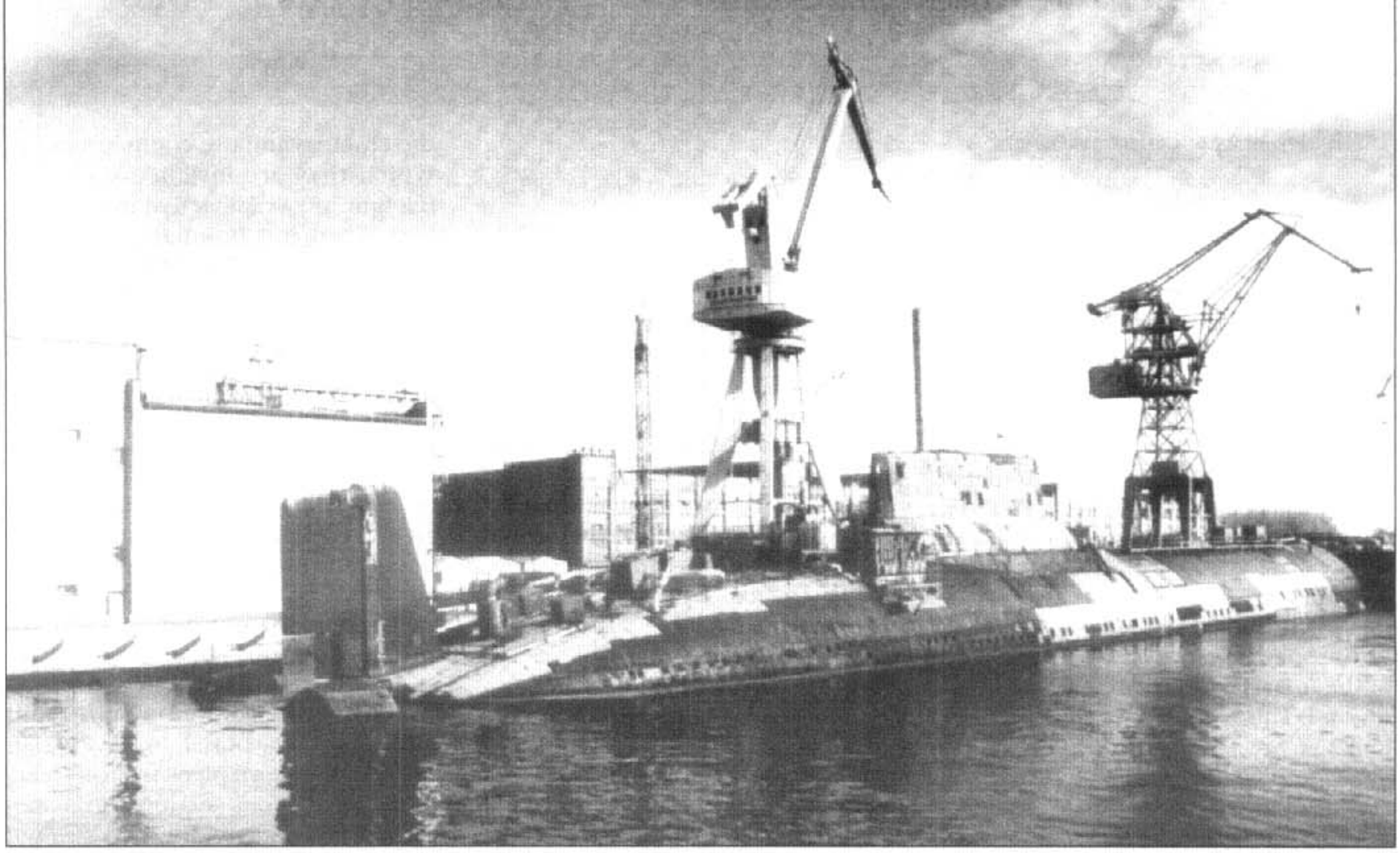
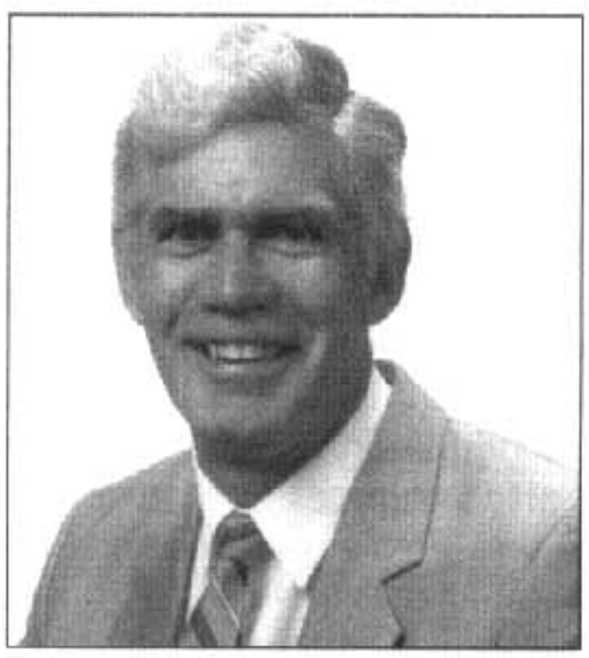


DECOMMISSIONING THE RUSSIAN FAR EAST FLEET'S NUCLEAR SUBMARINES

Ron Smith reports on a Vladivostok conference that focused on a worrying legacy of the Cold War.



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During the Cold War, the Soviet Union built up the largest fleet of nuclear-propelled submarines in the world, with something under half of them stationed in the Far East. Since the demise of the Soviet Union many of these vessels have been taken out of service, either as a consequence of arms control agreements or, more pressingly, because of lack of funds. They are now resting in various states of neglect and decay in harbours and inlets around the coastline of the Russian Far East.

The special problems of nuclear submarine decommissioning affect (or will affect) all five of the established nuclear powers, but only Russia faces the combination of a large number of ships that absolutely demand attention, a totally run-down infrastructure and a critical lack of funds. There have already been accidents in the course of decom-missioning and some undesirable practices have emerged, but the problems are still largely ahead. Unless Russia gets substantial financial and technical help from the rest of the world — most notably the United States, Britain and France — there is the prospect of an environmental disaster in the north-eastern corner of the Pacific. There is also a potential security threat from the nuclear material that is still in many of these ships, or in temporary storage on shore — the more so since some classes of nuclear propelled submarine used uranium fuel of 90 per cent enrichment (that is, weapons-grade material).

This is the background to a major international conference on the issue that was held in Vladivostok in September 2002.[1] The gathering also included a conducted tour of the main Far Eastern shipyard 'Zvezda', situated across Peter the Great Bay from Vladivostok. It was very clear from the thrust of many of the papers, and the nature of some of the activities, that the conference was only partly intended to review the many problems in nuclear submarine decommissioning and some of the possible solutions. It was also an effort to encourage interest and participation from abroad and, above all, to get financial support. For regional neighbours, the

TABLE 1 Inventory of Nuclear Submarines[3]

	United States	Russia	France	United Kingdom	China	TOTAL
Number built	179	245	12	24	5–6	465–6
Now out of service	100	180	4	15	0	299

possibility of radioactive contamination of the environment from accidents or inappropriate practices is a serious concern. Modelling of the ecological consequences of air or water spills, presented at the conference, shows how the various states might be affected in particular circumstances.[2] The submarines of the Russian Far East Fleet also pose a wider danger through the weapon potential of the spent fuel that is still in many of them, or held in temporary storage on land. This is arguably a global problem.

According to information provided at the conference, Russia has some 75 nuclear submarines in the Far Eastern region that have been withdrawn from service. Of these, around 25 have been partially or completely decommissioned. This is from a complete inventory of 245 submarines that were built during the Cold War period (see Table 1). There is some confusion in the terminology. Strictly, 'decommissioning' would refer to the permanent removal of a vessel from service. However, the term is used more generally to refer to a sequence of operations, the end point of which is the safe storage or disposal of dangerous material and the scrapping and recycling (where possible) of the rest of the hull and fittings. This is the sense in which the expression is used in this article.

A partly dismantled submarine with casing plates removed

Nuclear propelled submarines present particular problems when they come to the end of their operational lives. The highly reactive spent fuel has to be removed, and once it is removed it needs to be treated and safely disposed of. There are also special treatment problems with regard to residual radioactivity in the nuclear reactor and surrounding structures. For the most part technologies are available to address these problems and the United States is using them. In the case of Russia the matter is not so simple. Infrastructure is so degraded and money so short that what should be done is not being done and Russia's submarine fleets (both Far Eastern and Northern) present a growing and pressing problem.

Complex operation

The decommissioning of a nuclear-propelled submarine is a complex operation. If it also has nuclear weapons, these, of course, will be removed at an early stage. In the context, this is a relatively straightforward process, although the fissile material from the warhead needs secure storage once it is removed from the warhead. The proliferation danger from this material has long been recognised and there are now well-established mechanisms for its ultimate destruction. For the most part, the uranium-235 and plutonium-239 recovered from warhead 'pits' is being blended down and burnt in power reactors.

The major steps in decommissioning nuclear submarines concern the reactor (or reactors),[4] the reactor compartment and the disposal of various grades of nuclear waste that will have been produced. After as many as seven years in the reactor, the spent fuel will have become extremely radioactive, through the accumulation of fission products. It needs to be removed and held in a shielded environment while it cools, though this need will be less pressing if the reactor has been shut down for some years before the spent fuel is removed. Similarly, the reactors and the compartment in which they are installed will have become very radioactive through intense neutron bombardment over their service life. Because of this, they cannot be simply treated as scrap.

The solution adopted by Russia (and also by the United States in the decommissioning of its submarines) is to cut out as one block the reactor compartment, together with the two compartments on either side. In the case of the Pacific nuclear fleet, these are then sealed and left floating by the dockside to await a more permanent solution. In the United States the three-compartment blocks are transported from the Puget Sound naval shipyard to the Hanford nuclear facility (also in Washington state) and given a shallow burial. In the Russian Far East there are plans to store reactor-compartment sections on a specially constructed dry land storage platform at Chazma Bay, a little to the south of Zvezda. Ultimately, they may be buried (as in the United States) but no site has been designated for this and really there is no money available for the purpose (or for the Chazma Bay project, either, for that matter).

Many bottlenecks

The ultimate destination for the spent fuel removed from the nuclear submarines of the Russian Far Eastern Fleet is Mayak in western Russia, some five or six days away on the trans-Siberian railway. This is only one of the many bottlenecks holding up submarine decommissioning. There is presently only one set of rolling stock to transport spent fuel to Mayak from both the Northern and Far East fleets. In the case of the latter, there is also a problem with the railway line that connects the Zvezda Yard (where a new on-shore refuelling facility has been built) and the other sites where spent fuel is removed or held to the nearest point on the trans-Siberian railway. This is some 55 kilometres away. The result of all this is that the removed spent fuel cannot be got away and, since local storage capacity is full, no more de-fuelling can be undertaken.

Decommissioning nuclear submarines also produces nuclear contaminated liquid wastes. The intensity of radiation here is low but the material still needs appropriate disposal. Earlier Russian practice was to put this material in drums and drop it in a deep part of the Sea of Japan. After a 1993 episode, Japan provided a special barge to concentrate such wastes and prepare them for disposal on land. Sea dumping is in any case now forbidden

under the 1972 London Dumping Convention. However, no land disposal site for low-level nuclear wastes is available in the Russian Far East region, so that there is now an accumulation of such material. This constitutes yet another bottleneck in the process of submarine decommissioning, and it may be why a Japanese spokesman at the conference expressed 'disappointment' at the slow rate of progress since the barge (as part of a US$200 million package) was provided.

This is by no means the full range of problems. Only Russian submarines of the first and second generations are being dealt with at present (when money and capacity permit) and then only those that can be got to the Zvezda Yard. There are vessels in other locations in the Russian Far East (for example, at Avachinskaya Inlet on the Kamchatka peninsula) and many of these are in no state even to be towed. Indeed, some have 'lost buoyancy' altogether (they are sinking), others are in very shallow water (they are beached), and others again are being held up by pontoons. In some cases sufficient buoyancy may be achieved by injecting a special foam into the tanks so that they can be towed. There is also the possibility of de-fuelling using a nuclear submarine support vessel — the way the Soviet (now Russian) fleet was maintained in service (with refuelling to follow). But it still leaves the rest of the decommissioning process to be completed.

Radioactive problem

Earlier vessels involved in this activity are now also part of the problem, in their own right. Years of receiving spent fuel have made them significantly radioactive. To merely cut them up would be to produce a very large amount of low-level radioactive waste that would need to be disposed of. Other techniques are being investigated. Amongst these is a procedure that entails spray-coating the inner surfaces of the ship with a special polymer, which is then treated to 'lift-off' contamination. There are presently two former nuclear submarine service vessels that need this kind of decommissioning.

There is yet a further problem looming with the decommissioning of some of the later generations of nuclear submarine; and this is due to the extremely high enrichment levels in the fuel. Most nuclear submarines have operated with reactors that took fuel rods containing 20–45 per cent U-235 (compared with the 3–5 per cent enrichment of a typical civilian power reactor). This allows for a more compact power reactor and longer periods between refuelling, but it means that the concentration of radionuclides in the spent fuel is higher and thus that the problems for those dealing with the material are much greater.

A platform for the temporary storage of submarine reactor compartments in Primorski Krai

Despite this, with appropriate techniques, spent fuel can be safely handled in these cases. However, some of the later Soviet-designed submarines have fuel of 90 per cent enrichment (a level never used in US ships). In relation to this, one of the speakers at the conference estimated that, using present procedures, a decommissioning worker would receive his maximum annual permitted radiation exposure within four minutes. This suggests that new methods will be needed to decommission this class of vessels, or that the vessels will need to be left to 'cool' for a very long time; either way will be very expensive.

Special problems

There are also special problems with some of the older generations of submarines. In some cases there is damage to the reactor which will impede or prevent conventional decommission methods. In other instances, there have been accidents during the actual de-fuelling process. All of these irregular situations will require special treatment, which will no doubt cost a great deal. Russia also has a fleet of eight nuclear propelled icebreakers that will ultimately come up for decommissioning, adding to the overall burden of material to be treated and safely disposed of.

There is some very modest potential for the sale of metals and other materials that may be recycled from the decommissioning of Russia's nuclear submarines. But this income will be trivial compared with the enormous cost, put by several speakers at the conference at around US$3.8 billion, of implementing the programme immediately in hand. Since there seems little likelihood that Russia will be able to provide the funds for this, only a significant and sustained contribution from the rest of the world will ensure that it goes ahead.

Of course, they are Russia's submarines. Russia (or, at least, the Soviet Union) built them and (it might be said) it is its responsibility to deal with them. On the other hand, neighbouring states have a clear interest in heading off what could be a serious environmental problem if it is not dealt with appropriately. In light of the security threat that would be posed by spent fuel from highly enriched uranium fuel rods that was not adequately safeguarded, it may be that the wider world community has an interest in providing for its safe storage and removal.

NOTES

1. Ecological problems in nuclear submarines decommissioning and nuclear power industry development in the region' (ECOFLOT 2002), Vladivostok, Russia, 16–20 Sep 2002.
2. For example, by Vladimir Novikov of the International Institute of Applied Systems Analysis (IIASA) in Austria.
3. Data taken from Susanne Kopke, 'Nuclear Submarine Decommissioning and Related Problems', Bonn International Center for Conversion, Aug 1997.
4. Most Russian nuclear submarines are equipped with a pair of nuclear reactors. American practice is to use only one.