*Pure Appl. Chem.*, Vol. 72, No. 8, pp. 1471–1481, 2000.


INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

CHEMISTRY AND THE ENVIRONMENT DIVISION
COMMISSION ON ATMOSPHERIC CHEMISTRY*

# INTERNET AND OTHER SOURCES OF METHODS FOR THE ASSESSMENT OF WORKPLACE AIR QUALITY

## (Technical Report)

*Prepared for publication by*
R. H. BROWN
*Health and Safety Laboratory, Sheffield S3 7HQ, UK*

# Internet and other sources of methods for the assessment of workplace air quality
(Technical Report)

*Abstract*: Methods for assessing occupational exposure to toxic chemicals have been developed semi-independently by a number of standards organizations and regulatory authorities in Europe and beyond. Few of these have been systematically reviewed against Comité Europeén de Normalisation (CEN) criteria for accuracy and reliability. Some of these methods have been complied into indexes, either in hard copy or on the Internet, but existing indices are incomplete. There is a clear need for the harmonization and validation of these methods and for a full compendium of available methods and their validation status, while avoiding duplication of essentially equivalent procedures. Many of the methods are accessible on the Internet, so that in such instances the compendium need not contain full details of the methods themselves but can provide links to the pertinent web sites.

## INTRODUCTION

Impending legislation, particularly at the European level [1], is likely to lead to an increasing need for simple and cost-effective methods for monitoring the concentrations of toxic chemicals in workplace air. Such monitoring is needed in order to assess the potential for worker exposure to toxic chemicals by comparing results with air quality standards. There is also a need for the harmonization of available monitoring methods, if comparable data are to be obtained in all European Member States, while acknowledging the availability of equivalent methods in many cases. CEN/TC137 (Workplace air quality), WG2 (performance requirements of methods) has therefore developed procedures for the establishment of valid methods [2–5], but to date, few methods which fully meet the CEN requirements have been published. Also at present, there are no Euronorms (EN) on specific workplace air quality measurement methods; this task is expected to be undertaken by the International Standards Organization (ISO).

As a first stage toward the provision of harmonized methods, this document provides a source inventory of European standard methods, with particular reference to methods available on the Internet.

Similar considerations apply worldwide, and the IUPAC Commission on Atmospheric Chemistry (Commission VI.2) is actively encouraging the exchange of such information. In particular, the methods developed in the United States, particularly those of the National Institute for Occupational Safety and Health (NIOSH) [6] and the U.S. Occupational Safety and Health Administration (OSHA) [7,8], are in very wide use internationally and are included in this inventory of sources.

## SOURCES

### *Austria*

Austria follows the analytical methods of Germany's *Deutsche Forschungsgemeinschaft (DFG)*—see Germany.

### *Belgium*

Methods are published by the Belgian Standards Institute, *Belgisch Instituut voor Normalisatie*, Brussels, in the series NBN T96-XXXX. The web site http://www.ibn.be is in French or Dutch and directs to e-mail normes.belges@ibn.be for more information.

*Croatia*

Methods approved by ISO, NIOSH, OSHA, and VDI are used as appropriate. In 1995, the Croatian equivalent of ISO/TC146 "Air Quality" was established as the State Institute of Standardisation, which will adopt ISO and EN procedures as Croatian standards.

*Denmark*

Methods were published by the Danish National Institute for Occupational Health, *Arbejdsmiljøinstituttet*, Copenhagen in the L series. There was an additional series of biological methods in the B series, but both were published in the 1980s and are now regarded as outdated. Updated methods are available internally within the Institute. The web site http://www.ami.dk is in Danish and English and directs to e-mail ami@ami.dk for more information.

*Finland*

Methods are published by the Finnish Standards Organisation, Helsinki, in the series SFS-XXXX. The web site http://www.sfs.fi is in Finnish, Swedish, and English. Selecting ⇒ SFS catalogue ⇒ search (air quality) leads to titles (only) of six workplace methods.

*France*

France has three types of written methods:

- Standards published by the French Standardisation body, AFNOR, Paris, in the NF X 43-XXX series. The web site http://www.afnor.fr is in French and English. Selecting ⇒ standards on line ⇒ search (NF X43*) leads to titles (only) of 44 workplace methods with ordering information.
- Procedures written and published by INRS, *Institut National de Recherche et de Sécurité*, Vandœvre [9–11] include two general methods for organic vapors in the NF X43 series and a general guide to chemical methods. The web site is http://www.inrs.fr. Selecting ⇒ research (in French or English) ⇒ INOR database leads to useful information on other European and worldwide occupational health research organizations.
- Further (approximately 400) unpublished methods are available within INRS on paper or diskette. A decision on open publication is imminent.

*Germany*

Germany has four types of written methods:

- Methods published by the Workmen's Compensation Board, Berufsgenossenschaft, BG, in the ZH 1/120 series [12].
- Methods published by the German Research Association, Deutsche Forschungsgemeinschaft, DFG [13]; some of these methods are also available in English translation [14]. The web site http://www.dfg.de is in German and English. Selecting Luftanaysen in the free-text search gives access to a list these methods.
- Methods published by VDI-DIN [15]. The methods themselves are published as VDI guidelines. [15] is an index to these methods, available from VDI. The web site http://www.vdi.de is in German and English. Selecting ⇒ Commission on Air Pollution Prevention of VDI and DIN – Standards Committee ⇒ KRdL Publications gives an e-mail contact steen@vdi.de.

All VDI Guidelines can also be searched for within the electronic Beuth-Catalogue, which is available on http://www.beuth.de.

- Methods published by BIA (Berufsgenossenschaftliches Institute für Arbeitssicherheit) [16]. The web site http://www.hvbg.de/bia is in German and English. Selecting ⇒ Publications ⇒ Publications Database (in German only) and searching for the book title gives a short summary (Kurzfassung). The original is a useful compendium of some hundreds of methods (in summary).

*Greece*
Source materials are the legislated methods issued by the Hellenic Ministry of Labour, mostly in response to EC Directives. For example:

- Determination of benzene: Ministerial decision 1308/79—method of periodic test for the calculation of the benzene concentration in the atmosphere in the workplace.

*Ireland*
The Republic of Ireland follows approved NIOSH, EC, or UK (HSE/ MDHS) methods where appropriate, except in a few instances where regulations (e.g., for chrome plating) specify a particular analytical method.

*Italy*
Methods are published by UNICHIM, Associazione per l'unificazione nel settore dell'industria chimica, in the N-XXX series. The web site is http://www.unichim.it.

*The Netherlands*
Methods are published by NNI, Nederlands Normalisatie-instituut, Delft, in the NEN-XXXX series. The web site http://www.nni.nl is in Dutch, but an English version is in preparation. There are currently no workplace analytical methods on line.

*Norway*
Methods are published by the Norwegian Standardisation body, Norges Standardisieringsforbund, in the NS series. The web site http://www.standard.no is in Norwegian and English. The site directs to an e-mail address for further information, firmapost@standard.no or marked@standard.no. The site also links to a catalogue (Katalog over Norsk Standard) of standards with a free-text search.

*Portugal*
Methods are published by the Portuguese Institute for Quality as Portuguese Definitive Standards in the NP series. The web site http://www.ipq.pt/index1.htm is in Portuguese only. ⇒ "Products and services" is in preparation.

*Spain*
Methods are published by the Spanish National Institute for Occupational Safety and Health, Instituto Nacional de Seguridad e Hygiene en el Trabajo, Madrid in the MTA/MA-xxx (Environmental); MTA/MB-xxx (Biological) or MTA/PV-xxx (Validation protocols) series. The web site http://www.mtas.es/insht is in Spanish only.

*Sweden*
Swedish official recommendations are published in the Metodserien, 1001–1031, from the Swedish National Institute for Occupational Health, Arbetarskyddsstyrelsen/ Arbetslivsinstitutet, Stockholm (1977–1987), and in published papers from the Institute. The web site http://www.niwl.se is in Swedish and English. Selecting ⇒ publications ⇒ Arbete och Hälsa leads to a compendium of methods (see below). http://www.niwl.se/kemi links to NIOSH and OSHA methods (see below).

*Switzerland*
Since Switzerland is a multilingual country, there is no publication of national methods as found in other countries. Analytical methods used for air quality measurements refer to corresponding methods used at INRS, NIOSH, OSHA, DFG, BG, HSE, etc. In addition, laboratories and institutes in Switzerland develop and evaluate their own methods for the assessment of exposure.

*United Kingdom*
Methods from the British Standards institute are accessible to subscribers through http://www.bsi.org.uk ⇒ standards on line.

Methods are published by the Health and Safety Laboratory, Health and Safety Executive, Sheffield, in the MDHS series. Currently nearly 100 methods have been produced. MDHS methods are available from HSE Books, Sudbury. The web site is http://www.hsl.gov.uk. Selecting ⇒ information sources ⇒ HSE Books ⇒ Bookfinder catalogue ⇒ Search Bookfinder and selecting from Series list MDHS will give current titles.

### *United States of America*

The United States has five types of written methods:

- Methods in the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM) [6]. These methods are available in downloadable files from the Internet at http://www.cdc.gov/niosh/nmampub.html which also gives information on obtaining the full printed version. The NIOSH site also links to MSHA, EPA, ASTM, and ISO (see below).
- Methods developed by the Occupational Safety and Health Administration (OSHA) Analytical Methods Manual [7]. OSHA also has a list of partially validated methods, in the IMIS series [8], which is available in paper form or CD-ROM. Both sets of methods can be accessed on the Internet at http://www.osha-slc.gov/SLTC/index.html. From this site, ⇒ OSHA Technical Manual selects OSHA Sampling and Analytical Methods and ⇒ Chemical Sampling Information selects the IMIS methods.
- Methods developed by the Intersociety Committee (IC) [17].
- Methods developed by the U.S. Environmental Protection Agency (EPA) [18]. These methods are written for ambient air applications, but many are applicable also to the workplace. The methods are available on the Internet at http://www.epa.gov/standards.html.
- Methods developed by the American Society for the Testing of Materials (ASTM). These are indexed under http://www.astm.org and selecting ⇒ ASTM store.

### *International Standards Organisation*

Internationally agreed standards (which do not necessarily conform to the CEN/TC137 performance requirements, but generally include precision data according to ISO 5725) and published by the International Standards Organisation, Casa postale 56, CH-1211 Genève, Suisse. Many of these methods are translated into National Standards. The web site is http://www.iso.ch. Selecting ⇒ ISO catalogue ⇒ international standards (HTML) ⇒ ICS field 13 ⇒ ICS field 13.040.30 leads to workplace air quality standards.

## INDICES/COMPENDIA OF SOURCES

### *Leichnitz: Gefahrstoff-Analytik*

Leichnitz has published a source list [19], also available on CD-ROM (1999 edition, ISBN 3-609-48431-4) which includes method numbers, but no indication of the type of sampling and analysis for each method. Sources covered include BG, DFG, VDI-DIN, ISO, HSE/MDHS, NIOSH, OSHA, IC and EPA. The list also includes substance formulae, CAS Registry Number, and some physicochemical data.

### *Levin: Arbete och Hälsa*

Levin has published a source list [20], in Swedish, which includes method numbers and brief details of the type of sampling and analysis for each method. Sources covered include Metodserien, NIOSH, OSHA, and published literature references (mostly but not exclusively from the Institute). The list also includes CAS numbers.

### *NMI: Dohsbase*

NMI has a database for workplace air quality methods including EN > NEN (including ISO), > OSHA, NIOSH, BIA > others (e.g., published literature references). [“>” indicates a hierarchy, chosen to avoid

duplication of essentially similar methods.] The information given for each method includes details of the sampling and analytical procedure, including recommended sampling media, analytical method, sampling flow rates, sample size, desorption parameters, storage and transportation conditions, precision and detection limit. The database is currently only for internal NMI use.

*HSE: EH40 database*

HSE has a database for workplace air quality methods including ISO > MDHS > OSHA, NIOSH, DFG > others (e.g., published literature references). [">" indicates a hierarchy, chosen to avoid duplication of essentially similar methods.] The information given for each method includes details of the sampling and analytical procedure, including recommended sampling media, analytical method, sampling flow rates, sample size, and desorption parameters. Uptake rates are given for diffusive sampling procedures. Where available, data is given on whether methods meet the CEN criteria [2]. The database was publicly available on diskette up to the 1995 edition, but is currently only for internal HSE use.

## CONCLUSIONS

It is clear that there are many sources of methods for monitoring the concentrations of toxic chemicals in workplace air. Many of these duplicate methods are published elsewhere, but collectively they provide a useful guide to the occupational hygienist wishing to undertake workplace air quality monitoring.

It is less clear how many of the methods have been validated to CEN requirements, as this is often not stated. However, as an interim measure EN 482 allows already published partially validated methods to be counted as valid.

Accessing these methods is made simpler by using the compendia or databases of methods. Such compendia contain varying amounts of detail and usually do not reproduce the methods themselves in detail. Of the known compendia, the source materials are similar, so that it would seem reasonable to combine them in some way to avoid duplication of effort.

Increasingly, the methods are being placed on the Internet. In such cases, it would not be necessary to include a full description of the methods in the compendia, but only a web site address. If the compendium was itself on the Internet, than a method could be called up via a hot-link to the source URL.

## SOURCE ADDRESSES

*Austria (ON)*

Address: Österreichisches Normungsinstitut, Heinestrasse 38, Postfach 130, AT-1021 Wien
TEL: +43 1 213 00
FAX: +43 1 213 00 650
E-mail: elisabeth.stampfl-blaha@on-norm.at
Web site: http://www.on-norm.at/

*Belgium (IBN)*

Address: Institut belge de normalisation, Av. de la Brabançonne 29, BE-1000 Bruxelles
TEL.: +32 2 738 01 11
FAX: +32 2 733 42 64
E-mail: croon@ibn.be

*Denmark (NIOH)*

Address: Arbejdsmiljøinstituttet (National Institute of Occupational Health), AMI, Lerso Parkallé 105, DK-2100 København Ø
TEL.: +45 39 16 52 00

FAX: +45 39 16 52 01
E-mail: ami@ami.dk
Web site: http://www.ami.dk

*Finland (SFS)*
Address: Finnish Standards Association SFS, P.O. Box 116, FI-00241 Helsinki
TEL.: +358 9 149 93 31
FAX: +358 9 146 49 25
E-mail: sfs@sfs.fi
Web site: http://www.sfs.fi/

*France (AFNOR)*
Address: Association française de normalisation, Tour Europe, FR-92049 Paris la Défence Cedex
TEL.: +33 1 42 91 55 55
FAX: +33 1 42 91 56 56
E-mail: international@email.afnor.fr
Web site: http://www.afnor.fr/

*France (INRS)*
Address: Institut national de recherche et de sécurité pour la prevention des accidents du travail et des malades professionnelles (National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases), INRS, 30, rue Olivier-Noyer, F-75680 Paris Cedex 14
TEL.: +33 1 40 44 30 00
FAX: +33 1 40 44 30 99
E-mail: info@inrs.fr
Web site: http://www.inrs.fr

*Germany (BG)*
Berufsgenossenschaft, Pappelallee 35/37, D-22089 Hamburg
TEL.: +49 40 20207 0
FAX: +49 40 20207 525

*Germany (DFG)*
Address: Deutsche Forschungsgemeinschaft, Kennedyallée 40, 53175 Bonn
TEL.: +49 228 885 1
FAX: +49 228 885 2777
E-mail: postmaster@dfg.de

*Germany (DIN)*
Address: DIN Deutsches Institut für Normung, Burggrafenstrasse 6, DE-10787 Berlin
Postal address: DE-10772 Berlin
TEL.: +49 30 26 01-0
FAX: +49 30 26 01 12 31
E-mail: directorate.international@din.de
Web site: http://www.din.de

*Germany (VDI)*
Address: VDI Professional Division, P.O. Box 10 11 39, D-40002 Düsseldorf
TEL: +49 211 62 14 - 277 / 274
FAX: +49 211 62 14 - 575
E-mail: hg@vdi.de

*Greece (ELOT)*
Address: Hellenic Organization for Standardization, 313, Acharnon Street, GR-111 45 Athens

TEL.: +30 1 21 20 100
FAX: +30 1 21 20 131
E-mail: elotinfo@elot.gr
Web site: http://www.elot.gr/

*Ireland (NSAI)*
Address: National Standards Authority of Ireland, Glasnevin, IE-Dublin-9
TEL.: +353 1 807 38 00
FAX: +353 1 807 38 38
E-mail: nsai@nsai.ie
Web site: http://www.nsai.ie/

*Netherlands (NNI)*
Address: Nederlands Normalisatie-instituut, Kalfjeslaan 2, P.O. Box 5059, NL-2600 GB Delft
TEL: +31 15 2 69 03 90
FAX: +31 15 2 69 01 90
Telegram: normalisatie delft
E-mail: info@nni.nl
Web site: http://www.nni.nl

*Norway (NSF)*
Address: Norges Standardiseringsforbund, Drammensveien 145 A, Postboks 353 Skoyen, NO-0213 Oslo
TEL: +47 22 04 92 00
FAX: +47 22 04 92 11
E-mail: firmapost@standard.no
Web: http://www.standard.no/

*Portugal (IPQ)*
Address: Instituto Português da Qualidade, Rua António Gião, 2, PT-2829-513 Caparica
TEL: +351 21 294 81 00
FAX: +351 21 294 81 01
E-mail: ipq@mail.ipq.pt
Web site: http://www.ipq.pt/

*Spain (INSHT)*
Address: Instituto Nacional de Seguridad e Higiene en el Trabajo, Torrelaguna 73, E-28027 Madrid
TEL.: +34 91 403 70 00
FAX: +34 91 403 00 50
E-mail: info@insht.es
Web site: http://www.mtas.es/insht

*Sweden (NIWL)*
Address: Arbetslivsinstitutet (National Institute for Working Life) Warfvinges väg 25, SE-112 79 Stockholm
TEL.: +46 8 619 67 00
FAX: +46 8 619 67 28
Web site: http://www.niwl.se/niwl.htm

*Switzerland (SNV)*
Address: Swiss Association for Standardization, Mühlebachstrasse 54, CH-8008 Zürich
TEL: +41 1 254 54 54

FAX: +41 1 254 54 74
E-mail: info@snv.ch
Web site: http://www.snv.ch/

*United Kingdom (BSI)*
Address: British Standards Institution, 389 Chiswick High Road, GB-London W4 4AL
TEL: +44 208 996 90 00
FAX: +44 208 996 74 00
E-mail: standards_international@bsi.org.uk
Web site: http://www.bsi.org.uk

*United Kingdom (HSL)*
Address: Business Development Unit, Health & Safety Laboratory, Broad Lane, Sheffield S3 7HQ
TEL: +44 114 289 2920
FAX: +44 114 289 2830
E-mail: hslinfo@hsl.gov.uk

*USA (ANSI)*
Address: American National Standards Institute, 11 West 42nd Street, 13th floor, New York, NY 10036
TEL: +1 212 642 49 00
FAX: +1 212 398 00 23
E-mail: info@ansi.org
Web site: http://www.ansi.org/

*USA (NIOSH)*
Address: NIOSH, Hubert H. Humphrey Building, 200 Independence Avenue, S.W., Room 715, Washington, DC 20201
TEL.: +1 202 401 3749.
FAX: +1 202 260 1898
Web site: http://www.cdc.gov/niosh
Other address: Research Centers: Robert A. Taft Laboratory, 4676 Columbia Parkway, Cincinnati, Ohio 45226
TEL.: +1 513 533 8465
FAX: +1 513 533 8371

*USA (OSHA)*
Address: U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 200 Constitution Avenue, N.W., Washington, DC 20210
Other address: OSHA Salt Lake Technical Center, USDOL/OSHA/DTS/SLTC, 1781 South 300 West, Salt Lake City, UT 84115-1802
TEL: +1 801 487 0680

*USA (EPA)*
Address: Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460 USA
TEL: +1 202 260-2090

## OTHER SOURCES

Further addresses from ISO member bodies are located on the ISO web site http://www.iso.ch/addre.html.

Addresses of further research organizations are located on the EC Agency web site http://europe.osha.eu.int/ ⇒ research ⇒ research institutions. This includes the INRS INOR database accessible directly from http://www.inrs.fr/home/ENhomerecherche.html

NOTE: All web addresses are liable to change at short notice.

## REFERENCES


1. Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work (14th individual directive within the meaning of Article 166(1) of Directive 89/391/EEC).
2. EN 482:1994 Workplace atmospheres: General requirements for the performance of procedures for the measurement of chemical agents.
3. EN 838:1995 Workplace atmospheres: Requirements and test methods for diffusive samplers for the determination of gases and vapours.
4. EN 1076:1995 Workplace atmospheres: Requirements and test methods for pumped sorbent tubes for the determination of gases and vapours.
5. EN 1231:1996 Workplace atmospheres: Requirements and test methods for short term detector tube systems.
6. P. Eller and M. Cassinelli (Eds.). NIOSH Manual of Analytical Methods (NMAM), 4th ed., DHHS (NIOSH) Publication No 94-113 (1994).
7. OSHA Analytical Methods Manual, OSHA Analytical Laboratory, Salt Lake City, Utah (various methods, 1979–90, updated regularly).
8. OSHA Chemical Sampling Information database, 1997, OSHA Analytical Laboratory, Salt Lake City, Utah.
9. Prèlévement et analyse des pollutants organiques gazeux - support: charbon actif - fiches d'application de la norme NF X 43-252. INRS, 1990.
10. Prèlévement et analyse des pollutants organiques gazeux - support: gel de silice - fiches d'application de la norme NF X 43-258. INRS, 1990.
11. V. Blachere, J. Delcourt, L. Marsaud, J. C. Protois, A. Rolin, J. P. Sandino, R. Vincent. Cahiers de Notes Documentaires, 157, 451–459 (1994).
12. Analytical methods for the determination of carcinogenic substances in workplace air, Von der Berufgenossenschaften anerkannte Analysen verfahren zur Fest stellung der Konzentrationen krebserzeugender Arbeitsstoffe in der Luft in Arbeitsbereichen, 3rd ed., Carl Heymanns Verlag, Köln (1993).
13. Analytical methods for testing harmful substances, Analytische Methoden zur Prüfung gesundheitsschädlicher Arbeitsstoffe. A. Kettrup (Ed.), Th zur Mühlen, J. Angerer, Band 1, (looseleaf plus supplements), 1976–1993. Luftanalysen, Verlag Chemie, Weinheim.
14. Analyses of hazardous substances in air. A. Kettrup (Ed.), Vol. 1 (1991); Vol. 2 (1993); Vol. 3 (1999); Vol. 4 (1999). Verlag Chemie, Weinheim.
15. VDI-DIN-Handbuch Reinhaltung der Luft, von der Kommission Reinhaltung der Luft in VDI and DIN, (updated regularly, latest edition, August 1997) Verein Deutcher Ingenieure VDI, Dusseldorf.
16. Measurement of hazardous substances - BIA - Working folder - Determination of exposure to chemical and biological agents. BIA, Sankt Augustin, Germany (1997).
17. J. P. Lodge. Intersociety Committee. Methods of Air Sampling and Analysis, 3rd ed. Lewis Publishers, Chelsea, MI, USA.
18. W. T. Winberry, Jr., N. T. Murphy R.M. Riggin. Methods for Determination of Toxic Organic Compounds in Air. Compendium of methods for the determination of toxic organic compounds in ambient air. Environmental Protection Agency report EPA/600-4-89/018. June 1988, EPA, Research Triangle Park, NC.

19. K. Leichnitz. Gefahrstoff-Analytik, Vol. 47, section II -1.2 Analysenvervahren. Ecomed Verlagsgesellschaft (1998).
20. J.-O. Levin. Principer och metoder för provtagning och analys av ämnen på listan över hygieniska gränsvärden. Arbete och Hälsa, 1997:6 (1997).