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PROGRESS REPORT FOR
SNAP SUPPORTING R & D
JANUARY-MARCH 1962
(Title Unclassified)

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PROGRESS REPORT FOR
SNAP SUPPORTING R & D
JANUARY-MARCH 1962
(Title Unclassified)

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DATE 10/23/67

For The Atomic Energy Commission

W. H. Connelley
Chief, Declassification Branch

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NAA-SR-6996 October-December 1961

Issued: February 15, 1962

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PROJECT ENGINEER'S QUARTERLY REPORT

Program: SNAP Supporting R & D
 Project Engineer: W. J. Roberts
 Reporting Period: January-March 1962

I. PROJECT OBJECTIVES

The objective of the Supporting Research and Development Program is to give basic and general assistance to the SNAP programs under development and to supply the information necessary for their successful application. In this respect, basic work is under way in developing mathematical techniques appropriate to compact nuclear power systems for reactor core and shielding calculations. These mathematical techniques are augmented by experiments to determine the validity of the methods and to furnish basic data to the calculations. Advanced studies are in progress to insure that full use is made of SNAP technology and that applications of SNAP reactors in space are determined in order to ascertain where more detailed work in development areas must be initiated. To aid in extending the knowledge to higher powered and more efficient power systems, work is under way in developing thermionic power converters and in utilizing this technology in the design power systems to be used in space applications.

II. PROJECT ENGINEER'S SUMMARY EVALUATION OF PROGRESS TO DATE

A study of the applications of SNAP 2, 8, and 10 prepared under subcontract by the Sigma Corporation was completed.

The Shield Test Facility (STF) was activated. Low-power experiments were completed and the reactor was brought to power and calibrated. The fission plate was fabricated, installed, and calibrated. Its power at 50 kw reactor thermal power is 60 ± 3 watts.

Construction was begun on Building 012, the SNAP Critical Facility. Construction is about 80% complete.

Optimum spacing was found to occur in thermionic diodes for emitter temperatures below 1500°C but not for higher temperatures. Nb and Ir have been added to the materials being investigated under electrode performance studies. Studies of the effects of auxiliary discharges by use of a third electrode in a converter have been made. There is no evidence of improved performance above 1300°C from auxiliary discharges. The maximum benefit from the third electrode was a 13.5% gain in output power relative to diode operation at temperatures just below 1300°C .

Monte Carlo calculational approaches for SNAP shield geometries were made operational with the completion of LEMON, a generalized source and shield geometry code, and the ORANGE-AID and ORANGE codes. ORANGE-AID supplies a source to ORANGE. ORANGE handles concentric cone shield designs. LEMON handles more general quadratic surfaces of revolution.

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GE shielding codes 14-0, 14-1, 14-2, 14-3, FMC-N, and FMC-G were adapted to the Rocketdyne 7090 system and were turned over to SNAP 2/10A project.

The NDA code NIOBE was adapted to the Rocketdyne 7090, cross-sections were generated, and the code was put into production use.

MACE, a fast neutron collimator analysis routine, has been completed. The Oak Ridge collimator design has been analyzed and found to be satisfactory. The computed ratio of scattered to direct neutrons at the detector was 1%.

The SCA-3 critical assembly was installed and put into operation.

Noise analysis techniques have been refined and employed to determine B/l for the S2-DR. The measured value was 1277 sec^{-1} in comparison with the calculated value of 1275 sec^{-1} .

A noise analysis of the Shield Test Reactor (STR) was performed at power. A 7 c/s resonance, associated with the coolant pump, disappeared after tightening of the pump packing.

SEER, a Monte Carlo code for calculation of advanced reactor cores, has been completed and is operational.

ULCER, an advanced multigroup one-dimensional diffusion-theory code with provision for handling thermalization phenomena, is operational.

Libraries for 18-, 23-, and 40-group calculations were generated. Analyses of SNAP reactors were undertaken to obtain a comparison of thermalization calculations with AIM (non-thermalization) calculations.

An initial analytical approach to the hydrogen evolution from SNAP cores during transients was formulated and programmed. This kinetics analysis code is SNAPKIN.

A design study of a nuclear space power system with electrical output capabilities from 90 to 150 kw was completed. This system uses a modified SNAP 8 reactor and scaled-up SNAP 8 power-conversion system. Specific weight on the order of 35 lb/kw was predicted for the shielded 150-kw system.

A design study of a global surveillance satellite using a SNAP 8 power source was completed. The entire power system weight for a 5-rem target dose over a 1000-hr life was 6750 lb.

A study has been completed that reviews the applications of SNAP systems to electric propulsion.

A study of the integration of SNAP 2 with a manned space vehicle was made.

Two codes, CROCK and SHOCK, for optimizing the weight of condensing and non-condensing space radiators were completed.

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PROJECT ENGINEER'S QUARTERLY REPORT

The following reports have been issued:

- NAA-SR-5474, "Advanced Nuclear Space Power Systems Briefing for AEC-NASA, July 14, 1960"
- NAA-SR-5650, "Nuclear Space Power Systems"
- NAA-SR-5317, "SNAP 2 Radiative Condenser Analysis"
- NAA-SR-6727, "CROCK and SHOCK: FORTRAN codes for Optimization of Heat Rejection Systems For Space Power Plants"

Under Sigma Corporation subcontract:

- LA-3301, "Applications of Nuclear Power Supplies to Space Systems"
- LA-3302, "An Analysis of the Use of Satellites in Commercial Communications."
- NAA-SR-MEMO-6187, "Application of SNAP 2 to a Manned Space Vehicle"
- NAA-SR-MEMO-6373, "SNAP 8 Power Systems For The Global Surveillance Satellite"
- NAA-SR-MEMO-6735, "Preliminary Safeguards Report Experiment Test Building (019)"
- NAA-SR-7085, "Electrical Propulsion Applications For SNAP Systems"

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QUARTERLY PROJECT PROGRESS REPORT

Program: SNAP Supporting R&D	
Project: Compact Power Systems Analysis	
Responsible Engineer: M. G. Coombs	Project Engineer: W. J. Roberts
Reporting Period: January-March 1962	AEC Category: 04-30-02-40.1
General Order: 7590	Subaccount: 2004

I. PROJECT OBJECTIVES

A continuing need for long-life reliable lightweight power sources exists in the United States space program. As boosters become larger, payloads will demand more power, so that powers into the electrical megawatt region are of interest. Potential electrical propulsion and satellite communications applications will require lower and lower specific weights. This project will investigate logical outgrowths from SNAP 2, 8, and 10A programs with respect to these space objectives. Higher powers will be investigated. Dynamic versus static power-conversion systems will be evaluated. Space applications studies will be made. Mission studies and vehicle integration will be considered.

II. MAJOR ACCOMPLISHMENTS TO DATE

A generalized design procedure for the optimization of space radiator-condensers was published in NAA-SR-5317, "SNAP 2 Radiative Condenser Analyses." The method presented has been programmed and run on a digital computer, and minimum weights have been determined for radiator-condensers over wide ranges of power levels, working fluids, and condensing temperatures. The results obtained were presented in a briefing to representatives of NASA and AEC, the contents of which are summarized in NAA-SR-MEMO-5474, "Advanced Nuclear Space Power Systems Briefing for AEC-NASA, July 14, 1960."

A study was performed by the Sigma Corporation under subcontract to Atomics International on applications of SNAP 2, 8, and 10. A report summarizing this study was in two volumes: LA-3301, "Applications of Nuclear Power Supplies to Space Systems," and LA-3302, "An Analysis of the Use of Satellites in Commercial Communications."

Three papers on SNAP systems were presented to the American Rocket Society Meeting on Space Power Systems and a paper on radiator-condenser analysis was presented to the Winter Annual Meeting of ASME.

A paper entitled "The Practical Applications of Space Nuclear Power in the 1960's" was presented to the International Astronautics Congress.

A paper entitled "The SNAP Reactor Program" was presented to the Nucleonics in Flight Symposium of the American Nuclear Society.

The AI contribution to the ARPA handbook has been published as an AEC topical report, NAA-SR-5650, "Nuclear Space Power Systems." Revisions to cover the SNAP 10A reactor, shielding, and thermionic reactors were also included.

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A study was made of the integration of SNAP 2 in a manned space vehicle and the results summarized in NAA-SR-MEMO-6187. The weight of the power supply for a two-week mission, with 5-rem dose integrated and 50-ft reactor payload separation, was 1800 lb.

A design study was made of a global surveillance satellite using a SNAP 8 system as a power source was completed. The results of this study are presented in NAA-SR-MEMO-6373, "SNAP 8 Power System for the Global Surveillance Satellite." The entire power system weight for a 5-rem dose for 1000 hr was 6750 lb.

A report describing the codes of optimizing the weight for both condensing and non-condensing space radiators was published. This report is NAA-SR-6727, "CROCK and SHOCK: FORTRAN Codes for Optimization of Heat-Rejection Systems for Space Power Plants."

A design study of a nuclear space power system with electrical output capabilities from 90 to 150 kw was completed. The system utilizes a modified SNAP 8 reactor and scaled-up SNAP 8 power-conversion system. For a system designed for operation at 150 kw the shielded specific weight was 35 lb/kw. The results of the study were published in NAA-SR-MEMO-6735. Also presented in the report is a comprehensive mission analysis and a detailed preliminary design of each component.

III. PROGRESS DURING REPORT PERIOD

A paper entitled "Nuclear Space Power Systems — The SNAP Reactors" was given at the Winter Meeting of the AIEE, New York City.

A paper entitled "Compact Reactor Systems" was given at the "Symposium on Current Trends in Nuclear Power" at the University of Arizona, Tucson, on March 2.

A study has been completed on the use of SNAP systems for ion propulsion. The results of this study are given in NAA-SR-7085, "Electrical Propulsion Applications for SNAP Systems."

A design study is in progress to determine the potential performance of space power systems employing thermoelectric power conversion. The systems will be scaled-up versions of the SNAP 10A and incorporate advanced thermoelectric materials. A report on this activity will be issued next quarter.

An application study of the SNAP space systems for various communications missions is in progress. A report on this activity will be issued next quarter.

A preliminary design study of a 1.5-Mw Thermionic Reactor Space Power System was completed, and a report will be issued next quarter.

A preliminary design and program plan for a SNAP 8 reactor coupled to a conventional steam turbogenerator unit for terrestrial use was initiated; a report is in preparation.

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QUARTERLY PROJECT PROGRESS REPORT

IV. EVALUATION OF EFFORT TO DATE

Methods of approach to meet the objectives stated in Section I have been established. Work has been initiated in all the listed areas.

V. NEXT REPORT PERIOD ACTIVITIES

Work will continue on communications studies, the evaluation of systems employing thermoelectric power conversion, and the 1.5-Mw thermionic reactor design study, as well as on the SNAP 8 terrestrial system; the reports indicated above will be published. Work will be initiated in the area of ultrahigh temperature and power hydride space systems to establish the limits and system characteristics of this approach for advanced space power systems.

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QUARTERLY PROJECT PROGRESS REPORT

Program: SNAP Supporting R&D

Project: Basic Nuclear Analysis

Responsible Engineer: J. Miller

Project Engineer: W. J. Roberts

Reporting Period: January-March 1962

AEC Category: 04-30-02-40.1

General Order: 7590

Subaccount: 2030

I. PROJECT OBJECTIVES

This project will develop basic mathematical techniques for the static and dynamic analysis of compact reactor cores. Analysis of selected experiments will be made to verify and improve the theoretical approaches in order to extend the engineering of compact reactor systems. Analyses of advanced compact reactor concepts will be performed using the developed techniques. The study of reflector geometry and material will be extended and types of reactor controls will be analyzed. The information will be utilized in the design of more appropriate reactor systems.

II. MAJOR ACCOMPLISHMENTS TO DATE

Studies of neutron thermalization have resulted in the writing of ULCER, a multigroup, multiregion diffusion-theory code with upscatter. An 18-group cross section library has been prepared for temperatures up to 2000°F. The energy-transfer cross sections for hydrogen were obtained and have been checked against experimentally determined spectra using ULCER. Spectral coefficients computed by ULCER have correlated SER (SNAP Experimental Reactor) and SDR (SNAP Developmental Reactor) transient experiments.

A simplified input version of AIM-VI, a one-dimensional multigroup, multiregion, diffusion-theory code called FAIM was completed.

An initial version of SEER, a Monte Carlo code which calculates criticality and related static quantities for fast reactor configurations, was completed. A Monte Carlo code which calculates scattered intensities from fuel rods, called HAMBONE, was completed and used to correlate N_H with scattered thermal neutron intensity using the L-77 facility as a neutron source.

Studies of compact reactor kinetics have resulted in SNAPKIN, a reactor kinetics code particularly suited for SNAP reactors. This code includes hydrogen-evolution effects and temperature-dependent coefficient specification. Also, a kinetics program which allows mother-daughter delayed neutron precursors has been programmed and used to study beryllium photoneutron effects. Another kinetics code, TEAR, has been written and used to obtain reactivities from transient experiments.

III. PROGRESS DURING REPORT PERIOD

A final report on ULCER was written and is being printed. Final check-outs of the searches in this code were completed. A 40-group library was also prepared and used to calculate spectra. An auxiliary code named ULCER CURE,

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which accepts ULCER output and calculates averaged cross sections, was also put into production use. In addition, a code which performs spatially independent thermalization calculations, named QUICKIE, was incorporated into the ULCER code.

A final report on FAIM was written and printed.

Studies of the hydrogen-evolution mechanism in hydride fuels were initiated. This work is making use of the theoretical models developed in formulating hydrogen energy-transfer cross sections.

Correlations of recent critical experiments with calculational techniques were undertaken. The use of ULCER and FAIM in making accurate criticality and control calculations was considered.

IV. EVALUATION OF EFFORT TO DATE

Sufficient tools are now available with which to accomplish satisfactory static analyses of present compact reactor cores. The best use of these tools must be determined through study of available experimental results. Updating of the input data for the various codes must continue. High-temperature data are particularly in need of improvement.

Improvement is required in the ability to calculate worths of reflector controls. Examination of experimental results in conjunction with calculational procedures for various materials and configurations must be undertaken.

The kinetic behavior of SNAP reactors requires considerable additional study. The problem of hydrogen evolution in these reactors is particularly important and in need of further study.

V. NEXT REPORT PERIOD ACTIVITIES

ULCER will be modified by incorporating ULCER CURE and providing more suitable output format. Study of the use of this code in connection with other calculational techniques for accurate calculations of criticality and control will continue. The 40-group library will be completed.

Improvement in reflector control calculations will continue. Experimental results will be analyzed.

The hydrogen-evolution mechanism in SNAP reactors under transient conditions will be studied further.

Improvements in burnup calculational ability will be undertaken. Modifications to an existing computer code, SIZZLE, are planned.

Papers on the neutron thermalization studies and on ULCER and QUICKIE have been accepted and will be presented at the June meeting of the American Nuclear Society.

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Program: SNAP Supporting R&D	
Project: Critical Experiments	
Responsible Engineer: L. I. Moss	Project Engineer: W. J. Roberts
Reporting Period: January-March 1962	AEC Category: 04-30-02-40.1
General Order: 7590	Subaccount: 2031

I. PROJECT OBJECTIVES

Under this project are performed the nuclear experiments necessary to support the basic technology of compact reactors. The effort includes operation of the critical assemblies to furnish basic information for the design of power systems and to check calculational techniques prior to making computing programs operational. Measured parameters include power distribution, reactivity coefficients, effective cross section, reactor dynamics, reflector controls, and critical masses. This work will provide the experimental verification of the core loading and reflector control designs. Experiments will also be performed to determine the effects of submerging the reactor assemblies in water as a part of the studies of reactor safety during handling and operation.

The work will be extended to examine the above parameters for reactors with hydrogen densities in the range from 3 to 4.5 (10^{22}) at./cm³ and with nickel and steel reflector controls.

A fast reactor core using uranium monocarbide fuel and metal reflectors and controls will be designed to perform the experiments germane to the design of the high-power system for advanced space applications and for terrestrial applications where direct conversion to electricity is desired.

II. MAJOR ACCOMPLISHMENTS TO DATE

Experiments performed with SNAP critical assemblies SCA-1 and SCA-2 have provided necessary design information with regard to criticality, power distributions, comparative worths of reflector materials, neutron kinetics properties, the reactivity effects of various coolant and structural materials, and other properties of interest.

The design, construction, and installation of a critical assembly machine (SCA-3) designed for flexibility with regard to core diameters and lengths and reflector control element parameters have been completed. The fuel elements for the first core loading, consisting of a mixture of UO₂, ZrH_{1.9}, and H₃BO₃ powders inserted in stainless steel jackets and compacted with a vibratory technique, have been fabricated. The hazards report for this machine with the initial core loading has been written (NAA-SR-MEMO-1946, Addendum 4). The report has been approved by both the AI Compact Reactors Safeguards Committee and the AEC.

The Title II Design of the new SNAP Critical Facility (Building 012) was completed. The construction contractor was selected and construction begun.

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The expected completion date is April 15. The Facility hazards report has been written and reviewed by the AI Compact Reactors Safeguards Committee.

Pulsed-neutron techniques have been used to measure the quantity of the SCA-3. The determination of the time constant of prompt neutron decay is becoming the standard method of subcritical reactivity determination at the Facility.

III. PROGRESS DURING REPORT PERIOD

The Building 012 Facility hazards report was written and reviewed within AI.

Noise analysis techniques have been developed to greatly extend the frequency range of the method. These techniques include the use of scintillation detectors feeding chain amplifiers and fast ratemeter circuits for analysis of high frequencies (to 10,000 cps), and tape recorders in series for speedup of signals when analysis of low frequencies (to 0.01 cps) is desired.

IV. EVALUATION OF EFFORT TO DATE

The experiments being performed are meeting the above objectives of the project and are providing the input data needed for an estimate of the accuracy and for continuing refinement of calculational techniques. Improvements in experimental techniques will be utilized to extend the capability of the facility.

V. NEXT REPORT PERIOD ACTIVITIES

Building 012 will be activated. This will require installation of the control console and experimental equipment. The Facility hazards report will be submitted to the AEC for approval.

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QUARTERLY PROJECT PROGRESS REPORT

Program:	SNAP Supporting R&D		
Project:	Basic Compact Shielding Analysis		
Responsible Engineer:	K. L. Rooney	Project Engineer:	W. J. Roberts
Reporting Period:	January-March 1962	AEC Category:	04-30-02-40.1
General Order:	7590	Subaccount:	2032

I. PROJECT OBJECTIVES

This project will provide analytical considerations necessary to: design a shield for an engineered satellite system, evaluate the effects of modifications placed in the design by the realities of fabrication, and evaluate performance of the final system. The project will further serve to guide the shield experimental program, analyze experiments in that program, and interpret measurements in a way to make them useful in actual shield design.

The overall objective of all shielding accounts is the design of lightweight efficient shields for satellite systems.

II. MAJOR ACCOMPLISHMENTS TO DATE

The GE shielding codes have been set up for use at Atomics International and are now in production. These codes include the 14-0, 14-1, 14-2, 14-3, FMC-N and FMC-G programs.

The NIOBE code has been received at AI and is now in use to check out SNAP 2/10 shield designs.

III. PROGRESS DURING REPORT PERIOD

ORANGE, the SNAP shielding Monte Carlo code, is in final checkout. The geometry description was modified to allow for a three-dimensional input specification required for asymmetrical scattering media.

The MACE Monte Carlo code, to evaluate fast neutron collimator designs, was completed. The code results will be compared to experimental data received from ORNL to determine its effectiveness.

IV. EVALUATION OF EFFORT TO DATE

The analytic program to date has been highly successful. Agreement with independent techniques, where possible, has been good. An experimental program has been initiated to allow for comparison with measured values.

V. NEXT REPORT PERIOD ACTIVITIES

The ORANGE code will be placed in production.

An experimental program will be prepared for the Shield Test Facility, (STF) which will be used to confirm the shield design of the SNAP flight systems.

A fast neutron collimator will be designed for the STF. The literature search of space radiation information will continue.

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QUARTERLY PROJECT PROGRESS REPORT

Program: Compact Reactor Technology

Project: Shield Experiments

Responsible Engineer: R. L. Tomlinson

Project Engineer: W. J. Roberts

Reporting Period: January-March 1962

AEC Category: 04-30-02-40.1

General Order: 7590

Subaccount: 2033

I. PROJECT OBJECTIVES

The experimental techniques for determining the parameters affecting shield design for compact reactor systems will be developed on this project. Particular attention will be placed upon the development of radiation detectors to assist in the measurement of the following parameters: (1) attenuation of intermediate energy (0.1 to 4 Mev) neutrons through thin shields, (2) differential energy and angular distribution of neutrons as a function of shield composition and thickness, (3) heat-generation distributions within the shield, (4) measurement of the neutron and photon spectra emitted by the STE reactor and fission-source plate. The project will also provide the basic shield measurements not directly applicable to other experimental shielding accounts.

Because of the unique requirements of the SNAP Program, it becomes necessary to investigate the differential energy and directional behavior of neutrons emerging from thin shields. To satisfy this requirement, a shield testing facility has been constructed for performing experiments that can be analyzed to yield the basic input data necessary for exact calculations of satellite APU shielding.

II. MAJOR ACCOMPLISHMENTS TO DATE

A shield test facility has been designed and constructed. The facility has been activated and the reactor operated at the rated power level of 50 kw. The fission plate has been installed and calibrated. The first two sets of test shields have been delivered.

III. PROGRESS DURING REPORT PERIOD

The fission plate was calibrated using three different techniques each dealing with a different property of the fission process; (1) the rate of absorption of neutrons, (2) the rate of neutron production, and (3) the power dissipation within the fission plate. All three techniques yielded fission-plate powers in the range of 60 watts for 50 kw of reactor power. An error analysis is now being performed on the data in order to obtain the most probable power of the fission plate.

IV. EVALUATION OF EFFORT TO DATE

The low-power and high-power physics tests have shown the STE reactor to be adequately safe and stable for the intended experimental program. The fission-plate power as measured is only 20% of that which was originally

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calculated. An analytical effort to resolve this discrepancy is under way. The lower power is not expected to appreciably affect the early phases of the experimental program and techniques of raising the fission-plate power to the full rating are being investigated.

V. NEXT REPORT PERIOD ACTIVITIES

The neutron transmission measurements on varying thicknesses of LiH shields will begin early in the report period. Radiation testing and calibration of the fast neutron spectrometer will be performed during the report period.

Program: SNAP Advanced Technology	Project Engineer: W. J. Roberts
Project: Thermionic Conversion Research	AEC Category: 04-30-02-40.1
Responsible Engineer: C. C. Weeks	Subaccount: 2036
Reporting Period: January-March 1962	
General Order: 7590	

I. PROJECT OBJECTIVES

This project is directed toward achieving high efficiency and high power density thermionic energy conversion through understanding and applying the fundamental principles of operation. The ultimate objective is the extension of this technology to permit integration of thermionic conversion into long-life compact nuclear power plants having great superiority over more conventional systems.

II. MAJOR ACCOMPLISHMENTS TO DATE

Corrosion effects have been greatly reduced by better vacuum techniques and the use of getters without the converters. Diodes with emitters of molybdenum have been operated over 100 hr without any apparent evidence of sputtering or flaking. Converters with inherently long lifetimes can now be operated to provide reliable and reproducible data.

Based on an understanding of the performance capabilities of emission-limited converters and the emission processes, the systematic evaluation of the cesium-vapor refractory-metal converter has begun. Experiments with sealed cylindrical diodes have been performed to measure performance characteristics as a function of emitter material, emitter temperature, collector temperature, cesium pressure, and load. A variable-spaced diode has been operated to determine the effects of spacing and thereby provide information on transport effects. Experiments relating to series and parallel connected diodes and the effects of off-optimum performance of one diode on another have also been started.

III. PROGRESS DURING REPORT PERIOD

Electrode Performance Studies

In-device studies are still in progress on emission and associated optimum performance parameters for some of the most favorable refractory metals. Theoretical parameters have been computed for the optimum converter performance for emitters with bare work functions (ϕ_{eo}) of 4, 4.5, and 5 ev when transport losses are neglected. Work is in progress to also determine the transport losses as a function of cesium pressure, current, and spacing.

A molybdenum emitter was successfully plated with a 0.022-in. coating of tungsten and operated at temperatures up to 1900°C without deleterious effects. The pyrolytic deposition method, used to plate tungsten on molybdenum, was

also used to form pure tungsten emitters complete with black body cavities by depositing tungsten on a copper mandrel, then etching away the copper.

Variable-Spaced Diode

Power density vs spacing was measured for temperatures from 1290 to 1750°C and spacings from approximately 0.004 to 0.080 in. The 1290 and 1397°C curves each had a maximum power between 0.005 and 0.010 in., indicating an optimum spacing for the colder temperatures where surface ionization is insufficient for neutralization.

Apparent resistivities were measured for current densities from 0.5 to 10 amp/cm². The values obtained include the sheath voltage drop and back current which perturb the results. Calculations are being performed to determine the values of these perturbations.

The output characteristics as a function of input power, while holding all other parameters constant, were measured for a diode with a molybdenum emitter and 0.010-in. interelectrode spacing. The measurements were made for cesium temperatures of 350, 375, and 400°C and collector temperatures of 650 and 750°C while holding constant currents at values ranging from 3 to 10 amp/cm².

IV. EVALUATION OF EFFORT TO DATE

The analyses and experimental data continue to confirm the initial premise that thermionic conversion has the capability, with established technology and materials, of achieving the converter performance required for an attractive space power reactor. Improved fabrication techniques have produced diodes with fewer impurities, thus increasing their lifetime and effecting reproducible data. An understanding of the transport effects is being developed which will contribute to future converter development.

V. NEXT REPORT PERIOD

Emission studies of various refractory metals and the transport problems associated with each will continue. Because of budget limitations the effort will be small. A report covering the work to date will be issued.