SLOVENSKI STANDARD
SIST EN 689:2018+AC:2019

01-julij-2019

Izpostavljenost na delovnem mestu - Merjenje izpostavljenosti pri vdihavanju kemičnih agensov - Strategija preskušanja skladnosti z mejnimi vrednostmi za poklicno izpostavljenost (vključno s popravkom AC)

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

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation d'agents chimiques - Stratégie pour vérifier la conformité à des valeurs limites d'exposition professionnelle

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13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

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

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European foreword

This document (EN 689:2018+AC:2019) 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.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2018, and conflicting national standards shall be withdrawn at the latest by November 2018.

This document includes Corrigendum 1 issued by CEN on 10 April 2019.

This document includes the corrigendum 1 which modifies abbreviations, the content in several Annexes, and modifies the bibliography and references in the text.

This document supersedes ▌AC〉 EN 689:2018 〈AC▌.

The start and finish of text introduced or altered by corrigendum is indicated in the text by the tags ▌AC〉 〈AC▌.

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This document supersedes EN 689:1995.

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Introduction

This European Standard deals with the measurement of exposure to chemical agents in workplace atmospheres, and in particular with measurement 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.

Within this European Standard, compliance means that workers' time weighted average ▌AC⟩ occupational ⟨AC▐ exposure is below an OELV with a corresponding reference period. OELVs include legal values and other numerical criteria (see Annex B).

Representative measurement of ▌AC⟩ occupational ⟨AC▐ exposure to chemical agents is difficult, because of the variability of exposure. Processes and products affecting exposure are numerous. Different workplace conditions can correspond to different generation rates, can involve a variety of chemical agents and can therefore present specific exposure conditions. Exposure can be affected by the distance of the exposed workers 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 workers' practices and activities themselves.

The sampling equipment introduces its own limitations, and the analytical steps add further difficulties and uncertainties.

This European Standard is applicable for measuring procedures that fulfil the requirements of EN 482. If a measuring procedure does not fulfil these requirements some parts of the procedure described in this European Standard cannot be applied.

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 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 is not feasible or practical for many chemical agents due to limitations of the measurement techniques and costs.

The strategy described in this European Standard gives a procedure for the employer or other stakeholders 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 proposed 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, this European Standard does not take into account the use and effectiveness of RPE in testing compliance with the OELV.

Before any measurements are performed, it is essential for an appraiser to conduct a basic characterization in order to collect relevant information on workplace factors, 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.

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 (OELVs).

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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 and abbreviations

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
appraiser
person who is sufficiently trained and experienced in occupational hygiene principles, working and measurement techniques, to conduct the part of the assessment they are performing according to the state of the art

Note 1 to entry: The appraiser may be supported by a team of qualified persons.

3.1.2
exposure profile
description of the exposure variations to a chemical agent in relation to the definable series of activities from the periods under consideration

Note 1 to entry: See Annex D.

3.1.3
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

3.2 Abbreviations

AM	arithmetic mean
CAS	chemical abstracts service
DMEL	derived minimum effect level
DNEL	derived no-effect level
EC number	European community number
GSD	geometric standard deviation
GM	geometric mean
AC h AC	hour
LOQ	limit of quantification
OELV	occupational exposure limit value
RPE	respiratory protective equipment
RMM	risk management measures
SD	standard deviation
SEG	similar exposure group
WS	work shift

4 General

AC The assessment of occupational exposure to chemical agents based on air samples requires different procedures which shall be conducted by an appraiser. AC

AC It starts with an initial AC occupational AC exposure assessment (described in Clauses 5 and 6) followed by periodic reassessments (see Clause 7) AC. The initial AC occupational AC exposure assessment comprises different phases:

— basic characterization of the workplaces;

— constitution of similar exposure groups;

— selection of a suitable measuring procedure;

— performing exposure measurements;

— validation of exposure measurement results and SEGs;

— comparison of results with OELVs;

— reporting of results.

The sampling strategy comprises the constitution of SEGs and the definition of measuring procedures. If the initial AC occupational AC exposure assessment indicates non-compliance with OELVs for some SEGs, control measures shall be implemented and a new initial AC occupational AC exposure assessment shall be conducted. Following the initial AC occupational AC exposure assessment, periodic reassessments shall be conducted. When significant changes occur at the workplace that may affect

exposure conditions, the appraiser shall decide whether a new initial [AC] occupational [AC] exposure assessment shall be conducted.

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

[AC]

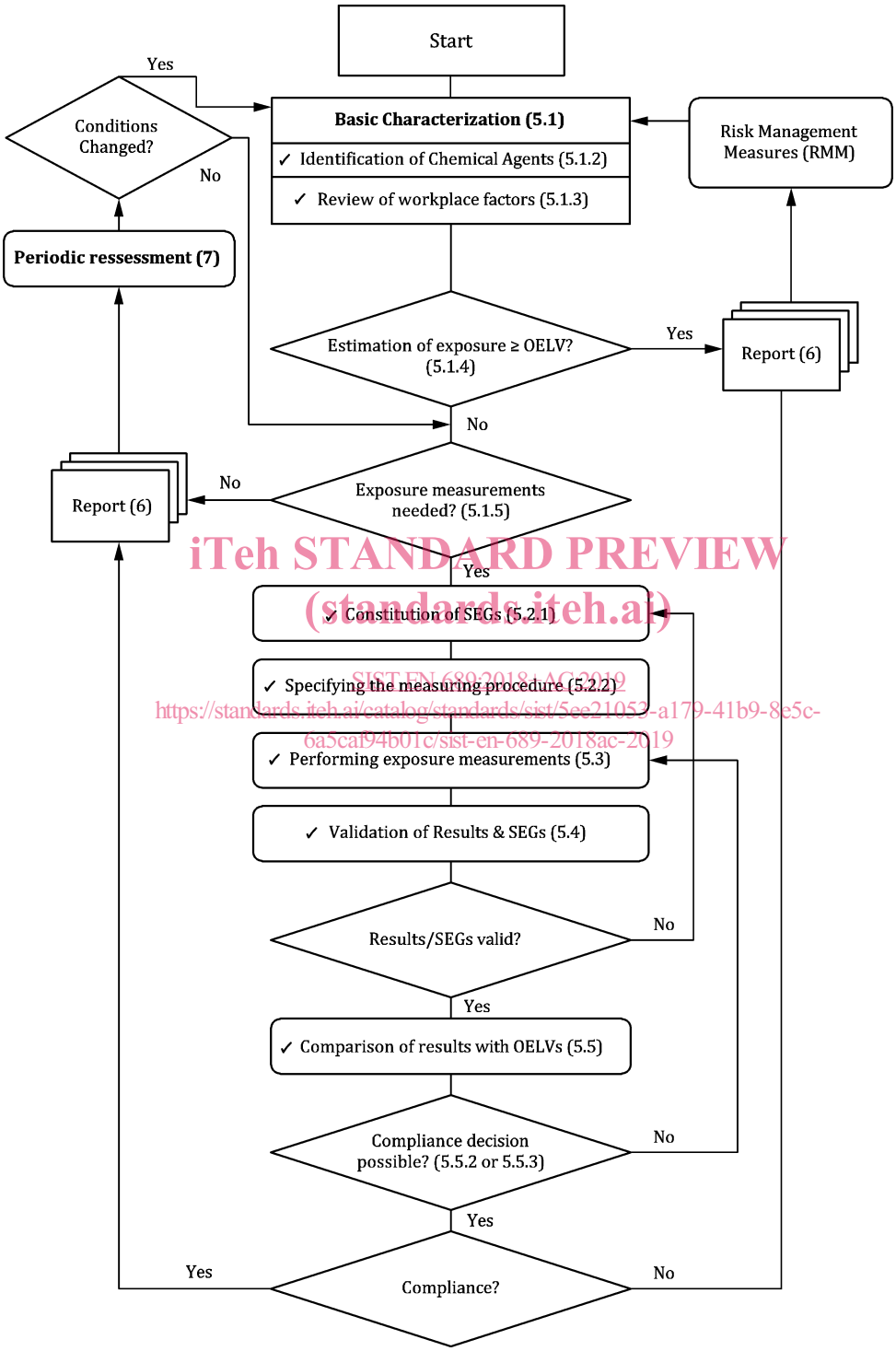

Figure 1 —Schematic overview of the occupational exposure assessment procedures [AC]

5 Occupational exposure assessment

5.1 Basic characterization

5.1.1 General

Prior to 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 and other information required;

— review of workplace factors;

— estimation of exposure.

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

— decide whether measurements are necessary or not (see 5.1.4);

— constitute 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.

5.1.2 Identification of chemical agents and other information required

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 any of the following:

— raw materials, primary products, impurities, intermediates, final products, reaction and process products and by-products, etc;

— the individual chemical agents, identified with chemical registration numbers (e.g. CAS#, EC#);

— hazardous properties, classification and labelling;

— 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 such as amount used, vapour pressure, temperature, saturation concentration, dustiness, etc.

5.1.3 Review of workplace factors

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

— work organization: activity, task, job title, work shift system, job functions, etc.;

— processes and techniques (type of processes, temperature, pressure, etc.);

— workplace layout and configuration, including confined spaces, open air, etc.;

— safety precautions and procedures (restricted area, etc.);

— cleanliness and tidiness of workplace;

— ventilation installations and other forms of engineering control and any information on their performance;

— emission sources and locations of high concentrations ;

— periods, frequencies and durations of exposure taking into account variation of exposure with time of day and season of the year;

— work load;

— worker behaviour, or

— activity or production rate indicators.

5.1.4 Estimation of exposure

The appraiser shall collect available information to allow reliable estimates of the exposure of the workers. Annex A gives guidance on this.

Possible sources of information include:

— earlier measurement results in this workplace, including from direct-reading instruments;

— measurement results from comparable installations or work processes (databases, literature, etc.);

— calculations based on relevant quantitative information;

— exposure modelling.

A decision that an exposure is much lower than the OELV should be made, for example in the following cases:

— the release capability is low because of the working conditions and the substance properties (e.g. low vapour pressure, high boiling point with low processing temperature, low dust-forming behaviour);

— the operational conditions cannot give rise to the formation of aerosols;

— only small quantities are used;

— only low emissions are possible, for example because of small source surfaces or short activity duration (<15 min).

The estimates shall be used to make a decision in 5.1.5.

The estimates shall also be used to verify whether the sampling and analysis techniques that are proposed for the measurements are adequate.

5.1.5 Decisions

The results of basic characterization lead to one of the following decisions:

— the exposure is higher than the OELV (non-compliance); then the appraiser shall report this (see Clause 6) and advise on a programme to reduce exposures, using RMM, before making measurements to test compliance;

— the exposure is well below the OELV (compliance); then the appraiser shall decide if measurements are necessary or not. If measurements are unnecessary, the appraiser shall report this (see Clause 6) and advise on a reassessment (see Clause 7);

— the available information on exposure is insufficient to decide on compliance with the OELV; then the appraiser shall continue to develop a sampling plan (see 5.2).

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 from exposure measurements that allows assessment of compliance with OELVs, an effective 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 using information on the profile of exposure and duration of the tasks performed in the working shifts throughout the year [20]. This requires occupational hygiene expertise, and the information most often includes:

— the job classification of the company;

— the inventory of tasks within a job;

— the task specific exposure profile;

— the operational conditions and risk management measures;

— the duration and location of the exposure within the shift and throughout time, determined by the frequency and period of the tasks;

— experience of the workforce;

— etc.

The SEG concept is developed to simplify the exposure assessment if several workers have the same exposure profile. If the exposure profile is specific to only one worker then the worker's exposure is assessed in the same manner as in the SEG.

If a SEG includes workers from different locations, care shall be taken that the SEG meets the definition 3.1.3 of this European Standard.

5.2.2 Specifying the measuring procedure

The aim of the measuring procedure and sampling strategy is to obtain valid and representative measurements of the exposure of the workers for comparison with the OELVs taking into account all possible conditions which can reasonably expected to be present throughout time.

Measuring procedures shall comply with the requirements of EN 482. If this is not technically feasible, the reasons shall be given in the report.

NOTE EN 482 refers to further requirements (e.g. on sensitivity, limit of quantification, specificity, capacity of samplers, transportation, stability) in other European Standards such as EN 481, EN 838, EN 1076, EN 13205-1, EN 13890 and EN 13936.

In order to measure the exposure of the worker at the workplace, personal sampling devices shall be used whenever possible, attached to workers' clothing within the breathing zone; workers should be informed about the purpose of the measurement and special recommendations about behaviour during the sampling time. Due to spatial variability of the concentration of chemical agents in workplace atmospheres, static sampling is 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 may exceed the OELV reference period if it is necessary to obtain valid and representative measurements in case of extended workshifts (>8 h).

The sampling duration should be chosen to represent the exposure for the task/activity and representatively describe the exposure for the reference period which is assessed (see Annex D). For this purpose the performance characteristics of the measuring procedure shall be taken into consideration.

The sampling duration should be as close to the OELV reference period as it is necessary to determine the average exposure for the reference period. If the total sampling duration is less than the OELV reference period, then the unsampled time should be assessed carefully and critically for exposure changes that have occurred in the unsampled period and that cannot be ignored. Examples of such situations are presented in Annex D.

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

— If exposures occur throughout the workshift and the appraiser considers that the workplace factors, including the tasks, are constant during the workshift, the total sampling duration may be shorter than the reference period with a minimum of 2 h;

— If the appraiser considers that the workplace factors, including the tasks, are not constant during the workshift, the total sampling duration shall be longer than 2 h and as close as possible to the shift duration;

— If the duration of exposure within the workshift is less than 2 h, the sampling duration should cover the whole period of exposure.

When testing compliance with short-term OELV, the sampling duration shall be 15 min.

Measurements shall 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 5.5.2 and 5.5.3. 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 locations.

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 workers more than once. As far as possible, this shall be done to make the measurements representative of the exposures in the SEG.

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 by remaining on site or arranging for it to be done by another person who is sufficiently trained and experienced to monitor the operation effectively. For each sample, the appraiser shall document the following relevant information for the future interpretation of the results of exposure measurements [15]:

— 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;

— RMM such as engineering control (including their operational status), PPE, work organization, etc.;

— relevant environmental conditions at the workplace (for example temperature, relative humidity, atmospheric pressure, air movement);

— interferences by nearby work activities or others (e.g. smoking);

— presence of other or unusual activities, incidents, etc.;

— sampling information, such as identification of samples and technical sampling equipment used, sampling flow rate, start and end of sampling, etc.

5.4 Validation of results and SEGs

5.4.1 General

Before testing compliance with the OELV it is necessary to consider the validity of each measurement and to use the measurements to evaluate the constitution of the SEG for testing compliance as explained in 5.5.

5.4.2 Validation of measurement results

When the measurement results are available, each measurement shall be evaluated using the information collected during measurement, and by comparison with the other measurements of the SEG.

If the result is unusually high or low, the possibility that this is because of errors of sampling or analysis shall be considered, and if this is the case then the result shall be excluded. However, before excluding a measurement, appraiser notes, and/or contextual information shall be used to identify measurements