Technical Secretariat of the Committee on Cooperation
to Assist the Destruction of Nuclear Weapons Reduced
in the Russian Federation

Ex-post Evaluation of Cooperation Program for Dismantling Decommissioned Nuclear Submarines in the Russian Far East

Summary Report

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Radwaste and Decommissioning Center

1. Outline of the project

Country : Russian Federation
Name of the project : Cooperation Program for Dismantling Decommissioned Nuclear Submarines in the Russian Far East
Area : Nuclear disarmament and environmental protection
Form of cooperation: Financial assistance
Total cost : Approximately 5.8 billion Japanese Yen (including approximately 0.88 billion Japanese Yen from Australia, Republic of Korea, and New Zealand)
Project duration : December 2003 – December 2009
Targeted organization:
Ministry of Atomic Energy (Presently, State Atomic Energy Corporation: ROSATOM)
FSUE-DalRAO (DalRAO)
FSUE-Far Eastern Shipyard, Zvezda (Zvezda Shipyard)
FSUE-North Eastern Regional Center MOD RF (North Eastern Regional Center)

1.1 Background of the project

After the end of the Cold War, the Russian Federation (Russia) should have implemented measures toward the elimination of large amounts of nuclear weapons by themselves, but it was hindered by circumstances such as political, economic and social disorder arising from the collapse of the Soviet Union. One of the issues was a large number of nuclear submarines (NSs) that were aged and expected to be decommissioned. This led to international concerns, related to nuclear disarmament, nuclear non-proliferation and environmental protection. Under these circumstances, at the Munich Summit in 1992, the G7 (group of seven industrial countries, including Japan) decided to provide support towards the safe disposal and non-proliferation of nuclear weapons and resolving related environmental issues in the former Soviet Union countries. In October 1993, in accordance with the decision at the Munich Summit, Japan concluded an agreement with Russia, which was “the Agreement between the Government of Japan and the Government of Russian Federation concerning Cooperation to Assist the Destruction of Nuclear Weapons Reduced in the Russian Federation and the Establishment of a Committee on this Cooperation”.

The Committee on Cooperation to Assist the Destruction of Nuclear Weapons Reduced in the Russian Federation (hereafter referred to as “Japan-Russia Committee”) provided Russia with a low-level liquid radioactive waste treatment plant named "Suzuran" (November, 2001) in response to the publication of sea dumping of radioactive waste in the Japan Sea by Russia.

The terrorist attack of 9.11 in 2001 in the United States highlighted to the international community the prevention of proliferation of weapons of mass destruction. At the Kananaskis Summit in Canada in 2002, the G8 (Group of eight industrialized countries) leaders launched the "G8 Global Partnership against the Spread of Weapons and Materials of Mass Destruction" (hereafter, G8GP) and agreed on assigning the dismantlement of Russian decommissioned NSs as one of the highest priorities.

In the Russian Far East, decommissioned NSs have long been kept afloat with spent nuclear fuels onboard. There were risks that these ships could cause radioactive contamination to the surrounding sea, as well as become subject to attacks by terrorists. Thus, Japan implemented the Program for Dismantling Decommissioned Nuclear Submarines in the Russian Far East (hereafter, referred to as “the Program”) from the viewpoints of nuclear disarmament, nuclear non-proliferation and environmental protection of the Japan Sea. The Program was also included in the Japan-Russia Action Plan.

1.2 Description of the project

On February 2003, the Japan-Russia Committee decided to provide assistance for the dismantlement of one Victor III-Class NS as the first project in the framework of the Program. The NS was dismantled from December 2003 through December 2004 at the Zvezda Shipyard in Primorsky Krai. Subsequently, in November 2005, the decision was made to provide assistance for the dismantlement of five NSs. From September 2006 through December 2009, one Victor-I Class NS and three Victor-III Class NSs were dismantled at the Zvezda Shipyard, and a Charlie-I Class NS was dismantled in the North Eastern Regional Center in Kamchatka Krai. A ceremony for completing the Program was held in March 2010 at Vladivostok. The project cost for dismantling six NSs was approximately 5.8 billion yen, including contribution from Australia, Republic of Korea, and New Zealand.

2. Outline of the ex-post evaluation

2.1 Objective of the ex-post evaluation

Through analysis of reports prepared to date, and collection and analysis of open information, this ex-post evaluation checks the results of the Program; whether Russia dismantled six decommissioned NSs rapidly (as planned) with safe procedures and methods, with financial assistance from Japan; and no significant changes in radioactivity levels in the surrounding sea were detected. It also investigates and evaluates the synergy between the Program and activities of other donors and Russia. In addition, it evaluates contributions of donors, including Japan, and Russia's self-help efforts towards resolving nuclear legacy problems in the Russian Far East. It finally draws lessons and gives recommendations on future cooperation activities with Russia.

2.2 Project Evaluation Procedures

The ex-post evaluation took the following procedures for the 5 evaluation criteria modifying the Development Assistance Committee (DAC) evaluation criteria:

(1) Collection and compilation of information
(2) Preparation of evaluation/investigation table
(3) Analysis and evaluation
(4) Lessons and recommendations

2.3 Methods and criteria for evaluation

The Program was assessed with the following criteria

Relevance: Consistency with the policies and needs of the Russian Government, actions by the Japanese Government and actions by the international community.

Effectiveness: Each process related to dismantlement achieved goals of the dismantlement in terms of environmental protection, radiation safety and industrial safety.

Efficiency: The shipyard had, and improved as necessary, human and technology resources appropriate for conducting dismantlement. The process and the cost for the dismantlement, and personnel and equipment invested by the shipyard, were proper. The

Japanese consultants checked progress of the dismantlement at the site properly. Radiation control was provided to the Japanese consultants and other relevant persons properly.

Impact: The Program had positive effects on the promotion of actions by other donors, and it linked with, or produced a synergy effect on their activities. It also contributed to the reduction of radioactivity contamination risks in the Russian Far East.

Sustainability: After the completion of the Program, the reactor compartment units have been handled safely according to the Russian program. Russia's self-help efforts have been made for safe management of the SNFs and radioactive waste.

Because on-site investigations (performance verifications) had been conducted during and at the time of completing each milestone of dismantlement by the Japanese consultants, it should be noted that the review for the criteria on effectiveness and efficiency was made only from the standpoint of a third party, deciding if their judgments were proper. For the towing of NSs and defueling of SNFs from the reactors, which were outside the scope of the Program, available information was collected to the extent possible. It analyzed how the work was carried out, and what safety measures were taken by Russia.

3. Results of evaluation

3.1 Relevance

This criterion was assessed in terms of consistency with the policies and needs of the Russian Government, actions by the Japanese Government, and actions by the international community.

3.1.1 Consistency with the policies and needs of the Russian Government

The Russian Government set up a comprehensive dismantling program, covering activities from the dismantlement of NSs to the disposal of radioactive waste arising from dismantling of NSs, and aiming at dismantling all decommissioned NSs (formation of 3-compartment reactor units and preparation for floating storage) by 2010. This required Russia to additionally dismantle 4-5 NSs a year in the Far East. However, due to a lack of finances and inadequate infrastructure provision, Russia could not achieve the goals alone. The Russian Government, having received

infrastructure support from the United States, requested financial assistance from the Japanese Government for the dismantlement of six NSs. The Program was launched by the Japanese Government in response to the Russian request to contribute to resolving one of the priority issues in the Russian comprehensive NS dismantlement program. Thus, it was considered to be consistent with the policy and the needs of the Russian Government.

3.1.2 Consistency with the actions by the Japanese Government

The Program was to accelerate the reduction of decommissioned NSs in the Russian Far East. It was implemented, subsequent to the project of providing the "Suzuran" that processed liquid radioactive waste generated by dismantling submarines, as one of the specific support projects to assist with the solution of Russian nuclear legacy problems. The Program was also one of the actions taken by the Japanese Government for nuclear disarmament, and nuclear non-proliferation through dismantlement of Russian NSs. The removal of nuclear materials and radioactive waste led to reduction of concerns about theft or occurrence of terrorism using the nuclear materials, as well as environmental contamination risks of the aged NSs. Thus, the Program is consistent with nuclear disarmament and non-proliferation actions and other actions relevant to the denuclearization cooperation and environmental protection taken by the Japanese Government, and could be regarded as beneficial to Japan as well.

3.1.3 Consistency with actions by the international community

Weakened management functions of nuclear weapons and nuclear materials in the former Soviet Union countries, arising from the collapse of the Soviet Union, caused concerns among the international community about nuclear proliferation. The dismantlement of Russian NSs, together with disposal of chemical weapons and other areas, was assigned as one of the highest priorities by the G8GP. However, Russia did not have sufficient means nor funds for safely managing the SNFs and radioactive waste generated by the dismantlement of decommissioned NSs. Support from the international community was essential. The Program, conducted as a support to Russia harmonized with the actions by the international community, received financial assistance from Australia, Republic of Korea and New Zealand. Taking opportunities of regular G8GP and CEG meetings, Japan coordinated its assistance program with the efforts of the U.S. and Canada, countries that led infrastructure development related to NS dismantlement. Thus, the Japanese activities were considered to be closely linked to and consistent with the international assistance to Russia.

Figure 1　3-compartment reactor unit formulated and temporarily set on the floating dock FD-90 (North Eastern Regional Center)

3.2 Effectiveness

This criterion was assessed in terms of the achievement level of the goals for ensuring safety in the dismantlement process, safe management of liquid and solid radioactive waste and protection of the environment in the Zvezda Shipyard and the North Eastern Regional Center. Towing and defueling NSs conducted with Russia's own fund was also assessed.

3.2.1 Achievement level of the goals of work within the Program

The Zvezda Shipyard and the North Eastern Regional Center as operators licensed to dismantle NSs were responsible for ensuring the safety of the dismantlement. The operators have procedures and instructions such as the Safety Control Plans for ensuring industrial and radiological safety pursuant to regulations and guidelines related to the dismantlement of NSs. They oblige their employees to comply with these procedures and instructions, and try to improve required technologies of their employees and ensure safety systematically. Specific measures and methods required to ensure safety were clearly stated by the shipyards.

For the handling of reactor compartments, to which most intensive attention should be paid in terms of radiological safety in the dismantlement work, safety measures were provided to control and prevent exposure to radiation such as installing a gamma

shield in lateral and vertical direction around the reactor compartment unit. Also, radiation controlled areas were set up depending on the air dose rate.

With regard to industrial safety, no significant accident occurred by taking safety measures for work in high places and work handling hazardous materials. Scrap materials from bow and stern sections, as well as other ship parts, were carefully examined with radiation detectors and judged to determine availability for recycling. The liquid radioactive waste was purified and, then released into the environment. The solid radioactive waste was stored in the designated containers.

The radiation dose of workers was estimated to be 2-4 mSv, 10-15 % of the annual dose limit, in the safety evaluation. The maximum annual dose was 0.3 mSv for the residents of Bolshoi Camen. The dose was lower than the dose limit for the public. No radiological accidents were reported during the Program. Thus, it was determined that the safety goal of workers and the general public during the dismantlement work was achieved. It should be noted that radioactivity in the environment was lower than the control basis in the Zvezda Shipyard. Even comparing with 1999, it was lower in 2007 when many NSs were dismantled. No increase in radioactivity was observed in bays in the area from Primorsky Krai to Kamchatka.

3.2.2 Measures for ensuring safety in the Russia-funded work

The towing and defueling operation of NSs, which preceded the dismantlement process, was outside the scope of the Program. Nonetheless, we were able to confirm that written approvals for this work was issued by the relevant authorities, showing that certain measures had been taken in advance to protect workers and the environment. It may be inferred therefore, that towing and defueling works were conducted without serious problems. However, detailed information on specific safety measures was not obtained because these stages were beyond the scope of the Program. The lack of available information made it difficult for us to make a further judgement on whether the measures the Russian side undertook were sufficient or not.

With regard to the safety of defueling SNFs, as pointed out in the feasibility study, the risk of contamination and radiation exposure due to the release of aerosol was considered to be small because the SNFs had enough cooling time and most of the short-lived nuclides decayed.

3.3 Efficiency

This criterion was assessed in terms of; whether the shipyard possessed the human and technological resources required for conducting dismantlement (implementation capability) and improved those resources when the necessity arose;, if the processes and the cost for the dismantlement, personnel and equipment were provided by the shipyard properly (implementation conditions);, if the Japanese consultants checked progress of the dismantlement at the site properly; and radiation control was provided to the Japanese consultants and other relevant persons properly (project management).

3.3.1 Implementation organization; whether the shipyard had sufficient human and technology resources or not.

Both the Zvezda Shipyard and the North Eastern Regional Center had adequate experiences for conducting dismantlement of NSs; 38 NSs were dismantled in the Zvezda Shipyard by 2007 and 16 in the North Eastern Regional Center by 2008. Both shipyards were granted a permit to conduct dismantlement of NSs and have facilities, equipment and systems, including those provided through international support, required by the Russian laws and regulations. The shipyards ensured the quality and safety of dismantlement work in compliance with the established procedures; the work plans and manuals for conducting dismantlement of NSs were prepared in accordance with the laws and regulations, approved by the relevant regulatory bodies and the responsible management, and then put into practice in the dockyard.

Meanwhile, some of aging facilities have been renovated at the expense of Russia, in part being covered by the financial assistance of Japan under the Program. The Zvezda Shipyard, with 4,500 employees, have dismantled 5-6 NSs a year, and the North Eastern Regional Center, with 1,800 employees, have the capability of annually dismantling 3-4 NSs. Based on the records of the Program, both shipyards were determined to have conducted proper facility operation and organizational management, and assigned the work to skilled workers.

3.3.2 Implementation conditions such as the cost for the dismantlement and personnel and equipment input by the shipyard

Both the Zvezda Shipyard and the North Eastern Regional Center had dismantled NSs for a long period of time without significant accident. Significant delay in the process was not observed in the Program. The dismantlement of NSs is the well-established

processes, similar to the scrapping of civilian ships, except for the difficulties of handling of SNFs and radioactive wastes. Thus, it was not very difficult for the shipyards to procure the personnel and equipment necessary for the dismantlement of NSs. As for the dismantlement cost, expenditure required for the Program was lower, in comparison with that for the dismantling projects in the North West region. The Program was considered to be properly conducted with regard to the input of human and equipment resources and dismantlement costs.

3.3.3 Performance verification by the Japanese consultants

The progress of the Program was monitored based on the monthly progress reports submitted from the Russian side, and the performance verifications conducted at the dismantlement site by the Japanese consultants. The radiation control for the Japanese consultants was conducted properly at the performance verification (inspection). At the entry to the dismantlement area for verification, Japanese radiation control personnel, together with Russian radiation control personnel, checked the radiation level of the area. These radiation control procedures were considered to be proper as they are basically the same as those practiced in Japan. The performance verification shall verify the completed work as well as the work in process, and because of timeliness and efficiency, verification of several milestones were conducted simultaneously to reduce the number of site visits. Thus, the performance verification was considered to be conducted properly.

3.4 Impact

This criterion was assessed in terms of; whether the Program had positive effects on the promotion of actions by other donors;, if it linked with or produced synergy effects on their activities;, and if it contributed to the reduction of radioactivity contamination risk.

3.4.1 Effects on actions by other donors activities, or synergy effects

The Russian comprehensive NS dismantlement program is not limited to the dismantlement of NS but it includes the defueling, storage and transportation of SNFs, and treatment and storage of radioactive waste generated during the dismantlement of NS. Therefore it required developing the infrastructures that facilitate those activities. The Program was implemented in coordination with the United States and Canada who supported infrastructure development such as the onshore de-fueling facility of SNFs, and the railway upgrade to transport SNF casks, respectively, in order to assist

Russia to implement their program. Meanwhile, the Program had the effect of making it easier for Australia, Republic of Korea and New Zealand, who shared concerns about non-proliferation and environmental risks in Russia, to contribute to the common goals of the G8GP. The utilization of the cooperation framework of the Program allowed these nations to assist the dismantlement of NSs in the Russian Far East. Thus the Program was determined to have been linked to, and had synergy effects on the activities of other donors in promoting the dismantlement of NSs in the Russian Far East.

3.4.2 Reduction of radioactivity contamination risk

Dismantlement of aged NSs that had been moored afloat and on-shore storage of SNFs and radioactive waste led to reduction of contamination risks in the surrounding sea. The 3-compartment reactor units that had most of the radioactivity in the defueled NSs and stored afloat on the sea had a risk of contaminating the surrounding sea by the corrosion of hulls if stored for a long period of time. In order to avoid this risk, the on-shore RC long-term storage facility has started operation, by which the risk will be eliminated or significantly reduced. In addition, SNFs stored in the Russian Far East were removed (transported). Thus, the environmental contamination risk has been significantly reduced.

3.5 Sustainability

After completing the Program in March 2010, this criterion was assessed in terms of whether the reactor compartment units have been handled safely according to the Russian program, and sustainable Russia's self-help efforts have been made for the safe management of the defueled SNFs and radioactive waste.

3.5.1 Safe handling of reactor compartment units

Activities to store the 3-compartment reactor units for a long time period were started, and these included: moving those units stored afloat on the sea to the onshore site (Figure 2); formation of 1-compartment reactor units; and operation of the onshore long-term storage facility (Figure 3). The annual capacity to move reactor compartments to the onshore facility is 3-5 units at present, though it is expected to increase up to 8 units in the future. The storage site has a maximum capacity of 100 units, which seems enough to accept all the units generated from the dismantlement of NSs and nuclear-driven surface ships in the region to date (86 units). This will allow 70 years of safe storage, during which radioactivity levels will be reduced to the

acceptable levels. Thus, the Russian program can be considered sustainable in terms of the treatment and storage of the reactor compartment units.

3.5.2 Sustainability of Russia's self-help efforts

Russian activities towards solution of nuclear legacy issues in the Russian Far East are implemented based on the comprehensive national program. The national program covers remaining legacy issues, including those left to be addressed by the Russian Government after the completion of the Program. The national program is updated every five years, taking account of the progress of the program, such as dismantlement of NSs, transportation of SNFs to the reprocessing plant in Mayak. In light of this, we could admit that sustainable efforts are being made in Russia.

There are still some uncertainties over financial resources to be appropriated for the future activities despite the recent economic circumstances. However, we consider that necessary resources comparable to those of the past programs will be budgeted for continuing works in the Far East because of the nature of the national program.

Figure 2　3-compartment reactor units stored afloat in Razboinik Bay

Figure 3　Reactor Compartment Long-term Storage Facility

3.6 Comprehensive evaluation results

Comprehensive evaluation results are summarized below.

Items and Criteria (shown in the parenthesis)	Basis for the judgement	Judgement
Relevance (Was the Program consistent with the policies and needs of the Russian Government, actions by the Japanese Government, and actions by the international community?)	The Program was consistent with the policies and needs of the Russian Government, actions by the Japanese Government and the international community.	**High**
Effectiveness (Did each process in the dismantlement achieve goals of the dismantlement in terms of environmental protection, radiation safety, and industrial safety?)	Each process in the dismantlement achieved goals in terms of environmental protection, radiation safety, and industrial safety, though detailed information on exposure to radiation and environment radioactivity is rather insufficient.	**High**
Efficiency (Were the implementation organizations in the shipyard such as dismantlement organization, dismantlement process/cost and input persons and equipment, and Japanese project progress control and radiation control proper?)	The effective implementation system was developed in both shipyards in terms of equipment and administrative resources. The works conducted in the Program were proper. There was no problem in the Japanese work management.	**High**
Impact (Did the Program have positive effects on the promotion of actions by other donors and link with or produce synergy effects on their activities to contribute to the reduction of radioactivity contamination risks at the Russian Far East?)	The Program promoted supports by other donor countries. The Program contributed to achieve nuclear nonproliferation in Russian Far East with a linkage or synergy with other donors. .	**High**
Sustainability (Were the reactor compartment units handled safely according to the Russian program, after completing the Program and were Russia's self-help efforts made for ensuring safe management of the defueled SNFs and radioactive waste?)	Self-help efforts were made by Russia to construct the long-term storage facility for the reactor compartment units, and remove defueled SNFs from the region in order to promote comprehensive NS dismantlement program.	**High**

4. Lessons learned and Recommendations

4.1 Lessons learned

Regarding the evaluation on sustainability, we recognize the sustainability as having a broad meaning in the present evaluation. We evaluated Russia's self-help efforts in general toward activities conducted subsequent to the activities in the Program (e.g. safe storage of reactor compartments) or activities related to the Program and required in the future (e.g. waste management). It is difficult to define objectives to be evaluated against sustainability criteria within the Program, whose tangible output is the scrapped submarines. On the other hand, as is stated in recommendation (1) below, if, for example, personnel training on industrial and radiation safety had been provided to the shipyards, sustainability could have been evaluated more specifically. In conducting ex-post evaluations in the future, more flexible evaluation criteria are expected to be formulated; e.g. putting more weight on the achievement level (effectiveness) tailored to the goals of individual project.

4.2 Recommendation

(1) Enhancement of support highlighting Japan's strong points

In spite of having plenty of knowledge on such individual sectors as nuclear engineering and shipbuilding (dismantlement), Japan does not have the technology or experience in the construction or dismantlement of NSs. Therefore, on the preparatory stage of the Program, it was difficult for Japanese experts to evaluate the safety and cost of the Program. As a result, the Japanese Government decided to extend a financial assistance to the Russian dismantlement of NSs, and did not provide technical support. It resulted in minimal transfer of technology and expertise from Japan to Russia. In the Program, the Russian Government that had been provided with basic infrastructures such as SNF defueling facility from the United States requested financial assistance for dismantlement of NSs to Japan. In terms of taking advantage of Japan's excellence and promoting Russia's efforts, it might be useful to enhance assistance in human resources development, such as inviting Russian shipyard specialists to Japan to be educated in nuclear safety, radiation control and industrial safety.

(2) Continuous information exchange with Russia on the mutual benefit basis

Dismantlement of NSs promoted by the Program could result in reduction of radioactive contamination risks by decommissioned NSs. One of the remaining

issues to be addressed subsequently by Russia is to clean up the contamination in coastal technical bases. It is not clear whether any surveys on the status of contamination and assistance for decontamination of these bases were requested from Russia in the preparatory consultation. However, neighboring countries including Japan must have concerns about this issue because these bases are located on the coast facing the Japan Sea. It would be important for Japan to keep updated on the future progress of Russian efforts to deal with the contaminated bases.

In Japan, in the wake of nuclear accident at TEPCO Fukushima Daiichi Nuclear Power Plant, R&D on decontamination and radiation measurement technologies have advanced extensively. Continuous information exchange on a reciprocal basis will be important in this field; i.e. application of these technologies in resolving Russian issues, or application of Russian developed technologies to the Japan's accident measures. An example will be the Russian tritium treatment technology that is under demonstration tests for contaminated water in TEPCO Fukushima Daiichi Nuclear Power Plant.