RADIOECOLOGICAL ASPECTS OF AT-SEA DUMPING OF NUCLEAR WASTES RESULTING FROM THE FSU NUCLEAR FLEET ACTIVITIES: RELIABILITY OF PACKINGS AND NECESSITY OF REHABILITATION MEASURES

S. LAVKOVSKY, N. KVASHA, V. KOBZEV, V. SADOVNIKOV, V. GOLTSEV
CDB Lazurit OJSC, Nizhny Novgorod, Russian Federation

Abstract

The practice of radioactive waste treatment in the former USSR was that prior to at-sea dumping of objects with spent nuclear fuel (SNF) a set of design and technological measures was undertaken with a view to form packings with additional barriers to prevent radionuclide release in the environment.Based upon the results of most conservative evaluations of the protective barrier corrosion resistance it was concluded, that till Year 2300 there will be no grounds to worry about a possibility of the loss of tightness of the majority of packings. However, should unfavourable external natural factors combine, the loss of sealing of the packing with the screening assembly of the nuclear icebreaker "Lenin" can occur at any moment.

INTRODUCTION

The International Science and Technology Centre (ISTC) in 1995 funded project #101 "Development of Scientific and Methodological Basis for Diagnostics and Forecast of the State of Nuclear Wastes at the Bottom of the Barents and Kara Seas and the Sea of Japan. Identification of Ways to Prevent Dangerous Ecological After-effects" (The code name of the theme is KURGAN).

The objective of the Project is to perform an assessment of the influence of radioactive wastes and materials dumped at sea as well as those located at decommissioned nuclear submarines and storage of spent nuclear fuel on the actual and potential radioecological situation in seas adjacent to the territory of Russia and to issue recommendations on rehabilitation of dangerous objects.

The work has been performed in several phases by a team of scientists and experts from the LAZURIT Central Design Bureau (CDB LAZURIT), RRC KURCHATOV INSTITUTE, TYPHOON Scientific & Production Association, Experimental Machine-building Design Bureau (OKBM), Power Engineering Research & Design Institute (NIKIET), Experimental Design Bureau HYDROPRESS (OKB HYDROPRESS) with engagement of experts from the operating and supervising agencies of the Navy, nuclear icebreaking fleet and industry.

During the Project execution a computer database on decommissioned nuclear submarines and ice-breakers, floating storage of solid and liquid radioactive wastes (SRW and LRW), coastal sites for temporary storage of SNF, SRW and LRW, as well as radioactive wastes dumped in the seas surrounding the territory of Russia has been collected and continues to be updated. Calculations-assessments of actual and potential release of radionuclides from the sources dumped in the Kara Sea in the marine environment have also been executed. Currently the real and potential radiation risk from the above-stated sources is being assessed. The task completion term is July, 2000. More in-depth information can be found in the Internet site: www.lazurit.nnov.ru.

Within this Project an assessment of reliability of design and technology applied for formation of SNF packings and necessity to undertake rehabilitation measures has been completed, a pontoon with the screening assembly of reactor # 02 of the OK-150 plant of the nuclear ice-breaker "Lenin" being taken as an example.

Methods to pack SRW

If SRW were subject to dumping and if their structures contained 25% of non-metallic wastes (overalls, footwear, cloth, tissue etc.), and metal wastes (equipment, fixtures and instrumentation of reactor primary, secondary and third circuits, etc.), which made 40% of all formed SRW, they were placed, as a rule, in containers made of steel and the free container space was filled with concrete or asphalt.

The Navy mainly used containers of 1x1x1 meter size. The wall thickness was 3 to 4 mm, the Murmansk Marine Shipping Company used containers of 1õ1õ1.43 m size with 4 to 5 mm wall thickness.

The rest of SRW, 35% of all formed SRW, is made by large-size equipment and constructions, which have been dumped non-containerised, but have been sealed hermetically or their internal spaces contacting reactor primary, secondary and third circuits have been decontaminated. Dumping of containerised and non-containerised SRW took place after their temporary storage on coastal sites or in the ships (lichters, barges etc.), not subject to further operation, or individually.

Besides the indicated types of SRW, several nuclear submarine reactor compartments both with SNF and without it , as well as one nuclear sub with SNF, a reactor compartment of the ice-breaker "Lenin", a reactor with SNF of a nuclear submarine, screening assembly with SNF of the ice-breaker "Lenin" and nuclear submarine reactor casings have also been dumped.

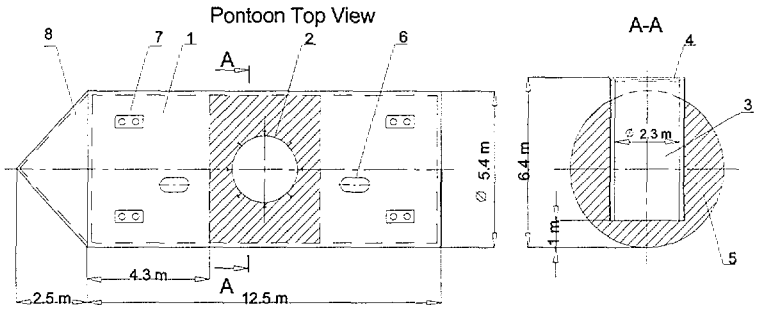
The reactor compartments before dumping have been subjected to conservation with application of hardening mixtures (based on furfurol, bitumen or concrete), that ensured establishment of additional protective barriers on the way of radionuclide release in the environment.

The radionuclide release in the marine environment during SRW dumping was excluded before the moment when corrosion started as it corrupted the container casings and plugs, i.e. within 30 to 50 years, and the availability of a concrete or asphalt filling material considerably hinders release of radionuclides contained in the corrosion products of SRW materials.

As for dumped objects with SNF, their conservation has reliably exclude radionuclide release from them into marine environment, which have been confirmed by measurements taken by the joint Russian- Norwegian cruises to the Kara Sea [1].

Description of the pontoon with the screening assembly of the ice-breaker "Lenin"

In February, 1965 an accident with the reactor plant ÎÊ-150 of the nuclear ice-breaker "Lenin" took place. It was accompanied by overheating of a part of the core of reactor #02, that made unloading of a part of heat-generating assemblies (ÒÂÑ) of the reactor core impossible. Non-removable HEAs (125 pieces or about 60%) were removed from the reactor together with the screening assembly (assembly # 2) and placed in a caisson made of stainless steel, in-welded to the central part of a cylindrical pontoon made of carbon steel (see Fig. 1).



Positions:

1 Pontoon. Material – 10mm carbon steel.
2 In-welded pontoon, material- 14mm stainless steel 08X18H10T
3 Assembly lowered into the caisson is filled in with furfurol
4 Caisson cover is welded to the caisson along the perimeter. Material –steel 08X18H10T.
5 Pontoon space around the caisson with the assembly is filled in with cerpentinite concrete
6 Pontoon is equipped with necks, leer rails and flooding system
7 Towing yokes
8 Bow cone for towing

Fig. 1. Scheme of pontoon assembly 02.

The caisson free spaces were filled in with a hardening mixture based on furfurol and a cover was welded to the caisson. In order to ensure allowable radiation conditions near the pontoon, the free space of the pontoon central part was filled in with concrete. The screening assembly activity made 11.3 thousand ÒBq at the moment of dumping, and now it is estimated about 1.4 ths. TBq.

About the dumping site of the pontoon with assembly 02

According to the information produced by the Yablokov Commission [2] and confirmed by the Murmansk Marine Shipping Company [3], the pontoon with the assembly 02 has been dumped in the Tsivolki Bay at 50 m depth. However, according to the data of CDB "Iceberg" which had designed the ice-breaker "Lenin" [4], the pontoon was dumped in the Kara Sea between the southern extremity of the Novaya Zemlya Archipelago and the Tsivolky Bay. The Medical Service of the Navy [5] specifies that the pontoon was dumped in the coastal area of the Litke Bay of the Novaya Zemlya Archipelago .

Taking into account the stated above, as well as the fact that the pontoon was not discovered in the Tsivolky bay during the joint Russian-Norwegian Cruise in 1993 [1], the location of the pontoon with assembly 02 should be considered non-identified.

Assessment of a possible status of the pontoon with assembly 02 after dumping

The assessment was conducted for Year 2000 [6] based on the conservative assumption about the pontoon location on a rocky ground at 10 to 30 m depth on an even keel under the impact of waves of 1% provision for a period of 100 years, tidal currents, ice formations (ice ridges, hummocks) and corrosive wear of material of the in-welded caisson.

The estimated calculations have shown, that at up to 20 m dumping the pontoon under the action of waves and currents will turn over from one extreme position to other and will drift-drag forward in the extreme positions (see Fig. 2).

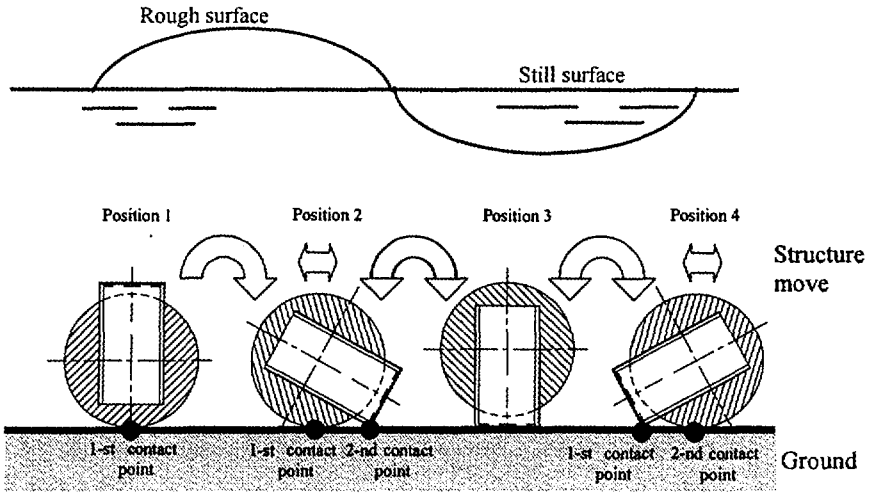


Fig. 2. Dynamics of pontoon motion at 10 to 20m depth, under the action of loads from currents and seaways.

The assessment calculations of the ice impact on the pontoon have shown that during the pontoon presence at 20m depth the ice during contact with the pontoon will try to displace it by dragging along the bottom. Partial breaking-off of the pontoon cover, its bend and subsequent full destruction of the weld, by which the cover was welded to the pontoon is possible.

When dumped at depths more than 20 m, the ice impact on the pontoon is excluded and the loss of sealing can occur only due to ulcerative or crevice corrosion. The assessment calculations of the caisson destruction under the impact of these corrosion processes have shown, that it can take place not before Year 2300.

Taking into account a principle possibility of the loss of sealing of the caisson with the screening assembly of the ice-breaker "Lenin" under the influence of waves, currents and ice, it is necessary to conduct a cruise for search of the pontoon and to inspect its status, and then to define the scope of required rehabilitation measures.

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DISCUSSION AFTER THE PRESENTATION OF S.A. LAVKOVSKY

G. Linsley (IAEA - Session Chair): One of the things which the IAEA does on behalf of the London Convention (formerly known as the London Dumping Convention) is to maintain a database on the controlled disposal of radioactive waste at sea and one on accidents at sea involving radioactive materials. I am pleased to say that the fact - just reported by you - that the reactor of the "Lenin" icebreaker is located in a place different from the original co-ordinates given in the Russian White Book is recorded in our accident database. An IAEA report on the content of the **[controlled disposal]** database**(s)** has been approved by the London Convention and will be published early next year.