



## Experience of NS Disposal at the Enterprise "Zvezdochka", in Severodvinsk. Problems of Ecological Safety.

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Decommissioning and **disposal of nuclear submarines** become a problem of great concern in our country. Up to date more than 150 nuclear submarines have been taken out from the fleet and are expected for disposal. When constructing the ship-building plants the problems of disposal were not considered, therefore **the industry failed to be ready** for the works on separation of nuclear ships. Each year a new amount of nuclear submarines is removed from the armed forces while the industry is not successful in disposal of the previous ones. For January 1, 1996 the following operations have been implemented at the enterprises of industry:

- Cutting and disposal of NS missile compartments - 34
- Preparation of NS for long-term storage afloat - 3
- NS disposal with the cutting of a reactor compartment for temporary storage afloat in composition of three-compartment units - 19

The nuclear vessels with the non-unloaded cores stay afloat and wait for their turn.

The ships often have the damages of the light shells and safety assurance systems. **Accidents of the ships** with nuclear-powered facilities can cause **global ecological catastrophes**.

Considering the problem of NS disposal, it is necessary to note that the general arrangement of disposal was defined 11 years ago by the Decree <sup>1</sup> 1095-296 of CC CPSU and MB USSR "On the Order of Scrapping the Decommissioned Navy's Vessels with NPF ". It defined:

- Decommissioning the ships;
- Unloading the weapon and stores;
- Reduction of the crew and displacement of NS in the laid-up places;
- Unloading SNF;
- Disposal according to the 8- and 3-compartment options;
- Transporting reactor compartments to long-term storage sites and assurance of nuclear safety monitoring.

With the purpose of realization of the general arrangement of disposal in August, 1992 the Government accepted **the Decree <sup>1</sup> 644-47**, in which all the aspects of NS disposal are reflected more fully, as well as the organizational and engineering policy concerning this matter and the basic enterprises fulfilling the works on disposal are defined.

Murmansk Region

SRZ "Nerpa"

Arkhangelsk Region

GMP "Zvezdochka"

Primorye Territory

DVZ "Zvezda"

For establishment of the common order of organization and carrying out the works on NS disposal the "**Federal programme on the industrial disposal of V and VT for the period till 2000**" was developed and approved in 1994.

In parallel with the Decrees of the Government and the Federal programme there has been additionally accepted a number of the Decrees and Directives of the President on realization of the top priority works and assignment of the status of the presidential programme to them. The conferences and workshops have been also held in the Murmansk and Arkhangelsk regions, and in Moscow.

For realization of the programme on disposal several **international programmes** function at the enterprises:

- Early in the month **the International Scientific & Development Centre** took the decision on financing the Project "Conception of complex disposal of nuclear submarines at the enterprises of the State Russian Centre for Nuclear Shipbuilding (GRTsAS)", which will allow to analyze the work experience at GMP "Zvezdochka", to make conclusions and to extend them into other enterprises.
- **The programme of Nann-Lugar "Cooperative Threat Reduction"**.
- The programme has been already carried out for more than two years. According to the agreements the enterprises have received the equipment for more than 30 million USD in total, including gas-cutting equipment, equipment for the mechanical cutting of a shell, and a factory for cable reprocessing, etc. It is planned to extend the programme in two major directions, including the delivery of a complex for radioactive waste reprocessing to the enterprise. It is necessary to underline that the programme "Cooperative Threat Reduction" **is the most effective and dynamic one**. Within the framework of the programme Mr. Perry, the Minister of defense of the USA, Mr. Nann and Mr. Lugar, the Senators, and the high officials of the Government of the USA visited our enterprise.
- **The Russian-Norwegian programme**. According to this programme Norway plans to allocate about 40 million USD for carrying out the **works on improving ecological situation** in the Northwest Russia. Besides, at GMP "Zvezdochka" it is planned to repair the liquid radioactive waste storage facility and special networks. A number of the projects which the Norwegian government intends to finance, will allow **to reduce the tension of "fuel line-up"**. These are such projects as:
  - Vessel - containership for transportation of spent fuel;
  - Special train for delivery of TK-18 containers to "Mayak";
  - Temporary storage facility at NPO "Mayak" etc.The start of the works under the projects is delayed. The Russian government could not sign the Government-to-government agreement with Norway for over a year.
- **The proposals of France**. At present we negotiate with the "Technicatom" corporation about the delivery of equipment for disposal of solid burnt radioactive wastes at the enterprise.

I would like to tell about the experience of disposal at our enterprise in detail.

Under the agreement "Start-2" the GMP "Zvezdochka" is defined as one of the enterprises dealing with the disposal of strategic nuclear submarines. 11 NS have been disposed at the enterprise within the recent 7 years: including 3 NS - according to the eight-compartment option, 8 NS of the second generation - to the three-compartment option. Thus, **the labour-intensiveness of disposal is permanently reducing**, it is achieved through the improvements of organizational and technological solutions. The disposal of nuclear submarines is fulfilled in accordance with the state defensive order under the contracts with the Navy, on the basis of the Working schedule approved by the Decree of the Government of the Russian Federation. The disposal at GMP "Zvezdochka" **is fulfilled** according to the most economically expedient **three-compartment option**. Realization of the works is carried out according to the key

process engineering, developed by the leading research and development institute of nuclear submarines disposal process engineering - NIPTB "Onega", included into the GMP "Zvezdochka". According to the key process engineering the scheme of complex NS disposal consists of the following:

- NS preparation to disposal;
- Core unloading;
- Placement of NS on the stocks;
- Cutting up a three-compartment unit;
- Preparation of the three-compartment unit for temporary storage;
- "Procedure" - cutting and separation of a missile compartment
- Disassembly of equipment, instrumentation, pipelines, electric cable;
- Cutting up a vessel into large sections, cutting up sections, equipment, separation of an electric cable into a secondary raw material;
- Launch of three-compartment unit on water for transporting to temporary storage site.

**The positioning method**, referred to as the positions, ensuring fulfilment of the works on disposal in a particular order at the particular equipped places, was accepted as the basis for objects' disposal organizational process at the enterprise. In disposal at the enterprise NS passes through 11 positions covering both the works on preparation of an object to disposal, process of disposal of the object and its elements, and shipment of a finished product.

**The enterprise has all the necessary infrastructures and objects for carrying out the complex disposal.**

Each position is equipped with the relevant complex of equipment, fittings, instruments, systems of the centralized power supply. Completing different methods of optimization of the disposal process, we have stopped on a method, which is based on the maximum dismantling of equipment, mechanisms, systems prior to NS laid-up on the stocks during NS preparation for unloading spent nuclear fuel. The advantage of this method lies in the fact that the period of NS stay in a dock is reduced as much as possible. For this purpose at the enterprise the leaktight removable shelters were manufactured practically for all the compartments, that allowed to open simultaneously several premises, not violating the requirements on vitality and insubmergibility of a ship. Prior to NS laid-up in dock up to 90 % of equipment is dismantled, including turbines, main condensers, etc., only the vitality and fire-extinguishing safety systems are left and supported in operational reliability state. The basic amount of the works on object's disposal is fulfilled on the stocks. Thus, an object on the stocks is cut up into four units with the subsequent dismantling of strong and light shells into large sections, as well as the unloading of equipment. The sizes of large sections are selected depending on the lifting-and-conveying machines at the enterprise. The equipment unloaded from the object is stored in containers. In disposal of an object on the stocks the basic method of dismantling the casings is thermal cutting and air - arc one. The gases - acetylene and oxygen - supplied in balloons to a workplace until recently, are used for thermal cutting. This year we installed the systems of **the centralized gas distribution** to distributing posts, which allowed to eliminate the intermediate operation on filling in balloons and delivery them to the stocks, and to reduce labour-intensiveness on ca 4,000 w/h for an object only on this operation.

In order to reduce the oxygen pipeline length and to ensure the necessary pressure in it, it is planned to fulfill the feed of oxygen from **gasifiers**. For fulfilment of the dismantling of vessel constructions in the areas of austenite welds the stocks are equipped with the multi-post welding rectifiers for the air - arc cutting. The dismantled equipment on the stocks **is loaded in**

**containers.** The removal of containers with equipment is carried out by common motor-car transport. It is possible to simplify the containers transportation from the stocks by purchase of a containership, which itself loads and unloads containers at the place of unloading-loading, eliminating the use of cranes during operations on unloading equipment and casings directly from the disposed objects, as well as at the places not equipped with the crane equipment. Now in view of all the measures used in NS disposal, the period of **stay in dock is reduced up to 3 months** instead of the 6 planned (object N 431), that allows to dispose 4 NS per a year. Two specialized sites at the enterprise are equipped for the reprocessing of large sections of a shell and the equipment elements from ferrous metals into scrap by thermal and mechanical methods of cutting. **The site for thermal cutting** is equipped with a system of the centralized gas distribution with its feed to distributing places, that greatly allowed to increase the productivity and to improve production culture. At the site the high-performance **gas-cutting equipment** delivered from the USA is used; it is more convenient in service and more durable. The use of **gas stations** allowed to increase the pressure of oxygen up to 16 kg/sm<sup>2</sup>, that in turn raised the productivity of the gas-cutting works in 2.5 times, and allowed to pass to **propane-butane mixture** instead of acetylene, the cost of such mixture is 11 times less. The separation of large sections of a shell at sites is fulfilled with the use of equipment for thermal cutting into a "piece" with further reprocessing on a stationary guillotine. With this purpose **the site of mechanical cutting** is equipped with the **stationary guillotine** of the "Harris" corporation and with two **hydraulic scissors** of the "Labaunty" corporation installed on a caterpillar excavator of the "Caterpillar" corporation. The experience of guillotine operation has shown its high productivity for cutting the casings of various configuration and mass. For increasing efficiency of the discharge operations a transporter was installed and a concrete platform was arranged this year. The application of the "Labaunty" guillotine for cutting the thin-walled constructions has not justified itself, because of the very high expenditures for fuel oil, therefore now this equipment is basically used for transport of casings over the site. **Regular crane equipment** is used for loading-unloading. The use of the "Mantissa" crane has proved the high efficiency of **grab captures** for transport of scrap-metal cut up into the "Marten" pieces. It is planned to use a **gantry crane of 35 tons load-carrying capacity** and to install it at the site in order to increase the effectiveness of operations on loading-unloading vehicles, displacing sections over the site and loading guillotine bunker. The basic operations on casings separation at the enterprise are carried out with the use of gas and electric arc cutting. Thereby manganous, chromium, carbonic and nitrous oxides and fluoric hydrogen, harmful for the man, are released in the atmosphere. The **analytical calculations** were held, which have shown that during the disposal of 4 NS per a year the concentration of harmful substances at the enterprise's territory and sanitary-protective zone **would not exceed MPC** /maximum permissible concentration/. The research works on test of the **alternative process engineerings of cutting** casings were carried out at the enterprise.

The following installations and methods have been tested:

- Laser installation of the subsidiary of RNTs "Kurchatov institute",
- Installation for hydro-abrasive cutting of the Hydroflex corporation,
- Casings separation with the application of directed explosion was carried out under the leadership of representatives of the Military Academy named after Dzerzhinsky.

As a result of these works it has been established, that the use of mechanical and gas cutting is **the most economically expedient** one. These conclusions are well co-ordinated with the

process engineering of casings separation accepted at the similar shipyard "Pugent Saunt" in the USA, which our experts have visited.

The **shipment** of scrap after mechanical cutting is fulfilled into coaches by a vehicle. In order to control the amount of loaded scrap it is planned to purchase and to install **carriage scales** at the loading site, the installation of which will eliminate the operation of preliminary weighing of scrap-metal prior to shipment. At the enterprise the **building of a terminal** for scrap-metal shipment by **water transport** was initiated, which would allow to reduce the transportations by railway coaches over the enterprise's territory up to 30 %, to accumulate scrap-metal up to 3-4 thousand tons, to improve the loading operations and to use at most water transport for sending off scrap-metal, the cost of water transport is 1.5-2 times less than railway one. The equipment of sites for mechanical and gas cutting will allow to reprocess not less than 50,000 tons of scrap-metal per a year after completion of all the planned works.

**The cable** produced during disposal is reprocessed at specialized site.

The site is equipped with cable-separation installation permitting to fulfill the reprocessing of cable of various sorts. The electric cable reprocessing, except the basic operation fulfilled on the installation, includes the preparatory - final operations, which require the technological equipping for their mechanization. The preparatory operations include the initial cutting of electric cable and delivering it to the cable-separation installation. It is possible to mechanize the preparatory operations by purchase of: an installation for the initial cutting of electric cable, an electric loading device with grabs and a device for electric cable selffeeding after initial cutting. The final operations during electric cable reprocessing present the packing of scrap in kind of chop into sacks, weighing and shipment to a customer. Mechanization of the operations dealing with unloading, loading and transport of loads in the straitened conditions at the site is solved by purchase of an electroloader of 5 tons load-carrying capacity with rotation of pitchfork in the horizontal plane. The monitoring of the scrap amount obtained or delivered to a customer, is solved by purchase of platform scales. The wastes from electric cable reprocessing on a cable-separation installation are transferred to a bunker, whence they are removed periodically into containers. Mechanization of the wastes loading into a container is solved by purchase of a conveyor belt (conveyor). The abovementioned equipment will allow at most to mechanize the process of cable reprocessing for the preparatory and final operations and to reduce the rate of hand-operated labour.

**Radioactive waste management** is one of the most complicated problems, into which the enterprise has run in disposal. **Spent nuclear fuel unloading and removal** is the most acute problem for today.

The fuel overload scheme applied till present is carried out in the following consequence:

- Fuel overloading on the floating technical base;
- Fuel cooling;
- Temporary storage of shrouds with SNF;
- Shipment to TK-VG-18 coaches;
- Sending off to NPO "Mayak" for reprocessing.

The fuel overloading is implemented by **the floating technical bases** located at the enterprise's territory. The unloaded fuel is cooled and temporarily stored on a ship in special pond. Then fuel is loaded into **TK-18 containers and coaches** at a platform equipped with special crane. One of the floating bases of the 2020 design was completely equipped, and at present it allows to load the "cold" fuel from disposed objects directly into transport

containers. All the works on fuel unloading are carried out by the Navy's staff with involvement of the experts of the enterprise. The vessels built in 1960 and 1985 are used for fuel unloading at the enterprise, one of which has already worked out the service life, and the other has been operated without repairing for 12 years by now. Two sets of overload fittings available at the enterprise have worked out the service life too. The equipment available at the enterprise allows to overcharge **no more than three NS per a year**, that is explicitly insufficient for the planned rates of disposal. For the resolution of this problem we offer at territory of the enterprise to build a **coastal base for spent fuel overloading** from disposed objects directly into transport containers of TK-18 type. The other complicated problem of fuel unloading is a special train, which should remove fuel to NPO "Mayak". At present in the country it is only one such echelon, it requires the major overhauling and does not explicitly cope with the rates of fuel removal from Severodvinsk, Murmansk and Bolshoy Kamen. In this matter we very much hope on the assistance of Norway, which in the Government-to-government agreement provided for the allocation of means for building one more special train.

A lot of **liquid and solid radioactive wastes** are produced in the process of disposal. The wastes have not been removed from the enterprise and have been accumulated at the SRW temporary storage site and in the liquid waste storage facility since 1993.

At present at the enterprise it is accumulated:

- LRW - 1,570 i<sup>3</sup>,
- SRW - 2,037 i<sup>3</sup>.

**Complex of the infrastructures for liquid and solid radioactive wastes reprocessing** was built and commissioned at the enterprise in 1965, but so far as it was easier to dump wastes in the seas, the complex was not used with its direct purpose. After signing by Russia of the London Convention and refusal from the marine RW disposal, it appeared that in the Northwest Russia there were no enterprises for waste reprocessing and equipped according to the ecological safety requirements for RW long-term storage facilities. At present VNIPIET in St.-Petersburg is elaborating a **Conception of RW Management in the North-European Region of Russia**. According to this conception three centres for RW reprocessing will be established in the North, including one in Severodvinsk, as well as a repository will be built on Novaya Zemlya archipelago.

We plan to create a scheme for wastes management in Severodvinsk as follows:

**Liquid radioactive wastes** will be unloaded from a ship and transferred throughout pipelines into 4 containers of 2000 i<sup>3</sup> total volume for temporary storage. The wastes from disposal and **special laundry** will be reprocessed on purifying installations, concentrated radionuclides will be solidified and put into containers, and purified water will be poured in a sewerage system after control. **Solid wastes** in containers will be transferred for sorting and milling.

Metallic wastes are planned to decontaminate and to transfer to a scrap-metal site.

"Soft" wastes are planned to burn, and all the remains and ashes after a furnace - to press on a super-press compactor and to put into containers. Containers with solidified wastes will be stored **at the SRW temporary storage site** till the commissioning of a repository on Novaya Zemlya. The complex is planned to equip with an updated **system of monitoring** external medium and radiation state at the objects. The building of a complex **will be financed** from the different sources, including the Russian state budget and involvement of the financial help from Norway, USA, France. Completion of the works is planned for 1999. Till that time wastes will be accumulated at the enterprise. In resolution of the current problems concerning the

reducing of liquid radioactive waste amounts the great help was rendered to us by the Government of Moscow and the Moscow plant "Radon", which delivered an installation and partially financed the reprocessing of 400 i<sup>3</sup> waters. After separation of NS's shells the by-products of disposal are prepared **for sale, reuse and burial**.

- **Scrap-metal** is cleaned from coatings and cut up into the "Marten" pieces.
- **Rubber coatings** are used for manufacture of plummets (sinkers for fishing nets) and rubber crumb, which one is applied in building roads, chemical industry etc. A part of rubber coating is glued together on special fittings for a reuse.
- A part of the **equipment** disassembled from disposed objects is **reconditioned** and reused or is sold. GMP "Zvezdochka" has mastered the repairing of fittings, pumps and other equipment.
- **Electronic instrumentation** containing precious metals, is prepared for sale at the specialized site. Cable is also separated; copper and a part of metal braiding are extracted from it, and rubber is reprocessed in crumb. Non-ferrous scrap metal is remelted in furnaces and prepared for sale.

**In the conclusion I would like once again to underline, that the enterprise has the large experience of disposal of the vessels with nuclear-powered facilities and it has got the qualified staff and the equipment necessary for separation of 4 NS per a year, and even more than four providing the small additional equipment. Spent nuclear fuel management is the main reason, which may retard the rates of disposal from the technical point of view.**