

Taiwan's Plan to Dispose of Nuclear Waste in North Korea Stirs Protests, Raises Questions

The announcement in January that the Taiwan Power Co had arranged to ship 200 000 barrels of low-level radioactive waste to North Korea for disposal created an international stir. And no wonder: If completed, the deal would be the first case of a country paying to dispose of its nuclear waste beyond its own borders. News of the venture struck sensitive political nerves across East Asia, and particularly in South Korea, where fears of an environmental disaster on the Korean peninsula led to outraged protestations. Amidst press accounts depicting near-famine conditions in North Korea, officials in Seoul and Taipei lobbied charges and countercharges, while angry anti-nuclear activists burned flags and effigies of Taiwanese leaders.

Although the nationalistic fervor has since abated, concerns continue to be raised regarding the safety, legality and appropriateness of the plan. And beyond the tale of one small country's nuclear waste dilemma looms a saga that has yet to play out.

A commercial deal

Despite the protests, the Taiwanese government has continued to support the venture, calling it "a lawful and appropriate commercial deal." As PHYSICS TODAY went to press, Taipower (as the state-owned utility is known) was completing its application for an export permit from Taiwan's Atomic Energy Council, but no date had been set for the shipment.

The low-level waste (LLW) that Taipower would export is said to consist of sludge from water treatment, protective clothing, cleaning materials and equipment from the company's three nuclear plants. (Definitions of LLW vary, but typically it is radioactive waste that is not high-level waste, transuranic waste, spent fuel or mill tailings; radioactivity can range from small concentrations of transuranics to larger amounts of radionuclides such as cobalt-60, iodine-129 and technetium-99.) According to Chin Shan Lee, a nuclear engineer at Taipower, the company follows the conventional practice of solidifying the waste in concrete and placing it in 200-liter steel drums.

At present, Taipower stores most of its LLW on Lan Yu, a tiny island about 65 km east of the main island's southern

As the furor raised by the Taiwan-North Korea deal illustrates, the technical issues of nuclear waste disposal are inseparable from the social and political concerns.

tip. But Lan Yu's inhabitants, members of the indigenous Yami tribe, have vigorously opposed the waste facility, claiming that the company never informed them of its true nature. Two years ago, Taipower promised to move the waste (about 100 000 barrels) by 2002, but failed to find an alternative site.

Then in mid-1996 came the offer from North Korea: For a cash payment, it would permanently store the waste at an existing facility there. Last fall, Taipower representatives surveyed the site—a converted coal mine 110 km south of Pyongyang and 95 km from the demilitarized zone—and reviewed North Korean reports on the site's hydrology and geology. According to Lee, the facility uses a standard multibarrier approach, with the waste drums stacked in concrete-lined structures, covered with backfill and further shielded by a 200-meter-thick layer of rock. Satisfied with the setup, Taipower signed a contract with North Korea on 11 January, for an initial shipment of 60 000 barrels, with the option to send a total of 200 000 barrels. (The fee of \$1150 per barrel reported in the press has not been confirmed by either party.)

"This is mutually beneficial," asserts Lee. "With our financial assistance, North Korea can improve its facility, and we will have a place to store our waste." Besides, he says, the handling of low-level waste "is a mature technology that can be used safely." Both the transport and storage will conform to national and international safety guidelines, Taipower has said.

But the proposed disposal site has never been inspected by the International Atomic Energy Agency (IAEA) or any other third party, leaving many to wonder if North Korea would have been able to meet the demands of such an involved undertaking. "Usually there is a rigorous screening process for sites that takes into account proximity to people, flooding, rainfall and

dozens of other parameters," explains James Kennedy, a senior project manager in the US Nuclear Regulatory Commission's LLW branch. "You have to demonstrate that the site meets all the criteria—for example, by modeling how the groundwater will behave over at least a 1000-year period." For comparison's sake, the NRC would typically spend about eight man-years and \$1 million or more to review a site for a new LLW disposal facility, which might cost \$50–100 million to construct.

Taipower officials have met with environmental groups to discuss their differences, but opposition continues. Last month, Greenpeace and the Taiwan Environmental Protection Union organized a conference in Taipei on nuclear energy, "to open up public debate among the Taiwanese people," says Anne Dingwall, executive director of Greenpeace China. Even the Yami, who would be only too glad

to see the waste leave Lan Yu, are said to oppose the deal. "They don't want to ship their suffering to the North Korean people," says Greenpeace's Wai Chi Ho. Meanwhile, in South Korea, members of a radical antinuclear group are conducting weekly boating drills, intent on blocking the Taiwanese shipment.

A hot potato

Physicists have also been drawn into the fray. According to Ngee-Pong Chang, who chairs the American Physical Society's Committee on International Scientific Affairs, the issue is under "active consideration" by the committee, as well as by APS's Panel on Public Affairs. "It's a hot potato," Chang admits. "We don't want to take a stand that infuriates Taiwan or Korea. But I hope that APS will make





ENVIRONMENTAL ACTIVISTS demonstrate in front of the Taiwan consulate in Seoul.

an informed statement, rather than hiding our heads in the sand."

In a letter to the presidents of Taiwan's Academia Sinica and North Korea's Academy of Sciences, members of the Association of Korean Physicists in America (AKPA) urged those groups to use their influence to terminate the agreement. "The disposal of radioactive waste must be solely based on scientific considerations and not [on] political or commercial expediency," the letter states. "We take it [as] self-evident that the handling of radioactive waste is the sole responsibility of the nation of its origin."

The principles of the IAEA would seem to support that view. The preamble to the Convention on the Safety of Radioactive Waste Management, now in draft form, states that "radioactive waste should, as far as is compatible with the safe management of such material, be disposed of in the State in which it was generated." But Hans-Friedrich Meyer, an IAEA spokesman, notes that "this is a 'should.' The door is kept open in the draft convention for regional agreements." And beyond a mildly worded expression of concern regarding the Taiwan-North Korea deal, the agency has not involved itself, in part because the two countries are not IAEA member states.

The US response has also been low-key. "We have expressed our concern based on regional sensitivities and have raised the question of whether the safety and environmental aspects of IAEA transboundary movement of nuclear waste will be met," says Alex Burkart, a State Department spokesman. But the US does not oppose such arrangements *per se*, he says, "as long as they're done safely."

Whether or not the deal is legal, is it right? AKPA president Yanglai Cho, a physicist at Argonne National Laboratory, worries about the moral precedent being set. "If we allow this kind of shipment, then poorer countries [may] become the dumping ground for richer countries," he argues.

Physicist Ben Young-Soo Oh of Pennsylvania State University says the AKPA letter was "a statement of conscience. We're really hoping that Taiwan doesn't proceed with the shipment. Clearly, North Korea is not prepared to handle such a quantity of nuclear waste."

Solar Neutrino Observatory Gets New Lease on Life

GALLEX, the gallium solar neutrino experiment at Italy's Gran Sasso National Laboratory in the Apennines east of Rome, was rescued last December, when Italy's National Institute for Nuclear Physics (INFN) agreed to pay the \$4.9 million still owed on the experiment's 30 tons of gallium. Had the funds not been raised by 1 April, all of the gallium would have had to be returned to the supplier, Sulzer AG of Winterthur, Switzerland. Now, instead of being shut down, GALLEX will be upgraded to reduce measurement errors, and there are plans to increase the gallium mass to 100 tons. Experimenters will look for variations in the solar neutrino flux over a full 11-year solar cycle. Renamed the Gallium Neutrino Observatory, or GNO, the experiment is scheduled to begin collecting data in December.

A nuclear dilemma

Taiwan's LLW woes are "the tip of the iceberg," says Jor-Shan Choi, a physicist at Lawrence Livermore National Laboratory who has studied the nuclear energy industry in East Asia. "Low-level waste is really a secondary problem. The primary problem is spent fuel," not just in Taiwan but throughout the region. Asia's nuclear energy industry is booming, with dozens of new reactors under construction or planned in Japan, South Korea, China, Thailand and Indonesia. Even North Korea is set to go nuclear; in 1994, it agreed to dismantle its nuclear weapons program in exchange for two light-water "proliferation-resistant" reactors to be built and paid for by outside nations.

Ultimately, all of these countries will have to decide how to dispose of their nuclear waste—and how to respond to the concerns of local communities and antinuclear groups. Indeed, as these countries become more democratic, public outcry is likely to grow, Choi observes. The solution may lie in a regional compact in which Asian countries agree to deal with their spent fuel problem collectively.

The US also has a stake in this process, says Choi. In terms of energy sources, "What options do these countries have? Do we want them competing with us for natural gas and oil? Whatever they decide to do, it's going to have global implications."

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Measurements of solar neutrinos from proton fusion and other processes at GALLEX, as well as at SAGE (the Russian-American Gallium Experiment, the world's only other gallium neutrino observatory) provided key evidence for a real discrepancy between the measured and predicted flux of solar neutrinos. (See *PHYSICS TODAY*, April 1995, page 19.) Now, several experiments are coming on line to test for neutrino oscillations—which would explain the dearth of solar neutrinos by the metamorphosis of a large fraction of electron neutrinos (the only neutrino flavor produced in the Sun) into other flavors before they are detected on Earth. (See the article by John Bahcall and colleagues, *PHYSICS TODAY*, July 1996, page 30.)

In the next stage of experiments, gallium detectors may not play quite the exciting role they have, admits