Potential for New Societal Contributions from the Advanced Test Reactor

John M.Ryskamp, Julie E. Conner,
Fred W. Ingram
(INEL, EG&G Idaho)

TABLE I

ATR Experiment and Isotope Production Fluxes at 250-MW Core Power

Number	Diameter (cm)	Name	Thermal Flux ($cm^{-2}s^{-1}$) (2200 m/s)	Fast Flux ($cm^{-2}m^{-1}$) (>1 MeV)
8	2.22	B	5.75 x 10^{14}	1.85 x 10^{14}
4	3.81	B	2.48 x 10^{14}	0.37 x 10^{14}
14	1.59	H	4.28 x 10^{14}	3.83 x 10^{14}
8	1.59	A	4.82 x 10^{14}	3.83 x 10^{14}
4	1.59	A	4.64 x 10^{14}	5.25 x 10^{14}
4	12.7	I	3.89 x 10^{13}	3.05 x 10^{12}
16	8.26	I	7.71 x 10^{13}	3.01 x 10^{12}
4	3.81	I	1.89 x 10^{13}	0.07 x 10^{13}
7	6.05	FT[a]	8.80 x 10^{14}	1.90 x 10^{14}
2	10.16	FT[a]	8.80 x 10^{14}	1.90 x 10^{14}

[a]Flux traps (nominal flux unperturbed, water-filled loop).

Potential for New Societal Contributions from the Advanced Test Reactor, *John M. Ryskamp, Julie E. Conner, Fred W. Ingram (INEL, EG&G Idaho)*

The mission of the Advanced Test Reactor (ATR) at the Idaho National Engineering Laboratory is to study the effects of intense radiation on materials and fuels and to produce radioisotopes for the U.S. Department of Energy (DOE) for government and commercial applications. Because of reductions in defense spending, four of the nine loop test spaces will become available in 1994. The purpose of this paper is to explore the potential benefits to society from these available neutrons.

The ATR is a 250-MW(thermal) light water reactor with highly enriched uranium in plate-type fuel. Forty fuel elements are arranged in a serpentine pattern, as shown in Fig. 1. The ATR uses a combination of hafnium control drums and shim rods to adjust power and hold flux distortion to a minimum. The different quadrants of the ATR can be operated at significantly different power levels to meet a variety of mission requirements. Irradiation positions are available at various locations throughout the core and beryllium reflector.

Table I summarizes the flux levels at various ATR reflector and loop positions. These fluxes are maintained with a relatively constant axial flux profile throughout cycles that last 35 to 42 days. These neutrons can be used for testing and irradiation programs that support commercial reactor license extension, advanced fuel development, materials effects studies, failure cause/effect studies, coolant chemistry evaluations, prototype testing programs (such as for space), isotope production, and basic research.

Radioisotope production falls into three categories: medical, industrial, and research. An approximate breakdown of radioisotopes produced by DOE includes medical (65%), research (20%), and industrial (15%), with a total product listing of ~1100 variations of isotopes of differing forms and enrichments. Serious shortages of radioisotopes and lack of existing inventories threaten U.S. industrial competitiveness and even more seriously threaten the lives of seriously ill patients requiring treatment from nuclear medicine. Table II shows the current and proposed isotope production at ATR along with the applications that benefit society.

Plutonium-238 is used to support the development of radioisotope thermal-electric generators (RTGs) for deep-space exploration missions. These ^{238}Pu RTGs have supported National Aeronautics and Space Administration (NASA) missions including *Apollo*, *Voyager*, and *Galileo*. Current NASA

TABLE II

Current and Proposed ATR Isotope Production

Isotope	Current Production (Ci/yr)	% of World Need
Ir-192	1.5M	50
Co-60	1.0M	10
Ni-63	250	50

Isotope	Proposed Production (Ci/yr)	Application
Strontium-89	3	Bone Cancer, Pain Relief
Ytterbium-169	120	Cancer Diagnostics
Sulphur-35	600	Bone Disease
Phosphorus-32	5	Leukemia Treatment
Selenium-75	70	Brain Imaging
Iodine-125	500	Diagnostic Imaging
Yttrium-90	25	Liver Cancer
Cadmium-109	0.5	Pediatric Imaging and Environmental Research

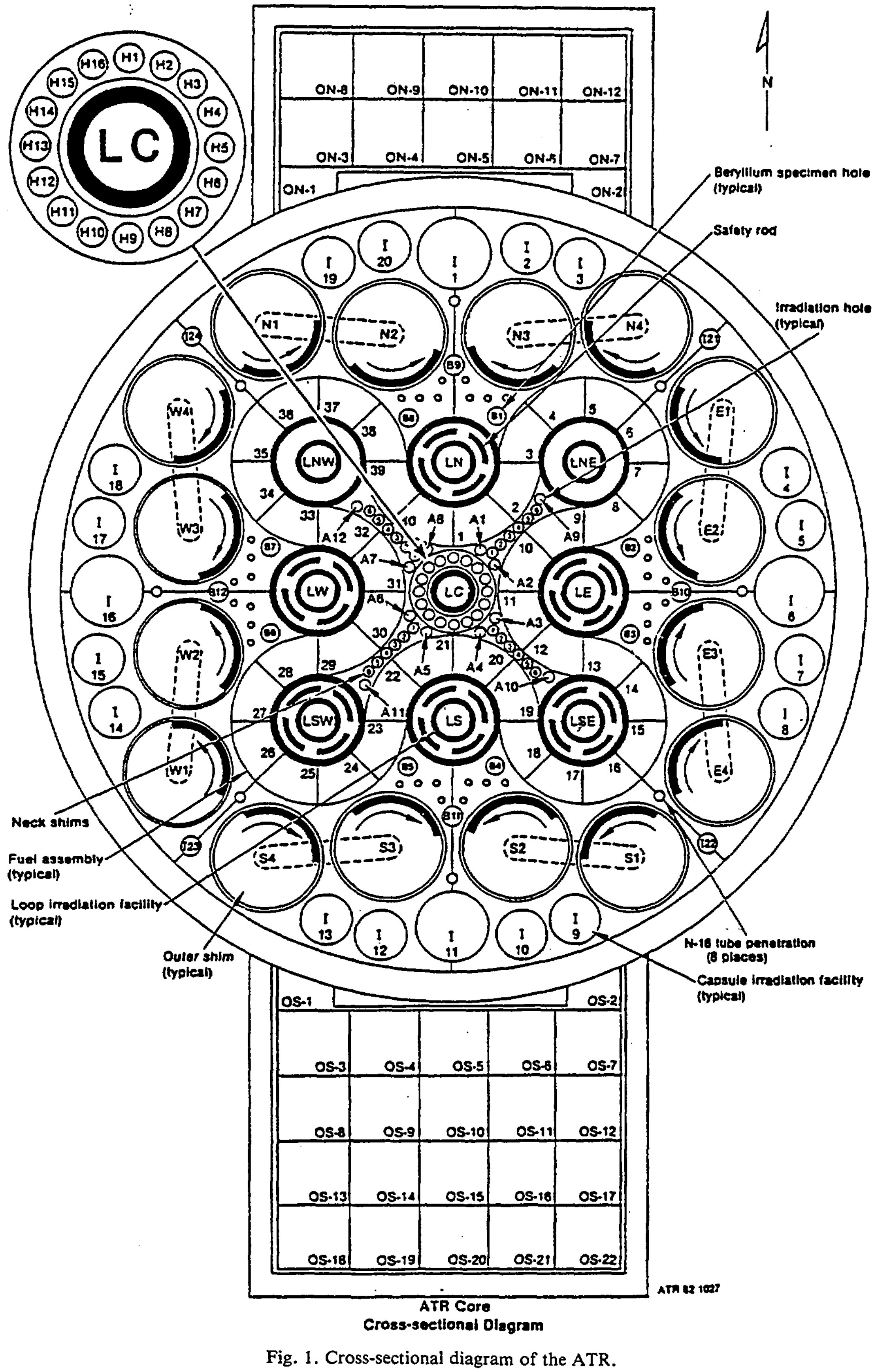

Fig. 1. Cross-sectional diagram of the ATR.

capabilities of ATR in support of ^{238}Pu production. Results of the study indicated that production of up to 13 kg ^{238}Pu/yr in the ATR is feasible.[1]

All nine of the experimental loop facilities are currently composed of pressurized water systems that are independent of the reactor primary coolant. This provides the opportunity for advanced fuel development testing at high neutron flux levels in various flow temperature, pressure, velocity, and chemistry conditions. For example, several types of advanced plutonium-based fuels are under consideration for disposition of weapons-grade plutonium in reactors. Some of these fuel forms will require extensive development programs. The ATR is capable of playing a key role in the development and licensing of these and other fuel types.

In summary, the ATR is a unique, high-power test reactor capable of supporting the current DOE mission and producing radioisotopes. Space available for radioisotope production and fuels or materials testing will increase by 44% in 1994, improving DOE's ability to support national needs in health care, industry, and research.

---

1. B. G. SCHNITZLER, "INEL Advanced Test Reactor Plutonium-238 Production Feasibility Assessment," *Proc. Space Nuclear Power and Propulsion Conf.*, Albuquerque, New Mexico, 1993, Vol. 1, p. 143.