PRELIMINARY RESULTS OF THE FIFTH EXPEDITION TO THE SITE OF THE LOSS OF THE SSN "KOMSOMOLETS" (16.06.94-11.08.94)

A. I. Vialyshev
M. G. Tolokonnikov
Ministry of Civil Defense
Emergencies and Elimination of the Consequences of the Natural Disasters (EMERCOM)
of the Russian Federation Moscow
Russia

The SSN "Komsomolets" sank in the Norwegian Sea to a depth of 1700 meters as a result of damage which took place in April of 1989. The submarine has one nuclear reactor in a smother state and two nuclear torpedoes on board. After a number of expeditions to the place of loss (1989,1991,1992, and 1993), it was established that the leakage of radioactive products from the nuclear reactor does not influence the environment significantly. The leakage of toxic plutonium-239 was not stopped. The blow of the SSN against the bottom and the explosion in the first part led to the formation of a hole (20 square meters) and, as a result, the hermetization of the front covers of upper torpedo apparatus was broken, as well as their rear parts and torpedo engines. All of this, including flows, became the reason for the flow of water through the bow part of the SSN which, because of intensive corrosion, could lead to the leakage of plutonium from the warheads into the ocean.

In the period from 02.07.94 to 28.07.94, the 5th expedition of the scientific research vessel of the Russian Academy of Science "Academic Mstislav Keldish"--specially organized by the Ministry of Emergencies of Russia--performed work in the Norwegian Sea with two deep-water vessels "Mir" on board. The oceanographic research vessel "Semen Degnev" also participated in the expedition. The expedition was partly financed by the Holland Government through the "Komsomolets" Foundation.

The main goals of the expedition were to carry out tasks preventing the leakage of plutonium from the SSN into environment and to perform oceanographic and radiation monitoring at the accident site.

The following results were achieved in the expedition:

a) Hermetization of the bow of the submarine;

b) Inspection of the SSN and collection of the information necessary for determining proposals concerning the next actions to be taken regarding the submarine--the actions determined will be carried out during the second stage of operations scheduled for 1995-1996;

c) Realization of large-scale oceanographic, bioecological and radiation research in place;

d) Determining concepts for organizing the ecological monitoring in the sites of possible

removal of nuclear products from the SSN and burial of the nuclear waste products; and

e) Examining the life-camera to estimate the chancing of raising it during the second stage of works with the SSN.

The main tasks of the expedition were accomplished with the help of deep-water vessels "Mir-1" and "Mir-2". Eighteen (pair) dives took place, the most of them in bad weather conditions.

The crews of the deep-water vessels attached nine covers onto the holes in the bow part of the SSN, six of which were attached to holes of the shields of the torpedo apparatus. Attachment of the covers was accomplished on custom made brackets. So, the project of the first stage of work on preventing leakage of plutonium from the SSN was accomplished. It was the first time that unique underwater work, which plays a big role in the protection of the sea environment, was carried out on a hazardous radioactive object, located at a depth of 1700 meters. The closing of these holes substantially blocked the flow of water through the bow part of the SSN and reduced the possibility and intensity of potential leakage of corrosion products from the submarine.

During the dives of the deep water vessels, damage of the light and hard hull, and the inner constructions of the first compartment of the SSN were examined in detail. Pictures and video films were made. The materials resulting from the examination of the SSN are sufficient for determining further projects according to the second stage of the project to prevent the leakage of plutonium from the SSN "Komsomolets".

The submarine hull was also examined. The resulting materials made it possible to estimate the technical state of the hull and if necessary, to plan the project of raising the camera. General oceanographic research was also made during the expedition. Such research is very important for forecasting the situation in the place of the accident of the SSN in the very near future. A number of hydro-physical studies of the structure of water also took place. The studies included sounding of regulating of temperature, salinity and transparency of water from the surface to the bottom, as well as measuring of speed and changeability of flows in the ground layer with the help of local bottom stations which were used during the 20 days.

Preliminary treatment of the recovered materials showed that during the observation, the main transfer in the ground layer is moving in the northwest direction at a speed of 5-10 cm/sec. It was also discovered that the speed of flow in the ground layer is extremely variable. An underwater storm was experienced during the first expedition that led to zero visibility, because the water was stirred up to 50 meters. The flow and its speed in the region where the operations were carried out changed rapidly depending upon the season of the year. The expedition placed measuring instruments to repair these processes for the long term. Inside the first compartment of the SSN, the speed of the flow sometimes reaches 8 cm/second after attaching the covers. This is proof of the water exchange between the bow part of the SSN and the environment into the water through the break in the first compartment.

The aim of the biological research was to find out any possible ways of migration of radioactive pollution to the food-chains. Different devices like 150 liter barometers, planktonnets, etc., as well as observation through portholes allowed the thorough examination of the chemical composition and distribution of living organ-

isms in the water from the surface to bottom. It appeared there is a possibility to transfer radioactive products through the food-chains from the ground into the surface layers. Scientific institutions also consider the transfer of the lowest layers of the water to the surface. This is possible, but in the summer such displacements were fixed. Four kinds of animals were discovered not far from the SSN. They inhabit all layers of the water, including the surface, where they are eaten by herring and young cod. As the major source of food organisms for herring and other fish are kinds which do not go down to the ground layers, potential carriers of radioactive products can make up no more than 2-3% in their food. Due to the fact that not all the plankton animals rise from the lowest layers and that possible radioactive pollution will be of a local character, direct transfer of radionuclides through trophic chains will not be considerable.

Geological research formed a complex of selection of sedimentary samples in the location of the SSN. Special bioscoops, subsoil tubes and other devices were used for this work. The work was carried out from on-board the ship and deep-water vessels. An important part of this geological program was visual observation through the port-holes of the deep-water vessels.

The research works showed that in the place of loss of the SSN there is a contour flow with a clear, turbid bottom layer. Concentration of the dregs there is 0, 5-0 ,8 mg/l, which is 2-3 times more than in the more transparent upper layer of water. Thin, suspended fractions flowing around the submarine generally don't fall onto the surface of the bottom.

Sedimentary material migrates to the bottom only after the concentration of the tranction into larger food lumps by plankton animal-filtrators and then--as a result of bioturbation--it penetrates into the thickness of sediments. Vertical flows of the sedimentary material of the bottom are 100-300 mg/m a day. Complex oceanographic research provided for main conceptions of longtime monitoring of the ecological system of the Norwegian Sea in the zone of the SSN and the nearest areas of water to be determined .

Radiation monitoring of the SSN and the nearest zone were carried out by means of two deep-water vessels, instruments and devices which were placed on them, including new specially created deep-water gamma spectrometers, barometers, different kinds of sample takers, filter plants, and telescopic instruments, etc. This equipment can be used for monitoring of other dangerous radioactive objects.

Radiation research near the SSN took place on both vessels taking part in the expedition. Primary treatment and measuring of water samples, bottom, and biological objects was done with the help of modern radiochemical methods of isolation of radioactive elements, and different laboratory alpha-, beta-, and gamma-spectrometers. Some of them were worked out specially for this expedition. Some experimental samples by the mass-spectrometer were used for the first time in the sea, and it was a success.

This was also the first time when a longtime module bottom station of radiation control was placed in the region of the SSN location.
The results of radiation monitoring are the following:

a) The measured concentrations and isotope structure of plutonium in the water samples, dregs and bottom sediments are similar to the concentration and structure of plutonium of global fallout. This proves the fact that the corrosion products of any plutonium located in the SSN practically do not go out into the sea.

b) The measured concentration of the main

radionuclide of reactor origin (Cesium-137) which is flowing out from the SSN is not more than 2*103 Bk/m3. Therefore, there are no great changes in the radiation state. Nevertheless, the concentration of Cesium-137, measured in the ventilation tube of the reactor compartment, is approximately 200 times more than it was several years before. Now, it is 106 Bk/m3, which makes it necessary to study more thoroughly all the recovered materials to determine the state of the reactor plant more precisely.

Foreign scientists, specialists from MAGATE, the Norwegian Society of Radiation, and all of the defense and ''Komsomolets' Foundation that were invited by the Russian Ministry of Emergencies to take part in the expedition received the necessary information. One of the representatives of the "Komsomolets" Foundation dove from on-board one of the deep-water vessels. As such, he had an opportunity to examine the damage in the lower part of the SSN.

The analysis of the results of the fifth expedition to the SSN "Komsomolets" lead to a number of conclusions:

a) Underwater technical operations carried out on hermitization of the bow part of the SSN are very important for the environment, for its protection from radioactive and toxic pollution;

b) There is no doubt about nuclear and radiation safety of the SSN now. But, it still remains a potential cause for radioactive pollution of the environment. This means that it is advisable to continue the monitoring of the region; and

c) Exchange of water between the first compartment of the SSN and the environment indicates that it is necessary to perform complete hermetization of the submarine. As it is impossible to exclude radioactive and toxic pollution of the environment with all the consequences, plutonium leakage must be prevented. This can be done by closing a big hole in the first compartment which will concentrate plutonium inside the submarine. This is to be done during the second stage of work on prevention of plutonium leakage from the SSN "Komsomolets".