NHTSA Report No. 108-CAN-18-014-I

LAMPS, REFLECTIVE DEVICES AND ASSOCIATED EQUIPMENT FMVSS-108

Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

CALCOAST – ITL
Lighting Technology
683 Thornton Street
San Leandro, CA 94577

23 July 2018

FINAL INDICANT REPORT

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, D.C. 20590

NHTSA Report No. 108-CAN-18-014-I

Prepared By: 

Approved By: 

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16. Abstract The scope of this testing was to compare the performance from aged headlamps with lens haze against the performance from a brand new headlamp with no haze.			
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INDICANT TEST REPORT

Report Date: 23 July 2018

Project Name: Haze Study -
2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp
NHTSA Indicant Report 108-CAN-18-014-I

Submitted by: NHTSA Office of Vehicle Safety Compliance
Washington, D.C. 20590

Test Laboratory: Calcoast – ITL
San Leandro, CA 94577

Samples Submitted: One (1) new 2007 Ford F150 LH Replaceable Bulb Headlamp, purchased by CCITL, designated "LH1"

Four (4) aged 2005 to 2007 Ford F150 LH Replaceable Bulb Headlamps, supplied by NHTSA, designated "H-LH1" to "H-LH4"

SUMMARY

The above samples' Lower Beam function were measured and compared to determine the effect of haze due to age and exposure.

Written by:

Douglas G. Cummins
Photometric Engineer

Approved by:

Mark A. Evans
Laboratory Director

SUMMARY SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

DESCRIPTION:

Four (4) aged driver's side (Left Hand or LH) headlamps from 2005 to 2007 Ford F150s were purchased by NHTSA from various auto recycling yards and sent directly to CCITL. CCITL labeled the headlamps H-LH1 through H-LH4.

Brand new 2007 Ford F150 Headlamps were purchased from a local Ford Dealership by CCITL as a part of NHTSA Compliance Report No. 108-CAN-18-014. Sample LH1 was used as a comparison to the aged headlamps. LH1's bulb was used as a light source for the aged headlamps.

PROCEDURE:

Samples mounted on headlamp fixture provided by the lamp manufacturer. Headlamp fixture was mounted on level goniometer with Lower Beam light source located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV, then adjusted the headlamp aim hardware until the Lower Beam cutoff was located at H/2.0R and balanced from H/1.0R to H/3.0R (VOR aim). If the Lower Beam cutoff was not suitable for aiming photoelectrically (e.g. on lamps with noticeable haze), the test engineer would attempt to aim the beam visually. If the beam was not able to be aimed visually, the Lower Beam maximum was placed at the same approximate vertical location as on the new headlamp.

After aiming, each sample was tested to FMVSS 108 Table XIX Lower Beam requirements and its color measured at 1.5D/2.0R. Then the luminous intensity from 5U to 10D, 20L to 20R was measured in 0.5° increments and compiled into an isoscan plot. Two additional 5° x 5° isoscan sub-plots were provided to highlight key areas in the scan. The luminous intensity in vertical slices from 10U to 10D in 0.1° increments was also measured at the 1L and V horizontal locations.

The isoscan measured data was then used to generate an isolux plot of the illuminance on the road. The data from the single LH headlamp sample was used to produce the isolux plot of a pair of headlamps with the given mounting height and lamp separation. No data was provided on the headlamps' mounting height or separation so arbitrary values were used representing the mounting height and separation of a similar vehicle's headlamps.

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Headlamp Aim

LH1 (New)

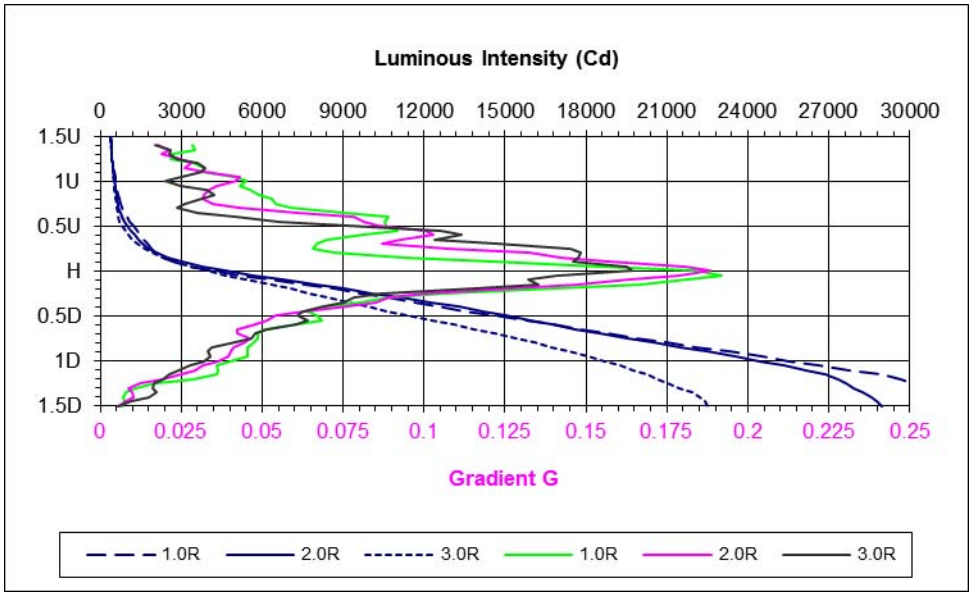
VOR Aim

Maximum Vertical Gradient

Location	Value	Required
0.05D/1.0R	0.192	> 0.13
H/2.0R	0.189	
H/3.0R	0.164	

Horizontal width of cutoff is greater than 2° centered at 2.0R.

Maximum inclination of cutoff is within ±0.2°.



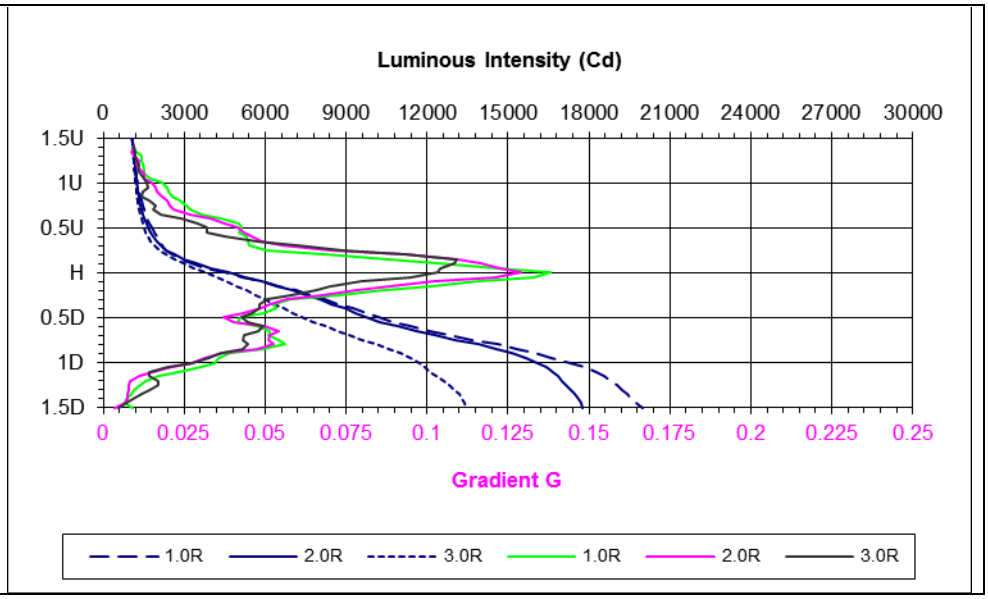
H-LH1 (Haze)

VOR Aim

Maximum Vertical Gradient

Location	Value	Required
H/1.0R	0.138	> 0.13
H/2.0R	0.129*	
0.15U/3.0R	0.102*	

*** - denotes failure.**



New sample meets S10.18.9 Visual/Optical Aiming cutoff requirements.
Aged samples do **NOT** meet S10.18.9 Visual/Optical Aiming cutoff requirements.

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

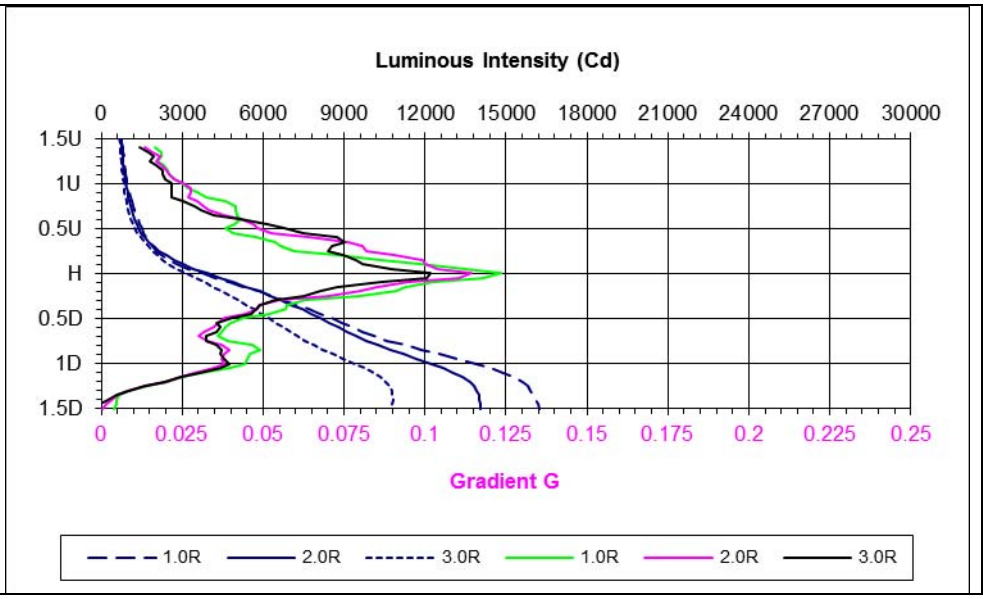
H-LH2 (Haze)

VOR Aim

Maximum Vertical Gradient

Location	Value	Required
H/1.0R	0.123*	> 0.13
H/2.0R	0.114*	
H/3.0R	0.102*	

*** - denotes failure.**



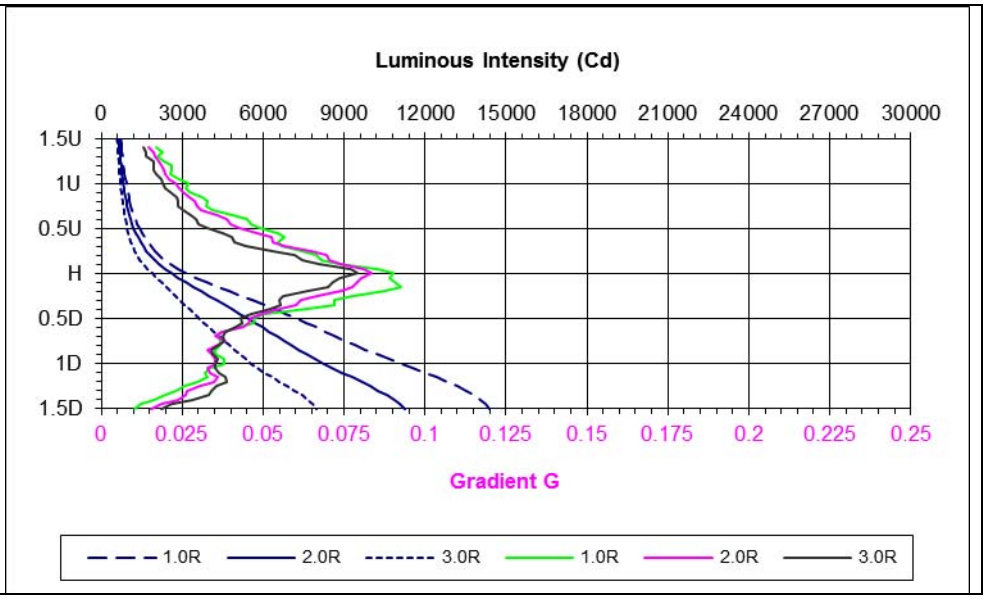
H-LH3 (Haze)

VOR Aim

Maximum Vertical Gradient

Location	Value	Required
0.15D/1.0R	0.092*	> 0.13
H/2.0R	0.083*	
H/3.0R	0.079*	

*** - denotes failure.**



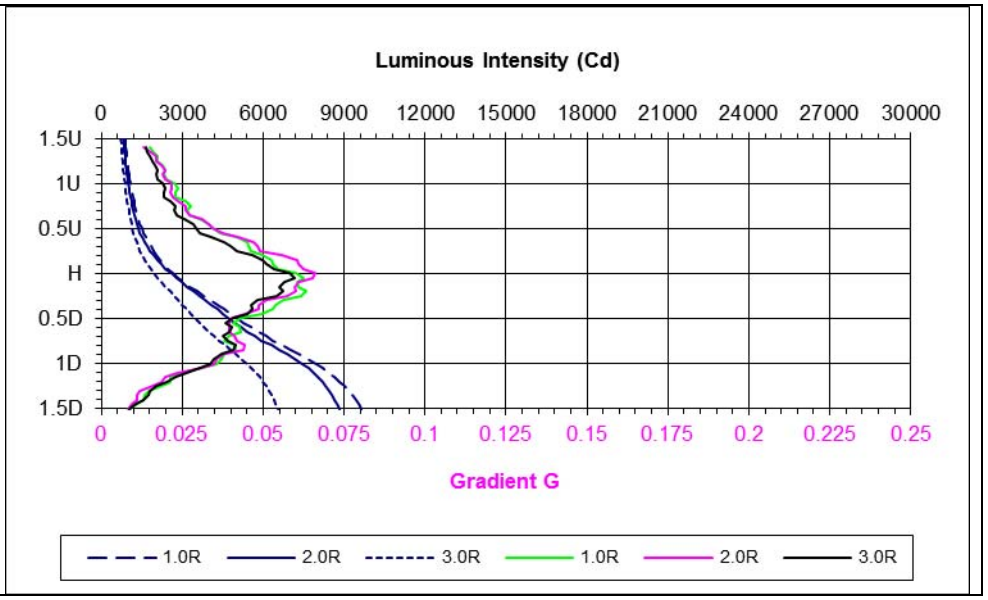
H-LH4 (Haze)

VOR Aim

Maximum Vertical Gradient

Location	Value	Required
0.20D/1.0R	0.063*	> 0.13
H/2.0R	0.066*	
0.05D/3.0R	0.060*	

*** - denotes failure.**



PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Sample Number: LH1 (new)

Specification: FMVSS108 Table XIX-a: LB2V (VO Headlamp - 2 Lamp System)
Color: White, Lower Beam
Luminous Intensity, Candela

Test	Point	Location	Measured	Reaim	Minimum	Maximum
4.0U	8.0L		147.10		64	-
4.0U	8.0R		129.48		64	-
2.0U	4.0L		255.63		135	-
1.5U	1.0R TO 3.0R	2.6R	372.35		200	-
1.5U	1.0R TO R	1.0R	384.87		-	1400
1.0U	1.5L TO L	1.5L	540.92		-	700
0.5U	1.5L TO L	1.5L	906.97		-	1000
0.5U	1.0R TO 3.0R	3.0R	770.52		500	-
0.5U	1.0R TO 3.0R	1.0R	1180.57		-	2700
H	8.0L		470.52		64	-
H	4.0L		740.85		135	-
H	V		2838.59		-	-
0.6D	1.3R		16884.51		10000	-
0.9D	3.5L		4168.23		1800	12000
0.9D	V		17989.35		4500	-
1.5D	2.0R		29069.54		15000	-
2.0D	15.0L		2737.81		1000	-
2.0D	9.0L		3722.28		1250	-
2.0D	9.0R		4347.34		1250	-
2.0D	15.0R		2913.93		1000	-
4.0D	20.0L		2987.41		300	-
4.0D	V		9777.55		-	-
4.0D	4.0R		6434.32		-	12500
4.0D	20.0R		1747.91		300	-
MAXIMUM		1.6D 0.9R	31741.61		-	-
MX(10U-90U/90L-90R)		10.0U 3.1L	95.83		-	125
		51.5U 48.6L	92.62		-	125

Sample meets test requirements at all points.

Bulb: Seasoned Sylvania H13 furnished with sample @ 12.80V / 4.589A

Aim: Sample mounted on fixture provided by Ford. Fixture mounted on level goniometer with H13 filament located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV. Adjusted aim hardware until LB Gmax located at H/2.0R and level from H/1.0R to H/3.0R (VOR aim).

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Sample Number: H-LH1 (aged)

Specification: FMVSS108 Table XIX-a: LB2V (VO Headlamp - 2 Lamp System)
Color: White, Lower Beam
Luminous Intensity, Candela

Test Point	Location	Measured	Reaim	Minimum	Maximum
4.0U 8.0L		407.61		64	-
4.0U 8.0R		447.98		64	-
2.0U 4.0L		815.61		135	-
1.5U 1.0R TO 3.0R	3.0R	1053.69		200	-
1.5U 1.0R TO R	1.1R	1097.73		-	1400
1.0U 1.5L TO L	1.5L	1225.34	1107.85*	-	700
0.5U 1.5L TO L	1.5L	1607.46	1357.30*	-	1000
0.5U 1.0R TO 3.0R	3.0R	1504.79		500	-
0.5U 1.0R TO 3.0R	1.0R	1846.74		-	2700
H 8.0L		1022.68		64	-
H 4.0L		1440.53		135	-
H V		3997.33		-	-
0.6D 1.3R		11634.74		10000	-
0.9D 3.5L		3914.96		1800	12000
0.9D V		13789.49		4500	-
1.5D 2.0R		17579.43		15000	-
2.0D 15.0L		1931.42		1000	-
2.0D 9.0L		2803.00		1250	-
2.0D 9.0R		3164.90		1250	-
2.0D 15.0R		1922.74		1000	-
4.0D 20.0L		2068.10		300	-
4.0D V		7637.99		-	-
4.0D 4.0R		4824.81		-	12500
4.0D 20.0R		1212.22		300	-
MAXIMUM	1.6D 0.6R	20950.67		-	-
MX(10U-90U/90L-90R)	10.0U 1.7L	167.34*		-	125

*** - Denotes Failure.**

Bulb: Seasoned Sylvania H13 furnished with new sample "LH1" @ 12.80V / 4.584A

Aim: Sample mounted on fixture provided by Ford. Fixture mounted on level goniometer with H13 filament located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV. Adjusted aim hardware until LB Gmax located at H/2.0R and level from H/1.0R to H/3.0R (VOR aim).

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Sample Number: H-LH2 (aged)

Specification: FMVSS108 Table XIX-a: LB2V (VO Headlamp - 2 Lamp System)
Color: White, Lower Beam
Luminous Intensity, Candela

Test	Point	Location	Measured	Reaim	Minimum	Maximum
4.0U	8.0L		289.73		64	-
4.0U	8.0R		244.03		64	-
2.0U	4.0L		516.28		135	-
1.5U	1.0R TO 3.0R	3.0R	662.67		200	-
1.5U	1.0R TO R	1.2R	733.76		-	1400
1.0U	1.5L TO L	1.5L	878.35	769.93*	-	700
0.5U	1.5L TO L	1.5L	1177.25	976.56	-	1000
0.5U	1.0R TO 3.0R	3.0R	1133.98		500	-
0.5U	1.0R TO 3.0R	1.0R	1395.26		-	2700
H	8.0L		629.48		64	-
H	4.0L		956.07		135	-
H	V		2483.97		-	-
0.6D	1.3R		8724.28	10750.80	10000	-
0.9D	3.5L		2674.46		1800	12000
0.9D	V		10015.18		4500	-
1.5D	2.0R		14255.03	14255.03*	15000	-
2.0D	15.0L		1973.63		1000	-
2.0D	9.0L		2387.28		1250	-
2.0D	9.0R		2332.35		1250	-
2.0D	15.0R		1467.99		1000	-
4.0D	20.0L		2214.90		300	-
4.0D	V		6077.30		-	-
4.0D	4.0R		4310.49		-	12500
4.0D	20.0R		946.74		300	-
MAXIMUM		1.9D 0.5R	17308.44		-	-
MX(10U-90U/90L-90R)		59.6U 5.1L	24.60		-	125

*** - Denotes Failure.**

Bulb: Seasoned Sylvania H13 furnished with new sample "LH1" @ 12.80V / 4.585A

Aim: Sample mounted on fixture provided by Ford. Fixture mounted on level goniometer with H13 filament located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV. Adjusted aim hardware until LB Gmax located at H/2.0R and level from H/1.0R to H/3.0R (VOR aim).

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Sample Number: H-LH3 (aged)

Specification: FMVSS108 Table XIX-a: LB2V (VO Headlamp - 2 Lamp System)
Color: White, Lower Beam
Luminous Intensity, Candela

Test Point	Location	Measured	Reaim	Minimum	Maximum
4.0U 8.0L		265.63		64	-
4.0U 8.0R		217.77		64	-
2.0U 4.0L		515.07		135	-
1.5U 1.0R TO 3.0R	3.0R	581.23		200	-
1.5U 1.0R TO R	1.0R	693.61		-	1400
1.0U 1.5L TO L	1.5L	904.68	780.36*	-	700
0.5U 1.5L TO L	1.5L	1260.59	1029.45*	-	1000
0.5U 1.0R TO 3.0R	3.0R	931.71		500	-
0.5U 1.0R TO 3.0R	1.0R	1333.01		-	2700
H 8.0L		621.96		64	-
H 4.0L		1033.74		135	-
H V		2727.05		-	-
0.6D 1.3R		6845.26	7944.92*	10000	-
0.9D 3.5L		2755.71		1800	12000
0.9D V		9615.82		4500	-
1.5D 2.0R		11056.46	11056.46*	15000	-
2.0D 15.0L		1743.00		1000	-
2.0D 9.0L		2156.78		1250	-
2.0D 9.0R		2113.87		1250	-
2.0D 15.0R		1260.28		1000	-
4.0D 20.0L		2179.83		300	-
4.0D V		6939.55		-	-
4.0D 4.0R		4700.00		-	12500
4.0D 20.0R		962.17		300	-
MAXIMUM	2.0D 0.1L	16664.25		-	-
MX(10U-90U/90L-90R)	10.0U 3.3L	147.74*		-	125

*** - Denotes Failure.**

Bulb: Seasoned Sylvania H13 furnished with new sample "LH1" @ 12.80V / 4.586A

Aim: Sample mounted on fixture provided by Ford. Fixture mounted on level goniometer with H13 filament located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV. Adjusted aim hardware until LB Gmax located at H/2.0R and level from H/1.0R to H/3.0R (VOR aim).

PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Sample Number: H-LH4 (aged)

Specification: FMVSS108 Table XIX-a: LB2V (VO Headlamp - 2 Lamp System)
Color: White, Lower Beam
Luminous Intensity, Candela

Test Point	Location	Measured	Reaim	Minimum	Maximum
4.0U 8.0L		347.66		64	-
4.0U 8.0R		269.42		64	-
2.0U 4.0L		613.01		135	-
1.5U 1.0R TO 3.0R	3.0R	722.52		200	-
1.5U 1.0R TO R	1.0R	849.16		-	1400
1.0U 1.5L TO L	1.5L	1030.98	911.79*	-	700
0.5U 1.5L TO L	1.5L	1274.63	1125.24*	-	1000
0.5U 1.0R TO 3.0R	3.0R	1147.70		500	-
0.5U 1.0R TO 3.0R	1.0R	1488.69		-	2700
H 8.0L		693.96		64	-
H 4.0L		1095.99		135	-
H V		2326.37		-	-
0.6D 1.3R		5432.20	6786.49*	10000	-
0.9D 3.5L		2263.09		1800	12000
0.9D V		6072.51		4500	-
1.5D 2.0R		8699.98	8699.98*	15000	-
2.0D 15.0L		1409.27		1000	-
2.0D 9.0L		1718.45		1250	-
2.0D 9.0R		1708.07		1250	-
2.0D 15.0R		967.28	1028.65	1000	-
4.0D 20.0L		1282.17		300	-
4.0D V		4150.66		-	-
4.0D 4.0R		3079.90		-	12500
4.0D 20.0R		674.86		300	-
MAXIMUM	1.8D 0.9R	9972.36		-	-
MX(10U-90U/90L-90R)	10.0U 2.7L	205.31*		-	125

*** - Denotes Failure.**

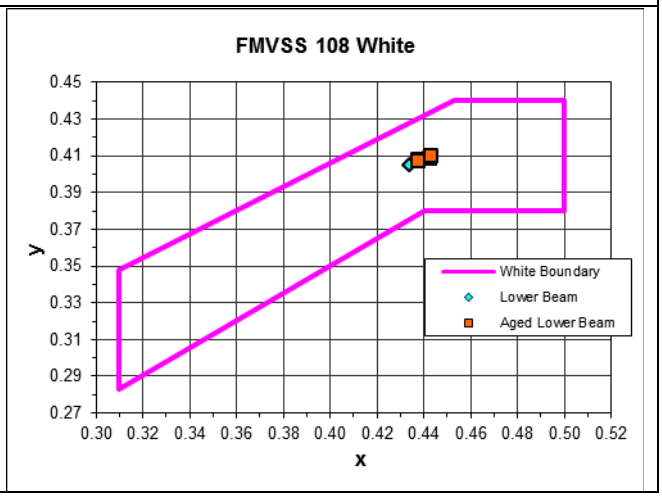
Bulb: Seasoned Sylvania H13 furnished with new sample "LH1" @ 12.80V / 4.582A

Aim: Sample mounted on fixture provided by Ford. Fixture mounted on level goniometer with H13 filament located at goniometer center of rotation and tilt with fixture markings aligned parallel and perpendicular to detector axis at HV. Adjusted aim hardware until LB Gmax located at H/2.0R and level from H/1.0R to H/3.0R (VOR aim).

COLOR TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Requirement: FMVSS 108 S14.4.1 Color Test
Test Method: FMVSS 108 S14.4.1.4 Tristimulus Method
Average of 3 reads
Instrument: Photo Research PR-655 Spectroradiometer with SRS-3 Target
Location: 1.5D/2.0R (Lower Beam), 25 ft
Voltages: 12.8V (Lower Beam)

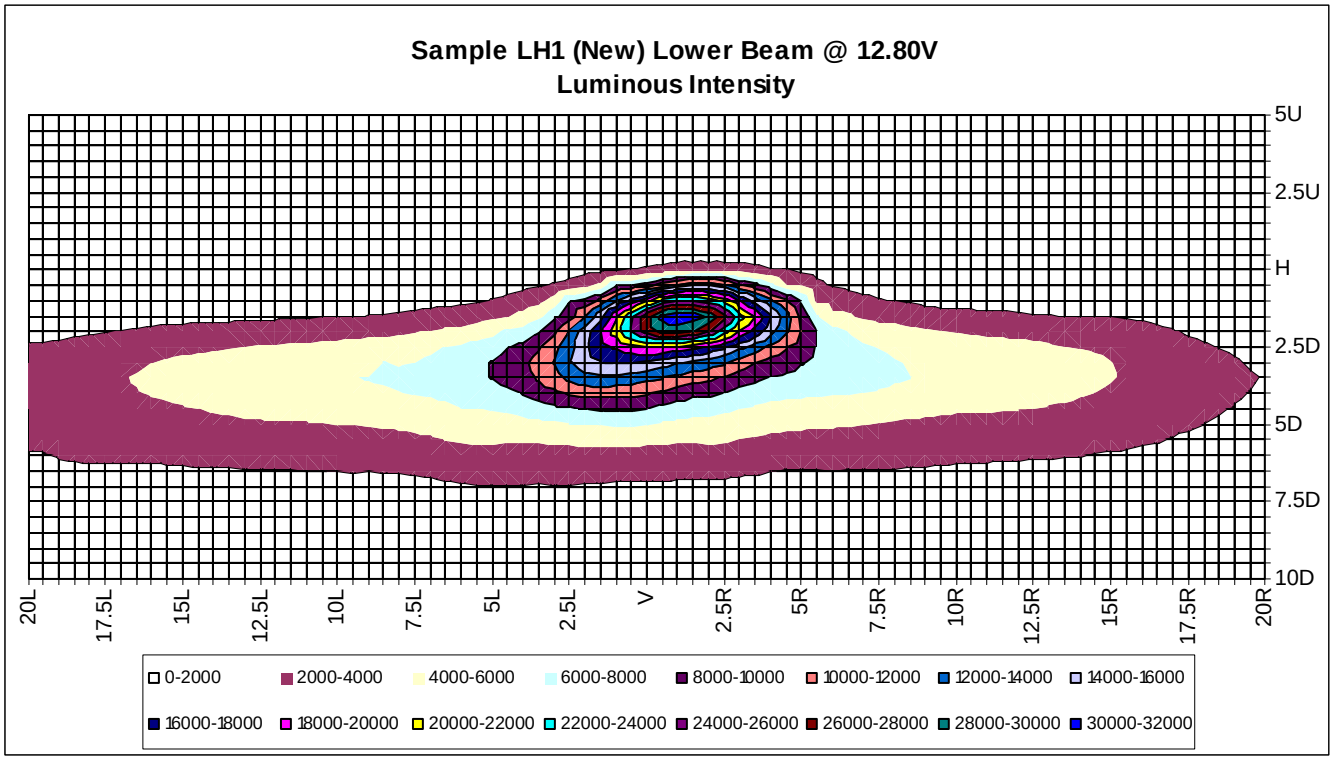
Measured (x, y)	Required	Chart
New LH1 (0.4341, 0.4048) Aged H-LH1 (0.4427, 0.4081) H-LH2 (0.4377, 0.4073) H-LH3 (0.4379, 0.4071) H-LH4 (0.4430, 0.4095)	0.31 ≤ x ≤ 0.50 0.38 ≤ y ≤ 0.44 y ≥ 0.75x + 0.05 y ≤ 0.64x + 0.15	

PHOTOMETRIC TEST DATA SHEET

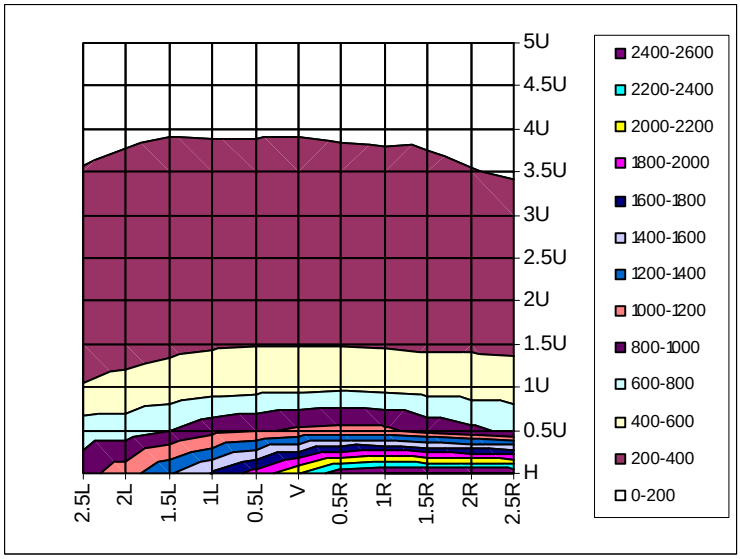
Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

ISO Scans

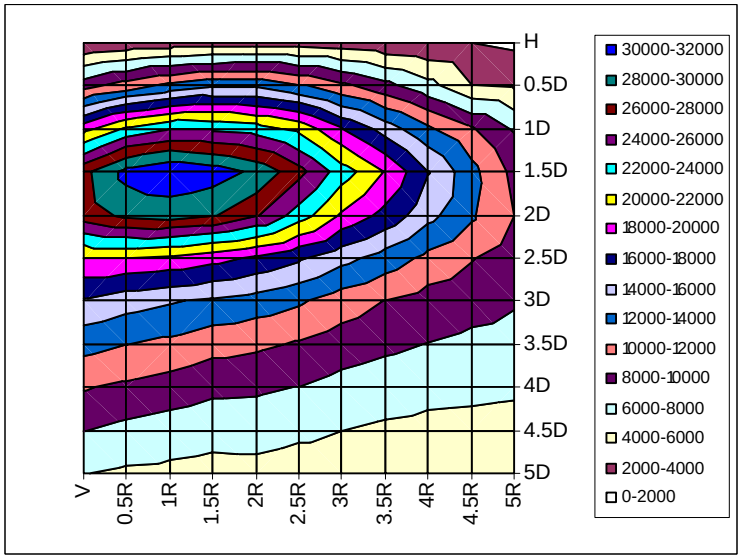
5U to 10D / 20L to 20R / 0.5° increments



Max Intensity: 31751 Cd @ 1.5D / 1.0R
Beam Flux: 424 Lm



5U to H / 2.5L to 2.5R



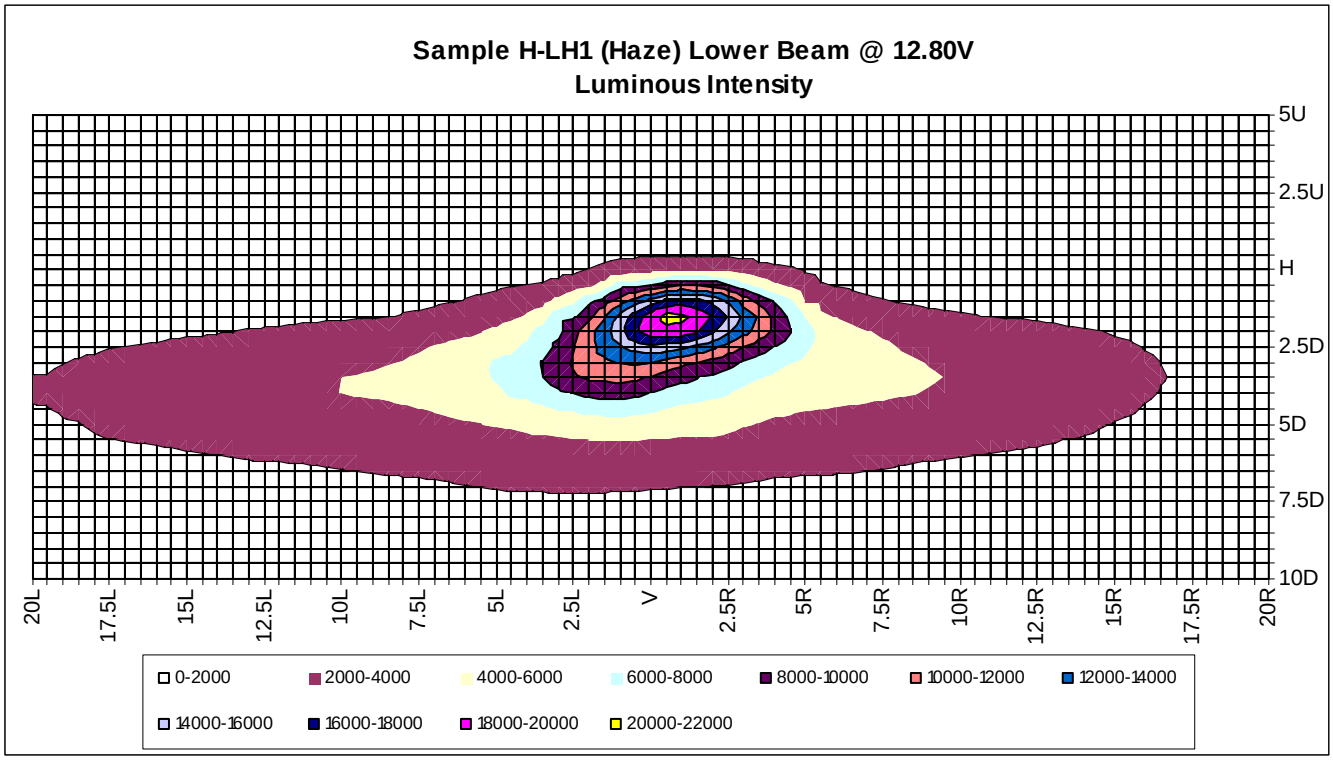
H to 5D / V to 5R

PHOTOMETRIC TEST DATA SHEET

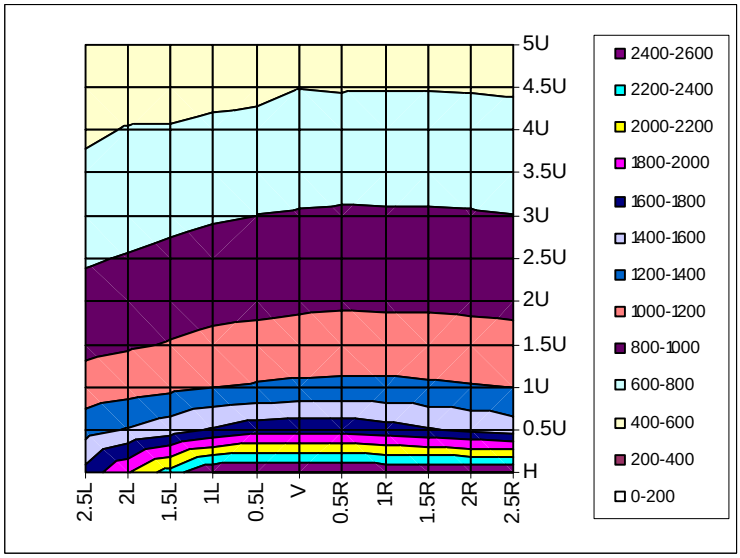
Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

ISO Scans

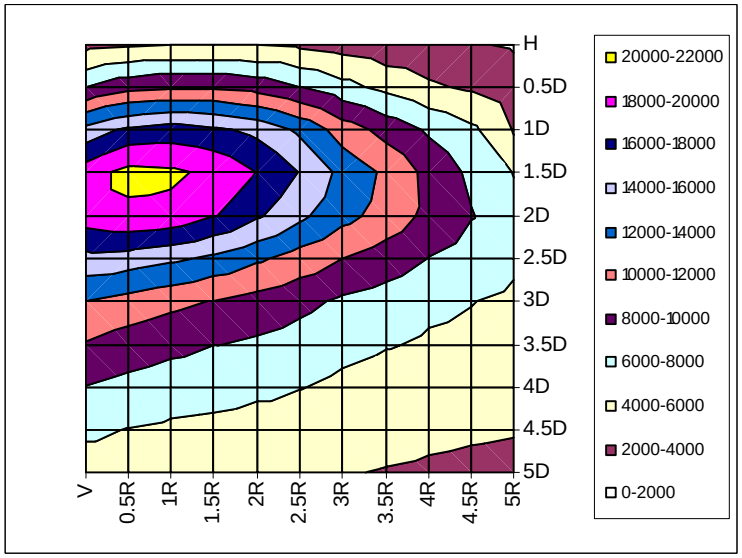
5U to 10D / 20L to 20R / 0.5° increments



Max Intensity: 20610 Cd @ 1.5D / 0.5R
Beam Flux: 366 Lm



5U to H / 2.5L to 2.5R



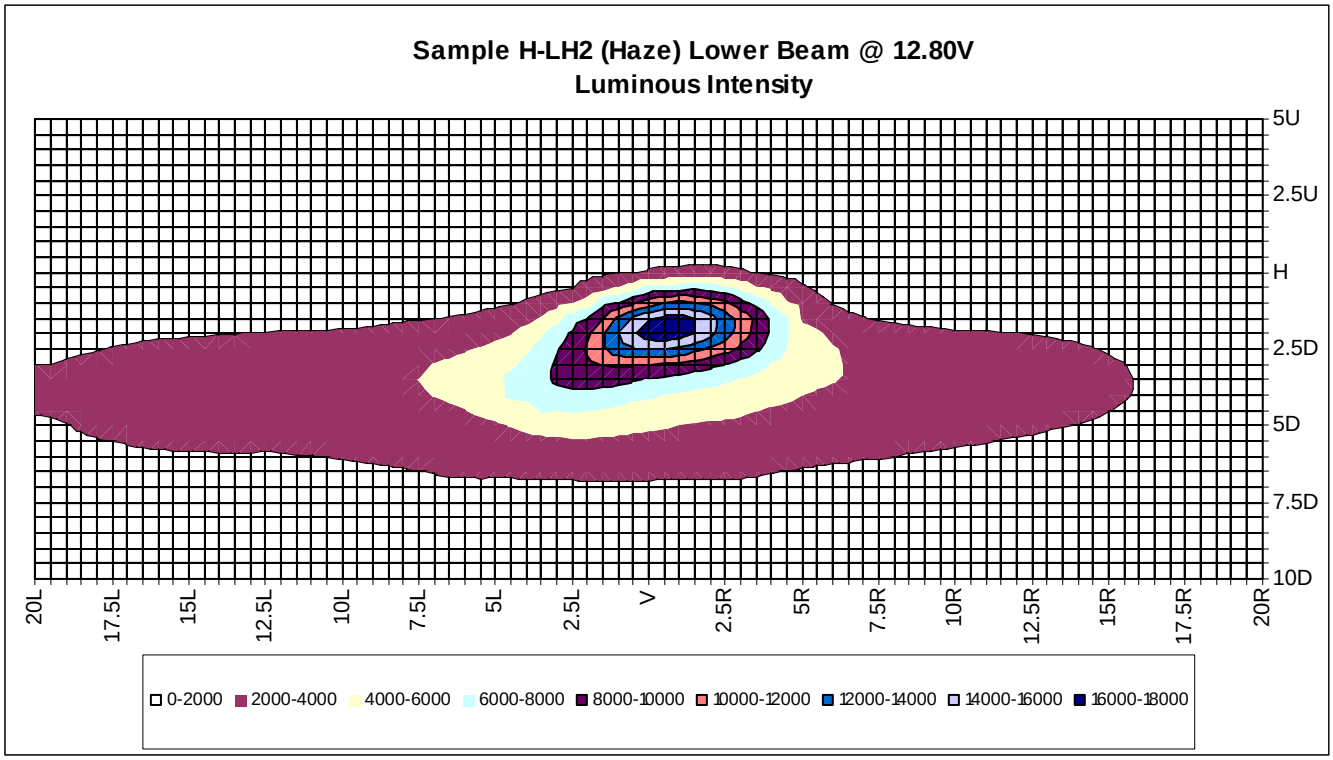
H to 5D / V to 5R

PHOTOMETRIC TEST DATA SHEET

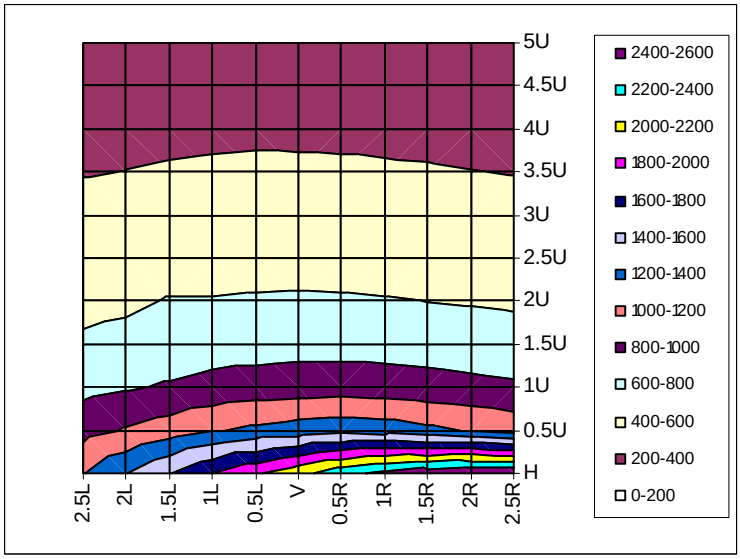
Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

ISO Scans

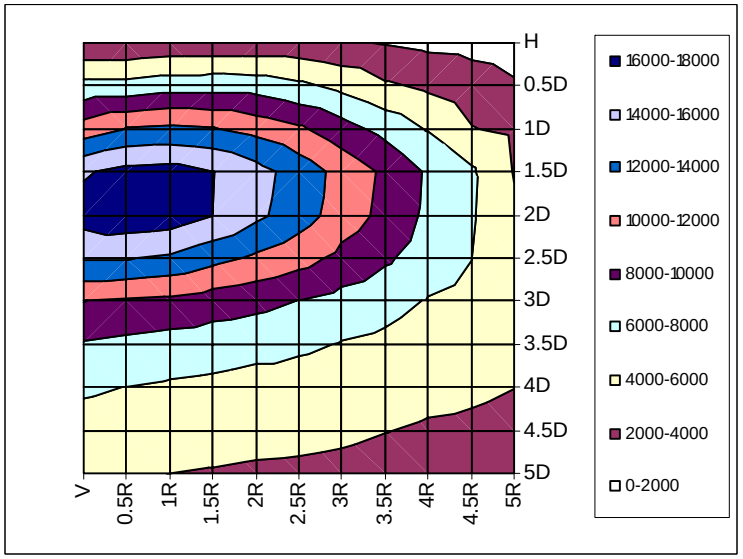
5U to 10D / 20L to 20R / 0.5° increments



Max Intensity: 17511 Cd @ 2.0D / 0.5R
Beam Flux: 304 Lm



5U to H / 2.5L to 2.5R



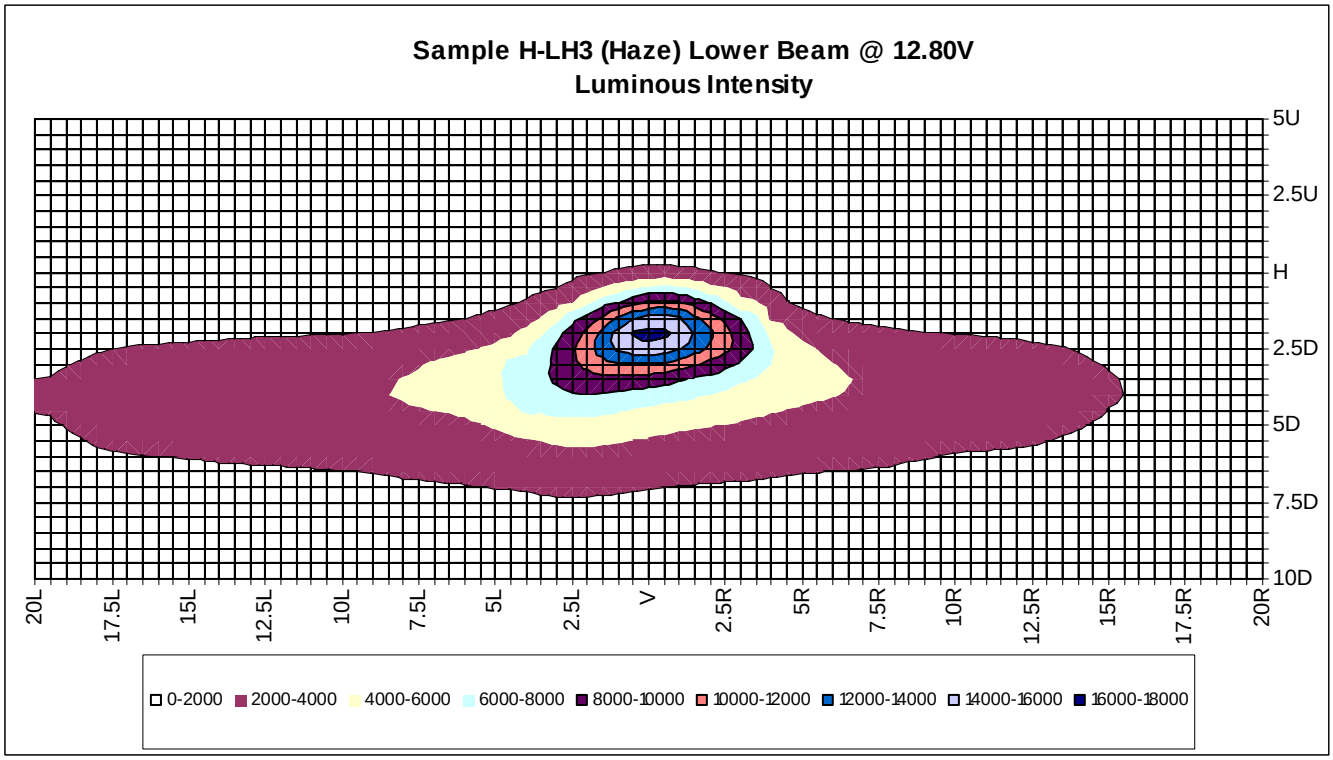
H to 5D / V to 5R

PHOTOMETRIC TEST DATA SHEET

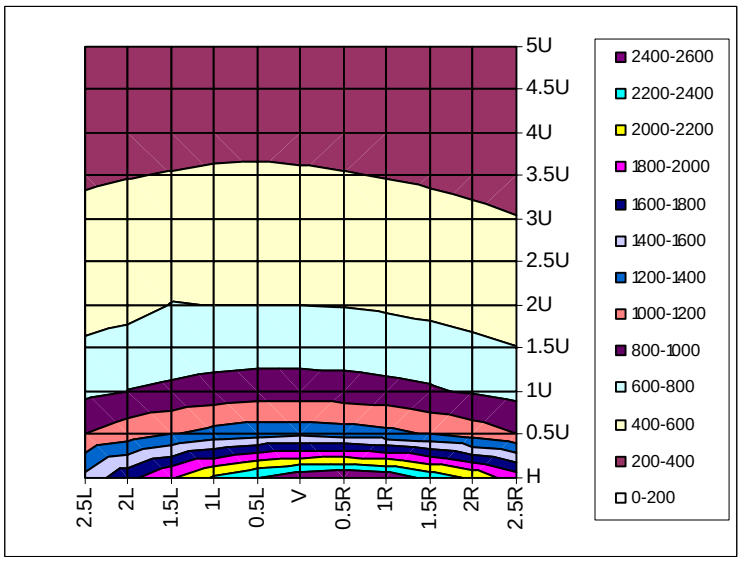
Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

ISO Scans

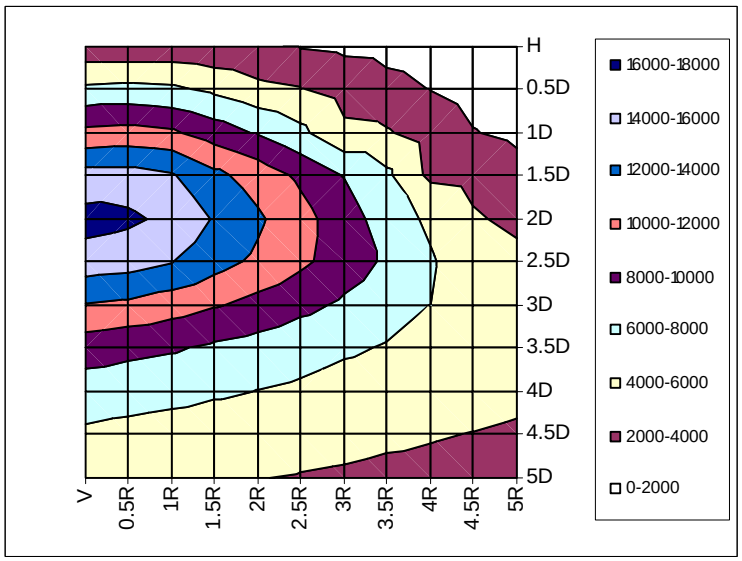
5U to 10D / 20L to 20R / 0.5° increments



Max Intensity: 16688 Cd @ 2.0D / V
Beam Flux: 310 Lm



5U to H / 2.5L to 2.5R



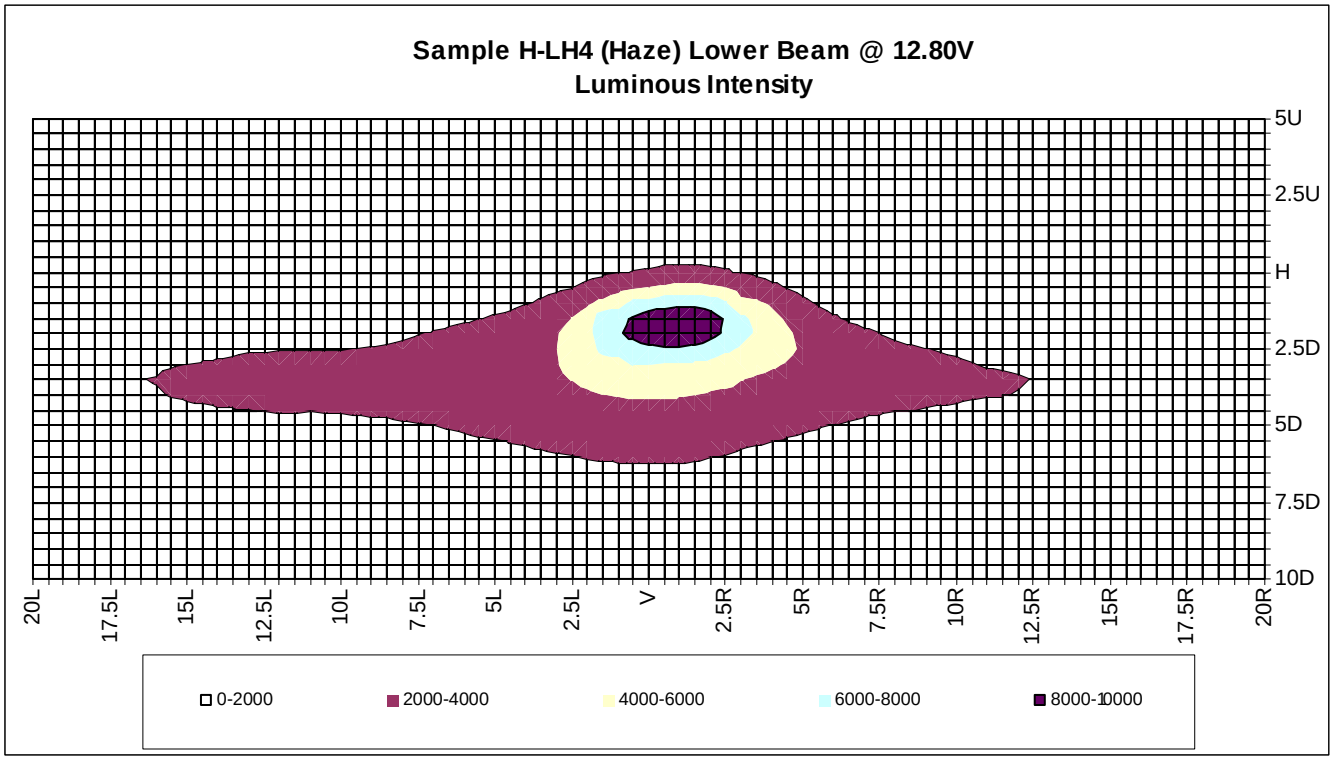
H to 5D / V to 5R

PHOTOMETRIC TEST DATA SHEET

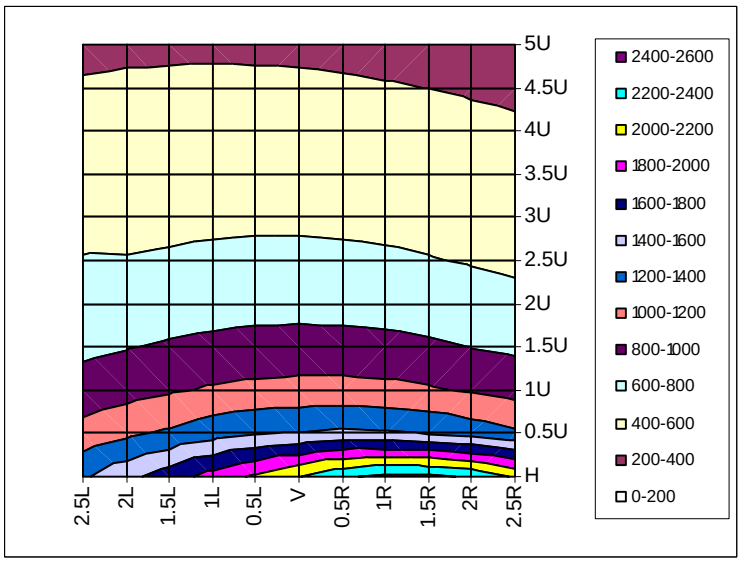
Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

ISO Scans

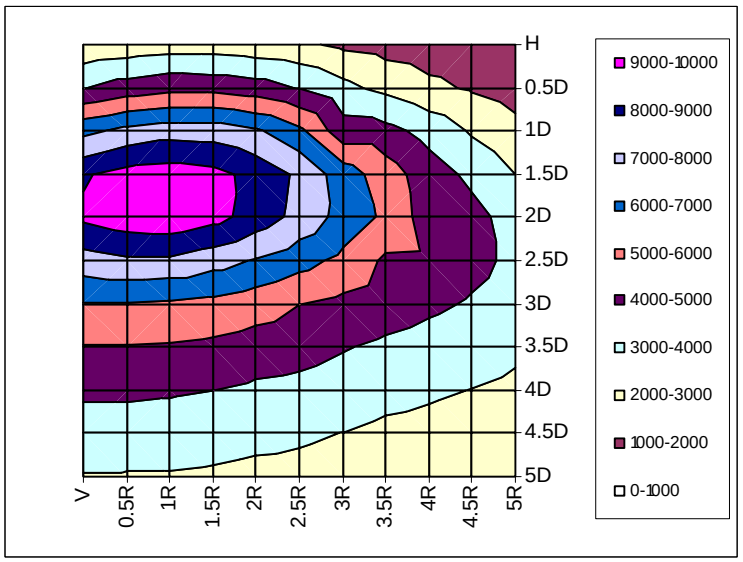
5U to 10D / 20L to 20R / 0.5° increments



Max Intensity: 9754 Cd @ 2.0D / 1.0R
Beam Flux: 221 Lm



5U to H / 2.5L to 2.5R



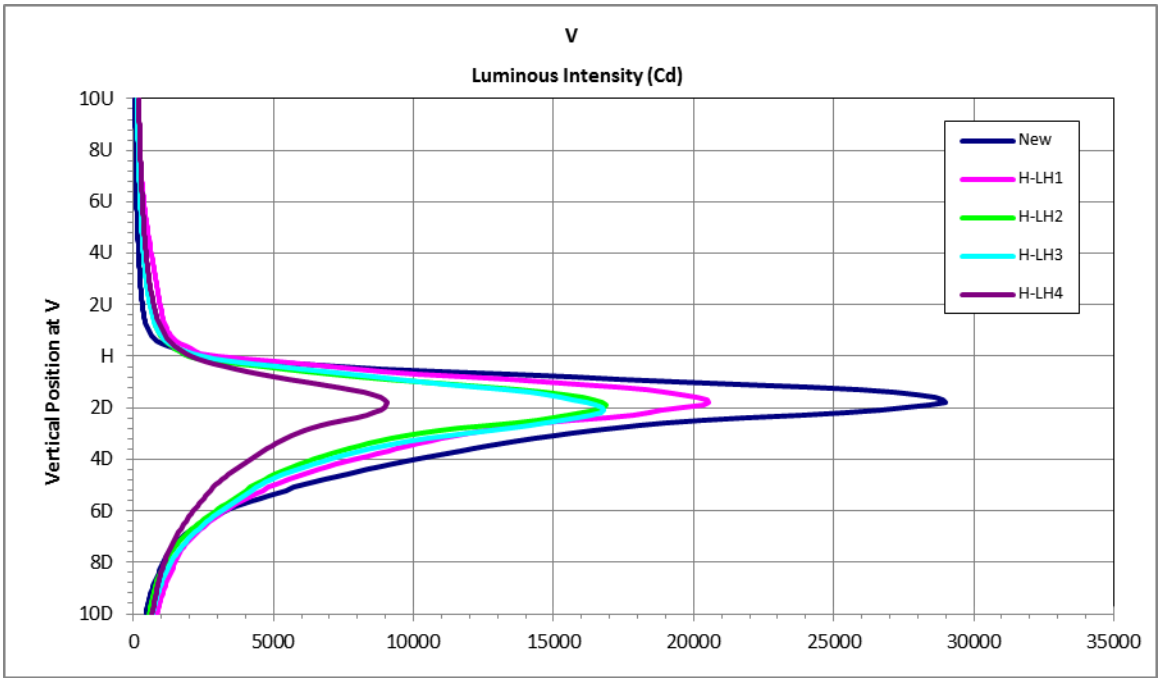
H to 5D / V to 5R

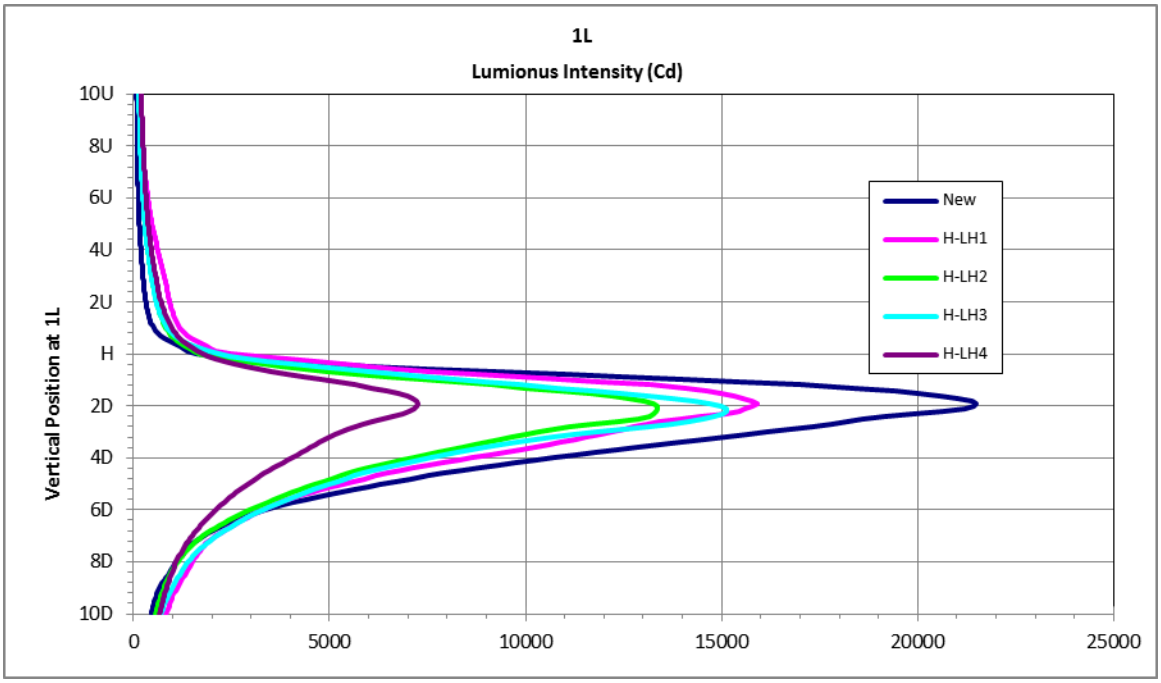
PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

Vertical Line Scans

10U to 10D / 0.1° increments along the V-V line and at 1L





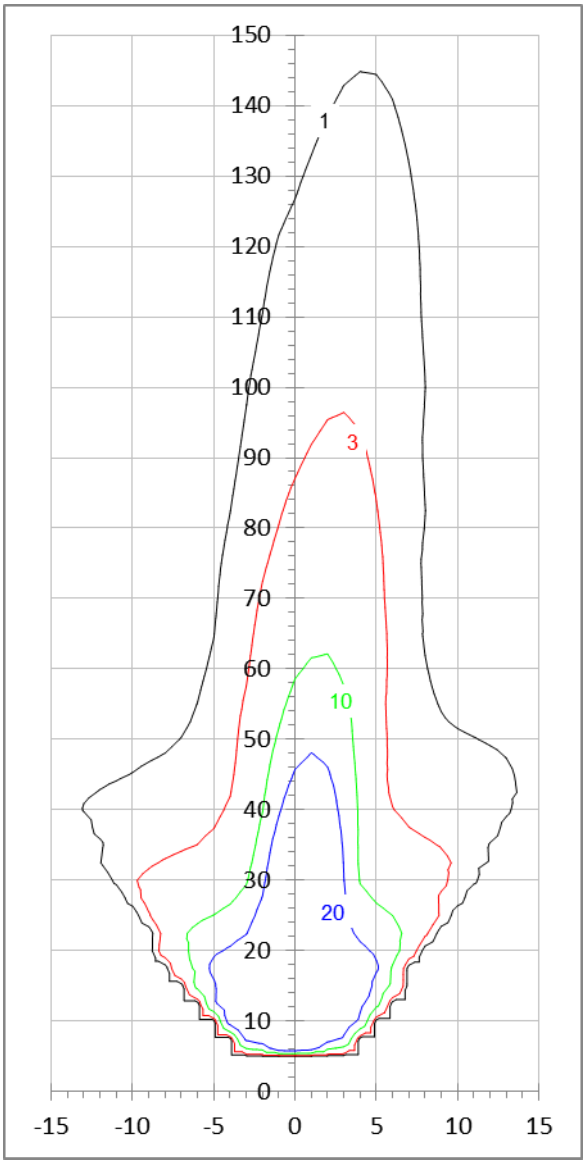
PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

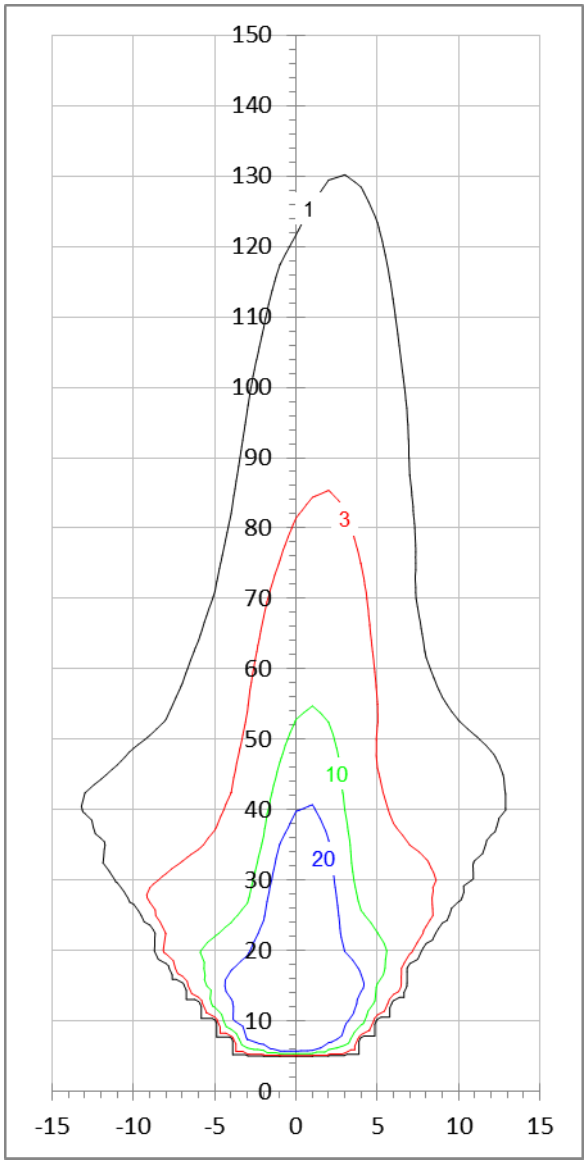
IsoLux projection on road

Lateral dimensions (from vehicle centerline): -15 m to 15 m, 1 m increments
Road Dimension (from lamp source): 0 m to 150 m, 2.5 m increments
Isolux contour lines of 1, 3, 10, and 20 lux

Mounting Height: 0.91 m
Headlamp Separation: 1.52 m



LH1 (New)



H-LH1 (Haze)

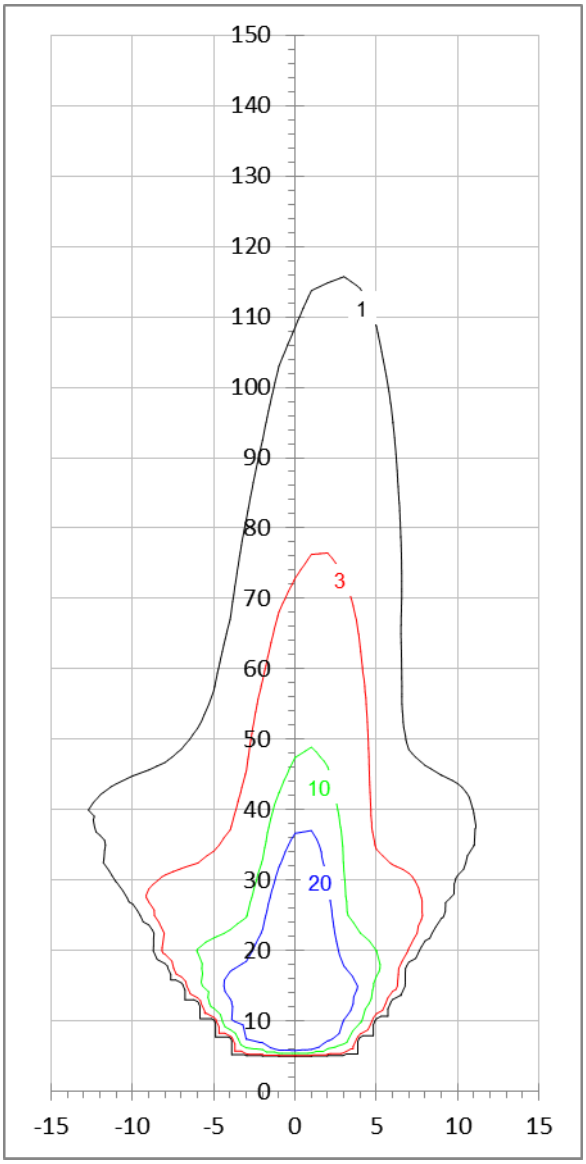
PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

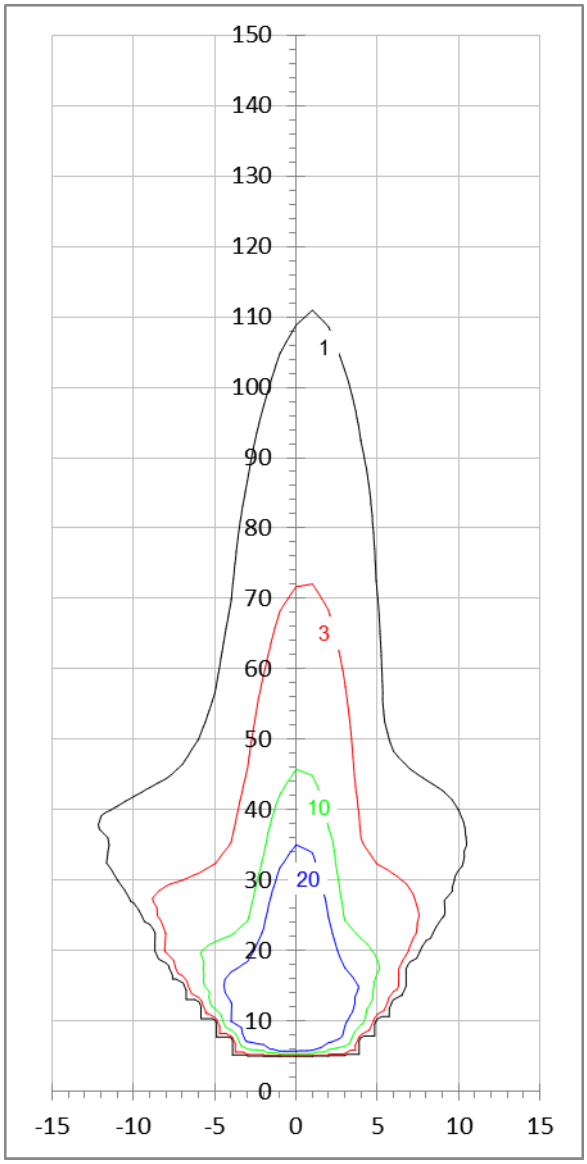
IsoLux projection on road

Lateral dimensions (from vehicle centerline): -15 m to 15 m, 1 m increments
Road Dimension (from lamp source): 0 m to 150 m, 2.5 m increments
Isolux contour lines of 1, 3, 10, and 20 lux

Mounting Height: 0.91 m
Headlamp Separation: 1.52 m



H-LH2 (Haze)



H-LH3 (Haze)

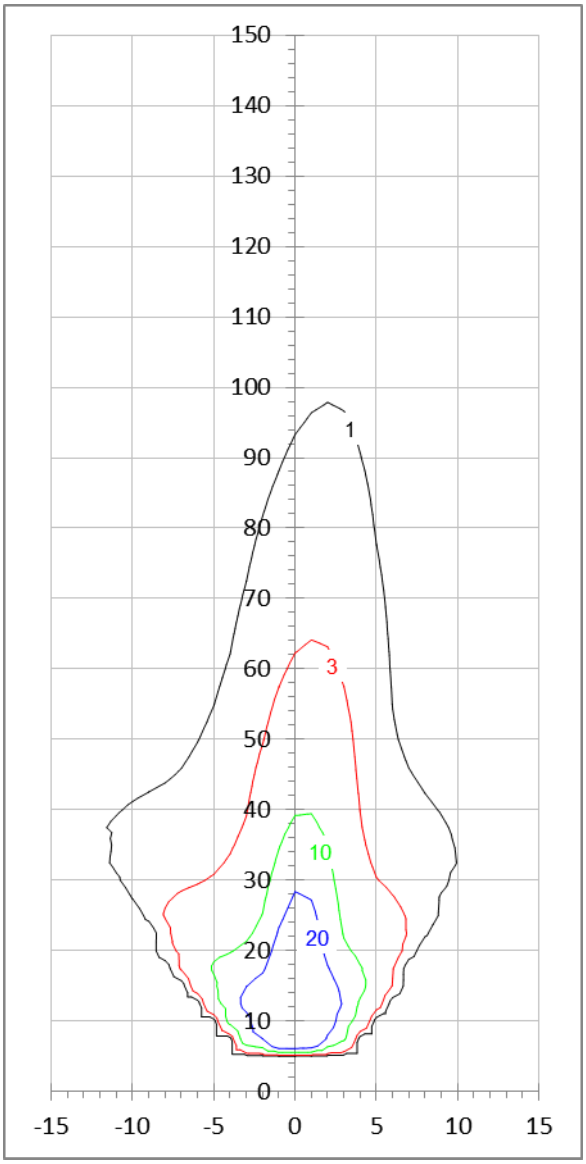
PHOTOMETRIC TEST DATA SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

IsoLux projection on road

Lateral dimensions (from vehicle centerline): -15 m to 15 m, 1 m increments
Road Dimension (from lamp source): 0 m to 150 m, 2.5 m increments
Isolux contour lines of 1, 3, 10, and 20 lux

Mounting Height: 0.91 m
Headlamp Separation: 1.52 m



H-LH4 (Haze)

PHOTOGRAPH SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

LH1 (New) for 2005 Ford F150

Lamp on Provided Fixture

PHOTOGRAPH SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

H-LH1 from 2005 Ford F150
(lens markings cleaned off using alcohol prior to testing)

H-LH2 from 2007 Ford F150
(included strobe tube on reflector floor near side reflex)

PHOTOGRAPH SHEET

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

H-LH3 from 2007 Ford F150

H-LH4 from 2005 Ford F150

EQUIPMENT LIST

Project Name: Haze Study - 2005 to 2007 Ford F150 VOR Replaceable Bulb Headlamp

PHOTOMETRY / COLOR — Last Calibrated

Goniometer
- ITL Custom with Aerotech ART-330, 320 Stepper Motors .....07 Jan 2015
  [resolution 0.001°, accuracy ±0.01°(±0.05%)] .....[due every 5 years]

Luminous Intensity
- Hoffman TSP-7501(HG), S/N 1060 .....15 Jan 2018
  [0.1 Cd to 600 kCd, ±0.01 Cd, accuracy ±2.0%] ..... [due every 12 months]

Color – Spectroradiometric
- Photoresearch PR-655 w/MS-75 lens & SRS-3 target,
  S/N 65160706 ..... 20 June 2018
  [resolution ±2nm, (x, y) ±0.001, ±4% luminance] ..... [due every 12 months]

ELECTRICAL — Last Calibrated

DC Power Supply
- HP6652A, S/N 3347A-01634 .....N/A
  [500W, 0-20V, 0-25A] ..... [use DMMs for measurement]

Voltage
- Fluke 45 (#1), S/N 7934019 .....15 Jan 2018
  [resolution 0.01V, accuracy ±0.02%] ..... [due every 12 months]

Current
- Keithley 197A (#1), S/N 741430 .....15 Jan 2018
  [resolution 0.001A, accuracy ±0.02%] ..... [due every 12 months]