that oversees the design and operation of the US Navy nuclear reactors. Therefore, I was interested to read the letter "New Life for Old Naval Reactors" (PHYSICS TODAY, January 2011, page 9) by Dave Dooling. He is correct about naval reactors being compact, proven power plants that are effective for propulsion of military vessels, but there are several problems in reusing them as he suggests. I believe the problems are large enough that a formal study would be a waste of time and money.

Naval reactors are designed for naval shipboard maneuvering, not constant high-power operation. Typical maneuvers may involve long periods of operating the reactor at 10–60% power followed by quick changes to and from 100% power. They do not operate at 100% power for weeks on end as an electrical power plant would. Constant operation would significantly shorten core lifetimes and necessitate more frequent refueling and thus a higher operating cost. The submarine power plant would be too expensive to operate on a basis of dollars per kilowatt hour for a small land facility. The larger aircraft-carrier plants might be less expensive to operate, but by the time they are decommissioned, they have seen 40-plus years of operation. The equipment then is near the end of its life because of neutron embrittlement and thermal cycling fatigue. Extensive and expensive materials testing would be required before further use, and the costs of installing a used power plant could not be justified because of its limited remaining life. Yes, a retired submarine is occasionally used as a prototype training facility in the Navy Nuclear Power Program, but the plant remains part of the ship, and the US Navy retains control.

Naval reactors are compact because they use specially designed fuel elements. Acquisition of the fuel would not be economical, because it is designed and built to withstand high shock loads that might be encountered in combat situations.

The statement that naval reactors could be made operational on a shorter schedule than new reactors could be built isn't realistic considering the necessary licensing, design and performance review, and availability. Decommissioned reactor plants have not been appropriately maintained for operational integrity; reactors that are still powering navy vessels will continue to do so until the ships wear out. Designing and installing a new land-based system that will last 40 years is a much better idea than removing and recycling a 40-year-old system for another 10 to 15 years maximum.

The safe operation that the Navy Nuclear Power Program is known for depends not only on the design of the reactor and plant components but also on the extreme training and high accountability of naval operators. The strict chain of command that the navy uses in operating its reactors is a major reason for the program's excellent nuclear safety record. Using personnel outside that chain of command, even if they are experienced, does not produce the same sense of accountability and oversight. I believe it would be unwise not to use active-duty personnel, and I don't know what the navy's attitude would be toward using its people as Dooling suggests.

Given the excellence achieved by NR engineers and designers, using NR to help design the next generation of nuclear power-generating plants is worth consideration. An NR design might possibly be used to generate hydrogen for fuel cells, but again, not with used reactors. A better idea would be to improve the light-water breeder reactor that NR designed in the early 1970s for the Shippingport Atomic Power Station. That reactor operated from 1977 to 1982 and successfully bred uranium-233 from a thorium-232 blanket. Argonne National Laboratory has issued a white paper on the Th/^{233}U breeder fuel cycle and potential design improvements.[1]

Reference

1. D. Yun, T. K. Kim, T. A. Taiwo, *Th/U-233 Multi-recycle in PWRs*, rep. no. ANL-FCRD-309, US Department of Energy, Washington, DC (11 August 2010).

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Dave Dooling's suggestion for reusing old naval reactors has precedent. I visited the US Air Force Ballistic Missile Early Warning System installation at Thule Air Base in Greenland in the mid 1990s. While there, I was told the diesel-fueled electric generators at the Top Camp radar site had been salvaged from World War II–era submarines. Recycling naval reactors has merit and represents a prudent use of tax dollars.

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Clarifying ozone emission spectra

In my article, "Infrared Radiation and Planetary Temperature" (PHYSICS TODAY, January 2011, page 33), figure 3a displays emission spectra from satellite-borne instruments viewing Earth. The text in the first full paragraph of page 37 that discusses the spike in the ozone feature inadvertently implies that the spike is of stratospheric origin, as is the case for the spike in the carbon dioxide (CO_2) feature. In reality, the spike in the ozone feature arises because ozone has a minimum opacity at that point in the spectrum, and the radiation leading to that feature comes from the ground, not the stratosphere.

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Fixing credit for voltage measurements

In the section that I authored in "Sensing the Ocean" (PHYSICS TODAY, February 2011, page 24), I mistakenly attributed the voltage measurements on the submarine cable between Key West, Florida, and Havana, Cuba, solely to Henry Stommel. Actually, Gunther Wertheim was the first to observe and publish the measurements.[1] He interpreted the voltages in terms of volume transports of the Florida Current. Stommel later published several papers based on Wertheim's and other measurements on the submarine cable.

I am pleased to recognize the foundational role of Wertheim, who recently wrote to me, saying, "At the time I was a graduate student in nuclear physics at Harvard, but obtained one year's worth of a more or less continuous record of that voltage after installing electrodes in the ocean near the Western Union Cable Huts at each end. WHOI [the Woods Hole Oceanographic Institution] provided the stable electrodes[;] Western Union made one of their spare cables available and provided space for the data acquisition, a chart recorder."

Reference

1. G. K. Wertheim, *Trans. Am. Geophys. Union* **35**, 872 (1954).

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Correction

March 2011, page 15—In figure 1, the labels "Shutter 1" and "Shutter 2" should have been reversed. ■

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