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STRATEGIC DEFENSE INITIATIVE*

MASTER

J. P. Nichols

The Engineering Technology Division has a leading role, including that of program management, in a major new programmatic thrust of the Oak Ridge National Laboratory that is in support of the national Strategic Defense Initiative (SDI). We believe that the SDI, a nominally 5-year, \$26 billion program with the objective of determining the scientific and engineering feasibility of strategic defensive technologies, is timely and in the national interest. We also believe that it is appropriate for the Laboratory to become significantly involved in the program because several of the most promising SDI technologies are in areas for which we (together with Y-12 and K-25) have strong capabilities and significant resources. The required research and development program will be long term and risky in nature, but it offers a potentially very high payoff.

Our initial work in support of the SDI program is focused on three technologies in which ORNL has extensive experience and traditionally strong research and development programs: (1) space nuclear power, (2) flywheel energy storage, and (3) neutral particle beams. The space nuclear program will utilize our capabilities in areas such as refractory materials, high-temperature alkali metal systems, shielding, and instrumentation. Space nuclear reactors capable of supplying multimewatt levels of electrical power on a continuous and long-term basis are envisioned to be required for a variety of SDI surveillance satellites and space-borne weapons platforms. We propose to investigate the feasibility of an alkali metal Rankine power conversion cycle, which has promise of providing high power with a very low system mass.

Flywheel energy storage for space applications will build upon successes in the ORNL mechanical energy storage technology program and more than 20 years of experience at K-25 in the development of centrifuges for uranium enrichment. Flywheel technology has high potential for application to rechargeable energy storage systems that would supply pulsed power for SDI weapons systems. We propose to design, fabricate, and test an advanced flywheel rotor with an ultimate energy storage density of 125 Wh/kg, which is double that achieved to date. This would demonstrate that flywheel storage systems can have energy and power densities higher than those of practical battery and fuel cell systems and are competitive with nuclear and chemical systems for pulsed power applications.

The technology for continuous-wave ion sources for neutral particle beams will draw upon our more than 40 years of experience beginning with the development of calutrons and continuing with our program for supplying neutral beam power to fusion energy devices. Neutral particle beam systems for SDI application will require a low-divergence, high-current source of negative ions. We are proposing to design, develop, and test a high-performance, continuous-wave, negative ion source to investigate the practical limits of low-divergence beam sources for application in a space-borne neutral beam generator.

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WE ARE SEEKING A MAJOR ROLE IN THE SDI

- PROGRAM IS IN THE NATIONAL INTEREST
 - ASSESS FEASIBILITY OF STRATEGIC DEFENSE
 - KEEP ABREAST OF SOVIET TECHNOLOGY
- INVOLVES LONG TERM, HIGH RISK, HIGH PAYOFF R&D
- HAS POTENTIAL FOR MANY BENEFICIAL HIGH TECH SPINOFFS
- WE HAVE QUALIFICATIONS AND RESOURCES TO MAKE IMPORTANT CONTRIBUTIONS
- OUR INITIAL FOCUS IS IN THREE AREAS
 - SPACE NUCLEAR POWER
 - FLYWHEEL ENERGY STORAGE/PULSED POWER
 - NEUTRAL BEAM TECHNOLOGY

MARTIN MARIETTA
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BALLISTIC MISSILE DEFENSE — PROBLEMS AND TECHNOLOGIES

OUR WORK FOCUSES ON 3 SDI TECHNOLOGIES

- MULTIMEGAWATT SPACE NUCLEAR POWER
- FLYWHEELS FOR ENERGY STORAGE AND PULSED POWER
- NEUTRAL PARTICLE BEAMS

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NUCLEAR REACTORS ARE THE ONLY PRACTICAL SOURCE FOR
GENERATION OF CONTINUOUS MULTIMEGAWATT
ELECTRICAL POWER IN SPACE

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**THE POTASSIUM RANKINE POWER CONVERSION CYCLE
PROVIDES SIMPLICITY, RELIABILITY, AND LOW MASS**

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BOILING POTASSIUM REACTOR

TECHNICAL DEVELOPMENT OF THE CONCEPT MUST ADDRESS THESE ISSUES

PRIMARY

- ASSURE CONTROLLED HEAT AND MASS TRANSPORT OF POTASSIUM LIQUID AND VAPOR IN ZERO-GRAVITY

SECONDARY

- DEVELOP A DESIGN DATA BASE FOR
 - FUEL AND STRUCTURAL MATERIALS
 - NUCLEONICS AND SHIELDING
 - CONTROLS, INSTRUMENTATION, AND COMMUNICATIONS
 - POWER CONVERSION AND CONDITIONING
 - SURETY (SAFETY, RELIABILITY, AND QUALITY ASSURANCE)

MARTIN MARIETTA HAS THE REQUIRED EXPERIENCE TO APPLY THE BOILING POTASSIUM RANKINE CYCLE FOR SPACE POWER

- ZERO-GRAVITY, TWO-PHASE FLOW TESTS
- BOILER AND RADIATOR CORROSION TESTS (76,000 hours)
- TURBINE PUMP EROSION TESTS (5000 hours)
- POTASSIUM LUBRICATED BEARING TESTS (4500 hours)
- INVENTORY CONTROL TESTS
- STABLE BOILING TESTS IN SIMULATED REACTOR CORES
- UN/T-111 FUEL IRRADIATION TESTS TO 3% BURNUP

**SHORT-TERM, ZERO-GRAVITY EXPERIMENTS WERE CONDUCTED
TO CONFIRM DESIGN METHODS FOR TWO-PHASE FLOW**

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**TESTS OF BOILERS AND RADIATORS SHOWED
NEGLECTIBLE CORROSION PROBLEMS**

BOILER

RADIATOR

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**TESTS OF TURBINE-DRIVEN CENTRIFUGAL
PUMPS SHOWED NEGLIGIBLE EROSION
AFTER 5000 HOURS OPERATION**

**MARTIN MARIETTA HAS PROVIDED MATERIALS
DEVELOPMENT SUPPORT TO SPACE NUCLEAR
POWER PROGRAMS FOR THE PAST 25 YEARS**

**REFRACTORY ALLOY
PROCESSING**

**IRRADIATED MATERIALS TENSILE
AND CREEP TESTING**

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MARTIN MARIETTA HAS PROVIDED MATERIALS
DEVELOPMENT SUPPORT TO SPACE NUCLEAR
POWER PROGRAMS FOR THE PAST
25 YEARS (Cont.)

SPECIALIZED REFRACTORY
ALLOY CREEP TESTING

ALKALI METAL HANDLING
AND MATERIALS
COMPATIBILITY TESTING

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FLYWHEELS ARE A PROMISING POWER SOURCE FOR SPACE WEAPONS

	FIRING TIME (s) AT 100 MW _e	
	STS (30,000 kg)	CLV (100,000 kg)
<u>SPRINT POWER SYSTEM</u>		
<u>PROPELLANT CHARGED, OPEN CYCLE</u>		
• NUCLEAR LH ₂ TURBOALTERNATOR	400–1000	2000–5000
• LH ₂ –LO ₂ TURBOALTERNATOR	200–800	1000–3000
<u>ELECTRICALLY CHARGED</u>		
• FLYWHEEL MOTOR/GENERATOR	100–200	400–800
• REGENERATIVE FUEL CELLS	50–100	200–400

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FLYWHEEL PULSED POWER SYSTEM DEVELOPMENT FOCUSES ON SEVERAL KEY TECHNOLOGY REQUIREMENTS

- COMPOSITE ROTOR DESIGN
- ROTOR FAILURE MODES
- DYNAMIC VIBRATION CONTROL
- HIGH POWER DENSITY IN POWER COMPONENTS
- RAPID DISCHARGE RATE
- SYSTEM RELIABILITY

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THE CENTRIFUGE PLANT DEMONSTRATION FACILITY HAS COMPLETED
2 YEARS OF SUCCESSFUL OPERATION WITH SET III MACHINES

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HIGH ENERGY ROTOR TEST FACILITIES ARE AVAILABLE

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**MAGNETIC-LEVITATION DEMONSTRATION
OF PRINCIPLE-TESTING IS UNDERWAY**

**MAGNETIC-LEVITATION
INSTRUMENTATION AND CONTROLS**

**MAGNETICALLY LEVITATED
HIGH ASPECT RATIO ROTOR**

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WE ARE PROPOSING A MAJOR ROLE IN SUPPORT OF NEUTRAL BEAM DEVELOPMENT

- AN EFFECTIVE DEVICE WOULD PRODUCE A COLLIMATED BEAM OF HYDROGEN ATOMS WITH POWER OF ~ 100 MW, ENERGY OF ~ 100 MeV, AND DIVERGENCE OF ~ 1 MICRORADIAN
- REQUIRES
 - SOURCE OF H^- IONS
 - MULTIPLE STAGES OF ACCELERATION
 - NEUTRALIZATION
- APPLICABLE ORNL EXPERIENCE INCLUDES
 - ION SOURCES FOR ELECTROMAGNETIC SEPARATORS AND ACCELERATORS
 - NEUTRAL BEAM INJECTORS FOR TOKAMAKS
 - HIGHLY COLLIMATED H^- SOURCES

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THE NATIONAL TECHNOLOGY DEVELOPMENT PROGRAM WILL ADDRESS EIGHT PRIMARY ISSUES

- * ION SOURCE AND ELECTROSTATIC ACCELERATOR
 - RADIO FREQUENCY QUADRUPOLE
 - COMPOSITE BEAM DEVELOPMENT
 - DRIFT TUBE LINAC
- * NEUTRALIZER
 - SYSTEMS INTEGRATION
 - BEAM DETECTION, TRACKING AND SIGNATURE DEVELOPMENT
 - AUTOMATION AND RELIABILITY

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**ONLY MARTIN MARIETTA HAS THE CALCULATIONAL TOOLS
NECESSARY TO DESIGN A HIGH PRECISION ION SOURCE
AND ELECTROSTATIC ACCELERATOR**

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BEST AVAILABLE COPY

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**OVER TWO DECADES OF ION SOURCE DEVELOPMENT
HAS BEEN PERFORMED**

HIGH-POWER BEAM TEST FACILITY

BEAM DAMAGED ISOLATION VALVE
(ONE-INCH THICK)

NEUTRAL PARTICLE BEAM INJECTION
SYSTEM

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**NEGATIVE ION RESEARCH IS CONDUCTED
IN A MODIFIED CALUTRON FACILITY**

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WE HAVE PROSPECTS FOR SUBSTANTIAL FUNDING IN FY 1986

	\$, MILLIONS		
	FY 1984	FY 1985	FY 1986
MULTIMEGAWATT SPACE POWER			
NATIONAL PROGRAM PLAN	0.2 ^a		
CONCEPT DEVELOPMENT		0.2	0.5
MATERIALS			3.0
SHIELDING			0.2
ENERGY CONVERSION			2.3
ENERGY STORAGE			0.7
FLYWHEEL DEVELOPMENT		0.9	~2.0
NEUTRAL PARTICLE BEAM	0.4	1.25 0.25 ^a	6.0

^aINTERNAL R&D FUNDS

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IMPORTANT NEAR-TERM TARGETS AND OBJECTIVES (THIS YEAR)

- COORDINATE OUR FY 1985 ACTIVITIES TO MAXIMIZE OUR IMPACT AND VISIBILITY
- PROMOTE ADDITIONAL RESOURCES TO ACHIEVE "EARLY SUCCESSSES"
 - TWO-PHASE FLOW SHUTTLE EXPERIMENT
 - ADVANCED FLYWHEEL ROTOR DEMONSTRATION
 - HIGH-PERFORMANCE ION SOURCE DEMONSTRATION
- ESTABLISH PROCEDURES PERMITTING FULL MARTIN MARIETTA ENERGY SYSTEMS, INC. PARTICIPATION
 - DEVELOP WORKING RELATIONSHIP WITH MARTIN MARIETTA AEROSPACE AND OTHER AEROSPACE FIRMS
 - UNDERSTAND THE DOE/DOD INTERFACE ON SDI FUNDING AND PROGRAM MANAGEMENT

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LONGER TERM GOALS AND OBJECTIVES (2–5 YEARS)

- ESTABLISH CONTINUING TECHNOLOGY DEVELOPMENT PROGRAMS IN:
 - NUCLEAR POWER SYSTEMS
 - BURST POWER SYSTEMS
 - NEUTRAL PARTICLE BEAM SYSTEMS
 - SUPPORTING TECHNOLOGIES (MATERIALS, SHIELDING, INSTRUMENTATION, ETC.)
- DEVELOP INFRASTRUCTURE FOR PROJECT IMPLEMENTATION THROUGH GROUND AND FLIGHT TESTS

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IN CONCLUSION

- WE ARE STARTING A NEW PROGRAM TO SUPPORT THE SDI AS A MAJOR NEW THRUST OF R&D WITHIN ETD AND ORNL
- WE BELIEVE THAT THIS WORK
 - IS IN THE NATIONAL INTEREST
 - IS PROPER FOR US AS A NATIONAL LABORATORY
 - WILL UTILIZE SOME OF OUR STRONGEST CAPABILITIES AND RESOURCES
- OUR INITIAL ACTIVITIES ARE FOCUSED IN THREE AREAS IN WHICH WE CAN MAKE SUBSTANTIAL CONTRIBUTIONS
 - SPACE NUCLEAR POWER
 - FLYWHEEL ENERGY STORAGE/PULSED POWER
 - NEUTRAL BEAM TECHNOLOGY
- WE WELCOME YOUR COMMENTS AND SUGGESTIONS

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