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# Activities within the Framework of the IAEA Contact Expert Group: Focus on input from Norway and Germany

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**Key words:**
IAEA Contact Expert Group. Nuclear legacy. Decommissioning and waste management.

**Abstract:**
This report briefly introduces the work completed by the IAEA Contact Expert Group (CEG) from its inception in 1995 until it ceased to exist in 2015. The CEG coordinated international projects on the topic of addressing problems related to legacy radioactive wastes and spent nuclear fuel originated from "cold-war" activities in the Russian Federation under the auspices of the IAEA.

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**Emneord:**
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**Resymé:**
Rapporten tar for seg arbeidet gjennomført av en internasjonal ekspertgruppe (CEG) under Det internasjonale atomenergibyrået (IAEA) fra gruppen startet opp i 1995 og til den opphørte i 2015. CEG koordinerte internasjonale prosjekt for å bistå Russland med håndtering av så kalt «legacy» radioaktivt avfall og brukt kjernebrensel som stammer fra den kalde krigen.

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Per Strand, director, Department of Emergency Preparedness and Environmental Radioactivity

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# Activities within the Framework of the IAEA Contact Expert Group: Focus on input from Norway and Germany

Statens strålevern

Norwegian Radiation Protection Authority
Østerås, 2017

This report was prepared as a joint German-Norwegian initiative by


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Oslo/Bonn/Cologne, July 2017

# Contents

# Summary

This report briefly introduces the work completed by the IAEA Contact Expert Group (CEG) from its inception in 1995 until it ceased to exist in 2015. The CEG was composed of 13 member states and international organisations: Belgium, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Russia, Sweden, United Kingdom, USA, European Commission, IAEA, ISTC and EBRD.

Areas of co-operation under the CEG framework covered the following main topics:

- Information exchange and optimal coordination, especially of bilateral programmes, programmes and projects of the G8 Global Partnership and of the Northern Dimension Environmental Partnership (NDEP) at the European Bank for Reconstruction and Development (EBRD).
- Contribution to the development of a comprehensive strategy for all activities and programmes in the field of decommissioning and waste management of the nuclear submarines and supply-vessels and the corresponding land-based sites.
- Development of an agreement to solve the three key international legal issues (access to the sites of project implementation, tax exemption of international assistance, liability issues for the donors) to pave the way for international projects (Multilateral Nuclear Environmental Protection Agreement (MNEPR)).

CEG members created several working groups to focus on specific topics of joint activities. The group reported the results of their work and findings at CEG meetings.

The efforts of CEG members were one of the most successful examples of joint multinational co-operation in the elimination of nuclear legacy, while the overall costs of joint efforts has exceeded $3bn. This report also briefly presents CEG project work, with a focus on Norwegian – German input, before conclusions are drawn and experiences discussed for possible future collaborations.

# 1 Introduction

After the end of the Cold War in the early 1990s, details of the extent and the state of the nuclear legacies of the Russian navy and the associated problems became publicly known several states proclaimed their interest to assist Russia tackling the problems caused by these legacies together. In detail, this concerned almost 200 decommissioned nuclear submarines as well as their radioactive waste (RW) and spent nuclear fuel (SNF), which was stored on the supply vessels and in the navy bases under inadequate storage conditions and hence posed a considerable risk to human health and the environment. Furthermore, there were concerns as to the safety and the physical protection of disused radioactive sources and of so-called Radioisotope Thermoelectric Generators (RTG), which were used e.g. along northern shipping routes to power beacons. These risks and concerns not only justified an urgent need to act for Russia, but also gave cause for its international partners to initiate major nuclear remediation projects. In the 1990s, when the first bilateral and multilateral projects in this area got underway, the Nordic countries proposed to establish a special plat-form for ensuring a comprehensive exchange of information and optimal co-ordination.

This initiative led to the setting-up of an expert group – the so-called Contact Expert Group (CEG) – for international projects on the topic of addressing problems related to legacy radioactive wastes and spent nuclear fuel originated from “cold-war” activities in the Russian Federation under the auspices of the IAEA. This group was then officially established at the workshop on "International Co-operation on Nuclear Waste Management in Russia", which was held at the IAEA in Vienna in May 1995. The Director General of the IAEA (Hans Blix) supported this initiative and invited interested member states to join the CEG. The IAEA provided a secretariat as a contact point for the member states and for planning and organizing the meetings. The CEG's Terms of Reference (ToR) were adopted at a meeting of the prospective member states in Sweden in September 1995. Amended versions of the ToR were created in 2005 and 2010. The first CEG meeting took place in Moscow in March 1996. CEG membership has included Belgium (1996-2014), Canada (2003-2012), Finland (1996-2015), France (1996-2014), Germany (1996-2015), Norway (1996-2015), Russia (1996-2014), Sweden (1996-2015). Subsequently, Italy (2003-2015), Japan (1996-2015), the Netherlands (1996-2014), the United Kingdom (1996-2013) and the USA (1996-2015) also joined the CEG. The EC (1996-2014) and the EBRD (1996-2015) participated as observers.

The objectives of CEG work were:

- To promote co-operation between CEG members in planning initiatives and implementing projects aimed at the elimination of nuclear legacy in Russia
- To provide a forum for discussion and exchange of information to identify priorities and presenting recommendations on specific projects for further cooperation
- To assure that the priorities are properly addressed and made known to the international community
- To avoid redundancy and duplication in project work
- To provide the point of contact to facilitate co-operation

The amount of radioactive waste as legacy of the Russian Navy that had accumulated in the Russian Federation by the time the CEG was established was more than half a billion cubic metres, with a total activity of about two billion curie (7.4 1019 Bq). This was added by approx. 8500 tons of SNF with an activity of about four billion curie (1.5 1020 Bq). At the time when CEG started, the SNF had only been removed from 42 of the 196 nuclear submarines that required decommissioning. Moreover, no strategies existed regarding the handling and storage of the spent fuel assemblies and radioactive waste on land. In addition, no plans existed for the decommissioning and dismantling of the remaining submarines, supply vessels, and the associated storage facilities on land nor for the remediation of the sites.

The first CEG General Meetings, which were held at half-yearly intervals with all member states and institutions, served predominantly for exchanging information between the donor countries and for the provision of new information and the proposal of urgent projects by the Russian side. The information provided about the number and the state of the submarines and supply vessels as well as of the associated installations on land was initially rather sparse and required repeated and persistent enquiries by the donor countries. The projects proposed by Russia were many and varied, covering a broad range of topics and did not show any noticeable prioritisation regarding their urgency, importance, or radiological hazard potential. It was also not always clear whether there had already been any financial pledges or bi-lateral negotiations with potential donor countries concerning the proposed projects or parts thereof. With regard to the prioritization of the projects, Russia was repeatedly asked to prepare and update a list of so-called “High Priority

Projects“. In addition, Russia was to develop a general strategy that was to integrate all decommissioning and remediation projects in northwest Russia and the Far East.

The priorities agreed upon by the CEG members and proposals for submarine dismantlement as well as RW and SNF management have become the priorities of the G8 Global Partnership Initiative against the Spread of Weapons and Materials of Mass Destruction. This initiative has led to the establishment of large national programmes with solid funding for a ten-year period. The Global Partnership has given a significant impetus to the whole programme of submarine dismantlement. In practice the CEG worked very efficient as a coordination and information exchange forum for the main G8 GP countries regarding nuclear submarine dismantling and to control legacy nuclear and radiological material. Without the CEG it would have been more difficult to carry out these projects in a cost-effective and quality assured manner.

At the last CEG meeting in November 2014, Russia stated that the biggest projects to eliminate nuclear legacy in Russia had either been completed or were nearing completion and, therefore, the CEG objectives had also been achieved. Following consultations between the CEG Chairman and the IAEA it was decided in December 2014 to bring all CEG activities under the umbrella of the IAEA to an end by June 2015. The CEG secretariat at the IAEA prepared a final report covering the activities up until that date and made it available to the donor countries in 2015.

Since the activities of the CEG were influenced to a considerable extent by Norway and Germany over the entire period, the two countries decided to prepare this short report, summarising the work from their point of view and addressing specific features and essential projects of the two countries. The report in hand therefore addresses the following topics:

- Strategy Working Group (SWG) and Strategic Master Plan (SMP)
- Multilateral Nuclear Environmental Protection Agreement (MNEPR)
- Links with the programmes and projects of the G8 Global Partnership
- Links with the projects of the NDEP at the EBRD
- Decommissioning and disposal of the nuclear submarines
- Decommissioning and remediation of the associated nuclear sites
- Handling of the legacies of the supply vessels
- Recovery, Replacement, Disassembly and Long-Term Storage of RTGs
- Sunken/dumped radioactive materials in the Kara/Barents region
- Projects implemented in Far East
- Norwegian/German co-operation projects with Russia

# 2 Strategy Working Group (SWG) and Strategic Master Plan (SMP)

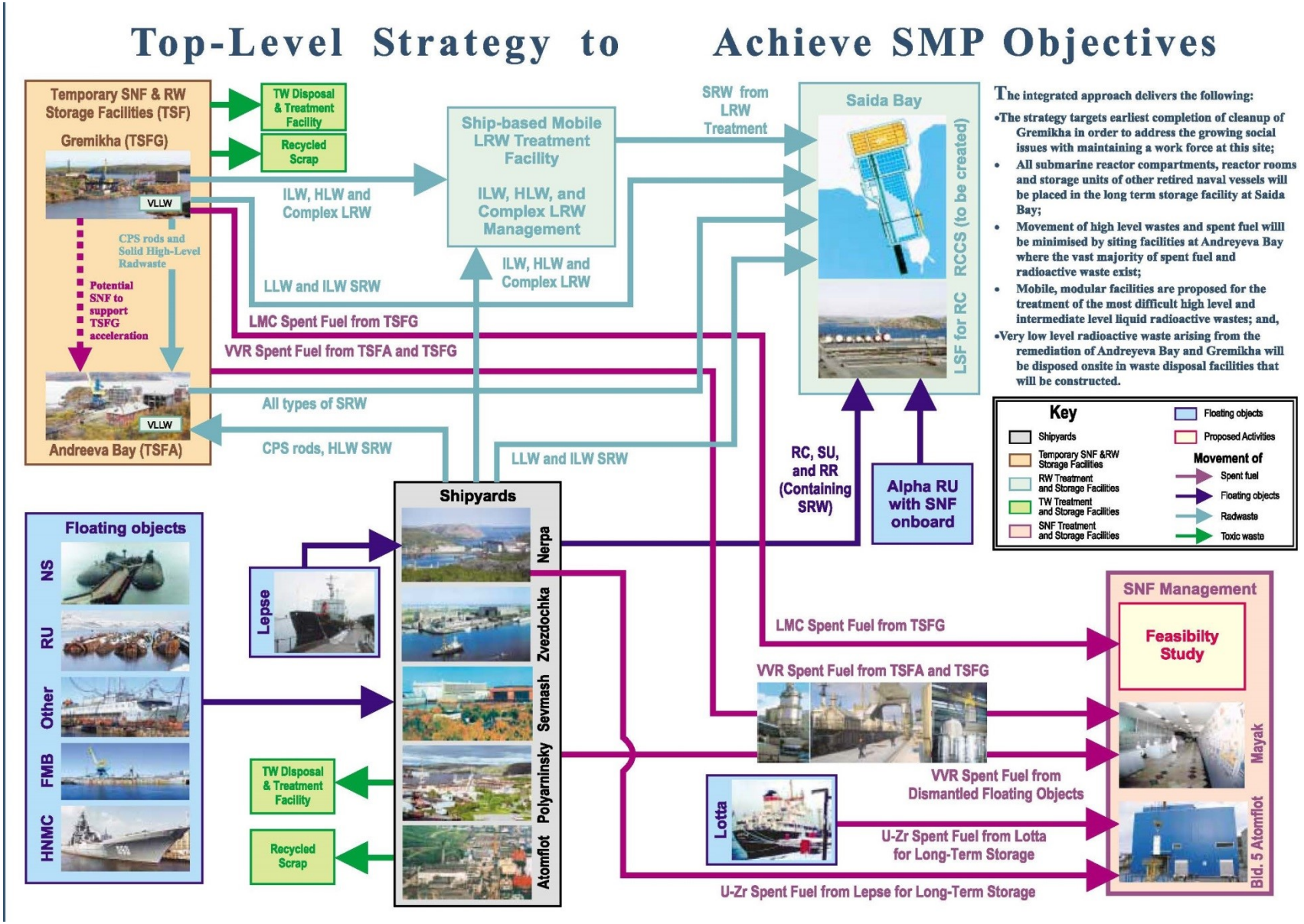
At the 8th CEG General Meeting in Fredrikstad, Norway, in the spring of 1999, an ad-hoc Working Group (WG) – later renamed Strategy Working Group (SWG) – was set up by the CEG to sup-port the Russian side regarding the "Russian Strategy on Handling Radioactive Waste and Spent Nuclear Fuel". This working group received financial support from the EC. The experts involved from Russia, Belgium, France, Germany, Norway, Sweden, the United Kingdom and the USA presented their final report at the 11th CEG General Meeting in Cherbourg (France) in October 2000.

In the Agreed Summary of the final report, the following three problems were identified that were deemed priority areas:

- decommissioning and dismantling of all nuclear submarines taken out of service,
- recovery and safe storage of the SNF and radioactive waste,
- remediation of the naval bases and further supply and disposal installations on land.

In addition, it was seen as urgent to plan storage and disposal facilities for SNF and radioactive waste and to specify how the SNF was to be handled further. In this context, the already existing facilities of the Federal State Unitarian Enterprise of the Production Combine "Mayak" (FSUE PC "Mayak") and their modernisation or expansion played a major role. It was made clear that decisions about strategies and investments by Russia should be taken soon.

As a follow-up activity to the work of the SWG, Russia declared itself ready to prepare a so-called Strategic Master Plan (SMP) as a central instrument for the planning and co-ordination of projects in northwest Russia. As a result, a "Strategic Master Plan (SMP) for Decommissioning the Retired Russian Nuclear Fleet and the Environmental Rehabilitation of its Supporting Infrastructure in North-West Russia“ was presented in 2007 and documented amongst other things in an Executive Summary Report. The SMP as shown in the subsequent figure was prepared by the Russian Institute for Safe Development of Nuclear Energy with funding from the Northern Dimension Environmental Partnership (NDEP) Programme, which was managed by the European Bank of Reconstruction and Development (EBRD). The SMP represented an essential milestone with regard to a prioritization of the projects proposed by Russia as well as to the development of a general decom-missioning, remediation and disposal strategy. The fact that Russia also attributed great importance to this SMP became clear after the decree passed on 26/12/2007 regarding the application of the results of the Strategic Master Plan (SMP) as a central instrument for the planning and co-ordination of projects in northwest Russia and the Far East.


Top-Level Strategy to Achieve SMP Objectives
Temporary SNF & RW Storage Facilities (TSF)
Gremikha (TSFG)
VLLW
CPS rods and Solid High-Level Radwaste
Potential SNF to support TSFG acceleration
VLLW
Andreeva Bay (TSFA)
TW Disposal & Treatment Facility
Recycled Scrap
ILW, HLW and Complex LRW
LLW and ILW SRW
LMC Spent Fuel from TSFG
VVR Spent Fuel from TSFA and TSFG
All types of SRW
CPS rods, HLW SRW
Ship-based Mobile LRW Treatment Facility
ILW, HLW, and Complex LRW Management
ILW, HLW and Complex LRW
LLW and ILW SRW
SRW from LRW Treatment
Saida Bay
LSF for RC
RCCS (to be created)
RC, SU, and RR (Containing SRW)
Alpha RU with SNF onboard
Floating objects
NS
RU
Other
FMB
HNMC
Lepse
Shipyards
Nerpa
Zvezdochka
Sevmash
Polyarninsky
Atomflot
TW Disposal & Treatment Facility
Recycled Scrap
The integrated approach delivers the following:
•The strategy targets earliest completion of cleanup of Gremikha in order to address the growing social issues with maintaining a work force at this site;
• All submarine reactor compartments, reactor rooms and storage units of other retired naval vessels will be placed in the long term storage facility at Saida Bay;
• Movement of high level wastes and spent fuel willl be minimised by siting facilities at Andreyeva Bay where the vast majority of spent fuel and radioactive waste exist;
• Mobile, modular facilities are proposed for the treatment of the most difficult high level and intermediate level liquid radioactive wastes; and,
•Very low level radioactive waste arising from the remediation of Andreyeva Bay and Gremikha will be disposed onsite in waste disposal facilities that will be constructed.
Key
Shipyards
Temporary SNF &RW Storage Facilities
RW Treatment and Storage Facilities
TW Treatment and Storage Facilities
SNF Treatment and Storage Facilities
Floating objects
Proposed Activities
Movement of
Spent fuel
Floating objects
Radwaste
Toxic waste
SNF Management
Feasibilty Study
LMC Spent Fuel from TSFG
VVR Spent Fuel from TSFA and TSFG
VVR Spent Fuel from Dismantled Floating Objects
Lotta
U-Zr Spent Fuel from Lotta for Long-Term Storage
U-Zr Spent Fuel from Lepse for Long-Term Storage
Mayak
Bld. 5 Atomflot

# 3 MNEPR Agreement

At the CEG meeting in Sweden in 2001, members proposed the establishment of a multilateral legal basis for co-operation – the so-called Multilateral Nuclear Environmental Protection Agreement (MNEPR). This agreement aimed at solving the three key international legal issues to pave the way for international projects:

- access to the sites of project implementation,
- tax exemption of international assistance and
- resolving liability issues for the donor countries.

Progress negotiating the MNEPR was discussed at a number of CEG meetings, and the multilateral agreement was eventually finalised in Sweden in 2003. This was a further important milestone for the orderly implementation of the ongoing and planned projects with Russia.

# 4 Links with the programmes and projects of the G8 Global Partnership

The priorities agreed upon by the CEG members and proposals for submarine dismantlement as well as radioactive waste and SNF management also became priorities of the G8 Global Partnership against the Spread of Weapons and Materials of Mass Destruction (2002-2012). This initiative led to the establishment of larger national programmes, with consistent funding over a ten-year period, to reduce the nuclear legacy in Russia. The Global Partnership gave significant impetus to the entire programme of decommissioning the submarine fleet. The programme led to a significant in-crease and optimisation of funding capabilities from the different countries involved and thus had a crucial influence on the scope and results of projects that were initiated. The leading countries who were in charge of Global Partnership national programmes were also members of the CEG.

# 5 Links with the projects of the NDEP at the EBRD

The Northern Dimension Environmental Partnership (NDEP) Programme is an environmental programme between states especially from the north of Europe devised for the execution of environmental remediation projects in northwest Russia. It consists of a general environmental part and the so-called “Nuclear Window”. To finance this programme, the NDEP Support Fund was established at the European Bank for Reconstruction and Development (EBRD) in 2002. Donor states of the Nuclear Window in the Fund are Belgium (€0.5m), Canada (€20m), Denmark (€1m), Finland (€2m), France (€40m), Great Britain (€30.2m), Germany (€10m), the Netherlands (€10m), Norway (€17.7m) as well as the European Commission (€40m). Thus the fund has currently a total volume of around €190m incl. gained interest in the Nuclear Window.

As already in the case of the projects of the G8 Global Partnership, it was possible to use additional money from the NDEP fund for the realisation of further projects to clear up nuclear legacies in

Russia. NDEP projects were executed in the form of individual Grant Implementation Agreements (GIAs). In many cases, those in charge of the project execution and monitoring the national NDEP budgets were also CEG members, such that optimal project co-ordination was guaranteed.

| ***Project*** | ***Financial volume*** | ***Recipient and contract start date*** | ***Status*** |
|---|---|---|---|
| **GIA No. 001**<br>Strategic Master Plan (SMP) | €7m | Rosatom<br>05/08/2005 | *Concluded and cleared* |
| **GIA No. 002**<br>Projects in Gremikha | €5.5m | SevRAO<br>05/08/2005 | *Concluded and cleared* |
| **GIA No. 003 / GIA No. 008**<br>Radiation protection monitoring in the Murmansk / Arkhangelsk regions | €5.1m | Murmansk Region Administration<br>05/08/2005 | *Concluded and cleared* |
| **GIA No. 004**<br>Decommissioning of Building No. 5 in Andreeva Bay | €4.25m | FCNRS<br>26/10/2011 | *In progress*<br>*End date uncertain* |
| **GIA No. 005 / GIA No. 010**<br>Decommissionng of the Lepse | €53m | FCNRS<br>11/05/2011 | *In progress*<br>*End date uncertain* |
| **GIA No. 006**<br>Disposal of fuel assemblies from the Papa class submarines | €12.5m | FCNRS<br>26/10/2011 | *Work concluded in 2015*<br>*Financial clearance pending* |
| **GIA No. 007**<br>System for the removal of spent fuel assemblies from Andreeva Bay | €55m | FCNRS<br>11/05/2011 | *First SNF shipment in 2017*<br>*End date uncertain* |

# 6 Decommissioning and disposal of the nuclear submarines

Information about the number and the state of nuclear submarines and the related onshore installations had been requested during the CEG meetings. Russia presented a summarising statistical overview of the situation of the submarines for the first time in 2001 (see Table). These figures subsequently represented an essential basis for the further discussions about the need and urgency of the projects proposed by Russia. Although the figures were not consistently updated in the years that followed, the number of all relevant nuclear-powered submarines known at the end of the CEG activities, a total of 196 submarines, differs only marginally from the number presented originally.

| Status 2001 | Submarine Class | Northern Fleet | | | | Pacific Fleet | | | | sunken | totally decom-missioned |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | decommis-sioned with fuel elements in the core | decommis-sioned without fuel elements in the core | dismantled | totally decom-missioned | decommis-sioned with fuel elements in the core | decommis-sioned without fuel elements in the core | demontiert | totally decom-missioned | | |
| 1st generation | Hotel I-III | 3 | 3 | 0 | **6** | 1 | 1 | 0 | **2** | **0** | **8** |
| | Echo I-II | 12 | 2 | 1 | **15** | 15 | 4 | 0 | **19** | **0** | **34** |
| | November | 6 | 2 | 0 | **8** | 2 | 2 | 0 | **4** | **1** | **13** |
| ***Subtotal*** | | ***21*** | ***7*** | ***1*** | ***29*** | ***18*** | ***7*** | ***0*** | ***25*** | ***1*** | ***55*** |
| 2nd generation | Delta I-IV | 2 | 0 | 13 | **15** | 6 | 3 | 3 | **12** | **0** | **27** |
| | Yankee I-II | 10 | 0 | 11 | **21** | 10 | 0 | 1 | **11** | **1** | **33** |
| | Charlie I-II | 5 | 0 | 1 | **6** | 11 | 0 | 0 | **11** | **0** | **17** |
| | Victor I-III | 23 | 3 | 1 | **27** | 11 | 0 | 0 | **11** | **0** | **38** |
| ***Subtotal*** | | ***40*** | ***3*** | ***26*** | ***69*** | ***38*** | ***3*** | ***4*** | ***45*** | ***1*** | ***115*** |
| 3rd generation | Typhoon | 3 | 0 | 0 | **3** | 0 | 0 | 0 | **0** | **0** | **3** |
| | Oscar | 2 | 0 | 0 | **2** | 0 | 0 | 0 | **0** | **1** | **3** |
| | Sierra | 1 | 0 | 0 | **1** | 0 | 0 | 0 | **0** | **0** | **1** |
| | Akula | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **0** | **0** |
| ***Subtotal*** | | ***6*** | ***0*** | ***0*** | ***6*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***7*** |
| 4th generation | Alfa | 3 | 0 | 4 | **7** | 0 | 0 | 0 | **0** | **0** | **7** |
| | Borei | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **0** | **0** |
| ***Subtotal*** | | ***3*** | ***0*** | ***4*** | ***7*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***7*** |
| Prototypes | Papa | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | **0** | **1** |
| | Novemberdesign | 0 | 0 | 1 | **1** | 0 | 0 | 0 | **0** | **0** | **1** |
| | Severodvinsk | **under construction** | | | | | | | | | |
| | Mike | 0 | 0 | 0 | **0** | 0 | 0 | 0 | **0** | **1** | **1** |
| ***Subtotal*** | | ***0*** | ***0*** | ***2*** | ***2*** | ***0*** | ***0*** | ***0*** | ***0*** | ***1*** | ***3*** |
| **Submarines (Total)** | | **70** | **10** | **33** | **113** | **56** | **10** | **4** | **70** | **4** | **187** |

# 7 Decommissioning and remediation of associated nuclear sites

## 7.1 Gremikha

Gremikha is a former Navy base located on the Kola Peninsula in North-west Russia. It was used for the maintenance of Alpha class submarines powered by lead cooled fast reactors. Initially nine reactor cores and one reactor (all containing SNF) were stored at the base. In addition, about 900 spent fuel assemblies from pressurrized water naval reactors were stored in old casks on a provisional concrete storage pad. The most important stage in decommissioning the base was the removal of SNF from Gremikha and transport to the Mayak plant for reprocessing. In 2012 all pressurized water reactor submarine fuel was safely repacked and removed from Gremikha. This SNF included damaged fuel assemblies, which required special technological solutions for handling and packing developed by the Russian and French partners. Special canisters have been designed and manufactured to make it possible to pack damaged fuel assemblies in standard TUK-18 casks.

## 7.2 Andreeva Bay

Andreeva Bay is a former naval base also located in North-West Russia. Since the early 1960s it was used for servicing the nuclear fleet and storage of submarine fuel, including SNF, and radioactive wastes arising from the operation of nuclear-powered submarines. Over 21,000 SNF assemblies were stored in cells contained in three dry storage units (DSU). In addition, SNF was stored in old casks placed in or in the vicinity of the DSU tanks. In 2000 the base was transferred from Naval to civil ownership, the Ministry of Atomic Energy (now Rosatom) for nuclear decommissioning.

International efforts at Andreeva Bay began in 2001 at the CEG workshop in Idaho Falls, USA. CEG members discussed in detail the status of SNF and RW management strategies and proposals of specific projects at Andreeva Bay. Several CEG members expressed interest in supporting activities in Andreeva Bay. The following key activities were agreed on:

- Creation of infrastructure for safe management of SNF and RW,
- SNF and RW management and its removal from the base and
- remediation of the site

Since then the CEG has regarded Andreeva Bay as a high priority project for implementation by international partners and devoted many of its meetings and workshops to this end. The CEG created the Andreeva Bay Project Management Group to address all project implementation issues. The group is currently still active and headed by Rosatom.

### 7.3 Saida Bay

The need to create a facility for conditioning and storage of legacy RW from the whole North-West region of Russia was discussed at CEG meetings and workshops in 2007 and 2008. Germany suggested using existing technologies from the RW management and storage facility in Lubmin (Ger-many) as well as supplying equipment. In 2009 Germany started the project for construction of the Regional Centre for Conditioning and Long-term Storage of Radioactive Waste at Saida Bay (s. a. chapter 10.1).

This Regional Centre will manage radioactive waste generated by the Russian Navy and icebreaker fleet in North-West Russia. The Centre is designed for decontaminating, processing, conditioning and interim storage (for 70-100 years) of up to 100 000 m3 conditioned radioactive waste. The waste will be conditioned according to the waste acceptance criteria for storage and subsequent disposal. The centre will manage solid and liquid low and medium level radioactive waste. The project included the establishment of a computer-assisted waste monitoring system to record all packaging and store sites of low and intermediate level radioactive waste and tracing it at any time. The liquid radioactive waste facilities are capable of reprocessing 1500 m3 of liquid waste into 155 m3 of solid waste a year. The Regional Centre was completed at the end of 2014.

### 7.4 Razbonynik Bay

An interim long-term storage pad for submarine reactor units and units of nuclear service ships of the pacific fleet was built in the Far East at Razboynik Bay together with a centre to prepare reactor units for long-term storage. The facility was mainly financed by Russia although Japan delivered various equipment and parts of the facility. In 2013 the centre started accepting reactor units and nuclear service ships for conditioning and storage. The CEG assisted the project by providing information exchange especially regarding the similar project in the Saida Bay that had been completed earlier in the North-West Russia.

## 8 Handling the legacy supply vessels

To handle the SNF and liquid / solid radioactive waste from the nuclear submarines, so-called supply vessels were used. These were assigned either to the Russian navy or to Atomflot. Within the framework of the CEG, the decommissioning of the three such supply vessels ("Floating Technical

Bases" (FTB)) Lepse, Lotta and Volodarsky was prioritized. Furthermore, also with the focus on decommissioning, four nuclear-powered icebreakers that had been taken out of service, a number of nuclear-powered warships of the Russian navy, and further supply vessels within the responsibility of Atomflot were included.

At the time of its decommissioning, there were 639 spent fuel assemblies – some of which were damaged – as well as solid and liquid radioactive waste onboard the Lepse, a former merchant ship which had been converted into a supply vessel. The Lepse was in a bad condition before it was towed from Murmansk to the Nerpa shipyard for decommissioning with funding aid from the NDEP programme. Following the retrofitting the shipyard infrastructure, the Lepse was pulled out of the water, and the remaining solid and liquid waste was removed. The Lepse was then cut into five segments. The two large segments (Large Storage Packages) with the spent fuel assemblies were fitted with additional shielding and sealed. The removal of the spent fuel assemblies and shipment to Saida Bay for long-term storage will take place at a later stage, solely with Russian financing.

Until 2015, spent fuel assemblies were onboard the Lotta supply vessel. These were unloaded with the help of British funds. To continue decommissioning, contaminated segments were removed and put in long-term storage.

The Volodarsky supply vessel was used in the 1960s for the disposal of radioactive waste. Financed by the Russian Federation, the Volodarsky was transferred to a floating dock in Saida Bay, where the vessel was cut into blocks and two contaminated segments were fitted with additional shielding and seals to prepare them for long-term storage.

# 9 Recovery, Replacement, Disassembly and Long-Term Storage of RTGs

Radioisotope Thermoelectric Generators (RTG) are autonomous power sources that convert thermal energy from high activity isotopes into electricity. They provide long term constant electricity supply with little maintenance, and therefore are suitable for powering navigational beacons in locations where no other source of electricity is available.

Russia deployed over 1,000 RTGs to supply constant power, primarily to lighthouses for navigational purposes, over an area covering thousands of kilometres from the Baltic Sea to the Pacific Ocean. These RTGs use strontium-90 for their radioactive heat sources (RHS), with the initial RTG activities ranging from 35,000 to 465,000 curies. Physical protection of these unattended RTGs with radioactive sources could not be accomplished at their remote locations. Moreover, with the useful life of these sources expiring after 2000, it was decided to remove RTGs from these sites and replace them with alternative power sources (APS), based primarily on solar systems. Once recovered, the RTGs were disassembled and the radiation heat sources removed and transported to the Mayak plant.

*Recovered RTGs ready for transport*

From 2005 the CEG was used as a forum for the exchange of information, planning, and carrying out projects for RTG decommissioning in Russia. Two workshops (in 2005 and 2008) were dedicated specifically to RTG issues. RTGs were part of other regional workshops where a special session was devoted to problems of RTG decommissioning. In 2006-2007 the Russian Kurchatov Institute, in coordination with Canada and other Russian agencies, created a Master Plan for the decommissioning of RTGs that included RTG accounting, temporary storage, transportation schemes, RTG disassembly facilities, long term storage of radioactive heat sources (RHS), regulatory issues, environmental impact assessments, as well as risk and cost analyses. In 2007, the completed Master Plan was presented at the CEG meeting to all member states. Consequently a comprehensive database was developed to track RTGs and APS replacements. In 2008 an Action Plan was developed for RTG decommissioning, which included all the above-mentioned phases. At each subsequent CEG plenary meeting reports on the status of RTG projects were presented. Members of the CEG created a working group (WG) specifically to address RTG-related questions, headed by Rosatom. All joint international projects were conducted by Russia. USA and Norway were the primary donor countries.

As a result of the international efforts nearly all the RTGs were recovered by the end of 2014. 482 RTGs were secured from the Russian Arctic and Far East with funds primarily from the USA with Canadian assistance, while Norway primarily funded the removal 180 RTGs from the Russian North West and Northern Sea Route with additional financial assistance from Canada. Russia re-covered 239 RTGs. In the Baltic Sea, Norway, France, Sweden, and Finland funded the removal of 87 RTGs.

# 10 Norwegian/German co-operation projects with Russia

## 10.1 Projects with German participation

In October 2003, a German-Russian agreement about technical support for decommissioning Russian nuclear submarines was signed. In November 2003, the Federal Republic of Germany, via its Federal Economics Ministry (BMWA, then BMWi) commissioned Energiewerke Nord (EWN) with the execution of this support in the form of individual projects. A total of approx. €600m was made available to realize the projects jointly defined with the Russian partners:

- Modernisation of the infrastructure for the dismantling of nuclear submarines at the Nerpa shipyard and the SevRao works. This comprised the reconditioning of two tugboats, ship hoists, construction of a platform for the dismantling of submarines and the associated piers as well as the repair of a floating dock and of cranes. Furthermore the formation of 20 reactor sections suitable for long-term storage was funded by Germany.

- Establishment of an ecologically safe condition at Saida Bay near Murmansk by recovering and disposing of 17 wrecks partly contaminated with radioactivity or other contaminants.
- Construction of a long-term storage facility in Saida Bay for 150 reactor sections from nuclear submarines as well as for radioactive sections of service vessels, including a building for the treatment of large components as well as the necessary technical equipment/infrastructure of the storage facility.

*The storage facility was handed over to the Russian side for operation in September 2011.*

- Construction of a regional disposal centre at Saida Bay for the treatment and storage of all radioactive waste arising in connection with the safekeeping of the submarines as well as the remaining radioactive materials that have arisen already over the past decades of service of the submarine fleet, with the associated segmenting, decontamination, conditioning and packaging facilities in analogy with the concept of EWN (storage facility "Nord" at Lub-min/Germany).

*The Saida disposal Centre was handed over to the Russian side for operation in August 2015.*

- Delivering of a rail-mounted heavy-goods-transport system, two all-terrain mobile cranes as well as a special transport system to support the DalRao works in the Far East.

## 10.2 Projects with Norwegian participation

The comprehensive nuclear activities during the Cold War left considerable amounts of radioactive waste and nuclear materials stored under unsatisfactory conditions in North-West Russia. It has therefore been in Norway's interest to have close cooperation with Russia and the former Soviet republics, both bilaterally and through its strong ties to the CEG. Projects with Norwegian participation have been funded by the Norwegian Ministry of Foreign Affairs, and for the most part coordinated by the Norwegian Radiation Protection Authority in collaboration with the Office of the County Governor of Finnmark. Cross-border radioactive contamination could have a major impact on Norwegian interests with regard to health and the environment. Norway’s commitment to both CEG work and the Norwegian Nuclear Action Plan reflects their similar goals: to help reduce the risk of serious accidents and radioactive contamination, and prevent radioactive and fissile material going astray.

- Submarine Dismantling
  Norway has funded and contributed to the dismantling of five submarines with nuclear fuel on board for the period 2003 to 2009. One of the submarines was dismantled in cooperation with UK. This has greatly reduced the risk that these five nuclear submarines posed for the local and regional environment, as decommissioning requires removal of the spent nuclear fuel and its transport to final treatment and disposal at the Mayak plant. The

remaining sealed reactor sections with radioactive waste are now stored long-term at the secure storage facility at Saida Bay.

- Removal of radioactive sources from lighthouses (RTGs)
  The former Soviet Union deployed about 1,000 radioisotope thermoelectric generators (RTG) to power lighthouses and beacons, mostly in remote areas along Russia's northern coastline. Lack of physical security of sources made them easily accessible to intruders. A number of attempted thefts revealed the potential that radioactive sources could go astray. Since 1998, Norway funded the removal of the RTGs used in lighthouses in Northwest Russia and the Baltic Sea, and replaced them with environmentally friendly solar technology. Norway has funded the removal of 251 RTGs: 180 along the coast of North-West Russia and in 71 Baltic Sea region. Cooperation between Russian, Norwegian, US, Swedish, Finnish and Canadian authorities has made valuable contribution to the remove and secure all the RTGs.
- Safety measures and infrastructure at Andreeva Bay
  After nuclear operations servicing the Russian submarine fleet stopped during the 1980s, the large quantities of spent nuclear fuel and radioactive wastes present at the site were stored under unsatisfactory conditions, presenting a risk of transboundary contamination. Since 1997, Norway, together with Russia, has undertaken projects to reduce the risk of radioactive contamination at the Andreeva site of temporary storage (STS) and facilitate removal of the spent nuclear fuel. Norway has also funded projects designed to prepare for safe SNF removal from the site, e.g.:
    - Cooperation with regulatory authorities on legislative and guiding documents for RW and SNF handling.
    - Soil surveys and mapping of the existing contamination at the plant.
    - Physically securing the area with fences, guard booths and alarm systems.
    - Upgrading roads, electricity, water and sewerage.
    - Buildings to ensure safe, comfortable conditions for employees during clean-up operations
    - Upgrading a pier for transporting radioactive materials out of the facility.
- Environmental monitoring and cooperation to assess the potential risks from dumped/sunken radioactive materials
  Until the 1990s the former Soviet Union, and later Russia, dumped large quantities of spent nuclear fuel and radioactive waste in the Kara and Barents Seas. This also constitutes a potential source of radioactive contamination from Northwest Russia. Risks also include contamination from the sunken submarines K-159, K-278 (Komsomolets) and as well as K-27. Norway has carried out a number of expeditions to the dumping sites in cooperation with Russia to investigate the environmental contamination and risks for potential leakage in future. The last expeditions were carried out to K-27 and K-159 in 2012 and 2014, respectively. Since 2006, Norway and Russia have cooperated on a joint environmental monitoring program covering both land and sea in these areas, resulting in an array of joint reports. The conclusion of these studies has been that the radioactive pollution in the area is low but there is a certain risk of future pollution.

## 10.3 Projects with Norwegian and German participation

The aim of the bilateral co-operation of Norway and Germany regarding the elimination of Russia's nuclear legacies was to achieve a sustained reduction of the risk to human health and the environment especially in the north-western region. This becomes particularly clear in the case of two joint projects.

- Within the framework of the co-operation project Norway and Germany, together with several other countries, conducted a "Feasibility investigation into a nuclear repository in permafrost soil on the Novaya Zemlya peninsula". The Project was based on a proposal from March 2002 prepared by a consortium made up of the German DBE Technology GmbH ("DBE Technology"), the Norwegian Institute for Energy Technology ("IFE") and the Swedish SKB International Consultants AB ("SKB International"), in co-operation with the Russian Subcontractor VNIPI PT. The Ministry of Foreign Affairs of Norway ("MFA"), the German Federal Ministry of Economics and Technology (BMWi) and the Swedish International Project Nuclear Safety ("SIP") were international donors. Minatom of Russia was the beneficiary of the Project.

  The aim of monitoring the Russian repository project was to recognise any possible risks to man and the environment in the corresponding region as a neighbouring state as early as possible and, if necessary, to influence the further planning. As a result of the investigation, the consortium established that the project was "generally feasible". This tipped the balance in favour of letting the same consortium monitor the second phase of the project, too. In this phase, it was planned to prepare specific application documents by the Russian project partners. As for the German side, the work mainly concentrated on the characterisation of the waste spectrum and the resulting waste acceptance requirements for disposal as well as on analyses regarding heat generation and possible gas formation of the waste intended for emplacement.

  Within the framework of the 17th General Meeting of the CEG in November 2003 in Murmansk, a meeting of the donors to the "Repository in permafrost soil on the Novaya Zemlya peninsula" project and the Russian partners took place. At that meeting, the Russian side (Dr. Akhunov/MINATOM) stated that the plans of the intended repository at Novaya Zemlya were no longer to be pursued. As a consequence, the donors decided unanimously not to sponsor the accompanying project any longer either, and to ask the partners in the consortium to submit a final summary report. That report was submitted at the end of the year 2014.
- Within the framework of two TACIS projects – RF/TS/36 and RF/TS/47 – Norway and Germany were involved in the support of Rostechnadzor in connection with the licensing procedure for decommissioning the Lepse. As part of this project, there were also activities to further develop the Russian nuclear regulations, and courses and seminars were held for staff and the authorities and the nuclear expert organisation SEC NRS.

In addition, both countries were active as part of a consortium within the framework of a project financed by the EBRD. The aim of this project was to give an expert opinion on three summary reports on the Lepse decommissioning project as well as an exchange with representatives of the authorities and their expert organisations during a seminar at which the results of the expert review were presented. The reports that were reviewed contained descriptions of the safety

analyses and environmental impact assessments that were per-formed and of the chosen technical/technological solutions. The reviews were based on relevant international recommendations, such as from the IAEA, and national "good practices". The project was realised together with IRSN (France) and other external experts under the leadership of NRPA (Norway). GRS (Germany) was in charge of the technical co-ordination. The project term was approx. half a year. It was concluded successfully at the end of September 2015.

# 11 Conclusions

The efforts of IAEA Contact Expert Group for Nuclear Legacy Initiatives in the Russian Federation (CEG) were one of the most successful examples of multinational cooperation in the elimination of nuclear legacy. The following conclusions are drawn:

- The dismantlement of 196 decommissioned nuclear submarines, completion of key facilities for RW management, partial removal of SNF from former Navy bases, securing RTGs and other projects in this regard were successfully initiated.
- The fact that CEG has worked under the IAEA auspices contributed to the status of the group and its influence.
- The CEG as a forum of technical experts and officials has played an important role in in-formation exchange about nuclear legacy problems and projects carried out by its 13 member states and multilateral groups in the North-West and Far-East of Russia.
- The CEG helped the members to agree on priorities and select specific projects in nuclear legacy programmes. CEG ensured that all key areas of the joint cooperation have been covered by the partners and that there would be no duplication of efforts.
- The priorities agreed upon by CEG members and proposals for submarine dismantlement as well as RW and SNF management have become the priorities of the G8 Global Partnership Initiative against the Spread of Weapons and Materials of Mass Destruction (phase one 2002-2012). The Global Partnership has given a significant impetus to the whole programme of submarine dismantlement.
- The group contributed to the development of trust and willingness to work together in the area of nuclear legacy that earlier had been closed for joint international efforts.
- As a forum for sharing information on ongoing multinational programmes and planning initiatives the CEG has supported senior officials in making robust justifications to national legislatures and the public.
- The members have gained valuable technological experience in management of SNF and RW, ensuring nuclear and radiation safety in this specific area of nuclear legacy. This experience could be used in the countries that have similar legacy issues.
- Elimination of threat from almost 200 decommissioned nuclear submarines and preventing possible nuclear accidents at legacy sites has contributed to enhancing the overall reputation of the nuclear community in the world. It also demonstrated that technologies are available for solving the most challenging problems inherited from the past nuclear activities.

# 12 Lessons learnt

The activities of the members of the Contact Expert Group (CEG) were characterized by the establishment of a comprehensive framework and the realization of very ambitious projects. The participants gained valuable experiences. Specialists learned from the experts of other countries participating in the projects.

The Development of strategies and decommissioning programmes (Strategic Master Plan and RTG Master Plan) and the Multilateral Nuclear Environmental Protection Agreement (MNEPR) proved to be very important to encourage international partners to find their niche of cooperation. This should be done at the earlier stages of such international endeavours. Also, it is worth mentioning that creation of a legal base for international projects (bilateral and multilateral agreements) for exemption of donors from nuclear liability, tax exemption and guaranteeing access of experts to the sites may take longer time than expected. That was a delaying factor for the projects to be started when the funds were already available. The engagement of nuclear regulators at the earliest stages of project planning and implementation proved to be very important.

In the early phase of the CEG the mutual respect was dominating. So one goal of financing projects was to gather information about the actual status of existing legacies e.g. the exact numbers of de-commissioned submarines. Gaining openness of project partners, both beneficiaries and donors, took time but was proved to be essential for a fruitful co-operation.

While developing big projects which often require years of preparation it is worthwhile to consider starting smaller and relatively easy projects as it is important to demonstrate initial successful projects to all stakeholders. In some cases, the initial desire to have an uncompromising (conservative) technological design may lead to setbacks when the final cost appears to be too high. In many cases the reliance on already existing and proven technologies e.g. of SNF and RW management, which meet safety requirements, appeared to be the right solution. Multinational funded projects showed its own challenges in terms of technical coordination as well as harmonization with Russian authorities.

The work of the CEG proved to be very successful with specific regard to the nuclear legacy of the Russian navy.

Co-financing between the CEG members in implementing legacy projects allowed a wider range of donors to support projects. An important factor to support and encourage international projects proved to be good information exchange and informing the public about these projects.

**List of abbreviations**

| | |
|---|---|
| APS | Alternative Power Sources |
| BMUB | Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit / German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety |
| BMWi | Bundesministerium für Wirtschaft und Energie / German Federal Ministry of Economics and Technologie |
| CEG | Contact Expert Group |
| DalRAO | Federal State Unitary Enterprise Far East Enterprise for Handling Radioactive Waste |
| DBE Technology | Deutsche Gesellschaft zum Bau und Betrieb von Endlagernd für Abfallstoffe mbH |
| DSU | Dry Storage Units |
| EBRD | European Bank for Reconstruction and Development |
| EC | European Commission |
| EWN GmbH | Energiewerke Nord GmbH |
| FCNRS | Federal Center for Nuclear and Radiation Safety (division of Rosatom) |
| FSUE PC “Mayak” | Federal State Unitarian Enterprise of the Production Combine “Mayak” |
| FTB | Floating Technical Bases |
| GIAs | Grant Implementation Agreements |
| GRS | Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH – Germany’s central expert organisation in the field of nuclear safety and radioactive waste management |
| G8 GP | G8 Global Partnership |
| IAEA | International Atomic Energy Agency |
| IFE | Norwegian Institute for Energy Technology |
| MFA | Ministry of Foreign Affairs of Norway |
| MINATOM | Ministry for Atomic Energy of the Russian Federation |
| MNEPR | Multilateral Nuclear Environmental Protection Agreement |
| NDEP | Northern Dimension Environmental Partnership |
| NRPA | Norwegian Radiation Protection Authority |
| RHS | Radioactive Heat Sources |
| ROSATOM | State Atomic Energy Corporation |
| RTGs | Radioisotope Thermoelectric Generators |
| RW | Radioactive Waste |

| | |
|---|---|
| SEC NRS | Scientific and Engineering Centre of Nuclear and Radiation Safety (Russian Technical Safety Organsiation) |
| SevRAO | Federal State Unitary Enterprise "Northern Radwaste Management Company" |
| SIP | Swedish International Project Nuclear Safety |
| SKB International | Swedish SKB International Consultants AB |
| SMP | Strategic Master Plan |
| SNF | Spent Nuclear Fuel |
| STS | Site of Temporary Storage |
| SWG | Strategy Working Group |
| TACIS | Technical Assistance to the Commonwealth of Independent States |
| ToR | Terms of Reference |
| VNIPI PT | VNIPI Promtekhnologii “All-Russian Design Institute for Industrial Technology” |
| WG | Working Group |

# ANNEX: CEG organization and main activities

**Chairman duties**

The CEG was chaired by one of the CEG members, elected for a two-year period by the full members of the CEG. A Vice-Chairman was elected simultaneously for the same period.

CEG Chairmen

| | |
|---|---|
| 2012-2015 | Norway, Ingar Amundsen |
| 2008-2012 | Canada, Michael Washer |
| 2006-2008 | France, Alain Mathiot |
| 2003-2006 | United Kingdom, Alan Heyes |
| 2001-2003 | Norway, Torbjorn Norendal |
| 1998-2000 | USA, Charles Newstead |
| 1996-1997 | Sweden, Jan Olof Snihs |

CEG Vice Chairmen

| | |
|---|---|
| 2013-2015 | Italy, Massimiliano Nobile |
| 2012-2013 | France, Alexandre Gorbatchev |
| 2008-2012 | Norway, Ingar Amundsen, |
| 2004-2008 | Canada, Michael Washer |
| 2003-2003 | United Kingdom, Alan Heyes |

**The CEG Secretariat**

The establishment and operation of the CEG Secretariat was entrusted to the IAEA, which provided the premises and infrastructure necessary for its work. The Secretariat consisted of an Executive Secretary and a part-time assistant.

CEG executive secretaries:

2008-2015 IAEA, Oleg Goroshko

2000-2007 IAEA, Sergey Bocharov

1996-2000 IAEA, Boris Semenov

**CEG plenary meetings**

Depending upon the requirements of CEG members, one or two plenary meetings were held annually.

2014 Italy, Rome, 28th meeting

2013 Russia, Murmansk, 27th meeting

2012 France, Paris 26th meeting

2011 Sweden, Aronsborg, 25th meeting

2010 Canada, Ottawa, 24th meeting

2009 Italy, Rome, 23rd meeting

2008 France, Paris, 22nd meeting

2007 Brugge, Belgium, 21st meeting

2006 Germany, Munich, 20th meeting

2005 Canada Ottawa, 19th meeting

2004 Russia, Moscow 18th meeting

2003 Russia, Murmansk, 17th meeting

2003 Netherlands, Hague, 16th meeting

2002 Belgium, Brussels, 15th meeting

2002 IAEA, Vienna, 14th meeting

2001 Sweden, Oskarshamn, 13th meeting

2001 Russia, St. Petersburg 12th meeting

2000 France, Cherbourg, 11th meeting

2000 Finland, Helsinki, 10th meeting

1999 Germany, Berlin, 9th meting

1999 Norway, Fredrikstad, 8th meeting

1998 Russia, Murmansk, 7th meeting

1998 USA, Augusta, 6th meeting

1997 UK, Windermere, 5th meeting

1997 Russia, Petersburg, 4th meeting

1997 Belgium, Brussels, 3rd meeting

1996 IAEA, Vienna, 2nd, meeting

1996 Russia, Moscow, 1st meeting

**CEG workshops**

1. Land based reactor compartment disposal 2001. Richland, USA.
2. Spent nuclear fuel and radioactive waste management at Andreeva Bay. 2001, Idaho Falls, USA.
3. Dismantlement of multipurpose nuclear submarines. 2003, Severodvinsk, Russia.
4. Remediation of the Gremikha Site 2003, Cadarache, France
5. Environmental Impact and Risk Assessment as Applied to Dismantling of Nuclear Submarines and Remediation of Sites. 2004, Oxford, United Kingdom
6. Methods and Technologies for Radioactive Waste Management Applicable for Remediation of Isolated Nuclear Sites. 2004, Petten, Netherlands.
7. Decommissioning and Replacement of RTGs. 2005, Oslo, Norway
8. Dismantlement of nuclear service ships and surface vessels with nuclear power installations. 2005, Murmansk, Russia
9. Strategic Aspects of Radioactive Waste Management and Remediation of Contaminated Sites. 2006, Stockholm, Sweden.
10. Isolation and Disposal of Radioactive Waste. 2006 Olkiluoto, Finland
11. Strategic Master Plan, Phase 2. 2007, London, United Kingdom
12. Nuclear Legacy Problems in the Far East of Russia. 2007, Vladivostok, Russia.
13. System for Radioactive Waste Management in the North-West Region of Russia. 2008, Oxford, United Kingdom
14. Problems of Decommissioning Radioisotope Thermoelectric Generators, 2008, Moscow, Russia.
15. Disposal of Radioactive Waste and Spent Nuclear Fuel – Experience and Plans 2009, Sweden
16. Regulatory and Licensing Issues of SNF and RW Management (including a special session on the Mayak Plant) 2009, St. Petersburg, Russia
17. CEG Workshop on Removal of Spent Nuclear Fuel (SNF) and Radioactive Waste (RW) from Andreeva Bay, and Strategies for Handling Sunken Objects Containing SNF in the Arctic Ocean. 2010, Hague, Netherlands
18. Final Elimination of the Nuclear Legacy in the Far East of Russia, 2010, Vladivostok, Russia
19. Management of Spent Fuel of Alpha Class Submarines – Removal from Gremikha, 2010, Rome, Italy
20. Investigation of Nuclear Submarines and Objects with Spent Nuclear Fuel and Radioactive Wastes Sunken in the Arctic Seas and Strategies for Radio Ecological Rehabilitation of the Arctic Region. 2011, Oslo, Norway
21. CEG Workshop on Predisposal of Legacy Radioactive Waste: Treatment, Conditioning and Storage. 2011, Heringsdorf, Germany
22. Economics of Spent Nuclear Fuel Management – Reprocessing and Direct Disposal 2011, Aronsborg, Stockholm, Sweden

23. Implementation of International Nuclear Legacy Programmes in Russia. 2012, Helsinki, Finland

24. International Programmes for Disused Radioactive Sources Management in Russia and Countries of Former Soviet Union. 2013, Vienna, IAEA

25. Topical Issues of Legacy RW and SNF Management in North West and Far East Russia.

2014, Bergen, Norway.

Statens strålevern
Norwegian Radiation Protection Authority

2017

**StrålevernRapport 2017:1**
Årsrapport 2016

**StrålevernRapport 2017:2**
Ionising radiation metrology infrastructure in Europe

**StrålevernRapport 2017:3**
Radon i nye boliger

**StrålevernRapport 2017:4**
Stråledoser til øyelinsen for intervensjons-personell

**StrålevernRapport 2017:5**
Persondosimetritjenesten ved Statens strålevern

**StrålevernRapport 2017:6**
Faglige anbefalinger for strålebehandling ved ikke-småcellet lungekreft

**StrålevernRapport 2017:7**
Faglige anbefalinger for kurativ stråle-behandling ved småcellet lungecancer

**StrålevernRapport 2017:8**
Faglige anbefalinger for lindrende stråle-behandling ved lungecancer

**StrålevernRapport 2017:9**
Environmental Impact Assessment Of The Removal of Spent Nuclear Fuel (SNF) From Andreeva Bay

**StrålevernRapport 2017:10**
Radioaktivitet i norsk mat

**StrålevernRapport 2017:11**
Radioaktivitet i utmarksbeitende dyr 2016

**StrålevernRapport 2017:12**
Radiological impact assessment for hypotheti-cal accident scenarios involving the Russian nuclear submarine K-159

**StrålevernRapport 2017:13**
Radioactivity in the Marine Environment 2012, 2013 and 2014

**StrålevernRapport 2017:14**
Activities within the Framework of the IAEA Contact Expert Group: Focus on input from Norway and Germany

**StrålevernRapport 2017:15**
Overvaking av radioaktivitet i omgivnadane 2016

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