ASHRAE JOURNAL

International Development of Standards For Ventilation of Buildings

By Bjarne W. Olesen, Ph.D.
Member ASHRAE

Standing Standard Project Committee 62 (SSPC 62) has been working since 1990 on a revision of *ANSI/ASHRAE Standard 62-1989, "Ventilation for Acceptable Indoor Air Quality."*

The revised draft puts more emphasis on indoor air quality than the existing standard. In addition to a ventilation rate per person, the draft also requires an additional ventilation rate based on floor area to account for any pollution emitted from the building or from the HVAC system itself. The draft also emphasizes air cleaning, ventilation effectiveness, and system requirements.

Other additions are sections on documentation, commissioning, operation and maintenance, and residential ventilation. While the existing standard does not distinguish between smoking and non-smoking except in smoking lounges, the revision assumes the absence of smoking. The revision, however, includes a separate annex to calculate the ventilation rate when smoking occurs.

During the same period, groups in other countries have been writing new or revising existing standards or guidelines for ventilation of buildings.

One of these groups is CEN, the European standards organization. A CEN working group under technical committee TC156, "Ventilation for Buildings," has developed a document prENV 1752, "Ventilation for Buildings: Design Criteria for the Indoor Environment" (CEN 1996), which also has been out for public review. The final vote has not been made. This is planned to be a European prestandard, which means it will be available for use in practice for a two-year trial. It will then be decided by the CEN member countries whether the standard, including modifications, will be adopted as a full standard. If adopted, all European countries must adopt it as a national standard.

European standards have the same relative status as ANSI standards. European standards are voluntary documents that are regarded as state of the art, but not law. The standards are, however, often referred to in building regulations and in this way may become legal documents.

In addition to CEN, groups in Germany, UK and Scandinavia also have been developing national standards or guidelines for ventilation in buildings. In the UK, CIBSE (Charter Institute of Building Service Engineers) has made a review draft of Guide A, sec. 2 "Environmental Criteria for Design" (CIBSE 1993). The German Standards Organization, DIN, has published a revision of DIN 1946, Part 2 "Ventilation and Air Conditioning: Technical Health Requirements" (DIN 1994).

This paper compares the requirements in these proposed standards or guidelines. There are some differences in the scopes of the documents, therefore they are not directly comparable. All, however, include a minimum ventilation rate which is the focus of this comparison.

Purpose and Scope

The purposes of ASHRAE Standard 62-1989R are:

(a) to define the roles of and requirements for ventilation, source management, and air cleaning in providing acceptable indoor air quality;

(b) to specify methods for determining minimum ventilation rates;

(c) to specify ventilation system design, operational, and maintenance requirements for various types of indoor spaces.

This is similar to the purposes of the other documents; but with some significant differences. The main use of all the standards is the design of ventilation systems. While ASHRAE goes into detail with requirements of mechanical systems, the other standards mainly deal with requirements as seen from the occupants' perspective. The other documents include parameters such as thermal environment, and noise and illumination levels.

Table 1 shows a comparison of the scopes. *Table 2* lists the contents.

ASHRAE 62-1989R is written in code language using mandatory words such as "shall" and "must." ASHRAE and CIBSE both include requirements for ventilation in residential buildings, while DIN and CEN have or are developing separate standards for residences.

While ASHRAE and DIN have very detailed requirements for the system and its components, the requirements in CEN and CIBSE relate only to the indoor environment. CEN, however, is developing several standards with requirements or test methods for the components of a ventilation system.

The following sections present the methods and requirements for the minimum ventilation rate:

Definition of Acceptable Indoor Air Quality

Each of these documents uses terms such as "indoor air quality," "perceived air quality," "acceptable indoor air qual-

About the Author

Bjarne Olesen is head of research and development at D.F. Liedelt "VELTA" GmbH, Norderstedt, Germany. He is a member of the committee revising ANSI/ASHRAE Standard 62-1989, chairman of *ASHRAE's Standing Standards Project Committee 55 "Thermal Environmental Conditions for Human Occupancy,"* and a member of several technical committees. Olesen also has leadership roles in ISO (International Organization for Standardization) and CEN (European Committee for Standardization). He authored more than 160 publications, and earned several awards including ASHRAE's Ralph G. Nevins Physiology and Human Environment Award. He has a master's degree and doctorate from Technical University of Denmark.

ASHRAE 62-92R (1996)	CEN prENV 1752 (1996)	CIBSE Guide A sec 2 (1993)	DIN 1946, Part 2 (1995)
• Requirements for commercial, institutional, and residential building spaces intended for human occupancy • Considers chemical, physical, and biological contaminants, as well as moisture and temperature that can affect human health and perceived air quality. • Thermal comfort is not included (See ASHRAE 55-1992) • Considering the diversity of sources and contaminants in indoor air and the range of susceptibility in the population, compliance with this standard will not necessarily ensure acceptable indoor air quality for everyone.	• Covers buildings which are subject to human occupancy, excluding dwellings. • Specifies how the quality of the indoor environment can be expressed for the design, commissioning, operation and control of ventilation and air-conditioning systems. • The indoor environment comprises the thermal environment, air quality and the acoustic environment. • Different levels of environmental quality are specified.	• No specific scope is stated	• Requirements for ventilation systems in work and public spaces in buildings • Health requirements for comfort for people at moderate activities. • Requirements for thermal comfort, indoor air quality and noise. • With natural ventilation a satisfactory air quality and comfort may not always be obtained.

Table 1. Scopes for ASHRAE 62-1989R; prENV 1752; DIN 1946, Part 2; and CIBSE Guide A.

ity" and "percentage of dissatisfied persons," but only ASHRAE gives a clear definition of the terms used:

Acceptable indoor air quality: *air in an occupied space towards which a substantial majority of occupants express dissatisfaction and in which there are not likely to be known contaminants at concentrations leading to exposure that pose a significant health risk.*

Acceptable perceived indoor air quality: *air in an occupied space towards which a substantial majority of occupants express dissatisfaction on the basis of odor and sensory irritation. Acceptable perceived indoor air quality is necessary-but not sufficient-to meet this standard's definitions of acceptable indoor air quality.*

In the ASHRAE definition, "a substantial majority" is not specified. In ASHRAE 62-1989 it was specified as more than 80%. The difference between the two definitions is quite important. There are pollution sources such as radon and carbon monoxide that do not cause odor or irritation, therefore an acceptable perceived indoor air quality would be relatively easy to obtain.

Another example is tobacco smoke which has been listed as a carcinogen by the U.S. Environmental Protection Agency (EPA). This means it might not be possible to reach an "acceptable indoor air quality," because of the health risk; but it might be possible to reach an "acceptable perceived indoor air quality" in a smoking environment.

In the CIBSE proposal, this definition is found in the text:

*"**Indoor air quality** may be said to be acceptable if less than 50% of the occupants can detect any odor, less than 20% experience discomfort, less than 10% suffer from mucosal irritation, and less than 5% experience annoyance for less than 2% of the time."*

However, the CIBSE draft also states that this comfort-related definition of "acceptable indoor air quality" does not take into account substances such as radon which potentially affect health but are odorless. All of the proposed standards deal with the health issue and not just with the comfort issue. CIBSE refers to the World Health Organization definition of good health as ... *"a state of complete physical, mental and social well-being, not merely the absence of disease and infirmity."* According to this definition, "comfort equates to well-being" and, therefore, is a component of health.

Because the committees which have developed these documents are dominated by members with engineering backgrounds, they have avoided setting new criteria for health, but refer to recommendations from international authorities such as the World Health Organization (WHO, 1987) or national authorities such as EPA, NIOSH, OSHA and ACGIH; which are involved in establishing Threshold Limit Values (TLV, MAK) or similar criteria.

The CEN document operates with ventilation requirements in three categories, representing satisfaction levels of 85%, 80% and 70%. The analytical method in the DIN document also operate with three levels: 90%, 80% and 70% of occupants satisfied. The analytical method presented in an appendix of ASHRAE 62-1989R also includes a method for establishing requirements at different levels of satisfaction.

Estimating Minimum Ventilation

In each of the documents, more than one procedure for estimating minimum ventilation is included. Each includes a prescriptive method where the minimum ventilation rates can be found in a table listing values for different type of spaces. Analytical procedures for calculating the minimum ventilation rate are also included. Using the analytical procedure, ventilation rates are calculated on the basis of pollutant type, emission rate and acceptable concentration.

Prescriptive procedure with table values.

ASHRAE 62-1989R has two prescriptive procedures: The Simple System Procedure and the Prescriptive Procedure. The

See Olesen, Page 34

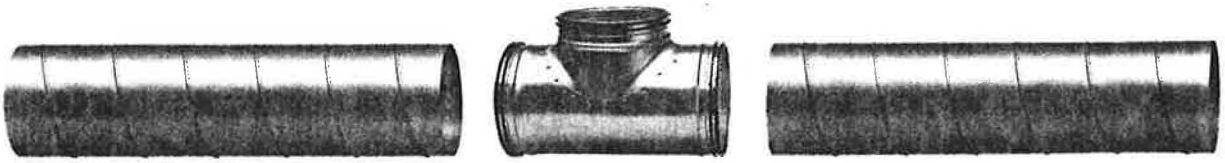
How tight are our duct seals? Think blue jeans. 1970.

As you know, a tight duct system is critical. And the tighter the system, the more accurately and efficiently it will deliver conditioned air. So on your next project insist on SPIROsafe®. It's the tightest fitting, fastest installing, longest lasting duct system anywhere. In fact, it's the leading duct system in the world. And for some very good reasons.

Each SPIROsafe fitting is factory equipped with a unique double-lipped, durable EPDM rubber gasket which automatically seals the system to SMACNA's leakage class 3 (-20 in W.G./+12 in W.G.), the tightest standard SMACNA addresses. So when it's sealed, it's sealed.

Since SPIROsafe components are manufactured to the only published tolerance standards in the industry, they install consistently and reliably. Also, each SPIROsafe fitting and sealing gasket is individually inspected at the factory, greatly reducing job site uncertainties. (And at an installed cost that may make you wonder why anyone would use traditional duct work.) Don't take chances. Specify Lindab's SPIROsafe duct system. For more information on SPIROsafe, call 1 800-79-SPIRO (797-7476).

SPIRO®



Lindab®

LINDAB INC., TWO STAMFORD LANDING, STAMFORD, CT 06902, PHONE 203 325-4666, FAX 203 325-2111.

(Circle No. 27 on Reader Service Card)

ASHRAE Standard 62R (1996)	CEN prENV 1752 (1996)	CIBSE GUIDE A (1993)	DIN 1946 Part 2 (1995)
• Purpose • Scope • Definitions • Applications and compliance • General requirements • Design ventilation rate • Construction and system start-up • Operating and maintenance procedures • Requirements for residential buildings • Normative references • 15 Appendices • Rationale • Analytical procedure • Air quality guideline • Smoking CO_2 • Ventilation system efficiency • VOC, Pre-occupancy ventilation, microbial growth etc.	• Introduction • Scope • **Normative References** • Definitions • Design assumptions • Design criteria • Thermal environment • Noise from systems • Ventilation • 7 Appendices • Development of design criteria (thermal environment, indoor air quality, acoustic environment • Step-by-step method • Practical examples • Table values (clo, met) • WHO air quality guidelines • Ventilation effectiveness • Guidelines for low-polluting buildings	• Introduction • Thermal environment • Humidity • Indoor air quality • Determination of required outdoor air supply rate • Visual environment • Acoustic environment • Vibration • Electromagnetic and electrostatic environment • References • Bibliography	• Scope • General • Occupied zone • Thermal comfort • Indoor air quality • Noise • Technical requirements • Commissioning • Maintenance and control of ventilation systems • Appendices • Ventilation for perceived indoor air quality • Normative references • Explanations

Table 2. Contents for ASHRAE 62-89R; CEN prENV 1752; CIBSE Guide A; and DIN 1946 Part 2.

Simple systems procedure	Prescriptive procedure
Minimum ventilation rate: $V_{ot} = \Sigma R_{sb}A_b$ L/s R_{sb} = Outdoor air (Table 4), L/s · m^2 A_b = Floor area, m^2	Design Ventilation Rate for each space: $DVR = R_pP_DD + R_bA_b$ L/s R_p = Outdoor air per Person (Table 4),L/s · Person P_D = Design occupancy per m^2 D = Occupant Diversity factor R_b = Outdoor air requirement per m^2 (Table 4), L/s · m^2 A_b = Floor area, m^2
Minimum supply air $MSR = R_{ss}A_b$ L/s R_{ss} = Supply air (Table 4), L/s · m^2	Minimum supply air $MSR \geq DVR/E_{ac}$ and $\geq 7{,}5P_DD/E_{ac}$ L/s E_{ac} = air change effectiveness

Table 3. Calculations for the two procedures

Category M1*		Category M2		Category M3
Maximum emission mg/m^2 · h		Maximum emission mg/m^2 · h		
TVOC	<0.2	TVOC	<0.4	• Emissions higher than M1 and M2
H_2CO	<0.05	H_2CO	<0.125	
NH_3	<0.03	NH_3	<0.06	• No emission data
Carcinogenic compounds	<0.0005	Carcinogenic compounds	<0.0005	
*Category 1 according to IARC (WHO)-classification				

Table 5. Category of materials

Olesen, From Page 32

Simple System Procedure may only be used for single zone systems and 100% outdoor air systems. Using this procedure, assumptions are made for occupant density, ventilation effectiveness and filter efficiency. The minimum ventilation rates for both prescriptive procedures are listed in a table. The method of calculation is shown in *Table 3*. Values for four typical spaces (single office, landscaped office, conference room and classroom) are shown in *Table 4*. In addition to the minimum ventilation requirement, ASHRAE 62-1989R also requires that the total amount of supply air (outside + recirculated) must be at least 7.5 L/s (15 cfm) per person.

The prescriptive method in ASHRAE 62-1989R requires a minimum ventilation rate per person and a minimum ventilation rate per square meter floor area. The two ventilation rates are added. The people-related ventilation rate dilutes pollution from a person (odor) and from the person's activity. In ASHRAE 62-1989, the minimum ventilation rate is given only as "per person."

In prENV 1752, a required minimum ventilation rate is given per person and per square meter floor area, and the values are added. It may, however, be assumed that the building is not emitting any pollution.

In DIN 1946, there is both a minimum required ventilation rate per person and a rate per square meter floor area. The larger of the two rates is the minimum requirement.

In a Nordic guideline, NKB-61 (NKB, 1991), a relatively simple procedure is recommended for calculating the minimum ventilation rate. A required ventilation rate per person (3.5 L/s · person) is added to the required ventilation rate per

Table 4: Minimum requirements for ventilation

Room	Standard	Class	People R_p L/s · person	Building			Area related
				Low polluting	R_B	Not low polluting	R_{SB} L/s · m²
Single office	prENV 1752 (96)	A B C	10 7 4	1.0 0.7 0.4		2.0 1.4 0.8	
	DIN 1946 (94)		11				1.11
	ASHRAE 62 (rev.96) ASHRAE 62-89		3.0 10		0.35		0.66
	NKB-61 (91)		3.5				0.7
	CIBSE-Guide A (rev.93)		8				
Landscaped office	prENV 1752	A B C	10 7 4	1.0 0.7 0.4		2.0 1.4 0.8	
	DIN 1946		16.6				1.67
	ASHRAE 62 (rev.96)		3.0		0.35		0.65
	ASHRAE 62-89		10				
	NKB-61 (91)		3.5				0.7
	CIBSE-Guide A (rev.93)		8				
Conference room	prENV 1752	A B C	10 7 4	1.0 0.7 0.4		2.0 1.4 0.8	
	DIN 1946		5.6				2.7 - 5.6
	ASHRAE 62 (rev.96)		2.5		0.35		1.6
	ASHRAE 62-89		10				
	NKB-61 (91)		3.5				0.7
	CIBSE-Guide A (rev.93)		8				
General classroom	prENV 1752	A B C	10 7 4	1.0 0.7 0.4		2.0 1.4 0.8	
	DIN 1946		8.3				4.2
	ASHRAE 62 (rev.96)		3.0		0.55		1.8
	ASHRAE 62-89		8				
	NKB-61 (91)		3.5				0.7
	CIBSE-Guide A (rev.93)		8				

Notes: PrENV 1752: People and Building are added.
DIN 1946: Highest value are used.
ASHRAE-62: People and Building are added or Simple Systems (RSB) is used. For unadapted people, 5 L/s · person is added to the Rp value.
NKB-61: People and Building are added, but total outside air must be ≥ 7 L/ · s · person.

floor area (0.7 L/s · mð). The total ventilation rate, however, must not be less than 7 L/s per person. The basic requirements are the same for all types of spaces. (see *Table 4*).

In the CIBSE Guide, the minimum required ventilation rate is given as "per person." The basic requirements for all cited proposed standards and guidelines are given in *Table 4* for four typical spaces.

Except for ASHRAE 62-1989R, all requirements are based on satisfying unadapted people, people who have just entered the space. In ASHRAE 62-1989R, the minimum requirements are based on adapted people, people who already are in the

Note: Divide L/s by .4719 to obtain f³/min (cfm)

Standards	Room	Occupancy	Only People			STANDARD Calculation			20 % Smokers		
		Person/m²	L/s m²			L/s m²			L/s m²		
Class			A	B	C	A	B	C	A	B	C
prENV 1752 (96)	Single office	0.1	1.0	0.7	0.4	2.0	1.4	0.8			
DIN 1946 (94)							1.1				
ASHRAE 62 (rev.96) ASHRAE 62-89							0.65* (1.15) 1.0				
NKB-61 (91)							1.05				
CIBSE-Guide A (rev. 93)							0.8				
prENV 1752	Landscaped office	0.07	0.7	0.5	0.3	1.7	1.2	0.7	2.4	1.7	1.0
DIN 1946							1.7			1.7	
ASHRAE 62 (rev.96) ASHRAE 62-89							0.56* (1.06) 0.7			1.1* (1.6) 0.7	
NKB-61 (91)							0.95			1.4	
CIBSE-Guide A (rev.93)							0.56			1.1	
prENV 1752	Conference room	0.5	5.0	3.5	2.0	6.0	4.2	2.4	1.0	7.8	4.4
DIN 1946							2.8 - 5.4			5.4	
ASHRAE 62 (rev.96) ASHRAE 62-89							1.5* (4.0) 5.0			4.4* (8.2) 5.0	
NKB-61 (91)							3.5			10.0	
CIBSE-Guide A (rev.93)							4.0			8.0	
prENV 1752	Classroom	0.5	5.0	3.5	2.0	6.0	4.2	2.4			
DIN 1946							4.2				
ASHRAE 62 (rev.96) ASHRAE 62-89							2.1* (4.6) 4.0				
NKB-61 (91)							3.5				
CIBSE-Guide A (rev. 93)							4.0				

Table 6: Minimum ventilation requirements in DIN 1946, ASHRAE 62 (rev. 96), ASHRAE 62-89, CIBSE-Guide A (rev. 93), NKB-61

*ASHRAE 62 (rev. 96) gives the minimums for adapted persons. The number in parentheses is the value for unadapted.

space. While the adaptation to body odor is significant, the minimum requirement per person is relatively small in ASHRAE 62-1989R. The standard does, however, allow the designer to design for unadapted people. In this case, 5 L/s per person is added to the Rp values in *Table 4*.

The values in *Table 4* are not directly comparable because of the different calculation methods used in the documents. The "person" values in DIN 1946 include some ventilation to take care of the building component, and the "building" value includes some ventilation to take care of the people component. For the simple systems procedure, a given people density is already included.;

The values in prENV 1752 are given for three classes where Class A corresponds to ~ 15 % dissatisfied, B to ~ 20 % and C to ~ 30 %.

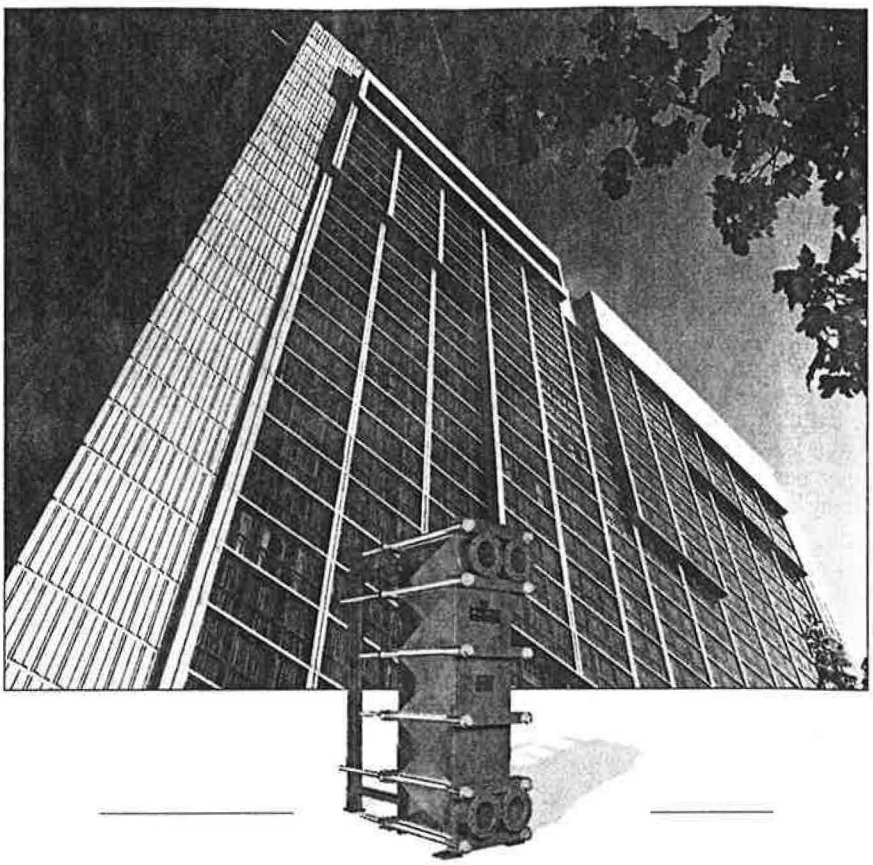
The minimum ventilation rate per person in ASHRAE 62-1989R is always lower than the rates in the other documents. However, if the space is designed for unadapted persons, where 5 L/s per person is added, then the values are comparable with Class B in the CEN proposal.

The base value per person for offices in ASHRAE 62-1989R is 3 L/s per person. This value also compensates for pollution related to the activity of the person. Therefore, different values are assigned in the document for conference rooms (2.5), restaurant kitchens (4.0), reception areas in offices (3.5), malls (4.0), fitness centers (12) and art classrooms (5.0).

Two categories of buildings are included in the CEN proposal: Low-polluting buildings and Not-low-polluting buildings. The values in *Table 5* are used as guidelines for the two categories. To

Note: Divide L/s by .4719 to obtain f³/min (cfm)

See Olesen, Page 38



"Free cooling from two Superchanger® units saves us 600 kwh per hour."

—Jose Peraza, Director of Mechanical Services for Colony Square

Colony Square, a high-rise complex in Atlanta, Georgia, has cut its energy consumption by 57.4% since installing two Tranter Superchanger plate and frame units in its HVAC system.

The reduction in energy use is due to the Superchangers' ability to bypass chillers whenever outside temperatures drop below 45°F. These heat transfer units provide 480 tons of refrigeration without the high cost of electricity to run the project's three 1250-ton centrifugal chillers. This results in a savings of approximately 600 kwh per hour. The Superchanger units paid for themselves in less than 18 months.

Once Colony Square was sold on the idea of a free cooling system they chose Tranter. Our Superchanger units offered the ease of installation and maintenance they required, and since we're based here in the U.S., our parts and service network can provide assistance within hours.

If you would like the details and calculations of Colony Square's energy savings, call us at (706) 738-7900 and request Bulletin No. SCH-14A. Better still, talk to your local Tranter representative. He can tell you about other Superchanger applications for HVAC plants, and about the most comprehensive range of plate-type heat exchangers on the market. Thinking heat transfer? Think plates. Thinking plates? Think Tranter!

THE heat transfer people

tranter®

Tranter, inc. ▲ Texas Division ▲ P.O. Box 2289 ▲ Wichita Falls, Texas 76307
(817) 723-7125 ▲ Fax (817) 723-5131

(Circle No. 28 on Reader Service Card)

Olesen, From Page 36

meet the requirements for "low polluting," a maximum of 20% of the materials used in the building must be from Category M2 and only an insignificant part from Category M3.

The building value Rb in ASHRAE 62-1989R uses as its basis 0.35 L/s.mð, but does vary from space to space. Other examples listed in ASHRAE 62-1989R are: restaurant kitchen ~ 2.85, shopping mall ~0.30, and art classroom ~ 1.85.

The building values (*Table 4*) in ASHRAE 62-1989R are generally lower than the values in prENV 1752, but they correspond closely to the values for Class C. The building value is assumed to be the same for adapted and unadapted persons, as the adaptation to pollution from building materials is small compared with the adaptation to human odor.

A comparison of the listed standards of the required minimum ventilation rate for four typical spaces is listed in *Table 6*. The values in *Table 6* for prENV 1752 are calculated for "people," alone, and under "standard" for low-polluting buildings. In addition, values for spaces with smokers are shown in *Table 6*.

For the "standard calculation," the minimum required rates in ASHRAE 62-1989R are the lowest. In most cases, the rates are lower than Class C. But the basis for the values also is different. While the minimum rates in ASHRAE 62-1989R are based on adapted persons, all the other documents are based on unadapted. If unadapted values had been used, then ASHRAE 62-1989R would correspond to Class B in the CEN proposal.

Standard	Class	Required ventilation L/s · person			
		no smoker	20% smoker	40% smoker	100% smoker
perENV1752 (96)	A	10	20	30	30
	B	7	14	21	21
	C	4	8	12	12
ASHRAE 62-89R	Adapted	3	6	17	25
	Unadapted	5	8	25	33
ASHRAE 62-89		10	10	10	10
NKB-61 (91)		7	20	20	20
CIBSE-Guide A (new 93)		8	16	24	43

Table 7: Required ventilation per person with and without smoking.

	*Unadapted (m^3/cig)	Adapted (m^3/cig)
Non-smokers	160	110
Smokers	40	30

*Divide m^3 by .02832 to obtain ft^3.

Table 8: Required ventilation per cigarette

Analytical Procedure

All of the listed documents contain an analytical procedure in the prescriptive text or in an informative appendix. In this procedure, the required ventilation rate is calculated on a comfort basis (perceived odor and/or irritation) and on a health basis. The highest calculated value, which in most cases will be the comfort value, is then used as the required minimum ventilation rate.

The basis for the calculation in all documents is based on a mass balance calculation. The required ventilation rate is calculated as:

$$Q = \frac{G}{(C_i - C_o) \cdot E_v} \qquad \text{L/s}$$

where

G = Total emission rate mg/s
Ci = Concentration limit mg/l
Co = Concentration in outside air mg/l
Ev = Ventilation effectiveness

Knowledge from the health perspective is limited about emission rates (G) and concentration limits (C_i). In the future, more knowledge and data will be available from ongoing research projects and from testing by manufacturers of building materials and furnishings.

The comfort calculation is not the same in all of the listed documents. The olf-decipol method is the basis for the calculation in prENV 1752, DIN 1946 and in the CIBSE proposal. The comfort calculation in ASHRAE 62-1989R is based on the addition of a ventilation rate per person (a function of adaptation and activity level), and a ventilation rate for the building (Rb values in *Table 4*).

In ASHRAE 62-1989R, air cleaning may be taken into account in the analytical procedure. Calculating the required amount of outside air is rather complicated in multiple space systems with recirculation and an air cleaner in the return air or supply air.

The concept of designing for different levels of indoor air quality is also included in the Scandinavian guideline (SCANVAC, 1991), in the Finnish guideline (FISIAQ, 1995) and in ASHRAE 62-1989R.

Smoking

In all documents, except for the existing ASHRAE Standard 62-1989, it is assumed that there is no smoking taking place. In the case of smoking, an additional amount of outside air must be used to obtain acceptable perceived indoor air quality. *Table 8* shows the required amount of ventilation air per person when smoking is taking place. The values in ASHRAE 62-1989R are calculated based on a given amount of air per cigarette (*Table 9*), a normal smoking rate of 1.1 cigarettes per hour, and 3 cigarettes per hour in smoking lounges (100% smoking).

In DIN 1946, an amount of 5.6 L/s per person must be added to the values in *Table 4* independent of the amount of smoking. In the U.S., 25% of the population smokes, and the average rate is 1.1 cigarettes per hour. In many buildings in the U.S., however, smoking is restricted to dedicated spaces.

Note: Divide L/s by .4719 to obtain(cfm). Divide m^3 by 0.2832 to obtain ft^3.

In *Table 6*, the influence of smoking is shown in a landscaped office and in a conference room. Again, the values for ASHRAE 62-1989R are based on adapted persons. The adaptation to tobacco smoke, however, is less than to body odor.

The values from the ASHRAE documents are again the lowest and correspond approximately to Class C in the CEN proposal. However, if the space is designed for unadapted persons, the values correspond to Class B in CEN.

Conclusions

A comparison between the required levels of ventilation rate in ASHRAE 62-1989, ASHRAE 62-1989R, prENV 1752 (European standard proposal, CEN), DIN 1946 Part 2 (Germany), CIBSE Guide A (UK) and NKB-61 (Nordic guideline) has been presented.

All documents include a prescriptive procedure where the required minimum ventilation rate is listed in tables with values for different types of spaces. All documents also include an analytical method where the required ventilation rate is calculated based on comfort and health criteria. ASHRAE 62-1989R, prENV 1742, and DIN 1946 include the possibility of designing for different levels of perceived air quality.

The minimum requirements in ASHRAE 62-1989R are based on adapted persons, while all other documents assume unadapted persons. It is possible, however, to design for unadapted persons in the ASHRAE revision.

All of the standards take ventilation effectiveness into account.

The lowest minimum outdoor air requirements are found in ASHRAE 62-1989R.

References

ASHRAE Standard 62-1989, "Ventilation for Acceptable Indoor Air Quality."

ASHRAE Public Review Draft 62-1989R, "Ventilation for Acceptable Indoor Air Quality."

CEN prENV 1752, 1996, "Ventilation for Buildings: Design Criteria for the Indoor Environment."

CIBSE Guide A, revision section 2, 1993, "Environmental Criteria for Design," Charter Institute of Building Service Engineers, UK.

DIN 1946 Part 2, 1994, "Ventilation and Air Conditioning: Technical Health Requirements."

FISIAQ, 1995, "Classification of Indoor Climate, Construction, and Finishing Materials," Finnish Society of Indoor Air Quality and Climate.

NKB Report no. 61, 1991, "Indoor Climate - Air Quality," Nordic Committee on Building Regulations NKB.

SCANVAC, 1991, "Classified Indoor Climate Systems. Guidelines and Specifications.".

The Federation of the Scandinavian HVAC Organizations. Table 1. Scope for ASHRAE 62-1989R, prENV 1752, DIN 1946, Part 2. and CIBSE Guide A. ■

Please circle the appropriate number on the Reader Service Card at the back of the publication.

Extremely Helpful 450
Helpful 451
Somewhat Helpful 452
Not Helpful 453