



REVISTA INGENIO

Study on Acceptable Noise Standards for Motorcycles, in Accordance with the Ecuadorian Technical Regulation INEN 136 (1R), Assessed Through Dynamic and Static Tests

Estudio sobre los estándares de Ruido Aceptables para Motocicletas, de Acuerdo con el Reglamento Técnico Ecuatoriano INEN 136 (1R), Evaluados a través de Pruebas Dinámicas y Estáticas

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RESUMEN

En el año 2020 el Ecuador y el mundo entero se vio afectado por la más grande crisis sanitaria de los últimos tiempos. El covid 19 obligó a muchos de los ecuatorianos a buscar nuevas fuentes de ingresos, y encontraron en las motocicletas la posibilidad de hacerlo ya que las entregas con servicios a domicilio fue una modalidad que adaptaron muchísimos negocios. Este aumento de motocicletas trae consigo que aumente la contaminación, proveniente del ruido que estas producen. Es por esto que nos planteamos la incógnita de si en este crecimiento fuera de la tendencia que tuvo la venta de motocicletas se siguieron cumpliendo las normas y límites máximos de ruido que se permite a las motocicletas producir al circular en nuestro país. Para esto adoptamos el papel de laboratorio acreditado y realizamos los ensayos estáticos y dinámicos, siguiendo los procedimientos de la Directiva Europea 78/1015/CEE, a una muestra de cinco motocicletas para comprobar si cumplían o no con la norma INEN RTE 136 Motocicletas, que es en donde se exponen los valores máximos que pueden emitir por categoría de cilindrada. Con los resultados obtenidos fuimos capaces de concluir y hacer ciertas recomendaciones.

ABSTRACT

In the year 2020 Ecuador and the whole world was affected by the biggest health crisis in recent times. Covid 19 forced many Ecuadorians to look for new sources of income, and they found the possibility of doing so in motorcycles, since deliveries were a modality that many businesses adapted. This increase in motorcycles brings with it an increase in noise pollution. That makes us question ourselves of whether in this growth outside the trend that the sale of motorcycles had, the standards and maximum noise limits that motorcycles are allowed to produce to be able to circulate in our country continued to be complied with. For this, we adopted the role of an accredited laboratory and carried out the static and dynamic tests, following the procedures of the European Directive 78/1015/CEE, on a sample of five motorcycles to verify whether or not they complied with the INEN RTE 136 Motorcycles standard, which It is where the maximum values that can be emitted by displacement category are exposed. With the results obtained we were able to conclude and make certain recommendations.

1. INTRODUCTION

This article discusses of analysis of annual motorbike sales in Ecuador over the past six years reveals an evolution marked by the COVID-19 pandemic. From 2016 to 2019, the market experienced steady growth, reaching a peak of 144,727 units sold in 2019. However, in 2020, the impact of the global health crisis was reflected in an abrupt decline to 130,483 units. Surprisingly, in 2021, sales recovered significantly, reaching a record 164,551 units by November. This dramatic change is directly attributed to the measures implemented in Ecuador in response to the

COVID-19 outbreak. 2020 marked an exceptional year, with the detection of the virus in February and emergency measures announced in March, including lockdowns, curfews and vehicle restrictions. These measures had an immediate impact on the economy and mobility, leading to a substantial decrease in demand for motorbikes. However, as society adapted to the new normal, motorbikes became a safer mode of transport, driving a rebound in sales by the end of 2020.

The positive trend continued in 2021, highlighting the

motorbike market's ability to adapt to changing circumstances. Demand increased as motorbikes positioned themselves as a safe and efficient alternative, especially in a context where online shopping and home deliveries gained prominence. In addition, many unemployed individuals found motorbikes as a source of income, contributing to increased sales. The regulatory context also plays a crucial role in the Ecuadorian motorbike market. The issuance of the Ecuadorian Technical Regulation RTE INEN 136 (1R) "Motorcycles" establishes the requirements that these vehicles must meet before they can be marketed. Both locally assembled and imported motorbikes must undergo rigorous testing, including tests on the braking system, tyres, lights, exhaust emissions and sound level. Obtaining the "Certificate of Conformity" is essential for commercialisation and is granted by bodies such as the National Agency for Regulation and Control of Land Transport, Transit and Road Safety (ANT), the Ministry of Industries and Productivity (MIPRO) and the Ecuadorian Institute of Standardisation (INEN). The Association of Automotive Companies of Ecuador (AEADE) reports that approximately 70% of motorbikes on the market are locally assembled.

This underlines the importance of regulations and quality standards in the industry, as they affect both domestic production and imports from various countries. In addition to economic and regulatory dynamics, the issue of noise generated by motorbikes emerges as a critical factor, especially in a growing urban environment. The amount of noise to which a population is exposed has proven effects on human health and the surrounding ecosystem. The Ecuadorian state, through the Ministry of Environment (MAE), is responsible for ensuring compliance with noise-related regulations. The MAE carries out environmental audits, monitoring reports and verifications of compliance with environmental management plans to mitigate the negative effects of noise on health and the environment. In this context, urban planning becomes crucial, highlighting the need for noise maps that help to segment areas according to their level of noise production.

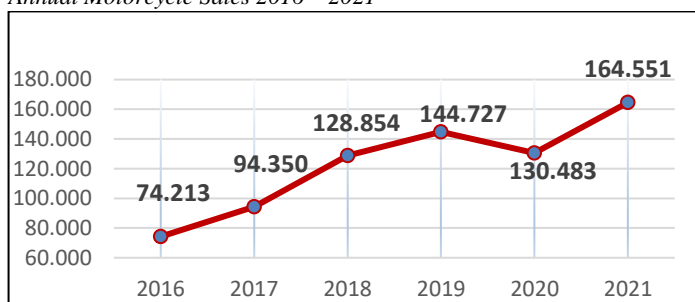
This tool facilitates the separation of residential, hospital and industrial areas, contributing to the well-being of the population and the preservation of the ecosystem. In conclusion, the motorbike market in Ecuador has experienced a trajectory notably influenced by the pandemic, demonstrating resilience and adaptability. The interplay between economic factors, regulations and environmental considerations plays an integral role in the development of this constantly evolving sector. Understanding these dynamics is essential to anticipate and address the challenges and opportunities that the

Ecuadorian motorbike market faces in the future[1]. This article not only contributes to the understanding of the current landscape of the motorbike market in Ecuador, but also provides valuable insight into the regulatory measures taken to mitigate noise pollution, while supporting its findings with concrete evidence from the field.

Motorcycle Market and the Pandemic

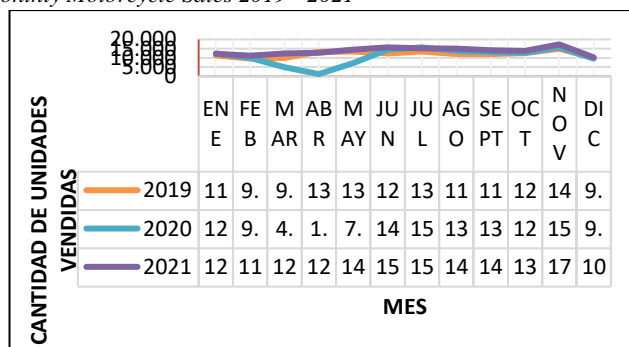
The annual motorcycle sales in our country over the last six years (2016 - 2021), we can observe that from 2016 to 2019, motorcycle sales showed consistent growth. In 2016, there were a total of 74,213 units sold, and in 2019, it increased to 144,727 units. However, in 2020, motorcycle sales decreased to 130,483 units. Subsequently, in 2021, sales rebounded and reached a record of 150,770 units sold until November 2021. Below, we will illustrate this behavior [2] [3] [4].

Figure 1
Annual Motorcycle Sales 2016 – 2021



To understand this behavior, we will focus on the last three years (2019-2021) by examining the monthly motorcycle sales figures (Figure 2):

Figure 2
Monthly Motorcycle Sales 2019 - 2021



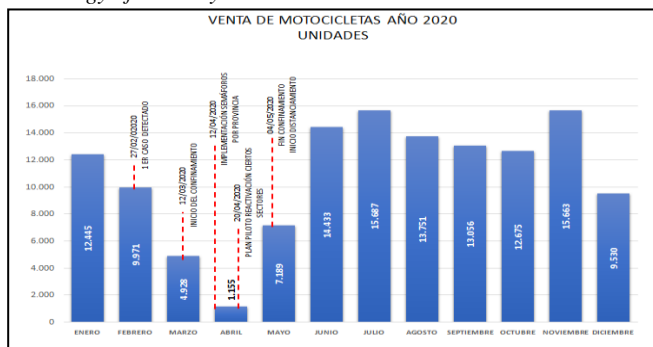
In the previous figure, the drop in motorcycle sales during the year 2020 is concentrated in the months of March and April. This is evident as the number of motorcycles sold in February for the years 2019 and 2020 is very similar, with 9,595 sold in 2019 and 9,971 in 2020.

This drastic reduction in motorcycle sales, deviating from the previous trend, can be attributed to the fact that in 2020, both Ecuador and the entire world faced the most significant public health crisis in recent memory. In our country, the COVID-19 virus was detected on February 27, 2020. Shortly thereafter, on March 12, authorities

announced some new policies, including declaring a state of health emergency, closing borders, imposing mandatory nationwide quarantine (except for medical staff and essential goods), implementing curfews, and enforcing vehicular restrictions with different schedules based on the affected regions [5].

In the following graph (Figure 3), we will compare the monthly motorcycle sales in 2020 with policies taken by our authorities due to the pandemic.

Figure 3
Chronology of Motorcycle Sales/Pandemic in 2020



The increase in motorcycle sales in April can be attributed to several factors. Motorcycles became a safer mode of transportation compared to buses, especially during the COVID-19. Many companies shifted to online shopping and home deliveries to reduce overcrowding and promote social distancing. Additionally, individuals who lost their jobs turned to motorcycles to generate income for themselves and their families [6]. This surge in motorcycle sales can be seen as a response to the changing dynamics brought about by the pandemic, with people seeking safer and more flexible mobility options.

The Ecuadorian State as a Regulatory Entity

The Ecuadorian government, responsible for ensuring the compliance of citizens' rights related to safety, the protection of human, animal, and plant life, the preservation of the environment, consumer protection against deceptive practices, and punishments, as stated in Article 1 of the Ecuadorian Quality System Law, issues the Ecuadorian Technical Regulation RTE INEN 136(1R) "Motorcycles." This regulation establishes all the requirements that motorcycles must meet before they can be marketed.

Regardless of the origin of the motorcycles, whether they are assembled inside or imported, they must undergo the required tests outlined in RTE INEN 136(2R) "Motorcycles." These tests cover aspects such as braking systems, tires, lighting, gas emissions, and acceptable noise levels. Successfully passing these tests results in the issuance of the "Certificate of Conformity," which

authorizes their commercialization. The entities responsible for granting the homologation or conformity certificate are the National Commission of Land Transport and Traffic (CNT), the Ministry of Industries and Productivity (MIPRO), and the Ecuadorian Institute of Standardization (INEN). [7] [8] [9]

The Noise as a Pollution Factor

The amount of noise to which a person is exposed has been proven to have various effects on an individual's health, such as sleep disorders, stress, hearing loss, and alterations in character. Natural ecosystems are also affected by these sounds and tend to migrate. This causes a series of negative effects and, in some cases, irreparable damage.

The quantity of noise is a measurable, regulatable, and even plannable characteristic. By this, we mean that a growing city typically zones areas, whether they are industrial, residential, hospital, commercial, or protected. Each of these zones, based on the number of people or traffic they attract (mobile sources), the equipment they use (fixed sources), and the hours they operate, will have different levels of noise production. With this information, authorities can create what are known as noise maps [10]. Noise maps are studies of sound levels produced by a specific area at a defined time and the population that is or will be affected by it. This is a valuable tool in urban planning for a city, as it allows, for example, the separation of residential or hospital areas from industrial areas and protected zones from major noise sources like airports, benefiting both people and the ecosystem [11].

In our country, the competent authority is the Ministry of the Environment (MAE). The Ministry, in order to ensure compliance with noise-related regulations, has functions that include conducting environmental audits, monitoring reports, and verification of compliance with environmental management plans [12].

Justification for this analysis

This research is being conducted due to the growth experienced in the motorcycle market in recent years. There is a need to practically verify whether these motorcycles meet the necessary requirements for commercialization, with the aim of safeguarding the safety of individuals and the environment. The analysis and conclusions drawn will be based on a comparison of the results obtained from dynamic and static tests with the limits outlined in the Ecuadorian Technical Regulation RTE INEN 136 (1R).

Objectives

General Objective

To verify, through dynamic and static tests outlined in the European Directive 78/105/CEE, that the noise generated

by motorcycles of various engine capacities and brands circulating in our country complies with the limits specified in the Ecuadorian Technical Regulation RTE INEN 136 (1R).

Specific Objectives

- To use the equipment needed to perform sound level measurements generated by motorcycles.
- To apply dynamic and static tests, as outlined in the European Directive 78/108/CEE.
- To determine the noise level produced by the tested motorcycles.
- To confirm the results against the limits specified in the Ecuadorian Technical Regulation RTE INEN 136 (1R).

Theoretical framework

The following is an overview of the regulations on exhaust noise emissions and test procedures for motorbikes in Ecuador:

- Motorcycles are defined as two-wheeled vehicles with an internal combustion engine, a displacement greater than 50 cm³, and a design speed exceeding 45 km/h [13]. The NTE INEN 2656 standard, which addresses vehicle classification for Ecuador, categorizes the motorcycles studied in our research as Category L, subcategory L3.

- Exhaust noise refers to the sound produced by combustion gases as they exit the engine through the exhaust pipe. It is measured in decibels (dB) using dynamic and static tests.

- A dimensionless measurement is used to express the ratio between a measured quantity and a reference quantity. It is employed to describe sound pressure levels, power, or intensity. Its symbol is "dB."

- Environmental noise refers to the noise present in the external environment, which has measurable or quantifiable intensity. It includes fixed and mobile noise sources.

- Admissible sound levels are the maximum limits of exhaust noise emissions, measured in decibels, allowed for motorcycles according to their engine displacement category.

- A type of test used to measure a vehicle's noise emissions, performed with the vehicle and drivetrain stationary but the engine running.

- A type of test used to measure a vehicle's noise emissions, conducted while the vehicle travels a specific distance in a test field, at predetermined speeds, gears, and engine revolutions.

- A document issued by the Ecuadorian state confirms that a duly identified product, process, or service complies with a technical regulation, technical standard, or other specified normative document prior to its commercialization. This certificate must be requested by motorcycle assemblers or importers before commercialization, following successful testing.

- An organization that has demonstrated technical competence to carry out conformity assessment activities through compliance with international, national standards, and other requirements set by the accreditation body.

- An organization or laboratory authorized by the Ministry of Production, Foreign Trade, Investments, and Fisheries (MPCEIP) in accordance with the provisions of the Ecuadorian Quality System Law to conduct specific conformity assessment activities.

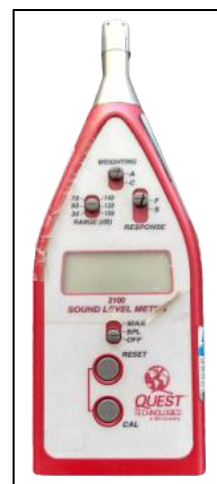
Equipment

The equipment used in the tests were operated by ELICROM, a company located in the city of Guayaquil that serves as an accredited laboratory. The following equipment was used [13] [14] [15]:

- Precision Sound Level Meter: 3M Quest Technologies brand, model 2100, with a measurement range of 0 to 140 decibels (Figure 4).

Figure 4

Precision Sound Level Meter



- Noise Calibrator: 3M Quest brand, model QC/10 - QC/20. This device emits a stable acoustic signal at a controlled frequency of 114 dB (Figure 10). This emitted signal can be read by the sound level meter to verify its calibration (Figure 5).

Figure 5
Noise regulator



- Tape Measure: Pretul brand, with a maximum length of 10 meters, and measurements in centimeters or meters (exhibit Figure 6).
- Metal Square: Swanson brand, a metal tool in the shape

of an isosceles triangle, with a right angle and two 45-degree angles (exhibit Figure 7).

- Hygrometer-Thermometer: Elicrom brand, model SH-110. This equipment is used to record relative humidity (%) and temperature of the environment on the day and time when the tests are conducted (exhibit Figure 8).
- Stroboscopic Tachometer: Equipment used to measure the engine's rotational speed (RPM) in those motorcycles where it is not displayed on the dashboard (exhibit Figure 9).
- Metal Plumb Bob: A tool used to mark the exact position of the exhaust pipe's outlet on the ground (exhibit Figure 10).

2. METHOD

A sample of 5 motorcycles was tested, which fall within the range of engine displacements from 150 to 650 cm³. The sample includes motorcycles of different origins, engine size, materials, number of exhaust outlets, exhaust device locations, etc

Table 1
Tested motorcycle specifications

Specifications of the Tested Motorcycles					
	Moto # 1	Moto # 2	Moto # 3	Moto # 4	Moto # 5
Origin	Chinese	India	Colombia	Chinese	Equator
Production Year	2018	2019	2019	2018	2019
Segment	Utilitarian	Utilitarian	Dual purpose	Dual purpose	Endurance
Mileage	10.588	6.595	25.954	8.045	19.123
Cylinder capacity (cm3)	248	155	645	250	200
Maximum engine rpm	8.500	8.000	8.000	8.000	8.000
Transmission	Mechanics	Mechanics	Mechanics	Mechanics	Mechanics
Marches	5	5	6	5	5
Tailpipe location	Right	Right	Right	Right	Right

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The procedure for conducting static tests.

Static tests involve accelerating the motorcycle, either in neutral or with the help of a stand that lifts the rear wheel, until a given number of engine revolutions is reached. The sound produced is then measured using a precision sound

level meter. This was done in accordance with the specific requirements outlined by the regulations:

The test area must be an enclosed space that forms a rectangle, leaving a minimum of 3 meters of space between

the ends of the motorcycle (as shown in Figure 12).

The ground should be a hard material like concrete or asphalt.

- The tests required the presence of two individuals. One person was responsible for accelerating the motorcycle to reach the specified engine revolutions and maintaining it at that RPM, while the other person operated the sound level meter to take readings.
- As mentioned earlier, the motorcycle must be neutral or on a stand that allows the rear wheel to be lifted. It was ensured that the motorcycle was positioned perpendicular to the ground.
- With the motorcycle in a perpendicular position, a plumb bob was used to mark the exact position of the exhaust pipe's mouth on the ground with a point (as shown in Figure 13). This point was used, in conjunction with a laser level, to mark the vertical plane in which the exhaust gas outlet is located (as shown in Figure 14).
- By standard, the orientation of the sound level meter is set at an angle of $45^{\circ} \pm 10^{\circ}$ degrees relative to the vertical plane in which the exhaust gas outlet is inscribed. A metal square is used for this purpose. One of its two equal sides is placed against the line marked by the laser level, pointing with the acute angle at the point marked on the ground (exhibit figure 14). The orientation line of the sound level meter will be the one indicated by the longer side of the square.
- Once the orientation line is marked, the standard specifies that the sound level meter should be positioned at 50 centimeters from the marked point on the ground, or in other words, 50 centimeters from the vertical plane formed by the exhaust gas outlet (exhibit Figure 15). Measure out the 50 centimeters and mark another point on the ground. This new point will be the position of the sound level meter's microphone, which will be used to test all the motorcycles.
- Proceed to place the sound level meter, ensuring that the minimum height is 20 centimeters from the ground. To verify this, you can use the metal square and the tape measure (exhibit Figure 16). The sound level meter comes equipped with a tripod, which will be of great help to keep it in position.

- If the motorcycle does not indicate the engine revolutions on its dashboard, it will be necessary to use the strobe gun to bring the motorcycle to the required engine speed (exhibit Figure 17).

- The regulations indicate that measurements should be taken when the motorcycle is stabilized at a certain number of revolutions, as given by the following formula (where S represents the maximum revolutions specified by the manufacturer):

$$\frac{S}{2} \text{ if } S \text{ is higher than } 5000 \text{ rpm}$$

$$\frac{3S}{4} \text{ if } S \text{ is lower than } 5000 \text{ rpm}$$

- In the sound level meter, the reaction time is set to "F" for fast, the decibel range is set to 50 - 120 dB, since the maximum value according to the standard is 86 dB, and the curve is set to "A." The accuracy of this equipment must be verified with the noise calibrator at the end of each test (exhibit figures 18, 19).
- The motorcycle is accelerated, stabilized at the previously defined engine speed, and the value is recorded. Three consecutive measurements will be taken for each motorcycle. The values will be considered valid when there is no bigger than 2 dB.

Procedure for carrying out dynamic tests

Dynamic tests are those in which the sound of a motorcycle passes a given point. The first step is to establish a point and mark it on the ground. With the help of a plumb line, we will position the tip of the precision sound level meter just above this point, on a stand that will help keep it stable during the tests.

This point will be at a height of 1.20 meters from the ground, and these requirements must be considered:

- Around this point, within a minimum radius of 50 meters, there should be no large objects such as fences, signs, buildings, or mountains that could affect the acoustic field in the area.
- Keep in mind that the noise will be measured over a period, so there should be no external noise sources around this point apart from the motorcycle being tested. Examples of this could be traffic, equipment like drills or grinders working nearby, street vendors, etc. The regulations state that the difference in noise between the selected point for the sound level meter and the center of the track where the motorcycle will circulate must be a maximum of ± 1 dB.

- It is also important to consider the noise generated by the moving motorcycle due to friction with the ground during the test. This is why the regulations specify that the ground must be made of concrete, asphalt, or any other hard material that is dry and free from loose soil or grass.

- During the test, the motorcycle will cover 20 meters, from line A-A' to line B-B' and back. The motorcycle will follow a straight path, which will be a reference line called C-C'.

- The sound level meter must be placed halfway along the reference line C-C' at 7.5 meters.

After delineating the location and setting up the equipment, our attention must shift to the motorcycle; it is necessary to know the maximum engine speed, displacement, and the number of gears in the transmission system. This data is used by the regulations to determine the parameters followed by the driver:

- The motorcycle must have reached its operating temperature, have sufficient fuel, and its exhaust system must be in good condition without alterations.

- The approach speed to the starting line of the test will be 50 km/h, steady and with the engine speed (rpm) between 50% - 75% of the manufacturer's maximum recommendations.

- Once the front tire crosses the starting line A-A', the driver must accelerate to the maximum throughout the entire journey until the rear tire of the motorcycle crosses the line B-B'. Afterward, the driver must immediately release the throttle and allow the motorcycle to decelerate without abrupt braking.

- The gear or gearshift to be used for the test is indicated by the regulations:

- Regarding the number of tests that must be conducted for each motorcycle, the regulations state that there should be 2 tests on each side of the motorcycle. The results should

be rounded to the nearest decibel, and they will only be accepted as valid when the difference between them does not exceed 2 dB. The measurement value to reported will be the result in the measurements minus 1 dB to counteract possible inaccuracies.

- The data obtained will be recorded in a test report. The report will also contain information about the motorcycle (manufacture, model, chassis number, maximum rpm, origin), environmental conditions (temperature, relative humidity), information about the sound level meter (initial verification, serial number), and the results separated by the side of the motorcycle (right or left).

- The tested motorcycle will be considered in compliance when the result of the four measurements is equal to or less than the limits set forth in the RTE INEN 136 (2R) Motorcycles, for the category of that motorcycle. In all other cases, it will be considered non-compliant [16] [17].

3. RESULTS AND DISCUSSION

The results will be compared to the maximum noise limits set forth by the Ecuadorian technical regulation RTE INEN 136 (1R) "Motorcycles" for their respective categories, to determine which of them complies with the conformity of this requirement. As we can see below, the results obtained for each motorcycle in the static tests tend to be higher than those obtained for the same motorcycle in the dynamic tests [18]. This is due to various factors, including the fact that in dynamic tests, the sound level meter is considerably farther away from the motorcycle compared to static tests. Dynamic tests are conducted in an open area, allowing for the dissipation of noise generated, and in dynamic tests, the sound level meter has less time to capture precise noise measurements because the motorcycle is in motion and moving away from it, whereas in static tests, the amount of noise to which the sound level meter is subjected remains constant.

Table 2*Presentation of Static Test Results*

Presentation of Results: Static Test				
Vehicle	Origin	Cylinder capacity	Test value	Maximum value per standard
Motorcycle # 1	Chinese	240 cm ³	81 dB	83 dB
Motorcycle # 2	India	155 cm ³	79 dB	83 dB
Motorcycle # 3	Colombia	645 cm ³	83 dB	86 dB
Motorcycle # 4	Chinese	250 cm ³	82 dB	83 dB
Motorcycle # 5	Equator	200 cm ³	87 dB	83 dB

When comparing the results obtained with those specified in the Technical Regulation INEN 136, we can observe that, in this test, the Ecuadorian-made motorcycle exceeds the value set by the standard by 4 decibels [18]. As the other motorcycles, fall within the allowed range. In other words, the noise they produce is lower than what the standard allows. The results of this test tend to be higher

than those obtained in dynamic tests and are not considered by the RTE INEN 136 (1R) "Motorcycles" to determine a motorcycle's compliance with the regulation. However, they provide an indication of the noise produced by a motorcycle tested on a bench and, therefore, offer a clear idea of what will happen in the dynamic tests.

Table 3*Presentation of Dynamic Test Results*

Presentation of Results: Dynamic Test					
Vehicle	Origin	Cylinder capacity	Value obtained in Test	Maximum value per standard	Conformity
Motorcycle # 1	Chinese	240 cm ³	74 dB	83 dB	Yes
Motorcycle # 2	India	155 cm ³	73 dB	83 dB	Yes
Motorcycle # 3	Colombia	645 cm ³	80 dB	86 dB	Yes
Motorcycle # 4	Chinese	250 cm ³	78 dB	83 dB	Yes
Motorcycle # 5	Equator	200 cm ³	77 dB	83 dB	Yes

Note: The exposed values have been rounded to the nearest decibel and subtracted one unit as indicated by the standard.

In the case of the results through the Dynamic test, when comparing them to the limits specified by the standard, we can see that all of the motorcycles are below these limits, meaning they are in compliance.

Based on the results from the static tests, the only

motorcycle that was in question regarding whether it would exceed the limits set by the regulation in these tests was the Ecuadorian-made one, which exceeded the regulation for its displacement category by 4 decibels (87 versus 83) in the static test. However, in the dynamic test, it remained 6

decibels below the regulation, which grants it the compliance required for commercialization and circulation in our country.

4. CONCLUSIONS

As we have observed throughout this study, the level of noise in a city is a measurable, regulatable, and even plannable characteristic. The authorities in our country have the information and tools to establish noise levels that are not harmful to the health of their residents and ecosystems, as well as the obligation to enforce the standards put in place for this purpose.

In unusual circumstances, such as the COVID-19, it can be challenging to predict population behaviors or trends. The increase in motorcycle sales post-pandemic can be considered one of these trends, as we saw a significant surge in sales from 1,155 units in April 2020 to 14,433 units in June 2020. While this was good for the market and Ecuadorian families, we must not neglect to enforce our regulations to ensure that today's solution does not become tomorrow's problem.

Motorcycles, represent a mobile noise pollution source, producing an average of around 83 decibels, depending on their engine size. If we multiply this value by the number of motorcycles circulating in the city during rush hours, we will have a substantial number of decibels adding to the noise that affects the population. Furthermore, in 2020, technical vehicle inspections were suspended due to the pandemic. In other words, we increased the number of motorcycles on the road in our country and suspended the review of compliance requirements for their circulation.

Through our static tests, we were able to demonstrate that the imported motorcycles complied with the maximum limits specified in the INEN RTE 136 (1R) "Motorcycles" regulation, there was a case of a motorcycle, #5, assembled in Ecuador that exceeded the maximum values allowed by 4 decibels. Although the results obtained from this type of test are not considered to determine

compliance with the regulation, it is a factor to consider for domestically assembled products.

Through this study, we were able to achieve the objective of determining that both domestically assembled and imported motorcycles comply with the technical regulation INEN RTE 136 (1R) "Motorcycles" in a small sample. However, we believe that the difference between the regulation's limit and the values obtained could improve [18].

Motorcycle assemblers in our country source most of the components from China. Very few parts are manufactured locally. Since the amount of noise produced by a motorcycle is controlled by the exhaust device, and this, in turn, is being imported for assembly in our country, we should consider importing higher-quality products. We should require importers or manufacturers to submit the respective supplier's declaration of conformity, a document in which the manufacturer or importer takes responsibility for having conducted tests to confirm that their products comply with the INEN RTE 136 (1R) "Motorcycles" regulation.

The INEN RTE 136 (1R) "Motorcycles" regulation adopts limit values from the European Directive 78/1015/CEE, which was established in Brussels in 1978. Over the years and with technological advancements, we should consider that we can acquire and producing products that generate less noise than what was specified in that year. This is mentioned because the motorcycles that did comply with the conformity in the tests are also very close to the limits [1].

Efforts should continue to reduce the amount of noise that our society generates, not only due to the impact on people but also because it represents an important factor in environmental conservation.

REFERENCES

- [1] Consejo de la Unión Europea, "Directiva 78/1015/CEE del Consejo, de 23 de noviembre de 1978, relativa a la aproximación de las legislaciones de los Estados Miembros sobre el nivel sonoro admisible y el dispositivo de escape de las motocicletas," 1978.
- [2] Asociación de Empresas Automovilísticas del Ecuador, "AEADE," (2022 Diciembre 22). [En línea]. Available: <https://www.aeade.net/wp-content/uploads/2023/01/12.-Sector-en-Cifras-Resumen-Diciembre.pdf>.
- [3] Asociación de Empresas Automotrices del Ecuador, "AEADE," (2022 Diciembre 22). [En línea]. Available: <https://www.aeade.net/wp-content/uploads/2023/01/12.-Sector-en-Cifras-Resumen-Diciembre.pdf>.
- [4] Asociación de Empresas Automotrices del Ecuador, "AEADE," (2022 Diciembre 08) . [En línea]. Available: <https://www.aeade.net/wp-content/uploads/2022/12/BOLETIN-DE-VENTAS-PARA-PRENSA-DICIEMBRE-2022.pdf>.
- [5] Líderes, "12 ensambladoras de motos se asocian para tomar velocidad," 2020.
- [6] Mercado Automotriz Ecuatoriano, "General Industria - YTO," pp. 1-8, Agosto 2021.
- [7] Servicio Ecuatoriano de Normalización,

- "Reglamento Técnico Ecuatoriano INEN 136 1(R) «Motocicletas,» 2019.
- [8] Servicio Ecuatoriano de Normalización, "Norma Técnica Ecuatoriana INEN 2656-1. Clasificación Vehicular según las Normas INEN," *Universidad Laica Eloy Alfaro de Manabí*, 2016.
- [9] Ley Orgánica de Transporte Terrestre Tránsito y Seguridad Vial, Quito: Registro Oficial Suplemento 398 de 07-ago.-2008, 2008, p. 48.
- [10] Parlamento Europeo y Consejo de la Unión Europea, "Directiva 2002/51/CE Del Parlamento Europeo y del Consejo de 19 de julio de 2002 aobre la reducción del nivel de emisiones contaminantes de los vehículos de motor de dos o tres ruedas, y por la que se modifica la Directiva 97/24/CE," 2002 Julio 19.
- [11] Automagazine.ec, "Ventas de la industria automotriz en Ecuador durante el 2020," 2021 Enero 13.
- [12] Ministerio del Ambiente, Agua y Transición Ecológica, "Ecuador le dice ¡NO AL RUIDO!," *ambiente.gob.ec*.
- [13] H. Y. Siregar, "Analysis on the characteristics and driving conditions for motorcycle and passenger car in Banda Aceh," *AIP Conference Proceedings*, vol. 2711, 2021.
- [14] ISO, "ISO/IEC 17067:2013(es) Evaluación de la conformidad - Fundamentos de la certificación de producto y directrices para los esquemas de certificación de producto," *Online Browsing Platform (OBP)*, 2013.
- [15] ISO, "ISO/IEC 17025:2017(es) Requisitos generales para la competencia de los laboratorios de ensayo y calibración," *Online Browsing Platform (OBP)*, 2017.
- [16] Organismo de Normalización Española, «UNE-EN ISO/IEC 17020:2012,» *une.org*, 2012.
- [17] El Universo, "El 'delivery' ayuda a sostener la venta de las motos en el mercado ecuatoriano," *eluniverson.com*, p. Noticias, 2020 agosto 29.
- [18] TULSMA, *Texto Unificado de Legislación Secundaria de Medio Ambiente*, Quito: Registro Oficial Edición Especial 2 de 31-mar.-2003, 2003.
- [19] B. Singh, "Assessment and Mapping of Noise Pollution Levels in Bus Stands: A Case Study of Haryana State, India," *MAPAN*, vol. 38, pp. 827 - 840, 2023.
- [20] A. Tobías, "Health impact assessment of traffic noise in Madrid (Spain)," *Environmental research*, vol. 137, pp. 136-140, 2015.
- [21] Instituto Nacional de Estadísticas y Censos, "Módulo de información ambiental 2014," www.ecuadorencifras.gob.ec, 2014.

Exhibit

Figure 6
10-meter tape measure



Figure 7
Metal square

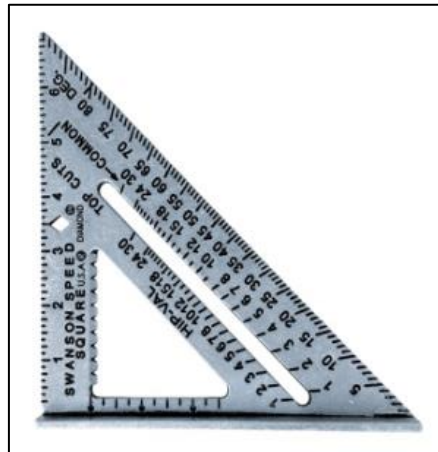


Figure 8
Thermo-hygrometer



Figure 9
Stroboscope gun



Figure 10
Metal plumb bob



Figure 11
Bosch brand laser level



Figure 12

Diagram of the area for static testing

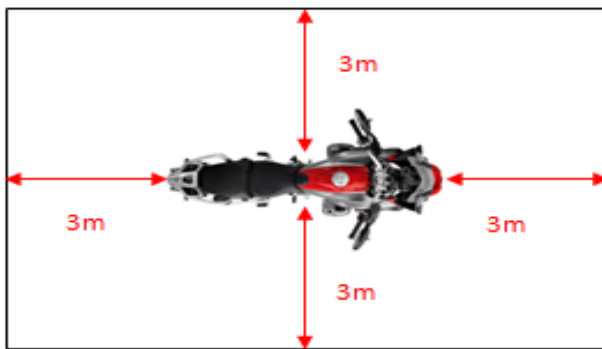


Figure 13

Using a plumb bob to mark a point on the ground.



Figure 14

Using a laser level to trace a vertical plane.

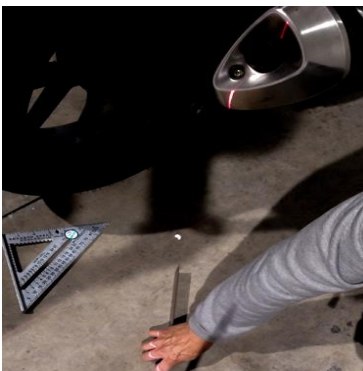


Figure 15

The sound level meter location set at 45 degrees.

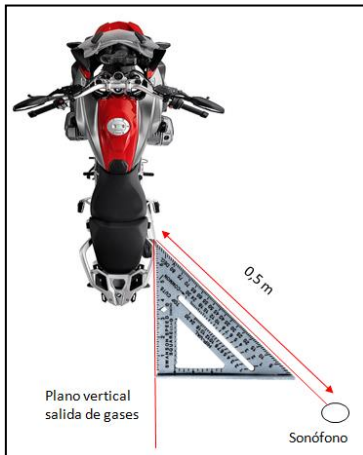


Figure 16

Verification of the sound level meter position



Figure 17

Measurement with a stroboscopic gun



Figure 18

Settings of the sound level meter for tests



Figure 19
Sound level meter calibration verification

