UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 24, 1990

MEMORANDUM FOR: Sheldon A. Schwartz, Deputy Director
Office of Governmental and Public Affairs

FROM: William C. Parler
General Counsel

My conversation with Becker re. Soviet import amounted to this:

If the imports were a model and from technical standpoint could not be made to produce or utilize SNM, then I would think we would not be dealing with a production or utilization facility which must be licensed.

Whether or not the thing to be imported has or does not have such capabilities is a technical not legal call.

William C. Parler
General Counsel

PRELIMINARY PROGRAM

8TH SYMPOSIUM ON SPACE NUCLEAR POWER SYSTEMS

INSTITUTE FOR SPACE NUCLEAR POWER STUDIES
Chemical and Nuclear Engineering Department
The University of New Mexico
Albuquerque, NM 87131
(505) 277-2813, 277-2814

Co-sponsored by:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
- HEADQUARTERS
- LEWIS RESEARCH CENTER

STRATEGIC DEFENSE INITIATIVE ORGANIZATION
UNITED STATES DEPARTMENT OF ENERGY
- ARGONNE NATIONAL LABORATORY
- IDAHO NATIONAL ENGINEERING LABORATORY
- LOS ALAMOS NATIONAL LABORATORY
- SANDIA NATIONAL LABORATORIES

UNITED STATES AIR FORCE
- SPACE TECHNOLOGY CENTER
- WEAPONS LABORATORY
- WRIGHT RESEARCH AND DEVELOPMENT CENTER

In cooperation with:

AMERICAN NUCLEAR SOCIETY
- ANS TRINITY SECTION
- ANS ENVIRONMENTAL SCIENCES DIVISION
- ANS NUCLEAR REACTOR SAFETY DIVISION

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
- HEAT TRANSFER AND ENERGY CONVERSION DIVISION

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
- NUCLEAR ENGINEERING DIVISION
- HEAT TRANSFER DIVISION

ASTM, COMMITTEE E-10 ON NUCLEAR TECHNOLOGY AND APPLICATIONS
INTERNATIONAL ASTRONAUTICAL FEDERATION
NEW MEXICO ACADEMY OF SCIENCE

Industry Affiliates:

BABCOCK & WILCOX COMPANY
GENERAL ELECTRIC COMPANY
ROCKWELL INTERNATIONAL CORPORATION
- ROCKETDYNE DIVISION

WESTINGHOUSE ELECTRIC CORPORATION

Albuquerque Convention Center
Albuquerque, New Mexico
January 6-10, 1991

Exhibitors will show the latest advancements in hardware and product applications for space power systems.

EXHIBITORS

Allied Signal Aerospace Company/
Garrett Fluid Systems Division
Argonne National Laboratory
Auburn University,
Babcock & Wilcox Company
General Atomics
General Dynamics Space Systems
Division
General Electric Company
Grumman Corporation
Idaho National Engineering Laboratory
Jet Propulsion Laboratory
Los Alamos National Laboratory
Mechanical Technology, Inc.
NASA Lewis Research Center
Pacific Northwest Laboratory
Poco Graphite, Inc.
Rockwell International
Corporation/Rocketdyne Division
S-Cubed, A Division of Maxwell
Laboratories
Sandia National Laboratories
Space Power, Inc.
University of New Mexico
Westinghouse Electric Corporation/
Advanced Energy Systems Division

NUCLEAR PROPULSION SHORT COURSE

THURSDAY, FRIDAY, AND SATURDAY
January, 3-5, 1991, 8:00 am - 6:00 pm
Hyatt Regency Hotel, Enchantment Ballroom

Short Course Organizer:

Professor Mohamed S. El-Genk
Institute for Space Nuclear Power Studies
University of New Mexico

Topics to be covered Thursday, January 3, 1991:
Fundamentals of orbital mechanics, nuclear propulsion, reactor design, and radiation shielding considerations.

Topics to be covered Friday, January 4, 1991:
Nuclear propulsion reactor concepts, nuclear fuel systems and materials technology issues, mission analysis, and vehicle integration.

Topics to be covered Saturday, January 5, 1991:
Energy conversion systems (potassium Rankine and Brayton), fundamentals of electric propulsion, thrusters technology, and turbo-pump design and technology.

Registrants will receive a copy of the short course notes. The course fees also include a hosted reception on Friday evening, January 4, 6:30 pm - 8:30 pm and a hosted lunch on Saturday, January 5.

Instructors:

Dr. John Barnett is supervisor of the Electric Propulsion and Plasma Technology Group at the Jet Propulsion Laboratory in Pasadena, California. JPL's Electric Propulsion Laboratory is presently developing ion engines, magnetoplasmadynamic (MPD) thrusters, electron cyclotron resonance (ECR) thrusters, and

arcjets for NASA and DOD sponsors. Dr. Barnett's work over the past 11 years has included the experimental study of MPD thrusters, the development of pulsed coaxial plasma accelerators for radiation production, the study of Soviet electric propulsion, and the evaluation of various electric engines for application to robotic and piloted solar system exploration missions. He holds a U.S. degree in Mechanical Engineering from Rice University, and M.A. and Ph.D. degrees in Mechanical and Aerospace Engineering from Princeton University. Dr. Barnett is a member of the AIAA Electric Propulsion Technical Committee.

Mr. Richard J. Bohl was associated with Rover Program activities from the late 1950s until the program was terminated in 1973. He was the Test Director for the Nuclear Furnace-1 (NF-1) test series. The NF-1 was operated at full power for nearly two hours--that is the longest time at full power for any Rover/NERVA tests. He participated in the test planning and data analysis for most Rover tests. Non-linear, dynamic models were derived and simulated on electric analog and digital computers. He designed the digital flow rate and core outlet temperature controllers used in the NF-1. He is currently the technical project manager for the Thermionic Fuel Element (TFE) Verification Program at Los Alamos National Laboratory. The TFE Verification Program is basically a component development program with a demonstration of a six-cell TFE in EVR-II operating under prototype conditions of a 2-MWe point design. A seven-year lifetime will be demonstrated for all components.

Dr. Stanley K. Borowski works as a research scientist at NASA Lewis Research Center's Advanced Space Analysis Office. His area of specialization is advanced propulsion system design (with particular emphasis on nuclear thermal rocket technology), lunar and Mars mission analysis and spacecraft configurational design. Dr. Borowski received his B. S. and M. S. degrees in nuclear engineering from Pennsylvania State University and his Ph. D. from the University of Michigan also in nuclear engineering. He is a member of the American Institute of Astronautics and Aeronautics (AIAA), the American Nuclear Society (ANS), and the American Physical Society/Division of Plasma Physics (APS). He has worked as a staff scientist at Oak Ridge National Laboratory's Fusion Engineering Design Center in the area of fusion reactor design and performance and also at the Aerojet Propulsion Research Institute in the advanced propulsion systems area. Dr. Borowski will lecture on nuclear thermal rocket (NTR) technology options, their performance potential for both lunar and Mars missions in NASA's Space Exploration Initiative, and on NTR vehicle design considerations.

Dr. Stanley Gunn: Biography was not available at the time of printing.

Mr. Albert J. Juhasz is presently serving as the manager of Lewis Research Center Advanced Thermal Systems projects. In this role he is responsible for the definition, planning, organization, and implementation of multi-agency and multi-center projects, including the development of advanced radiators for SP-100, heat pipe analysis and code development, and design and construction of a heat pipe test facility. After receiving a degree in mechanical engineering from CSU in 1960, he did research in the design, fabrication, and testing of automatic and semi-automatic turret lathes. After his transfer to NASA Lewis Research Center, he performed experiments on gaseous and two-phase boiling, hydrogen heat transfer in support of the NERVA program, gas turbine combustion chamber design and testing, diffuser boundary layer flow control, and combined cycle magnetohydrodynamic power plant analysis. He developed a more energy

PLENARY SESSION IV
SPACE POWER PROGRAMS

MONDAY, January 7, 1991
4:00 pm - 6:00 pm
Upper Level, Convention Center Ballroom

Stephen J. Lanes, Chairman
Deputy Assistant Secretary,
Space and Defense Power Programs
United States Department of Energy
Washington, DC

Richard L. Verga, Co-Chairman
Manager of Power
for Strategic Defense Initiative
Strategic Defense Initiative
Organization
Washington, DC

1. ***Realizing the Dream***
   James A. Turi, United States Department of Energy
2. ***Multimegawatt and Thermionic Space Reactors Programs***
   Wade Carroll, United States Department of Energy and Michael J. Schuller, Weapons Laboratory, USAF
3. ***Planning for the Space Exploration Initiative: The Nuclear Propulsion Option***
   Gary L. Bennett, NASA Headquarters and Thomas J. Miller, NASA Lewis Research Center
4. ***SP-100 Systems and Technology Development Progress***
   J. Sam Armijo, General Electric Company, Astro Space Division

POSTER SESSION

MONDAY, January 7, 1991
9:00 am - 6:30 pm
Upper Level, Convention Center Lobby

Andrew C. Klein, Chairman
Oregon State University
Corvallis, OR

Mark D. Hoover, Co-Chairman
Inhalation Toxicology Research
Institute
Albuquerque, NM

1. ***Scalability of Space Reactor Power Systems in the 10 to 100 kWe Range***
   N. F. Shepard, R. E. Biddiscombe, H. Choe, F. C. Greenwood, A. S. Kirpich, J. D. Stephen, and S. L. Stewart, General Electric Company
2. ***Novel Ceciation Approaches for Thermionic Reactors***
   Elliot B. Kennel and K. Y. Kim, Wright Research and Development Center; and Edward J. Britt and Hyop S. Rhee, Space Power, Inc.
3. ***An Available 6-30 kWe Power System for Lunar Outposts***
   Joseph R. Welch, Lester L. Begg, N. G. Gunther, Space Power, Inc. and Boris ObgJobin, Central Design Bureau, Leningrad, USSR and Nikolai N. Ponomarev-Stepnoi, Kurchatov Institute of Atomic Energy, USSR
4. ***Pu-238 Oxalate Precipitation for Direct Fabrication of General Purpose Heat Sources (GPHS)***
   E. A. Kyser, Westinghouse Savannah River Company

5. ***Procurement of a Fully Licensed Radioisotope Thermoelectric Generator Transportation System***
   Harold E. Adkins, Thomas E. Bearden, and Richard J. Smith, Westinghouse Hanford Company
6. ***An On-Line Information System for Radioisotope Thermal Generator Production***
   Gary R. Kiebel and Michael J. Wiemers, Westinghouse Hanford Company
7. ***Brayton Cycle Conversion and Future French Prospects on Space Nuclear Power Systems***
   Zéphyr P. Tilliette, Jean Delaplace, and Eric Proust, Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, France
8. ***Bubble Membrane Radiator Modeling and Ground Testing***
   Keith A. Pauley, Pacific Northwest Laboratory and Hoenam Al-Baroudi and Andrew C. Klein, Oregon State University
9. ***Water Heat Pipe Ceramic Fabric Wick Experimentation***
   Keith A. Pauley, Zenen I. Antoniak, Matthew Cooper, and James Bates, Pacific Northwest Laboratory
10. ***Pegasus II: A Multi-megawatt Nuclear Electric Propulsion System***
    Keith A. Pauley, Brent J. Webb, and Edmund P. Coomes, Pacific Northwest Laboratory
11. ***Power System Limits to Growth***
    Stephen M. Slater and Andrew C. Klein, Oregon State University and Brent J. Webb and Keith A. Pauley, Pacific Northwest Laboratory
12. ***Handling and Disposal of SP-100 Ground Test Nuclear Fuel and Equipment***
    Charles E. Wilson, Jerry D. Potter, and Richard D. Hodgson, Westinghouse Hanford Company
13. ***SP-100 Reactor Disassembly Remote Handling Test Program***
    Charles E. Wilson, Jerry D. Potter, Glenn E. Maiden, and David P. Vader, Westinghouse Hanford Company
14. ***Testing of SP-100 Reactor Control Approaches in the NAT***
    Sang K. Rhow, General Electric Aerospace
15. ***Methods of Identification of Non-stationary Processes and Diagnostics of the State of Nuclear Power Units based on Perturbation Theory***
    Institute of Physics and Power Engineering, USSR
16. ***Void Control in the Crystallization of Lithium Fluoride***
    Donald A. Jaworske, NASA Lewis Research Center, and W. D. Perry, Auburn University
17. ***Vacuum Thermal Cycle Life Testing of High Temperature Thermal Energy Storage***
    Rengasamy Ponnappan, Universal Energy Systems, Inc. and Jerry E. Beam, USAF Wright Research & Development Center
18. ***Application of the Monolithic Solid-Oxide Fuel Cell to Space Power Systems***
    K. M. Myles and Samit K. Bhattacharyya, Argonne National Laboratory

HIGH SCHOOL SPECIAL SESSION

MONDAY, January 7, 1991
8:15 am - 11:45 am
Cochiti/Taos Room

Irene L. El-Genk, Chairwoman
Education Outreach Committee
Albuquerque, NM

Rose Thome, Co-Chairwoman
Albuquerque, NM

1. ***Welcome and Opening Remarks***
   Barbara Lujar, NASA
2. ***Introduction of Space Design Contest Winners***
   David Kauffman, University of New Mexico
3. ***Mars Exploration***
   To Be Determined
4. ***Space Exploration and Development Spinoffs***
   Steve M. Riddlebaugh, NASA Lewis Research Center
5. ***Soviet and American Students' Questions and Answers on Science and Education***
   Panel of Soviet College and American High School Students
6. ***What Does It Take To Be An Astronaut***
   Franklin Chang-Diaz*, NASA Astronaut

*Invited

UNCLASSIFIED TECHNICAL SESSIONS

[1] SPACE APPLICATIONS/ EXPLORATION

TUESDAY, January 8, 1991
8:00 am - 10:00 am
Taos/Cochiti Room

Gregory Reck, Chairman
NASA Headquarters
Washington, DC

Mel Sverdling, Co-Chairman
TRW, Inc.
Sepulveda, CA

1. ***NASA Mission Planning For Space Nuclear Power***
   Gary L. Bennett and A. Dan Schnyer, National Aeronautics and Space Administration Headquarters
2. ***Summary of Nuclear Propulsion Workshops***
   Thomas J. Miller and John Clark, NASA Lewis Research Center, and John Barnett, Jet Propulsion Laboratory
3. ***The Broad View of Nuclear Technology for Aerospace***
   David Buden, Idaho National Engineering Laboratory, and Joseph A. Angelo, Jr., EG& G, Inc.

4. ***Lunar Mission Design using Nuclear Thermal Rockets***
   Michael L. Stancati and John T. Collins, Science Applications International Corporation and Stanley K. Borowski, NASA Lewis Research Center
5. ***Nuclear Energy Reactor Variants for Energy Supply for Intraorbit Flights***
   Science-Production Cooperation "Krasnaya Zvezda", Kurchatov Institute of Atomic Energy, USSR

[2] SPACE NUCLEAR SAFETY I: ULYSSES SAFETY ANALYSIS & EVALUATION

TUESDAY, January 8, 1991
8:00 am - 10:00 am
Santa Ana/Sandia Room

Joseph A. Sholtis, Jr., Chairman
U. S. Air Force
Kirtland AFB, NM

A. Thomas Clark, Co-Chairman
U. S. Department of Energy
Washington, DC

1. ***GPHS-RTG Launch Accident Analysis for Galileo and Ulysses***
   C. Thomas Bradshaw, General Electric Astro Space Division
2. ***Nuclear Risk Analysis of the Ulysses Mission***
   Bart W. Bartram, R. W. Englehart, and F. R. Vaughan, NUS Corporation
3. ***SRB Burnback Fragment Analysis***
   Marshall B.Eck and M. Mikunda, Fairchild Space Company
4. ***Conduct and Results of the Interagency Nuclear Safety Review Panel's Evaluation of Ulysses***
   Joseph A. Sholtis, Jr., United States Air Force and others
5. ***Uncertainty Analysis for Ulysses Safety Evaluation Report***
   Michael B. Frank, Safety Factor Associates
6. ***Interagency Nuclear Safety Review Panel Power System Subpanel Review for the Ulysses Mission***
   William H. McCulloch, Sandia National Laboratories
7. ***Plutonium Risks for the Ulysses Mission***
   Marvin Goldman, University of California, Davis, Robert Nelson, Idaho National Engineering Laboratory, and others

[3] MATERIALS I

TUESDAY, January 8, 1991
8:00 am - 10:00 am
Picuris Room

Peter J. Ring, Chairman
General Electric Aerospace
San Jose, CA

R. William Buckman, Co-Chairman
Westinghouse Electric Corporation
Pittsburgh, PA

1. ***Short-Term Creep Rupture Predictions for Tantalum Alloy T-111***
   John J. Stephens, Sandia National Laboratories

2. *Effect of Thermomechanical Processing on Microstructure of PWC-11*
Mehmet Uz, LaFayette University

3. *Microstructure and Creep Behavior of an Nb-Zr-C Alloy*
Robert H. Titran, NASA Lewis Research Center

4. *Refractory Metal Alloy Composites*
Toni L. Grobstein, NASA Lewis Research Center

[4] REACTORS AND SHIELDING I

TUESDAY, January 8, 1991
8:00 am - 10:00 am
Acoma Room

H. Sterling Bailey, Chairman
General Electric Aerospace
San Jose, CA

Russell M. Ball, Co-Chairman
Babcock & Wilcox Company
Lynchburg, VA

1. *Nuclear Design of the Least Power Ultra-High Temperature UF_6 Vapor Core Reactor System*
Samer D. Kahook, University of Florida

2. *Studies of PuF_6 and the Transplutonic Material's Critical Properties for Space High Power Pumped Lasers*
Albert G. Gu and Mark S. Miller, Mississippi State University

3. *Analysis of the Results of Calculations and Experiments on Critical Assemblies to Determine the Physical Characteristics of Reactors for Group TVS Experiments*
Kurchatov Institute of Atomic Energy, Moscow, USSR and Institute of Physics and Power Engineering, Obninsk, USSR

4. *Advanced Thermionic Reactor Systems Design Code*
Bryan R. Lewis, Ronald A. Pawlowski, Kevin J. Greek, and Andrew C. Klein, Oregon State University

5. *Reactor and Shield Mass Minimization Models Based on RSMASS Approach*
Albert C. Marshall, Sandia National Laboratories

[5] SPACE MISSIONS AND POWER NEEDS

TUESDAY, January 8, 1991
10:30 am - 12:30 pm
Taos/Cochiti Room

David Buden, Chairman
Idaho National Engineering Laboratory
Idaho Falls, ID

James H. Lee, Jr., Co-Chairman
Strategic Defense Initiative Organization/
Sandia National Laboratory
Washington, DC

1. *Scientific and Terrestrial Benefits of the Space Exploration Initiative*
T. J. Dolan, David M Woodall, J. Negus-Devys, E. H. Ottewitte, J. S. Herring, and David Buden, Idaho National Engineering Laboratory

2. *Exploration Mission Enhancements Possible with Power Beaming*
Judith Ann Bamberger and Edmund P. Coomes, Pacific Northwest Laboratory and Donald R. Segna, U. S. Department of Energy

3. *Overview of the Power Requirements for a Manned Mars Rover Mission using a Nuclear Reactor Power Source*
Nicholas J. Morley and Mohamed S. El-Genk, University of New Mexico, and Robert Cataldo and Harvey Bloomfield, NASA Lewis Research Center

4. *Lunar Rover Powered by SP-100 Laser Diode Array*
Russell J. DeYoung, M.D. Williams, G.H Walker, Gary L. Schuster, and J. H. Lee, Jr., NASA Langley Research Center

5. *Nuclear Fission Applications for Space Exploration*
John Martinell, Jim Lake, and Jack Ramstaller, Idaho National Engineering Laboratory

6. *The Energy Propulsion Facility on the Base of the YaEU with Tubular Power Transformer for Providing an Accelerated Expedition to Mars*
Kurchatov Institute of Atomic Energy, Moscow, USSR, Research Institute of Thermal Processes, Moscow, USSR

[6] SPACE NUCLEAR SAFETY II

TUESDAY, January 8, 1991
10:30 am - 12:30 pm
Santa Ana/Sandia Room

Neil W. Brown, Chairman
General Electric Aerospace
San Jose, CA

Brian Wade, Co-Chairman
United Kingdom Atomic Energy
Harwell Laboratory
Oxfordshire, England

1. *DIPS Human Exploration Initiative Safety*
Terry E. Dix, Rockwell International Corporation/Rocketdyne Division

2. *Analysis of the Survivability of Multi-Element Thermionic Power Systems at Various Disruptions of TTE*
Institute of Physics and Power Engineering, Obninsk, USSR

3. *Safety Provisions for the SP-100 Nuclear Assembly Test Article*
Mark I. Temme, General Electric Aerospace

4. *SP-100 Ground Engineering Systems Site Safety Review*
Gary Smith, Westinghouse Hanford Company

5. *Reactor Safety for the Human Exploration Initiative Planetary Systems*
Terry E. Dix, Rockwell International Corporation/Rocketdyne Division