Non-electronic measuring devices

Information provided by Argentina, Montenegro, Uganda, the USA, and other stakeholders (ZMWG)

Thermometers

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	Thermometers (including pyrometers))
3. Information on the use of the product	**Argentina** In Argentina, FITE S.A. is the only company that produces thermometers. Types of thermometers. • Precision thermometers • Temperature greater than 150 ° C • Standard chemical thermometers • Combined (with densimeters) According to FITE S.A., different types of thermometers are used in Argentina, mainly in chemical industry, petroleum laboratories and pharmaceutical industry. **Information from experts** • Glass mercury thermometer is a thermometer in which mercury is sealed as a temperature sensitive liquid inside a transparent glass tube. • The amount of mercury used depends on the required accuracy, and is about 4 to 20 g per thermometer. The finer the scale (minimum display that can be confirmed), the greater the amount of mercury used. • There is almost no residual mercury in the narrow tube, shows good reproducibility, is highly accurate, and the temperature of substances such as hydrochloric acid, sulfuric acid, and other highly corrosive substances can be measured. • In addition to being used alone, these are incorporated in hygrometers, floats for LPG measurement, diesel engines, medical equipment (gas sterilizers), pycnometers, and flash point testers. • Demand for glass mercury thermometers with a scale of 1 ° C or higher is declining. **Information from experts**

	• Pyrometers are a form of mercury dial thermometer used for high temperature measurements such as in foundry application for the measurement of the temperature of diesel exhaust (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). • Infrared thermometers appear to have replaced mercury thermometers, and new pyrometers are not manufactured with mercury (NEWMOA, 2016). There are no significant environmental risks or technical feasibility limitations around mercury-free alternatives, however electronic infrared pyrometers are more expensive (while also providing increased functionality). • In pyrometers, radiation from the measured body is focused on a detector, equipped with a dial gauge and temperature-sensing stem (thermocouple) (NEWMOA, 2016). • Range of mercury content/ consumption per unit product: 5-10 g contained within the thermocouple (sensor) (NEWMOA, 2016).
4. Information on the availability of mercury-free (or less-mercury) alternatives	**Argentina** • Precision thermometers – They are exempt from the Convention. • Temperatures greater than 150 ° C – Without replacement, in search of alternative technological solutions • Standard chemical thermometers – They only have replacements in temperatures below 150 ° C • Combined (with densimeters) - These do have replacements **Information from experts** • Currently, thermometers and digital thermometers that use other specific type of liquid as the temperature sensitive liquid are available. **Information from experts** • Main alternatives to pyrometers: Infrared thermometer, pyrometers with nitrogen-containing stem • Infrared thermometers are non-contact temperature measurement devices. They consist of a lens to focus infrared energy on to a detector (thermocouple) which converts the energy to an electrical signal (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).
5.(i) Information on the technical feasibility of alternatives	**Argentina** • The Argentine company, FITE S.A., has begun its activities to replace the thermometers with temperatures below 150 ° C and the standard chemical thermometers with temperatures below 150 ° C. The replacement material for many of the applications that previously used mercury is galinstan, a eutectic alloy of gallium, indium, and tin. • The work related to the technical specifications is being carried out jointly with the National Institute of Industrial Technology (INTI) and Physical Metrology sector.

	• The companies that supply the inputs for the manufacture of the instruments are foreign. FITE S.A. has already started making relevant contacts with the companies that produce galinstan and glass tubes. The supplier of the latter will a German company. • Once they have the technical specifications and the purchase of supplies, they will proceed to the corresponding tests for the replacement of mercury in the instruments. **Information from experts** • Due to performance issues, replacement with mercury-free thermometers is not possible for some applications. Specifically, replacement is not possible for the following: • The maximum temperature that can be measured is 300 ° C or less, and the scale is 0.5 ° C or less. • The maximum measurable temperature is over 300 ° C and less than 500 ° C, and the scale is 2 ° C or less. • Thermometers that can measure the temperature of hydrochloric acid, sulfuric acid and other highly corrosive chemicals, the maximum temperature that can be measured is more than 200 ° C and 500 ° C or less, and the scale is 2 ° C or less. • Replacement during the time of repair with replacement products is difficult mainly due to factors such as simple replacement not being possible due to size differences. • Glass mercury thermometer is specified in the Japanese petroleum test. With digital thermometers, dealing with total immersion is difficult and standard data used until now cannot be used any more. Hence, requests have been made to continue manufacturing glass mercury thermometers even after 2020. • In addition to the thermometers specified in the standard, there is a possibility of continuing the manufacture of a small number of custom-made products that cannot be replaced. **Information from experts** • There are no technical feasibility barriers associated with infrared pyrometers, evidenced by their use having replaced mercury pyrometers in industry.
5.(ii) Information on the economic feasibility of alternatives	**Information from experts** • A glass mercury thermometer costs around 1,000 yen, while a digital thermometer costs around 5,000 to 10,000 yen and is more expensive. • Some digital thermometers have high accuracy. However, in order to increase accuracy, it is necessary to increase the accuracy of both the temperature sensing unit and the display unit, which can be very expensive. **Information from experts**

	• Infrared thermometers and pyrometers are electrical and cost more than mercury thermometers, however, have additional features and so are not directly comparable. Mercury pyrometers are no longer manufactured in the USA and Europe and have been replaced by infrared pyrometers and so economic barriers do not appear to be a significant factor (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011) (NEWMOA, 2016).
6. Information on environmental and health risks and benefits of alternatives	**Information from experts** • The human health and environmental risks related to electronic/ infrared thermometers (and pyrometers) is insignificant compared with potential emission and exposure associated with mercury thermometers/pyrometers (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	**Information from experts** • There are 10 manufacturers in Japan. • Glass mercury thermometer (excluding those listed below) will be regulated by the Act on Preventing Environmental Pollution of Mercury of Japan after the phase-out deadline of the Minamata Convention (end of 2020). Exemptions included in Annex A of the Minamata Convention ([Products for research, calibration of instruments, for use as reference products], [Measuring devices for which no feasible mercury-free alternative for replacement is available],[Measuring devices installed in large-scale equipment or those used for high precision measurement, where no suitable mercury-free alternative is available]) are also not subject to regulation under the Act on Preventing Environmental Pollution of Mercury of Japan (During the review process, the scope of exemption for products will be determined by the use mentioned above). • Products for which the maximum temperature that can be measured is 300 ° C or less, and the scale is 0.5 ° C or less. • Products for which the maximum measurable temperature is above 300 ° C and 500 ° C or less, and the scale is 2 ° C or less. • Products that can measure the temperature of hydrochloric acid, sulfuric acid and other highly corrosive chemicals, the maximum temperature that can be measured is more than 200 ° C and 500 ° C or less, and the scale is 2 ° C or less. **Information from experts** Examples of regional or national restrictions • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that

	activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers. • In the EU, mercury thermometers, including pyrometers and psychrometers are banned by the Mercury Regulation 2017/852 and the REACH regulation 1907/2006 except for use in scientific research and development. Also exempted are platinum resistance thermometers using the triple point of mercury. ECHA (2011) concluded that 'for all known applications, there are technically feasible alternatives that can replace all mercury thermometers and other non-electrical thermometric devices using mercury, with the exception of - thermometers used for testing according to analysis standards (test methods) that prescribe mercury thermometers.' However, standards are subject to regular revisions during which mercury-free thermometers of the same accuracy may be included, a process that is already underway. Alternatives include: - Mercury-free liquid-in-glass thermometers containing liquids such as alcohol or gallium alloys - Gas or liquid dial thermometers - Bi-metal dial thermometers - Electronic thermometers - Infrared thermometers • In Europe, the export, import and manufacturing in the Union of non-electronic thermometers and other non-electrical thermometric applications is prohibited by 31 December 2020 according to Regulation 2018/852 on mercury. According to the Regulation 1907/2007 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), thermometers and other non-electrical thermometric applications intended for industrial and professional uses containing mercury shall not be placed on the market from 10 April 2014. • Some US states prohibit the sale of mercury-added pyrometers under the category of mercury-containing measuring devices (Minnesota, New Hampshire, New York, Vermont) (NEWMOA, 2016).
8. Other relevant information pursuant to Decision MC-3/1	
9. References	**Information from experts** Information was collected through interviews with a group of domestic manufacturers of glass measuring instruments. ECHA. (2011). Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices

Barometers

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	Barometers
3. Information on the use of the product	**Information from experts** • Liquid column type mercury barometer is a barometer that utilizes the principle that when a glass tube with one end closed is filled with mercury and placed in mercury contained in another container, the weight of the mercury in the glass tube balances with the pressure applied to the mercury surface in the container. • Currently, there is not much demand for this product and almost no production. In the future, products that are able to get certification by the Japan Meteorological Agency will be used as reference standard products for research and calibration, and hence there is a demand of manufacture for these specific products.
4. Information on the availability of mercury-free (or less-mercury) alternatives	**Information from experts** • Digital barometers are available.
5.(i) Information on the technical feasibility of alternatives	
5.(ii) Information on the economic feasibility of alternatives	
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the	**Information from experts** • Liquid column type mercury barometers will be regulated by the Act on Preventing Environmental Pollution of Mercury of Japan after the phase-out deadline of the Minamata Convention (end of 2020). Exemptions included in Annex A of the Minamata Convention (Products for research, calibration of instruments, for use as reference

Convention not addressed above (e.g. manufacture, general trade information, etc.)	products) are also not subject to regulation under the Act on Preventing Environmental Pollution of Mercury of Japan (During the review process, the scope of exemption for products will be determined by the use mentioned above). • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers. • In the EU, the REACH regulation 1907/2006 bans barometers with the exemption of use in scientific research and development.
8. Other relevant information pursuant to Decision MC-3/1	
9. References	**Information from experts** Information was collected through interviews with a group of domestic manufacturers of glass measuring instruments.

Devices using mercury to measure the density of liquids	
Name of the product use and/or process	Hydrometer (non-electric)
Alternative names	Areometer, densimeter For specific applications: urinometer (med.), lactometer, alcohol meter, battery condition indicator, anti-freeze tester, anti-freeze meter, thermohydrometer, saccharometer
Purpose of the product/process	A hydrometer is an instrument used for measuring the relative density of liquids based on the concept of buoyancy. They are typically calibrated and graduated with one or more scales such as specific gravity, but typically they contain a scale that directly indicates the information of interest, e.g. the content of alcohol in a water/alcohol mixture (Lemon 2013).

	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.  **Figure 1: Examples of hydrometers: from left to right: lactometer, antifreeze meter, alcohol meter, battery tester (filled with mercury or other high-density materials: Food museums of the province of Parma 2019, Butch 2015b, Michel 2017, Butch 2015a)**
Field of application	Urinometer (for urine analysis), lactometer (testing of milk), alcohol meter (determining the alcoholic strength of liquids), battery tester (battery condition tester), anti-freeze meter (test of cool liquid in a car), thermohydrometer (hydrometer with thermometer for measuring the density of petroleum products, like fuel oils), saccharometer (determining the amount of sugar in a solution), soil analysis (particle size distribution in fine-grained soils)
Mercury content	Several grams, depending on the hydrometer type, measuring range and volume of the hydrometer.
Extent of use/ production (globally, regionally)	Mercury filled hydrometers could not be identified on the European or US markets except antique objects (Lassen and Maxson 2008, NEWMOA 2016b). No information on production and use outside the EU and the USA available

Environmental or health risk	• Risk of mercury spillage in case of breakage of the product • Risk of mercury release in case of inappropriate disposal of waste product
Available non-mercury alternatives	• Hydrometers filled with lead or other high-density materials, electric devices
Advantages of mercury compared to alternatives	None
Additional comments	Visual assessment of products offered on international trading platforms (Alibaba.com, Made-in-china.com, ExportersIndia.com), indicate that most offered hydrometers do not contain liquid mercury, but other materials. More information is needed to verify this assumption.
References and sources for further information	Butch (2015a): Battery condition indicator indicates the amount of charge in the battery (around 1985). Available online at https://upload.wikimedia.org/wikipedia/commons/4/44/Battery_condition_indicator.jpg, checked on 9/24/2019. Butch (2015b): Device to measure to what temperature the coolant of a car is protected against freezing. Available online at https://upload.wikimedia.org/wikipedia/commons/9/9d/Coolant_indicator.jpg, checked on 9/24/2019. Food museums of the province of Parma (2019): Densimetro o galattometro con custodia. Available online at https://upload.wikimedia.org/wikipedia/commons/b/b8/Densimetro_o_galattometro_con_custodia_-_Musei_del_cibo_-_Parmigiano_-_314a.jpg, checked on 9/24/2019. Lassen, C.; Maxson, P. (2008): Options for reducing mercury use in products and applications, and the fate of mercury already circulating in the society. Final Report. Edited by COWI. Available online at https://ec.europa.eu/environment/chemicals/mercury/pdf/study_report2008.pdf, checked on 9/24/2019. Lemon, K. (2013): Hydrometers- A Guide to applications and usage. Cambridge, United Kingdom (Camlab). Available online at https://camblab.info/wp/index.php/hydrometers-a-guide-to-applications-and-usage/, updated on 2/8/2013, checked on 6/10/2019. Michel (2017): Hydrometer in a still. Available online at https://commons.wikimedia.org/wiki/File:Hydrometer_in_a_still_(cropped).jpg, checked on 9/24/2019. NEWMOA (Ed.) (2016): Hospital equipment. Available online at http://www.newmoa.org/prevention/mercury/projects/legacy/healthcare.cfm, checked on 9/24/2019.

Devices using mercury to measure fluxes/flows (flow meter, non-electric)	
Name of the product use and/or process	Flow meters
Alternative names	Analogue flow meters, fluxmeter, flow sensor, flow measuring device, flow rate meter
Purpose of the product/process	Flow meters are used in water and sewage treatment plants, power stations, and other industrial applications. They may also be used in public water supply facilities, including pumping stations, distribution systems, and treatment plants. Flow meters are custom-designed for specific applications. The design depends on the substance being measured (liquid or gas) and the flow rate needed (volumetric or mass). Flow meters measure the flow of gas, water, air, and steam. The mercury in a flow meter is typically encased in a manometer, which is attached to an assembly or pipe system. The mercury in this manometer rises and falls with changes in the rate of flow of the liquid or gas (Environmental Protection Agency 2010, NEWMOA 2016c).  **Figure 2: Mercury flow meters (NEWMOA 2016c)**
Field of application	Measuring technology

Mercury content	A mercury flow meter can contain as much as 5 kg of elemental mercury.
Extent of use/ production (globally, regionally)	No production anymore, use unknown
Environmental or health risk	• Risk of mercury spillage/exposure in case of breakage of the product or leakage of mercury • Risk of mercury release in case of inappropriate disposal of waste product
Available non-mercury alternatives	• Non-mercury alternatives include digital, optical, and ball-actuated flow meters.
Advantages of mercury compared to alternatives	None
Additional comments	Mercury-containing flow meters were commonly used prior to the 1970s. Mercury is not used in the manufacture of new flow meters; however, older flow meters may still be in use. • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers.
References and sources for further information	Environmental Protection Agency (EPA) (2010): Elemental Mercury Used in Flow Meters, Natural Gas Manometers, and Pyrometers; Significant New Use Rule. Available online at https://www.federalregister.gov/documents/2010/07/21/2010-17718/elemental-mercury-used-in-flow-meters-natural-gas-manometers-and-pyrometers-significant-new-use-rule, checked on 7/25/2019. NEWMOA (Ed.) (2016): Measuring Devices (Miscellaneous). Available online at http://www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm, updated on 12/30/2016, checked on 9/24/2019.

Strain gauge

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	**Strain gauge**
3. Information on the use of the product	• Mercury is used in strain gauge plethysmography to measure blood flow and blood pressure. This is used to diagnose arteriosclerosis, a disease affecting arterial walls and resulting in reduced blood circulation. The mercury strain gauge consists of a fine rubber tube filled with mercury which is placed around the body in the area where blood pressure is to be measured. • Mercury usage in plethysmography is low in comparison to some other medical applications such as sphygmomanometers. 1.25g elemental mercury is used per strain gauge (ECHA, 2011). • Mercury-containing strain gauges are now rare. No mercury strain gauges have been sold in Europe since 2014 and according to NEWMOA, mercury-filled strain gauges are rarely used (NEWMOA, 2016). It is estimated that, for example, in Sweden only 200 strain gauges are used per year, and one major global producer of strain gauges consumed 946 grams of mercury in 2004 (ECHA, 2011). It is estimated that 0.014 t Hg was placed on the EU market in 2010.
4. Information on the availability of mercury-free (or less-mercury) alternatives	Main alternatives: *Strain gauges with indium-gallium, photo cell/laser-Doppler techniques* There are technically and economically feasible mercury-free alternatives available (ECHA, 2011). • Indium-gallium strain gauges are the main alternative to mercury strain gauges. • Photo cell and Doppler techniques are typically used for measurements in fingers and toes, for which indium-gallium gauges are not suitable (COWI, 2008). The photo cell technique registers changes in tissue colour at different pressures. The Doppler technique measures the velocity of red blood cells to determine blood flow. Ultrasonic devices are used for larger applications, and laser devices are used for measuring smaller volumes. • The world leading manufacturer is D.E. Hokanson, Inc., in the USA where both mercury and indium-gallium strain gauges are produced for export (COWI & ICF, 2017).
5.(i) Information on the technical feasibility of alternatives	• According to COWI (2008) photo cell and laser-Doppler technique or gallium/indium strain gauges are capable of identifying a variety of diagnosis offered by mercury-containing equipment. Indium-gallium strain gauges can be used with existing plethysmographs for the same application as mercury strain gauges (ECHA, 2011). • In the area of research, however, there is no alternative to mercury-containing plethysmographs where absolute blood flow in arms and legs is measured. This is due to the body of research and reference materials built up over decades of use. Indium-gallium gauges have a higher freezing point

	and lower resistance and so cannot be used for some applications, specifically Raynaud's disease or small digit tests, or cold water immersion studies (Hokanson, 2019) (COWI & ICF, 2017).
5.(ii) Information on the economic feasibility of alternatives	The driving factor for ongoing use of mercury-containing strain gauges is economic as mercury-containing tubes are inexpensive. However, they are designed to work with complex electronic equipment costing in excess of EUR 20,000 and with life spans of 10-15 years. As such, clinics are hesitant to replace the complete system other than in the case of technical failure (COWI, 2008). It is possible to retrofit indium-gallium gauges with Hokanson plethysmographs with a few exceptions (COWI & ICF, 2017). The prices of indium-gallium strain gauges are approximately 40% higher than mercury gauges according to a major supplier (COWI & ICF, 2017). However, ECHA (2011) judged that indium-gallium gauges are economically feasible and estimated the cost of compliance in the EU for restrictions on mercury-containing strain gauges at EUR 2.6 million in the period of 2015-2034. A major producer of mercury strain gauge claimed that indium-gallium is also more difficult to handle during production, requiring more assembly time.
6. Information on environmental and health risks and benefits of alternatives	Gallium is reported to cause skin, eye and respiratory irritation and may cause bone marrow abnormalities with damage to blood forming tissues (ECHA, 2011). There is less information on the toxicological properties of indium. However, according to the submitter of the information, due to the clear evidence on the hazardous properties and risk of mercury, the usage of indium-gallium strain agues is considered to reduce overall risk to environment and health.
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	

8. Other relevant information pursuant to Decision MC-3/1	The export, import and manufacturing of mercury-containing strain gauges to be used with plethysmographs are prohibited in the EU from 31 December 2020 by Regulation (EU) 2017/852 on Mercury. There are some exemptions to the restriction, notably: • Non-electronic measuring devices installed in large-scale equipment or those used for high precision measurement where no suitable mercury-free alternative is available • Measuring devices more than 50 years old on 3 October 2007 • Measuring devices which are to be displayed in public exhibitions for cultural and historical purposes Strain gauges to be used with plethysmographs intended for industrial and professional uses were restricted from being placed on the market from 10 April 2014. The restriction also applies to devices which are placed on the market empty if intended to be filled with mercury. In the USA, mercury strain-gauges are prohibited from sale in the states of Maine, Louisiana, Connecticut and Rhode Island. **ZMWG** In Serbia, strain gauges to be used with plethysmographs intended for industrial and professional uses have not been placed on the market since 1 October 2018.

9. References

COWI & ICF. (2017). Support to assessing the impacts of certain amendments to the Proposal of the Commission for a Regulation on Mercury. Retrieved from http://ec.europa.eu/environment/chemicals/mercury/pdf/Final%20Report_KH0617141ENN.pdf

COWI. (2008). Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society. Retrieved from http://ec.europa.eu/environment/chemicals/mercury/pdf/EU_Mercury_Study2008.pdf

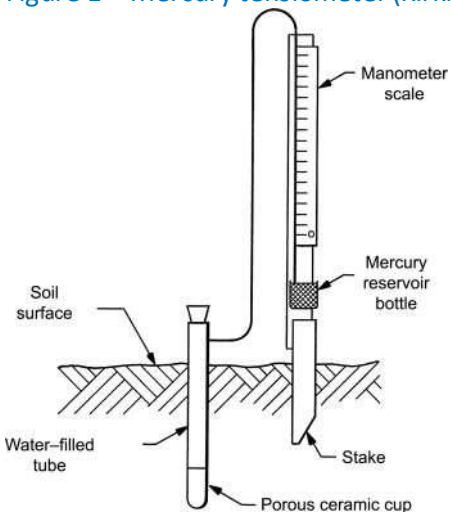
ECHA. (2011). Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices. Retrieved from https://echa.europa.eu/documents/10162/20f4ee0a-6bcf-4ed0-a271-6674cd333710

Hokanson. (2019). Strain Gauges . Retrieved from http://hokansonvascular.com/products/133386

NEWMOA. (2016). Hospital Equipment. Retrieved from http://www.newmoa.org/prevention/mercury/projects/legacy/healthcare.cfm

Minamata Initial Assessment for Serbia, 2018, Available at https://www.researchgate.net/publication/330514455_Mercury_initial_assessment_for_the_Republic_of_Serbia

Tensiometer [David: already covered by the Convention?]

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	**Tensiometer**
3. Information on the use of the product	Figure 1 – Mercury tensiometer (Kirkham, 2005)  Tensiometers measure the surface tension of liquids and are used in applications such as the determination of soil moisture tension, or for measuring tension in wire, fibres and beams (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). 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. Mercury manometers/tensiometers are shipped without mercury and filled with mercury by the user (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). There may also be risk of release from breakage, but the highest risk of release is in the waste phase. 70-140 g mercury is used per manometer. There was roughly 4 t of mercury estimated to have been accumulated in manometers in the EU in 2011, and 0.04-0.4 t Hg per year placed on the market (ECHA, 2010).

4. Information on the availability of mercury-free (or less-mercury) alternatives	Main alternatives: *Liquid filled in tube manometers, mechanical alternatives/elastic pressure sensors, electric manometers, other devices* • The mercury manometers used in tensiometers are usually replaced by elastic pressure sensors or electric manometers. • Elastic pressure sensors contain elements that are deformed or stretched when pressure is applied to them. The level of displacement is recorded. Common elastic pressure sensors include Bourdon tube manometers and pressure gauges with diaphragms. Bourdon tube manometers use a C-shape tube sealed at one end. Pressure is applied at the open end, causing pressure to be transferred to a gear and indicating needle. Pressure gauges with diaphragms can be mechanical or electric and contain a flexible two-sided membrane, with one side enclosed in a capsule containing a fluid such as air at a known pressure. Pressure is applied to the other side and the bending in the membrane is recorded. • Electric manometers use pressure transducers connected to an analogue to digital converter to transform the sensor response to an electrical signal. • Liquid filled tube manometers can contain liquids other than mercury e.g. water or alcohol. • There are also alternative methods to manometers to measure soil moisture. The gravimetric method determines the water content of soil by weighing it, drying it and measuring the difference in weight. **Information from experts** • Alternatives are readily available for tensiometers for measuring soil moisture tension. • If mercury tensionmeters are always accompanied by mercury manometers, are tensionmeters already effectively prohibited under the manometer ban in Annex A? This is an important issue that requires clarification, and for which the compilation is unclear.
5.(i) Information on the technical feasibility of alternatives	• According to a European producer of mercury manometers, there was no application where mercury manometers cannot be replaced by other devices (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). • Bourdon tube manometers are more robust than mercury manometers and suitable for measuring higher pressures (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). • Pressure gauges with diaphragm are equally accurate as traditional mercury manometers.

	• Electronic manometers are widely used and have advantages compared to mercury manometers such as requiring less maintenance and less expertise to use. • The gravimetric method is time consuming and labour-intensive, however is accurate and low-cost.
5.(ii) Information on the economic feasibility of alternatives	Alternatives to mercury manometers are usually cheaper (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). Mercury manometers costed around €108 in 2006. Prices for bourdon tube manometers ranged from €54 to €122, and prices for pressure gauges with diaphragms ranged from €30 to €76. Electric manometers were the exception to this, costing 3-4 times more than mercury manometers for similar pressure ranges (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).
6. Information on environmental and health risks and benefits of alternatives	Mercury manometers/tensiometers are shipped without mercury and filled with mercury by the user (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). There may also be risk of release from breakage, but the highest risk of release is in the waste phase. There is no risk associated with the use of alternative liquids in manometers and the risks associated with electronic alternatives are not significant (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	
8. Other relevant information pursuant to Decision MC-3/1	**EU** In Europe, tensiometers containing mercury intended for industrial and professional uses have been prohibited from being placed on the market from April 2014 according to the Regulation 1907/2007 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). This restriction also applies to tensiometers supplied to the market empty with the intention of being filled with mercury. Electronic manometers also fall under restriction of the RoHS Directive which prohibits maximum mercury concentration over 0.1% in electrical and electronic equipment placed on the market.

	• US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers. **ZMWG** In Serbia, tensiometers intended for industrial and professional uses have not been placed on the market since 1 October 2018.

9. References

Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011. Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices. [Online] Available at: https://echa.europa.eu/documents/10162/20f4ee0a-6bcf-4ed0-a271-6674cd333710

COWI, 2008. Options for reducing mercury use in products and applications, and the fate of mercury already circulating in society. [Online] Available at: http://ec.europa.eu/environment/chemicals/mercury/pdf/EU_Mercury_Study2008.pdf

ECHA, 2010. Annex XV Restriction Report: Proposal for a restriction. [Online] Available at: https://echa.europa.eu/documents/10162/13641/annex_xv_restriction_report_mercury_en.pdf/e6f7cce2-ecf4-49cc-ba4e-34bb2c60b4a5

Kirkham, M., 2005. Tensiometers. [Online] Available at: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tensiometers

Minamata Initial Assessment for Serbia, 2018, Available at https://www.researchgate.net/publication/330514455_Mercury_initial_assessment_for_the_Republic_of_Serbia

Mercury column type pressure gauge

1. Category of mercury-added product	Non-electronic measuring devices

2. Further description of the product	Mercury column type pressure gauge
3. Information on the use of the product	・A pressure gauge that can accurately measure pressure using the density (specific gravity), height, and gravitational acceleration of mercury. ・The average amount of mercury used is 1,500 g / piece. These are mainly used at research institutes and for calibration of pressure gauges, for purposes such as calibration of high-precision pressure gauges and inspection of aneroid sphygmomanometers. ・Used for calibration purpose and not incorporated into other equipment.
4. Information on the availability of mercury-free (or less-mercury) alternatives	・When using the certification system of the Measurement Law, a reference liquid column type pressure gauge is required. Hence, substitution with non-mercury alternative is difficult.
5.(i) Information on the technical feasibility of alternatives	・In order to achieve the same level of performance, no other liquid exists that can replace mercury and hence replacement is not possible. There is a request for continual manufacture according to the order.
5.(ii) Information on the economic feasibility of alternatives	
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	・There are two manufacturers in Japan.
8. Other relevant information pursuant to Decision MC-3/1	Mercury column type pressure gauges will be regulated by the Act on Preventing Environmental Pollution of Mercury of Japan after the phase-out deadline of the Minamata Convention (end of 2020). Exemptions included in Annex A of the Minamata Convention (Products for research, calibration of instruments, for use as reference products) are also not subject to regulation under the Act on Preventing Environmental Pollution of Mercury of Japan (During the review process, the scope of exemption for products will be determined by the use mentioned). **Information from experts**

	In the EU, all types of mercury-containing manometers are banned by Mercury Regulation and the REACH regulation except for applications in scientific research and development. Mercury-free alternatives are available and in use (ECHA 2011). ECHA. (2011). Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers.
9. References	・Information was collected through a questionnaire survey of domestic manufacturers of pressure gauges and thermometers.

High temperature diaphragm seal pressure gauge

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product (if any)	High temperature diaphragm seal pressure gauge
3. Information on the use of the product	・・A measuring instrument that measures the pressure of a substance that is in a molten state under the harsh conditions of high temperature and high pressure. ・The average amount of mercury used is 40 to 50 g / piece. Used as a part of chemical fiber / chemical resin machines and injection type resin molding machines.
4. Information on the availability of mercury-free (or less-mercury) alternatives	・Pressure gauges used below 230 ° C have been replaced by alternative products (silicone oil).

5.(i) Information on the technical feasibility of alternatives	・There is no alternative for pressure measurements at or above 230 ° C and those used with a scale of 5 MPa or less.
5.(ii) Information on the economic feasibility of alternatives	・It is technically and economically difficult to develop alternative products for mercury for pressure measurement at 230 ° C or higher with a scale of 5 MPa or lower.
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	・There are two manufacturers in Japan.
8. Other relevant information pursuant to Decision MC-3/1	・High-temperature diaphragm seal pressure gauges (pressure measurement at 230 ° C or higher, used at a scale of 5 MPa or lower) can be manufactured in Japan even after the phase-out deadline (end of 2020) of the Minamata Convention (not subject to the Enforcement Ordinance of the Act on Preventing Environmental Pollution of Mercury of Japan).
9. References	・Information was collected through a questionnaire survey of domestic manufacturers of pressure gauges and thermometers.

McLeod gauge

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	McLeod gauge
3. Information on the use of the product	・A pressure gauge that can measure the degree of vacuum by compressing the residual gas in the capillary by rotating it and measuring the difference in the liquid column generated. ・The measurement range is 0.1Pa to 1,300Pa (logarithmic scale). Mercury is used as a working fluid in a transparent glass gauge tube. ・The amount of mercury used is about 135 g / unit.

	・These are used in chemical plants (vacuum distillation), steel mills (vacuum heat treatment), universities, etc. They may be placed in a vacuum for measurement, or may be connected with a rubber tube for measurement. ・Embedded products are almost nonexistent.
4. Information on the availability of mercury-free (or less-mercury) alternatives	・Heat conduction type vacuum gauge is under development as an alternative.
5.(i) Information on the technical feasibility of alternatives	・The alternative under development has the same measurement range as the McLeod gauge. However, the alternative is not explosion-proof because it requires an external power supply, as compared to the McLeod gauge, which does not require electricity. ・In addition, durability of the sensor unit is of concern in certain cases (use in an environment where temperature changes and electric / magnetic fields are intense, where vibration is intense or where there are many droplets).
5.(ii) Information on the economic feasibility of alternatives	・Price difference is an issue because the price of the alternative is about 1.5 times that of the McLeod gauge.
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	・There is only one manufacturer in Japan. **Information from experts** • In the EU, all types of mercury-containing manometers are banned by Mercury Regulation and the REACH regulation except for applications in scientific research and development. Mercury-free alternatives are available and in use (ECHA 2011). ECHA. (2011). Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that

	activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers.
8. Other relevant information pursuant to Decision MC-3/1	・McLeod gauges (maximum measurable pressure at 1,300 Pa or less, scale of 300 Pa or less) can possibly be manufactured in Japan even after the phase-out deadline (end of 2020) of the Minamata Convention (Not subject to enforcement ordinance regulations of the Act on Preventing Environmental Pollution of Mercury of Japan).
9. References	・Information was collected through interviews with groups of domestic manufacturers of scientific instruments.

U-shaped vacuum gauge

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product (if any)	U-shaped vacuum gauge These gauges are type of manometers.
3. Information on the use of the product	・A vacuum gauge (made of U-shaped glass with one side sealed) that can directly measure the pressure of gas using the difference in the height of the liquid column with a differential pressure that is evacuated to a vacuum and sealed. The measurement range is 200Pa to 28,000Pa. Scale 200Pa (equal spacing, scale spacing is about 1mm). ・Mercury is used as a working fluid in a transparent glass gauge tube. ・The amount of mercury used is about 50 g / unit. ・These are used in chemical plants (vacuum distillation), steel mills (vacuum heat treatment), universities, etc. They may be placed in a vacuum, or connected with a rubber tube etc. for measurement. ・Embedded products are almost nonexistent.
4. Information on the availability of mercury-free (or less-mercury) alternatives	・Diaphragmatic pressure gauges have been on the market as an alternative since 2012 and many U-shaped pressure gauges have been replaced by this alternative product.

5.(i) Information on the technical feasibility of alternatives	・Measurement accuracy of the alternative is comparable to the U-shaped pressure gauge, but they are not explosion-proof.
5.(ii) Information on the economic feasibility of alternatives	・The price of the alternative product is more than three times that of the U-shaped pressure gauge and hence is an issue.
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	・There is only one manufacturer in Japan.
8. Other relevant information pursuant to Decision MC-3/1	・U-shaped pressure gauges (maximum measurable pressure of 66,000 Pa or less, scale of 200 Pa or less) can be manufactured in Japan even after the phase-out deadline (end of 2020) of the Minamata Convention (Not subject to enforcement ordinance regulations of the Act on Preventing Environmental Pollution of Mercury of Japan). **Information from experts** • In the EU, all types of mercury-containing manometers are banned by Mercury Regulation and the REACH regulation except for applications in scientific research and development. Mercury-free alternatives are available and in use (ECHA 2011). ECHA. (2011). Background document to the opinions on the Annex XV dossier proposing restrictions on Mercury in measuring devices • US EPA promulgated a significant new use rule (SNUR), effective June 29, 2012, under the Toxic Substances Control Act (TSCA) for elemental mercury use in barometers, manometers, hygrometers, and psychrometers. This action would require persons who intend to manufacture (including import) or process elemental mercury for an activity that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity. The required notification would provide EPA with the opportunity to evaluate the intended use and, if necessary, to prohibit or limit that activity before it occurs. • US EPA promulgated another SNUR (effective August 20, 2010) for elementary mercury use in flow meters, natural gas manometers, and pyrometers.

9. References	・Information was collected through interviews with groups of domestic manufacturers of scientific instruments.

Non-electronic measuring devices to be phased out pursuant to Annex A

1. Category of mercury-added product	Non-electronic measuring devices
2. Further description of the product	
3. Information on the use of the product	**Uganda** Estimated Mercury input in the environment in Uganda (MIAs report, 2018) • At disposal phase, mercury containing thermometers contribute to 21 kg/Hg/Yr • At disposal phase, Manometers and gauges contribute to 205kg/Hg/Yr Information on use • In Uganda, measuring devices are extensively used in various sectors such as laboratory analysis, environmental monitoring, healthcare, academia, manufacturing, meteorology, agriculture, etc. Available mercury-free alternatives include alcohol (spirit) thermometers, electronic thermometers, oscillometric sphygmomanometers, etc. Many of these mercury-free measuring devices also conform to industry standards, calibration and other performance-related requirements. • The replacement of mercury-added measuring devices by mercury-free devices has received worldwide attention in some sectors such as in healthcare. Accordingly, the World Health Organization (WHO) has been heavily involved in advocating the shift to mercury-free measuring devices in healthcare facilities. The WHO indeed published a document in 2015 outlining national strategies for phasing out mercury-added thermometers and sphygmomanometers.[7] **Montenegro** Montenegro has no production of the mercury added products. It has information on quantities of imported products, including non-electronic measuring devices, in 2019. However, most of these tariff numbers cover a wider range of product

	types which cannot be claimed with certainty to contain mercury. The country welcomes HS codes for mercury-added products. **Information from experts** (Thermometers) The most common mercury thermometers used in Indonesia is clinical thermometers. A clinical mercury thermometer mainly consists of a bulb, a stem or capillary connected to the bulb, a scale and a body. The bulb is filled with mercury which expands through the stem when the temperature of an object being measured rises. The bulb, the stem and the scale are contained in the body, usually a glass tube with a scale along the stem to indicate the temperature level units, both in Celsius and Fahrenheit degrees. Due to the fragility of the thermometer, the manufacturers usually provide a protective case along with the unit. Clinical thermometers are used to measure the temperature of a human body as well as an animal/pet in both households and health-care facilities. Based on the intermediate results of an on-going project in Indonesia and the Philippines funded by Japan-ASEAN Integration Fund, namely Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-containing Medical Measuring Devices, the clinical thermometers used in the health sector in Indonesia are relatively distributed in sub-district public health center (71%), hospitals (18%), clinics (6.5%), and the rest are in private practices and others. The intermediate results of the project also reveals that about 84% of the mercury-containing thermometers has been substituted. The remaining ones are expected to be eliminated by the end of 2020. (Sphygmomanometers) Sphygmomanometers are used to measure the pressure of blood of a human body in both households and health-care facilities. Based on the intermediate results of an on-going project in Indonesia and the Philippines funded by Japan-ASEAN Integration Fund, namely Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-containing Medical Measuring Devices, the sphygmomanometers used in the health sector in Indonesia are relatively distributed in sub-district public health center (71%), hospitals (18%), clinics (6.5%), and the rest are in private practices and others. The intermediate results of the project also reveals that currently Indonesia has achieved the phase-out levels of 76% of desk sphygmomanometers and 86% of standing sphygmomanometers. The remaining ones are expected to be eliminated by the end of 2020.
4. Information on the availability of mercury-free (or less-mercury) alternatives	**Uganda** *Barometer products with no mercury* • *Aneroid* • *Digital*

	• *Fortin* *Manometer products with no mercury* • *Aneroid* • *Digital* *Hygrometer products with no mercury* • *Data loggers* *Thermometer products with no mercury* • *Digital* • *Alcohol / spirit* *Electronic and combined for special applications (e.g., data loggers, temperature/conductivity meter, etc.)* *Gallium-tin* • *Infra-red (laboratory)* • *Standard Platinum Resistance* • *Tympanic/temporal (clinical)* *Blood pressure measuring devices with no mercury* • *Aneroid* • *Digital* **Information submitted by WHO** WHO Reference: https://apps.who.int/iris/handle/10665/331749 - Aneroid sphygmomanometer: A manual BPMD with a manometer, composed of an inflation bulb for controlling the air pressure within the cuff that is attached to the manometer by tubing. The manometer head contains mechanical parts that convert the cuff pressure into readings. - Automated BPMD: A device that estimates BP after automatic inflation and deflation of the cuff and displays the values on an electronic display. The semi-automated device requires manual inflation. - Semi-automated BPMD: Device that operates by manual cuff inflation and electronic cuff deflation. BP is estimated as with other electronic devices. This device is energy-efficient because the cuff is inflated manually with a bulb. - Sphygmomanometer: Medical device for measuring arterial BP compromised of a cuff, an inflation bulb with release valve and a manometer (typically either a mercury column or an aneroid dial).

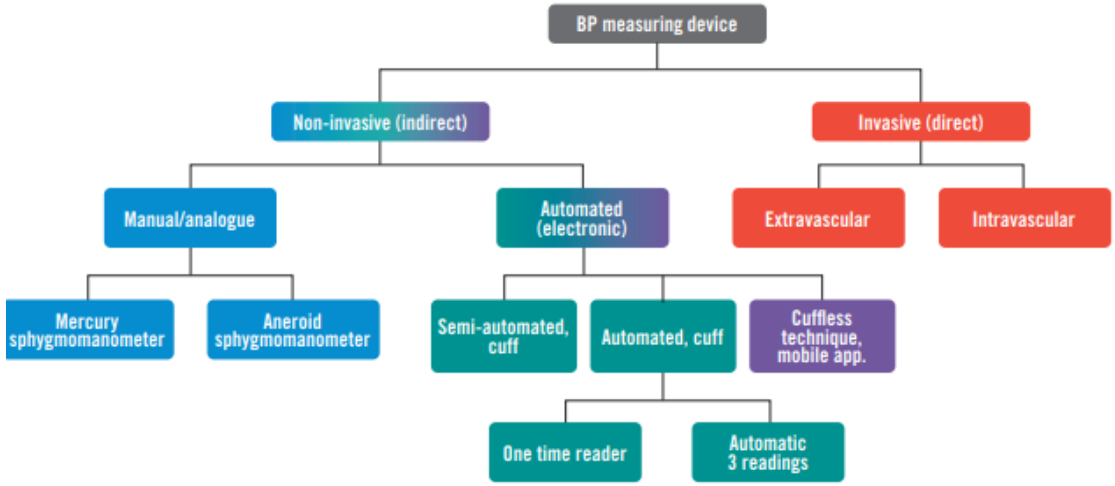


Fig. 2. Main means for measuring BP

WHO documents on medical measuring devices

WHO technical specifications for automated non-invasive blood pressure measuring devices with cuff (2020)
https://apps.who.int/iris/handle/10665/331749
This document contains detailed information, including the definitions of the different types of blood pressure measuring devices.

Technical guidance on replacement of mercury thermometers and sphygmomanometers (2011)
https://apps.who.int/iris/handle/10665/44592
WHO plans to develop a document on technical specifications for thermometers to complement the new 2020 document on blood-pressure measuring devices.

Developing national strategies for phasing out mercury-containing thermometers and sphygmomanometers in health care, including in the context of the Minamata Convention on Mercury: key considerations and step-by-step guidance
https://apps.who.int/iris/handle/10665/259448

	- (responding to a question) The battery life of the infrared thermometers will vary depending on the device. Usually, this is contained in the manufacturer's specifications normally available on the internet or on device packages.
5.(i) Information on the technical feasibility of alternatives	**Uganda** ・There is limited knowledge by consumers in Uganda on existence of alternatives ・There is limited policy restrictions on importation of listed Non-electronic measuring devices ・There are no incentives on use/importation of alternatives ・There is an institutional framework for promoting adoption of alternatives
5.(ii) Information on the economic feasibility of alternatives	**Uganda** ・The alternatives usually cost higher than the more toxic ones ・Alternatives are mainly imported, hence transferring taxation costs to the consumer
6. Information on environmental and health risks and benefits of alternatives	
7. If any, additional information being submitted on mercury-added products pursuant to Article 4.4 of the Convention not addressed above (e.g. manufacture, general trade information, etc.)	
8. Other relevant information pursuant to Decision MC-3/1	**Montenegro** ・In terms of waste management in Montenegro, the Decree on the procedure for establishing a system for collection and treatment of electrical and electronic waste ("OG of MNE", No. 24/12) prescribes pre-treatment of electrical and electronic waste and Rulebook on the limit values of the hazardous substances in electrical and electronic equipment ("OG of MNE", No. 067/18) prescribes the limit values for the presence of hazardous substances (mercury, among the others) in electrical and electronic products, the designation of the type of waste and the method of waste management arising from these products.

	ZMWG In Serbia, the national legislation on Chemicals prescribes bans and restrictions of use, placing on the market and production of Mercury and Mercury compounds. The law established the legal basis for adoption of the Rulebook on Bans and Restrictions of Production ("Off. Gazette RS" No. 90/2013, 25/2015, 2/2016 and 44/2017), placing on the Market and Use of Chemicals which has been harmonized with Annex XVII of EU Regulation No. 1907/2006 (REACH). According to this rulebook, the following mercury-added products cannot be placed on the market: (a) in fever thermometers (b) in other measuring devices intended for sale to the general public (such as manometers, barometers, sphygmomanometers, thermometers other than fever thermometers). The restriction applies to measuring devices that were placed on the market after 5 July 2011. The following mercury-containing measuring devices intended for industrial and professional uses have not be placed on the market after 1 October 2018: (a) barometers (b) hygrometers (c) manometers (d) sphygmomanometers (e) thermometers and other non-electrical thermometric applications. The restriction also applies to measuring devices under points (a) to (e) which are placed on the market empty, if intended to be filled with mercury.
9. References	**Uganda** ・Developing National Strategies for Phasing Out Mercury Containing Thermometers and Sphygmomanometers in Health Care, Including in the Context of the Minamata Convention on Mercury, World Health Organization, 2015. Available at http://www.who.int/ipcs/assessment/public_health/WHOGuidanceReportonMercury2015.pdf?ua= ・UNEP (2013): Minamata Convention on Mercury. Available at http://www.mercuryconvention.org ・Minamata Initial Assessments report, 2018 ・Mercury Learn - HS codes (2015); COMTRADE database **ZMWG**

	Minamata Initial Assessment for Serbia, 2018, Available at https://www.researchgate.net/publication/330514455_Mercury_initial_assessment_for_the_Republic_of_Serbia