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REVISTA INGENIO

Implementation of the Lighting Test for the Homologation of Motorcycles and Tricycles According to the ISO 11460:2007 Standard

Prueba preliminar de Iluminación para la Homologación de Motocicletas y Triciclos según la Norma ISO 1460:2007

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PALABRAS CLAVE
Norma ISO 11460:2007, dispositivos de iluminación, luxómetro.

RESUMEN
El desarrollo de este artículo aborda la temática de la aplicación de la normativa internacional ISO 11460:2007 y su cumplimiento para la evaluación de motocicletas y tricimotos de la ciudad de Quito, la cual se encuentra específicamente relacionada a la colocación y nivel de iluminación de los dispositivos de iluminación de estos vehículos. Por esa razón, el objetivo principal del estudio se encuentra relacionado a realizar el ensayo de iluminación que se usa para la homologación de motocicletas y tricimotos acorde a la norma ISO 11460:2007, para lo cual se utilizó como muestra a varias motos aprobadas para circulación en nuestro medio tomadas del mercado a partir del año 2019, ensambladas en el país y en el exterior, el mismo que pondrá en evidencia las falencias y nivel de cumplimiento observados en las motos que conforman la muestra para la investigación, cuyos resultados permitirán establecer la realidad actual de esta problemática.
Se realizó un procedimiento adecuado para la evaluación de las motocicletas en el ensayo de iluminación, así como el enfoque, los métodos e instrumentos que permitieron analizar y recolectar información de acuerdo con los lineamientos planteados. Posteriormente en los resultados obtenidos del ensayo de iluminación y los datos de la norma ISO 11460:2007, demostrando que las motos evaluadas desobedecen a dicha norma en algunos de sus dispositivos de iluminación.

KEY WORDS
ISO 11460:2007 standard, lighting devices, lux meter.

ABSTRACT
The development of this article addresses the issue of the application of the regulations international ISO 11460:2007 and its compliance for the evaluation of motorcycles and tricycles of the city of Quito, which is specifically related to the placement and lighting level of the lighting devices of these vehicles. For this reason, the main objective of the study is related to carrying out the test of illumination that is used for the homologation of motorcycles and tricycles according to the ISO 11460:2007 standard, for which five motorcycles taken from the market from the year 2019, assembled in the country and abroad, the same that will put in evidence the shortcomings and level of compliance observed in the motorcycles that make up the sample for the investigation, whose results will allow establishing the current reality of this problematic.
An adequate procedure was carried out for the evaluation of motorcycles in the lighting test, as well as the approach, methods and instruments that allowed analyze and collect information according to the guidelines set forth. Subsequently, in the results obtained from the lighting test and the data from the ISO 11460:2007 standard, showing that the 5 evaluated motorcycles disobey said standard in some of their lighting fixtures

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1. INTRODUCTION

The purpose of this work is to know about the international standard ISO 11460:2007 and its assessment of motorcycles and tricycles in Quito [1]. This is specifically related to determine the kind of illumination devices in these vehicles. The configuration and intensity of headlights play a crucial role in the prevention of traffic accidents, both in four-wheeled vehicles and on motorcycles and tricycles. It is recognized that low headlight intensity can prevent a driver approaching an intersection from detecting the presence of another vehicle, which could lead to accidents, especially in areas without traffic lights or signaling [2]. On the other hand, excessively high intensity can make it difficult for oncoming drivers to see. In relation to this issue, the National Traffic Agency (ANT) reports that, until April 2021, of all accidents registered in Ecuador, 33 are linked to various mechanical problems, of which 29 are related to the lighting and design of the devices, representing 0.4% of the total. Therefore, the primary objective of this study was to conduct lighting tests for the certification of motorcycles and tricycles in Quito. To conduct these tests, five motorcycles from the 2019 and latest, both domestically assembled and imported, were selected as a sample. The study related to this international standard is detailed in an evaluation test report, which will demonstrate the deficiencies and compliance levels observed in the motorcycles that make up the study sample.

The results will determine the current state of this study's issue [3], [4]. This study is divided into three parts:

The first part deals with the origins and the significance of motorcycle lighting systems. The second part analyzes how these systems impact the performance of motorcycles. Finally, it provides a detailed examination of the application of lighting systems and their advantages from previous studies [5].

In conclusion, the study presents the following research objectives:

Interpret the parameters in accordance with the required regulations for conducting lighting tests on motorcycles and tricycles, following ISO 11460:2007.

Implement the devices used in the lighting tests.

Analyze various cases and research on lighting systems and their use in the automotive field, focusing on different components of a motorcycle.

This research will focus on analyzing the degree of compliance with the aforementioned requirement according to ISO 11460 of the International Organization for Standardization. It is important to note that there is neither a specific regulatory body for this standard nor established tools to measure its application.

2. METHOD

2.1. The motorcycle lighting system, in accordance with ISO 11460:2007 regulations [6]

It is a critical component of any motorcycle. Each light on a motorcycle serves a specific function, and its location, size, and color depend on its intended purpose. According to the regulations [7], the basic requirements that must be considered include:

Headlight: Position and orientation. It can be separate from the front light and may be installed above, below, or to the sides of the front light, with reference centers being symmetric with respect to the longitudinal plane of the vehicle [8]. The lights should be oriented forward.

Dipped Beam Light: Position and orientation. It can be separate or reciprocal to the front light, with installation above, below, or on each side of the front light. If there are two dipped beam lights, they must be incorporated in such a way that they are symmetrical with respect to the vehicle's longitudinal plane. Their height should not be less than 500 mm or more than 1200 mm from the ground. The lights must be oriented forward.

Front Position Light: Position and orientation. Like the previous lights, it can be separate or combined with another front light. The height of the light with respect to the ground should not be less than 350 mm or more than 1200 mm. The headlight beams are oriented forward.

Side Retroreflective Device: Position and orientation. There are no specific width requirements, but its height should not be less than 300 mm or more than 900 mm from the ground. The orientation should be perpendicular to the vehicle's median longitudinal plane and outward.

Rear Retroreflective Device: Position and orientation. Its reference center should be oriented to the vehicle's median longitudinal plane. The reference center should be symmetrical concerning

the longitudinal plane [9]. The height should not be less than 250 mm or more than 900 mm above the ground. The orientation should be backward.
Direction Indicator Lamp: Position, orientation, intensity. Regarding the front indicators, they must have a minimum separation of 240 mm. They should be situated outside the tangential longitudinal vertical planes relative to the outer edges of the illuminating surface. If the intensity is 90 cd, the separation is 75 mm. If the intensity is 175, the separation is 40 mm. If the intensity is 250, the separation is 20 mm. If the intensity is 400 cd, the separation is 0 mm. As for orientation, the front indicators move with the steering angle.
Brake Light: Position and orientation. Its height should not be less than 250 mm or more than 1500 mm. The brake light should be positioned at the rear of the vehicle. Concerning orientation, the lamps should be oriented backward.
Rear Position Light: Position and orientation.
Rear Registration Plate Light: Position and orientation. They should illuminate the space reserved for the vehicle's registration plate.
Emergency Light: Position and orientation. They should match the signals provided by the simultaneous operation of all direction indicators.
Front Fog Light: Position and orientation. The reference center should be on the median longitudinal plane of the vehicle or at the edge of the illuminating surface, not more than 250 mm away. Its height should not be less than 250 mm above the ground. The fog light should be oriented forward.
Rear Fog Light: Position and orientation.

2.2. Direct observations were conducted on each of the motorcycles according to regulation [7].

The steps to be followed for each test are as follows:
- Evaluation of Parallel Lighting Devices to the Roadway Support Plane [6]

a) With the help of a laser level, the motorcycle was positioned perpendicular to the road surface on the track.
b) The vehicle was supported on a stand.
c) The handlebar was positioned straight ahead.
d) It was ensured that the lighting units mounted symmetrically on the median longitudinal plane had the same height to confirm compliance with this condition.

- Evaluation of Perpendicular Retroreflective Devices to the Vehicle's Median Plane [3], [7]

a) The motorcycle or tricycles were positioned perpendicular to the road surface on the track.
b) The vehicle was held on a stand.
c) The handlebars were set in the relevant position, straight ahead.

- Evaluation of Headlights

a) Assess whether they are independent or mutually incorporated.
b) Evaluate the arrangement of independent lights, whether horizontally symmetrical with respect to another headlight or vertically symmetrical in the longitudinal plane compared to another headlight.
c) In case of horizontal arrangement, the distance between the two headlights should not exceed 200 mm.
d) The main headlight's height should not be less than 500 mm or more than 1300 mm above the ground.
e) The maximum height above the ground is measured from the highest point, and the minimum height is measured from the lowest point of the illuminating surface.
f) The front position lights must be oriented forward. The lamps can move with the steering angle.

- Evaluation of Dipped Beam Lights

a) Assess whether they are independent or mutually incorporated.
b) The height of the obliquely illuminated headlight should not be less than 500 mm or more than 1200 mm.
c) The maximum height above the ground should be measured from the highest point, and the minimum height should be measured from the lowest point of the illuminating surface.
d) The separation between the two headlights should not exceed 200 mm.
e) The front position lights must be oriented forward. The lamps can move with the steering angle.
f) Record the color and the number of lights on the vehicle.

- Evaluation of Front Position Lights

a) Assess whether they are independent or mutually incorporated.
b) A front position light can be independent or combined with another front light.
c) The height of a front position light should not be less than 350 mm or more than 1200 mm above the ground.

d) The maximum height above the ground should be measured from the highest point, and the minimum height should be measured from the lowest point of the illuminating surface.
e) Front position lights should be oriented forward. The lamps can move with the steering angle.
f) Record the color and the number of lights on the vehicle.

- Evaluation of Side Retroreflective Devices

a) There are no specific requirements for width.
b) The height of the lateral retroreflective device should not be less than 300 mm or more than 900 mm above the ground.
c) The maximum height above the ground should be measured from the highest point, and the minimum height should be measured from the lowest point of the illuminating surface.
d) Regarding length, the position of the lateral retroreflective devices should ensure they are not hidden by the rider, passenger, or their clothing under normal circumstances.
e) The reference axis of the lateral retroreflective device should be perpendicular to the vehicle's median longitudinal plane and directed outward. It can move with the steering angle.
f) Record the color and the number of lights on the vehicle.

- Evaluation of Rear Retroreflective Devices [3], [7]

a) For motorcycles equipped with a rear retroreflective device, the reference center should be on the longitudinal plane of the vehicle's central axis.
b) If the motorcycle has two rear retroreflective devices, they should be mounted so that their reference centers are symmetrical with respect to the vehicle's median longitudinal plane.
c) The height of a rear retroreflective device should not be less than 250 mm or more than 900 mm above the ground.
d) The rear retroreflective device should be oriented backward.
e) Record the color and the number of lights on the vehicle.

- Evaluation of Direction Indicator Lamps

a) Regarding width, the direction indicator lamps should meet the following requirements as applicable.
b) The separation between the two direction indicators should be at least 240 mm.
c) The indicator should be located outside the longitudinal vertical plane tangent to the outer edge of the illuminating surface of the dipped beam light.
d) In the case of rear indicators, the space between the inner edges of the two illuminating surfaces should be at least 180 mm.
e) The height of the direction indicators should not be less than 350 mm or more than 1200 mm above the ground.
f) Regarding length, the distance forward from the reference center of the rear indicator to the transverse plane forming the rear limit of the vehicle's total length should not exceed 300 mm.
g) The front indicator can move with the steering angle.

- Evaluation of Brake Lights

a) The height of the brake lights should not be less than 250 mm or more than 1500 mm.
b) In length, the brake light should be located at the rear of the vehicle.
c) Parking lights should be oriented backward.
d) Record the color and the number of lights on the vehicle.

- Evaluation of Rear Position Lights [10]

a) The height of the parking lights should not be less than 250 mm or more than 1500 mm.
b) In length, the brake light should be located at the rear of the vehicle.
c) Parking lights should be oriented backward.
d) Record the color and the number of lights on the vehicle.

- Evaluation of Registration Plate Light

The rear registration plate light should be positioned and oriented to illuminate the space designated for the registration plate.

Evaluation of Emergency Light

The location and direction of the emergency light should be the same as that provided by the simultaneous operation of all direction indicators.

- Evaluation of Front Fog Lights

a) Regarding width, the reference core of the fog light should be on the vehicle's longitudinal axis or no more than 250 mm from the nearest illuminating surface edge in that plane.
b) The height of the front fog lights should not be less than 250 mm above the ground. The illuminating surface point should not be higher than the highest point of the dipped beam light illuminating surface.
c) The front fog lights should be oriented forward. The lamps can move with the steering angle.

d) Record the color.

- Evaluation of Rear Fog Light

a) The length of the rear fog light should not be less than 250 mm or more than 900 mm.
b) In extension, a rear fog light should be installed at the rear of the vehicle.
c) The proximity between the illuminated part of the rear fog light and the rear parking light should not be less than 100 mm.
d) The rear fog lights should be oriented backward.
e) Record the color.

- Assessment of the Luminous Intensity of Lighting Equipment [6]

a) Position the device in front of the lighting equipment to be analyzed.
b) Try to maintain a maximum distance of 100 mm from the headlight.
c) Raise or lower the device until the maximum illumination value is confirmed.
d) Record the estimated values in an appropriate format.

3. RESULTS

After conducting each of the evaluations and obtaining the results, we proceeded with the assessment reports, with the following results:
Motorcycle 1, based on the parameters indicated in the relevant standard, has independent road lights, position lights, and dipped beam lights, with lighting devices parallel to the roadway support plane.

However, it does not meet the requirements for side retroreflective devices, fog lights, and emergency lights based on its model and characteristics. Please refer to the sections below and see figure 1.

Motorcycle 2, as shown in figure 2, complies with the parameters specified in the relevant standards. It has incorporated lights, with its main headlights being independent and its position, located in the center.

The turn signals and emergency lights are positioned at 400 mm, which is within the applicable range, as the minimum requirement is 240 mm. Additionally, the height of these lights is 760 mm. However, the side retroreflective devices and fog lights do not meet the requirements based on their type and characteristics.

Motorcycle 3, based on the parameters specified in the relevant standard, features road lights, position lights, and dipped beam lights that are mutually incorporated, each at a height of 980 mm. The lighting devices are parallel to the roadway support plane.

However, like the previous cases, it does not meet the requirements for side retroreflective devices, fog lights, and emergency lights based on its model and characteristics. See figure 3 for visual reference.

Finally, Motorcycle 5 features road lights and dipped beam lights that are mutually incorporated at a height of 970 mm. The position lights at a height of 890 mm are independent and arranged one above the other with symmetry concerning the median longitudinal plane.

The turn signals and emergency lights are positioned at 430 mm, which is within the applicable range, with a height of 9300 mm.
However, the side retroreflective devices and fog lights do not meet the requirements based on their type and characteristics. See figure 5 for visual reference.

3.1. Discussion

Ecuadorian regulations establish specific requirements for motorcycle lighting, addressing the position, orientation, and height of both the headlight and the low beam. These parameters seek to ensure adequate visibility and symmetry in the arrangement of the lights. In contrast, studies in the United States reveal that many motorcycle accidents involve drivers who do not perceive motorcycles, especially at night, highlighting the importance of effective lighting.

Experiments showed that during the day, a large headlamp or daytime running lights improve visibility, while at night, a large headlamp, and additions such as illuminated fairings benefit identification in nighttime traffic [11]. The conclusion is that Ecuadorian regulations and lighting recommendations derived from studies in

Figure 1.

Evaluation Test Report for Motorcycle

COMPARISON OF DATA OBTAINED FROM THE MOTORCYCLE LIGHTING TEST ACCORDING TO THE ISO 11460:2007 STANDARD

Motorcycle Data 1

Year	2019	Country of origin	India	Displaceme	155CC

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing
Highway lights	Position	Independent or reciprocally		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median p
		Height (between 500 mm to 1300 mm)		880mm
	Orientation	Forward		Forward
Beam	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median p
		Height (between 500 mm to 1200 mm)		880mm
	Orientation	Forward		Forward
Front position light	Position	Independent or reciprocally incorporated		Independent
		Independent light arrangement (Lights on top of each other) (Lights side by side) - symmetrical in relation to the median longitudinal plane of the vehicle		Lights on top of each other (below): in the median longitudinal plane of the vehicle
		Symmetry in independent lights (Between high beam, low beam and position light with the median plane)		Symmetrical with the median longitudinal plane of the vehicle
		Height (between 350 mm to 1200 mm)		790mm
	Orientation	Forward		Forward
Retro-reflective device	Lateral retro-reflective device	Position and Orientation		It does not have a lateral retro-reflective device
	Rear catadioptric device	Position	In median longitudinal plane	In median longitudinal plane
			Height (between 250 mm to 900	530mm
		Orientation	Backward	Backward

Data required by ISO 11460:2007 standard					Data obtained from motorcycle testing
Front direction indicator lamp	Position	Distance between direction lights (min.			330mm
		Location (do not obstruct outer edges of low beam headlights)			Does not obstruct the outer edges of the low beam headlights
		Height (between 350 mm to 1200 mm			1070mm
		Minimum separation distance from headlights (mm)			Minimum separation distance from headlights (mm)
		75			190
		40			-
		20			-
		0			-
		Measurement distance between the evaluated light and the device (m)			
		1,2			
		Minimum direction indicator intensity (cd)			Minimum direction indicator intensity (lux) / Minimum direction indicator intensity (cd)
		90 - 174			42,1 / 60,624
		175 - 249			- / -
		250 - 399			- / -
		400			- / -
	Orientation	Forward			Forward
Rear direction indicator lamp	Position	Distance between direction lights (min. 180 mm)			310mm
		Distance from the center of light to the transverse plane, from the rear limit of the vehicle (max. 300 mm)			120mm
		Height (between 350 mm to 1200 mm			200mm
	Orientation	Backward			Backward
Brake light and rear position lamp	Position	Height (between 250 mm to 1500 mm			750mm
		Location (rear of vehicle)			Rear of the vehicle
	Orientation	Backward			Backward
Rear license plate light		It must illuminate the space reserved for the license plate			Illuminates the space reserved for the license plate
Emergency light		Position and orientation same as direction indicator lights			Does not have emergency light
fog light		Position and orientation			Does not have fog light

4.6 This national standard defines the position of the following lighting and signaling devices: - High beam (see 5.1); - Low beam (see 5.2); - Front position light (see 5.3); - Side retro-reflective device (see 5.3); see 5.4);- Rear retro-reflective device (see 5.5);- Direction indicator light (see 5.6);- Brake light (see 5.7);- Rear position light (see 5.8);- Rear license plate light (see 5.9);- Emergency light (5.10);- Front fog light (see 5.11);- Rear fog light (see 5.12).
5, Specific requirements (ISO 11460:2007 standard)
Data collected from the trial
5.6.1.1.1 Table 1 - Minimum intensity of the direction indicator light and corresponding minimum separation distance with the nearest low beam
Measured value in (lux)
Calculated value in (cd)
Absence of devices in the vehicle

Figure 2.

Evaluation Test Report for Motorcycle 2

COMPARISON OF DATA OBTAINED FROM THE MOTORCYCLE LIGHTING TEST ACCORDING TO THE ISO 11460:2007 STANDARD

Motorcycle Facts 2

Year	2018	Country of origin	China	Displacem ent	248cc

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing
Highway lights	Position	Independent or reciprocally		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1300 mm)		850mm
	Orientation	Forward		Forward
Beam	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1200 mm)		850mm
	Orientation	Forward		Forward
Front position light	Position	Independent or reciprocally incorporated		Independent
		Independent light arrangement (Lights on top of each other) (Lights side by side) - symmetrical in relation to the median longitudinal plane of the vehicle		Lights side by side: in the median longitudinal plane of the vehicle
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Does not apply
		Symmetry in independent lights (Between high beam, low beam and position light with the median plane)		Symmetrical with the median longitudinal plane of the vehicle
		Height (between 350 mm to 1200 mm)		810mm
	Orientation	Forward		Forward
Retro-reflective device	Lateral retro-reflective device	Position and Orientation		It does not have a lateral retro-reflective device
	Rear catadioptric device	Position	In median longitudinal plane	In median longitudinal plane
			Height (between 250 mm to 900 mm)	800mm
		Orientation	Backward	Backward

Data required by ISO 11460:2007 standard					Data obtained from motorcycle testing
Front direction indicator lamp	Position	Distance between direction lights (min. 240			400mm
		Location (do not obstruct outer edges of low beam headlights)			Does not obstruct the outer edges of the low beam headlights
		Height (between 350 mm to 1200 mm)			760mm
		Minimum separation distance from headlights (mm)			Minimum separation distance from headlights (mm)
		75			210mm
		40			-
		20			-
		0			-
		Measurement distance between the evaluated light and the device (m)			
		1,2			
		Minimum direction indicator intensity (cd)			Minimum direction indicator intensity (lux) / Minimum direction indicator intensity (cd)
		90 - 174			67,2 / 96,768
		175 - 249			- / -
		250 - 399			- / -
		400			- / -
	Orientation	Forward			Forward
Rear direction indicator lamp	Position	Distance between direction lights (min. 180 mm)			260mm
		Distance from the center of light to the transverse plane, from the rear limit of the vehicle (max. 300 mm)			210mm
		Height (between 350 mm to 1200 mm)			150mm
	Orientation	Backward			Backward
Brake light and rear position lamp	Position	Height (between 250 mm to 1500 mm)			940mm
		Location (rear of vehicle)			Rear of the vehicle
	Orientation	Backward			Backward
Rear license plate light		It must illuminate the space reserved for the license plate			Illuminates the space reserved for the license plate
Emergency light		Position and orientation same as direction indicator lights			Has emergency light
fog light		Position and orientation			Does not have fog light

4.6 This national standard defines the position of the following lighting and signaling devices: - High beam (see 5.1); - Low beam (see 5.2); - Front position light (see 5.3); - Side retro-reflective device (see 5.3); see 5.4);- Rear retro-reflective device (see 5.5);- Direction indicator light (see 5.6);- Brake light (see 5.7);- Rear position light (see 5.8);- Rear license plate light (see 5.9);- Emergency light (5.10);- Front fog light (see 5.11);- Rear fog light (see 5.12).
5, Specific requirements (ISO 11460:2007 standard)
Data collected from the trial
5.6.1.1.1 Table 1 - Minimum intensity of the direction indicator light and corresponding minimum separation distance with the nearest low beam
Measured value in (lux)
Calculated value in (cd)
Absence of devices in the vehicle

Figure 3.
Evaluation Test Report for Motorcycle 3

COMPARISON OF DATA OBTAINED FROM THE MOTORCYCLE LIGHTING TEST ACCORDING TO THE ISO 11460:2007 STANDARD

Motorcycle Facts 3

Year	2018	Country of origin	Ecuador	Displacement	198cc

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing
Highway lights	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1300		980mm
	Orientation	Forward		Forward
Beam	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1200		980mm
	Orientation	Forward		Forward
Front position light	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Independent light arrangement (Lights on top of each other) (Lights side by side) - symmetrical in relation to the median longitudinal plane of the vehicle		Does not apply
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Symmetry in independent lights (Between high beam, low beam and position light with the median plane)		Does not apply
		Height (between 350 mm to 1200 mm)		980mm
	Orientation	Forward		Forward
Retro-reflective device	Lateral retro-reflective device	Position and Orientation		It does not have a lateral retro-reflective device
	Rear catadioptric device	Position	In median longitudinal plane	In median longitudinal plane
			Height (between 250 mm to 900 mm)	630mm
		Orientation	Backward	Backward

Data required by ISO 11460:2007 standard			Data obtained from motorcycle testing	
Front direction indicator lamp	Position	Distance between direction lights (min. 240 mm)	375mm	
		Location (do not obstruct outer edges of low beam headlights)	Does not obstruct the outer edges of the low beam headlights	
		Height (between 350 mm to 1200 mm)	995mm	
		Minimum separation distance from headlights (mm)	Minimum separation distance from headlights (mm)	
		75	210	
		40	-	
		20	-	
		0	-	
		Measurement distance between the evaluated light and the device (m)	1,2	
		Minimum direction indicator intensity (cd)	Minimum direction indicator intensity (lux)	Minimum direction indicator intensity (cd)
		90 - 174	35,6	51,264
		175 - 249	-	-
		250 - 399	-	-
		400	-	-
	Orientation	Forward	Forward	
Rear direction indicator lamp	Position	Distance between direction lights (min. 180 mm)	290mm	
		Distance from the center of light to the transverse plane, from the rear limit of the vehicle (max. 300 mm)	260mm	
		Height (between 350 mm to 1200 mm)	200mm	
	Orientation	Backward	Backward	
Brake light and rear position lamp	Position	Height (between 250 mm to 1500 mm)	900mm	
		Location (rear of vehicle)	Rear of the vehicle	
	Orientation	Backward	Backward	
Rear license plate light		It must illuminate the space reserved for the license plate	Illuminates the space reserved for the license plate	
Emergency light		Position and orientation same as direction indicator lights	Does not have emergency light	
fog light		Position and orientation	Does not have fog light	

4.6 This national standard defines the position of the following lighting and signaling devices: - High beam (see 5.1); - Low beam (see 5.2); - Front position light (see 5.3); - Side retro-reflective device (see 5.3); see 5.4);- Rear retro-reflective device (see 5.5);- Direction indicator light (see 5.6);- Brake light (see 5.7);- Rear position light (see 5.8);- Rear license plate light (see 5.9);- Emergency light (5.10);- Front fog light (see 5.11);- Rear fog light (see 5.12).
5, Specific requirements (ISO 11460:2007 standard)
Data collected from the trial
5.6.1.1.1 Table 1 - Minimum intensity of the direction indicator light and corresponding minimum separation distance with the nearest low beam
Measured value in (lux)
Calculated value in (cd)
Absence of devices in the vehicle

Figure 4.
Evaluation Test Report for Motorcycle 4

COMPARISON OF DATA OBTAINED FROM THE MOTORCYCLE LIGHTING TEST ACCORDING TO THE ISO 11460:2007 STANDARD

Motorcycle Facts 4

Year	2018	Country of origin	Colombia	Displacement	248cc

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing
Highway lights	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1300 mm)		950mm
	Orientation	Forward		Forward
Beam	Position	Independent or reciprocally incorporated		Reciprocally incorporated
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Center of reference to the median plane
		Height (between 500 mm to 1200		950mm
	Orientation	Forward		Forward
Front position light	Position	Independent or reciprocally incorporated		Independent
		Independent light arrangement (Lights on top of each other) (Lights side by side) - symmetrical in relation to the median longitudinal plane of the vehicle		Lights on top of each other (below): in the median longitudinal plane of the vehicle
		Reciprocally incorporated light arrangement (center of reference to the median plane)		Does not apply
		Symmetry in independent lights (Between high beam, low beam and position light with the median plane)		Symmetrical with the median longitudinal plane of the vehicle
		Height (between 350 mm to 1200 mm)		890mm
	Orientation	Forward		Forward
Retro-reflective device	reflective device	Position and Orientation		It does not have a lateral retro-reflective device
	Rear catadioptric device	Position	In median longitudinal plane	In median longitudinal plane
			Height (between 250 mm to 900 mm)	785mm
		Orientation	Backward	Backward

Data required by ISO 11460:2007 standard			Data obtained from motorcycle testing	
Front direction indicator lamp	Position	Distance between direction lights (min. 240 mm)	430mm	
		Location (do not obstruct outer edges of low beam headlights)	Does not obstruct the outer edges of the low beam headlights	
		Height (between 350 mm to 1200 mm)	840mm	
		Minimum separation distance from headlights (mm)	Minimum separation distance from headlights (mm)	
		75	220mm	
		40	-	
		20	-	
		0	-	
		Measurement distance between the evaluated light and the device (m)	1,2	
		Minimum direction indicator intensity (cd)	Minimum direction indicator intensity (lux)	Minimum direction indicator intensity (cd)
		90 - 174	35,3	50,832
		175 - 249	-	-
		250 - 399	-	-
		400	-	-
	Orientation	Forward	Forward	
Rear direction indicator lamp	Position	Distance between direction lights (min. 180 mm)	240mm	
		Distance from the center of light to the transverse plane, from the rear limit of the vehicle (max. 300 mm)	111mm	
		Height (between 350 mm to 1200 mm)	830mm	
	Orientation	Backward	Backward	
Brake light and rear position lamp	Position	Height (between 250 mm to 1500 mm)	870mm	
		Location (rear of vehicle)	Rear of the vehicle	
	Orientation	Backward	Backward	
Rear license plate light		It must illuminate the space reserved for the license plate	Illuminates the space reserved for the license plate	
Emergency light		Position and orientation same as direction indicator lights	Does not have emergency light	
fog light		Position and orientation	Does not have fog light	

4.6 This national standard defines the position of the following lighting and signaling devices: - High beam (see 5.1); - Low beam (see 5.2); - Front position light (see 5.3); - Side retro-reflective device (see 5.3); see 5.4);- Rear retro-reflective device (see 5.5);- Direction indicator light (see 5.6);- Brake light (see 5.7);- Rear position light (see 5.8);- Rear license plate light (see 5.9);- Emergency light (5.10);- Front fog light (see 5.11);- Rear fog light (see 5.12).
5, Specific requirements (ISO 11460:2007 standard)
Data collected from the trial
5.6.1.1.1 Table 1 - Minimum intensity of the direction indicator light and corresponding minimum separation distance with the nearest low beam
Measured value in (lux)
Calculated value in (cd)
Absence of devices in the vehicle

Figure 5.
Evaluation Test Report for Motorcycle 5

COMPARISON OF DATA OBTAINED FROM THE MOTORCYCLE LIGHTING TEST ACCORDING TO THE ISO 11460:2007 STANDARD

Motorcycle Facts 5

Year	2018	Country of origin	China	Displacem	198cc

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing
Highway lights	Position		Independent or reciprocally	Reciprocally incorporated
			Reciprocally incorporated light arrangement (center of reference to the median plane)	Center of reference to the median plane
			Height (between 500 mm to 1300	970mm
	Orientation		Forward	Forward
Beam	Position		Independent or reciprocally incorporated	Reciprocally incorporated
			Reciprocally incorporated light arrangement (center of reference to the median plane)	Center of reference to the median plane
			Height (between 500 mm to 1200	970mm
	Orientation		Forward	Forward
Front position light	Position		Independent or reciprocally incorporated	Independent
			Independent light arrangement (Lights on top of each other) (Lights side by side) - symmetrical in relation to the median longitudinal plane of the vehicle	Lights on top of each other (below): in the median longitudinal plane of the vehicle
			Reciprocally incorporated light arrangement (center of reference to the median plane)	Does not apply
			Symmetry in independent lights (Between high beam, low beam and position light with the median plane)	Symmetrical with the median longitudinal plane of the vehicle
			Height (between 350 mm to 1200 mm)	890mm
	Orientation		Forward	Forward
Retro-reflective device	retro-reflective device		Position and Orientation	It does not have a lateral retro-reflective device
	Rear catadioptric device	Position	In median longitudinal plane	In median longitudinal plane
			Height (between 250 mm to 900 mm)	745mm
		Orientation	Backward	Backward

Data required by ISO 11460:2007 standard				Data obtained from motorcycle testing	
Front direction indicator lamp	Position		Distance between direction lights (min.	370mm	
			Location (do not obstruct outer edges of low beam headlights)	Does not obstruct the outer edges of the low beam headlights	
			Height (between 350 mm to 1200 mm)	930mm	
			Minimum separation distance from headlights (mm)	Minimum separation distance from headlights (mm)	
			75	200mm	
			40	-	
			20	-	
			0	-	
			Measurement distance between the evaluated light and the device (m)		
			1,2		
			Minimum direction indicator intensity (cd)	Minimum direction indicator intensity (lux)	Minimum direction indicator intensity (cd)
			90 - 174	70,5	101,52
			175 - 249	-	-
			250 - 399	-	-
			400	-	-
	Orientation		Forward	Forward	
Rear direction indicator lamp	Position		Distance between direction lights (min. 180 mm)	335mm	
			Distance from the center of light to the transverse plane, from the rear limit of the vehicle (max. 300 mm)	280mm	
			Height (between 350 mm to 1200 mm)	190mm	
	Orientation		Backward	Backward	
Brake light and rear position lamp	Position		Height (between 250 mm to 1500 mm)	880mm	
			Location (rear of vehicle)	Rear of the vehicle	
	Orientation		Backward	Backward	
Rear license plate light			It must illuminate the space reserved for the license plate	Illuminates the space reserved for the license plate	
Emergency light			Position and orientation same as direction indicator lights	Has emergency light	
fog light			Position and orientation	Does not have fog light	

4.6 This national standard defines the position of the following lighting and signaling devices: - High beam (see 5.1); - Low beam (see 5.2); - Front position light (see 5.3); - Side retro-reflective device (see 5.3); see 5.4);- Rear retro-reflective device (see 5.5);- Direction indicator light (see 5.6);- Brake light (see 5.7);- Rear position light (see 5.8);- Rear license plate light (see 5.9);- Emergency light (5.10);- Front fog light (see 5.11);- Rear fog light (see 5.12).
5, Specific requirements (ISO 11460:2007 standard)
Data collected from the trial
5.6.1.1.1 Table 1 - Minimum intensity of the direction indicator light and corresponding minimum separation distance with the nearest low beam
Measured value in (lux)
Calculated value in (cd)
Absence of devices in the vehicle

the United States converge on the importance of ensuring optimal visibility for motorcycles, both day and night, through specific lighting provisions. In accordance with the sections required by the regulations on lighting devices, the specific requirements, the number of motorcycles tested, the positive results and the deficiencies identified are presented in figure 6(Annex figure 6). In particular cases, all five motorcycles were found to lack side retroreflective devices, as well as front and rear fog lights. In addition, it was found that motorcycles one and two were not equipped with emergency lighting devices.

Analyzing several other research globally, we can find that in 2020, high fatality rates among motorcyclists in the U.S. highlighted the need to assess road safety [12]. Despite accounting for only 3% of vehicles, motorcycles contribute significantly to 42% of fatal guardrail impacts. The lack of specific crash tests for motorcycles raises questions about their safety in U.S. Road conditions. A study using NCHRP data compared impact characteristics between motorcycles, passenger vehicles, and trucks, revealing similar angles of impact between motorcycles and passenger vehicles. However, it was evidenced that tractor-trailers have shallower angles. In addition, motorcycles show troubling trends, with a high propensity for rollover and rider separation during events, signaling the need to evaluate and improve motorcycle safety on U.S. roads [12].

In a different context, this study on the application of the ISO 11460:2007 standard in motorcycle lighting in Ecuador revealed deficiencies in the

compliance of the evaluated motorcycles with the standard, highlighting the need to address these issues to improve road safety in the country.

The study of the LONG (Longitudinal Oriented Normative Time Gap compensation) concept highlights an innovative lighting system for motorcycles that seeks to improve visibility by considering psychological and design factors [13]. Based on the hypothesis that motorcycles can be perceived farther and slower than automobiles due to their higher light placement and narrow design, the LONG system distributes illumination along a vertical axis. Evaluations in right-turn scenarios showed that motorcycles equipped with this system have visibility comparable to that of cars [13]. Contrasting this innovative approach, the ISO 11460:2007 standard for lighting tests on motorcycles and tricycles stands out, which establishes specific parameters to ensure road safety.

The research proposes to analyze compliance with this regulation in Ecuador, pointing out the lack of a specific regulatory body and tools to measure its application. This comparison underscores the need to explore technologies such as the LONG system and consider their implementation in the existing regulatory framework to improve motorcycle riding safety.

In Ecuador, the approval process for motorcycles and tricycles, carried out by a conformity assessment body and the National Transit Agency, does not include mandatory lighting requirements, as set out in the RTE INEN 136 1R "Motorcycles" standard. This gap highlights the need for a physical assessment to confirm compliance with the specified lighting fixtures, as the motorcycles assessed do not meet the noted standards. In contrast, in Malaysia, motorcycles account for half of registered vehicles, and despite their popularity, road accidents, mainly involving motorcyclists, are a concern [14].

Safety technology in automobiles, such as the anti-lock braking system (ABS), has proven to be essential for occupant safety. In a study focused on low-displacement motorcycles, braking distance and stability were compared between motorcycles with and without ABS, revealing a significant reduction of 50% and 12% in dry and wet conditions, respectively. This finding underscores the effectiveness of ABS in improving braking performance on low-displacement motorcycles, highlighting the importance of considering similar safety technologies in the context of vehicle homologation and regulation in different regions [14].

4. CONCLUSIONS

In Ecuador, for motorcycles and tricycles to be allowed in circulation, compliance with the homologation process is needed. This process is carried out through a conformity assessment body and the National Transit Agency. It's worth mentioning that the lighting requirement is not mandatory within the homologation process as indicated in RTE INEN 136 1R "Motorcycles" - Amendment 5.

It is evident that a physical evaluation of motorcycles and tricycles is necessary to confirm that they comply with the lighting device requirements outlined in RTE INEN 136 1R "Motorcycles" since the evaluated motorcycles do not meet the specified standards.

Every year, many individuals make modifications to their motorcycles. Regardless of the model, there are specialized companies that offer various accessories to facilitate these modifications, including lights, mirrors, and even seats different from the original. Although many of these are marketed as homologated, it's not always the case, and in some instances, this can lead to costly consequences when they are not accepted during the respective inspections. For these and other reasons, it's essential to ensure that any modification complies with the regulations to proceed with the respective homologation [15], [16].

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Appendix

Figure 6.

Analysis of Results from the Lighting Devices Test According to ISO 11460:2007 Standard

Analysis of Results from the Lighting Devices Test According to ISO 11460:2007 Standard															
Standard Requirement	**Motorcycle 01**			**Motorcycle 02**			**Motorcycle 03**			**Motorcycle 04**			**Motorcycle 05**		
	Year	Country-Origin	Cylinder capacity	Year	Country-Origin	Cylinder capacity	Year	Country-Origin	capacity	Year	Country-Origin	Cylinder capacity	Year	Country-Origin	Cylinder capacity
	2019	India	155 cc	2019	Ecuador	198 cc	2019	China	248 cc	2019	China	250 cc	2019	Colombia	645 cc
Headlight	✓			✓			✓			✓			✓		
Turn signal	✓			✓			✓			✓			✓		
Position Light	✓			✓			✓			✓			✓		
Lateral Catadioptric Device	X			X			X			X			X		
Rear Catadioptric Device	✓			✓			✓			✓			✓		
Indicator Light for Direction	✓			✓			✓			✓			✓		
Indicator Light for Reverse	✓			✓			✓			✓			✓		
Brake Light and Position Light for Rear	✓			✓			✓			✓			✓		
License Plate Light	✓			✓			✓			✓			✓		
Emergency Light	X			X			✓			✓			X		
Antifog Light	X			X			X			X			X		

	Specific Requirements of Normative 11460:2007
	Quantity of Motorcycles Involved
	Description of Motorcycles
✓	Complies with the required standard
X	Does not comply with the required standard