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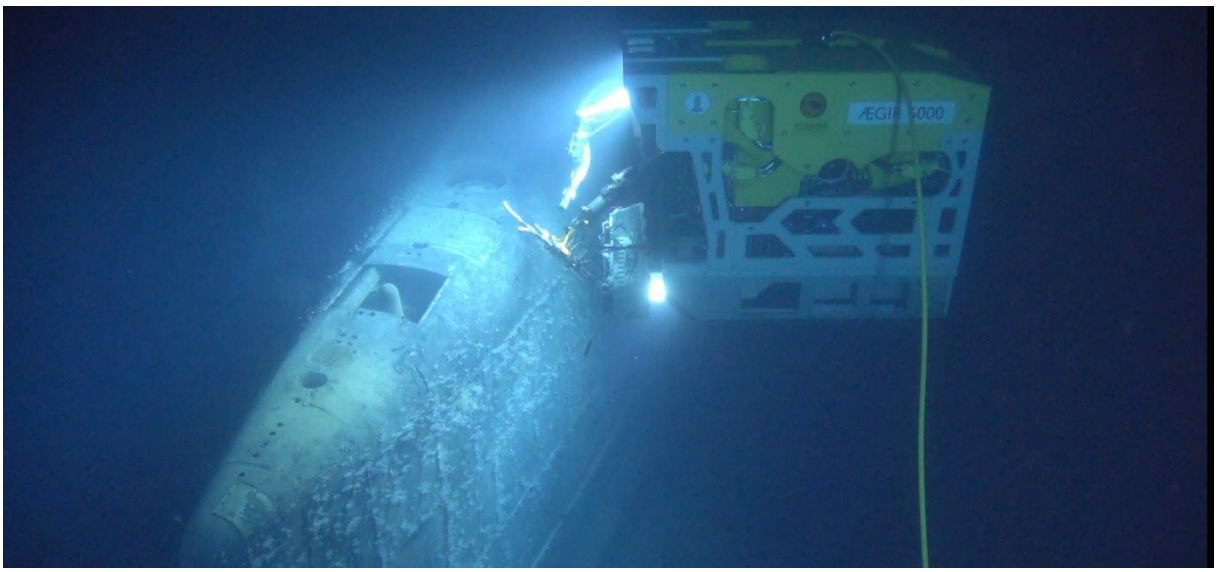
Status of the sunken nuclear submarine Komsomolets

A 2019 Norwegian research cruise to the sunken nuclear submarine Komsomolets has confirmed that radioactive releases from the reactor are still occurring. These releases have had little impact on the surrounding marine environment. The research cruise detected specific uranium and plutonium isotopes which suggest that the nuclear fuel assemblies have been damaged and that the nuclear fuel is in direct contact with seawater and deteriorating. Further work should be carried out to understand any corrosion processes and their implications.



The sunken nuclear submarine Komsomolets on the seafloor in the Norwegian Sea (Photo IMR).

The Russian nuclear submarine Komsomolets (K-278) sank in the Norwegian Sea on the 7th of April 1989 following a fire and now lies at a depth of 1680 m, southwest of Bear Island. Of the 69 crew onboard, 42 were killed. Komsomolets was powered by a single pressurised water reactor that was shut down in the early stages of the accident. In addition, it was reported to be carrying two nuclear torpedoes in its armament when it sank. The remaining activity in the reactor is thought to be around 3 PBq, and mainly due to the radionuclides Cesium-137 (Cs-137) and Strontium-90 (Sr-90).

Monitoring of Komsomolets

Soviet and subsequently Russian investigations were carried out between 1989 and 2007 with the aid of manned submersibles. Norway has carried out annual monitoring around Komsomolets since 1990. Due to the depth at which Komsomolets lies, it can be difficult to know the exact position and distance to the submarine of any collected seawater or sediment when using traditional sampling gear. In 2019, the use of a deep sea remotely operated vehicle (ROV) allowed Norwegian researchers to collect seawater, sediment and biota samples next to the submarine for the first time, including from the location where releases had previously been reported by Soviet and Russian investigations. The use of the ROV also allowed Norwegian researchers to visually examine the condition of the submarine for the first time.

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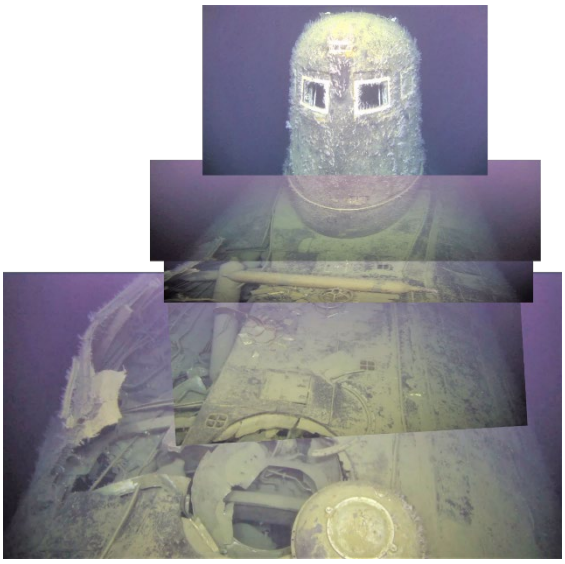
Results from the 2019 research cruise

The forward section of the submarine has suffered considerable damage to both the outer hull and inner pressure hull, particularly around the torpedo compartment. The various coverings installed around the torpedo compartment by Russia in the 1990s were still in place.



Damage to the outer hull of Komsomolets (Photo IMR/DSA).

Releases of radionuclides from the reactor were detected from a ventilation pipe, as previously reported by Russia. These releases were not continuous. When elevated levels of radionuclides were detected in or near the ventilation pipe, a simultaneous visual release could be observed emerging from the ventilation pipe. Visual releases and elevated levels of radionuclides were also detected from a metal grill next to the ventilation pipe. No obvious visual releases were observed emerging from any other opening around the submarine. There was no indication of any release of weapon grade plutonium from the two nuclear warheads that have been reported to be in the torpedo compartment.

The range of Cs-137 activity concentrations in seawater samples collected from or near the ventilation pipe and metal grill when visual releases were observed were within the range of values reported previously. The maximum observed activity concentrations of Sr-90 and Cs-137 in these samples were 400 000 and 800 000 times higher, respectively, than typical background values for these radionuclides in seawater from the Norwegian Sea. Elevated levels of plutonium and uranium isotopes were also identified in seawater samples collected from or near the ventilation pipe and metal grill. However, the releases of these radionuclides from the reactor in Komsomolets appear to be rapidly diluted in the surrounding seawater and appear to have had little impact on the surrounding marine environment. The elevated levels of the detected radionuclides as well as the specific ratios of plutonium isotopes in releases from the reactor in Komsomolets would suggest that the nuclear fuel assemblies have been damaged and that nuclear fuel is in direct contact with seawater and deteriorating.

Elevated concentrations of several trace elements in the same releases as well as in sediment around Komsomolets and in marine biota growing on the hull likely indicate ongoing corrosion processes within the submarine. Any impacts from the elevated levels of some these trace elements (e.g., nickel, copper and zinc) are likely to be limited to the immediate area around the submarine.

The need for further work

Releases from the reactor in Komsomolets can be expected to continue in the future. Further investigations should be carried out to determine the mechanisms behind the observed releases, the corrosion processes that are occurring within the reactor and the implications of these for further releases and the fate of the remaining nuclear material in the reactor. Komsomolets provides a unique opportunity to understand the risks from other sunken or dumped reactors in the Arctic as well as from any further accidents involving nuclear powered vessels or other type of nuclear technologies used at sea. It is important therefore that further monitoring of Komsomolets is carried out.

Reference to full report

Gwynn, J.P., Heldal, H.E., Teien, H.C., Volynkin, A., Jerome, S.M. Lind, O.C., 2024. Investigation into the radioecological status of the sunken nuclear submarine Komsomolets in the Norwegian Sea. Results from the 2019 Norwegian research cruise. DSA report 2024:03, Norwegian Radiation and Nuclear Safety Authority, Østerås, Norway.