Topic: B11. Policy, codes and guidelines

LATEST DEVELOPMENTS IN HEALTH CANADA'S RESIDENTIAL INDOOR AIR QUALITY GUIDELINES

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SUMMARY

Health Canada's residential indoor air program has traditionally been centered on the development of residential Indoor Air Quality guidelines, which set maximum exposure limits for a number of contaminants. The guidelines serve as recommendations only, and are not enforceable under any Canadian legislation or regulatory action. Instead, they serve as scientific rationale for local governments to adopt regulations to limit exposure. Also, they can motivate organizations to produce educational materials such that individuals can take action to protect themselves.

Revised guidelines have recently been released for formaldehyde and mould. The review process for guidelines on carbon monoxide, nitrogen dioxide, ozone and fine particulate matter are underway. In April 2007, Health Canada made the commitment to develop a priority list of indoor air contaminants which are national in scope and require government action. Pollutants included in the proposed priority list so far, are: benzene, toluene, xylenes, carbon dioxide (as an index of ventilation), house dust mites, diethylphthalate, polybrominated diphenyl ethers, *Legionella pneumophila*, and low relative humidity. Health Canada also conducts exposure studies in order to assess levels of exposure of Canadians and describe the impact of indoor air pollution sources.

INTRODUCTION

Health Canada established its first residential indoor air quality guidelines in 1987 (Health Canada, 1989). These guidelines assessed the health risks and, where possible, established indoor exposure limits for mould, formaldehyde, carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3) and fine particulate matter ($PM_{2.5}$). These guidelines are in the process of being revised, and new guidelines for mould and formaldehyde have since been completed (Health Canada, 2006 and Health Canada, 2007).

While not directly enforceable, Health Canada's Guidelines serve as the scientific foundation for activities to reduce the risk from indoor exposure to contaminants. When Health Canada issues a guideline documenting a potential risk, this may serve as a rationale for local governments to adopt regulations to limit exposure, and motivates organizations to produce educational materials such that individuals can take action to protect themselves.

In April 2007, the Government of Canada released a new Clean Air Agenda focused on reducing air emissions and improving air quality nationally, which also included a specific focus on indoor air quality. Specifically, the Minister of Health made the commitment to develop a priority list of indoor air contaminants, in consultation with the health departments of the provincial and territorial governments. The resulting priority list would then be used to guide Health Canada's actions to improve air quality, through the development of guidelines or other risk management activities. Health Canada is also committed to conducting exposure studies in order to provide information on background exposure as well as data for the development of models that describe the impact of air pollution sources, including the impact on indoor air.

METHODOLOGIES

Reviewing Exposure Limits and Establishing Guidelines

Currently, Health Canada's Residential Indoor Air Quality Guidelines focus on particular contaminants and employ a conventional risk assessment process: (1) Hazard Identification (What health impacts could the pollutant have?) (2) Dose-Response Assessment (How would health impacts vary with different concentrations of the pollutant?) (3) Exposure Assessment (How many people are exposed to the pollutant and to what levels?) (4) Risk Characterization (What are the health risks at specified concentrations?).

The assessment is based on a comprehensive literature search and critical analysis of published scientific studies concerning the sources, exposure levels and health hazards of the contaminant (based on both toxicological and epidemiological data). All such information must be evaluated in terms of its acceptability for use in carrying out the assessment. To be acceptable, the data must be both reliable and relevant. In the risk characterization step, the best available information on probable exposure levels in Canadian dwellings and the levels at which different adverse effects may occur are presented and analyzed. Qualitative and quantitative data are summarized and the causal relationship between exposure to the contaminant and health effects is discussed. In short, the nature of the risks, the circumstances under which various adverse effects may occur, and the likelihood that these health effects will occur, are described in detail and are used to derive a quantitative exposure level below which there are no (or limited) known observable adverse health effects.

For some contaminants it is not possible to set such quantitative exposure limits. In the case of mould, for example, it was not possible to set a concentration for any measure of mould in indoor air below which no health effects would occur. The best available scientific evidence showed only that the presence of mould indoors increased the likelihood of experiencing health symptoms. The purpose of these qualitative guidelines is to clearly communicate the potential health risks associated with exposure to these contaminants, even if we cannot specify a level of contamination at which health effects may occur.

Nomination Process for the Proposed Priority List

A candidate pool of contaminants for the Priority List was developed in consultation with the provinces and territories, as they have the primary responsibility for front-line public health interventions, and deal most directly with indoor air issues. It was also done to ensure that the list of selected contaminants would be national in scope.

Substances for which indoor air risk assessment have been or are being conducted (NO2, CO, Ozone, PM2.5, etc) were not considered part of the priority list, as the priority list was meant to focus on new contaminants which have not yet been assessed. It also excluded those contaminants which clearly fall under the jurisdiction of other Canadian government agencies. Pesticides, for example, where excluded from consideration as they are already assessed by the Pesticide Management Regulatory Agency (PMRA).

The discussions yielded a list of qualities that participants may consider when nominating a contaminant to the priority list including;

- Percentage of population exposed at levels of concern
- Need expressed by provinces / territories for specific guidelines/regulations
- Burden of illness caused by the pollutant and severity of effects
- Vulnerability to exposure
- Possible synergistic effects with other indoor air contaminants
- Existence of guideline/regulation in other jurisdictions
- Growing trends in prevalence and use
- Ability to measure concentration of pollutant in indoor air

Two separate consultations on the priority list were also held with representatives of health-focused non-government organizations and selected industry representatives.

Research Efforts to Support Guidelines Revision and Development

Information on the levels of indoor air contaminants currently found in Canadian homes is essential to both the identification of priorities for assessment and the risk assessment process itself. Given the significant regional variation in the sources of indoor air pollutants (particularly as a result of different heating and cooking systems), it would clearly be impossible to obtain an entirely representative sample of Canadian dwellings using data from a study conducted in a single region of the country. At the same time, a Canada-wide study would be impractical due to the significant resources that would be required. An acceptable compromise is to conduct a number of studies in different regions of the country using stratified sampling to ensure adequate representation of houses having the desired characteristics, even if the characteristics are less widespread in the regions selected than in the country as a whole.

There are three main objectives when research studies are conducted to support the revision and development of guidelines:

1. What are typical indoor residential air pollution levels in Canada?
2. What factors indoors are associated with the presence of high levels of these pollutants?
3. What is the contribution of outdoor sources to indoor concentrations of these pollutants?

Health Canada has collaborated with many regional partners to conduct exposure studies: Prince Edward Island (2002), Ottawa (2002-2003), Windsor, Ontario (2005-2006), Quebec City, Quebec (2005), Regina, Saskatchewan (2007), Montreal, Quebec (2008), and Halifax, Nova Scotia (2009).

RESULTS AND DISCUSSION

Revision Status of the 1987 Guidelines

Since 1987, significant research has been carried out and published on the health effects of some of the indoor contaminants. Newer toxicological and clinical studies now use a more refined assessment of health effects, including objective measures such as cellular and biochemical markers of inflammation in body fluids; while in older studies, pulmonary function and subjective parameters based on respiratory symptoms were used to characterize health effects. Also, there have been new developments in epidemiological exposure assessment, such that suitable epidemiological studies are now available for use as a basis for quantitative risk assessment. For the reasons mentioned above, most of Health Canada's indoor air guidelines need to be reassessed. Table 1 presents the existing guidelines and their revision status.

Table1. Summary of Health Canada Residential Indoor Air Quality Guidelines: Contaminants, Exposure Limits, and Date of issue/revision.

Contaminants	Exposure limits or recommendations	Date of issue/revision
Formaldehyde	50 $\mu g/m^3$ (40 ppb) per 8-hour average concentration 123 $\mu g/m^3$ (100ppb) per one hour average concentration	Issued in 2006
Mould	1. To control humidity and diligently repair any water damage in residences to prevent mould growth; and 2. To clean thoroughly any visible or concealed mould growing in residential buildings.	Issued in 2007
Carbon Monoxide (CO)	$\leq$ 10 ppm per 24-hour average concentration $\leq$25 ppm per one hour average concentration	Proposed in 2009
Nitrogen dioxide (NO_2)	$\leq$100 $\mu g/m^3$ ($\leq$0.05 ppm) per 8-hour average concentration $\leq$480 $\mu g/m^3$ ($\leq$0.25 ppm) per one hour average concentration	Issued in 1987 Revision in progress
Ozone (O_3)	$\leq$20 ppb 8-hour average concentration	Proposed in 2009

Fine Particulate Matter ($PM_{2.5}$)	≤40 μg/m^3 per 8-hour average concentration ≤100 μg/m^3 per one hour average concentration	Issued in 1987 Revision in progress

Proposed Priority List

The consultation process identified ten contaminants that were perceived to be of greatest concern to health by experts in the field:

- Benzene
- Toluene
- Carbon dioxide (as an index of reduced ventilation)
- House dust mites
- Naphthalene
- Diethylphthalate
- *Legionella pneumophila*
- Xylenes
- Polybrominated Diphenyl Ethers (PBDEs)
- Low relative humidity

This list shows a high degree of overlap with priority lists created by other international jurisdictions, as shown in Table 2. The fact that there is similarity in the priority lists reinforces the importance of assessing these particular contaminants. Health Canada intends to work with other organizations, particularly the World Health Organization, such that its guidelines are coherent.

Table 2. Contaminants nominated for inclusion in Health Canada's priority list, indicating which were declared a priority by the World Health Organization, the European Union and the Netherlands.

Nominated Priority Contaminants	WHO (WHO, 2006)	EU (EU, 2005)	Netherlands (Dusseldorp et al., 2007)
Napthlene	X	X	
Benzene	X	X	X
Toluene	X	X	
Xylenes	X	X	X
Carbon dioxide (index of ventilation)			X
House dust mites			X
Diethylphthalate	X		
Legionella pneumophila			X
Polybrominated Diphenyl Ethers (PBDEs)	X		
Low Relative Humidity			

Exposure Research Results Supporting Guidelines Revision and Development

The study conducted in 96 homes in Quebec City in the winter of 2005 investigated the relationship between air change rates and indoor concentrations of formaldehyde (Gilbert et al., 2008). It was thus possible to estimate the air change rate that ensures a formaldehyde concentration below Health Canada's guideline (Table 3).

Table 3: Air change rate and predicted proportion of homes with formaldehyde concentrations below Health Canada guideline (50 µg/m^3)

Sample/sub-sample	Air change rate ($h^{-1)}$ associated with formaldehyde level <50 µg/m^3 in 95% of homes
Entire sample (n=96)	0.26
Homes heated mainly by electrical baseboard heaters (n=32)	0.37
Homes with a recent source of formaldehyde off-gassing (n=39)	0.34

These results indicated that the air change rates in the homes sampled were relatively low compared to the rate of 0.35 h^{-1} recommended by ASHRAE Standard 62-1999 (1999), and that ASHRAE's recommendation appears sufficient to ensure a formaldehyde concentration within the 50 µg/m^3 guideline in most homes. However, some specific sub-groups such as homes with new off-gassing sources and those heated by electrical baseboard heaters may require a higher air change rate or source-rate reduction measures to keep formaldehyde levels within the current Health Canada guideline. Also, no inference could be made for homes less than five years old, because only four of these homes were included in this study. The reason for which formaldehyde was higher in homes with baseboard heating has not been determined.

CONCLUSIONS

There are practical limits to how many contaminants may be assessed by Health Canada. The final selection for inclusion on the Priority List is based on comments received during consultation with public health, environmental and industry groups, along with logistical criteria related to technical feasibility and in consideration of complementary Government actions. There is a need to continue research efforts in order to obtain data on Canadians' exposure to contaminants identified in the priority list, and to identify pollutant sources and building characteristics associated with the observed levels of exposure.

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