

# EXPERTISE IN THE FIELD OF ODORS MEASUREMENT

Measurements and standards  
*Emissions problems*



**UNIVERSITÀ  
DEGLI STUDI  
DI UDINE**

hic sunt futura

Focus

*Emissions*

*Monitoring*

*Measurement*

*Standards*





MEASUREMENTS  
AND STANDARDS

EMISSIONS  
PROBLEMS



# INTRODUCTION

**Lod Srl** was founded in 2003, within the framework of the event "Parco Tecnologico di Friuli Innovazione", as a **Laboratory of dynamic olfactometry** specialized in odors measurement. As a spin-off of the Udine University since 2007, LOD offers services to public and private companies, among which the quantification of odorigenous emissions and the evaluation of potential olfactive impacts.





## SERVICES:

- DYNAMIC OLFACTOMETRY
- ODOR PROTOCOL
- DISPERSION MODELS
- ELECTRONIC NOSES
- RHINO-ANALYSIS
- EVALUATION OF HEDONIC TONE
- ODOUR FIELD INSPECTION

**LOD** has been continuously cooperating with various technical organizations or institutions for a long time.

This is why:

- since 2012, Lod has been a member of the **"Odors" work group of AIDIC** (Italian Association of Chemical Engineering), handling technical standards revision;
- since 2014, Lod has been a member of the **work group ISO/TC 193/WG 5**;
- since February 2015, Lod has been a member of the **work group UNI/CT 004/GL 04 "Air Quality" (mixed Environment/UNICHIM)**;
- since April 2015, Lod has been a member of the **work group CEN/TC 264/WG 41 "Electronic sensors for odorant Monitoring" and CENT/TC 264/WG 2 "Air quality - determination of odor concentration by dynamic olfactometry"**;
- since 2017, Lod has been belonging to the **Italian Biogas Consortium**;
- since 2017, Lod has been a member of the **UNI work group created "ad hoc" to study olfactive impacts.**







# DYNAMIC OLFACTOMETRY



Dynamic olfactometry is the only methodology acknowledged on an international scale for the measurement of odor concentration (European Commission – JRC Reference Report on Monitoring of Emissions to Air and Water from IED Installations - 2018).  
It is subject to the technical Standard UNI EN 13725:2004 *“Air Quality – Determination of odor concentration by dynamic olfactometry”*.





The Dynamic Olfactometry Laboratory of Gruppo Luci is qualified by **ACCREDIA - Accreditation n.1744L** – as of standard UNI CEI EN ISO/IEC 17025:2005 for the **execution of tests meant to determine odor concentration by dynamic olfactometry.**

It is possible to summarize the various activities as follows:

- Survey on site
- Sampling of odorigenous elements at the source of emissions (stacks, biofilters, reservoirs, heaps...)
- Samples analysis in an olfactometric room
- Evaluation of results .

LOD quantifies odors present in air samples collected under the most various types of environmental conditions. The collected samples are analyzed in olfactometric rooms, in compliance with the standard, within thirty hours from sampling.

A group of selected people (panel or examiners) determines a threshold for the detection of the odor contained in the sampled effluent, in compliance with sensorial and behavioral criteria. The number of dilutions with neutral air at which the odor becomes perceivable by 50% of the examiners is the index of odor concentration, expressed as **Odorimetric Units per Cubic Meter ( $ou_e/m^3$ ).**

Olfactometric analyses are associated with industrial activities of research and development in any type of plant. **They are essential for the control of odors, whether in plants subject to an Integrated Environmental Authorization or to an Environmental Certification, or from the point of view of art. 272 - bis of Decree Law 152/2006.** Through olfactometric analysis, it is also possible to evaluate the efficiency of environmental equipment designed to abate odors, as well as obtain useful information for the proper management of a plant.

LOD has been taking part since 2009 to the only initiative of worldwide inter-calibration, with excellent results as regards the repeatability of olfactometric analysis, as well as its accuracy.





# ODOR PROTOCOL



The odor protocol makes it possible to identify chemical mixtures that might be responsible for odorigenous emission.







The **correlation between odor concentration and pollutants that are present** is complementary to olfactometric analysis.

The mixtures to take into consideration depend on the typology of plant examined. Therefore, it is necessary to carry out an accurate preliminary study of the production process and raw materials involved.

The various steps are the following:

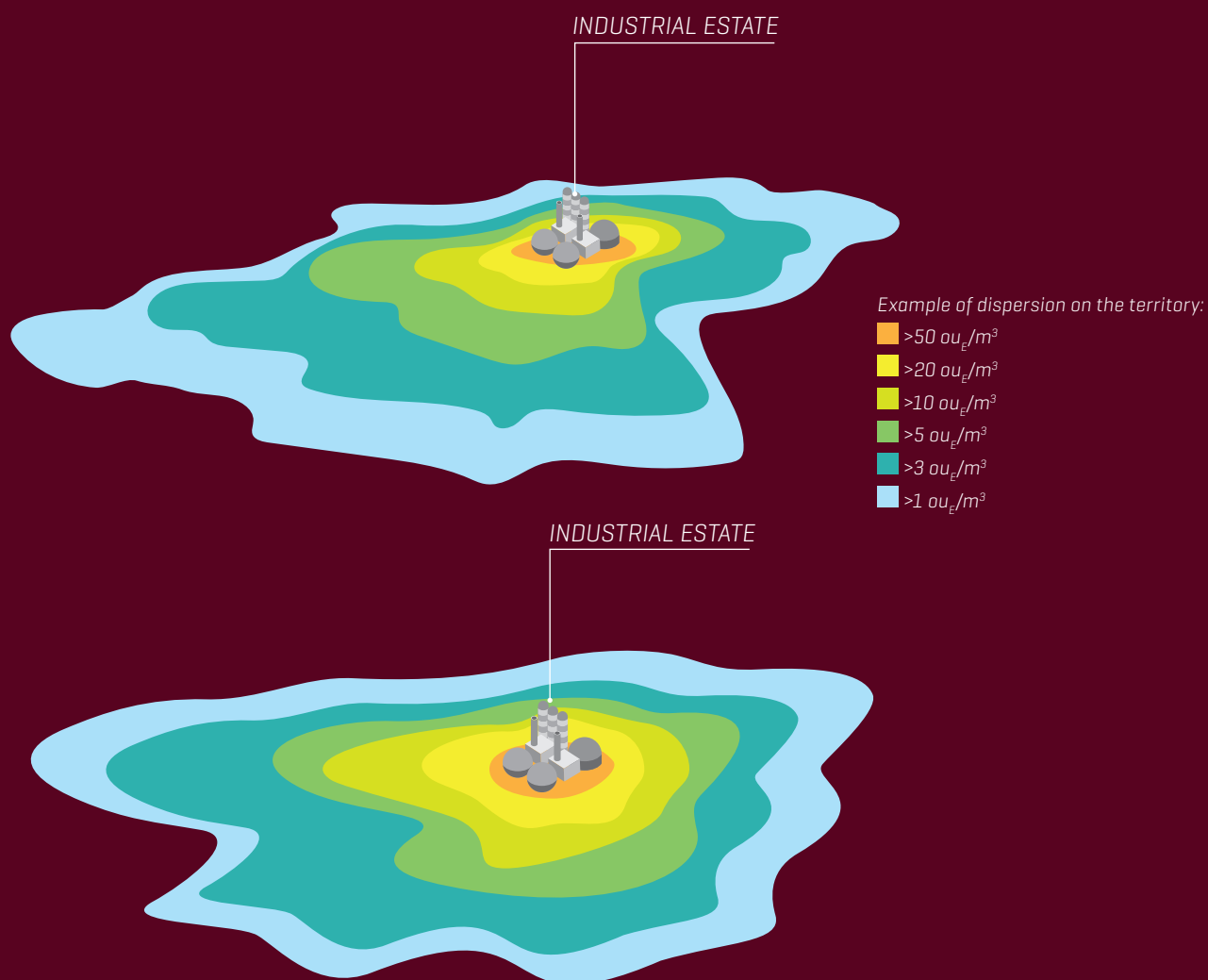
- **Collection** of odorigenous samples, together with chemical sampling
- **Analysis** of samples, chemical and olfactometric
- **Comparison** of chemical concentration values with thresholds of olfactive perception described in literature
- **Determination** of synergy-masking reactions among various components in odor formation

A starting point for a comparison between results of chemical analyses and olfactive perception thresholds is to be found in Chart 2 of Attachment 4 in the **Deliberation of regional council dated February 15, 2012 - n. IX/3018 "General determinations regarding the characterization of gaseous emissions to the atmosphere due to activities with a strong odorigenous impact"**.

This is based on the study entitled "Measurement of Odor Threshold by Triangle Odor Bag Method", Yoshio Nagata, Japan Environmental Sanitation Center.



# DISPERSION MODELS



Dispersion models are mathematical simulations that allow describing odor and pollutants dispersion ( $\text{NO}_x$ ,  $\text{SO}_x$ , CO,  $\text{PM}_{10}$ ...) in a territory surrounding production premises.



**Ministerial Decree n. 261 dated 01/10/2002** "Regulation with technical directives for the preliminary evaluation of environmental air quality, criteria for the elaboration of a project and programs as of articles 8 and 9 of Decree Law dated August 4, 1999, n. 351" considers dispersion models a useful tool, as in the following cases:

- *To obtain concentration fields (ranges) in parts of the territory where there are no measurement spots; or to extend the capacity of this measurement to achieve a spatial representation*
- *To evaluate the impact of pollutants, not measured by the monitoring network*
- *To study alternative emissions hypotheses, in comparison to present or past situation.*

Odors dispersion models allow **quantifying the osmogenous impact of premises on the surrounding territory**. They operate on the ground of olfactometric data, meteorological data and territory orography. A dispersion model supplies a precise indication of premises olfactive impact on their neighboring areas.

The main steps to come to a dispersion model are the following:

- Determination of emissions sources
- Collection of meteorological data, for instance from ARPA (Regional Agency for Environmental Protection), of orography data and information on the use of soil
- Simulation of consequences due to odor and / or polluting elements
- Evaluation of the actual impact of the production facility on the surrounding territory.

Guidelines of **Region Lombardy** recommend the use of dispersion models to evaluate the olfactive impact on sensitive receptors. "Guidelines for the characterization and the authorization of gaseous emissions to the atmosphere for activities having an odorigenous impact" issued following the Deliberation of the Regional Council dated February 15, 2012 - n. IX/3018, are a reference on the national scale.

As of today, **dispersion models are the only tool allowing for some "forecasts" on potential consequences of pollutants and odors on the territory, before any facility is put into place.**

# ELECTRONIC NOSES



Electronic noses are tools that work as the human olfactory system. They are capable of measuring and recognizing an odor during fall-out, when it reaches sensitive receptors positioned at a given distance from a production facility.





Electronic noses (or artificial olfactometric systems) are tools that simulate the recognition of odors by the human olfactory system with the help of metal oxides semiconductors sensors, supplying a so-called "olfactory imprinting". Analyses with the help of electronic noses consider the following steps:

- Collection and analysis of odorigenous samples
- Training of the tool
- Monitoring at the receptor level
- Quantitative and qualitative determination of the potential impact of various sources.

**Training** is an essential step in the use of electronic noses, because it allows instructing the tool for it to recognize odors that monitoring will detect. The electronic nose does not carry out a chemical analysis of the gaseous mixture examined, but it supplies its olfactory imprint and then compares it with the reference file containing data memorized during training.

In fact, as a human nose, electronic noses recognize an odor only if they have experienced it in the past.

LOD uses **electronic noses EOS Ambiente** of the company SACMI, both for test stands and for outside use.

Their use can supply information:

- to plant managers who want to survey olfactory impact
- to institutions or committees of citizens that want to survey olfactory impact in a receptor.

Electronic noses are particularly useful when there are several odor sources on the territory, if it is necessary to find out which source has the strongest impact on a receptor.

LOD takes part actively to the **UNI Work Group** handling the editing of standards regarding electronic noses (IOMS - *Instrumental Odor Monitoring System*).

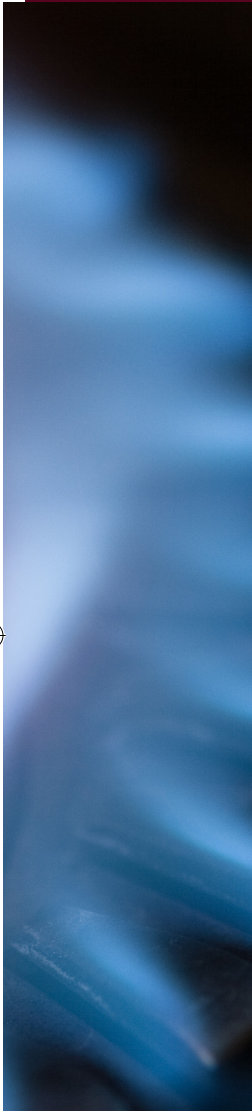







# RHINO ANALYSIS



Rhino analysis is a sensorial technique, regulated and defined by standard **UNI 7133**, designed to check the proper **degree of gases odorisation**, particularly as regards **biomethane**. Lod is the only private laboratory in Italy to be equipped with a rhino-analytical chamber and accredited for rhino-analytical measurement as of standard **UNI 7133-3:2019**.





**The most critical aspect in view of the introduction of gases online (including biomethane) concerns odorization.** In fact, in the case of gases for domestic use and transport, they must have some precise olfactive characteristics to guarantee users' safety.

Determining the proper odorization degree is thus of the utmost importance. This activity takes place inside a rhino-analytical chamber, as specified by **Standard UNI 7133-3: 2019** "Odorization of gas for domestic use and similar uses – Part 3: Procedures for the definition of olfactive characteristics of fragrant fluids".

Rhino analysis is the only acknowledged technique for the verification of the proper odorization for biomethane, as of **Technical Standard UNI 7133-2:2019**.

#### **RHINO-ANALYTICAL CHAMBER**

**LOD** rhino-analytical chamber, where analyses take place, is a room of 16 cubic meters approximately, coated with aluminum, where to have evaporate a known quantity of odorizing product and mix it with the gas to be tested. Examiners (rhino-analysts) selected and trained, walk through the room and record their olfactive sensations on a **Deca Sales scale**. The results are compared with the reference odorization data.



# EVALUATION OF HEDONIC TONE



The evaluation of the hedonic tone allows determining if an odor is pleasant or unpleasant. It takes place in an olfactometric room, as of **Standard VDI 3882**.

Tone evaluation is adequate to **evaluate the potential pleasure or nuisance caused by a given odor, in order to objectify a subjective perception**. Examiners involved in the analysis panel have to be selected beforehand, based on their reaction to two reference substances (guaiacol and vanillin).

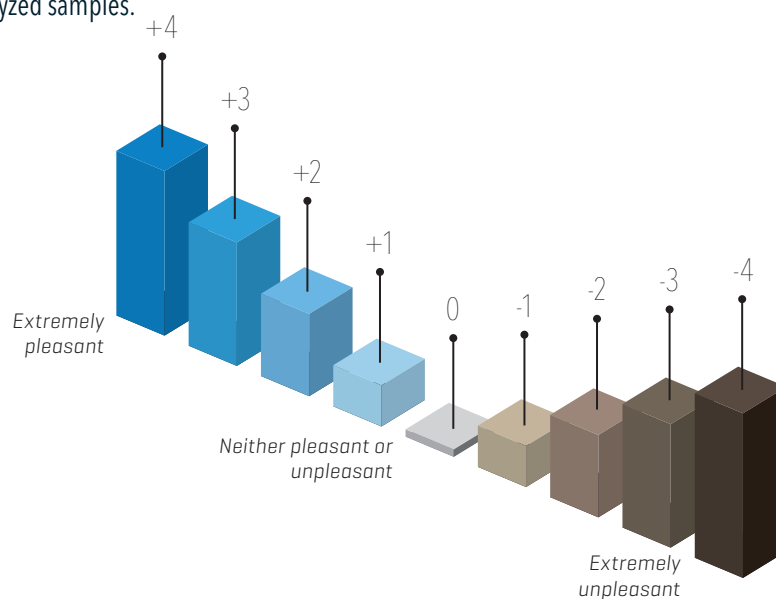




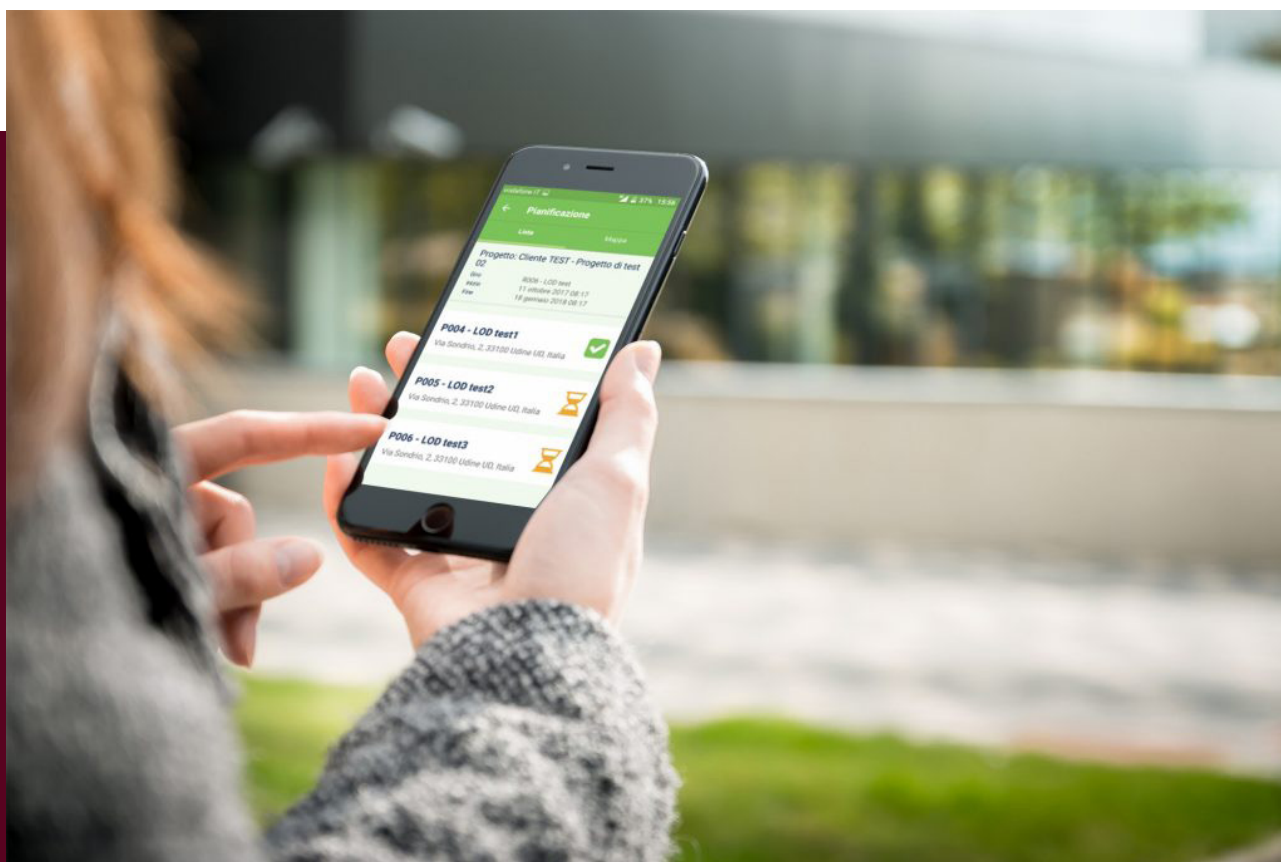


### Sequence of activities:

- A determination of odor **concentration in the odorigenous sample** (UNI EN 13725: 2004) takes place initially. Once this datum has been defined, it is possible to determine the concentration interval of this odor that examiners will have to appraise
- The odor stimulate is presented to examiners, at a casual concentration within the established interval, through the olfactometer. The **stimulus** remains for 15 seconds, followed by a further 5-second decisional time interval, and a minimum 1-minute break between two stimuli
- By analyzing various dilutions of a sample (even below perception threshold), **examiners associate a number from - 4 to + 4 to every perception**
- After the **evaluation in the olfactometric room**, statistic calculations allow evaluating the relative frequency that accumulated at the various dilution steps analyzed, in order to determine the **correlation** existing between odor dilution and the fact that the odor is pleasant / unpleasant
- At the end, it is possible to obtain characteristic **curves of the hedonic tone**. The ordinate shows the values of hedonic tone obtained, while the abscissa shows the odor units of analyzed samples.



# ODOUR FIELD INSPECTION



Odor Field Inspection is a method of analysis, defined in **standard UNI EN 16841:2017**, that foresees direct determination of odors in the air, thanks to qualified examiners.



Standard UNI EN 16841-1: "Environmental air – Determination of odor in environmental air by a field investigation – Part 1: Grid Method", based on the German standard VDI 3940 part 1 and acknowledged in Italy in 2017, regulates **Odor Field Inspection**, a method to analyze odorigenous impact in a given territory, through an evaluation by selected examiners.

In particular, the grid method, as described in part 1 of the abovementioned standard, consists in the representation of sensitive receptors, with a regular grid of equidistant spots spread over the investigation area, between which to define the measurement paths.

After a suitable training, a numerous enough panel of examiners supplies indications on the possible presence of odor on every spot, pointing out at the typology and intensity of it. The data collected during the investigation, lasting from 6 to 12 months to be sufficiently representative of weather conditions in the area, are then examined statistically.



#### GEONOSE: THE FIRST SAAS SERVICE (SOFTWARE AS A SERVICE) DEDICATED TO THE SURVEY OF ODORS IN THE ENVIRONMENT

LOD has recently created **Geonose**, a management software consisting of a portal, plus an application for smartphones and tablets, that can be used by examiners directly on site. This software allows implementing Field Inspection data, while supplying a geolocated measurement of the odor.

#### **Lod Srl**

Via Sondrio , 2  
33100 Udine \_ Italia

t +39 0432 1715695

lod@gruppoluci.it  
www.lodsr.it





[www.gruppoluci.it](http://www.gruppoluci.it)

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