A NEW RUSSIAN WASTE MANAGEMENT INSTALLATION

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ABSTRACT

The Polyarninsky Shipyard (sometimes called Navy Yard No. 10 or the Shkval Shipyard) has been designated as the recipient for Solid Radioactive Waste (SRW) management facilities under the Arctic Military Environmental Cooperation (AMEC) Program. The existing SRW storage site at this shipyard is filled to capacity, which is forcing the shipyard to reduce its submarine dismantlement activities. The Polyarninsky Shipyard Waste Management Installation is planned as a combination of several AMEC projects. It will have several elements, including a set of hydraulic metal cutting tools, containers for transport and storage, the Mobile Pretreatment Facility (MPF) for Solid Radioactive Waste, the PICASSO system for radiation monitoring, and a Waste Storage Facility.

Hydraulically operated cutting tools can cut many metal items via shearing so that dusts or particulates are not generated. The AMEC Program procured a cutting tool system, consisting of a motor and hydraulic pumping unit, a 38-mm conduit-cutting tool, a 100-mm pipe-cutting tool, and a spreading tool all mounted on a wheeled cart. The vendor modified the tool system for extremely cold conditions and Russian electrical standards, then delivered the tool system to the Polyarninsky shipyard.

A new container for transportation and storage of SRW and been designed and fabricated. The first 400 of these containers have been delivered to the Northern Fleet of the Russian Navy for use at the Polyarninsky Shipyard Waste Management Installation. These containers are cylindrical in shape and can hold seven standard 200-liter drums. They are

the first containers ever certified in Russia for the offsite transport of military SRW. These containers can be transported by truck, rail, barge, or ship.

The MPF will be the focal point of the Polyarninsky Shipyard Waste Management Installation and a key element in meeting the nuclear submarine dismantlement and waste processing needs of the Russian Federation. It will receive raw waste in various conditions, treat it, package it in standard 200-liter drums, and load these drums into the new transportation and storage containers. The MPF has been designed, fabricated, and assembled at the fabrication site, the Zvezdochka Shipyard. It passed a demonstration test in September 2002. The entire MPF has been disassembled into its transportable modules, which are currently stored at the Zvezdochka Shipyard. In the spring of 2003, the MPF modules will be transported to the Polyarninsky Shipyard, where they will be reassembled and the facility will be cold tested. The site preparation work is already under way for the installation at the Polyarninsky Shipyard.

An automatic radiation monitoring system, PICASSO-AMEC, has been developed and will be installed at Polyarninsky Shipyard as one of the elements of the installation. The radiation monitoring system is based on the software package PICASSO-3, developed by the Institute for Energy Technology in Norway.

Treated waste from the MPF will require safe and secure storage. The Waste Storage Facility will be connected to the MPF, and it will be large enough to store all 400 of the new containers. Incoming waste boxes in overpacks will enter one part of the storage facility on trucks. Then they will be inspected and transferred into the MPF through the receiving area. Drums of processed waste in containers will be removed from the MPF and stacked in another part of the storage facility via a bridge crane. This facility will be designed and construction will begin during the winter of 2002/2003.

I. INTRODUCTION

The Polyarninsky Shipyard (sometimes called Navy Yard No. 10 or the Shkval Shipyard) has been designated as the recipient for SRW pretreatment and storage facilities under the Arctic Military Environmental Cooperation (AMEC) Program. The overall AMEC Program is discussed elsewhere in this conference (1), while this paper focuses on the AMEC work at the Polyarninsky Shipyard. This shipyard is near Murmansk and it serves the Northern Fleet of the Russian Navy by servicing, repairing, and dismantling naval vessels. The Polyarninsky Shipyard Waste Management Installation (abbreviated PPP RAO from the Russian language) is planned as a combination of AMEC Projects.

It has been estimated that about 20,000 cubic meters of SRW has accumulated from prior dismantlement of nuclear submarines and other related military activities at Russia's Northern Fleet bases on the Kola Peninsula and in Severodvinsk (2). There is a significant backlog of submarines (~150 both ballistic missile and general purpose submarines) awaiting dismantlement as part of Cooperative Threat Reduction activities or other multilateral cooperative programs that will significantly add to this SRW volume in the near future.


Figure 1. Metal boxes with radioactive waste.

The generation rate of SRW has been estimated to be about 1000 cubic meters per year (3,4) and could increase if the rate of submarine dismantlement increases. Existing storage containers and facilities are full and/or deteriorating. New waste is continuing to be generated and stored in an open-air environment, as shown in Figure 1. This waste will require stabilization. It is estimated that 25 to 30 percent of the SRW is presently uncovered and exposed to the elements. Much of this waste has not been well characterized, however, it is believed that from a third to a half of the waste is metallic. The metallic waste consists of equipment, piping, fittings, previously used containers, and other metal scraps.

Some SRW is stored loosely intermingled in large compartments, while other SRW has been placed in metal containers. Most of these containers are past their useful life and many contain free water; therefore, they must be considered part of the waste for pretreatment (i.e., cut up and volume reduced). Stabilization of this waste via removal of the free water, segregation, and repackaging into new containers is a prime objective for northwest Russia.

The PPP RAO will have several elements, including a set of hydraulic metal cutting tools, the Mobile Pretreatment Facility (MPF) for Solid Radioactive Waste, the PICASSO system for radiation monitoring, and a Waste Storage Facility. Each of these elements is discussed separately below. In the future, a liquid radioactive waste treatment facility could be added to the PPP RAO.

II. HYDRAULIC METAL CUTTING TOOLS

The Polyarninsky Shipyard currently employs various mechanical grinding/cutting (disks and saws) and thermal cutting techniques (gas/plasma torches) to size reduce submarine components and structures. Such techniques readily generate dusts and particulates that can lead to spread of radioactive contamination or respirable hazards. Russian Navy representatives first became aware of the benefits of hydraulically operated metal cutting tools at the Waste Management 1999 Symposium and Exhibition. After discussions with the vendor as to the capabilities and expected productivity and safety aspects, it was agreed that a set of tools would be procured and deployed as an advance demonstration at the Polyarninsky shipyard for eventual operations to support the MPF. Such tools, however, had never been deployed in an Arctic environment before.

After an assessment of Russian shipyard needs, a set of Mega Tech Services metal cutting tools was procured, consisting of a motor and hydraulic pumping unit, a 38 mm conduit cutting tool, a 100 mm pipe cutting tool, and a spreading tool all mounted on a wheeled cart for ready deployment where needed around the shipyard. The vendor modified the tool system to allow its use in Arctic conditions and to make it compatible with Russian electrical standards (5). It was then cold-room tested at –40 ^{o}C at the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory in Hanover, NH (6). The modifications performed as anticipated and the tools were able to cut all test specimens. Some were actually easier to cut at –40 ^{o}C, due to brittle failure.

A Mega Tech Services representative conducted a training course on the operation, safety, and maintenance of the cutting tools, which was hosted at the RTP Atomflot facility in Murmansk. The course provided instruction and hands on operational experience to eight representatives from the Polyarninsky shipyard including the Chief Engineer. During training, the tools were readily applied to a variety of available materials. The tools successfully cut ¾-inch concrete rebar, 2-inch Schedule 40 carbon steel pipe, ¼-inch thick carbon steel angle bracing, 4-inch carbon steel I-beam, 3-inch Schedule 120 stainless steel pipe, and other stainless steel structural members. The tools with the supplied blades were not able to cut 1½ inch wire rope cabling due to flattening of the wire bundle in the tool jaw. However, additional notched blades will be supplied to address these types of materials. Also, the trainees expressed interest in the other larger tools in the Mega Tech line that can cut up to 6-inch pipes. They readily acknowledged that the tools will not universally replace their current techniques, but should enhance their productivity and safety on the types of materials for which it is best suited. After the training, the tools were delivered to Polyarninsky shipyard.

III. CONTAINERS FOR WASTE TRANSPORT AND STORAGE

The AMEC Program sponsored the fabrication of a new container for the transport and storage of solid radioactive waste. The PST1A-6 container is shown in Figure 2. These are the only containers in Russia presently certified for the offsite transport of military SRW. The container is stronger and more durable than most U.S. low-level waste containers. The vertical wall thickness is 6 mm; the top and bottom components are 8 mm thick. The special paint and gaskets can withstand extreme temperatures from –60^{o}C up to +70^{o}C. The container can also retain its radioactive contents under an extreme air pressure variation, in which the ambient air pressure goes down to 25 kPa (3.6 psi).

Figure 2. PST1A-6 Container with Seven Standard 200-liter Drums

Development of the PST1A-6 container has helped to create a self-sustaining waste management infrastructure in Russia, featuring safe and secure waste transport and storage. The container is in compliance with the requirements of Russian as well as IAEA international standards for safe transportation and storage of solid radioactive wastes. The Russian Navy has taken possession of the first 400 containers. Some wastes can be packed into drums, which are then loaded into the PST1A-6 containers, and some wastes can be loaded directly into the containers. All 400 containers will be shipped from Severodvinsk to the Polyarninsky Shipyard near Murmansk in early 2003. These containers will provide safe, secure storage for roughly 1,000 cubic meters of solid waste in northwest Russia.

Compliance with Regulations

The container complies with all the requirements of IAEA standards and Russian Federation regulations:

- IAEA Type A transportation packaging as described in "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised in 2000), IAEA Safety Standards Series № TS-R-1 (ST-1, Revised)"; and
- Russian Type A transportation packaging as described in GOST 16327-88 "Transportation packaging for radioactive materials: General specifications."

Main Technical Characteristics/Parameters of the PST1A-6 Container

Type of waste: low-level SRW.
Temperature of exploitation: from -60°C up to +70°C.
Service period: not less than 10 years.
External and internal diameters: 2.000 m and 1.860 m.
External and internal heights: 1.274 m and 0.950 m.
Wall thickness: 6 mm.
Construction material: Russian steel type 10XSND.
Shape: cylindrical.
Internal volume: 2.58 m^3.
Mass of the empty container: 990 kg.
Maximum payload mass for transport: 2300 kg.
Ratio between the shortest distance from the center of gravity projection onto supporting horizontal surface to any lateral side flip-over edge and the center of gravity height over supportive horizontal surface is not less than 1.25.
The paint is resistant to decontamination solutions.
The paint will not crack, chip or peel at temperatures from –60°C to +70°C.
Removable lid is sealed with a gasket made of a special rubber (IRP3012) that remains flexible at temperatures as low as –60°C.
The lid is bolted to the container body with 16 bolts.
The container will retain its contents if the ambient pressure is reduced down to 25 kPa, or if the internal pressure increases up to 100 kPa.
The lid has two D25 pipe fittings for the purpose of leak testing the container.
The sidewall of the container is equipped with a protected (sealed) box for the documents that must accompany the container.
The container can be lifted by crane or forklift.
The lid of the container has four eyes for lifting it by crane.

Documentation

The following documents are available with the containers:

- exploitation instructions (users' manual);
- technical specifications;
- Certificate of Compliance to IAEA standards for Type A packaging;
- Certificate of compliance to GOST standards; and
- program of tests, including the test results.

Exploitation Rules

The container is reusable. Before each loading it is necessary to check visually the condition of the rubber gasket and to grease it. If the gasket is broken or deformed, it must be replaced. Even if the gasket is not broken or deformed after 10 loading and unloading operations, it must be replaced anyway. Furthermore, after 10 loading and unloading operations, it is necessary to examine the container, including a leakage test. Radiating safety during loading and unloading operations, storage, and transportation of loaded containers is the user's responsibility and all users must satisfy the federal standards and regulations.

Drums and Drum Lifters

The AMEC Program also procured enough drums to fill all 400 of the PST1A-6 containers. In order to place drums into the PST1A-6 container or remove drums from the container, a lifting tool in necessary. FSUE "Zvezdochka" designed and built a simple drum lifter that is lightweight and can be operated remotely. The device fits standard 200-liter (55-gallon) drums and it is adjustable because these drums have slight variations in their diameters. The lifting capacity is 550 kg.

The Production of PST1A-6 Containers

FSUE "Zvezdochka" executes every step of production in accordance with the requirements of the Russian Federation. The complete container production process includes the following distinct activities:

- design management and quality control;
- development of design documentation for the container;
- fabrication of containers;
- certification of containers;
- testing of containers; and
- shipment of containers to the customer.

The container design was developed in accordance with the terms of the license of Gosatomnadzor (State Nuclear Regulatory Agency) of Russia № CE-07-102-0261 dated 24 September 1998. During construction all the technical requirements were fulfilled. The design documentation was developed by leading specialists of RSI "Onega," who are licensed in accordance with Russian Regulations RD5.AEISH.3216-98, "Studying and Testing of Norms, Rules and Instructions for Nuclear and Radioactive Safety Knowledge."

The biological protection (radiation shielding) calculation, based on the composition of the wastes and the level of their gamma radiation up to 30 mRem/h (0.3 mSv/h) at distance of 0.1 meter from the surface, yielded the optimum container wall thickness (6 mm). Based on the strength calculations the design was finalized and working drawings of all construction elements were developed. The design was labeled PST1A-6 (or УКТ 1A-6 in Russian). The containers are in full compliance with requirements of GOST 16327-88. "Packing Transport Sets for Transportation of Radioactive Materials, General Technical Terms". The reliability parameters were selected according to GOST 26291-84, based on the most severe conditions of use, and taking into account possible extreme/emergency conditions during transport.

The fabrication process consists of the following technological steps: steel cutting and bending, unit welding and assembly, precision machining, air-tightness check, and priming and painting operations.

Most of these are normal industrial operations, but the precision machining operations could not be preformed in an ordinary machine shop because these operations require extra large lathes with vertical axes of rotation. The Onega Design Bureau designed the container this way because the Zvezdochka Shipyard has several of these special lathes in their propeller fabrication shop. The flange surfaces of the container body and lid must be machined with precision to make the lid fit properly. Each container will be sealed with a rubber gasket, which requires a ring groove to be cut into the flange on the container body. The ring groove is cut into the flange immediately after the flange is finished, which allows the container body to be mounted in the special lathe only one time for both machining operations. The bolt holes are drilled through both the container body and lid flanges at the same time to ensure that the holes are lined up properly.

Delivery

Taking into consideration favorable the geographical position of FSUE "Zvezdochka," the container transportation to the Northern Fleet of the Russian Navy can be carried out either by sea or railroad. The transportation by sea can be performed directly from Severodvinsk to the point of destination. The loading of ships or barges can be performed directly on the territory of FSUE "Zvezdochka", which eliminates the need for any intermediate transportation. The transportation by sea depends on seasonal conditions. Navigation in the port of Severodvinsk lasts until December, i.e. until the establishment of strong steady frosts in the Severodvinsk area and on the White Sea. The transportation by train can be performed on the route from Severodvinsk to Moscow to the point of destination, or from Severodvinsk to St. Petersburg to the point of destination. The loading of standard railroad cars can be performed on the territory FSUE "Zvezdochka," which eliminates the need for any intermediate transportation. The transportation by train does not depend on climate conditions and can be done during any season. It is possible to place 12 containers on each railcar.

IV. MOBILE PRETREATMENT FACILITY FOR SOLID RADIOACTIVE WASTE

The MPF will be the focal point of the PPP-RAO and a key element in meeting the nuclear submarine dismantlement and waste processing needs of the Russian Federation.

History

To initiate the development of the MPF, a Technical Specification document and a Statement of Work (SOW) were released for an international competitive procurement. In addition to specifying waste parameters and bounding conditions for the MPF feed streams, these documents also specified the technical requirements for the MPF. Important design factors include the ability for the facility to be mobile to allow its movement between various sites within Russia, the capability for the facility to operate in a harsh northern Russian climate, the ability to meet the throughput and technical requirements (waste volumes, processing specifications, etc.), and the ability to provide a high degree of operational flexibility due to the uncertain nature and characterization of the SRW to be processed. A key to the mobility of the facility is its modular design and construction (i.e., the facility is made up of eight modules that can be transported separately and reassembled at any site where submarine dismantlement SRW has been accumulated or will be generated).

The original Conceptual Design for the MPF was developed under a joint venture by a Norwegian and Russian team named Storvik & Zvezdochka (S&Z). This original design met the overall intent of the requirements specified during the procurement phase, but was sub-optimal in terms of radiological control, flexibility, and operability. Once selected as the design build firm for the MPF, S&Z expanded and modified the design and developed a Technical Design for the MPF, which improved upon the previous limitations. This Technical Design also provided optional features for the decontamination and free release of metals, for processing high dose material, and for the inclusion of an analytical laboratory within the MPF. While these optional features were requested by the Russian Navy, they were not included in the first phase of the project due to funding constraints and liability concerns related to free-release of metals. During this phase of the project, a critical issue was identified related to the development a Russian Statement of Work document called a Technicheskoye Zadaniye (TZ). This document, which is typically developed and approved at the start of any Russian project, is required by Russian regulations and is a key element in the review and approval cycle of the Russian regulatory bodies. To avoid a possible delay in the design approval process, a TZ was developed for the MPF project with input by the US, Norwegian, and Russian parties. To date, the TZ for the MPF has undergone several changes and reviews and will be further modified to reflect the final design and as-built conditions of the MPF.

After review by the AMEC team, the Technical Design was expanded into a Detailed Design for use during the construction process (incorporating shop drawings, material lists, construction details, and other Detailed Design information). Further design modifications were incorporated into this Detailed Design to enhance the operability and functionality of the facility and to meet ongoing design and funding constraints within the AMEC program. During this phase of the project the Technical Design was provided to the Russian regulatory organizations for review and approval. Final approval of the Technical Design was obtained in the fall of 2001.

In preparation for the construction phase, the equipment procurement process began in early 2001 and the initial construction began in late 2001. Both were initiated in a phased approach to meet decision milestones and to support the AMEC funding profile. The frames for the first six modules were completed and inspected by the end of 2001 and the construction of the facility was completed by the middle of 2002. The facility passed the initial demonstration tests at the Zvezdochka Shipyard in September 2002. The facility has now been disassembled into its modules and stored for the winter.

In the spring of 2003, the modules will be transported to the Polyarninsky Shipyard and reassembled. Following this, the facility will undergo testing (equipment, systems, cold & hot testing), training, certification, and start-up. The timing and logistics for the deployment of the MPF are still under negotiation.

Current MPF Design and Capability

While the scope and specifics of the design have undergone a number of modifications, the major functionality of the facility has remained unchanged since its inception. The layout for the Russian-approved Technical Design is shown in Figure 3. This schematic shows the rooms in which various activities will take place.

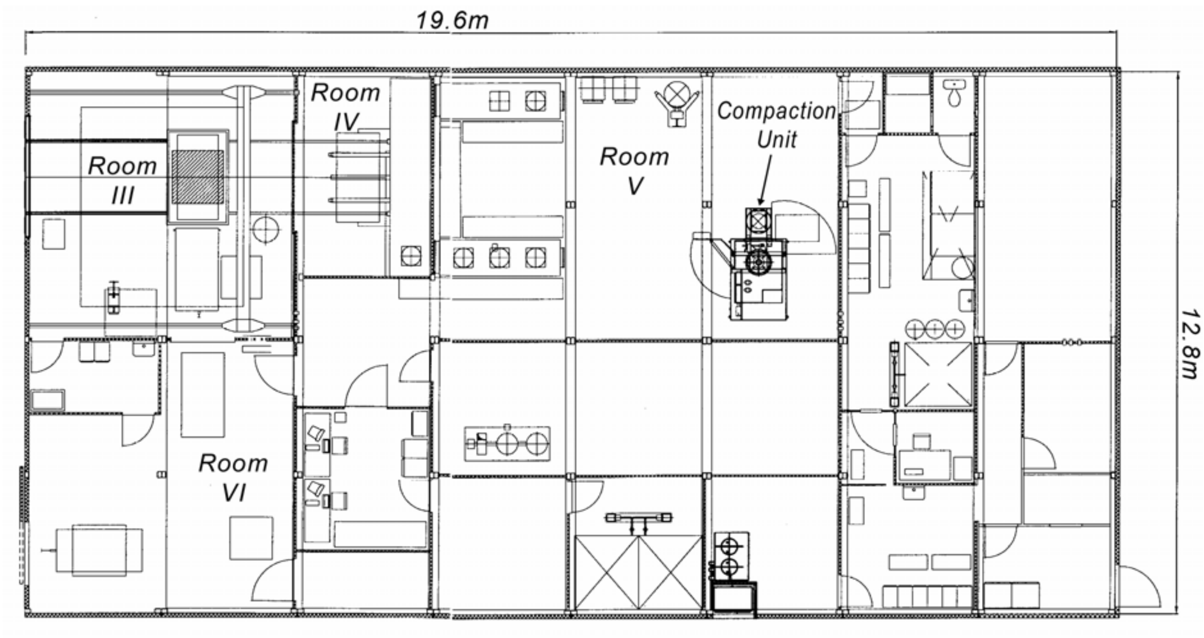

Figure 3. Layout of the MPF

The material flow through the MPF will be as follows. Material will be brought into the MPF in metal waste containers using a forklift. These containers will be brought one at a time into the airlock or air sluice and placed onto a trolley where the initial dose reading can be obtained. This trolley can then be moved into Room III. Here additional dose measurements can be obtained from the waste box, the lid of the box removed (either unbolted or cut off), and the contents and internal dose levels of the container measured. Operators using the necessary personal protection equipment (PPE) and monitoring equipment will perform all these operations. Acceptable processing criteria exist for the incoming waste containers and their contents (surface dose rates at or below 2 mSv/hr and 1-m dose rates at or below 0.1 mSv/h, no removable contamination present, fixed contamination levels below 10 particles/cm^2-min for alpha and below 100 particles/cm^2-min for beta, and design specified size and weight limitations for individual content items). If rejected, the waste box will be closed and removed from the facility for continued storage pending treatment.

If the container is determined to be acceptable for processing, the waste box will be moved via the trolley into Room IV and placed onto a tilter (a device that lifts and tilts the waste box to allow the contents to be moved onto a glovebox sorting table for processing). The entire facility incorporates typical radiological and contamination control mechanisms (shielding, stepwise negative pressure gradients, multiple stage HEPA filters, PPE, dosimeters, hand held detectors, air monitors, stationary detectors, and access and material control). These controls are most restrictive for rooms in which waste is handled directly (Rooms III, IV, & V). Once the material is moved onto the glovebox sorting table (shown as part of Room V), each individual waste item will be monitored and sorted into compressible and non-compressible streams. Waste items above the sorting table dose limit (gamma dose rates above 0.3 mSv/hr at 10 cm) will be placed into a special shielded drum under the sorting table (via an access port at the lower end of the sorting table).

The acceptable non-compressible waste will be moved into the bottom leg of the glove box while the acceptable compressible waste will be moved into the top leg. Various workstations and equipment are available within each leg of the glovebox to allow the operators to inspect, dry & dewater (blowers & rollers), or size reduce (using chop saws, guillotines, and hand tools) the waste items. Liquid that is present in the waste box or generated from the processing operations will be collected into drums underneath the glovebox line. Once full, this liquid will be transferred to storage tanks within the MPF. At the conclusion of processing, the SRW will be bagged out of the glove box. Non-compressible waste will be placed directly into waste drums while compressible waste will be placed into a compaction unit for further size reduction (shown in Room V).

Once full, both types of drums will bee moved via a drum dolly to the packaging area (shown in Room VI). Here the drums will be checked, sealed, and labeled (contents, dose levels, waste streams, etc.) and then placed into a PST1A-6 container. Other types of transportation containers may also be considered for use within the facility as long as their weight and dimensions can be accommodated within the facility.

In addition to normal processing, the facility is capable of handling some out-of-tolerance material. The facility has additional equipment (jackhammers and cutting and shearing tools) to allow oversized items to be size reduced and placed into either waste drums (in Room III) or Type 1 metal containers (1m x 1m x 2m). The facility also incorporates all necessary dose measurement equipment (personal dosimetry, hand held detectors, air monitors, stationary detectors) to maintain a safety envelop for the workers and control potential contamination within the facility. A decontamination solution distribution system has been incorporated into the design to allow the rooms, containers, and equipment to be decontaminated and the spent solution collected. In addition, water from the personnel showers and sinks will be collected and tested prior to release.

What's Next

The facility will be shipped to the Polyarninsky Shipyard for reassembly and for subsequent cold and hot testing. There are several issues associated with this phase of the project that are currently being addressed such as the transportation of the facility to Polyarninsky Shipyard, the specifics of testing at the construction yard and the operational site, the warrantee and spare parts & supplies to be provided, and the operational and maintenance requirements for the facility.

In preparation for its arrival at the Polyarninsky Shipyard, the AMEC team is currently evaluating the necessary site preparation work. Since the PPP-RAO will support multiple projects, an integrated approach is being taken to site preparation activities by incorporating the requirements for all the proposed PPP-RAO facilities. These activities will address both typical utility modifications and tie-ins (water, sewer, electricity, alarms, roads, drainage, etc.) and the site-specific requirements such as fencing, guard gates, cameras, personnel access control, building pads, and material accountability.

V. PICASSO

The goals of AMEC Projects 1.5 (Cooperation in radiation and environmental safety) and 1.5-1 (Radiation control at facilities – application of the PICASSO system) are to enhance and improve the technical means of the Russian Navy for measuring and controlling radiation exposure of personnel, local population and the environment at sites involved in decommissioning and dismantlement of nuclear submarines.

An automatic radiation monitoring system, PICASSO-AMEC, has been developed and will be installed at Polyarninsky Shipyard as one of the elements of the integrated installation, PPP-RAO. There are also other radiation hazardous locations at the shipyard, which are relevant for deployment of the radiation monitoring system. This includes the existing open pad for interim storage of solid radioactive waste, laid-up submarines at the piers awaiting dismantlement, floating tanks with liquid radioactive waste and the floating docks where submarines are dismantled.

The radiation monitoring system is based on the software package PICASSO-3, developed by the Institute for Energy Technology (IFE), Norway (7). This data presentation and visualization software is well suited when large amounts of data are to be stored, transferred to a user interface and be presented graphically in real-time in a user friendly and flexible manner.

Under the framework of AMEC, IFE programmers developed a prototype system for presentation of radioecological data, PICASSO-Environmental Monitoring System. Russian Naval officers and programmers from Nuclear Safety Institute (IBRAE) in Moscow received training at IFE, and the software was transferred from Norway to Russia. The software was adapted to the Russian language and an operating model of a measuring unit based on the PICASSO-AMEC system was created and demonstrated to the AMEC principals and senior officials from the Russian Federation and Norwegian Kingdom Ministries of Defence and the U.S. Department of Defense on 14 August 2000. The model includes two types of radiation sensors, a smart controller, radio channel for data transmission, software for data acquisition and processing and adapted PICASSO-AMEC software. The sensors are of Russian manufacture, a gross gamma air detector and a submersible underwater scintillation detector.

The design for installation of the system at the Polyarninsky Shipyard has been completed, and the project is ready to enter the installation phase. The system will provide remote stand-alone radiation monitoring with presentation of the data in real-time with the option of comparison with historical data. Alarm limits will be defined. The computer network will consist of servers, working stations and sensor concentrating units. Eight gross gamma air detectors and one submersible detector are planned at the shipyard, including one gross gamma detector in the city of Polyarny. The exact placement of detectors in the vicinity of the PPP-RAO, including the MPF, will be decided when the final design and the exact layout of the installation has been approved.

VI. WASTE STORAGE FACILITY

Treated waste from the MPF will need to be stored safely and securely. The AMEC Program has investigated the feasibility of using lightweight steel structures on concrete pads for this purpose. Such structures are proven to be able to survive Arctic conditions and there is no Russian regulation that would prevent using them for storing treated radioactive waste. Thus, the plan for the PPP RAO includes one of these structures. This storage facility will have a storage volume sufficient for all 400 of the new containers full of treated SRW.

VII. CONCLUSIONS

As the Russian Navy dismantles more nuclear submarines, the need for radioactive waste management grows more and more acute in northwest Russia. The AMEC Program is working to meet this challenge by building an integrated waste management installation at the Polyarninsky Shipyard. Metal-cutting tools have been delivered, waste transport containers have been fabricated and certified, a solid waste treatment facility is being built, and a treated waste storage facility is also planned. All these elements will have an integrated radiation monitoring system, built upon the PICASSO computer system.

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