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PROPOSED RISK MANAGEMENT APPROACH

for

Vanadium oxide

(Vanadium pentoxide)

Chemical Abstracts Service Registry Number (CAS RN):
1314-62-1

Environment Canada
Health Canada

September 2010

Canada

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This proposed risk management approach document builds on the previously released risk management scope document for vanadium pentoxide, and outlines the proposed control actions for this substance. Stakeholders are invited to submit comments on the content of this proposed risk management approach or provide other information that would help to inform decision making. Following this consultation period, the Government of Canada will initiate the development of the specific risk management instrument(s) and or regulation(s) where necessary. Comments received on the proposed risk management approach will be taken into consideration in developing the instrument(s) and or regulations(s). Consultation will also take place as instrument(s) and or regulation(s) are developed.

SUMMARY OF PROPOSED RISK MANAGEMENT

1. Reductions of vanadium pentoxide as a result of co-benefits of existing and proposed programs to reduce particulate emissions from combustion of certain fossil fuels.
2. The Government of Canada plans to implement Significant New Activity provisions under CEPA 1999 to vanadium pentoxide.
3. Vanadium pentoxide is proposed to be added to the *Environmental Emergency Regulations*.

Note: This summary is an abridged list of the instruments and tools proposed to risk manage this substance. Please see section 9.1 of this document for a complete explanation of risk management.

1. ISSUE

1.1 Categorization and the Challenge to Industry and Other Interested Stakeholders

The *Canadian Environmental Protection Act, 1999* (CEPA 1999) (Canada 1999) requires the Minister of the Environment and the Minister of Health (the Ministers) to categorize substances on the *Domestic Substances List* (DSL). Categorization involves identifying those substances on the DSL that, in accordance with the criteria at section 73 of the Act, a) are considered to be persistent (P) or bioaccumulative (B), based on the criteria set out in the *Persistence and Bioaccumulation Regulations* (Canada 2000), and "inherently toxic" (iT) to humans or other organisms, or b) may present, to individuals in Canada, the greatest potential for exposure (GPE). In addition, the Act requires the Ministers to conduct screening assessments of substances that meet the categorization criteria. The assessment further determines whether the substance meets one or more of the criteria set out in section 64 of the Act[1].

[1] A determination of whether one or more of the criteria of section 64 are met and whether risk management may be required is based upon an assessment of potential risks to the environment and/or to human health associated with exposures in the general environment. For humans, this includes exposures from ambient and indoor air, drinking water, foodstuffs and the use of consumer products. A conclusion under CEPA 1999 on the substances in the Chemicals Management Plan (CMP) Challenge Batches 1-12 is not relevant to nor does it preclude an assessment against the hazard criteria specified in the Workplace Hazardous Materials Information System [WHMIS] *Controlled Products Regulations* for products intended for workplace use.

In December 2006, the Challenge identified 193 chemical substances through categorization which became high priorities for assessment due to their hazardous properties and their potential to pose risks to human health and the environment. In February 2007, the Ministers began publishing, for industry and stakeholder comments, profiles of batches containing 12 to 19 high-priority substances. New batches are released for comments every three months.

Information-gathering authority in section 71 of CEPA 1999 is being used under the Challenge to gather specific information where it is required. The information that is collected through the Challenge is used to make informed decisions and appropriately manage any risks that may be associated with these substances.

The substance vanadium oxide, Chemical Abstracts Service Registry Number (CAS RN)[2] 1314-62-1, referred to throughout this document as "vanadium pentoxide" is included in Batch 9 of the Challenge under the Chemicals Management Plan. For the sake of clarity, the substance will be referred to as vanadium pentoxide in this proposed risk management approach, even though its name on the DSL is vanadium oxide.

1.2 Final Screening Assessment Report Conclusion for Vanadium Pentoxide

A notice summarizing the scientific considerations of a final screening assessment report was published by Environment Canada and Health Canada in the *Canada Gazette*, Part I, for vanadium pentoxide on September 18, 2010, under subsection 77(6) of CEPA 1999. The final screening assessment report concluded that vanadium pentoxide is not entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity or that constitute or may constitute a danger to the environment on which life depends.

On the basis of the carcinogenicity of vanadium pentoxide, for which there may be a probability of harm at any level of exposure, it is proposed that vanadium pentoxide should be considered to be a substance that may be entering the environment in a quantity or concentration or under conditions that constitute or may constitute a danger in Canada to human life or health.

The final screening assessment report also concluded that vanadium pentoxide meets the criteria for persistence but does not meet the criteria for bioaccumulation, as defined in the *Persistence and Bioaccumulation Regulations* made under CEPA 1999. The presence of vanadium pentoxide in the environment results primarily from human activity.

For further information on the final screening assessment report conclusion for vanadium pentoxide, refer to the final screening assessment report, available at http://www.chemicalsubstanceschimiques.gc.ca/challenge-defi/batch-lot-9/index-eng.php.

[2] CAS RN: Chemical Abstracts Service Registry Number. The Chemical Abstracts Service information is the property of the American Chemical Society and any use or redistribution, except as required in supporting regulatory requirements and/or for reports to the Government of Canada when the information and the reports are required by law or administrative policy, is not permitted without the prior, written permission of the American Chemical Society.

1.3 Proposed Measure

As a result of a screening assessment of a substance under section 74 of CEPA 1999, the substance may be found to meet one or more of the criteria under section 64 of CEPA 1999. The Ministers can propose to take no further action with respect to the substance, add the substance to the Priority Substances List (PSL) for further assessment, or recommend the addition of the substance to the List of Toxic Substances in Schedule 1 of the Act. Under certain circumstances, the Ministers must make a specific proposal to recommend the implementation of virtual elimination. In this case, the Ministers proposed to recommend the addition of vanadium pentoxide to the List of Toxic Substances in Schedule 1. As a result, the Ministers will develop a regulation or instrument respecting preventive or control actions to protect the health of Canadians and the environment from the potential effects of exposure to this substance.

Vanadium pentoxide is not subject to the virtual elimination provisions under CEPA 1999 and will be managed using a lifecycle approach, to prevent or minimize its release into the environment.

2. BACKGROUND

2.1 Substance Information

Vanadium pentoxide is part of the chemical grouping discrete inorganics and the chemical sub grouping oxides.

Table 1 presents other names, trade names, chemical groupings, the chemical formula, the chemical structure and the molecular mass for vanadium pentoxide.

Table 1. Identity of vanadium pentoxide

Chemical Abstracts Service Registry Number (CAS RN)	**1314-62-1**
DSL name	**Vanadium oxide**
NCI names	Vanadium oxide (AICS, ASIA-PAC, NZIoC, PICCS, SWISS, TSCA) Divanadium pentaoxide (ECL, EINECS) Vanadium pentoxide (ENCS, PICCS)
Other names	C.I. 77938; Divanadium pentoxide; Pentaoxodivanadium; Shcherbinaite[1]; UN 2862; UN 2862 (DOT); Vanadia; Vanadic anhydride; Vanadium oxide (V_4O_{10}); Vanadium(V) oxide
Chemical group (DSL stream)	Discrete inorganics
Major chemical class or use	Vanadium-containing inorganic compounds
Major chemical subclass	Oxides
Chemical formula	V_2O_5

Chemical structure	
SMILES	O=[V](=O)O[V](=O)=O
Molecular mass	181.9 g/mol

Abbreviations: AICS, Australian Inventory of Chemical Substances; ASIA-PAC, Asia-Pacific Substances Lists; CAS RN, Chemical Abstracts Service Registry Number; DSL, Domestic Substances List; ECL, Korean Existing Chemicals List; EINECS, European Inventory of Existing Commercial Chemical Substances; ENCS, Japanese Existing and New Chemical Substances; NCI, National Chemical Inventories; NZIoC, New Zealand Inventory of Chemicals; PICCS, Philippine Inventory of Chemicals and Chemical Substances; SWISS, Swiss Giftliste 1 and Inventory of Notified New Substances; SMILES, simplified molecular input line entry specification; TSCA, *Toxic Substances Control Act* Chemical Substance Inventory.
[1] Hughes and Finger (1983).
Source: NCI (2006)

3. WHY WE NEED ACTION

3.1 Characterization of Risk

Evaluation of risk to human health involves consideration of data relevant to estimation of exposure (non-occupational) of the general population, as well as information on health hazards.

Based principally on the weight of evidence–based assessments of international or other national agencies (NTP 2002; Ress et al. 2003; IARC 2006), a critical effect for characterization of risk to human health for vanadium pentoxide from inhalation exposure is carcinogenicity. Significantly increased incidences of lung tumours were observed in male and female mice in all groups following inhalation exposure. In rats, the incidence of lung carcinomas and combined adenomas and carcinomas in males exceeded historical control ranges at 0.5 and 2 mg/m^3. Genotoxicity was observed in both *in vivo* and *in vitro* assays with vanadium pentoxide in mammalian cells. Although the mode of induction of tumours in mice has not been fully elucidated, based on the weight of evidence of carcinogenicity and the genotoxicity of vanadium pentoxide, it cannot be precluded that the tumours observed may have resulted from direct interaction with genetic material.

With respect to non-cancer effects, respiratory tract effects were among the primary adverse effects seen following inhalation exposure. The LOAEC for chronic exposure in rats (0.5 mg/m^3) was selected as the critical non-cancer effect level for repeated-dose inhalation exposure, based on an increased incidence of inflammation, fibrosis and hyperplasia in the respiratory tract (lungs, larynx and nose) of male and female rats exposed for 2 years. This LOAEC has been selected as a critical effect level by the US Agency for Toxic Substances and Disease Registry (ATSDR 2009) as well, which led to the selection by ATSDR of the NTP (2002) chronic rat study as the basis for the determination of a chronic-duration inhalation estimate of exposure levels posing minimal risk to humans for vanadium. It is likely that the irritating effects of inhaled vanadium pentoxide will serve to limit human exposures subsequent to an acutely irritating episode.

From oral exposure studies, the lowest oral LOAEL for subchronic exposure was a dose range of 0.25–0.30 mg/kg-bw per day as vanadium pentoxide or sodium metavanadate. In this dose range, reductions in phagocytosis were noted in male rats in a 6-month study, while histological changes in the spleen, kidney and lung were noted in male rats after 3 months of exposure. For short-term exposure, the lowest oral LOAEL was 3.7 mg/kg-bw per day based on histological and enzymatic alterations in the liver and kidney tissues of male rats exposed for 3 weeks. Long-term oral studies were not identified in the literature.

Estimates of daily intake of vanadium pentoxide for the general population were derived from measured concentrations of vanadium in environmental media and food. Based on the reported concentrations of vanadium in environmental media and the smaller contributions from food, upper-bounding estimates of daily intake of vanadium pentoxide range from 1.01 to 5.58 µg/kg-bw per day for the general population of Canada (Canada 2010a). Soil ingestion represented a principal source of exposure for most age groups. For example, for children aged 0.5–4 years, soil ingestion represented about 71% of total vanadium exposure. Given that a significant proportion of the vanadium in environmental media (soil) and food is considered to be naturally occurring and that the speciation is unknown, it was not considered meaningful to derive margins of exposure between the exposure estimates and the critical effect level obtained following oral administration to rats.

The main source of vanadium pentoxide in air is considered to be the combustion of fossil fuels. As there was some evidence of induction of tumours at the critical non-neoplastic effect level for inhalation exposure in rats (0.5 mg/m^3), margins of exposure were not derived, as there is considered to be a probability of harm at any level of exposure.

4. CURRENT USES AND INDUSTRIAL SECTORS

The main uses of vanadium pentoxide worldwide are as a formulation component in the production of metal alloys, particularly ferrovanadium, and as a catalyst in the production of sulphuric acid (Perron 2001). Other reported uses include its uses as a catalyst in the production of maleic anhydride for the manufacture of polyester and alkyd resins (Haber 2009), an electrolyte in vanadium redox batteries (Magyar 2003) and a pigment in the production of ceramics and glass (Motolese et al. 1993; Moskalyk and Alfantazi 2003; Vanitec 2009). Vanadium pentoxide is an additive that can be found at concentrations up to 1% in ultraviolet light–resistant tellurite glass (El-Mallawany 2001). It can be mixed with oxides of tungsten, titanium, silicon and other elements in various amounts to give other properties to glass (Blume and Drummond 2002; Kaoua et al. 2007). Vanadium pentoxide may also be employed for the catalytic reduction of industrial nitrogen oxide and sulphur emissions (Hagerman and Faust 1955; Vanitec 2009). Vanadium pentoxide can be found naturally in phosphate fertilizers as a result of phosphate rock processing (Mortvedt and Beaton 1995).

According to information submitted under section 71 of CEPA 1999, between 1 000 000 and 10 000 000 kg of vanadium pentoxide was used in Canada in 2006 (Environment Canada 2009). The majority (92%) of the vanadium pentoxide was used in the production of ferrovanadium alloys for the manufacture of hardened steel. Vanadium pentoxide was also widely used as a catalyst: for manufacturing sulphuric acid at concentrations ranging between 3% and 9% , for catalytic cracking applications at a concentration of approximately 0.03% and for the selective

catalytic reduction of nitrogen oxide and sulphur emissions from power plants at concentrations up to 1% (Environment Canada 2009). Minor uses of vanadium pentoxide in Canada in the 2006 reporting year included its use as an oxidizing agent and for corrosion protection. A quantity of 38 300 kg of vanadium pentoxide was used in 2006 for chemical fertilizer manufacturing, and a quantity of 24 900 kg (present in alumina) was used for the production of aluminum. In the latter case, some vanadium, presumably in the form of vanadium pentoxide, is reported to be naturally present in alumina (Environment Canada 2009).

Vanadium pentoxide was previously identified to be present as a medicinal ingredient in two final pharmaceutical products listed in the Drug Product Database (DPD): each product contained a total of 5 µg of vanadium pentoxide per tablet (DPD 2010). These products have since been discontinued (DPD 2010). Vanadium pentoxide is listed in the Natural Health Products Ingredients Database (NHPID) without a medicinal or non-medicinal role (NHPID 2010). The NHPID specifies that vanadium pentoxide will not be authorized for use in natural health products. Vanadium pentoxide is not listed in the Licensed Natural Health Products Database, thus is not present in any currently licensed natural health products (LNHPD 2010). Additionally, the Natural Health Products Directorate multi-vitamin/mineral monograph does not indicate that vanadium pentoxide is a source of vanadium in natural health products (Health Canada 2007).

5. PRESENCE IN THE CANADIAN ENVIRONMENT AND EXPOSURE SOURCES

5.1 Releases to the Environment

The amount of vanadium pentoxide released from natural sources, such as continental dust, sea salt sprays and volcanic emissions, is expected to be limited in comparison with releases from anthropogenic sources. Vanadium pentoxide is not listed on the National Pollutant Release Inventory (NPRI 2009). However, the reporting of vanadium (CAS RN 7440-62-2) compounds, except when in an alloy, is required. According to data from the NPRI, 158 tonnes of vanadium compounds were released to the environment in 2006: 156 tonnes were released to air, 1 tonne to water and the remaining amount to land (NPRI 2009). Approximately 1800 tonnes of vanadium compounds were also sent off-site for either disposal or recycling, and a further 1369 tonnes were disposed of on-site. It is noteworthy that the majority of the reported releases were from oil refineries and electrical power generation plants, with minor contributions from the metallurgy and cement industries (NPRI 2009). This is consistent with information submitted under section 71, where oil refineries and electrical power generation plants were identified as the major producers of vanadium pentoxide, through incidental production associated with particulate matter emissions.

Emissions from the largest user of vanadium oxide in Canada (a steel manufacturer) are expected to be minimal since vanadium pentoxide is not produced at the high operating temperature of the furnaces in this facility (1800°C) according to Lee and Wu (2002). Emissions to air are also limited by the use of baghouse pollution control devices, the contents of which are then recycled back into the process as a raw material.

According to information submitted under section 71, the releases of vanadium pentoxide in Canada were mainly from the combustion of fossil fuels and wood fuels (Environment Canada 2009). Most submissions reported on vanadium pentoxide; however, there were a few submissions on releases of vanadium for which the respondents did not know whether it was in the form of vanadium pentoxide. It was conservatively assumed that all vanadium reported under section 71 to be in the form of vanadium pentoxide. Between 100 000 to 1 000 000 kg of vanadium pentoxide was reportedly released to air in the 2006 calendar year, Between 1000 to 10 000 kg to water and between 100 000 to 200 000 kg to land. Between 1 000 000 and 10 000 000 kg of vanadium pentoxide was transferred to an off-site waste management facility, about 99% of which was treated as non-hazardous waste. Most of the vanadium released into the atmosphere during combustion is in the form of vanadium pentoxide (i.e., V_2O_5) associated with particulate matter (Tullar and Suffet 1975), and lower oxides of vanadium will be ultimately oxidized to this compound (US EPA 1985).

Vanadium pentoxide is not currently mined in Canada; therefore, its emission to the environment is mostly associated with particulate matter and as an incidental result of anthropogenic activities. According to information submitted in response to a notice published under section 71 of CEPA 1999, between 1 000 000 and 10 000 000 kg of vanadium pentoxide was manufactured in the 2006 calendar year (Environment Canada 2009). The term “manufacture” as defined in the section 71 notice includes the incidental production of a substance at any level of concentration as a result of the manufacturing, processing or other uses of other substances, mixtures or products. The energy sector (i.e., petroleum refineries and electrical power generation plants) collectively incidentally produced about 75% of the vanadium pentoxide that was reported, mostly in combustion by-products such as fly ash, soot and bottom ash, but also as a residual in spent catalysts. The pulp and paper industry reported 15% of the total vanadium pentoxide that was produced incidentally through the burning of fossil fuels and wood fuels. About 9% was in the form of by-products from the production of ferrovanadium alloys and, to a lesser degree, other metals (Environment Canada 2009). In addition to the vanadium pentoxide that was produced, between 100 000 and 1 000 000 kg of vanadium pentoxide was imported into Canada in the 2006 reporting year.

5.2 Exposure Sources

The major anthropogenic source of vanadium pentoxide is the burning of fossil fuels (Environment Canada 2009). Vanadium is present in fossil fuels such as oil and coal, and the combustion of such fossil fuels leads to the formation of by-products that contain vanadium pentoxide, including solid residues, soot and fly ash. Crude oil and residual fuel oil contain vanadium at concentrations ranging from 3 to 260 μg/g, and from 0.2 to 160 μg/g, respectively (IPCS 2001). Coals from Alberta, British Columbia and Nova Scotia have average vanadium contents of 100 μg/g, 400 μg/g and 800 μg/g, respectively (Spectrum Laboratories Inc. 2009). Petroleum coke, which contains even higher vanadium levels, is increasingly being used as a full or partial replacement for coal in electrical power generation (Scott and Thomas 2007). The content of vanadium pentoxide in fly ash from co-combustion of coal and petroleum coke is approximately 3% (Scott and Thomas 2007). Vanadium pentoxide is also formed as a residue in spent catalysts used in petroleum refinery processes such as cracking and can be recovered. Metallurgy, particularly the production of ferrovanadium, may also contribute to the incidental production of vanadium pentoxide. However as the quantity of vanadium pentoxide released

during ferrovanadium production is negligible compared with releases from other sources, very little human exposure is expected and no exposure scenario has been developed for metallurgical works.

Data based on the measurement of vanadium will be used for derivation of exposure estimates from environmental media and food. Although this is likely to present an over-estimate of the actual concentrations of vanadium pentoxide, measurements based on vanadium are the only available data and considered appropriate for providing upper-bounding estimates of exposure for the general population.

Since the combustion of fossil fuels such as oil and coal is the primary source of vanadium pentoxide, it is expected that inhalation of ambient air and particulate matter would present a predominant route of exposure for the general population of Canada. The presence of vanadium in soil and food resulting from both the metals natural occurrence and its release as a result of anthropogenic activities is expected to contribute to general population exposure to vanadium. However, the bioavailability of vanadium pentoxide from oral ingestion of soil or food is low (Tyler 2004). Studies of vanadium uptake as a function of pH and redox potential of the nutrient solution suggested that under normal conditions, VO_3^- and VO_2^+ were the predominant forms of vanadium taken up by plant roots from soil through passive diffusion (Welch 1973,Tyler 2004).

Vanadium pentoxide is a naturally occurring substance mainly found at concentrations between 1.5% and 2.5% in titaniferous magnetite deposits worldwide (IPCS 2001). South Africa has the world's largest titaniferous magnetite deposit, with an average grade of 1.5% vanadium pentoxide, and produces nearly half of the global demand for high-purity (≥99.5%) vanadium pentoxide (Perron 2001; IARC 2006). The world's second largest deposit of titaniferous magnetite can be found in Canada, at Lac Doré in Quebec, with an average grade of 0.55% vanadium pentoxide. However, vanadium pentoxide is not mined at the Lac Doré site (Apella Resources 2009). In addition to the mining of titaniferous magnetite deposits, vanadium pentoxide is recovered from spent catalysts, petroleum residues and vanadium-bearing slag, the latter of which can contain up to 24% vanadium pentoxide (IPCS 2001). In 2004, worldwide production of vanadium pentoxide was approximately 86 200 tonnes (Woolery 2005).

Wind-blown continental dust, sea salt sprays and volcanic emissions are also natural sources of vanadium and are estimated to release between 1.6 and 54.2 tonnes of vanadium each year (Mamane and Pirrone 1998; Nriagu and Pirrone 1998). The amount of vanadium emitted from these natural sources is relatively small compared with global anthropogenic emissions, which are considerable at 70 000–210 000 tonnes per year (Hope 1994; Mamane and Pirrone 1998; Nriagu and Pirrone 1998). The contribution of vanadium pentoxide to the total emissions of vanadium is unknown, but it is expected that these natural sources of vanadium pentoxide are insignificant in comparison with anthropogenic sources. Emission estimates based on data from the late 1990s indicate that the natural vanadium cycle may be heavily disturbed by human activities, with anthropogenic emissions to the atmosphere estimated to be 8.6 times higher than natural emissions of this metal on a global scale (2.4×10^5 vs. 2.8×10^4 tonnes per year: Nriagu and Pirrone 1998; Pacyna and Pacyna 2001).

6. OVERVIEW OF EXISTING ACTIONS

6.1 Existing Canadian Risk Management

Nova Scotia, Ontario and Alberta all have provincial requirements for emissions from the electricity sector for nitrogen oxides, sulfur dioxide and mercury (NS and AB only) (CCME 2006b). These requirements are expected to have co-benefits that reduce emissions of substances such as other metals (including vanadium pentoxide) and particulate matter.

Ontario's phase out of inefficient coal-fired electric power generation plants by the end of 2014 will result in many air quality benefits including: reduced emissions of metals and particulate matter (Ontario 2009).

The Government of Canada is taking action to reduce greenhouse gas emissions in the electricity sector by moving forward with regulations on coal-fired electricity generation (Canada 2010).

As it is associated with particulate matter, vanadium pentoxide concentrations in air may be influenced by actions taken by the Government of Canada and provinces to work towards the Canada-Wide Standards (CWS) for Particulate Matter (PM) and Ozone measured in ambient air. The CWS for $PM_{2.5}$ is 30 $\mu g/m^3$ (24 hour average) to be achieved by year 2010 (CCME 2006a). Similarly, actions taken by the Government of Canada and provinces to meet the CWS for Mercury Emissions from Coal-fired Electric Power Generation Plants are expected to reduce emissions of particulate matter and other metals from these sources (CCME 2006b).

As a result of risk management activities under the Chemical Management Plan the Government of Canada will no longer authorize the use of vanadium pentoxide for either medicinal or non-medicinal purposes in natural health products.

Vanadium pentoxide is listed as a pollutant in Schedule 1 of the *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* (Canada 2007). The Regulations promote the elimination of deliberate, negligent or accidental discharge of ship-source pollutants from ships into the marine environment and the safe operation of chemical tankers.

Vanadium pentoxide is listed in the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (Canada 2005) in the non-fused form. The purpose of the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* is to protect Canada's environment and the health of Canadians from the risks posed by the transboundary movement of hazardous wastes and hazardous recyclable materials through exports from and imports into Canada and to implement Canada's international obligations.

Vanadium and its compounds, except when in an alloy, are listed on the National Pollutant Release Inventory (NPRI).

6.2 Existing International Risk Management

United States

- Vanadium pentoxide is:
    - Identified as a hazardous waste and subject to regulation under the Identification and Listing of Hazardous Waste, 40CRF261.
    - Subject to Emergency Planning and Notification, 40CFR355, which establishes requirements for a facility to provide information necessary for developing and implementing state and local chemical emergency response plans and requirements for emergency notification of chemical releases.
    - Found under the Standards for the Management of Specific Hazardous Wastes and Types of Hazardous Waste Management Facilities, 40CFR266, which provides reference air concentrations and health based limits for exclusion of waste derived residues (non-metals-residue concentration limits).

Europe

- The European Union has placed vanadium pentoxide on the list of substances which must not form part of the composition of cosmetic products.

New Zealand

- New Zealand has placed vanadium pentoxide on Schedule 4 of the Cosmetic Products Group Standard, Components Cosmetic Products Must Not Contain.

7. CONSIDERATIONS

7.1 Alternative Chemicals or Substitutes

Vanadium is typically found in heavy fuel oils. Most oil-fired power plants used to burn heavy oil in their furnaces. However, over the last two decades, these power plants have gradually started to use lighter fuels such as natural gas in order to reduce air pollution (Statistics Canada 2007). It is important to note that these substitutes may not have undergone an assessment to determine whether they meet the criteria under section 64 of CEPA 1999.

7.2 Alternative Technologies and/or Techniques

No alternative technologies or techniques have been identified.

7.3 Socio-economic Considerations

Socio-economic factors have been considered in the selection process for a regulation and/or instrument respecting preventive or control actions, and in the development of the risk management objective(s). Socio-economic factors will also be considered in the development of regulations, instrument(s) and/or tool(s) as identified in the *Cabinet Directive on Streamlining Regulation* (Treasury Board of Canada Secretariat 2007) and the guidance provided in the Treasury Board document *Assessing, Selecting, and Implementing Instruments for Government Action*.

Socio-economic considerations for vanadium pentoxide include:

- In the 2006 calendar year, between 1 000 000 and 10 000 000 kg of vanadium pentoxide was incidentally produced, between 100 000 to 1 000 000 kg was imported and between 1 000 000 to 10 000 000 kg of vanadium pentoxide was used in Canada (Environment Canada 2009).
- Vanadium pentoxide is listed on the 2004 and 2007 OECD High Production Volume (HPV) chemicals lists (OECD 2004, OECD 2009), as an HPV chemical in Europe (ESIS 2010).
- Between 2005 and 2009, the average price of vanadium pentoxide (in the United States) fluctuated between $16.28 US per pound in 2005, primarily due to strong demand from the steel and aerospace industries and supply shortages, and $3.60 US per pound in April 2009, due to decreased demand from the steel industry as a result of the financial downturn. (USGS 2010, USGS 2006).
- The majority of vanadium pentoxide was used in the production of ferrovanadium alloys for the manufacture of hardened steel. There products are included in the Iron and Steel Mills and Ferro-Alloy Manufacturing Industry (NAICS 33111) (Environment Canada 2009). The revenue of this industry was $14.5 billion in 2008 with 100 establishments employing approximately 19 000 employees. In 2008, approximately 44 percent of establishments were in Ontario, 23 percent in the Prairie provinces (Alberta, Saskatchewan and Manitoba) and 21 percent in Quebec (Statistics Canada 2010b).
- The value of Canadian annual exports for Iron and Steel Mills and Ferro-Alloy Manufacturing was $3.7 billion in 2009 while the value of Canadian imports was $4.6 billion. The top trading partner in 2009 was the United States, receiving 79 percent of Canadian exports and supplying 72 percent of Canada imports (Industry Canada 2010b).
- A quantity of 38 300 kg of vanadium pentoxide was used in 2006 for chemical fertilizer manufacturing, which is included in the Chemical Fertilizer (except Potash) Manufacturing Industry (NAICS 325313) (Environment Canada 2009). This industry had revenues of $3.9 billion in 2008, with 70 establishments employing approximately 2 100 employees. In 2008, approximately 30 percent of establishments were in Quebec, 29 percent in the Prairie provinces (Alberta, Saskatchewan and Manitoba) and 26 percent in Ontario (Statistics Canada 2010a).
- The value of Canadian annual exports for Chemical Fertilizer (except Potash) Manufacturing was $1.5 billion in 2009 while the value of imports was $430 million. Canada's top trading partner in 2009 was the United States, supplying 61 percent of imports and receiving 97 percent of exports (Industry Canada 2010a).
- A quantity of 24 900 kg (present in alumina) was used for the production of aluminum which is included in the Primary Production of Alumina and Aluminum Industry (NAICS 331313) (Environment Canada 2009). This industry had revenues of $8.8 billion in 2008, with 41 establishments employing approximately 14 000 employees. In 2008, approximately 56 percent of establishments were in Quebec and 29 percent were in Ontario (Statistics Canada 2010c).
- The value of Canadian annual exports for the Primary Production of Alumina and Aluminum was $4.7 billion in 2009 while the value of imports was $1.4 billion. The United States was the top destination for exports (82 percent), while Brazil was the top source of imports (41 percent) (Industry Canada 2010c).

7.4 Children's Exposure

The Government of Canada considered, where available, risk assessment information relevant to children's exposure to this substance. As part of the Challenge, the Government asked industry and interested stakeholders to submit any information on the substance that may be used to inform risk assessment, risk management and product stewardship. In particular, stakeholders were asked through a questionnaire if any of the products containing the substance were intended for use by children. Given the information received, it is proposed that no risk management actions to specifically protect children are required for this substance at this time.

8. PROPOSED OBJECTIVES

8.1 Human Health Objective

A human health objective is a quantitative or qualitative statement of what should be achieved to address environmental or human health concerns identified during a risk assessment.

The proposed human health objective for vanadium pentoxide is to minimize human exposure to the greatest extent practicable.

8.2 Risk Management Objectives

A risk management objective is a target expected to be achieved for a given substance by the implementation of risk management regulations, instrument(s) and/or tool(s). The proposed risk management objectives for vanadium pentoxide are to prevent increases in exposure and reduce industrial emissions associated with particulate matter which may contain vanadium pentoxide.

9. PROPOSED RISK MANAGEMENT

9.1 Proposed Risk Management Regulation and Instrument(s)

As required by the Government of Canada's *Cabinet Directive on Streamlining Regulation*[3] and criteria identified in the Treasury Board document entitled *Assessing, Selecting, and Implementing Instruments for Government Action*, the proposed risk management tools were selected using a consistent approach, and took into consideration the information that was received through the Challenge and other information available at the time.

The principal focus of risk management actions is to address the prioritized sources such as the combustion of fossil fuels including oil and coal.

[3] Section 4.4 of the *Cabinet Directive on Streamlining Regulation* states that "Departments and agencies are to: identify the appropriate instrument or mix of instruments, including regulatory and non-regulatory measures, and justify their application before submitting a regulatory proposal".

As a result of the risk management activities on vanadium pentoxide undertaken by the Chemicals Management Plan the Government of Canada has changed the listing for vanadium pentoxide on the Natural Health Products Ingredients Database from a restricted substance to a substance which will not be authorized for use in natural health products. (http://webprod.hc-sc.gc.ca/nhpid-bdipsn/ingredReq.do?id=2786&lang=eng).

In order to achieve the risk management objective and to work towards achieving the environmental or human health objective(s), the risk management being considered for vanadium pentoxide includes **(1**) **reductions of vanadium pentoxide as a result of co-benefits of existing and proposed programs to reduce particulate emissions from combustion of certain fossil fuels.** Work is underway to update the Government's knowledge of the health impacts of various industrial sectors including electricity generation (coal-fired power plants) and petroleum refining. The objective of this work is to inform federal and provincial decision-making on implementation of regulatory activities in the long-term. **(2) The Government of Canada plans to implement Significant New Activity provisions under CEPA 1999 to this substance.** This would require that any proposed new manufacture, import or use be subject to further assessment, and would determine if the new activity requires further risk management consideration **(3) addition of vanadium pentoxide to the *Environmental Emergency Regulations*.** This would require facilities at or above the associated quantities and concentrations to prepare environmental emergency plans that will prevent, prepare for, respond to and recover from an environmental emergency.

9.2 Implementation Plan

The proposed regulation or instrument respecting preventative or control actions in relation to vanadium pentoxide will be published in the *Canada Gazette*, Part I, no later than September 2012.

10. CONSULTATION APPROACH

The risk management scope document for vanadium pentoxide, which summarized the proposed risk management under consideration at that time, was published on March 20, 2010. Industry and other interested stakeholders were invited to submit comments on the risk management scope document during a 60-day comment period. Comments received on the risk management scope document were taken into consideration in the development of this proposed risk management approach document.

Consultation for the proposed risk management approach document will involve publication on September 18, 2010, and a 60-day public comment period.

The primary stakeholders include:

- Petroleum sector
- Power generation sector

- Steel manufacturing sector
- Natural health products sector

11. NEXT STEPS / PROPOSED TIMELINE

Actions	Date
Electronic consultation on proposed risk management approach document	September 18,2010 to November 17, 2010
Response to comments on proposed the risk management approach document	No later than at the time of publication of the proposed instrument
Consultation on the draft instrument	Summer/fall 2011
Publication of the proposed instrument	No later than September 2012
Formal public comment period on the proposed instrument	No later than winter 2013
Publication of the final instrument	No later than March 2014

Industry and other interested stakeholders are invited to submit comments on the content of this proposed risk management approach or provide other information that would help to inform decision making. Please submit comments prior to November 17, 2010, since the risk management of vanadium pentoxide will be moving forward after this date. During the development of regulations, instrument(s) and tool(s), there will be opportunity for consultation. Comments and information submissions on the proposed risk management approach should be submitted to the address provided below:

Chemicals Management Division
Gatineau Quebec K1A 0H3
Tel: 1-888-228-0530 / 819-956-9313
Fax: 819-953-7155
Email: Existing.Substances.Existantes@ec.gc.ca

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