

Crematoria Environmental Emissions and Risks

Original title: Why citizens are saying NO to the construction of a crematorium in St-Bruno de Montarville: The environmental aspect and health risks

Translated from the document dated February 29, 2020 and revised July 7, 2020 by Robert Forget Ph.D.

List of acronyms

APEI : Air Pollutant Emission Inventory Report, Environment and Climate Change Canada
CANA : Crematorium Association of North America
CFDGM : Coopérative Funéraire du Grand Montréal
D/F : Dioxins and furans
EPA : Environmental Protection Agency, USA
HCl : Hydrochloride acid
Hg : Mercury
MECP : Ministry of the Environment, Conservation and Parks, Ontario
MELCC : Ministère de l'Environnement et de la Lutte contre les Changements Climatiques, Québec
PCDD : polychlorinated dibenzo-p-dioxins
PCDF : polychlorinated dibenzofurans
PM_{2.5} : Particule Matter ≤ 2.5 microns
POI : Point-of-Impingement concentrations
RAA : Règlement sur l'assainissement de l'atmosphère, Québec
µg : micrograms (1E-6 grams)
ng : nanograms (1E-9 grams)
pg : picograms (1E-12 grams)
WHO : World Health Organisation

In recent months, the citizens of Saint-Bruno in the province of Quebec have mobilized against the construction of a crematorium on Parent Street at the entrance to the city and less than 25 metres from a residential neighbourhood. On January 27th 2020, under pressure from citizens and citing the social unacceptability of this project, the St-Bruno de Montarville municipal council voted unanimously against the establishment of a crematorium to be built by the Coopérative Funéraire du Grand Montréal (CFDGM).

Behind this “social unacceptability” are many valid reasons. For example, the increase in traffic and the lack of consideration for the parking spaces that will overflow onto Parent Street, which is a small street 11 metres wide, and the surrounding residential streets. The fact that this traffic would increase the risk of accidents for children and adults travelling on the bicycle path bordering this street. The fact that a crematorium is an industry that has nothing to do with a neighbourhood business. The fact that the establishment of such a crematorium will decrease the value of neighbouring houses. And last, but not least, the fact that a crematorium is a polluting industry with toxic emissions that are dangerous to the environment and to health.

It is this last point that is the subject of this paper. Being a neurophysiologist and a researcher (professor at the School of Rehabilitation of the Faculty of Medicine of the Université de Montréal for 27 years, founder and scientific director for 10 years of an interdisciplinary research centre subsidized by the Fonds de Recherche du Québec en Santé and the Fonds de Recherche du Québec Société et Culture), I will therefore document here, with a brief review of the scientific literature, the evidence and validity of my statements and reflections on this subject.

Crematorium emissions

Scientific studies clearly show that crematory ovens release pollutants and toxins. Indeed, crematoriums produce emissions of airborne particles, metals, volatile and non-volatile organic compounds, hydrogen chloride, combustion gases and odours. Although some of these releases may be within the maximum standards issued by governments over a specific period of time, no studies appear to consider hazardous materials that accumulate over time and remain in the environment (i.e., bioaccumulate), exposing the population or entering the food chain, for example. Of these releases, dioxins are probably the most dangerous and toxic.

“Dioxins” is the term generally used to include PCDDs (polychlorinated dibenzo-p-dioxins) and PCDFs (polychlorinated dibenzofurans). The formation of PCDD/Fs is the result of chemical reactions produced at high temperatures between chlorine and organic compounds. The main sources of dioxins are anthropogenic (man-made) and mainly from incineration processes and combustion (such as wood burning) (Dopico and Gomez 2015).

Dioxins and cremation

The procedures and bodies incinerated in crematoria are the source of dioxin emissions (Alcock et al., 1999). The body contains chlorine (think of NaCl salt) and thus the cremation of bodies produce dioxin. Although the inventories of the 1990s estimate that crematoriums are the source of nearly 1% of the dioxins emitted in Europe (Landesrumweltaamt, 1997) and the United States (USEPA, 1998), crematoriums nevertheless remain a significant source of dioxins and their contribution, as we shall see below, is constantly increasing.

Indeed, several scientific studies have demonstrated that there are toxic emissions of PCDD/F and mercury from crematoria (see literature review by Mari and Domingo 2010). Because of their toxic properties, in addition to their ability to persist, the 2001 Stockholm Convention on Persistent Organic Pollutants put PCDD/Fs on the list of the 12 most toxic “dirty dozen” products in the world, whose levels should be significantly reduced. Wang et al, (2003) mention that the U.S. Environmental Protection Agency (EPA) reported that there appears to be no “safe” level of exposure to dioxins and that dioxin levels in the general U.S. population are “at or near levels associated with adverse health effects” (US EPA 2000). Of the various ways of direct exposure to these pollutants, inhalation appears to be the most important route (Nadal et al., 2004).

Wang et al (2003) report that ground-level PCDD/F concentrations near crematoria (2 sites at distances of 65 and 80 m from the chimney) are highest on the prevailing wind side and 22 times higher than in residential areas and even 2.7 times higher than in industrial areas. These authors also report that annual dioxin emissions from crematoria in the USA are 2 to 7 times higher than those in Japan (although 99.8% of people are incinerated in Japan).

In an article entitled “Review of the current state and main sources of dioxins around the world”, Dopico and Gomez (2015) report that a human body incinerated in the 2000s in a crematorium in Asia emits about 9.85 micrograms (median between 6.1 and 13.6) I-TEQ of dioxins, while it emits 3 microgram I-TEQ of dioxins if incinerated in Europe. In comparison, the combustion of 1 kg of untreated wood emits 1.32 nanograms (median between 0.077 and 2.57) I-TEQ of dioxins (Lavric et al. 2004). Thus, the incineration of a single human body would produce in dioxins the equivalent of burning between 7.5 tonnes (in Asia) and 2.3 tonnes (in Europe) of untreated wood. A single body incinerated (for example in Europe) would therefore produce an amount of dioxin equivalent of 383 houses burning 6 kg of wood.

Dioxins are toxic to health

According to Mandal's (2005) scientific literature review, dioxins are highly persistent contaminants in the environment and one of the most potent toxins. They can induce a broad spectrum of biological responses, including disruption of hormone signalling, genes and protein synthesis, reproductive and developmental defects, immunotoxicity, liver damage, wasting syndrome (severe weight loss) and cancer. As a reference point, it should be noted that Agent Orange, used by Americans in Vietnam and elsewhere in the world as a defoliant, contained herbicides and dioxins. On a smaller scale, let us also recall the serious Seveso accident in Italy in 1976 involving a spill of dioxins into the atmosphere. This disaster affected thousands of residents and gave rise to scientific studies on these populations for several decades, confirming a significant increase in cancers among disaster victims (Bertazzi et al., 2001; Pesatori et al., 2009). This accident also resulted in regulation of the industry which, to date, corresponds to the industrial safety regulations of the European Union known as the [Seveso III Directive](#) effective June 2015.

A study that deserves to be cited, in terms of the number of people monitored, is that of Dummer et al, (2003). This study, which covered nearly a quarter of a million births (244,758 births over a 40-year period between 1953 and 1993), was carried out on people living near incinerators and crematoria in England, showed a significant increase in congenital anomalies, particularly spina bifida (a defect in the development of the neural tube leading to walking disabilities) and cardiac defects in newborns.

Emission standards for crematoria in North America

Unfortunately, there is a lack of independent North American studies on the environmental rules for crematoria. The Crematorium Association of North America (CANA) issued standards of practice following their emissions tests in 1999. These standards have become the EPA's (Environment Protection Agency, USA) reference for crematorium emissions in the USA (Mari and Domingo, 2010). Even today, after a search on the EPA website for information on crematorium regulations, one can read: "General information about environmental and safety issues of cremation is available from the Cremation Association of North America (CANA)". This appears to be an apparent conflict of interest and a blatant lack of objectivity.

In Quebec, emission standards must follow the Environment Quality Act and particularly the Regulation respecting the cleanliness of the atmosphere (RAA: Règlement sur l'assainissement de l'atmosphère). However, crematoriums are in a separate category and their rules are dictated by Chapter VIII of the RAA. Thus, crematoriums are only required to report the sampling of total particulate emissions every 5 years. Unlike incinerators (which they are), they are not required to sample other contaminants (such as fine particles (PM_{2.5}), dioxins, HCl, mercury and other pollutants) as required annually by Chapter VII of the RAA for incinerators. Therefore, when the CFDMG reports that they are at 60% of the limit of the permitted standards, this only concerns total particles and not even fine particles (PM_{2.5}) that penetrate deep into the lungs. What about other pollutant measurements? Why not publish their figures? If crematoriums say "beyond any doubt" that they pose "no risk to public health or the environment" then prove it, because that is not what the scientific literature and emission reports indicate. Our optimistic impression is that they do not know it because they are simply following Quebec regulations.

The MELCC (Ministère de l'Environnement et de la Lutte contre les Changements Climatiques) now requires atmospheric dispersion modeling of the contaminants emitted prior to the construction of a crematorium or the installation of a new cremation unit in order to ensure compliance with atmospheric quality standards and criteria and to issue the required ministerial authorization. It must be understood that modelling is the creation of a model that attempts to predict and generalize a complex phenomenon. Although the MELCC tells us that several factors

are taken into consideration, such as the worst weather conditions and prevailing winds, the regulations also seem to require modelling under normal operating conditions. Since the cremation unit has not yet been installed, this modeling is provided by the manufacturer of the cremation unit. In addition, the direction of prevailing winds does not appear to be a factor that is taken into consideration when locating a crematorium, but only when determining the height of the chimney. Doesn't this push the problem into the neighbour's yard?

What about the fact that the city of St-Bruno, and other cities no doubt, ask crematoriums to keep the chimney as low as possible so as not to be visible. This seems to reflect ignorance of the regulations and the discharge of contaminants. How could such a crematorium be built on Parent Street in St-Bruno, less than 25 meters from the residences, when this entire residential area receives its dominant winds from the very direction (west, southwest) where the crematorium would be located?

What about the fact that 37 of the 85 crematoriums (44%) established in Quebec are located less than 20 meters from residences and homes? Or that 75 of these 85 crematoriums (88%) are less than 300 metres from homes? (S.M.Piamonte 2020, published on the COCARH website). This does not seem to be a reflection of a regulation that takes seriously into account the prevailing winds, the discharge of highly polluting and toxic contaminants such as fine particles of less than 2.5 microns, dioxins as well as mercury and their bioaccumulation. In some countries (e.g. Western Australia) and municipalities (e.g. Mississauga, Ontario) a buffer distance of 300 m is mandatory between crematoriums and sensitive areas (such as residences, daycares, schools, shopping centres).

The MELCC does not sample crematorium fumes or test for bioaccumulation of pollutants in the immediate environment of crematoriums. For the Ministry, if the initial pre-construction modeling is within standards, then it is assumed that the criteria will be met in the future and that ambient air monitoring is generally not required to ensure this. In these circumstances, there is no sampling of contaminant releases (other than total particulate matter), either by crematoriums that are not required to do so by current legislation, or by the MELCC relying on the crematorium manufacturer's modeling. In addition, it does not take into consideration possible wear, malfunction and operator errors. Yet, the number of crematoriums is constantly increasing, as are their polluting and toxic emissions.

Polluting and toxic emissions from crematoriums are increasing in Canada.

According to Canada's 2019 Air Pollutant Emission Inventory (APEI), which shows the change in emissions from 1990 to 2017 in Canada, 14 of the 17 air pollutants covered have decreased from their historical levels from all sources. However, crematoriums are the exception and their emissions increased gradually and systematically over this period. Crematoriums emit 10 of these pollutants, including two of the most toxic, mercury (Hg), a toxic metal under the Canadian Environmental Protection Act, and dioxins and furans (D/F), which are persistent organic pollutants.

For the year 2017, when looking at pollution sources, the "Incineration and Waste Sources" category, which includes crematoria, is the largest source of hexachlorobenzene (HCB) (61%) and dioxins and furans (D/F) (37%). Incineration contributes 15% of total mercury emissions in Canada and crematoria are the largest source of emissions (64%) in this category with 280 kg of mercury emitted in 2017. Crematoria also contribute 13% of the dioxin and furan emissions produced by incineration and 4.8% of the emissions of these toxins from all sources combined.

What is very interesting in this report is the comparative evolution from 1990 to 2017 of the 12 most polluting products. Thus, during this period, the emissions of these products in the category "Incineration and Waste

Source” decreased on average by 42.6% (only the emissions of 3 pollutants out of 12, i.e. sulphur, lead and polycyclic aromatic hydrocarbons (PAHs) increased slightly by 26%, 21% and 6%, respectively). What is striking, however, is the increase in all products emitted by crematoria in this category. Indeed, the emission of 10 of the 12 polluting products (with the exception of ammonia and PAHs, which are not or only slightly emitted by crematoria) increased on average by 262% (range between 162% for fine particles (PM < 2.5µ) and 291% for dioxins and furans) for crematoria during this period.

Emissions studies of a Burlington, Ontario crematorium

Following a request from the City of St-Bruno, a study of the impact of crematoriums on air quality was presented to the citizens of the city at an information meeting held at the Centre Marcel-Dulude on January 20, 2020. This study (available on the City of St-Bruno's website), prepared by Wood Environment & Infrastructure Solutions in October 2019, was commissioned by Pyrox Industries, a Montreal industry that manufactures crematoriums for humans and animals in the United States and Canada. It was done as part of a compliance source testing study of the Bayview Crematorium in Burlington, Ontario. Although the results of the study show that the emissions meet the standards issued by the Ontario Ministry of the Environment (Table ES.4 shows the Ministry of the Environment, Conservation and Parks (MECP) Point-of-Impingement (POI) concentrations), the summary of results in Table 17 are revealing and of concern. Indeed, it can be seen that several compounds are emitted and that the concentration values of some pollutants are close to the maximum permitted limits.

Of particular note is a strong acid, hydrogen chloride (HCl at 79% of the maximum limit), which when mixed with water produces hydrochloric acid. The products that are close to the maximum limit are the most toxic, namely dioxins (at 94% of the maximum allowable limit). In addition, polluting and toxic compounds are emitted such as mercury (1.26%) toxic to the peripheral and central nervous system, cadmium (2.49%) which is carcinogenic and stores in the kidneys and liver and Benzo(a)pyrene (1.37%) listed as a Group 1 carcinogen by the World Health Organisation (WHO). In addition, odours reach 32.3% of the allowable limit and the concentration of total suspended particles (TSP) reaches 9.57% of the maximum limit.

It is therefore false to claim that there are no polluting and toxic emissions into the environment from a crematorium and that these emissions are harmless to health.

Many of these products bioaccumulate in the environment, and even if the concentrations are within the emission standards calculated over a short period of time (e.g. one hour for the duration of the test), the quantities emitted are deposited cumulatively over time and this is not taken into account in these reports or studies. Taking the example of the suspended particulate matter concentration (SPM), with an average emission rate of 0.0288 grams per second, this does not seem like much. However, multiplied by one hour (x 3600 seconds) and we get an emission of 103.68 grams. If we continue (x 8 hours of operation per day), we are at 829 grams (x 5 days per week) = 4.147 kilos per week. Not surprising, that citizens living near a crematorium, like the lady who spoke at the January 20th meeting, complain that their car is often dirty when they do not use it often. If we do the same type of calculation again with HCl (0.0396 g/s), we get 5.7 kilos of hydrogen chloride per week, and so on. What about extremely toxic products such as dioxins, which are already at the maximum allowable limit with 235 picograms/s, when there is no safe level of dioxins and that these emissions should be zero?

Finally, what should we make of the fact that the Bayview crematorium test was done on only one oven and that the crematorium proposed by the CFDGM would have two identical crematory ovens to the one in Bayview. We are entitled to assume that, if the number of ovens and therefore cremations is doubled, the levels of fumes should also double. This would imply that the total fume emissions of HCl and dioxins would double, thus exceeding the maximum allowable limits for these two compounds.

Conclusion

The scientific literature clearly demonstrates that crematoria emit pollutants and toxins into the atmosphere. Some of these pollutants, such as dioxins, are among the most dangerous in the world. Even the study that was provided to the city, which concluded that the air pollutants from the crematorium in Bayview, Ontario, are safe, shows worrisome levels of dioxins and hydrogen chloride that are close to the maximum limits allowed by the Ontario ministry. These limits would most likely be exceeded if the crematorium built in St-Bruno included two crematoriums ovens instead of one. In addition, the effects of bioaccumulation of these toxins have not yet been studied. These contaminants are found in higher concentrations in the immediate environment near the crematoriums, but are also transported by the winds. The geographical location of the St-Bruno industrial park means that, regardless of where the crematorium is located in the park, the prevailing winds would carry these pollutants to the city, which is also located on the mountainside. The number of crematoriums is constantly increasing. The latest Canadian pollutant emissions report shows that crematoriums emit 10 of the 12 most dangerous pollutants for the environment and health. While pollutant emissions have decreased by 50% since 1990 in Canada from all sources, they have increased by nearly 300% for crematoriums. In conclusion, the citizens of St-Bruno are right to be concerned. The risks of pollution and odour as well as health risks are not nil, quite the contrary. The principles of “precaution” and “social unacceptability” are invoked here to strongly oppose the construction of this crematorium.

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