TESTIMONY of

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before the
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
of the
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

October 9, 1985

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
Operated by
Martin Marietta Energy Systems, Inc.
for the
U.S. Department of Energy
under Contract No. DE-AC05-84OR21400

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Madam Chairman and Members of the Subcommittee, I am pleased to speak to you today on behalf of Oak Ridge National Laboratory (ORNL) which is operated for the Department of Energy (DOE) by Martin Marietta Energy Systems, Inc. ORNL was extensively involved in space nuclear power technology from the late 1950s through the early 1970s, and much of this technology is useful for the current resurgence of interest in space nuclear power which we strongly support. I also have a personal interest in that I began my professional career in 1962 with the Pratt and Whitney Corporation in the area of space nuclear power — an involvement that I continued at ORNL until the early 1970s.

My brief presentation today will consist of four parts — first, a few introductory comments about space nuclear power technology; second, a description of activities currently underway at Martin Marietta Energy Systems; third, a discussion of future directions at Martin Marietta Energy Systems; and fourth, some recommendations for your consideration.

INTRODUCTION

All space platforms require electric power. Current unmanned platforms require power for transmitting and sensing electromagnetic radiation, computing, and heating and cooling. Reliable power also must be provided for life support systems on manned platforms. Moreover, recent successes in satellite maintenance hint of a broad...
future for using remote technology as well as manned units to operate and maintain complex systems in space.

In general, present space platforms have rather modest power needs, requiring long-term (multiyear) electric power of no greater than about 1 kW and short-term (multiweek) power of no greater than about 10 kW. Future development and utilization of space for advanced civilian and defense purposes will require higher power capabilities. Nowhere is this more evident than in consideration of space-based defensive weapons.

Space-based defense systems will require intermediate-level power sources to support high-resolution sensors, advanced radar, platform control, and secure communications systems. These uses will require continuous power generating capabilities ranging from tens to hundreds of kilowatts. Advanced defensive weapon concepts, including neutral particle beams, electromagnetic rail guns, and space-based lasers, have very large power needs. For these applications, power of one hundred megawatts or more for periods of hundreds to thousands of seconds will be required. In addition to high output, any power system for defense applications must be optimized for the desired deployment strategy, low mass, low volume, reliability, and survivability. The performance and physical requirements of these space platforms point to the need for nuclear power systems. In particular, it appears that nuclear fission power is required to meet long-term power demands of 100 kW or more and to provide repeated bursts of high power (above 1 MW) with specific energy greater than 1 to 2.5 MJ per kg of power system mass. These power systems will require development periods similar to those needed for the weapons that they will power. It is, therefore, important to commit resources now to space nuclear power development commensurate with the efforts on advanced energy weapons.

DESCRIPTION OF CURRENT ACTIVITIES

RTG Technology Support Program

The fabrication and quality assurance capabilities at Oak Ridge
National Laboratory are utilized to provide improved iridium alloy hardware components for encapsulation of radioactive heat source materials and to provide carbon-bonded carbon-fiber (CBCF) insulators which are essential materials for use in isotope heat sources for radioisotope thermoelectric generators (RTGs). This unique laboratory-based production effort includes iridium refining and management activities to ensure the availability of sufficient iridium inventory for future space missions. Recent accomplishments include: (1) delivery in FY 1984 of the last installment of 1900 iridium alloy forming blanks and 220 CBCF insulator sets for the Galileo and Ulysses missions scheduled for launch in May 1986; (2) demonstration of an improved alloy sheet fabrication procedure for reducing the rejection rate by a factor of three, reducing costs by 25%, and providing a higher reliability product with improved impact properties; and (3) development of an improved CBCF process using advanced rayon-base fiber material for a more reliable and uniform product.

The reduction of $7.8 million in the DOE FY-1986 budget for space and special applications threatens the continued availability of this essential production capability. I appreciate the efforts of this subcommittee to restore that budget and hope that the final budget provides sufficient support. The Department of Energy is in agreement with us that the iridium alloy and CBCF production capability should not be sacrificed.

**SP-100 Technology Support Program**

ORNL has assumed a lead role in the development, production, procurement, and characterization of refractory alloys that are required for the very high-temperature space reactor applications. A variety of product forms of alloys based on niobium, tantalum, molybdenum, and tungsten have been procured or produced in unique ORNL fabrication facilities, and characterized extensively in terms of mechanical properties and the effects of irradiation. We have determined that development and demonstration of an adequate total manufacturing capability will be required on a priority basis in order to avoid a high risk of significant schedule delays and cost overruns.
On the basis of an extensive review, ORNL has found that only for selected niobium and tantalum alloys is it possible to build an adequate engineering data base for the ground engineering system (GES) phase beginning in FY 1986.

Multimegawatt Program

Two activities are being performed at ORNL as part of the Strategic Defense Initiative (SDI) multimegawatt space power program. Conceptual designs are being developed for multimegawatt space nuclear power systems -- in particular space nuclear reactors that utilize liquid potassium cooled Rankine cycles for power conversion and flywheels for energy storage. ORNL has also been cooperating with representatives of other national laboratories to assist the DOE Office of Defense Energy Projects and Special Applications in the preparation of a technology development plan for multimegawatt space nuclear power. ORNL has the lead role in the technology areas of materials, shielding, and energy conversion and storage. In FY 1986, we expect to continue conceptual design studies and to function as the lead laboratory for our areas of responsibility.

FUTURE DIRECTIONS

Martin Marietta Energy Systems is firmly committed to the development of space nuclear power. Our close association with Martin Marietta Aerospace provides us with a unique total systems perspective. At Energy Systems, the combination of ORNL facilities and staff with the advanced fabrication capabilities at the Y-12 Plant and the facilities and staff of the Oak Ridge Gaseous Diffusion Plant (K-25) represents the largest concentration of resources available to this effort. The termination of the gas centrifuge development program forces us to move quickly to retain skills and resources for development of flywheel energy storage and leads us to plan to locate more of our space nuclear program activities at the K-25 site. Because of time limitations, I will describe very briefly the following areas where Martin Marietta Energy Systems can best contribute to the national effort:

1. ORNL is one of five organizations competing for the test
site of the SP-100 Ground Engineering System. We believe that our Thorium Uranium Recycle Facility (TURF) is especially appropriate for this test and that we offer key capabilities needed to make the test successful. If ORNL is not chosen as the test site, we will be glad to cooperate fully with the chosen site in the testing program.

2. We have a unique capability to design, build, and operate refractory alloy components and systems cooled by liquid metals. ORNL has more than 100,000 hours of test experience with liquid-metal-cooled/refractory alloy systems operating at very high temperatures and high vacuum. This experience represents a major resource for component development and testing for space nuclear power.

3. We believe that the SDI needs for very high, short-term power can best be met by a steady-state reactor coupled to a flywheel energy storage system. Centrifuge technology provides an opportunity for developing an advanced flywheel energy storage capability on a surprisingly short schedule. We expect to demonstrate a pre-prototype flywheel within the next six months.

4. ORNL has always been the center for space reactor shielding development. As a result of our involvement in the Systems for Nuclear Auxiliary Power program, we have a SNAP 10 reactor which can be used for shield testing at our Tower Shielding Facility.

5. ORNL has traditionally been the leader in reactor control and instrumentation. We have operated the Bulk Shielding Reactor by remote control for many years, and our 100 MW High Flux Isotope Reactor has demonstrated fully automatic control and has had greater than 90% availability during 20 years of operation. In our new work, we are developing distributed control, expert systems, and fiber optic technologies that can be applied to space nuclear power.
6. We continue our expertise in high-temperature structural design which is an obvious need for space reactors. This expertise is currently being applied in support of the fusion program and for the development of advanced jet engines; however, reduction in breeder reactor program activities makes resources available now for space applications.

7. Our work in the 1960s on boiling potassium Rankine space reactors (Medium Power Reactor Experiment) and our more recent work on potassium topping cycles for coal utilization have given us strong capabilities in the area of energy conversion systems involving boiling alkali metals. We are particularly interested in continuing experimental work to prove the viability of the Rankine cycle in the microgravity environment of space. We believe this power conversion cycle offers the lightest and most compact system for closed cycle multimegawatt space power.

RECOMMENDATIONS

I firmly believe that space nuclear power options can be successfully developed to meet the requirements of performance, reliability, and safety. Each year large numbers of experts from the space nuclear power program of the 1960s retire and become unavailable. We must proceed now with a step-by-step commitment to capture and build on existing technology. The power supply for an advanced energy weapon or for high-power surveillance or communication satellites will require as long for development as the end-use technology. Options for power must therefore be developed with priority equal to that for advanced energy weapons. Martin Marietta Energy Systems is committed to contribute substantially to the success of space nuclear power.

This concludes my prepared comments and I want again to express my appreciation for the opportunity to speak today.
Fred Richard Mynatt is Associate Director for Nuclear and Engineering Technologies of Oak Ridge National Laboratory which is operated for the Department of Energy by Martin Marietta Energy Systems, Inc. His area of responsibility includes the Laboratory's civilian nuclear energy programs, nuclear and chemical waste programs, and work for the Department of Defense.

Before his appointment as ORNL Associate Director last year, Dr. Mynatt was Director of the Instrumentation and Controls Division where he was responsible for research, development, and maintenance in the areas of measurement and control sciences. From 1977 to 1981 he was the Director of Nuclear Regulatory Commission Programs at ORNL. In 1979 he coordinated the ORNL assistance provided after the Three Mile Island accident. He was a member of ORNL's Neutron Physics Division from 1971 to 1977, serving as head of the Nuclear Engineering Analysis Section. Dr. Mynatt originally began his work in Oak Ridge in 1965 as a member of the Scientific Applications Department at the Computing Technology Center. He worked at Pratt and Whitney's Connecticut Advanced Nuclear Engineering Laboratory in 1962-63.

Dr. Mynatt's areas of technical expertise include nuclear reactor theory and operation, radiation shielding, reactor safety, and scientific application of large-scale computers.

He received his B.S., M.S., and Ph.D. degrees in Nuclear Engineering from The University of Tennessee, the latter in 1969. He was elected a Fellow of the American Nuclear Society in 1978 and was recognized as an Outstanding Engineering Alumnus by The University of Tennessee in 1980. He received the prestigious E. O. Lawrence award from the Department of Energy in 1981.