NUCLEAR DESALINATION

Thirsting for Solutions

The United Nations estimates that the number of people without access to safe drinking water is 1.1 billion, or nearly one in six persons worldwide. One solution is to draw water from the ocean and remove its salt.

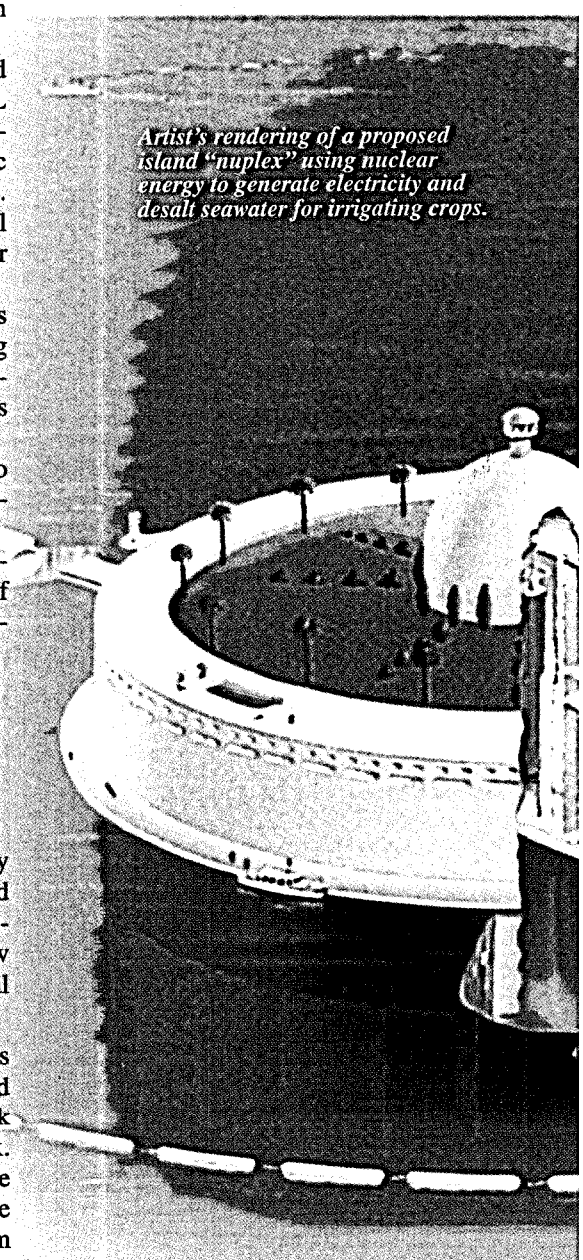
In 1963 ORNL's Philip Hammond promoted the idea that fresh water can be obtained cheaply by desalting seawater using excess heat from large nuclear power plants. ORNL Director Alvin Weinberg—then a member of President Kennedy's Science Advisory Committee—described this method of providing energy and making the "desert bloom" to Atomic Energy Commission and Interior Department officials and obtained project funding for ORNL.

Hammond's concept was featured at a 1964 United Nations Conference on Peaceful Uses of Atomic Energy in Geneva, was supported by President Johnson's 1965 "Water for Peace" program, and is endorsed by the International Atomic Energy Agency.

ORNL researchers contributed to desalination technology in two ways. Hammond's team improved distillation technology, to separate salt from seawater more efficiently using heat from nuclear plants. The group developed enhanced heat-transfer surfaces and processes for multi-stage flash distillation and designed aluminum vertical tube evaporators that were four times more efficient than contemporary models.

Kurt Kraus's team increased the efficiency of reverse osmosis (RO) and adapted it to desalination. In RO, pure water is produced by forcing salt-bearing water through a semi-permeable membrane that prevents salt passage.

RO is used in almost half of today's desalination plants. The heat source for desalination is oil or gas, except for a new plant in Kalpakkam, India, which is coupled to a pair of existing reactors. At least three other nations are developing desalination reactors, suggesting that nuclear desalination may become a major fresh water source.



Artist's rendering of a proposed island "nuplex" using nuclear energy to generate electricity and desalt seawater for irrigating crops.

NUCLEAR NONPROLIFERATION

Reducing the Nuclear Threat

After the Soviet Union was dissolved, its nations had nearly 1300 metric tons of weapons-usable nuclear material under varying degrees of safeguards and security. The U.S. feared that impoverished, unemployed weapons researchers might divert the material to terrorists or rogue nations. In response, the Department of Energy established nuclear nonproliferation programs that sponsor ORNL teams that have

- helped more than 80 Russian facilities secure weapons-usable nuclear materials, upgrade safeguards and security, and improve material accounting systems;
- helped the Russian Ministry of Defense improve weapons-systems security and worked with the U.S. Department of Defense to monitor the dismantlement of Russian weapons delivery systems;
- assisted Russian customs officials in detecting any nuclear materials being smuggled out of the country and provided them with radiation monitoring equipment and training;
- developed technology to verify that highly enriched uranium (HEU) from dismantled weapons has been blended down in Russian Federation facilities to produce low enriched uranium for use in commercial power plants;
- helped ensure in 1994 that 600 kilograms of HEU were loaded safely and shipped securely from Kazakhstan to the Oak Ridge Y-12 National Security Complex. Later, several hundred kilograms were transferred, with ORNL's help, from the Republic of Georgia to a United Kingdom processing facility. In 2002, an ORNL team worked with experts from DOE's National Nuclear Security Administration, the U.S. Department of State, and the International Atomic Energy Agency to safely remove 50 kg of HEU from a Yugoslavian reactor. The material was transported to Russia for conversion to reactor-grade fuel.

To reduce surplus weapons-grade plutonium from U.S. and Russian reactors, ORNL manages a multi-site effort to fabricate, irradiate, and test plutonium-based mixed-oxide (MOX) fuels for light-water reactors. ORNL manages and conducts research with Russia to develop the technology needed to fabricate MOX fuels for Russian reactors.

ORNL is creating meaningful jobs for former Soviet Union weapons researchers through the commercialization of indigenous technology and reindustrialization efforts.

ORNL's small "swimming-pool" reactor shown to President Eisenhower at UN conference

Alvin Weinberg named ORNL director, a position he held for 18 years

1956

Messenger RNA discovered; first bone marrow transplant demonstrated

Projections by National Academy of Sciences committee of genetic effects of radiation on humans, based on ORNL mouse data

1957

ORNL's first fusion research device (Direct-Current Experiment) built

Determination of permissible levels of radiation for medical uses and of radionuclides in the workplace influenced by ORNL leadership