Mercury pollution in Russia: problems and recommendations

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PREFACE

We are pleased to present this publication dedicated to the problem of mercury contamination in the Russian Federation. It provides information on sources of mercury emissions and releases, and mercury-containing waste at Russian industrial facilities, as well as data on mercury-contaminated sites. Materials for the publication were produced in the course of **the Pilot project on the Development of Mercury Inventory in the Russian Federation**, implemented with the support of the Global Environment Facility (GEF) and the United Nations Environment Programme (UN Environment) from 2013 to 2017. The publication also includes data of the projects for identification of mercury emission sources and contaminated territories implemented by IPEN — the international network of NGOs working for development and implementation of safe chemical policies and practices to protect human health and the environment.

The publication particularly focuses on issues of mercury, mercury compounds and mercury-containing waste management in the Russian Federation in relation to the Minamata Convention on Mercury — a global treaty to control mercury pollution. In January 2013, governments of 140 counties agreed on the final text of the Minamata Convention that stipulates actions for gradual phase-out of mercury use in the economy. By April 24, 2017, the Convention was signed by 128 countries and 40 countries had ratified this international treaty. 50 ratifications are needed to make the Convention effective. The Russian Federation signed the Minamata Convention on September 24, 2014.

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ACRONYMS AND ABBREVIATIONS

ACAP — Working Group for Elimination of Arctic Pollution (former Arctic Council Plan to Address the Arctic Pollution)

AMAP — Arctic Monitoring and Assessment Program

"ARSO" — A non-commercial partnership (the Association of Enterprises on Management of Mercury-containing and other Hazardous Waste)

ASGM — Artisanal and small-scale gold mining

BAT — Best available technique

CJSC — Closed joint-stock company

CMT — Cadmium-mercury-tellurium

COP — Conference of Parties to an international treaty

COWI — a Danish consultancy

CPMM — Chlorine production by mercury method

EEC — Eurasian Economic Commission

EIA — Environmental impact assessment

FER — Fuel and energy resources

FL — Federal Legislation of the Russian Federation

FD — Federal District

FSUE — Federal state unitary enterprise

GCWHLL — Draft standards for waste generation and limits on their location

GD — Guideline document

GEF — Global Environment Facility

GEOKHI RAS — Institute of Geochemistry and Analytic Chemistry in the name of V. I. Vernadsky of the Russian Academy of Sciences

“Giprotsement” JSC — R&D Institute of the Cement Industry JSC

GOST — State standard

Hg — Chemical symbol of mercury

HM — Heavy metals

IPEN — The International POPs (persistant organic pollutants) Elimination Network

ISO — International standards (recognised independent system for safety and quality assessments)

JSC — Joint stock company

LLC — Limited liability company

LMICs — Low and medium income countries

MAC — Maximal allowed concentration

MAD — Maximal allowed dose/discharges

MAE — Maximal allowed emissions

MCW — Mercury-containing waste

MG — Methodological guidelines

MINPRIRODI — Ministry of Natural Resources and Environment of the Russian Federation

MINPROMTORG — Ministry of Industry and Trade of the Russian Federation

MM — Measurement methodology

MMP — Mining and metallurgy plant

MPP — Mining and processing plant

N 2-TP (air), N 2-TP (water management) — Statistical reporting forms

NGO — Non-governmental organisation

SRI Atmosphere JSC — Scientific Research Institute for Atmospheric Air Protection JSC

NIP — National Action Plan

OR — Oil refinery

PA — Production association

“PUR” LLC — “Sustainable Development Facility” JSC

PVC — Polyvinyl chloride

R&D enterprise — Research and development enterprise

RDIC — Research and Development Engineering Centre

RF — the Russian Federation

RAS — the Russian Academy of Sciences

Rosprirodnadzor — Federal Service for the Supervision of Natural Resources of the Russian Federation

Rosstat — Federal State Statistics Service of the Russian Federation

“RusKhlor” Association — the Russian Association of Chlorine Industry Companies

SanPiN — Sanitary rules and norms

SB RAS — the Siberian Branch of the Russian Academy of Sciences

SC — State company

SMW — Solid municipal waste

SS — Sewage sludge

UN — United Nations

UN ECE — UN Economic Commission for Europe

UNEP (UN Environment) — the United Nations Environment Programme

USSR — the Union of Soviet Socialist Republics

“VTI” — All-Russian Thermal Engineering Scientific and Research Institute

INTRODUCTION

Ensuring environmentally sound management of mercury, its compounds and mercury-containing waste is one of the most important environmental tasks. Mercury is a global pollutant. Once released into the air by emissions, mercury precipitates on land or water surfaces nearby or away from pollution sources due to global atmosphere transfer and circulation. When mercury enters aquatic ecosystems, microorganisms convert it into methylmercury — a mercury compound with much higher toxicity than elemental mercury in low doses. In the form of methylmercury, mercury enters food chains and accumulates in aquatic organisms, including fish and shellfish, as well as in birds, mammals and humans that eat them. In some fish species, concentrations of methylmercury may be millions of times higher than in ambient water. In reproduction processes, methylmercury from a maternal body migrates to the developing foetus, accumulates and may reach high concentrations.

Mercury, especially methylmercury, is extremely toxic for humans. Human foetuses, infants and children are particularly vulnerable to adverse mercury impacts, as mercury primarily affects neurodevelopment. If a pregnant woman consumes fish that contains methylmercury, the toxic chemical substance crosses the placentary barrier and affects the foetus. According to research results, foetal methylmercury levels are higher than maternal. In addition, mercury contaminates breast milk, entering a child's body at the early development stage. Children that consume mercury-contaminated food in early years of life are exposed to its hazardous impacts. Exposure to methylmercury results in damage to the brain functions of a developing child, causing speech, memory and attention disorders, and deviations in motor skills and in visual perception. If exposure to mercury is combined with malnutrition, risks of adverse effects increase manifold.

The overall human-induced mercury pressures on the environment increase intensively every year. Coal burning is now considered the largest single source of global mercury emissions. Mercury is also released to the environment by metallurgic plants, crematoria, producers of mercury cells, chlor-alkali plants, waste incinerators and other point sources of pollution. In the global economy, mercury is used in batteries, in chlor-alkali production with application of the mercury process, small scale mining of gold and silver, dental amalgam, monitoring and metering instruments, electric regulators and switches, in lighting appliances and even in cosmetics. According to UNEP estimates, cumulative global mercury emissions from both anthropogenic and natural sources reach 5000–8000 metric tons per annum.

As mercury is prone to long range transport, no single government or a single region could ensure protection of human health and the environment from the adverse effects of mercury pollution independently. The mercury pollution problem is recognised as a global problem of major significance. Therefore, in 2009 governments agreed to launch intergovernmental negotiations for the development of a global, legally binding instrument for mercury control. The first meeting of the Intergovernmental Negotiating Committee for development of the legally binding instrument (a Treaty or Convention) was held in Stockholm (Sweden), in June 2010. Over numerous Negotiating Committee meetings, the negotiators sought to agree on the final version of the treaty text. Text was finally adopted by a Diplomatic Conference in Japan in 2013 as the *Minamata Convention on Mercury*; named as a tribute to the memory of victims of acute mercury poisoning in Minamata, Japan in the first half of the 1900s. The treaty is a legally binding instrument requiring all Parties to act jointly in finding solutions to address mercury pollution problems.

The Minamata Convention aims to protect human health and the environment from anthropogenic emissions of mercury and its compounds. The treaty seeks to reduce mercury supply and mercury trade, to phase-out or restrict application of certain goods and processes with use of mercury, and to control mercury releases into the environment.

The Minamata Convention has not come into force yet; however, governments of many countries have already started to make certain steps to control — in their jurisdictions — industrial and other activities that release mercury into the environment. In particular, as early as in 2006, the Security Council of the Russian Federation for the first time discussed "Problems of mercury contamination of the environment and measures to address them" at a session of the Inter-agency Commission for Environmental Security. The meeting documents suggested that amounts of mercury releases to the environment due to fossil fuel burning, processing of different metal ores and other mineral resources are fairly significant but have not been ever quantified. No large scale federal projects were implemented in the territory of the country to assess sources of mercury releases into the environment and contamination of the country's territory.

The Security Council recommended to address the problem more actively and with public participation. In some constituents of the Russian Federation, regional priority action programs were adopted to tighten control over management of mercury-containing waste, and public awareness-raising activities were implemented with the support of NGOs and education facilities.

Following recommendations of the Security Council and requirements of the Minamata Convention, in July 2013, the **Pilot project on the Development of Mercury Inventory in the Russian Federation** was launched with the support UNEP and the GEF. The project objectives include evaluation of the situation in management of mercury, mercury compounds and mercury waste in constituents of the Russian Federation and industries; evaluation of the scale of mercury releases into the environment; analysis of existing laws and regulations on mercury management; and evaluation of available resources to address specific problems, as well as to prevent mercury pollution and to reduce its adverse impacts on human health and ecosystems.

On July 1–2, 2015, the Ministry of Natural Resources and Environment of the Russian Federation hosted a meeting of the Intergovernmental Negotiating Committee Bureau. The meeting was a recognition of the Russian Federation's contribution to development of the Minamata Convention. The Russian Federation was one of the main originators of the global treaty and considers the Minamata Convention as one of the key environmental treaties developed in the last decade in the UN framework with the involvement of the Russian Federation.

The Minamata Convention —

http://mercuryconvention.org/Convention/tabid/3426/language/en-US/Default.aspx

Main provisions

The Convention introduces restrictions for industrial processes with application of mercury and for mercury-containing products. The following Articles are directly associated with mercury pollution issues:

Article 3 Mercury supply sources and trade

Article 4 Mercury-added products

Article 5 Manufacturing processes in which mercury or mercury compounds are used

Article 7 Artisanal and small-scale gold mining

Article 8 Emissions (air)

Article 9 Releases (land and water)

Article 10 Environmentally sound interim storage of mercury, other than waste mercury

Article 11 Mercury wastes

Article 12 Contaminated sites

Article 16 Health aspects

Minamata disease[1]

The most famous example of acute mercury contamination occurred in fishing villages along the shore of Minamata Bay, Japan. Chisso, a chemical company located near the bay, used mercury sulphate and mercury chloride as catalysts in the production of acetaldehyde and vinyl chloride. Wastewater from the plant was discharged into Minamata Bay and contained both inorganic mercury and methylmercury. The methylmercury originated mainly as a side product of the acetaldehyde production process.

Methylmercury accumulated in the fish and shellfish in the bay and in local people who ate the fish and shellfish. The result was a form of mercury poisoning that is now known as Minamata disease. The patients complained of a loss of sensation and numbness in their hands and feet. They could not run or walk without stumbling, and they had difficulties seeing, hearing, and swallowing. A high proportion of these people died. The disease was first

[1] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

diagnosed in 1956. By 1959, a strong case had been made that the disease was caused by the high concentrations of methylmercury that were present in the fish and shellfish in the bay.

Mercury discharges from the Chisso plant into the bay were continuous from the time the factory started using the acetaldehyde-production process in 1932 until 1968, when the factory discontinued this production method. Production of vinyl chloride using a mercury catalyst continued at the plant until 1971, but after 1968 the wastewater was diverted to a special pond.

The second outbreak of Minamata disease occurred in 1965 in Japan in the Agano River basin in the Niigata Prefecture. A different chemical company, producing acetaldehyde using a mercury sulphate catalyst and a similar process, dumped its wastewater into the Agano River. The Japanese government certified 690 people as victims of mercury pollution.

Another example of Minamata disease occurred in the early 1970s in Iraq when an estimated 10,000 people died and 100,000 were severely and permanently brain damaged from eating wheat that had been treated with methylmercury.

Yet another example is the poisoning of Canadian indigenous people at Grassy Narrows, which was caused by mercury discharges from a chlor-alkali plant and pulp and paper mill in Dryden, Ontario, between 1962 and 1970.

Less well-known and less dramatic cases of acute mercury pollution continue to occur. According to Masazumi Harada, a leading world expert on Minamata disease, "Rivers in the Amazon Valley, Canada, and China have been affected by mercury poisoning, but as with Minamata disease, there are few patients who look severely ill at first glance. People are clearly affected by mercury, but the mercury is found in small amounts in patients' bodies, or they are still in the initial stages of the disease."[2]

In addition to the Minamata Convention, the following international legal instruments regulate management of mercury, mercury-containing products and wastes:

UN Environment (UNEP) conventions http://www.chem.unep.ch/ http://synergies.pops.int/:

Basel Convention on the control of transboundary movements of hazardous wastes and their disposal of March 22, 1989 http://www.basel.int/

Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade of September 10, 1998 http://www.pic.int/

Integrating international document — the Strategic Approach to International Chemicals Management (SAICM), 2006 http://www.saicm.org/

Russian participation in international mercury treaties

Russia signed the Minamata Convention on September 24, 2014. If the Russian Federation ratifies the Convention in the near future, the country is obliged to cancel its production of acetaldehyde with use of mercury catalysts (by 2018) and terminate chlor-alkali production with mercury process by 2025. In particular cases, mercury application in medical instruments may be allowed up to 2030.

In 1998, in the framework of the UNECE Convention on Long-range Transboundary Air Pollution, the international community signed the Protocol on Heavy Metals, which predominantly seeks to control air emissions of heavy metals. According to the Protocol, mercury is a priority heavy metal. Every Party of the Protocol has to develop and maintain registers of their emissions of heavy metals (particularly cadmium, lead and mercury). Information on national emissions is submitted to the Centre of Emission Registers and Forecasts, where the information is processed and generalised by substances, countries and years.

As the Russian Federation has not ratified the Protocol on Heavy Metals, the country does not submit information on its national emissions to the Centre of Emission Registers and Forecasts.

[2] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

CHAPTER 1

MERCURY REGULATION AND ACCOUNTING PRACTICES IN THE RUSSIAN FEDERATION

RUSSIAN LAWS AND REGULATIONS ON MERCURY MANAGEMENT

The Russian Federation has a broad legislative framework for regulation of pollutants, including mercury and mercury compounds. The key legal acts of relevance to mercury management in the Russian Federation include the following ones:

The National Security Strategy of the Russian Federation, approved by Decree # 683 of the President of the Russian Federation of 31.12.2015;

The Framework State Policy in the Sphere of Ensuring Chemical and Biological Security of the Russian Federation up to 2025 and onward, approved by Order # 2573 of the President of the Russian Federation of 1.11.2013;

Decree # 913 of the Government of the Russian Federation of 13.09.2016 on Rates of Charges for Adverse Environmental Impacts and Additional Factors;

Decree # 1062 of the Government of the Russian Federation of 03.10.2015 on Licensing Activities of Collection, Transportation, Processing, Recycle, Neutralisation and Disposal of Wastes of I — IV Hazard Classes (accompanied by Regulation on Licensing Activities of Collection, Transportation, Processing, Recycle, Neutralisation and Disposal of Wastes of I — IV Hazard Classes);

Decree # 827 of the Government of the Russian Federation of 22.12.2004 on Approval of the Regulation on Processing Requests for Rights to Subsurface Use for Burial of Radioactive Waste and Wastes of I — V Hazard Classes in Deep Formations, Ensuring Containment of the Wastes;

Order # 114 of the Chief State Sanitarian of the Russian Federation of 30.05.2003 (as amended on 30.08.2016) on Enactment of HN 2.1.6.1338–03 (accompanied by Hygiene Norms HN 2.1.6.1338–03. Maximal Allowable Concentrations (MACs) of Pollutants in Ambient Air in Human Settlements, approved by the RF Chief State Sanitarian on 21.05.2003) (Registered in the Ministry of Justice of Russia on 11.06.2003, # 4679);

Federal Law # 96-FZ of 04.05.1999 on Ambient Air Protection;

Federal Law # 7-FZ of 10.01.2002 on Environmental Protection;

Federal Law # 89-FZ of 24.06.1998 on Production and Consumption Waste;

Federal Law # 52-FZ of 30.03.1999 on Sanitary and Epidemiological Wellbeing of the Population;

Federal Law # 174-FZ of 23.11.1995 on Environmental Appraisal;

Federal Law # 99-FZ of 04.05.2011 on Licensing Certain Types of Activities;

Order # 445 of the Federal Supervisory Natural Resources Management Service of 18.07.2014 on Approval of the Federal Waste Classification Catalogue (Registered in the RF Ministry of Justice on 01.08.2014 # 33393);

SanPiN 2.1.6.1032–01. Hygiene Requirements to Ensuring Ambient Air Quality in Human Settlements;

Sanitary Rules for Handling Mercury, Mercury Compounds and Mercury-filled Instruments. April 4, 1988, # 4607–88;

Sanitary Rules for Storage, Transportation and Application of Pesticides in Agriculture. Approved by the Chief Sanitarian of the USSR on September 20, 1973, # 1123–73;

Sanitary Rules for Design, Equipment, Operation and Maintenance of Mercury Production Facilities. Approved by V. N. Burgasov, the Chief Sanitarian of the USSR on December 27, 1979, # 2116–79;

Federal Law # 7-FZ of 10.01.2002 on Environmental Protection is the key legislative act of relevance to regulation of relations in the sphere of environmental protection. According to Article 4.1 of the Law, the list of pollutants subject to state regulation measures in the sphere of environmental protection, shall be defined by the Government of the Russian Federation. A relevant Governmental Decree (# 1316-r) was approved on 08.07.2015.

Mercury and mercury compounds are specified in the list for all environmental media:

I. For ambient air:

— Diethyl mercury (in terms of mercury);

— Mercury and mercury compounds, except diethyl mercury.

II. For water bodies:

— Mercury and mercury compounds.

III. For soils:

— Inorganic and organic mercury compounds.

Decree # 913 of the Government of the Russian Federation of 13.09.2016 on Rates of Charges for Adverse Environmental Impacts and Additional Factors sets rates of charges for environmental pollution.

Charges for emissions of point sources are set for:

— Diethyl mercury (in terms of mercury);

— Mercury and mercury compounds, except diethyl mercury.

Charges for discharges of pollutants to water bodies are set for:

— Mercury and mercury compounds.

Charges for disposal of production and consumption waste depending on their hazard classes. Mercury-containing waste is classified as waste of I hazard class.

According to Article 16 of Federal Law on Environmental Protection, payments for environmental pollution do not free economic actors and other parties from the need to implement environmental protection measures and to redress environmental damages.

According to Federal Law # 52-FZ of 30.03.1999 on Sanitary and Epidemiological Wellbeing of the Population, sanitary norms shall set MACs for chemicals, biologic agents and microorganisms in air, water and soils. In the Russian Federation, hygiene norms/limits were developed and adopted for mercury/mercury compounds in workplace zone air and environmental media, including ambient air, water in different types of water bodies (drinking, recreational, fishing, etc.), and soils.

Federal Law # 89-FZ of 24.06.1998 on Production and Consumption Waste (as amended on 13.07.2015) is the key legislative act in the sphere of production and consumption waste management. According to Article 11 of the Federal Law, in the course of operating buildings, constructions and other facilities of relevance to waste management, legal entities and individual entrepreneurs must:

- inventory wastes and their disposal sites;
- monitor environmental quality and environmental contamination on waste disposal sites;
- report necessary information in the sphere of waste management.

According to Article 12 of Federal Law # 99-FZ of 04.05.2011 on Licensing Certain Types of Activities, activities in the sphere of collection, transportation, processing, recycling, neutralisation and disposal of wastes of I — IV hazard classes are subject to licensing requirements.

The Federal Supervisory Natural Resources Management Service maintains the State Waste Register that incorporates the Federal Waste Classification Catalogue, the State Register of Waste Disposal Sites, and the database on waste and recycling/neutralisation technologies for different types of waste. In addition, the Service deals with certification of wastes of I — IV hazard classes.

The Federal Waste Classification Catalogue was approved by Order # 445 of the Federal Supervisory Natural Resources Management Service of 18.07.2014 and the Catalogue is regularly updated. The Catalogue incorporates waste-containing waste.

GOST R 52105–2003 “Resource conservation. Waste management. Classification and methods for processing mercury-containing waste. Main provisions” is the main standard in the sphere of sound waste management (including mercury-containing waste). The standard was enacted on 01.07.2004 and establishes classification of mercury-containing waste and appropriate methods for their processing. The standard covers all solid and slurry production and consumption of MCWs, including faulty and obsolete products, such as fluorescent and other mercury lamps, as well as mercury oxide cells. The standard does not cover radioactive or biological waste.

Acceptable mercury levels in products and the list of such products are set in the common sanitary requirements of the Customs Union, as approved by Decision # 299 of the Customs Union Commission of 28.05.2010. The requirements regulate mercury levels in the majority of food product types and in toys.

Technical Regulation of the Customs Union — TR CU 015/2011 on Grain Safety — approved by Decision # 874 of the Customs Union Commission of 09.12.2011 — sets limits for mercury levels in grain for food and/or feed products.

Technical Regulation of the Customs Union — TR CU 021/2011 on Food Products Safety — approved by Decision # 880 of the Customs Union Commission of 9.12.2011, provides for hygiene safety requirements to food products, including requirements to maximal allowable mercury contents.

Technical Regulation of the Customs Union — TR CU 029/2013 on Requirements to Safety of

Food Additives, Flavouring Agents and Processing Supplements — approved by Decision # 58 of the Board of the Eurasian Economic Commission of 20.07.2012, regulates limits for mercury levels in flavouring agents and food additives.

Technical Regulation of the Customs Union — TR CU 008/2011 on Toys Safety — approved by Decision # 798 of the Customs Union Commission of September 23, 2011, regulates mercury levels in materials.

Technical Regulation of the Customs Union — TR CU 007/2011 on Safety of Products for Children and Adolescents — approved by Decision # 797 of the Customs Union Commission of 23.09.2011, regulates mercury levels in materials applied for production of school supplies and textile items.

Technical Regulation of the Customs Union — TR CU 009/2011 on Safety of Perfumes and Cosmetic Products — approved by Decision # 799 of the Customs Union Commission of 23.09.2011, regulates mercury levels in perfumes and cosmetics with natural plant or mineral components.

According to Decision # 30 of the Board of the Eurasian Commission of 21.04.2015, the following types of hazardous wastes are prohibited for import to the territory of the Customs Union:

- mercury/mercury compounds waste;
- metal residues or residues with alloys of any of the following substances: arsenic, beryllium, lead, mercury;
- selenium-mercury slurry from sulphuric acid production;
- burnt mercury bulbs and fluorescent tube lamps.

Restrictions are imposed on transboundary movements of the following types of hazardous waste through the customs border of the Customs Union in the course of their import and/or export: scrap electric equipment or equipment units with cells/batteries, mercury switches, glass of CRTs and other glass with coatings of or contaminated by cadmium, mercury, lead and polychlorinated diphelyls with concentrations of 50 mg/kg or higher (Decision # 30 of the Board of the Eurasian Commission of 21.04.2015). A special permit is necessary for transboundary movement of such waste.

Toxic substances, subject to restrictions for transboundary movements through the customs border of the Customs Union (in the course of export and import operations), include (unless such goods are controlled by the export control system of a member-country of the Customs Union) metal mercury and such mercury compounds as mercury diiodide, mercury dichloride, mercury cyanate, mercury salicylate and mercury cyanide.

The list of highly toxic and toxic substances was approved by Decree # 964 of the RF Government of 29.12.2007. Metal mercury is included in the list.

Constituents of the Russian Federation impose additional requirements on mercury handling.

A number of national and international methodological documents on matters of monitoring mercury releases into the environment are used for purposes of the state environmental and sanitary-epidemiological supervision:

GD 52.18.636. —2002. Guideline Document. Methodological Guidelines. Measurement of mass concentrations of mercury in water samples. Methods of measurements by UKR-1MTs universal mercury analyser. The Guidelines set the methodology for measurements of mass concentrations of mercury in samples of surface water and treated wastewater by flameless atomic absorption with application of UKR-1MTs universal mercury analyser. The method allows to measure mercury concentrations in samples in the range from 0.00001 to 0.01 mg/m^3.

MG 4.1.1469–03. Atomic absorption determination of mass concentrations of mercury in drinking water, natural water and wastewater. The Methodological Guidelines provide the atomic absorption method for determination of mercury levels in different types of water (drinking water, natural water, wastewater) and in water bodies. The method is based on sample digestion, chemical reduction of different mercury forms in solution into elementary mercury, transfer of mercury into gaseous phase and subsequent quantitative determination of mercury by flameless atomic absorption spectroscopy.

PND F 14.1:2:4.136–98. Quantitative chemical analysis of water. Methodology of measurement of mass concentrations of mercury by atomic absorption spectrophotometry. The methodology is used for determination of mass concentrations of mercury in drinking water, natural water, wastewater and precipitation by flameless atomic absorption spectrophotometry (“cold vapour” method). Mass concentrations are measured in the range from 0.01 μg/dm^3 to 10 μg/dm^3.

MM 2865–2004. GSI Recommendation. Mass concentrations of total mercury in drinking water, natural water and treated wastewater. Methods of measurement — atomic absorption.

ISO 12846:2012 Water quality. Determination of mercury. Method using atomic absorption spectrometry (AAS) with and without enrichment. The standard describes two methods for determination of mercury in drinking, surface, ground, rain and waste water. In the first method, an enrichment step by amalgamation of the Hg on a gold/platinum absorber is used. In the second method, the enrichment step is omitted. The method with enrichment may be applied in the range from 0.01 µg/l to 1 µg/l. The method without enrichment is usually practically applied starting from 0.05 µg/l.

ISO 17852:2006. Water quality. Determination of mercury. Method using atomic fluorescence spectrometry. The standard specifies a method for the determination of mercury in drinking, surface, ground and rain water using atomic fluorescence spectrometry. It may be applied to industrial and municipal wastewater after additional treatment step under appropriate conditions. The working range of concentrations for the method: 10 ng/l — 10 µg/l.

GOST R 51768–2001. Resource conservation. Waste management. Methods of mercury determination in mercury-containing waste. The standard sets methods for determination of mass concentrations of mercury and covers solid and slurry production and consumption MCWs, including faulty and obsolete products, such as fluorescent and other mercury lamps, as well as mercury cells. The standard stipulates application of flameless atomic absorption with cold vapour method for mercury mass concentrations from 0.00002% to 0.01%, flameless atomic absorption with thermal sample decomposition for mercury mass concentrations from 0.000002% to 0.001% and atomic emission method with inductively coupled plasma (ICP) for mercury mass concentrations from 0.01% and higher.

MG 4.1.1471–03. Atomic absorption determination of mass concentrations of mercury in soil and solid mineral materials. Determination of mercury concentrations in soil, solid mineral materials (sand, concrete, cement, bricks, etc.) and in mineral waste includes thermal evaporation of mercury from samples, interim concentration of mercury on absorbers, secondary transfer of mercury into gaseous phase and quantitative determination of mercury by flameless atomic absorption spectrometry.

SanPiN 42–128–4433–87. "Sanitary norms for allowable concentrations of chemicals in soils". According to the Sanitary Norms, mercury concentrations in soils are determined with reduction of mercury to elementary Hg and with use of selective absorption of monochromatic light (253.7 nm, cold vapour method). The detection limit reaches 0.001 µg/kg of soil. Measured concentrations vary from 0.006 to 6.0 mg/kg of soil.

US EPA Method 105: Determination of Mercury in Wastewater Treatment Plant Sewage Sludges. The method is applied for determination of all inorganic and organic mercury compounds in wastewater sludges. The method allows to measure mercury concentrations in samples from 0.2 to 5 µg/g.

EPA Method 1631. Mercury in Water by Oxidation, Purge and Trap, and Cold Vapour Atomic Fluorescence Spectrometry. The method allows to measure mercury concentrations in the range from 0.5 to 100 ng/l.

CONCLUSIONS

In general, underlying standards and methodologies for mercury control and monitoring in environmental media, products, production inputs and waste in the country are relevant and meet contemporary requirements. However, lack of uniform guidelines on mercury determination in different media, as well as different status of available methodologies (and, as a result, their different titles) substantially complicate research and require special skills and knowledge. These factors may substantially complicate activities of different facilities.

Now, in the Russian Federation (and in the Customs Union), there are sufficient numbers (comparatively to other industrialised countries) of already developed and enacted standards on limits for mercury concentrations in different products (including food products and toys). Moreover, in the majority of cases, Russian limits are comparative to limits of other industrialised countries or are even stricter.

STATE REGISTRATION/REPORTING ON MERCURY IN THE RUSSIAN FEDERATION

State accounting of environmental impacts of economic actors relies on statistical reporting. All production facilities, organisations or individual entrepreneurs with emissions and/or discharges of pollutants to air and water bodies, or with generation of waste, must submit reporting forms 2-TP. The statistical reporting forms include form 2-TP (air) with information on ambient air protection, form 2-TP (water management) with information on adverse impacts on water bodies and form 2-TP (waste) with information on generation, use, neutralisation, transportation and disposal of production and consumption waste.

Submission of false information and untimely submission of reports is sanctioned by administrative fines and (in some cases) by temporary suspension of activities.

Reporting forms 2-TP (water management) must be submitted to territorial bodies of the Federal Agency for Water Resources by individual entrepreneurs and legal entities that:

- discharge wastewater;
- intake more than 50 m^3 of water from water bodies (except agricultural facilities);
- take water from water supply systems (from respondent suppliers) in amounts over 300 m^3 daily for any types of water use, except production of agricultural products;
- take water from water supply systems (from respondent suppliers) with intake of water from water bodies in amounts over 150 m^3 daily for production of agricultural products;
- operate water recycling systems with the total capacity over 5000 m^3 daily, regardless of water intake volumes.

Reporting forms 2-TP (waste) must be submitted to territorial bodies of the Federal Service for Supervision of Natural Resource Use by legal entities, individual entrepreneurs operating in the sphere of management of consumption and production waste.

Reporting forms 2-TP (waste) include information on all types of waste, except radioactive ones.

Reporting forms 2-TP (waste) are compiled on the basis of registration of generated, used, neutralised transferred to/received from other parties wastes, as well as disposed wastes, waste data sheets of I — IV hazard class wastes, and substantiations for categorising wastes to environmental hazard classes.

In the course of compiling these forms, information should be provided separately for every type of waste, specifying waste codes of the Federal Waste Classification Catalogue (approved by RF MoE Order # 511 of 15.06.2001), and should be listed in the order from I to V hazard class, inclusive.

Reporting forms 2-TP (air) must be submitted to territorial bodies of the Federal State Statistics Service by legal entities and individual entrepreneurs with fixed sources of pollutants emissions into ambient air (including boilers) regardless of installation of pollution control equipment.

Mandatory reporting covers all pollutants in flue gases from fixed pollution sources of a respondent and in aspiration air (except carbon dioxide (CO_2), ozone (O_3) and radioactive substances). Amounts of pollutants within a reporting period (total solid, gaseous and liquid and by separate ingredients) should be estimated by measuring instruments and calculated according to duly approved methodologies.

Reporting forms 2-TP (air) do not provide data on mobile pollution sources, including road vehicles. Furthermore, the reporting forms do not include information on releases of some substances with flue gases if such substances are used in production processes as inputs or intermediate products as initially stipulated in the applied technology design.

Reporting is submitted by facilities of a legal entity (a legal entity with separate subdivisions) or an individual entrepreneur:

- with authorised emissions over 10 tons/year;
- with authorised emissions from 5 to 10 tons/year inclusive, if the emissions include pollutants of 1st and/or 2nd hazard classes.

CHAPTER 2

RESULTS OF THE PREVIOUS ASSESSMENT OF MERCURY RELEASES INTO THE ENVIRONMENT

The first and the most complete assessment of mercury releases into the environment in the Russian Federation was conducted in 2005, in the course of implementation of research studies under the Arctic Council Action Plan to Eliminate Pollution in the Arctic (Reduction of mercury emissions of Arctic countries).

The study results are presented in the report **Assessment of mercury releases into the environment from the territory of the Russian Federation**[3], produced by the Federal Service for Environmental, Technological and Nuclear Supervision of the Russian Federation in cooperation with the Danish Environmental Protection Agency**.**

The assessment was compiled with application of official statistics and expert assessments, based on amounts of mercury applied intentionally or mobilised (as impurities) in different economic sectors in 2001–2002. For every activity sphere, mercury fate is followed from its extraction/production to emissions/discharges and to waste disposal. The relevant information is outlined at Fig. 2.1.

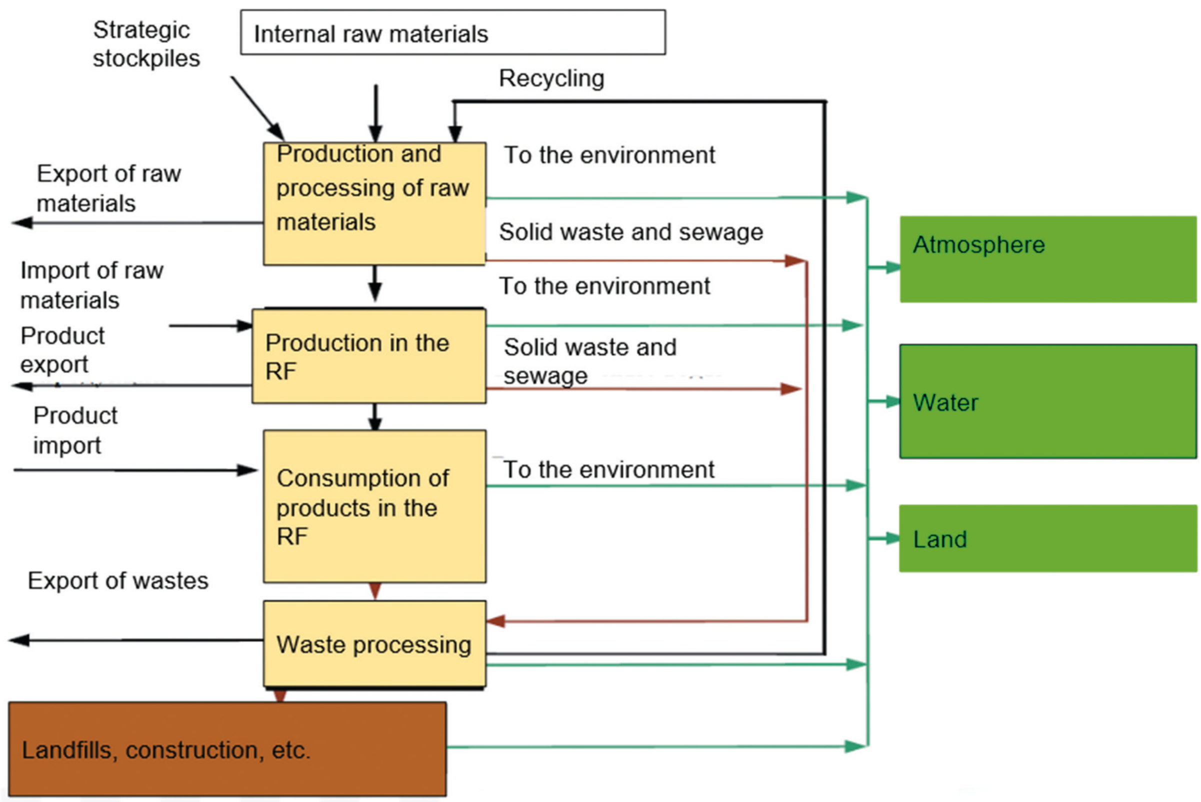

Figure 2.1. Schematic outline of mercury movements in technosphere

[3] ACAP. 2005. Assessment of mercury releases into the environment from the territory of the Russian Federation. Arctic Council Plan to Address the Arctic Pollution (ACAP). The Federal Service for Environmental, Technological and Nuclear Supervision in cooperation with the Danish Environmental Protection Agency, Copenhagen. http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

MERCURY USE IN RUSSIA AND WAYS OF ITS MOBILISATION INTO THE ENVIRONMENT

The Russian Federation has major mercury reserves; the third most in the world after Spain and Kyrgyzstan. Mercury (Hg) deposits belong to hydrothermal, low temperature deposits that form at moderate depths nearby the surface. Deeper deposits are mainly associated with sedimentary rocks (limestone, sandstone).

By early 2001, in the territory of the Russian Federation, 24 mercury deposits were identified in 13 constituents of the Russian Federation. See regional distribution of mercury reserves in Russia in Table 2.1.

The majority of them are classified as mercury (cinnabar) deposits, generally with estimated reserves under 2 thousand tons of mercury. Only four deposits are relatively large — Tamvatneiskoye (14 thousand tons), West Palyanskoye (10.1 thousand tons), Chagan-Uzunskoye (14 thousand tons), and Zvezdochka (3 thousand tons). In 2001, the overall identified reserves of mercury in Russia were estimated at the level of 45.3 thousand tons (including 15.6 thousand tons in industrial category deposits).

Table 2.1

Regional distribution of mercury reserves in Russia[4]

Constituents of the Russian Federation	Deposits	Geological / industrial types	The share of reserves, %	Hg ore content,%
Mercury deposits				
Altayskiy Krai	Sukhonkoye	Carbonate	0.6	0.24
Kamchatskaya oblast	Lyapganayskoye	Opalite	3.5	0.63
	Olyutorskoye	Opalite	1.7	1.05
	Chempurinskoye	Opalite	0.7	1.07
Kemerovskaya oblast	Kuprianovskoye	Quartz-dickite	0.2	0.32
Krasnodarskiy Krai	Belokamennoye Salinskoye Dalneye Kaskadnoye	Quartz-dickite	2.3	0.47
		Quartz-dickite	2.4	0.42
		Quartz-dickite	1.8	0.31
		Quartz-dickite	0.1	0.14
Altay Republic	Chagan-Uzunskoye	Listvenite	7.0	0.42
	Cheremshanskoye	Carbonate	0.1	0.50
Sakha Republic (Yakutia)	Zvezdochka	Quartz-dickite	6.2	1.59
	Gal-Khaya	Quartz-dickite	1.1	0.60
	Severnoye	Quartz-dickite	0.4	1.09
	Sredneye	Quartz-dickite	0.3	3.40
	Balgikakchan	Quartz-dickite	0.1	1.63
Tyva Republic	Terliglhayskoye	Polyargylite	5.1	0.22
North Osetia — Alania Republic	Tibskoye	Quartz-dickite	1.6	0.25
Khabarovskiy Krai	Lanskoye	Polyargylite	1.2	0.52
Chukotka Autonomous District	Tamvatneiskoye	Listvenite	33.1	0.70
	West-Palyanskoye	Quartz-dickite	24.0	0.53
Mercury-containing deposits				
Bashkortostan Republic	Podolskoye	Copper-sulphide	4.6	0.0025
Chelyabinskaya oblast	Talganskoye	Copper-sulphide	0.6	0.0059
Sverdlovskaya oblast	Safyanovskoye	Copper-sulphide	0.2	0.0014

[4] http://protown.ru/information/hide/5600.html

In the majority of known Russian mercury deposits, ores contain rather low mercury levels (much lower than 1%). Only ores from Zvezdochka, Balgikakchan, Chemporinskoye and Olyutorskoye deposits demonstrate an exception. Due to this, mining of primary mercury ores was cancelled in Russia in 1992, while production of primary mercury was cancelled in 1995. All mercury production in Russia is associated with circulation of secondary mercury.

The chemical industry is the largest mercury consumer in Russia. Mercury is used for quantitative determination of ammonia and as a catalyst in industrial production of acetaldehyde from acetylene. 40% of mercury uses are associated with production of chlorine and caustic soda. Mercury cathodes are applied for electrolytic production of alkali, chlorine and many active metals. In metallurgy, mercury is used for production of alloys. Mercury is also used in the thermal power industry, medicine, engineering, agriculture, etc.

In medicine, mercury is used in medical thermometers and as a vaccine preservative. The metal is also used in radiopharmacy and for dental applications. In agriculture, mercury compounds are used as pesticides and for grain treatment.

In engineering applications, mercury is used as a working medium for mercury thermometers. Thermometers for low temperatures are filled by thallium-mercury alloys. Fluorescent lamps are filled by mercury vapour to generate UV radiation. Mercury and mercury-based alloys are used for sealed switches. The metal is applied in some electric cells, including widely known mercury-zinc cells.

In 2001, the total intentional use of mercury in the Russian Federation decreased by 82% (comparatively to 1989) and reached 155 t (see Table 2.2)[5].

Table 2.2

Mercury use in the Russian Federation, 1989–2001

Industries, spheres of application	1989		1993		2001	
	t/year	%	t/year	%	t/year	%
Chemical industry	462	53.4	310	57.6	111	72
Medical, pharmaceutical, dental applications	12.5	1.4	9	1.7	0.7	0.5
Electric equipment	108.3	12.5	71	13.2	8.3	5
Instruments, electronic applications	133	15.4	80	14.9	26	17
Non-ferrous metallurgy	10	1.1	8	1.5	5.5	2.9
Agrochemistry	50	5.8	10	1.8	0.6	0.4
Research, modern technologies	25	2.9	10	1.0	3.5	2.3
Defence industry	40	4.6	20	3.7	-	-
Other	25	2.9	20	3.7	?	-
Total	**865.8**	**100**	**538**	**99**	**155.6**	**100**

The assessment was based on information provided by main industrial mercury users in the country. According to official forecasts, in 1999–2001, potential annual mercury demand of Russian facilities was evaluated as 280–300 t/year. The difference might be attributed to the following reasons:

1) the potential demand was assessed for installed production capacity that was not fully utilised in recent years;

2) in the specified period, some major indus-

[5] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

trial mercury users in Russia were decommissioned;

3) in the case of some industrial facilities, mercury consumption gradually decreased or varied in different years;

4) mercury use for "other purposes" might be substantial;

5) the assessment was limited to intentional mercury use in the civil sector.

In terms of dynamics, mercury use in Russia followed the global trend of reduction of mercury use in the majority of spheres of its intentional application (see Table 2.3)[6]. In 2001, per capita mercury use reached 1.1 g.

Table 2.3

Mercury use in the Russian Federation, 2001–2002

Activity categories	Use /mobilisation		
	Optimal assessment, t/year	Interval, t/year	% of the total
Intentional mercury use			
Chlor-alkali production	103	103	36
VCM production	7.5	7.5	2.6
Gold extraction with amalgamation	5.5	3–8	1.9
Dental amalgam	0.7	0.6–0.8	0.2
Production of thermometers	26	26	9.1
Production of barometers, manometers and other instruments	0.2	0.2–1	0.1
Production of cells and batteries	0.8	0.8	0.28
Production of lighting appliances	7.5	7.5	2.6
Laboratory applications	3.5	2–5	1.2
Biocides and pesticides	0.6	0.4–0.8	0.2
Other intentional use	?		
Total	155	151–160	54
Mercury mobilisation from impurities			
Coal	22	20–24	7.7
Oil[1]	33	5–50	11
Gas, condensate, oil shale and biofuel	8	2–12	2.8
Zinc and lead production[2]	31	16–47	11
Copper and nickel production[2]	28	14–42	9.8
Other non-ferrous metals[2]	6	4–8	2.1
Iron and steel production	1.8	1.2–2.4	0.6
Cement production	2	1.6–2.8	0.7
Total	**132**	**66–198**	**46**
Total	**287**	**217–358**	**100**

[1] Mercury in oil processing products in the Russian Federation.

[2] Includes mercury in concentrates. The total mercury content in processed ores might be much higher.

CHEMICAL INDUSTRY

The chemical industry (chlor-alkali production, vinyl chloride monomer production, etc.) is the main sphere of mercury application in Russia. Main mercury losses (up to 80%) at Russian chlor-alkali plants are associated with spills of metal mercury, and its incomplete recovery in the course of operation, repairs and in the case of accidents. Such plants have to report only their estimated emissions of elementary mercury vapour into the ambient air[7].

[6] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/Udgiv/publications/2005/87–7614–541–7/html/kap06_rus.htm

[7] The list of methodologies for measuring concentrations of pollutants in industrial emissions into the ambient air, used in 2014 for standard setting and estimating emissions of harmful (polluting) substances into the ambient air http://www.nii-atmosphere.ru/wp-content/uploads/2017/08/perechen_10.03.2017.pdf

Chlorine and alkali production still remains a major sphere of mercury application in Russia — mercury is used as electrode material. In 2002, about 103 tons of mercury were used for these purposes, and additionally about 7.5 t of mercury (as mercury chloride) were used as catalysts for production of vinyl chloride monomer (VCM) — a semi-product for production of polyvinylchloride. In both cases, mercury is used as a technological substance and only minimal amounts of mercury are released with final products. Mercury is believed to accumulate predominantly in building constructions, in soils on-site and in nearby chlor-alkali plants. Mercury is released into the ambient air with ventilation exhaust and flue gases.

What does the Minamata Convention say about manufacturing processes in which mercury or its compounds are used?[8]

- Phased-out processes using mercury include chlor-alkali production (2025) and acetaldehyde production using mercury or mercury compounds as a catalyst (2018).
- Convention Parties can apply for a five-year exemption to the phase-out date under Article 6, renewable for a total of 10 years, making the effective phase-out dates for the processes above 2035 and 2028 respectively.
- Restricted processes allow continued use of mercury with no current phase-out date. These include the production of VCM, sodium or potassium methylate or ethylate, and polyurethane. Note: VCM production does not appear in UNEP air emission inventories due to lack of data. VCM production using coal and a mercury catalyst is unique to China and a potentially enormous source of mercury releases.
- For VCM and sodium or potassium methylate or ethylate production, Parties are to reduce mercury per unit production by 50 percent in 2020 compared to 2010 use. Since this is calculated on a "per facility" basis, total mercury use and release can rise as new facilities are built.
- Additional measures for VCM include promoting measures to reduce use of mercury from primary mining, supporting research and development of mercury-free catalysts and processes, and prohibiting the use of mercury within five years after the COP establishes that mercury-free catalysts based on existing processes are technically and economically feasible.
- For sodium or potassium methylate or ethylate, Parties have to aim to phase-out this use as fast as possible and within 10 years of entry into force of the treaty, prohibit the use of fresh mercury from primary mining, support research and development of mercury-free catalysts and processes, and prohibit the use of mercury within five years after the COP establishes that mercury-free catalysts based on existing processes are technically and economically feasible.
- For polyurethane, Parties are to aim "at the phase out of this use as fast as possible, within 10 years of the entry into force of the Convention." However, the treaty exempts this process from paragraph 6, which prohibits Parties from using mercury in a facility that did not exist prior to the date of entry into force. This implies that new polyurethane production facilities using mercury can be operated after the treaty comes into force for a Party.
- Parties have to "take measures" to control emissions and releases as outlined in Articles 8 and 9, and report to the COP on implementation. Parties have to try to identify facilities that use mercury for the processes in Annex B and submit information on estimated amounts of mercury used by them to the Secretariat three years after entry into force for the country.
- Exempted processes not covered by Articles 8 and 9 include processes using mercury-added products, processes for manufacturing mercury-added products, or processes that process mercury-containing waste.
- Parties are not allowed to permit the use of mercury in new chlor-alkali plants and acetaldehyde production facilities after the treaty comes into force (estimated to be approximately 2018).
- Parties are supposed to "discourage" the development of new processes using mercury. Note: Parties can allow these mercury-using processes if the country can demonstrate to the COP that it "provides significant environmental and health benefits and that there are no technically and economically feasible mercury-free alternatives available providing such benefits".

[8] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

• Parties can propose additional processes to be phased-out, including by providing information on technical and economic feasibility as well as environmental and health risks and benefits.

• The list of prohibited and restricted processes will be reviewed by the COP five years after the treaty enters into force; this could be approximately 2023.

According to the Minamata Convention, countries are required to "take measures" to ensure that when a chlor-alkali plant closes, the excess mercury is disposed of according to treaty requirements and not subject to recovery, recycling, reclamation, direct re-use, or alternative uses[9].

NON-FERROUS METALLURGY

In the majority of ore deposits, mercury is an accompanying element. In some cases, e.g. in copper and silver ores, mercury is present in its own minerals. In platinum ores mercury is incorporated into complex minerals, while in the case of copper sulphide, copper and nickel, sulphide and polymetallic ores mercury is present as a trace element. See ranges of mercury concentrations in industrial ore concentrates in Table 2.4[10].

Sulphide ores contain substantial amounts of mercury, with particularly high levels in sulphide ores of zinc (up to 10–100 g/t). Average mercury levels in sulphide ores reach about 1 g/t, and about 1.1 g/t in polymetallic ores.

Average mercury levels in copper and nickel sulphide ores reach 1 g/t, while in some ores (e.g. in the case of Monchegorskoye copper and nickel ore deposit) its concentration may reach up to 9 g/t. Mercury levels in copper sulphide polymetallic ores reach 5–10 g/t; while its levels in barite and fluorite ores reach 1–10 g/t.

Table 2.4

Ranges of mercury levels in industrial concentrates, g/t

Deposit industrial types	Zinc	Lead	Copper	Pyrite	Molybdenum	Tin	Tungsten
Sulphide polymetallic	0.3–175	0.3–390	0.22–65	0.2–11.4	-	-	-
Stratiform lead and zinc	8–1700	0.6–520	2–290	2–90	1–4	-	-
Skarn and metasomatic lead and zinc	6.4–70	1–39	-	-	-	-	-
Vein lead and zinc	?	5	-	-	-	-	-
Copper sulphide	1–390	-	0.3–150	0.1–26	-	-	-
Cupriferous sandstone	20	6	4	-	-	-	-
Vanadium, iron and copper	30	-	70	901	-	-	-
Copper and molybdenum	-	-	0.02	-	0.1	-	-
Copper and nickel	-	-	0.14–0.4	0.45–2	18–362	-	-
Molybdenum and tungsten	-	-	-	-	0.2–0.5	-	?
Tin and tin-tungsten	-	-	-	-	-	0.01–0.8	0.035–0.09
Antimony	-	-	-	0.7–353	-	-	-

[1] Iron concentrate [2] Platinum concentrate [3] Antimony concentrate

Mercury is present in ores as finely dispersed inclusions of mercury sulphide in main ore minerals. Mercury is mainly concentrated in sphalerite, and some other concentrating minerals, such as fahl ore, galenite, bornite, cupropyrite and pyrite. In the course of ore processing operations at ore dressing plants, ores are milled with subsequent flotation and production of different industrial concentrates.

[9] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

[10] Bobrova L. V., Kondrashova O. V., Fedorchuk N. V. Economics of geological exploration works for mercury, antimony and bismuth. . M.: Nedra, 1990. . 156 p. (Rus.).

In the case of sulphide ores, the major share of their mercury content retains in concentrates that are delivered for further processing and only small amounts of mercury (up to 2–7% of the initial mercury content in ores) are transferred to ore dressing waste that are disposed into tailing ponds. Nevertheless, presence of substantial amounts of waste materials with some mercury contents in areas of ore dressing plants predetermine potential possibilities of mercury incorporation into migration chains.

In the course of ore mining operations (particularly ores of zinc, copper, nickel, lead and gold), substantial amounts of mercury are released into the environment. The main share of mercury is mobilised with zinc and copper concentrates that are processed at Russian metallurgy plants. In the course of processing these concentrates, mercury is either released into the air, or enters waste flows or by-products (e.g. technical grade sulphuric acid). Only minor shares of mercury remain in the commercial metals produced.

Primary zinc production is accompanied by production of sulphuric acid by the standard technology. Raw inputs for zinc production include mainly polymetallic sulphide ores that also contain lead, copper, cadmium and other metals' compounds. Due to low metal contents, sulphide ores undergo preliminary processing for production of concentrates. In the course of ore dressing processes (grinding, preliminary enrichment and flotation), depending on composition of raw ores, different zinc concentrates and other concentrates are produced. Zinc concentrates of ore dressing plants (particularly in the Urals) that process ores of copper sulphide deposits have rather high mercury levels. For example, mercury contents in zinc concentrates of Uchalinskiy MPP reach 76–123 g/t.

Accounting for specifics of mercury distribution in the course of sintering of zinc concentrates, it is assumed that about 8% of initial mercury inflow into the technological process concentrate in particulates that are recovered and returned into the process, while about 2% of mercury remains in slag. Mercury emissions and losses (migration to sulphuric acid, sludges, dust) in the course of primary zinc production at Russian plants in 2001[11] are shown in Table 2.5.

Table 2.5

Mercury emissions and losses (migration to sulphuric acid, sludges, dust) in the course of primary zinc production at Russian plants in 2001

Plants	Mass Hg input with concentrates (tons)	Mercury distribution, t					
		Air emissions	Sludges	Sulphuric acid	Discharge to sewers	Lead cake	Copper cake
Chelyabinsk zinc plant	20	1.229	5.4	5	0.1	3	0.4
Elektrotsink	11	0.72	2.97	2.75	0.055	1.65	0.22
Belovskiy zinc plant	0.3	0.024	0.081	0.075	0.001	0.045	0.006
Total	**31.3**	**1.973**	**8.451**	**7.825**	**0.156**	**4.695**	**0.626**

Main sources of nickel in Russia include magmatic copper and nickel sulphide ore deposits (Taymyr Peninsula, Kola Peninsula) and silicate cobalt and nickel ore deposits of Middle and South Urals.

In the course of metal nickel production raw ores and other production inputs undergo multiple high temperature treatment stages; as a result, almost all mercury from these materials evaporates (see Table 2.6).

[11] Yanin E. P. Mercury emissions into the environment by Russian non-ferrous metallurgy plants // Ekologicheskaya ekspertiza, 2004, # 5 (Rus.)

[12] Krivtsov A. I., Klimenko N. G. Mineral resources. Nickel and cobalt. Reference book. — M., 1997. (Rus.).

Table 2.6

Nickel production and mercury emissions in the course of processing silicate (oxidised) ore

Facilities	Nickel production, thousand tons	Nickel in ore,%	Nickel extraction into the final product,%	Total nickel in ore, thousand tons	Ore processed, thousand tons	Mercury in ore, kg[1]	Hg air emissions, kg[2]	Specific Hg emission g Hg/t Ni
«Rezhnikel»	4.4	1.0	89.5	4.92	546	49	44	10
«Ufaleynikel»	9.5	0.90	82.3	11.54	1154	103	93	9.8
«Yuzhuranikel»	9.1	1.03	75.5	12.1	1174	105	95	10.4
Other	4.0	-	-	-	-	-	403	10.1
Total	**27**	-	-	-	-	-	**272**	-

[1] At average Hg content in ores of 0.09 g/t.

[2] Estimates are based on assumption of release of 90% of initial mercury content in raw inputs with flue gases.

[3] At average specific emission of 10.1 g Hg/ton of nickel produced

Average annual air emissions of mercury are estimated as 272 kg, based on the assumption of release of 90% of mercury contents in raw nickel ores with flue gases.

Production of crude copper from copper ore concentrates is of particular importance for assessments of mercury releases into the environment. In Russia, the main share of copper production (up to 70%) is associated with processing of ores from copper and nickel ore deposits of Taymyr Peninsula and Kola Peninsula, while the rest is associated with ores from copper sulphide and copper-zinc sulphide ore deposits in the Urals region.

Processing of **copper ores** is usually associated with production of sulphuric acid from kiln (flue) gases — in the process mercury intensively concentrates in sludges of sulphuric acid production lines.

Available statistically sound reports on mercury contents in copper ores of the Urals region and copper concentrates suggest that copper sulphide ores of "III Internatsionala" deposit (Sverdlovskaya oblast) contain from less than 0.5 to 20 g/t, ores of Sibayskoye deposit (Bashkortostan) contain 10–900 g/t, and ores of Gayskoye deposit (Orenburgskaya oblast) contain 1–90 g/t, while ores from Uchalinskoye, Degtyarskoye and several other deposits contain 19 g/t. In addition, ores of all industrial grades and mineralogical types that are processed by Uchalinskiy MPP demonstrate high variation of mercury levels (from a few tens mg/t to 800 g/t in ores from Uzelginskoye deposit, from 2 to 560 g/t in ores from Uchalinskoye deposit and from 1 to 88 g/t in ores from Novouchalinskoye deposit).

Copper and nickel are produced by "Norilsk Nickel MMC" PJSC. The company incorporates its transpolar branch (Krasnoyarskiy Krai, Taymyr Peninsula), "Kola Mining and Metallurgic Company", including "Pechenganikel MMC" JSC and "Severonikel Combinate" JSC (Muermanskaya oblast, Kola Peninsula) and several other facilities. "Norilsk Nickel MMC" PJSC belongs to leading Russian and global producers of copper, nickel, cobalt, and some rare and precious metals.

The share of "Norilsk Nickel MMC" in the total Russian production of nickel is stable and reaches 95–96%, while its share in production of refined copper reaches 55–57%. In recent years, its annual average extraction and processing of copper and nickel sulphide ores at Taymyr Peninsula and Kola Peninsula reached up to 18.5–19.8 million tons. Average mercury content in the copper and nickel sulphide ores reaches 1 g/t.

According to the Ministry of Natural Resources of the Russian Federation, in 2001, the major share of lead (in ores and concentrates) was produced by ore deposits of Primorskiy Krai and Krasnoyarskiy Krai. **Mercury concentrations in lead concentrates** vary from 0.3 to 520 g/t. In the course of oxidising nebulising sintering of lead concentrates, the major share of mercury (more than 90%) evaporates and accumulates in dust of electrostatic precipitators or sleeve filters and is collected in the course of treatment of flue gases. In the case of production of sulphuric acid, about 5.5% of mercury precipitates in washing towers. Lead dust contains elevated concentrations of mercury and other metals. An approximate average mercury emission factor for primary lead production reaches 2 g/ton of the metal produced. Available information allows for assessment of the total national mercury emissions from lead production as follows: 60 kg from production of 30 thousand tons of primary lead and 6 kg from production of 30 thousand tons of secondary lead. Only a minor share of mercury is released from technological processes with emissions, final products and waste flows; the main share of mercury is accumulated in circulating intermediate products.

Average mercury levels in **tin ores** (from ore deposits of Primorskiy Krai and Krasnoyarskiy Krai) reach 0.1 g/t. According to different sources, in tin concentrates (from ore deposits of Yakutia and Zabaikalie) and in sulphide tin concentrates, mercury levels vary from 0.01 to 0.5–1.89 g/t. In 2001, Novosibirsk Tin Plant JSC was the only tin producer in Russia (Novosibirsk). Estimates of mercury emissions from tin production at the Novosibirsk plant in early 1990s suggest about 9–33 kg/year. The estimate is based on mercury concentrations in tin concentrates processed (0.01–0.5 mg/kg) and annual processing of 8 thousand tons of pyrite from the Urals region (with mercury content of 1 g/t).

The major share of mercury evaporates from tin concentrates at the sintering stage; remaining mercury (5% of the total Hg weight) is removed at leaching and melting operations. An efficient dust removal system allows to precipitate at least 60% of mercury in flue gases in dust at pollution control filters.

In 2000–2001, antimony, molybdenum, tungsten and some other rare metals were produced in Russia from ores/concentrates in small amounts (mainly as by-products). Annual production of the above concentrates was very low. Substantial shares of antimony, molybdenum and tungsten concentrates were exported and only small amounts of these concentrates were processed at Russian plants. Mercury levels in the concentrates (or in ores) rarely exceeded 1 g/t.

In general, Russian non-ferrous metallurgy plants are substantial sources of mercury releases into the environment due to high mercury concentrations in ores. In the course of ore dressing operations in non-ferrous metallurgy, substantial amounts of mercury are transferred to concentrates (zinc, copper and pyrite concentrates) and are involved into metallurgic conversion processes. Large amounts of mercury accumulate in ore dressing waste disposed of nearby relevant plants.

In 2001, with production inputs, more than 60 tons of mercury entered Russian plants for production of zinc, crude copper, nickel and some other non-ferrous metals. As applied technologies for processing ores and concentrates of non-ferrous metals at Russian plants do not provide for recovery of mercury as a by-product, it was released into the environment, waste, industrial products and some final products.

FERROUS METALLURGY

The ferrous metallurgy industry incorporates facilities for iron ore mining and processing, iron smelting, production of steel, production of rolled steel and pipes, ferroalloys, iron powders, alloys, refractory products and secondary processing of ferrous metals (see Table 2.7).

Table 2.7

Production of main types of ferrous metallurgy products in Russia in 1999–2002, million tons[13, 14]

Year	Commercial iron ore	Coke (6% moisture content)	Pig iron	Steel	Rolled products	Steel pipes
1999	82.2	28.1	40.9	52.5	40.9	3.3
2000	87.1	30.0	44.8	59.1	46.7	4.8
2001	82.8	29.9	47.1	59.0	47.1	5.4
2002	84.2	30.9	46.3	59.8	48.7	5.1

[13] ACAP. 2005. Assessment of mercury releases into the environment from the territory of the Russian Federation. Arctic Council Plan to Address the Arctic Pollution (ACAP). The Federal Service for Environmental, Technological and Nuclear Supervision in cooperation with the Danish Environmental Protection Agency, Copenhagen. http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

[14] http://ecsn.ru/files/pdf/201502/201502_72.pdf

In the course of assessment of mercury in ferrous metallurgy we may rely on research of mercury contents in iron ores from deposits of Kursk Magnetic Anomaly (the main sources of raw iron ores for Russian plants) — it is assessed at the level from 0.01 to 0.1 mg/kg. Mercury levels in the concentrate of Korshunovskoye deposit (Siberia) are assessed as 0.02–0.085 mg/kg. Average mercury levels reach: 0.06 mg/kg in iron ore and pellets, 0.0004 mg/kg in sinter, metal additives and coke, 0.1 μg/m^3 in natural gas, 0.05 mg/kg in limestone, and 0.06 mg/kg in manganese ore. Specific consumption of main inputs for production of 1 ton of pig iron and associated mercury amounts are shown in Table 2.8.

Table 2.8

Specific consumption of main inputs for production of 1 ton of pig iron and associated mercury amounts, kg[15]

Inputs	2000	2001	Average mercury levels, mg/kg1	Mass of mercury entering production processes, mg
Iron ore part of the charge, including:	1674	1660		
Iron ore	17	16	0.06	0.96
Sinter	1137	1141	0.0004	0.456
Pellets	520	502	0.06	30.12
Metal additives	15	20	0.0004	0.008
Skip coke	468	457	0.0004	0.183
Natural gas, m3	92	92	0.01 μg/m3	0.009
Oxygen, m3	85	81	-	-
Limestone	161	158	0.05	8.05
Manganese ore	1.3	1.3	0.06	0.078
Total				**39.864**

[1] Minimal concentrations of mercury were applied for 2001 estimates. Actually, some plants use limestone and iron ores with higher mercury concentrations.

Estimates suggest that the specific mercury input reaches 39.86 mg per 1 ton of the pig iron produced (0.03986 g/t).

COKE AND BY-PRODUCTS PRODUCTION

Coke and by-products production supplies raw inputs for production of plastics, fibres, dyes and other synthetic materials, and may be considered as a source of mercury releases. 85% of source coal for coke production in Russia are supplied by Kuznetsk Coal Basin (Kemerovskaya oblast). The oblast supplies about 59% of all Russian coal and 75% of coke grade coal.

In the course of coal washing operations, mercury distributes as follows (see Table 2.9.): the major share retains in coal concentrates (up to 58–62%) and in processing waste — waste rock and tails (up to 24–26%). Average indicative mercury levels in coal of Kuznetsk Coal Basin reach 0.08 g/t. In coke grade coal of Pechora Coal Basin, mercury levels vary from 0.01 to 0.1 g/t. Temperatures in coking furnaces reach 1000°C or higher; as a result, mercury almost completely releases into raw coke gas and eventually into other solid, liquid and gaseous products of the production process.

[15] Analytical note on state of ferrous metallurgy in Russia // Bulletin of the Accounts Chamber of the Russian Federation, 2002, # 9 (57) // Materials of the official website of the RF Accounts Chamber http://www.ach.gov.ru/

Table 2.9

Approximate distribution of mercury in the course of coke and by-products production (for processing of 1 million tons of feed coal)[16]

Mercury distribution	Share,%	Amount of mercury, kg	g Hg/t of coke
Into air at charging	~ 5	3.8	0.0047
Into sludge	~ 2.5	1.9	0.0023
Into industrial products	~ 3.5	2.7	0.0033
Into tails	~ 2.5	1.9	0.0023
Into waste rock	~ 22.5	17.1	0.0213
Into air at carbonisation	~ 40.5	30.8	0.0385
Into coke	~ 0.5	0.4	0.0004
Into tar water	~ 2.5	2.7	0.0033
Into final chemical products	~ 17	12.9	0.0161

In 2001, in Russia, about 42.9 million tons of coal were used for coke production. Assuming the average mercury content of 0.076 g/t, the overall mercury input with the coal might reach 3260 kg (see Table 2.10).

Table 2.10

Approximate distribution of mercury in the course of coke production in Russia in 2001[17]

Mercury distribution	Amount of mercury, kg	Share,%
Mercury input with coal	3260	100
inc. collected by pollution control units	494	15
Total mercury releases into the environment	2766	85
including:		
into air at charging	141	4.3
into sludges	69	2.1
into industrial products	99	3.1
into tails	69	2.1
into waste rock	639	19.6
into air at carbonisation	1155	35.4
into coke	12	0.4
into tar water	99	3.1
into final chemical products	483	14.9

[16] Karasik M. A., Dvornikov A. G. Mercury contents in Donetsk Coal Basin coal and coal processing products. — M.: ONTI VIEMS, 1968 (Rus.)

[17] Yanin E. P. Mercury emissions into the environment in coke production in Russia. — M.: IMGRE, 2004 (Rus.)

CEMENT AND LIME PRODUCTION

Raw materials for **production of cement and lime** include limestone and clay minerals, containing calcium oxide, silica, aluminium oxide and iron oxide that undergo high temperature calcination up to 800°C. All mercury is released at 300°C; it evaporates and escapes with flue gases.

Cement clinker (a semi-product) is a mixture of carbonates and clay minerals roasted to sintering/melting stage. Carbonate and clay components of the mixture should provide a certain ratio of silica to alumina. In the course of cement production, in order to get a necessary chemical composition of clinker, different additives are used, including iron-based ones (burnt pyrites, blast furnace dust, iron ore sleeve residues) and alumina-containing additives (sand, silica clay, tripoli) — usually under 0.09 t per 1 ton of cement clinker.

Mercury mobilisation in the course of cement production was assessed to be in the range from 1.6 to 2.8 tons (mercury sources include mineral production inputs and fuel). Production of lime is also accompanied by mercury emissions. Mercury mobilisation in the course of lime production was assumed to be much lower than in the course of cement production.

MERCURY USE IN SEMICONDUCTORS

Production of modern electronic and optoelectronic devices (LDRs, LEDs, Hall transducers, high sensitivity optical detectors, semiconductor lasers, etc.) may include application of mercury-containing semiconductor materials, including mercury-cadmium-telluride alloy materials. Mercury use in the semiconductor industry of Russia may be very approximately assessed in the range from 0.5 to 2 t/year. No information is available on mercury releases in the industry. However, it is known that mercury-cadmium-telluride technology relies on thermal treatment of the finished material in mercury vapour. As a result, it is fairly possible that synthesis of semiconductors may be accompanied by mercury contamination of production chambers and by mercury releases into the workplace environment (e.g. due to depressurisation of production equipment).

MERCURY USE IN ELECTRIC LAMPS PRODUCTION

What does the Minamata Convention say about mercury use for production of electric lamps?[18]

Article 4 of the mercury treaty lists high-pressure mercury vapour lamps, mercury in a variety of cold cathode fluorescent lamps and external electrode fluorescent lamps for phase-out by 2020 (with an option to extend this time limit to 2030).

Mercury is a component of discharge lamps that generate light due to electric discharge in metal vapours or vapour and gas mixtures. In the course of production, mercury is added as liquid metal or as amalgam. Due to lower mercury vapour pressures over amalgams, amalgam-based lamps are more acceptable in production and use. In the overwhelming majority of cases, Russian producers of electric lamps apply liquid metal mercury in the course of vacuum filling operations — with inevitable associated technological losses, emissions of the toxic metal into the environment and development of technogenic pollution zones. In the early 2000s, the main producers of mercury lamps (and, correspondingly, main mercury consumers) included “Lisma” JSC in Saransk (since 2007, it operates as “Lisma” State Unitary Enterprise of Mordovia Republic) and “Svet” Smolensk Electric Lamps Plant JSC. “Svet” specialised in production of low-pressure fluorescent lamps, producing up to 50% of all Russian lamps annually (in 2001, the plant produced more than 35.6 million lamps). “Lisma” produced more than 700 types of lighting appliances (see Table 2.11).

Low pressure fluorescent lamps are the most common type in use. In such lamps, UV radiation generated by electric discharge in mercury vapour is transformed into visible light of different colour profiles by a phosphor coating at the inner tube surface.

[18] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

Table 2.11

Mercury consumption of Russian electric lamps producers in 2001[19]

Consumers	Mass of mercury, kg	Share,%
«Lisma» JSC, Saransk	44001	58.7
«Svet» JSC, Smolensk	2600	34.7
Other producers	350	4.6
Production of neon lights	150	2
Total	75002	100

[1] Saransk Electric Lamps Plant consumes up to 90% of mercury.

[2] Up to 87% of mercury is used for production of low pressure fluorescent lamps

In 2000–2004, annual production of low pressure fluorescent lamps in Russia reached 69–71 million lamps, in addition to 6.5–7 million high pressure lamps. See information on mercury contents in main types of Russian discharge lamps in Table 2.12[20].

Table 2.12

Mercury contents in main types of Russian discharge lamps, 2001

Types of lamps	Mercury amount in 1 lamp, mg
Fluorescent tube lamps	40–65 (average 52)
Compact fluorescent bulbs	5
High pressure lamps (DRL type)	75–350
High pressure lamps (DRT type)	50–600
Metal halide lamps	40–60
Sodium high pressure lamps	30–50
Neon lights	over 10

COAL-FIRED POWER PLANTS

What does the Minamata Convention say about mercury emissions from coal burning?[21]

According to UNEP's "Global Mercury Assessment 2013" report, the second largest source of global anthropogenic mercury emissions to air is burning fossil fuels, especially coal. Fossil fuel burning accounts for 25 percent of anthropogenic mercury emissions to the atmosphere. In 2010 burning coal contributed 475 metric tons of mercury to the atmosphere, compared to 10 metric tons from all other fossil fuel sources. More than 85 percent of the mercury emissions in the coal sector are from coal-fired power stations and industrial boilers.

[19] ACAP. 2005. Assessment of mercury releases into the environment from the territory of the Russian Federation. Arctic Council Plan to Address the Arctic Pollution (ACAP). The Federal Service for Environmental, Technological and Nuclear Supervision in cooperation with the Danish Environmental Protection Agency, Copenhagen. http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

[20] E. P. Yanin Mercury containing lamps as a source of mercury pollution of the environment. M.: MIGRE, 2005. — 28 p. (Rus)

[21] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

Russia has the second largest coal reserves in the world. Coal-fired power plants generate the largest adverse environmental impact, including toxic gaseous products, corrosive liquid effluents, ash disposal sites, fugitive ash and heat discharges.

Estimates of mercury contents in coal used by 129 Russian power plants in 2002 suggest 6–8.5 tons at the average mercury concentration in coal at the level of 0.08 mg/kg. At high temperatures of combustion all mercury evaporates and is eventually released into air with flue gases or concentrates at particles that are collected by specialised pollution control units.

In general, mercury mobilisation in connection with coal use (including mainly coal burning for electricity/heat generation and coal use for coke production) reached about 20–24 tons in 2002. Mercury levels in coal from different coal basins of the country may differ by two orders of magnitude, and uncertainty of estimated total mercury mobilisation in 2002 was associated with uncertainty of mercury levels in actually-used coal.

BATTERIES/CELLS

For a long time, substantial amounts of mercury were used in Russia for industrial production of some types of batteries (primary and secondary batteries), mercury switches, sensors and sealed switches, mercury rectifiers, manometers, barometers and other instruments. Mercury was also used as working liquid in different devices (vacuum pumps, densimeters, porometers, gyro horizon, mercury turbines, etc.). Now, batch production and large scale application of many such instruments and devices has been cancelled or substantially reduced due to economical, technological, health and environmental considerations. However, some produced earlier are still used for different domestic, industrial and research applications, and some mercury-containing instruments and devices are still stored in storage facilities of enterprises and organisations. Some Russian facilities continue small scale production of mercury-based and mercury-containing cells and batteries, as well as some other mercury-containing items.

In the period from 1990 to 2002, the overall production of batteries and cells in Russia decreased by 100 times, with an associated almost 100-fold sharp reduction of mercury use for these purposes (in the late 1980s, the overall production of all types of batteries and cells in the USSR reached 1 billion items/year).

In 2001–2003, in Russia, main producers of batteries and cells for household appliances, communication gear, etc. included "Uralelement" FSUE in Verkhniy Ufaley (alkaline manganese dioxide-zinc cells, manganese dioxide air cells, silver oxide-zinc cells), "Energia" JSC in Yelets (alkaline manganese dioxide-zinc cells, mercury oxide-zinc cells and batteries) and some others.

GOLD MINING

Mercury contents in gold concentrates of gold refining plants may be associated with both higher mercury levels in ores (and in cyanide process sludges) and its direct application for processing of legacy placers and tailings.

Application of mercury for enrichment of gold ores in Russia is prohibited. However, according to available data for 2001, amalgamation enrichment was illegally used by small facilities in remote areas with weak environmental controls. Indicative total application of mercury for gold mining purposes in 2001 was estimated in the range from 3 to 8 tons (or 10 times lower than in the period from 1976 to 1990, when mercury use for these purposes might reach about 40 t/year). As such mercury use is illegal, official statistics lack necessary information to substantiate the latter expert assessment.

In addition, it was noted that "other intentional uses" of mercury also existed, including production of semiconductors, ultrapure metals by amalgamation and other possible uses of mercury. No actual data for 2001 were available.

Now, five main sources of mercury releases into the environment in connection with gold mining can be found. Their quantitative parameters depend on types of gold deposits and gold reserves, duration and intensity of mining operations and use of mercury in technological processes:

- Mercury emissions into air from surface of waste rock piles, ore processing tailings, and contaminated soils, as well as their water erosion with pollution of water courses, upper soils, aquatic and terrestrial ecosystems.
- Current widely applied practices of secondary processing of legacy placers, as well as processing of concentration tailings and stream concentrates.
- Continued illegal use of mercury for enrichment of gold ores/concentrates.

- Gold extraction at deposits with naturally high mercury contents.
- Industrial gold refining operations with use of gold concentrates with elevated natural or technogenic mercury levels.

According to rough estimates, recovery of mercury as a by-product of gold extraction might reach 4–8 t/year. The major share of the metal accumulated is in waste rock and tailing, while about 20% of mercury might be emitted into air.

OIL AND GAS INDUSTRY

Assessment of the overall amount of accompanying mercury in the course of oil extraction is based on the national average mercury contents in oil in the Russian Federation (180 μg/kg) and the overall estimated oil extraction — 336 million tons. These parameters suggest the annual volume of mercury at the level of 61 tons. While it seems fairly possible that the major share of the mercury is removed from oil at the first separation stage, amounts of such removed mercury and its eventual fate are unknown. Amounts of residual mercury in oil after its processing are assessed at the level of 32 tons. Estimates suggest that product fuels contain about 3.4 tons of mercury. The latter figure may be compared with estimated amounts of mercury releases into air from coal burning in 2002 (about 14.3 tons).

In natural gas, gas condensate contains about 1.4 μg/m^3, natural gas liquids contain 270 μg/kg, while unstable gas condensate contains 470 μg/kg. Commercially supplied gas for consumers contains very low mercury levels — about 0.05 μg/m^3. According to estimates, the overall annual production amount of gas and gas condensate may contain from 2 to 10 tons of mercury. In gas pipelines, mercury tends to condensate on the inner surface of pipes (often with formation of amalgams with pipe materials). As a result, at the end of a pipeline mercury levels in gas are very low. The mercury in pipelines may remain there for a long time (or may release to the environment when pipelines are opened or damaged). Gas flaring may release 65 kg of mercury per annum, while use of natural gas may promote substantial reduction of mercury emissions.

MERCURY IN CONSUMER GOODS

What does the Minamata Convention say about mercury-added products?[22]

The treaty uses a so-called 'positive list' approach. This means that the products to be phased-out are listed in the treaty; the treaty does not address others.

- Parties are to discourage the manufacture and distribution in commerce of new mercury-added products before the treaty enters into force for them unless they find that a risk and benefits analysis shows environmental or human health benefits. These 'loophole' products are to be reported to the Secretariat, which will make the information publicly available.
- There is a list of products that are scheduled for phasing-out by 2020. However (see Article 6), countries can apply for a five-year exemption to the phase-out date and this can be renewed for a total of 10 years, making 2030 the effective phase-out date for a product.
- Products to be phased out by 2020 include batteries (except for button zinc silver oxide batteries with a mercury content < 2 percent and button zinc air batteries with a mercury content < 2 percent); most switches and relays; CFL bulbs equal to or less than 30 watts containing more than 5 mg mercury per bulb (an unusually high amount); linear fluorescent bulbs — triband lamps less than 60 watts and containing greater than 5 mg mercury and halophosphate lamps less than 40 watts and containing greater than 10 mg mercury; high pressure mercury vapour lamps; mercury in a variety of cold cathode fluorescent lamps (CCFL) and external electrode fluorescent lamps (EEFL); cosmetics including skin lightening products with mercury above 1 ppm except mascara and other eye area cosmetics (because the treaty claims that no effective safe substitute alternatives are available); pesticides, biocides, and topic antiseptics; and non-electronic devices such as barometers, hygrometers, manometers, thermometers, and sphygmomanometers (to measure blood pressure).
- A product to be "phased-down" is dental amalgam, and countries are supposed to pick two measures from a list of nine possibilities taking into account "the Party's domestic circumstances and relevant international guidance." The possible

[22] http://ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

actions from the list include establishing prevention programs to minimize the need for fillings, promoting use of cost-effective and clinically effective mercury-free alternatives, discouraging insurance programs that favour mercury amalgam over mercury-free alternatives, and restricting the use of amalgam to its encapsulated form.

- Products excluded from treaty include products essential for civil protection and military uses; products for research and calibration of instruments for use as a reference standard; switches and relays, CCFL and EEFL for electronic displays, and measuring devices, if no mercury-free alternative is available; products used in traditional or religious practices; vaccines containing thimerosal as preservatives (also known as thimerosal); and mercury in mascara and other eye area cosmetics (as noted above).
- Note: some products listed for prohibition in previous drafts such as paints were excluded during the negotiation process.
- The Convention Secretariat will receive information from Parties on mercury-added products and make the information publicly available along with any other relevant information.
- Parties can propose additional products to be phased-out, including by providing information on technical and economic feasibility and environmental and health risks and benefits.
- The list of prohibited products will be reviewed by the COP five years after the treaty enters into force.

In contrast to many Western countries, use of mercury for dental applications in Russia has almost completely ceased.

The main share of mercury use in consumer goods is applied for production of **mercury thermometers and lamps**. Moreover, amounts of mercury in mercury-containing consumer goods in the Russian market differ from the amounts of mercury used for their production. These difference are attributed to certain technological losses, as well as to import and export of mercury-added goods. In 2001, the overall amount of mercury in consumer goods in the domestic market of the country was estimated at the level of about 18 t (see Table 2.13).

It is necessary to note that application of mercury in Russia for production of thermometers, cells/batteries, other electric equipment and instruments decreased by several times within the recent decade, while production of some items and instruments was almost completely cancelled (mercury switches, rectifiers, manometers, etc.)

Table 2.13

Mercury in consumer goods supplied to the Russian market in 2001[23]

Mercury-containing products	Mercury use for production, t/year	Mercury contents in final products, t/year	Mercury contents in products supplied to the domestic Russian market, t/year[1]
Thermometers	24.2	24.0	9.4
Lighting appliances	7.5	4.7	4.7
Batteries/cells	0.8	0.6	1.6
Switches, manometers, etc.	0.2	0.2	< 2
Total (rounded)	**33**	**30**	**18**

[1] Including import/export.

However, mercury might still be present in some types of imported equipment, e.g. in switches in some cars (mainly of US manufacturers). The overall inflow of mercury to Russia with such equipment was assessed at the level under 2 t.

[23] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

UNINTENTIONAL SPREAD OF MERCURY WITH DIFFERENT PRODUCTS

According to assessments in the framework of the ACAP project, more than 16 t of mercury per annum are released as undesirable impurities in different final products and by-products. The eventual fate of such mercury is unknown but sooner or later it will enter the environment or waste flows. Amounts of mercury in oil products (except petrol, diesel oil and fuel oil) were not estimated, but the total content might be substantial.

Mercury releases into the ambient air

In the course of study of mercury in the environment, including its long-range transport, it is very important to do an inventory of mercury emissions. The inventory stipulates accounting for the maximal possible number of technogenic mercury emissions as mercury vapour/gaseous releases and emissions with particulate emissions of industrial facilities.

In the territory of the Russian Federation, main sources of mercury releases into the ambient air include processing and use of fossil fuels, ores and other mineral production inputs that contain mercury as a natural impurity. The major share of such mercury is releases by stationary sources (power plants, smelters, coke plants, cement plants, etc.). In the majority of cases, pollution control equipment (primarily designed to reduce particulate emissions) ensure only negligible capture of fugitive mercury releases from raw materials or fossil fuels under high temperature treatment. A substantial share of mobilised mercury in the sector is emitted to the atmosphere.

In connection with coal use, the total mercury emissions reached about 14 t annually, including 8 t in the course of electric/heat energy generation, 1.3 t in the course of coke production, 2 t from municipal boilers and household heaters, and 3 t from other coal uses. Combined heat and power stations use pollution control equipment to capture particulates and desulphurisation units; however, according to rough estimates, about 80% of mercury content in coal is released into the ambient air.

Some part of mercury in crude oil, in the course of oil processing operations, enters products and — eventually — is released into the air after their combustion. If we compare the overall amount of mercury inputs with crude oil to oil processing facilities of Russia with total emissions from combustion of oil products, we may note that a substantial share of mercury is released either in the initial oil processing, or in the course of oil treatment.

In non-ferrous metallurgy, a substantial share of mercury is captured by sulphur emissions control equipment, and a minor share of mercury inputs with ore concentrates is released to air. According to estimates, annual mercury emissions in Russia from non-ferrous metallurgy reach about 8 t of mercury, mainly from production of zinc, copper and nickel.

Mercury emissions from incineration of solid municipal waste are estimated at the level of 3.5 t. There are several operational waste incineration plants in Russia, which process only a minor share of annual solid municipal waste (SMW) generated in the country. Main sources of mercury in incinerated SMW include hazardous waste, mercury thermometers, batteries, lamps and switches.

The evaluation suggests that gold extraction from legacy placers (waste rocks, tailings, etc.), that were earlier processed with application of amalgamation methods, is a substantial source of mercury releases into the environment. Associated mercury emissions may reach 0.9–3.9 t/year or about 60% of its total content in secondary raw materials processed (1.5–6.5 t/year). In the whole history of gold mining in Russia, about 6000 tons of mercury were used. A substantial share of the mercury is still retained in legacy placers, while some part of it is released to air in the course of secondary processing and gold extraction. Developed technologies and equipment for processing of gold- and mercury-containing materials allow for extraction of different forms of mercury quantitatively and separate metal mercury by thermal treatment of concentrates and condensation of mercury vapour. However, such equipment is rarely used.

Gold extraction from legacy placers substantially accelerates secondary mobilisation of mercury from waste, while mercury emissions from all types of mercury-containing waste may be substantial. Only very limited information is available on amounts of mercury releases from waste; other secondary emission source were not analysed in quantitative terms.

Generalised information on mercury emissions into the ambient air (by activity categories) in the Russian Federation in 2001–2002[24] is shown in Table 2.14.

[24] ACAP. 2005. Assessment of mercury releases into the environment from the territory of the Russian Federation. Arctic Council Plan to Address the Arctic Pollution (ACAP). The Federal Service for Environmental, Technological and Nuclear Supervision in cooperation with the Danish Environmental Protection Agency, Copenhagen. http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

Table 2.14

Mercury emissions into the ambient air in Russia, 2001–2002

Activity categories	Mercury emissions	
	Optimal assessment, t/year	% of the total
Intentional mercury use		
Chlor-alkali production	1.2*	3.0
VCM production	0.02	0.05
Gold extraction with amalgamation and processing of legacy placers	3.1	8.0
Dental amalgam	0.05	0.1
Production of thermometers	0.009	0.02
Production of barometers, manometers and other instruments	0.01	0.03
Production of lighting appliances	0.15	0.4
Other intentional use	?	-
Total	5.3	12
Mercury mobilisation from impurities		
Coal — electricity generation	8.0	21
Coal — municipal and domestic heating	2.1	6.0
Coal — coke production	1.3	3.0
Coal — other uses	3.0	8.0
Oil processing	?	-
Use of petrol, diesel oil and fuel oil	3.4	9.0
Gas, condensate, oil shale and biofuel	1.0	2.6
Zinc production	1.9	5.0
Copper and nickel production	5.3	14
Other non-ferrous metals	1.2	3.0
Iron and steel production	1.4	4.0
Cement production	1.6	4.0
Use of by-products **	?	-
Total	30	79
Waste processing		
Production of secondary mercury	0.05	0.1
Iron and steel processing	?	-
Waste incineration	3.5	9.0
Landfilling	?	-
Recycle of lamps	0.1	0.3
Sewage sludge incineration	<0.1	0.3
Total	**3.8**	**10**
Cumulative total amount	**42.6**	**100**

* — Direct emissions in the course of technological processes. Certain amounts of mercury may be released to the atmosphere due to so called "unaccounted losses," which were assessed in 2002 at the level of 50 tons.

** — Mercury emissions to the atmosphere from by-products, such as sulphuric acid, nitric acid, bitumen, etc. were not assessed but they might be substantial.

Mercury discharges to water bodies

According to official statistics, in Russia, the overall inflow of mercury to water bodies with wastewater of industrial facilities reached 0.177 t in 2001 (see tables 2.15 and 2.16)[25]. The main category of discharge sources is associated with the chemical industry (mainly chlor-alkali plants). In comparison to mercury emissions to the atmosphere, its direct discharges to water bodies represent a minor share of its technogenic releases to the environment.

Table 2.15

Mercury discharges to surface water bodies, by regions of Russia, in 2001

Territorial units	Polluted wastewater discharges, million m^3	Mercury discharge, kg	Notes
The Russian Federation (total)	22370	177	
St. Petersburg	1244	19	
Leningradskaya oblast	413	2	
Moscow	2185	2	
Kirovskaya oblast	183	2	Chemical industry
Bashkortostan Rep.	449	16	Chemical industry
Novosibirskaya oblast	385	1	
Kraskoyarskiy Krai	644	1	
Irkutskaya oblast	911	129	Chemical industry
Sakha Rep. (Yakutia)	93	4	
Amurskaya oblast	109	1	

Wastewater discharges of medical facilities may contribute to inflow of mercury to municipal sewers, as well as mercury from broken thermometers and electric items (e.g. broken switches). A large share of mercury-containing goods and devices that were produced many years ago, are still in use and may represent a potential source of mercury inflows into wastewater.

Table 2.16

Mercury discharges into surface water bodies, by industries, in 2001[26]

Industries	Polluted wastewater discharges, million m^3	Mercury discharge, kg
The Russian Federation (total)	22370	177
Industry:	7273	156
Non-ferrous metallurgy	593	6
Chemical industry	855	146
Pulp and paper	1421	1
Flour, cereals and fodder	23	2
Housing and utilities	13474	20

Mercury releases to soils

One of the main sources of direct releases of mercury to soils (besides waste dumps) is associated with unaccounted losses of chlor-alkali plants — mercury directly contaminates soils on-site or nearby production facilities. Mercury may also be non-intentionally released to soils from other production facilities that use it.

Application and production of mercury-containing agro-chemicals in Russia are now prohibited. Nonetheless, in 2001, mercury-containing pesticides (mainly granozan) were still applied in agriculture, resulting in releases of up to 0.6 t of mercury to soils. Now, mercury-containing pesticides are stored in storage facilities and their overall mercury content in the country may reach up to 20 t. Many storage facilities in rural areas are dilapidated; as a result, it is possible that hazardous chemicals (pesticides) may be released into the environment.

In Russia, only a minor share of annually generated sewage sludge is used for agromelioration purposes. Nonetheless, the latter source may release about 1 t of mercury to cultivated lands.

Mercury in dental amalgam sooner or later will enter soil after burial (at cemeteries) — its amounts may reach up to several tons/year.

Mercury in sewage sludge

Accounting for estimates of mercury levels in sewage sludge, the overall releases from municipal wastewater treatment facilities were assessed at levels of 3 to 12 t. A similar amount of mercury may accumulate in sewage sludge that is usually discharged to sludge draining beds and landfilled. Unfortunately, in many Russian cities, industrial facilities discharge their wastewater to municipal sewers for eventual treatment at wastewater treatment facilities.

In the majority of Russian cities, centralised municipal wastewater treatment facilities operate and usually treat combined municipal and industrial wastewater. Wastewater treatment is accompanied by generation of substantial volumes of sewage sludge (slimy mixtures of mineral and organic matter) that are discharged to drying grounds nearby municipal wastewater treatment facilities.

Generally, the intensity of mercury accumulation in sewage sludge depends on specific production facilities in cities, on volumes and quality of industrial wastewater inflows to municipal sewers and — finally — to wastewater treatment facilities (see Table 2.17). Relatively small cities, such as Klin and Saransk, where some industrial facilities use mercury in their technological processes, demonstrate more intensive accumulation of mercury in sewage sludge. For example, the amount of mercury in sewage sludge of Klin (with a plant for production of mercury-containing instruments) may reach 15–20 t.

[25] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

[26] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

Table 2.17

Mercury in sewage sludge — *estimates*[27, 28],

Cities	Mercury, mg/kg
Moscow oblast	
Klin (a plant for production of mercury thermometers)	220
Kolomna	10
Aprelevka	3.6
Zagorsk	2.8
Orekhovo-Zuevo	2.4
Bronnitsy	0.8
Serpukhov	0.4
Zaraisk	0.4
Voskresensk	0.3
Domodedovo	0.2
Pavlovskiy Posad	0.2
Podolsk	0.2
Shatura	0.2
Elektrostal	0.1
Belozerskiy	0.1
Istra	0.1
Naro-Fominsk	0.1
Ramenskoye	0.03
Moscow	
Lyuberetskaya aeration station	1.8
Kuryanovskaya aeration station	1.3
St. Petersburg	
Municipal WWTF	1.6
Mordovia Republic	
Saransk (a plant for production of mercury lamps)	4 (3–5)
Tatarstan Republic	
Kazan	0.41
Naberezhnye Chelny	0.45

After disposal to sludge draining beds, the sewage sludge becomes a source of secondary mercury contamination of the environment. Such contamination is caused by infiltration of leachate to groundwater, mercury emissions to the atmosphere and wind erosion of upper layers of the sludge.

Mercury in solid waste

Annually disposed/landfilled amounts of solid waste in Russia may contain about 95 tons of mercury. About 32 tons of secondary mercury are recovered in the course of processing different types of waste and crude metals refinement (see Table 2.18). It is worth noting that mercury in waste flows exists in different chemical forms with different mobility.

Waste flows of chlorine and alkali plants supplied up to 39 t of mercury to landfills. Now, these types of wastes are not recycled for mercury recovery; however, the main part of waste from VCM (vinyl chloride monomer) production was processed for production of new catalysts.

In addition, about 0.6–1.6 t (≈ 20%) from 3 to 8 tons of used mercury might be released to waste rock and tailings by illegal gold miners.

[27] A. G. Kocharyan, I. P. Lebedeva The Institute of Water Problems of RF Acad. Sci. (Moscow) Specifics of mercury contamination at urbanised territories. Risk management in urban development. UDK504.06 2011. (Rus.)

[28] E. P. Yanin Sewage sludge as a source of mercury releases into the environment. — IMGRE, 2004 (Rus.)

Table 2.18

Mercury in solid waste in the Russian Federation, 2001–2002[29]

Activity category	Mercury in solid waste			
	disposed/landfilled			recycled, the most precise estimate t/year
	the most precise estimate t/year	% of the total	Uncertainty category[2]	
Intentional mercury use				
Chlor-alkali production	39	41	A	
VCM production	0.0	0.0	A	4.7
Gold extraction with amalgamation	1.1	1	B	
Production of thermometers	0.1	0.1	A	
Production of cells/batteries, barometers, manometers and other instruments	0.2	0.2	A	
Production of lighting appliances	0.001	0.0	A	2.3
Laboratory applications	2.2	2.3	B	
Other intentional uses	?	-	-	
Total	43	45		7
Mercury mobilisation from impurities				
Coal — mining and processing	3.1	3.0	B	
Coal — electricity generation	2	2.1	B	
Coal — other uses	0.5	0.5	B	
Oil processing	?	-	C	
Gas and biofuel	?	0	C	
Zinc production	8.5	9	C	5.4
Copper and nickel production	6.6	7.0	C	
Other non-ferrous metals (including gold)	4.2	4.0	C	
Cement production	0.4	0.4	B	
Use of by-products	?	-		
Total	22	23		5.4
Waste processing				
Mercury processing	0.003	0.0	A	
Iron and steel processing	?	-	-	
Municipal and hospital waste:	24	25	B	
- thermometers	20	21	B	
- cells/batteries	1.6	1.7	C	0.02
- light sources	1.6	1.7	B	
- instruments, switches, etc.	0.04	0.0	C	0.5
- amalgam	1	1.1	C	
- other solid waste	?	-	-	
Sewage sludge	5.7	6.0	B	
Metal mercury of unknown origin[1]	?	-	A	21
Total	**30**	**32**		**22**
The cumulative total	**95**	**100**		**34**

[1] Metal mercury for recycling purposes from unspecified sources; such sources may include instruments, switches, stocks, etc.

[2] Uncertainty categories: A: based on actual facilities' reporting data — the uncertainty is associated with unaccounted losses; B: expert assessments — the most likely actual value lies within the range of ± 50% of the most accurate estimate; C: expert assessments — the actual value may substantially exceed the range of ± 50% of the most accurate estimate. About 5.6 t of mercury retained in bottom ash and fugitive ash from coal burning. A small share of coal ash is used for cement production, while the bulk of it is landfilled.

[29] Assessment of mercury releases into the environment from the territory of the Russian Federation, http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

Overall, at the time of the past assessment, wastes of non-ferrous smelters accumulated about 11 t of mercury. No information is available on mobility of mercury in wastes of mining facilities and its eventual releases into the environment. Results of some research studies suggest that mercury in tailings of coal washing plants is relatively mobile and may release into the ambient air.

The fate of mobilised mercury is not well known and mercury amounts in final production waste might be substantially higher. Preliminary estimates suggest the difference at the level of 75 t.

Amounts of mercury in solid municipal waste were estimated as minimum 24 t. Information on naturally occurring mercury levels (as a trace element) in all types of waste is almost completely lacking. Obsolete (broken) mercury thermometers seem to be the main source of mercury in solid municipal waste. Some part of mercury from these thermometers might be also released to sewers. Other sources of mercury in SMW include mercury-containing lamps, switches, batteries and dental amalgam. If we account for the fact that large amounts of mercury were used in early 2000s for production of cells/batteries, switches, instruments and other electric equipment, and might enter solid waste flows with such products, the latter estimate may be considered as too underestimated.

In 2001, Russian production facilities recycled mercury-containing waste and recovered about 30 t of secondary mercury. In general, production or secondary mercury varies from one year to another.

CHAPTER 3

RESULTS OF IMPLEMENTATION OF THE PILOT PROJECT ON THE DEVELOPMENT OF MERCURY INVENTORY IN THE RUSSIAN FEDERATION

THE RUSSIAN FEDERATION MERCURY RELEASES INVENTORY FOR 2012

In 2017, the Pilot Project on the Development of Mercury Inventory in the Russian Federation was completed. One of the key project objectives was associated with development of a detailed inventory of sources of mercury releases into the environment from the territory of the Russian Federation. The project sought to build capacity of relevant stakeholders of the Russian Federation for identification of sources of mercury-containing substances, quantitative measurements, analysis and monitoring of mercury releases into the environment. In addition, the project allowed for development of a list of priority actions to address mercury pollution problems in the framework of implementation of the global Minamata Convention on Mercury by the Russian Federation.

In the course of development of the mercury inventory in the Russian Federation, its developers collected and analysed information on mercury use in different industries, as well as information on mercury contents in raw materials and fuel. The national inventory of sources and amounts of mercury releases was conducted with application of **the Toolkit for Identification and Quantification of Mercury Releases**, recommended for use by UNEP Chemicals. The methodology was developed by Danish consultancy COWI A/S and revised with support of the AMAP Secretariat (the Arctic Monitoring and Assessment Program).

The methodology is based on the mass balance principle. All the mercury fed into the system with materials and fuels (e.g. in industry) will come out again, as releases to the environment.

The generalised formula used in the calculations is:

Estimated mercury release = activity rate x input factor x output distribution factor for pathway,

where:

mercury release means mercury releases to the environmental media under assessment or to products;

activity rate means amounts of raw materials used or products produced per unit of time;

mercury input factor means mercury contents per unit of raw materials processed or products produced;

output distribution factor means a share of mercury released to a given media.

The methodology offers two inventory levels: a simplified option and a detailed one. Manuals are provided for both levels with step-by-step inventory instructions. The Level 2 methodology allows for applying national output distribution factors for calculations. The Reference Report was developed for Level 2 inventories, with detailed descriptions of mercury pollution sources. To simplify the inventory process, electronic spreadsheets were developed for every inventory level with such source data as amounts of raw materials and fuel used, and amounts of products produced. Then, the software automatically provides quantitative assessments of mercury releases and its distribution between environmental media, relying on factors predetermined by the Toolkit developers.

ANNEX I to this publication contains methodological materials from the updated version of the UNEP Toolkit for Identification and Quantification of Mercury Sources (UNEP Toolkit) 2015, which was used for the Project implementation.

According to the methodology, mercury inventories are made for separate sectors.

Sector "Energy fuels, consumption and production" covers mining, burning and use of coal and other types of fuel.

Coal burning is subdivided into coal combustion in large power plants and other types of coal use, such as use of coal by coke and by-products plants and households.

Combustion of other types of fuel includes use of diesel oil, petrol, natural gas and fuel oil.

Sector "Primary metals production" covers extraction and production of metals from ores with mercury impurities, such as: zinc, copper, lead, gold, aluminium, nickel and iron.

Sector "Chemicals production" covers production of chemicals with application of mercury. The sector includes:

- chlor-alkali production with mercury-cells;
- vinyl chloride monomer (VCM) production with mercury catalyst;
- acetaldehyde production with mercury sulphate catalyst;
- production of other elements and polymers with application of mercury.

Sector "Production of other materials with mercury releases" covers mercury releases in production of cement and lime, and (in some cases) mercury-containing pesticides/biocides/fungicides in pulp and paper production.

Sector "Consumer goods with intentional mercury use" covers national consumption of a broad range of consumer goods (such as thermometers and fluorescent lamps), as well as products with mercury added to ensure their functionality (such as dental amalgam and manometers).

Sector "Waste treatment and recycling" covers all types of waste processing, burial, incineration. disposal, open fire burning and treatment.

Sector "Crematoria and cemeteries" covers mercury releases from the cremation and burial of human corpses.

The inventory of mercury releases was made for 2012 at Level 1 and Level 2 for various source categories.

Main sources of information included the following:

- official data of the Federal State Statistics Service;
- data of the state report on Status and Use of Mineral Resources of the Russian Federation, developed by "Mineral" Information and Analysis Centre;
- data of the technical report — Assessment of Mercury Environmental Pollution in the Russian Federation from the Cement Industry in the Framework of the UNEP-GEF Pilot Project on the Development of Mercury Inventory in the Russian Federation — developed in 2013 by "Giprotsement" JSC;
- data of the research report — Assessment of Mercury Environmental Pollution in the Russian Federation from the Heat and Power Complex in the Framework of the UNEP-GEF Pilot Project on the Development of Mercury Inventory in the Russian Federation — developed in 2013 by "VTI" JSC;
- data of the report — Data and Inventory on Total Mercury Use in Products, such as Metal Mercury and Mercury-containing Substance, on Mercury-containing Waste, on Mercury in Production of Primary and Secondary Non-ferrous Metals, on Mercury in Crematoria and Cemeteries, on Mercury in Fuels — developed in 2015 by "PUR" JSC;
- data of the report — Data and Inventory on Domestic Production of Metals and Raw Materials — developed in 2015 by "PUR" JSC;
- data of the research technical report — Survey of the Chlor-alkali Industry in the Russian Federation in Terms of its Contribution into Mercury Contamination of the Environment in the period from 2008 to 2012 — developed in 2014 by "RusKhlor" Association;
- data of the report — Vinyl Chloride Production in the Russian Federation in Terms of its Contribution into Mercury Contamination of the Environment in the period from 2008 to 2012 — developed in 2014 by "Sintez" JSC;
- data of the research technical report — Assessment of Mercury Environmental Pollution in the Russian Federation from the Pulp and Paper Industry in the Framework of the UNEP-GEF Pilot Project on the Development of Mercury Inventory in the Russian Federation — developed in 2014 by the St. Petersburg Technological University of Plant Polymers.

According to 2012 inventory data, different sources in the Russian Federation released 1.5 thousand tons of mercury into the environment, including 91.8 t into the ambient air, 27.6 t to water bodies, 747.36 t to soils, 230.3 t into by-products and impurities and 402.3 t into wastes (see Table 3.1).

Table 3.1

Summary table of mercury releases into the environment in the Russian Federation, 2012 г

Source categories	Estimated mercury releases kg/year							Percent of the total release
	Air	Water	Soil	By-products and impurities	General waste	Sector specific waste treatment /disposal	Total releases by source categories	
5.1: Energy fuels, consumption and production	28 590.5	801.1	-	1 106.6	-	8 251.7	38 750	3%
5.2: Primary metals production	46 219.8	18 637.0	731 507.0	224 488.3	260 245.6	52 919.6	1 334 017	89%
5.3: Production of other materials with mercury releases[1]	4 788.8	-	-	1 372.5	74.6	1 372.5	7 608	0.5%
5.4: Production of chemicals with mercury use	4 098.0	521.3	397.4	2 628.2	-	38 292.5	45 937	3%
5.5: Consumer goods with intentional mercury use[2]	4 774.5	4 945.4	10 979.5	-	20 856.8	8 186.4	49 743	3%
5.6: Other intentional use in products / processes[3]	93.1	2 633.9	43.0	665.1	5 444.7	5 146.1	14 026	1%
5.7: Production of recycled metals	72.8	87.3	-	-	-	4.4	164	0.01%
5.8: Waste incineration and burning	2048	-	-	-	-	1452	3500	0.23%
5.9: Waste disposal/tailings and wastewater treatment	758	43	3.5	-	16.9	11.3	889	0.05%
5.10: Crematoria and cemeteries	334.9	-	4 430.9	-	-	-	4 766	0.3%
TOTAL[4, 5]	**91 778**	**27 641**	**747 358**	**230 261**	**286 639**	**115 636**	**1 499 313**	**100%**

1 — Production of cement, lime, pulp and paper and light-weight aggregate.

2 — Production of mercury thermometers, mercury-containing light sources and batteries.

3 — Dental amalgam, manometers and sensors, laboratory chemical equipment and other types of product use.

4 — The estimate includes mercury in products that was also accounted for in every product category. In order to avoid double accounting, discharges to soils due to unauthorised disposal of general waste were automatically deducted from the TOTAL.

5 — Estimated input factor and discharges to water include mercury that was accounted for in every product category. In order to avoid double accounting, discharges to water from sewers/WWTFs were automatically deducted from the TOTAL.

According to the report *Assessment of mercury releases into the environment from the territory of the Russian Federation*, produced in 2005 under the Arctic Council Plan to Address the Arctic Pollution (ACAP), in the territory of Russia, 1.1 million tons of mercury-containing waste were accumulated. It is worth noting that 58% of the overall amount of these wastes contain 10-30 mg/kg of mercury, about 12% contain from 100 to 5000 mg/kg of mercury, and 30% contain over 5000 mg/kg of mercury. Amounts of mercury in on-site soils and tailings of industrial facilities are estimated at the level of 3000 tons, while waste rock, ore clarification tailings and tailing ponds of gold mining facilities accumulated up to 6000 tons of mercury, posing a real threat to the national security of Russia. According to published information, annual releases of mercury to soils from waste storage facilities of chlor-alkali plants reach up to 50 tons. Annual mercury emissions of waste incinerators reach up to 3.5 tons.

According to assessments, primary metals production is the main source of mercury releases into the environment — 89% of the total. Aside from that, such categories as energy fuels production and consumption, use of mercury in industrial processes, and consumer goods with intentional mercury use each add 3% of mercury releases. Contributions of other sources do not exceed 1%.

Primary metals production plays a decisive role in mercury releases to soils (98%) and releases to by-products (98%). Contributions of each of the other sources for these media do not exceed 1.5%.

50% of mercury emissions to ambient air are associated with primary metals production, while 31% are associated with energy fuels production and consumption. Contributions of other sources do not exceed 5% (see Figure 3.1).

Primary metals production is the main source of mercury discharges to water bodies (68%). Production of consumer goods (mercury thermometers, mercury-containing lamps and batteries) is accompanied by discharges of 18% of mercury to water. Application of laboratory chemical equipment, manometers, etc. add 9% of mercury discharges; energy fuels production and consumption add 3% of mercury discharges; while production of chemicals (chlor-alkali and VCM production) adds 2% (see Figure 3.2).

78% of mercury content in wastes is associated with primary metals production, followed by chemicals production (10%), production of consumer goods (7%), by — use of products (3%) and by — energy fuels production and consumption (2%) (see Figure 3.3).

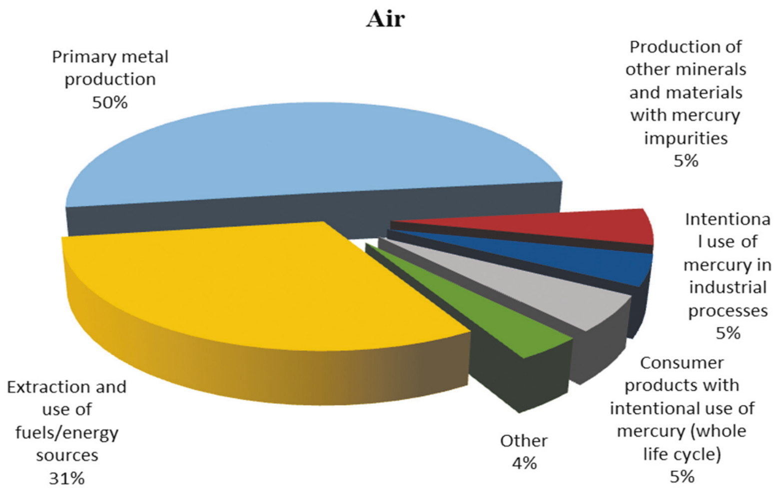

Figure 3.1. Shares of specific source categories in mercury releases into ambient air in 2012, %

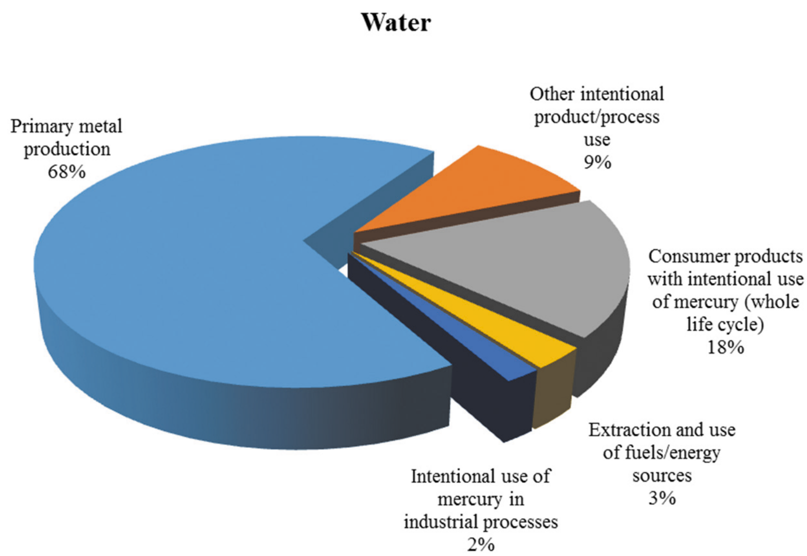

Figure 3.2. Shares of specific source categories in mercury releases into water bodies in 2012, %

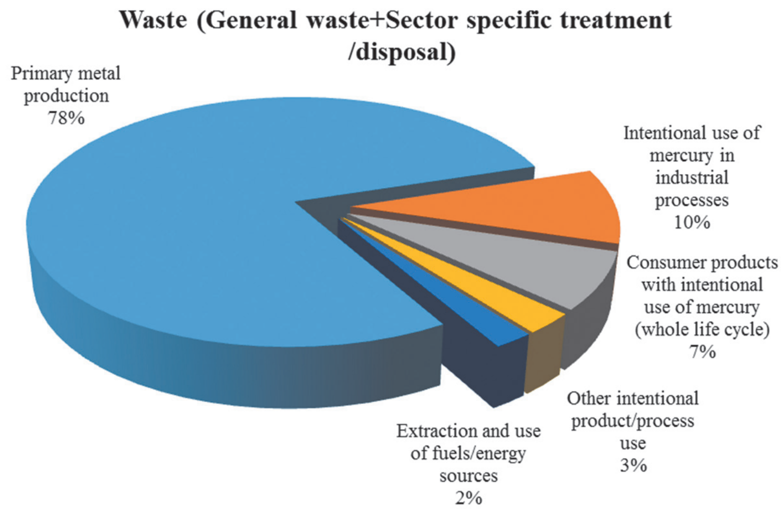

Figure 3.3. Shares of specific source categories in mercury releases into wastes in 2012,%

MERCURY RELEASES FROM PRIMARY METALS PRODUCTION

Under this category, the following source sub-categories are considered:

- Mercury (primary) extraction and initial processing;
- Gold (and silver) extraction with mercury amalgamation process;
- Zinc extraction and initial processing;
- Copper extraction and initial processing;
- Lead extraction and initial processing;
- Gold extraction by methods other than mercury amalgamation;
- Aluminium extraction and initial processing;
- Other non-ferrous metals — mining and processing (nickel);
- Primary iron production.

The mercury inventory for all source sub-categories (except sub-category "Aluminium extraction and initial processing") was made at Level 2.

Mercury inventory data for primary metals production (by separate sub-categories) are shown in Table 3.2.

Table 3.2

Mercury releases into the environment in primary metals production, kg

Source sub-categories	Air	Water	Soil	By-products and impurities	General waste	Sector specific waste treatment /disposal
Mercury (primary) extraction and initial processing	-	-	-	-	-	-
Gold (and silver) extraction with mercury amalgamation process	-	-	-	-	-	-
Zinc extraction and initial processing	8471.2	1694.2	0.0	93257.0	11068.1	38967.6
Copper extraction and initial processing	2991.9	598.4	0.0	70234.7	147558.1	13762.7
Lead extraction and initial processing	0.0	0.0	0.0	202.0	28651.6	0.0
Gold extraction by methods other than mercury amalgamation	32511	16256	731507	32511	0.0	0.0
Aluminium extraction and initial processing	133.1	88.7	0.0	0.0	576.6	88.7
Other non-ferrous metals — mining and processing (nickel)	201.5	0.0	0.0	0.0	22.4	0.0
Primary iron production	1910.7	0.0	0.0	0.0	0.0	100.6

Shares of different source sub-categories are shown at Fig. 3.4.

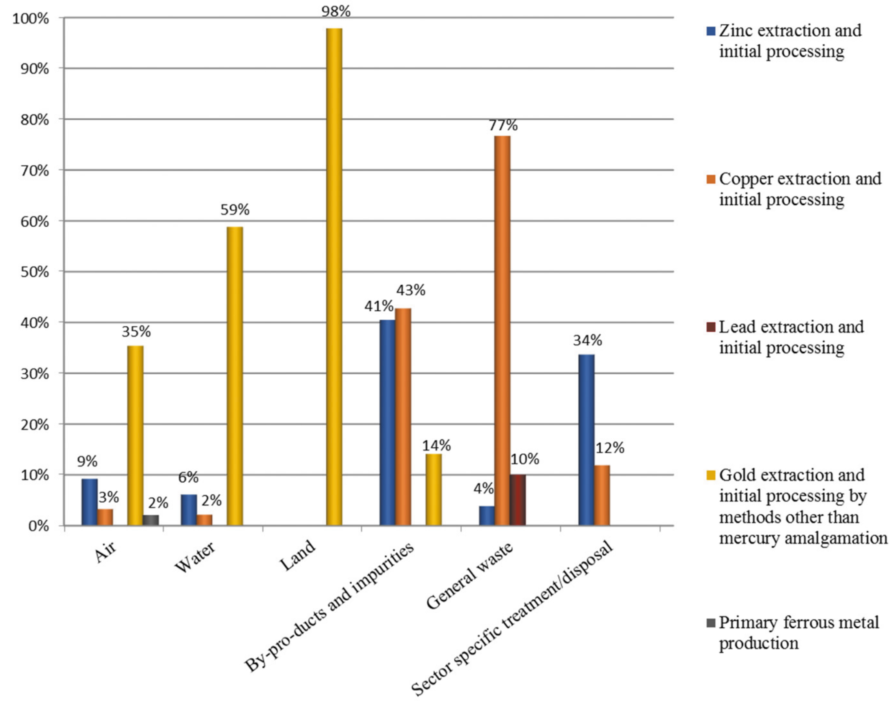

Figure 3.4. Shares of different mercury source sub-categories in primary metals production, 2012,%

As Fig. 3.4 shows, sub-category "Gold extraction by methods other than mercury amalgamation" is the only source of mercury releases to soils — 98% of the overall amount of mercury releases to soils. The sub-category is also a major contributor to mercury releases to air (35%) and water (59%).

Sub-category "Copper extraction and initial processing" is the main one for generation of general waste — 77%.

Sub-category "Zinc extraction and initial processing" is a major contributor to sector — specific waste treatment/disposal (34%) and by — products and impurities (41%).

Production of aluminium, lead, nickel and primary iron practically do not influence mercury releases into the environment substantially.

See below more detailed information on mercury inventory results for separate source sub-categories.

(Primary) mercury extraction and initial processing

In Russia, small-scale mercury extraction was maintained in Zabaikalie region (1759–1853) at Ildikanskoye deposit. After discovery of Nikitovskoye deposit in Donbass in 1879, systematic mercury extraction started there in 1886. Notwithstanding predominantly manual labour, substantial amounts of mercury were extracted: production of mercury peaked in 1897 (615 tons of mercury). Later on, due to exhaustion of rich upper ore layers at the deposit, mercury extraction levels decreased sharply.

After the October Revolution in 1917, mercury extraction at Nikitovskoye deposit was relaunched. Further development of the mercury industry relied on more rational use of raw materials, introduction of progressive equipment and technologies, and improvement of labour conditions. Improved technologies were applied for processing of raw and depleted ores. Pneumatic tools and water-flush drilling were introduced, as well as more efficient ore mining technologies with ore stopping, scraping and underground railway ore transportation. Up to 1941, Nikitovskiy Mercury Plant remained the only mercury supplier for the national economy. In the course of the Great Patriotic War (1941-45), equipment of Mikitovskiy Mercury Plant was evacuated to Central Asia (Khaidaranskiy mercury and antimony deposit), and by late 1941, the plant restarted its operations. At that time, several small deposits were used in Central Asia (Chauvaiskoye, Symapskoye, Birskuiskoye, etc.), in the Mountainous Altai (Aktashskoye) and in the Northern Caucasus, etc. Expansion of production capacity was accompanied by introduction of new processes for clarification of polymetallic ores and development of a radically new vacuum technology for mercury extraction. In parallel to large, energy-efficient tubular rotary kilns, small retort ovens were also broadly used. After liberation of Donbass in 1943, mercury extraction at Nikitovskoye deposit was renewed.

Now, in the majority of known Russian mercury deposits, mercury levels in ores are rather low (substantially lower than 1%). Due to this, mining of mercury ores in Russia was cancelled in 1992, while production of primary mercury ceased in 1995. All current mercury production in Russia is associated with secondary mercury recovery.

Gold (and silver) extraction with mercury amalgamation process

Industrial gold extraction started in 1745. The first gold mining site was discovered by peasant Erofei Markov, who reported its location (later known as Berezovskoye deposit). Now, 16 Russian companies operate in the sphere of gold production. "Polyus Zoloto" company is the leading gold producer with its 1/5 extraction market share. Artisanal gold miners predominantly operate in Magadanskaya, Irkutskaya and Amurskaya oblasts, at Chukotka, in Krasnoyarskiy Krai and Khabarovskiy Krai. Russia is rated the fourth global gold producer with its 7% global share.

Now, mercury amalgamation process in gold extraction is applied only by artisanal miners. In the Russian Federation, artisanal gold mining is illegal. It is prohibited to extract gold without agreement with duly licensed gold mining companies. Illegal extraction of precious metals and gemstones entails criminal sanctions. Illegal gold mining operations are criminalised by Art. 191 of the RF Criminal Code (illegal trafficking of metals, natural gemstones or pearls) that stipulates sanctions of up to 3 years of restriction of liberty. In the case of aggravating circumstances — such as gold extraction by a group of persons — sanctions may be tighter (a monetary fine from RUR 1 to 3 million or up to 7 years of imprisonment).

So, official gold extraction with mercury amalgamation process does not exist in Russia now. However, it is worth noting that artisanal and small-scale gold mining (ASGM) with application of amalgamation process may be a substantial source of mercury releases to the environment. It is necessary to account for the fact that ASGM is not a prohibited activity under the Minamata Convention — therefore, it is important for Russia to take proactive measures for prevention of mercury application in ASGM.

Mercury releases into the environment due to ASGM may be monitored by sampling bio-markers (e.g. human hair, urine, blood and nails) and food products (e.g. fish and rice), to demonstrate that mercury from ASGM enters local food chains and affects human health. WHO standards for safe mercury levels in bio-markers are broadly applied as reference levels.

Later on, such information may be used to demonstrate existence of substantial levels of ASGM to governmental authorities if they have not recognised it yet[30].

Zinc extraction and initial processing

In sub-category "Zinc extraction and initial processing", mercury releases into the environment are assessed in ore clarification processes and production of zinc concentrates, as well as in the course of production of refined metal. See Fig. 3.5 for information on mining, production of ores, concentrates and metal zinc, as well as information on export and import in 2012.

[30] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

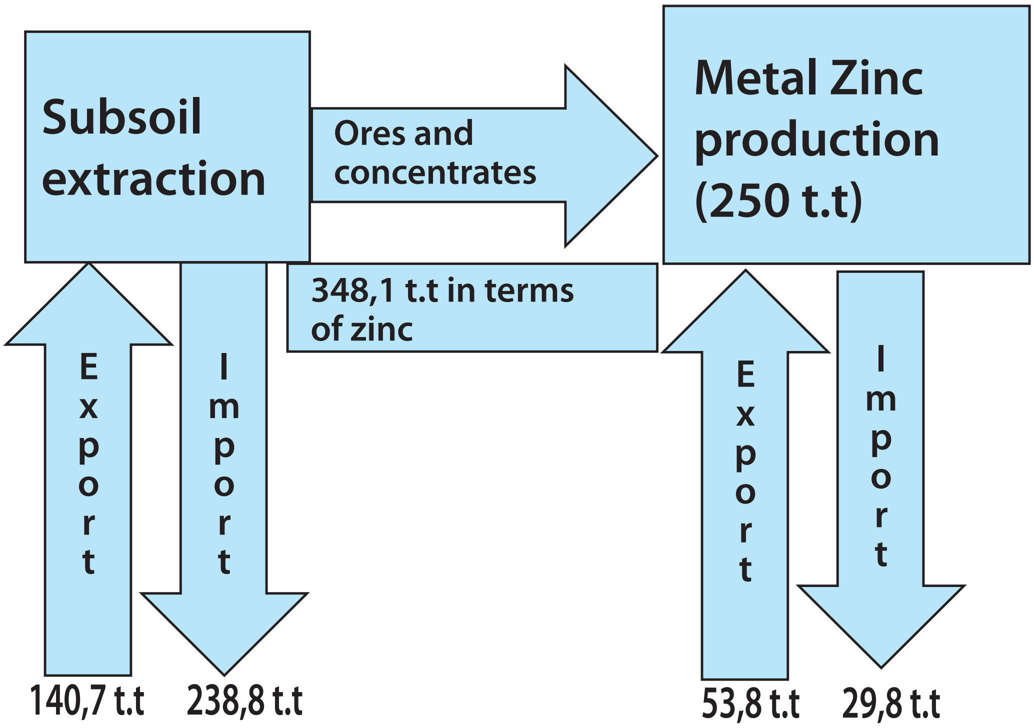

Figure 3.5. Information on mining, production of ores, concentrates and metal zinc, as well as information on export and import in 2012.

In 2012, main producers of primary zinc included:

- Uchalinskiy MPP JSC — 151.8 thousand tons (44%),
- facilities of "UGMK" Holding — 110.6 thousand tons (32%),
- Gorevskiy MPP — 25.8 thousand tons (7%),
- facilities of "RMK" JSC — 22.16 thousand tons (6%),
- "Dalpolimetal GMK" JSC — 19.7 thousand tons (5%).

For purposes of mercury inventory, only Uchalinskiy MPP JSC and "Dalpolimetal GMK" JSC were considered, as in their case zinc is the main component in the ores extracted. Overall, in 2012, these companies extracted slightly over 7014.9 thousand tons of ores, including 6319 thousand tons by Uchalinskiy MPP JSC and 695.9 thousand tons by "Dalpolimetal GMK" JSC. Mercury levels in ores of Uchalinskiy MPP JSC reach 9.8 g/t. Information of mercury levels in ores of "Dalpolimetal GMK" JSC is not available. As Uchalinskiy MPP JSC extracts 90% of ore, in the course of inventory estimates mercury levels in ores of the latter company were used.

Overall, **in the course of ore extraction and clarification, 68.75 tons of mercury were released by the above producers into the environment**. In the course of ore clarification operations, some part of mercury (83.9%) goes to zinc concentrates, while another part (16.1%) remains in tailings of the clarification process.

Chelyabinsk Zinc Plant JSC was the largest producer of refined zinc in Russia in 2012 (160 thousand tons of metal zinc and zinc alloys or 64% of the total zinc production), followed by "Elektrozink" JSC with 90 thousand tons or 36%. These plants operate smelting units with wet scrubbers and produce sulphuric acid.

The above plants used 456.2 thousand tons of zinc concentrates for production of metal zinc. Mercury contents in the concentrates varied from 10 to 430 g/t. In the course of inventory estimates, the average mercury level was used (185.7 g of mercury /t of concentrate). Overall, in the course of processing of the zinc concentrates, mercury releases into the environment reached 84.7 tons of mercury. See distribution of the releases by environmental media in Table 3.3.

Table 3.3

Mercury releases into different media in the course of processing of zinc concentrates

Total mercury releases, tons	Mercury releases into different media — t Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector specific waste treatment /disposal
84.71	8.47	1.69	0.00	35.58	0.00	38.97

Therefore, **overall releases of mercury into the environment from ore extraction, clarification and zinc concentrate processing reached 153.46 tons** (68.75 t + 84.71 t).

Copper extraction and initial processing

In the sub-category "Copper extraction and initial processing", mercury releases into the environment are assessed in ore clarification processes and production of copper concentrates, as well as in the course of production of refined metal. Overall, in 2012, in Russia primary copper extraction reached 580.98 thousand tons (in terms of copper).

See Fig. 3.6 for information on mining, production of ores, concentrates and metal copper, as well as information on export and import.

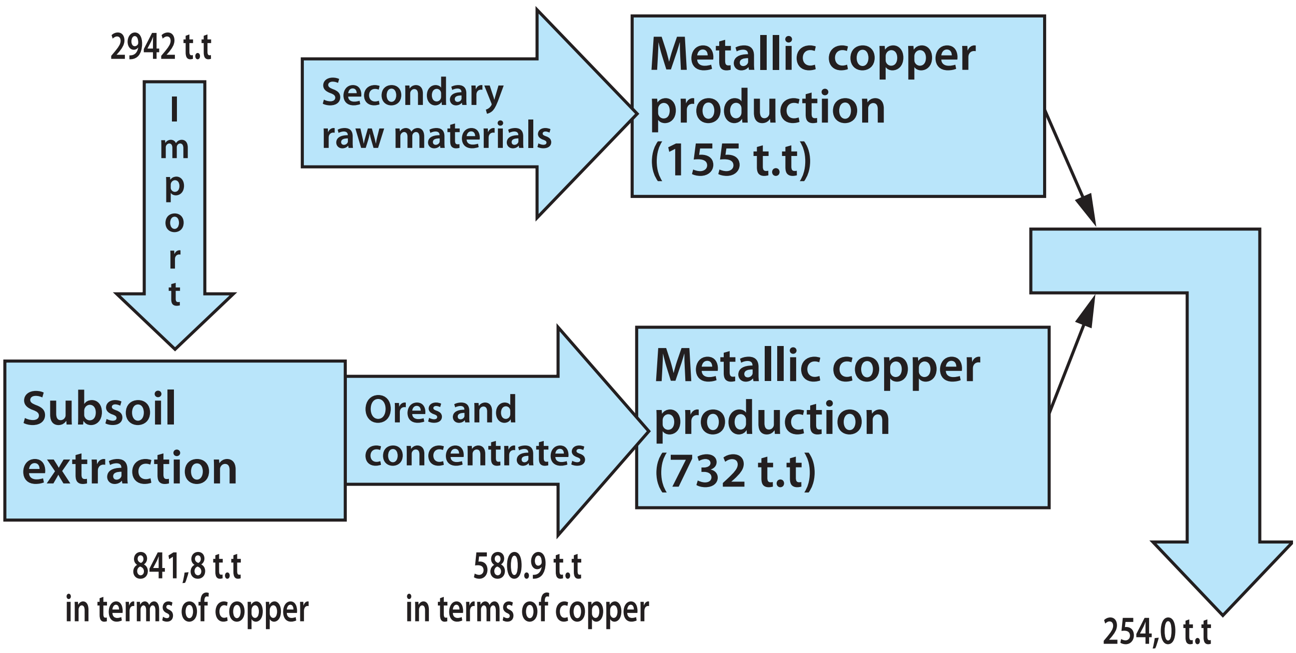

Figure 3.6. Information on mining, production of ores, concentrates and metal copper, as well as information on export and import in 2012.

From all facilities that extract ores and produce copper concentrates, mercury levels were estimated for plants with copper as the prevailing component in their ores (see Table 3.4). Overall, the plants in the Table extracted 50.525 million tons of ores with mercury contents of 305.87 tons.

In the course of inventory estimates, the average mercury level in ores was applied — 305.87 tons / 50.525 million tons of ores = 6.054 g/t. In the course of ore clarification operations, mercury from ores (305.87 t), is distributed as follows: 28.1% go to concentrates, while the rest (71.9%) is retained in waste.

Production of refined copper in 2012 reached 887.4 thousand tons, including about 732.4 thousand tons from ores and concentrates and about 155 thousand tons from secondary raw materials. Plants of three companies produce all refined copper in Russia: "Urals Mining and Metalurgy Co."

(“Uralelektromed” Plant in Sverdlovskaya oblast), “Norilsk Nickel MMC” JSC” (including its transpolar branch in Norilsk and “Severonikel” Plant in Murmanskaya oblast) and “Russian Copper Company” JSC (Kyshtym copper electrolysis plant in Chelyabinskaya oblast, Novgorod Metallurgy Plant and “Uralgidromed” Integrated Plant in Sverdlovskaya oblast).

Table 3.4

Producers of copper ores and copper concentrates

<table>
<tr><th>Facilities</th><th>Ore production, th. tons</th><th>Mercury content, g/t</th><th>Mercury in ores produced, tons</th><th>Mercury transition to concentrates</th><th>Production of concentrates, th. tons</th><th>Mercury contents in concentrates, g/t</th><th>Total mercury in concentrates, tons</th></tr>
<tr><td>«Gaiskiy MPP» JSC</td><td>7437.4</td><td>13</td><td>96.68</td><td>no data</td><td>450</td><td>2.2</td><td>0.989</td></tr>
<tr><td>«Aleksandrinskaya Mining Company» JSC</td><td>221</td><td>11.5</td><td>2.54</td><td rowspan="10">no data</td><td rowspan="10">1278</td><td rowspan="10">13.8</td><td rowspan="10">17.638</td></tr>
<tr><td>«Verkhneuralskaya Ruda» JSC</td><td>336</td><td>11.5</td><td>4.62</td></tr>
<tr><td>«Gaiskiy MPP» JSC</td><td>7437</td><td>13</td><td>96.68</td></tr>
<tr><td>«Svyatogor» JSC (including «Shemur» JSC)</td><td>2490.1</td><td>11.5</td><td>28.63</td></tr>
<tr><td>«Uralelektromed» JSC (including «Safyanovskaya Med» JSC)</td><td>1210</td><td>14</td><td>16.94</td></tr>
<tr><td>«Sibir-Polymetally» JSC</td><td>713.7</td><td>no data</td><td>no data</td></tr>
<tr><td>«Urupskiy MPP» JSC</td><td>408</td><td>8.95</td><td>3.56</td></tr>
<tr><td>«Buribaevskiy MPP» JSC</td><td>223.5</td><td>11.5</td><td>2.57</td></tr>
<tr><td>«Bashkirskaya Med» JSC</td><td>1429.1</td><td>11.5</td><td>16.43</td></tr>
<tr><td>«Sredneuralskiy Copper Smelter» JSC</td><td>1077.3</td><td>2</td><td>2.15</td></tr>
<tr><td>«Aktyubinskaya Copper Company» JSC</td><td>2942</td><td>1.4</td><td>3.97</td><td>12%</td><td>information is not required</td><td>information is not required</td><td>0.477</td></tr>
<tr><td>Transpolar branch of «Norilsk Nickel MMP» JSC</td><td>16700</td><td>1.18</td><td>19.70</td><td>30%</td><td>information is not required</td><td>information is not required</td><td>5.910</td></tr>
<tr><td>«Kolskaya MMP» JSC</td><td>7900</td><td>1.41</td><td>11.40</td><td>15%</td><td>not required</td><td>not required</td><td>1.671</td></tr>
<tr><td>Total:</td><td>50525.1</td><td></td><td>305.87</td><td></td><td></td><td></td><td>26.208</td></tr>
</table>

In 2012, the companies listed above processed 3 million tons of concentrates (including imported ones), with mercury contents from 2.2 to 13.8 g/ton. All these plants operate smelting units with wet scrubbers and produce sulphuric acid.

In the course of inventory estimates, the average mercury level was used (9.55 g of mercury /t of concentrate). **Overall, in the course of processing of copper concentrates** (including imported concentrates), **mercury releases into the environment reached 29.92 tons**. See distribution of the releases by environmental media in Table 3.5.

Table 3.5

Mercury releases into different media in the course of processing of copper concentrates

Total mercury releases, tons	Mercury releases into different media — t Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector — specific waste treatment /disposal
29.920	2 .992	0.598	0.00	12.566	0.00	13.763

Overall, under sub-category «Copper extraction and initial processing» **releases of mercury into the environment from ore extraction, clarification and copper concentrates processing reached 335.8 t** (305.87 t +29.92 t).

Lead extraction and initial processing

In Russia, all metal lead and lead alloys are produced from secondary raw materials. With this in mind, mercury releases were estimated only for ore clarification and production of concentrates that are completely exported. In 2012, 194.6 thousand tons of ores were extracted (in terms of lead — see Fig. 3.7).

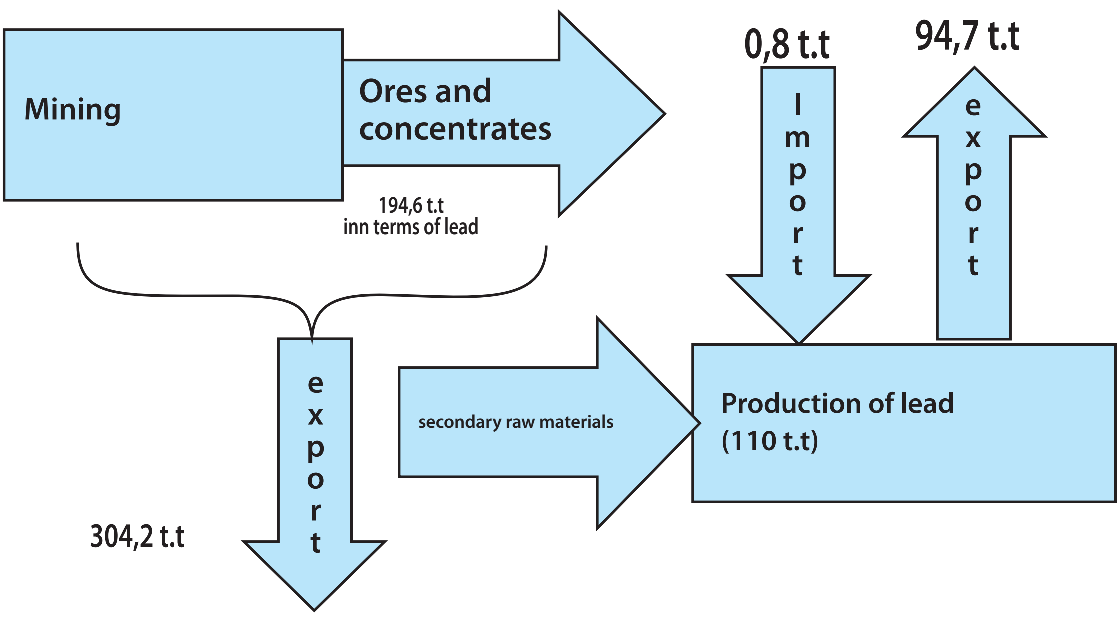

Figure 3.7. Information on mining, production of ores, concentrates and metal lead, as well as information on export and import in 2012.

Of the four largest Russian companies that extract lead-containing ores, only two companies extract ores with lead as the prevailing ore component: "Gorevskiy MPP" JSC (2.382 million tons) and "Novoshirokinskiy Mine" JSC (0.489 million tons). Information on mercury levels in ores is available only for "Gorevskiy MPP" JSC — 10.05 g/t. "Gorevskiy MPP" JSC extracts 83% of all ores, so its mercury levels in ores were used for estimation of mercury releases. Overall, these companies extracted 2.87 million tons of ores. Therefore, under this subcategory, 28.8 t of mercury were released to the environment.

In the course of ore clarification process, mercury is distributed between two categories: some of its part goes to concentrates (0.01%) and the rest (99.99%) is retained in waste.

Gold extraction by methods other than mercury amalgamation and initial processing

In 2012, primary gold extraction (including placers and ores) reached 199.8 t, while extraction of gold as a by-product in the course of processing polymetallic deposits reached 17.5 t. The ratio of gold from placers to gold from ores remains stable at the level of previous years: production of gold from placers is about three times lower. From the overall Russian gold production in 2012 (217.3 t), 92% was produced by 13 regions (see Table 3.6), at the Urals and in Siberia.

Table 3.6

Gold extraction in Russian regions in 2012

Ranking in 2012	Regions	2012
1	Krasnoyarskiy Krai	43.9
2	Amurskaya oblast	29.1
3	Sakha Republic (Yakutia)	20.9
4	Magadanskaya oblast	20.7
5	Irkutskaya oblast	18.9
6	Khabarovskiy Krai	18.1
7	Chukotka Autonomous District	18.0
8	Sverdlovskaya oblast	7.6
9	Zabaikalskiy Krai	8.3
10	Buryatia Republic	6.0
11	Chelyabinskaya oblast	5.0
12	Kamchatskiy Krai	2.5
13	Tyva Republic	1.7
TOTAL		200.7

Krasnoyarskiy Krai was the largest gold producer in 2012 (43.9 t of gold). A large part of the gold was extracted at Olimpiadninskiy deposit («ZDK Polyus» JSC). Amurskaya oblast was the second largest producer in 2012 (almost 30 tons, including more than 22 t of gold from ores). Leading gold producers in Amurskaya oblast include facilities of «Petropavlovsk» mining company (see Table 3.7). Sakha Republic (Yakutia) is rated third in the Russian rating of gold producers. Large companies operate many facilities and mines, often in different regions of the country. Table 3.7 contains information on gold extraction and gold contents in sands/ores at main sites of the largest gold mining companies.

Table 3.7

Gold extraction at main sites of the largest gold mining companies in 2012

Companies and mining sites	Gold extraction, t	Gold contents in ores (g/t) and sands	Amounts of ores processed (thousand tons)
1. *ZDK Polyus» JSC: total and by sites:*	48.8		
- Olimpiada, Krasnoyarskiy Krai	20.3	4.1	4951
- Blagodatnoye, Krasnoyarskiy Krai	12.5	2.4	5208
- Titimukhta, Krasnoyarskiy Krai	3.6	3.3	1091
- Kuranakh mine, Yakutia	4.3	2	2150
- Verninskoye, Irkutskaya oblast	1.3	3.1	419
- placers, Irkutskaya oblast, Lenzoloto JSC	6.7	n.a.	
2. *«Petropavlovsk» MC, total and by sites:*	22.1		
- Pioner, Amurskaya oblast	10.4	1.8	5778
- Malomyrskoye, Amurskaya oblast	3.2	2.4	1333
- Pokrovskoye, Amurskaya oblast	2.9	4.5	644
- Albyn, Amurskaya oblast	2.8	n.a.	
- placers, Amurskaya oblast	2.9	4.5	644
3. *«Polymetall» JSC: total and by sites*	15.2		
- Vorontsovskoye, Sverdlovskaya oblast	5.0	11.6	431
- Albazino, Khabarovskiy Krai	2.0	6.9	290
- Khakandzinskoye, Khabarovskiy Krai	2.8	9.8	286
- Birkachan, Oroch, Sopka Kvartsevaya, etc.	4.0	n.a.	
- auxiliary mining, Magadanskaya oblast	1.4	n.a.	
4. *«Chukotskaya» MC JSC, total and by sites*	14.3		
- Kupol, Chukotka AD	14.3	18.8	761
5. *Nord Gold NV, total and by sites*	10.1		
- Zun-Kholbinskoye, Altaiskiy Krai	2	11.5	174
- Irokindinskoye, Altaiskiy Krai	1.5	2.9	517
- Berezitovoye, Amurskaya oblast	5.4	4.2	1286
- Pogromnoye, Chitinskaya oblast	0.8	1.35	593
- Tabornoye, Sakha Republic (Yakutia)	0.4	1.02	392
6. *«Russdragmet» JSC, total and by sites*	6.7		
- Mnogovershinnoye, Khabarovskiy Krai	5	20.7	242
7. *«Yuzhuralzoloto» JSC, total and by sites*	6.4		
- Svetlinskoye, Chelyabinskaya oblast	5.4	3.1	1742
- Kochkarskoye, Chelyabinskaya oblast	1.0	11.6	86

Gold mining in Russia is unique both in terms of gold extraction from placers and sizes of associated facilities. The largest facilities extract up to 2 tons of gold from placers. Among the largest gold producers from placers, «Solovievskiy Mine» JSC dominates (2.5 t) (see Table 3.8).

Table 3.8

Largest Russian producers of gold from placers (2012)

Regions and producers	Production, t
Magadanskaya oblast	13.1
- Drazhnik JSC (Susumanzoloto JSC)	1.4
- Mayskaya JSC	1.2
Irkurskaya oblast	12.0
- Vitim JSC	2.2
- Svetliy JSC (Lenzoloto JSC)	2.0
- Lenzoloto ZDK (Lenzoloto JSC)	1.7
- Lensib JSC (Lenzoloto JSC)	1.0
Sahka Republic (Yakutia)	10.2
- Yantar JSC	1.2
Amurskaya oblast	6.6
- Solovievskiy mine, JSC	2.5
Zabaikalskiy Krai	5.3
Chukotka AD	2.0
Tyva Republic	1.3
- Oina	1.2
Buryatia Republic	1.2

Some companies that produce gold from ores maintain facilities that extract gold from placers as well. In particular, «Polus Zolota» JSC incorporates «Lenzoloto» JSC with subordinate companies that produced 6.7 tons of gold from placers in 2012 (see Table 3.7).

Source data for assessment of mercury releases into the environment include amounts of ores processed. In order to avoid double count in mercury releases inventory, in this category only primary gold was accounted for — 199.8 t.

In order to assess amounts of the ores processed to produce 199.8 t of gold, it is necessary to know gold contents in the ores. According to data of Table 3.7, 107 tons of gold were produced from 29018.37 thousand tons of gold ores. Extrapolation gives the overall amount of processed ores at the level of 54185.7 thousand tons.

According to estimates, in the course of gold mining, 812.8 tons of mercury were released into the environment and by-products. See distribution by environmental media in Table 3.10.

Table 3.10

Mercury releases into different media in the course of gold mining

Total mercury releases, tons	Mercury releases into different media — t Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
812.785	32.511	16.256	731.507	32.511	0.00	0.00

Aluminium extraction and initial processing

Inventory of mercury releases under category "Aluminium extraction and initial processing" (by Level 2 methodology) accounted for aluminium production from bauxites and from alumina. As mercury levels in alumina in Russia were not studied, Level 1 methodology was used for the latter category (assuming that mercury releases were associated only with aluminium production from bauxites).

In addition to bauxites, rich nephelinite ores are also used as production inputs for aluminium production in Russia; urtites that are not used for aluminium production in other countries. In 2012, production of alumina from bauxites reached 1774 thousand tons, while its production from nephelinite ores reached 945 thousand tons.

According to estimates (with application of Level 1 of UNEP methodology), **production of aluminium resulted in releases of 0.9 t of mercury**. See mercury distribution by environmental media in Table 3.11.

Table 3.11

Mercury releases into different media in the course of aluminium production

Total mercury releases, kg	Mercury releases into different media — kg Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
887	133.1	88.7	0.0	0.0	576.6	88.7

Other non-ferrous metals — mining and processing (nickel)

Source data for assessment of mercury releases into the environment under category “Other non-ferrous metals — mining and processing (nickel) ” include amounts of ores processed for production of the metal. In 2012, primary extraction of ores reached 348.5 thousand tons (in terms of metal), while nickel production reached 254.1 thousand tons (see Fig. 3.8).

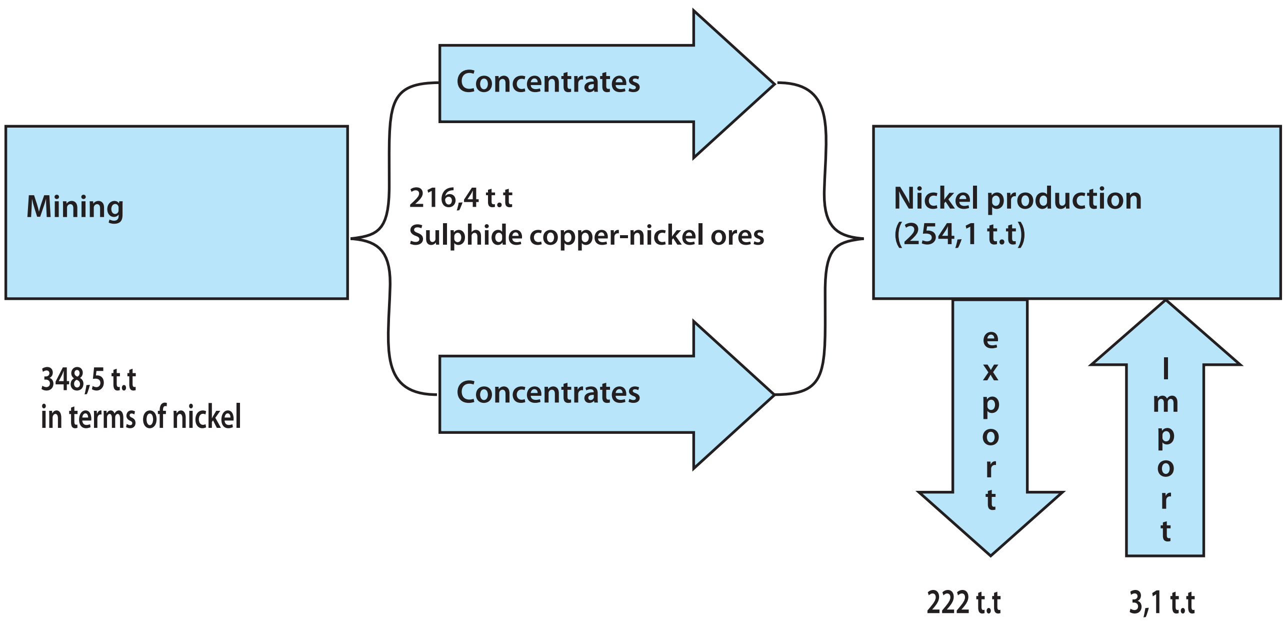

Figure 3.8. Information on mining, production of ores, concentrates and metal nickel, as well as information on export and import in 2012.

“Norilsk Nickel” is the largest producer of nickel from ores (233.6 thousand tons). Mercury inventory estimates for the company were listed under category “Copper extraction” and they fully cover mercury in nickel. Under the same category, nickel production of “Uralelektromed” JSC was also accounted for (0.954 thousand tons).

Therefore, the overall nickel production for purposes of accounting under the category (except for the above — listed producers) reached was: 254.1–233.6–0.954 = 19.546 thousand tons.

Among the remaining nickel producers, the three largest ones are listed in Table 3.12 below (with relevant production data).

Table 3.12

Metal nickel producers in 2012

Producers	Nickel production, thousand tons	Ores processed, thousand tons	Mercury contents in the ores, kg
«Rezhnikel» PA	0.299	33.407	3
«Ufaleinikel» JSC	7.107	896.328	80
«Yuzhuralnukel» JSC	9.779	1257.505	113
TOTAL	**17.185**	**2187.24**	**196**

According to estimates, **in the course of nickel production, 0.22 t of mercury were released into the environment**. See distribution of mercury by environmental media in Table 3.13.

Table 3.13

Mercury releases into different media in the course of nickel production

Total mercury releases, kg	Mercury releases into different media — kg Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
223.86	201.47	0.00	0.00	0.00	22.39	0.00

Production of primary iron

In the sub-category of "Production of primary iron" are mercury releases in the course of pig iron production. According to the RF Statistics Service, pig iron production in 2012 reached 50.5 million tons. According to data of ACAP "Assessment of mercury releases into the environment from the territory of the Russian Federation", mercury contents in production inputs for blast-furnace process reach 0.03986 g/t of the pig iron produced.

According to estimates, **in the course of pig iron production, a little bit over 2 tons of mercury were released into the environment**. See distribution of mercury by environmental media in Table 3.14.

Table 3.14

Mercury releases into different media in the course of pig iron production

Total mercury releases, kg	Mercury releases into different media — kg Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
2011.29	1910.73	0.00	0.00	0.00	0.00	100.56

Mercury releases in connection with energy fuels, consumption and production

In this category, the following processes are considered:

- Coal combustion in large power plants;
- Other types of coal use;
- Petroleum-based fuels — extraction, refining and use;
- Extraction, processing and use of natural gas;
- Other fossil fuels — extraction and use;
- Biomass-fuelled power plants and heat generation;

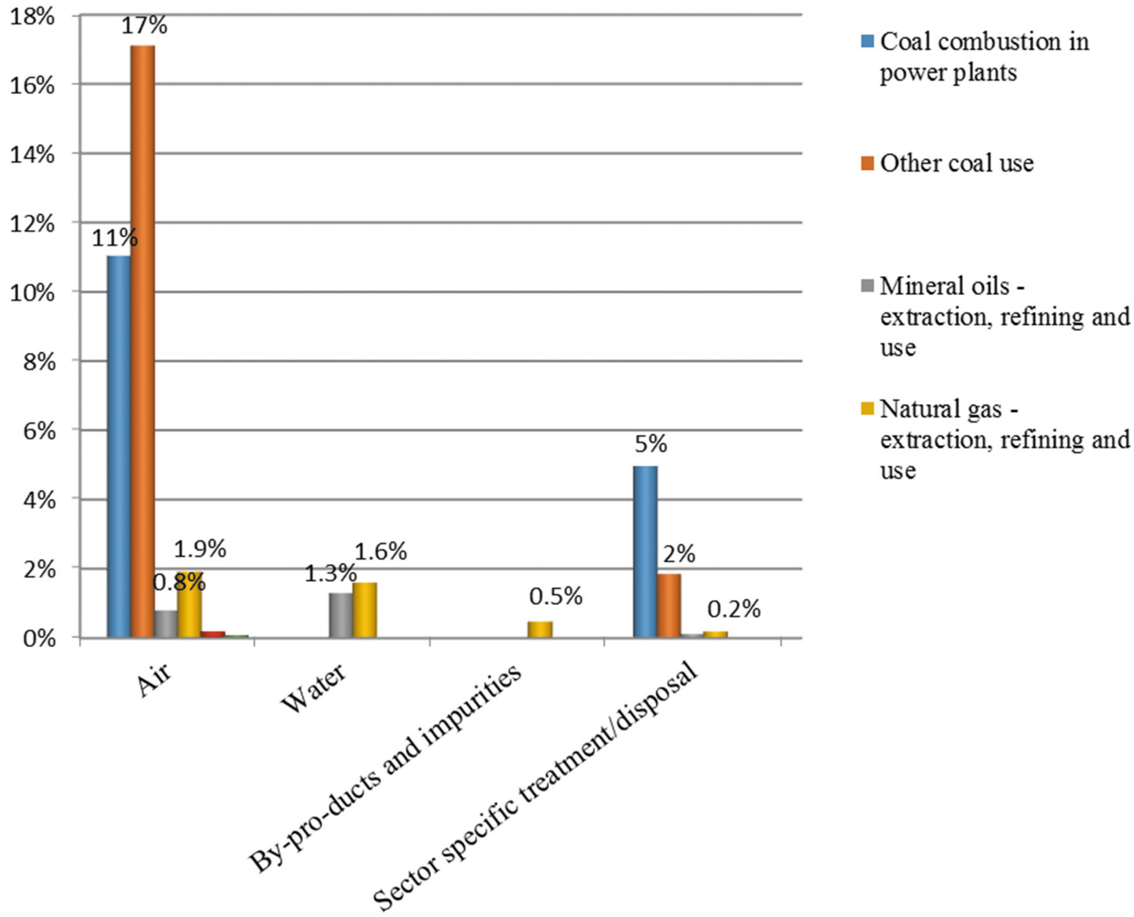

Figure 3.9. Shares of separate sources of mercury releases in the course of energy fuels extraction and production in 2012,%

The main mercury releases into the environment are associated with sub-categories "Coal combustion in large power plants" and "Other types of coal use" — 33.7 tons, including 25.8 tons of air emissions.

The sub-category "Other types of coal use" contributes 17% to the overall mercury emissions into the ambient air, and 2% into sector — specific waste treatment/disposal.

The sub-category "Coal combustion in large power plants" contributes 11% to the overall mercury emissions into the ambient air, and 5% into sector — specific waste treatment/disposal.

Other sub-categories do not substantially influence mercury releases into the environment.

More detailed information on mercury inventory results for separate sub-categories is provided below.

Coal combustion in large power plants

The sub-category "Coal combustion in large power plants" covers coal combustion by large power plants with rated thermal capacity over 300 MW. In the Russian Federation, the largest coal reserves are located in the East, mainly in Kuznetskiy and Kansko-Achinskiy coal basins. 8% of the overall coal reserves of Russia are located in the European part of the country. More than a half of Russian coal reserves (51.7%) belong to lignite grade coal; Kansko-Achinskiy coal basin contains the main part of the lignite reserves (about 80%). The lignite there is of high quality; lignite deposits have favourable geologic characteristics and are suitable for opencast mining.

In the Russian Federation, all coal types are extracted, including both coke grade and power plant grade coal of diverse quality and technological properties. A substantial share of Russian coal belongs to coal of high quality with low sulphur (0.3–0.8%) and ash (10–16%) contents and high caloric value. High quality coal (including coke grade coal) is predominantly located in Kuznetskiy, Pechorskiy and Yuzhno-Yakutskiy coal basins (see Table 3.15).

Table 3.15

Coal properties in main coal basins

Coal basins	Coal type	Extraction in 2012, million t	Coal quality		
			contents of,%		caloric value, MJ/kg
			ash	sulphur	
Kansko-Achinskiy (Krasnoyarskiy Krai, Kemerovskaya oblast)	L, C	42.1	6–15	0.3–1	11.8–15.5
Kuznetskiy (Kemerovskaya oblast)	L, C	175.5	10–16	0.3–0.8	22.8–29.8
Irkutskiy (Irkutskaya oblast)	L, C	12.4	7–15	1.5–5	17.6–22.6
Pechorskiy (Komi Republic)	C	10.6	8.5–25	0.5–1	18.1–26.7
Donetskiy (Rostovskaya oblast)	C	4	10.5–29	1.8–4.2	18.5–20.1
Yuzhno-Yakutskiy (Sakha Republic — Yakutia)	C	11.4	10–18	0.3–0.5	22–37.4
Minusinskiy (Khakasia Republic)	C	12.5	6.6–29.7	0.5–0.6	18–32

Notes: L — lignite, C — coal

In 2012, according to underground surveys, coal extraction in the country reached 321.8 million tons, while the gross production (including waste minerals) reached 354.8 million tons. Coal export in 2012 reached 130.4 million tons or 37.7% of the national coal production. Coal import in 2012 reached 31.2 million tons (more than 95% of imported coal was used for power generation purposes).

Amounts of coal processing in Russia are relatively low; however, shares of washed coal increase every consecutive year. In 2012, 139.5 million tons of coal were supplied to coal dressing plants, or 39.4% of the gross coal production. The largest Russian coal users include heat generating and power plants (36.4% of the gross coal production), coke and by-product plants (11.3%), household users (6.9%) and other users (7.7%).

In 2012, according to the RF Statistics Service, coal use in the country reached 243.56 million tons. Gas is used as the main fuel of heat generating and power plants (70.3%).

According to the All-Russian Thermal Engineering Institute (VTI), overall, 121 coal-fired power plants operate in Russia. However, in the fuel mix of 27 of these power plants, shares of coal are lower than 20%.

All power plants are equipped with fly ash precipitators. Four main types of ash precipitators are predominantly applied: electrostatic separators, wet centrifugal Venturi filters, dry centrifugal dust collectors and combinations of such units.

Electrostatic separators allow operation of ash separation efficiency from 92.6 to 99.3% (depending on specific brands and ash properties). Ash separation efficiency of wet centrifugal separators varies from 90.6 to 99%, with up to 99.5% separation efficiency of emulsifiers. Ash separation efficiency of multi-cyclones varies from 54.6 to 95%.

Thermal power plants of Russia burn about 170 types of coal from different coal basins and deposits. See information on coal consumption in 2012 by types of coal deposits, mercury contents in different types of coal and estimates of mercury releases into the environment in Table 3.16.

Table 3.16

Coal use by types of coal deposits in 2012

Coal deposits	Coal use, t/year	Mercury contents, g/t		Approximate mercury releases, kg	
		min	max	min	Max
Azeiskiy coal	1 730 285	0.17	0.5	294.1	865.1
Anadyrskiy coal	165 560	n.a.	n.a.	n.a.	n.a.
Arkagalinskiy coal	62 235	n.a.	n.a.	n.a.	n.a.
Bain-Zurkhe coal	981 976	n.a.	n.a.	n.a.	n.a.
Bashkirskiy coal	627 374	n.a.	n.a.	n.a.	n.a.
Berezovskiy coal	6 477 240	0.04	0.04	259.1	259.1
Bikinskiy coal	3 974 856	n.a.	n.a.	n.a.	n.a.
Vorkutinskiy coal	1 357 309	0.05	0.29	67.9	393.6
Golovinskiy coal	928 489	n.a.	n.a.	n.a.	n.a.
Donetskiy coal	3 567 947	0.094	0.094	335.4	335.4
Yerkovetskiy coal	1 522 817	0.1	0.1	152.3	152.3
Zheronskiy coal	1 032 396	n.a.	n.a.	n.a.	n.a.
Zyryanskiy coal	59 961	n.a.	n.a.	n.a.	n.a.
Intinskiy coal	981 277	n.a.	n.a.	n.a.	n.a.
Irbeiskiy coal	2 224 770	n.a.	n.a.	n.a.	n.a.
Irsha-Borodinskiy coal	11 199 377	n.a.	n.a.	n.a.	n.a.
Kanskiy coal	185 259	n.a.	n.a.	n.a.	n.a.
Karabulskiy coal	65646	n.a.	n.a.	n.a.	n.a.
Other Krasnoyarskiy coal	479 648	n.a.	n.a.	n.a.	n.a.
Kuznetskiy coal	23 921 773	0.08	0.4	1913.7	9568.7
Lipovetskiy coal	493 814	n.a.	n.a.	n.a.	n.a.
Mugunskiy coal	5 935 218	n.a.	n.a.	n.a.	n.a.
Nazarovskiy coal	3 642 926	0.1	0.1	364.3	364.3
Nezhinskiy coal	302 023	n.a.	n.a.	n.a.	n.a.
Neryungrinskiy coal	3 240 017	n.a.	n.a.	n.a.	n.a.
Orkhonskiy coal	212 869	n.a.	n.a.	n.a.	n.a.
Okino-Klyuchevskiy deposit coal	1 041 204	n.a.	n.a.	n.a.	n.a.
Other imported coal	2 244 081	n.a.	n.a.	n.a.	n.a.
Other Siberian coal	1 860 762	n.a.	n.a.	n.a.	n.a.
Other European coal	9 897	n.a.	n.a.	n.a.	n.a.
Pavlovskiy coal	1 909 320	n.a.	n.a.	n.a.	n.a.
Pereyaslovskiy coal	3 466 925	n.a.	n.a.	n.a.	n.a.
Podmoskovniy coal	285 737	0.2	0.2	57.1	57.1
Podgorodnenskiy coal	216 704	n.a.	n.a.	n.a.	n.a.
Other Primorskiy coal	458 435	n.a.	n.a.	n.a.	n.a.
Raichikhinskiy coal	550 775	0.4	0.4	220.3	220.3
Rakovskiy coal	489 631	n.a.	n.a.	n.a.	n.a.
Sakhalinskiy coal	1 204 367	0.11	0.11	132.5	132.5
Sarykolskiy coal	16012	n.a.	n.a.	n.a.	n.a.
Sverdlovskiy coal	1 110 518	0.1	0.1	111.1	111.1
Tataurovskiy coal	750 399	n.a.	n.a.	n.a.	n.a.
Tuvinskiy coal	166 495	0.1	0.1	16.6	16.6
Tugnuiskiy coal	391 057	0.1	0.1	39.1	39.1
Urgalskiy coal	1 484 662	0.1	0.1	148.5	148.5
Urtuiskiy coal	1 258 246	n.a.	n.a.	n.a.	n.a.
Kharanoirskiy coal	2 724 376	0.02	0.19	54.5	517.6
Khakasskiy coal	2 090 079	0.1	0.1	209.0	209.0
Chelyabinskiy coal	785 122	0.1	0.1	78.5	78.5
Cheremkhovskiy coal	1 350 451	0.17	0.25	229.6	337.6
Elibastuzskiy coal	24 787 344	<0.02	0.12	495.7	2974.5
Total	**126025661**			**5179.3**	**16781.0**

Data from the Table allows estimation of average mercury levels in coal. According to estimates for types of coal with known mercury levels, combustion of 79151280 tons of coal is accompanied by releases of 5179.3 kg of mercury into the environment (for minimal levels) or 16781 kg (for maximal levels). Therefore, combustion of 1 t of coal results in release of 0.065 g of mercury (min.) or 0.212 g of mercury (max.). The average level of 0.1385 g of mercury per 1 t of coal burned was used for the inventory purposes.

33 out of 121 power plants have rated thermal capacity over 300 MW and burn 11395800 tons of coal from different coal deposits. Therefore, large thermal power plants burned 126025661–11395800 = 114627161 t of coal. According to the UNEP methodology, mercury releases into the environment were estimated separately for coal and lignite.

According to statistical data, the share of lignite used by thermal generation and power plants reaches 49%. Amounts of lignite burned reached 56167308,89 t, while amounts of hard coal used reached 114627161–56167308.89 = 58459852.11 t. Due to lack of information on mercury levels in lignite, the same level of 0.1385 g Hg per 1 t of coal burned was used for both lignite and hard coal.

According to estimates (Level 2 of the UNEP methodology) **coal combustion resulted in release of 15.9 tons of mercury into the environment**. See distribution of mercury by environmental media in Table 3.17.

Table 3.17

Mercury releases into different media in the course of coal burning at large power plants

Total mercury releases, tons	Mercury releases into different media — t Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
15.876	10.129	0.00	0.00	0.00	0.00	5.747

Other types of coal use

The sub-category "Other types of coal use" covers coal use by coke and by-products plants, households, small power plants and boilers with rated thermal capacity under 300 MW, and by industrial facilities.

In 2012, coke and by-products plants used 40092400 tons of coal. According to the RF Statistic Service, 2012, residential users consumed 4235739 tons of coal, including 937590 tons of lignite. Small power plants and industrial facilities burned 84602354 tons of coal, including 32571906.3 tons of lignite.

According to estimates (Level 2 of the UNEP methodology) **coke production and coal combustion resulted in release of 17.9 tons of mercury into the environment**. See distribution of mercury by environmental media in Table 3.18.

Table 3.18

Mercury releases into different media in the course of coal burning

Total mercury releases, tons	**Mercury releases into different media — t Hg/year**					
	Air	**Water**	**Soils**	**By-products and impurities**	**General waste**	**Sector - specific waste treatment /disposal**
17.857	15.709	0.00	0.00	0.00	0.00	2.148

According to some studies[31], in 2012, mercury emissions into ambient air from coal burning in thermal generation and power plants reached 8.26 t, coal burning by other users added 3.9 t, while coke production added 1.56 t.

Oil fuels — extraction, refining and use

The sub-category "Oil fuels — extraction, refining and use" covers extraction of crude oil, use of heavy oil and oil coke, diesel oil, petrol and light fuels.

Crude oil extraction and primary processing

Primary extraction of crude oil in 2012 reached 513.91 million tons, including 496.06 million tons of oil and 17.85 million tons of condensate. Export of oil (including condensate) reached 240 million tons. Primary oil processing reached 265.8 million tons. Production of oil products reached 265.7 million tons, including: 38.2 million tons of petrol, 10 million tons of jet fuel (kerosene), 69.7 million tons of diesel oil and 74.5 million tons of heavy oil. In 2012, export of oil products reached 138.2 million tons.

There are 83 major oil fields in the country with estimated oil reserves from 60 to 300 million tons, and 12 unique oil fields with oil reserves of 300 million tons. The share of major and unique oil fields in explored oil reserves of Russia reaches 57% and these oil fields produce 58% of the national oil extraction. Nine unique and 56 major oil fields are located in the Western Siberian oil and gas basin — the second largest in the world after the Persian Gulf. The basin contains almost two thirds of Russia's oil reserves, with over 40% of its prospective and more than a half of forecast resources. In addition, the basin contains about 60% of Russian condensate reserves. The basin provides about two thirds of annual oil and condensate production of the Russian Federation.

The share of oil processing in the overall volume of oil production reaches 54.2%. The overall capacity of operational oil refineries in Russia reaches 279 million tons/year. In terms of oil processing, Russia belongs to the top global leaders (after US and China). In Russia, 32 major oil refineries and more than 200 small refineries operate. Some gas processing plants also process liquid hydrocarbons.

"NC "Rosneft" JSC is the leader in terms of primary oil processing. In 2012, its plants processed 51.5 million tons of oil. The company, jointly with "Gazprom" Group (45.2 million t of crude oil) and "Lukoil" JSC (44.7 million tons), ensured more than half of all Russian oil processing.

Substantial amounts of oil and condensate were also processed by "TNK-BP Holding" JSC (25 million t), "ANK Bashneft" JSC (20.8 million t), "Surgutneftegaz" JSC (20.6 million t), and "Slavneft" JSC (15.3 million t).

Primary oil processing allows for production of different types of fuel. In 2012, 265.7 million t of different oil products were produced in Russia. Among the oil products, production of heavy and intermediate fractions dominates, particularly heavy fuel oil (74.5 million t) and diesel oil (69.7 million t). Production of petrol reached 38.2 million tons, while production of jet fuel reached 10 million tons[31].

In the course of oil and condensate extraction and initial processing, mercury releases into the environment reached 370.5 kg of mercury, mainly (61%) into the ambient air (see Table 3.19).

Table 3.19

Mercury releases into different media in the course of oil extraction and primary processing

Total mercury releases, kg	Mercury releases into different media — kg Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
370.5	225.9	9.04	0.00	0.00	0.00	135.56

[31] Tatsiy Yu. G. Mercury emissions into atmosphere from coal burning in the Russian Federation. V. I. Vernadskiy Institute of Geochemistry and Analytical Chemistry of the RF Acad. Sci. Moscow. (Rus.)

[32] The state report on Status and Use of Mineral Resources of the Russian Federation in 2012, Moscow, «Mineral» Information and Analysis Centre, 2013.

Use of heavy oil fuel

According to statistical reporting data, in 2012, 17254881 TOE of oil (including gas condensate) were used, including 983863 TOE for heat/power generation, 15704020 TOE of industrial fuel oil (including 7391885 TOE for heat/power generation) and 1076770 TOE of marine bunker fuel.

The use for non-fuel purposes reached 131453 TOE of oil; 5821 TOE of industrial fuel oil and 819 TOE of marine bunker fuel.

The following factors were used for recalculation of tons of reference fuel oil equivalent (TOE) into metric tons[33]:

- oil, including gas condensate — 1.43;
- industrial fuel oil — 1.37;
- marine bunker fuel — 1.43.

Therefore, accounting for the conversion, overall, 13868868.389 tons of oil products were burned. Non-combustion use of oil fuels reached 96746.807 tons.

According to the UNEP Methodology, all mercury releases in the course of use of heavy oil fuel (279.3 kg) were emitted into the ambient air.

Use of petrol, diesel oil, light fuels, kerosene, LNG and other light distillates

Information on fuel use in 2012 is shown in Table 3.20.

Table 3.20

Fuel use by types in 2012

Types of fuel	Units	Used in the reporting year					
		Total	furnace fuel	motor fuel[2]	as production input[3]	non-fuel use[4]	sold to residents
Aviation grade petrol	tons	22903	0	15015	0	1255	0
Motor petrol	tons	41142178	4191	5313789	31	2449	21851251
Kerosene	tons	7126169	n.a.	4670112	7898	30087	2119
Diesel oil	tons	56275740	1706557	21308832	13418	50979	8469756
Heating oil[1]	tons	994699	127283	16611	2646	375	32722
Dry refinery gas	tons	8571023	889754	-	31075	1194	8540
Liquidified gas (LNG)	tons	5724414	46627	361163	2057862	17925	783136
Total	**tons**	**119857126**	**2774412**	**31685522**	**2112930**	**104264**	**31147524**

1 — oil products from straight run and secondary diesel oil fractions (mainly for household heaters);

2 — fuels for internal combustion engines (cars, trucks, tractors, agricultural machinery, airplanes, marine and river vessels, etc.);

3 — fuel products used as production inputs for production of chemicals, petrochemicals and other non-fuel products;

4 — fuel products used for other non-fuel purposes, e.g. oil for well washing, use of fuel oil for lubrication, use of kerosene for workpiece washing, etc.

For the mercury releases inventory purposes, the overall amount of the fuel use should be subdivided into three types/processes of use:

- use for transport vehicles and other non-combustion types of use;
- residential heating installations without emission control systems;
- other fuel burning installations.

Diesel oil and liquidified gas for residential use are applied for residential heating, cooking, and as motor fuels. However, no information is available on separate types of consumption. With this in mind, and accounting for equal mercury release factors for all three processes, the fuel amounts in Table 3.20 were used for estimates under "residential heating installations without emission control systems" (9294154 tons).

Therefore, the category of use for transport vehicles and other non-combustion types of use (including use of motor fuels, use as production inputs, non-fuel uses, as well as motor petrol and kerosene sold to residential users) covers 55756086 tons of fuel. The category of use for residential heating installations without emission control systems (including diesel oil, furnace heavy oil, LNG and LPG sold to residential users) covers 9294154 tons of fuel, while the category of other fuel burning installations covers 54806886 tons.

[33] Order # 46 of the RF State Committee for Statistics of June 23, 1999 on Approval of the Methodological Guidelines on Estimation of Fuel and Energy Balance of the Russian Federation According to the International Practice (Rus.)

According to the UNEP Methodology, all mercury releases in the course of use of petrol, diesel oil, kerosene, LPG and other light distillates (228.75 kg) were emitted into the ambient air.

Overall, in the course of oil fuels extraction, refining and use, 1.23 tons of mercury were released into the environment. See distribution of mercury by environmental media in Table 3.21.

Table 3.21

Mercury releases into different media in the course of oil fuels extraction, refining and use

Total mercury releases, t	Mercury releases into different media — t Hg/year					
	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
1.228	0.734	0.358	0.00	0.00	0.00	0.136

Natural gas — extraction, processing and use

The Russian Federation is the leading country in terms of natural gas reserves with its 40% share of global gas reserves. Natural gas reserves of the Russian Federation include both free gas and associated gas (dissolved in oil). Free gas includes gas reservoirs and gas in caps over oil deposits. The share of free gas in Russian gas reserves reaches 96%, including about 12% in gas caps.

More than two thirds of Russian free gas reserves are located in the West Siberian oil and gas basin (particularly in its northern section). The share of dry gas in the RF gas reserves reaches about 50%, while the rest contains ethane. The largest part of Russian reserves of associated gas is located in the West Siberian oil and gas basin, including over 60% in the territory of Yamalo-Nenetskiy and Khanty-Mansiiskiy autonomous districts.

Under this sub-category, mercury releases into the environment were estimated for natural gas extraction and its use.

Natural gas extraction

Overall, in 2012, 624.95 billion m^3 of free gas and 36.84 billion m^3 of associated gas were extracted. More than a half of free gas (47%) was extracted at three unique gas fields of Nadym-Pur-Tazovskiy region in Yamalo-Nenetskiy Autonomous District — Zapolyarnoye, Urengoiskoye and Yamburgskoye. Total gas extraction at Urengoiskoye and Yamburgskoye gas fields reached 178.7 billion m^3. Gas extraction at the relatively new Zapolyarnoye gas field reached 112.6 billion m^3. In 2012, 193.3 billion m^3 of natural gas were exported.

Estimates of mercury releases into the environment in the course of natural gas extraction relied on average mercury contents in gas of 2. 4 μg/m^3 for casinghead gas in gas from oil wells and 3.4 μg/m^3 for free gas from gas wells[34].

Mercury releases into the environment in the course of natural gas extraction reached 2.213 tons. See distribution of mercury to environmental media in Table 3.22.

Table 3.22

Mercury releases into different media in the course of natural gas extraction

Total mercury releases, t	**Mercury releases into different media — t Hg/year**					
	Air	**Water**	**Soils**	**By-products and impurities**	**General waste**	**Sector - specific waste treatment /disposal**
2.213	0.442	0.443	0.00	1.107	0.00	0.221

[34] ACAP. 2005. Assessment of mercury releases into the environment from the territory of the Russian Federation. Arctic Council Plan to Address the Arctic Pollution (ACAP). The Federal Service for Environmental, Technological and Nuclear Supervision in cooperation with the Danish Environmental Protection Agency, Copenhagen. http://www.zeromercury.org/library/Reports%20General/0502%20Dk%20report%20on%20Hg%20releases%20in%20Russia.pdf

Use of natural gas

Information on natural gas use by different users is shown in Table 3.23.

Table 3.23

Natural gas use in 2012

Types of fuel	Units	Used in the reporting year					
		Total[1]	furnace fuel	motor fuel[2]	as production input[3]	non-fuel use[4]	sold to residents
Natural free and casinghead gas	thousand m^3	765060812	342636935	5676886	29531843	1966077	44180736

1 — «Total» includes also gas supplied to industrial facilities;

2 — fuels for internal combustion engines (cars, trucks, tractors, agricultural machinery, airplanes, marine and river vessels, etc.);

3 — fuel products used as production inputs for production of chemicals, petrochemicals and other non-fuel products;

4 — fuel products used for other non-fuel purposes, e.g. gas for injection into underground formations to maintain pressure.

In the UNEP methodology, use of natural gas is sub-divided into two categories:

1. Use of raw or pre-treated gas — 379811741 thousand m^3.

2. Use of gas supplied from gas pipelines (end-user quality) — 385249071 thousand m^3.

Estimates of mercury releases into the environment in the course of use of raw or pre-treated gas relied on mercury contents in free gas from gas wells — 3.4 µg/m^3.

Estimates of mercury releases into the environment in the course of use of gas supplied from gas pipelines relied on mercury contents in Russian gas — 0.065 mg/m^3.

According to the UNEP Methodology, all mercury releases in the course of natural gas burning (1.3 t) were emitted into the ambient air.

Other fossil fuels — extraction and use

This sub-category covers mercury releases into the environment in the course of burning peat and oil shales.

Peat burning

According to the International Peatland Society, global peat reserves exceed 400 million ha. Russia is the largest global holder of peat reserves. The country's share in total global peat reserves — according to different estimates — reaches from 40 to 60%. Commercial peat reserves in Russia are estimated at the level of 30.8 billion t (at 40% moisture content) or more than 10.7 billion TOE. Peat reserves in Russia are evenly distributed over the country's territory; however, in recent years, peat extraction in the Russian Federation steadily declined due to availability of high reserves and intensive extraction of other types of fuel with much higher caloric values (oil, natural gas and coal).

According to the RF Statistics Service, in ten recent years, peat extraction in Russia decreased by almost 3.5 times. While in 2000, about 4.1 million tons of peat (with standard moisture content) were extracted, by 2009, peat extraction decreased to 1.2 million tons. In the Russian Federation, peat is extracted in Privolzhskiy, Central, North-Western, Urals, Siberian and Far East federal districts, with the highest contribution of Provolzhskiy Federal Districts (62% of the national peat extraction).

Peat was used in Russia for more than 200 years. Initially, peat was used solely as a fuel.

For many years, milled peat was used as a fuel at thermal power plants. Peat use at Russian power plants peaked in 1965 (27.9 million tons). In 30 subsequent years, peat consumption decreased. Now, only 12 Russian thermal power plants can burn peat.

Peat is currently actively used in agriculture, and peat processing products are used in different sectors.

According to statistical data, in 2012, 919.2 thousand tons of peat were used, including 812.9 thousand tons of fuel peat (see Table 3.24).

Table 3.24

Peat use in 2012

Types of fuel	Units	Used in the reporting year			
		Total	furnace fuel	as production input[1]	sold to residents
Milled fuel peat	Tons	894559	788486	6912	-
Sod fuel peat	Tons	8171	7980	-	-
Fuel peat briquettes	Tons	16466	16445	-	10
Total[2]		**919196**	**812911**	**6912**	**10**

1 — fuel products used as production inputs for production of chemicals, petrochemicals and other non-fuel products;
2 — «Total» also includes fuel supplied to industrial facilities (in addition to amounts listed in the table).

The Institute of Climate and Ecosystem Monitoring of SB RF Acad. Sci. (Tomsk) studied mercury levels in peat profiles at native and human-affected areas of the Big Vasyuganskoye Marshes (see Table 3.25).

Table 3.25

Mercury concentrations in peat samples in different sites

Peat sites	Mercury concentrations in peat samples, ng/g									
	Site-wide averages	max	min	Averages for depth ranges, cm						
				0–50	50–100	100–150	150–200	200–250	250–300	300–350
Relatively intact marshes										
Bakcharskoye (SF)	209	277	129	209	-	-	-	-	-	-
Bakcharskoye (HR)	128	192	67	145	90	-	-	-	-	-
Bakcharskoye (LR)	54	75	19	63	40	38	54	27	22	-
Bakcharskoye (SSM)	59	99	19	86	52	56	24	19	33	-
Samara	76	184	12	116	68	44	45	44	29	-
Tagan (N)	85	305	24	159	69	61	58	58	65	44
Vasyuganskoye (LR)	36	57	12	44	23	-	-	-	-	-
Salymo-Yuganskoye, SYuGMK	132	185	106	92	150	130	126	141	143	-
Human-affected marshes										
Vasyuganskoye, Nrmel	47	90	10	65	22	21	27	-	-	-
Tagan (WOA)	91	153	17	101	76	-	-	-	-	-
Sukhoye-Vavilovskoye	24	76	11	31	15	15	19	25	18	-
Ozernoye	117	255	28	144	64	121	117	91	76	84

Notes: SF — swamp forest, HR — high riam1, LR — low riam, SSM — sedge-sphagnum marshes, N — natural section, WOA — worked out area.
«-» no measurements

According to the study results, average mercury levels in peat of native bog ecosystems vary substantially: from 12 to 305 ng/g. In peat samples from areas under human pressure average mercury levels vary from 24 to 85 ng/g.

Estimates of mercury releases from peat burning relied on average mercury contents in peat at the level of 0.2 mg/kg.

Use of oil shales

By 2012, oil shales mining in Russia completely ceased. Earlier, oil shales were extracted in the Baltic basin with average mercury contents at the level of 0.4 mg/kg (estimate). In 2012, 34530 tons of oils shales were burned.

Overall, burning of peat and oil shale resulted in releases of 177.8 kg of mercury into the environment. According to the UNEP Methodology, all the mercury was emitted into the ambient air.

MERCURY RELEASES IN CHEMICALS PRODUCTION

The category "Chemicals production with use of mercury" covers:

• chlor-alkali production with application of mercury cells;

• production of VCM (vinyl chloride monomer) with use of mercury dichloride as a catalyst;

• production of acetaldehyde with use of mercury sulphate as a catalyst;

• production of other elements and polymers with application of mercury.

Now, in the Russian Federation, mercury compounds are not applied for industrial production of acetaldehyde — therefore, in the course of mercury inventory, only chlor-alkali and VCM production was accounted for.

Chlor-alkali production

In the Russian Federation, chlor-alkali production reporting is based on caustic soda output. This is associated with simple and easy control (based on volumes of solutions and relevant concentrations of caustic soda in them). For reporting purposes in the Russian Federation, chlorine output is assumed to reach 90% of caustic soda output. The share of mercury process — based production in the overall production of chlorine and caustic soda in the Russian Federation reaches about 30%.

In 2012, mercury cell process for production of caustic soda was applied by three facilities: "Kaustik" JSC in Volgograd (132 thousand tons), "Bashkir Soda Company" JSC in Sterletamak (100 thousand tons) and "GaloPolimer Kirovo-Chepetsk" JSC (92.3 thousand tons). Use of mercury by these facilities reached: 667.3 kg for "Kaustik" JSC, 2587.5 kg for "Bashkir Soda Company" JSC and 36486.4 kg for "GaloPolimer Kirovo-Chepetsk" JSC. High mercury consumption figures in the case of "GaloPolimer Kirovo-Chepetsk" JSC are associated with specifics of applied technology and with high depreciation of production installations at brin preparation stage. Amounts of mercury consumption per 1 ton of Cl_2 output reach, respectively: 5.56 g for "Kaustik" JSC, 19.45 g for "Bashkir Soda Company" JSC and 226.63 g for "GaloPolimer Kirovo-Chepetsk" JSC.

Therefore, chlor-alkali production resulted in releases of 39.7 tons of mercury into the environment. See distribution in environmental media in Table 3.26.

In the late 1990s, in Russia, active measures were launched to ensure real reduction of mercury consumption in chlor-alkali production with application of the mercury process. Initially, these measures were induced by the need to reduce consumption of expensive mercury and by internal environmental problems. However, since 2002, Russia started to participate in international projects seeking to address the problem at the global scale.

In February 2005, the Global Partnership Project for Mercury Emissions Reduction was launched under the auspices of the UN Environment. Since April 2005, in the framework of the project, the Arctic Council established partnership relations with "RusKhlor" Association seeking to involve Russian producers into these activities for their further development. As a strategic objective, the partnership intends to ensure sustainable reduction of mercury consumption and emissions by member-companies of the partnership by several hundred kg per annum.

Completed works included conversion of one production facility with transition to electrolysis with ion exchange membranes ("Sayankhimplast" JSC) — as a result, in 2007, direct technological mercury emissions there were completely eliminated. Additionally, measures were implemented for improvement of technologies, equipment and operation practices at other operational chlor-alkali plants in Sterlitamak ("Kaustik" JSC), in Volgograd ("Kaustik" JSC), and in Kirovo-Chepetsk ("KChKhK Polymere Plant").

Due to activities in the framework of the Partnership, by 2010, the overall mercury emissions were reduced by 74.3 t, (including 1.706 t to air, 0.354 t to water, 0.073 t to products and 72.123 t to solid wastes).

Further measures for modernisation of industrial mercury cells were intended to ensure reliable reduction of mercury emissions and energy consumption, as well as to improve operational safety of the cells. However, the key problems have not been resolved yet — 1) radical reduction of mercury contents in solid waste, and 2) further reduction of mercury releases to air, water and products with ensuring sustainable effect of the measures applied. The following sequence of actions was proposed to address these problems:

1. To avoid setting specific deadlines for the sector's transition to mercury-free technologies, allowing individual plants to decide on the matter independently, according for their own technical and investment readiness;

2. To ensure a technological level allowing to keep mercury emissions at operational plants as low as possible and to maintain the level;

3. To ensure accountability and transparency of mercury sales, to impose strict controls over technological mercury and to ensure reliable protection of mercury from stealing;

4. To prevent production capacity expansion at operational plants, as well as commissioning of new mercury cells;

5. To reduce mercury purchases by operational plants (up to complete cessation) due to:

a) reduction of their overall mercury consumption (without adverse effects for technological processes);

b) maximal possible utilisation of internal mercury reserves by recovery and recycling of mercury from already accumulated production waste;

6. To ensure and maintain the quality of burials of mercury-containing wastes (at both operational and decommissioned plants).

These proposals were reviewed by the World Chlorine Council. The majority of them were reflected in the official WCC position paper in the course of preparations to adopt the Minamata Convention on Mercury in 2013.

Vinyl chloride production

Now, three different technologies are used for production of vinyl chloride:

1. Chlorine-balanced method (from ethylene and chlorine);

2. Hydrochlorination of acetylene (from acetylene and gaseous hydrogen chloride);

3. A combined method with application of diluted ethylene and acetylene (from naphtha or propane-butane fraction and chlorine — diluted mixtures of ethylene and acetylene are produced by naphtha pyrolysis).

Mercury-based catalysis is applied only by plants that use concentrated or diluted acetylene as a production input.

In 2012, only two companies produced vinyl chloride with application of mercury catalysts in the Russian Federation: "Khimprom" JSC (21 thousand tons) and "Kaustik" JSC (87 thousand tons). Therefore, mercury releases into the environment were estimated only for these 2 companies.

"Khimpron" JSC produces vinyl chloride by gas phase hydrochlorination of acetylene (from calcium carbide) by hydrogen chloride with a catalysis (mercury dichloride on activated charcoal), while "Kaustik" JSC produces VCM by a combined method with use of diluted ethylene and acetylene.

The catalyst consumption factor reaches 1 kg/t VCM (1 kg of the catalyst contains 13% of mercury dichloride; while the compound contains 73.9% of pure mercury). Service life of the catalyst reaches about 1 year — in 1 year, contents of mercury dichloride in the catalyst decreases from 13 to 3% mass. At the latter residual level of mercury dichloride the catalyst becomes inactive and should be removed and processed.

In the course of VCM production, 6.196 t of mercury were released into the environment.

Therefore, **overall, 45.9 t of mercury were released into the environment in the course of chemicals production**. See mercury distribution in environmental media in Table 3.26.

Table 3.26

Mercury releases into different media in the course of chemicals production, t

Source sub-categories	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
Chlor-alkali production with application of mercury cells	3.974	0.397	0.397	0.397	0.0	34.575
Production of VCM with application of mercury catalysts	0.124	0.124	0.0	2.231	0.0	3.718
Total	**4.098**	**0.521**	**0.397**	**2.628**	**0.0**	**38.292**

The research study results suggest that chlor-alkali production makes a substantial contribution to mercury releases into different media, particularly into sector - specific waste for treatment/disposal. The category of mercury in by-products is an exception (in this case, VCM production dominates, but its contribution is low and does not exceed 1% of all sources in the Russian Federation — see Fig. 3.10).

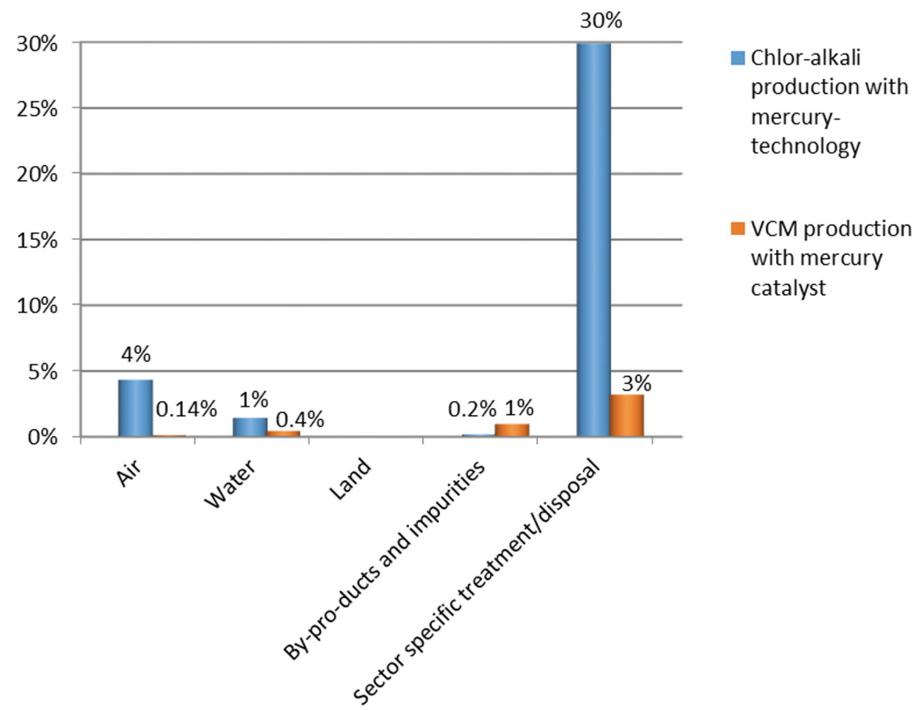

Figure 3.10 — Contributions of source sub-categories of "Chemicals production" category into total mercury releases into different media in the Russian Federation in 2012,%

MERCURY RELEASES IN THE COURSE OF PRODUCTION AND USE OF CONSUMER GOODS

This category covers mercury releases in the course of national production and use of a wide range of consumer goods, including imported ones (such as thermometers, fluorescent bulbs, relays and switches, batteries and cells). Some other products are also covered, such as products with mercury additions for their functionality (e.g. dental amalgams and manometers).

In 2012, only "Termopribor" JSC produced mercury thermometers in the Russian Federation. Overall, in 2012, the company produced 4687137 medical thermometers, 14988 thermometers for ambient air temperature measurements, 87494 industrial and special-purpose thermometers and 2607 other mercury thermometers.

Per item mercury contents in medical thermometers reach 1.00 g, thermometers for ambient air temperature measurements contain 5.6 g/item, industrial and special-purpose thermometers contain 3.9 g/item, while other mercury thermometers contain 5.6 g/item. Medical thermometers are produced from purchased, pre-filled parts. Other thermometers and contact thermometers are produced with application of metal mercury.

No information was available on production of mercury-containing switches and relays in the territory of the Russian Federation. Imported mercury-containing relays and switches are used in Russia. As switches are used in different electric installations, remote control and automatic instruments, mercury estimates were made on the basis of the country population with access to power supply.

In the case of the lamp market, we analysed production, export and import of mercury-containing lamps.

In 2012, the main producers of batteries and cells for household appliances included "Uralelement" JSC and "Energia" JSC. The overall consumption of mercury for production of batteries and cells reached 1.7 t. According to the RF Customs Service, import of mercury-oxide cells reached 1 kg at export of 227 kg, while import of air-zinc tablet type batteries reached 41075 kg at export of 21 kg. Mercury contents in mercury-oxide cells reach 320 kg/t, while mercury contents in air-zinc batteries reach 12 kg/t.

Overall, in the course of production and use of mercury-containing consumer goods, 49.7 tons of mercury were released into the environment, or 3% of total mercury releases in 2012.

Wastes contain the largest amounts of mercury (29 tons). Almost 11 tons of mercury were discharged to soils, 4.8 tons were emitted to atmosphere and 4.9 tons of mercury were discharged to water (see Table 3.27).

Table 3.27

Mercury releases into different media in the course of production and use of consumer goods, t

Source sub-categories	Air	Water	Soils	By-products and impurities	General waste	Sector - specific waste treatment /disposal
Mercury thermometers	0.312	0.910	0.054	-	1.785	0.065
Mercury-containing switches and relays	1.864	0.0	1.864	-	7.458	7.458
Mercury-containing lamps	0.485	0.026	0.790	-	3.899	0.312
Mercury batteries and cells	0.113	0.008	0.272	-	1.714	0.351
Mercury-containing biocides and pesticides	2.000	4.000	8.000	-	6.000	0.0
Total	**4.774**	**4.944**	**10.980**	**-**	**20.856**	**8.186**

OTHER SOURCES OF MERCURY RELEASES

In this section, mercury releases from smaller sources are considered (sources with contributions into total mercury releases into the environment under 1%).

These sources include:

- production of materials with mercury impurities (cement, pulp and paper, etc.);
- mercury use in products (dental amalgam, manometers and sensors, laboratory chemicals and equipment);
- reduction of metals;
- waste incineration and burning;
- landfilling/tailings and wastewater treatment;
- crematoria and cemeteries.

Overall, the above sources released 66.7 t of mercury into the environment, including 12.8 t into air, 5.1 t into water,15.5 t into soils, 1.4 into by-products, and 32 t into waste.

Conclusions

Comparative analysis of the results produced in the course of development of the inventory of mercury release sources vis-a-vis data of the national state mercury reporting and registration demonstrates that:

1. According to the inventory results, in 2012, mercury releases into the ambient air reached 97.8 t, while data of the RF Statistics Service suggest 2.993 t.

2. According to the inventory results, in 2012, mercury discharges to water reached 27.3 t (vs 0.01 t, as data of the Federal Water Resources Agency suggest).

Differences between results of the inventory according to the UNEP Methodology and the national statistics data suggest that mercury registration and control in the Russian Federation lacks completeness. In order to get a complete picture of mercury releases into the environment from sources in the territory of the Russian Federation, it is necessary to review the system of sources' inventory and to tighten control of credible data in facilities' reporting.

A reliable inventory of mercury release sources in the Russian Federation is the base for purposeful actions to reduce mercury application in the country and its adverse health and environmental impacts.

CHAPTER 4

ROLES OF NGOS IN IDENTIFICATION OF MERCURY CONTAMINATION HOT SPOTS

INTRODUCTION

In the course of the pilot project for development of the inventory of mercury pollution in the Russian Federation, issues of identification of hot spots of mercury contamination of soils and water were not addressed. Nevertheless, we consider the problem as a highly relevant one for Russia, particularly in connection with data received in the course of the pilot project and provided by non-governmental organisations (NGOs) — members of the International POPs Elimination Network (IPEN).

For purposes of identification and description of contaminated sites, IPEN developed the Guidance for Identification, Management and Remediation of Mercury-Contaminated Sites. The Russian version of the Guidance was posted on the website of Eco-Accord Centre — the IPEN regional focal point in East Europe, Caucasus and Central Asia[35]. The document provides guidance for identification and management of mercury-contaminated sites, including such aspects as stakeholder involvement, which are crucial for successful management and remediation of such sites. The document also provides information on well-developed and emerging technologies for rehabilitation of mercury-contaminated areas, as well as technologies and practices for environmentally sound rehabilitation of such sites.

Contaminated sites emerge as a result of several types of human activities, including industrial production, mining and waste disposal. Primary considerations for dealing with such sites are associated with their potential hazards for human health and the environment. Depending on pollution sources, such sites may be contaminated by an individual substance or a complex mixture of different chemicals and metals. The IPEN Guidance focuses on identification and management of mercury-contaminated sites.

The Minamata Convention and contaminated sites[36]

The Minamata Convention on Mercury outlines activities Parties can undertake to address contaminated sites and generate information for the public to raise awareness about their implications for human health and the environment. The IPEN Guidance for Identification, Management and Remediation of Mercury-Contaminated Sites can assist to build capacity within the community, NGOs and policy makers to address mercury-contaminated sites within their country, pending the ratification of the Minamata Convention. No provision of the Treaty precludes any signatory from taking early action to remedy mercury pollution issues in their country.

Article 12 of the Minamata Convention on Mercury states that "*each Party will endeavour to identify and assess sites contaminated by mercury and mercury compounds and that actions to reduce the risks posed by these sites will be performed in an environmentally sound manner*" (ESM). While many countries have not yet ratified the Convention, national environmental authorities could benefit from adopting the suggested approaches of the Convention for identifying and assessing mercury-contaminated sites.

At this point the Parties to the Convention have not yet developed specific guidance for contaminated sites, but this does not prohibit national governments from developing their own management frameworks, policies and legislation to assess, identify, characterise and remediate contaminated sites. It is also important to be aware of the specific statements made in the Treaty about mercury-contaminated sites and the need for public engagement, given that successful remediation of sites may be dependent on this factor.

[35] http://www.ecoaccord.org/pop/White.pdf

[36] http://www.ipen.org/documents/guidance-identification-management-and-remediation-mercury-contaminated-sites

While the Convention is yet to develop specific, detailed guidance on the management of mercury-contaminated sites, it is suggested that the activities that should be undertaken include:

- Site identification and characterization;
- Engaging the public;
- Human health and environmental risk assessments;
- Options for managing the risks posed by contaminated sites;
- Evaluation of benefits and costs; and
- Validation of outcomes.

In addition, Parties are encouraged to develop strategies and implementing activities for "*identifying, assessing, prioritizing, managing and, as appropriate, remediating contaminated sites*."

The Minamata Convention is specifically focused on sites contaminated with mercury and mercury compounds but the processes identified above can be applied to sites with any form of chemical contamination.

Other Articles of the Convention that may have relevance to contaminated sites include:

Article 11 — Mercury wastes;

Article 13 — Financial resources and mechanism;

Article 14 — Capacity-building, technical assistance and technology transfer;

Article 16 — Health aspects;

Article 17 — Information exchange;

Article 18 — Public information, awareness and education; and

Article 19 — Research, development and monitoring.

Under Article 12, "Contaminated sites", the Conference of Parties is required to prepare guidance on managing contaminated sites that include methods and approaches for "Engaging the Public".

In addition, under Article 18, "Public information, awareness and education", each Party is required to provide to the public information on mercury pollution as well as the "results of its research, development and monitoring activities under Article 19". Parties are also required to provide education, training and public awareness related to mercury health effects in collaboration with relevant intergovernmental entities, NGOs and vulnerable populations.

Some information on mercury levels in fish and human hair in Russia

Organisations of the RF Hydrometeorological Service maintain background and selective monitoring of mercury pollution in the territory of Russia. According to the State of Environment and Environmental Pollution in the Russian Federation reports in 2008–2010[37], mercury pollution in Russia was controlled only selectively, in locations of background monitoring stations of the RF Hydrometeorological Service. In particular, background levels of mercury in ambient air in the Central region remained low and stable: in 2010, the annual average concentration reached 2.5 ng/m^3.

In Bratsk water reservoir (also known as the Bratsk Sea), in some cases mercury levels in water reached sanitary toxicological MACs. Such levels are not acceptable in the case of fishing waters, as the Bratsk Sea is used as fishing grounds by Balaganskiy fish processing plant, and fish belongs to the main food products of local residents. In the majority of cases, mercury levels in fish exceeded applicable limits by two time or even higher. The highest mercury levels were found in perch with maximal mercury concentrations in muscle tissues up to 6 mg/kg. In the Bratsk Sea ecosystem, perch and pike are on the top levels of food chains; both species are predators and accumulate more mercury than other fish species.

For comparison — mercury levels in fish in the Minamata Bay (Japan) varied from 5.6 to 35.7 mg/kg. According to findings of Canadian researchers that demonstrated that, in cold water bodies, at constant mercury intake, methylmercury levels in fish increase by 3.5–5 times every 12 years, we may predict that in due time, mercury levels in fish from the Bratsk Sea will reach levels of the Minamata Bay. Similarly to Minamata, gulls display clear mercury poisoning symptoms, high mercury levels were registered for 40% of fish-eating waterfowl. In many cases their meat cannot be used for human consumption. According to scientists of Siberian Branch of the Russian Academy of Sciences, mercury levels in fish in the Bratsk Sea are directly proportional to mercury contents in bottom sediments.

[37] The State of Environment and Environmental Pollution in the Russian Federation report for 2008, The RF Hydrometeorological Service, 2009. (Rus.) http://www.igce.ru/page/review2008

The situation is attributed to the fact that mercury methylation by micro-organisms goes on in bottom sediments without oxygen access. Mercury methylation processes are more efficient in thicker layers of bottom sediments. In addition, the intensity of mercury methylation also depends on organic contents in water (in the course of filling the Bratsk water reservoir, water covered huge areas of non-felled forests and humus-rich cultivated lands). In contrast to elementary mercury, methylmercury is soluble in water; it accumulates in phytoplankton in bottom sediments and then in fish.

Study of mercury accumulation in human hair is the most broadly applied research method for eco-epidemiological studies. In the case of steady mercury intake, its levels in a human body (and in hair) rapidly increase, reaching a half of its maximal value in one half-life period and then exponentially decreasing after elimination of the intake. In the case of people with minimal fish consumption, shares of methylmercury in total mercury content in their hair reach about 20–25% and generally do not exceed 1–4 µg/g of hair. In the case of people with high consumption of seafood, almost all mercury in their hair is present in the form of methylmercury (based on long-term studies of the health of new-borns and their mothers at Faeroes, Seychelles and New Zealand, with substantial consumption of seafood). The US National Committee for Science adopted 10 µg/g as the acceptable mercury level in maternal hair[38], but we do not know about such high mercury levels in hair of urban dwellers in Russia.

According to research results of I. V. Bezgorodov ("Hygiene assessment of mercury contamination in Irkutskaya oblast")[39], who studied the situation in areas nearby "Usoliekhimprom" and "Sayanskkhimplast", the mercury health impact risk zone covers contaminated areas and residents of Usolskiy, Balaganskiy, Kuitunskiy and Ziminskiy districts, and Ust-Ordynskiy Buryat National District (about 17 thousand rural residents in total). Mercury health impacts are identified by presence of mercury in biosubstrates. 73.7% of the surveyed persons were found to have mercury levels in hair over the background level (1 mg/kg), while 4.0% of them were found to have mercury levels above the acceptable limit (5 mg/kg). The maximal value of 42.5 mg/kg exceeded the neurotoxic impact limit. Mercury concentrations in urine exceeded the background level for 77.9% of the surveyed persons, while the acceptable limit was exceeded for 10.5% of them. Analysis of mercury excretion with urine suggested higher mercury concentrations for adults comparatively to children[40, 41].

Mercury body burden was detected for residents of Balagansk township (4.5 thousand residents)[42] located nearby Bratsk water reservoir, who eat fish regularly: 5.6 ± 0.6 µg/l in urine, 2.1 ± 0.2 µg/g in hair (for adults). These persons had the following health problems:

- neurologic syndrome;
- hypertension;
- ischaemic heart disease;
- endocrine pathology risks for women.

Risks of multisystem pathologies were found for 27% of the persons surveyed.

According to O. V. Matveev (1997)[43], in the course of surveying residents of Sayansk (46 thousand residents), the following mercury levels were found: up to 2 µg/l in urine (adults), 0.08–0.4 µg/g in hair (children), and 5.2–6 µg/l in breastmilk.

Results of NGO project of assessment of mercury levels in fish and human hair in Volgograd[44]

In 2012, Volgograd-Ecopress NGO and Eco-Accord Centre implemented their joint project for assessment of mercury levels in samples of fish and human hair, collected nearby facilities of "Kaustik" JSC in Krasnoarmeiskiy and Svetloyarskiy districts of Volgograd and in Raigorod township (to the south from Volgograd). Three fish species were selected for the study form three different locations: perch (Krasnoarmeiskiy district), crucian (wastewater pond of "Kaustik" facility) and catfish (Svetloyarskiy district).

According to data in Table 4.1, average mercury levels in catfish and perch samples more than twice exceeded the safe impact limit set by US EPA, while average levels in crucian also exceeded the safe lim-

[38] Grandjean P., Weinhe, Whitr P., Deves R. F. et al. // Neurotoxicol. and Tetatol. — 1997. — Vol. 20. — P. 1.

http://medical-diss.com/medicina/gigienicheskaya-otsenka-rtutnogo-zagryazneniya-v-irkutskoy-obl

[40] http://medical-diss.com/medicina/gigienicheskaya-otsenka-rtutnogo-zagryazneniya-v-irkutskoy-obl

[41] Dynamics of mercury body burden of workers in Semenovskiy township in the Bashkortostan Republic, T. K. Larionova, 1999 (Rus.)

[42] Dyakovich M. P. Assessment of health risks of methylmercury impacts // M. P. Dyakovioch, N. V. Efimova / Hygiene and Sanitation. — 2001. — # 2. pp. 49–51 (Rus.)

[43] http://medical-diss.com/medicina/gigienicheskaya-otsenka-deystviya-nitratov-i-rtuti-v-usloviyah-selskohozyaystvennogo-proizvodstva

[44] http://www.ecoaccord.org/pop/final.pdf

it. Actually, in all samples of perch and catfish the safe limit was exceeded, and in 90% of crucian samples the safe level was also exceeded. In the case of two crucian samples and three samples of perch and catfish, the EU limit for mercury in food products (fish) — 0.5 mg/kg — was exceeded. In five samples, Russian MACs for mercury in fish (0.6 mg/kg) was exceeded. In comparison to the majority of other countries, information on mercury levels in Russian fish is rarely available, especially accounting for its size. These considerations make data in Table 4.1. particularly significant.

Table 4.1

Mercury levels in fish from Sarpa lake (Krasnoarmeiskiy district; perch), the Volga river (Svetloyarskiy districts; catfish) and "Kaustik" facility wastewater pond (crucian) nearby Volgograd (Russia)

	Sample size	Average Hg (ppm, ww)	Standard deviation	min Hg (ppm)	max Hg (ppm)	Safe[2] impact level (ppm)	Sample HG to limit ratio	Limits[3] (ppm)
All fish samples	30	0.443	0.157	0.187	0.843	0.22	97%	0.5
Perch	10	0.468	0.157	0.269	0.786	0.22	100%	0.5
Crucian	10	0.362	0.138	0.187	0.613	0.22	90%	0.5
Catfish	10	0.498	0.156	0.264	0.843	0.22	100%	0.5

Abbreviations: Hg — mercury; ppm — parts per million of mg/kg; ww — wet weight; min. — minimal; max-maximal.

In Table 4.2. information about mercury levels in hair samples of volunteers is shown. The samples were collected in two locations nearby "Kaustik" JSC facility. The Table contains information for all samples collected in Volgograd in the course of the study.

The average THg level in all hair samples of 28 volunteers from Krasnoarmeiskiy district of Volgograd and Raigorod township exceeded the US MAC almost twice. The MAC was exceeded for almost two thirds of the persons surveyed. The maximal THg (total mercury contents) in hair samples exceeded the MAC almost 5.5 times. Clear differences in THg concentrations in hair were observed between two groups of persons. Higher mercury levels in hair samples from Raigorod township in comparison to residents of Krasnoarmeiskiy district may be attributed to higher age of the participants and to some differences in food rations. The average age of participants from Raigorod township reached 46 years, while the average age of volunteers from Krasnoarmeiskiy district reached 29.5 years. Additionally, volunteers from Raigorod more often eat fish comparatively to volunteers from Krasnoarmeiskiy district.

Table 4.2.

Mercury levels in hair samples from Krasnoarmeiskiy district and Raigorod township. Both territories are located nearby "Kaustik" JSC facility in Volgograd

	Number of samples	Average Hg (ppm, ww)	Standard deviation	min Hg (ppm)	max Hg (ppm)	Dose limits[4] (ppm)	Sample HG to limit ratio
All hair samples	28	1.928	1.509	0.003	5.470	1.00	67%
Krasnoarmeiskiy district	14	1.524	1.256	0.100	4.240	1.00	64%
Raigorod township	14	2.332	1.674	0.003	5.470	1.00	71%

Abbreviations: Hg — mercury; ppm — parts per million of mg/kg; min. — minimal; max-maximal.

ECONOMIC IMPLICATIONS OF MERCURY IMPACTS

In particular, the NGO data for Volgograd were used for development of the research paper "Economic implications of mercury exposure in the context of the global mercury treaty: hair mercury levels and estimated lost economic productivity in selected developing countries", which was published in the Journal of Environmental Management"[45]. The paper is the first reviewed research study dedicated to assessment of economic implications of mercury contamination in developing and transition countries.

The study assessed general potential income losses at the level of $ 77.4 million (for areas in 15 countries nearby the mercury pollution sources listed in the Minamata Convention). Governments agreed that these mercury sources belong to the most hazardous ones in the world. The study covers only a few contaminated areas; therefore, the study results allow one to assume that developing countries and transition economies would be able to avoid substantial economic losses due to timely implementation of measures for prevention of adverse mercury impacts.

That first reviewed study relies on information on mercury levels in samples of human hair submitted by 236 persons from 15 countries (namely: Albania, Bangladesh, Belarus, Cameroon, Cook Islands, India, Indonesia, Kenya, Mexico, Nepal, Russia, Sri Lanka, Tanzania, Thailand and Uruguay). The study participants reside nearby mercury pollution sources listed in the Minamata Convention. The Convention requires to identify, minimise and eliminate mercury pollution sources for protection of human health and the environment. Its provisions cover: chlor-alkali production (Article 5); artisanal and small-scale gold mining (ASGM) (Article 7); coal-fired power plants, waste incineration, production of non-ferrous metals, cement plants (Article 8); waste (Article 11); and contaminated areas (Article 12). Territories with mixed contamination patterns were also included into the study as many countries actually encounter such contamination patterns. One country from the group of small island developing countries (Cook Islands) was also included into the study to reflect global mercury contamination of oceans and associated contamination of fish.

What were the mercury levels found?

Mercury levels in hair samples of the study participants reached up to 13.30 ppm (parts per million or mg/kg). Average mercury levels varied from 0.48 mg/kg to 4.60 mg/kg in all 15 countries. In hair samples of 61% of the study participants mercury levels exceeded 1 mg/kg — i.e. the level approximately corresponding to the US EPA reference level. Updated estimates of the dose resulted in setting the limit of 0.58 mg/kg. In hair samples of 73% of the study participants mercury levels reached 0.58 mg/kg or higher.

What do standards of 1 mg/kg and 0.58 mg/kg mean?

Mercury concentrations in hair at the level of 1 mg/kg approximately correspond to the US EPA reference dose — i.e. the level of daily mercury impacts that — according to the Agency — "will not result in noticeable adverse life-long effects."[46] The limit of 0.58 mg/kg was proposed in line with the data that suggest adverse mercury impacts even at lower exposure levels.

Mercury affects the nervous system, kidneys and the cardio-vascular system. According to the World Health Organisation, "developing body systems (e.g. foetal nervous system) are particularly vulnerable to toxic mercury impacts … Other potentially affected systems include respiratory, gastric-intestine, haematological, immune and reproductive systems."[47] Human exposure to mercury is mainly associated with consumption of contaminated fish; however, rice and direct exposure to mercury vapour may also belong to substantial local pollution sources.

What are assessments of economic implications of mercury impacts at contaminated areas?

Based on the reference dose of 1 mg/kg, economic productivity losses were estimated at the level of $77.4 million. Without application of the reference dose, the estimate would reach $130 million.

[45] Trasande L, DiGangi J, Evers D, Petrlik J, Buck D, Samanek J, Beeler B, Turnquist MA, Regan K (2016) Economic implications of mercury exposure in the context of the global mercury treaty: hair mercury levels and estimated lost economic productivity in selected developing countries, Journal of Environmental Management 183:229–235, doi: 10.1016/j.jenvman.2016.08.058

[46] https://www.epa.gov/iris/reference-dose-rfd-description-and-use-health-risk-assessments

[47] "Guidance for Identifying Populations at Risk from Mercury Exposure," UNEP DTIE Chemicals Branch and WHO Department of Food Safety, Zoonosis, and Foodborne Diseases, 2008, p.4., http://www.who.int/foodsafety/publications/risk-mercury-exposure/en/

How were the economic implications estimated?

The study authors modelled mercury levels based on the assumption that mercury distribution among the population in areas where hair samples were collected would be similar for pregnant women as well — with associated mercury impacts on foetal health and subsequent IQ losses for children. Then, they collected birth rate data for specific areas to calculate lost IQ points/year and estimated economic impacts from lost IQ points based on results of their previous studies (1 lost IQ point was found to correspond to economic losses of $19269). The study authors used the latter figure to estimate relevant country-specific factors for IQ losses (due to differences in GDP) for calculation of economic losses from mercury impacts (in terms of lost IQ points) in every particular location covered by the study.

What does "lack of a reference level" mean in terms of economic estimates?

Lack of a reference level means that there is no safe levels for methylmercury impacts. Economic losses estimated without any reference level are higher as any level of methylmercury impacts is assumed to result in some IQ loss.

What are limitation of the study?

Potential effects of mercury emissions to the atmosphere may vary from local to global ones due to ability of mercury to long-range transfer; however, assessment of the transfer is outside the study coverage. Hair samples were collected only from a small share of general populations of individual contaminated areas and no formal representativeness tests were made. The modelling was based on linkages between IQ losses and life-long human economic productivity as estimated for the USA. Taking into account that technological development in low and medium income countries (LMICs) may be more intensive, economic productivity losses due to methylmercury impacts may be well underestimated. In the group of LMICs, major differences in rates of technological development exist, therefore the study might be prone to substantial inaccuracies (that may be aggravated by application of the methodology for one developed country). Due to lack of resources, a control group was not used in the study (persons residing far away from industrial sites).

Analytical results of the study suggest that mercury impacts in Russia result in annual economic losses from RUR 376 million to RUR 588 million. In 82% of hair samples, mercury levels exceeded 0.58 mg/kg.

The study provides just a small example of detrimental effects of mercury impacts for economic development of the country. Most likely, a similar situation exists in other contaminated areas of Russia. It is clear that major economic losses associated with mercury impacts should induce serious measures to address problems of mercury-contaminated areas.

Russian NGOs implemented a series of projects for identification of such contaminated areas and informing residents on mercury hazards to human health. Some results of these projects are provided below.

STUDY OF MERCURY CONTAMINATION IN KRASNODARSKIY KRAI[48,49]

The project was implemented in the territory of the mountainous forest zones of Abinskiy district of Krasnodarskiy Krai. Project activities covered an area of about 75 km^2. The territory includes several settlements: Kholmskaya, Sinegorie, Noviy and Grushki townships, with the overall population of about 23,000 residents (with Kholmskaya township as the main settlement). The Sakhalin mercury ore deposit is located at a distance of 15 km to the south from Kholmskaya township, at the foothills of the Greater Caucasus Mountain Range. Two main watercourses in the area include Khabl and Zybza rivers. According to local residents, in the recent 20–25 years, fish in the rivers have almost disappeared, and if one manages to catch a fish it may be seriously "infested by worms", so local residents eat only fish from the Kryukov water reservoir.

In the second half of the last century, "Krasnodarrtut" (a state-run industrial association) launched exploitation of mercury ore deposits at Sakhalin mining site nearby Noviy township. Initially, mining operations at the site went smoothly, three new underground mine galleries were cut, the ores had high cinnabar content and — as a result — production targets were met without problems. However, later on, symptoms of mercury poisoning were observed among miners. Additional measurements of air mercury levels in mines did not reveal elevated mercury concentrations, but numbers of mercury poisonings increased at alarming rates. The min-

48 http://www.ecoaccord.org/pop/final.pdf

49 http://www.ecoaccord.org/pop/final.pdf

ing facility managers decided to terminate ore extraction operations at Sakhalin ore deposit. But the mine stayed idle only for a short time, as inmates of a strict regime penitentiary facility (Novosadoviy township) were mobilised to work in particularly hazardous mines. The ore from the deposit was transported to the mercury processing plant in trucks, through three residential townships — the ore trucks did not even use covers.

The ore extraction operations included both open cast (with use of excavators) and underground mining. The mining activities at the site were cancelled due to worsening socioeconomic situations in the country, loss-making financial performance of the mining operations and poor management of the facility. In 1990, the underground mines at the site were closed, and in 1993 open cast operations were also cancelled. From 1993 to 1995, primary mercury was produced from earlier extracted ores, while since 1988 production of secondary mercury from mercury-containing products has been initiated at the former mercury plant (since 1998, the plant belongs to a private company — "Kubantsvetmet" JSC).

Now, "Kubantsvetmet" JSC includes a set of production facilities allowing to collect, store, transport, process and neutralise lead and mercury products. It is the only production facility in Russia that operates technologies and equipment for regeneration of lead and mercury. The plant's capacity allows it to process all types of secondary mercury-containing materials (up to 10 thousand tons/year) and produce commercial grade metal of up to 98.89% purity. Waste processing operations of the plant result in annual production of more than 20 tons of liquid mercury, which is further used by other production units of the facility. Recovered and refined to a purity of 99.99999%, mercury is used for production of mercury compounds — the facility produces mercury nitrate, sulphate, chloride, thiocyanate, sulphide and iodide.

Production unit "Ekotrom-2" at the facility processes fluorescent lamps of up to 45 mm diameter (up to 500 lamps/hour). In 1998, the plant commissioned a reverberator kiln for processing of scrap lead, allowing for processing of up to 15 tons of feedstocks /day and secondary lead recovery level over 99.0%. In 2000, some production capacity of "Kubantsvetmet" JSC was transferred to the newly established private company — Mercury Safety Agency Co. Now, the facility receives mercury-containing waste (up to 1.5 million mercury-containing bulbs only), waste rubber, paints, plastics, liquid waste of oil refineries, clinical waste, outdated office equipment, alcohol-containing waste, animal husbandry waste, waste paper and board. In 2012, Mercury Safety Agency Co. attempted to construct a major waste incineration plant (a unique one for Russia) near the Kholmskaya township. The plant was intended to incinerate up to 50 thousand tons of hazardous waste, including oil slurries, oil-contaminated soil, chemical production waste, electric appliances, instruments, devices and their components, waste acids and alkaline substances, food and agricultural waste.

Due to protests of local residents and the company's own failure to comply with the due legislation in the course of EIA procedures, the incinerator project was not authorised for implementation. However, according to local residents of Kholmskaya township, incineration units were nevertheless installed and now operate illegally.

In Krasnodarskiy Krai, mercury levels in environmental media are almost never controlled. Levels of lead, benz(a)pyrene, zinc, cadmium, organochlorine and organophosphorus compounds are monitored only in major cities and in large rivers of Krasnodarskiy Krai. Information on contamination by heavy metals may be found only in reports on research studies at specially protected territories of Krasnodarskiy Krai, including the Caucasian Biosphere Reserve (located to the southeast from Abinskiy district). The studies were implemented in the mid-1990s[50].

The study of mercury levels in water, soils and fish in the course of the Volgograd Ecopress NGO project was actually the first such study in the last 15 to 20 years. While interviewing residents of Kholmskaya township, they learned of large numbers of cancer-related deaths in 5 recent years among adult residents (aged from 35 to 70 years) on one street of Kholmskaya township, and high incidence of leucosis cases in adjacent Chernomorskiy and Pervomaiskiy communities. In comparison with other districts of Krasnodarskiy Krai, Abinskiy district demonstrates the worst rate of mortality from cardiovascular diseases in employable age.

Now, the RF Government is responsible for the site as it is considered a historical environmental liability. The site may be rehabilitated under the Federal Dedicated Program for Elimination of Historic

[50] https://natural-sciences.ru/ru/article/view?id=9409

Environmental Liabilities; however, the particular site is not incorporated into the Program.

No plans exist now for cleaning and rehabilitation of the area. After decommissioning of the ore mining site "Kubantsvetmet" Co. planned to process more than 7 thousand tons of ore (or about 6 tons of mercury), that were stockpiled nearby the plant. The same plant planned to process another ore stockpile (30 thousand tons or about 25 tons of mercury) nearby former mines and the open pit of Sakhalin ore deposit (former mining facilities). However, no information is available on the implementation of these plans.

From the range of 4 selected potential pollution sources (the mercury mining site, facilities of "Kubantsvetmet" and the Mercury Safety Agency, and the waste incinerator), local residents particularly focused on the Mercury Safety Agency and the waste incineration plant (that is not officially operational yet).

Notwithstanding rather high awareness of local residents of potential adverse environmental impacts of the industrial facilities, they continue to eat mushrooms and berries from forests in vicinity of the facilities, as well as fish caught downstream of the plants. The surveyed residents proposed rather radical measures to improve the situation — i.e. to close all these facilities or some of them.

At the second stage of the project activities (in February — March 2015), a field visit was organised for sampling. Fish samples were taken from the Khabl river (5 samples) and from the Kryukov water reservoir (1 sample). The sampling process was conducted with participation of local residents of Kholmskaya township and representatives of the Abinskiy district Administration. All analysed fish samples were found to contain mercury in different concentrations, and in three fish samples MACs for mercury in fish were exceeded (0.3–0.4 mg/kg).

Target groups of the project included representatives of authorities of Krasnodarskiy Krai and Abinskiy district, managers of the mercury-processing facilities and local residents. Representatives of the Abinskiy district Administration were involved into the project implementation activities from its earliest stage — in selection of sampling locations and in taking samples in the vicinity of the "Kubantsvetmet" facility. In the course of communicating with local residents at sampling sites, the representative of the Administration assured them that the District Administration is ready to serve as an active mediator in settling conflicts between the facility and local residents. The process is associated with permanent conflicts due to unwillingness of the managers to maintain an open information policy and due to their specific production plans (e.g. with intentions of the Mercury Safety Agency to expand its hazardous waste processing operations).

In the course of discussions on the problem and prospective activities in the future, the district residents expressed their serious concerns in connection with virtually non-existent pollution control and environmental monitoring activities in the district. They recommended to implement similar research activities in connection with environmental contamination by lead and other heavy metals.

MERCURY CONTAMINATION IN THE VOLGA RIVER BASIN[51,52]

The majority of historic environmental liability sites — chemical plants — are located in Povolzhie regions (Priovolzhskiy and Central Federal Districts). Such locations include: Kirovo-Chepetsk (Kirovskaya oblast), Sterlitamak (Bashkortostan Republic), Volgograd (Volgograndskaya oblast), Dzerzhinsk (Nizhegorodskaya oblast), Saransk (Mordovia Republic), and several sites and facilities in the territory of Moskovskaya oblast, etc. In 2014, the RF Supervisory Natural Resources Management Service reported an absence of mercury emission sources in the territory of Provolzhskiy Federal District. NGOs question such information.

Dzerzhinsk is the largest chemical industry centre in Russia. According to the RF Hydrometeorological Service, in 1988, production facilities of Dzerzhinsk emitted annually 0.14 tons of mercury into the atmosphere. From 1948 to 1982, a chlor-alkali production unit with mercury cells operated on the site of "Kaprolaktam" plant.

After decommissioning of "Kaprolaktam" plant in 2013 (including the northernmost chlorine production unit operating in the open), the plant site belongs now to Industrial Park "Oka-polimer" JSC. According to a representative of SPES NGOs, contemporary managers of the industrial park refuse to provide information on waste amounts.

"Sintez" Plant in Dzerzhinsk produced granozan pesticide (ethyl mercury chloride) from 1952 to 1989. The production capacity varied from 5 to

[51] http://www.ecoaccord.org/pop/final.pdf

[52] http://www.ecoaccord.org/pop/final.pdf

200 tons of the pesticide per annum. Furthermore, in the period from 1985 to 1989, granozan waste was buried on the production site. According to information for 2015, the pesticide production facility was not fenced. Access to the mercury contaminated site is restricted only by a warning sign and a written notification of the site leaseholders. Production constructions of the granozan unit and local wastewater treatment installations are dilapidated; moreover, these constructions are contaminated by mercury. The site also includes 22 containers (1 m^3 each) with mercury-containing waste (waste charcoal with 5% mercury content — 20 tons of mercury waste or up to 1 ton of mercury). The waste storage fails to meet applicable environmental requirements as the containers leak.

Other mercury pollution sources in Povolzhie

• "Volosyanikha" channel in Dzerzhinsk suburbs that was used for wastewater discharges since 1939 (bottom sediments of the channel contain mercury, PCB, dioxins, DDT, arsenic and HCB);

• 3 illegal burials of pesticides in the Oka river water protection zone (2006–2008), including DDT and granozan;

• In the course of public inspection by SPES NGO, at "Igumnovo" landfill (located between Nizhniy Novgorod and Dzerzhinsk), a major burial of mercury-containing bulbs and e-waste was found.

During project implementation in Povolzhie, information was collected on main sources of mercury pollution in Provilzhskiy Federal District. Information requests were sent to facilities that had earlier produced chlorine and granozan. In the territory of Nizhegorodskaya oblast, samples of bottom sediments, soils and landfill leachate were collected. Information on coal and fuel oil boilers was collected to assess mercury emissions. And information was collected on numbers of burnt mercury-containing lamps being collected annually in Nizhegorodskaya oblast and on facilities that process them.

HAZARDOUS WASTES TO THEIR PLACE — THE PROJECT FOR ADDRESSING THE PROBLEM OF MERCURY-CONTAINING WASTE IN IRKUTSK[53]

Notwithstanding broad application of mercury-containing lamps in household settings, the system of their collection is just starting to develop. In Irkutsk, "Baikal Ecological Wave" NGO implemented its project — "Toxic wastes to their place!" — dedicated to addressing the problem of mercury-containing waste. The project was intended to raise awareness of Irkutsk residents on hazards of mercury health impacts, on mercury pollution sources and mercury-containing consumer goods. They particularly focused on collection and processing of mercury-containing energy-efficient bulbs. In the framework of the project, actions were conducted to collect burnt mercury lamps from the city residents.

According to the NGO, burnt energy efficient bulbs in Irkutsk are collected only by two remotely located facilities, so the city residents do not use their services. Mobile collection units organised by the NGO were found to be of high demand among the city residents.

Similar mobile units for collection of burnt mercury-containing bulbs are organised in many cities. In 2013, a mobile mercury waste collection units operated in the capital city of Karelia Republic (Petrozavodsk). Within one year, Petrozavodsk residents returned about 4 thousand mercury-containing bulbs. In 2012, in Naberezhnye Chelny (Tatarstan Republic), 12 containers were installed for collection of burnt mercury-containing bulbs, broken thermometers and used batteries. A facility for collection of mercury-containing lamps was organised in Ufa (the capital city of Bashkortostan Republic). Additionally, «Ecomobile» action is implemented in the republic, covering such cities as Uchaly, Neftekamsk and Tuimazy.

In September 2013, in Cheboksary (the capital city of Chuvashia Republic), 10 containers for collection of mercury-containing bulbs were installed. In November 2013, the administration of Kotelnicheskiy district (Kirovskaya oblast) issued its Order on approval of procedures for collection of burnt mercury-containing lamps at the territory of Birtyaevskoye rural settlement.

CONCLUSIONS

The projects with involvement of Russian NGOs are directly associated with meeting requirements of the Minamata Convention, including the ones of relevance to identification of contaminated sites. These activities are of major importance for local residents, allowing them to get information on risks of mercury contamination of food products and on sources of mercury releases to the environment. The data collected by NGOs on mercury levels in envi-

[53] http://www.ecoaccord.org/pop/final.pdf

ronmental media, food products and human hair also allows authorities and industrial facilities to understand the problem of mercury pollution better. The information of NGOs should be used as a base for immediate actions for reduction of adverse health impacts.

Other projects of NGOs are equally vital, such as projects for reduction of production and consumption of mercury-containing products (including energy efficient bulbs) and for collection of household mercury-containing waste. These projects are of major importance for meeting requirements of the Minamata Convention by the Russian Federation. NGOs work with both residents and producers, requiring in the course of their campaigns to disclose information on mercury in products and to apply safety marking for products. These campaigns seek to ensure rapid phase-out of mercury-containing products and waste, including in general waste flows for disposal or incineration.

CHAPTER 5

PROPOSALS FOR THE NATIONAL ACTION PLAN FOR MERCURY MANAGEMENT IN THE RUSSIAN FEDERATION

To fulfil its obligations under the Minamata Convention, every Party (i.e. a country that has ratified the Convention), according to Art. 20, may develop a plan for the Treaty implementation — the National Action Plan (NAP). The Convention does not stipulate any deadlines for development of such a Plan. When a NAP is developed and approved for implementation, it should be submitted to the Convention Secretariat. Later on, the Party may review and update its implementation plan, taking into account its domestic circumstances and referring to guidance from the Conference of the Parties and other relevant guidance.

As NAPs are designed to define measures necessary for fulfilment of commitments under the Convention, the relevant proposals are developed based on article-by-article analysis of the Convention, as provided below.

MERCURY SUPPLY SOURCES AND TRADE (ART. 3)

According to Art. 3, **primary mercury mining** should be prohibited. Such prohibitions are imposed depending on conduction of primary mercury mining at the Party's territory. If a Party conducts primary mercury mining, the prohibition should be imposed not later than in fifteen years from the date of entry of the Convention into legal force. Otherwise, the prohibition should be imposed from the date of entry of the Convention into legal force. Now, primary mercury mining is not conducted in Russia, but it is not prohibited — as a result, the date of prohibition will depend on conduction of primary mining. The Ministry of Natural Resources and Environment of the Russian Federation is authorised to impose such a prohibition.

Additionally, Art. 3 of the Convention stipulates that each Party **should endeavour** to identify individual **stocks of mercury or mercury compounds** exceeding 50 tons, as well as **sources of mercury supply** generating stocks exceeding 10 tons per year, that are located within its territory.

Since the 1990s, mercury use in Russia substantially decreased due to decommissioning of some chlor-alkali plants with mercury cells, transition to application of mercury-free technologies, cessation of production of mercury-based batteries and cells, etc.

Now, mercury (mercury cathodes and mercury catalysts) is used by three chlor-alkali plants: "Bashkir Soda Company" JSC ("Kaustik" plant in Sperlitamak, Bashkortostan Republic), "GaloPolimer Kirovo-Chepetsk" JSC in Korivo-Chepetsk (Kirovskaya oblast) and "Kaustik" JSC in Volgograd (Volgogradskaya oblast). According to the global register of mercury-using chlor-alkali plants, in 2015, use of mercury by these three Russian facilities reached 20.8 tons.

"Novosibirsk Chemical Concentrates Plant" JSC in Novosibirsk still remains a major mercury user (about 24 tons/year).

Overall use of mercury by all producers of fluorescent lamps and mercury thermometers does not exceed 9 tons/year.

In Russia, major mercury producers (more than 10 tons/year) include "Kubantsvetmet" JSC (Krasnodarskiy Krai, Abinskiy district, Kholmskaya township) and "Merkom" JSC (Moskovskaya oblast, Lytkarino, Turaevo township). They produce mercury from mercury-containing waste. Now, these producers do not operate their full production capacity due to low amounts of wastes supplied for processing. As the mercury production is insufficient to meet demands of Russian producers, mercury is periodically imported to the country.

Therefore, currently both economic actors that produce (recover) mercury and the ones that use mercury and its compounds are known. At the same time, there are no economic actors that use mercury and mercury compounds with individual stocks over 50 tons. Sources of mercury supply (producers) generating over 10 tons/year include "Kubantsvetmet" JSC and "Merkom" JSC.

The third obligation under Art. 3 includes the requirement that if **excess mercury** from the decommissioning of chlor-alkali facilities is available, such mercury should be **disposed of in accordance with the guidelines for environmentally sound management**, using operations that do not lead to recovery, recycling, reclamation, direct re-use or alternative uses.

As a Party of the Basel Convention, the Russian Federation incorporated relevant international legal norms into its national legislation. As a result, the Russian legislation on waste management stipulates provisions on environmentally sound waste management.

Accounting for the above considerations, the Russian legislation should be amended to stipulate that excess mercury from the decommissioning of chlor-alkali facilities should be disposed of in an environmentally sound manner according to the waste management legislation and should not be recycled.

Another requirement of Art. 3 of the Convention includes **prohibition of mercury exports**, except for allowed uses or for safe interim storage, **and prohibition of mercury imports**, if the mercury originates from prohibited sources. As the Russian legislation does not provide for such prohibitions, they should be set, accounting for provisions of the Convention.

In particular, it is necessary to prohibit import of mercury from a non-Party, unless the non-Party has provided certification that the mercury is not from sources identified as not allowed (i.e. from primary mining or from decommissioned chlor-alkali plants). As pertains to mercury from other sources, the already-established regulatory approval procedures for import of metal mercury will remain in force.

Aside from that, mercury exports should be prohibited. The prohibition should not cover cases of mercury exports to the territory of a Party that provides its written consent (including certification) demonstrating that such mercury will be used only for a use allowed to the importing Party under this Convention or for environmentally sound interim storage as set out in Article 10. The prohibition also should not cover cases of export to the territory of a non-Party that has provided its written consent, including certification demonstrating that the importing country has measures in place to ensure the protection of human health and the environment and to ensure its compliance with the provisions of Articles 10 and 11. The importing country should also confirm that the mercury will be used only for a use allowed under the Convention or for environmentally sound interim storage as set out in Article 10.

MERCURY-ADDED PRODUCTS (ART. 4)

Article 4 of the Convention stipulates **prohibition of import, export and production of mercury-added products**, listed in Part I of Annex A, after the phase-out date specified for those products. The prohibition covers 9 product groups, including: batteries, relays and switches, fluorescent lamps, general purpose lamps, cosmetics, pesticides, biocides, topical antiseptics and non-electronic instruments. As an alternative, different measures may be implemented in connection with the products listed in Part I of Annex A, if the Party can demonstrate that it has already reduced to a de minimis level the manufacture, import, and export of the large majority of such products.

The Russian Federation produces mercury-added products listed in Part I of Annex A, that are exported and imported. Their production, export and import are not prohibited.

If application of the above alternative seems impossible, it is necessary to impose the prohibition by means of relevant legislative amendments. Terms of enactment of the relevant legislation depend on registration (in necessary cases) of exemptions as foreseen by Art. 6 of the Convention (i.e. delaying prohibition of a product — up to January 01, 2030). Exemptions may cover all or only some goods (products) listed in Part I of Annex A.

Furthermore, according to Art. 4, **measures should be taken to prevent the incorporation of mercury-added products into assembled products,** the manufacture, import and export of which are not allowed. As the Russian legislation does not stipulate any relevant restrictions, their introduction should be provided for in the NAP.

Another obligation under Art. 4 is associated with the need to **apply** two or more **measures**, specified in Part II of Annex A. So far, Part II of Annex A specifies measures only **in connection with dental amalgam**, which is applied in Russia without any restrictions. Accounting for these considerations, we propose to include some measures into the NAP for development of an action plan including the measures listed in Part II of Annex A. The plan should seek to reduce application of dental amalgams, accounting for internal circumstances and relevant international guidelines.

In the case of new products (new equipment, technologies, substances), the Russian legislation provides for state environmental appraisal at the federal level to evaluate their compliance with the environmental requirements due. In addion to that, works should be implemented to ensure safety of new products for human health (i.e. to ensure their compliance with the due sanitary and epidemiological requirements). Therefore, no additional legislative amendments would be needed to fulfil obligations under Art. 4 on prevention of production and sale of products that do not meet environmental, sanitary and epidemiological requirements. Accounting for these considerations in connection with the obligation under Art. 4, measures for ensuring compliance with these provisions of the Russian legislation may be incorporated into the NAP.

Measures for disclosure of information on new mercury-added products may be also included into the NAP. According to Art. 4 of the Convention, a similar requirement is of voluntary nature, and it is important to specify that in the NAP. The information should include risk assessments for such products, as well as information on their health or environmental benefits.

MANUFACTURING PROCESSES IN WHICH MERCURY OR MERCURY COMPOUNDS ARE USED (ART. 5)

Art. 5 of the Convention stipulates the following commitments:

- **prohibition of application of mercury or mercury compounds in manufacturing processes, listed in Part I of Annex B** (from 2018 for acetaldehyde production and from 2015 for chlor-alkali production), except in cases of registered exemptions (phase-out rescheduling) according to Art. 6;
- **taking measures to restrict application of mercury or mercury compounds in processes listed in Part II of Annex B** (production of vinyl chloride monomer, sodium or potassium methylate/ethylate, production of polyurethane with application of mercury-containing catalysts), according to relevant provisions;
- **taking measures for identification of facilities that apply mercury (mercury compounds) in manufacturing processes, listed in Annex B,** and submission — not later than 3 years after the date of ratification of the Convention — of information on the number and types of such facilities and the estimated annual amount of mercury or mercury compounds used in those facilities, and on addressing releases of mercury or mercury compounds from these facilities;
- **prohibition of application of mercury (mercury compounds) at new sites that use production processes listed in Annex B,** as well as taking measures to prevent establishment of new production facilities that use mercury (mercury compounds), except in cases when relevant production processes provide substantial health and environmental benefits or when mercury-free alternatives are not available.

Now, mercury is used by three chlor-alkali plants: “Bashkir Soda Company” JSC, “Kaustik” plant, “GaloPolimer Kirovo-Chepetsk” JSC and “Kaustik” JSC. The mercury method is not applied for production of acetaldehyde in Russia. As no prohibitions are imposed on use of mercury or mercury compounds, it is necessary to register an exemption (to delay phase-out) according to Art. 6 of the Convention. To this end, a motivated substantiation should be submitted. Additionally, development of some measures might be required for gradual phase-out of mercury use in chlor-alkali production. Introduction of prohibitions for application of mercury (mercury compounds) in manufacturing processes, listed in Part I of Annex B, would require amendments to the Russian legislation. The effective date of such a prohibition for mercury use in chlor-alkali production would depend on duration of a registered exemption (or the lack of it).

As pertains to the processes, listed in Part II of Annex B, only “Kaustik” JSC in Volgograd applies mercury-containing catalysts for production of vinyl chloride monomer. Mercury-containing catalysts are not used for production of sodium and potassium methylate/ethylate and polyurethane. With this in mind, it is necessary to take measures, stipulated by Part II of Annex B, for VCM production, including reduction of mercury use per unit of output by 50% by 2020 comparatively to 2010.

As facilities with the production processes listed in Annex B have been identified, information on their mercury use is available, and issues of relevance to their emissions and discharges of mercury (mercury compounds) are settled legislatively. Therefore, the NAP may include measures for acting on (from the moment of submission to the Convention Secretariat) the information on estimated annual consumption of mercury (mercury compounds) by production facilities with technological processes listed in Annex B (including information on numbers and types of such production facilities).

Notwithstanding that new production facilities apply mercury-free technologies, no prohibitions exist for application of mercury (mercury compounds) in production processes, including their application by new facilities — therefore, the NAP should provide for introduction of relevant bans by means of amending the due legislation (with effective dates depending on the date of ratification of the Convention).

ARTISANAL AND SMALL-SCALE GOLD MINING (ART. 7)

Art. 7 of the Convention contains obligations in connection with artisanal and small-scale gold mining and processing in which mercury amalgamation is used to extract gold from ore.

Provisions of Art. 7 do not apply to the Russian Federation as application of mercury in gold mining was prohibited by Order # 124 of the USSR State Committee on Precious Metals of 29.12.1988 (Order on Elimination of mercury use (amalgamation) in technological processes for clarification of gold-bearing ores and sands).

EMISSIONS AND RELEASES (ARTICLES 8 AND 9)

Art. 8 concerns controlling and, where feasible, reducing emissions of mercury and mercury compounds to the atmosphere through measures to control emissions from the point sources falling within the source categories listed in Annex D.

Similarly, Art. 9 concerns controlling and, where feasible, reducing releases of mercury and mercury compounds to land and water from the relevant (significant anthropogenic) point sources not addressed in other provisions of this Convention.

The majority of obligations under Articles 8 and 9 are secured by already-adopted provisions of the RF legislation. In particular, within 5 years after ratification of the Convention, Parties should develop and then maintain **inventories of emissions of mercury and mercury compounds from sources** falling within the source categories listed in Annex D, **and releases of mercury and mercury compounds from any significant anthropogenic sources.** These should be identified within 3 years after ratification of the Convention and then should be identified continuously.

In Russia, the state register of sites with adverse environmental impacts was developed and is maintained (the Register) as a state information system[54]. In the course of registration of such sites, they are categorised into 4 categories depending on the intensity of their environmental impacts. The first category covers sites with significant adverse environmental impacts that are subject to application of the best available technologies.

Source categories listed in Annex D correspond to types of activities subject to application of BATs — i.e. source categories of Annex D (referred to as relevant sources for purposes of Art. 8 of the Convention) belong to source category I according to the Russian legislation.

The Register contains quantitative data on pollutant emissions and releases of the sources (including mercury and mercury compounds).

The Register allows for identification of significant sources of releases of mercury and mercury compounds (or relevant sources for purposes of Art. 9 of the Convention — for purposes of fulfilling obligations under para 3 of Art. 9 of the Convention).

Additionally, the Register is a system that allows for compilation of data on emissions and releases of mercury and mercury compounds, as well as on their sources — i.e. to maintain a register of emissions and releases from relevant sources for fulfilling obligations under para 7 of Art. 8 and para 6 of Art. 9 of the Convention.

Accounting for these considerations, the NAP may include measures for identification of source categories with significant releases of mercury (mercury compounds) based on the Register data with subsequent continuous identification of such source categories and compilation of data on emissions and releases of mercury (mercury compounds) from relevant sources.

In connection with existing sources, Parties should take **measures to control emissions and releases** such as:

- Setting a quantified goal for controlling and, where feasible, reducing emissions/releases from relevant sources;
- Setting emission limit values for controlling and, where feasible, reducing emissions/releases from relevant sources;
- Using best available techniques and best environmental practices to control emissions/releases from relevant sources;
- Formulating a multi-pollutant control strategy that would deliver co-benefits for control of mercury emissions/releases;
- Taking alternative measures to reduce emissions/releases from relevant sources.

[54] http://www.profiz.ru/eco/3_2016/gos_uchet_nvos/

Accounting for existing legal provisions in the Russian legislation, the following measures are proposed for incorporation into the NAP:

- gradual development of sectoral technical and information guidelines on best available technologies, applicable to relevant sources, and — whenever appropriate — accounting for guidance on best available technologies and best environmental practices adopted by the Conference of Parties;
- setting technological parameters of best available technologies (limit values for mercury emissions and releases) for relevant source categories by environmental standards and regulations;
- incorporation of technological standards into comprehensive environmental permits for setting limit values for mercury emissions and releases for controlling and, where feasible, reducing emissions/releases from relevant sources;
- phased transition (from 2019) to application of best available technologies at facilities with significant adverse environmental impacts (1st category sites) that belong to relevant sources.

Furthermore, according to Articles 8 and 9 of the Convention, a Party may prepare a national plan (or plans that might be incorporated into a NAP) setting out the measures to be taken to control emissions/releases and its expected targets, goals and outcomes.

Accounting for the voluntary nature of the obligations on the national plan on emissions and releases, the above measures for implementation of measures for control of emissions/releases may be incorporated into the NAP as a separate block or may be presented separately from the NAP.

The expected targets, goals and outcomes should be defined at a later stage of implementation of the Convention, relying on analysis of actual emissions and releases in dynamics. To this end, we propose to incorporate measures for assessment of dynamics of mercury emissions and releases into the NAP (allowing also to assess efficiency of the measures taken).

Art. 8 of the Convention separately stipulates obligations to apply best available techniques and best environmental practices for control of emissions of new source categories listed in Annex D, and — whenever feasible — for reduction of emissions, not later than within five years after the date of ratification of the Convention. Emission limit values compatible with application of best available techniques may be applied voluntarily.

According to the Russian legislation, starting from 2019, technological parameters of best available technologies will be applied for design, construction and reconstruction of facilities of the first category sources. As it was already noted, the source categories listed in Annex D belong to types of activities subject to application of best available technologies (with approval of relevant sectoral technical and information guidelines). From 2019, the control of compliance with the requirement to apply technological parameters of best available technologies in the course of design, construction and reconstruction of 1st category sources will be conducted in the course of issuance of comprehensive environmental permits.

Accounting for the above considerations, we propose to incorporate measures into the NAP to ensure control of compliance with the requirement to apply technological parameters of best available technologies for design, construction and reconstruction of facilities of the first category source that belong to source categories listed in Annex D to the Convention, and that will be commissioned within five years from the date of ratification of the Convention.

ENVIRONMENTALLY SOUND INTERIM STORAGE OF MERCURY, OTHER THAN WASTE MERCURY (ART. 10)

Art. 10 deals with interim storage of mercury and mercury compounds and it does not cover mercury wastes.

Measures are required to ensure that the **interim storage of mercury and mercury compounds intended for a use allowed to a Party under this Convention is undertaken in an environmentally sound manner**, taking into account any guidelines and according to any requirements adopted by the Conference of Parties.

As the Russian legislation sufficiently regulates issues of safe storage of mercury (mercury compounds), and guidelines or manuals on environmentally sound interim storage of mercury under control have not been adopted yet by the Conference of Parties, we propose to include measures to the NAP stipulating introduction of amendments into the legislation (if deemed necessary) to account for relevant requirements after their adoption by the Conference of Parties.

Art. 10 also provides recommendations on **cooperation** of Parties with each other and with relevant intergovernmental organizations and other entities, **to enhance capacity-building for the environmen-**

tally sound interim storage of such mercury and mercury compounds.On this point, we propose to include measures to the NAP that are similar to the recommendations.

MERCURY WASTES (ART. 11)

Art. 11 stipulates obligations of Parties to take the following measures:

• for **management of mercury wastes in an environmentally sound manner**, taking into account the guidelines developed under the Basel Convention and in accordance with requirements that the Conference of the Parties will adopt in an additional annex to the Convention;

• for application of **recovered, recycled, reclaimed or directly re-used mercury waste solely for a use allowed to a Party** under this Convention **or for environmentally sound disposal** according to the above obligation;

• **for prohibition to Parties to the Basel Convention, to transport mercury waste across international boundaries except for the purpose of environmentally sound disposal**.

As a Party of the Basel Convention, the Russian Federation incorporated relevant international legal norms into its national legislation. The Russian legislation on waste management contains provisions that confirm application of the necessary measures (except accounting for the requirements that the Conference of the Parties will adopt in an additional annex to the Convention). Taking into account that measures for reduction of use of mercury and mercury compounds are stipulated by Articles 3–5 of the Convention (see above the proposals on measures under Articles 3–5 of the Convention for incorporation into the NAP), in connection with Article 11 we propose to include measures of introduction of amendments into the RF legislation (if deemed necessary) to account for the relevant requirements after their adoption by the Conference of Parties.

Article 11 also recommends Parties to **cooperate** with other Parties, with relevant intergovernmental organisations and other entities **for development and maintenance of global, regional and national capacity for environmentally sound management of mercury wastes**. We therefore propose to incorporate similar measures to the NAP.

CONTAMINATED SITES (ART. 12)

According to Art. 12, Parties should **endeavour to develop appropriate strategies for identifying and assessing sites contaminated by mercury or mercury compounds**. Any **actions to reduce the risks** posed by such sites should be performed in **an environmentally sound manner** incorporating, where appropriate, **an assessment of the risks to human health and the environment** from the mercury or mercury compounds they contain.

In the Russian Federation, a system of measures is applied for identification and assessment of land areas contaminated by heavy metals (including mercury or mercury compounds), as well as for actions (including risk assessments) to prevent land contamination by chemicals, production and consumption waste, and other adverse impacts. Taking into account the above considerations, as well as implementation of the measures recommended by Art. 12 by relevant federal executive bodies, we propose to incorporate these measures into the NAP, namely:

• identification and assessment of sites contaminated by mercury or mercury compounds in the course of state land monitoring;

• organisation and conduction of state environmental appraisal (at the federal level) of projects for rehabilitation of lands contaminated by mercury or mercury compounds, and other projects for mitigation of mercury contamination of land (the appraisal materials incorporate EIA materials with assessments of health and environmental risks of proposed activities).

Similarly to recommendations on cooperation in Articles 10 and 11, recommendations on cooperation of Parties in Art. 12 (in developing strategies and implementing activities for identifying, assessing, prioritizing, managing and, as appropriate, remediating contaminated sites) should be reflected in the NAP. Moreover, as — in addition to these Articles — cooperation-related recommendations are also included into Articles 14 and 19, including cooperation for purposes of information exchange (Articles 5 and 17), in the NAP relevant measures may be grouped into one measure or into a separate block.

CAPACITY-BUILDING, TECHNICAL ASSISTANCE AND TECHNOLOGY TRANSFER (ART. 14)

According to Art. 14, Parties **are recommended to cooperate to provide, within their respective capabilities, timely and appropriate capacity-building and technical assistance to developing country Parties, and Parties with economies in transition**.

A relevant measure is proposed for incorporation into the NAP with a clarifying note on its implementation where feasible.

HEALTH ASPECTS (ART. 16)

Obligations under Art. 16 are of an advisory nature and include the following:

- **Promote the development and implementation of strategies and programmes to identify and protect populations at risk**, particularly vulnerable populations, and which may include adopting science-based health guidelines relating to the exposure to mercury and mercury compounds, setting targets for mercury exposure reduction, where appropriate, and public education, with the participation of public health and other involved sectors;
- **Promote the development and implementation of science-based educational and preventive programmes** on occupational exposure to mercury and mercury compounds;
- **Promote appropriate health-care services** for prevention, treatment and care for populations affected by the exposure to mercury or mercury compounds**;**
- **Establish and strengthen, as appropriate, the institutional and health professional capacities** for the prevention, diagnosis, treatment and monitoring of health risks related to the exposure to mercury and mercury compounds.

The advisory provisions of Art. 16 are covered by the measures applied in the Russian Federation to ensure chemical security, including protection from threats of health impacts of mercury and mercury compounds.

We propose to incorporate into the NAP the following measures that are implemented for sanitary, epidemiological and public health support of protection of human health from threats of hazardous chemical impacts, including impacts of mercury and mercury compounds:

- development of a legal and regulatory framework for reduction of adverse health and environmental impacts of hazardous chemicals, including introduction of sanitary and epidemiological requirements ensuring safe and healthy environment;
- development of programs in the sphere of chemical security;
- implementation of programs and projects in the sphere of chemical security;
- federal and state sanitary and epidemiological supervision, medical and sanitary support for workers in specific industries with particularly hazardous workplace conditions;
- ensuring security of critically important chemical industry sites to minimise or eliminate hazards of adverse health and environmental impacts of their technological processes, products and wastes;
- protection of workers from hazardous chemicals;
- professional training of medical sanitary and epidemiological specialists, their retraining, refresher training and in-work training for ensuring chemical safety of the population;
- prevention of occupational diseases and poisonings caused by super-ecotoxicants;
- monitoring of hazardous chemicals and associated chemicals-induced diseases for prediction of chemical hazards and taking planned and extraordinary sanitary and epidemiological measures to ensure chemical safety of the population and the environment;
- identification of causes and conditions of emerging and spreading diseases (poisonings) by means of specialised sanitary and epidemiological investigations, identification of causal linkages between human health and the living environment;
- swift response to emergencies associated with releases of hazardous chemicals into the environment;
- control of implementation of the state policy in the sphere of ensuring chemical security and federal and state sanitary and epidemiological supervision for health protection and ensuring sanitary and epidemiological well-being of the population;
- providing public information on matters of ensuring chemical security with use of mass media outlets, information dissemination and awareness-raising materials.

INFORMATION EXCHANGE (ART. 17)

According to Art. 17, Parties **are recommended to facilitate exchange of the following information**:

- Scientific, technical, economic and legal information concerning mercury and mercury compounds, including toxicological, eco-toxicological and safety information;
- Information on the reduction or elimination of the production, use, trade, emissions and releases of mercury and mercury compounds;
- Information on technically and economically viable alternatives to:

- Mercury-added products;
- Manufacturing processes in which mercury or mercury compounds are used;
- Activities and processes that emit or release mercury or mercury compounds, including information on the health and environmental risks and economic and social costs and benefits of such alternatives;
- Epidemiological information concerning health impacts associated with exposure to mercury and mercury compounds, in close cooperation with the World Health Organization and other relevant organizations, as appropriate.

Accounting for the above considerations, measures to organise cooperation of Parties for exchange of such information (including exchanges through the Convention Secretariat or in cooperation with other relevant organisations) should be reflected in the NAP.

Art. 17 also includes a provision on the need to designate a **national focal point for the exchange of information under the Convention**, including with regard to the consent of importing Parties under Article 3. As the RF Ministry of Ecology may be designated (as the agency in charge of organisation of the Convention implementation), we propose to designate the national focal point by means of issuing legal acts of the RF Government and the RF MoE, and to include development of draft legal acts into the NAP as separate measures.

PUBLIC INFORMATION, AWARENESS AND EDUCATION (ART. 18)

According to Art. 18, Parties, within their capabilities, should **promote and facilitate provision to the public of available information on**:

- The health and environmental effects of mercury and mercury compounds;
- Alternatives to mercury and mercury compounds;
- The topics identified in Article 17 of the Convention;
- The results of research, development and monitoring activities under Article 19 of the Convention;
- Activities to meet obligations under the Convention.

In addition, as appropriate, Parties should **facilitate and promote education, training and public awareness** related to the effects of exposure to mercury and mercury compounds on human health and the environment in collaboration with relevant intergovernmental and non-governmental organizations and vulnerable populations.

Each **Party should use existing mechanisms or give consideration to the development of mechanisms, such as Pollutant Release and Transfer Registers (PRTRs) where applicable, for the collection and dissemination of information on estimates of its annual quantities of mercury and mercury compounds** that are emitted, released or disposed of through human activities.

Promotion of PRTR development[55]

There is a strong role for a Pollutant Release and Transfer Register (PRTR) in developing an inventory of industrial mercury sources. NGOs can advocate for the establishment of a PRTR (either for mercury alone or preferably for a range of key pollutants) as facilities identified in Annex D to the Minamata Convention are required to report their mercury emissions annually to a public online database. This not only assists in developing a national inventory, but can be useful in assessing the potential mercury reductions from individual facilities (and the entire sector) over time. It can also be used as an audit tool to gauge whether 'existing' sources can be identified and considered for treatment as 'new' sources due to higher reported mercury emissions.

The above information may be provided to the general public by means of posting it on the website of the Russian Ministry of Natural Resources and Environment. It is proposed to include measures for organisation of public disclosure of the information into the NAP.

As it was already noted, In Russia, the state register (the Register) of sites with adverse environ-

[55] http://www.ipen.org/documents/ngo-introduction-mercury-pollution-and-minamata-convention-mercury

mental impacts was developed and is maintained as a state information system[56]. The Register incorporates information on mercury-containing emissions, releases and wastes, and on fixed sources of their generation. Information in the Register is publicly accessible (except information entries categorised as state or commercial secrets according to the relevant legislation of the Russian Federation). As the Register meets the above criteria, we propose to incorporate measures to the NAP to ensure openness of the Register's data on amounts of mercury (mercury compounds) in emissions, releases and wastes generated.

RESEARCH, DEVELOPMENT AND MONITORING (ART. 19)

Art. 19 of the Convention, in addition to the previously considered issues of cooperation of Parties (Articles 10–12 and 14), including their cooperation for information exchange purposes (Articles 5 and 17), contains provisions on **cooperation for development and improvement (taking into account respective circumstances and capabilities of the Parties) of**:

- Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds;
- Modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media (including biotic media such as fish, marine mammals, sea turtles and birds), as well as collaboration in the collection and exchange of relevant and appropriate samples;
- Assessments of the impact of mercury and mercury compounds on human health and the environment, in addition to social, economic and cultural impacts, particularly in respect to vulnerable populations;
- Harmonized methodologies for the activities listed above;
- Information on the environmental cycle, transport (including long-range transport and deposition), transformation and fate of mercury and mercury compounds in a range of ecosystems, taking appropriate account of the distinction between anthropogenic and natural emissions and releases of mercury and of remobilization of mercury from historic deposition;
- Information on commerce and trade in mercury and mercury compounds and mercury-added products;
- Information and research on the technical and economic availability of mercury-free products and processes and on best available techniques and best environmental practices to reduce and monitor emissions and releases of mercury and mercury compounds.

In the course of these activities, Parties are recommended, where appropriate, to build on existing monitoring networks and research programmes.

The issues for research-related cooperation, as listed in Art. 19, deal with different state policy aspects belonging to spheres of competence of several different federal executive bodies. Every individual executive body independently contracts R&D works (within relevant federal budgetary allocations) or orders R&D works to its subordinate federal budgetary research facilities. In this connection, general measures may be incorporated into the NAP, stipulating (as appropriate) implementation of R&D works by relevant federal executive bodies in the framework of cooperation with Parties of the Convention on issues under Art. 19 of the Convention.

REPORTING (ART. 21)

Finally, as its integral part, the NAP should include provisions on reporting to the Convention Secretariat.

Art. 21 stipulates that each Party should report to the Conference of the Parties, through the Secretariat, on the measures it has taken to implement the provisions of the Convention and on the effectiveness of such measures and the possible challenges in meeting the objectives of the Convention.

In its reporting, each Party should include information specified in Articles 3, 5, 7, 8 and 9 of the Convention.

It is necessary to note that the proposals for development of the Russian NAP presented in Chapter 5 are not exhaustive. It is crucial to establish working groups for the NAP development with involvement of representatives of governmental bodies, industries and non-governmental organisations active in the sphere of public health and environment. Such a group would account for all necessary aspects in the NAP, in line with the Minamata Convention requirements, interests of the Russian economy and the country's residents.

56 https://onv.fsrpn.ru/#/public/registry/federal/list

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

Information and data from this publication were presented at the Regional Workshop on Mercury Pollution Problems in Eastern Europe, Caucasus and Central Asia (March 26–27, 2017, Moscow). The workshop participants noted the importance of the results of implementation of the GEF/UNEP Pilot Project on the Development of Mercury Inventory in the Russian Federation, which was launched in 2013. They highlighted relevance of materials on mercury circulation in the Russian economy, on accumulation of mercury-containing waste, and on contamination of environmental media by emissions and releases of mercury and mercury compounds. Presentations and the final document of the workshop are posted on the Eco-Accord website[57] (see section "The Regional Workshop on Mercury Pollution Problems in Eastern Europe, Caucasus and Central Asia — EECCA").

Recommendations[57]

of participants of the Regional Workshop on Mercury Pollution Problems in Eastern Europe, Caucasus and Central Asia (Moscow, Russia, March 26–27, 2017)

We, representatives of the expert community and non-governmental organisations, participants of the Regional Workshop on Mercury Contamination Problems in Eastern Europe, Caucasus and Central Asia (EECCA) Countries, emphasize the importance of the information presented at the workshop in relation to mercury in circulation in EECCA countries' economy, accumulation of mercury waste, and mercury contamination of environmental media by emissions and discharges of mercury compounds. As the presented data suggests, the above problems are of major relevance to ensuring environmental security in countries of the region.

We note the high relevance and timeliness of the implementation of the project of the UN Environment Programme (UNEP) and the Global Environmental Facility (GEF) — the 2013–2017 **Pilot project on the Development of Mercury Inventory in the Russian Federation** (the Project under which the regional workshop was organised).

We stress that quantitative information on sources and intensity of mercury releases are primarily based on calculations and estimates. The lack of instrumental monitoring of mercury emissions and discharges does not allow for the study of impacts of mercury releases on ecosystems, to estimate critical loads and to assess risks for human health and the environment.

We underline that while mercury in EECCA countries is categorised as a first hazard class substance and is listed for regulation, it is not incorporated into the list of substances for mandatory emission reporting by enterprises, except for reporting by those facilities that use mercury in their production processes. As a result, the majority of EECCA facilities do not control mercury levels in their production inputs, emissions and discharges. Moreover, mercury levels in raw materials are almost never measured in the majority of production processes.

We point out that, according to available estimates, generally, in the Russian Federation and in other countries of the region, the largest amounts of mercury releases into the environment are associated with ore processing and primary production of non-ferrous metals. Primary metal production operations play the decisive role in terms of mercury releases to soils, its releases to by-products, waste generation and mercury discharges to water. At the same time, mercury levels in environmental media in the vicinity of such plants are not monitored, and, as a result, it is impossible — for example — to assess environmental and health hazards of tailings.

We note that the second largest source of mercury releases to the environment is associated with extraction and the use of fuel and energy resources, and their consumption in EECCA countries continues to grow, including inter alia construction of new coal-

[57] http://www.ecoaccord.org/

58 www.ecoaccord.org

fired power plants and cement kilns. Mercury releases in the course of extraction and use of fuel and energy resources make even larger contributions into total air emissions of the fuel and energy complex, but such mercury emissions are not monitored.

We point out that gold mining and primary processing operations are associated with collateral extraction of mercury with ores, resulting in substantial pollution of air, water and soils. At the same time, mercury levels in the vicinity of gold mining sites are not monitored.

We note that while none of the EECCA countries admitted artisanal gold mining with the use of mercury amalgamation process as a major problem, such mining operations really are underway in some EECCA countries and may result in serious environmental impacts, compatible with the ones faced now by some developing countries of Africa and Southeast Asia.

We note that, notwithstanding available information on mercury levels in almost all environmental media and on mercury environmental impacts and mercury migration in food chains, relevant data is often fragmentary, and observations are generally of an irregular pattern and cover only short periods of times.

We note that measurements of mercury levels in food products and body burden monitoring in EECCA countries are of sporadic and non-systemic patterns. The countries do not issue recommendations on daily intake of mercury-containing food products, including fish and rice, that are particularly important for pregnant women and children. In addition, in some EECCA countries, limits for mercury levels in fish are not set. In other EECCA countries that have established such limits, they are usually set lower than relevant limits of developed countries, thus reducing the level of protection of EECCA residents from the adverse health impacts of mercury.

We emphasise the need to pay major attention to mercury pollution hot spots — regions with developed non-ferrous metallurgy, coal-fired power plants, cement and chemical industries, and areas with accumulated mercury-containing waste; namely, the sites of decommissioned plants that used mercury and mercury compounds in the past.

We stress the inadequacy of systems of management of mercury-containing e-waste in EECCA countries that deal with municipal, household and medical waste flows.

We note that unusable (broken) mercury thermometers represent the main source of mercury entering solid domestic waste (SDW). Some parts of mercury from these thermometers may also enter sewers. Other sources of mercury in SDW include mercury-containing bulbs, cells/batteries and dental amalgam. Lack of waste separation systems in EECCA countries results in a situation where unseparated waste with mercury-containing items reach landfills and waste incineration plants.

We point out that there is only one producer operating production of vinyl chloride monomer with application of mercury in EECCA countries — «Kaustik» JSC in Volgograd (Volgograd oblast), formed «Plastkard» JSC. Recently commissioned plants for production of vinyl chloride monomer (for production of PVC) — «Rysvynyl» JCS, etc. — apply mercury-free technologies. The largest (and the only one before 2013) Russian producer of acetaldehyde — «Nevinnomysskiy Azot» JSC of «Eurokhim» Mineral Chemical Company — as well as other producers do not apply mercury in their production processes.

We stress that the following three chlorine-alkali plants use mercury-based technology: «Bashkir Soda Company» ISC, Sterlitamak (the Republic of Bashkortostan); «Kaustik» JSC, Volgograd (Volgograd oblast); and «Galopolimer Kirovo-Chepetsk» JSC, Kirovo-Chepetsk (Kirov oblast). «Sayanskhimplast» JSC in Sayansk (Irkutsk oblast) is the only Russian plant that successfully switched from a mercury-based process to a membrane-based technology.

Recommendations

1. In order to get the most complete picture of mercury releases into the environment from pollution sources, it is necessary to review the system of sources' inventory and tighten control of reliability of information provided in facilities' reporting. We believe that it is necessary to include mercury into the list of controlled elements in production inputs and releases of facilities that use mineral resources (such as non-ferrous metallurgy, thermal power plants, cement plants and waste incinerators).

2. Assessment of sources and mercury releases

into the environment should be conducted at the base of the complete mercury cycle, using material balances of facilities.

3. Waste-related laws, standards and regulations should be adjusted. Wastes with mercury contents over 0.1% should be considered as 1st hazard class waste. Harmonised reporting forms on mercury contamination should be introduced in the EECCA region.

4. As a priority, at the majority of potentially hazardous sites in terms of releases of mercury and mercury compounds into the environment, best available technologies should be introduced to prevent uncontrolled mercury releases into the environment. In the course of transition to best available technologies (BATs), mercury should be excluded from the production cycle.

5. It is necessary to maintain systemic performance monitoring of facilities that introduced best available technologies to control mercury emissions and releases — based on reporting forms 2-TP (air), (water management), (wastes).

6. In the course of registration of non-intentional sources of release into the environment, a mandatory requirement should be introduced for incorporation of mercury into the list of declared emissions, releases and wastes, covering both facilities that use (produce) mercury-containing substances, and collateral releases.

7. It is necessary to conduct detailed surveys of groups of plants that use different types of mineral inputs, and combustion units for assessment of associated mercury contents. Without such detailed and relevant information on mercury levels in emissions, and in releases into water bodies and products, it would be impossible to make definite conclusions on actual mercury releases into the environment. Many countries need support for purchase of laboratory equipment and access to certified laboratories for analysis of mercury in samples.

8. State environmental supervision should be introduced at mining and metallurgy plants (particularly in non-ferrous metallurgy) to control mercury levels in all technological lines.

9. In many EECCA countries, the Extractive Industries Transparency Initiative (EITI) was adopted and is implemented — the initiative is a partnership of three actors: governments, mining companies and NGOs. Accountability under EITI indicators on environmental protection and workers' health should be strengthened.

10. A uniform system of environmental monitoring and bio-monitoring of mercury (including methylmercury) in environmental media should be established, with a single information clearinghouse and swift data transfer to national mercury registers. Introduction of bio-monitoring is of particular importance for areas with high technogenic mercury pressures.

11. It is necessary to develop recommendations on daily intake of mercury-containing food products, including fish and rice (particularly for pregnant women and children). Such recommendations should account for processes of mercury accumulation in the human body and mercury impacts on foetal and infant health.

12. It is necessary to promote gradual phase-out of mercury-added products and their replacement by alternative products. To this end, it is necessary to implement a program seeking to:

- ascertain the assortment and develop a detailed catalogue of mercury-based and mercury-containing instruments and devices that are now produced and/or used in the country;
- inventory facilities and organisations that use mercury-based and mercury-containing instruments and devices (with quantitative inventory of the mercury contained in them);
- evaluate the contemporary scale of mercury use for production of mercury-based and mercury-containing instruments and devices, and their import to EECCA countries;
- conduct quantitative assessments of mercury emissions into the environment in the course of production, use and recycle of mercury-containing instruments and devices;
- assess annual consumption of mercury that is used as a working liquid in different spheres of household, industrial and research activities;
- conduct detailed eco-geochemical surveys in areas of decommissioned and operational plants for production of mercury-based and mercury-containing instruments and devices, in order to collect information necessary for assessment of environmental quality and for substantiation of decontamination and other environmental activities;
- inventory wastes accumulated in areas of decommissioned and operational plants for production of mercury-based and mercury-containing instruments and devices (including storages of spoiled products), with their qualitative and quantitative characterisation, and including development of plans for their recycle (reuse);

• establish a system for selective collection of used mercury-based and mercury-containing instruments and devices for their maximal possible removal from general production and consumption waste flows and eventual recycle (with recovery of secondary mercury and other valuable components);

• conduct an environmental audit of operational demercurisation units in the country and other similar organisations that collect failed (used) mercury-based and mercury-containing instruments and devices for recycling;

• modernise existing technologies and installations for recycling of batteries/cells, other mercury-containing instruments and devices (primarily to ensure advanced treatment of flue gases and maximal possible removal of mercury from secondary products);

• creation of a series of small facilities in the region in areas of high concentration of battery production waste, allowing to establish an efficient system for processing of spoiled and used mercury-containing instruments and devices.

13. Construction of new waste incineration plants should be avoided (as potentially large sources of mercury emissions). In order to prevent inflow of mercury-containing waste to waste incineration plants, the following measures should be taken:

• organisation of separate collection of mercury-containing wastes at all sites of generation of solid municipal waste (SMW).

• enhancement of the level of participation of non-governmental organisations in monitoring sources of mercury inflows into SMW and mercury emissions of waste incineration plants.

14. It is extremely important to strengthen cooperation between NGOs, local authorities and industries for identification of contaminated sites, collection and processing of mercury-containing waste. Such cooperation would allow for development of efficient policies in the sphere, to define the most appropriate approaches for reduction of adverse health impacts, to organise collection of household mercury-containing waste, and to minimise inflow of the wastes to landfills and waste incineration plants.

15. It is necessary to implement broad awareness-raising activities among residents of all age groups on mercury hazard matters, including dissemination of information about methylmercury levels in raw food and food products. Information materials should be disseminated in partnerships with mass media outlets with experience in eco-journalism.

16. It is necessary to support initiatives of NGOs on monitoring of mercury pollution sources, public information and awareness-raising activities, and participation in policies for implementation of the Minamata Convention.

17. Development of regional cooperation for exchange of information and experience in the sphere of addressing mercury pollution problems and implementation of the Minamata Convention (including cooperation between NGOs) is of major importance. Initiatives in the sphere need support.

18. We are convinced on the need of the earliest possible ratification of the Minamata Convention by all EECCA countries. Ratification of the Minamata Convention demonstrates readiness of the countries to participate in the international process of environmentally sound mercury management and reduction of its adverse health and environmental impacts. So far, none of the EECCA countries has ratified the Minamata Convention.

19. Enactment of the Minamata Convention would allow EECCA countries to intensify activities for reduction of mercury emissions and releases, reduction of mercury health risks and expanding production of mercury-free products.

20. It is important to note that compliance with the Convention requirements on introduction of best available technologies and best environmental practices is intended to improve energy efficiency and to reduce mercury emissions from industrial sources, including coal-fired power plants — i.e. one of the most important objectives of EECCA countries. According to UNEP, in 2010, mercury emissions of coal-fired power plants reached 24% of the overall mercury emissions from anthropogenic sources. Enactment of the Minamata Convention would facilitate inflow of investment for introduction of new technologies allowing to reduce mercury emissions substantially.

21. Ratification of the Minamata Convention should become a priority for EECCA countries. Earliest possible enactment of the Treaty would demonstrate willingness of countries to avoid repetition of the Minamata tragedy with thousands of human lives lost. It would become a practical step to ensure chemical security and support citizens' constitutional rights to health and a healthy environment.

In the course of quantitative assessment of mercury releases into the environment, year 2012 was selected as the pilot year. During development of the national inventory, a major amount of data was collected, including data collected with support of NGOs. However, information on sources of mercury releases in Russia is primarily based on estimates and expert assessments, as results of direct measurements of mercury releases, mercury levels in fuel and raw materials are scattered and fragmentary.

In the course of development of the inventory, production of primary metals was found to be the key source of mercury releases into the environment in Russia.

Ore clarification and primary metal production plants contribute 89% (1334 t of mercury) to the overall mercury releases into the environment. Primary metal production plays the decisive role in mercury releases to soils — 98% (731.5 t), in transfer to by-products — 98% (224.5 t), in waste generation — 78% (313.2 t), in mercury discharges to water — 68% (18.6 t) and in emissions to ambient air — 50% (46.2 t).

All mercury releases to soils in the course of metal processing and production are associated with gold mining and primary processing plants. Additionally, these facilities substantially contribute to mercury emissions into air (35%) and releases into water (59%).

The largest amount of mercury-containing waste (212 t) is generated by copper ore mining, processing and primary copper production — 77% of the overall generation of mercury-containing wastes.

In terms of mercury releases into the environment, zinc mining and processing plants are significant sources; their mercury releases are mainly associated with transfer to by-products and impurities — 93.3 t (41%). Inflows to sector-specific waste disposal/treatment reached 39 t of mercury (34%), and 8.5 t of mercury (9%) were releases into air. The contribution of the category into mercury releases to other environmental media is less significant and does not exceed 6%.

Other metallurgical industries (aluminium, lead, nickel and primary iron) are not substantial contributors to mercury releases into the environment.

Use of energy fuels resulted in releases of 38.75 t of mercury into the environment, including 28.6 tons (31%) of emissions to air, 0.8 tons (3%) of releases to water, and 8.3 tons of releases to waste (2% of the overall amount of waste). The rest (1.1 tons of mercury) is transferred to by-products and impurities. From all energy fuel sub-categories reviewed, use of coal is the largest single contributor with releases of 33.7 t of mercury (including 25.8 t to air and 7.9 t to wastes).

Chlor-alkali plants and production of VCM are associated with releases of 45.9 tons of mercury into the environment (including 4.1 t to air, 0.5 t to water, 0.4 t to soils, 2.6 t to by-products and impurities, and 38.3 t to wastes).

Production of consumer goods (thermometers, lighting appliances, batteries, etc.) results in releases of 49.7 tons of mercury into the environment (including 4.8 t to air, 4.9 t to water, 11 t to soils, and 29.0 t top wastes).

In the course of mercury use in products (dental amalgam, manometers and sensors, chemical laboratory equipment, etc.) mercury releases into the environment reached 14.03 t (including 0.09 t to air, 2.6 t to water, 0.04 t to soils, 0.7 t to by-products, and 10.6 t to wastes).

Cement, pulp and paper production resulted in release of 7.6 t of mercury to the environment, including 4.8 t to air, 1.4 t to waste, and 1.4 t to by-products and impurities.

Other sources (production of other recycled metals, wastes, crematoria and cemeteries) released 6.4 t of mercury into the environment, including 1.8 t to air, 0.1 to water, 4.4 t to soils and 0.10 to waste.

Overall, the inventory results suggest that, in 2012, sources within the territory of the Russian Federation released 1.5 thousand tons of mercury into the environment. The largest share belongs to releases to soils (747.4 t), while the minimal share belongs to releases to water (27.6 t). Additionally, 402.3 t of mercury were released to wastes, 230.3 t to by-products and 91.8 t to the atmosphere.

According to the national statistics, in 2012, mercury releases to the atmosphere reached 2.993 t, while mercury discharges to wastewater reached 0.01 t.

Differences between results of the inventory and the national statistics data suggest that mercury registration and control in the Russian Federation lacks completeness. **In order to get a complete picture**

of mercury releases into the environment from sources in the territory of the Russian Federation, it is necessary to review the system of sources' inventory and to tighten control of reliability of data in facilities' reporting.

To this end, it is necessary to conduct detailed surveys of groups of plants that use different types of mineral inputs, and combustion units for assessment of associated mercury contents. Without such detailed and relevant information on mercury levels in emissions, in releases into water bodies and products, it would be impossible to make definite conclusions on actual mercury releases into the environment.

As a priority, at the majority of potentially hazardous sites (in terms of releases of mercury and mercury compounds into the environment), best available technologies should be introduced to prevent uncontrolled mercury releases into the environment.

State environmental supervision should be tightened at mining and metallurgy plants (particularly in non-ferrous metallurgy) to control mercury levels in all technological lines.

The system of management of mercury-containing waste needs improvement, including in such spheres as e-waste, wastes in the housing and utilities sector, and medical waste.

It is necessary to implement broad awareness-raising activities among residents of all age groups on the problem of mercury hazards. It is extremely important to strengthen cooperation between NGOs, local authorities and industries for identification of contaminated sites, collection and processing of mercury-containing waste in regions of Russia. Such cooperation would allow for development of efficient policies in the sphere, to define the most appropriate approaches for reduction of adverse health impacts of mercury, to organise collection of household mercury-containing waste, and to minimise inflow of the wastes to landfills and waste incineration plants.

A reliable inventory of sources of mercury releases into the environment in the territory of the Russian Federation provides the base for purposeful actions to reduce mercury use in the country and its adverse health and environmental impacts.

As analysis of the underlying regulatory norms conducted in the course of the inventory suggests, generally, the underlying national laws, standards, regulations and methodologies of mercury control and monitoring in environmental media, products, production inputs and wastes are relevant and meet contemporary requirements. However, lack of uniform guidelines on mercury assessments in different media, as well as differences in status of available methodologies in the country (and — correspondingly — their different coding) substantially complicate searching for them and require specialised skills and knowledge. These factors may pose serious obstacles to businesses, especially to SMEs.

Adopted mercury limits of the Russian Federation for different products (including food products and toys) are similar to those of other developed countries or are set even more strictly. However, in order to improve mercury monitoring and control, some improvements in the RF legislation are needed in the sphere. To this end, the following recommendations are proposed:

1. To adopt a Decree of the Government of the Russian Federation on the Set of Measures for Fulfilment of Commitments under the Minamata Convention, stipulating the following actions:

- establishment of an inter-agency council (or a working group similar to the one being established in the framework of SAICM[59]);
- development of the Action Plan for Implementation of the Minamata Convention (to be approved by a Governmental Decree).

2. To create a uniform system for mercury monitoring in environmental media, with a single information clearinghouse and swift data transfer to the National Mercury Register.

3. To develop a set of economic incentives to promote reduction of generation of mercury-containing wastes, including mercury emissions into the atmosphere and discharges of mercury and mercury compounds to water bodies.

4. As pertains to management of mercury-containing waste, it is necessary:

- to consider opportunities for establishment of a system of interaction of all actors in the process of management of mercury and mercury-containing products, including permanent control of operations of specialised facilities for recycle of waste-containing products;
- to amend the "List of main types of solid and slurry toxic industrial waste prohibited for disposal at solid municipal waste landfills" for incorporation

[59] The Strategic Approach to International Chemicals Management. http://www.saicm.org/

of other types of mercury-containing solid wastes of concern under the Minamata Convention;

- to conduct detailed eco-geochemical surveys in areas of decommissioned and operational plants for production of mercury-based and mercury-containing instruments and devices, in order to collect information necessary for assessment of environmental quality and for substantiation of decontamination and other environmental activities;
- to inventory wastes accumulated in areas of decommissioned and operational plants for production of mercury-based and mercury-containing instruments and devices (including storages of spoiled products), with their qualitative and quantitative characterisation, and including development of plans for their recycle (reuse);
- to establish a system for selective collection of used mercury-based and mercury-containing instruments and devices for their maximal possible removal from general production and consumption waste flows and eventual recycle (with recovery of secondary mercury and other valuable components);
- to conduct an environmental audit of operational demercurisation units in the country and other similar organisations that collect failed (used) mercury-based and mercury-containing instruments and devices for recycling;
- to modernise existing technologies and installations for recycling of batteries/cells and other mercury-containing instruments and devices (primarily to ensure advanced treatment of flue gases and maximal possible removal of mercury from secondary products);
- to create a series of small facilities in areas of high concentration of battery production waste, allowing to establish an efficient system for processing of spoiled and used mercury-containing instruments and devices in the country.

5. In the course of development of BAT guidelines, it is necessary to provide for measures to minimise mercury emissions. In particular, reference book ITS 6–2015 “Cement Production” already contains requirements for reduction of mercury level in emissions.

6. In order to improve registration of releases of mercury and mercury compounds it is necessary to adjust forms of federal statistic supervision. Now, reporting on pollutant releases should be submitted by legal entities or individual entrepreneurs with authorised releases over 10 tons/year (or from 5 to 10 tons/year inclusive if their emissions to the atmosphere contain pollutants of 1st and/or 2nd hazard classes).

The threshold limit for the requirement to submit reporting under form “2-TP (air)” should be reduced to 1 kg/year for facilities that emit mercury and/or mercury-containing substances.

7. To ensure that when implementing industrial environmental control mercury and its compounds are introduced as mandatory marker substance

8. To introduce a special marking for mercury-containing items for improvement of monitoring of mercury in circulation, to modernise statistical reporting on mercury-containing goods (lamps, thermometers, etc.), to allocate them into a separate category and to stipulate the option of separate registration of groups of goods depending on their mercury contents. Customs statistics on import and export of mercury-containing items should also rely on these groups of goods.

9. To establish a major storage of metal mercury in a large mercury plant («Kubantsvetment» JSC is the most appropriate option), to ensure unobstructed reception of mercury, as well as a network of mercury accumulation centres in all regions of the Russian Federation.

ANNEX I

METHODOLOGIC MATERIALS FOR INVENTORY OF MERCURY RELEASES

The updated Toolkit for Identification and Quantification of Mercury Releases is the main methodological document (UNEP Toolkit 2015, the document was translated into Russian).

The Toolkit provides the methodology for identification and quantification of sources of mercury releases into the environment and incorporates:

- The Guidelines for Inventory Level 1;
- Electronic spreadsheets for calculation of estimates of mercury inputs and releases in Inventory Level 1;
- Templates for data collection letters and the inventory report;
- References.

The references give additional guidance on inventory development and describe the background inventory principles and the mercury source categories in more detail.

Additionally, the document describes Inventory Level 2, which gives guidance to performing more detailed and potentially more technically accurate mercury inventories.

All these materials are intended to simplify organisation and calculations for the first national mercury inventory.

Inventory works should proceed in the following sequence of steps.

- Getting started.
- Energy consumption and fuel production.
- Domestic production of metals and raw materials.
- Domestic production and processing with intentional mercury use.
- Waste treatment and recycling.
- General consumption of mercury in products, as metal mercury and as mercury-containing substances.
- Miscellaneous mercury sources not quantified in Inventory Level 1, as well as crematoria and cemeteries.
- Reporting and refining the inventory.

The mercury release calculations used in this Toolkit are based on the mass balance principle: All the mercury fed into the system (e.g. an industrial sector) with materials and fuels will come out again, either as releases to the environment or in some kind of product stream. In other words: “Sum of inputs = sum of outputs”.

Estimated mercury release to pathway Y = **activity rate x input factor x output distribution factor for pathway Y**

Mercury concentrations in raw materials, fuels or products used vary depending on their type and origin and this naturally affects the amount of mercury being released. Production set-ups and pollution reduction equipment configurations may also influence the distribution of mercury releases among the release output pathways (air, water, land, waste, etc.). All these factors are integrated in the methodology. In some cases where detailed mass balances have not been available, default output distribution factors were developed preliminarily based on expert assessments.

In a simplified form, the description of mercury input and release factors for different media is presented below:

Calculation result type	Description
Estimated Hg input, Kg Hg/y	***The amount of mercury entering a source category with input materials; for example, mercury amount in the amount of coal used annually in the country for combustion in large power plants.***
Air	Mercury emissions to the atmosphere from point sources and diffuse sources from which mercury may be spread locally or over long distances with air masses; for example from: • Point sources such as coal fired power plants, metal smelters, waste incineration; • Diffuse sources such as small scale gold mining, informally burned waste with fluorescent lamps, batteries and thermometers.
Water	Mercury releases to aquatic environments and to waste water systems: Point sources and diffuse sources from which mercury will be spread to marine environments (oceans), and freshwaters (rivers, lakes, etc.); for example from: • Wet flue cleaning systems from coal fired power plants; • Industry, households, etc. to aquatic environments; • Surface run-off and leachate from mercury-contaminated soil and waste dumps.
Land	Mercury releases to soil, the terrestrial environment: General soil and ground water; for example from: • Solid residues from flue gas cleaning on coal fired power plants used for gravel road construction; • Uncollected waste products dumped or buried informally; • Local un-confined releases from industry such as on-site hazardous waste storage/burials; • Spreading of sewage sludge with mercury content on agricultural land (sludge used as fertilizer); • Application on land, seeds or seedlings of pesticides with mercury compounds.
By-products and impurities	By-products that contain mercury, which are sent back into the market and cannot be directly allocated to environmental releases; for example from: • Gypsum wallboard produced from solid residues from flue gas cleaning on coal fired power plants; • Sulphuric acid produced from desulphurization of flue gas (flue gas cleaning) in non-ferrous metal plants with mercury trace concentrations; • Chlorine and sodium hydroxide produced with mercury-based chlor-alkali technology with mercury trace concentrations; • Metal mercury or calomel as by-product from non-ferrous metal mining high mercury concentrations.
General waste	General waste: Also called municipal waste in some countries. Typically household and institution waste where the waste undergoes a general treatment, such as incineration, landfilling or informal dumping. The mercury sources to waste are consumer products with intentional mercury content (batteries, thermometers, fluorescent tubes, etc.) as well as high volume waste like printed paper, plastic, etc., with small trace concentrations of mercury.
Sector-specific waste treatment / disposal	Waste from industry and consumers that is collected and treated in separate systems, and in some cases recycled; for example from: • Confined deposition of solid residues from flue gas cleaning on coal fired power plants on dedicated sites; • Hazardous industrial waste with high mercury content which is deposited in dedicated, safe sites; • Hazardous consumer waste with mercury content, mainly separately collected and safely treated batteries, thermometers, mercury switches, lost teeth with amalgam fillings, etc.; • Confined deposition of tailings and high volume rock/waste from extraction of non-ferrous metals.

Assessments of energy consumption and fuel production should cover the use of fossil fuels and plant matter (biomass) for production of electricity and heat.

Fuel consumption
Coal combustion in large power plants (typically with thermal boiler effect above 300 MW)
Other coal uses (sum for all other uses)
Combustion/use of petroleum coke and heavy oil
Combustion/use of diesel, gasoil, petroleum, kerosene
Combustion/use of natural gas
Biomass fired power and heat production (wood, etc.)
Charcoal combustion
Fuel production
Oil extraction
Oil refining
Extraction and processing of natural gas

Consideration of the mercury problem in production of metals, other products and ore mining should cover activities in:

- Industrial mining and primary processing of metals where the mercury source is trace concentrations in the ore material — also in ore for extraction of other metals than mercury;
- Small scale gold mining with mercury amalgamation, where mercury is added to extract the gold; and
- Industrial production of the large volume materials — cement and paper.

Primary metal production (industrial)
Mercury (primary) extraction and initial processing
Production of zinc from concentrates
Production of copper from concentrates
Production of lead from concentrates
Gold extraction by methods other than mercury amalgamation
Alumina production from bauxite (aluminium production)
Primary ferrous metal production (pig iron production)
Gold mining with mercury amalgamation
Gold extraction with mercury amalgamation — without use of retorts
Gold extraction with mercury amalgamation — with use of retorts
Other high volume materials production with mercury releases
Cement production
Pulp and paper production

Assessments of production and processing with intentional mercury use should cover the following types of activities:

- Industrial production of chemicals;
- Industrial production of mercury-added products.

Production of chemicals and polymers
Chlor-alkali production with mercury-cells
Vinyl chloride monomer (VCM) production with mercury catalyst
Acetaldehyde production with mercury catalyst
Production of products with mercury content
Hg thermometers (medical, air, lab, industrial, etc.)
Electrical switches and relays with mercury
Light sources with mercury (fluorescent, compact, others)
Batteries with mercury
Manometers and gauges with mercury
Biocides and pesticides with mercury
Paints with mercury
Skin lightening creams and soaps with mercury chemicals

Assessments of mercury problems in the sphere of waste treatment and recycling should cover all **types of waste treatment, landfilling, incineration, dumping, open burning and recycling activities**.

Recycling of metals
Production of recycled mercury («secondary production”)
Production of recycled ferrous metals (iron and steel)
Waste incineration
Incineration of municipal/general waste
Incineration of hazardous waste
Incineration of medical waste
Sewage sludge incineration
Open fire waste burning (on landfills and informally)
Waste deposition/landfilling
Controlled landfills/deposits
Informal dumping of general waste
Waste water treatment

Assessment of general consumption of mercury in products, as metal mercury and as mercury containing substances. This step includes national consumption of a wide variety of consumer products (such as thermometers and fluorescent light bulbs), and products where mercury must be added for its function (such as dental amalgam and manometers). The included products may be produced domestically, but may also be imported, and therefore need to be quantified separately.

National annual consumption is defined as:

Consumption = production + import — export (in the same year)

Use and disposal of products with mercury content
1. *Dental amalgam fillings («silver» fillings)*
Preparations of fillings at dental clinics
Use — from fillings already in the mouth
Disposal (lost and extracted teeth)
2. *Thermometers*
Medical Hg thermometers
Other glass Hg thermometers (air, laboratory, dairy, etc.)
Engine control Hg thermometers and other large industrial/speciality Hg thermometers
Electrical switches and relays with mercury
3. *Light sources with mercury*
Fluorescent tubes (double end)
Compact fluorescent lamp (CFL single end)
Other Hg-containing light sources
4. *Batteries with mercury*
Mercury oxide (button cells and other sizes); also called mercury zinc cells
Other button cells (zinc-air, alkaline button cells, silver-oxide)
Other batteries with mercury (plain cylindrical alkaline, permanganate, etc.)
5. Polyurethane (PU, PUR) produced with mercury catalyst
6. Paints with mercury preservatives
7. Skin lightening creams and soaps with mercury chemicals
8. Medical blood pressure gauges (mercury sphygmomanometers)
9. Other manometers and gauges with mercury
10. Laboratory chemicals
11. Other laboratory and medical equipment with mercury (porosimetry, pycnometry, hanging drop electrodes = polarimetry, etc.)

Assessment of crematoria and cemeteries covers mercury releases from the cremation and burial of human corpses. The main original mercury source is dental amalgam fillings, and mercury is present as fillings in remaining teeth and also in the body tissue at minor concentrations. At cremation, the mercury is released with the flue gas. At burial the mercury is released to the cemetery soil or immediate surroundings.

Miscellaneous mercury release sources:

1. Combustion of oil shale
2. Combustion of peat
3. Geothermal power production
4. Production of other recycled metals
5. Production of lime
6. Production of lightweight aggregates (burnt clay nuts for building purposes)
7. Chloride and sodium hydroxide produced from mercury-cell technology
8. Polyurethane production with mercury catalysts
9. Seed dressing with mercury chemicals
10. Infra-red detection semiconductors
11. Bougie tubes and Cantor tubes (medical)
12. Educational uses
13. Gyroscopes with mercury
14. Vacuum pumps with mercury
15. Mercury used in religious rituals (amulets and other uses)
16. Mercury used in traditional medicines (Ayurveda and others) and homeopathic medicine
17. Use of mercury as a refrigerant in certain cooling systems
18. Light houses (levelling bearings in marine navigation lights)
19. Mercury in large bearings of rotating mechanic parts in, for example, older waste water treatment plants
20. Tanning
21. Pigments
22. Products for browning and etching steel
23. Certain colour photograph paper types
24. Recoil softeners in rifles
25. Explosives (mercury-fulminate, etc.)
26. Fireworks