INDOOR AIR QUALITY IN BUILDINGS

STANDARDS, RISKS AND CHALLENGES FOR THE POLISH REAL ESTATE MARKET

REPORT 2025

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CONTENTS

01 From the Authors p.4

02 Current European and Polish requirements for construction and finishing materials p.6

02.1 Chemicals permitted on the European market p.6

02.2 Air quality in Polish interiors – legislative requirements p.8

02.3 Emissions from building materials in Poland p.9

03 Material emission tests and standards p.10

03.1 The process of laboratory testing of building material samples p.10

03.2 Emissions certificate standards and requirements p.11

04 The most harmful groups of building materials p.14

05 Indoor air quality in buildings – construction and operation of buildings p.16

05.1 Air quality during construction p.16

05.2 Air quality during building operation p.19

06 Strategies for ensuring high indoor air quality in selected multi-criteria certification systems p.20

07 Summary p.28

08 Bibliography p.30

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01

FROM THE AUTHORS

This report was developed in response to the need to organise knowledge on the impact of indoor air quality on the health and well-being of building occupants, and to summarise the current legal framework for the authorisation of building materials placed on the Polish market that shape the indoor environments of the spaces in which we live, work, and study.

Another important element of the report is raising market awareness of correlation between obtaining a sustainable building certificate and the actual scope of VOC verification of the materials introduced into the building, as well as the final air quality tests.

Several months of regular meetings and exchange of experiences and knowledge in a small but highly committed group allowed us to delve into the topic and present the results of our analyses. The critical importance of air quality in buildings for our health is evidenced by WHO data, which indicates that poor air quality in homes caused 3.2 million deaths worldwide in 2020[1].

Indoor air quality is crucial to our health and well-being, and the choices made during the construction process, including the selection of finishing materials, equipment and interior design are key to achieving optimal air parameters for years to come. It is also important to adopt a conscious and critical approach to the content of material certificates, especially those written in small print, which may contain significant limitations or exclusions.

There is no doubt that we spend most of our time in buildings. We might believe that in urban areas, due to vehicular traffic, pollution mainly affects streets, while inside buildings, it might seem that structured legal regulations and certificates developed by specialised entities ensure that we can trust construction industry professionals, administration and control bodies in selection of products and materials used in our indoor environment. After all, there are regulations, authorities regularly verify workplaces, building materials are subject to authorisation procedures, and buildings undergo mandatory inspections. Certification bodies grant their certificates to buildings.

However, behind the closed doors of our homes and offices we and our loved ones are exposed to a different profile of pollutants that can cause a variety of ailments, ranging in severity, often referred to as Sick Building Syndrome:

- **Respiratory pathologies**, e.g. asthma, cough, rhinitis, bronchitis, bronchiolitis in children, chest pain, lung cancer, lung infections
- **Cardiovascular system pathologies**, e.g. myocardial infarction, stroke, shortness of breath and chest pain
- **Reproductive system pathologies**, e.g. reduced fertility, increased intrauterine mortality, risk of miscarriages, low birth weight of newborns
- **Other ailments**: headaches, eye irritation, deterioration of the body's immunity, disturbance of the nervous system and/or kidney and liver function

We invite you to read the full report and encourage you to contact us with any questions, suggestions or to share your perspective on this topic.

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[1] https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

PLEASE REFER TO THE WEBSITES BELOW FOR MORE INFORMATION:

WHO AMBIENT (OUTDOOR) AIR POLLUTION

WHO HOUSEHOLD AIR POLLUTION

NIH THE HEALTH EFFECTS OF NON-INDUSTRIAL INDOOR AIR POLLUTION

02

CURRENT EUROPEAN AND POLISH REQUIREMENTS FOR CONSTRUCTION AND FINISHING MATERIALS

02.1

Chemicals permitted on the European market

The placement of chemicals on the European Union market is strictly regulated under the REACH Regulation. Many of these substances are components of popular construction products. Manufacturers and importers are required to register chemical substances, and in the case of new, previously unknown substances, they must conduct specific laboratory tests. The scope of these tests is determined by the European Chemicals Agency (ECHA).

As part of the safety assessment of chemicals, a variety of tests are performed, including:

- **Epidemiological studies** – long-term population observations aimed at analysing the impact of substances on human health. Due to the need to collect and analyse large data sets, these studies are demanding and time-consuming. The difficulty of data analysis and the complexity of the process were well shown in the film Dark Waters.
- **Studies on living organisms** – these include toxicological tests conducted on animals such as rats, guinea pigs, and fish. Animals with a short life cycle (e.g. mice with a lifespan of about two years) allow for the analysis of long-term effects of exposure, including the incidence of disease and the effect of the substance on lifespan. The conditions of exposure in such studies are strictly controlled, which allows for precise results.
- **Cellular studies** – experiments conducted on tissues, living cells or cell-free systems that play an important role in assessing the risk to human health and the environment. In vitro studies support the assessment of the toxicity of a substance, often as a preliminary step before conducting in vivo tests.

It often happens that the properties of substances and their potentially harmful effects are the subject of ongoing research. In such situations, Member States can introduce chemicals onto lists of substances requiring special authorisation and restrict their use in specific products. Substances that are carcinogenic (causing cancer), mutagenic (causing heritable genetic changes) and reprotoxic (affecting fertility and reproduction) of category 1, i.e. with well-documented effects, cannot be found in consumer products if their concentration exceeds a specific concentration limit – most often 0.1%.

Recently, new classes of threats to human health and life have emerged, including substances that act as endocrine disruptors, causing hormonal imbalances in the human body. These regulations aim to make it more difficult to introduce chemicals with untested health effects to the market and to limit the use of particularly harmful substances.

Endocrine disruptors are substances and their mixtures that disrupt the functioning of hormones in the body. Some mimic hormones, others block their functioning and affect their levels in the blood or change the body's sensitivity to hormones. As a result, their activity may cause reduced sperm quality, infertility, genital defects, endometriosis, premature puberty, nervous and immune system disorders, cancer, respiratory problems, metabolic problems (diabetes, obesity).

02.2

Air quality in Polish interiors – legislative requirements

In Poland, there are still no regulations specifying the permissible levels of harmful emissions from building materials and equipment in occupiable spaces. The Polish Commissioner for Human Rights has repeatedly drawn attention to this issue and undertaken various interventions, which, however, have not yet produced the expected results[2]. As a consequence, even if the State Sanitary Inspectorate detects the presence of concentrations of chemical substances hazardous to health, the lack of appropriate regulations makes it impossible to take administrative action.

A similar situation also occurs with the documentation concerning air quality required when notifying the district sanitary-epidemiological station about the completion of construction works. Our experience shows that there is no single, generally applicable procedure in this regard. Depending on the location and specific guidelines of a given station, the investor should prepare for one of three possible options:

- a statement by the construction manager regarding the use of construction products commonly used in construction sector that have the CE and B markings
- presentation of certificates for the building materials used
- presentation of research results, but only in the case of facilities such as pre-schools, nurseries, schools and hospitals

The sanitary inspection authority does not normally verify test results for all types of buildings, and furthermore, in the case of fit-out works which, according to applicable law, are not covered by a building permit, the acceptance procedure does not apply.

Is it therefore prudent to rely on the existing legislation on the testing of harmful factors in the workplace, in accordance with the provisions of the Regulation of the Minister of Health of 2 February 2011 on testing and measurements of factors harmful to health in the work environment (Journal of Laws 2023, item 419, as amended) and the values specified in the Regulation of the Minister of Family, Labor and Social Policy of 12 June 2018 on the maximum permissible concentrations and intensities of factors harmful to health in the work environment (Journal of Laws 2018, item 1286, as amended)?

As a standard practice, such tests are conducted before the commencement of operations at a given workplace and then repeated the following year. According to § 7 of this regulation, if the results of the last two tests show that the measurements of harmful chemical substances or dusts do not exceed 0.1 of the Maximum Allowable Concentration (MAC) value, the employer may discontinue testing.

Outdoor air also significantly impacts indoor air quality. The primary pollutants entering indoors from the outside are particulate matter, conventionally classified according to particle size – PM 2.5 and PM 10 (particle size in µm), ozone, sulfur dioxide, nitrogen dioxide and oxide, benzene and carbon monoxide and dioxide. In the European Union, Directive 2024/2881 of the European Parliament and of the Council of 23 October 2024 on ambient air quality and cleaner air for Europe (recast), committed Member States to continue to work towards eliminating outdoor air pollution.

The limit values for the protection of human health are defined as numerical values, and data on specific measurements are published on the website of the Chief Inspectorate for Environmental Protection. One of the steps taken by city authorities is the introduction of clean transport zones, where only cars with low exhaust emissions can drive. So far, in Poland, such a zone is only in force in Warsaw.

The **Maximum Allowable Concentration (MAC)** is the highest average concentration of a chemical substance or dust to which a worker can be safely exposed in the workplace for 8 hours a day over many years, without adverse effects on their health.

So is the air in Polish cities truly clean? On March 21, 2025, GIOŚ issued a statement on the current and forecasted air quality in Poland, warning about the risk of exceeding the alarm level for PM 10 suspended dust, meaning exceeding the average daily concentration above 150 µg/m3, including in Warsaw[3].

[2] https://bip.brpo.gov.pl/pl/content/rpo-stezenie-substancji-chemicznych-odpowiedz-mz
https://bip.brpo.gov.pl/pl/content/obywatele-czekaja-na-skuteczna-walke-ze-szkodliwymi-wyziewami-w-pomieszczeniach-wystapienie-rpo-do-MIiR

[3] The GIOŚ Outdoor Air Quality Portal is available at: https://powietrze.gios.gov.pl/pjp/home

02.3

Emissions from building materials in Poland

Unlike some European Union countries, such as Germany[4], France, Belgium or Italy, Poland does not have additional requirements regarding the emissions from building materials.

The Regulation of the Minister of Health and Social Security of 12 March 1996 on the permissible concentrations and intensities of factors harmful to health emitted by building materials, devices and equipment in rooms intended for human stay[5] is in force in Poland. This document specifies the permissible concentrations of chemical substances and indicates which substances are subject to restrictions in their use in building materials. Unfortunately, according to the applicable law, the Minister's regulation from 1996 cannot be the basis for issuing an administrative decision.

Materials used in our country do not have to be tested for emissions, unless this is required by regulations for a specific product group or the manufacturer intends to export them to other EU countries where emission limits apply. This means that many materials present on our market have not been tested, because such tests, according to the manufacturers' declarations, are time-consuming and expensive.

However, due to the popularity of multi-criteria certification systems and the willingness of investors to meet the technical criteria of the EU Taxonomy, this picture is slowly changing.

Our experience shows that manufacturers, when repeatedly asked for the results of their products' emission tests, finally decide to test their products. We will describe the test procedure in the next chapter.

[4] https://www.eurofins.com/media/1560/agbb-dibt_-_pl.pdf

[5] https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WMP19960190231

03

MATERIAL EMISSION TESTS AND STANDARDS

When we think about construction products introduced to the European market, we automatically have a certain amount of confidence that the product meets the standards and is therefore of good quality and safe. In this respect, EU countries are protected by the Regulation of the European Parliament Construction Product Regulation (EU) No 305/2011, indicating, among other things, general requirements for materials introduced to the European market. The annex to this act specifies guidelines for the design and construction of buildings, including those concerning the health of their occupier. We can read here that buildings must not pose a threat to human health throughout their life cycle, in particular resulting from, among other things, the release of toxic gases, emissions of hazardous substances, volatile organic compounds (VOCs) or other hazardous particles into indoor air as well as ambient air. Given that such regulations exist, the question arises: how are construction materials tested?

03.1 The process of laboratory testing of building material samples

Samples of building materials in Europe are tested according to selected standards depending on the type of substance. Total volatile organic compounds (TVOC) – gases emitted by chemicals in liquids or solids (such as tile adhesive, carpet or cleaning agent), are most often tested using the methodology of the EN 16516+A1 or ISO 16000-9 standard. The EN 717-1 standard is used to test formaldehyde emissions in wood-based panels. The test conditions described in the above-mentioned standards differ slightly[6].

The testing laboratory must be accredited to ISO 17025, which confirms its preparedness to perform tests in accordance with the requirements.

COMPARISON OF TEST CONDITIONS IN THE REFERENCE ROOM ACCORDING TO THE INDICATED STANDARDS

	EN 16516+A1	ISO 16000-9	EN 717-1
TEMPERATURE	23°C	23°C	23°C
RELATIVE AIR HUMIDITY	50%	50%	45%
NUMBER OF AIR CHANGES PER HOUR	0.5	0.5	0.5
VOLUME	30 m^3	17.4 m^3	lack specifications

The table is based on publicly available studies, therefore it may contain data from previous versions of the cited standards, according to the source documents.

[6] https://www.eurofins.com/media/1721/gst-2014-x738-oppl-cen-ts-16516.pdf, data dostępu 23/03/2025

03.2 Emissions certificate standards and requirements

The methodology for testing VOCs in construction products is regulated by the EN 16516+A1 standard. Thanks to such tests, we can control and reduce the impact of these substances on the health of building users, including by controlling emissions from construction products such as paints, adhesives, wallpapers, insulation and other materials used in construction.

EMISSION LIMITS OF SELECTED HAZARDOUS SUBSTANCES ACCORDING TO SELECTED SYSTEMS AND NATIONAL REQUIREMENTS

	Identification of substances	EU Taxonomy	Belgian VOC Regulation – Royal Decree C – 2014/24239	French VOC Label (Decret n° 2011-321) Class A+	German ABG Regulation (MVV TB Annex 8) after 28 days	Italian CAM Regulation after 28 days	LEED NC v5 / WELL	BREEAM v7
TVOC	EN 16516+A1		≤ 1000 µg/m^3	< 1000 µg/m^3	≤ 1000 µg/m^3	< 1500 µg/m^3		≤ 1000 µg/m^3
CARCINOGENS	1A i 1B	< 1 µg/m^3	≤ 1 µg/m^3		≤ 1 µg/m^3	< 1 µg/ m^3		≤ 1 µg/m^3
TOLUENE	CAS 108-88-3		≤ 300 µg/m^3	< 300 µg/m^3		< 450 µg/m^3	< 300 µg/m^3	
FORMALDEHYDE	CAS 50-00-0	< 60 µg/m^3	≤ 100 µg/m^3	< 10 µg/m^3		< 60 µg/m^3	< 20 µg/m^3	< 60 µg/m^3
ACETALDEHYDE	CAS 75-07-0		≤ 200 µg/m^3	< 200 µg/m^3		< 300 µg/m^3	< 140 µg/m^3	
ADDITIONALLY TESTED AS PART OF THE STANDARD/ CERTIFICATE				Chloroethylenes Benzenes Xylene Styrene	Ammonia Nitrosamines	Chloroethylenes Benzenes Xylene Styrene	Chloroethylenes Benzenes Xylene Naphthalene Phenol Ammonia	

Note: The indicated values refer to the emission of the incorporated materials tested in the laboratory.

03.2

Emissions certificate standards and requirements

The EU Taxonomy indicates emission limits for carcinogenic VOCs cat. 1A and 1B, including formaldehyde. Some EU countries have introduced their own standards for several substances, such as total volatile organic compounds (TVOC), but also specific ones for formaldehyde, toluene, acetaldehyde, ammonia or benzene. These limits may vary depending on the standard.

Sustainable building certifications such as LEED, WELL or BREEAM award points for the use of low-emission materials, specifying limit values for several substances in the certification guidelines.

A good practice that we can apply both in fit-out projects and in our homes is to use wet-applied materials, such as paints, varnishes, adhesives and sealants, which have test results confirming a reduced content of volatile organic compounds.

FOR EXAMPLE, WE CAN USE PRODUCTS WITH THE FOLLOWING CERTIFICATES

Although the limit values indicated in the certification standards and guidelines differ slightly, it is worth noting that no standard imposes emission limits for all harmful substances present in building materials. They also do not impose the necessity of meeting these guidelines to obtain a certificate, classifying these guidelines as optimisations.

SO, WHICH SUBSTANCES SHOULD BE PARTICULARLY AVOIDED

04

THE MOST HARMFUL GROUPS OF BUILDING MATERIALS

There are many groups of harmful chemicals, and their names are often so complicated that it would be difficult to recommend in any practical way which products should not be used, or which should be used with great caution. For example, we can mention chloroalkanes present in assembly foams, bisphenol in epoxy floors or formaldehyde in furniture boards.

The matter is relatively simple in the case of mixtures. These are products consisting of two or more substances. And the procedures for introducing substances require the need to classify them in terms of harmful effects. The manufacturer of the mixture checks the number of specific substances in his product and then, depending on their concentration, classifies the mixture. The most harmful products receive pictograms[7].

AS CONSUMERS, WE SHOULD PAY SPECIAL ATTENTION TO THE FOLLOWING SYMBOLS

WHAT DOES IT MEAN?
ONE OR MORE
OF THE FOLLOWING:

- May be fatal if swallowed and enters airway.
- Causes organ damage
- May cause organ damage
- May damage fertility or the unborn child.
- Suspected of damaging fertility or the unborn child
- May cause cancer
- Suspected of causing cancer
- May cause genetic defects
- It is suspected of causing genetic defects.
- May cause allergy or asthma symptoms or breathing difficulties if inhaled

WHAT DOES IT MEAN?
ONE OR MORE
OF THE FOLLOWING:

- Very toxic to aquatic life with long lasting effects
- Toxic to aquatic life with long lasting effects

[7] https://echa.europa.eu/pl/regulations/clp/clp-pictograms

It is more difficult to verify harmful substances used in the manufacture of articles. In theory, manufacturers are obliged to notify all products placed on the EU market containing a substance of very high concern (SVHC) on the candidate list at a concentration exceeding 0.1% w/w.

As consumers, we should therefore be able to easily check whether a specific product contains harmful substances. Unfortunately, in practice, manufacturers enter products into the database using names that are inaccessible to consumers. In this case, if we want to find out whether a product contains substances from the SVHC list, we should contact the manufacturer directly[8].

Typically, emissions of harmful substances from construction products and finishing materials are highest immediately after their installation in the building. Over time, after many air exchanges, their emission decreases, which is reflected in the parameters of the test methods adopted after 3 and after 28 days with a standard number of air exchanges and standards regarding permissible emission after these periods. The concentration of hazardous substances in each room depends, in addition to the age of the material and the efficiency of ventilation, on factors such as the size of the room, temperature and humidity, so it is not a clear-cut matter.

SO, CAN WE INFLUENCE THE QUALITY OF INDOOR AIR? AND IF SO, HOW?

SVHC substances are a list of special substances that have been classified as particularly dangerous and ultimately, we should strive to limit their use. This list is regularly updated and available on the ECHA website[9].

The SCIP database containing information on substances of concern in articles, established under the Waste Framework Directive (2008/98/EC), is available at the following link: **https://echa.europa.eu/pl/scip-database**

[8] https://echa.europa.eu/pl/substances-of-very-high-concern-identification-explained

[9] https://echa.europa.eu/pl/candidate-list-table

05

INDOOR AIR QUALITY IN BUILDINGS – construction and operation of buildings

Modern building standards and sustainable development principles increasingly include Indoor Air Quality (IAQ) management as one of the priorities in the design and operation of buildings. Two key stages in which air quality can be compromised are during construction and during the operation of the building, both requiring appropriate remedial measures.

Air pollution occurring during construction, including construction dust, is not only a nuisance factor, but above all a serious threat to the health of the human respiratory system. Their long-term exposure can lead to permanent lung damage, significantly reducing the quality of life, and in extreme cases – contributing to death[10].

05.1

Air quality during construction

In Poland, the construction sector plays a significant role in the economy, employing almost half a million people (according to data from the Central Statistical Office of the Central Statistical Office, GUS), in 2023, approximately 422.4 thousand people worked in the construction industry. However, broader analyses, also considering smaller entities, indicate higher values: 700-800 thousand people). At the construction stage, there are many factors that can affect the later indoor air quality in the building.

The choice of building materials, the way they are stored, as well as the techniques used during construction and finishing works can determine the level of pollutants, such as volatile organic compounds or dust. In addition, improper moisture management during construction can lead to the development of mold and fungi. Therefore, it is so important to pay special attention to the practices and materials that will have a direct impact on the health of the future occupants of the building, already at the construction stage.

[10] cdp-hae-dangers-of-dust.pdf

05.1

Air quality during construction

Addressing these aspects during the construction stage is **crucial for ensuring high indoor air quality**. Optimal selection of materials, proper execution of ventilation systems, and minimisation of pollution contribute to creating a healthy and comfortable environment for building occupants.

WHAT FACTORS DURING THE CONSTRUCTION PHASE CAN INFLUENCE THE SUBSEQUENT AIR QUALITY IN THE BUILDING?

The quality of indoor air in a building during its use is influenced by many factors related to the construction stage. The key ones are:

A. SELECTION AND QUALITY OF BUILDING MATERIALS

Materials used during construction can emit harmful substances such as volatile organic compounds (VOCs), including formaldehyde and benzene. The most common sources of emissions are paints, adhesives, varnishes, chipboard and finishing materials. High concentrations of these substances in indoor air can cause health problems such as respiratory irritation, headaches or allergic reactions.

B. AIRTIGHTNESS OF THE BUILDING

Niewłaściwe wykonanie izolacji i brak kontroli nad szczelnością może prowadzić do niekontrolowanej infiltracji powietrza zewnętrznego, co wpływa na efektywność systemów wentylacyjnych. Dobrze wykonane uszczelnienia pomagają w ograniczeniu przedostawania się zanieczyszczeń z zewnątrz oraz poprawiają komfort użytkowania budynku.

C. DESIGN AND IMPLEMENTATION OF VENTILATION SYSTEMS

Proper ventilation is essential for indoor air quality. Poorly designed or improperly implemented systems can lead to moisture accumulation, mold growth, and excessive carbon dioxide levels. It is important to avoid mistakes such as insufficient air exchange or recirculation of contaminated air due to poor placement of intake and exhaust vents.

D. AIR INTAKE LOCATION

Air intakes should be located away from sources of pollution, such as busy streets, parking lots or industrial chimneys. Inappropriate location may lead to the intake of air contaminated with dust, exhaust fumes or other harmful substances.

E. WEATHER AND ENVIRONMENTAL CONDITIONS DURING CONSTRUCTION WORKS

Humidity, temperature and the presence of pollutants at the construction site can affect the quality of building materials and their subsequent impact on indoor air. For example, too high humidity during construction can promote the growth of mold in the building, which poses a health risk to its occupiers.

F. DUST AND CHEMICAL POLLUTION GENERATED ON THE CONSTRUCTION SITE

During construction works, such as cutting, grinding or transporting materials, significant amounts of dust are released into the air, which can settle in the building structure. Inadequate removal can lead to the gradual release of pollutants during building occupancy.

05.1

Air quality during construction

The construction process is a critical moment for implementing measures to reduce air pollution and protect the health of future occupants.

Source of pollution	Description
Construction dust	Created during cutting, grinding and mixing of materials: PM10, PM2.5, asbestos, quartz dust
Chemical pollution	Emission of volatile organic compounds (VOC) from paints, adhesives and varnishes: formaldehyde, volatile organic compounds – VOC, phthalates, isocyanates, PCBs
Technological moisture	It comes from concrete, plasters and paint coatings, construction processes using water, atmospheric moisture. It promotes the growth of mold and fungi.
Emissions from construction machinery	Gaseous emissions: nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), VOCs, sulfur and its oxides (SO_2, SO_3) Particulate matter emissions: PM10 and PM2.5 particulate matter, black carbon, heavy metals (cadmium, lead, arsenic) Mechanical emissions (secondary air pollution): dust and particulate matter from mechanical processes, dispersion of existing pollutants Liquid and chemical emissions: fuel and lubricant leaks

05.1

Air quality during construction

THE MAIN METHODS OF REDUCING POLLUTION ON CONSTRUCTION SITE INCLUDE:

- **Selection of low-emitting materials** – limiting the use of materials containing formaldehyde, benzene and other harmful compounds.
- **Storing materials in appropriate conditions** – avoiding moisture and chemical contamination.
- **Dust and ventilation management** – use of dust filters, ventilation systems and airing of spaces during construction works
- **HVAC system cleaning** – ensuring that ventilation ducts are free from contamination before the building is occupied.
- **Air flushing** – intensive ventilation of a building before its occupancy.

05.2

Air quality during building operation

After construction is completed, air quality is still threatened by finishing materials, operation of HVAC systems, external factors and occupant behavior.

Employing high air quality standards that promote the appropriate selection of finishing materials, as well as effective ventilation and filtration systems, contributes to minimizing the emission levels of harmful substances and improving the overall quality of the building environment. However, to ensure the continuity of high indoor environment quality, it is important to implement appropriate air quality management methods, especially in the first years of the building's operation when the emission of volatile organic compounds and other substances may be at its highest.

Regular maintenance and modernisation of HVAC systems, as well as the use of high-efficiency filters, are key to maintaining optimal air quality parameters in the long term. At the same time, the implementation of indoor air quality monitoring systems allows for early detection of problems and allows for their immediate correction, which directly translates into the comfort and health of the building's occupants. Indoor air quality is therefore an important element of sustainable construction, affecting not only the well-being of residents, but also the energy efficiency of buildings, their durability and their ability to meet rigorous environmental standards.

Main sources of pollution during occupancy:

- Emissions of volatile organic compounds (VOCs) from furniture, paints and carpets
- Biological contaminants – molds, bacteria, allergens
- External pollution – smog, radon, exhaust fumes penetrating the building

06

STRATEGIES FOR ENSURING HIGH INDOOR AIR QUALITY in selected multi-criteria certification systems

HOW CAN WE ENHANCE THE IMPLEMENTATION OF BUILDINGS THAT ENSURE HIGH INDOOR AIR QUALITY? IS THERE A CHECKLIST AVAILABLE FOR THIS PURPOSE?

Support in this regard can be provided by multi-criteria environmental certificates, often referred to as green certificates. These are independent, voluntary assessment systems that define – depending on the system – a set of preconditions (obligatory requirements) and optimisation requirements, which affect the final level of the granted certification. The most popular certificates on the Polish market include foreign certifications such as British BREEAM, American LEED and WELL, and German DGNB. The Polish Green Building Council PLGBC has also developed its Zielony Dom (Green House) certification system, dedicated to the residential sector.

The first green certifications were created several decades before the publication of the EU Taxonomy requirements – BREEAM in 1990, and LEED in 1998, and for decades they set the standards for sustainable construction. To a varying extent, they address the issue of indoor air quality in buildings. Here, both the implementation of individual requirements, which may be optional and scored towards the final certification level, and the scope of certification defining which parts of the building are certified influence whether obtaining a given certificate translates into a real and significant improvement of the internal environment.

Asbestos

In Poland, the ban on the use of asbestos was introduced by the Act of 19 June 1997 on the prohibition of the use of products containing asbestos. However, for decades, asbestos was used both inside buildings and externally, for example in roof coverings.

We can identify several key strategies for ensuring indoor air quality that are promoted by individual certification systems:

- **Strategies for controlling and monitoring the concentration of pollutants and diluting pollutants in indoor air.** Certification guidelines may prohibit the installation of materials that contain known substances affecting air quality, such as volatile organic compounds (VOCs), asbestos, or lead in paints. This is crucial not only in the construction of new buildings but also in renovations, where we may encounter substances that have been legally withdrawn from circulation but are still present in existing structures.
- **Strategies for controlling and monitoring the concentration of pollutants and diluting pollutants in indoor air.** Certification systems promote solutions such as increasing the supply of outdoor air beyond applicable standards or monitoring the concentration of carbon monoxide or dioxide. Elevated concentrations of these substances may trigger the alarm system or activate a more efficient ventilation mode, thereby improving air quality. Following the Covid 19 pandemic, some certification systems have implemented guidelines for ventilation to prevent infectious diseases, based on the American standard ASHRAE Standard 241, Control of Infectious Aerosols. In addition to continuous monitoring of pollutants, certifications may require a one-time comprehensive check of the content of organic and inorganic pollutants, including radon, benzene, formaldehyde and toluene, in the building after construction is completed or a 'flush-out,' which is an intensive ventilation process to remove volatile pollutants after construction work.
- **Strategies to limit the introduction of pollutants from the external environment, including those brought by users.** These include the filtration of air supplied from outside or recirculated air using particle filters or, in the case of recirculation, carbon filters, and purification using UVGI (Ultraviolet Germicidal Irradiation) technology, which is a disinfection technique utilising ultraviolet radiation. Another method is to design systems that slow down the airflow at building entrances or limit the introduction of pollutants by users, such as air curtains, revolving door systems, or vestibules with double doors and regularly cleaned mats. Some certifications also emphasize the importance of building tightness and reward the performance of building tightness tests, which is also included in the EU Taxonomy guidelines for buildings with an area of over 5,000 sqm.
- **In addition to these main strategies, some certificates also reward the implementation of air quality control procedures during construction works. These procedures include securing HVAC system elements, protecting materials against moisture, and replacing filters after the completion of work. Furthermore, certifications may include procedures related to building maintenance, such as regular inspections of HVAC systems for moisture and mould, and the replacement of filters.**

WELL certification has extensive guidelines for indoor air quality. One of the optimisations is the continuous monitoring of indoor air quality during the building's operational phase, specifically tracking three of the following parameters: PM 2.5 or PM 10 dust, carbon dioxide, carbon monoxide, ozone, nitrogen dioxide, VOCs, and formaldehyde.

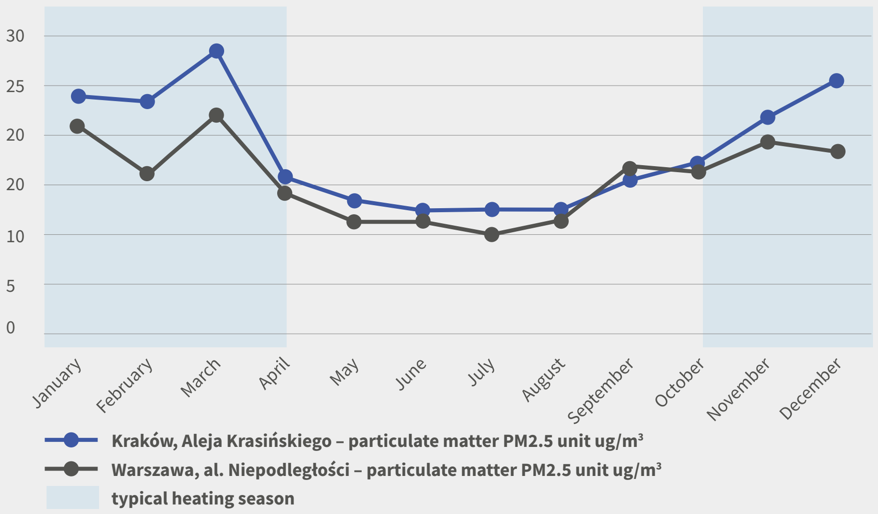
Strategies for ensuring high indoor air quality in selected multi-criteria certification systems

PARTICLE FILTER SELECTION PARAMETERS IN CERTIFICATIONS

CERTIFICATION	WELL	LEED	BREEAM NC
REQUIREMENT	**The selection of filters depends on the average annual concentration of PM2.5 dust in the outdoor air:** the concentration of • **23 µg/m³ or less** requires filtration of particles of size 0.3-1 µm with an efficiency of at least 35% (M6 filters) • **24–39 µg/m³** –filtration efficiency 75% (F8 or ePM1 75%) • **40 µg/m³ or more** – 95% (E10 or ePM1 95%)	**Use of filters class min. MERV 13 (F7) or ePM1 50%**	**The selection of filters depends on the quality of outdoor air, determined according to the criteria of the EN16798-3:2017 standard and the required class of supply air SUP 2:** • **ODA (P) 1** – average filtration efficiency for a 0.4 µm particle 80% (F7 equivalent) • **ODA (P) 2** – average filtration efficiency for a 0.4 µm particle 88% (F7 equivalent) • **ODA (P) 3** – average filtration efficiency for a 0.4 µm particle 96% (F9 equivalent)

The concentration of individual pollutants in outdoor air may vary seasonally. For example, the concentration of PM2.5 is usually the highest during the heating season. According to data collected by **powietrze.gios.gov.pl**, the level of PM2.5 in Krakow in 2024 averaged about 18.5 µg/m³, while the maximum concentration level reached up to 180 µg/m³. Other pollutants may also exhibit seasonal fluctuations, such as ozone, which is characterised by a higher concentration in the summer.

AVERAGE CONCENTRATION OF PM2.5 DUST FOR THE CITY OF KRAKOW AND WARSAW IN 2024 ACCORDING TO DATA FROM POWIETRZE.GIOS.GOV.PL



UNDERSTANDING AIR FILTERS: HOW TO IDENTIFY THEM AND DECODE THEIR NAMES

The three main standards defining filter efficiency are: EN779:2012, ASHRAE 52.2-2017 and ISO 16890:2016, each of which categorises particle filters based on slightly different parameters. The EN 779 standard refers to the efficiency of filtering synthetic dust particles and dust of 0.4 µm, while the ISO and ASHRAE standards differentiate the efficiency of filtering particles of 0.3-1 µm, and additionally ASHREA 1-3 µm and 3-10 µm, and ISO 0.3-2.5 µm, 0.3-10 µm and larger particles (ISO coarse). Despite these differences, we can compare them using the simplified table:

CLASSIFICATION OF PARTICLE FILTERS

Filtration level	Classification according to EN 779:2012 (withdrawn)	Average efficiency (Em) for 0.4 µm particle [%] or average synthetic dust retention (Am)	Corresponding classification according to ISO 16890:2016 (for ISO ePM1 filter group – 0.3-1 µm)	Corresponding classification according to ASHRAE 52.2-2017
COARSE	G1	50≤Am<65	-	MERV 1
	G2	65≤Am<80	-	MERV 2 MERV 3 MERV 4
	G3	80≤Am<90	-	MERV 5 MERV 6
	G4	90≤Am	-	MERV 7 MERV 8
MEDIUM	M5	40≤Em<60	5%-35%	MERV 9 MERV 10
	M6	60≤Em<80	10%-40%	MERV 11 MERV 12
FINE	F7	80≤Em<90	40%-65%	MERV 13
	F8	90≤Em<95	65%-90%	MERV 14
	F9	95≤Em	80%-90%	MERV 15 MERV 16

* A direct comparison of filter classes according to EN 779 and ISO 16890 is not possible.
Simplified comparison based on the Eurovent European Industry Association study Selection of EN ISO 16890 rated air filter classes for general ventilation applications

06

Strategies for ensuring high indoor air quality in selected multi-criteria certification systems

Some green certification systems are intended for buildings in the design phase, while others are for existing structures. Without a detailed examination of their requirements, it can be challenging to evaluate their actual impact on indoor air quality. The table below illustrates the main design and management strategies rewarded by certification systems that aim to ensure high air quality. The list includes the latest requirements at the time of this publication. Mandatory and optimisation requirements are marked in color:

KEY STRATEGIES FOR ENSURING HIGH AIR QUALITY IN BUILDINGS IN POPULAR CERTIFICATION SYSTEMS

○ necessary requirement
● voluntary optimisation

Certification	BREEAM NC v7 PRE-RELEASE FOR FEEDBACK	BREEAM in USE v6	LEED BD+C: New Construction v5	WELL Q2 2025
THE DESIGN AND CONSTRUCTION PHASE OF FACILITIES, INCLUDING RENOVATIONS				
Preparation of an indoor air quality plan at the design stage	●			
Above-standard requirements for ventilation design	●		●	●
Design of building entrances to limit the ingress of pollutants			○	●
Air Quality Management Plan for construction works			○	○
Openable windows				●
Envelope commissioning, including tightness tests	●		●	●
Increased requirements for supply air filtration	●		○	●
Post-construction tests of selected indoor air pollutant levels	●		●	●
Air intakes located away from sources of pollution	●	●		
Flush-out after completion of construction works	●			

REPORT 2025

Certification	BREEAM NC v7 PRE-RELEASE FOR FEEDBACK	BREEAM in USE v6	LEED BD+C: New Construction v5	WELL Q2 2025
BUILT-IN BUILDING AND FINISHING MATERIALS				
Low-emitting building materials, including:	●	●*	● at least 90% in 3 categories	● at least one category, 75% – 100% of products depending on the category
Paint coatings, paints and varnishes	●	●*	●	●
Adhesives and sealants used indoors	●	●*	●	●
Floor finishing materials	●	●*	●	●
Furniture		●*	●	●
Internal insulation materials	●		●	●
Wall coverings	●		●	●
Ceiling coverings	●		●	●
Composite wood	●		●	
Cleaning agents		●*		
Ingredients of built-in materials, including:			●	●
Transparency of product's ingredients confirmed by external certifications**			●	●
Ingredients restrictions			●	●
OPERATIONAL STAGE				
Constant monitoring of indoor air quality (sensors or regular tests)	● CO_2	● CO, CO_2	● CO_2, PM2,5, TVOC	● three of: PM2.5/PM10, CO, CO_2, O_3, NO_2, TVOC, Formaldehyde
Smoking is prohibited inside and around the building	●	●	○	○
No idling			○	●
UV lamps cleaning HVAC devices				●
Ventilation modes – protection against infectious diseases mode			●	●
Ban on using open combustion and use of low emission devices and energy sources	●			●
Cleaning procedures, including cleaning agents' ingredients		●		●
HVAC systems cleanliness inspection procedures		●		●

* applies to new products, not built-in

** EPD declarations not included

Strategies for ensuring high indoor air quality in selected multi-criteria certification systems

As we can see, respective certification systems provide varying degrees of guidelines for air quality management. Some, such as BREEAM NC or LEED BD+C, primarily focus on design strategies implemented during the construction stage. Others, like BREEAM In-Use, emphasize facility management procedures, while WELL applies to all stages of a facility's life. However, most of these strategies are not mandatory for obtaining a certificate (marked in red in the table above). Therefore, it is important to note that neither obtaining a certificate nor its level automatically translates into the quantity or effectiveness of the implemented solutions. It is crucial to delve into the scope of certification in detail.

Regarding indoor air quality, for example, of the approximately 2,100 LEED-certified facilities in Europe, 44% of projects earned points for implementing the low-emitting finishing materials credit, which is a similar percentage to that of projects in Poland.

Detailed statistics are collected in the tables below:

Environmental Product Declaration (EPD) is a document that discloses the environmental impact of a product in accordance with the ISO 14025 standard, considering the entire life cycle assessment (LCA). While determining the environmental impact of a product requires specifying its composition, EPDs do not confirm the absence of substances classified as Substances of Very High Concern (SVHC). The EPD includes information such as energy consumption, resources used in the supply chain, Global Warming Potential (GWP) emissions generated during production and use, and the type of waste produced during the product's disposal.

Environmental certification systems in Poland and their implementation
According to data collected by Cushman and Wakefield at the end of the first quarter of 2025, among 1,500 Polish office buildings, just over 30% have at least one LEED, BREEAM NC, or BREEAM in USE certificate, and 25% have received at least the second highest level of one of the certifications systems.

LEVEL OF IMPLEMENTATION OF SELECTED OPTIMISATIONS RELATED TO AIR QUALITY IN LEED CERTIFICATION

	PERCENTAGE OF PROJECTS REGISTERED IN EUROPE THAT WERE AWARDED THE CREDITS*	PERCENTAGE OF PROJECTS REGISTERED IN POLAND THAT WERE AWARDED THE CREDITS*
Indoor Air Quality Assessment credit	26%	46%
Low-emitting Materials credit	44%	44%

* As of March 4, 2025, data applies to projects certified in BD+C/ID+C v4/v4.1.
The project pool includes over 2,100 projects in Europe, of which approx. 3% are in Poland.

Source: GBCI Europe

As we can see in the graphs below, a higher level of certification correlates with a higher percentage of projects that implemented air quality credits, for example, 20% of projects that received a LEED Certified certificate in Poland implemented the Low Emitting Materials credit and none of them implemented the Indoor Air Quality Assessment credit, while 60% and 80% of Platinum rated projects implemented these credits, respectively.

PERCENTAGE OF PROJECTS THAT WERE AWARDED AIR QUALITY-RELATED CREDITS BY LEED CERTIFICATE LEVEL FOR PROJECTS REGISTERED IN POLAND

POLAND	Indoor Air Quality Assessment credit	Low-emitting Materials
Certified Level	0%	20%
Silver Level	14%	71%
Gold Level	49%	38%
Platinum Level	80%	60%
Total	46%	44%

Source: GBCI Europe

PERCENTAGE OF PROJECTS THAT WERE AWARDED AIR QUALITY-RELATED CREDITS BY LEED CERTIFICATE LEVEL FOR PROJECTS REGISTERED IN EUROPE

EUROPE	Indoor Air Quality Assessment credit	Low-emitting Materials
Certified Level	12%	11%
Silver Level	22%	25%
Gold Level	26%	45%
Platinum Level	39%	78%
Total	26%	44%

Source: GBCI Europe

07 SUMMARY

The quality of indoor air in buildings is influenced by numerous factors, including the efficiency of the ventilation system, the quality of outdoor (supplied) air, and the number of pollutants emitted into the indoor environment by building materials, finishing materials, and equipment. Additionally, pollutants can be introduced by people, animals, and vegetation within buildings. Unfortunately, current legal regulations do not guarantee the complete elimination of substances harmful to health from indoor air. Therefore, it is essential for all participants of the construction process to be aware and make concerted efforts to ensure that the interiors of homes, offices, and public spaces are safe and healthy for us and our children.

We hope that this study, in which we have outlined the essence and scope of the problem and highlighted good practices, will contribute to increasingly conscious air quality management in the design, construction, and use of buildings.

08

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