DET NORSKE VERITAS

Rapport

Evaluation of the Norwegian funded project on the removal, transport and handling of radioactive strontium batteries

Norwegian Radiation Protection Authority

DNV Reference: 15F9KEN-1
Rev. 0, 2012-12-19

Evaluation of the Norwegian funded project on the removal, transport and handling of radioactive strontium batteries	
For: Norwegian Radiation Protection Authority Postboks 55 1361 ØSTERÅS Norway	
Account Ref.:	

DET NORSKE VERITAS AS
P.O.Box 300
1322 Høvik, Norway
Tel: +47 67 57 99 00
Fax: +47 67 57 99 11
http://www.dnv.com
Org. No: 945 748 931 MVA

Date of First Issue:	2012-11-19	Project No.:	PP051547
Report No.:	Final report	Organization Unit:	Operational Excellence (OPE/MOC)
Revision No.:		Subject Group:	

Summary:

Between 2001 and 2009 Norway financed the removal, handling and transport of 180 radioactive strontium batteries (Radioactive Thermoelectric Generators / RTGs) from Northwest-Russia. Det Norske Veritas (DNV) has been asked to undertake an evaluation of the effectiveness of project management, as well as improvements in nuclear safety, nuclear security and environmental protection

In DNV's opinion, Norwegian funding has been instrumental in ensuring that the removal, handling and transport of the RTGs took place without any reported serious events with subsequent release of radioactivity to the environment or uncontrolled exposure to people. Compared to the alternative of non-intervention, DNV is of the impression that improvements in nuclear safety, security and environmental protection have been achieved.

Prepared by:	*Name and Position* Pia Fagernes Angela Miller Morten Bremer Mærli	*Signature* Pia Fagernes
Verified by:	*Name and Position* Rune M. Moen	*Signature* Rune Moen
Approved by:	*Name and Position* Anett Hollum Valsvik Head of Department	*Signature* Anett H. Valsvik

	No distribution without permission from the client or responsible organizational unit (however, free distribution for internal use within DNV after 3 years)	**Indexing Terms**	
X	No distribution without permission from the client or responsible organizational unit	Key Words	
	Strictly confidential	Service Area	
	Unrestricted distribution	Market Segment	

Rev. No. / Date:	Reason for Issue:	Prepared by:	Verified by:	Accepted by:
0/11.12.2012	Draft report	Pia Fagernes	Rune M. Moen	Anett Valsvik

© 2012 Det Norske Veritas AS
Reference to part of this report which may lead to misinterpretation is not permissible.

Table of Contents

EXECUTIVE SUMMARY

Between 2001 and 2009 Norway financed the removal, handling and transport of 180 radioactive strontium batteries (Radioactive Thermoelectric Generators / RTGs) from Northwest-Russia. Nuclear safety in the north is an important part of the collaboration between Norway and Russia. The Norwegian Government established a Nuclear Action Plan in 1995 which is considered to be the most important management tool of the Norwegian authorities in their nuclear safety work with Russia. One of the programs in the Action Plan has been the dismantlement of RTGs.

Det Norske Veritas (DNV) has been tasked to undertake an independent evaluation of the:

(i) Effectiveness of project management for the RTG-removal project in the Northwest Russia (Task 1)

(ii) Success in achieving improvements in nuclear safety and environmental protection (Task 2)

The evaluation was undertaken as a desktop study supported by interviews with selected key stakeholders between September and November 2012.

For the purpose of the evaluation DNV has analyzed achievements of the RTG-removal project along the following major success areas; long-term impact, removal performance, cooperation and knowledge sharing, fulfillments of requirements and deliverables.

In DNV's opinion, Norwegian funding has been instrumental in ensuring that the removal, handling and transport of the 180 RTGs took place without any reported serious events with subsequent release of radioactivity to the environment or uncontrolled exposure to people.

Compared to the alternative of non-intervention, DNV is of the impression that improvements in nuclear safety, security and environmental protection have been achieved; see Table 1 - summary of the achievements, Task 2. Chapter 15 provides a more detailed explanation of the summary table.

The open contribution from all interviewees has been a valuable input to this report.

Table 1 - Summary of achievements, Task 2

	Description of goals	Degree of goal accomplishment	Score
Long term impact	Reducing the risk of accidents and pollution from nuclear installations (RTGs) in Northwest Russia and preventing radioactive and fissionable material from going astray.	180 RTGs (some defect, with damaged shielding) were removed and no longer pose a security, nuclear safety or environmental threat in unprotected areas along the coast of Northwest Russia	
Removal performance	Main risks identified and acted upon during each phase of the RTG-removal process	RTG-removals were performed without any serious incidents involving uncontrolled releases of radioactivity to the environment or exposure to people. Decommissioning may, however, have relied more heavily on practical risk management experiences than structured, norm-based risk assessment regimes.	
	Reduction of risks of accidents and pollution	Failure to decommission the RTGs in safe and secure ways is likely to increase risk over time. Safe use of RTGs requires containment of radioisotopes long after the productive life of the unit. Intervention is hence desirable, despite elevated risks during the period of intervention.	
	Preventing the loss of radioactive material	Radioactive material potentially exposed to theft and diversion have been handled and included into traditional Russian radioactive waste management streams. Long term storage for the RHS has been established.	
Cooperation and knowledge sharing	Improved collaboration (with Russia and other sponsoring organizations)	The cooperation has led to positive development locally; effects on the regional level are unclear The contributions of other countries, e.g. Canada and France, have been facilitated through the joint Norwegian-Russian cooperation.	
	Strengthened Russian administrative and supervisory authorities in the areas of nuclear safety, radiation protection, preparedness and environmental monitoring	Russian counterparts are given full responsibility for the planning, implementation and follow-up of the RTG-removal project. There has been important establishment of the relevant regulations related to the decommissioning of RTGs.	
Fulfillment of requirements	EIAs prepared according to Russian requirements and international best practices	EIAs were developed throughout the project, both as a prerequisite for licensing of contractors, as well as a demand from sponsoring party. However, there has been limited or no focus on environmental protection per se in the RTG-removal projects.	
	Use of EIAs in RTG-removal project	EIA was carried out for all the RTGs in the Norwegian-funded project before the removal and allocation of funding.	
	Removal undertaken according to Russian laws and regulations/licensing	Russians unable to fully comply with domestic licensing demands for subcontractors. High standards of physical protection were maintained by the military. However, the extent to which the RTGs were protected at all relevant stages in accordance with the strict requirements set out by the IAEA for category A material, remains unclear.	
Deliver-ables	Removal of 180 RTGs	Despite external factors and delays on Russian side, the project has been managed in a dedicated and effective manner. Concrete project, easy to perform, good relationship, Russians were motivated.	

1 INTRODUCTION

1.1 Background

Nuclear safety in the north is an important part of the collaboration between Norway and Russia. The Norwegian Government has established a Nuclear Action Plan (hereafter called “the action plan”) which is considered to be the most important management tool of the Norwegian authorities in their nuclear safety work with Russia.

Part of the action plan involves financial support for removal, handling and transport of Russian radioactive strontium batteries (Radioactive Thermoelectric Generators / RTGs), hereinafter called the RTG-removal project. The batteries have been used as energy sources in Russian lighthouses/beacons.

The Norwegian Ministry of Foreign Affairs (MFA) has funded this work while the Norwegian Radiation Protection Authority (NRPA) has acted as the professional advisor and undertaken reviews of risk assessment documentation and maintained close dialogue with the Russian supervisory authorities. The project manager (PM) on the Norwegian side for the RTG-removal project was the Office of the Finnmark County Governor (FCG).

In February 2005 Norway and Russia entered into a Memorandum of Understanding (MoU) where Norway declared its intention to assist Russia in removing the RTGs along the coast of the Barents Sea to the Kara Passage, including the western side of Novaya Zemlya. Totally 180 RTGs from Northwest Russia have been removed in a cooperation between Norway and Russia.

In the 2011 grant letter from the Ministry of Health and Care Services and MFA to NRPA, NRPA is asked to undertake an independent evaluation of Norwegian-funded RTG-removal project. Det Norske Veritas (DNV) was selected to undertake an independent evaluation in September 2012. This report provides the findings from the evaluation.

1.2 Scope

The scope of the evaluation was:

Task 1	Evaluation of effectiveness of project management for the RTG-removal project in the Northwest Russia
Task 2	Evaluate success in achieving improvements in nuclear safety and environmental protection

With respect to Task 1, the assessment focuses on to what extent critical elements of project management were covered and how the project management was carried out during the RTG-removal projects. With respect to Task 2, environmental protection refers to improvements in risk reduction as a result of removal, transport and handling of Russian strontium batteries (Radioactive Thermoelectric Generators / RTGs). NRPA has in an e-mail defined Task 2 further: “The mission of the evaluation involves assessing the "net" utility of the removal of 180 RTGs in Northwest Russia and finally storage at Mayak - both with regard to:

- safety (the sources are now safely stored, that no one can use them in “dirty bombs),
- environment (that they no longer represent a pollution problem) and
- health (that no person may be inadvertently exposed to sources)”

The evaluation was undertaken as a desktop study supported by interviews with selected key stakeholders during the assignment period between September and November 2012.

For the purpose of the evaluation DNV has analyzed achievements of the RTG-removal project along the following major success areas; long-term impact, removal performance, cooperation and knowledge sharing, fulfillments of requirements and deliverables. Each success area was scored[1] along the dimensions goal accomplishment and performance.

1.2.1 Limitations

The evaluation does not cover specific considerations related to:

- The effectiveness of project management related to the installation of Alternative Energy Source (AES)
- The quality of the Russian produced EIAs.
- A cost-benefit analysis of the RTG-removal project.
- Budget compliance.[2]
- The activities of Russian stakeholders and pertinent Russian documentation.

1.3 Abbreviations

RTGs	Radioactive Thermoelectric Generators
RHS / RIT	Radioactive Heat Source / Radioactive units/isotopes
RHS	Radioisotope Heat Source
NRPA	Norwegian Radiation Protection Authority
MFA	Ministry of Foreign Affairs
IAEA	International Atomic Energy Agency
CEG	IAEA Contact Expert Group
ICWG	International Coordination Working Group on RTGs
PM	Project Manager
FCG	Office of the Finnmark County Governor
GMR	Government in Murmansk Region
NGO	Non-governmental organization

1.4 Key terms

Key terms used in this report are:

Environmental impact assessment (EIA)	A legal requirement under EU Directive 85/337/EEC (as amended) for certain types of project, including various categories of radioactive waste management project. It requires information on the environmental impacts of a project proposal to be submitted by the developer and evaluated by the relevant competent authority (the planning authority, Health Safety and Environment or other regulators concerned). In this evaluation EIA is used as an abbreviation covering the systematic risk assessment performed for all phases in the RTG-removal project, including transport and storage.
Environmental protection	Protection from contamination from nuclear fuel and radioactive waste coming from the RTGs.

[1] The scoring is only undertaken for part two of the scope.
[2] as this has been evaluated by the Officer of the Auditor of General in Norway

Environmental risk	Actual or potential threat of adverse effects on living organisms and environment by effluents, emissions, wastes, resource depletion, etc., arising out of an organization's activities.
Nuclear installation safety	The role of safety in the design, construction and operation of nuclear installation facilities.
Nuclear safety	IAEA's definitions to nuclear safety are used. Nuclear safety concerns the protection of people and the environment against radiation risks, and the safety of facilities and activities that give rise to radiation risks. Safety concerns both risks under normal circumstances and risks as a consequence of incidents, as well as other possible direct consequences of a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation. Nuclear safety covers the actions taken to prevent nuclear and radiation accidents and to limit their consequences. Safety matters, in contrast to security matters, are intrinsic to activities, and transparent and probabilistic safety analysis is used. As stated in IAEA Safety Standards (No. RS-G1.10): "Attention should be paid to both safety and security in safety assessments. Some measures designed to provide safety, such as the use of interlocks and radiation detectors, will also provide a degree of security against the loss of sources or attempts to gain control over a source. Similarly, the measures designed to prevent unauthorized access to sources will contribute to their safety by reducing the likelihood of misuse."
Nuclear security	The prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities. Security matters concern malicious actions and are confidential, and threat based judgment is used.
Radioactive waste	By-products from nuclear power generation and other applications of nuclear fission or nuclear technology that contain radioactive material hazardous to the environment and to human health.

2 APPROACH

The evaluation has followed an approach as outlined in the Figure 1.

Figure 1 - Approach

2.1 Project initiation and planning

The project was initiated with a Kick-off meeting between NRPA and DNV. The following was discussed and agreed upon:

- The practical background and scope
- Revision and weighting of project goals
- Overview of Stakeholders - Actors and roles
- Project implementation/execution
- Interview objects and their availability
- Schedule and milestones
- Deliveries
- Limitations and clarifications
- Required supporting documentation
- Communication between DNV, NRPA and other stakeholders

2.2 Data gathering

The evaluation was done as a desktop study supported by interviews of selected key stakeholders and data collection at the NRPA and FCG. No data collection was received from Russian stakeholders. Interviews were undertaken during the assignment period between September and November 2012. A list of persons met is included in Appendix 1. The open contribution from all interviewees has been a valuable input to the report.

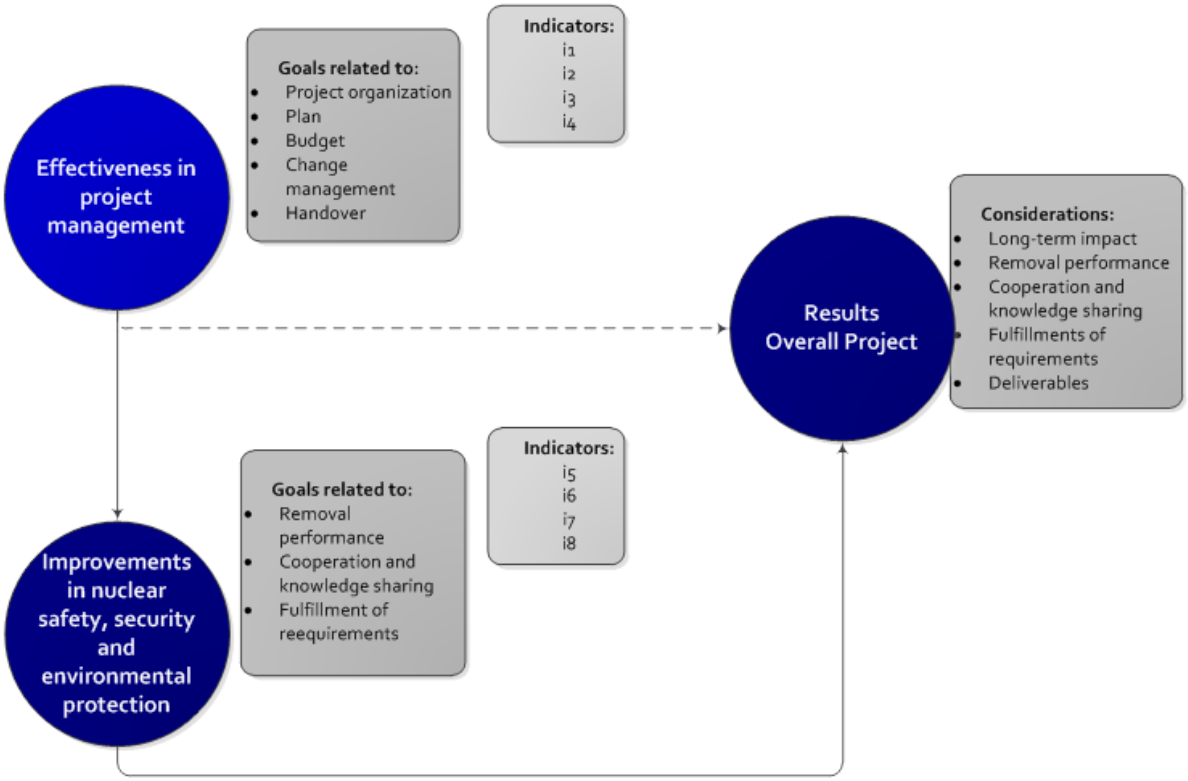
2.3 Analysis

As illustrated in Figure 2, the level of success achieved in Task 1 and 2 will jointly have an impact on the success of the RTG-removal project as a whole. Successful completion of Task 1 (effectiveness of project management for the RTG-removal project in the Northwest Russia) directly influences the result of Task 2 (success in achieving improvements in nuclear safety and environmental protection).

The Norwegian-funded program for removal, transport and handling of the strontium batteries in Northwest Russia has resulted in the dismantling of 180 RTG units. The sheer number of dismantled items calls for a combined analytical approach. Hence, a high-level assessment of overall project processes and flow of documents are carried out jointly with focused evaluations of selected contracts concerning the removal of RTGs.

An overview of DNVs structure of the evaluation according to mandate is given in Figure 2.

Figure 2 – Overview of the structure of DNVs evaluation according to mandate, and the structure of this report



3 ORGANISATION OF THE RTG-REMOVAL PROJECT

3.1 Introduction

FCG/PM and The Norwegian Coastal Administration of Troms and Finnmark started the rebuilding and installation of solar panels in Russia in 1996, after two years of evaluation as to whether the RTGs could be satisfactorily dismantled, handled and stored by the Russian authorities and institutions. As this was concluded, the first RTG-removal project, covering 10 RTGs, was initiated by the North Fleet, Mintrans Hydrographic Service`s department (MinAtom) and GMR in 2001. Before the first RTG-removal contract was signed between the FCG and the Governor in Murmansk, the contract had been reviewed by the legal department in MFA with regard to the legal aspects/content.

The first RTG-removal project was considered a pilot project where the mission was to:

- Prevent radioactive pollution of ocean and land
- Prevent radiation exposure to humans
- Prevent production of “dirty bombs”

Since the initiation of this successful pilot project, 180 RTGs have subsequently been removed. This has been based on annual contracts written directly between the FCG and three contract partners (GMR, Mayak and NIIFTA). The contracts were signed according to annual funding

from MFA. The signed contracts, with appendices, and the annual grant letter from MFA have functioned as project plan for the Norwegian FCG/PM.

MFA prepared annual grant letter on the basis of an overall allocation memorandum, annual meetings between the ministries and the FCG/PM and FCG/PM's proposal to its own tasks related to nuclear safety effort for the relevant year.

RTG-removal projects were initially based on annual contracts. In 2008 the Murmansk administration requested multi-year contracts in order to reduce the number of applications from the Governor of Murmansk, which had to be sent to the Russian Government Commission on technical and humanitarian assistance.

FCG/PM did not have access to Mayak or VNIIFTA during the period fall 2004 - fall 2007. The Russian ambassador in Norway forwarded a message from the Russian authorities that the entry permit would be granted, provided that the Mayak and VNIIFTA were direct contractual partners to FCG. Therefore from 2007 both Mayak and VNIIFTA became contract partners.

3.2 Roles and responsibilities

The main stakeholders in the RTG program with corresponding roles and responsibilities are outlined in Table 2.

Table 2 – Stakeholders and responsibilities

Stakeholder	Role and responsibility
Norwegian Ministry of Foreign Affairs (MFA)	• Overall responsibility for overseeing and implementing the Action Plan. • Prepare annual grant letter to FCG/PM • Providing funding for the all projects and programs under the Action Plan. • Administers MFA's advisory board on nuclear projects and programs under the Action Plan.
Norwegian Radiation Protection Agency (NRPA)	• Professional advisor to the MFA in the fields of radiation protection and nuclear safety and security. • Responsible for reviewing the risk assessment documentation related to the RTG-removal project. • Responsible for maintaining dialogue with the Russian radiation protection authorities and the Norwegian Project Manager.
Project Managers (PM)	• Norwegian Project Manager: Per Einar Fiskebeck, at the Office of the County Governor of Finnmark. • Overseeing, facilitating and follow-up of RTG-removal project according to contracts Russian Project Manager:
Russian contractors	• Before 2007: Sub-agreements with Mayak, VNIIFTA, Izotop and Mintrans • After 2007: Government in Murmansk Region, NIIFTA and Mayak
Russian Authorities	• Responsible for ensuring that Russian rules and regulations are followed • Responsible for the development and approving of EIAs where acquired, and was the supervisory authority during implementation of the project
VNIIFTA/NIIFTA	• All Russian Scientific Research Institute of Technical Physics and Automaton, o Public research institute before 2000: VNIIFTA, o Private research institute after 2000: NIIFTA • Developed EIAs on behalf of GMR

3.3 Project organizations

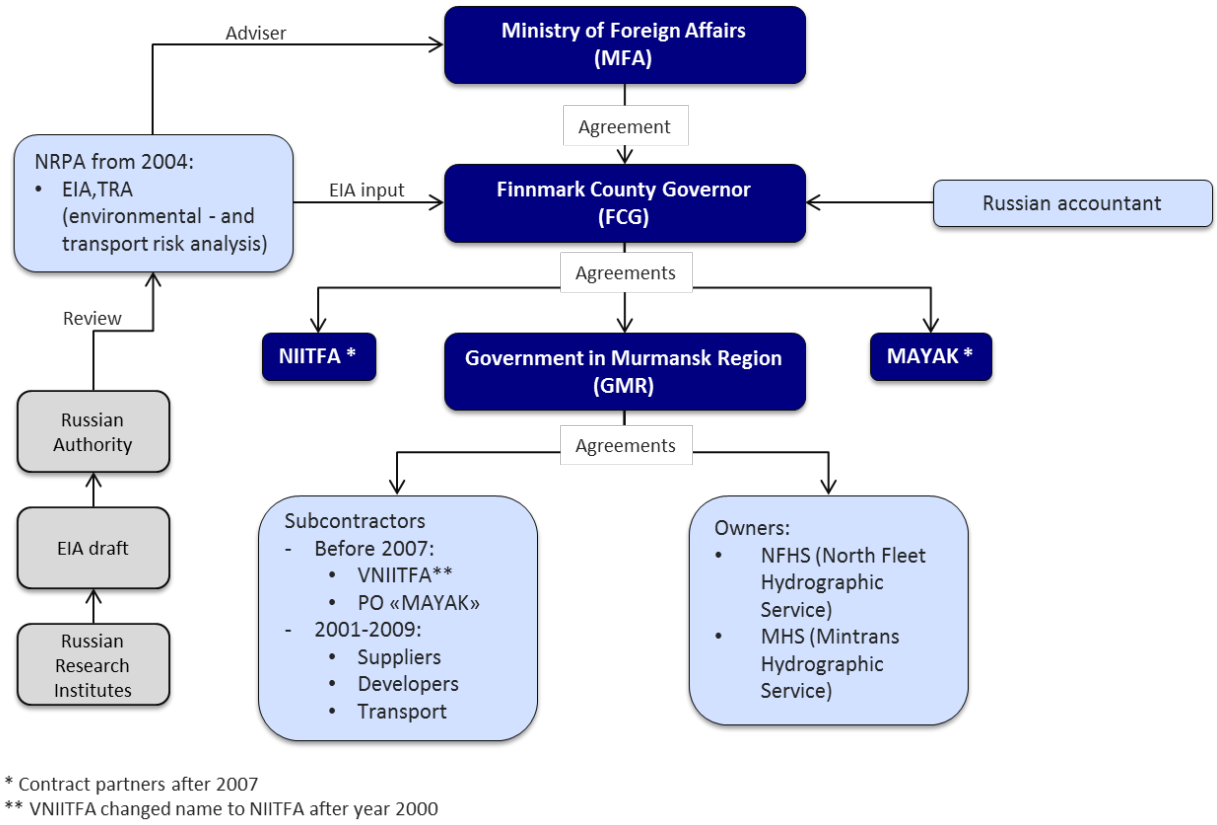
The removal of RTGs and installing of AESs were initially handled according to two separate contracts. After 2008 these contracts were merged into one contract to relief the administration work in GMR.

3.3.1 RTG-removal project

The contracts for RTG-removal were signed by two contract partners until fall 2007; FCG and GMR. Contracts signed after 2007 have been signed by four parties; FCG, GMR, NIIFTA and Mayak.

Figure 3 illustrates the organizations of the RTG-removal project from 2001 - 2009.

Figure 3 - Organization of the RTG-removal project from 2001 – 2009



* Contract partners after 2007
** VNIITFA changed name to NIITFA after year 2000

4 ASSESSMENT OF EFFECTIVENESS IN PROJECT MANAGEMENT

4.1 Introduction

The purpose of Task 1 was twofold:

1. Get an overview of the RTG-removal project and the administrative and management arrangements associated with them. This overview will also include key stages in the RTG-removal project and project performance against planned schedules and budgets.

2. Undertake an independent assessment of the effectiveness of project management of the RTG-removal project.

4.2 Scope and methodology

During the assessment of the effectiveness in project management, DNV has considered different steps in project performance. Figure 4 shows a generic project management framework covering phases from start-up to completion.

Figure 4 - Project Management Framework

	Project start up	Project implementation		Project completion
Strategies and appraisal documents	Needs	Actual spend vs budget		Handover
	Objectives	Procurement		Approval
	Expected impact	Contractual arrangements	Changes in scope and the effect on plan/budget/quality	
	Requirements			Documentation
	Project organisation	Project organisation and control		
	Plan	Communication		Transfer of responsibility
	Budget	Use of subcontractors		Transfer of knowledge
	Change management	Quality assurance		Lessons learned

4.2.1 Performance indicators

For the purpose of the assessment, key elements from the framework are grouped into performance areas and then analyzed based on a set of performance indicators[3] illustrated in Table 3.

[3] A further elaboration of performance indicators was discussed and agreed with NRPA during the planning and initiation phase (kick-off meeting)

Table 3 – Examples performance indicators for project management

	Description of goals	Performance indicators
Project organization	Get an overview of the RTG-removal project and the administrative and management arrangements associated with them. This overview will also include key stages in the RTG-removal project and project performance against planned schedules and budgets. Undertake an independent assessment of the effectiveness of project management of the RTG-removal project.	• Roles and responsibilities, including contractual arrangements • Lines of communication • Monitoring, control and quality assurance
Plan		• Anticipated vs actual implementation period • Follow-up and adjustments
Budget		• Actual spend vs budget • System for transfer of funds
Change manage-ment		• Change in project organization • System for change handling • Change in scope
Handover	Handover of final report has not taken place yet, and is therefore not evaluated by DNV. DNV recommend NRPA to do this after handover of Final report.	• Approval • Documentation • Transfer of knowledge • Lessons learned

Three contracts were chosen for analysis in DNVs assessment. Contracts were selected in order to ensure relevancy, while maintaining consistency over time.
Contracts were selected on the basis of the following criteria:

- Projects over long time period
- Projects that reflect changes in project management over the years
- Projects with defect RTGs and thereby most challenging

The following contracts were selected:

1. 04-10/08: duration November 2005 – December 2006
2. 04-05/19: duration February 2007 – December 2008, replaced by contract 04-05/20 due to new contract partners: duration June 2007 – December 2008
3. 04-05/28: duration February 2009 – December 2010 (in order to handle 8 defect RTGs discovered during the hole project period)

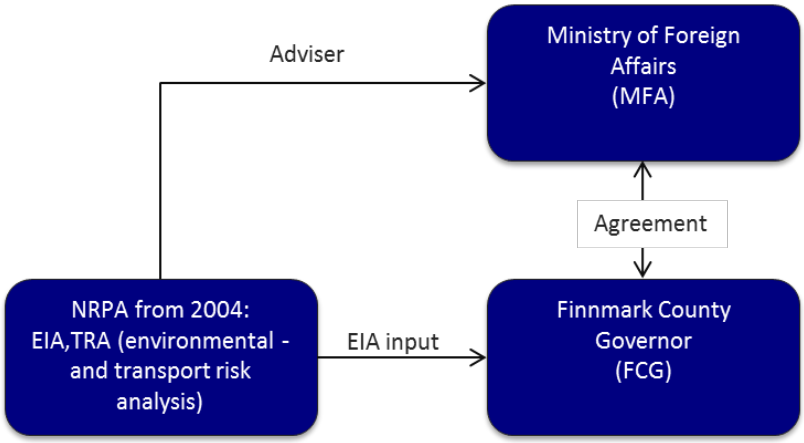
4.3 Assessment

4.3.1 Project organization

Indicator - Roles and responsibilities, including contractual requirements

Table 2 presents the roles and responsibilities for the key stakeholders in the RTG-removal project. Figure 3 illustrates the organization of the RTG-removal project. Figure 5 illustrates the organization of the RTG-removal project related to the Nuclear Action Plan.

Figure 5 - Organization of the RTG-removal project related to the Nuclear Action Plan



MFA is the Advisory Board on nuclear issues and has the responsibility authority in forming strategies and priorities for the work. MFA have prepared annual grant letters to FCG/PM on the basis of an overall allocation memorandum, annual meetings between the ministries and FCG and FCG/PM's proposal to its own tasks related to nuclear safety effort for the relevant year.

The NRPA is organized under the Ministry of Health and Care Services. It serves as a directorate for the MFA and the Ministry of Environment and provides assistance to all ministries on matters dealing with radiation, radiation protection and nuclear safety, including the MFA. NRPA has a directorate role in carrying out the Nuclear Action Plan within the areas of radiation protection, nuclear safety, emergency preparedness, non-proliferation and radioactive contamination[4]. Furthermore NRPA has been an advisory professional body with respect to the EIAs prepared by the Russians. NRPA has made recommendations to FCG/PM for how to carry out the RTG-removal project.

The Norwegian PMs role was to ensure that the Russian PM/GMR preformed the RTG-removal project according to:

- Agreed contracts/project plans
- EIAs which were developed by Russian research institutes
- Grant letter from MFA

As the FCG/PM did not have access to the financial documentation, FCG/PM engaged an independent Russian accountant.

[4] Reference: NRPA report 2009:13

Russian research institute (VNIIFTA/NIIFTA) has, on behalf of the Russian Authority, been responsible for the preparing of the Russians EIAs.

The Norwegian Coastal Administration of Troms and Finnmark has given technical advices to FCG/PM regarding the installation of solar panel cells, focusing on technical/electronic and finance. FCG/PM and the Norwegian Coastal Administration in Troms and Finnmark have cooperated in the advisory and supervision of the installation of solar panels.

Several contracts have been signed during the period 2001 – 2009 for the removal of 180 RTGs. Although the responsibilities of the main stakeholders remained the same throughout the removal, transport and handling of the 180 RTGs, the contractual arrangements with regard to the contents of the contracts have changed during the project period.

The annual contracts are based on the same structure. Articles in the contracts give the same set of requirements/information:

1. Purpose of the contract
2. Obligation of the FCG, e.g.:
   - FCG must grant financial-technical aid to GMR for utilization of a defined number of RTGs
   - FCG must pay GMR every month in accordance with budget the total plan, Annex I and agreement between the Parties on what GMR shall execute the next month.
3. Obligations of the GMR, e.g.:
   - GMR must prepare technical and economic reports at the end of each month, showing the progress of the work and the cost of expenses according to annex II in the contract.
   - GMR has the responsibility, both legally and financially, for any usage of subcontractors (…) when implementing the signed contract.
   - The GMR has the responsibility for ensuring that an EIA is carried out in connection with the implementation of this contract. NRPA has to check and accept the quality of the EIA before the signed contract is being valid.
   - Any expenses exceeding a given amount must be covered by the GMR.
4. Language
5. Taxes
6. Inspection
7. Revision
8. International auditing
   - The project account prepared by the Russian Party shall be audited by an international auditor by the end of the project. FCG has to conclude a contract with an auditor who has international auditing experience.
9. Suspension and termination
10. Enter into force
11. Requisites

In addition, Annexes to the contracts require that the Russian PM/GMR shall report to the FCG/PM on the following:

- Annex I: The budget on the project
- Annex II: Intermediate report
- Annex III: The schedule on work implementation, with given deadlines
- Annex IV: The list of the enterprises and organizations – initiators of activities

Findings:

- The basis for the provision of funds from MFA is given in MoU, signed February 2005.
- Roles and responsibilities are clearly defined in the RTG-removal project and described in signed RTG-removal contracts.
- Reviewed documents from FCG/PM indicate that the reporting routines have worked according to requirements given in signed contracts.
- The reviewed contracts and documents reveal the fulfillments of important indicators with regard to project performance, illustrated in Figure 4, e.g.:
    - Statement of the obligations of the Parties involved in the RTG-removal project on an annual basis.
    - The obligation on following-up of contracts with appendixes.
    - Contracts have been replaced by other contracts when needed due to change in project / incidents / external factors on the Russian side.

Indicator - Lines of communication

NRPAs responsibility during the RTG-removal projects has been to advise MFA on matters concerning the Nuclear Action Plan and give input and recommendations regarding the EIAs delivered by the Russian PM/GMR/side to FCG.

FCG/PMs responsibility is given in the annual grant letters from MFA: to ensure funding has been used according to project plans/contracts and that given recommendations from NRPA on EIAs have been implemented in project operations.

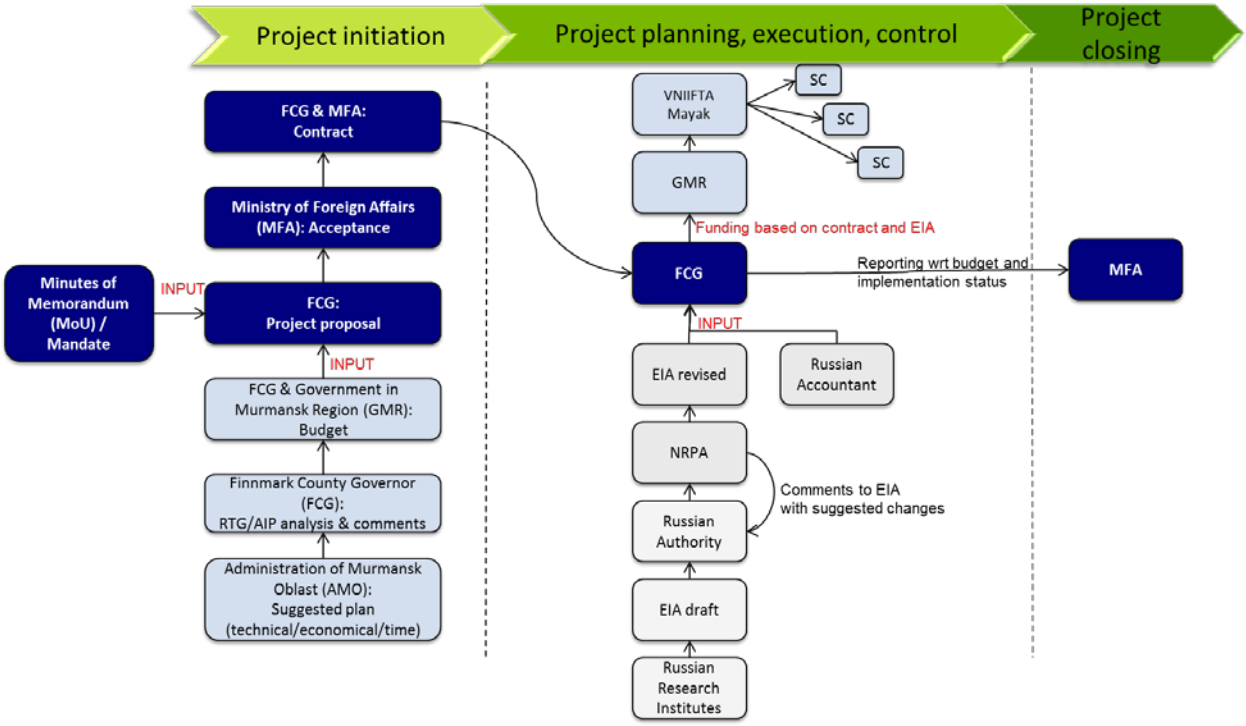
FCG/PM has arranged bilateral RTG-meetings with Russians and NRPA present; giving the Parties involved the possibility to discuss the progress and other issues of concern.

FCG has had direct contact with the MFA regarding budgets. Issues of concern among Norwegian authorities are forwarded to FCG/PM, who is then responsible for follow-up towards GMR. It is difficult to assess to what extent the lines of communication functioned only from reviewing documents. However, interviews with the NRPA as well as the FCG indicate that lack of communication was not an issue during the RTG-removal project. Rather, the FCG/PM has been acknowledged by the MFA for his project management skills and for communicating well with the Russian counterparts during the period of 1994-2009.

The main line of communication between the GMR, FCG/PM, NRPA and MFA with regard to project management from project initiation to closing is outlined in Figure 6.

DNV has not gone into detail with regards to budget follow-up, as this was done earlier by the Office of the Auditor General of Norway[5].

Figure 6 – Flow of documents in RTG-removal project



Findings:

- A well-defined communication line and the bilateral annual RTG-meetings have been described and contributed to an effective implementation of RTG-removal projects and building of relations with Russian Parties/subcontractors.

Indicator - Monitoring, control and quality assurance

Article 6 in in RTG-removal contracts states that GMR shall provide that FCG/PM has the necessary access to all sites, in order to verify that funding form MFA have been used according to signed Contracts. Documentations from FCG/PMs visits to RTG-sites have been reviewed by DNV.

GMR and FCG met twice a year in order to (i) deliver protocol of budget and (ii) to agree on budget and signing of contract.

MFA only required FCG/PM to report on financial matters concerning the RTG-removal project. FCG/PM was never asked to document on project management or environmental and nuclear safety issues during the RTG-removal projects.

[5] The Office of the Auditor General of Norway, Document 3:5 (2011-2012), 6th of December 2011

FCG/PM has on an annual basis visited the Russian counterpart and overseen the usage of funding from MFA and implementation of EIAs in the project work. FCG/PM has not reported on any deviations in the RTG-removal project.

According to FCG/PM, NRPA has only to a limited extent asked for specific documentation from FCG/PM related to health, environment and nuclear safety/-security, i.e. results of dosimeter analysis. However, bilateral RTG-meetings arranged by FCG/PM with Russians and NRPA present have been an instrumental tool in ensuring monitoring control and quality assurance.

Findings:

- MFA have only focused on financial control during the RTG-removal projects.
- No non-conformities have been reported on financial matters.
- NRPA has only to a limited extent asked for specific documentation from FCG/PM related to health, environment and nuclear safety/-security.

4.3.2 Plan

Due to the strict and detailed content in RTG-removal contracts, with Appendices, the contracts have functioned as project plans for the individual RTG-removal project while the EIAs have been used in daily planning of RTG-removals, handling, transport and storage. See Chapter 1for further information on this.

The RTG-removal contracts give the Russians fully responsibility for the planning, implementation and follow-up of RTG-removal projects.

Planning of budget was not part of the Russian plans before this was required by FCG/PM.

Indicator - Anticipated vs actual implementation period

RTG-removal projects lasted for 16 years. The same person has been the Norwegian PM these years, ensuring stability and continuity during these years. There have been 4 stops/delays in the projects, see “Indicator – Follow-up and adjustments” below.

Findings:

- Despite the stops/delays in RTG-removal projects, all 180 RTGs were removed according to plan and time. DNV assumes the stability and continuity of the FCG/PM has been crucial for this project.

Indicator - Follow-up and adjustments

The removal of 180 RTGs has taken place over a period of 16 years. Nine annual contracts have been signed in the period of 2005 – 2008. In the beginning of this period there were separate contracts for the removal of RTGs and the installation of solar panels. These contracts were merged into one contract in 2008 to facilitate less administrative work for the GMR.

During the course of the project several conditions/factors resulted in delays in the project:

1. Stop in Russian transport of RTGs in 2004 due to differences between military and civil transport of RTGs. Formalities had to be clarified and agreed upon before transport could resume.

2. Norwegian participants in the project were denied entry to NIIFTA and Mayak during the period fall 2004 – fall 2007. This was finally solved when the Russian Governor in Murmansk negotiated a change in the Norwegian – Russian contracts to include NIITFA and Mayak as main contract partners in the project cooperation (revised contract 04-05/21 in 2008).
3. Change of Russian Governor in April 2009, two weeks before the last RTG-removal, resulted in total change of all personnel working on the RTG-removal project in Russia. FCG/PM had to spend time training the new personnel before the last RTG-removal could take place.
4. The sinking of the submarine K-141 Kursk in August 2000 delayed the progression of the project because of the lack of military personnel to assist in the RTG project.
5. The first detection of a defect RTG (REU-3-2K from lighthouse No 69) was discovered at NIIFTA during the contract No 04-10/08 signed in November 2005. This defect RTG, together with later on detected defect RTGs, required a different handling and storing than the other RTGs. Contract 04-05/28 was signed in 2009 as a result of the detection of defect RTGs with special needs regarding handing and storing.

Contract 04-05/19 was replaced by contract 04-05/21, signed in 2008, due to new permit of access to Russia.

Findings:

- Reviewed RTG-removal contracts document that follow-ups and adjustments during the RTG-project period have happened.

4.3.3 Budget

Indicator - Actual spend vs budget

According to contracts, FCG shall grant financial-technical aid to GMR for utilization of a certain number of radioactive units (RHSs / RITs) and installation of alternative energy sources on lighthouses.

MFA prepared annual grant letters on the basis of an overall allocation memorandum, annual meetings between the ministries and the County and County's proposal to its own tasks related to nuclear safety effort for the relevant year.

According to information given by FCG/PM, FCG/PM inspected the planned RTGs to be removed before transfer of funding to GMR. This is confirmed by the Office of the Auditor General in Norway[6].

MFA required FCG to report on the following:

- 1st of July: semi-annual reports with financial information
- 1th of January: annual reports on implementation status
- Quarterly: debit authorizations

[6] The Office of the Auditor General of Norway, Document 3:5 (2011-2012), 6th of December 2011

Article 3, No 5 in the reviewed contracts between the Parties states that expenses exceeding the given sum in the contract shall be covered by the GMR. DNV has not seen any documentation revealing this has occurred.

Findings:

- Reviewed documents states that FCG/PM has reported to MFA as required.
- Grant letters from MFA to FCG/PM has been clear and reflecting input on financial issues given from FCG/PM.

Indicator - System for transfer of funds

The Norwegian Parliament Decision on EIAs of May 12th 1999 requires EIAs on activities involving risks for radioactive contamination prior to allocation of funding. MFA has prior to EIAs quality ensured and approved by NRPA, funded the RTG-removal projects.

Article 2, No 3 in reviewed RTG-removal contracts states that payment from FCG to GMR will take place when NRPA has audited and accepted the EIAs prepared by GMR.

The Office of the Auditor General of Norway has commented on how the funding from MFA to FCG/PM where transferred[7]; until 2008 funding was transferred to the FCGs operating account. In cases where funding was not fully used, the money would be placed on the FCGs account. MFA funding has been transferred to a debit account since 2010.

Findings:

- The Office of the Auditor General of Norway has in Document 3:5 (2011-2012) commented on how the funding was transferred from MFA to FCG/PM. This resulted in change of transfer of funding from MFA to FCG/PM in 2008.

4.3.4 Change management

Indicator - Change in project organization

The detection of defect RTGs during the handling of RTGs resulted in the developing of new technologies in cooperation between FCG/PM and the Russians.

The governor in GMR, and rest of the personnel were replaced two weeks before the removal of the last RTG. The new Russian personnel needed to be trained by the FCG/PM and the Coastal Administration in Troms and Finnmark.

Norwegian participants in the project were denied entry to NIIFTA and Mayak during the period fall 2004 – fall 2007. This was finally solved when the Russian Governor in Murmansk negotiated a change in the Norwegian – Russian contracts to include NIITFA and Mayak as main contract partners in the project cooperation (revised contract 04-05/21 in 2008).

Findings:

- Contractual partners were changed in order to give the FCG/PM access to RTG-sites in Russia.

[7] The Office of the Auditor General of Norway, Document 3:5 (2011-2012), 6th of December 2011

Indicator - System for change handling

Change in RTG-removal projects have occurred due to incidents on the Russian side, e.g. denying the Norwegians entrance. This has led to change in work procedures (new procedures) during the projects lifetime.

Findings:

- DNV has not come across any change management plans for the chosen RTG-removal projects during the documentation review. Even though it is of DNVs opinion that changes which have occurred during the removal of 180 RTGs have been professionally handled by the FCG/PM, e.g. handling of defect RTGs, change in contractual partners.

Indicator - Change in scope

Defect RTGs required change in operative procedures for handling these RTGs.

Change of Russian personnel two weeks before the removal of the last RTG resulted in need of training the new personnel, and thereby spending more time on training than initially expected.

Initially the Russian´s methods for installing Solar Panels resulted in many comments/deviations from the Norwegian Coastal Administration (NCA) in Troms and Finnmark. The numbers of deviations were reduced after NCA had given the Russians better instructions and a course in the installation of solar panels.

Findings:

- FCG/PM has during the RTG-removal projects revealed lack of competence with AES on Russian side, and trained the personnel accordingly to build the right competence before removing, handling, transporting and storing of RTGs.

4.3.5 Handover

The last RTG-removal project ended 1. September 2009. This was marked by a visit by the State Secretary, Elisabeth Walaas, to the project sites in Vajgatsj and Sjda-bay where she stated: "Norway is very satisfied with the very specific and good result from the work on replacing the RTG's with environmentally friendly solar panels to prevent a possible radioactive contamination of the marine environment and to prevent such material going astray and eventually be used for the production of "dirty bombs". I was able to join the last gathering on the island Vajgatsj Nenets County recently. It was a great ending to a comprehensive cooperation"[8].

Indicator – Approval

Handover of Final report has not yet taken place and is therefore not evaluated by DNV.

Indicator - Documentation

FCG/PM has not been given the responsibility for the development of a final report summarizing the removal of all 180 RTGs. GMR is responsible for the development of this final report. FCG/PM will nevertheless perform the quality assurance of this report.

[8] MFA, News story, 11.09.2009
http://www.regjeringen.no/nb/dep/ud/aktuelt/nyheter/2009/atomsikkerhet_komm.html?id=576718

According to information from FCG/PM, GMR is responsible for the development of a final report. GMR has engaged a Russian printing company, without knowledge of the RTG-removal projects, to develop a draft of report.

FCG/PM indicated that the final report, summarizing the RTG-removal projects as a total, will be finalized and made public available within January 2013.

Findings:

- Apparently, final key project documentation might be produced by non-specialists.

Indicator - Transfer of knowledge

The detection of defect RTGs resulted in the need of developing new technical solutions for the transport of defect RTGs.

Russians have included all comments/advises from the Norwegian Coastal Administration in Troms and Finnmark in their plans and implementation.

Russian´s methods used for the installing of Solar Panels have been improved due to transfer of knowledge from the Coastal Administration of Troms and Finnmark.

Findings:

- Russian actors seemingly have adopted, or at least, aligned themselves well with relevant technical solutions made available on the removing of RTGs, environment and waste management.

Indicator - Lessons learned

DNV has not come across any documents summarizing lessons learned during the RTG-removal projects. The Norwegian PM has not changed during the 16 years of the RTG-removal projects. DNV assume this has been crucial for the continuity in the projects and the possibility to improve and learn by mistakes.

Findings:

- DNV assume the stability of the FCG/PM has been crucial for the success in this project as a total. Experiences have been gathered and acted upon during these 16 years, however, with little or no effort of institutionalizing lessons learned.

4.4 Summary of findings

	Description of goals	Performance indicators	Summary of findings
Project organization	Get an overview of the RTG-removal project and the administrative and management arrangements associated with them. This overview will also include key stages in the RTG-removal project and project performance against planned schedules and budgets. Undertake an independent assessment of the effectiveness of project management of the RTG-removal project.	• Roles and responsibilities, including contractual arrangements	• The basis for the provision of funds from MFA is given in MoU, signed February 2005. • Roles and responsibilities are clearly defined in the RTG-removal project and described in signed RTG-removal contracts. • Reviewed documents from FCG/PM indicate that the reporting routines have worked according to requirements given in signed contracts. • The reviewed contracts and documents reveal the fulfillments of important indicators with regard to project performance, illustrated in Figure 4, e.g.: o Statement of the obligations of the Parties involved in the RTG-removal project on an annual basis. o The obligation on following-up of contracts with appendixes. o Contracts have been replaced by other contracts when needed due to change in project / incidents / external factors on the Russian side.
		• Lines of communication	• A well-defined communication line and the bilateral annual RTG-meetings have been described and contributed to an effective implementation of RTG-removal projects and building of relations with Russian Parties/subcontractors.
		• Monitoring, control and quality assurance	• MFA have only focused on financial control during the RTG-removal projects. • No non-conformities have been reported on financial matters. • NRPA has only to a limited extent asked for specific documentation from FCG/PM related to health, environment and nuclear safety /-security.
Plan		• Anticipated vs actual implementation period	• Despite the stops/delays in RTG-removal projects, all 180 RTGs were removed according to plan and time. DNV assumes the stability and continuity of the FCG/PM has been crucial for this project.
		• Follow-up and adjustments	• Reviewed RTG-removal contracts document that follow-ups and adjustments during the RTG-project period have happened.

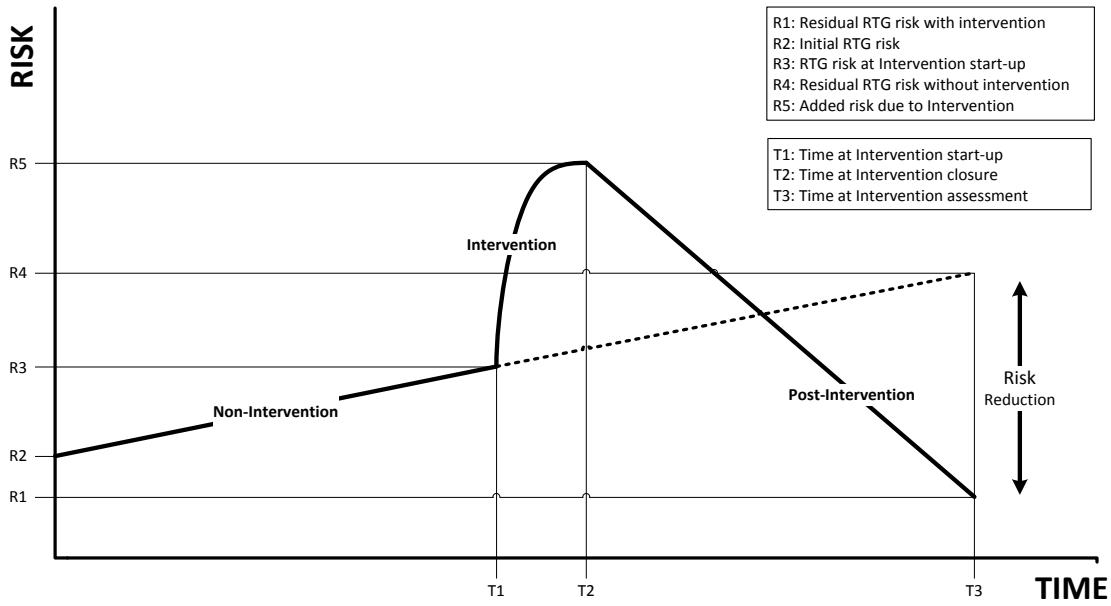
Budget		• Actual spend vs budget	• Reviewed documents states that FCG/PM has reported to MFA as required. • Grant letters from MFA to FCG/PM has been clear and reflecting input on financial issues given from FCG/PM.
		• System for transfer of funds	• The Office of the Auditor General of Norway has in Document 3:5 (2011-2012) commented on how the funding was transferred from MFA to FCG/PM. This resulted in change of transfer of funding from MFA to FCG/PM in 2008.
Change management		• Change in project organization	• Contractual partners were changed in order to give the FCG/PM access to RTG-sites in Russia.
		• System for change handling	• DNV has not come across any change management plans for the chosen RTG-removal projects during the documentation review. Even though it is of DNVs opinion that changes which have occurred during the removal of 180 RTGs have been professionally handled by the FCG/PM, e.g. handling of defect RTGs, change in contractual partners.
		• Change in scope	• FCG/PM has during the RTG-removal projects revealed lack of competence with AES on Russian side, and trained the personnel accordingly to build the right competence before removing, handling, transporting and storing of RTGs.
Handover	Handover of Final report has not taken place yet, and is therefore not evaluated by DNV.	• Approval	
		• Documentation	• Apparently, final key project documentation might be produced by non-specialists.
		• Transfer of knowledge	• Russian actors seemingly have adopted, or at least, aligned themselves well with relevant technical solutions made available on the removing of RTGs, environment and waste management
		• Lessons learned	• DNV assume the stability of the FCG/PM has been crucial for the success in this project as a total. Experiences have been gathered and acted upon during these 16 years, however, with little or no effort of institutionalizing lessons learned.

5 ASSESSMENT OF NUCLEAR SAFETY, SECURITY AND ENVIRONMENTAL PROTECTION IMPROVEMENTS

5.1 Introduction

Several considerations are embedded in the Norwegian RTG-engagement. Failure to decommission the lighthouses in safe and secure ways is likely to increase risk over time. Safe use of RTGs requires containment of radioisotopes long after the productive life of the unit. Intervention is hence desirable, despite elevated risks during the period of intervention. Risk variations are described in Figure 7. Net risk reduction at a given moment in time, may be described as the difference between the residual risk without intervention and the residual risk with intervention.

Figure 7 – Non risk intervention, intervention, and post-intervention



The purpose of this task is the review of improvements in nuclear safety, security and environmental protection in Northwest Russia as a result of the Norwegian – Russian cooperation. It includes the following:

- Removal performance
- Reduction of risks of accidents and pollution
- Prevent the loss of radioactive material

5.2 Scope and methodology

During the assessment, DNV has considered nuclear safety, security and environmental protection during the decommissioning steps. The steps in the decommissioning process are well described in the NRPA report 2009:13:

1. Initiation: RTG Inspection to determine status (integrity check)
2. RTG Removal from locations and transport to temporary storage (reloading areas)
3. RTG Transport from temporary storage/reloading areas to dismantling

4. Extraction and packaging of RHS
5. RHS transport to processing and long term storage
6. RHS processing for long-term storage prior to final disposal

Safety matters are intrinsic to all nuclear activities. Specifically, in conjunction with RTG decommissioning, there are a range of different situations possibly creating safety risks to possible 1st party (workers) and 3rd party (public) for instance the safety of nuclear installations, radiation safety, the safety of radioactive waste management and safety in the transport of radioactive material.

Security risk relate to material diversion and the possible production of Radiological Dispersal Devises, and finally, direct attacks against nuclear activities, causing radioactive releases and exposures. Continuous surveillance must be in place by operator personnel in order to prevent unauthorized removal and tampering. There have been several attempts at stealing valuable shielding materials by perpetrators unknowledgeable of radiation hazards. If the RTGs are targeted, there should be a system of barriers in place to provide delay sufficient to enable response of personnel to interdict.

Environmental risk relates to possible releases to air, land or sea – causing harm to flora and fauna, and possibly, indirect harm to humans. As such, environmental risks may be seen as an integral part of safety risks and possible 1st Party and 3rd Party exposures.

The assessment is based on document reviews and interviews with Norwegian project members or advisors. Their Russian counterparts, who were responsible for the actual decommissioning procedures and follow-up, have not been a part of this assessment.

5.2.1 Performance indicators

For assessing the improvements in nuclear safety, security and environmental protection during the decommissioning a set of performance indicators for removal performance, cooperation and knowledge sharing, fulfilments of requirements have been identified. These are based on international safety and security standards and recommendations[9], pertaining to the RTG context.

[9] IAEA Safety Standards for protecting of people and the environment, Safety Guide No. RS-G-1.10.
IAEA Security of Radiation Sources – Interim Guidance for Comment, IAEA-TECDOC-1355
The Development and Application of a System of Radiation Protection for the Environment. Proceedings of the Third International Symposium on the Protection of the Environment from Ionising Radiation (SPEIR 3) held in Darwin, Australia, 22–26 July 2002. http://www-pub.iaea.org/MTCD/publications/PDF/csp_017c/CD/Contents.pdf, p. 102.

Table 4 – Performance indicators for improvements in nuclear safety, security and environmental protection

	Description of goals	Performance indicators
Removal performance	Main risks identified and acted upon during each phase of the RTG-removal process	• Incidents • Nuclear safety • Nuclear security • Environmental protection
	Reduction of risks of accidents and pollution	
	Preventing the loss of radioactive material	
Cooperation and knowledge sharing	Improved collaboration (with Russia and other sponsoring organizations)	• Collaboration and changed practices, including increased knowledge and technology development.
	Strengthened Russian administrative and supervisory authorities in the area of nuclear safety, radiation protection, preparedness and environmental monitoring	
Fulfilment of requirements	Environmental impact assessments prepared according to Russian requirements and international best practice	• RTG removal impact assessments prepared and reviewed • Environmental, transport and health impact assessments actively applied • Licenses issued for all steps in the decommissioning
	Use of Environmental, transport and health impact assessments in RTG-removal project	
	Removal undertaken according to Russian laws and regulations/licensing	

5.2.1.1 Indicator - Incidents[10]

Incidents are an important indicator for the overall project quality with regard to risk management, as well as information flow and reporting.

- Loss of control over a radiation source, including theft
- Unplanned exposures from a source
- Unauthorized access to, or unauthorized use of, a source
- Failures of equipment that may have safety or security implications
- Discovery of an unaccounted for source

5.2.1.2 Indicator - Nuclear Safety

Safety indicators relate to protection and safety measures for sources made at different stages of the decommissioning.[11]

[10] Source: IAEA Safety Standards for protecting of people and the environment, Safety Guide No. RS-G-1.10, p. 10.
[11] Source: IAEA Safety Standards, for protecting of people and the environment, Safety Guide No. RS-G-1.10, p. 10.

- Radiation protection measures to control exposure in planned activities
- Radiation safety and other supporting measures to prevent accidents
- Result of environmental impact assessments applied to project operations

Radiation protection measures to control exposure in planned activities included a description of radiation hazardous works carried out during decommissioning, good knowledge of type of RTG, activity level and isotope composition.

Radiation safety and other supporting measures to prevent accidents should be covered by a description of technical solutions and means used to ensure radiation safety of the declared activity. RTG integrity may depend upon several factors such as location, history, operating and physical condition of the unit.

The result of EIAs should be actively applied to project operations.

5.2.1.3 Indicator - Nuclear Security[12]

RTGs are categorized as Category 1 material with a corresponding security level A. Security level A requires the highest degree of security in order to prevent unauthorized removal of a source. The following indicators will be of relevance:

- Continuous surveillance by operator personnel
- Barriers in place to provide delay sufficient to enable response of personnel to interdict
- Rapid, dependable, diverse means of communication and procedures
- Results from a security plan which provides for response to increased threat levels

Continuous surveillance should be in place by operator personnel in order to prevent unauthorized removal and tampering. There have been several attempts at stealing valuable shielding materials by perpetrators unknowledgeable of radiation hazards. If the RTGs are targeted, there should be a system of barriers in place to provide delay sufficient to enable response of personnel to interdict.

Rapid, dependable, diverse means of communication and procedures are essential for the secure chain of custody throughout decommissioning steps. This applies particularly to the intersection between the military and civilian domains. Results from a security plan which conforms to regulatory requirements and provides for response to increased threat levels. This includes procedures for timely reporting of security events, background checks for all personnel authorized for unescorted access to the source location and for access to sensitive information.

5.2.1.4 Indicator - Environmental protection[13]

A set of environmental indicators is necessary to assess the possible environmental impacts from radiation. Some basic elements of a system for the protection of the environment are:

- Clear set of goals and objectives for environmental protection

[12] IAEA Security of Radiation Sources – Interim Guidance for Comment, IAEA-TECDOC-1355.
[13] The Development and Application of a System of Radiation Protection for the Environment. Proceedings of the Third International Symposium on the Protection of the Environment from Ionising Radiation (SPEIR 3) held in Darwin, Australia, 22–26 July 2002. http://www-pub.iaea.org/MTCD/publications/PDF/csp_017c/CD/Contents.pdf, p. 102.

- Reference set of dose models and values to estimate radiation exposure
- Means of monitoring goals and objectives

5.2.1.5 Indicator - Cooperation and knowledge sharing

Questions to be answered in this context are:

- Are there indications of improved collaboration between Norwegian and Russian counterparts?
- Has this cooperation led to any changes in regulatory approaches or practices, including increased knowledge and technology development?

Indicators are based on stakeholder's views and experiences.

5.2.1.6 Indicator - Fulfilment of requirements

Relevant indicators will be the presence of RTG removal impact assessments and how these have developed over time, including revisions being prepared. Furthermore, the degree to which these EIAs have been actively applied in project operations is essential. The final indicator relates to the presence of licenses in all steps of the decommissioning.

5.3 Assessment

5.3.1 Long term impact

Long-term impact	Reducing the risk of accidents and pollution from nuclear installations (RTGs) in Northwest Russia and preventing radioactive and fissionable material from going astray

None of the documents reviewed by DNV clearly addressed the aspect of monitoring and follow-up in order to assess potential long term impact on humans and the environment resulting from the dismantling. This aspect, together with limited information on the further handling and final disposal of radioactive material at Mayak, makes it difficult to assess improvements in nuclear safety and environmental protection in a long term perspective. However, the fact remains that 180 RTGs were removed and no longer pose a security, safety threat in unprotected areas.

Findings:

- 180 RTGs (some defect with damaged shielding) were removed and no longer pose a security, nuclear safety or environmental threat in unprotected areas along the coast of Northwest Russia.

5.3.2 Removal performance

Removal performance
Main risks identified and acted upon during each phase of the RTG-removal process
Reduction of risks of accidents and pollution
Prevent the loss of radioactive material

5.3.2.1 Main risks identified and acted upon during each phase of the RTG-removal process

As a point of departure for the assessment, a set of nuclear safety/security and environmental protection risks associated with the RTG-removal projects were identified[14]. The probability and the consequences of the scenarios outlined will differ. Associated risks will vary accordingly. Scenarios written in bold in Table 5 are assumed the more probable ones.

Table 5 - Risk associated with the RTG-removal process. RDD = Radiological Dispersal Device.

	SAFETY				SECURITY		
	RELEASE		EXPOSURE		EXPLOSIVE		ATTACK
STAGE	*SEA/LAND*	*AIR*	*1. PARTY*	*3. PARTY*	*RDD**	*NUCLEAR*	*HIT*
1. Initiation: RTG Inspection to determine status	Release may occur after mishaps or non-procedural performances	Release may occur after mishaps or non-procedural performances	**Workers exposed during inspection, if insufficient shielding of source**	N.A.	N.A.	N.A.	N.A.
2. RTG Removal from locations and transport to temporary storage	**Release may occur after mishaps or non-procedural performances**	**Release may occur after mishaps or non-procedural performances**	**Workers exposed in conjunction with release or loss of source integrity**	Public exposed (long-term) in conjunction with release	Source applied in "dirty bomb"	N.A	Source integrity compromised (explosives, force, rocket)
3. RTG Transport from temporary storage to dismantling	**Release may occur after mishaps or non-procedural performances**	**Release may occur after mishaps or non-procedural performances**	**Workers exposed in conjunction with release or loss of source integrity**	Public exposed (long-term) in conjunction with release	Source applied in "dirty bomb"	N.A	Source integrity compromised (explosives, force, rocket)

[14] Risk identification is understood as the process to find, list and characterize elements of risk. This would typically include identification of the property or situation that could lead to harm.

4. Extraction and packaging of RHS	**Release may occur after mishaps or non-procedural performances**	**Release may occur after mishaps or non-procedural performances**	**Workers exposed in conjunction with release or loss of source integrity**	Public exposed (long-term) in conjunction with release	**Source applied in "dirty bomb"**	N.A	Source integrity compromised (explosives, force, rocket)
5. RHS transport to processing and long term storage	**Release may occur after mishaps or non-procedural performances**	**Release may occur after mishaps or non-procedural performances**	**Workers exposed in conjunction with release or loss of source integrity**	Public exposed (long-term) in conjunction with release	Source applied in "dirty bomb"	N.A	Source integrity compromised (explosives, force, rocket)
6. RHS processing for long term storage prior to disposal	**Release may occur after mishaps or non-procedural performances**	**Release may occur after mishaps or non-procedural performances**	**Workers exposed in conjunction with release or loss of source integrity**	Public exposed (long-term) in conjunction with release	Source applied in "dirty bomb"	N.A	Source integrity compromised (explosives, force, rocket)

The first risk assessment for the removal of RTGs carried out in 2004 estimated the impact to the environment and human health (stated as ecological and radiation safety). Subsequent risk assessments have been carried out every year up until 2010 and have included all steps in the decommissioning processes as they have progressed (from identification of damaged RTGs to storage and disposal). Updating of these risk assessments was also a prerequisite in the contracts and were mentioned in annexes to the contracts and were actively budgeted for during the course of the projects. A good overview of the risk assessments carried out the Russian research institutions and authorities between 2004 and 2009 is given in the NRPA report 2009: 13. An addition to the risk assessments was also performed in 2010.

Results of these assessments have been communicated to the contract partners and the RTG project management teams in Norway and the County Governor of Murmansk.

Findings:

- Seemingly, risk assessments have to a high degree been acted upon during the decommissioning process.
- Due to contractual arrangements some of the risk assessments may be exceedingly generalized to account for specific risks during the dismantlement of specific RTGs.

5.3.2.2 Reduction of risks of accidents and pollution

The RTG-removals took place with few reported serious incidents and with no release of radioactivity to the environment or uncontrolled exposure to people working in the projects. Only one major incident was reported during the decommissioning of the 180 RTGs. RTGs being transported by helicopter, fell during transport, reportedly due to strong winds.

According to the Office of the Auditor General of Russia´s report[15] the projects conducted during the period 2001 – 2009 have not caused impact on personnel, population or the environment that exceeds Russian sanitation requirements.

Findings:

- Compared to the alternative of non-intervention, it appears that improvements in nuclear safety and environmental protection and the reduction of risks during the duration of the project have been achieved.

5.3.2.3 Prevent the loss of radioactive material

According to the Office of the Auditor General of Russia´s report, the RTGs are secured by military forces during storage and transportation. Intermediate storage sites have been equipped with physical security and access control. Transportation of the RTGs is conducted under a shroud of secrecy. Restricted areas are established while the transportation vehicles are loaded. The vehicles are under GPS-surveillance throughout the transport route till its final destination at Mayak.

However, despite security measures put in place, during the course of this project, 3 incidents connected to non-authorized access of RTGs (dismantling/tampering with the purpose to steal metals) have occurred:

- 2001 Murmansk area (Kandalaksha) - 3 RTGs Beta-M type
- 2003 in Kola bay - 3 RTGs Beta-M type
- 2003 Arkhangelsk (island Golets) - RTG IEU-1 type.

Findings:

- Radioactive material potentially exposed to theft and diversion have been handled and included into traditional Russian radioactive waste management streams. With Mayak as it final destination, the radioactive material is assumingly now well-accounted for and protected.
- High standards of physical protection were maintained by the military. However, the extent to which the RTGs were protected at all relevant stages in accordance with the strict requirements set out by the IAEA for category A material, remains unclear.

5.3.3 Cooperation and knowledge sharing

Cooperation and knowledge sharing	Improved collaboration (with Russia and other sponsoring organizations)
	Strengthened Russian administrative and supervisory authorities in the areas of nuclear safety, radiation protection, preparedness and environmental monitoring

[15] The Office of the Auditor General of Norway, Document 3:5 (2011-2012), Appendix III

5.3.3.1 Improved collaboration (with Russia and other sponsoring organizations)

During the development and approval of EIAs, NRPA cooperate with other donor countries in the review of the EIA, ensuring that health, safety, security, environment and transport of RTGs are satisfactorily included in the EIA. The NRPA maintained a close contact with the Russian regulatory authority (Rostechnadzor) during this process. According to NRPA[16] this reviewing process has contributed to strengthening of the contact between the respective technical and regulatory authorities in Norway, Russia and other countries.

In furthering its pioneering role, Norway has been an active player in relevant international fora, e.g. CEG and ICWG. The latter forum created a platform for RTG-attention, knowledge-sharing, and coordination for countries like Canada, France and United States.

The NRPA and the CEG Secretariat, in close cooperation with Rosatom (the Russian Nuclear Energy State Corporation) have moreover organised an international workshop on "Security and Safety of Radioactive Sources: Decommissioning and Replacement of RTGs" in Norway in February 2005[17]. This workshop was the basis for the establishment of the ICWG and has met regularly since 2008.

A large number of Russian counterparts were taken off the project in 2009, including the GMR, only two weeks before the removal of the last RTGs were to take place. Here, the Norwegian project participants were instrumental in bring their new Russian counterparts up to speed in order to finalise the last phase of the project.

Incidents or challenges faced during the undertaking of these projects have also to a high degree resulted in changes in procedures or development of new strategies or technologies in Russia. Some examples include:

- Procedures for detection of containment integrity (radiation) and physical/mechanical assessment before removal.
- Development of special straps to ensure stability during flight and buoy recovery system for use during transport with helicopter.
- Development of procedures and specially designed equipment for removal and transport of defective RTGs.
- Dosimeter measures measurements undertaken during transport and special protective barriers in place (ship and trucks).
- Personnel dosimeter procedures introduced. Two of the ship's crew were taken off the project before their annual accepted doses were reached.
- Procedures developed for the removal of RHS from damaged RTGs.
- Better quality transport containers for RHS transport developed (12 transport containers in wolfram reused during the project).
- Development of vitrification process for permanent storage of RHS (and therefore not a part of the ordinary waste stream at Mayak).

[16] NRPA report (2009:13)
[17] NRPA report (2009:13)

Findings:

- Local collaboration between Russian and other sponsoring organizations have been strengthened by involvement with the Norwegian RTG project. The extent to which regional collaboration have benefited in the same manner is unclear.
- Incidents or challenges faced during the undertaking of these projects have also to a high degree resulted in changes in procedures or development of new strategies or technologies.
- Norway has been instrumental in encouraging and coordinating international cooperation on the decommissioning of RTGs.

5.3.3.2 Strengthened Russian administrative and supervisory authorities in the areas of nuclear safety, radiation protection, preparedness and environmental monitoring

Cooperation on legal framework was established between relevant Norwegian and Russian authorities concerning the establishment of the regulatory framework for RTGs.[18] Dialog between the Russian regulatory and supervisory authorities has resulted in improved regulatory basis and inspection work.

According to the Office of the Auditor General of Russia, Rostekhndzor and local authorities issued 11 authorizations (licenses, diplomas, contracts) for the RTG projects during the period 2001 – 2009. There were also performed several inspections, conferences and handling of specific cases about safety issues during this period. At the same time this report does indicate a lack of co-operation between GMR and Federal authorities, making it not possible to secure a correct organization and implementation of the Russia state inspections with the safety/security of the RTG removal projects. At the same time the GMR had signed contracts with subcontractors (civil and military) than did not have the proper licenses and certificates.[19]

Findings:

- It is not possible to identify any clear indications that Russian administrative and supervisory authorities have been strengthened during the course of this project
- There has been an establishment of relevant regulatory framework for the RTGs and the Norwegian-Russian collaboration has contributed to this regulatory development.

[18] NRPA report (2007:5)
[19] Document 3:5 (2001-2012) by the Office of the Auditor General of Russia, p.76

5.3.4 Fulfillment of requirements

Fulfillment of requirements	
	EIA assessments prepared according to Russian requirements and international best practices
	Use of EIAs in RTG-removal project
	Removal undertaken according to Russian laws and regulations/licencing

5.3.4.1 EIA assessments prepared according to Russian requirements and international best practices

According to the documentation reviewed by DNV, it is clear that EIAs have been prepared for all 180 RTGs from the Russian side and cover all steps in the decommissioning process. These risk assessments, prepared by Russian research and engineering institutions, were subjected to approval by Russian authorities. According to the Office of the Auditor General of Russia, Russian Federal law of January 10, 2002 states that "an EIA must be performed in order to prevent or lessen the impact of economic and other activities on the environment and prevent or reduce social, economic or other impacts in this regard".

EIAs were also made available to and reviewed by NRPA; NRPA reviews were acted upon and resulted in revisions of the EIAs. A list of EIAs are well documented in the NRPA report 2009:13, with exception of the EIA addition document submitted in 2010 for the disposal of RTG in Nenets AO in 2010.

Results of these assessments have been communicated to the contract partners and the RTG project management teams in Norway and the Office of the County Governor of Murmansk and specific actions have been implemented.

Findings:

- It is DNV's opinion that risk assessments have prepared for all phases of the decommissioning process according to Russian requirements. DNV is not able to ascertain if this is also in accordance with international best practice, as the quality of the EIA's was not examined. However, subcontractors that develop EIAs ideally need to be in compliance with Russian law in order to be granted licenses.

5.3.4.2 Use of EIAs in RTG-removal project

See items 5.3.2.1 and 0.

5.3.4.3 Removal undertaken according to Russian laws and regulations/licencing

Contracts with Russian counterparts (civilian and military) did not contain specific clauses concerning compliance with Russian health and environmental laws and regulation. However the appendixes to the contracts state that the preparation or updating of EIA is a prerequisite to removal.

A prerequisite for receiving a contract with GMR is that all subcontractors have the necessary permits/licenses to operate. According to the Office of the Auditor General of Russia, some

subcontractors that received contracts with the GMR did not have the necessary licences. A list of all pertinent diplomas and licenses was available at the FCG offices.

Findings:

- Russian auditors have uncovered that some subcontractors did not have proper licenses to operate.

5.3.5 Deliverables

Deliverables	Removal of 180 RTGs

During the course of the project several conditions/factors resulted in delays in the project:

- 2009 – Norwegian participants in the project were denied entry to NIITFA and Mayak. This was finally solved when the Russian Governor in Murmansk negotiated a change in the Norwegian – Russian contracts to include NIITFA and Mayak as main contract partners in the project co-operation (revised contract 04-05/21 in 2008)
- 2004 – Stop in the Russian transport of RTGs for approx. 1.5 years due to differences between military and civil transport of RTGs. Formalities had to be clarified and agreed upon before transport could resume
- 2000 – The sinking of the submarine K-141 *Kursk* in August 2000 delayed the progression of the project because of the lack of military personnel to assist

Norwegian funding was instrumental for ensuring that the 180 RTGs were removed, handled and transported and destined for disposal. The RTG-removals were performed under a professional and well established setting in Russia. Norwegian continuity (stable personnel and access to funding) over several years has been crucial for the success of these projects.

Findings:

- Despite several conditions and factors that delayed the projects, the projects were completed to a large degree on time.

5.4 Summary of findings

	Description of goals	Performance indicators	Summary of findings
Long term impact	Reducing the risk of accidents and pollution from nuclear installations (RTGs) in Northwest Russia and preventing radioactive and fissionable material from going astray	• Incidents • Nuclear safety • Nuclear security • Environmental protection	• 180 RTGs (some defect with damaged shielding) were removed and no longer pose a security, nuclear safety or environmental threat in unprotected areas along the coast of Northwest Russia
Removal performance	Main risks identified and acted upon during each phase of the RTG-removal process		• Seemingly, risk assessments have to a high degree been acted upon during the decommissioning process. • Due to contractual arrangements some of the risk assessments may be exceedingly generalized to account for specific risks during the dismantlement of specific RTGs.
	Reduction of risks of accidents and pollution		• Compared to the alternative of non-intervention, it appears that improvements in nuclear safety and environmental protection and the reduction of risks during the duration of the project have been achieved.
	Preventing the loss of radioactive material		• Radioactive material potentially exposed to theft and diversion have been handled and included into traditional Russian radioactive waste management streams. With Mayak as it final destination, the radioactive material is assumingly now well-accounted for and protected. • High standards of physical protection were maintained by the military. However, the extent to which the RTGs were protected at all relevant stages in accordance with the strict requirements set out by the IAEA for category A material, remains unclear.

Cooperation and knowledge sharing	Improved collaboration (with Russia and other sponsoring organizations)	• Collaboration and changed practices, including increased knowledge and technology development.	• Local collaboration between Russian and other sponsoring organizations have been strengthened by involvement with the Norwegian RTG project. The extent to which regional collaboration have benefited in the same manner is unclear. • Incidents or challenges faced during the undertaking of these projects have also to a high degree resulted in changes in procedures or development of new strategies or technologies. • Norway has been instrumental in attracting international attention.
	Strengthened Russian administrative and supervisory authorities in the area of nuclear safety, radiation protection, preparedness and environmental monitoring		• It is not possible to come to a definite conclusion about this topic (at the local or federal level) without input from Russian authorities and other Russian counterparts. • There has been an establishment of relevant regulatory framework for the RTGS and the Norwegian-Russian collaboration has contributed to this regulatory development.
Fulfilment of requirements	EIAss prepared according to Russian requirements and international best practice	• RTG removal impact assessments prepared and reviewed • Environmental, transport and health impact assessments actively applied • Licenses issued for all steps in the decommissioning	• Risk assessments have prepared for all phases of the decommissioning process according to Russian requirements. DNV is not able to ascertain if this is also in accordance with international best practice, as the quality of the EIA's was not examined. However, subcontractors that develop EIAs need to be in compliance with Russian law in order to be granted licenses.
	Use of EIAs in RTG-removal project		• Ref above
	Removal undertaken according to Russian laws and regulations/licensing		
Deliver-ables	Removal of 180 RTGs	• Fulfillment of Task 1	• Despite several conditions and factors that delayed the projects, the projects were completed to a large degree on time.

6 CONCLUSIONS

6.1 Effectiveness of project management for the RTG-removal project in the Northwest Russia

- Project organization of RTG-removal project appeared to function well.
- Grant letters from MFA to FCG/PM have been clear and reflecting input on financial issues given from FCG/PM.
- Signed contracts have functioned as project plans for the RTG-removal projects.
- Transfer of funding from MFA was linked to NRPAs quality assurance and approval of EIAs and annual inspections by the FCG/PM - appeared to function well and no deviations found.
- FCG/PM has followed-up on the RTG-removal projects on the basis of the EIAs.
- RTG-removals were undertaken according to agreed plan despite external delays.
- FCG/PM has been acknowledged for his project management skills and his communication with Russian counterparts despite external delays.
- Having the same Norwegian PM on board during the period of 16 years was an obviously strength for the implementation, continuity in the projects and the possibility to improve and learn by mistakes.
- Handover of final report from GMR to FCG/PM, summarizing all the RTG-removal projects, has not taken place yet and is therefore not evaluated by DNV. Apparently, final key project documentation might be produced by non-specialists. DNV is told that the final report is expected to be completed by the Russians in December 2012. The quality of the final report will be assessed by the FCG/PM, even though this is not included in FCG/PMs mandate from MFA.

6.1.1 Improvement areas:

- Internal control procedures:
  - Reference to fraudulent and corrupt practices as well as to competitive bidding should be included in the contractual documents.
  - Reference to relevant laws and regulations should be included in the contractual documents. This should also be an obligation to subcontractors.
- A “Lessons learned chapter” in the forthcoming final RTG-removal project report will institutionalize this element in a better way.

6.2 Success in achieving improvements in nuclear safety, security and environmental protection

The scoring in Table 6 is qualitative and based on DNVs best judgment from assessing program documents, protocols, reports and results of interviews with relevant stakeholders. The performance has been measured according to achieved success compared to the given or assumed goals, with the following colors:

Color	*Level of Goal Accomplishment*
	Goal accomplished
	Goal largely accomplished
	Goal partly accomplished
	Goal largely unaccomplished
	Goal unaccomplished

Table 6 - Summary of achievements

	Description of goals	Degree of goal accomplishment	Score
Long term impact	Reducing the risk of accidents and pollution from RTGs in Northwest Russia and preventing radioactive and fissionable material from going astray	180 RTGs (some defect, with damaged shielding) were removed and no longer pose a security, nuclear safety or environmental threat in unprotected areas along the coast of Northwest Russia	
Removal performance	Main risks identified and acted upon during each phase of the RTG-removal process	RTG-removals were performed without any serious incidents involving uncontrolled releases of radioactivity to the environment or exposure to people. Decommissioning may, however, have relied more heavily on practical risk management experiences than structured, norm-based risk assessment regimes.	
	Reduction of risks of accidents and pollution	Failure to decommission the RTGs in safe and secure ways is likely to increase risk over time. Safe use of RTGs requires containment of radioisotopes long after the productive life of the unit. Intervention is hence desirable, despite elevated risks during the period of intervention.	
	Preventing the loss of radioactive material	Radioactive material potentially exposed to theft and diversion have been handled and included into traditional Russian radioactive waste management streams. Long term storage for the RHS has been established.	
Cooperation and knowledge sharing	Improved collaboration (with Russia and other sponsoring organizations)	The cooperation has led to positive development locally; effects on the regional level are unclear. The contributions of other countries, e.g. Canada and France, have been facilitated through the joint Norwegian-Russian cooperation.	
	Strengthened Russian administrative and supervisory authorities in the areas of nuclear safety, radiation protection, preparedness and environmental monitoring	Russian counterparts are given full responsibility for the planning, implementation and follow-up of the RTG-removal project. There has been important establishment of the relevant regulations related to the decommissioning of RTGs.	
Fulfillment of requirements	EIAs prepared according to Russian requirements and international best practices	EIAs were developed throughout the project, both as a prerequisite for licensing of contractors, as well as a demand from sponsoring party. However, there has been limited or no focus on environmental protection as the mandate has not included this aspect in the RTG-removal projects	
	Use of EIAs in RTG-removal project	Risk and environmental impact assessment was carried out for all the RTGs in the Norwegian-funded project before the removal and allocation of funding.	
	Removal undertaken according to Russian laws and regulations/licensing	Russians unable to fully comply with domestic licensing demands for subcontractors. High standards of physical protection were maintained by the military. However, the extent to which the RTGs were protected at all relevant stages in accordance with the strict requirements set out by the IAEA for category A material, remains unclear.	
Deliver-ables	Removal of 180 RTGs	Despite external factors and delays on Russian side, the project has been managed in a dedicated and effective manner. Concrete project, easy to perform, good relationship, Russians were motivated	

Appendix 1
List of interviewed persons

Date	Organization and name(s)	Roles and responsibility
27.9.2012 (meeting)	**NRPA**:	
	Ingar Amundsen	Section leader and project sponsor
	Mahwash Ajaz	Adviser and project manager
9.10.2012 (meeting)	**Bellona**:	
	Igor Kudrik	Advisor Nuclear safety in Russia
9.10.2012 (telephone meeting)	**Office of the County Governor in Finnmark (CGF) / Norwegian PM:**	
	Per Einar Fiskebeck	Chief Engineer at the Office of the County Governor in Finnmark and PM in RTG-removal project
30.10.2012 (meeting)	**Office of the County Governor in Finnmark (CGF) / Norwegian PM:**	
	Gunnar Kjønøy	County Governor at the Office of the County Governor in Finnmark
	Per Einar Fiskebeck	Chief Engineer at the Office of the County Governor in Finnmark, PM in RTG-removal project
	Jarl Tuv	Senior engineer at The Norwegian Coastal Administration, Troms & Finnmark, technical expert in lighthouse electronics

Det Norske Veritas:

Det Norske Veritas (DNV) is a leading, independent provider of services for managing risk with a global presence and a network of 300 offices in 100 different countries. DNV's objective is to safeguard life, property and the environment.

DNV assists its customers in managing risk by providing three categories of service: classification, certification and consultancy. Since establishment as an independent foundation in 1864, DNV has become an internationally recognized provider of technical and managerial consultancy services and one of the world's leading classification societies. This means continuously developing new approaches to health, safety, quality and environmental management, so businesses can run smoothly in a world full of surprises.

Global impact for a safe and sustainable future:

Learn more on www.dnv.com