Laboratory Fume Hoods European Standards and Regulations

by Roberto Zerbi

Executive Summary

This document highlights key European laws and regulations governing performance specifications, approval, commissioning, operation, and maintenance of fume hoods with direct air exhaust to the outside.

Index

Aim

This document is intended to help identify the European standards and laws that a Variable Air Volume (VAV) control system for laboratory fume hoods with exhaust of air and fumes to the outside of the facility, through ducted venting that extends above the height of the surrounding buildings must comply to.

Introduction

"Results from thousands of performance tests by my company, 3Flow, indicate that 15 percent to 30 percent of fume hoods do not meet performance criteria described in ANSI/AIHA/ASSP Z9.5-2012, Laboratory Ventilation" (cf. https://synergist.aiha.org/202008-fume-hood-performance-tests#id1584475250634-7).

"Engineering firm goes broke when multiple 5,000 CFM fume exhaust fans, 7 feet tall they designed blow toxic chemical vapors back into University Health and Safety Lab. Stack raised 40 feet above the roof". From the presentation: "VAV and Low Flow: Which Strategies save More?", by Victor Neuman, Precision Environments Group (cf. https://i2sl.org/elibrary/documents/neuman.pdf).

Laboratory fume hoods, with constant or variable air volume (CAV or VAV), must be specified in coordination with other vital elements of the laboratory such as the exhaust air system. The air inlet dampers, the air extraction fans, the sensors, any independent fan-coils, and the automatic Building Management System (BMS) that controls the environmental parameters, are all essential to keep the laboratory safe.

Laboratory fume hoods are collective protection devices. As such they are subject to stringent regulations that have civil and criminal relevance. This document represents a broad, though not exhaustive, summary of these regulations.

The Eurotherm Digital Fume Hoods VAV kit is intended to be an aid to simplify, through an Industry 4.0 approach, the fulfillment of specific requirements set out in the standards and laws referred to hereafter.

Key norm

EN 14175

EN 14175-1:2003

Fume cupboards - Part 1: Vocabulary

This part 1 of EN 14175 provides terms and definitions for fume cupboards (see 3.1). Corresponding terms in eight European languages are given in the normative annex A. For safety and performance requirements of fume cupboards EN 14175-2 applies. For type testing of fume cupboards EN 14175-3 applies. For microbiological safety cabinets EN 12469 applies. This part of EN 14175 does not address recirculatory filtration fume cupboards or devices used as animal accommodation.

EN 14175-2:2003

Fume cupboards - Part 2: Safety and performance requirements

This part 2 of EN 14175 specifies safety and performance requirements and objectives for general purpose fume cupboards. In addition, dimensions and marking of general purpose fume cupboards are specified as well as requirements on the product manual to be supplied with fume cupboards.

Recommendations on the evaluation of conformity of general purpose fume cupboards with the requirements of this part 2 of EN 14175 are given in the informative annex A.

EN 14175-3:2019

Fume cupboards - Part 3: Type test methods

This document specifies type test methods for the assessment of safety and performance of fume cupboards connected to an exhaust air system. For on-site test methods of fume cupboards, EN 14175-4 applies. For the type testing and on-site testing of variable air volume (VAV) fume cupboards, EN 14175-6 applies in addition to this standard.

EN 14175-4:2004

Fume cupboards - Part 4: On-site test methods

Part 4 of the European Standard specifies a selection of on-site test methods for the following fume cupboards:

- Fume cupboards designed in accordance with Part 2 of this European Standard and type tested in accordance with Part 3 of this European Standard.
- Fume cupboards designed in accordance with Part 2 of this European Standard and not type tested.

CEN/TS 14175-5:2006

Fume cupboards - Part 5: Recommendations for installation and maintenance

This Technical Specification specifies a selection of recommendations for the installation and maintenance of fume cupboards in accordance with EN 14175-2 and EN 14175-6.

EN 14175-6:2006

Fume cupboards - Part 6: Variable air volume fume cupboards

This document specifies requirements and type test methods for VAV systems. It also specifies additional requirements to those in EN 14175-2 and additional test methods to those in EN 14175-3 and EN 14175-4 for fume cupboards with VAV systems (VAV fume cupboards).

Other regulations

Additional standards referable to fume hoods are listed hereafter. For each standard we include title, abstract and where the norm is referred to in the main standards concerning fume hoods.

EN 689:2018 + AC:2019

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

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 standard comprises important innovations:

Before proceeding with the occupational exposure measurements it is necessary that an assessor, appointed by the company, performs a basic characterization including the evaluation of the working environment, the evaluation of the chemical agents used, the type of exposure, the characteristics of the work environment, the type of the expected exposure, etc.

The results of the characterization will lead the assessor to one of the following decisions:

1. Exposure is above the OELVs (non-compliance); the assessor must report this situation to the employer and recommend a program to reduce exposures, using RMM (Risk Management Measures), before carrying out monitoring to test compliance
2. Exposure is well below the OELVs (compliance); the assessor decides if the occupational exposure measurements are necessary or not and reports this situation to the employer by recommending a re-evaluation
3. The available information on exposure is insufficient to decide on compliance with the OELVs; the assessor continues to develop a sampling plan

If the assessor deems it necessary to carry out measurements, the EN 689:2018+AC:2019 standard prescribes to proceed as follows:

- A "Preliminary Test" must be performed. It requires three to five exposure measurements on workers belonging to a SEG *(Similar Exposure Group: groups of workers having the same general exposure profile for the agent(s) being studied because of the similarity and frequency of the tasks they perform, materials being used, process being run, and controls in place).*
- If the analytical results of the Preliminary Test are not satisfactory according to the OELVs, it is necessary to perform additional monitoring by carrying out the "Statistical Test" (requiring a minimum of 6 measurements for each chemical agent).

EN 842:1996 + A1:2008

Safety of machinery. Visual danger signals. General requirements, design and testing

This European Standard describes criteria for the perception of visual danger signals in the area that people are intended to perceive and to react to such a signal. It specifies the safety and ergonomic requirements and the corresponding physical measurements and subjective visual check.

Referenced by *EN 14175 – 6 / 4.3: "General requirements for visual danger signals are given in EN 842."*

EN ISO 3740:2019

Acoustics - Determination of sound power levels of noise sources - Guidelines for the use of basic standards

ISO 3740:2019 gives guidance for the use of a set of twelve basic International Standards (see Tables 1, 2 and 3) describing various methods for determining sound power levels from all types of machinery, equipment and products. It provides guidance on the selection of one or more of these standards, appropriate to any particular type of sound source, measurement environment and desired accuracy. The guidance given applies to airborne sound.

Referenced by *EN 14175 – 3 / Annex A: "If sound power levels are stated, they shall be measured in accordance with the guidelines for the use of basic standards given in EN ISO 3740."*

EN ISO 5167-1:2003

Measurement of fluid flow by means of pressure differential devices inserted in circular cross- section conduits running full - Part 1: General principles and requirements

ISO 5167-1:2003 defines terms and symbols and establishes the general principles for methods of measurement and computation of the flowrate of fluid flowing in a conduit by means of pressure differential devices (orifice plates, nozzles and Venturi tubes) when they are inserted into a circular cross-section conduit running full. ISO 5167-1:2003 also specifies the general requirements for methods of measurement, installation and determination of the uncertainty of the measurement of flowrate.

Referenced by *EN 14175 – 3 / 5.1: "For each extract volume flow rate setting, the volume flow rate shall be measured in the extract duct in accordance with EN ISO 5167-1."*

Referenced by *EN 14175 – 6 / 5.3.2.2: "Parallel flow former with openings of 5 mm to 10 mm diameter and conforming to EN ISO 5167-1."*

Referenced by *EN 14175 – 6 / 5.3.2.3: "Flow rate measuring device conforming to EN ISO 5167-1."*

EN ISO 11202:2010

Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections

ISO 11202:2010 specifies a method for determining the emission sound pressure levels of machinery or equipment, at a work station and at other specified positions nearby, in situ.

Emission sound pressure levels are determined as A-weighted levels. Additionally, levels in frequency bands and C-weighted peak emission sound pressure levels can be determined in accordance with ISO 11202:2010, if required.

Referenced by *EN 14175 – 4 / 5.11.2: "The sound level meter shall be calibrated in accordance with the manufacturer's instructions. The measurement method shall be in accordance with EN ISO 11202."*

EN ISO 11204:2010

Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections

ISO 11204:2010 specifies a method for determining the emission sound pressure levels of machinery or equipment, at a work station and at other specified positions nearby, in any environment which meets certain qualification requirements.

Emission sound pressure levels are determined as A-weighted levels. Additionally, levels in frequency bands and C-weighted peak emission sound pressure levels can be determined in accordance with ISO 11204:2010, if required.

Referenced by *EN 14175 – 3 / Annex A: "If emission sound pressure levels are stated, they shall be measured in accordance with EN ISO 11204"*

EN ISO 12100:2010 (Replaces EN 292-1:1992)

Safety of machinery - General principles for design - Risk assessment and risk reduction

ISO 12100:2010 basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective. These principles are based on knowledge and experience of the design, use, incidents, accidents and risks associated with machinery.

Referenced by *EN 14175 – 2 / 7.3.4: "Powered sash(es) shall comply with EN 292-1 and EN 292-2."*

EN ISO 12569:2017

Thermal performance of buildings and materials. Determination of specific airflow rate in buildings. Tracer gas dilution method

ISO 12569:2017 establishes methods to obtain the ventilation rate or specific airflow rate in a building space (which is considered to be a single zone) using a tracer gas.

ISO 12569:2017 provides three measurement methods using a tracer gas: concentration

Referenced by *EN 14175 – 3/ 5.5.4: "Calculate the air exchange rate per hour, n, according to EN ISO 12569 from the gradient of a log-linear fit using the measured values from 5.5.3.2 in the range of 80 % to 20 % of the initial tracer gas concentration."*

EN 12589:2001

Ventilation for buildings. Air terminal units. Aerodynamic testing and rating of constant and variable rate terminal units

This European Standard specifies methods for the aerodynamic testing and rating of constant and variable flow rate terminal units suitable for use with air distribution systems.

Referenced by *EN 14175 – 6 / 5.3.1: "Type testing of VAV systems not fitted to an individual fume cupboard shall be performed in association with the test box shown in Figure 1. NOTE Basis for this type test is EN 12589."*

Referenced by *EN 14175 – 6 / 5.3.2.2: "Test equipment shall be in accordance with EN 12589 / 4.1, 4.2, and 4.3, and the text box in accordance with Figure 1."*

Referenced by *EN 14175 – 6 / 5.3.2.3: "The static pressure measurement shall be performed according to EN 12589:2001, Annex A."*

Referenced by *EN 14175 – 6 / 5.3.2.5: "With the sash in the required position or fully open follow the test procedure given in EN 12589, 5.3.1.2.1 to 5.3.1.2.4. The manufacturer shall specify the maximum and minimum pressure difference to be used in the test."*

Referenced by *EN 14175 – 6 / 5.3.2.6: "Calculation of the test results shall be done in accordance with EN 12589, 5.5.1 and 5.5.2. The minimum length w shall be stated in the type test report (see 9.1)."*

Referenced by *EN 14175 – 6 / 5.3.2.7: "Presentation of the test results shall be done in accordance with EN 12589, 5.6."*

EN 13150:2020

Workbenches for laboratories in educational institutions. Dimensions, safety and durability requirements and test methods

This document applies to workbenches, movable science tables and workbench shelves designed for use in educational institutions and similar laboratories. This document specifies safety and durability requirements and test methods and gives dimensions.

Referenced by *EN 14175 – 2 / 7.1: "Fume cupboards shall comply with relevant safety requirements specified in EN 13150, clause 5."*

Referenced by *EN 14175 – 3 / 8: "Testing of the basic safety requirements specified in EN 14175-2:2003, 7.1 and 7.2 shall be performed by visual inspection, function testing and dimensional checking aided by simple measurement equipment such as a tape measure. If there is a need of measurement and evaluation of deformation (see EN 14175-2:2003, 7.2.2 and 7.2.6), this can be performed in accordance with EN 13150:2001, 6.2 and A.3.4."*

EN 16798-3:2017 (Replaces EN 13779:2004)

Ventilation for non-residential buildings. Performance requirements for ventilation and room- conditioning systems

EN 13779:2004 applied to the design of ventilation and room conditioning systems for non-residential buildings subject to human occupancy.

The European Standard **EN 16798-3** applies to the design and implementation of ventilation, air conditioning and room conditioning systems for non-residential buildings subject to human occupancy, excluding applications like industrial processes. It focuses on the definitions of the various parameters that are relevant for such systems.

The guidance for design given in this standard and accompanying FprCEN/TR 16798-4 are mainly applicable to mechanical supply and exhaust ventilation systems. Natural ventilation systems or natural parts of hybrid ventilation systems are not covered by this standard. Reference is made to the Technical Report for informative guidance on the design of such systems.

Applications for residential ventilation are not dealt with in this standard. Performance of ventilation systems in residential buildings are dealt with in EN 15665 and CEN/TR 14788.

Referenced by *EN 14175 – 5 / 4.4: "The air requirements of the fume cupboards within a laboratory should be given to the designers of the fume extract and air make-up system of the laboratory room or building to enable the optimal function of the fume cupboards. Requirements for room and building ventilation are given in EN 13779."*

EN 13792:2002

Color coding of taps and valves for use in laboratories

This European Standard specifies colour codes and nomenclature for liquids, gases and vacuum and the application of these codes and nomenclature on or in the vicinity of laboratory service controls.

This European Standard does not apply to medical or healthcare facilities using medical gases from a medical supply system conforming to EN 737.

Referenced by *EN 14175 – 2 / 11: "The operating devices of cocks and valves shall be color coded and marked corresponding to the material flowing through the device according to EN 13792."*

EN 14056: 2003

Laboratory furniture. Recommendations for design and installation

This European Standard gives guidance for the installation of laboratory benches, storage units and services and their connections and fittings.

Referenced by *EN 14175 – 2 / 9.1: "NOTE Fuel gases include natural gas, propane, butane or mixtures thereof. Other gases, such as acetylene or hydrogen, are not included (see EN 14056)."*

Referenced by *EN 14175 – 5 / 4.1: "Clauses 8, 9 and 11, particularly regarding services accessibility, services input and services outlets."*

Referenced by *EN 14175 – 2 / 9.1: "The outlets shall be located in the workspace of the fume cupboard and should be easily accessible. The operating devices for all the services shall be located on the outer surface of the fume cupboard. The operating device shall be unambiguously associated with its outlet and positioned in such a way as to minimise interference with airflow. Operating devices for fuel gases shall be protected against accidental opening."*

EN 60529:1991

Degrees of protection provided by enclosures (IP Code)

This European Standard applies to the classification of degrees of protection provided by enclosures for electrical equipment with a rated voltage not exceeding 72.5 kV. Has the status of a basic safety publication in accordance with IEC Guide 104.

The standard is classified in these International Classification for Standard (ICS) categories:

13.260 Protection against electric shock. Live working
29.020 Electrical engineering in general

Referenced by *EN 14175 – 2 / 9.3: "Whenever possible electrical sockets should be located on the outer surface of the fume cupboard and not within the workspace. If they are located outside on a low level fascia, below the work surface, they shall be protected against liquid spillage and shall have a minimum protection level of IP44 in accordance with EN 60529."*

EN 61672-1:2013

Electroacoustics. Sound level meter. Part1: Specifications

IEC 61672-1:2013 gives electroacoustical performance specifications for three kinds of sound measuring instruments: time-weighting sound level meters that measure exponential-time-weighted, frequency-weighted sound levels; integrating averaging sound level meters that measure time-averaged, frequency-weighted sound levels; and integrating sound level meters that measure frequency-weighted sound exposure levels.

Sound level meters specified in this standard are intended to measure sounds generally in the range of human hearing. Two performance categories, class 1 and class 2, are specified in this standard. Acceptance limits for class 2 are greater than, or equal to, those for class 1. This standard is applicable to a range of designs for sound level meters.

Referenced by *EN 14175 – 4 / 5.11.2: "The measurement of the sound pressure level should be performed as a weighted sound pressure level in dB(A) using a sound level meter conforming to EN 61672-1"*

ISO 5221:1984 (Status: Withdrawn)

Air distribution and air diffusion — Rules to methods of measuring air flow rate in an air handling duct

This International Standard gives different methods of measuring air flow rate in an air handling duct which, without the need of calibration, meet various specific requirements in the field of air distribution and air diffusion.

For the purpose of this standard, an "air handling duct" is defined as a tight section of straight ductwork such that the general conditions for device installation can be met. The cross-section of the duct may be circular or, excluding for device 14, rectangular.

Referenced by *EN 14175 – 4 / 5.5.1: "The extract volume flow discharged from a fume cupboard can generally be measured according to ISO 5221. When the requirements for the use of this method are not fulfilled, one of the following methods can be applied: Average face velocity method, or calibrated pressure difference method."*

Technical Specification UNI/TS 11710 (applicable in Italy)

Fume cupboards for chemical handling – Limit values for containment, face velocity and air exchange efficiency

Revision: May 2018

This technical specification contains the performance specifications required for fume cupboards to be used in the handling of chemicals in industrial, research and teaching activities, in particular the acceptability limit values for:

- containment and robustness of containment
- face velocity
- number of air exchanges

The Appendix contains the criteria for installation and usage of a new fume hood. The methodologies and procedures for conducting the verification tests of the above requirements are defined in the EN 14175 - 3 standard.

Note: *As stated, UNI TS 11710 is currently applicable only in Italy. It is included in this white paper since it represents a benchmark for other countries: it is the first specification in Europe connecting performance and intended use, defining the laboratory's dynamics during tests, and for a real protection assessment in the event of a potential hazard.*

Conclusions

The safety of laboratory operators is the first concern of any laboratory manager. The standards set out in this document support the definition of the most adequate, effective, and efficient operating practices.

Building a complete and comprehensive framework capable of establishing guidelines that are immediately understandable, easy to implement and ready to execute is a very complex task. The real operating conditions, the variety of experiments to be carried out under the fume hood, the heterogeneity and turnover of operators, put a strain on any safety manual.

Fortunately, digitalization comes to the rescue. One example is the Eurotherm Digital Fume Hood VAV kit. In addition to controlling hood performance of the hood operation to optimize energy consumption, an "Industry 4.0" module has been added that, through a personal mobile interface, allows the operator to access, with simplicity, consistency and continuity, the information needed to safely use the collective protection device called "Fume Hood".

About the author

Roberto Zerbi is the Global Business Development Manager of the Pharmaceutical segment for Eurotherm. Roberto has spent more than 25 years at Eurotherm, covering various roles: project management, sales, marketing, nurturing partnerships with OEM machine builders, strategy, and digital innovation. His experience ranges from continuous to batch processes, covering the life cycle from detailed design to predictive maintenance. In recent years Roberto has been involved in digital transformation, the impact of innovation on business processes, Quality by Design, and risk management. He is passionate about robotics, artificial intelligence, and cognitive processes. Roberto is a member of the Alumni of the Politecnico di Milano and of the International Society for Pharmaceutical Engineering (ISPE).

Eurotherm

Faraday Close, Worthing West
Sussex BN13 3PL United
Kingdom

Phone: +44 (0) 1903 268500

www.eurotherm.com

Published April 2023

Eurotherm document number HA033652 Issue 2