# First Standard UNE 77270 "Building Collaborative Odour Maps through Citizen Science"

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There are many methodologies for assessing odour impact, such as dynamic olfactometry coupled with dispersion models, field inspections, Instrumental Odour Monitoring Systems and many others. However, none of these techniques can directly link this odour impact to the annoyance caused.

Traditionally, odour impact assessment has been carried out using psychometry, which focuses on the theory and technique of psychological measurement used for several decades in the odour field. Nowadays, it is possible to assess odour impact using more advanced psychometric tools based on mobile applications that record an odour observation's exact time/ location.

The International Environmental Association of Odour Managers (AMIGO) and other consultants, NGOs, odour-emitting activities and public administrations developed and published the first standard on mapping odour annoyance using advanced psychometry (UNE 77270) in September 2023.

This standard is the first one, to our knowledge, that deals with using Citizen Science to take a snapshot of the odour reality in a community. There are several tens of projects around the world on this topic, but until now, no methodology has been developed to allow the unification of criteria when evaluating odour annoyance.

## 1. Introduction

Although there are several methodologies to assess an odour impact, such as dynamic olfactometry (EN 13725:2022) coupled with the use of dispersion modelling or field inspections (EN 16841:2017), none of these techniques directly involve the citizens who suffer the nuisance.

There is much literature on the use of citizen science to measure odours. Recently Mauro, F., & Borghesi, R. (2024) investigated the literature published in Scopus during the decade 2013–2023, regarding citizen science applications for environmental purposes with a focus on odours related to activities under the Directive 2010/75/EU (the Industrial Emissions Directive—IED).

For example, The DNOSES European Horizon 2020 project studied the use of mapping odour annoyance to describe and study the impact of this environmental vector. Several papers have addressed this project and its results (Arias et al. 2018; Capelli et al. 2020).

The involvement of the public in environmental matters has been explicitly addressed by European Directives concerning environmental permits for territorial planning/programs (Directive 2001/42/EC) or construction and industrial projects (Directive 2011/92/EU). Regarding emissions management from industrial plants, it's noteworthy that Directive 2010/75/EU (Industrial Emissions Directive—IED) mandates public participation throughout the entire process aimed at establishing the Integrated Environmental Authorization (IEA).

After years of work, in September 2023, the Spanish standardization body (UNE) published the final document approving the new UNE 77270 Standard "Building Collaborative Odour Maps through Citizen Science", developed by the *Technical Committee for Standardization* CTN 77/SC 2/GT 1 - Odour nuisance mapping.

This standard describes a method for building collaborative odour maps to assess odour annoyance through real-time communication by participating citizens, known as citizen science. A citizen science project should meet the minimum requirements of the *10 principles of citizen science* established by the *European Citizen Science Association*.

The aim of this paper is to present some of the key chapters of the UNE 77270.

## 2. Methodology of the Standard

The group, which started its work in 2018, was divided into three working groups to work and advance separately: 1) Participation and transparency, 2) Methodology, and 3) Plausibility verification.

### 2.1 Participation and Transparency

The projects are based on the public's observations of odours. It is necessary to identify the key stakeholders which are *Activities Potentially Causing Odour Nuisance* (APCONs), citizens, environmental local and regional authorities and other organisations and parties to ensure the correct development of the methodology.

### 2.1.1. Action Group
In the *Action Group* (AG), stakeholders should include:
1. Residents in the study area who report odour and may actively engage in other project aspects.
2. Representatives from odour-generating activities whose involvement is beneficial.
3. Public entities to mediate between activities and affected individuals, facilitating communication.
4. Experts in odour, citizen science, or familiar with this standard, guiding data analysis and plausibility.

At least two of these parties must be involved in building a collaborative odour map via citizen science. Real-time odour observations from affected citizens are crucial, requiring participation from individuals potentially impacted by the odour alongside another involved party.

### 2.1.2. Action Group Development and Operation
The AG is an interdisciplinary team tasked with achieving the objectives of this standard, fostering an environment that encourages participation from all involved individuals and organisations. The AG determines strategies to engage the most citizens, analysing community organisations comprehensively. It defines project objectives and actions, ensuring accessibility of information and data to participating citizens. The AG conducts informative activities, such as discussion tables and workshops, to share methodologies for receiving information from involved parties. Project coordination is led by an odour or citizen science expert, who may also handle management and coordination.

Participation in the AG is voluntary, requiring a collaboration agreement outlining objectives, AG constitution, party independence, roles, responsibilities, working basis, joint actions, communication plan, etc. A minimum and maximum number of representatives from each party is agreed upon, ensuring equal weight in decision-making. The AG maintains a proactive and ethical stance, respecting all stakeholders involved and prioritising collective interests to achieve the common goal collaboratively.

### 2.1.3. Role of stakeholders
The role of stakeholders in the Action Group (AG) involves several key responsibilities:
- Setting up the collaboration agreement, defining roles, and communicating and planning action plans.
- Designating a communication focal point for multilateral communication with the AG.
- Fulfilling commitments outlined in the collaboration agreement.
- Ensuring the entire process remains open, free, and accessible to all citizens.
- Contributing to proposals for future actions to minimise odour impact.

Additionally, the standard outlines specific roles for each involved part, such as individuals potentially affected by odour impact, APCON representatives, representatives of public entities, experts in odour or citizen science, project management and project coordination.

### 2.1.4. Promoting participation
To foster high participation, the AG should promote citizen involvement with tailored strategies for each situation, defining approaches to motivate and encourage participation based on individual case studies. Keeping citizens informed is crucial to maintaining motivation and engagement throughout the study period.

### 2.1.5. Communication Plan
The communication plan aims to establish a roadmap for internal and external communication within the AG. It should be collaboratively developed and approved by all stakeholders. Internally, the plan facilitates information transfer among AG members, with frequency tailored to the study period and project needs. Externally, the plan ensures project transparency and accessibility to the public. It should be open-access and address all

stakeholders. Communication frequency depends on public involvement levels, utilising various channels and strategies to reach diverse populations and uphold the right to citizen participation.

### 2.1.6. Action Plan
The action plan is designed to propose realistic and feasible action to mitigate the impact of odour. When the is part of the AG, collaborative efforts should define implementation timelines for proposed actions. These actions, stemming from collective efforts, can include various measures such as implementing best practices, operating during off-peak hours, or reducing production during odour episodes.

### 2.2 Methodology

The Action Group coordinator is in charge to establish and monitor the development of the following points:

### 2.2.1. Delimitation of the study area
The study area is defined around the identified APCONs or based on an area affected by an existing complaint history, extending towards the prevailing wind directions. A nearby representative meteorological station or a meteorological model that meets defined requirements has to be located.

### 2.2.2. Creation of the participating citizenship panel
The participation panel is open to anyone who wishes to participate and can perceive odours. The standard does not prescribe to test the sense of smell of participants. This is not an issue, as there are implemented other tools in the standard to overcome this limitation. The minimum size of the panel participating in an odour monitoring project depends on demographic characteristics.
The size of the participating citizen panel is larger when there are more APCONs involved. However, the coordinator will ultimately determine the panel size based on specific variables of each project.

### 2.2.3. Formation of the participating citizenship panel
To ensure high participation, the AG must employ tailored strategies, focusing on mitigating issues through collaborative problem-solving. The coordinator is in charge to oversee project communication, objectives, timeline, and result relevance. Informative and training sessions are designed to guide participating citizens on handling odour perceptions, identifying odour types, and completing registration forms. Practical sessions on-site aid in odour recognition and encourage participation. Participants are informed that false records or non-compliance will result in exclusion from the project.

### 2.2.4. Odour records form
Several tools must be available and accessible to any population level to report a perceived odour, ranging from the manual format (completed within 24 hours of the observation) to any available digital or computerised form. The minimum data that an odour registration form must contain are:
- Details of the participant making the odour registration: name, surname and e-mail address.
- Odour record data: date, time, location, odour character, hedonic tone and intensity of each record.

A "no odour" rating can also be included in the recording form, which is useful when the study's objective is comparative, i.e., to assess the odour impact in an area exposed to different conditions.

### 2.2.5. Communication report to the action group and citizen participants
The results of the odour records and episodes should be communicated to the Action Group and the participating citizens so that the content and evolution of the project are fully transparent. The report should contain, at minimum, the number of people on the citizenship panel participating, the days per month on which odour records have been made for the same odour character, the number of odour records for the same odour character, a map of odour records, and a summary and identification map of odour episodes, if any.

### 2.2.6. Study period
The minimum time for a project will be three months, which is representative of the disturbance. However, obtaining data for twelve months to complete the annual meteorological variability would be advisable.

### 2.2.7. Data analysis
The data analysis will consist of grouping the data by combining them with all types of information (meteorological, APCON actions, ...). Two types of analytical approaches will be used:
- Odour records. General analysis of all the records is carried out, considering wind speed and direction, time of day and odour data collected among the citizens: intensity (according to the VDI 3882:1 scale), hedonic tone (according to the VDI 3882:2 scale) and odour character.
- Odour Episodes (OE). Each of the episodes is analysed by relating them meteorologically and establishing a minimum number of records that characterize the same episode.

To characterize an odour episode, which is the minimum number of odour records needed to be established, using three months data, as the formula follows:

$$\overline{X}_{records}\,OE = \frac{N_{Total\,records\,of\,the\,citizen\,participant\,panel,\,3\,months}}{t} \tag{1}$$

$$N\,records\,min\,(OE) = (\overline{X}_{records} + P) + k \tag{2}$$

Where:

- $X_{records}$ OE: average number of odour records that compose an odour episode.
- t: total days of the study period
- P: variable value between 1 and 3 depending on the size of the participating citizenship panel
- N records min (OE): minimum number of odour records to consider an odour episode.
- $k \in [-1, +1]$ The choice of the k value should be decided by the project coordination.

To compare odour episodes with each other, a parameter (intensity of an odour episode) is given in %.

$$Intensity\,(OE)\% = \frac{No.\,of\,participants\,who\,have\,reported}{Total\,participants} \times 100 \tag{3}$$

The number of odour episodes obtained can be compared, analysed, and communicated to all the parties involved in the project so that they are aware of the critical situations that most annoy the population.

### 2.2.8. Annoyance Degree (AD)

This is a new value resulting from the correlation between the intensity and the hedonic tone of the reported odour, which is calculated for each odour episode. The Annoyance Degree (AD) is the index that quantifies the annoyance caused by an episode and its impact on the environment, providing objective data that allows comparing the episodes over during the project, shown on the Matrix degree of discomfort as follows:

*Table 1: Annoyance Matrix (AM).*

| Hedonic Tone / Intensity | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 4 | 1 | 1 | 2 | 2 | 2 | 3 |
| 3 | 1 | 2 | 2 | 3 | 3 | 4 |
| 2 | 2 | 2 | 3 | 3 | 4 | 4 |
| 1 | 3 | 3 | 4 | 4 | 4 | 5 |
| 0 | 3 | 4 | 4 | 5 | 5 | 5 |
| -1 | 4 | 4 | 5 | 5 | 6 | 6 |
| -2 | 5 | 5 | 5 | 6 | 6 | 7 |
| -3 | 5 | 6 | 6 | 7 | 7 | 7 |
| -4 | 6 | 6 | 7 | 7 | 7 | 7 |

Then, the AD of an odour episode is calculated based on the sum of the weighted value between the odour intensity and the hedonic tone of the individual odour records collected in the odour episode from the participating citizenship panel. Still, only the one with the highest intensity will be taken into account if the same participant reports more than one odour record during the odour episode.

$$AD_{OE} = \frac{\sum AM_t}{Total\,participants \times 7} \times 100 \tag{4}$$

### 2.3 Plausibility verification

Odour records or episodes must undergo plausibility checks, using external, objective tools to ensure their reliability across studies. The aim is to confirm alignment with known activities in the study area without considering records erroneous. Several methods can assess the plausibility of odour records and episodes:

### 2.3.1. Plausibility through odour episodes

By analysing repeated odour records from participants in the same project area during the time period of the episode. Different scenarios arise depending on the number of known activities, of wind directions and the possibility of unknown odour sources.

### 2.3.2. Plausibility through meteorological data

Checking meteorological data to determine the origin of the wind during the odour record or episode.

**a)** Meteorology can be used to check the plausibility of odour records or odour episodes in simple cases to determine the origin of the wind, using the methodology outlined in German VDI 3883-Part 4: 2017. Key meteorological factors include: wind direction, wind speed, additional meteorological conditions like thermal inversion and odour record site's distance and position relative to emission sources, local terrain, etc.

**b)** This section also establishes the minimum criteria that must be fulfilled (and some recommendations) in order to use or select a meteorological station as an instrument for the plausibility of odour records or odour episodes, such as:

- Ensure periodic verification and maintenance align with *World Meteorological Organisation* (WMO) criteria and technical recommendations.
- Consider data representativeness based on meteorological station topography concerning the location of the APCONs.
- Use of a proper anemometer (known the detection level)

If a meteorological station fails to meet minimum criteria or representative stations are unavailable this tool should not be used, instead other tools described in this standard should be used.

**c)** This section also establishes the minimum criteria that must be fulfilled (and some recommendations) in order to use or select a meteorological model as an instrument for the plausibility of odour records or odour episodes, such as:

- Consider the study area's topography when configuring the modelling system.
- Calibrate the model based on criteria and recommendations from national/supranational meteorological agencies and/or referenced scientific literature. Focus on wind variables, comparing model data with at least one meteorological station meeting the minimum criteria annually.
- Annual calibration results should demonstrate accuracy, drift, and correlation between observed and model data.

### 2.3.3. Plausibility through transport modelling

Using mathematical transport algorithms, such as back-trajectory, that allow a more accurate assessment of the origin of an odour.

Advanced pollutant and odour transport modelling techniques can enhance the plausibility analysis of odour record or episodes, taking into account that each odour record within an episode must be individually analysed. The minimum criteria for the application of these tools are the following:

- The chosen model should allow for three-dimensional spatial and temporal data input and output, with at least hourly resolution.
- Analyse the study area's topography for configuring the modelling system.
- Ensure the meteorological data used meets the minimum criteria outlined in previous sections.

### 2.3.4. Plausibility through dispersion modelling

Use of odour dispersion modelling techniques offers concentration estimates in the activities nearby for quantitative analysis of potential impact alongside the plausibility analysis of odour records or episodes.

To use dispersion modelling effectively for this purpose, the following minimum criteria must be met:

- Justify the selection of the dispersion model based on physiographic characteristics, study typology, and the number of odour sources. Consider limitations of different dispersion models (Gaussian, Lagrangian, Eulerian) based on study characteristics.
- Ensure the selected dispersion model allows for three-dimensional spatial and at least hourly temporal resolution for data input and output.
- Analyse and consider the study area's topography when configuring the modelling system.
- Use meteorological data meeting the minimum criteria outlined in previous sections of this standard.

Finally, there are other tools, guidelines or methodologies in addition to those described in this standard to be able to plausibility of odour records or odour episodes, which should be used depending on their availability whenever their use can be justified.

These tools for verifying the plausibility of odour records or events can be used individually or together, all being equally valid. Their selection depends on project requirements or availability. However, their use doesn't categorise odour records as correct or incorrect; rather, they indicate the plausibility of being caused by known sources within the project area.

## 3. Conclusions

The present paper sets out the methodology of the new Spanish standard in force since September 2023.

It details the most important parts of the standard, such as: a) participation and transparency, where the actors and the work of the action group, among others, are described; b) the methodology for project design, data

collection and analysis; and finally, c) the study of plausibility through the different tools analysed in the standard, such as plausibility through odour episode, meteorological data, transport and dispersion modelling.

Now it is time to test this standard in new projects, to give validity and rigour to the methodology, or even to find failures in order to solve them in future revisions. In addition, there is an opportunity to create a European working group to try to develop an European Standard and to extend the scope of this text to more countries.

**Nomenclature**

AD - Annoyance Degree
AG – Action Group
AM - Annoyance Matrix
APCON - Activity Potentially Causing Odour Nuisance
OE – Odour Episodes

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**References**

Arias, R.; Capelli L.; Diaz Jimenez C.; A New Methodology Based on Citizen Science to Improve Environmental Odour Management. Chemical Engineering Transactions 2018, 2283 -9216. DOI: 10.3303/CET1868002

Capelli, L.; Arias, R.; Uribe-Echevarria, J.; Sironi, S. Overview of odour measurement methods: The odour observatory as an informative tool for citizen science based approaches to odour management. Detritus 2020, 12, 169–175.

Developing of a New Spanish Standard "Building Collaborative Odour Maps through Citizen Science", 2020, C. Izquierdo, C. Diaz, A. Antón, F. Andrés, J. M. Felisi, G. Sánchez, L. Saúco, L. Rodríguez, presented at NOSE2020.

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment. OJ L 197, 21.7.2001, p. 30–37.

Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJ L 334, 17.12.2010, p. 17–119.

Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, OJ L 26, 28.1.2012, p. 1–21.

ECSA (European Citizen Science Association). 2015. Ten Principles of Citizen Science. Berlin. http://doi.org/10.17605/OSF.IO/XPR2N

EN 16841-1, 2016, Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method, European Committee for Standardization (CEN), TC264 WG27, Brussels.

Mauro, F., & Borghesi, R. (2024). Using Citizen Science to Manage Odour Emissions in National IED Plants: A Systematic Review of the Scientific Literature. Atmosphere, 15(3), 302. https://doi.org/10.3390/atmos15030302

UNE 77270:2023, Building collaborative odour maps through citizen science, CTN 77/SC 2/GT 1 - Mapeo de molestias por olor, Spain.

VDI 3882 Part 1, 1992, Olfactometry; determination of odour intensity, German Engineering Association VDI/DIN Commission on Air Pollution Control (KRdL), Germany.

VDI 3882 Part 2, 1994, Olfactometry - Determination of hedonic odour tone, German Engineering Association VDI/DIN Commission on Air Pollution Control (KRdL), Germany.

VDI 3883 Part 4, 2017, Effects and assessment of odours - Processing odour complaint, German Engineering Association VDI/DIN Commission on Air Pollution Control (KRdL), Germany.