THE MURMANSK INITIATIVE - RF: TEST OPERATION

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ABSTRACT

The Murmansk Initiative-RF (MI) was conceived to provide the Russian Federation (RF) with the capacity to manage low-level liquid radioactive waste (LLRW) and comply with the requirements of the London Convention that prohibit ocean dumping. The trilateral project among Norway, the RF, and the United States of America (U.S.) began in 1994 and was the first to utilize exclusively Russian subcontractors to upgrade and expand an existing LLRW treatment plant on the premises of RTP Atomflot in Murmansk, Russia. The project moved quickly through the design phase. Progress during the construction phase was somewhat slower because of difficulties with acquisition of hardware, inexperience with automated instrumentation and control equipment, and unexpected design changes in the cementation unit. The project advanced into the test-operation phase, which is currently underway, in June 2001. Initial runs with liquid waste have revealed that procedures for unloading spent ion-exchange sorbents could be improved and that sludges formed during removal of alkaline-earth metals should be compacted in order for the facility to operate at its full potential. Resolution of these issues is expected within the next few months.

INTRODUCTION

The project known as The Murmansk Initiative-RF (MI) began in 1994 as a trilateral effort among Norway, the Russian Federation (RF), and the United States of America (U.S.) to improve the capability of the RF to comply with the requirements of the London Convention that prohibit ocean dumping of low-level liquid radioactive waste (LLRW). In conjunction with other construction projects in the RF, in particular, Zvezda and Bol'shoi Kamen in the Far East and Severodvinsk in the Russian Northwest, the MI would also provide a significant capacity to treat LLRW generated by decommissioning of retired nuclear submarines, thereby enhancing the rate at which demilitarization goals could be met.

In May 1994, Norway together with the U.S. started discussions with RTP Atomflot and Murmansk Shipping Company regarding a joint project to expand and increase the capacity of the LLRW treatment plant on the premises of RTP. At that time the plant treated ~1200 m^3/yr of LLRW from the nuclear icebreaker fleet. The goal was to increase that capacity to ~5000 m^3/yr and also expand the treatment options to include high-salt LLRW coming from the Russian Northern Fleet in addition to low-salt solutions from reactor loops and medium-salt solutions from decontamination work and a special laundry. The Gore—Chernomyrdin Commission supported the project by expressing its desire to increase cooperation to solve the LLRW problems in the Russian Arctic.

The project was divided into three phases. The first phase was the Design Phase, which included cooperation among the partners on the conceptual design and feasibility studies.

This phase lasted from April to December 1995 and concluded when the partners approved a scheme for the financing and construction of the upgraded and expanded facility by signing the so-called Oslo Protocol in December 1995. The protocol specified the financing responsibilities of the three countries and called for evaluations when the construction was 0, 20, 50, 80, and 100% completed [1].

The second phase was the Construction Phase [2, 3]. This phase lasted from December 1995 until June 2001. Initial efforts were directed at fabricating the rooms needed to house the equipment of the facility. For this, the large volume of the RTK building at RTP Atomflot was subdivided into several smaller rooms with thick concrete walls to produce essentially a building within a building. The facility comprises three floors and three small rooms for air- and gas-handling equipment on top of them. The roof of the third floor is 8.6 m above ground level. In addition to the facility for treating LLRW, a cementation unit was also constructed within the RTK. This unit sits immediately adjacent to the facility and is an integral part of the whole system. The cementation unit was not part of the original design but was included later when the Murmansk Ecological Committee required cementation of solid waste produced by the facility as a condition for granting an operating license. The cementation unit was funded by Norway as a separate project and was constructed when the main facility was nearly finished. However, a facility without the cementation unit would not obtain approval to operate so this unit must be considered part of the MI.

Even before the facility was completely constructed, heating, ventilation, and equipment installation began. One reason for this was to compress the schedule. Another was to simplify the placement of large equipment in its final location before walls and doors could interfere with this. Major equipment included electrodialyzers, electroconcentrators, an electrodestructor, sorbent columns, and settling tanks.

Once the major pieces of equipment were in place, piping, valves, and pumps were installed. This work required labor-intensive welding and running of cables. Electrical panels are located in rooms separate from the main facility. The final stages of the construction phase included installation of sensors and motors for the computerized instrumentation and control systems, loading and verification of the software, cold testing with water, and painting. The computerized I&C systems were the only equipment not supplied by Russian manufacturers. It was supplied by the U.S. through the TIES program.

The third phase was the test operation phase [4]. This project is currently in this phase. A small amount (~450 m^3) of LLRW has been treated. However, some issues must still be resolved before the test operation can be considered a success.

In particular, cold testing revealed that removal of spent ion-exchange sorbents and other materials from columns was likely to be problematical. Thus, hydrojets that had been used for other applications at other sites were modified for use at this facility. The latest information from Murmansk indicates that although the difficulty with removal of these materials has been greatly dimished, improvement is still required.

Another issue that requires resolution is connected with the amount of sludge produced by removal of metals from the solutions. The original design included settlers that were designed to accomplish this removal. As it turns out, the volume of the sludge from the settlers is much greater than originally anticipated. This increases greatly the volume of waste going to the cementation unit and, as a consequence, the volume of cement. Therefore, RTP management considers it necessary to install one or more centrifuges that can be used to compact the sludge and reduce its volume.

DESIGN PHASE

Initial plans for the upgraded and expanded facility were the basis of the design phase. In order to familiarize Russian experts with the design of operating waste treatment plants in the West, a visit to the U.S. Department of Energy Hanford Site in the state of Washington was organized in the autumn of 1994. During this visit, representatives from the RF, Norway and the U.S. toured facilities for treating nonradioactive effluent waste from the 300 Area and LLRW from the 200 Area. Then, the Russian company Aspect (Association for Advanced Technologies) in collaboration with Murmansk Shipping Company and the All-Russian Scientific and Design Institute for Power Engineering (VNIPIET) developed a conceptual design for the upgrade and expansion of the facility in Murmansk. After several iterations with Norwegian and U.S. experts, the design was finalized. The design phase was formally concluded with the signing of the Oslo Protocol in December 1995. In addition, Gosatomnadzor (GAN) and the Murmansk Ecological Committee, among others, approved somewhat later the final design. Further details of the design phase can be found in a report [1].

CONSTRUCTION PHASE

A period of 18 months was originally estimated for the duration of this phase. The financial contributions from Norway and the U.S. were set at a total of $1.55M. In addition, the U.S. committed up to $300K of additional funding under the U.S. TIES program to promote the use of innovative U.S. technologies to solve environmental problems in other countries. The Technical Team identified three such technologies. These were pleated membrane filters, programmable logic controllers, and high integrity containers.

According to the Oslo Protocol, the country lead organizations (CLOs) for this phase were Murmansk Shipping Company (Murmansk, Russia), the Norwegian Ministry of Foreign Affairs (Oslo, Norway), and the U.S. Environmental Protection Agency (Washington, D.C.). The Norwegian Radiation Protection Authority (NRPA) was designated the technical lead organization (TLO) for Norway; Brookhaven National Laboratory, the TLO for the U.S.; and RTP Atomflot, the construction lead organization for the RF. The joint U.S./Norwegian/Russian Technical Team that had been assembled for the Design Phase continued to provide technical review and advice and was available to discuss any technical suggestions and/or concerns with their counterparts in participating Russian organizations.

A principal focus of the early stages of this phase was the procurement of long-lead-time items. For example, electrodialyzers and electroconcentrators are not commonly mass-produced and have to be fabricated on a demand basis. In addition, the company that produces them is located in Kazakhstan, which brought into consideration export/import issues. Table I contains a list of the principal subcontractors that participated in the project.

Table I. Subcontractors Used for the Murmansk Initiative-RF

Basic industrial equipment
- KP "Tsilingidromash", Akmola, Kazakhstan
- GAO "Dvigatel´," Tallinn, Estonia
- Chemical Machine-Building Plant, Dimitrovgrad, Ul´yanov District
- Chemical Machine-Building Plant "Krasnyi Oktyabr´"
- Fastovo, Kiev District
- Chemical Machine-Building Plant, Kemerovo
- TOO "Membrannye Tekhnologii," Almaty, Kazakhstan
- FAKB "Vosrozhdenie," Sergeev Posad, Moscow District
- AO Nizhneturinskii Machine-Building Plant "Venta," Tura, Sverdlovsk District
- SverdNIIKhimmash, Sverdlovsk
- OOO "NIK i K"
- RTP "Atomflot" (nonstandard equipment)

Industrial Part (Pipes and Valves)
- AO "Armaturnyi Zavod," Penza
- AO "Volzhskii Mashinostroitel´nyi Zavod," Rybinsk, Yaroslav District
- AO "Armagus," Gus´-Khrustal´nyi
- AOZT NPF "Regulyator," St. Petersburg

Electrical Equipment
- AO "Tulaprivod," Tula

Support Equipment
- AO Nizhneturinskii Machine-Building Plant "Venta," Tura, Sverdlovsk District
- AO "Volzhskii Mashinostroitel´nyi Zavod," Rybinsk, Yaroslav District
- GAO "Dvigatel´," Tallinn, Estonia

Automation and Control Equipment
- OZ "Progress," Protvino, Moscow District

Monitoring and Control Equipment
- Machine-Building Plant "Molniya," Moscow

Another focus of the initial construction phase was the development of construction plans and schedules. The workscope included the following major activities:

Development of Construction Phase plans and schedules
Site preparation including foundations and utilities
Purchase, storage and inspection of materials and supplies
Purchase, storage and inspection of equipment

Installation of materials and equipment
Functional testing of equipment and systems after installation
Verification of waste stream constituents and concentrations
Development of Operating Procedures and Operational Performance Criteria
Demonstration of adherence to discharge limits
Development of a maintenance program including schedules and procedures
Training of operations and maintenance personnel
Acceptance testing of the completed LLRW system

The Oslo Protocol also outlined a Post-Construction Phase for the purpose of establishing a period following construction during which information exchange, assessment and assistance would be continued to ensure successful operation of the facility. This would provide technical assistance during the critical first year of operation. It has since been renamed the Test Operation Phase and will be discussed below.

The general responsibilities of the lead organizations were clearly defined in the Oslo Protocol. For Russia, these included, among others: provide overall project management and accept financial responsibility for completion of the project. For Norway, the responsibilities included, among others: provide coordination between the government Agencies/Ministries of the participating countries, ensure technical adequacy and consistency with Norwegian environmental objectives, have authority for acceptance of all deliverables developed in the Construction and Post-Construction (Test Operation) Phases. For the U.S., the responsibilities included, among others: provide U.S. funding and establish a method for disbursing those funds as construction work is completed and ensure technical adequacy and consistency with U.S. environmental objectives.

The Oslo Protocol outlined the methods by which payments would be made. Progressive payments would be made to the Russian side based on the incremental completion of construction work. The TLOs from Norway and the U.S. had the responsibility for monitoring the progress of construction and for recommending the disbursement of funds to the Russian side when each Progress Report and Request for Payment was received. The Russian side had the task of preparing a bar-chart for the Construction Schedule and a corresponding Payment Schedule. Each payment would be made based on the amount of work completed during the previous month. A provision was included to supply advance payments to purchase long-lead-time equipment.

A feature that distinguishes the MI from other projects in the RF that are aimed at LLRW treatment is that exclusively Russian (or CIS) subcontractors were enlisted. These subcontractors supplied basic industrial equipment, pipes and valves, electrical equipment, support equipment, automation and control equipment, and monitoring and control equipment. Table 1 lists these subcontractors and their locations. The Russian firm Interindustry Coordination Center (ICC) Nuklid fulfilled the role of project manager and was responsible for the contract negotiations, cost, and schedule.

During the Construction Phase, Minatom (Department of Ecological Safety and Emergency Situations, DESES) played an important role by organizing a Russian Project

Management Group (PMG) that met approximately monthly to discuss progress on the project. The PMG included representatives from Minatom (DESES), Mintrans (Department of Marine Transport), Minprirody (Ministry of the Environment), Gosatomnadzor (Regulatory Agency), Ministry of Foreign Affairs, and the Murmansk District Administration. Representatives of RTP Atomflot, Murmansk Shipping Company, All-Russian Scientific-Research Institute of Chemical Technology (VNIIKhT), All-Russian Scientific and Design Institute of Power Engineering (VNIPIET), and ICC Nuklid, among others, regularly attended the meetings. Activities at these meetings included review of the schedule and discussion of issues hindering adherence to it. By agreement of all participating countries, the CLOs of Norway and the U.S. nominated observers to attend the PMG meetings in order to provide rapid communication of topics discussed and to assist in information dissemination.

The progress of the Construction Phase was monitored mainly through a series of informal inspection visits and formal 0, 20, 50, 80, and 100% completion visits. The agenda for these visits generally included a discussion of progress attained since the last visit, a tour of the facility to witness first-hand the progress, a report on the financial status, an update on the equipment that had been ordered, manufactured, and delivered, and the signing of a protocol. The issues that arose and the methods used to resolve these issues have been discussed in a previous report [5].

The Oslo Protocol was formally completed in June 2001. The upgraded facility at RTP Atomflot was presented to the Russian State Technical Commission and approved on March 14, 2001. A decision was made to initiate complex tests using real solutions. The tests were started in April 2001, marking the start-up of the test period. RTP Atomflot obtained permission from Russian Regulatory Authorities for testing and pilot operation that is valid until April 2002. The international part of the Murmansk Initiative-RF is regarded as complete. The Russian party bears responsibility for the implementation of corrective measures on the basis of outcomes of complex testing and test operation as well as for full operation of the facility. A ceremony was held in June 2001 in Murmansk to celebrate this occasion. Speakers from Murmansk District Administration, Minatom, Russian Ministry of Foreign Affairs, Mintrans, the U.S., Norway, Finmark County in Norway, and others all expressed their satisfaction with the success of the project.

TEST-OPERATION

With the start of test operation, the facility entered the last phase before routine operation. This phase was included in the project plan so that deficiencies in equipment or hardware could be identified and resolved. As a result, two issues have arisen.

First, the difficulty with unloading sorbents from columns that was identified during the last stages of the Construction Phase has not yet been fully resolved. The plan was to adapt technology for hydro-unloading that has been used at other Russian nuclear sites to the facility in Murmansk. For this purpose, RTP Atomflot will fabricate the necessary equipment in their own workshop. However, the need to raise the Kursk caused demands on the budget that left insufficient resources for this work.

Second, the amount of sludge produced during the removal of alkaline-earth metals is much larger than anticipated. This means that the volume of waste going to the cementation unit is also much larger than anticipated. Thus, the volume of cemented waste that would be produced would quickly fill the available storage space. Therefore, a way to reduce the amount of sludge must be found. The most feasible method in the opinion of RTP Atomflot is to install one or more centrifuges in the facility. This would provide a means to compact the sludge before it is sent to the cementation unit. NRPA has provided funding to purchase two centrifuges for this purpose. RTP Atomflot will seek proposals for the design of this new equipment and expects to select the organization to supply the design in early 2002 so that the equipment can be installed by the end of the first quarter of 2002.

The Murmansk Environmental Committee normally inspects RTP in January of each year and grants a discharge license after this. For 2002, RTP Atomflot expects to receive a license to discharge 2000 m^3. Therefore, no problems are anticipated when the current license for test operation expires on 30 April 2002.

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