Report on the work of the ad hoc group of experts on the review of Annexes A and B

I. Introduction

1. The Conference of the Parties to the Minamata Convention on Mercury adopted decision MC-3/1 on the review of annexes A and B. In that decision, the Conference requested the Secretariat to call for submissions from Parties, including information on mercury-added products, processes that use mercury or mercury compounds, and availability, technical and economic feasibility, and environmental and health risks and benefits of their non-mercury alternatives. The Conference also decided to establish an ad hoc group of experts to prepare a document in which it will enhance and organize the information for each use submitted by Parties, taking into account further information available to the experts, and in which it will clearly identify the sources of information.

2. The ad hoc group of experts was established consisting of 18 experts nominated by parties. The group elected two co-chairs and identified eight experts from non-governmental organizations and the scientific community as observers. The group also invited the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) to its meetings.

3. Decision MC-3/1 provided that the group will have one face-to-face meeting subject to the availability of resources. However, a meeting could not be convened due to the COVID-19 pandemic. The group agreed on an alternative arrangement for enhancing and organizing the information, involving online meetings of the group and a series of group calls inviting Parties that submitted information as well as experts who have specialized technical knowledge on the specific categories of products and processes.

4. In response to the Secretariat's call for information, Argentina, Canada, Colombia, the European Union, Montenegro, Norway, Japan, Uganda and the United States of America submitted information. Nepal, seven non-governmental organizations and one individual expert submitted additional information. Further information was collected from the members and the observers of the group, the Parties and other stakeholders who had submitted information, and other experts identified by the group.

5. This report summarizes the outcome of the work of the group. The submitted and supplemented information, organized in a tabular format indicating the sources of information, is presented in the "compilation document" attached as an appendix to this report. As of 30 April 2021, by which the report on the work of the group was due, some additional information on mercury added products, particularly on lamps, was still to be provided by experts or to be incorporated into the compilation document. The group will further work to organize such additional information into the compilation document by 30 June 2021, which will be made available to the Conference of the Parties as an information document.

II. Information on products

6. Part I of Annex A to the Convention lists nine categories of mercury-added products subject to the general obligation of the Parties not to allow manufacture, import or export after the specified phase-out date. Part II provides for measures to be taken on dental amalgam. Information submitted by Parties and others on the nine product categories listed in Part I, as well as on additional products not addressed by the Convention, are presented in this section. Information on the availability, feasibility, risks and benefits of non-mercury alternatives to dental amalgam was compiled following a separate decision in MC-3/2 and is therefore not included in this report.

Batteries

Information on the use of the product

7. Annex A to the Convention lists batteries except for button zinc silver oxide batteries and button zinc air batteries with mercury content less than 2%. Information was provided to the expert group on three types of button cell batteries that contain mercury: zinc air, silver oxide and alkaline. These batteries contain mercury in small amounts (typically 0.1-2%) to prevent the build-up of hydrogen gas. The two exempt batteries, silver oxide and zinc air batteries, are generally used for powering high-drain devices such as watches and hearing aids.

Availability of mercury-free alternatives

8. All stakeholders agree that mercury-free alternatives are commercially available for all applications of the main types of button cell batteries; silver oxide, alkaline and zinc air, and have been available from major battery manufacturers since the late 1990s and early 2000s. All members of the battery associations of Japan, Europe, North America and Latin America have ceased the manufacturing of mercury-added button cell batteries and supply mercury-free alternatives. Indonesia stated that one of the four manufacturers in that country still use mercury in dry cell batteries, but conversion to mercury-free alternatives is in progress.

9. An industry association also provided information to the expert group that mercury-free alternatives are available in China, India and Africa. China notified the World Trade Organisation (WTO) in their notification G/TBT/N/CHN/1503 dated November 2020 that China intends to limit the mercury content of all button cells to 0.0005%. India relies upon imports, principally from China and EU manufacturers for non-mercury silver oxide and zinc air button cells respectively. Africa relies upon imports as well, primarily from Europe, USA and Japan.

Feasibility of alternatives

10. Information was provided on the availability of mercury-free alternatives to button cells and their performance parameters such as self-discharge, leak resistance, capacity and pulse capability. Such information indicates that the technical performance of mercury-free alternatives is comparable to or better than traditional mercury-added button cells. Literature in 2012 showed that mercury-free alternatives cost approximately 10% more than mercury-added cells. The Battery Association of Japan also reported on an increased cost of mercury-free button cells due to initial capital investments, which was alleviated by cost-recovery with increased production and no longer applies. There are economic benefits to waste collectors and recyclers from mercury-free alternatives in the form of a 30-40% lower cost of recycling button cell waste batteries.

Environmental and health risks and benefits of alternatives

11. No information was provided on the environmental health risks of mercury-free alternatives.

Switches and relays

12. Annex A Part I to the Convention lists switches and relays, except for very high accuracy capacitance and loss measurement bridges and high frequency radio frequency switches and relays in monitoring and control instruments with a maximum mercury content of 20 mg per bridge, switch or relay.

13. A number of countries reported on the use of exempted or allowed uses of mercury switches and relays. Japan reported that it could not confirm the domestic manufacturing of such exempted switches and relays. The United States of America reported on the use of mercury and mercury compounds in switches, relays, sensors and valves in the 2018 reporting period under the mercury inventory reporting rule. Canada reported that it is considering removing the exemption in its regulations for high frequency radio frequency switches and relays due to the fact that there were no imports of these products in 2016.

14. The expert group noted that mercury-added thermostats used to control room temperature use a mercury-added switch to turn on and off heating and cooling equipment, and thus the switch is the sole mercury-added component of the product. Parties may therefore be considering such thermostats to be included under the listing of switches and relays in Annex A. On the other hand, since a thermostat is used to measure room temperature, other Parties may consider such products a measuring device. Annex A does list a number of measuring devices, but differentiates between electronic and non-electronic measuring devices. Since these particular kinds of thermostats are electronic, other Parties may therefore not be considering such switches and relays to be included in the products listed in Annex A.

Lamps

Information on the use of the product

15. Annex A to the Convention lists and restricts compact fluorescent lamps (CFL) and linear fluorescent lamps (LFL) for general lighting purposes and cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for electronic displays with mercury content higher than specified thresholds. The Annex also lists and restricts high pressure mercury vapour lamps (HPMV), which is one type of high intensity discharge (HID) lamps, for general lighting purposes. The primary mercury-free alternatives to mercury containing lamps for general lighting purposes are light emitting diodes (LED).

16. Information was submitted for fluorescent lamps listed or not listed in Annex A, HID lamps not listed in Annex A (i.e., high-pressure sodium lamps and metal halide lamps), and non-fluorescent low-pressure discharge lamps.

17. A fluorescent lamp is a low-pressure mercury- vapour gas-discharge lamp that uses fluorescence to produce light. An electric current in the gas excites mercury vapour, which produces short-wave ultraviolet light that is then converted by the phosphor coating inside the lamp to visible wavelengths. Fluorescent lamps require a ballast to regulate the current through the lamp. Fluorescent lamps are available in different shapes, including compact fluorescent lamps (CFL) and linear fluorescent lamps (LFL). In CFLs, the ballast can either be integrated into the lamp (CFL.i) or separated from the lamp (CFL.ni). CFL.i are screw-based lamps which can be directly connected to mains-voltage lightbulb sockets. CFL.ni and LFL can only operate safely in combination with specific dedicated luminaires, which contain a matching driver or ballast. Most fluorescent lamps use electrodes that emit electrons by heat, known as hot cathodes, but cold cathode fluorescent lamps (CCFL) have cathodes that emit electrons only due to the large voltage between the electrodes. Most fluorescent lamps have electrodes inside the glass tube, but external electrode fluorescent lamps (EEFL) consist of a sealed glass tube containing mercury and external electrodes.

18. High Intensity discharge (HID) lamps are a wide range of lamp families, including types such as high pressure mercury vapour, metal halide (MH) and high pressure sodium (HPS) lamps. They produce light of extremely high intensity and are used for general lighting purposes (e.g. city streetlighting, sports facilities and entertainment) and for other applications.

19. Non-fluorescent low-pressure discharge lamps produce ultraviolet light. They are designed for applications in areas such as healthcare (e.g. therapy), and industry (e.g. water / wastewater disinfection and chemical and biological processes).

Alternatives to fluorescent lamps

20. In the opinion of the expert group, retrofit LED lamps as well as LED luminaires are alternatives to the large majority of CFL and LFL lamps types for general lighting purposes. The group noted that it is technically and economically feasible to retrofit LEDs for CFL.i. While in 2015 some retrofit products may have not provided the same light intensity, brighter LEDs are available today. Currently, the technical feasibility is lower for CFL.ni. In terms of cost, one country stated that LEDs have a larger upfront cost than CFL.i but, it like many other countries, believes that this cost is outweighed by higher energy efficiency and longer product life. It was observed that the cost of LEDs has continuously declined over the last decade. For example, the payback period to replace CFL.ni with LEDs is 1.3-3 years. Various submissions reported that placing CFL.i on the market will be banned or is being phased down in many countries in Africa, Asia and Europe.

21. The expert group received diverging information on the availability of LED retrofit lamps for existing CFL.ni and LFL fixtures. Recent studies were presented indicating that a large majority of CFL.ni and LFL fixtures could receive LED retrofit lamps. On the other hand, industry associations pointed out that the replaceability may be somewhat lower due to incompatibility of LED products with some drivers in existing fixtures and because comparable efficiencies and life-time quality are sometimes not available. However, the expert group noted that the market is developing dynamically and retrofit LEDs to replace CFL.ni may become more widely available in the near future. To avoid quality and safety issues in the application, advice from professional installers is recommended before a replacement is undertaken and rewiring or replacing the luminaire may be necessary. A regional group reported significant net savings were calculated from phasing out CFLni, and T5 and T8 LFL lamps. Several studies have demonstrated significant cost savings from replacing CFL.i and CFL.ni with LEDs, although there is disagreement on the exact amount and length of payback period.

22. Halophosphate LFLs can be replaced by triband phosphor lamps, which have a significantly lower mercury content and/or by LEDs. Experts reported that halophosphate lamps are cheaper than triband phosphor lamps, but they have substantially lower lifetimes and are less energy efficient. Halophosphate lamps have been phased-out in many countries for more than a decade, but are still found in certain markets.

23. According to several submissions, LEDs have replaced CCFLs and EEFLs in the backlighting of flat panel displays. LEDs are more energy efficient, have longer life spans, and are produced for comparable costs when compared to CCFLs and EEFLs. CCFLs and EEFLs are still produced in limited numbers for replacement in certain control instruments (e.g., flight instrumentation displays) and for special purpose applications in the chemical, biotechnical and vaccine industries.

24. Fluorescent lamps used for special purposes include products with distinct application features that are achieved by special design/specifications, materials, and process steps. In comparison with other fluorescent lamps their market share is rather small. LED alternatives are currently in development, but for many applications there are currently no mercury-free lamps available.

Alternatives to high intensity discharge lamps

25. A wide range of different HID lamp technologies, fixtures/drivers and applications exist. The group was informed that LED lamps are available for many indoor and outdoor general lighting applications where previously mainly HID lamps where used. The group took note of reports that HID lamps in new vehicles have been entirely or largely replaced by LED lamps in many countries and by many major automakers. LED lamps are also gaining market share in outdoor lighting. One large country in Asia is in the process of replacing most of their HID streetlights with LED fixtures. While one country noted that upfront costs for installing high pressure sodium lamps can still be lower than LEDs, lifespan costs are lower for LEDs considering the reduced maintenance and energy efficiency improvements. Upfront costs for LEDs and metal halide lamps are now very close and LEDs are more energy efficient. Divergent information was presented to what extend HID lamps can be retrofitted by LED lamps in existing installations. A number of experts agree that LEDs can replace many types of high intensity discharge lamps. Industry associations pointed out that mercury-containing HID lamps in existing installations may not be simply replaced, e.g., because LED retrofit lamps have a higher weight, need more space, or have compatibility issues. In such cases, the entire luminaire may need to be replaced.

Alternatives to non-fluorescent low-pressure lamps

26. The expert group was informed that UV LEDs have entered the market, but they are more costly and less energy efficient than mercury-containing lamps. So far, UV LED lamps are only available for a limited range of applications.

Environmental and health risks and benefits of alternatives

27. The experts agreed that LEDs are a mercury-free and, in most cases, more energy efficient alternative to mercury-containing fluorescent lamps. Improvements and new technologies for LEDs continue to be developed. An expert reported an estimation that if CFLs and LFLs were to be phased-out globally, several dozens of tonnes of mercury could be saved in a ten-year period. Due to lower energy consumption, further mercury emissions from coal-fired power stations can be avoided. The Group was informed on the phase-out of halophosphate lamps in a regional group of countries that had resulted in a 53% decrease of mercury per lamp. Regarding end-of-life management it was recommended to consider the copper and nickel content of LEDs. The Group was also informed that although there are no recent life cycle analysis studies comparing LFLs and LEDs, the life cycle impact of CFLs and LEDs were shown as equivalent as early as 2012.

Non-electric measuring devices

28. Annex A to the Convention lists barometers, hygrometers, manometers, thermometers and sphygmomanometers, except those installed in large-scale equipment or those used for high precision measurements, where no suitable mercury-free alternative is available.

29. Japan provided information on the continuing need for mercury-containing barometers and pressure gauges for reference standard and calibration. Argentina, supplemented by other experts, submitted information on the continuing need for the use of mercury in high precision thermometers and the measurement of temperatures greater than 150 °C. Information was provided by experts on the use of mercury in pyrometers, a type of remote-sensing thermometer used to measure the temperature of distant objects. Mercury pyrometers are no longer manufactured in the United States and Europe and have been replaced by infrared pyrometers, hence the technical and economic barriers do not appear to be a significant factor.

30. A country, supplemented by an expert, submitted information on hydrometers, which are used for measurement of relative density of liquids based on the concept of buoyancy. A hydrometer usually consists of a sealed hollow glass tube with a wider bottom portion for buoyancy, a ballast such as lead or mercury for stability, and a narrow stem with graduations for measuring, and can contain several grams of mercury, depending on the product type, measuring range and volume of the hydrometer. Mercury-free alternatives include hydrometers filled with lead or other high-density materials, and electric devices.

31. A country, supplemented by an expert, submitted information on flowmeters, which are used in water and sewage treatment plants, power stations, public water supply facilities and other industrial applications to measure the flow of gas, water, air and steam. A mercury flow meter can contain as much as five kilograms of elemental mercury, and mercury is typically encased in a manometer which is attached to an assembly or pipe system. Mercury-free alternatives include digital, optical and ball-actuated flow meters.

32. Information was also submitted with respect to strain gauges and tensiometers. Strain gauges are used to measure blood flow and blood pressure. Indium-gallium strain gauges are the main alternatives to mercury strain gauges. Photocell and doppler techniques are typically used for measurements of blood pressure in fingers and toes, for the case in which indium-gallium gauges are not suitable. Tensiometers are used to measure the surface tension of liquids, used in applications such as the determination of soil moisture tension, or for measuring tension in wire, fibres and beams. The potentially mercury-containing component of a tensiometer is a manometer. It is linked via a capillary tubing to a water-filled tube with porous cup. If inserted into soil water from the tube may be sucked into the soil thus producing a vacuum that is measured by the manometer.

Other electric devices

Slip rings

33. A mercury slip ring is a device that provides 360-degree rotations to transmit signal and power between stator (stationary) side and rotor side of different industrial equipment. This product uses mercury as a conductor to transfer current and signal as a liquid at normal temperatures and is widely available in all shapes and sizes.

34. The Group was informed that there are many manufacturers of mercury-free slip rings, which are widely available in all shapes and sizes. An industry association identified specific medical devices in which mercury-containing slip rings could not be replaced.

Reference electrodes

35. The expert group reviewed information on reference electrodes. Reference electrodes are used in electrochemical measurements, allowing the control of the potential of a working electrode or the measurement of an indicator electrode. Mercury-containing reference electrodes include calomel (Hg/Hg_2Cl_2), mercurous sulphate (Hg/Hg_2SO_4) and mercuric oxide (Hg/HgO) electrodes. The calomel electrode was widely used for pH measurements, while mercurous sulphate is used for other potentiometric measurements e.g. for silver, halides and chemical oxygen demand titrations.

36. Non-mercury alternatives include standard hydrogen electrodes, silver chloride electrodes and proprietary electrode systems. At least for the vast majority of fluids to be measured (pH 1-14, aqueous and non-aqueous, presence or absence of chloride) these types allow reliable and traceable measurements of pH as well as other solution properties. Also, mercury-free measuring devices are available for the monitoring of strong alkaline solutions (pH >14).

37. Silver/silver chloride electrodes have replaced mercury chloride electrodes in most applications but cannot replace low chloride, mercury sulphate or mercury oxide.

Infrared detectors

38. An infrared detector is a device for the measurements of electromagnetic radiation with wavelengths longer than those of visible light (700 nm to 1 mm). They are used in many civilian as well as military applications such as thermal efficiency analysis, remote temperature sensing, short-range wireless communication, moisture measurement, spectroscopy, astronomy, target acquisition, surveillance, night vision and many more. Mercury-containing infrared detectors use semiconductors whose electrical resistance decreases with increasing radiation. Among them, mercury cadmium telluride (MCT) is the commercially most important material type. It is a mixture of mercury telluride (HgTe) and cadmium telluride (CdTe). Changing the mixing ratio allows an optimization of the sensitivity at certain wavelengths. That is why MCT detectors, unlike other systems, can cover a quite broad spectral range (2 – 16 µm). That includes spectral ranges that are poorly covered by other semiconductor types, especially in the short wave and medium wave infrared spectrum. Detectors typically contain from 10 to 500 mg of MCT.

39. Depending on application, several mercury-free types of infrared detectors are available including (but not limited to): InGaAs (indium gallium arsenide), InAs/GaInSb (indium arsenide/gallium antimonide), InSb (indium antimonide), SiAs (silicon arsenide), PbSe (lead selenide), InSb (indium antimonide) and SiSb (silicon antimonide), and SiGe (silicon germanium). Detectors

may also use a combination of the different types of technologies. New high-performance infrared detectors are also using emerging technologies based on nanomaterials, including graphene. At least one regional group has exemptions in its domestic legislation for the use of mercury or cadmium in the infrared detectors.

40. Information was also provided by experts on the potential use of mercury iodide (HgI_2) for other radiation detectors such as gamma rays. However, no information was found on the presence of such detectors on the market.

Melt pressure transducers, transmitters and sensors

41. Melt pressure transducers, transmitters and sensors enable accurate pressure measurements to be made, enhancing product quality and limiting damage to equipment. In melt pressure transducers, pressure transmission occurs in a closed capillary system filled with a transmission medium (i.e. mercury). The system is designed to transfer the pressure exerted on the diaphragm to the transduction feature (i.e. upper diaphragm with the strain gauge). The strain gauge then converts the physical pressure into an electric signal. In cases of excess pressure during extrusion, this process enables transducers to ensure safety, by switching off extruder driving systems when defined pressure limits have been exceeded.

42. Although mercury devices are still on the market, a number of alternative transmission mediums exist. The two key alternatives to the use of mercury as a transmission medium are silicon oil and sodium-potassium alloy (NaK). The latter is capable of transferring pressure with comparable quality to mercury. Some companies have also developed sensors which do not require a transmission fluid. Instead, pressure is transferred to a silicon element through a diaphragm. Mercury-free alternatives are technically feasible and already commercially available. Due to increasing pressure from a number of domestic regulatory authorities, several manufacturers already produce mercury-free alternatives.

Mercury vacuum pumps

43. A Sprengel pump is a form of non-electric vacuum pump that uses drops of mercury falling through a small-bore capillary tube in order to trap air. Another type of mercury containing vacuum pumps are electrical mercury diffusion pumps, which use the principle that a jet of heavy gas vapour directs (lighter) gas molecules in the pump throat down into the bottom of the pump and out the exhaust.

44. Main alternatives to mercury vacuum pumps are positive displacement pumps, which use a mechanism to expand a cavity, causing gases to flow in from the chamber that is to be extracted, after which the chamber is sealed and gases are exhausted. Those alternatives are technically and economically feasible.

Other non-electric products

45. Specialized silver halide photographic papers and motion picture and X-ray films may contain trace amounts of mercury in order to reduce the formation of an unwanted background image during processing, but mercury has now been replaced in silver halide photographic papers and films.

46. Canada also submitted information on mercury-containing counter balancers, including tire balancers or wheel weights. A number of Parties have prohibited their use. The mercury-added products are being replaced by alternatives such as non-liquid wheel weights made of tin, steel or polymer composites.

Cosmetics

47. Annex A to the Convention lists cosmetics with mercury content above 1 ppm, not including eye area cosmetics where mercury is used as preservative and no effective and safe substitute preservatives are available.

48. Mercury concentrations in eye makeup cosmetics vary depending on the product but usually do not exceed 1 ppm. Thiomersal is no longer used by the European and United States cosmetics industry. Non-mercury alternatives include phenoxyethanol, methylisothiazolinone, parabens, benzoic acid, sorbic acid, honey and sea salt. Some companies also use sterilisation and replacement of water with a gelled substitute as an alternative to preservatives.

Pesticides, biocides and topical antiseptics

49. Annex A lists pesticides, biocides and tropical antiseptics. No information was submitted on the continued use of mercury in these product categories.

Satellite propulsion

50. Information on the potential use of mercury as a propellant for ion thrusters (ion engines) for satellites and spacecrafts was provided by a number of stakeholders, supplemented by individual experts from the space industry.

51. Ion thrusters are used for spacecraft propulsion to create thrust by accelerating ions using electricity, which ionize a propellant by adding or removing electrons to produce ions. According to published articles, mercury has been used as a satellite propellant in the past. Concerns related to mercury toxicity led to its abandonment. Potential risks in mercury to be re-used as a propellant for ion thruster were provided. According to available information, a thruster may contain up to 20 kg of mercury. Plans to launch several hundreds of satellites within a few years could lead to a release of up to 20 tonnes of mercury in orbit.

52. Although mercury is one of the cheapest and easiest-to-store propellants for electric propulsion, the group of experts pointed out the environmental and health risks of mercury use for ion thrusters, such as the risk of spillage and contamination on the ground and emissions of mercury in orbit. Considering typical failure rates for rocket launches, there is a risk of depositing high amounts of mercury directly on earth, around the launch-sites or in the oceans. An expert explained that mercury used as a propellant will be expelled possibly in the low earth orbit and exhausted mercury is likely to travel back to earth's atmosphere and eventually to the surface of the earth over several years.

53. Alternatives to mercury-based propellants are available and have been used for many years, including. Xenon (Xe), Krypton (Kr), Argon (Ar), Neon (Ne), Helium (He), Hydrogen (H_2), Iodine (I_2), Buckminsterfullerene (C_{60}), Adamantane ($C_{10}H_{16}$), and Air (nitrogen/oxygen).

III. Information on processes

54. Part I of Annex B lists two manufacturing processes, namely chlor-alkali production and acetaldehyde production, subject to the obligation of Parties not to allow the use of mercury or mercury compounds in such processes after the specified phase-out date. Part II lists three manufacturing processes, namely vinyl chloride monomer production, sodium or potassium methylate or ethylate production and polyurethane production, and sets out measures that Parties shall take to restrict the use of mercury or mercury compounds in those processes. Information has been received for these processes except for acetaldehyde production, along with information on other processes in which mercury or mercury compounds are used.

Chlor-alkali production

55. Part I of Annex B to the Convention lists chlor-alkali production as a process subject to the obligation of Parties not to allow the use of mercury after the specified phase-out date. Some countries submitted information on the plan for phasing out mercury-cell chlor-alkali process.

Other processes using mercury as electrodes

56. Apart from the chlor-alkali and alcoholates production processes, mercury electrodes are also found to be used in the production of sodium dithionite and production of alkali metals. Montenegro has developed a rulebook that prescribes its conditions of use and release of mercury, mercury compounds, and mixtures of mercury in these production processes. A number of Parties have or will take measures that effectively prohibit all remaining processes using mercury as an electrode.

Vinyl chloride monomer production

57. Part II of Annex B to the Convention lists vinyl chloride monomer (VCM) production and sets out measures that Parties shall take to restrict the use of mercury or mercury compounds in the process, including not allowing the use of mercury five years after the Conference of the Parties has established that mercury-free catalysts based on existing processes have become technically and economically feasible.

58. VCM is an industrial chemical mainly used in the production of polyvinyl chloride (PVC), which is used as building material and in household products. In the acetylene process where mercury is used, coal-derived coke is heated with calcium carbonate to produce calcium carbide, which is then

hydrolysed to create acetylene. Acetylene is then reacted with hydrogen chloride using mercury (II) chloride ($HgCl_2$) as a catalyst to produce vinyl chloride, which is then polymerized to create PVC.

59. Although there are a select number of VCM facilities using mercury in the European Union, Russia and potentially a limited number of other countries, the vast majority of this production is in China. China reported that, for calendar years 2017-2018, mercury use in the range of 700-820 tonnes at 69 facilities. Approximately 20 tonnes of catalyst containing 10% by weight of mercury chloride (2 tonnes) is consumed annually in the only plant within the EU, which is required to cease the use of mercury as a catalyst by January 2022.

60. Except for a limited number of countries, VCM production does not involve mercury catalysts because ethylene is used as the hydrocarbon feedstock. Ethylene is produced from petroleum or natural gas, while acetylene is produced mainly from coal and can also be produced from natural gas. There is an ongoing research into production of VCM using acetylene using alternative catalysts, most notably gold catalysts, which have been demonstrated to have comparable catalytic efficiency to commercial mercury catalysts. Other alternative catalysts include nitrogen-doped activated carbon, copper and ruthenium.

61. There is a five-year Global Environment Facility (GEF) funded project underway with funding of over USD 16 million for the reduction and minimization of mercury in PVC production in China. This project is scheduled to be completed in 2022, and includes an expert panel established to review the mercury-free VCM production technologies, and at least two mercury-free VCM production technologies evaluated.

Production of polyurethane

62. Part II of Annex B to the Convention lists production of polyurethane using mercury containing catalysts and sets out measures that Parties shall take to restrict the use of mercury or mercury compounds in the process, including aiming at the phase-out of this use as fast as possible, within 10 years of the entry into force of the Convention. Unlike other processes listed in Annex B, there is no prohibition on new facilities for polyurethane production.

63. In the formation of polyurethane, mercury catalysts are used in the reaction between a polyol and an isocyanate component. During the reaction, mercury catalysts enable a long induction period, followed by a rapid reaction for curing the product. The catalyst tends to be present in the polyol component. The mercury catalyst is integrated into the polymer and remains present in the final polyurethane product. Over time, and accelerated by exposure to harsh environments, UV, abrasion, etc., the polymer structure breaks down and mercury is likely to be released.

64. Viable substitutes to mercury catalysts are already in use for over 95% of polyurethane elastomer systems and have been in use for many years as attested to by regulations and information from Japan, the United States, and the EU where only non-mercury alternatives are used. The cost of mercury-free catalysts is comparable with the cost of mercury catalysts. Tin and amine catalysts are alternatives to Hg catalysts for some polyurethane elastomer applications, titanium and zirconium compounds have been introduced for others, while bismuth, zinc, platinum, palladium, hafnium, etc., compounds are marketed for still others.

Other processes using mercury-containing catalysts

65. Apart from VCM and polyurethane production, mercury catalysts may also be used to promote a large range of chemical reactions in production processes, for example in producing 1-aminoanthraquinone and anthraquinone derivates, vinyl acetate and keto acids. There are substitutes available to the use of mercury in polymer production processes, such as catalysts based on zinc and palladium. A regional group informed that they have banned processes that use mercury-containing catalysts.

Other processes

66. Another expert submitted information on the use of mercury in gold plating / fire gilding in some countries, and electroplating as a mercury-free alternative.