



SLOVENSKI STANDARD

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**Zrak na delovnem mestu - Merjenje izpostavljenosti pri vdihavanju kemičnih snovi
- Postopki za preskušanje skladnosti z mejnimi vrednostmi za poklicno
izpostavljenost**

Workplace exposure - Measurement of exposure by inhalation to chemical agents -
Strategy for testing compliance with occupational exposure limit values

Exposition am Arbeitsplatz - Messung der Exposition durch Einatmung chemischer
Arbeitsstoffe - Strategie zur Überprüfung der Einhaltung von Arbeitsplatzgrenzwerten
(Überarbeitung von EN 689:1995)

[SIST EN 689:2018](https://standards.iteh.ai/catalog/standards/sist/e1ac62dc-0722-4a5b-b86f-300120c71918/sist-pr-en-689-2016)

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation aux agents
chimiques - Stratégie de détermination de la conformité aux valeurs limites d'exposition
professionnelle

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Workplace exposure - Measurement of exposure by inhalation to chemical agents - Strategy for testing compliance with occupational exposure limit values

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation aux agents chimiques - Stratégie de détermination de la conformité aux valeurs limites d'exposition professionnelle

Exposition am Arbeitsplatz - Messung der Exposition durch Einatmung chemischer Arbeitsstoffe - Strategie zur Überprüfung der Einhaltung von Arbeitsplatzgrenzwerten (Überarbeitung von EN 689:1995)

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 137.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (prEN 689:2016) has been prepared by Technical Committee CEN/TC 137 “Assessment of workplace exposure to chemical and biological agents”, the secretariat of which is held by DIN.

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Introduction

This European Standard deals with the measurement of exposure to chemical agents in workplace atmospheres, and in particular with sampling strategy for comparing workers exposure by inhalation with occupational exposure limit values (OELVs). Other parts of management of exposure of workers are not dealt with in detail in this European Standard.

OELVs include legal values and other numerical criteria.

Representative measurement of occupational exposure to chemical agents is difficult, because of the variability of exposure. Processes and products affecting exposure are numerous. Different occupational conditions can correspond to different generation rates and involve a variety of chemical agents, and can therefore present specific exposure conditions. Exposure can be affected by the distance of the exposed worker from emission sources; and parameters such as emission intensity, ventilation, climatic conditions, seasonal variations and the controls applied can also have a very marked influence. The spatial and temporal variabilities of exposure conditions are further enhanced by the workers' practices and activity itself.

The sampling equipment often introduces its own limitations, sometimes critical, as in aerosol fraction measurement. The analytical steps add further difficulties or uncertainties, e.g. insufficient identification or separation of chemical species, or interferences, or limits of quantification which are too high. This can lead to practical problems to fulfil requirements of EN 482. As a consequence, some parts of the described procedure in this European Standard cannot be applicable.

To assess the exposure of workers to chemicals and to state with certainty that it does not exceed the OELVs (short-term or long-term) would therefore require measurement of the exposure of every worker for every working day. Unfortunately while this approach is possible for some agents such as ionizing radiation, it cannot be done for chemicals because of their diversity, limitations of the measurement techniques, and costs.

The strategy described in this European Standard gives a procedure for the employer to overcome the problem of variability and to use a relatively small number of measurements to demonstrate with a high degree of confidence that workers are unlikely to be exposed to concentrations exceeding the OELVs. To reduce the number of exposure measurements, and therefore the cost of assessment, personal air samples are collected among workers within similar exposure groups (SEGs). A single measurement or even several measurements below the limit value can be insufficient to reliably demonstrate compliance without using a statistical test like the one described in this European Standard.

Respiratory protective equipment (RPE) is used to reduce the amount of the chemical agent that is inhaled by the worker. However, due to different regulations in different countries for dealing with effectiveness of RPE in relation to compliance testing and the fact that OELVs are compared with workplace airborne concentrations that are measured outside any RPE, this European Standard does not take into account the use and effectiveness of RPE in testing compliance with the OELV.

Before any measurements are conducted, it is necessary for an appraiser to conduct a basic characterization in order to collect relevant information on exposure determinants, and the available information on exposure in the workplace concerned. This includes information on variation of exposure with time of day and season of the year, so that the measurement is representative.

If the basic characterization shows that exposure is probably higher than the OELV, then it is recommended to reduce exposure by risk management measures (RMM) before measurements are planned for compliance testing.

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1 Scope

This European Standard specifies a strategy to perform representative measurements of exposure by inhalation to chemical agents in order to demonstrate the compliance with occupational exposure limit values (OELV).

This European Standard is not applicable to OELVs with reference periods less than 15 min.

NOTE Measurement for compliance testing is only one part of the management of exposure of workers. Some background and advice on when measurement can be carried out is given in Annex A.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 482, *Workplace atmospheres — General requirements for the performance of procedures for the measurement of chemical agents*

EN 1540, *Workplace exposure - Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540 and the following apply.

3.1 exposure profile

description of the exposure variations to a chemical agent during a workshift in relation to the definable series of activities

Note 1 to entry: See Annex D. standards.iteh.ai/catalog/standards/sist/e1ae62dc-0722-4a5b-b86f-66aa299c1914/sist-en-689-2018

3.2 similar exposure group SEG

group of workers having the same general exposure profile for the chemical agent(s) being studied because of the similarity and frequency of the tasks performed, the materials and processes with which they work, and the similarity of the way they perform the tasks

3.3 work pattern

the definable series of activities from the periods under consideration

4 General

The assessment of occupational exposure to chemical agents based on air sampling requires the development of a strategy including different phases which shall be conducted by an appraiser who is sufficiently trained and experienced in occupational hygiene principles and techniques to conduct, according to the state of the art, the part of the assessment for which he or she is performing.

The initial survey (as described in Clauses 5 and 6) conducted to assess exposure comprises different phases:

- basic characterization or general evaluation of the workplaces;
- constitution of similar exposure groups;

- definition of a measurement procedure;
- performing exposure measurements;
- validation of exposure measurements results and SEGs;
- comparison of results with occupational exposure limit value (OELVs);
- communication of results and compliance diagnosis.

The sampling strategy comprises the constitution of SEGs and the definition of measurement procedures. If the initial survey indicates non-compliance with OELVs for some SEGs, control measures shall be implemented and a new initial survey shall be conducted. Following the initial survey, periodic reassessments shall be conducted. When significant changes occur at the workplaces and affect exposure conditions, a new initial survey should be conducted.

Figure 1 gives a schematic overview of the procedures described in this European Standard.

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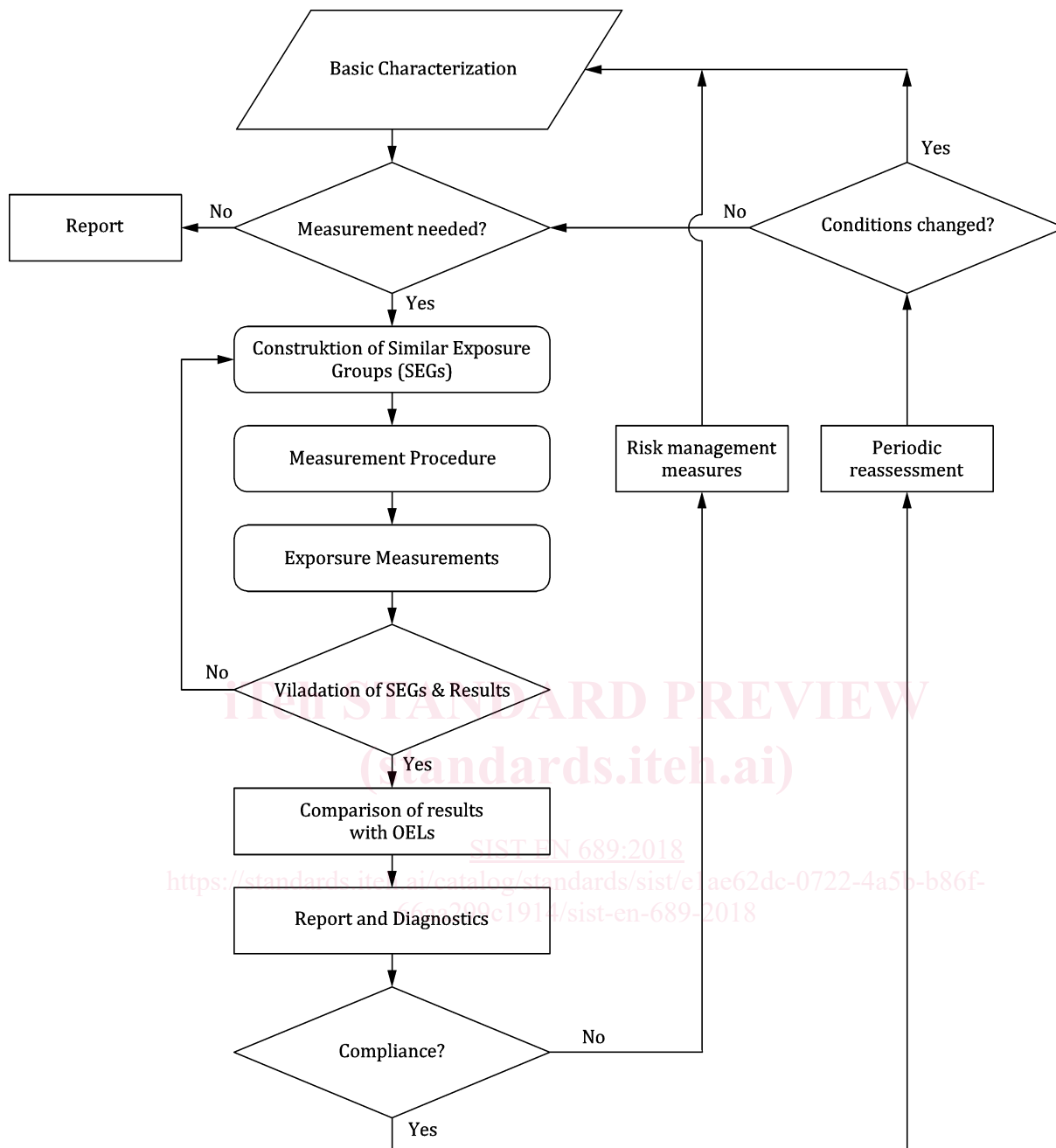


Figure 1 —Schematic overview of the strategy

5 Occupational exposure assessment

5.1 Basic characterization

5.1.1 General

Prior to conduct of exposure measurements, the workplace and the related exposure profile under consideration shall be considered.

The basic characterization of exposure determinants is in three steps:

- identification of chemical agents (hazards, OELVs, physical properties);

- identification of determinants of exposure;
- estimation of exposure.

All the information collected during the basic characterization shall be used to:

- decide whether measurements are necessary or not (see Annex A);
- constitute a priori the different SEGs.

Use of exposure monitoring devices able to give an instant feedback to the user, either as a single or a continuous reading (so called direct-reading instruments), can give valuable information about approximate exposure level, the exposure pattern, and spatial, time and worker variability of the exposure.

If the basic characterization concludes that measurements are unnecessary, a report shall be written explaining the reasons and the time of periodic reassessment.

5.1.2 Identification of chemical agents

The preparation of a list of all chemical agents in the workplace and the relevant information concerned is an essential first step to the identification of the potential for hazardous exposure. The safety data sheets and other available information are useful to establish the list. The list shall include, as far as any of them can contribute significantly to exposures:

- primary products, impurities, intermediates, final products, reaction products and by-products, etc.;
- the individual chemical agents, identified in preference by their CAS#¹⁾ or EINECS#²⁾;
- appropriate OELVs depending on the goal of the assessment (see Annex B);
- whether dermal and oral exposure of the chemical agents is relevant (this European Standard only deals with measuring inhalation exposure, but knowledge of other routes can be important in the management of exposure);
- additional information like vapour pressure, saturation concentration, dustiness.

5.1.3 Identification of determinants of exposure

The work processes and procedures shall be evaluated to gauge the potential for exposure and the exposure profile to chemical agents by a detailed review of workplace factors, such as

- work organization: activity, task, qualification, work shift system, job functions, etc.,
- production processes and techniques (type of processes, temperature, pressure, amount, etc.),
- workplace configuration (confined spaces, open air spaces, etc.),
- safety precautions and procedures (restricted area, etc.),
- personal protective equipment (PPE),

1) Chemical Abstracts Service registry number

2) Number for European Inventory of Existing Chemical Substances

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- ventilation installations and other forms of engineering control,
- emission sources and localized concentrations,
- periods, frequencies and durations of exposure,
- work load, or
- activity or production rate indicators.

5.1.4 Estimation of exposure

The estimation of potential exposures should permit the appraiser to obtain reliable quantitative information about exposure of workers concerned, taking particular account of tasks with high exposures (see Annex A).

The possible sources of information include

- earlier measurements,
- measurements from comparable installations or work processes,
- reliable calculations based upon relevant quantitative data, and
- exposure modelling.

The estimation of potential exposures shall determine whether it is necessary to perform measurements especially when exposure is apparently much higher than the OELVs. In this case, it is better to implement a program to reduce exposures, and then proceed to action before conducting exposure measurements.

The information collected on the expected exposure levels shall also verify the adequacy of the measurement techniques and analysis that are implemented

5.2 Sampling strategy**5.2.1 Constitution of Similar Exposure Groups (SEGs)**

In practice it is usually not possible to measure the exposure of each worker during each working day. In order to obtain quantitative data on exposure measurement, an approach shall be taken that allows the most efficient use of resources.

This approach, based on the observation of working conditions, permits measurement of exposure of a small number of workers belonging to a SEG for comparison with OELVs. Where exposure measurements on some workers of the SEG indicate that the OELVs are met (compliance), then it is considered that this is so for all workers in the SEG.

The SEG shall be constituted with information on the nature, level and duration of the tasks performed in the working shifts throughout the year. This requires occupational hygiene expertise, and the information most often includes

- a) the job classification of the company, as a useful starting point,
- b) the inventory of tasks within a job,
- c) the task specific exposure nature and the estimation of the potential exposure level, collected in the basic characterization (see 5.1) and if possible combined with the Operational Conditions (OC) and Risk Management Measures (RMM) from a corresponding REACH Exposure Scenario, and

- d) the duration of the exposure within the shift and throughout the year, determined by the frequency and period of the tasks.

The real level of exposure is determined as described in 5.3 and further of this European Standard.

A SEG can be constituted by one worker.

If a SEG includes worker from different locations, care shall be taken that the SEG meets definition 3.2 of this European Standard.

5.2.2 Measurement procedure

The measurement procedure shall give results representative of worker exposure.

The sampling protocol aims to specify all the elements that guarantee to have representative and reliable results of exposure measurements for comparison with limit values.

Sampling and analytical techniques shall be in accordance with standards or national recommended methods. Sensitivity, specificity, capacity of samplers, transportation and stability of the sample shall be particularly checked (see EN 482).

In order to measure the exposure of the worker at the workplace, personal sampling devices shall be used whenever possible, attached to workers' clothing close to the breathing zone; workers should be aware of how the sampling device works. Due to spatial variability of chemical air concentrations, static samples are generally less representative of worker exposure.

The sampling duration is also an important factor that can influence the representativeness of exposure measurements.

The sampling duration should be representative of the reference period of the limit value controlled and should be established considering the concentration variability, the limit of quantification and other performance characteristics of the analytical method.

In the case of extended work shift, the daily exposure (E_d) is used for comparison with the OELV (see Annex G).

If the total sampling duration is less than the OELV reference period, then the unsampled time remains a serious weakness in the credibility of any exposure measurement.

During this time careful observation of events is necessary. The assumption that changes have not occurred in the unsampled period shall always be critically examined. Examples of such situations are presented in Annex D.

For testing compliance with OELV-8 h, three cases shall be considered:

- If the appraiser considers that the exposure determinants, including the tasks, are constant during the workshift, the total sampling duration could be shorter than the reference period with a minimum of 2 h.
- If the appraiser considers that the exposure determinants, including the tasks, are not constant during the workshift, the total sampling duration shall be longer than 2 h and much closer to shift duration.
- If the duration of exposure is less than 2 h, the sampling duration should cover the period of exposure.

Where the exposure times are very short, there can be problems with the measurement because the limit of quantification is too high to compare the results with the OELV (see EN 482). It can be helpful in such cases to collect more of chemical agents by continuing the sampling when exposure to the agents is repeated.

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Measurements should be performed on sufficient days and during various specific operations in order to gain insight into the pattern of exposure. It is important to consider different episodes during which exposure conditions can vary (night and day cycles, seasonal variations).

The minimum number of measurements shall be in accordance with 5.5.1. The appraiser shall also take into consideration the number of workers belonging to the SEG in order to determine the number of measurements that shall be conducted, to ensure that the results are representative of the whole SEG. This is especially important if workers in a SEG belong to different premises.

5.3 Performing exposure measurements

Before starting the survey, the appraiser shall make contact with the employer and should ensure that workers are informed about the objectives of exposure measurements. The appraiser shall check that the work activity is consistent with that taken into account in the sampling strategy. The appraiser shall monitor the success of the sampling operation. The appraiser shall remain on site to do this, or arrange for it to be done by another responsible person. For each sample, the appraiser shall obtain the following relevant information for the future interpretation of the results of exposure measurements:

- identification of the SEG and of the workers;
- description of the workplace;
- chemical agents relevant for the activity;
- work tasks performed;
- daily working hours and the duration of exposure to chemical agents considered;
- risk management measures such as engineering control, PPE, work organization, administration control, etc.;
- relevant environmental conditions at the workplace (for example temperature, relative humidity, pressure);
- presence of other activities, incidents, etc.;
- sampling information, such as identification of technical sampling equipment used and samples, sampling flow rate, start and end of sampling, ambient conditions, etc.;

5.4 Validity of SEGs and results**5.4.1 General**

Before testing the compliance with the OELV (or other numerical value), it is necessary to evaluate the representativeness of each measure and a posteriori confirm the constitution of SEGs. Therefore, the evaluation of measurement results serves two objectives:

- a) The representativeness of each sample is evaluated.
- b) Each SEG is confirmed as being suitable for compliance testing as explained in 5.5.

5.4.2 Representativeness of measurement results

Based on results of analysis and information collected during the measurement campaign, the representativeness of each sample shall be evaluated, i.e. outliers shall be identified. To detect outlier values, several graphical or statistical methods can be implemented together or separately, of which

examples are given in Annex E. However, these tests shall only be used to identify potential outliers, but cannot be the sole reason for excluding samples from the comparison with the OELV. Before excluding a sample, appraiser notes, and/or contextual information shall be used to identify measurements for which accidents, malfunctions or deliberate misuse have occurred related to the activity or sampling. If no accidents, malfunctions or misuse can be identified, the sample shall not be excluded. In case outliers are excluded, it can be necessary to repeat exposure measurements to have sufficient representative measurements to test compliance.

Any removal of outliers and the reasons shall be explicitly described in the report.

5.4.3 Validity of SEGs

After evaluating the representativeness of each measurement, the validity of each SEG shall be confirmed a posteriori using valid results and information collected during the survey. The constitution of the SEG needs to be confirmed because:

- a) all individuals in the SEG should have the same general exposure profile for the chemical agent(s) being studied because of the similarity and frequency of the tasks performed, the materials and processes with which they work, and the similarity of the way they perform the tasks as defined in 3.2;
- b) the measurement results ought to follow the same distribution as assumed in the (statistical) compliance test (as indicated in 5.5). Exposure measurements are usually lognormally distributed, because exposure measurement results generally follow this distribution

To check whether all individuals belong to the same SEG, and whether the distribution of measurements is log-normal, the log probability plot of the data shall be analysed. Guidance is given in Annex E.

If a measurement value is found to not belong to the SEG, it shall be put in a separate SEG, and it can be necessary to repeat exposure measurements to have sufficient representative measurements for each SEG to test compliance by the method in 5.5.

An important complication is that two workers doing the same job need not to have the same exposure. This phenomenon, known as between-worker variability, means that measurements of one worker's exposure cannot simply be assumed to apply to others doing nominally the same job. Furthermore, exposure varies from shift to shift, giving rise to within-worker variability.

If the measurements show that one or more workers have exceptional exposure, which seems inconsistent with the distribution of results from the rest of the SEG, the reasons shall be investigated and these workers may be treated separately, for example forming a new SEG and taking more measurements as necessary. Guidance is given in Annex E.

Any changes to the SEG as a result of these tests shall be recorded in the report (see Clause 6).

5.5 Comparison of results with OELVs

5.5.1 General

5.5.2 and 5.5.3 describe the comparison for a single chemical agent with an OELV. If a mixture is present, the same procedure is applied, but the exposure index for the mixture is compared with 1 (see Annex C).

The workers chosen for exposure measurement, and the times of measurement, shall be selected so that the measured exposures are representative of the exposure of the workers in the SEG, and this means that it can be necessary to make the measurements at different times. If the number of measurements to be made is greater than the number of workers in the SEG, it will be necessary to measure some