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**Preparation of a global legally binding instrument
on mercury**

Cost-benefit analysis of existing alternatives to mercury-based products, processes and technologies

Note by the secretariat

1. At its first session, held from 7 to 11 June 2010, the intergovernmental negotiating committee to prepare a global legally binding instrument on mercury requested the secretariat to prepare information on a cost-benefit analysis of existing alternatives to mercury-based products, processes and technologies.

2. The secretariat had made available to the committee at its first session a document on the costs and benefits associated with each of the provisions identified in decision 25/5 of the Governing Council (UNEP(DTIE)/Hg/INC.1/19). Following the first session, the secretariat contacted all Governments requesting any available information on the costs and benefits specifically relating to existing alternatives to mercury-based products, processes and technologies. The information submitted in response to the secretariat's request is summarized in the present note, which should be read in conjunction with the full report provided to the committee at its first session.

3. The committee may wish to bear in mind that little new information is available on the costs and benefits of existing alternatives. It may also wish to consider this information along with the information presented in document UNEP(DTIE)/Hg/INC.2/11 on known mercury-containing products, processes and technologies and alternatives to them.

I. Information supplied by the Government of Canada

4. The Government of Canada has provided a number of studies giving additional information on the costs and benefits of alternatives to mercury-based products, processes and technologies, including a social and economic study and mass balance study for mercury-containing products, produced in November 2009, and a costs and benefits impact analysis of the proposed Canadian regulations on mercury-containing products, produced in January 2010.

5. In the social and economic study, information is presented on Canadian projections regarding the use of mercury in a range of products, considering a business-as-usual scenario versus a risk-management scenario that assumes the application of proposed Canadian regulations to control

* UNEP(DTIE)/Hg/INC.2/1.

products containing toxic substances. Information is also provided on releases of mercury to air, water and land for each product category. The study concluded that the proposed regulations would be expected to reduce the use of mercury in products in Canada by more than 3 tonnes in 2013 and more than 5 tonnes in 2033. Remaining uses were expected to be mainly for dental amalgam and lamps.

6. A qualitative analysis of the costs and benefits highlights the costs for manufacturers, consumers and the Canadian Government, along with the benefits for the environment, health and domestic manufacturers, associated with application of the proposed regulations. It is estimated that in 2008 9.4 tonnes of mercury was used in products within Canada. The proposed regulations would control the manufacture, import and sale of mercury in products in Canada, and would result in both costs and benefits for Canadian society. It was considered that the regulations would result in limited costs for domestic manufacturers. Mercury is used to produce lamps, with most manufacturers already making voluntary commitments to reducing such use. For importers, the additional cost of mercury-free alternatives may have an impact where imported mercury products are used as inputs in the production of larger final goods. Such additional costs are likely to be passed on to consumers. For consumers, most mercury-containing products have similarly priced mercury-free alternatives available, some of which may have improved performance and potential savings over the long term in comparison to mercury-containing products. For some products, such as button-cell batteries, there may be a short-term additional cost, estimated at less than Can$1 per purchase, with the relative price difference decreasing with technological development and economies of scale. The Government is expected to incur costs relating to training, compliance and enforcement of up to Can$1 million per year initially.

7. The proposed regulations will benefit the environment, health and domestic manufacturers. For the environment, the regulations are expected to reduce the amount of mercury entering the air, water and soil in Canada. This will reduce the potential for damage to ecosystems, and will provide benefits to those using the outdoors for recreation and for commercial gain, as the number of fish consumption advisories is expected to fall as less mercury is released. The health benefits for virtually all Canadians are based on the primary route of exposure to mercury being through the consumption of fish and fish-eating mammals with elevated levels of methylmercury. Reduced environmental levels of mercury will produce a consequential decrease in exposure for the population as a whole, but in particular for the people of northern Canada, who consume the most fish and fish-eating mammals. An additional benefit lies in the reduction of the potential for exposure through breakage or spillage of products during use. Lastly, the regulations will benefit domestic manufacturers, in particular manufacturers of lamps. The regulations will ensure equal competitiveness for lamps made in Canada, where manufacturers have voluntarily reduced the amount of mercury used, and imported lamps, which contain more mercury. The regulations would control mercury levels in lamps for all sources.

II. Information supplied by the Government of Norway

8. Before imposing a general ban on mercury in products, the Norwegian Government undertook an impact assessment.[1] The assessment concluded that, even though the Norwegian authorities did not have a complete overview of the costs for all areas of use, the introduction of the ban would not lead to significant economic costs. This was based in part upon the assumption that permanent or time-limited exemptions would be granted for specified areas. Comprehensive restrictions on the use of mercury had already been introduced (thermometers in 1998) or were about to be carried out through voluntary reductions (e.g., dental amalgam). This made it difficult to differentiate between a reduction in the use of mercury as a result of voluntary substitution and a reduction arising from a ban. Uncertainty associated with quantification of the impacts of the benefits and the costs made it difficult to specify the social and economic profitability of the ban. A general ban on mercury in products was assumed to have a limited impact on Norwegian enterprises, and the ban would thus have no significant effect on employment. The administrative costs associated with the ban were estimated to be low.

III. Information available from the Government of the United States of America

9. The United States Government has compiled data via discussions with numerous stakeholders, including product manufacturers, staff members of state-level environmental protection agencies and associations (e.g., the Quicksilver Caucus of the Environmental Council of the States), and other non-governmental organizations and trade associations (e.g., the American Society for Testing and

1 The full text of the impact assessment was sent to the secretariat on 19 February 2010 in response to a call for information concerning mercury.

Materials, the National Electrical Manufacturers Association, the Northeast Waste Management Officials' Association and the Product Stewardship Institute).

10. In compiling data pertaining to the stated costs, advantages and disadvantages associated with mercury-free alternatives, the Environmental Protection Agency made a preliminary judgment that the manufacture and import of some mercury-containing products, including hydrometers, natural gas manometers and pyrometers, had ceased. For other mercury-containing products, the compiled data suggest that effective and economically feasible alternatives exist. These products include switches, relays and contactors, flame sensors, button cell batteries, measuring devices (e.g., non-fever thermometers, manometers, barometers, pyrometers, flow meters and psychrometers or hygrometers), toys, jewellery and novelty items. A summary table describing and comparing mercury content, cost, relevant legislation and advantages and disadvantages for mercury-containing products and mercury-free alternatives is set out below. The listing of advantages and disadvantages compares qualities such as cost, function and mechanics, accuracy, durability, reliability and other characteristics.

Summary table for mercury-added product and substitutes provided by the United States[2]

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)[3]*	*Alternatives/cost per unit*	*Advantages/disadvantages*
Medical devices • Sphygmomanometers • Oesophageal dilators (bougies) • Gastrointestinal tubes	Sphygmomanometers	3 (2003) although 2 reported 2004 totals to the Interstate Mercury Education and Reduction Clearinghouse (IMERC)	20–60 (Environment Canada); 70–90 (US EPA)	Hg: $111–$299 Aneroid: $59–$264 Oscillometric: $645–$995	Aneroid: A – Familiarity, easy to read, cost D – Perception of being inferior and easily damaged during use Oscillometric: A – Easy to read, easy to use, self-calibrating D – High cost, external power source
	Oesophageal dilators (bougies)	1 (2003)	≥1	Hg: $3,395 Tungsten/gel: $3,000–$4,000	Tungsten/gel: A – Safer environmental use/disposal, widely available, well received. D – May contain PVC covering (incineration)
	Gastrointestinal tubes	None identified	1,000 (local hazardous waste programme in King County)	Hg: Not available[4] Unweighted: $300–$400 Tungsten: $300– $400	Unweighted: A – Sterile water as weight D – Longer medical procedures Tungsten A – Opaque in X-ray (can track in body) D – None identified
Measurement devices • Manometers • Thermometers (non-fever, basal) • Thermometers (non-fever, industrial/commercial)	Manometers	N/A	28–74; 100–500 (Environment Canada)	Hg: $20–$375 Needle/bourdon: $50–250 Digital: $100–$700	Needle/bourdon: A – None identified D – Requires calibration Digital: A – More precise if properly calibrated D – Requires calibration

2 Figures are in United States dollars.

3 Unless otherwise noted, "Hg content per unit" is based on estimates in the University of Massachusetts – Lowell, Lowell Center for Sustainable Production "An Investigation of Alternatives to Mercury Containing Products (22 January 2003).

4 Research suggests that gastrointestinal tubes are not widely used and are generally sold without mercury, which must be purchased separately.

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)*[3]	*Alternatives/cost per unit*	*Advantages/disadvantages*
• Barometers • Psychrometers /hygrometers	Thermometers (non-fever, basal)	None identified	≤0.005–5 (Environment Canada (upper bound)	Hg: $10–$710 Liquid in glass: ≤$15 Digital: approx. $12	Liquid-in-glass: A – Cost D – Size (larger), unknown toxicity of "liquid" Digital: A – Faster reading, digital features (signal, recall) D – External power source
	Thermometers (non-fever, industrial/commercial)	6	≤0.005–≥11	Hg: $10–$60 Bimetal: $6–$138 Liquid-filled: $2–$138 Digital: $14–$260 Infrared: $92–$270	Bimetal: A – None identified D – Requires calibration, perception (Hg standard) Liquid-filled A – None identified D – Requires calibration, column separation, perception (Hg standard) Digital A – Accuracy, easy to read D – Requires calibration, perception (Hg standard) Infrared A – Accuracy, easy to read D – Requires calibration, perception (Hg standard)
	Barometers	N/A	300–622 (Environment Canada (lower bound))	Hg: $100–$1000 Aneroid: $100–$1000 Digital: $25–$300	Aneroid A – Cost D – None identified Digital A – Field programmable, cost D – None identified

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)*[3]	*Alternatives/cost per unit*	*Advantages/disadvantages*
	Psychrometers/hygrometers	N/A	0.01–6	Hg: $24–$300 Spirit-filled: $30–$80 Digital: $15–$60	Spirit-filled: A – cost D – None identified Digital A – Accuracy, cost D – Requires calibration
Thermostats • Thermostats (residential) • Thermostats (industrial/commercial)	Thermostats (residential)	≤6	0.01 –4: 3–18 (Environment Canada)	Hg: $18–$87 Digital: $21–$295	Digital A – Programmable, energy efficient D – None identified
	Thermostats (industrial/commercial	N/A	0.01 –≥1 3–18 (Environment Canada)	Hg: $65–$350 Digital: customized	Digital A – None identified D – May not be suitable for extreme environments
Mercury-added components					
Relays/switches • Float switches • Tilt/vibration switches • Pressure switches	Float switches • Air conditioner • Hot water heater • Septic tank • Boiler • Pump control • Waste treatment	12 (2003)	≥0.1–67 (IMERC fact sheet)	Hg: $15–$150 Mechanical: $10–$150 Magnetic dry reed: $6–$500 Optical: $120–$400 Conductivity: $40–$800	Mechanical A – Reliability, durability, lifetime, can be hermetically sealed, no swing area D – None identified Magnetic dry reed A – Lifetime, small/narrow enclosures D – Low contact rating, requires clean environment Optical A – Unaffected by liquid colour density, very slight hysteresis, high repeatability, high chemical resistance D – Cost Conductivity A – No moving parts, reliability, colour/hydrocarbon sensitive D – Requires conductive liquid environment

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)*[3]	*Alternatives/cost per unit*	*Advantages/disadvantages*
				Metallic ball: $17–$170 Sonic/ultrasonic: $150–$600 Pressure transmitter: $825 Thermal: $87 Capacitance: $150–$500	Metallic ball A – Lifetime D – Susceptible to shock/vibration, required swing area Sonic/ultrasonic A – Accuracy, appropriate for non-conductive/viscous liquids, easily removed/cleaned D – Requires rigid mounting Pressure transmitter A – Reliability, appropriate where no electrical power or hazardous conditions D – None identified Thermal A – Appropriate for caustic liquids, not affected by moderate build-up D – Not suitable for high temperature or high viscosity Capacitance A – No moving parts, chemical and vibration resistant D – Not suitable for high viscosity.
	Tilt/vibration switches • Home security • Clothing iron • Space heater • Medical equipment (X-ray machine, magnetic resonance imaging scanner) • Precision measuring device	8 (2003)	0.05–1 (IMERC fact sheet)	Hg: $2–$300 Metallic ball: $1–$11 Electrolytic: $5–$50	Metallic ball A – Suited for high electromagnetic interference, lifetime D – Susceptible to shock/vibration Electrolytic: A – Repeatability, stability, accuracy, extreme environments, requires low power D – Complex

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)*[3]	*Alternatives/cost per unit*	*Advantages/disadvantages*
				Potentiometer: $0.25–$300 Mechanical: $100–$350 Solid-state: $100–$250 Capacitive: $80–$250	Potentiometer A – Cost, reliability, lifetime, compact D – None identified Mechanical A – Reliability, lifetime, compact D – None identified Solid-state A – Accuracy, high resolution, responsiveness, temperature range, lifetime, resistant to shock/vibration D – Cost Capacitive A – Accuracy, stability, requires low power D – None identified
	Pressure switches • Heating, ventilation and air-conditioning equipment • Tyre pressure device • Vacuum cleaner • Hydraulic system • Furnaces • Medical equipment	1 (2003)	1–20 (Environment Canada)	Hg: $150–$170 Mechanical: $40–$600 Solid-state: $200–$350	 Mechanical A – Accuracy, reliability, lifetime, resistant to shock/vibrations D – None identified Solid-state A – Accuracy, temperature range, lifetime, field programmable, no contact bounce D – Susceptible to shock/temperature/power spike
	Temperature switches • Thermostat • Boiler • Home security • Refrigeration equipment • Power generator	1 (2003)	1–10 (Environment Canada)	Hg: $150–$250 Mechanical: $8–$600	 Mechanical A – Reliability, lifetime, high inductive load D – None identified

Product category	*Product*	*Known manufacturers*	*Hg content per unit (g)*[3]	*Alternatives/cost per unit*	*Advantages/disadvantages*
	• Ventilating equipment			Solid-state: $350–$600	Solid-state A – Accuracy, repeatability, reliability,. Field programmable, requires low power, no calibration D – Cost
	Relays/Contactors • Heating, ventilation and air-conditioning equipment • Alarm system • Lighting equipment • Commercial aircraft equipment • Telecommunications equipment • Manufacturing equipment	10 (2003)	0.001–≥153 (IMERC fact sheet)	Hg: $10–$150 Dry magnetic reed: $2–$15 Electromagnetic: $1–$35 Solid-state: $1–$150 Silicon-controlled: $30–$150 Hybrid: $40–$140	 Dry magnetic reed A – Lifetime, rapid cycling, mounting, contact resistance D – Susceptible to electromagnetic interference/shock, contact bounce Electromagnetic A – cost, resistant to electromagnetic interference/high temperature D – Lifetime Solid-state A – Lifetime, resistant to electromagnetic interference/high temperature D – Susceptible to shock/high temperature Silicon-controlled A – Responsive, control, requires low maintenance/power D – Cost Hybrid: A – Lifetime, silent, resistant to high temperature D – Availability
Measurement/control devices Flame sensors	• Flame sensors • Gas boiler • Gas range/oven	9 (2003)	Approx. 1 (Environment Canada)	Hg: $300–$1,000 Electronic ignition: $300–$1,000	Electronic ignition A – None identified D – Requires electricity.