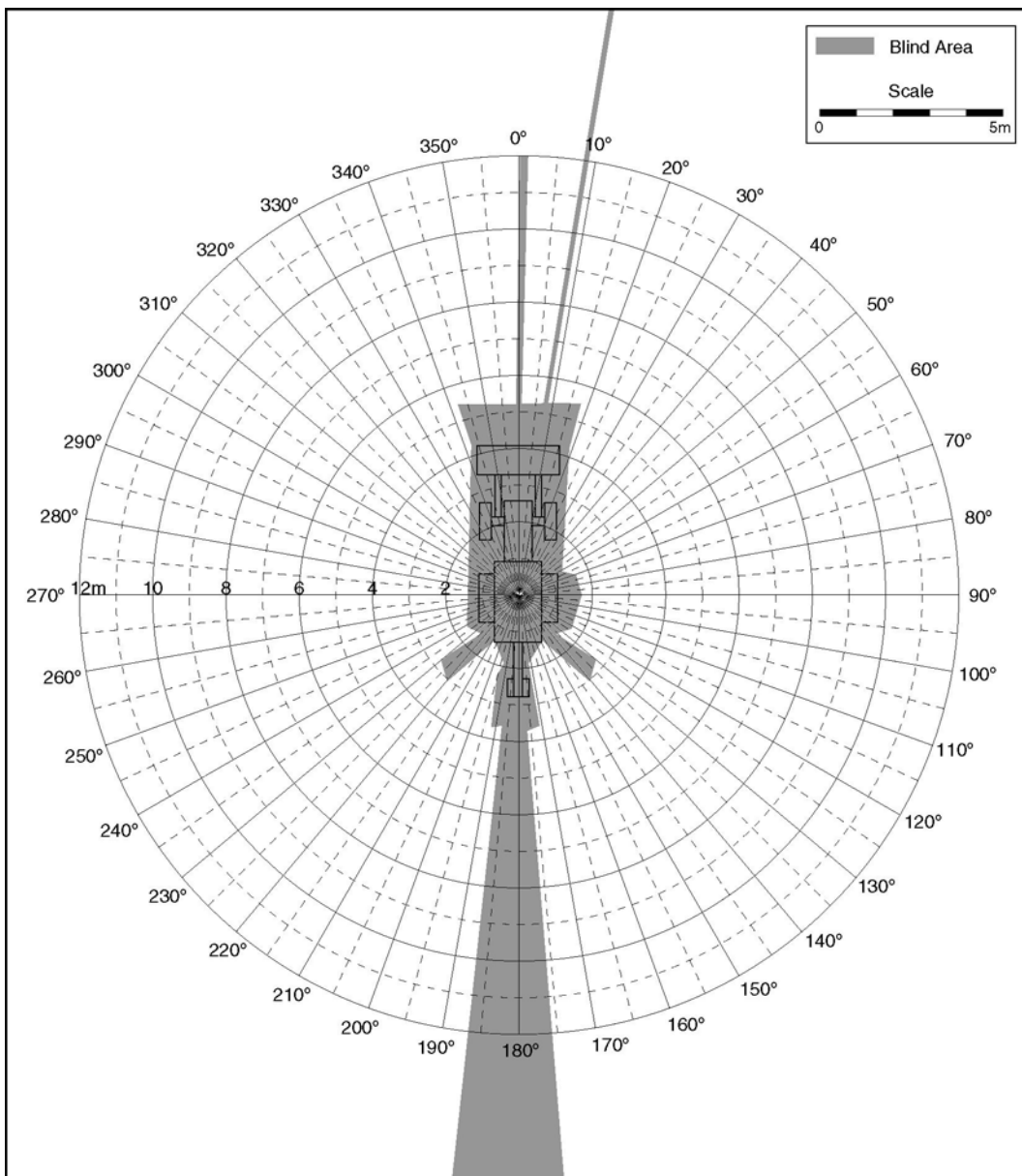
Blind Area Diagram for Construction Vehicle – Ground Plane

BHLoader (Manufacturer and Model)	Cat 430D
GVW	16,217 lb
Serial #	1A12572
Machine Dimensions	10' 7" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



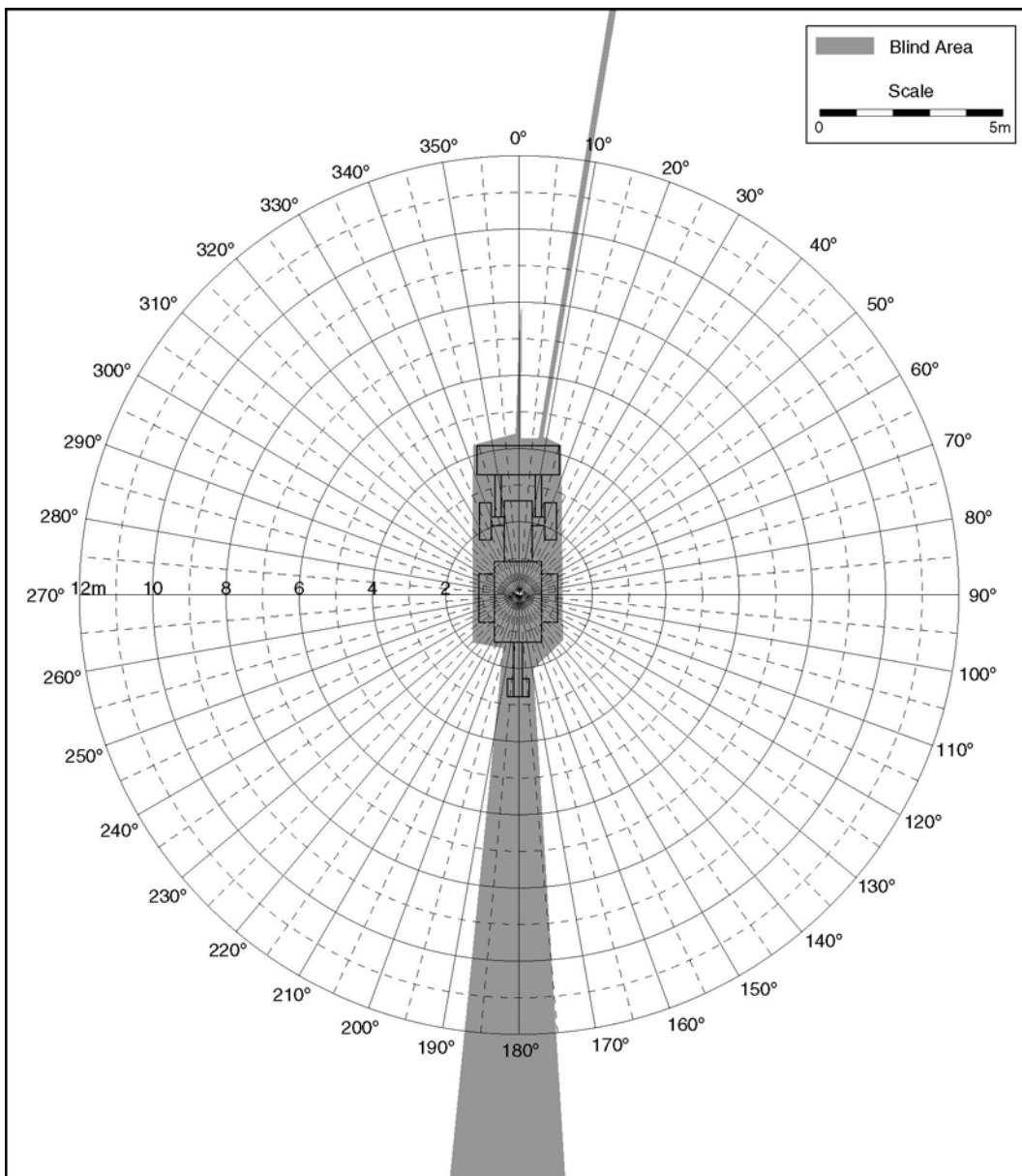
Blind Area Diagram for Construction Vehicle – 900 mm Plane

BHLoader (Manufacturer and Model)	Cat 430D
GVW	16,217 lb
Serial #	1A12572
Machine Dimensions	10' 7" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



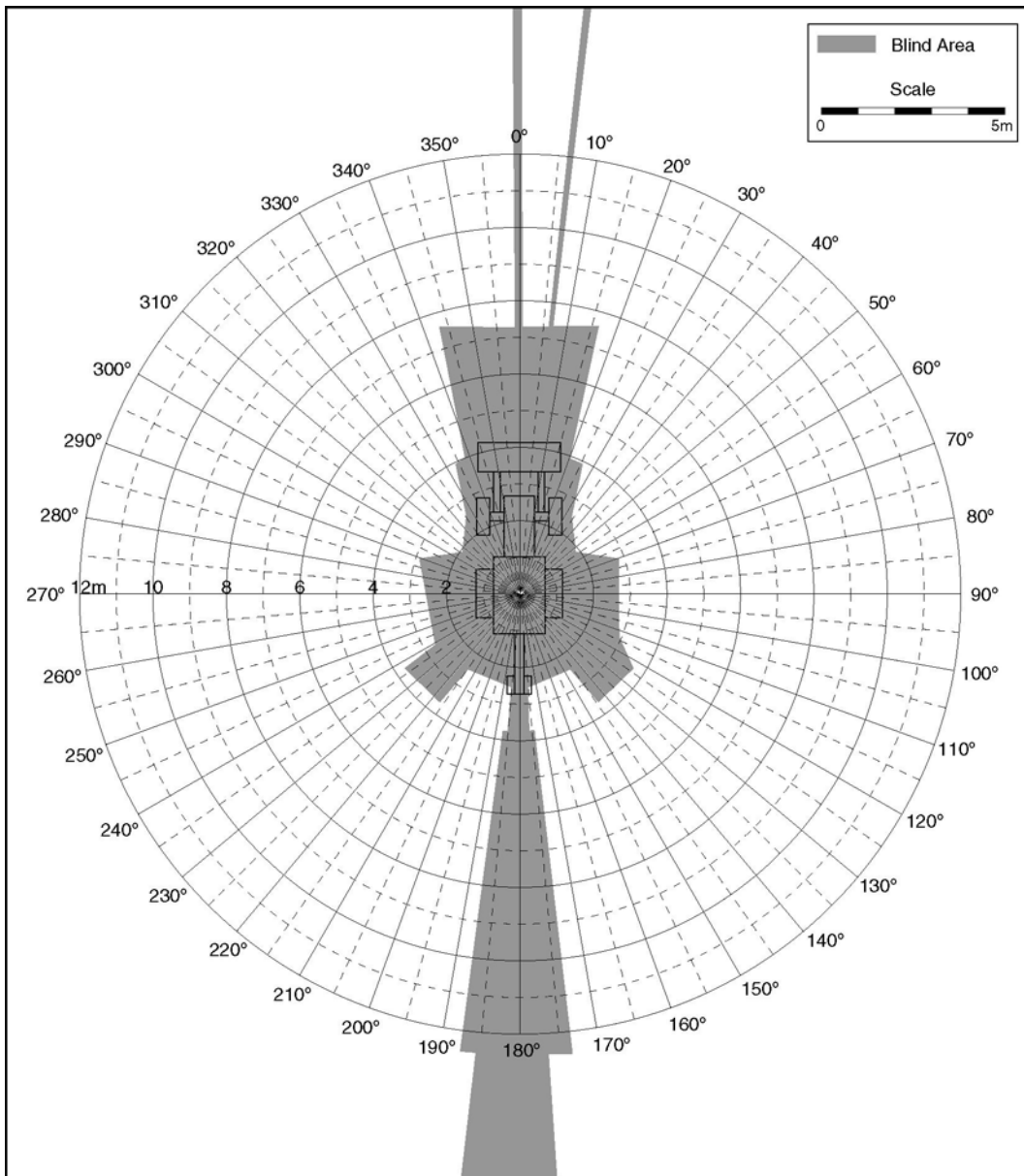
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

BHLoader (Manufacturer and Model)	Cat 430D
GVW	16,217 lb
Serial #	1A12572
Machine Dimensions	10' 7" wide 24' long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



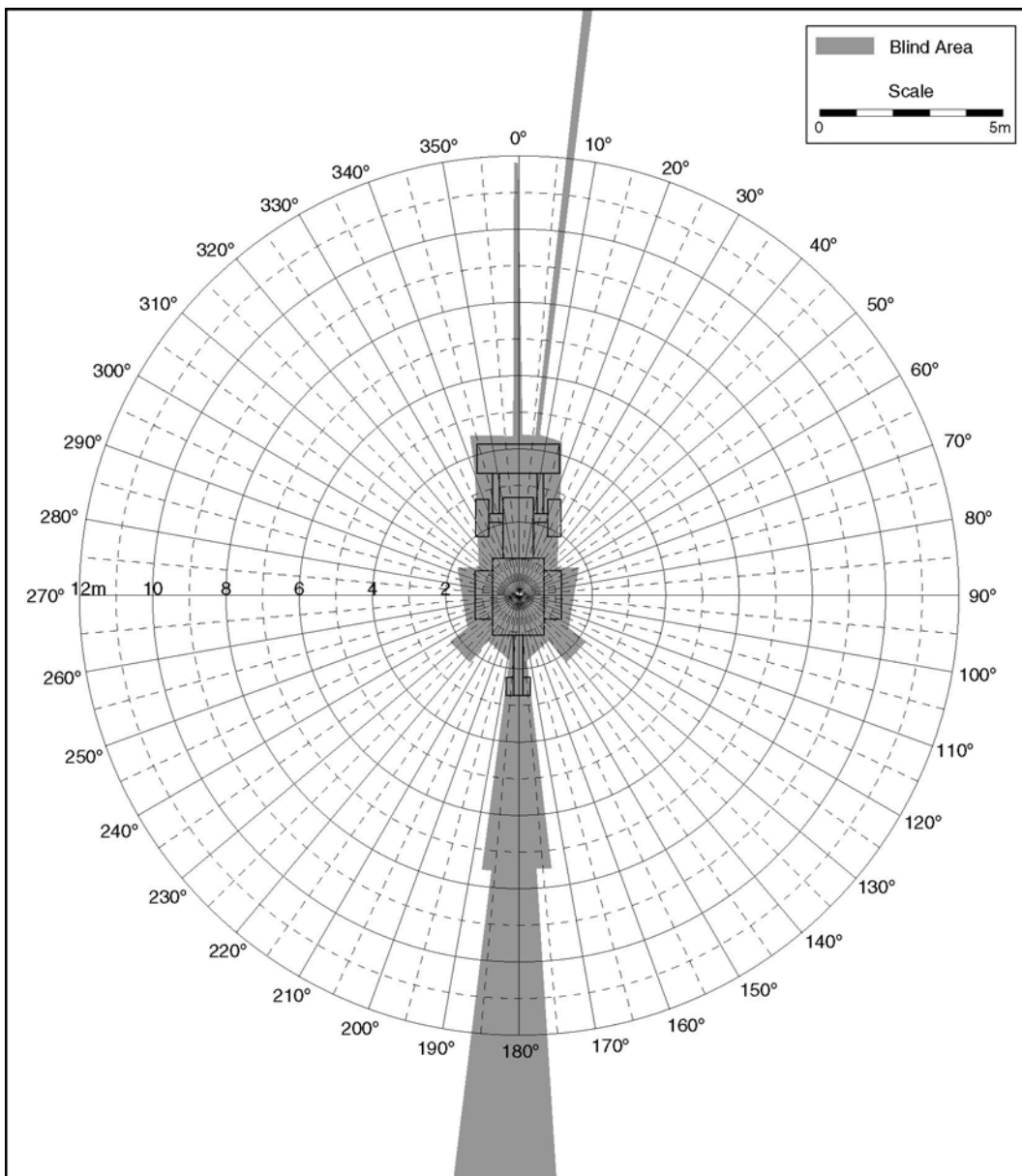
Blind Area Diagram for Construction Vehicle – Ground Plane

BHLoader (Manufacturer and Model)	Cat 416C
GVW	13,960 lb
Serial #	1A11922
Machine Dimensions	10' 7" wide 22' 10" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



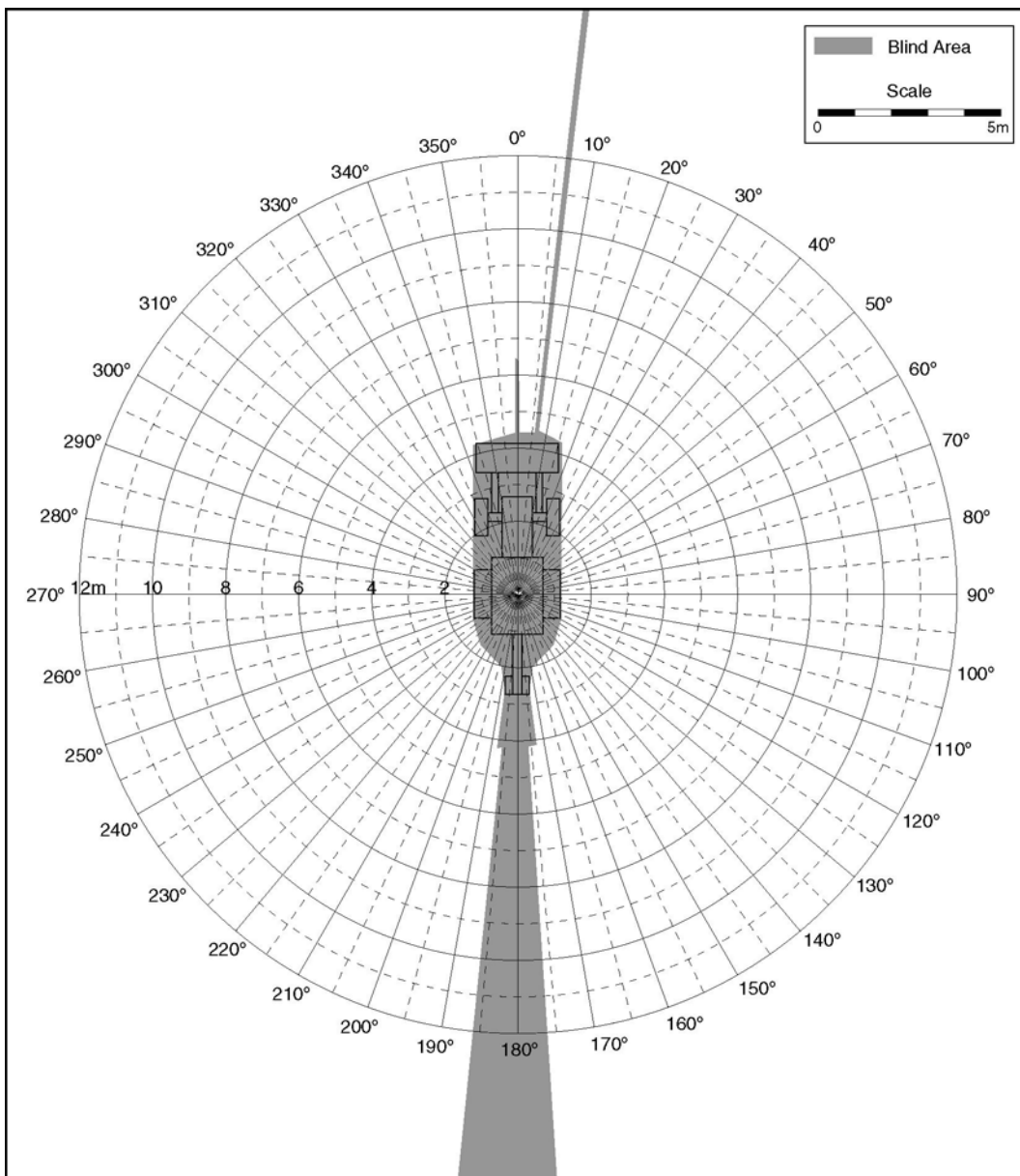
Blind Area Diagram for Construction Vehicle – 900 mm Plane

BHLoader (Manufacturer and Model)	Cat 416C
GVW	13,960 lb
Serial #	1A11922
Machine Dimensions	10' 7" wide 22' 10" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



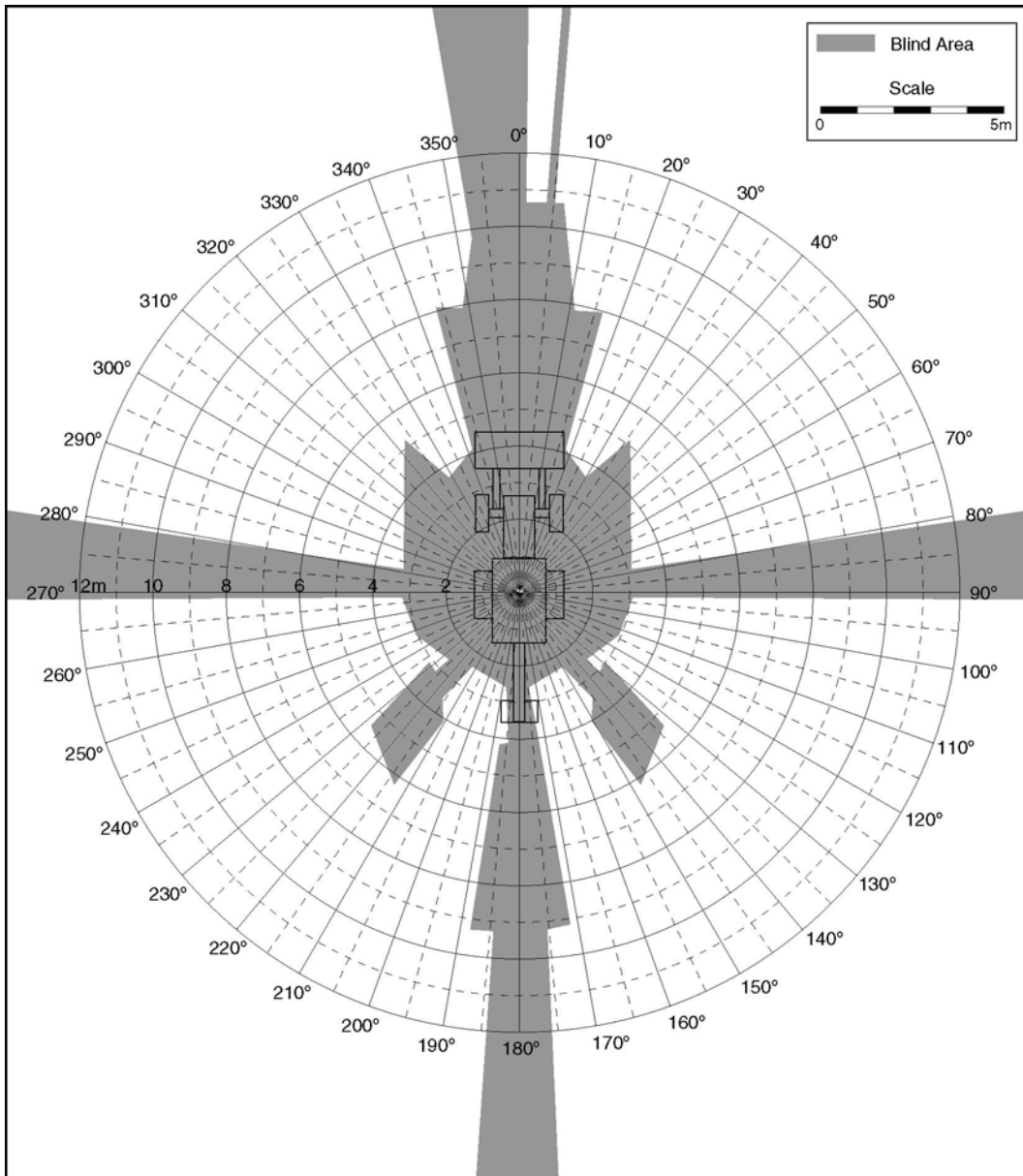
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

BHLoader (Manufacturer and Model)	Cat 416C
GVW	13,960 lb
Serial #	1A11922
Machine Dimensions	10' 7" wide 22' 10" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



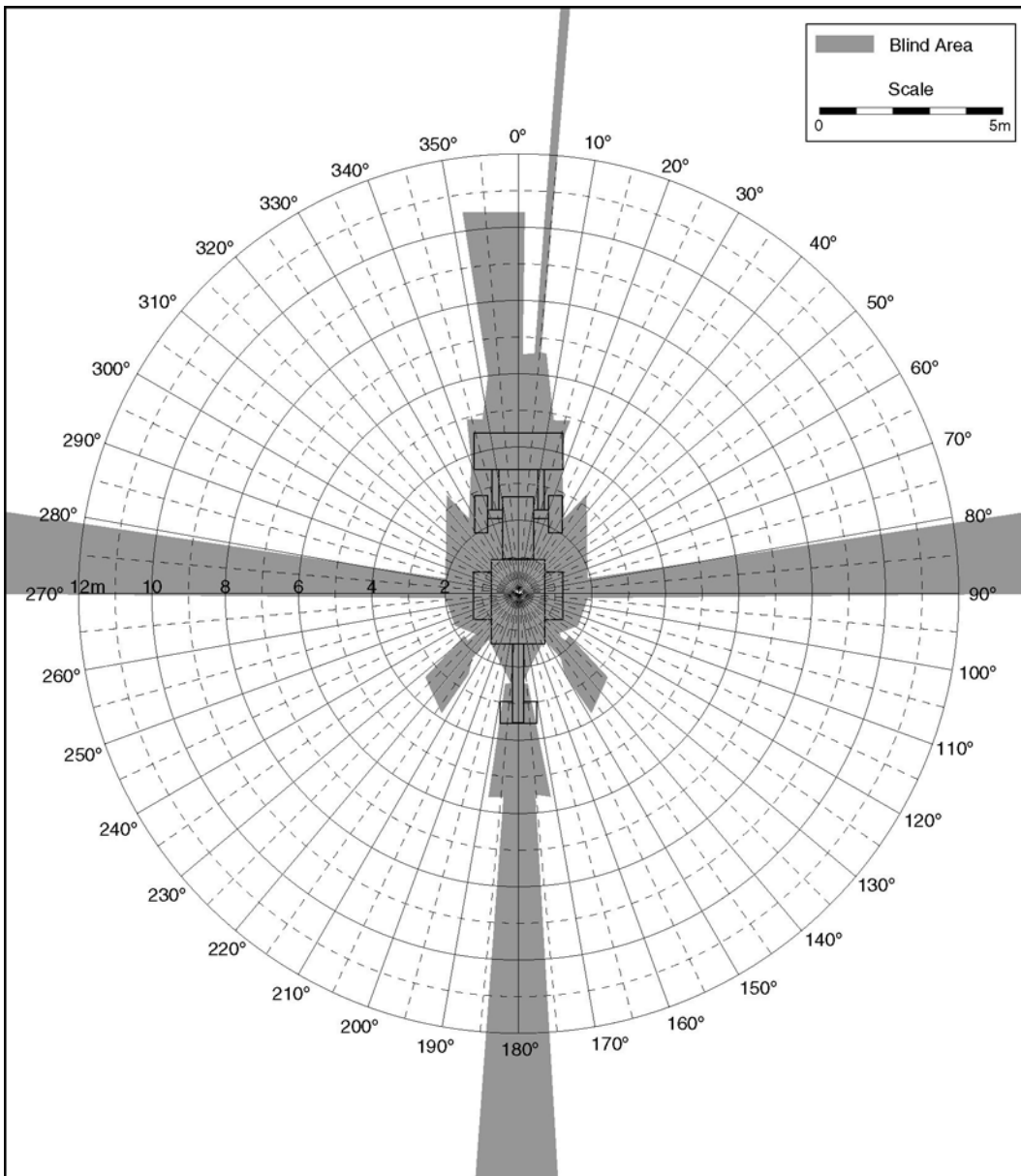
Blind Area Diagram for Construction Vehicle – Ground Plane

BHLoader (Manufacturer and Model)	Cat 446B
GVW	19,603 lb
Serial #	1A12941
Machine Dimensions	11' 10" wide 26' 4" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



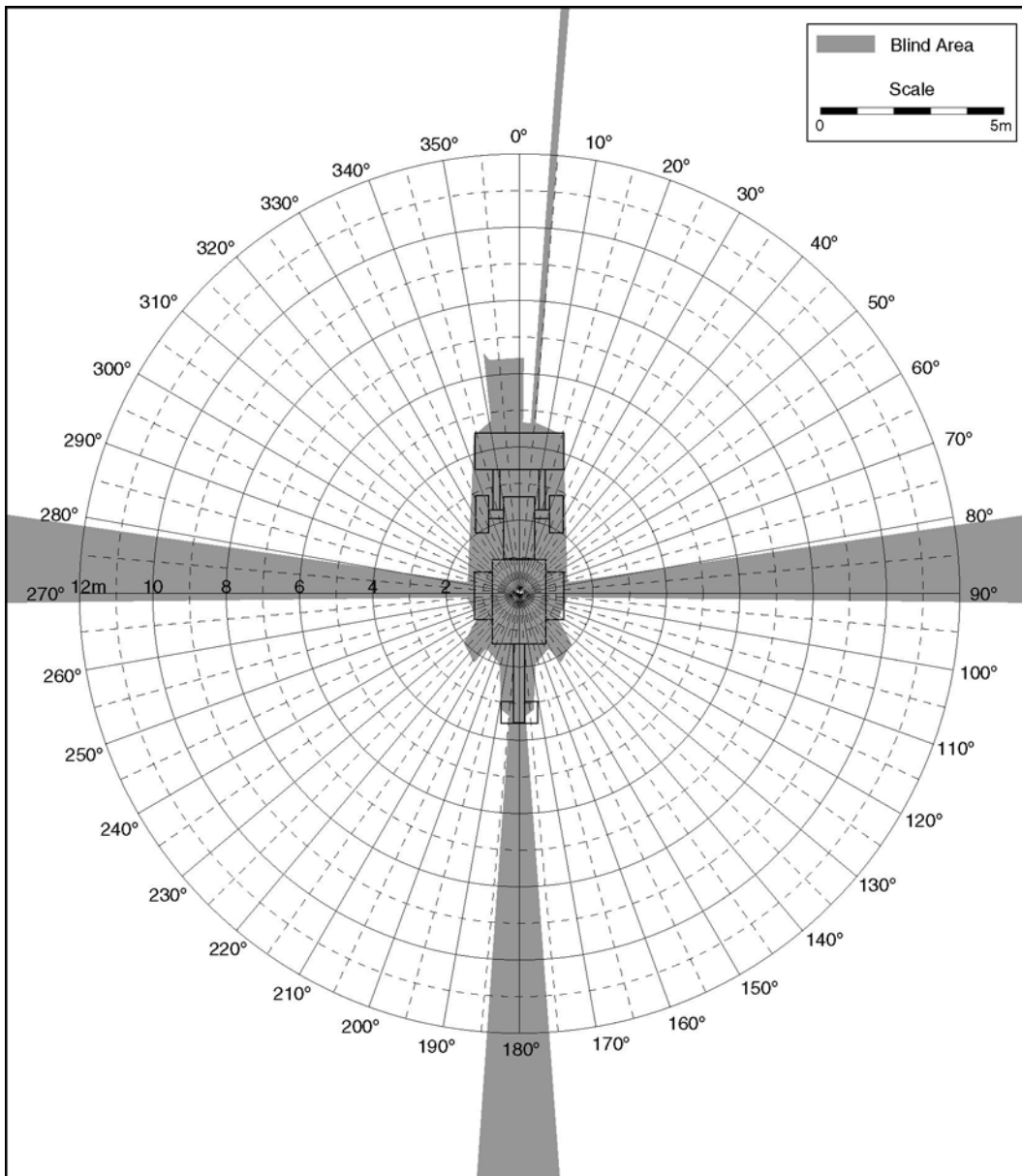
Blind Area Diagram for Construction Vehicle – 900 mm Plane

BHLoader (Manufacturer and Model)	Cat 446B
GVW	19,603 lb
Serial #	1A12941
Machine Dimensions	11' 10" wide 26' 4" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



Blind Area Diagram for Construction Vehicle – 1500 mm Plane

BHLoader (Manufacturer and Model)	Cat 446B
GVW	19,603 lb
Serial #	1A12941
Machine Dimensions	11' 10" wide 26' 4" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



Caterpillar Inc.
PO Box 1875
Peoria, Illinois 61656-1875

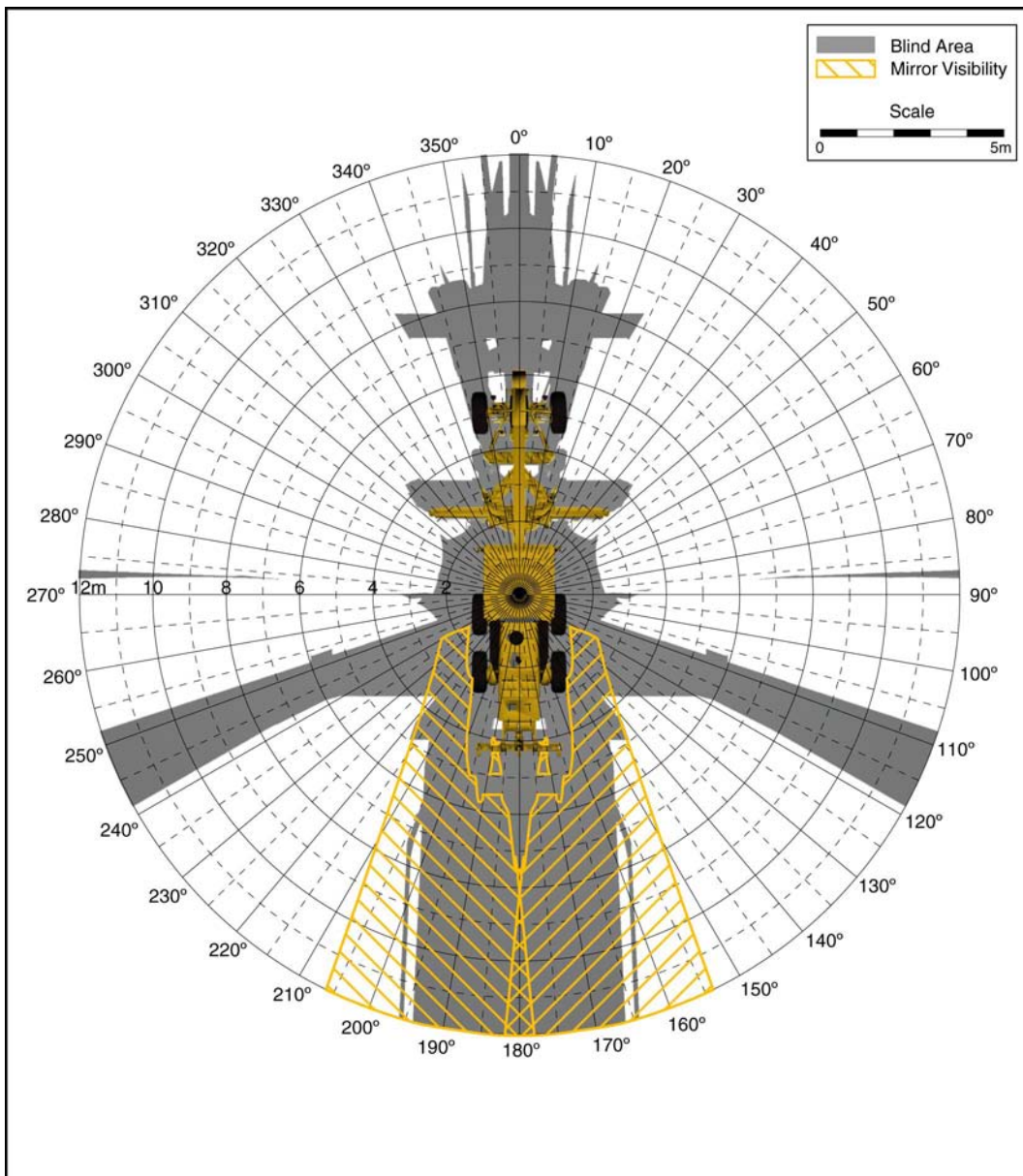
Contract # 200-2002-00563

Grader / Scraper

Cat 12G
Volvo G726
Cat 611
Cat 623

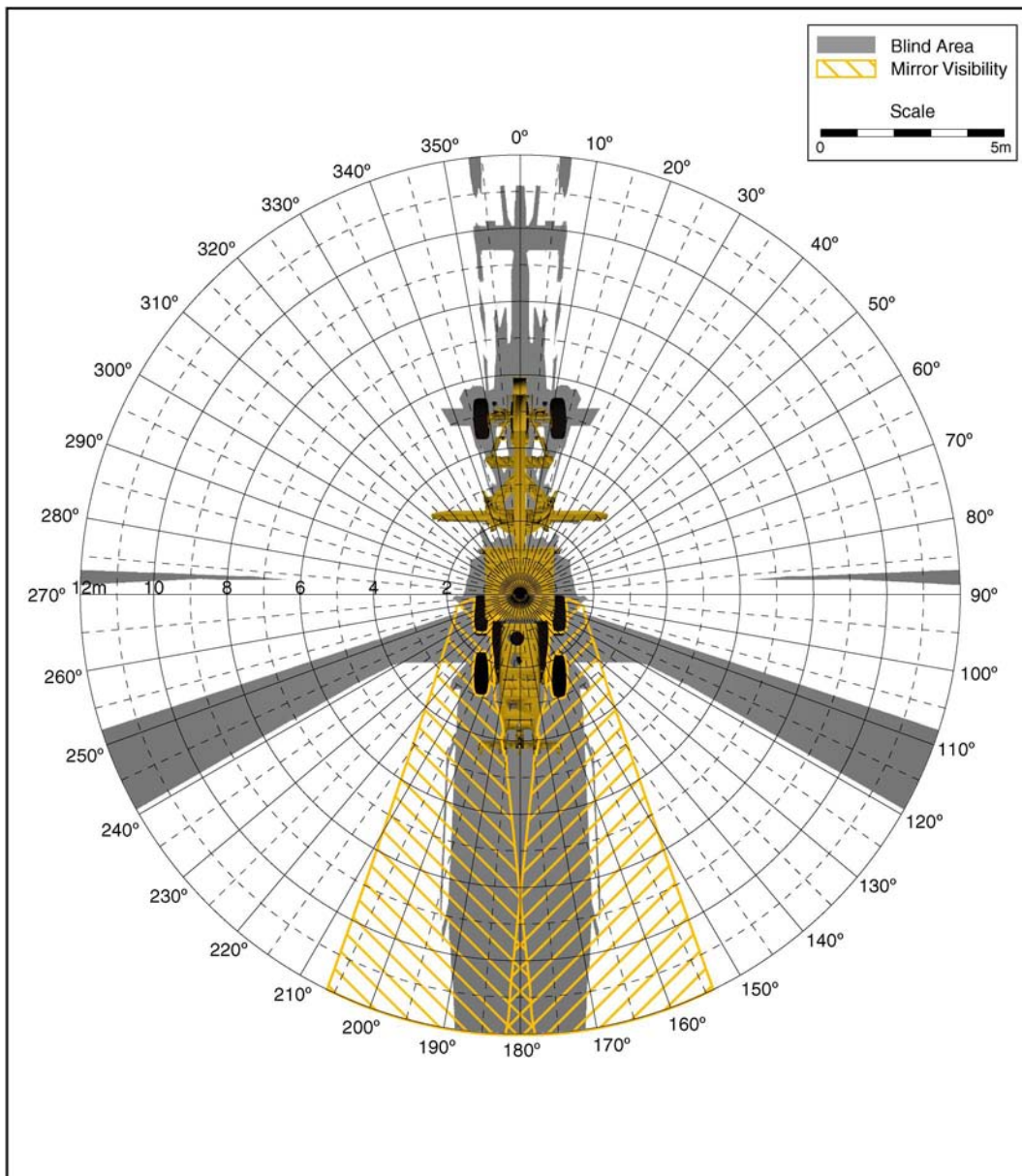
Blind Area Diagram for Construction Vehicle – Ground Plane

Grader (Manufacturer and Model)	Cat 12G
GVW	31,410 lb
Serial #	61Mxxxxxxx
Machine Dimensions	8' 2" wide 28'
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer



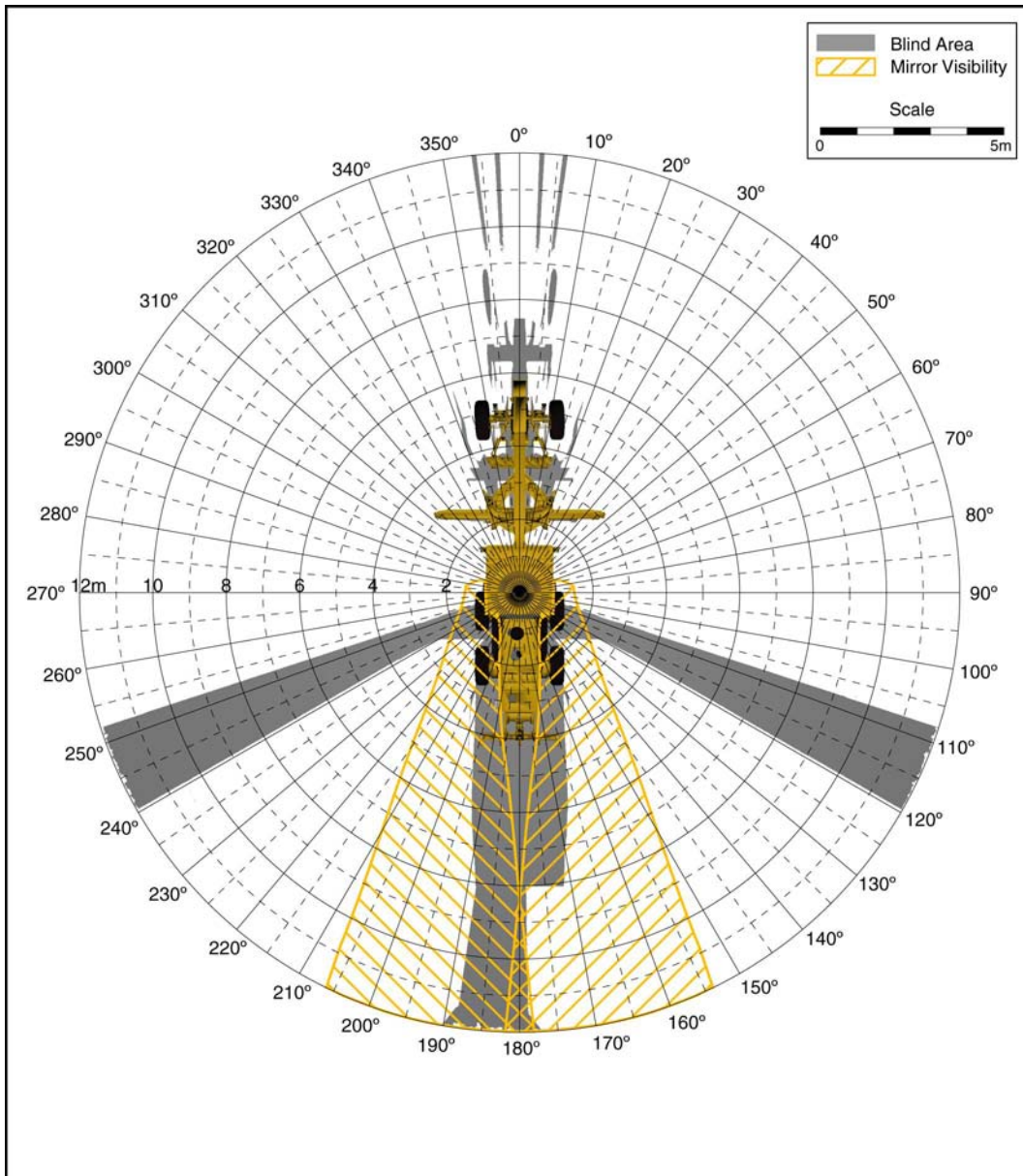
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Grader (Manufacturer and Model)	Cat 12G
GVW	31,410 lb
Serial #	61Mxxxxxxx
Machine Dimensions	8' 2" wide 28'
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer



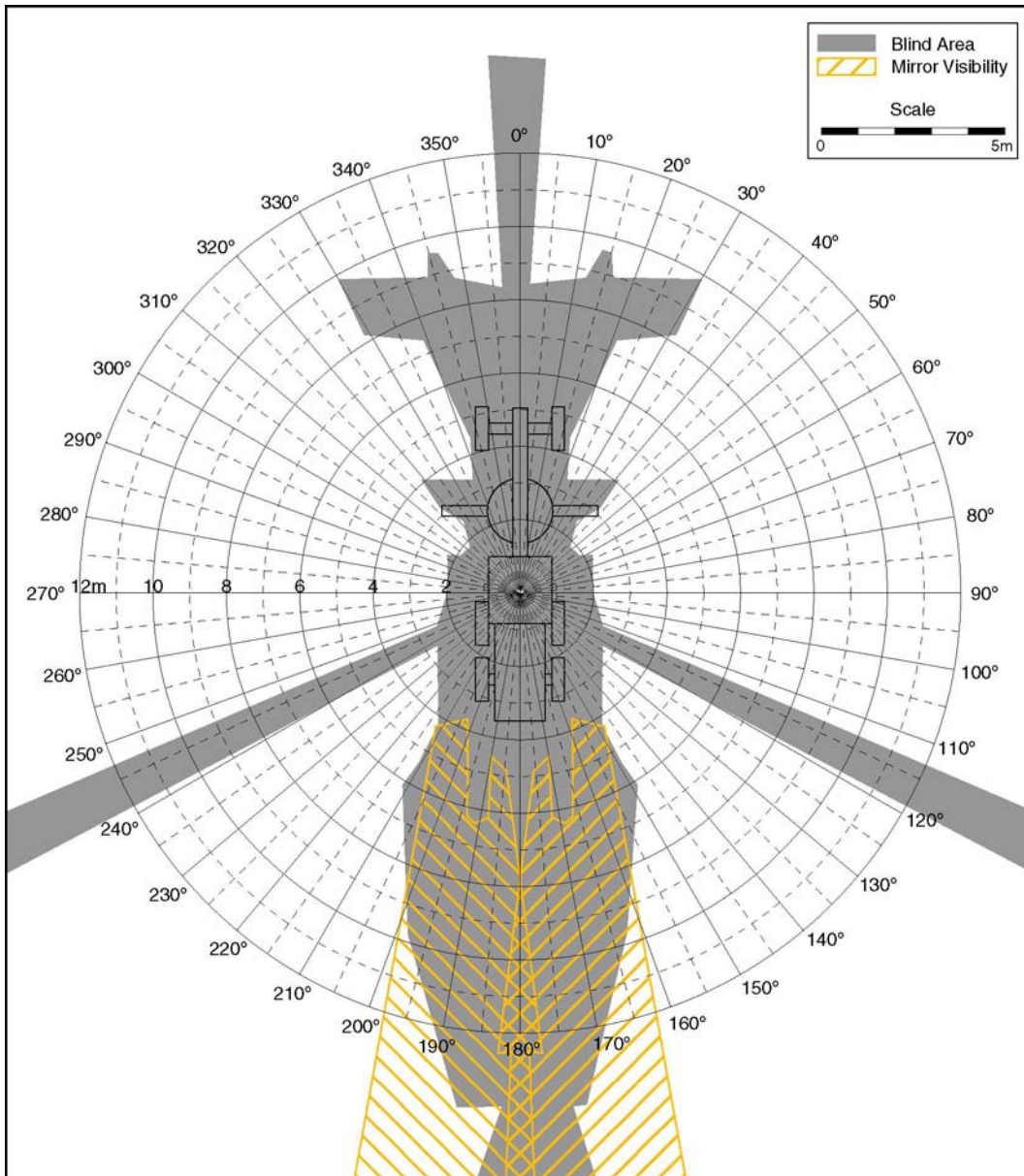
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Grader (Manufacturer and Model)	Cat 12G
GVW	31,410 lb
Serial #	61Mxxxxxxx
Machine Dimensions	8' 2" wide 28'
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Computer



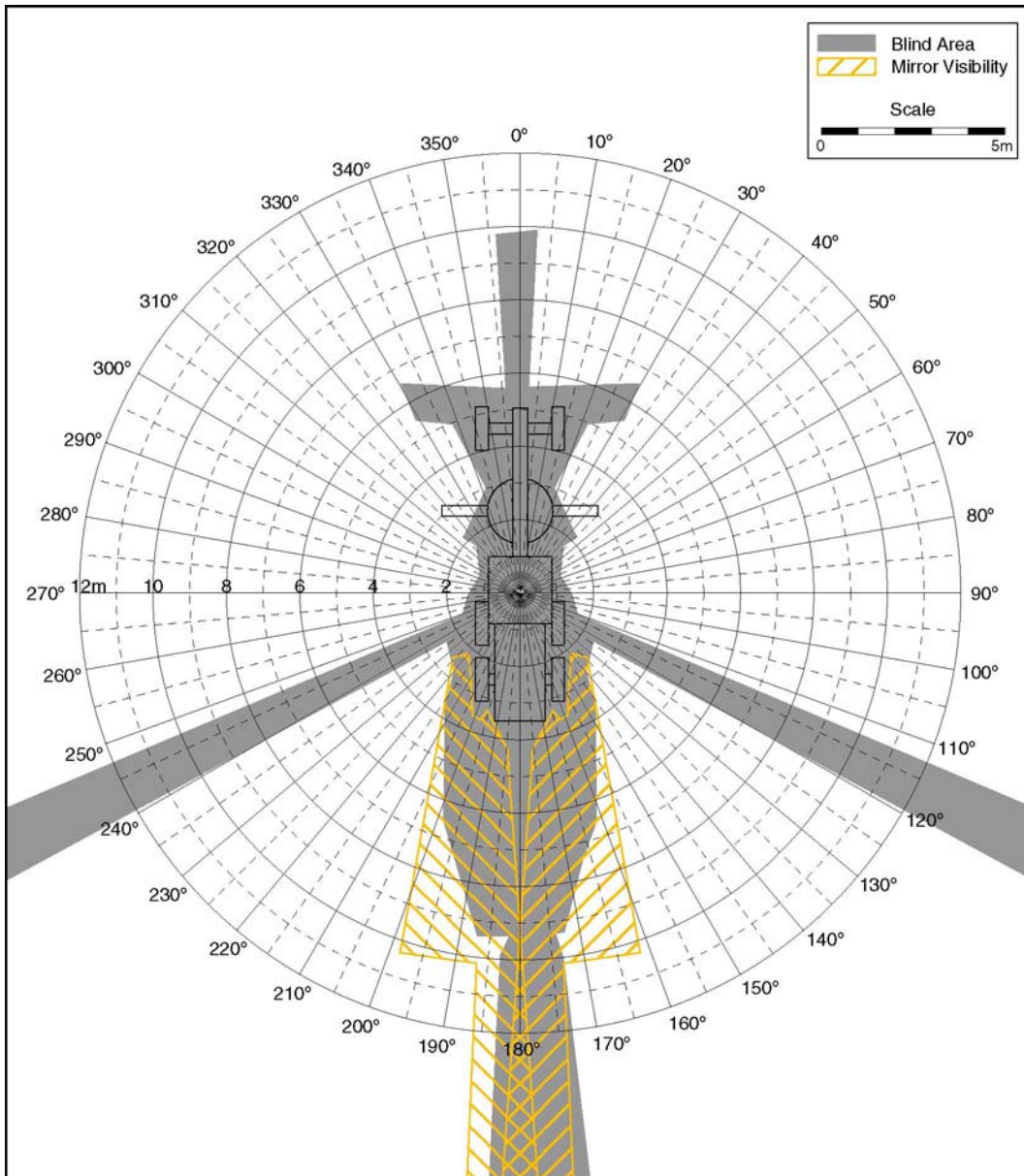
Blind Area Diagram for Construction Machine – Ground Plane

Grader (Manufacturer and Model)	Volvo G726
GVW	35,400 lb
Serial #	33192
Machine Dimensions	8' 4" wide 29' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



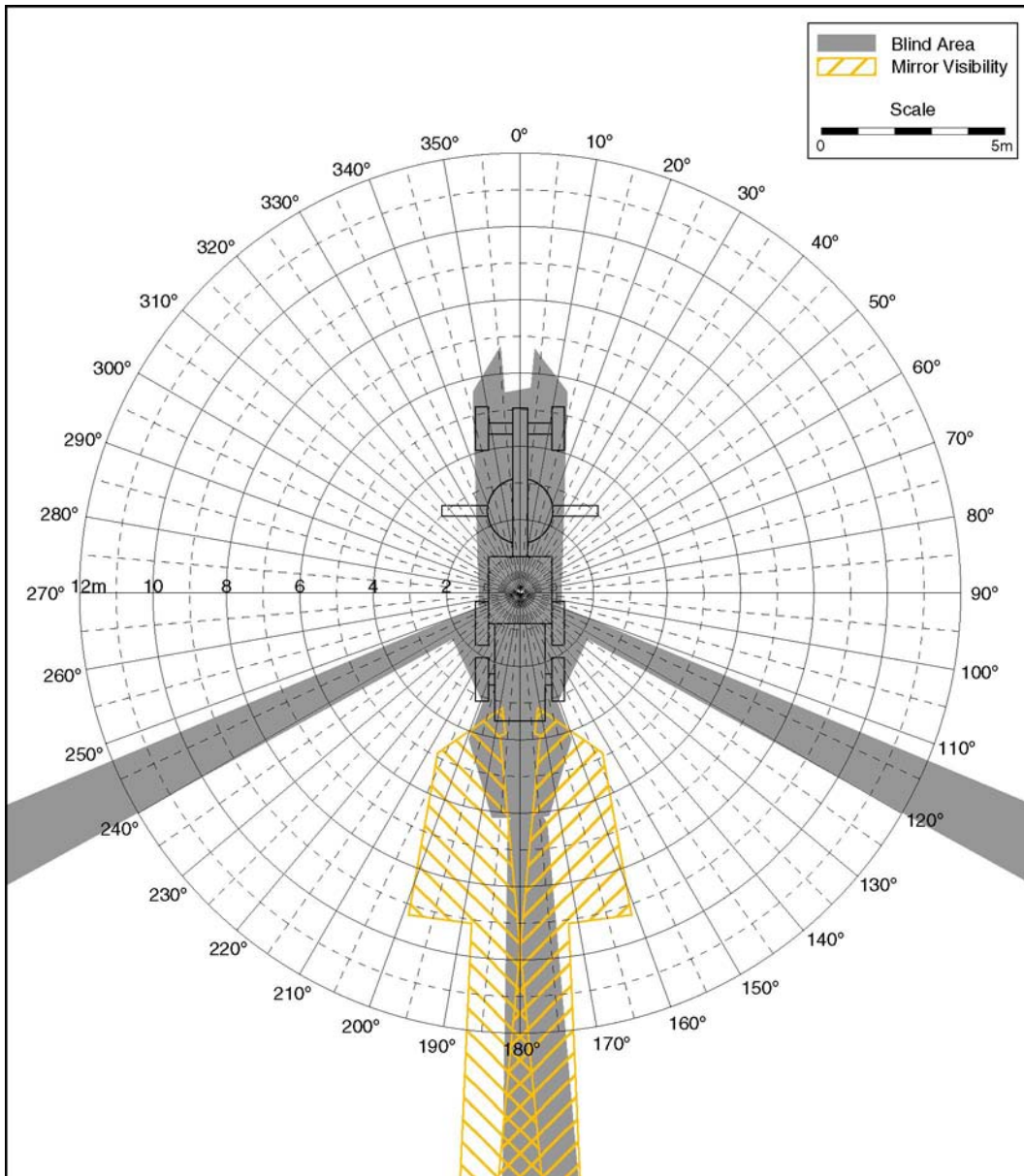
Blind Area Diagram for Construction Machine – 900 mm Plane

Grader (Manufacturer and Model)	Volvo G726
GVW	35,400 lb
Serial #	33192
Machine Dimensions	8' 4" wide 29' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



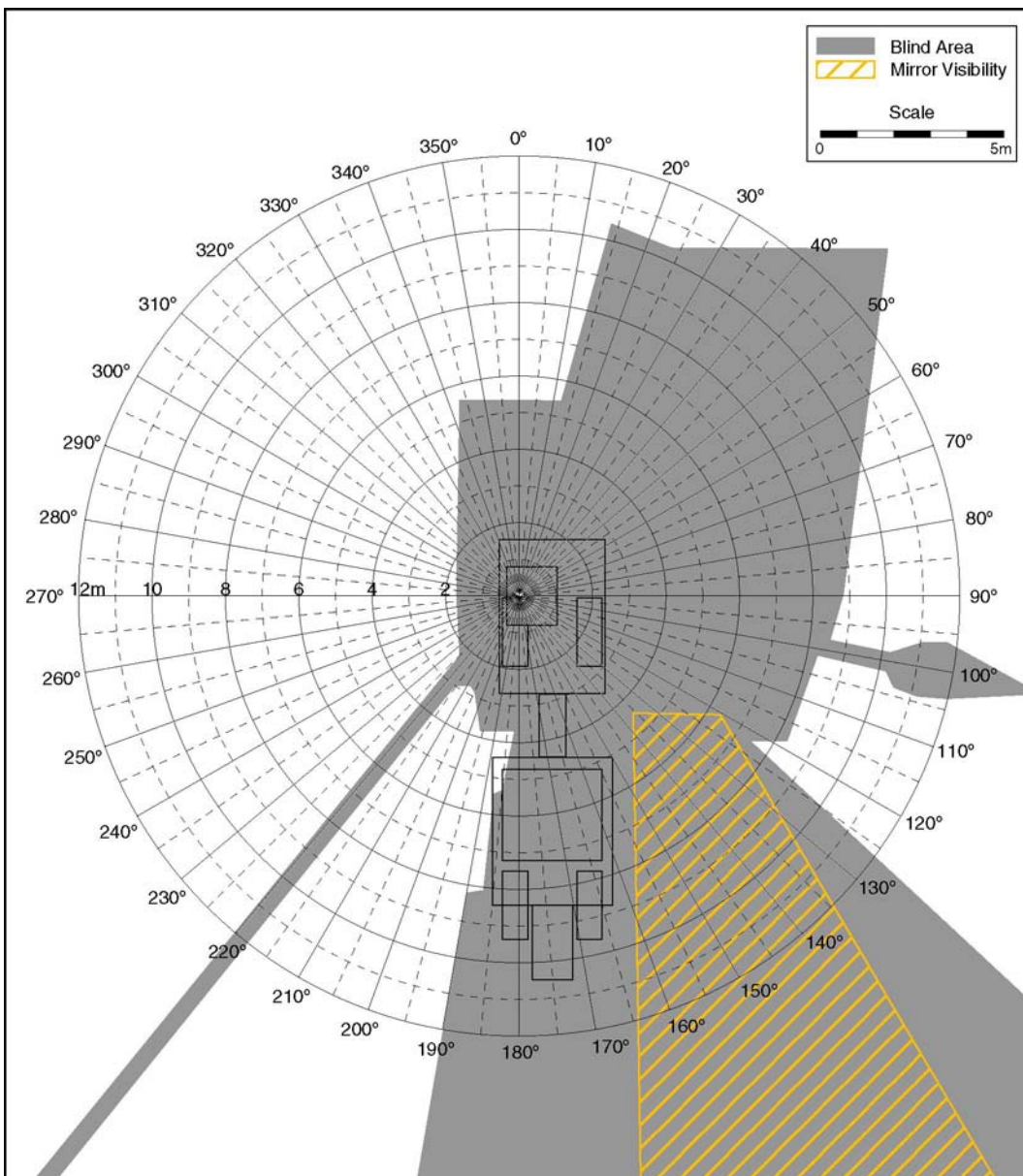
Blind Area Diagram for Construction Machine – 1500 mm Plane

Grader (Manufacturer and Model)	Volvo G726
GVW	35,400 lb
Serial #	33192
Machine Dimensions	8' 4" wide 29' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



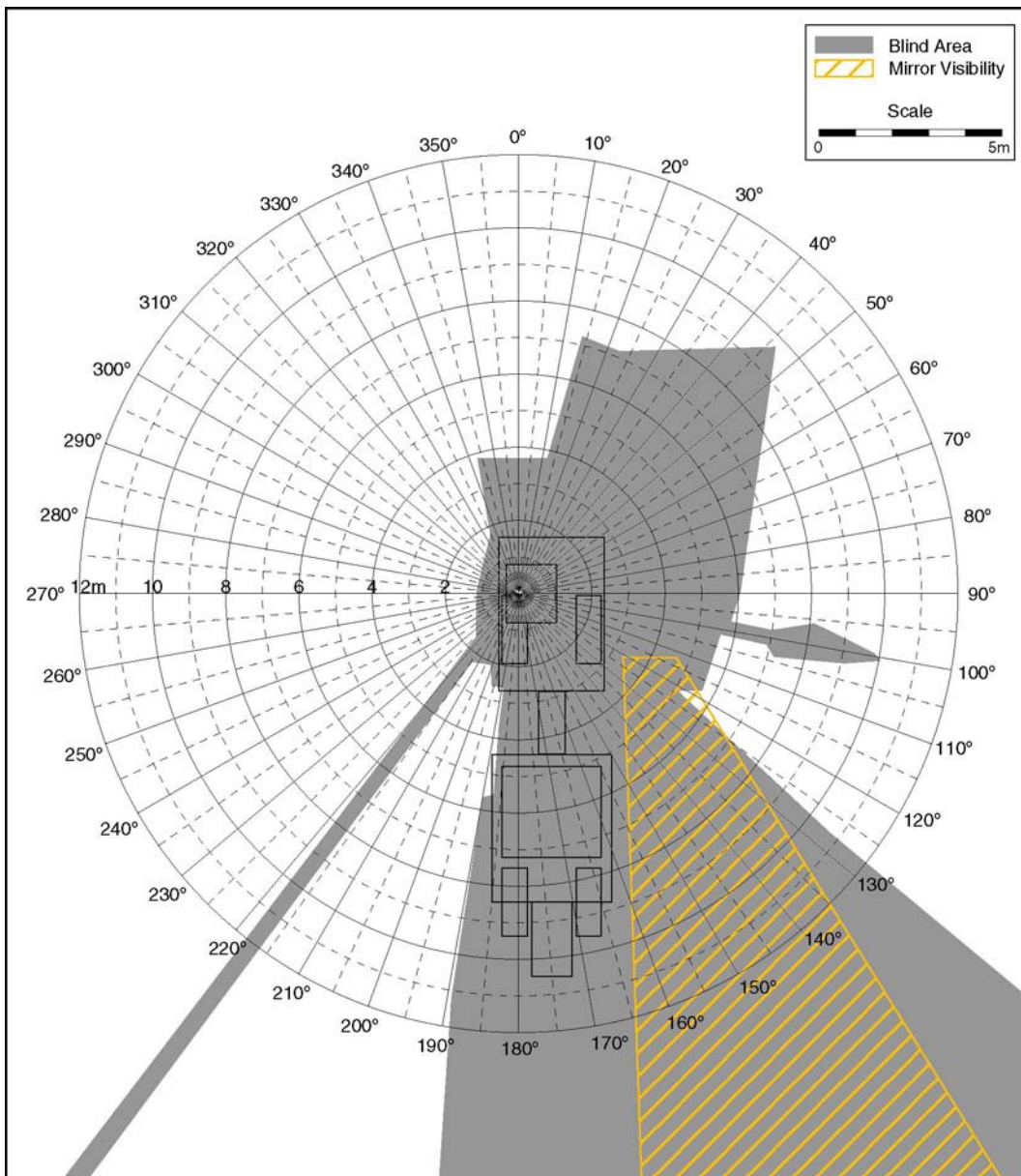
Blind Area Diagram for Construction Vehicle – Ground Plane

Scraper (Manufacturer and Model)	Cat 611
GVW	11/15yd ³
Serial #	6SZ00181
Machine Dimensions	9' 11" wide 39' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



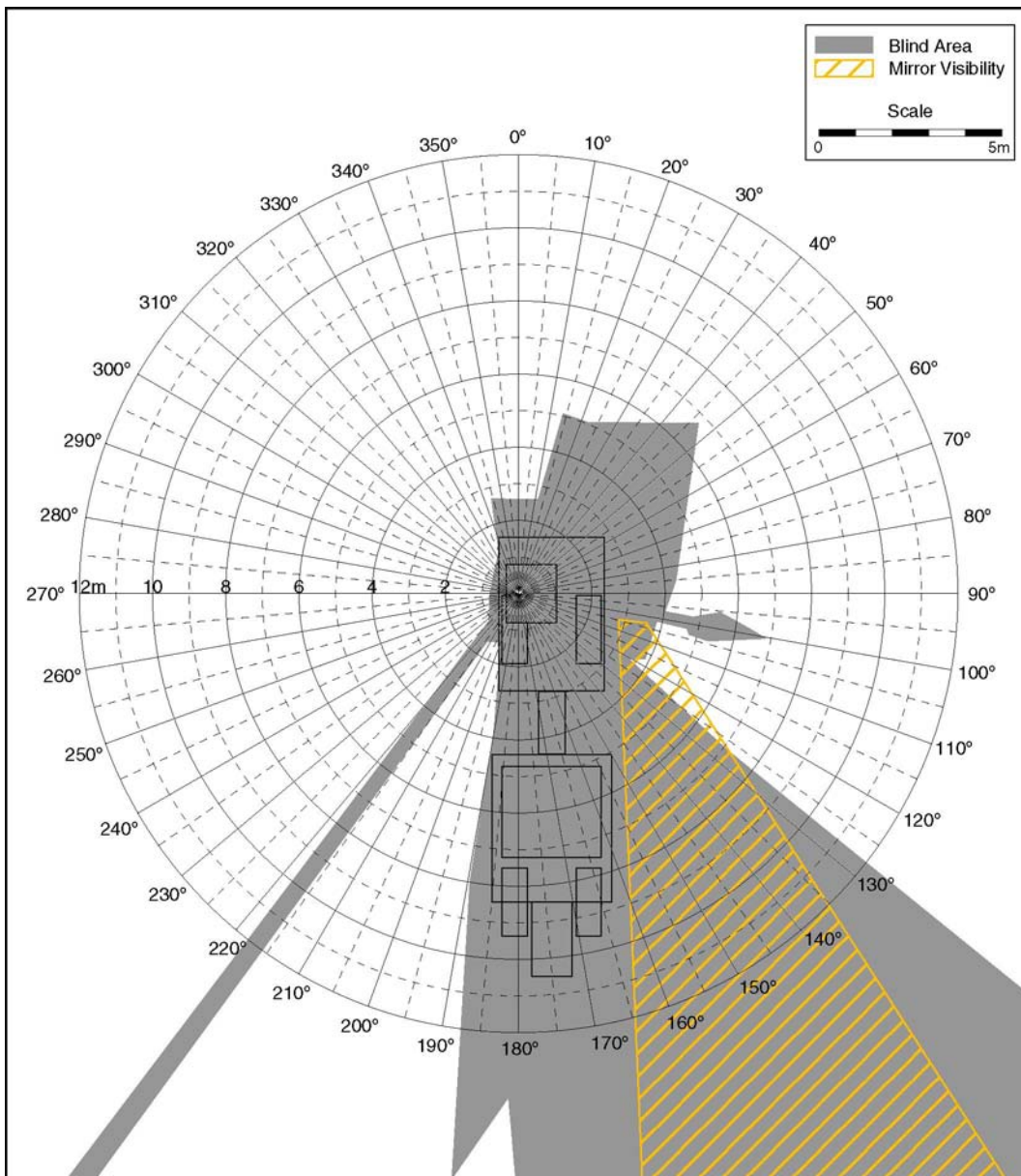
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Scraper (Manufacturer and Model)	Cat 611
GVW	11/15yd ³
Serial #	6SZ00181
Machine Dimensions	9' 11" wide 39' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



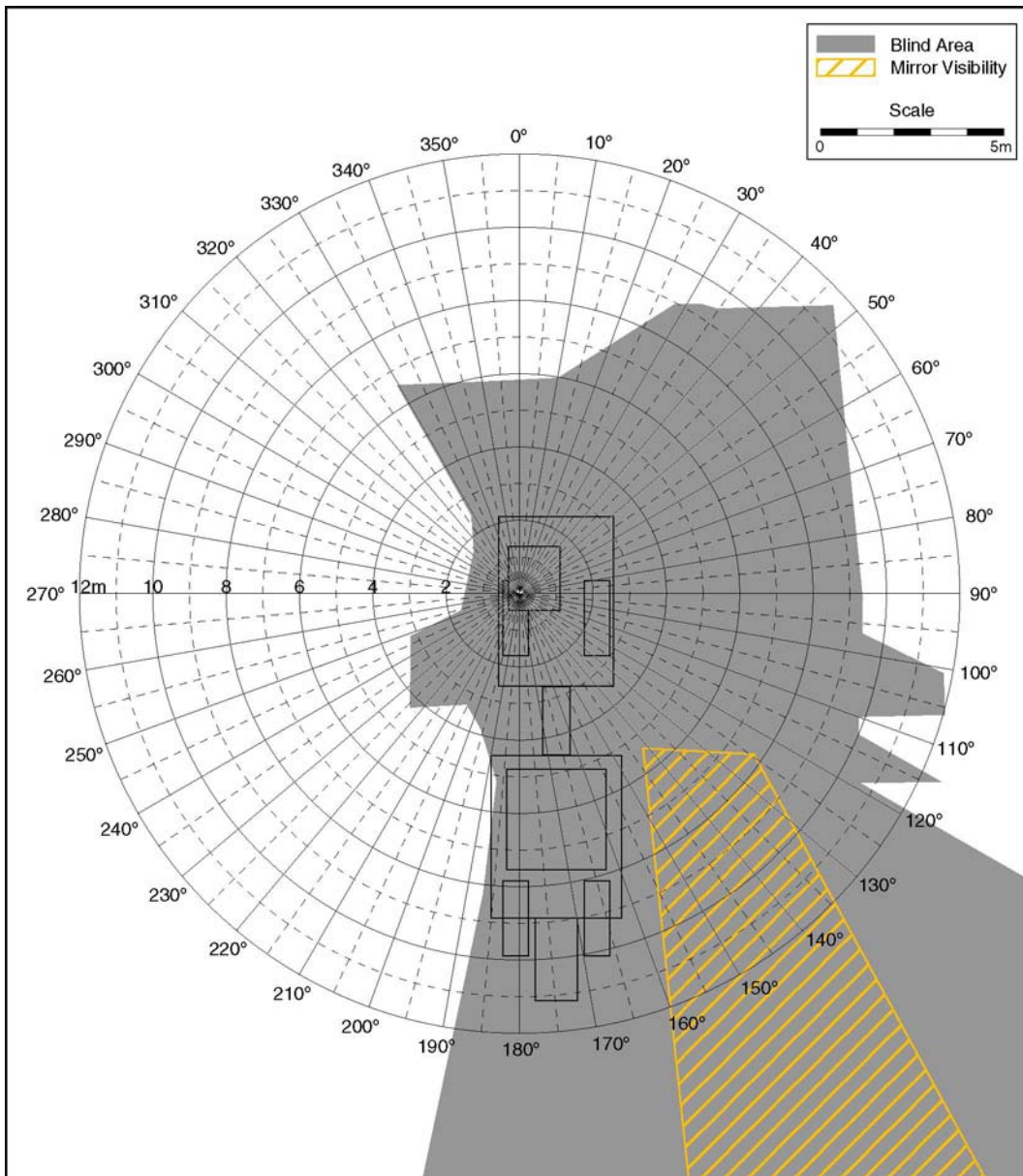
Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Scraper (Manufacturer and Model)	Cat 611
GVW	11/15yd ³
Serial #	6SZ00181
Machine Dimensions	9' 11" wide 39' 5" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



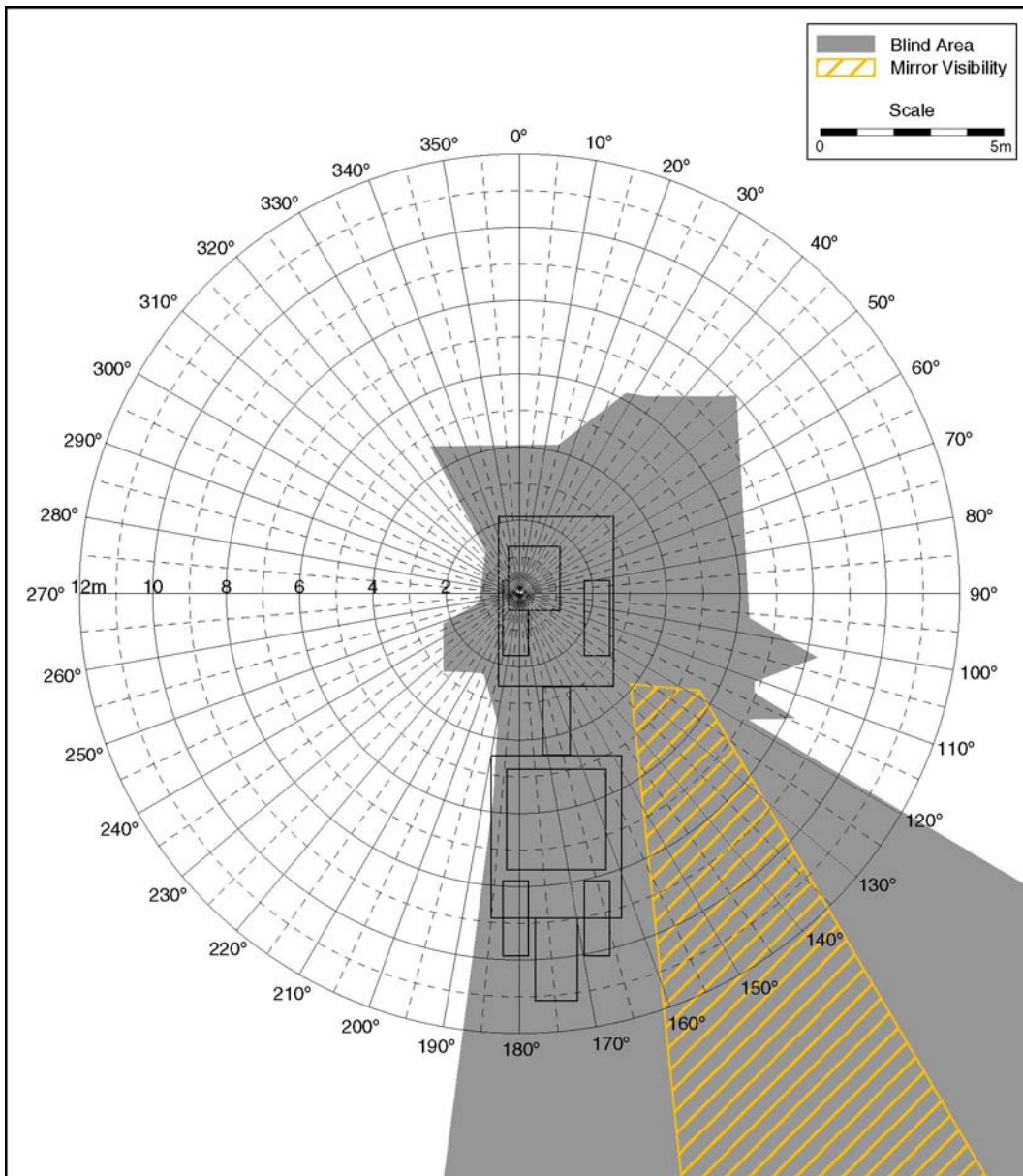
Blind Area Diagram for Construction Vehicle – Ground Plane

Scraper (Manufacturer and Model)	Cat 623G
GVW	18/23yd ³
Serial #	1A11928
Machine Dimensions	11' 8" wide 41' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



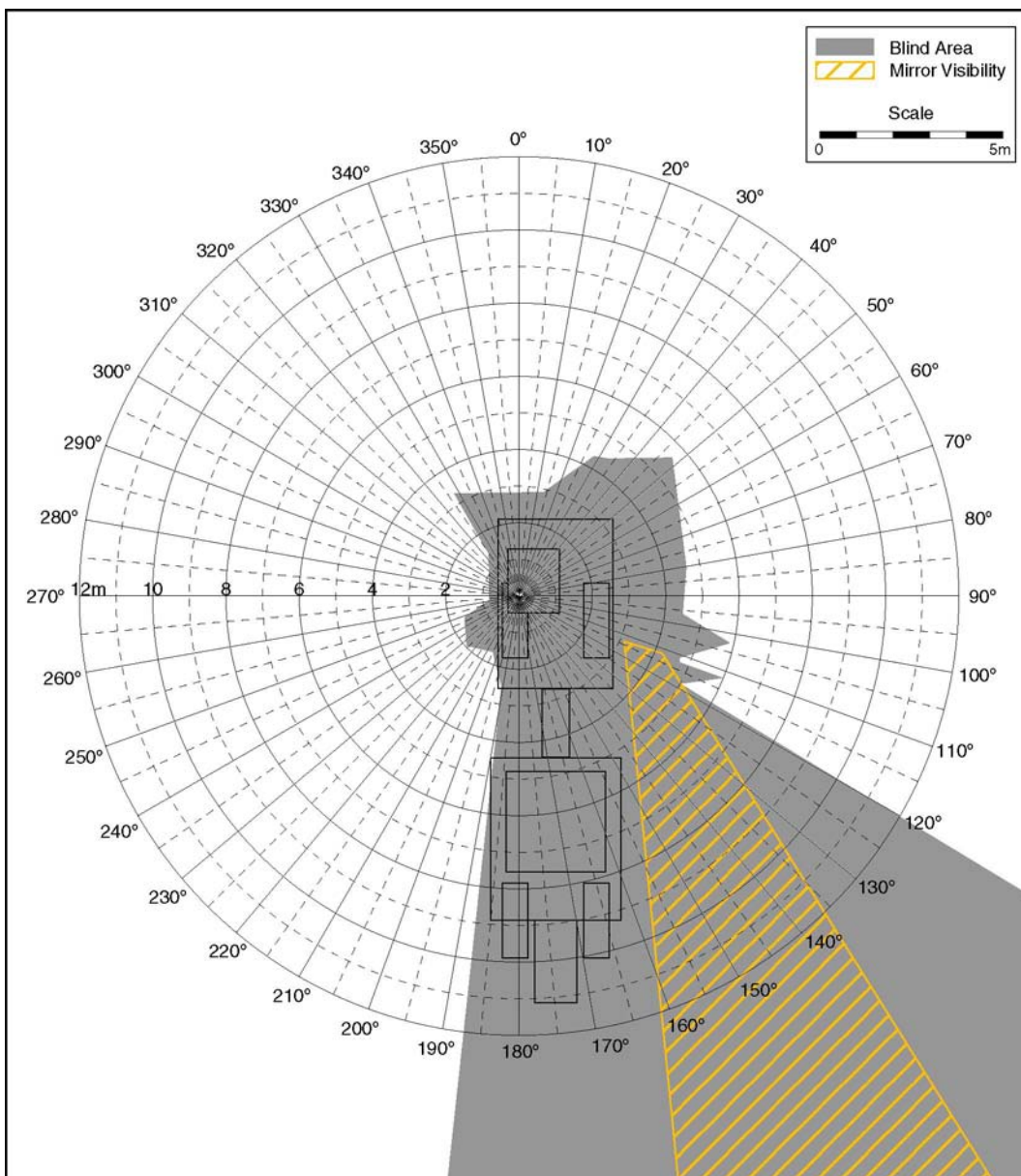
Blind Area Diagram for Construction Vehicle – 900 mm Plane

Scraper (Manufacturer and Model)	Cat 623G
GVW	18/23yd ³
Serial #	1A11928
Machine Dimensions	11' 8" wide 41' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



Blind Area Diagram for Construction Vehicle – 1500 mm Plane

Scraper (Manufacturer and Model)	Cat 623G
GVW	18/23yd ³
Serial #	1A11928
Machine Dimensions	11' 8" wide 41' 11" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



Appendix

Test Procedure

Description of Test Measurement Method

A combination of physical measurements and computer simulation were used to generate the blind area diagrams. Both methods utilized the upcoming revision of the ISO 5006 "Earth-moving machinery - Operator's field of view Part 1: Test method" test procedure, which uses light sources to represent the operator's eyes. The eye point was representative of the 50th percentile worldwide operator as defined in ISO 3411 "Earth-moving machinery - Human physical dimensions of operators and minimum operator space envelope" and was 680mm above and 20mm in front of the Seat Index Point (SIP) as defined in ISO 5353 "Earth-moving machinery, and tractors and machinery for agriculture and forestry - Seat index point" (see Figure 1). Light source horizontal spacings as defined in ISO 5006 for the various sectors of vision around the machine, shown in Figure 2, were used for mapping the shadows, which represent the visibility blind areas. These spacings represent the ability of an operator to move his head laterally to see around visibility blockages.

Blind areas were determined for three planes of elevation; the ground plane, a plane corresponding to the height of a 5th percentile female standing on the ground, and a plane corresponding to the height of channelizing devices which is 900 mm above the ground plane. For the second plane, 1500 mm above the ground plane was used. This is slightly less than the stature of the 5th percentile operator defined in ISO 3411 but represents the visibility of enough of the head that an operator can identify that there is a person in that area. Polar plots of the recorded data were generated with 5-degree increments and 1-meter intervals up to the 12 or 24-meter test circle perimeter, depending on machine size.

The indirect visibility, through the use of mirrors, was measured using a single light source in accordance with ISO/CD 14401-1 "Earth-Moving Machines - Surveillance and Rear-View Mirrors, Field of Vision - Part 1 - Test Method".

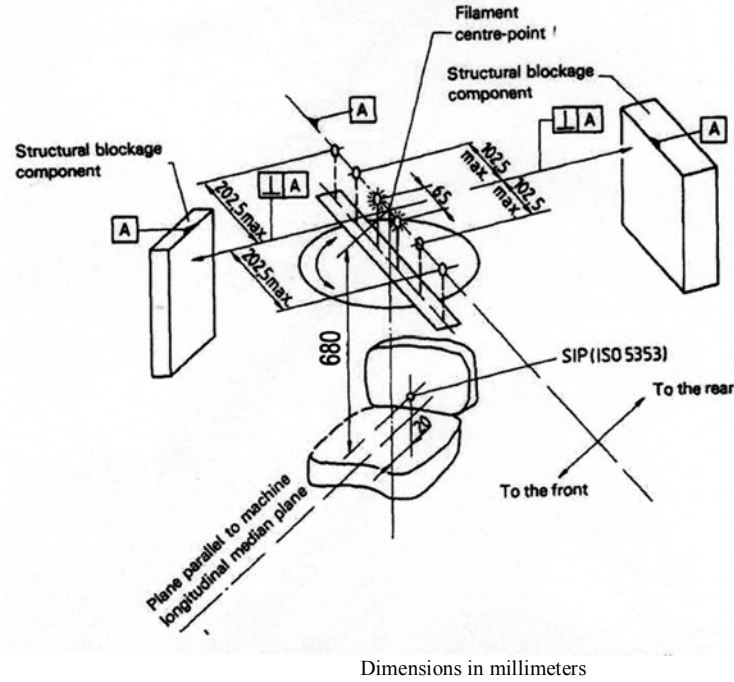


Figure 1 - Arrangement of the test equipment.

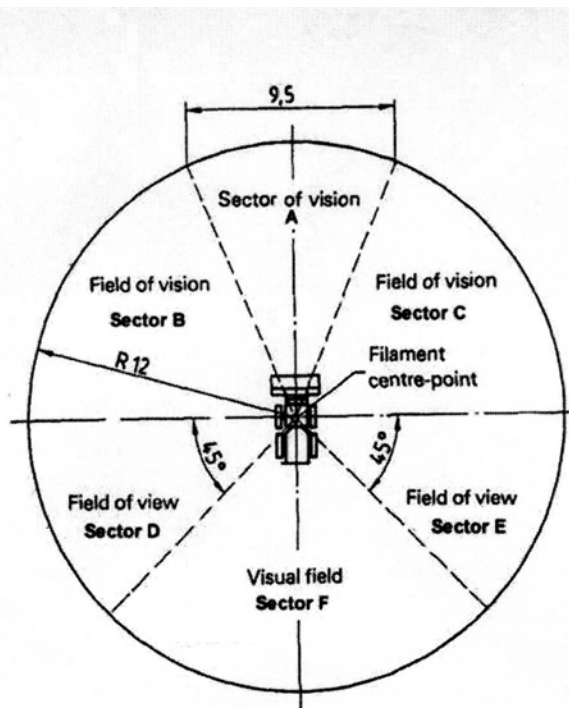


Figure 2 - Visibility test sectors

Physical Measurements

Physical measurements were made on 20 of the vehicles and machines. These tests were conducted in the semi-anechoic building used for sound testing at Caterpillar's Peoria Proving Ground. This facility provided the dark environment needed for the light/shadow technique to be used. The methodology used in the proposed revision of ISO 5006, ISO FDIS 5006, was used for these measurements. With this methodology, light bulbs, or more specifically filaments, are used to simulate the operator's eyes. The bulbs are mounted on a bar that allows each bulb to be moved horizontally, from a center position, up to 202.5 mm (405 mm total bulb spacing). The actual light support device used for the physical tests is shown in Figure 3. The filament spacing represents the range of eye movement that an operator will use to look around a blockage. Each filament casts a separate shadow due to a visibility blockage. If the two shadows overlap, a dark shadow is created, called a masking or blind area, where neither filament can "see". If the two shadows do not overlap, there is no blind area because at least one filament can "see" the area of interest.

A Pentax R115N Electronic Total Station surveying instrument was used to collect the data points that define the machine boundary and the blind areas. This instrument does not require a prism reflector for measurements and provides rectangular coordinates of the target. The target was mounted on an adjustable height stand for the planes 900 mm and 1500 mm above the ground plane. See Figure 4.



Figure 3. Light Support Device Test Setup.



Figure 4. Adjustable Target Stand.

Physical Measurements Test Procedure

1. Initial machine placement: The test engineer places the center of the SIP measuring device directly above the center of the visibility test circle. The best practice is to use a plumb bob to center the filament side-to-side with the front-to-back visually approximate.

2. Final machine placement: Once the side-to-side position is accurate, place the filament fixture in the cab at 680 mm above and 20 mm in front of the SIP. Use a plumb bob and straight edge to mark a reference point on the side of the machine. Hold the plumb bob at the reference point and move the machine forward or backward as necessary.

3. Position the implement attachments as described in ISO 5006. The position depends on the type and size of the machine being tested.

4. Adjust the bulb filament spacing for the sector of vision being recorded according to ISO 5006.

5. Position the support bar holding the light bulbs perpendicular to the visibility blockage being measured. A technique called "focusing" is used to ensure that the light bar is perpendicular to the vertical blockage. To "focus", the light bar is moved +/- 45 degrees from the approximate perpendicular position. The light bar is "focused" when the dark shadow, if there is one, is at its minimum width. If there is no dark shadow, the blockage does not create a blind area for the given filament spacing. Horizontal blockages are created by hoods, fenders, the bottom edges of windows, etc. and do not have a single point perpendicular to the blockage. In this case, the light bar is rotated to positions that will reasonably capture the blind area.

6. Measure and record the blind areas on the ground plane using the surveying instrument and target.
7. Repeat steps 3 - 6 until all blind areas in all of the sectors have been recorded.
8. Measure indirect visibility areas of mirrors.
9. Set surveying target height to 900 mm.
10. Repeat steps 3 - 8.
11. Set surveying target height to 1500 mm.
12. Repeat steps 3 - 8.

Computer Simulation

Caterpillar product designers use Pro-Engineer CAD software and, as a result, the operator visibility for many Cat machines can be simulated. The Caterpillar product groups provide the Pro-Engineer machine files for simulation, including implement attachments as agreed upon. The SIP coordinates are included in the Pro/E machine file for easy placement of the light test device. Maya software is used to generate the eye-point light sources, the shadows (visibility blockages), and the intersection of the shadows with the three horizontal planes requested. Mirrors are simulated in this software and are used to determine the indirect visibility areas.

Simulation Test Procedure

1. Initial machine placement: The test engineer places the center of the SIP measuring device directly above the center of the visibility test circle. To do this Caterpillar Inc. uses the coordinate offsets obtained from the ProE model and then locates the machine geometry in the Maya software. The 20mm forward offset of the filament center point in the location of the machine is maintained in the machine geometry ProE file.

2. The test engineer positions the implement attachments as described in ISO 5006. The position depends on the type and size of the machine being tested.

3. The test engineer positions two light sources at 680 mm above and 20 mm in front of the SIP. This point is used as the center point about which the light sources will pivot. Also, the test engineer adjusts the light source spacing for the sector of vision being recorded according to ISO 5006.

4. The test engineer positions the "support bar" between the light sources perpendicular to the visibility blockage being measured. A technique called "focusing" is used to ensure that the light bar is perpendicular to the vertical blockage. The light bar is "focused" when the dark shadow, if there is one, is at its minimum width. If there is no dark

shadow, the blockage does not create a masking for the given filament spacing. Horizontal blockages are created by hoods, fenders, the bottom edges of windows, etc. and do not have a single point perpendicular to the blockage. In this case, the light bar is rotated to positions that will reasonably capture the masking.

5. Once a blockage has been "focused" and a blind area exists, the test engineer saves the rendered file to disk with a descriptive name of the blockage. The rendered image will be a "pie slice" since the lights in the Maya setup file has been truncated to illuminate only the geometry that is being evaluated at the time.

6. The test engineer repeats steps 4 & 5 until all sectors and objects have been rendered.

7. Measure indirect visibility areas of mirrors.

8. The test engineer creates a new "ground plane" 900 mm above the true ground plane.

9. Repeat steps 4 -7.

10. The test engineer creates a new "ground plane" 1500 mm above the true ground plane.

11. Repeat steps 4 -7.

12. The test engineer uses PhotoShop to assemble the pie-shaped renderings into a composite image for each reference plane.