

Commentary

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A well-known Canadian nuclear scientist, now working for the International Atomic Energy Agency in Vienna, recently flagged "nuclear submarines" and "small modular nuclear reactors for isolated communities" as ideal applications of nuclear power.

Yes nuclear submarines are indeed an "ideal" application of nuclear power — the main, if not the only rationale for such submarines, being to carry enough nuclear warheads to destroy every major city in the Northern Hemisphere if so desired. What a wonderful and uplifting application of science and technology. Where would we be were it not for the "security" of multilaterally assured nuclear annihilation? In large part, this "security" is provided by the boon of nuclear submarines.

Let's not mention the radioactive hulks of defunct submarines that are left behind, and the endlessly perplexing decommissioning problems associated with the radioactive carcasses of these behemoths. As with all facilities having nuclear reactors — including SMNRs (Small Modular Nuclear Reactors) — building a nuclear submarine is a lot easier than taking it apart and storing the wastes for eternity. The core of the reactor is millions of times more radioactive after use than during installation. The structures themselves have become intensely radioactive, so long-lived radioactive waste remains behind even after (and if !!) the cores have been "safely" transported off-site.

Jobs for nuclear scientists for eternity? Future careers in the nuclear field guaranteed forever? Or permanent ad hoc abandoned nuclear waste repositories littering the landscape of Canada from sea to sea to sea, in hundreds of isolated communities?

Perpetual Sources of Radioactive Pollution of Ocean Water

"A total of nine [nuclear submarines](#) have sunk as a consequence of either accident or extensive damage. The [United States Navy](#) (USN) has lost two boats while five were lost in the [Soviet Navy](#) (one of which sank twice), and two from the [Russian Navy](#). Only three were lost with all hands: two from the United States Navy (129 and 99 lives lost) and one from the Russian

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Navy (118 lives lost), accounting for the three largest losses of life in a submarine. All sank as a result of accident except for *K-27*, which was scuttled in the *Kara Sea* when proper decommissioning was considered too expensive.” https://en.wikipedia.org/wiki/List_of_sunken_nuclear_submarines

"A Russian government report acknowledged in March 1993, that "during the period of 1965 to 1988 the *Northern Fleet* had dumped four [submarine] reactor compartments with eight reactors (three containing damaged fuel) in the *Abrosimov Gulf* in 20 to 40 meters of water."^[3] Six other [submarine] compartments, containing nine reactors in all, had also been dumped into the water in the 1960s and 1970s.^[3]"
https://en.wikipedia.org/wiki/Decommissioning_of_Russian_nuclear-powered_vessels

Hundreds of irradiated reactor cores

"From 1950 to 2003, the *Soviet Union* and its major successor state, *Russia*, constructed the largest nuclear-powered navy in the world,^[2] more ships than all other navies combined.^[3] 248 submarines (91 *attack submarines*, 62 *cruise missile submarines*, 91 *ballistic missile submarines* and four research submarines), four *Kirov class battlecruisers*, and a missile test ship,^[1] as well as nine *icebreakers*.^[4] Many were or are powered by two reactors each, bringing the total to 468 reactors.^[4] “

"On 10 August 1985, *control rods* were incorrectly removed from a *Victor* class submarine during defueling at *Chazma Bay* naval yard outside *Vladivostok*, resulting in an explosion, the "release of large amounts of radioactivity", and ten deaths.^[3] In addition to this *Victor*, five other submarines have damaged cores preventing their defueling by normal methods.^[3] “

"In 1995, a *Northern Fleet* submarine based near *Murmansk* nearly suffered a *nuclear meltdown* when power was cut off due to unpaid electricity bills.^{[3][5]} Decommissioned vessels are often left in floating storage until funds can be allocated for their dismantling.^[1] As of November 2001, "up to 40% of the decommissioned submarines have been in floating storage without much maintenance for more than 10 years".^[1]"
https://en.wikipedia.org/wiki/Decommissioning_of_Russian_nuclear-powered_vessels

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See also the March 2015 BBC story, "How Do You Dismantle a Nuclear Submarine":
<http://www.bbc.com/future/story/20150330-where-nuclear-subs-go-to-die>

"At the end of their useful lives the subs essentially become floating nuclear hazards, fizzing with lethal, spent nuclear fuel that's extremely hard to get out. Nuclear navies have to go to extraordinary lengths to cope with their bloated and aging Cold War fleets of hunter-killer & ballistic missile nuclear subs."

"Although the reactor machinery – steam generators, pumps, valves and piping – now contains no enriched uranium, the metals in it are rendered radioactive by decades of neutron bombardment shredding their atoms. So after fuel removal, the sub is towed into dry dock where cutting tools and blowtorches are used to sever the reactor compartment, plus an emptied compartment either side of it, from the submarine's hull. Then thick steel seals are welded to either end. So the canisters are not merely receptacles: they are giant high-pressure steel segments of the nuclear submarine itself..."

Small Modular Nuclear Reactors – Nothing New?

The nuclear submarine propulsion units are among the world's first examples of "small modular nuclear reactors". The ghastly legacy of radioactive junk, pollution and debris from the nuclear submarine fleet should not be repeated on land by deploying hundreds or thousands of SMNRs throughout Canada and the world. The original core of an SMNR may be trucked in or shipped in with relative ease, but the irradiated core will be enormously more difficult to extract and transport off-site, due to extremely high rates of gamma radiation and neutron radiation, and an extraordinarily dangerous inventory of hundreds of human-made radioactive poisons inside the irradiated core. Moreover, the structural materials surrounding the core area will become intensely radioactive due to neutron "activation" and will pose separate radioactive exposure problems during dismantling, packaging and removing, and/or storing the radioactive rubble onsite, thereby creating sources of radioactive pollution throughout the country for many millennia.

See www.ccnr.org/Long-Lived_Activation_Products_Table.pdf

Canadian nuclear power reactors have always used "natural" unenriched uranium fuel. These SMNRs would use enriched uranium fuel, in most

cases much more highly enriched than the fuel for any existing commercial reactors, or plutonium-based fuel, for the fast reactors. The use of plutonium-based or thorium-based “advanced” fuel cycles were forbidden by the Canadian government in the 1970s, yet many of these SMNR designs depend on such advanced fuel cycles. Canadian reactors have always used water (naturally-occurring heavy water) as reactor coolant, yet many SMNR designs would use liquid sodium, or other liquid metals, or highly corrosive molten salts, as coolant. To try to pretend that there is “nothing new” in such developments is disingenuous to say the least.

And why is it that our nuclear scientist friend says there is a "favourable regulatory environment (especially in Canada) for considering non-traditional designs" – as indeed there is! Is it not because the regulator is a complete captive of the industry that it regulates? Is it not because the CNSC Commissioners have never, in their 18 year history, ever denied a licence that was requested? Not even once? Is it not because the Canadian nuclear industry is the creation of the Government of Canada, and that the CNSC reports to the Minister of Natural Resources, who is the primary champion at the federal level for developing and deploying SMNRs in Canada? Is it not because CNSC staff are doing everything they can to have these SMNRs exempted from fully public environmental assessments with independent panels? A favourable regulatory environment indeed!

The observations made by Gregory Jaczko, former Chairman of the US Nuclear Regulatory Commission, about the lack of balanced considerations in the American regulatory agency and the near-total co-option of the regulatory mindset by the nuclear industry are even more applicable, in my experience, to the Canadian situation: see <https://bit.ly/2SYmSjQ>

It is time for Canadian scientists to wake up and realize that the wrongs perpetrated for the sake of promoting nuclear power & nuclear weapons will continue to undermine the positive, humanitarian and conscientious public image of science and technology that we would all like to see promoted.

Gordon Edwards.