

**A Review of Chronic Health Effects Information Disclosed on Material Safety
Data Sheets for Lead-Containing Products used in Canada**

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Report Authored By:

Paul A. Demers, Ph.D. (1,2)
Anne-Marie Nicol, Ph.D. (1,2)
Anya R. Keefe, M.Sc. (1)

1. School of Occupational and Environmental Hygiene, University of British Columbia
2. Centre for Health and Environment Research, University of British Columbia

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Introduction

Material Safety Data Sheets (MSDSs) are one of the primary means that users of hazardous chemicals have to guide them in the safe handling, as well as health effects, of products. The content and availability of MSDSs in Canada are regulated under the *Hazardous Products Act* (the *Act*), *Controlled Products Regulations* (*CPR*). The *Act and Regulations* are administered by the Workplace Hazardous Materials Information System (WHMIS), a federal program housed within Health Canada. Enforcement of the *Act* and the *CPR* has been delegated to the thirteen provinces and territories for most workplaces.

At the request of the WHMIS Division, an audit was performed on selected MSDSs for lead-containing products used in Canada to evaluate how well they complied with the requirements of the *Hazardous Products Act*, the *CPR*, and WHMIS Guideline documents. This report presents the findings of that review, focusing specifically on the disclosure of information regarding the some of the chronic health effects of lead. In addition, a readability review was undertaken to evaluate the clarity and reading level of the hazard information disclosed. Results of that analysis are also provided.

Chronic Health Effects of Lead Exposure

Lead has a very broad range of health effects. Exposure to excess levels can have an adverse impact on the nervous, reproductive, cardiovascular, haematological, as well as other organ systems [ATSDR, 1999]. For the purposes of this audit we have focused on its' carcinogenic, reproductive, and developmental effects because of their special WHMIS requirements. In addition, we have focused on its' broad neurobehavioural effects because of their wide recognition.

Carcinogenicity

Lead has long been known to cause cancer in animals and was classified as a "possible human carcinogen" (Category 2B) by the International Agency for Research on Cancer (IARC) in 1980 [IARC Vol. 23, 1981]. Based on the results of some epidemiologic studies that have found an excess of some cancers in exposed workers, IARC upgraded its classification of inorganic lead compounds to a probable human carcinogen (Category 2A) in 2004 [IARC Vol. 87, 2004]. Lead has been classified by the American Conference of Governmental Industrial Hygienists (ACGIH) as A3 (Confirmed Animal Carcinogen with unknown relevance to humans) since 1993.

Reproductive and Developmental Effects

Exposure to lead has been associated with a wide range of reproductive and developmental health effects [ATSDR, 1999]. Exposure has been found to cause infertility in both women and men. In men, lowered sperm counts and abnormal sperm (motility, transfer problems) have been observed. There is also some evidence that lead may adversely impact performance by reducing testosterone synthesis in men or by disrupting regulation of luteinizing hormone secretion in both sexes.

The potential for lead to cause teratogenic, embryotoxic, and other developmental effects is enhanced by its ability to cross the placental barrier. Spontaneous abortions, stillbirths, miscarriages may occur at high levels of exposure. However, shortened time of gestation and decreased fetal mental development and growth may occur at lower levels of exposure. Intellectual and behavioral deficits in children have been observed. Birth defects (hemangiomas,

lymphangiomas, minor skin anomalies such as tags and papillae, and undescended testicles) and childhood deaths during the first year have also been reported.

Neurologic Effects

Lead has a wide range of neurotoxic effects. Central Nervous System (CNS) effects and symptoms include fatigue, irritability, insomnia, headaches, and subtle evidence of mental and intellectual decline. Peripheral Nervous System (PNS) effects and symptoms include local paralysis described as “wrist drop” or “foot drop” and decrease motor nerve conduction velocity.

Relevant Regulations and Guidelines

Under the *Hazardous Products Act*, lead (Pb) is considered a controlled product. It is classified in Subdivision A (Very Toxic Material) of Division 2 (Materials Causing Other Toxic Effects) of Class D (Poisonous and Infectious Material) under the *CPR* and WHMIS. In general, the *Hazardous Products Act* requires chemical ingredients to be specifically listed if they are present at 1.0% or more in a product. However, the threshold is reduced to 0.1% or more for “highly toxic” substances including teratogens, embryotoxins, reproductive toxins, respiratory tract sensitizers, carcinogens, and mutagens. Based on their known health effects, lead-containing products clearly fall into this category.

The *CPR* sets out the legal requirements by which information on controlled and hazardous products must be communicated. It requires that MSDSs disclose the following toxicological information: route of entry, effects of acute exposure, exposure limits, effects of chronic exposure, irritancy of product, sensitization, carcinogenicity, reproductive toxicity, teratogenicity, mutagenicity, and synergistic products. In addition, Subsection 12(11) of the *CPR* requires the disclosure of “any other hazard information with respect to the controlled product of which the supplier is aware or ought reasonably to be aware.” Additional requirements that pertain to the work undertaken in this audit are set out below.

Carcinogenicity

As previously mentioned, IARC has designated lead a “probable human carcinogen” (Category 2A). In addition, the ACGIH has classified it as a “confirmed animal carcinogen with unknown relevance to humans” (Category A3). The requirements regarding carcinogenicity are specifically addressed in the *CPR* and WHMIS Guidelines. Under the *CPR* (Paragraph 54) a substance is classified as a carcinogen:

“...if it is listed in

(a) section A1a, A1b or A2 of Appendix A of the *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment*, published by the ACGIH, as amended from time to time; or

(b) Group 1 or Group 2 in the *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, published by the World Health Organization, as amended from time to time.”

Reproductive and Developmental Toxicity

Lead is on both the European Union’s (EU) list of substances classified as toxic to reproduction (OECD, 1999) and the California Environmental Protection Agency’s (EPA) list of “chemicals known to the state to be toxic to reproduction.” Lead has been classified as a

developmental toxin by both the California EPA and the EU (OECD, 1999). California EPA classifies it as a reproductive toxin for both men and women.

The requirements regarding reproductive and developmental toxicity are specifically addressed in the *CPR* as well as in the WHMIS Guidelines. Under the *CPR* (Paragraph 55) a substance is classified as a reproductive toxin when:

“...there is evidence that shows that it causes sterility or an adverse effect on reproductive capability in persons following exposure to it in the work place; or sterility or an adverse effect on reproductive capability is shown in an animal assay for reproductive toxicity [carried out in accordance with OECD Test Guidelines No. 415 or 416]”.

Under the *CPR* (Paragraph 53) a substance is classified as a developmental toxin when it is:

“...shown to cause injury to the embryo or fetus in a statistically significant proportion of the test population at a concentration that has no adverse effect on the pregnant female when tested [in accordance with OECD Test Guidelines No. 414, 415, or 416.]”

Injury includes death, malformation, permanent metabolic or physiological dysfunction, growth retardation or psychological or behavioural alteration that occurs during pregnancy, at birth or in the postnatal period.

The WHMIS Guidelines for Disclosure of Toxicologic Information on a Material Safety Data Sheet (June, 1997) goes further to require that:

“For the purpose of MSDS disclosure, any indication of an adverse effect on fetal development or reproductive parameters must be disclosed on the MSDS irrespective of whether or not there is an adverse effect on the pregnant female.”

In addition, the Guidelines also state that

“Any relevant epidemiological evidence must also be disclosed.”

Methods

The audit was undertaken in five distinct phases. In the first phase, the team designed and tested an audit form, developed clear criteria for selection of MSDSs, and worked out a protocol for the review. The second phase focussed on acquiring MSDSs that met the selection criteria. In the third phase, the selected MSDSs were reviewed for the presence or absence of information required under the *Act* or the *CPR*. To ensure that each MSDS was reviewed consistently and systematically, the review relied on the audit form developed in phase 1 of the project. The readability review and analysis of the database encompassed the fourth and fifth phases of the project, respectively.

Phase 1: Developing the Audit Form, Selection Criteria and the Audit Protocol

Using two pre-existing audit forms¹ as a starting point, the team developed an audit form for lead-containing MSDS's. The form was designed to be compatible with the WHMIS

¹ The first was an audit form developed for a previous review of toluene diisocyanate (TDI) performed by the authors of this report and funded by Health Canada. The second was a form designed by Dr. Linda Frazier and colleagues at the University of Kansas [Frazier et al, 2001].

“Guidelines for the Disclosure of Toxicological Information on a Material Safety Data Sheet”, as well as the requirements of the *Hazardous Products Act* and the *CPR*. A copy of the final audit form used is included as Appendix 1.

MSDSs were to be selected for review provided they met the following inclusion criteria:

- the product had to contain a minimum of 0.1% Pb
- the MSDS had to have been reviewed or updated within three years prior to the commencement of the project
- the product had to be either produced or distributed by a Canadian company
- the products had to represent a range of different uses (e.g., paint, solder, etc.)
- the potential for exposure had to vary by product and by type of use, and
- a maximum of five products, representing the range in use, could be selected from any single manufacturer or distributor².

Products that met all of these criteria, but were produced outside of Canada, could also be included if the MSDS specifically mentioned WHMIS.

The team developed the following protocol for auditing the MSDS's. Once each MSDS had been assigned a unique identifier, basic descriptive information from Sections A and B of the audit form would be entered into an Excel database (see Appendix 1 for items listed on the audit form). A team member would then review each MSDS for the presence or absence of the items listed in Section C (items C1 through C17) of the audit form. Where chronic health effects were noted, the full sentences used to describe them were to be entered. The actual language used would then be reviewed for clarity and a grade level would be assigned using the Flesch-Kincaid scoring system.

Phase 2: Selecting and Acquiring the Material Safety Data Sheets

The Canadian Centre for Occupational Health and Safety (CCOHS)³ maintains and administers a comprehensive, searchable database of MSDSs prepared in compliance with North American regulations. This database, called “MSDS”, includes over 200,000 MSDSs contributed by 1200 North American manufacturers and suppliers. MSDS's in the database are presented exactly as provided by the manufacturer or supplier. They are downloadable in either HTML or .PDF format. In conjunction with this database, the CCOHS maintains and provides access to CHEMINFO, a database produced by in-house occupational health and safety specialists. This database contains information on and chemical profiles for over 1300 important workplace chemicals.

Systematic searches were conducted of the MSDS and CHEMINFO databases to identify MSDSs meeting the selection criteria. CHEMINFO was the primary source of information on product use, as well as on the range of lead compounds that might be present in products

² In this situation, the protocol specified that, once duplicates were eliminated, every fifth MSDS was to be downloaded.

³ The CCOHS is a federal departmental corporation, which reports to the Parliament of Canada through the federal Minister of Labour. Complete information about the CCOHS, its mandate and the services it provides can be found on its website (www.ccohs.org).

commonly found in the workplace. Searches of CHEMINFO yielded a list of lead compounds and their Chemical Abstracts Services (CAS) numbers (see Table 1).

Table 1: List of Lead Compounds and CAS Numbers Identified in CHEMINFO

Substance or Compound	CAS Number
Lead	7439-92-1
Lead acetate	301-04-2 or 6080-56-4
Lead chloride	7758-95-4
Lead chromate	7758-97-6
Lead dioxide	1309-60-0
Lead nitrate	10099-74-8
Lead oxide	1314-41-6
Lead perchlorate	13453-62-8
Lead sulfate	7446-14-2
Lead tetramethyl	75-74-1

This list of compounds provided the starting point for subsequent searches of the MSDS database. From the menu of search options provided in the database, the team initially elected to search the database using very broad criteria. In its first iteration, the team searched for any MSDS with the word ‘lead’ within the text. This search yielded over 15,000 hits. In reviewing a sample of the MSDS’s identified, it became quickly apparent that a great number of the hits had been generated because the word “lead” is also a verb.

As a result, the team decided to focus its searches using the following fields: name, product, synonym, chemical family, ingredient, publication years, country of origin, and company of name. One feature of the database is that, in addition to providing specific search parameters, it also permits the user to search the entire MSDS for specific strings of text. To avoid the problem encountered with searches using the word “lead”, the team took advantage of this feature to search MSDS’s for the CAS Numbers listed in Table 1.

Before downloading any MSDS, the team member responsible for this phase of the project read each of the MSDS’s identified to ensure that:

- the product did, in fact, contain lead
- the product contained a minimum of 0.1% lead, and
- all other selection criteria were met.

Eligible MSDS’s were then downloaded and saved in electronic form. All Canadian manufacturers/supplier and all foreign distributors that specifically mention WHMIS regulations were selected. A maximum of six MSDS’s from each manufacturer/supplier were selected for auditing. In cases where more products were available, a sample representing the range of

products was chosen. In addition, 40 foreign MSDS's without mention of Canadian regulations were selected to provide a comparison group.

Phase 3: Reviewing the MSDS's

Using the audit protocol described above, each eligible MSDS was reviewed for the presence or absence of the items listed on the audit form. All information collected on the audit form was entered into an Excel database for statistical analysis. This included full sentences describing chronic health effects when the MSDS disclosed such effects.

Phase 4: Assessing Readability

Where an MSDS disclosed chronic health effects (Section 11) associated with exposure to lead and/or lead-containing products, the actual language used was cut and pasted verbatim into the Excel spreadsheet. The readability of the hazard information disclosed was then assessed using the Flesch-Kincaid scoring system, which provides a score that is equivalent to a grade level. This system provides a quantitative assessment of the words per sentence, sentences per paragraph, and length of sentences and polysyllabic words. The potential scoring range is from Grade 3 to Grade 12+ (requiring higher than Grade 12 education for ease of readability).

The chronic health effects information was also qualitatively assessed for the presence of jargon or overly scientific language that can decrease the readability of written text. The WHMIS guidelines recommend that MSDS preparers "minimize the disclosure of extraneous scientific or technical jargon" (Information Bulletin, Issue No. 12, April 1997). Examples of jargon were noted and compiled in a table.

Phase 5: Analyzing the Data

All data collected in the audit was entered into an Excel spreadsheet. Once data collection was complete and the database was cleaned of any data entry errors, the team analyzed the data to generate the following descriptive statistics:

- number of MSDS's reviewed
- number of MSDS's by manufacturer or supplier
- number of MSDS's by geographic location
- number of MSDS's reporting routes of exposure and exposure limits
- number of MSDS's in which the carcinogenicity of lead was disclosed (stratified by "any mention of cancer", "IARC cited", "ACGIH cited")
- number of MSDS's in which the neurologic effects of lead were disclosed (stratified by "any neurologic", "CNS effects", "peripheral effects")
- number of MSDS's in which the reproductive and developmental effects of lead were disclosed (stratified by "any", "male effects" and "female effects" for reproductive toxicity and stratified by "any" and "death/birth" for developmental effects)

In analyzing the data, the team considered several factors that may potentially influence the quality of information disclosed on the MSDS's, such as the amount of lead in the product and the country of origin.

Results

In total, 152 MSDS's for lead-containing products were reviewed. These were produced by 60 companies. The team examined a range of one to six sheets per company. Of the 60 companies, 27 were Canadian, 31 were American, one was Japanese, and one was Swedish company. Stratifying the American MSDS's by whether or not they mentioned Canadian regulations, roughly half (16 companies) made reference to WHMIS. Neither the Japanese nor the Swedish MSDS mentioned WHMIS. Of the 152 MSDS's assessed, 68 were from the 27 Canadian companies, 44 were from the 16 American companies that mentioned WHMIS, 40 were from the 15 American companies and 2 offshore companies that did not mention WHMIS.

Routes of Exposure & Exposure Limits

The great majority of MSDSs in all three categories reported inhalation and the majority also reported oral as potential routes of exposure (Table 2). Reporting of the dermal route of exposure was less consistent. Reporting did not seem to be consistently associated with the lead content of the product.

Two-thirds of Canadian MSDS's listed an ACGIH TLV® for lead (or the specific lead compound)(Table 2). Reporting was somewhat better for both categories of US-based companies. A smaller percentage of the MSDS's, primarily from US companies, listed another exposure limit when not listing the TLV®. Only three MSDSs listed the Biological Exposure Limit (BEI®) for lead in blood. Reporting of exposure limits did not appear to be related to lead content in the product in the Canadian companies.

Table 2: Route of Exposure & Exposure Limits by Manufacturer & Lead Concentration

Manufacturer/ Supplier	Lead Content	Total	Route of Exposure			Exposure Limits		
			Inhal.	Oral	Derm	TLV	Other OEL	BEI listed
Canadian	0.1-0.9%	12	92% (11)	25% (3)	75% (9)	67% (8)	-- (0)	-- (0)
	1-9%	15	73% (11)	80% (12)	67% (10)	60% (9)	-- (0)	-- (0)
	10%+	41	90% (37)	88% (36)	59% (24)	68% (28)	10% (4)	-- (0)
	Total	68	87% (59)	75% (51)	63% (43)	66% (45)	6% (4)	-- (0)
Foreign with reference to WHMIS	0.1-0.9%	7	71% (5)	71% (5)	71% (5)	57% (4)	14% (1)	-- (0)
	1-9%	6	100% (6)	83% (5)	100% (6)	67% (4)	33% (2)	-- (0)
	10%+	31	90% (28)	100% (31)	65% (20)	90% (28)	32% (10)	13% (4)
	Total	44	89% (39)	93% (41)	70% (31)	82% (36)	30% (13)	9% (4)
Foreign without reference to WHMIS	0.1-0.9%	2	100% (2)	50% (1)	100% (2)	100% (2)	-- (0)	-- (0)
	1-9%	3	100% (3)	100% (3)	100% (3)	100% (3)	33% (1)	-- (0)
	10%+	35	89% (31)	80% (28)	71% (25)	89% (31)	63% (22)	-- (0)
	Total	40	90% (36)	80% (32)	75% (30)	90% (36)	58% (23)	-- (0)

Carcinogenicity

A little over 2/3 of MSDS's from Canadian and US companies known to distribute in Canada made any mention of potential cancer risk (Table 3). Reporting was somewhat better for the foreign companies referencing WHMIS. Less than half of Canadian MSDS's reported the relevant IARC category and reporting was slightly poorer for the ACGIH cancer category.

Reporting for both was better among the foreign companies. Reporting did not appear to be consistently related to lead content.

Table 3: Carcinogen Designation by Manufacturer and Lead Concentration

Manufacturer/ Supplier	Lead Content	Total	Any Mention of Cancer	IARC Cited	ACGIH Cited
Canadian	0.1-0.9%	12	42% (5)	33% (4)	33% (4)
	1-9%	15	73% (11)	33% (5)	20% (3)
	10%+	41	76% (31)	49% (20)	34% (14)
	Total	68	69% (47)	43% (29)	31% (21)
Foreign with reference to WHMIS	0.1-0.9%	7	100% (7)	57% (4)	-- (0)
	1-9%	6	83% (5)	33% (2)	50% (3)
	10%+	31	74% (23)	55% (17)	45% (14)
	Total	44	80% (35)	52% (23)	39% (17)
Foreign without reference to WHMIS	0.1-0.9%	2	100% (2)	50% (1)	-- (0)
	1-9%	3	67% (2)	33% (1)	33% (1)
	10%+	35	57% (20)	63% (22)	49% (17)
	Total	40	60% (24)	60% (24)	45% (18)

Neurologic Effects

Sixty-two percent of Canadian MSDS's mentioned potential neurologic effects in general (Table 4). Of those reporting, almost all mentioned central nervous system (CNS) or cognitive effects. Reporting of peripheral nervous system (PNS) or motor effects was much less common. A different pattern was observed among the foreign companies. A much greater percentage of foreign MSDS's mentioned CNS effects, while a smaller percentage mentioned neurologic effects in general or made mention to peripheral effects. Reporting did not appear to improve consistently with increasing lead content.

Table 4: Chronic Neurological Effects by Manufacturer & Lead Concentration

Manufacturer/ Supplier	Lead Content	Total	Any Neurologic	CNS Effects	Peripheral Effects
Canadian	0.1-0.9%	12	50% (6)	50% (6)	17% (2)
	1-9%	15	33% (5)	40% (6)	20% (3)
	10%+	41	76% (31)	76% (31)	51% (21)
	Total	68	62% (42)	63% (43)	38% (26)
Foreign with reference to WHMIS	0.1-0.9%	7	43% (3)	100% (7)	14% (1)
	1-9%	6	100% (6)	100% (6)	33% (2)
	10%+	31	42% (13)	71% (22)	35% (11)
	Total	44	50% (22)	80% (35)	32% (14)
Foreign without reference to WHMIS	0.1-0.9%	2	100% (2)	100% (2)	100% (2)
	1-9%	3	67% (2)	100% (3)	33% (1)
	10%+	35	31% (11)	89% (31)	6% (2)
	Total	40	38% (15)	90% (36)	13% (5)

Reproductive & Developmental Effects

Half of MSDS's from Canadian companies made mention of potential reproductive effects, although reporting appeared to improve with lead content (Table 5). Reporting on reproductive effects in general was much better for both categories of foreign companies, but was unrelated to lead content. One fifth of MSDS's from Canadian companies made mention of specific male or female reproductive effects. One quarter of MSDS's from foreign based companies mentioned male effects, although fewer mentioned specific female reproductive effects.

Approximately 40% of MSDS's from Canadian companies made mention of potential developmental effects, although reporting appeared to improve with lead content (Table 5). Reporting was much better for both categories of foreign-based companies, but was unrelated to lead content. Relatively few mention the potential for birth defects or fetal death and all but one of these were either Canadian or foreign MSDS's which mentioned WHMIS and had a lead content greater than 10%.

Table 5: Reproductive & Developmental Effects by Manufacturer & Lead Concentration

Manufacturer/ Supplier	Lead Content	Total	Reproductive			Developmental	
			Any	Male Effects	Female Effects	Any	Death/ Birth
Canadian	0.1-0.9%	12	25% (3)	17% (2)	17% (2)	25% (3)	-- (0)
	1-9%	15	47% (7)	7% (1)	7% (1)	33% (5)	-- (0)
	10%+	41	61% (25)	24% (10)	24% (10)	49% (20)	20% (8)
	Total	68	51% (35)	19% (13)	19% (13)	41% (28)	12% (8)
Foreign with reference to WHMIS	0.1-0.9%	7	86% (6)	14% (1)	-- (0)	57% (4)	-- (0)
	1-9%	6	83% (5)	17% (1)	17% (1)	83% (5)	-- (0)
	10%+	31	84% (26)	32% (10)	26% (8)	74% (23)	16% (5)
	Total	44	84% (37)	27% (12)	20% (9)	73% (32)	11% (5)
Foreign without reference to WHMIS	0.1-0.9%	2	100% (2)	-- (0)	-- (0)	100% (2)	50% (1)
	1-9%	3	100% (3)	33% (1)	-- (0)	33% (1)	-- (0)
	10%+	35	83% (29)	26% (9)	3% (1)	71% (25)	-- (0)
	Total	40	85% (34)	25% (10)	3% (1)	70% (28)	3% (1)

Readability Assessment

Examples of phrases used in MSDS's to describe reproductive and developmental hazards are listed in Tables 6 and 7, respectively. The majority of the chronic health information was written at the 12th grade level or higher, although some of the sentences were shorter and were written with simpler words. It should be noted that a very small number of MSDS's stated that the product *did not* present a reproductive or developmental hazard.

The hazard information contained words that were considered to be scientific jargon. Frequently found jargon included terms such as: teratogen/teratogenic, mutagen/mutagenic and embryotoxic. There were also instances of unique jargon such as "reproductive effector" and "preborn offspring".

Table 6: Reproductive Toxicity Examples and Flesch-Kincaid Grade Level

Sentence	Grade
Implicated as causative agent for the impairment of female reproductive capacity.	12+
Male and female reproductive systems can be adversely affected by concentrations of lead in the body.	12+
Ingestion or inhalation of lead can pose risk to developing fetuses and may also impair the reproductive systems in both men and women.	12
Known to cause reproductive harm.	5.2
Prolonged exposure may cause delayed effects involving reproductive system.	12+
Possible risk of impaired fertility.	12
No adverse reproductive effects are anticipated.	12+
Lead compounds can cause adverse reproductive effects to both males and females.	7.7

Table 7: Developmental Toxicity Examples and Flesch-Kincaid Grade Level

Sentence	Grade
Pregnant women should be protected from excessive exposure to prevent lead crossing the placental barrier and causing neurological damage.	12+
Teratogenic and mutagenic effects have been reported in some studies.	12+
May cause birth defects.	5.7
Known to State of California to cause birth defects.	6.2
Lead investigated as a tumorigen, mutagen and reproductive effector.	12+
Lead may have adverse effects on preborn offspring.	5.2
No adverse teratogenic or mutagenic effects anticipated.	12+

Conclusions

The results of this audit for Canadian MSDS's were extremely disappointing. A third did not list occupational exposure limits and very few mentioned biological monitoring, despite the fact that lead may enter the body via other means than inhalation. Over a third did not list any central nervous system effects and the majority did not list the potential for peripheral nervous system effects. Only half listed reproductive effects and the majority did not list potential developmental effects. Of those that listed reproductive effects, very few indicated that it could harm both men and women. Of those that mentioned the potential for developmental effects, very few mentioned the most severe (birth defects and fetal death). Almost a third did not mention cancer. Foreign (almost exclusively U.S.) MSDS's more frequently listed occupational exposure limits, specific CNS effects, reproductive and developmental effects, and carcinogen classifications by IARC and the TLV Committee. However, all MSDS's reviewed were found to have important deficiencies.

The majority of the chronic health effects information contained in the Lead MSDSs was written at a grade level (Grade 12 and above) that may be too high for many lay users to comprehend. Statistics Canada [2003a] has estimated that 42% of Canadians have low literacy and 27% of these adult Canadians are able to read only simple material and 16% have difficulty comprehending any printed material. Literacy levels are also found to vary by occupation. Statistics Canada's survey [2003b] found that people employed in the manufacturing and natural resource sectors reported, on average, low literacy skills (2). When literacy levels are low, it is generally recommended that text be written at a Grade 4-5 level. For example, the National Working Group on Literacy and Health in the US [1998] recommends a 5th grade reading level for health information. In addition, many of the MSDS's for lead used scientific jargon to describe risk. These complex and often polysyllabic words could be replaced with plain language wording to improve the readability of the hazard information.

The result of this audit may not be surprising to many occupational health professionals who have long believed that MSDS's are of limited use for the protection of worker health. It is particularly discouraging to see this poor performance for a substance with such severe and widely recognized health effects. However, providing accurate information on the hazards of toxic chemicals to the users is an essential component of prevention and some effective means needs to be found to ensure this information is provided.

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Appendix 1: Lead MSDS Audit Form

- A1. MSDS ID number assigned for this study _____
- A2. Trade name: _____
- A3. Copy: PDF=1 or Text=2
- A4. Reviewer initials (i.e. AMN, AK, PD, JV): _____
- A5. Manufacturer: _____ (assign code #) _____
- A6. Product Type/use _____
- A7. Province, State, or Country _____
- A7a. If not Canadian, specific mention of WHMIS: Yes=1, no=2
- A8. MSDS revision date (list most recent date, D/M/Y): ____/____/____
- A9. Lead % by weight, do not review if less than 0.1%: _____
- B1. ACGIH TLV for Lead: _____,
- B1b. units (circle): ppm=1, mg/m³=2, Absent=9
- B2. ACGIH BEI for lead (in blood): _____ µg/dL
- B3. Other exposure limit: NIOSH=1, Canadian province/federal=2, OSHA=3, Other=4, Multiple=5, Miss=9

Carcinogenicity	
B4. ACGIH cancer designation	Listed: No=0 Yes or List designation (i.e. A3)
B5. IARC cancer designation	Listed: No=0 Yes or List designation (i.e. 2B or 2A)
B6. Other cancer designation	Listed: No=0 Yes=List organization (i.e. NTP, OECD) _____
B7. General mention (i.e. may cause cancer)	Listed: No=0 Yes=1
B8. Flag for example/review	No=0 Good=1 Bad=2 Problem=3

Routes of Entry	
B9. Inhalation	Listed: No=0 Yes=1
B10. Skin absorption/contact	Listed: No=0 Yes=1
B11. Ingestion	Listed: No=0 Yes=1
B12. Eyes	Listed: No=0 Yes=1
B13. Flag for example/review	No=0 Good=1 Bad=2 Problem=3

Developmental/Teratogenic/Embryotoxic Effects	
<p>C7. Mentions increased risk of fetal death, abnormal birth Circle or list all that apply:</p> <p>Miscarriage Premature birth Spontaneous Abortion Still Birth Fetal Death Shortened time of gestation Fetal Toxicity/Toxin Post-Implantation Mortality</p> <p>Other _____ _____</p>	Listed: No=0 Yes=1
<p>C8. Mentions increase risk of other developmental disorders Circle or list all that apply:</p> <p>Birth defects Decreased fetal mental development Decreased fetal growth Intellectual & behavioral deficits in children Infant neurological disorders Extra embryonic structures Weaving or laceration index effects on newborn Specific developmental abnormalities to a body system in the fetus (describe system(s) if noted)</p> <p>Other _____ _____</p>	Listed: No=0 Yes=1
<p>C9. Mentions general cautionary language Circle or list all that apply:</p> <p>Teratogen Embryotoxic May cause harm to the unborn child Injury to the developing fetus Pregnant women should be protected from excessive exposure Damage to the fetus from exposure to pregnant women Women of child bearing age should avoid exposure to lead due to its post-natal effects</p> <p>Other _____ _____</p>	Listed: No=0 Yes=1
C10. Flag for example/review	No=0 Good=1 Bad=2 Problem=3

Neurotoxic Effects on the Worker	
<p>C11 Mentions Central Nervous System (CNS)/cognitive effects</p> <p>Explain _____ _____</p>	Listed: No=0 Yes=1
<p>C12 Mentions Peripheral Nervous System/motor effects</p> <p>Explain _____ _____</p>	Listed: No=0 Yes=1
C13. Flag for example/review	No=0 Good=1 Bad=2 Problem=3

