Signaling and Vision Requirements

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I. Document overview

This paper defines the requirements for lightning and vision in the solar sustained vehicle developed by Mälardalen University Solar Team (MUST).

II. Purpose of this document

The purpose of this document is to state all of the requirements that the lightning, sound and vision system of our solar car needs to fulfill. This to be able to participate in the Bridgestone World Solar Challenge 2021.

III. Requirement specification Lightning

The following list contains the requirements of the lightning system.

A. BWSC Requirements

- The solar car must be fitted with two rear and one rear central stop light emitting red light.
- The solar car must be fitted with two front daytime running lamps emitting white light.
- The solar car must be fitted with two front, two side and two rear indicator lights emitting amber light.
- The indicators must flash with 90 ± 30 per minute.
- The indicators must be able to flash simultaneously to act as a hazard light.
- The stop lamps must operate whenever driving is possible and the brakes are applied.
- Daytime running lamps must operate whenever driving is possible.
- Lamps must be compliant with UNECE Regulations 6, 7 and 87, or the SAE/DOT equivalents. Teams must demonstrate compliance by the presence of compliance markings on the lamps.

B. Positing of lamps

- Daytime running lamps must be mounted at the front of the solar car and at least 600 mm apart and at least 250 mm above the ground.
- The entire apparent surface of the daytime running lamps must be visible 10° upwards, 10° downwards, 20° outwards and 20° inwards.
- Side direction indicator lamps must be less than 1800 mm behind the front most part of the solar car and within 400 mm of the extreme outer edge of the solar car on each side.
- The entire apparent surface of direction indicator lamps must be visible 15° up and 5° down. Minimum horizontal visibility requirements (of the right direction indicator lamps) are shown in Figure 1.
- Front and rear direction indicator lamps must be within 400 mm of the extreme outer edge of the solar car on each side, at least 600 mm apart, and at least 350 mm above the ground.
- The lateral position of the central stop lamp must coincide with the visual centre of the drivers compartment. The bottom of the lamp must be higher than the top of the rear stop lamps. The entire apparent surface must be visible 10° up, 5° down and 10° to the left and right.
- Rear stop lamps must be within 400 mm of the extreme outer edge of the solar car on each side, at least 600 mm apart and at least 350 mm above the ground.
- The entire apparent surface of the rear stop lamps must be visible 15° up, 5° down and 45° to the left and right.
- Solar cars must have the correct type of lamp in each position. Lamps must be mounted with the correct orientation so that the photometric requirements of UNECE Regulations 6, 7 and 87, or the SAE/DOT equivalents, are met. See table I.

C. System requirements

- The flashing circuit should be designed of that fashion that it requires minimum energy meaning no use of heavy relays.
- The system must provide a feedback showing the state of the indicators.

IV. Requirement specification Rear Vision

The following list contains the requirements of the vision system.

A. BWSC Requirements

- The solar car must have rear vision systems that enable the driver, when seated in the normal driving position with the safety-belt fastened, to see the ground in the shaded areas shown in the diagrams below (UNECE Regulation 46, Section 15), see Figure 2.
- Rear vision systems must operate whenever the solar car is in motion under its own power or about to be driven.
- Rear vision images must be oriented so that objects on the right of the solar car are on the right of the image.

B. Positing of camera and screen

- The cameras should be mounted so that they do not obstruct the lamps or affect the aerodynamic properties of the car.
- The Rear Vision screen should be placed so that it dos not obstruct the vision for the driver nor cover any other instruments.

C. System requirements

- The screen and cameras must be powered from the main battery only.

V. Requirement specification Sound Horn

The following list contains the requirements of the sound horn system.

A. BWSC Requirements

- An audible warning device complying with the intent of UNECE Regulation 28 must be fitted to the solar car.
- The device must emit a continuous and uniform sound. The audible warning device must be capable of operating for 50,000 cycles of on for one second and off for four seconds.
- It must be possible to measure a sound pressure level greater than LA = 105 dB 2 m from the sound horn.
- The sound horn device must be positioned so that it does not risk exposing the driver or other persons in the vehicle to excessive sound pressure levels

VI. Appendix

Lamps	UNECE category
Front indicators	1, 1a, 1b
Rear indicators	2a, 2b
Side indicators	5, 6
Stop lamps	S1, S2
Central stop lamps	S3
Daytime running lamp	RL

Table I
TABLE OF UNECE CATEGORIES

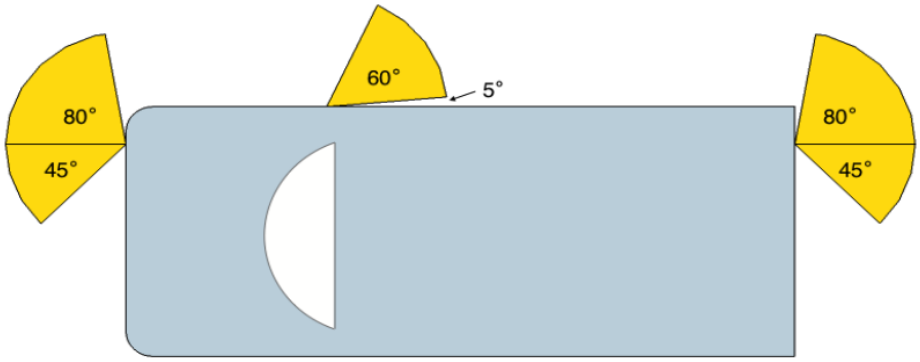

Figure 1. Angle for front, side and rear indicators. Picture from Bridgestone World Solar Challenge Regulation 2021

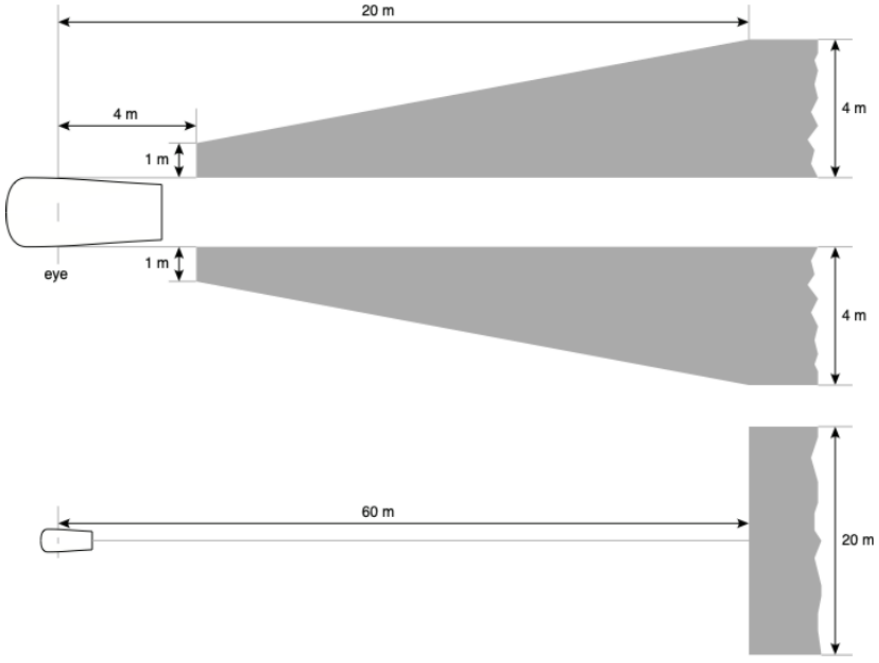

Figure 2. Rear Vision. Picture from Bridgestone World Solar Challenge Regulation 2021