

COLLECTIVE EXPERT APPRAISAL: SUMMARY AND CONCLUSIONS

Regarding the "expert appraisal for recommending occupational exposure limits for chemical agents"

Assessment of health effects and methods for the measurement of exposure levels in workplace atmospheres for

Methylamine (CAS No. 74-89-5)

This document summarises the work of the Expert Committee on expert appraisal for recommending occupational exposure limits for chemical agents (OEL Committee) and the Working groups on health effects and on metrology.

Presentation of the issue

On 12 June 2007, AFSSET, which became ANSES in July 2010, was requested by the Directorate General for Labour to conduct the expert appraisal work required for establishing recommendations on measures to be taken in the event of specific exposure profiles such as those with peaks.

A first report¹ published in June 2009 issued recommendations on measures to be taken in the event of an 8h-OELV with no short-term exposure limit (STELV).

In 2010, ANSES published a second report that recommended studying the 36 substances in France with a short-term exposure limit but no time-weighted average (TWA) to recommend health values taken from the most recent scientific literature (ANSES, 2010).

In this context, an assessment was undertaken for methylamine, which has a short-term exposure limit in France set at 12 mg.m⁻³ in a Circular² of 1982 but no TWA.

Scientific background

The French system for establishing OELVs has three clearly distinct phases:

- Independent scientific expertise (the only phase entrusted to ANSES);
- Proposal by the Ministry of Labour of a draft regulation for the establishment of limit values, which may be binding or indicative;
- Stakeholder consultation during the presentation of the draft regulation to the French Steering Committee on Working Conditions (COCT). The aim of this phase is to discuss the effectiveness of the limit values and if necessary to determine a possible implementation timetable, depending on any technical and economic feasibility problems.

¹ http://www.anses.fr/ET/DocumentsET/VLEP_Picsdexpo_Avis_0906.pdf

² Circular of 19 July 1982 on the acceptable values for concentrations of certain hazardous substances in workplace atmospheres.

The organisation of the scientific expertise phase required for the establishment of Occupational Exposure Limits (OELVs) was entrusted to AFSSET in the framework of the 2005-2009 Occupational Health Plan (PST) and then to ANSES after AFSSET and AFSSA merged in 2010.

The OELs, as proposed by the Committee on expert appraisal for recommending occupational exposure limits for chemical agents (OEL Committee), are concentration levels of pollutants in workplace atmospheres that should not be exceeded over a determined reference period and below which the risk of impaired health is negligible. Although reversible physiological changes are sometimes tolerated, no organic or functional damage of an irreversible or prolonged nature is accepted at this level of exposure for the large majority of workers. These concentration levels are determined by considering that the exposed population (the workers) is one that excludes both children and the elderly.

These concentration levels are determined by the OEL Committee experts based on information available from epidemiological, clinical, animal toxicology studies, etc. Identifying concentrations that are safe for human health generally requires adjustment factors to be applied to the values identified directly by the studies. These factors take into account a number of uncertainties inherent to the extrapolation process conducted as part of an assessment of the health effects of chemicals on humans.

The Committee recommends the use of three types of values:

- 8-hour occupational exposure limit (8h-OEL): this corresponds to the limit of the time-weighted average (TWA) of the concentration of a chemical in the worker's breathing zone over the course of an 8-hour work shift. In the current state of scientific knowledge (toxicology, medicine, epidemiology, etc.), the 8h-OEL is designed to protect workers exposed regularly and for the duration of their working life from the medium- and long-term health effects of the chemical in question;
- Short-term exposure limit (STEL): this corresponds to the limit of the time-weighted average (TWA) of the concentration of a chemical in the worker's breathing zone over a 15-minute reference period during the peak of exposure, irrespective of its duration. It aims to protect workers from adverse health effects (immediate or short-term toxic effects such as irritation phenomena) due to peaks of exposure;
- Ceiling value: this is the limit of the concentration of a chemical in the worker's breathing zone that should not be exceeded at any time during the working period. This value is recommended for substances known to be highly irritating or corrosive or likely to cause serious potentially irreversible effects after a very short period of exposure.

These three types of values are expressed:

- either in $\text{mg}\cdot\text{m}^{-3}$, i.e. in milligrams of chemical per cubic metre of air and in ppm (parts per million), i.e. in cubic centimetres of chemical per cubic metre of air, for gases and vapours;
- or in $\text{mg}\cdot\text{m}^{-3}$, only for liquid and solid aerosols;
- or in $\text{f}\cdot\text{cm}^{-3}$, i.e. in fibres per cubic centimetre for fibrous materials.

The 8h-OELV may be exceeded for short periods during the working day provided that:

- the weighted average of values over the entire working day is not exceeded;
- the value of the short term limit value (STEL), when it exists, is not exceeded.

In addition to the OELs, the OEL Committee assesses the need to assign a "skin" notation, when significant penetration through the skin is possible (ANSES, 2014a). This notation

indicates the need to consider the dermal route of exposure in the exposure assessment and, where necessary, to implement appropriate preventive measures (such as wearing protective gloves). Skin penetration of substances is not taken into account when determining the atmospheric limit levels, yet can potentially cause health effects even when the atmospheric levels are respected.

The OEL Committee assesses the need to assign an “ototoxic” notation indicating a risk of hearing impairment in the event of co-exposure to noise and the substance below the recommended OELs, to enable preventionists to implement appropriate measures (collective, individual and/or medical) (ANSES, 2014a).

The OEL Committee also assesses the applicable reference methods for the measurement of exposure levels in the workplace. The quality of these methods and their applicability to the measurement of exposure levels for comparison with an OEL are assessed, particularly with regards to their compliance with the performance requirements in the NF-EN 482 Standard and their level of validation.

Organisation of the expert appraisal

ANSES entrusted examination of this request to the Expert Committee on expert appraisal for recommending occupational exposure limits for chemical agents (OEL Committee). The Agency also mandated:

- The working group on health effects to conduct the expert appraisal work on health effects;
- The working group on metrology to assess measurement methods in workplace atmospheres.

The methodological and scientific aspects of the work of this group were regularly submitted to the Expert Committee.

The report produced by the working group takes account of observations and additional information provided by the Committee members.

This expert appraisal was therefore conducted by a group of experts with complementary skills. It was carried out in accordance with the French Standard NF X 50-110 “Quality in Expertise Activities”.

Preventing risks of conflicts of interest

ANSES analyses interests declared by the experts before they are appointed and throughout their work in order to prevent potential conflicts of interest in relation to the points addressed in expert appraisals.

The experts’ declarations of interests are made public on ANSES's website (www.anses.fr).

Description of the method

For the assessment of health effects:

A summary report on the health effects of methylamine was prepared by the working group (WG) on health effects and submitted to the OEL Committee, which commented on it and added to it.

The summary report was based on bibliographic information taking into account the scientific literature that had been published on this substance up to 2013. The literature search was carried out using the summary report produced by the National Toxicology Program (NTP, 1996) and the interim document regarding AEGLs³ of the US-EPA⁴ (2008) and articles found in the Medline, Toxline and HSDB (ToxNet) databases.

For assessment of methods for measuring exposure levels in workplace:

A summary report was prepared by the working group on metrology and submitted to the OEL Committee, which added its own comments.

The summary report presents the various protocols for measuring methylamine in workplace atmospheres grouped together based on the methods they use. These methods were then assessed and classified based on the performance requirements set out particularly in the French Standard NF EN 482: "Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents" and the decision-making criteria listed in the methodology report (ANSES, 2014a).

A list of the main sources consulted is detailed in the methodology report (ANSES, 2014a).

These methods were classified as follows:

- Category 1A: the method has been recognized and validated (all of the performance criteria in the NF-EN 482 Standard are met);
- Category 1B: the method has been partially validated (the essential performance criteria in the NF-EN 482 Standard are met);
- Category 2: the method is indicative (essential criteria for validation are not clear enough);
- Category 3: the method is not recommended (essential criteria for validation are lacking or inappropriate).

A detailed comparative study of the methods in Categories 1A, 1B and 2 was conducted with respect to their various validation data and technical feasibility, in order to recommend the most suitable method(s) for measuring concentrations for comparison with OELs.

The collective expert appraisal work and its conclusions and recommendations were adopted on 17 May 2014 by the OEL Committee.

The collective expert appraisal work and the summary report were submitted to public consultation from 12/06/2015 to 12/08/2015. The people or organizations who contributed to the public consultation are listed in appendix of the report (only available in French). The comments received were reviewed by the OEL Committee (term of office 2014-2017) who adopted this version on 7 march 2016.

³ Acute Exposure Guideline Levels

⁴ United States Environmental Protection Agency

Results of the collective expert appraisal on the health effects

Kinetics

No data were found in the literature regarding the absorption, distribution or metabolisation of methylamine in humans.

Experimental studies (rats) reported biphasic first-order excretion of methylamine in blood after administration of a single intravenous bolus dose (Streeter *et al.*, 1990). Some distribution parameters were also calculated in this study.

Moreover, still according to Streeter *et al.* (1990), methylamine is likely ionised at physiological pH and therefore does not build up in fatty tissues.

In mammals, semicarbazide-sensitive amine oxidase (SSAO), an enzyme identified in methylamine metabolisation, is capable of oxidising it, leading in particular to the formation of hydrogen peroxide, formate, formaldehyde and ammonia. Other methylamine metabolisation products have been identified, including monomethylurea (NTP, 1996; US-EPA, 2008; Yu *et al.*, 1990). It was reported that in most tissues, SSAO activity was higher in humans than in rats or pigs (sometimes ten times higher) (Boosma *et al.*, 2000).

It should be noted that methylamine has been identified as a product of the metabolism of xenobiotics (nicotine, N-methylformamide, methamphetamine) and endogenous substances (epinephrine, sarcosine, glycine and creatine) (Davis and deRopp, 1961; McKennis *et al.*, 1962; NTP, 1996; Schayer *et al.*, 1952; Tulip and Timbrell, 1988).

There are significant gaps in the data reported for humans. It was reported that 24 hours after ingestion, methylamine was found in urine, at approximately 2% of the ingested dose (Rechenberger, 1940 cited in US-EPA, 2008). It was also reported that in workers, urinary concentrations of methylamine (no information about the sampling time) were relatively insensitive to increases in exposure levels (Bittersohl and Heberer, 1980 cited in US-EPA, 2008).

Experimental studies essentially report data on the excretion of methylamine in unchanged form within 24 hours (in urine, 10% of the dose administered by i.v. or i.p. injection; in exhaled air, less than 0.1% of the dose administered by intraperitoneal injection) (NTP, 1996; Schwartz *et al.*, 1966; Streeter *et al.*, 1990).

General toxicity

Toxicity in humans

Acute and subacute toxicity

In humans, in situations of accidental exposure (with no knowledge of exposure levels), there have been reports of respiratory difficulty (to various degrees) that can lead to oedema, burning and necrosis of the pulmonary tissue, that can result in death (several days after the accident), tissue damage of the nose and mouth, and eye and skin lesions (US-EPA, 2008).

Above 100 ppm, an intolerable ammoniacal odour was described as well as nose and throat irritation, violent sneezing, coughing, a burning sensation of the throat, larynx constriction and difficulty breathing (US-EPA, 2008).

Irritation of the eyes and upper airways was reported for exposure levels of 20 to 100 ppm. Secondary sources report that the irritation threshold for methylamine is 8 ppm or 18 ppm according to various authors with no additional details (Izmerov *et al.*, 1982 and Ruth, 1986 cited in US-EPA, 2008).

The reported olfactory detection threshold differs greatly depending on the source, ranging from 0.008 to 9 ppm (Leonardos *et al.*, 1969 and Dabaev 1981 cited in US-EPA, 2008).

Chronic toxicity

As with the description of acute effects, chronic toxicity data in humans have only been taken from secondary sources, not giving a clear idea of the exposure levels associated with the described effects: allergic bronchitis was reported from 2 to 60 ppm and no effects were observed from 0.5 to 29 ppm (ACGIH, 2001; US-EPA, 2008).

Toxicity in animals

As with the studies in humans, the toxicity data have primarily been taken from secondary sources (the publications were not found in the scientific literature), not giving a clear idea of the exposure levels associated with the described effects. Often, only the LOAEL⁵ was reported in the consulted summary reports.

Acute and subacute toxicity

Exposure to very high concentrations of methylamine induces respiratory distress, as well as eye and lung lesions that can lead to death.

In rats, the following lethal concentrations for 50% of animals (LC₅₀) were reported (US-EPA, 2008):

- 9,600 ppm for 20 minutes of exposure;
- 4,800 to 7,100 ppm for 60 minutes of exposure;
- 1,700 to 4,800 ppm for four hours of exposure

It should be noted that some authors determined a LC₅₀ in rats of approximately 500 ppm for 150 minutes of exposure with death occurring up to 24 hours after exposure (US-EPA, 2008).

In animals, at high concentrations (exposure by inhalation), methylamine induces systemic effects, such as neurological effects and pathological lesions of the liver, thymus, pancreas, lungs and brain (US-EPA, 2008). Studies in rats (exposed for 30 minutes to 465 ppm) reported the occurrence of lung oedema with lymphocyte infiltration (one week after the end of exposure), followed by interstitial pneumonitis (four weeks after exposure) progressing to fibrosis (ten weeks after exposure) (Jeevaratnam and Sriramachari, 1994; Sriramachari and Jeevaratnam, 1994).

Kinney *et al.* (study conducted by industry) exposed, by inhalation (nose only), groups of ten eight-week-old male CD rats to 75, 250 or 750 ppm of methylamine, six hours per day, five days per week for 14 days and compared the results with those obtained for a group of ten rats exposed to air. After sacrifice (five animals after the 14 days and five animals 14 days after the end of exposure), various clinical, biological and anatomopathological examinations were performed.

At 750 ppm, the clinical examination of the animals showed hyperactivity and aggressiveness; they had ruffled fur and facial hair loss (several symptoms continued during the recovery period)

⁵ Lowest Observed Adverse Effect Level

and four animals died during the study. The anatomopathological examination showed dilation of the gastrointestinal tract, atrophy of the spleen and thymus related to lymphocyte depletion (reflecting the stressful state of the animals, according to the authors), bone marrow hypocellularity and hepatic necrosis.

The examination of the animals exposed to 750 ppm also showed several changes in the values of biological parameters (serum cholesterol, alanin and aspartate aminotransferase activity, serum proteins and haematological parameters), which returned to normal after a 14-day recovery period. At 250 ppm, with the exception of elevated blood urea nitrogen values, the biological examination did not show any other changes.

In all of the exposed groups, a reddish nasal discharge (more severe at 250 and 750 ppm) was observed. Effects related to the progression of respiratory tract irritation⁶ were observed (prevalence levels for lesions observed in the respiratory tract are given in Table 1):

- at 750 ppm: respiratory difficulty, lung noise, necrosis of the nasal cavity mucosa leading to atrophy and septal perforation; lung congestion);
- at 250 ppm: erosions, ulcerations and necrosis of the nasal cavity mucosa accompanied by blood clots.

Table 1: prevalence of respiratory tract lesions in rats exposed to methylamine (according to Kinney *et al.*, 1990)

Concentration (ppm)	0	75	250	750	0	75	250	750
Effects	Prevalence at D10* (%)				Prevalence at R14* (%)			
Focal interstitial pneumonitis	20	60	20	14	60	80	80	60
Lung congestion	0	20	0	43	0	0	0	30
Mucinous bronchiolitis	20	20	0	14	0	0	0	0
Tracheitis	0	40	0	29	20	20	0	0
Necrosis or ulceration of the respiratory mucosa	0	0	100	71	0	0	20	30

* D10: observations after ten days of exposure; R14: observations after 14 days of recovery.

Other effects such as rhinitis, blood clots in the nasal cavities and metaplasia of the nasal cavity mucosa have not been reported here since prevalence levels were very high in the controls.

In mice, rabbits and cats, the irritation threshold (determined using various methods such as decrease in respiratory rate and increase in salivation) was identified respectively at 141, 102 and 157 ppm (Gagnaire, 1989 and Izmerov *et al.*, 1982 and Gorbachev, 1957 cited in US-EPA, 2008).

Chronic toxicity

The neurotoxicity induced by methylamine and ammonia is likely due to their ability to induce the formation of nerve impulses (Pirisino *et al.*, 2005). Methylamine and ammonia act on the voltage-dependent neuronal potassium channels, inducing neurotransmitter release. Like ammonia, methylamine can cause hypophagia (reduction in feeding) in mice without inducing dopamine or serotonin release. In rats, methylamine stimulates the release of nitric oxide by the hypothalamus, which is associated with the occurrence of certain neurodegenerative diseases.

⁶ Temporary irritation was also observed at 75 ppm; it diminished after two weeks without exposure.

Dabaev *et al.* (1981) reported neurological effects at 0.008 and 0.042 ppm (not at 0.003 ppm). It should be noted that this study has methodological limitations that can call into question the reported results (not enough information regarding exposure, particularly the way in which the tested concentrations were measured; too many investigated effects such as genotoxicity in males and females and mutagenesis; non-specific blood markers, etc.).

According to the ACGIH⁷ (2001) document, there are no data on the carcinogenicity of methylamine in humans.

According to the US-EPA report, studies in female rats and mice exposed during gestation did not report any effects on the oestrous cycle, fertility indices, gestation, live birth, development, lactation or the average weight of pups at birth or weaning, but reported a significant decrease in average rat size at birth when the mothers had been exposed⁸ (Sarkar and Sastry, 1990 cited in US-EPA, 2008).

A 48-hour culture of mouse embryonic cells (at eight days) in methylamine (0.75; 1.0; 2.0 mM) caused a decrease in DNA, RNA and protein that was significantly correlated with the exposure dose. The authors assumed that methylamine may act as an endogenous teratogen in certain conditions (Guest and Varma, 1991).

Establishment of OELs

No conclusions can be drawn from the few data available in the literature as to the medium- or long-term systemic toxicity of methylamine.

The irritative and corrosive properties of methylamine are related to its alkalinity (pKa of 10.65 at 25°C). In humans and animals, studies have shown irritating effects of methylamine for the respiratory tract and eyes. There have also been reports in animals, at very high concentrations over short periods, of effects such as respiratory distress, eye lesions and lung lesions that can lead to death. These effects were accompanied by liver, thymus, pancreas and brain lesions.

Thus, in accordance with the methodological document on the establishment of limit values for irritants and corrosives, a 15min-STEEL can be recommended to protect workers from the irritating effects of methylamine. However, it does not appear relevant to recommend an 8h-OEL for this substance (ANSES, 2014b).

15min-STEEL

The study by Kinney *et al.* (1990) described above has some methodological advantages (use of a control group, exposure by inhalation). Therefore, despite some limitations (small study population and wide range of concentrations measured in the inhalation chambers), it was used to establish the 15min-STEEL.

Necrosis of the respiratory mucosa was selected as the critical effect. A dose-response relationship was found for this effect and a NOAEL⁹/LOAEL was determined. The experts considered that the LOAEL for this effect was 250 ppm (reversible effect after a recovery period) and that the NOAEL was 75 ppm, a level at which the authors reported "only mild nasal

⁷ American Conference of Governmental Industrial Hygienists

⁸ Daily oral exposure of female Wistar rats to 5 mg.kg⁻¹ of methylamine before mating.

⁹ No Observed Adverse Effect Level.

irritation", which was reversible after cessation of exposure. Thus, based on the NOAEL of 75 ppm, the OEL Committee proposes applying the following adjustment factors:

- an adjustment factor of 3 to take into account the small database;
- an adjustment factor of 3 to take into account inter-individual variability.

No adjustment factors were introduced to take into account inter-species variability; according to the methodology of the OEL Committee, in the case of a non-systemic effect (irritation and corrosion), the mechanism of action of the chemical substance varies little, irrespective of the species in question (bioavailability, metabolism, excretion and detoxification mechanisms do not impact the occurrence of local effects).

Therefore: $75 \text{ ppm} / 9 = 8.3 \text{ ppm}$ or 10.75 mg.m^{-3} (20°C conversion factor and 101 kPa^{10}).

This value of 10.75 mg.m^{-3} is rounded to recommend a 15min-STEEL of 11 mg.m^{-3} .

"Skin notation"

In the absence of a conclusion on systemic toxicity, the "skin" notation was not assigned for methylamine.

"Ototoxic notation"

In the absence of scientific data on the ototoxic effects of methylamine, the "ototoxic" notation was not assigned for this substance.

Results of the collective expert appraisal on measurement methods in workplace atmospheres

Four methods for measuring concentrations of methylamine in workplace atmospheres were identified and assessed in relation to the 15min-STEEL recommended by the OEL Committee (see Table 2).

¹⁰ Conversion factor : $1 \text{ mg.m}^{-3} = 0,772 \text{ ppm}$

Table 2: Assessment of methods for measuring concentrations of methylamine in workplace atmospheres

No.	Methods	Protocols ¹¹	Category ¹²	
			For regulatory technical control of the 15min-STEEL	For monitoring short-term exposure
1	Sampling in an impregnated glass fibre filter - high-performance liquid chromatography-mass spectrometry (HPLC-MS)	IRSST Amine analysis by LC-MS Method 363	3	
2	Sampling in a silica gel tube - desorption with an acetonitrile/m-toluoyl chloride mixture and NaOH or KOH - analysis by high-performance liquid chromatography with ultra-violet/visible detection (HPLC/UV-VIS)	INRS MétroPol 026: 2004	3	
3	Sampling in an active charcoal tube treated with sulphuric acid (preceded by a Teflon filter) - water desorption - analysis by ion chromatography with conductivity detection.	Methylamine BGIA Method 7853: 2005	2	1B
4	Sampling in an XAD-7 tube impregnated with NBD chloride - desorption in tetrahydrofuran - analysis by high-performance liquid chromatography with fluorescence or visible light detection.	Methylamine OSHA Method 40: 1982	1B	

The graph below presents the ranges for which the various methods were tested, as well as their limits of quantification in relation to the 15min-STEEL recommended by the OEL Committee.

¹¹ INRS: National Research and Safety Institute; IRSST: Institut de recherche Robert-Sauvé en santé et en sécurité du travail; BGIA: Berufsgenossenschaftliches Institut für Arbeitsschutz; OSHA: Occupational Safety and Health Administration.

¹² Validation and performance criteria for methods for monitoring STELs are defined in the NF EN 482 Standard from 0.5 to 2 times the STEL. Under the French regulations, for the technical control of the exposure limit, the measurement method must be able to measure one-tenth of the 15min-STEEL (Ministerial Order of 15 December 2009 on technical controls of occupational exposure limits in workplace atmospheres and conditions for accrediting the organisations in charge of controls, published in the OJ of 17 December 2009). As such, when a method cannot measure one-tenth of the 15min-STEEL, it cannot be classified in category 1A or 1B for regulatory control of the 15min-STEEL. However, it may be classified in category 1A or 1B solely for assessing occupational exposure.

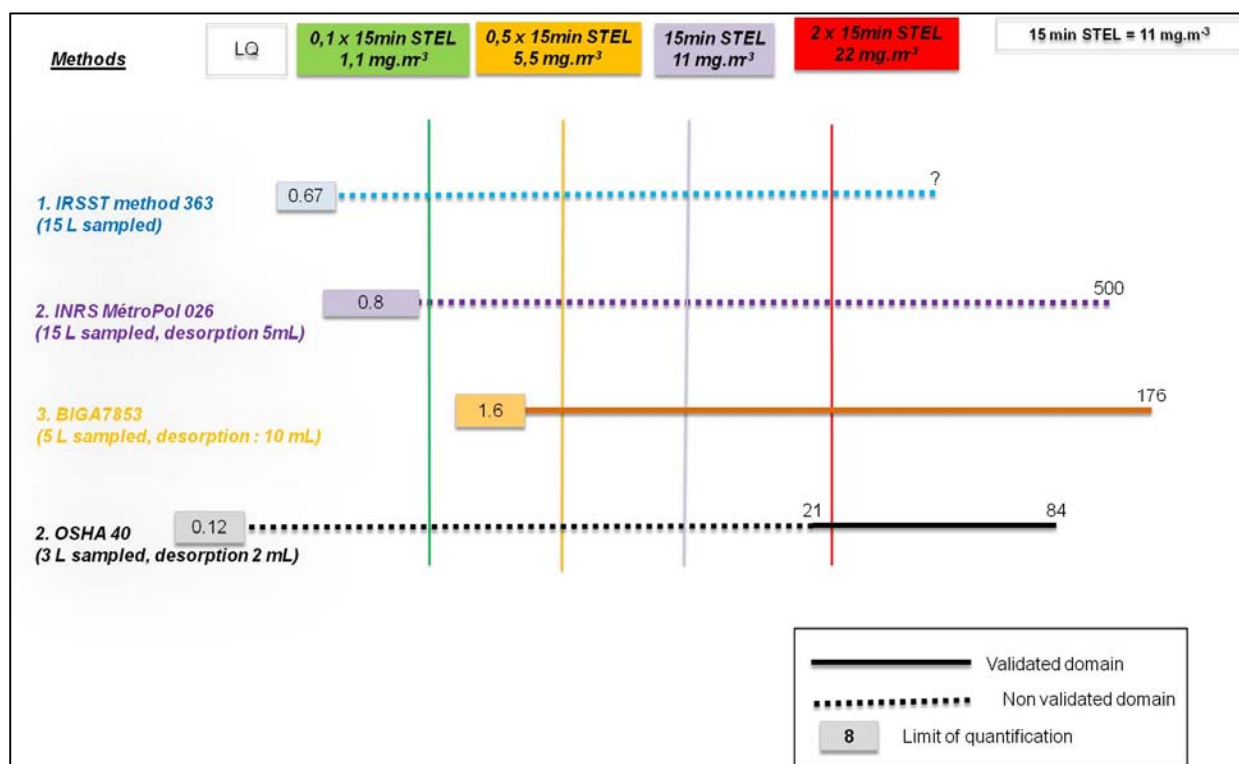


Figure 1: Ranges of validity and limits of quantification for the various compared methods from 0.1 to 2 times the 15min-STEEL recommended by the OEL Committee for methylamine

Of the four identified methods, considering the validation data presented and the available measurement range, only method 4 described in the OSHA 40: 1982 protocol meets the main requirements of the NF EN 482 Standard and can measure one-tenth of the 15min-STEEL. It has therefore been classified in category 1B for technical control of the 15min-STEEL and the monitoring of short-term exposure.

Method 3, described in the BGIA 7853: 2005 protocol, is validated for the range of 0.15 to 15 times the 15min-STEEL and meets the main requirements of the NF EN 482 Standard. It has therefore been classified in category 1B for the monitoring of short-term exposure. It cannot reach one-tenth of the 15min-STEEL recommended by the OEL Committee. However, with a desorption volume of 5 mL instead of 10 mL, the limit of quantification can be adapted. It has therefore been classified in category 2 for technical control of the 15min-STEEL.

Methods 1 and 2, described respectively in the IRSST 363 and INRS MétroPol 026 protocols, have been classified in category 3 due to the lack of published validation data.

Conclusions of the collective expert appraisal

Based on the data currently available for methylamine, the OEL Committee recommends establishing a 15min-STEEL of 11 mg.m⁻³ and does not recommend an 8h-OEL considering the data available.

The OEL Committee does not recommend a "skin" notation.

The OEL Committee does not recommend a "ototoxic" notation.

In light of the assessment of methods for measuring concentrations of methylamine in workplace atmospheres, the OEL Committee recommends, for the regulatory technical control of the 15min-STEEL and the monitoring of short-term exposure, the method described in the OSHA 40 protocol. This method, classified in category 1B, involves active sampling in a tube of impregnated XAD-7, desorption in tetrahydrofuran and analysis by high-performance liquid chromatography with fluorescence or visible light detection.

For the monitoring of short-term exposure, the OEL Committee also recommends the method described in the BGIA 7853 protocol involving active sampling in an active charcoal tube treated with sulphuric acid (preceded by a Teflon filter), water desorption and then analysis by ion chromatography with conductivity detection. This method is partially validated (category 1B classification) for the monitoring of short-term exposure but indicative (category 2 classification) for the technical control of the 15min-STEEL.

Further details: General information on the substance

1) Identification of the substance:

Name:	Methylamine
CAS No	74-89-5
EU No	200-820-0
Molecular weight	31.1
Empirical formula	CH ₅ N

2) Physico-chemical properties:

Physical form, appearance:	Gas with a strong smell of ammonia (odour threshold 0.02 ppm v/v)
Flash point:	- 30°C (combustible gas) - 18°C (40% aqueous solution)
Melting point:	- 93.5°C
Boiling point:	- 6.3°C
Solubility in water (hydrolysis?)	108 g.100 mL ⁻¹ at 25°C
Relative density (air=1)	1.07
Relative density (water=1)	0.7
Explosive limits (in % vol air)	4.9 - 20.7
Conversion factor	1 mg.m ³ = 0.772 ppm

3) Professional uses:

Methylamine is a highly reactive substance. It is used as a starting molecule in the synthesis of many organic substances containing nitrogen. These may have applications as diverse as use in agrochemicals, as biocides, plant protection products, food additives, surface treatments for metals, paints, petrochemicals, rubber, water treatment, etc.

Methylamine is marketed in the form of compressed gas, as an aqueous solution or as salts.

(Source: toxnet.nlm.nih.gov, accessed on 5/11/2013)

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Metrology section

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