



# LEGISLATION AND STANDARDS FOR THE MEASUREMENT AND ASSESSMENT OF INTRUSIVE NOISE

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## ABSTRACT

Intrusive noise, perceived as a specific recognizable sound capable of generating a disturbing and annoying input, is one of the main factors that make a living and working environment uncomfortable. In most national and international legislative and regulatory systems there are no unambiguous guidelines for the measurement and assessment of intrusive noise and its effects on health, perceived and objective quality of places and value of buildings and no generally accepted definition of intrusive noise can be found.

In Italy the UNI/TS 11844:2022 Technical Specification, starting from the standards dedicated to the assessment of noise emissions, describes measuring procedures and parameters to be considered for the evaluation of the intrusive noise emitted by one or more sources, as function of the noise itself and background noise. This TS is based on Signal Detection Theory and introduces the Detectability Level D'L parameter, relevant for all sources and scenarios, outdoor and indoor.

In this paper a short presentation of the method for measuring intrusive noise according to the UNI/TS 11844:2022 is shown.

Keywords: *intrusive, detectability, annoyance, SDT*

## 1. INTRODUCTION

Sound can be described by means of objective parameters (defined by physics and propagation laws) and subjective

parameters (defined by psychoacoustics) which have complex relationships between them.

A sound is disturbing because it is unwanted, out of place, intrusive (perceived as an intrusion).

Intrusive noise, which overlaps the background noise, raising the ambient noise level, can be responsible for harmful to health exposure in living and working environments.

Intrusive noise, even if is lower than the action limit values envisaged for workplaces and less than the absolute or differential limit values envisaged for emissions measured in living environments, can still be perceived as disturbing and generate neighborhood conflicts which in some cases can lead to legal disputes.

## 2. MEASUREMENT AND EVALUATION OF INTRUSIVE NOISE – THE ITALIAN EXPERIENCE

The Italian National Standard Body (UNI) published in March 2022 the UNI/TS 11844:2022 a Technical Specification document which defines the measurement procedures to be followed and the parameters to be considered for the assessment of intrusive noise.

According to the UNI definition, this Technical Specification describes measuring procedures and parameters to be considered for the evaluation of the intrusive noise emitted by one or more sources, as function of the noise itself and background noise. This Technical Specification is relevant for all sound sources as house appliances, industrial plant, transport infrastructure, anthropic noise, etc. [3]

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The technical specification has introduced concepts and methods that can show interesting and useful applications for solving disputes regarding noise and the disturbance caused by noise.

In the universe of disputes concerning noise emissions, the references are many and different. It is necessary that with the technical help of acousticians, judges consider the entity of intrusive noise and evaluate its tolerability.

Acousticians, lawyers and judges should be aware of all the methodologies and able to choose the most suitable one for the specific circumstance and acoustic scenarios, characterized by type of source and contexts of sensitivity of the disturbed citizens.

In many EU countries at legislation level, there are law inspired by END Directive. In Italy the framework law on noise pollution and its decrees represents an organic and exhaustive (or nearly so) collection of all the possible types of sources and noise emissions.

Nevertheless, in the regulatory system, there is not a clear and unambiguous collection of references for assessing the intrusiveness of noise, despite existing and tested standards such as UNI ISO 1996:2016 which contains the definitions of the fundamental quantities for the description of noise environment and UNI 10855:1999 which describes the criteria for measuring and evaluating the acoustic contribution of individual sources.

However, none of them deals explicitly and directly with the intrusiveness of noise, nor does it contain a parameter that defines it: this is why UNI/TS 11844:2022 is of particular importance. In fact, this technical specification inserts the concept of intrusive noise into the Italian regulatory framework, in a completely consistent and integrated way with the other standards mentioned above, and gives to acousticians and experts in forensic acoustics a method and a parameter to measure it.

### 3. SIGNAL DETECTION THEORY AND INTRUSIVE NOISE

The new technical specification defines the Detectability, i.e. the intrusiveness (recognizability) of a sound event, introducing the D'L parameter in application of the principles of Signal Detection Theory to acoustic scenarios.

The Signal Detection Theory (SDT) is a well-known diagnostic procedure to support decision-making processes in contexts of uncertainty.

According to the approach inspired by this theory, based on the signal/noise ratio present in a given measurement context, a noise emission is the more intrusive the more it alters a pre-existing acoustic scenario.

The methodological novelty constituted by the use of the Signal Detection Theory, at the basis of the UNI/TS 11844:2022 technical specification, is important. In summary, the UNI specification describes the procedures for estimating the 1/3-octave band spectrum of intrusive noise and determining the parameter  $d'$  for each band, obtained by comparing the spectrum estimated above with that measured for residual noise. From the values of  $d'$  accumulated in an overall value and in the corresponding level of Detectability D'L, there is a quantification of the intrusiveness of the sound produced by a given source.

Comparing the parameters of the signal-to-noise ratio in frequency, considering the different size and relative weighting of the individual 1/3-octave bands, allows us to overcome one of the criticalities of the differential and comparative criteria frequently used in input assessments. This criticality derives from the fact that the background noise, being contemporary to the intrusive noise, is impossible to measure and is thus replaced by the so called residual noise which is never contemporary to the intrusive noise and can assume different values depending on the depending on when it is measured.

Working in the frequency field, comparing ambient and residual levels not as SPL equivalent levels but for single bands (and with appropriate corrective factors), as described in the technical specification, allows to overcome or significantly reduce this criticality, providing more precise data regarding the individuation and assessment of the intrusive event with respect to what can be derived from the differential (comparative) level.

### 4. VALIDATION AND FURTHER DEVELOPMENT OF THE NEW STANDARD

According to UNI regulation, the critical experimentation of the Technical Specification is planned in a period of three years following its enactment.

The first results are being collected in a systematic and rational way, cataloged by type of source or acoustic scenario.

The assessment of intrusiveness through the application of UNI/TS 11844:2022 is resulting particularly effective in assessing the noise contributions of different sources that contribute to disturbing situations in the same scenario: think of transport infrastructures: roads or railways traveled respectively by vehicles or trains of different types and sizes, with different speed and emission characteristics; areas affected by airport noise overflown by different aircraft which may have different take-off and landing trajectories; neighborhood noise generated by productive or recreational

activities or by combinations of events that introduce different types of noise into the receiving environments, generated by different sources or activities.

In all these cases, and in many others, where measurements show similar (or exactly the same) absolute and/or differential comparative levels, a different intrusiveness of the noise produced in one or another emission scenario, can lead to the identification of the more impactful and disturbing sources, find the responsible, provide for the limitation or elimination of significant noise contributions, plan and manage activities respecting the compatibility with the tolerability of noise by the exposed people.

The need of a International standard covering the theme of Intrusive Noise is evident.

As the three-year testing phase of the Italian new Technical Specific is giving positive feedback, where the standard applied to several different sources (road, railway, airport, neighborhood, leisure, wind turbines and more), National Standard bodies of other countries are showing and sharing interest in the idea of possible collaboration with UNI for drafting an international standard on intrusive noise, also asking for the creation of a specific ISO working group.

For example in Spain a specific plan to raise interest has been proposed to the Plenary Committee of UNE-CTN74 - Acoustics and contacts are open among members of the acoustics commissions, committees and working groups from five countries, discussing the opportunities to initiate a WI in ISO to enable an ISO standard in this regard

## 5. CONCLUSIONS

Noise, defined as "unwanted sound" or as "sound out of place", thus finds a measure of its being inappropriate with respect to the soundscape in which it is inserted, activating a specific source.

This unwanted and out of place sound is often the reason for complaints which, if not resolved amicably, lead to legal disputes which require correct technical assessments of the entity of the noise introduced and its intrusiveness to provide the judges with the tools to be able to evaluate its tolerability by exposed people. The UNI/TS 11844:2022 technical specification, published in March 2022, defines the procedures and parameters to be considered for the measurement and evaluation of intrusive noise. The three years of experimentation are underway and good results are coming from many application scenarios