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Case# 2020CF2054

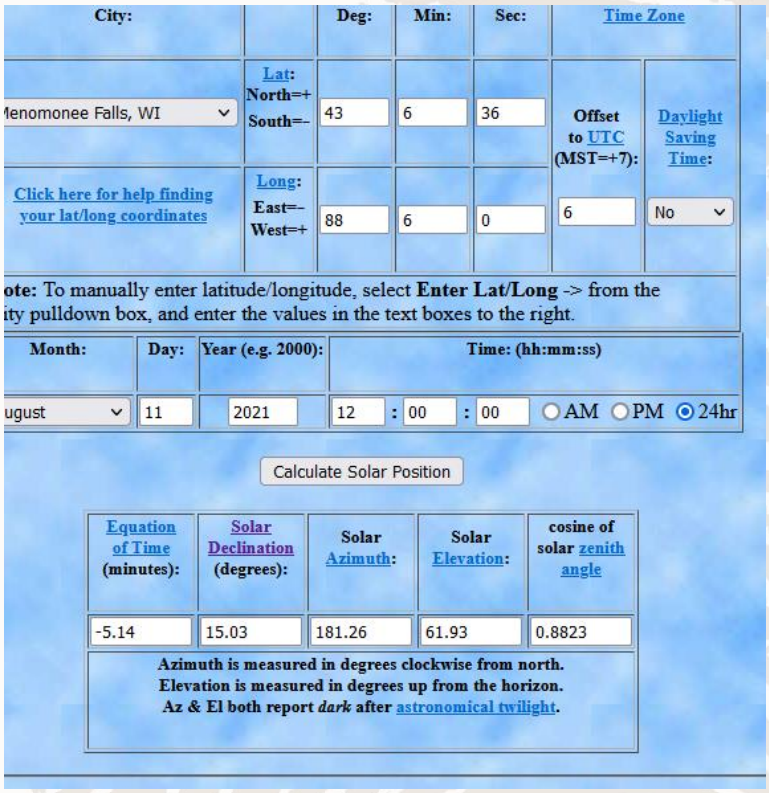
State v. Andre Brown

February 14, 2022 responded to Madison Police Department Training Center, 5702 Femrite Drive to perform lighting intensity measurements to determine visibility inside the vehicle under parked conditions:

Light intensity measured at the front seating area and the driver's door.
(The passenger's window was not in condition to perform any field testing.)

The test was designed to quantify the amount of light that is getting in the box by way of the windshield and 2 side windows. This "equation" addresses the question with a very basic process.
The light offered by the external sources:
the amount of light that is scattered by the reflective surface of the glass.

The quiescent state of the lighting is controlled by the available light found for both the time of the incident and the time of the test. This is done to arrange the artificial lighting in the lab to better match that of the day of the incident.



City:		Deg:	Min:	Sec:	Time Zone	
Menomonee Falls, WI	Lat: North=+ South=-	43	6	36	Offset to UTC (MST=+7):	Daylight Saving Time:
Click here for help finding your lat/long coordinates	Long: East=- West=+	88	6	0	6	No

ote: To manually enter latitude/longitude, select **Enter Lat/Long** -> from the ity pulldown box, and enter the values in the text boxes to the right.

Month:	Day:	Year (e.g. 2000):	Time: (hh:mm:ss)
ugust	11	2021	12 : 00 : 00 AM PM 24hr

Calculate Solar Position

Equation of Time (minutes):	Solar Declination (degrees):	Solar Azimuth:	Solar Elevation:	cosine of solar zenith angle
-5.14	15.03	181.26	61.93	0.8823

Azimuth is measured in degrees clockwise from north.
Elevation is measured in degrees up from the horizon.
Az & El both report *dark* after astronomical twilight.

NOAA Statistics

Quiescent State:

Sun light was measured in and around the vehicles test location.
Ambient average: ***1617 + 1750 Lx / 2 +1683.5 Lx***

Measured incoming light at 6 locations on the interior surface driver's window @ glass surface angle, door/ window closed.
Average light entering window ***(149 + 143 + 122 + 140 + 135 + 157 Lx)/ 6 = 141Lx average***
Measured light at interior center console, sensor facing up toward ceiling.
Front seat quiescent lighting ***67 + 69 + 71 + 60 + 60 + 65 / 6 = 65.3 Lx average***

Each of these three measurements give us:
The light loss coming in through the windows,
creating a lighted environment inside
giving the data to calculate the division and distribution of the light.

From this information, a test fixture is built to simulate the system.

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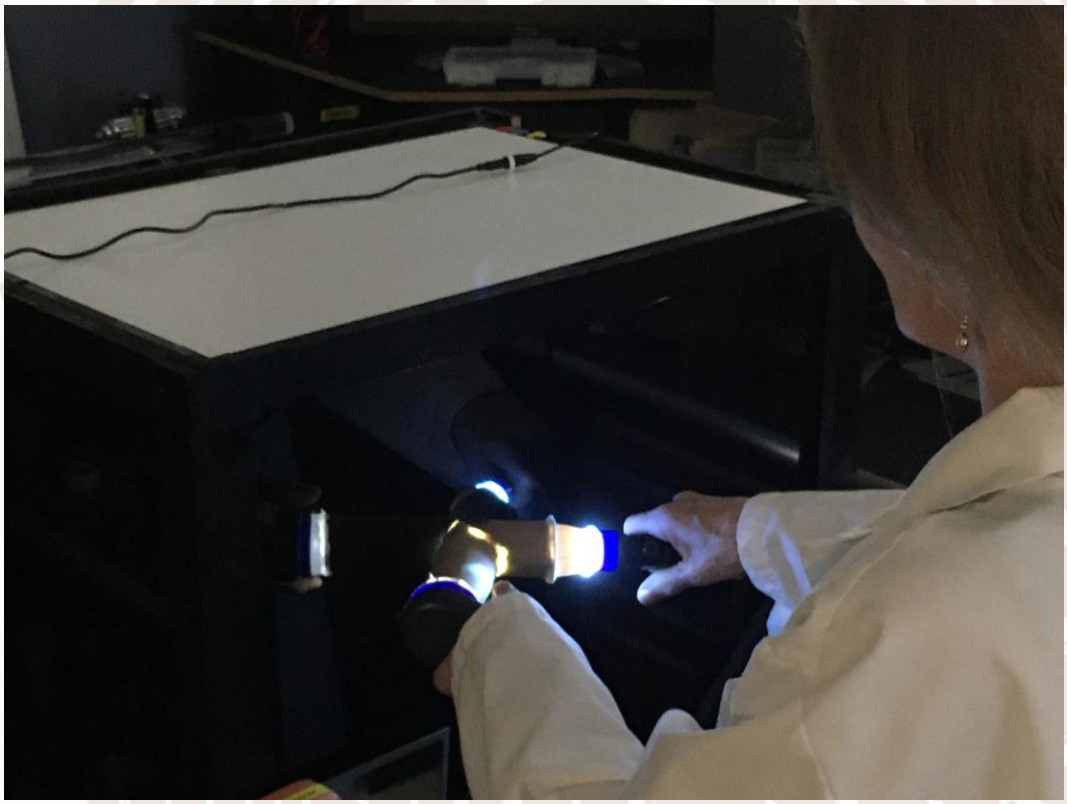
The test fixture was constructed to simulate a scale model of the lighting characteristics found at the time of the incident.
The box was made approximately 20” x 25.5”x 20”. The 1/4’ glass with 5% window tinting installed matches the tint on the subject vehicle. The tint rating is for the transparency. There is 5% of the light getting through the filter. 95% of the light is blocked. The actual measured amount is slightly different and explained below.

This box had the window preparation installed on two sides and the front (representing the glass around the front occupants of the car. The back (4th side) is solid wood.

The Path of the Light

Light from every source arrives at outside surface of the window.
+1683.5 Lx Total environment Source

The tinting and natural filtering of the glass reduces the Lux magnitude by the amount generally indicated by the marketing Transparency percentage. In this case 5%, (a slightly higher transparency, 8.7% is measured). (91.3% reduction)
-141 Lx Reduction by Tint



Scatter Measurement

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Scatter Measurement

There is a loss of light as a portion reflecting off the surface from multiple angle of incidence and does not enter the vehicle. A fixture was configured to radiate light from a known value white light source at an angle of 45 degrees. The light bounces off the out surface of the glass at an equal angle. A sensor was set up on the output side of the reflector fixture so the reflected light can be measured.

Two configurations were used for comparison. The first a glass full spectrum mirror was used for the reflector. Approaching maximum reflection, the light sensor "sees" a light intensity of 12,000 Lx. The fixture positioned over the tinted wall reflected 3850 Lx.

This test indicates that approx. 32% of the light striking the tinted glass reflects away.
-538 Lx Reduction by reflection

As the light appears at the interior surface, it travels to a subject to enlighten. Bouncing off the subject and sending an unknown and changing value of light back to the window as the rest is scattered in other directions. As the light scatters around the inside of the cabin, it compounds with all photons that have not found its way out a window yet. This light energy is measured by the console (center of cabin) test.

-65.3 Lx Balanced intensity, measured at center of cabin.

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With the top panel of LEDs tuned to the 65 lux found at the test scene, and all possible exterior lights turned off. Baby Yoda is clearly seen. There is no scatter that would interfere with seeing the interior image.

When the exterior lights are on, seen here at 24200 lux and the inside diminished image, 200 lux, (the reflection is 120 times the intensity of the image

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The image is lost from all directions.

The last stop to the eyes of the viewer is passing back through the window leaving 32 % behind in reflection.
20.9 Lx This scatter has already been counted as quiescent light measured at center.

The "signal" reducing the same measured 91.3% as light passes through the window tint
3.86 Lx Reduction by tint

When arriving in its diminished state, the image formed by the light is now a very dim picture. If this dark picture was all there was, then, in this case, the intensity of the immerging light might be seen by most viewers, however, remember the first part when the light is working its way into the box and had 32% reflect. That 32% measure 538 lux. The diminished picture of something in the box is 3.86, or the scatter is 140 times greater intensity than the diminished image. This will have a complete effect on interfering with the viewer's eyes.

As the sun light, or any source, increases in brightness, the percentage of scatter stays the same but by definition the scatter also increases in intensity. The brighter the day the less you see coming out of the box. Current reliable data shows a reference to an excepted 0.1 Lx threshold for the human eye to see over the optical noise of the body*** . The inside image is there, it just gets lost in the thick fog known as reflected sunlight.

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