CONF 901057 12

CONF-901057--12

DE91 002653

Invited paper presented at the
Seventh International Conference on
Capture Gamma-Ray Spectroscopy
and Related Topics
Asilomar, California, 14-19 October, 1990

THE ADVANCED NEUTRON SOURCE

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ABSTRACT

The Advanced Neutron Source (ANS) is a new user experimental facility planned to be operational at Oak Ridge in the late 1990's. The centerpiece of the ANS will be a steady-state research reactor of unprecedented thermal neutron flux ($\phi_{th} \approx 8 \times 10^{19}$ m^{-2}. s^{-1}) accompanied by extensive and comprehensive equipment and facilities for neutron-based research.

INTRODUCTION

Many research reactors were designed and built in the 1950's and 1960's, culminating with the high-flux reactors at the Brookhaven National Laboratory (HFBR) and at the Oak Ridge National Laboratory (HFIR) in the United States and at the Institute Laue-Langevin (ILL) in France; all of these reactors offer fluxes of $\approx 1.5 \times 10^{19}$ m^{-2}. s^{-1}. However, while new research reactors have come on-line (or are about to do so) since that time in Western Europe, Japan, the Soviet Union, and elsewhere, it is now about 25 years since the last research reactor was constructed in the United States. The Advanced Neutron Source (ANS) is a new multi-purpose research reactor being designed under the leadership of the Oak Ridge National Laboratory (ORNL), with construction scheduled for the mid-1990's.

THE NEUTRON SOURCE

The ANS reactor is being designed to optimize the flux in a variety of neutron beams, both in the central reactor building and in a series of neutron guides extending out into a guide hall . The reactor is of a coaxial, split core design in which the two halves are axially separated and separately cooled. The reactor volume of 67.4 L contains 18 kg of ^{235}U (93% enriched) in the form of involute plates of U_3Si_2 in an Al matrix. The unperturbed peak thermal flux generated in the reflector is expected to be $\approx 8 \times 10^{19}$ m^{-2}.s^{-1} at a power level of 350 MW. The reactor core is cooled by a heavy water primary coolant loop, with coolant upflow. Safety is a primary concern in the reactor design. The reactor is controlled by four independent control rods in the central core channel, with a second independent shutdown system outside the core. Two liquid deuterium cold sources and one graphite hot source will complement the thermal neutron source provided by the heavy water reflector. In addition, a number of irradiation positions in the reflector tank will support programs for transplutonium and other isotopes production, materials irradiation, and analytical chemistry programs.

RESEARCH FACILITIES

Three user halls are planned for experimental work at the ANS (Fig. 1). The *Ground Floor Beam Room* (Fig. 2) will provide "conventional" access to thermal and hot neutrons via horizontal tubes terminating at the outside of the biological shielding.

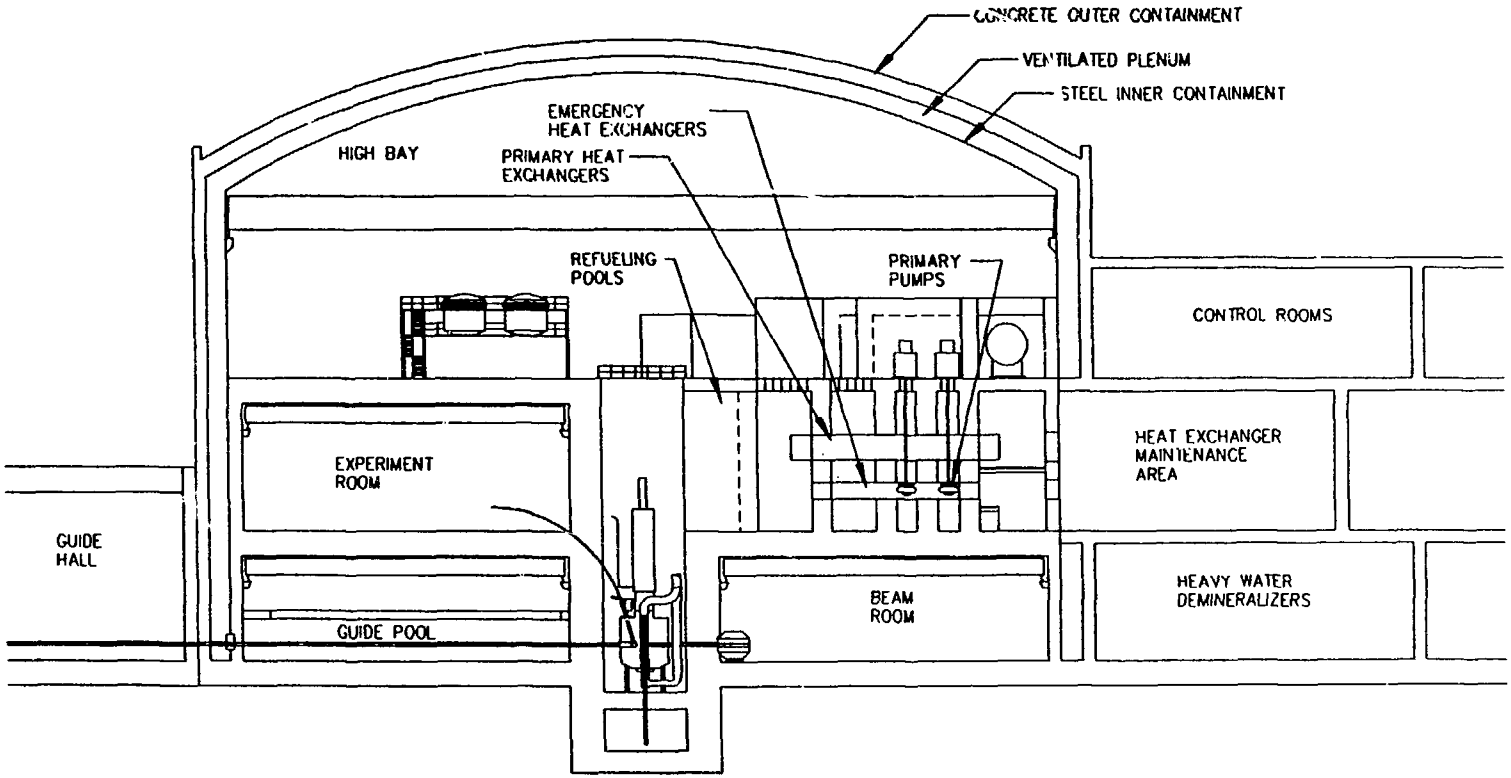

Figure 1. Section through reactor containment building, showing experimental areas.

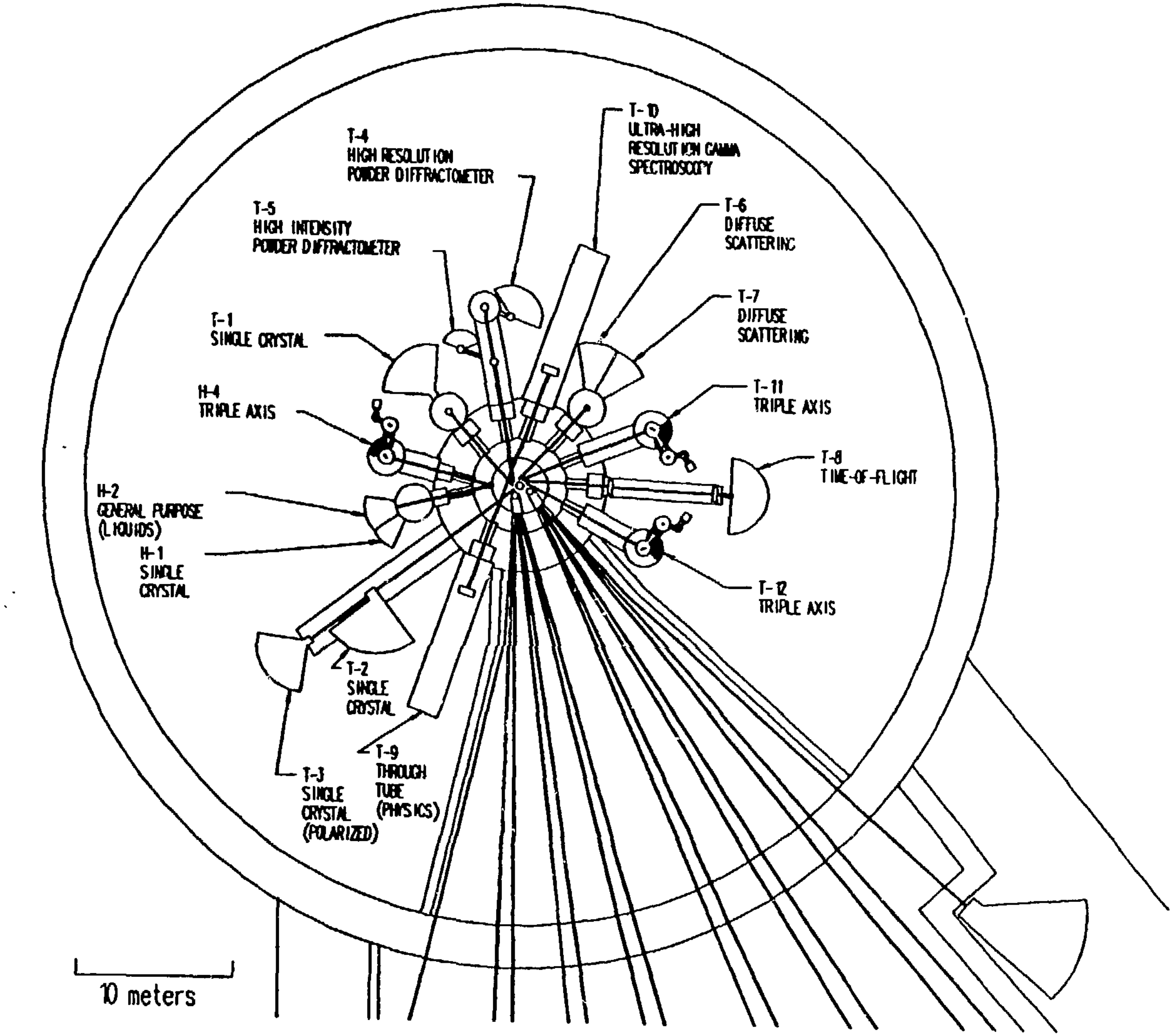

Figure 2. The ground floor beam room.

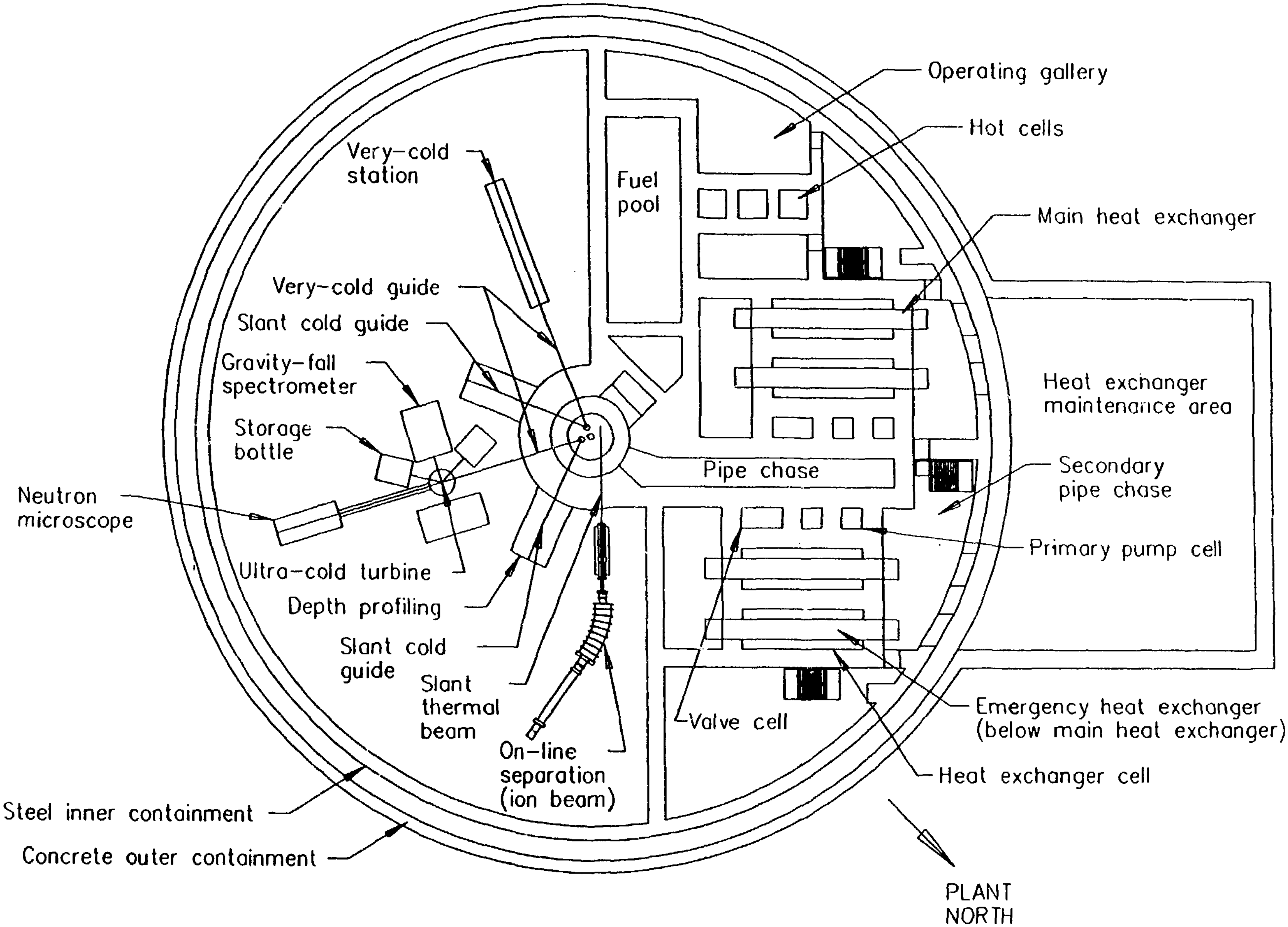

Figure 3. The second floor beam room.

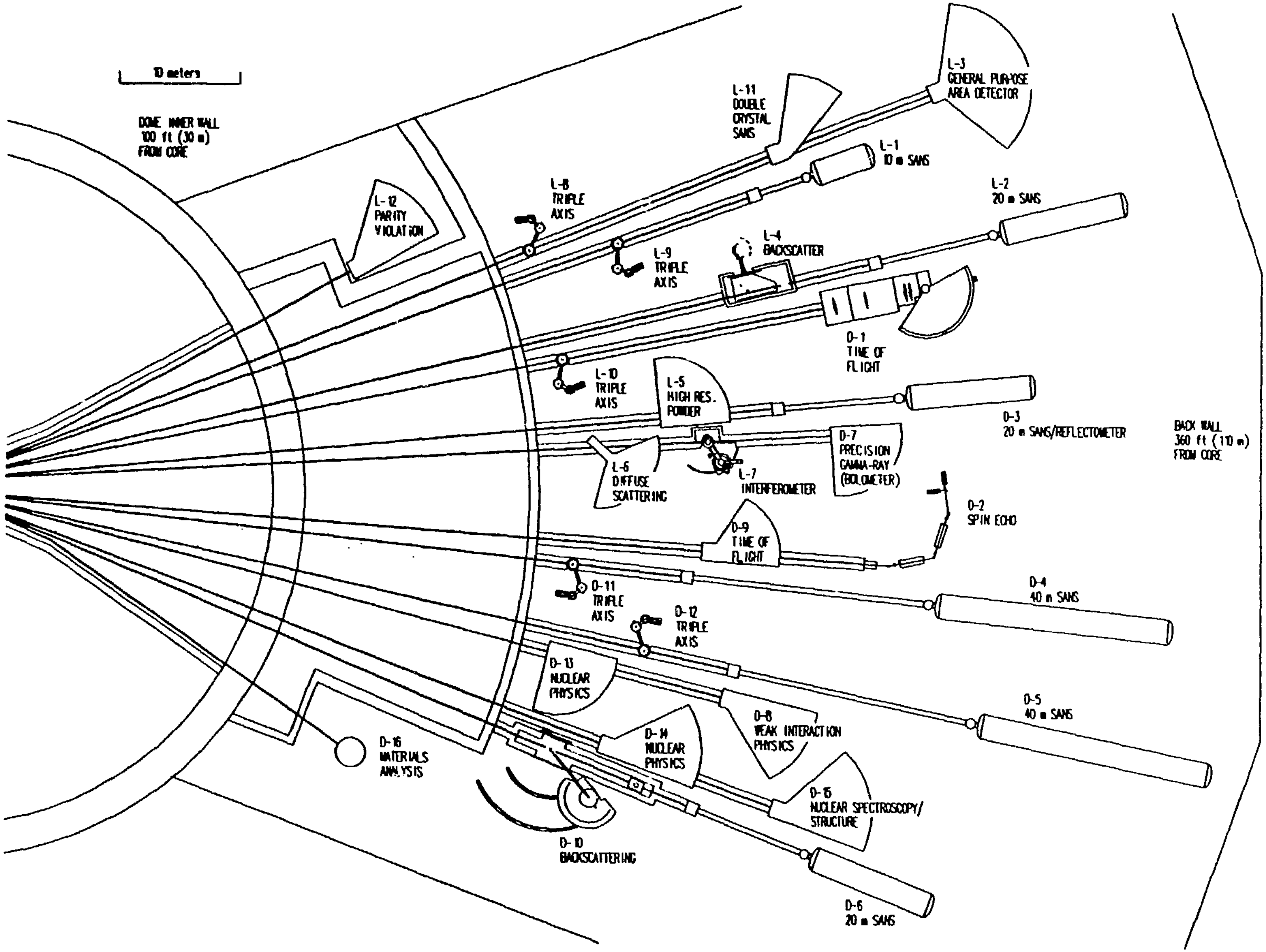

Figure 4. The cold neutron guide hall.

Inclined beams and other services, such as rabbit tubes, will terminate in the *Second Floor Experiment Room* (Fig. 3). Very cold and ultracold neutron research will take place on this level, as well as such activities as neutron depth profiling and some of the fundamental and nuclear physics work including an on-line isotope separator. The third main experimental area is the *Neutron Guide Hall* (Fig. 4), which will provide the primary instrumentation for cool and cold neutron research.

NUCLEAR AND FUNDAMENTAL PHYSICS

Under current plans, most of the facilities in the Ground Floor Beam Room (Fig. 2) will be used for a variety of neutron scattering programs. However, the through tube (with end positions designated T-9 and T-10) is intended for nuclear and fundamental physics use. This tube will be located slightly outside the peak thermal flux resulting in a small reduction in the thermal flux but a significant reduction in the fast neutron and gamma flux. Other access to the thermal flux, as well as very cold and ultracold neutrons, will be provided from the second floor (Fig. 3).

The current layout calls for 14 neutron guides extending into the Neutron Guide Hall (Fig. 4) with seven guides pointing at each of two cold sources. A total of 28 experimental stations are located on these guides. Six stations in the guide hall are currently shown as being dedicated to nuclear and fundamental physics programs. Of these, stations D-8, D-13, D-14, and D-15 are located on "cold" guides pointed at cold source CS-1 (not shown). The fifth station, D-7, is located on a guide pointing at cold source CS-2. Although current plans call for identical cold sources, the guides may be customized as necessary, using Ni or supermirror coatings; straight guides will provide access to all "cool" and "cold" wavelengths. Stations D-7 and D-8 are currently indicated as utilizing polarized neutrons at the ends of the guides. Station L-12 provides a clean, cold, polarized beam to an area intended for the safe handling of liquid hydrogen targets.

Nuclear physicists who study fundamental interactions use a wide variety of techniques and facilities, often combined with other fields. In developing a long range plan for nuclear science, the Nuclear Science Advisory Committee (for the U.S. Department of Energy and the National Science Foundation) has identified the ANS as a facility of major importance for carrying out basic experiments on parity violation, time-reversal violation, and the lifetime, electric dipole moment, and beta-decay angular correlation of the free neutron. A facility capable of providing high fluxes of cold and ultracold neutrons has great potential for advancing the field of both basic and applied radiative neutron capture. These research opportunities will be explored in a series of workshops in the coming years. Input from the physics community is being solicited so that the criteria used for the design will enable the ANS to meet the needs for research programs in the 21st century.

*Operated by Martin Marietta Energy Systems, Inc., under contract DE-AC05-84OR21400 with the U.S. Department of Energy.