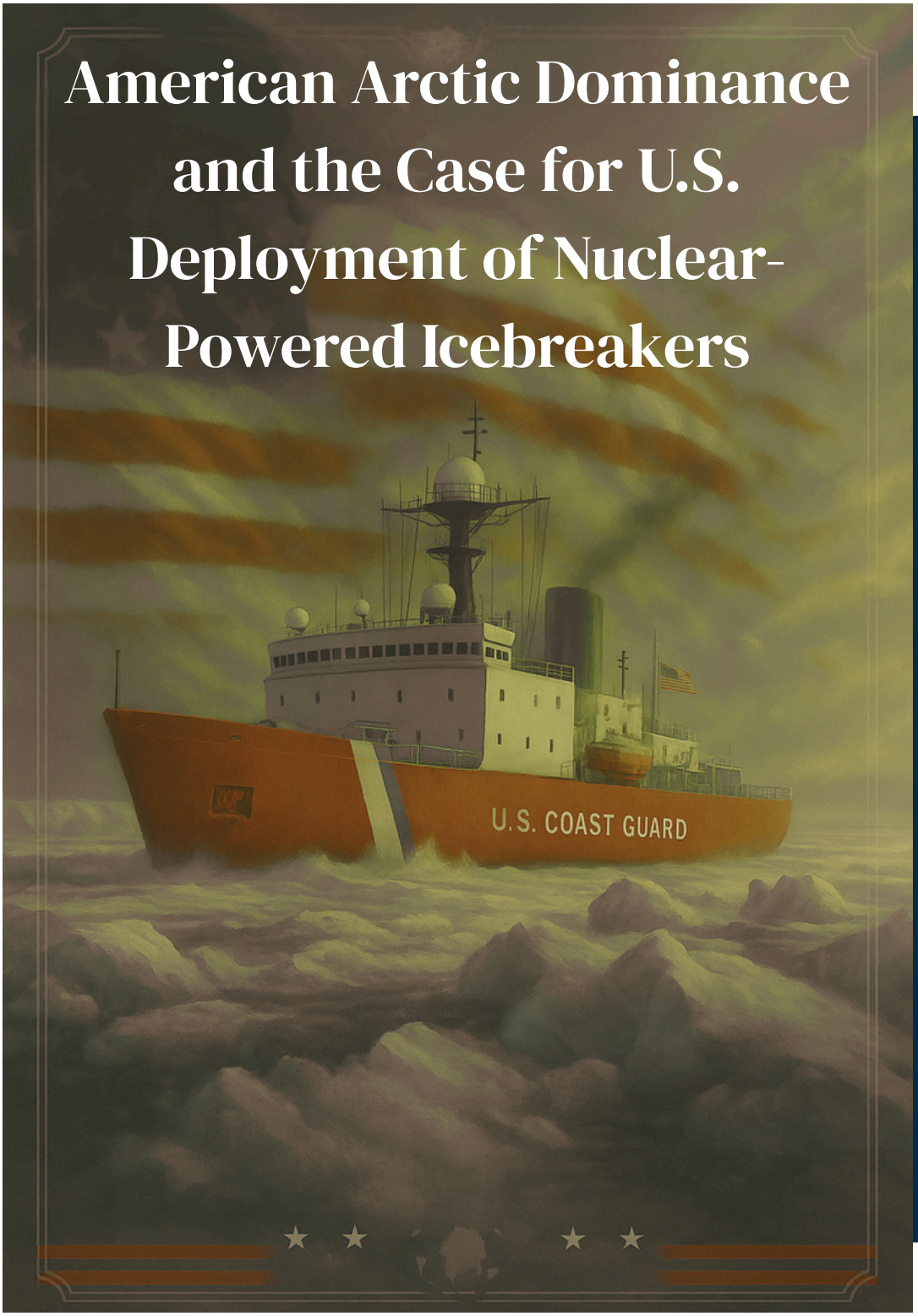
Lightbridge

White Paper

American Arctic Dominance and the Case for U.S. Deployment of Nuclear-Powered Icebreakers



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About Lightbridge

Lightbridge Corporation (NASDAQ: LTBR) is focused on developing advanced nuclear fuel technology essential for delivering abundant, zero-emission, clean energy and providing energy security to the world. The Company is developing Lightbridge Fuel™, a proprietary next-generation nuclear fuel technology for existing light water reactors and pressurized heavy water reactors, significantly enhancing reactor safety, economics, and proliferation resistance. The Company is also developing Lightbridge Fuel for new small modular reactors (SMRs) to bring the same benefits plus load-following with renewables on a zero-carbon electric grid.

Lightbridge has entered into two long-term framework agreements with Battelle Energy Alliance, LLC, the United States Department of Energy's (DOE) operating contractor for Idaho National Laboratory (INL), the United States' lead nuclear energy research and development laboratory. DOE's Gateway for Accelerated Innovation in Nuclear (GAIN) program has twice awarded Lightbridge to support the development of Lightbridge Fuel over the past several years. Lightbridge is participating in two university-led studies through the DOE Nuclear Energy University Program at Massachusetts Institute of Technology and Texas A&M University. An extensive worldwide patent portfolio backs Lightbridge's innovative fuel technology. Lightbridge is included in the Russell 2000® Index and the Russell 3000® Index. For more information, please visit www.ltbridge.com.

Lightbridge surrogate rods used for a thermal-hydraulic flow experiment

Executive Summary

The United States faces a rapidly escalating strategic vulnerability in the Arctic—one that threatens our ability to access, secure, and protect critical shipping routes and mineral-rich territories. Unlike the U.S., our adversaries have operational and planned fleets of nuclear-powered icebreakers that enable a persistent year-round presence and dominance in this geopolitically vital region. In contrast, the U.S. currently lacks even a single nuclear-powered icebreaker, placing us at a serious disadvantage. In some cases, this gap could mean that non-allied nations gain exclusive access to areas the U.S. may be unable to reach at all, jeopardizing national security, economic interests, and energy independence. With the Arctic's role expanding as a frontier for global commerce, strategic resource extraction, and military positioning, American leadership must include the development and deployment of nuclear-powered icebreakers to ensure we are not outpaced, outmaneuvered, or outmatched in this critical theater.

Strategic Gap between the U.S. and Our Adversaries

The Arctic is a region rapidly growing in geopolitical and economic significance due to receding ice, where new maritime routes are opening, significantly shortening global shipping lanes and offering unprecedented access to vast untapped natural resources, including oil, gas, and rare earth minerals. Even with receding ice, icebreaker ships are required to keep the Arctic shipping routes and mineral extraction areas open year-round. In particular, nuclear-powered icebreaker ships are required for operation in arctic conditions with the need to break thicker ice and the need for longer deployments than what is practically achievable with conventional icebreaker ships.

Currently, Russia holds a commanding lead with seven nuclear-powered icebreakers in operation and several more under construction, including the massive Project 22220 and Lider-class vessels, which are designed to keep Arctic shipping lanes open year-round. China also has a major program to deploy nuclear-powered icebreaker ships, even though it does not border the Arctic. In stark contrast, the United States has zero nuclear-powered icebreakers, with only two conventionally powered heavy icebreakers in service - one of which, the aging Polar Star, was commissioned in the 1970s. By investing in its own nuclear-powered icebreaker fleet, the U.S. can begin to close this strategic gap, assert its sovereign interests, and prevent potential adversaries from monopolizing critical passages and Arctic resources.

Nuclear-Powered Icebreakers

Nuclear propulsion offers unparalleled endurance and power, allowing icebreakers to operate year-round without the need for constant refueling - an essential capability in the remote and severe Arctic environment. In addition to keeping commercial American shipping lanes open year-round in the Arctic, these vessels can reinforce national security, enable rapid response to emergencies or emerging threats, and support scientific research. Furthermore, the presence of a strong U.S. icebreaker fleet would serve as a visible symbol of commitment to Arctic engagement, strengthening alliances with other Arctic nations and signaling resolve to adversaries. We currently risk a show of weakness where our icebreakers are unable to break through thicker ice that Russian nuclear-powered icebreakers can navigate.

While the U.S. is working to add new conventionally powered icebreaker ships, including contemplating the purchase of such ships from Finland, these ships will be inferior to Russia's nuclear-powered ships. The strategic advantages of nuclear propulsion are well established by the U.S. Navy's nuclear-powered submarines and aircraft carriers and their ability to project ever-present American dominance across the globe. These strategic advantages should also be extended to our nation's icebreaker fleet in the Arctic. The U.S. needs nuclear-powered icebreakers.

Expedited Deployment of U.S. Nuclear-Powered Icebreakers

We believe that a U.S. government program backed by Congressional authorizations and appropriations could develop a U.S. nuclear-powered icebreaker on an accelerated timeline, potentially within three to five years.

Since the U.S. is already working with Finland to develop conventional icebreaker ships, this relationship could be leveraged to allow the U.S. and Finland to develop a nuclear-powered icebreaker ship platform in a timely manner into which the nuclear propulsion system could be inserted. Since reactors designed for submarines and aircraft carriers would not work, due to weight and other restrictions for an icebreaker ship, the propulsion system could be based on a compact reactor, fueled with a variant of Lightbridge Fuel™ using High-Enriched Uranium (HEU). A company like BWXT, that produces nuclear propulsion systems for the U.S. Navy, could produce a compact pressurized water reactor design fueled by a variant of Lightbridge Fuel, within a short timeframe. This combination is expect-

ed to be the fastest and best route to deploying a U.S. nuclear icebreaker for the Arctic region.

Lightbridge Fuel, with its advanced metallic nuclear fuel technology, presents a compelling solution for powering U.S. nuclear-powered icebreakers. In fact, Lightbridge's commercial fuel design was inspired by a proven icebreaker fuel which was specially adapted for use in commercial nuclear power plants using enrichments below 20%. Nuclear fuel based on a similar material alloy composition and using HEU previously operated successfully for over two decades in Russian icebreakers. Unlike traditional uranium dioxide fuel which is used in commercial nuclear power applications, Lightbridge's proprietary metallic fuel is mechanically robust and offers superior performance, including a more durable mechanical construction, better heat transfer capability, and greater power density, enabling reactors to be smaller and to operate longer, more efficiently, and safely under extreme conditions - ideal for the demands of an icebreaker ship in the Arctic environment. Using HEU would reduce the need for frequent refueling, enhancing the operational range and endurance of nuclear icebreakers in remote polar regions.

An expedited deployment program would include the testing and verification of the Lightbridge Fuel variant using HEU within the U.S. National Laboratory system. An expedited timeframe for this testing is supported in part by the existence of and ability to produce Lightbridge Fuel samples using HEU that are similar in enrichment to the required fuel for icebreaker operations. Such samples have already been produced by Idaho National Laboratory (INL) and are slated for testing in INL's Advanced Test Reactor (ATR) beginning in 202[SH1] 5. Dedicated testing of the Lightbridge icebreaker fuel variant materials could additionally be conducted at Oak Ridge National Laboratory's (ORNL) High Flux Isotope Reactor (HFIR). The HFIR's high neutron flux enables accelerated irradiation testing where materials can be exposed to a lifetime's worth of irradiation in a significantly abbreviated time period.

Leadership/Organization

This initiative would require White House leadership. The Coast Guard operates the two conventionally powered icebreaker ships and has no nuclear capabilities, while the Navy operates nuclear-powered aircraft carriers and submarines but has no icebreaker experience. The Navy and Coast Guard could be directed to work together to determine the best manner in which to obtain nuclear-trained personnel for the new ships.

The White House should direct the Departments of Defense and Homeland Security to coordinate this effort.

Conclusions:

Russia and China are leading the U.S. with regard to nuclear icebreakers in the Arctic. This puts the U.S. at a disadvantage with regard to securing access to Arctic shipping routes and access to the region's critical mineral resources. To secure our nations' strategic advantages in the Arctic, the U.S. should embark on an expedited nuclear-powered icebreaker deployment initiative. When the Soviet Union deployed its first nuclear-powered icebreaker ship, it was a proud moment for their nation, and they named the first ship "LENIN." The U.S. should not let this go unchallenged. Our nation should deploy the most powerful icebreaker ships in the world.

Lightbridge

11710 Plaza America Drive
Suite 2000
Reston, Virginia 20190 USA
www.ltbridge.com