Scottish CND

Kursk

The following is an initial assessment of the radiation risks arising from the loss of the Russian submarine Kursk and general issues about explosive hazards on nuclear submarines. The most recent accounts of the accident give rise to concern that the reactor may have been damaged.

Sequence of events on Kursk

Kursk was taking part in a major Russian Naval exercise in the Barents Sea on Saturday 12th August 2000. It has been reported that the last radio message received from the submarine was to say that a torpedo had just been fired. Russian Navy spokesmen have said that there was probably an explosion in the area of the torpedo compartment. The US Navy had two submarines and one ship listening to the exercise and have reported that there was one explosion followed very soon after by a second larger explosion.

The official inquiry into the sinking of the USS Scorpion said that the detonation of one torpedo in the torpedo compartment would be likely to lead to the detonation of one or more other torpedoes. Kursk would be capable of carrying 20 - 30 torpedoes plus 24 "Shipwreck" missiles. The actual munitions on board has not been made public. The Russian Navy has said that it was not carrying any nuclear weapons.

The vessel is on the seabed in 100 m of water. Initial reports indicated that: one torpedo hatch on the starboard side is open, one missile hatch on the starboard side below the coning tower is missing, there is damage to the bow and there is also debris on the seabed at the port side near the bow. Later reports have said that there was massive damage reaching from the bow to the coning tower.. The vessel is listing 60 degrees to the port. There could be damage to the port side which is not visible.

The double hull on Kursk is designed to withstand the impact of an average torpedo and provides the vessel with a lot of buoyancy. The fact that the submarine sank and could not recover itself suggests that the explosion resulted in extensive damage.

The US have said that there was one explosion followed very shortly by a second larger explosion. This suggests that one torpedo exploded and set off a massive explosion of several torpedoes within the bow compartment. This caused enough damage outwith the internal pressure hull to sink the vessel. It must have caused far more damage within the pressure hull. Most of the blast will have gone backwards, probably completely wrecking the control room, making it impossible to send out any messages saying the reactor was shut down or anything else. This makes it highly likely that there will have been some damage to the reactor area itself.

Even aft of the reactor it is highly likely that there would have been fire and fumes as secondary events triggered by the huge blast at the bow. It may have been very difficult for any reactor events triggered by the huge blast at the bow. It may have been very difficult for any reactor controls in the aft to be operated. The sinking of the Russian submarine K-219 in 1986 shows the sequence of events which can follow an explosion. In that case the initial explosion was in a launch tube containing a liquid fuelled missile. This was followed by a fire and the release of toxic fumes. The vessel surfaced and the second reactor was started. Water caused a short circuit which triggered a reactor shut down, but the control rods did not drop properly. One man died after manually lowering the control rods. Fire broke out again, most of the crew were evacuated and then the submarine sank.

Even if the reactor did shut down automatically the coolant circuit may not be intact. In addition it is unlikely that it was shut down in a controlled manner. When a submarine reactor is shut down there is still a significant amount of heat produced in the reactor from radioactive decay. For this reason the coolant pumps are kept running after the reactor has shut down. It is unlikely that this would have been possible on the Kursk.

Radiation hazard from Kursk

According to the Norway based group Bellona the Kursk has two OK-650 b reactors each of which produces 50,000 shaft horsepower. The power output of each reactor is given as 190 MW. So the total output from the reactors on the submarine would be 380 MW.

This can be compared with estimates for a British Trafalgar class submarine. These produce 15,000 shaft horsepower. The power output from the single reactor is estimated to be around 70 MW.

The significant difference can be related to the relative size of the vessels. The Oscar II class has a beam of 18 metres and a draft of 9 metres. Whereas the Trafalgar class have a beam of 9.6 metres and a draft of 8 metres. With a much larger size substantially more power is needed to propel the Russian submarine at speed through the water.

Amount of Uranium

The fuel core in a Trafalgar class submarines may contain around 220 kg of Uranium. Each reactor on Kursk is likely to contain around 600 kg of Uranium. So there will be around 1.2 tonnes on the submarine. Calculations John Large has made for the Komsomolets suggest the amount of Uranium may as great as 3 tonnes. As the level of enrichment is probably lower than on British submarines the total mass of the fuel core will be greater. Uranium 235 has a half life of 710 million years.

Radioactive Inventory

One MoD document gives a standard Trafalgar core inventory of 440,000 TBq. Assuming that the power output of Kursk is 5 times greater, the core inventory at the time of reactor shut down could have been 2,200,000 TBq. This will decline rapidly over the first few days and slowly thereafter. These figures are equivalent to between 0.6 and 3 percent of the inventory of the Chernobyl reactor.

Long Term Risk

Over time the metalwork which contains the radioactive material will decay allowing it to be released into the sea. The radioactive inventory will by then have decreased, but will still be substantial. Before the sinking on the Kursk there were already 5 nuclear powered submarines on the seabed, 2 American and 3 Russian. All of these are at depths of over 1500 m. Kursk is in water around 100 m deep. One consequence of this is that any release of radiation will more water around 100 m deep. One consequence of this is that any release of radiation will more rapidly reach the food chain.

Map showing likely dispersal paths.

Explosive hazards on submarines

Nuclear powered submarines carry a dangerous cocktail of explosives and nuclear material. No high explosives would ever be permitted next to a civil reactor. While the problems are particularly acute with the Russian Navy the danger is inherent in all military nuclear powered vessels. The Spearfish torpedoes carried on British submarines today are a particular problem because of the large explosive power in the warheads and the toxic and explosive hazards of the Otto fuel which propels them. Two workers were killed during early experiments with this fuel. A Trident submarine carries 700 tonnes of high explosive in the form of solid fuel in the rockets. The following is a list of some explosions on submarines in the last 45 years:

HMS Sidon June 1955 The diesel powered British submarine sank following a torpedo explosion in Portland harbour.
K-129 8 March 1968 Explosion on this Russian diesel powered nuclear armed submarine in the Pacific resulted in the vessel sinking. Reported to have been raised by the US Navy in 1974.
USS Scorpion 22 May 1968 Nuclear powered US submarine. The official inquiry into the sinking implied that it must have jettisoned a torpedo which then turned and sank the vessel. The alternative of an explosion in the torpedo compartment was examined but considered less likely.
K-219 Yankee class 6 October 1986 Explosion in the missile launch tube of this Russian nuclear powered submarine. The vessel then surfaced. A second fire affected the reactor. Most of the crew were evacuated. 4 lives were lost.
Typhoon class October 1991 Explosion of a ballistic missile in the launch tube of a Russian Typhoon class in the Norwegian sea. Returned to port.
Rubis class 30 March 1994 Explosion in the steam system on French nuclear powered submarine 45 miles from Toulon. 10 died.

Nuclear submarines on the seabed

USS Thresher 10 April 1963 The Thresher was on deep diving trials when the reactor shut down. Attempt to blow the tanks failed and the submarine sank 100 miles east of New England. The submarine is in six sections on the seabed. Depth 2590 m. All 139 onboard died. Cobalt 60 from the reactor was detected in the sediment. 1 nuclear reactor onboard.
USS Scorpion 22 May 1968 Details above. 400 miles SW of Azores. In three sections on the seabed. Depth 3300 m. 2 nuclear weapons and 1 reactor onboard.
K-8 November class 8 April 1970 Fires on this Russian nuclear submarine resulted in a reactor shut down. The vessel surfaced but auxiliary power supplies could not be started. Some of the crew were evacuated. On 11 April control of the vessel was lost and it sank in the Bay of Biscay. 52 died. Depth 4000 m. 2 nuclear reactors
K-219 Yankee class 6 October 1986 Details above. Near Bermuda. Depth 5500. 34 nuclear weapons and 2 reactors onboard.
K-278 Komsomolets. 7 April 1989 There was a fire on this Russian nuclear powered submarine and the vessel surfaced then lost power. Some of the crew were evacuated but 41 lives were lost when it sank near Norway. Depth 1685 m. 2 nuclear weapons and 1 reactor onboard.

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Sources:

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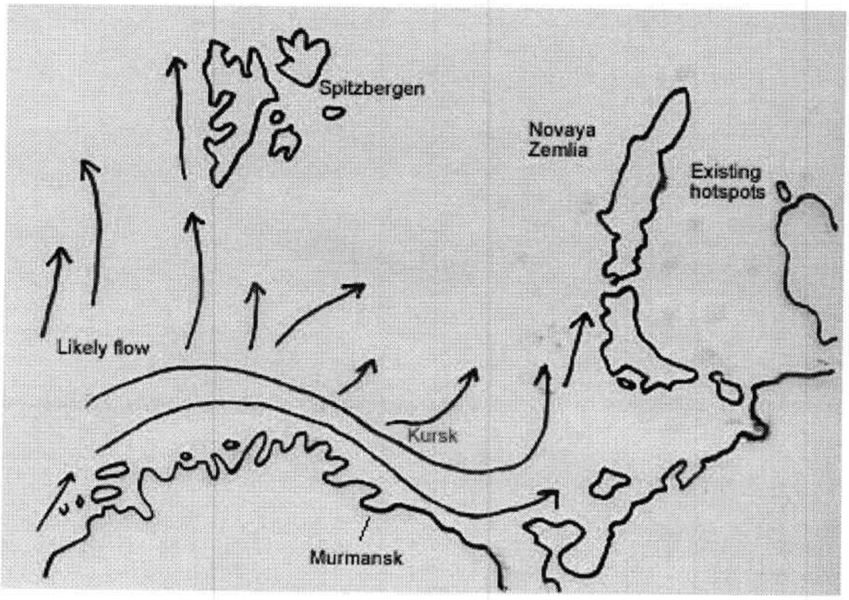

The above map shows the likely distribution paths of radioactivity in surface water in the Barents Sea. Flow lines are in Green. Existing concentrations of Caesium 137 which are likely to have been caused by Russian nuclear weapons testing and nuclear dumping around Novaya Zemlia are in yellow.

This is based on a map in the report on radiation prepared for the Russian President in 1993. The original map also shows concentrations of Caesium in the Western side of the Barents Sea which appear to originate from the inflow of water from the West and are probably partly due to Sellafield.

Return to Scottish CND report on Kursk