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SNAP 10A PROGRAM

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SNAP 10A PROGRAM

By

D. G. LILJA

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ATOMICS INTERNATIONAL

A DIVISION OF NORTH AMERICAN AVIATION, INC.

CONTRACT: AT(11-1)-GEN-8
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FOREWORD

This document contains an annotated bibliography of the SNAP 10A Program produced at Atomics International. Technical Data Records (TDR's) and other preliminary issuances intended exclusively for internal use are not included.

Most of the reports referenced are classified either Confidential or Secret. However, to allow this document to be issued and distributed in the most convenient manner, all titles and abstracts were appropriately edited to allow their publication in an unclassified document.

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I. SUBJECT INDEX

A. GENERAL

PROGRAM, GENERAL

NAA-SR-MEMO-3273 SRD

TITLE: TRIP REPORT - VISIT TO MINNESOTA MINING AND MANUFACTURING TO
DISCUSS DIRECT THERMOELECTRIC ENERGY CONVERSION

AUTHOR: D. J. Cockeran

10-30-58

ABSTRACT: The purpose of the visit was to determine the present status of the thermoelectric conversion project.

NAA-SR-MEMO-4169 UNCL

TITLE: SNAP AUTHORIZED PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

Detailed cost estimates will be prepared with individual conceptual plans for the facilities in subsequent submittals.

NAA-SR-MEMO-4170 UNCL

TITLE: SNAP PROPOSED PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNPA Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

Detailed cost estimates will be prepared with individual conceptual plans to the facilities in subsequent submittals.

NAA-SR-MEMO-4171 OUO

TITLE: SNAP POTENTIAL PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

PROGRAM, GENERAL

NAA-SR-MEMO-4221 SRD

TITLE: SNAP X SYSTEMS ANALYSIS PROGRAM

AUTHOR: A. E. Tucker

8-5-59

ABSTRACT: The activities and completion dates for the initial SNAP X systems analysis study.

NAA-SR-MEMO-4889 SECRET RD

TITLE: SNAP SPACE POWER PROGRESS

AUTHOR: Staff

2-13-60

ABSTRACT: The current AEC program proceeding at Atomics International has been planned so as to serve as the basis of such an AEC space reactor development program. The existing program consists of advanced technology studies, the 300 w thermoelectric SNAP 10 system development, and the 3000 w turboelectric SNAP 2 system development. The 30,000 w turboelectric SNAP 8 reactor is currently being initiated. The subsequent programs should consist of a 300,000 w system, a 1 to 3 Mw system, and ultimately a 10 to 30 Mw system.

NAA-SR-MEMO-4930 SECRET RD

TITLE: TENTATIVE APU DELIVERY AND TEST SCHEDULE

AUTHOR: R. L. Wallerstedt

2-1-60

ABSTRACT: In order that a comprehensive APU program can be implemented at AI and at TRW, the tentative delivery and test schedule has been prepared covering FY 1961, 1962, and 1963.

NAA-SR-MEMO-4975 SECRET

TITLE: SPACE NUCLEAR POWER REQUIREMENTS

AUTHOR: Staff

2-15-60

ABSTRACT: In order to achieve a reasonable space reactor development program, the requirement for such a program should be recognized and voiced now. Full support must be provided for the existing SNAP program to develop the capability, technology, and flight hardware necessary to support the national space effort.

NAA-SR-MEMO-5581 SECRET RD

TITLE: MEETING WITH LOCKHEED MISSILE AND SPACE DIVISION PERSONNEL,
AUGUST 3, 1960 - SNAP 10 FLIGHT TEST PROGRAM

AUTHOR: A. W. Thiele

8-10-60

ABSTRACT: AI visited Lockheed Missile and Space Division (LMSD) at Sunnyvale, California to discuss problems related to the flight test program for the SNAP 10 system.

PROGRAM, GENERAL

NAA-SR-MEMO-5899 UNCL

TITLE: SNAP 10 FY 62-63 PROGRAM PLANNING GUIDE

AUTHOR: A. W. Thiele

11-21-60

ABSTRACT: "Outlines all phases of the SNAP 10 Program for the fiscal year as indicated."

NAA-SR-MEMO-5908 SECRET RD

TITLE: DISCUSSION OF SNAP X WITH LOCKHEED - 5-5-59

AUTHOR: A. W. Thiele

5-22-59

ABSTRACT: A meeting of Lockheed and Atomics International personnel was held at Palo Alto on May 5, 1959, to discuss the application of the SNAP X APU. The current specifications of the SNAP X system were presented and from the response and questions asked, were received in a favorable manner.

NAA-SR-MEMO-6133 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

S-10-FSM-2 (Mechanical Mockup)

July, 1962

A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)

January, 1963 delivery

April, 1963 flight

S-10-FS-3 (Second flight system)

March, 1963 delivery

August, 1963 flight

Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

PROGRAM, GENERAL

NAA-SR-MEMO-6224 CONF RD

TITLE: SNAPSHOT NUCLEAR FLIGHT SAFETY PROGRAM
AUTHOR: Staff 3-31-61

ABSTRACT: A nuclear flight safety program for the SNAPSHOT program is presented as a preliminary plan. The program is intended to be compatible with the Atomic Energy Commission's responsibility for nuclear materials used in the SNAPSHOT satellite launch series.

Analytical and experimental safety studies are described under three headings: Nuclear Studies, Radiological Safety Studies, and Engineering Design Studies. Program milestones are listed and a description of continuing studies is appended.

NAA-SR-6263 SECRET RD

TITLE: PRELIMINARY DESIGN STUDY OF THE SNAP 10A DIRECT CONVERSION NUCLEAR AUXILIARY POWER UNIT

AUTHOR: J. L. Johnson 6-20-61

ABSTRACT: The SNAP 10A concept was first proposed in a report entitled, "Feasibility Study of a Convection Cooled SNAP 10 System." A power source is described therein, using a SNAP 2 reactor, an array of thermoelectric elements, and a heat transfer loop, which could produce 300 w of electrical energy. Since that time, a need has arisen for a 500 w electrical power source for a space mission. The requirements for this mission are summarized and design parameters outlined.

NAA-SR-MEMO-6367 CONF RD

TITLE: MEETING WITH LOCKHEED MISSILES AND SPACE DIVISION, APRIL 11 AND 12, 1961

AUTHOR: A. W. Thiele 5-1-61

ABSTRACT: A meeting was held with representatives of Lockheed Aircraft Corporation April 11 and 12, to discuss problems associated with the SNAPSHOT program.

NAA-SR-MEMO-6444 SECRET DI

TITLE: TRIP REPORT TO LOCKHEED, CALIFORNIA DIVISION - MONDAY, MAY 15, 1961

AUTHOR: R. A. Stone 5-23-61

ABSTRACT: On Monday, May 15, 1961 a meeting was held at Lockheed to discuss applications of SNAP reactors.

PROGRAM, GENERAL

NAA-SR-MEMO-6564 UNCL

TITLE: SNAP 10A PROGRAM MILESTONE CHARTS

AUTHOR: J. W. Tait

6-29-61

ABSTRACT: The SNAP 10A Program Milestone Charts are attached.

These charts have been reviewed and approved by the Department Director, Chief Project Engineer - SNAP 10A - and the Chief Project Engineer - SNAPSHOT.

Program Milestone status will be reported on a monthly basis to the AEC.

NAA-SR-MEMO-6599 CONF RD

TITLE: A RELIABILITY IMPROVEMENT PROGRAM PLANNING REPORT FOR THE SNAP 10A SPACE NUCLEAR POWER UNIT

AUTHOR: M. G. Coombs, C. K. Smith and L. A. Wilson

3-14-61

ABSTRACT: To obtain necessary economic information on the cost of achieving a given reliability, three different programs are considered in addition to the existing R & D program.

NAA-SR-MEMO-6612 UNCL

TITLE: SNAPSHOT PLANNING SCHEDULE

AUTHOR: R. L. Wallerstedt and J. E. Gackle

7-25-61

ABSTRACT: The first draft of the SNAPSHOT planning schedule for use by the various AI administrative departments.

NAA-SR-MEMO-6652 CONF RD

TITLE: FISCAL YEAR 1962-63 SNAP 10A PROGRAM PROPOSAL

AUTHOR: Staff

8-15-61

ABSTRACT: The purpose of this document is to present information regarding the need for additional funds in FY 1962 for the SNAP 10A Program.

NAA-SR-MEMO-6898 CONF RD

TITLE: SNAPSHOT FLIGHT UNITS

AUTHOR: R. Bales

11-29-61

ABSTRACT: Because of the possibility of a delay in the SNAP 2 program, as evidenced by TRW failure to qualify the power conversion unit, some early planning with regard to the effect on the SNAPSHOT program should be made. In reviewing the Air Force document, WDLPS-69, issued April 17, 1961, entitled "Nuclear Auxiliary Power Orbital Tests (SNAPSHOT)", following are some remarks which are worth reviewing in light of possible schedule slippage.

PROGRAM, GENERAL

NAA-SR-MEMO-6937 UNCL

TITLE: SNAP 10A PROGRAM REVISION - SHIELD SPECIFICATION CHANGE

AUTHOR: R. F. Wilson

12-13-61

ABSTRACT: This document is a single sheet which presents the schedule revision for the Non-Nuclear and Nuclear systems in which the first Flight Delivery was changed from January, 1963 to May, 1963.

NAA-SR-MEMO-7399 UNCL

TITLE: SNAPSHOT SAFETY PROGRAM PLAN

AUTHOR: Staff

6-20-62

ABSTRACT: The SNAPSHOT Safety Program Plan, as described in this document, is formulated to align safety studies performed by separate agencies and their contractors. At the present stage in program development, the plan is principally concerned with the initial SNAPSHOT flight (SNAP 10A).

NAA-SR-MEMO-7550 UNCL

TITLE: SNAP 10A SNAPSHOT PROGRAM DEVELOPMENT

AUTHOR: R. F. Wilson

7-10-62

ABSTRACT: The purpose of this document is to outline the ground rules for the component and system development program which will result in a flight SNAP 10A to meet the goals which have been set up for the SNAPSHOT program. From this development plan, a set of detailed component and system testing plans can be formulated. These detailed plans must then reflect all of the ground rules set forth in this section. It is recognized that many of the component development programs are well advanced and some have been planning in detail. It is expected, where necessary, that all of these test plans will be reviewed and revised as necessary so as to reflect the guidance contained herein.

NAA-SR-MEMO-7645 CONF RD

TITLE: FLIGHT TEST PROGRAM DEVELOPMENT PLAN

AUTHOR: R. Wallerstedt

11-12-62

ABSTRACT: The purpose of this document is to outline the ground rules for the component and system development program which will result in a flight SNAP 2 to meet the goals which have been set up for the program. From this development plan, a set of detailed component and system testing plans can be formulated. These detailed plans must then reflect all of the ground rules set forth in this section. It is recognized that many of the component development programs are well advanced and some have been planned in detail. It is expected, where necessary, that all of these test plans will be reviewed and revised as necessary to reflect the guidance contained herein.

PROGRAM, GENERAL

NAA-SR-MEMO-7652 UNCL

TITLE: NUCLEAR SPACE POWER SYSTEMS - THE SNAP REACTORS

AUTHOR: R. E. Wimmer

2-1-62

ABSTRACT: There is a rapidly increasing demand for electric power for space missions. The SNAP reactors are intended to answer part of this demand. Schedule and characteristics are given for the systems under development, and feasible extensions of the present technology are indicated. Comparison of various power systems shows nuclear reactors to be most attractive for high-power, long-duration missions. Interaction of payload and reactor must be considered, and appreciable weight savings may be realized by careful system integration.

NAA-SR-MEMO-7987 SECRET DI

TITLE: SNAP FIVE-YEAR FACILITIES PLAN AT ATOMICS INTERNATIONAL

AUTHOR: Staff

1-15-63

ABSTRACT: This report outlines a 5-Year Facilities Program to support the Systems for Nuclear Auxiliary Power (SNAP) Research and Development Programs at Atomics International.

NAA-SR-MEMO-8215 CONF RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS, PART 1
SPACE POWER REQUIREMENTS AND DEVELOPMENT PHILOSOPHY

AUTHOR: R. Balent and B. B. Chew

3-15-63

ABSTRACT: Available projections of the National Space Program have been reviewed to evaluate areas of SNAP nuclear power application. Results of this review indicate approximately 100 missions between 1965 and 1975 can advantageously use nuclear auxiliary power; all but a very few are in the power range of 500 w to 35 kwe. Missions using more than 100 kwe power are not expected to occur until after 1975, and are dependent upon very large boosters not now firmly programmed.

NAA-SR-MEMO-8215 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS
PART 1A, SNAP 2/10A REACTOR

AUTHOR: J. Susnir

3-15-63

ABSTRACT: A summation of activities to date on the program, together with plans for future activities.

PROGRAM, GENERAL

NAA-SR-MEMO-8215, PART 2 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 2, SNAP 10A

AUTHOR: R. F. Wilson

3-15-63

ABSTRACT: SNAP 10A is a nuclear reactor auxiliary power unit being developed to provide a minimum of 500 electrical watts at 28.5 v dc for a period of one year in a space environment. As presently scheduled, the SNAP 10A system will be the first reactor-powered electrical system to be flight tested in earth orbit. The SNAP 10A Program is directed toward the early exploitation of both the technical and operational aspects of such a device.

NAA-SR-MEMO-8215, PART 7 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 7, SNAP 10A FLIGHT NUCLEAR SAFETY

AUTHOR: R. G. Courson

5-1-63

ABSTRACT: The potential programming of a nuclear-power system for a space mission invariably involves many questions of nuclear safety and hazards to the general public as well as to the personnel associated with the actual launching. The impending orbital tests of SNAPS 10A and 2 have led to a detailed consideration of these hazards which will be forthcoming in the "Final Safeguards Report - SNAP 10A Flight Tests." Since the majority of these safety conclusions apply to any reactor nuclear-power system, it is desirable to summarize the SNAP 10A considerations to highlight the general considerations which will be applicable to the safety of all nuclear power systems. Since factory-to-flight safety is readily managed by controlled handling procedures, only postlift-off safety is discussed.

NAA-SR-MEMO-8215, PART 10 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS
PART 10, PROGRAM COSTS

AUTHOR: R. Balent and W. D. Ambrose

4-5-63

ABSTRACT: Total costs (actual + projected) for ground demonstration, first flight demonstration and limited one-year life testing for the AEC SNAP 10A, 2, and 8 programs for the time period 1956 to 1969 are estimated to be \$350,000,000. Estimated costs for operational development and follow-on phases for these projects which will establish initial operational status for a family of nuclear APU's within the power range of 500 w to 50-100 kwe is \$250,000,000. These amounts do not include the cost of launch vehicles or launch support for the flight test phases, reliability demonstration, or the production phases.

In addition to the development costs by phases, typical SNAP unit costs for production rates of 3 per year and 10 per year are given for three power categories. Also, costs in orbit for typical 1, 10, and 100 kw units are developed.

PROGRAM, GENERAL

NAA-SR-MEMO-8818 SECRET RD

TITLE: 2-KW SNAP 10A DEVELOPMENT PROGRAM

AUTHOR: R. F. Wilson

8-14-63

ABSTRACT: The purpose of this document is to guide the work required to develop a follow-on SNAP 10A system capable of producing between 2 and 3 electrical kw, and to define the sequence and timing of the various phases of work as they interrelate with each other and with the overall development schedule and technical progress. The program described encompasses the development of 1300°F components, engineering, and ground testing of a 2 kwe system, utilizing the 1200°F SNAP 2 reactor and shield, and flight testing two 2-kwe systems. The reference system has a radiator area of about 120 ft² and a weight of about 1400 lb. The 1300°F components will allow the same system to grow to 3 kw with the incorporation of SNAP 8 technology into the SNAP 2 reactor.

NAA-SR-MEMO-9786 UNCL

TITLE: SNAP 10A DEVELOPMENT REACTOR MOCKUP TEST PROGRAM SUMMARY

AUTHOR: R. H. Prowett

10-1-64

ABSTRACT: The SNAP 10A (Space Nuclear Auxiliary Power) Program at Atomics International was inaugurated by the United States Atomic Energy Commission to:

- 1) Demonstrate the usefulness of nuclear power for space applications,
- 2) Verify that nuclear space power can be used safely, and
- 3) Obtain technical information that will enhance the application of current systems and further the development of the larger and more complex systems required for the future.

NAA-SR-MEMO-9839 UNCL

TITLE: REACTOR THERMOELECTRIC SPACE POWER

AUTHOR: J. Stewart

4-15-64

ABSTRACT: The SNAP 10A (Space Nuclear Auxiliary Power) Program at Atomics International was inaugurated by the United States Atomic Energy Commission to:

- 1) Demonstrate the usefulness of nuclear power for space applications,
- 2) Verify that nuclear space power can be used safely, and
- 3) Obtain technical information that will enhance the application of current systems and further the development of the larger and more complex systems required for the future.

PROGRAM, GENERAL

NAA-SR-MEMO-10605 UNCL

TITLE: SNAPSHOT NUCLEAR POWER FOR SPACE

AUTHOR: W. F. Heine 11-25-64

ABSTRACT: The objectives of the SNAPSHOT program are to demonstrate the utility of nuclear reactor power systems for space application, and to obtain technical information for utilization and further development of these systems. Light weight, reliable sources of electrical power such as these are a major requirement for the expansion of space exploration.

RELIABILITY

NAA-SR-MEMO-6599 CONF RD

TITLE: A RELIABILITY IMPROVEMENT PROGRAM PLANNING REPORT FOR THE SNAP 10A SPACE NUCLEAR POWER UNIT

AUTHOR: M. G. Coombs, C. K. Smith and L. A. Wilson

3-14-61

ABSTRACT: To obtain necessary economic information on the cost of achieving a given reliability, three different programs are considered in addition to the existing R & D program.

NAA-SR-MEMO-8215, PART 9, CONF RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS, PART 9 NUCLEAR SYSTEM RELIABILITY REQUIREMENTS

AUTHOR: J. E. Brunings

7-1-63

ABSTRACT: The successful development of nuclear power units for space application is contingent upon the achievement of an appropriate level of reliability consistent with each phase of the development program. The initial phase of the SNAP 10A and 2 program is oriented to achieve at least one successful flight demonstration. An optimum flight demonstration program occurs for the SNAP 10A System when the power system reliability is developed to about 0.55 at the time of the initial flight test. This results in a predicted probability of flight test success of 0.33 and most likely requires three flight tests to achieve at least one successful demonstration.

NAA-SR-MEMO-10301 CONF RD

TITLE: SNAP 10A FS-1 RELIABILITY EVALUATION

AUTHOR: S. Miner

8-14-64

ABSTRACT: Documentation of a verbal presentation on S10FS-1 reliability made to the AEC in May, 1964.

NAA-SR-MEMO-10718 UNCL

TITLE: DETERMINATION OF PROBABILITY OF EJECTION OF REFLECTORS DURING ORBITAL FLIGHT TESTING OF THE SNAP 10A NUCLEAR POWER UNIT

AUTHOR: R. M. Ohlenkamp

2-15-65

ABSTRACT: This report presents a method for the solution of the problem of ascertaining the probability of SNAP 10A reflector ejection and hence, reactor shutdown, after an orbital startup. Conservative solutions are given in tabular and graphical form over the continuous period from launch to 100 years.

MATERIALS DATA

NAA-SR-6901 CONF RD

TITLE: CERAMIC COATINGS FOR LEAD TELLURIDE THERMOELECTRIC ELEMENTS

AUTHOR: D. O. Raleigh

3-1-62

ABSTRACT: A number of preliminary adherency experiments, as well as recourse to wettability theory, indicated that lead telluride is difficult to wet with inert, homogeneous melts. A technique was developed.

NAA-SR-MEMO-7217 CONF RD

TITLE: COMPATIBILITY STUDIES OF SOME SNAP 2/10A FUEL ELEMENT MATERIALS

AUTHOR: L. B. Lundberg

3-13-62

ABSTRACT: Pieces of beryllium, chrome-plated beryllium and beryllium plasma-arc-coated with alumina (Al_2O_3), beryllia (BeO), zirconia (ZrO_2) and thoria (ThO_2) were placed in contact with a coating, which had been applied to a chromized Hastelloy N substrate and tested for 1000 hr at $1300^{\circ}F$ in a hydrogen atmosphere.

NAA-SR-9007 SECRET RD

TITLE: SNAP FUEL AND CORE MATERIALS COMPATIBILITY SCREENING TESTS

AUTHOR: L. B. Lundberg

3-1-64

ABSTRACT: Screening tests have been performed to determine the compatibility of many of the materials in contact with each other in the SNAP 10A/2 and SNAP 8 reactor cores. In some cases of known incompatibility, reaction barriers were studied. The tests involved placing small samples of the materials under consideration in intimate contact at temperatures from 1200 to $1450^{\circ}F$ for periods up to 1000 hr in environments similar to those encountered in the particular reactor. The mutual compatibility of the sample materials was determined by metallographic examination. Reactions were observed between the following components: fuel and the bare cladding (without hydrogen barrier); fuel cladding and the SNAP 2 beryllium internal radial reflector; and several fuel element thermal bond materials and both the fuel and the enamel hydrogen barrier. Reaction barriers for fuel cladding and the SNAP 2 beryllium internal radial reflector were examined, but none were found to be effective. The majority of the suggested reactor core materials were found compatible in this study.

NAA-SR-MEMO-9815 CONF RD

TITLE: SELF-WELDING IN SPACE - AEROSPACE SAFETY SURVEY

AUTHOR: H. H. Johnson

4-3-64

ABSTRACT: The purpose of this TDR is to review the general literature on self-welding and to survey the program at Atomics International in order to evaluate the possibility that self-welding of the beryllium reflector to the 316 stainless steel reactor core will occur while the SNAP system is in operation in space. Seizure of the reflector to the reactor will affect the burnup of the system on reentry into the atmosphere.

MATERIALS DATA

NAA-SR-9898, Volume III CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 3, SHIELD, GROUND TEST ASSEMBLY, AND MATERIALS APPLICATIONS

AUTHOR: W. J. Kurzeka, Editor

2-10-65

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR-MEMO-10080 OUO

TITLE: RESISTANCE DEGRADATION OF ELECTRICAL INSULATION, AT VACUUM AND ELEVATED TEMPERATURE, AS A RESULT OF EQUIPMENT OIL DEPOSITION

AUTHOR: W. G. Long

6-12-64

ABSTRACT: The Developmental effort on the cable harness and coil techniques programs includes life-testing components at high temperature and vacuum. Back-streaming of oil from diffusion and roughing pumps in these tests has contributed to erroneous values of insulation resistance (I. R.). Under vacuum at elevated temperatures, the oil deposited on the test specimen carbonizes and creates a low resistance current leakage path.

To isolate the variables associated with testing in different types of equipment, tests were conducted in :

- 1) Untrapped oil diffusion systems,
- 2) Oil diffusion systems employing liquid nitrogen on water cooled baffles above the diffusion pump, and
- 3) An ionization pumping system. Oil contamination is not a factor in ion-pumping systems and the samples can be considered contaminant-free.

NAA-SR-MEMO-12023

MATERIALS DATA

NAA-SR-MEMO-10391 UNC

TITLE: EFFECT OF FOSTERSEAL RESIN ON SUPERTEMP CABLE SAMPLES

AUTHOR: W. G. Long

9-18-64

ABSTRACT: Cable samples with and without Fosterseal resin were tested at 10^{-5} torr at 900, 1100, and 1300 . The 1300°F tests were terminated after 200 hours due to the rapid decrease in insulation resistance. The 900° and 1100°F tests showed only a slight effect due to the addition of Fosterseal. These tests were continued for 1000 hr.

The most pronounced effect produced in this test was the decomposition of the Fosterseal during initial startup.

NAA-SR-MEMO-11149 UNCL

TITLE: PROPERTIES OF CLADDING MATERIALS FOR SNAP HYDRIDE REACTORS

AUTHOR: G. F. Burdi

3-22-65

ABSTRACT: This report has been published to increase the usability of previously collected and classified information by distributing this compiled information in an unclassified report. This report contains currently available property data on potential cladding materials for SNAP hydride reactors and was compiled under the direction of the Atomics International SNAP General Supporting Technology Program.

RADIATION DAMAGE AND HARDENING

NAA-SR-MEMO-8044 CONF DI

TITLE: RADIATION EFFECTS ON SNAP 10A THERMOELECTRIC MODULES

AUTHOR: S. Friedlander

12-26-62

ABSTRACT: This report includes test data to 11-20-62 on two RCA vacuum converter modules.

The two modules are early developmental types with aluminum hot straps.

In summary, these modules have shown excellent resistance to fast neutron irradiation. Power output (i. e. $\alpha^2 r$) has remained constant up to a neutron flux level of 3×10^{16} nvt.

NAA-SR-MEMO-8446 CONF RD

TITLE: RADIATION DAMAGE EFFECTS ON SNAP 10A COMPONENTS SUMMARY

AUTHOR: J. E. Stewart

4-30-63

ABSTRACT: The components on SNAP 10A which have a predominant influence on system life include the reactor and fuel elements, the thermoelectric pump and the SiGe thermoelectric power conversion unit. Radiation damage rate and the evaluation on each of these components indicates very high probability of operation for one year or more as influenced by nuclear environment.

NAA-SR-MEMO-9113 UNCL

TITLE: IRRADIATION OF SNAP ELECTRONICS COMPONENTS IN THE SHIELD TEST REACTORS EXPERIMENTS 1-8

AUTHOR: S. G. Kimble

8-21-63

ABSTRACT: Eight irradiation experiments were performed in the AI SNAP Shield Test Reactor (STR) to provide information required for the development of electronic control and instrumentation components for SNAP systems. Where gamma damage was expected to be significant, parts were pre-gamma dosed to the desired level before neutron irradiation at the low-gamma STR. In-pile data was generated for electronic parts, subassemblies, and whole components held at controlled temperatures during test. This effort was primarily for screening and special effects studies supporting the program of irradiations of statistical-size samples of SNAP parts at the Battelle Research Reactor.

NAA-SR-9634 UNCL

TITLE: LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRICAL AND ELECTRONIC COMPONENTS (BMI-LF-3)

AUTHOR: M. N. Robinson, S. G. Kimble and D. M. Walker

2-14-64

ABSTRACT: This report describes screening tests of nuclear radiation effects on electrical and electronic components for the SNAP 2 and 8 control systems.

Five transistor models, three capacitor types, and several encapsulation materials were irradiated to 10^{16} nvt (>0.1 Mev) and 4×10^8 r (gamma). The components were maintained at a temperature of 140°F and a vacuum of 5×10^{-4} Torr. Measurements were taken of electrical characteristics during irradiation, and the resulting degradation curves were plotted by computer.

RADIATION DAMAGE AND HARDENING

NAA-SR-MEMO-9724 CONF RD

TITLE: SNAP 10A STARTUP CONTROLLER ENDURANCE IRRADIATION

AUTHOR: S. G. Kimble

3-26-64

ABSTRACT: This report describes a temperature vacuum irradiation environment test on a SNAP 10A Startup Controller which had been irradiated in an earlier experiment to qualification dose levels (3×10^{13} nvt, 2×10^7 R γ). More extensive measurements were taken in the present test in an effort to study the temperature-dose dependency of the failure point and the mode of failure. Results are presented which indicate operational limits as a function of dose and time.

NAA-SR-MEMO-9811 UNCL

TITLE: NUCLEAR RADIATION EFFECTS ON SEMICONDUCTOR DEVICES (STR #19)

AUTHOR: M. N. Robinson

4-16-64

ABSTRACT: Radiation effects on the electrical characteristics of five transistor types, two Zener diode models, one power diode model, and two Thyrite samples, in a simulated reactor environment, are evaluated. The devices were irradiated to 2×10^7 R (gamma) at the AI Co⁶⁰ Gamma Facility, followed by neutron irradiation to 7.2×10^{13} nvt at the Shield Test and Irradiation Reactor (STIR).

The critical electrical parameters were measured during irradiation, and the resulting degradation curves are presented and interpreted.

NAA-SR-MEMO-10037 CONF RD

TITLE: QUALIFICATION IRRADIATION OF SELECTED SNAP 10A INSTRUMENTATION COMPONENTS, STR #14

AUTHOR: S. G. Kimble

6-9-64

ABSTRACT: The component irradiation described in this report was designed to produce information that could be used to determine irradiation qualification status for SNAP 10A Flight System instrumentation components. The test was conducted in vacuum at temperature in the shield test facility Fission Plate Capsule between November 18, 1963 and December 6, 1963. Tested components were subjected to a total neutron dose of 1×10^{14} nvt (E above one Mev) and a γ dose of 0.025×10^7 R. Results are included in tabular and/or graph form for the components which were instrumented for in-pile data taking.

NAA-SR-MEMO-10205 UNCL

TITLE: RADIATION-INDUCED SURFACE EFFECTS ON SNAP 10A STARTUP CONTROLLER TRANSISTORS

AUTHOR: M. N. Robinson

7-10-64

ABSTRACT: A gamma irradiation test for potential surface effects on SNAP 10A Startup Controller transistors is described. Measurements of collector leakage current under "use" bias conditions are presented and interpreted. Of the two models tested, the 2N744 transistors showed no discernible surface effects, as determined by this parameter, while the effect on the 2N1072 transistors was below the level which would adversely affect performance of the Controller.

RADIATION DAMAGE AND HARDENING

NAA-SR-10284 UNCL

TITLE: LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRONIC COMPONENTS
(BMI-LF-2)

AUTHOR: M. N. Robinson, S. G. Kimble, N. F. Davies and D. M. Walker 4-20-65

ABSTRACT: The second of a series of irradiation experiments on electronic devices intended for SNAP reactor control systems is described.

Several diode and transistor types, sensitizers, capacitors, and an oscillator from a prototype SNAP 10A Startup Controller were irradiated to 3×10^{15} nvt (>0.1 Mev) and 5×10^8 r (gamma) at the Battelle Memorial Institute Research Reactor.

Results are presented of in-pile measurements of the critical electrical characteristics, in the form of graphs produced automatically by a computer peripheral plotting facility.

NAA-SR-10856 UNCL

TITLE: COMPARISON OF NEUTRON AND GAMMA RADIATION DAMAGE IN SEMICONDUCTORS

AUTHOR: M. N. Robinson 6-15-65

ABSTRACT: Calculations are presented which relate the damages produced in silicon semiconductors by SNAP (Systems for Nuclear Auxiliary Power) reactor neutrons and gammas. Design dose levels are derived for SNAP payload components, consistent both with this relation and with the necessity of minimizing shield weight.

COMPUTER PROGRAMS

NAA-SR-8414 UNCL

TITLE: BOOMER - A DIGITAL PROGRAM FOR EVALUATING THE THERMAL AND KINETICS RESPONSE OF A SNAP 2/10A REACTOR

AUTHOR: R. W. Winson 5-31-64

ABSTRACT: A mathematical model of the SNAP 2/10A reactor was developed describing the reactor kinetics, heat transfer, and hydrogen diffusion within the reactor core. This theoretical model was then modified, on the basis of current test data, to realistically predict the transient response of the reactor. The model was then programmed into a digital code called BOOMER. The development of this code is described in detail in this report.

NAA-SR-MEMO-8768 CONF RD

TITLE: FAST NEUTRON FLUX THROUGH THE SNAP 10A SHIELD AS COMPUTED BY SEVERAL METHODS

AUTHOR: J. A. Belcher and W. M. Farr 7-23-63

ABSTRACT: Fast neutron fluxes through the SNAP 10A shield as computed by several methods are compared. The methods and the codes using the methods are:

- 1) Neutron transport - DTK,
- 2) Neutron diffusion - AIM-6,
- 3) Monte Carlo - FMC-N, and
- 4) Neutron removal theory - 14-0.

These various methods predicted fluxes through the shield which agree reasonably well. On the basis of these analyses and recent Shield Test Facility experiments, a lithium hydride removal cross section of 0.156 cm^{-1} is recommended for use in removal theory code studies of the SNAP 10A shield. Comparable analysis of the SNAP 2 shield indicates that a removal cross section of 0.160 cm^{-1} is valid for use in SNAP 2 shielding studies.

NAA-SR-MEMO-8768 Addendum CONF RD

TITLE: LiH CROSS SECTION DETERMINATION FOR REMOVAL THEORY CODES

AUTHOR: R. D. Anderson, Jr. 7-23-63

ABSTRACT: To correlate a realistic 14-0 code removal cross section with computed fluxes obtained using AIM-6 and DTK nuclear codes.

COMPUTER PROGRAMS

NAA-SR-MEMO-9440 UNCL

TITLE: FSM-I - A DATA REDUCTION PROGRAM

AUTHOR: R. J. Mikell and G. T. Chang

3-25-64

ABSTRACT: The FSM-I data reduction program consists of three parts.

Part I is a data reduction and analysis program which performs statistical calculations and numerical analysis of data gathered on punched paper tape. The signals to the paper tape punch are obtained from reactor instrumentation. One of the output media from Part I is a magnetic tape. This tape is used as the input to Part II.

Part II is the IBSYS* sort program. This program takes the output magnetic tapes generated by Part I, sorts and merges the data, and, if desired, deletes records from the sorted and merged tapes. This is done to order and update a history tape of accumulated test runs processed by Part I. This accumulated history tape then becomes the input to Part III.

Part III is a normalizing and graphical display program. In this portion of the FSM-I package, plots of the various parameters which describe the system's performance are obtained.

NAA-SR-MEMO-9565 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT QUALIFICATION TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-4-64

ABSTRACT: Deck No. 9w-037 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element qualification testing data reduction. This report defines the required input data format and describes the program output.

NAA-SR-MEMO-9566 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT EXPLORATORY TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-6-64

ABSTRACT: Deck No. 9W-038 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element exploratory testing data reduction. This report defines the required input data format and describes the program output.

COMPUTER PROGRAMS

NAA-SR-MEMO-9589 CONF RD

TITLE: TRANCORE-10A: A DIGITAL PROGRAM EVALUATING TRANSIENT TEMPERATURES WITHIN THE SNAP 10A REACTOR CORE

AUTHOR: P. M. Magee 3-5-64

ABSTRACT: A mathematical model has been developed which describes the reactor kinetics, core heat transfer and thermoelectric pump performance of the SNAP 10A system. From the model, a digital computer code, "TRANCORE-10A", has been prepared which predicts transient temperatures within the reactor core. The code can be used to investigate a wide variety of reactor operational behavior: steady-state, startup, scram, loss of coolant flow, etc. It has been used extensively to predict startup transients. However, the code cannot be used to evaluate the effects of rapid reactivity changes, i. e., operation near prompt critical.

NAA-SR-MEMO-10913 UNCL

TITLE: HISTORY ANALYSIS PROGRAM FOR FSM-4, FS-3, AND FLAP-4

AUTHOR: R. J. Mikell and G. T. Chang 9-1-65

ABSTRACT: The History Analysis Program is a data handling, display and analysis program. This program is made up of several subroutines which may be optioned singly or in combinations to examine data generated by the following SNAP data reduction and analysis programs for FSM-4, FS-3, and FLAP-4. The data used by the History Analysis Program is an accumulation of runs from daily acquisitions of the above three SNAP systems. The available options may be found in the Purpose sections. Other options may be added.

NAA-SR-11400 CONF RD

TITLE: FUSAk A COMPUTING CODE FOR THEORETICAL EVALUATION OF SNAP 8 AND SNAP 10A FUEL ELEMENT PERFORMANCE DURING REACTOR OPERATION

AUTHOR: M. E. Nathan 11-1-65

ABSTRACT: The FUSAk computing code, developed for rigorous analysis of performance of SNAP 8 and SNAP 10A fuel elements under any mode of reactor operating conditions, is described. A FUSAk computation for a particular fuel element of a SNAP reactor core evaluates hydrogen redistribution equilibrium dissociation pressure and hydrogen permeation for selected time steps.

B. SYSTEMS

SYSTEM DESIGN AND ANALYSIS

NAA-SR-5650 UNCL

TITLE: NUCLEAR SPACE POWER SYSTEMS

AUTHOR: R. A. Stone

4-1-61

ABSTRACT: This report presents a detailed description of the nuclear space power systems presently under development. In addition, weight and performance estimates are given for higher power and more advanced nuclear systems employing thermo-electric, turboelectric and thermionic power conversion methods. Various aspects of reactor design are discussed with respect to inherent limitations and system requirements. Many problems which are common to all nuclear systems such as shielding, reliability, heat rejection, safety, and operational considerations are presented in some detail.

NAA-SR-6463 SECRET RD

TITLE: PRELIMINARY DESIGN STUDY OF THE SNAP 10A DIRECT CONVERSION NUCLEAR AUXILIARY POWER UNIT

AUTHOR: J. L. Johnson

6-20-61

ABSTRACT: The SNAP 10A concept was first proposed in a report entitled, "Feasibility Study of a Convection Cooled SNAP 10 System." A power source is described therein, using a SNAP 2 reactor, an array of thermoelectric elements, and a heat transfer loop, which could produce 300 w of electrical energy. Since that time, a need has arisen for a 300 w electrical power source for a space mission. The requirements for this mission are summarized and design parameters outlined.

NAA-SR-MEMO-6721 CONF RD

TITLE: SNAP 10A TOTAL SYSTEM SIMULATION

AUTHOR: P. Pekrul

10-3-61

ABSTRACT: The purpose of this report is to describe and explain the results from an analytical model of the total SNAP 10A Vacuum System.

- 1) Simulation of the entire SNAP 10 APU.
- 2) Establish control system specifications.
- 3) Obtain system transient and stability information.
- 4) Evaluate electrical load and environmental effects on the system.
- 5) Establish programmer requirements.

SYSTEM DESIGN AND ANALYSIS

NAA-SR-9720 CONF RD

TITLE: SNAP 10A PRESTARTUP AND STARTUP PERFORMANCE

AUTHOR: G. S. Drucker and T. J. Boyle

6-30-64

ABSTRACT: Presented are the results of analyses to determine the thermal behavior of the SNAP 10A System in orbit prior to startup, and the nuclear, thermal, and hydraulic behavior of the system during startup. Parameter studies were made to determine the effects of variations from the nominal design conditions on maximum and minimum system temperatures prior to startup and the severity of the startup transient. Also included are the mathematical models used in the digital and analog computer solutions. The analyses results indicate that the SNAP 10A system will meet its prestartup and startup requirements.

SYSTEM TESTING

NAA-SR-MEMO-4606 SECRET RD

TITLE: SNAP 10 POWER TEST COOLING

AUTHOR: H. N. Rosenberg

11-5-59

ABSTRACT: A maximum air velocity of 1.5 ft/sec will be required for cooling the SNAP 10 Power Test Reactor. This could be provided with a 1 ft² annular duct around the bottom of the reactor, and, with safety, a 200 standard CFM blower. Care should be taken to assure a high emissivity, oxidized surface on the reactor container because of the importance of radiation in the cooling.

NAA-SR-MEMO-6115 REVISION 1 UNCL

TITLE: OPERATION MANUAL FOR SNAP ENVIRONMENTAL TEST FACILITY
BUILDING NO. 024

AUTHOR: H. V. Lee

5-5-61

ABSTRACT: SNAP Environmental Test Facility (SETF) has been built to accommodate the testing of this Compact Power System (SNAP 2). This system shall be tested under controlled environmental conditions. The necessary shielding, inert gas (nitrogen) atmosphere, pressure, and temperature controls are provided with this facility.

This document has been prepared to instruct the operating personnel how to safely perform the tasks of operating the systems within this facility.

NAA-SR-MEMO-7286 CONF RD

TITLE: ACCEPTANCE TEST FACILITY SAFEGUARDS REPORT

AUTHOR: W. H. Heneveld

9-24-62

ABSTRACT: The purpose of this report is to describe the operation of the Acceptance Test Facility (ATF) and testing of SNAP 10A Auxiliary Power Units (APU) in the facility. A hazards analysis of the facility is included with a discussion of maximum credible accidents and consequences. The Acceptance Test program is presented along with those tests procedures associated with the reactor operation. This report covers only the tests and operations to be conducted with SNAP 10A systems; acceptance tests of SNAP 2 and 8 systems, which will also be conducted in this facility, will be presented in an addendum to be published at a later date. A separate operation manual, presenting descriptions and detailed test procedures, will be issued prior to operation of the facility.

NAA-SR-MEMO-7951 CONF RD

TITLE: ELECTROMAGNETIC INTERFERENCE TEST OF FSEM-2 APU SYSTEM

AUTHOR: W. Holsborg and J. L. Johnson

11-8-62

ABSTRACT: This TDR describes the conducted electromagnetic interference test as prescribed by the Military Specification MIL-I-26600 (USAF) Amendment 2 performed on the FSEM-2 APU system.

The results of this test indicate that the test specimen generates interference in excess of the prescribed limits of MIL-I-26600.

NAA-SR-MEMO-12023

SYSTEM TESTING

NAA-SR-MEMO-9440 UNCL

TITLE: FSM-I A DATA REDUCTION PROGRAM

AUTHOR: R. J. Mikell and G. T. Chang

3-25-64

ABSTRACT: The FSM-I data reduction program consists of three parts.

Part I is a data reduction and analysis program which performs statistical calculations and numerical analysis of data gathered on punched paper tape. The signals to the paper tape punch are obtained from reactor instrumentation. One of the output media from Part I is a magnetic tape. This tape is used as the input to Part II.

Part II is the IBSYS sort program. This program takes the output magnetic tapes generated by Part I, sorts and merges the data, and, if desired, deletes records from the sorted and merged tapes. This is done to order and update a history tape of accumulated test runs processed by Part I. This accumulated history tape then becomes the input to Part III.

Part III is a normalizing and graphical display program. In this portion of the FSM-I package, plots of the various parameters which describe the system's performance are obtained.

NAA-SR- 9893 UNCL

TITLE: SNAP 10A/AGENA ELECTRICAL MOCKUP TEST (S10A/FSEM-2)

AUTHOR: M. J. Teresa

7-30-64

ABSTRACT: A test program to establish preflight confidence in SNAP 10A and Agena electrical systems was conducted at LMSC's Sunnyvale facility between November 1962 and June 1963. The tests were performed with an electrical mockup of the NPU, designated FSEM-2, and an Agena development test vehicle or functional mockup (FMU). Final checkout of Agena subsystems extended into early May 1963. During the month of May integrated systems tests were conducted with the FSEM-2/FMU. The two mockups were programmed through a simulated sequence of operation from prelaunch to end of life.

NAA-SR-MEMO-10278 CONF RD

TITLE: SNAP 10A FSM-4 TEST STATUS

AUTHOR: J. Brunings and W. Vaughn

9-15-64

ABSTRACT: This report describes the FSM-4 system test program, schedule, and test objectives. An evaluation of the system test reliability is summarized based on component test data available as of June 1, 1964.

SYSTEM TESTING

NAA-SR-MEMO-10446 UNCL

TITLE: SNAP-10A FSM-4 PERFORMANCE ANALYSIS - NaK LOADING AND THERMAL
REFERENCE TEST

AUTHOR: G. E. Berg

9-15-64

ABSTRACT: Data taken during NaK loading and thermal reference testing of the SNAP-10A FSM-4 non-nuclear ground test system are presented and analyzed. For purposes of analysis the performance was divided into five categories:

- 1) System temperatures,
- 2) System heat losses,
- 3) Converter electrical performance,
- 4) Pump performance, and
- 5) Flight instrumentation performance.

In each category emphasis was placed on comparison of measured data to predicted performance and thermal reference performance of the 10FSM-1 and 10FS-1 systems. In almost every case both FSM-4 performance and agreement with predicted values were excellent. An average of 509 w was produced at a core outlet temperature of 1011° F. The only important problem was a low converter to ground resistance which would have caused a very small decrease in power output if the system had been grounded.

NAA-SR-MEMO-10673 CONF RD

TITLE: THERMAL REFERENCE TEST, SNAP 10A FS-4

AUTHOR: W. C. Christensen

2-2-65

ABSTRACT: The SNAP 10A, FS-4 flight system was tested following the listed specifications, in accordance with the Flight System Configuration and Acceptance Test Requirement specifications.

NAA-SR-10735 UNCL

TITLE: SNAP 10A FLIGHT SYSTEM PROTOTYPE (FSM-1) PERFORMANCE

AUTHOR: L. L. Bixson

5-15-65

ABSTRACT: A summary and evaluation of the thermal tests performed on the SNAP 10A, FSM-1 thermoelectric power conversion system is presented. The unit was a developmental, nonnuclear, full-scale version of the nuclear-powered flight system. The overall results of the tests verified the validity of the flight system design. Reactor heat was developed by an electrical core heater. Liquid metal coolant pumped through the reactor core by a thermoelectrically-driven, electromagnetic pump was maintained at an average temperature of over 920° F for more than 90 days. During this period a total of 831 kwh of energy was generated by the thermoelectric converter at an average power level of 400 w. The test was performed in a vacuum environment to simulate the heat transfer characteristics encountered in space. Additional tests simulated conditions and the sequence of events from ground launch to nuclear startup in earth orbit.

NAA-SR-MEMO-12023

SYSTEM TESTING

NAA-SR-MEMO-10767 UNCL

TITLE: TEST CONTROL DEVICES - SNAP 10A VIBRATION TEST PROGRAM

AUTHOR: R. M. Oliva and E. L. Gardner

12-10-64

ABSTRACT: The solutions to various test control problems are recorded in this paper which discusses the input, response, and safety control devices employed during vibration testing on past and current SNAP 10A vehicles. Each device's description, function, and operation are discussed in detail.

This paper was prepared for presentation at the 34th Symposium on Shock, Vibration, and Associated Environments which was held in Pacific Grove, California on October 13-15, 1964.

NAA-SR-MEMO-10909 CONF RD

TITLE: TEST PROCEDURE 10FS3-050 "WET CRITICAL AND NUCLEAR ACCEPTANCE TEST"

AUTHOR: D. S. Brinkman

10-12-65

ABSTRACT: Results of Test Procedure 10FS3-050 "Wet Critical and Nuclear Acceptance Test"

NAA-SR-MEMO-11058 CONF RD

TITLE: WET CRITICAL AND THERMAL REFERENCE TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

10-12-65

ABSTRACT: Data taken during Wet Critical and Thermal Reference Testing of the SNAP 10A FS-5 flight system are presented. In addition, the results of both hot and cold control drum calibrations are included. Where appropriate, a comparison of the measured data with the performance of the 10FSM-4 and 10FS-4 systems is presented. The performance of FS-5 system and agreement with system requirements was, in most instances, excellent. When corrected to normal converter connections, the power output was 512 w at a reactor outlet temperature of 1025° F. Nuclear performance was as expected. The major deviation from system requirements was a low NaK flow of 12. 9 gpm instead of the required 13. 0 gpm.

NAA-SR-11129 UNCL

TITLE: SNAP 10A FSEM-3 AGENA COMPATIBILITY TEST

AUTHOR: M. Teresa

6-15-65

ABSTRACT: This report summarizes the results of SNAP 10A/Agena developmental testing and final vehicle systems tests. Developmental testing was performed with the SNAP 10A FSEM-3 payload electrical simulator and an Agena Functional Mockup. FSEM-3 was utilized during vehicle systems testing prior to shipment of the Agena to the launch site.

SYSTEM TESTING

NAA-SR-11206 CONF RD

TITLE: PRELIMINARY TEST RESULTS - SNAP 10A FS-3

AUTHOR: S. Miner, L. Bixon and D. Brinkman

9-1-65

ABSTRACT: The S10FS-3 was the first SNAP 10A flight system to undergo the complete SNAP 10A test program. Following successful completion of shock and vibration testing, the system was loaded with fuel and NaK. The system was then thermal and nuclear acceptance tested and brought up to full-power operation at design conditions. This report covers the acceptance testing and the first 90 days of power operation tests which have been successfully completed at design conditions in a simulated space environment.

PROTOTYPES: PSM-1, -1A, -1B, -2, -3

NAA-SR-MEMO-6133 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

S-10-FSM-2 (Mechanical Mockup)

July, 1962

A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)

January, 1963 delivery

April, 1963 flight

S-10-FS-3 (Second flight system)

March, 1963 delivery

August, 1963 flight

Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

A schedule for the design, fabrication, assembly, and test of those systems as well as the test system for use at AI has been prepared for comment.

NAA-SR-MEMO-7295 UNCL

TITLE: PSM-2 SNAP 10A ANALOG SIMULATOR OPERATIONS MANUAL

AUTHOR: A. C. Leisberg

4-24-62

ABSTRACT: The SNAP-10A-PSM-2 Analog Simulator will provide a power source having dynamic and static characteristics equivalent to the thermoelectric converter on the SNAP-10A system. The design requirements for the Analog Simulator are per PSM-2 system description #SD-10A-200-1.

NAA-SR-MEMO-7385 CONF DI

TITLE: SNAP 10A PSM-1 SHIELD THERMAL TEST

AUTHOR: E. C. Phillips

5-10-62

ABSTRACT: Three phase thermal test was performed on the SNAP 10A PSM-1 shield. Phase I consisted of heating the shield to 800°F at 60°F/hr, maintaining the shield at 800°F for three hours, and cooling the shield at 20°F/hr. Phase II consisted of heating at 20°F/hr to 800°F then cooling at 60°F/hr. Phase III consisted of heating and cooling the shield to and from 800°F at 60°F/hr three times.

PROTOTYPES: PSM-1, -1A, -1B, -2, -3

NAA-SR- 8399 UNCL

TITLE: SNAP 10A-PSM-1 TEST RESULTS

AUTHOR: R. M. Oliva

7-15-64

ABSTRACT: On November 14, 1961, an environmental test program commenced on the first SNAP 10A system structure, S10A-PSM-1. The object of this test was to subject the test vehicle to specified vibration, shock, and acceleration inputs and thereby determine various structural characteristics, such as major resonant frequencies, damping rates, magnification factors at various vehicle locations, stress levels at various preselected points, and deflections of structure and components under static (acceleration) loads. The results of these tests would be useful in verifying the integrity of the design tested and would yield information invaluable to the analysis and design of this and future SNAP 10A systems.

NAA-SR- 9280 UNCL

TITLE: THERMAL TESTING OF THE SNAP 10A PROTOTYPE SYSTEM (PSM-3)

AUTHOR: W. F. Marten and J. H. Van Osdol

7-15-64

ABSTRACT: From April 18, 1962 through October 11, 1962, the SNAP 10A PSM-3 non-nuclear test vehicle underwent thermal, electrical, and hydraulic tests at the Santa Susana Test Facility of Atomics International located in Chatsworth, California. This report defines the test vehicle and facilities, describes the tests and their objectives, and presents an evaluation of the tests. In general, the SNAP 10A PSM-3 test vehicle met its design goals.

NAA-SR- 9820 UNCL

TITLE: STRUCTURAL TEST ON THE FINAL SNAP 10A PROTOTYPE SYSTEM (PSM-1A)

AUTHOR: H. L. Henley and W. H. Dauterman

7-15-64

ABSTRACT: This report presents the results of the structural tests which were performed on the S10A-PSM-1A system to qualify the basic structural design for the anticipated launch environment. Included in this report are data from the damping, vibration, shock, acoustic, and static test programs. Testing was performed in accordance with NS10 PSM-1A-00-001, "PSM-1A Structural Test Specification."

PROTOTYPES: PSM-1, -1A, -1B, -2, -3

NAA-SR-MEMO-10033 CONF RD

TITLE: SNAP 10A FS-3 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky

6-11-64

ABSTRACT: Certifications, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-3 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, -3 and -4 core loadings. The 128 fuel elements for the FS-1, FS-3 and FS-4 cores were originally produced and designated for the FS-3, FS-4 and FS-5 cores. The reassignment of these fuel elements to the FS-1, FS-3 and FS-4 Reactor Systems occurred after their delivery to the Compact Systems Division. Therefore, all records and correspondence during production reflect the earlier system assignment and must be taken into consideration during any future examination of original data records.

FSM-1

NAA-SR-MEMO-8434 CONF RD

TITLE: 10FSM-1 REFLECTOR ASSEMBLY ACCEPTANCE TEST

AUTHOR: J. B. Tathwell

4-25-63

ABSTRACT: A list of all parts, their respective weights, and tooling assembled to the 10FSM1 reflector are presented. A check of critical clearances before and after the high temperature - high vacuum acceptance test on the reactor vessel-reflector assembly indicate that adequate clearances were maintained in the test environment. An increase in the friction of the coarse drum bearing was found by measuring the torque of the unloaded drums before and after test. The use of such torque measurements in future acceptance testing is recommended as a qualitative means of determining material and/or assembly difficulties.

NAA-SR-MEMO-9440 UNCL

TITLE: FSM-I A DATA REDUCTION PROGRAM

AUTHOR: R. J. Mikell and G. T. Chang

3-25-64

ABSTRACT: The FSM-I data reduction program consists of three parts.

Part I is a data reduction and analysis program which performs statistical calculations and numerical analysis of data gathered on punched paper tape. The signals to the paper tape punch are obtained from reactor instrumentation. One of the output media from Part I is a magnetic tape. This tape is used as the input to Part II.

Part II is the IBSYS sort program. This program takes the output magnetic tapes generated by Part I, sorts and merges the data, and, if desired, deletes records from the sorted and merged tapes. This is done to order and update a history tape of accumulated test runs processed by Part I. This accumulated history tape then becomes the input to Part III.

Part III is a normalizing and graphical display program. In this portion of the FSM-I package, plots of the various parameters which describe the system's performance are obtained.

NAA-SR-MEMO-9652 CONF DI

TITLE: S10A FSM-1 MAXIMUM POWER TRANSFER TEST

AUTHOR: R. Morberg

3-12-64

ABSTRACT: The enclosed data was derived from tests conducted on the S10A FSM-1 Power System during the 90 Day Test. The maximum power transfer tests were conducted on a programmed schedule beginning on October 30, 1963 and ending January 17, 1964.

FSM-1

NAA-SR-MEMO-9807 CONF DI

TITLE: SNAP 10A FSM-1 SHUTDOWN PERFORMANCE

AUTHOR: G. E. Berg

4-13-64

ABSTRACT: Data taken during the shutdown of the SNAP 10A FSM-1 system test is presented and analyzed. In analyzing shutdown performance, the system was divided into four categories:

- 1) Thermal,
- 2) Converter electrical,
- 3) Pump, and
- 4) Expansion Compensator.

In each category emphasis was placed on comparison of shutdown to thermal reference data and any departures from expected behavior. Generally, system and component performance was satisfactory and conformed to expected behavior.

NAA-SR-MEMO-9808 CONF RD

TITLE: FSM-1 STARTUP TEST RESULTS

AUTHOR: G. H. Parker

2-26-64

ABSTRACT: The results of the SNAP 10A FSM-1 startup tests are presented with an evaluation and comparison with expected transient performance. A chronology is given for the major milestones in planning the tests as well as the major events in the conduct of the tests.

NAA-SR-MEMO-10142 CONF RD

TITLE: EXAMINATION OF SNAP 10 FSM-1 POSITIONING BRACKET AND REFLECTOR HINGE SURFACES

AUTHOR: P. P. King

6-26-64

ABSTRACT: SNAP 10 FSM-1 reflector positioning bolt, reflector positioning bracket, reflector stop and reflector hinge hard surfaces were examined for degradation after the 90 day test sequence. Some minor chipping was observed on the aluminum oxide coated surfaces and some metal transfer occurred between bolt heads and aluminum oxide surfaces. The mating surfaces appear to be in satisfactory condition after tests with no gross damage, which would compromise the mission objectives. Metal transfer will not occur in subsequent systems because Al_2O_3 is substituted for the LC-1A chromium carbide coating.

FSM-1

NAA-SR- 10735 UNCL

TITLE: SNAP 10A FLIGHT SYSTEM PROTOTYPE (FSM-1) PERFORMANCE

AUTHOR: L. L. Bixson

5-15-65

ABSTRACT: A summary and evaluation of the thermal tests performed on the SNAP 10A, FSM-1 thermoelectric power conversion system is presented. The unit was a developmental, nonnuclear, full-scale version of the nuclear-powered flight system. The overall results of the tests verified the validity of the flight system design. Reactor heat was developed by an electrical core heater. Liquid metal coolant pumped through the reactor core by a thermoelectrically-driven, electromagnetic pump was maintained at an average temperature of over 920°F for more than 90 days. During this period a total of 831 kwh of energy was generated by the thermoelectric converter at an average power level of 400 w. The test was performed in a vacuum environment to simulate the heat transfer characteristics encountered in space. Additional tests simulated conditions and the sequence of events from ground launch to nuclear startup in earth orbit.

NAA-SR-MEMO-11240 UNCL

TITLE: S10A FSM-1 SYSTEM TEST DATA LIBRARY, VOLUMES I, II, III AND IV

AUTHOR: W. F. Marten

3-18-65

ABSTRACT: The following list summarizes the S10A FSM-1 data and associated documents which are on file in volume form in a system test data library being maintained in Building 037, Santa Susana, by D/722-251.

- 1) Assembly Records - complete history of assembly phase including identification of components, inspection coverage and system checkout.
- 2) Shock and Vibration Test Records - complete history of shock and vibration testing including all mechanical and electrical check sheets, performance evaluation and test discrepancies.
- 3) Thermal Test Records - includes all test specifications, test reports, operating discrepancies and periodically conducted check sheets.
- 4) Thermal Test Data Collected - includes all original data logger sheets and original system performance curves generated during the thermal testing from August 23, 1963 to January 17, 1964.

FSEM-2

NAA-SR-MEMO-6135 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

S-10-FSM-2 (Mechanical Mockup)

July, 1962

A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)

January, 1963 delivery

April, 1963 flight

S-10-FS-3 (Second flight system)

March, 1963 delivery

August, 1963 flight

Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

NAA-SR-MEMO-7951 CONF RD

TITLE: ELECTROMAGNETIC INTERFERENCE TEST OF FSEM-2 APU SYSTEM

AUTHOR: W. Holsborg and J. L. Johnson

11-8-62

ABSTRACT: This TDR describes the conducted electromagnetic interference test as prescribed by the Military Specification MIL-I-26600 (USAF) Amendment 2 performed on the FSEM-2 APU system.

The results of this test indicate that the test specimen generates interference in excess of the prescribed limits of MIL-I-26600.

NAA-SR-9893 UNCL

TITLE: SNAP 10A/AGENA ELECTRICAL MOCKUP TEST (S10A/FSEM-2)

AUTHOR: M. J. Teresa

7-30-64

ABSTRACT: A test program to establish preflight confidence in SNAP 10A and Agena electrical systems was conducted at LMSC's Sunnyvale facility between November 1962 and June 1963. The tests were performed with an electrical mockup of the NPU, designated FSEM-2, and an Agena development test vehicle or functional mockup (FMU). Final checkout of Agena subsystems extended into early May 1963. During the month of May integrated systems tests were conducted with the FSEM-2/FMU. The two mockups were programmed through a simulated sequence of operation from prelaunch to end of life.

14 FSEM-2

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME I, INTRODUCTION,
SUMMARY, AND DEVELOPMENT AND QUALIFICATION PROGRAM

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six
volumes, of which this volume (Volume I) is one.

Volume I contains an introduction and a summary of the component qualification
status and test data, and a description of the development and qualification program.
Included in the latter are descriptions of the component qualification program, and
the FSEM-2, FSEM-3, FS-1, and FSM-4 test programs.

FSEM-3

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME I, INTRODUCTION, SUMMARY, AND DEVELOPMENT AND QUALIFICATION PROGRAM

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume I) is one.

Volume I contains an introduction and a summary of the component qualification status and test data, and a description of the development and qualification program. Included in the latter are descriptions of the component qualification program, and the FSEM-2, FSEM-3, FS-1, and FSM-4 test programs.

NAA-SR- 11129 UNCL

TITLE: SNAP 10A FSEM-3 AGENA COMPATIBILITY TEST

AUTHOR: M. Teresa 6-15-65

ABSTRACT: This report summarizes the results of SNAP 10A/Agena developmental testing and final vehicle systems tests. Developmental testing was performed with the SNAP 10A FSEM-3 payload electrical simulator and an Agena Functional Mockup. FSEM-3 was utilized during vehicle systems testing prior to shipment of the Agena to the launch site.

FSM-4 (FS-2)

NAA-SR-MEMO-6155 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

S-10-FSM-2 (Mechanical Mockup)

July, 1962

A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)

January, 1963 delivery

April, 1963 flight

S-10-FS-3 (Second flight system)

March, 1963 delivery

August, 1963 flight

Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME I, INTRODUCTION, SUMMARY, AND DEVELOPMENT AND QUALIFICATION PROGRAM

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume I) is one.

Volume I contains an introduction and a summary of the component qualification status and test data, and a description of the development and qualification program. Included in the latter are descriptions of the component qualification program, and the FSEM-2, FSEM-3, FS-1, and FSM-4 test programs.

NAA-SR-MEMO-10278 CONF RD

TITLE: SNAP 10A FSM-4 TEST STATUS

AUTHOR: J. Brunings and W. Vaughn

9-15-64

ABSTRACT: This report describes the FSM-4 system test program, schedule, and test objectives. An evaluation of the system test reliability is summarized based on component test data available as of June 1, 1964.

FSM-4 (FS-2)

NAA-SR-MEMO-10446 UNCL

TITLE: SNAP-10A FSM-4 PERFORMANCE ANALYSIS - NaK LOADING AND THERMAL
REFERENCE TEST

AUTHOR: G. E. Berg 9-15-64

ABSTRACT: Data taken during NaK loading and thermal reference testing of the SNAP-10A FSM-4 non-nuclear ground test system are presented and analyzed. For purposes of analysis the performance was divided into five categories:

- 1) System temperatures,
- 2) System heat losses,
- 3) Converter electrical performance,
- 4) Pump performance, and
- 5) Flight instrumentation performance.

In each category emphasis was placed on comparison of measured data to predicted performance and thermal reference performance of the 10FSM-1 and 10FS-1 systems. In almost every case both FSM-4 performance and agreement with predicted values were excellent. An average of 509 w was produced at a core outlet temperature of 1011°F. The only important problem was a low converter to ground resistance which would have caused a very small decrease in power output if the system had been grounded.

NAA-SR-MEMO-10913 UNCL

TITLE: HISTORY ANALYSIS PROGRAM FOR FSM-4, FS-3, AND FLAP-4

AUTHOR: R. J. Mikell and G. T. Chang 9-1-65

ABSTRACT: The History Analysis Program is a data handling, display and analysis program. This program is made up of several subroutines which may be optioned singly or in combinations to examine data generated by the following SNAP data reduction and analysis programs for FSM-4, FS-3, and FLAP-4. The data used by the History Analysis Program is an accumulation of runs from daily acquisitions of the above three SNAP systems. The available options may be found in the Purpose sections. Other options may be added.

FS-1

NAA-SR-MEMO-8272 SECRET RD

TITLE: SNAP 10A FS-1 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS
AUTHOR: D. C. Campbell 2-15-63
ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-1 Core. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-8325 CONF RD

TITLE: 10FS-1 ACCIDENT ANALYSIS
AUTHOR: D. R. Paddleford and R. W. Winson 3-19-63
ABSTRACT: Power and energy transients are presented for accidents corresponding to the insertion of 1, 2, and 4 control drums simultaneously into the reactor at the maximum insertion rate. These transients were obtained for the case of "hot" (70°F) and "cold" (800°F) initial conditions with no coolant flow through the reactor.

NAA-SR-MEMO-9855 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR FIRST DELIVERY
AUTHOR: W. Sawicky 4-28-64
ABSTRACT: Certifications, test and inspection results, and copies of all waivers for the forty 6.35 nominal N_H and ten 6.0 nominal N_H fuel elements delivered for the FS-1 Core are given herein. In addition, all pertinent aspects of the test and inspection operations are discussed.

NAA-SR-MEMO-9926 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR SECOND DELIVERY
AUTHOR: W. Sawicky 5-8-64
ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A Nuclear Ground Test Reactor are given herein. In addition, pertinent aspects of test and inspection operation are discussed. This discussion includes changes in N_H, carbon, Sm₂O₃, shock and vibration requirements which were not reflected in formalized specification changes. Descriptions are given of sampling methods, data analysis, and test operations for the more critical fuel element parameters.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME I, INTRODUCTION, SUMMARY, AND DEVELOPMENT AND QUALIFICATION PROGRAM

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume I) is one.

Volume I contains an introduction and a summary of the component qualification status and test data, and a description of the development and qualification program. Included in the latter are descriptions of the component qualification program, and the FSEM-2, FSEM-3, FS-1, and FSM-4 test programs.

NAA-SR-MEMO-10301 CONF RD

TITLE: SNAP 10A FS-1 RELIABILITY EVALUATION

AUTHOR: S. Miner 8-14-64

ABSTRACT: Documentation of a verbal presentation of S10FS-1 reliability made to the AEC in May, 1964.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky 12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low N_H - High Sr_nO₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO-10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-MEMO-6133 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

S-10-FSM-2 (Mechanical Mockup)

July, 1962

A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)

January, 1963 delivery

April, 1963 flight

S-10-FS-3 (Second flight system)

March, 1963 delivery

August, 1963 flight

Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

NAA-SR-MEMO-8809 SECRET RD

TITLE: SNAP 10A FS-3, -4 AND -5 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

7-25-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-3, -4 and -5 Cores. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky

12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low NH - High Sm₂O₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO-10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-MEMO-10909 CONF RD

TITLE: TEST PROCEDURE 10FS3-050 "WET CRITICAL AND NUCLEAR ACCEPTANCE TEST"

AUTHOR: D. S. Brinkman 10-12-65

ABSTRACT: Results of Test Procedure 10FS3-050 "Wet Critical and Nuclear Acceptance Test"

NAA-SR-MEMO-10913 UNCL

TITLE: HISTORY ANALYSIS PROGRAM FOR FSM-4, FS-3, AND FLAP-4

AUTHOR: R. J. Mikell and G. T. Chang 9-1-65

ABSTRACT: The History Analysis Program is a data handling, display and analysis program. This program is made up of several subroutines which may be optioned singly or in combinations to examine data generated by the following SNAP data reduction and analysis programs for FSM-4, FS-3, and FLAP-4. For data used by the History Analysis Program is an accumulation of runs from daily acquisitions of the above three SNAP systems. The available options may be found in the Purpose sections. Other options may be added.

NAA-SR-11206 CONF RD

TITLE: PRELIMINARY TEST RESULTS - SNAP 10A FS-3

AUTHOR: S. Miner, L. Bixon and D. Brinkman 9-1-65

ABSTRACT: The S10FS-3 was the first SNAP 10A flight system to undergo the complete SNAP 10A test program. Following successful completion of shock and vibration testing, the system was loaded with fuel and NaK. The system was then thermal and nuclear acceptance tested and brought up to full-power operation at design conditions. This report covers the acceptance testing and the first 90 days of power operation tests which have been successfully completed at design conditions in a simulated space environment.

NAA-SR-MEMO-8809 SECRET RD

TITLE: SNAP 10A FS-3, -4 AND -5 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

7-25-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-3, -4 and -5 Cores. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-9217 CONF RD

TITLE: S-10-FS-4 FUEL CALIBRATION WITH BARE CLADDING

AUTHOR: D. W. Clifford

11-18-63

ABSTRACT: The SCA-4A reactor assembly was employed to measure closely the reactivity worth of each FS-4 fuel rod in a reference configuration. Subsequently, a full core loading of 37 FS-4 rods was measured in the 4A machine with the S-10-FS-1 reflector configuration.

NAA-SR-MEMO-10208 CONF RD

TITLE: SNAP 10A FS-4 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky

7-13-64

ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-4 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, FS-3 and FS-4 Core loadings. The average N_H and permeation rate, as well as the total Uranium, U_{235} and Sm_2O_3 contents for this Core as reported herein, was based on the assignment of the 37 fuel elements made by the Compact Systems Division as of this report date. Any change in this assignment involving the surplus fuel elements for the Core may require recalculation of the above four Core characteristics.

NAA-SR-MEMO-10673 CONF RD

TITLE: THERMAL REFERENCE TEST, SNAP 10A FS-4

AUTHOR: W. C. Christensen

2-2-65

ABSTRACT: The SNAP 10A, FS-4 flight system was tested following the listed specifications, in accordance with the Flight System Configuration and Acceptance Test Requirement specifications.

NAA-SR-MEMO-10670 CONF RD

TITLE: FUEL LOADING-DRY CRITICAL TESTS, SNAP 10A FS-4

AUTHOR: W. N. Louie

12-18-64

ABSTRACT: Fuel loading of the S10 FS-4 SNAP unit was initiated on October 21, 1964, in accordance with the loading specification, NA0222-026. There were no major deviations from the loading sequence presented in the specification, and the procedure was followed without any changes to load the full complement of 37 elements.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky

12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low N_H - High Sm₂O₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO -10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-MEMO-8809 SECRET RD

TITLE: SNAP 10A FS-3, -4 AND -5 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong 7-25-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-3, -4 and -5 Cores. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky 12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low NH - High Sm₂O₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO-10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-MEMO-11057 CONF RD

TITLE: FUEL LOADING - DRY CRITICAL TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford 3-25-65

ABSTRACT: Describes the following activities: Load the SNAP 10A FS-5 reactor with a full complement of fuel elements, perform drum calibrations and determine excess reactivity in accordance with specification NA0222-36.

NAA-SR-MEMO-11058 CONF RD

TITLE: WET CRITICAL AND THERMAL REFERENCE TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford 10-12-65

ABSTRACT: Data taken during Wet Critical and Thermal Reference Testing of the SNAP 10A FS-5 flight system are presented. In addition, the results of both hot and cold control drum calibrations are included. Where appropriate, a comparison of the measured data with the performance of the 10FSM-4 and 10FS-4 systems is presented. The performance of FS-5 system and agreement with system requirements was, in most instances, excellent. When corrected to normal converter connections, the power output was 512 w at a reactor outlet temperature of 1025°F. Nuclear performance was as expected. The major deviation from system requirements was a low NaK flow of 12.9 gpm instead of the required 13.0 gpm.

C. REACTOR

REACTOR, GENERAL

NAA-SR-MEMO-4839 SECRET RD

TITLE: SER-STATUS REPORT FOR PERIOD BEGINNING 0000 HOURS ON 12/27/59 AND
ENDING 1/2/60

AUTHOR: R. R. Eggleston

1-26-60

ABSTRACT: Describes tasks completed during the period indicated.

NAA-SR-MEMO-5359 UNCL

TITLE: FEASIBILITY STUDY OF A CONVECTION COOLED SNAP 10 SYSTEM

AUTHOR: A. W. Thiele

6-6-60

ABSTRACT: The basic requirements of the SNAP 10 system were formulated in the Spring of 1959 and presented in the Project Proposal for FY 60 as Project 2100 of NAA-SR-3613, June 1959.

Since this pure conduction cooled reactor-converter-radiator concept was selected - the SNAP Experimental Reactor (SER), a NaK cooled SNAP 2 concept, has been operated for over 125,000 kwh of thermal output with excellent results. This integrated output is in excess of the power required for the SNAP 10 System during the one year life. It thus appears possible to reduce the complexity of the overall development effort for the SNAP 10 program by utilizing a standardized SNAP 2 reactor in the SNAP 10 system rather than develop a reactor specifically tailored to the low power system.

NAA-SR-MEMO-7593 UNCL

TITLE: SNAP 2/10A REACTOR DEVELOPMENT PLAN

AUTHOR: J. Susnir

9-1-62

ABSTRACT: Various aspects of the SNAP 2/10A reactor development program are discussed. These include discussions of reactor concepts, design parameters, performance objectives, reliability goals, and developmental schedules. It is noted that, except for power generation concepts, the design of SNAP 2 is identical to that of SNAP 10A. The power generation systems differ due to the higher temperature and power requirements of the SNAP 2 reactor. Reliability goals established by the customer are outlined for the SNAP 10A system; no reliability goals have been set to date for the SNAP 2 system. Component and systems tests to be utilized to demonstrate the feasibility of the reactor design are described, including descriptions of the nuclear experiments and the reactor experiments. The nuclear experiments will be conducted on the SNAP critical assemblies and the shield test facility; the reactor experiments will provide tests of the experimental and developmental reactors. Systems tests of the mockup assemblies and the flight system assembly are described. Delivery schedules of flight test systems of both SNAP 2 and SNAP 10A reactors are outlined.

REACTOR, GENERAL

NAA-SR-9898, Volume 1 CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME I, CONTROL
COMPONENTS

AUTHOR: W. J. Kurzeka, Editor

8-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR-9898, Volume II CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 2, SAFETY AND
DIAGNOSTIC COMPONENTS

AUTHOR: W. J. Kurzeka, Editor

12-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

REACTOR DESIGN

NAA-SR-MEMO-3886 UNCL

TITLE: EVALUATION OF ORBITAL STARTUP METHODS

AUTHOR: O. P. Steele, III

7-20-59

ABSTRACT: The political implications of a hot reactor falling in a populated area due to launching mishap has placed strong emphasis on orbital startup of the reactor system. To evaluate the weight penalty of orbital startup some of the methods of achieving this have been investigated. This report compares these methods and outlines some of the development problems involved.

NAA-SR-MEMO-7886 CONF RD

TITLE: SNAP 10A POWER UNIT

AUTHOR: L. L. Bixson

6-30-64

ABSTRACT: A conceptual drawing of the SNAP 10A system is shown in Figure 1 and the engineering drawing in Figure 2. The reactor is typical of the zirconium hydride-uranium fueled SNAP type. The fuel chosen gives a high hydrogen density and hence small overall size and weight, and achieves the relative control simplicity typical of thermal neutron spectrum systems. The reactor core is reflected by beryllium and is controlled by four semicylindrical control drums operating in the reflector. These drums function by varying the neutron leakage flux. Sodium potassium (NaK-78) coolant circulates through the core, entering at 859°F and exiting at 987°F. The overall reactor power required is 39.5 kw. This particular reactor type possesses a strong negative temperature coefficient which is used for inherent control and stability over the operating lifetime thus eliminating the need for continuous control drum actuation. This static, or inherent, control system is possible because of the low power rating of the reactor, which results in negligible reactivity shift due to fuel burnup, and low reactor temperatures which minimize the dissociation and subsequent loss of hydrogen from the fuel.

NAA-SR-8613 CONF RD

TITLE: FINAL REPORT ON THE SNAP 10A CRITICAL ASSEMBLY STUDIES

AUTHOR: D. Clifford

4-29-64

ABSTRACT: A detailed experimental program conducted on the SCA-4C reactor assembly has yielded extensive design information for the SNAP 2/10A flight reactor. The experiments were primarily concerned with core reactivity and buckling measurements, and external reflector studies. The core measurements showed how control of hydrogen and beryllium in the fuel region could be used to control the excess reactivity of the system without excessive flux perturbations. The reflector thickness could be used as a fine adjustment of system reactivity. Data on shutdown margins and drum control were also provided. Additionally, other core parameters and various component and human mockups were studied in an effort to ascertain reactivity worths of core components and possible environmental effects on the system.

REACTOR DESIGN

NAA-SR-MEMO-8679, REVISION 1 SECRET RD

TITLE: SNAP 10A REACTOR DESIGN SUMMARY

AUTHOR: W. W. Davis

10-26-64

ABSTRACT: An updated description of the SNAP 10A reactor subsystem is presented. Design details of the principal assemblies which constitute the reactor subsystem are discussed. System behavior for abnormal conditions such as disassembly during re-entry, operation in rain filled craters, and long term operation in space are included.

NAA-SR-9007 SECRET RD

TITLE: SNAP FUEL AND CORE MATERIALS COMPATIBILITY SCREENING TESTS

AUTHOR: L. B. Lundberg

3-1-64

ABSTRACT: Screening tests have been performed to determine the compatibility of many of the materials in contact with each other in the SNAP 10A/2 and SNAP 8 reactor cores. In some cases of known incompatibility, reaction barriers were studied. The tests involved placing small samples of the materials under consideration in intimate contact at temperatures from 1200 to 1450°F for periods up to 1000 hr in environments similar to those encountered in the particular reactor. The mutual compatibility of the sample materials was determined by metallographic examination. Reactions were observed between the following components: fuel and the bare cladding (without hydrogen barrier); fuel cladding and the SNAP 2 beryllium internal radial reflector; and several fuel element thermal bond materials and both the fuel and the enamel hydrogen barrier. Reaction barriers for fuel cladding and the SNAP 2 beryllium internal radial reflector were examined, but none were found to be effective. The majority of the suggested reactor core materials were found compatible in this study.

NAA-SR-9898, VOLUME III CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 3, SHIELD, GROUND TEST ASSEMBLY, AND MATERIALS APPLICATIONS

AUTHOR: W. J. Kurzeka, Editor

2-10-65

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-MEMO-3794 SECRET RD

TITLE: BERYLLIUM REPLACEMENT IN THE SNAP X REACTOR

AUTHOR: C. M. Podeweltz

4-23-59

ABSTRACT: The results indicate that a considerable reduction in ΔT can be obtained without incurring too large a penalty in increased reactor weight, up to volume fractions of 25% - 35% beryllium. Larger fractions of beryllium further reduce the ΔT , but the weight increases much more rapidly than at first. Once it is determined what reduction in radiator and structure weight will be effected by the reductions in ΔT , an optimum fraction of beryllium can be chosen.

NAA-SR-MEMO-4137 SECRET RD

TITLE: ANALYSIS OF A RECTANGULAR FINNED RADIATOR FOR THE SNAP 10

AUTHOR: R. L. Hirsch

7-15-59

ABSTRACT: The radiator for the SNAP 10 consists of a cylindrical base annulus from which rectangular fins project radially. This report describes the two methods that were incorporated to describe heat flow in this body. Because of its simplicity, the first method yielded a useful, early description of the radiator. A later, more detailed analysis indicated that the results of the first work were a little optimistic.

NAA-SR-MEMO-4338 SECRET RD

TITLE: NEUTRON STREAMING EFFECTS IN THE SNAP CRITICAL ASSEMBLY

AUTHOR: L. I. Moss

9-3-59

ABSTRACT: For the design of SNAP X it is necessary to know the reactivity worths of air gaps and of various materials in these gaps. For this purpose, an experiment has been performed on the SNAP critical assembly.

NAA-SR-MEMO-4599 SECRET RD

TITLE: THERMAL STRESS PROBLEM AREAS IN THE SNAP 10 REACTOR

AUTHOR: R. A. Stone

11-2-59

ABSTRACT: Describes the approach to the known problem areas existing at the time.

NAA-SR-MEMO-4739 SECRET RD

TITLE: TRANSIENT RESPONSE OF SNAP 10 TO STEP CHANGES IN REACTIVITY

AUTHOR: J. Reichman

12-11-59

ABSTRACT: Equations are developed to determine energy release, peak powers and the time to reach peak power for step reactivity changes greater than one dollar. These equations can be readily used to recalculate these variables when more accurate values are available for the SNAP 10 reactor parameters.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-MEMO-4992 SECRET RD

TITLE: EFFECTS OF SNAP 10 PARAMETER CHANGES UPON ELECTRICAL POWER
OUTPUT

AUTHOR: J. Reichman

2-19-60

ABSTRACT: During operation, the SNAP 10 reactor system will undergo a series of normal changes in parameters that will cause the electrical power output to vary. While these changes will be occurring simultaneously, each at an unknown rate, the separate effects upon the power output can be determined and thus give an estimate of their relative importance. It is the purpose of this TDR to consider these effects separately and determine the power change.

NAA-SR-MEMO-5027 SECRET RD

TITLE: ESTIMATE OF SNAP 10 POWER COEFFICIENT OF REACTIVITY AND REACTIVITY
CHANGE IN GOING TO FULL POWER

AUTHOR: W. T. Hayes

3-1-60

ABSTRACT: A calculation of the power coefficient of reactivity for the SNAP 10 reactor at rated power (~10-13 kw) and of the total change in reactivity in going to full power state from start-up is of importance in the design of the system. These two quantities are estimated using one group perturbation theory.

NAA-SR-MEMO-5107 CONF RD

TITLE: ORBITAL STARTUP OF SNAP 10 REACTOR

AUTHOR: J. Reichman

3-31-60

ABSTRACT: Startup reactivity control of the SNAP 10 reactor is achieved by separating the reactor into two halves. The two halves are initially separates so that the reactor is sufficiently subcritical to prevent any conceivable nuclear accident. The two halves will be brought together at a predetermined rate by a motorized drive mechanism. The purpose of this report is to determine what rate is to be used to drive the halves together.

NAA-SR-MEMO-5315 SECRET RD

TITLE: THE SNAP 10 CRITICAL ASSEMBLIES

AUTHOR: C. M. Podeweltz

5-24-60

ABSTRACT: Estimation of the critical dimensions for the SNAP 10 critical assemblies.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-MEMO-6725 UNCL

TITLE: SNAP 10A PREPOISONING

AUTHOR: H. Baucom

9-6-61

ABSTRACT: The long term control requirements for SNAP 10A may be minimized through the use of a burnable poison. It is recommended that natural samarium oxide be mixed homogeneously in the ceramic hydrogen barrier material throughout the total length of the fuel element. The specification is $6.6 \pm 10\%$ milligrams of natural Sm_2O_3 per linear inch of fuel rod per fuel rod. This corresponds to about 3 grams Sm_2O_3 in the SNAP 10A reactor.

NAA-SR-MEMO-7877 CONF RD

TITLE: THERMO-PHYSICS TECHNICAL NOTE NO. 14: SNAP 10A REACTOR TEMPERATURES AND POWER DECAY IN SPACE FOR ZERO NaK FLOW AND LOSS OF NaK

AUTHOR: S. R. Fields

10-11-62

ABSTRACT: The steady-state temperatures of the SNAP 10A reactor in orbit following complete loss of NaK have been calculated at various power levels for full sun and dark sky conditions. The results of the heat transfer analysis were used to determine the reactor power decay. In addition, the power decay calculations of a previous analysis were modified to include the effect of fuel burnup.

NAA-SR-MEMO-8325 CONF RD

TITLE: 10FS-1 ACCIDENT ANALYSIS

AUTHOR: D. F. Paddleford and R. W. Winson

3-19-63

ABSTRACT: Power and energy transients are presented for accidents corresponding to the insertion of 1, 2, and 4 control drums simultaneously into the reactor at the maximum insertion rate. These transients were obtained for the case of "hot" (70°F) and "cold" (800°F) initial conditions with no coolant flow through the reactor.

NAA-SR-MEMO-9217 CONF RD

TITLE: S-10-FS-4 FUEL CALIBRATION WITH BARE CLADDING

AUTHOR: D. W. Clifford

11-18-63

ABSTRACT: The SCA-4A reactor assembly was employed to measure closely the reactivity worth of each FS-4 fuel rod in a reference configuration. Subsequently, a full core loading of 37 FS-4 rods was measured in the 4A machine with the S-10-FS-1 reflector configuration.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-MEMO-9514 CONF RD

TITLE: LONG TERM SNAP 10A REACTOR OPERATION ANALYSIS

AUTHOR: W. R. Lahs

2-7-64

ABSTRACT: This report presents the description and results of the long term reactor operation code used to solve the above problem. The code represents the heat transfer and fluid flow in a five node reactor representation coupled with a radiator heat transfer equation and a reactivity relationship. The model is solved at discrete points in time based on the assumption that for the operating histories considered, time dependent terms involving changes in heat capacities can be neglected without significant error. The code does not solve for any power or temperature transients but instead calculates reactor temperatures and powers under conditions of relatively slow coolant flow and/or radiator emissivity coating degradations. A 0.1 year time increment is generally used between calculation points; however, a 0.01 year increment is sometimes used to eliminate convergence problems. Assuming the SNAP 10A system with time dependent NaK flow and emissivity coating degradation as input data, the resulting reactor inlet and outlet coolant temperatures and the reactor power are presented as a function of time.

NAA-SR-MEMO-9589 CONF RD

TITLE: TRANCORE-10A: A DIGITAL PROGRAM EVALUATING TRANSIENT TEMPERATURES WITHIN THE SNAP 10A REACTOR CORE

AUTHOR: P. M. Magee

3-5-64

ABSTRACT: A mathematical model has been developed which describes the reactor kinetics, core heat transfer and thermoelectric pump performance of the SNAP 10A system. From the model, a digital computer code, "TRANCORE-10A", has been prepared which predicts transient temperatures within the reactor core. The code can be used to investigate a wide variety of reactor operational behavior: steady-state, startup, scram, loss of coolant flow, etc. It has been used extensively to predict startup transients. However, the code cannot be used to evaluate the effects of rapid reactivity changes, i. e., operation near prompt critical.

NAA-SR-9720 CONF RD

TITLE: SNAP 10A PRESTARTUP AND STARTUP PERFORMANCE

AUTHOR: G. S. Drucker and T. J. Boyle

6-30-64

ABSTRACT: Presented are the results of analyses to determine the thermal behavior of the SNAP 10A System in orbit prior to startup, and the nuclear, thermal, and hydraulic behavior of the system during startup. Parameter studies were made to determine the effects of variations from the nominal design conditions on maximum and minimum system temperatures prior to startup and the severity of the startup transient. Also included are the mathematical models used in the digital and analog computer solutions. The analyses results indicate that the SNAP 10A system will meet its pre-startup and startup requirements.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-9723 UNCL

TITLE: BEHAVIOR OF SNAP 10A DURING ORBITAL REENTRY

AUTHOR: D. K. Nelson

7-15-64

ABSTRACT: This report presents an analysis of the SNAP 10A power system during orbital reentry to gain information regarding the ablation of various nuclear reactor components. The SNAP 10A power system uses thermoelectric elements to convert the heat developed by a compact nuclear reactor into electrical energy. The initial point in the analysis occurs, after system operation in space, at an altitude in the process of satellite orbit decay where the satellite will not make another complete circuit of the earth. The analysis considered an oblate rotating earth.

NAA-SR-MEMO-10580 CONF RD

TITLE: A STUDY OF NEUTRON POISON EFFECTIVENESS IN A WATER-FLOODED SNAP 10A CORE DUE TO NEUTRON SPECTRAL CHANGES

AUTHOR: R. H. Norman and D. G. Oliver

10-19-64

ABSTRACT: This report presents the reactivity effects of several possible poison loadings that will insure subcriticality in the bare SNAP 10A core in a water environment.

NAA-SR-MEMO-10670 CONF RD

TITLE: FUEL LOADING-DRY CRITICAL TESTS, SNAP 10A FS-4

AUTHOR: W. N. Louie

12-18-64

ABSTRACT: Fuel loading of the S10 FS-4 SNAP unit was initiated on October 21, 1964, in accordance with the loading specification, NA0222-026. There were no major deviations from the loading sequence presented in the specification, and the procedure was followed without any changes to load the full complement of 37 elements.

NAA-SR-MEMO-10759 CONF RD

TITLE: SNAP 10A REACTOR HYDROGEN REDISTRIBUTION

AUTHOR: N. K. Simon

12-1-64

ABSTRACT: SCA-4A critical assembly hydrogen worth data is combined with results of HYTRAN-II hydrogen distribution calculations to determine the equilibrium hydrogen redistribution in SNAP 10A reactors. Experimental worth values are compared with a previously assumed flux-squared worth curve. HYTRAN-II runs were made for each core position at minimum, nominal, and maximum values of redistribution parameters to illustrate the major part of the uncertainty in redistribution worth.

REACTOR/NUCLEAR ANALYSIS

NAA-SR-MEMO-10926 CONF RD

TITLE: PERFORMANCE CAPABILITIES OF THE SNAP 10A/2 REACTOR UNDER ACTIVE CONTROL

AUTHOR: D. J. McGoff and K. R. Birney

1-18-65

ABSTRACT: An analysis of the Temperature-Power-Lifetime capabilities of the SNAP 10A/2 reactor core under active control was performed. Reactivity, heat transfer, and material limitations were considered.

NAA-SR-MEMO-11057 CONF RD

TITLE: FUEL LOADING - DRY CRITICAL TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

3-25-65

ABSTRACT: Describes the following activities: Load the SNAP 10A FS-5 reactor with a full complement of fuel elements, perform drum calibrations and determine excess reactivity in accordance with specification NA0222-36.

NAA-SR-11642 UNCL

TITLE: THE PREDICTED FISSION PRODUCT DECAY OF SNAPSHOT I

AUTHOR: W. B. Sayer and R. S. Hart

1-15-66

ABSTRACT: SNAPSHOT-I was the first flight test of a direct power conversion system utilizing a nuclear reactor as the heat source. This report shows the calculated fission product inventory formed during the orbital operation of the SNAP 10A reactor and the predicted decay of this activity and the associated gamma radiation levels. A brief system description and summary of the operational phase is included.

REACTOR TESTING

NAA-SR-MEMO-5103 UNCL

TITLE: EXPERIMENTAL SHIELDING EVALUATION OF THE SETF USING SDR-I AND SNAP 10 AS RADIATION SOURCES

AUTHOR: R. L. Tomlinson

3-29-60

ABSTRACT: The SNAP Environmental Test Facility, which is now under construction, has been designed for the full-power testing of unshielded SNAP reactors in an environment that will approach that of satellite conditions. Special care has been observed in its design to facilitate personnel access to the power test cells in which the reactors will be operated, after a waiting period of 30 days and removal of all portable equipment that has been exposed to the nuclear radiation present during reactor operation at full or fractional power levels. In this regard, many special features have been designed into this facility. This report will deal only with the evaluation of those features concerned with nuclear radiation and shielding as they affect the operation of the SETF.

NAA-SR-8414 UNCL

TITLE: BOOMER - A DIGITAL PROGRAM FOR EVALUATING THE THERMAL AND KINETICS RESPONSE OF A SNAP 2/10A REACTOR

AUTHOR: R. W. Winson

5-31-64

ABSTRACT: A mathematical model of the SNAP 2/10A reactor was developed describing the reactor kinetics, heat transfer, and hydrogen diffusion within the reactor core. This theoretical model was then modified, on the basis of current test data, to realistically predict the transient response of the reactor. The model was then programmed into a digital code called BOOMER. The development of this code is described in detail in this report.

NAA-SR-9894 UNCL

TITLE: DEVELOPMENT OF HIGH-TEMPERATURE ELECTRICAL GROUND TEST HEATERS FOR THE SNAP 10A PROGRAM

AUTHOR: R. Blevitt, G. Paine and S. Sudar

3-1-65

ABSTRACT: The development and qualification of the system acceptance test heaters and the reactor simulator heater are described in this progress report.

NAA-SR-MEMO-1007b UNCL

TITLE: SNAPTRAN 2/10A -1 ACCEPTANCE TEST RESULTS

AUTHOR: R. K. Stitt

10-31-63

ABSTRACT: Mechanical checkout and acceptance tests on the SNAPTRAN 2/10A -1 machine at AI prior to its shipment to NRTS for transient testing.

FUEL DEVELOPMFNT

NAA-SR-MEMO-4175 SECRET RD

TITLE: FUEL REQUIREMENTS FOR SNAP X PROGRAM

AUTHOR: A. W. Thiele

7-29-59

ABSTRACT: The fuel for SNAP X will be in the shape of right circular cylinders. The information presented represents the present state of the reactor design, and may be subject to revision.

NAA-SR-MEMO-4573 SECRET RD

TITLE: FUEL ELEMENTS FOR SNAP 10 PROGRAM

AUTHOR: A. W. Thiele

10-28-59

ABSTRACT: Presents the requirements for fuel elements for the SNAP 10 program.

NAA-SR-MEMO-4663 SECRET RD

TITLE: RFCOMMENDATIONS ON CLADDING MATERIALS FOR THE SNAP 10 REACTOR

AUTHOR: C. J. Romero

11-17-59

ABSTRACT: For purposes of ease of assembly it would be best to use an available material that can be fabricated into a container with the lowest coefficient of thermal expansion. Hastelloy B appears satisfactory for these and other reasons. Considering difficulty of fabrication, Hastelloy N would be the next choice. Other materials do not lend themselves to this application.

The tolerances and dimensions of the container for assembly depend on the material used. It appears that containers for the SNAP 10 could be fabricated by spinning, deep drawing, rubber die forming, or explosive forming. The choice of method is dependent on hardenability of the material, availability of vendor facilities and experience, and general economics.

NAA-SR-MEMO-4718 SECRET RD

TITLE: PRELIMINARY QUALITY CONTROL DATA SHEETS FOR SDR-1 AND SNAP 10 FUEL ELEMENTS

AUTHOR: H. Taketani

12-14-59

ABSTRACT: For long range planning, preliminary quality control specifications for SDR-I and SNAP 10 fuel element need to be written down and examined.

FUEL DEVELOPMENT

NAA-SR-5648 SECRET

TITLE: PROCESSING OF SNAP-10 FUEL ELEMENTS

AUTHOR: P. S. Drennan and H. Taketani

11-1-61

ABSTRACT: Describes the processing cycle and techniques developed for the processing of fuel rods for the SNAP-10 reactor.

NAA-SR-MEMO-6067 UNCL

TITLE: PLAN OF ACTION (FOR HYDRIDING DEVELOPMENT)

AUTHOR: H. G. Weidberg

1-23-61

ABSTRACT: A hydriding mechanism is postulated based on available knowledge. Through a series of experiments, this postulate will be proved or disproved. It is expected that some insight into the hydriding mechanism will be obtained.

NAA-SR-MEMO-6645 CONF RD

TITLE: SPECIFICATIONS FOR ALLOYING AND FORMING SNAP 10A AND 2 FUEL MATERIALS

AUTHOR: T. S. Kirsch

8-9-63

ABSTRACT: This Memo describes the SNAP 10A-2 melting and forming process used by Atomics International, from compacting to final extrusion.

NAA-SR-MEMO-7166 UNCL

TITLE: PRESSING SNAP 2 AND 10 FUEL ROD ASSEMBLIES

AUTHOR: C. J. Ambrose

2-26-62

ABSTRACT: Feasibility of pressing the SNAP 2 and 10 fuel rod assemblies to increase production and improve heat transfer.

NAA-SR-MEMO-7317 CONF RD

TITLE: FUEL CLADDING DEVELOPMENT FOR SNAP REACTORS

AUTHOR: W. F. Dennison

4-17-62

ABSTRACT: Cladding development for SNAP 2, 8, and 10A has been in progress at Atomics International since 1958. As major steps within the program, two core loadings, the SER and the S-2DR were fabricated. The SNAP Experimental Reactor (SER) started operation in the fall of 1959 and operated for the equivalent of half a full power year before completion of planned experimental studies. The second in the series of SNAP-2 reactors, the S-2DR, began power operations about a year ago and is still active.

FUEL DEVELOPMENT

NAA-SR-MEMO-7671 CONF RD

TITLE: SNAP 2-10A CUP DEVELOPMENT

AUTHOR: W. F. Dennison

9-5-62

ABSTRACT: Development of the cup for SNAP 2-10A fuel elements is described.

NAA-SR-MEMO-8251 SECRET RD

TITLE: INTENTIONAL RUPTURE OF A SNAP 2/10A FUEL ELEMENT

AUTHOR: W. F. Dennison

2-11-63

ABSTRACT: An instrumented SNAP 2/10A fuel element was gradually heated in an evacuated autoclave until the internal H_2 pressure caused the cladding to burst. This element failed at $1738^{\circ}F$ at an internal pressure of 900 psig. Within overall experimental error (composition of the fuel rod, temperature and pressure measurements, etc.), the values obtained in this test agree with literature data.

NAA-SR-MEMO-9217 CONF RD

TITLE: S-10-FS-4 FUEL CALIBRATION WITH BARE CLADDING

AUTHOR: D. W. Clifford

11-18-63

ABSTRACT: The SCA-4A reactor assembly was employed to measure closely the reactivity worth of each FS-4 fuel rod in a reference configuration. Subsequently, a full core loading of 37 FS-4 rods was measured in the 4A machine with the S-10-FS-1 reflector configuration.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME III COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - REACTOR FUEL

AUTHOR: Staff

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume III) is one.

It contains a description of the component development and qualification test status of the reactor fuel.

FUEL DEVELOPMENT

NAA-SR-MEMO-11149 UNCL

TITLE: PROPERTIES OF CLADDING MATERIALS FOR SNAP HYDRIDE REACTORS

AUTHOR: G. F. Burdi

3-22-65

ABSTRACT: This report has been published to increase the usability of previously collected and classified information by distributing this compiled information in an unclassified report. This report contains currently available property data on potential cladding materials for SNAP hydride reactors and was compiled under the direction of the Atomics International SNAP General Supporting Technology Program.

FUEL ANALYSIS

NAA-SR-MEMO-4453 SECRET RD

TITLE: FUEL PROCESSING AND HANDLING SAFETY FOR SNAP 10 AND SDR-1

AUTHOR: W. T. Hayes

10-6-59

ABSTRACT: Calculate safe masses of fuel and alloy materials for handling during fuel fabrication and storage. The fuel to be that for the SNAP 10 and the SDR-1 reactors.

NAA-SR-MEMO-5136 UNCL

TITLE: CRITICALITY OF HANDLING SNAP 10 PLATES

AUTHOR: N. Ketzlach

4-1-60

ABSTRACT: The calculated minimum critical number of plates at optimum water-moderation and reflection is nine. Therefore, it is safe to handle four of these plates in any volume independent of the degree of water flooding and water moderation. No other moderator such as beryllium, beryllium oxide, heavy water, or graphite may be present. Safe spacings of groups of four plates may be determined from the criteria previously outlined.

NAA-SR-MEMO-7392 CONF RD

TITLE: HISTORY OF SNAP 2/10A FUEL ELEMENT LEAK RATES

AUTHOR: J. K. Balkwill

5-14-62

ABSTRACT: Prompted by our current concern with the production of low-leakage SNAP 10A fuel elements, I have tried to put down a historical summary of what hydrogen leak rates have been in the past, where they may be expected to be in the future, and why the project expects us to meet their design leak rate.

NAA-SR-MEMO-7217 CONF RD

TITLE: COMPATIBILITY STUDIES OF SOME SNAP 2/10A FUEL ELEMENT MATERIALS

AUTHOR: L. B. Lundberg

3-13-62

ABSTRACT: Pieces of beryllium, chrome-plated beryllium and beryllium plasma-arc-coated with alumina (Al_2O_3), beryllia (BeO), zirconia (ZrO_2) and thoria (ThO_2) were placed in contact with a coating, which had been applied to a chromized Hastelloy N substrate and tested for 1000 hr at 1300°F in a hydrogen atmosphere.

FUEL ANALYSIS

NAA-SR-MEMO-7734 CONF RD

TITLE: PERMEATION - TEMPERATURE CORRELATION FOR SNAP 10A FUEL ELEMENTS
AUTHOR: A. J. Fitzgerald and J. G. Spraul 9-19-62
ABSTRACT: Eight SNAP 10A fuel elements which contained normal uranium were used for this program. These elements had passed quality assurance tests prior to their use in this program. Each element was permeation tested several times over the temperature range of 900°F to 1200°F.

NAA-SR-MEMO-8155 CONF RD

TITLE: EFFECT OF EXCESSIVELY HIGH TEMPERATURE ON SNAP 10A FUEL ELEMENTS
AUTHOR: T. G. Parker 1-25-63
ABSTRACT: Two SNAP 10A fuel elements (normal uranium) were subjected to temperatures in excess of normal operating temperature to determine:
1) Maximum temperature without damaging fuel element,
2) Temperature at which the cladding yields, and
3) Temperature at which the ceramic hydrogen barrier fails.

NAA-SR-MEMO-8211 CONF RD

TITLE: SNAP 10A FUEL ELEMENT TEMPERATURES, CLEARANCES, THERMAL STRESSES DURING ORBITAL STARTUP
AUTHOR: J. D. Wilde 2-18-63
ABSTRACT: The most severe transient to which the SNAP 10A fuel elements are normally exposed is the orbital startup. Temperature distributions in the fuel, clad, and fuel element end caps were found for the transient power, flow and inlet temperature curves from the Startup System Description.

NAA-SR-MEMO-9654 CONF RD

TITLE: STUDIES OF SURFACES AND INTERFACES OF SNAP FUEL ELEMENTS
AUTHOR: L. Maisel 3-12-64
ABSTRACT: An oxidation kinetic study of chromized Hastelloy N was performed with surface identifications by X-ray diffraction; a complete metallographic examination of the surface formations was conducted for chromized Hastelloy N. The concentration profile of chromium in chromized Hastelloy N was also determined.

FUEL ANALYSIS

NAA-SR-9782 CONF RD

TITLE: TOPICAL REPORT, THERMOPHYSICAL PROPERTIES OF SNAP FUELS

AUTHOR: R. E. Taylor and C. J. Ambrose

6-26-64

ABSTRACT: The specific heat, thermal diffusivity, thermal conductivity, electrical resistivity, and thermal expansion of various zirconium-uranium hydrides were measured. Calculations of the specific heat based on this model are within 8% of the experimental results obtained by numerous laboratories on a variety of compositions.

NAA-SR-MEMO-9927 CONF RD

TITLE: METHOD FOR DETERMINING THE CONTENT AND DISTRIBUTION OF SAMARIUM POISON IN SNAP 10A FUEL ELEMENTS

AUTHOR: T. L. Iliff

6-1-64

ABSTRACT: This report describes the methods developed and used for controlling and determining the amount and distribution of samarium poison in fuel elements for the SNAP 10A FS and SNAPTRAN Reactor Systems. The major problems encountered, some of the limitations of these methods, and recommendations for improvements in the fuel element samarium determination and manufacturing processing are presented.

NAA-SR-MEMO-10476 CONF RD

TITLE: INTERIM SNAP 10A/2 REACTOR ISOTHERMAL FUEL TEMPERATURE COEFFICIENT

AUTHOR: E. M. Faelten and L. D. Swenson

9-24-64

ABSTRACT: The total isothermal fuel temperature coefficient consisting of a fuel expansion coefficient and a spectral coefficient has been calculated for the SNAP 10A and Interim SNAP 10A/2 Reactors. The fuel expansion coefficient takes into account fuel density changes as a function of temperature while the spectral coefficient considers changes in the nuclear cross sections with temperature.

NAA-SR-MEMO-10542 CONF RD

TITLE: FAILURE ANALYSIS OF SNAP 10A FS-1 FUEL ELEMENT NO. E-0343

AUTHOR: W. Sawicky

10-8-64

ABSTRACT: Determine the cause of the excessive hydrogen leak rate from Fuel Element No. E-0343, as the result of the FS-1 System test.

FUEL ANALYSIS

NAA-SR-11400 CONF RD

TITLE: FUSAk - A COMPUTING CODE FOR THEORETICAL EVALUATION OF SNAP 8 AND
SNAP 10A FUEL ELEMENT PERFORMANCE DURING REACTOR OPERATION

AUTHOR: M. E. Nathan

11-1-65

ABSTRACT: The FUSAk computing code, developed for rigorous analysis of performance of SNAP 8 and SNAP 10A fuel elements under any mode of reactor operating conditions, is described. A FUSAk computation for a particular fuel element of a SNAP reactor core evaluates hydrogen redistribution equilibrium dissociation pressure and hydrogen permeation for selected time steps.

FUEL FABRICATION

NAA-SR-MEMO-4477 SECRET RD

TITLE: FEASIBILITY REPORT FOR FABRICATION OF SNAP 10 FUEL ELEMENTS
AUTHOR: R. R. Turk and P. S. Drennan 11-2-59
ABSTRACT: A total of thirty-two (32) hydrided alloy fuel elements are to be produced from zirconium and uranium raw materials. The process consists of compacting and arc melting the component materials to form an initial alloy ingot, sectioning of the ingots into slugs and canning of the slugs, forging the slugs into discs, decanning and machining of the discs, hydriding and grinding.

NAA-SR-MEMO-6645 CONF RD

TITLE: SPECIFICATIONS FOR ALLOYING AND FORMING SNAP 2 AND 10A FUEL MATERIALS
AUTHOR: P. S. Drennan 12-18-61
ABSTRACT: This specification sets forth the requirements for alloying and forming fuel materials for SNAP 2 and 10A programs. Only homogeneous alloys produced by triple consumable arc melting and free of internal defects will be acceptable for fuel element material.

NAA-SR-MEMO-7810 CONF RD

TITLE: SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGE
AUTHOR: W. E. Nagel, Ted Baker and J. Fitzgerald 10-15-62
ABSTRACT: This document contains the complete data on fabrication and testing of fuel elements delivered for system use.

NAA-SR-MEMO-8272 SECRET RD

TITLE: SNAP 10A FS-1 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS
AUTHOR: D. C. Campbell 2-15-63
ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-1 Core. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

FUEL FABRICATION

NAA-SR-MEMO-8809 SECRET RD

TITLE: SNAP 10A FS-3, -4 AND -5 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

7-25-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-3, -4 and -5 Cores. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-10033 CONF RD

TITLE: SNAP 10A FS-3 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky

6-11-64

ABSTRACT: Certifications, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-3 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, -3 and -4 core loadings. The 128 fuel elements for the FS-1, FS-3 and FS-4 cores were originally produced and designated for the FS-3, FS-4 and FS-5 cores. The reassignment of these fuel elements to the FS-1, FS-3 and FS-4 Reactor Systems occurred after their delivery to the Compact Systems Division. Therefore, all records and correspondence during production reflect the earlier system assignment and must be taken into consideration during any future examination of original data records.

NAA-SR-MEMO-10539 CONF RD

TITLE: SNAP 10A LOW N_H ELEMENTS FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

10-7-64

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the low N_H SNAP 10A elements. The Fabrication Process Sheets describe specific fabrication operations in detail, while the Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

FUEL TESTING

NAA-SR-MEMO-6754 UNCL

TITLE: SUMMARY OF SHOCK VIBRATION AND LEAK TESTING OF SNAP 2-10 NORMAL URANIUM FUEL ELEMENTS

AUTHOR: L. E. Manners 9-13-61

ABSTRACT: The fuel elements reported on the attached chart were subjected to the SNAP 10A vibration and shock tests. All elements were tested singly in air and one group of seven was retested as a cluster in a water filled fixture.

NAA-SR-MEMO-6936 CONF RD

TITLE: PROCEDURES FOR QUALIFICATION TESTING OF SNAP 2/10A FUEL ELEMENTS

AUTHOR: T. G. Parker, Jr. 12-12-61

ABSTRACT: Initial draft of the qualification test specification for the SNAP 2/10A fuel elements.

NAA-SR-MEMO-8210 SECRET RD

TITLE: SHORT SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGES

AUTHOR: Staff 2-14-63

ABSTRACT: A compilation of inspection and test data sheets.

NAA-SR-MEMO-8469 CONF RD

TITLE: SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGES

AUTHOR: Staff 5-9-63

ABSTRACT: Contains copies of test data sheets for 57 SNAP 10A normal fuel elements completed during the period of September, 1962 through February, 1963.

NAA-SR-8476 SECRET

TITLE: ENVIRONMENTAL TESTING OF SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: T. G. Parker, Jr. 12-31-63

ABSTRACT: Eight SNAP 10A fuel elements (normal uranium) were vibrated and shocked at levels more severe than required for qualification for flight conditions. Hydrogen permeation measurements were made, before and after the mechanical inputs, to determine whether the elements were damaged. The elements are presently undergoing thermal endurance test at 1100°F. Future work with these elements is outlined. Specific results of the testing to date are classified, and are given in the body of the report.

FUEL TESTING

NAA-SR-MEMO-8851 SECRET RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - JULY 1963

AUTHOR: D. H. Stone and T. G. Parker, Jr.

8-7-63

ABSTRACT: Results to date indicate little or no effect of environmental inputs on SNAP 10A fuel elements. Testing is done in accordance with procedures outlined in NA0422-005, "SNAP 10A Fuel Element Environmental Test Specification."

NAA-SR-9007 SECRET RD

TITLE: SNAP FUEL AND CORE MATERIALS COMPATIBILITY SCREENING TESTS

AUTHOR: L. B. Lundberg

3-1-64

ABSTRACT: Screening tests have been performed to determine the compatibility of many of the materials in contact with each other in the SNAP 10A/2 and SNAP 8 reactor cores. In some cases of known incompatibility, reaction barriers were studied. The tests involved placing small samples of the materials under consideration in intimate contact at temperatures from 1200 to 1450°F for periods up to 1000 hr in environments similar to those encountered in the particular reactor. The mutual compatibility of the sample materials was determined by metallographic examination. Reactions were observed between the following components: fuel and the bare cladding (without hydrogen barrier); fuel cladding and the SNAP 2 beryllium internal radial reflector; and several fuel element thermal bond materials and both the fuel and the enamel hydrogen barrier. Reaction barriers for fuel cladding and the SNAP 2 beryllium internal radial reflector were examined, but none were found to be effective. The majority of the suggested reactor core materials were found compatible in this study.

NAA-SR-9136 SECRET RD

TITLE: ENVIRONMENTAL TESTING OF PROTOTYPE SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: T. G. Parker, Jr.

3-15-64

ABSTRACT: Ten prototype SNAP 10A fuel elements (normal uranium) were vibrated and shocked several times, at levels more severe than required for qualification for flight conditions. Hydrogen permeation measurements were made, before and after each cycle of the mechanical inputs, to determine whether the elements were damaged. The elements have undergone endurance test at 1200°F, and are now undergoing endurance test at 1300°F. Future work with these elements is outlined. Specific results of the testing to date, which are classified, are given in the body of the report.

FUEL TESTING

NAA-SR-9496 SECRET RD

TITLE: QUALIFICATION TESTING SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: A. J. Fitzgerald

6-15-64

ABSTRACT: An experimental program is being performed to demonstrate the reliability of SNAP 10A fuel elements to withstand simulated reactor conditions. This interim report shows the effects of thermal and mechanical inputs on the hydrogen permeation of the fuel elements. Based on the available test data, demonstrated reliability of the fuel elements is given for the prescribed inputs, including 90 days of thermal endurance. Results of this program are classified, and are given in the body of the report.

NAA-SR-MEMO-9551 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - JANUARY 1964

AUTHOR: J. D. Whitlock

2-19-64

ABSTRACT: Ten fuel elements have received 2928 hr of endurance test at 1200°F after receiving:

- 1) Thermal cycles,
- 2) High level vibration and shock, and
- 3) Isothermal ramp heating.

NAA-SR-MEMO-9565 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT QUALIFICATION TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-4-64

ABSTRACT: Deck No. 9W-037 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element qualification testing data reduction. This report defines the required input data format and describes the program output.

NAA-SR-MEMO-9566 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT EXPLORATORY TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-6-64

ABSTRACT: Deck No. 9W-038 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element exploratory testing data reduction. This report defines the required input data format and describes the program output.

FUEL TESTING

NAA-SR-MEMO-9831 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - FEBRUARY-MARCH 1964

AUTHOR: J. D. Whitlock

5-5-64

ABSTRACT: This report contains the data from the fuel element environmental test program.

NAA-SR-MEMO-9855 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR FIRST DELIVERY

AUTHOR: W. Sawicky

4-28-64

ABSTRACT: Certifications, test and inspection results, and copies of all waivers for the forty 6.35 nominal NH and ten 6.0 nominal NH fuel elements delivered for the FS-1 Core are given herein. In addition, all pertinent aspects of the test and inspection operations are discussed.

NAA-SR-MEMO-9926 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR SECOND DELIVERY

AUTHOR: W. Sawicky

5-8-64

ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A Nuclear Ground Test Reactor are given herein. In addition, pertinent aspects of test and inspection operation are discussed. This discussion includes changes in NH , carbon, Sm_2O_3 , shock and vibration requirements which were not reflected in formalized specification changes. Descriptions are given of sampling methods, data analysis, and test operations for the more critical fuel element parameters.

NAA-SR-MEMO-9971 PART 1 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - APRIL 1964

AUTHOR: J. D. Whitlock

5-25-64

ABSTRACT: Sixteen fuel elements are undergoing endurance testing after receiving:

- 1) Thermal cycle inputs,
- 2) High level vibration and shock, and
- 3) Ramp heat inputs.

FUEL TESTING

NAA-SR-MEMO-9971 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - APRIL 1964

AUTHOR: J. D. Whitlock 5-22-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-MEMO-9831.

NAA-SR-MEMO-10016 PART I SECRET RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, MARCH-APRIL 1964

AUTHOR: A. J. Fitzgerald 6-9-64

ABSTRACT: This report consists of 2 parts. Part I presents a summary of the test data and the analysis of the results obtained. Part II presents a complete listing of pertinent fuel element data - including acceptance (quality control) tests as well as qualification test results.

NAA-SR-MEMO-10016 PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, MARCH-APRIL 1964

AUTHOR: A. J. Fitzgerald 6-12-64

ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents IBM listings of all test data accumulated to date. The listings include pertinent element assembly data, acceptance test data, and all qualification test data. The qualification data will be updated periodically.

NAA-SR-MEMO-10128 PART I CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - MAY 1964

AUTHOR: J. D. Whitlock 6-22-64

ABSTRACT: Ten fuel elements have received 5712 hr of endurance testing at 1200°F after receiving:

- 1) Thermal cycling,
- 2) High level vibration and shock, and
- 3) Isothermal ramp heating.

Six fuel elements have received 1032 hr of endurance testing at 1300°F after receiving 1 and 2 above and gradient ramp heating.

FUEL TESTING

NAA-SR-MEMO-10128 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TESTING - MAY 1964

AUTHOR: J. D. Whitlock

6-17-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-MEMO-9831.

NAA-SR-MEMO-10208 CONF RD

TITLE: SNAP 10A FS-4 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky

7-13-64

ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-4 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, FS-3 and FS-4 Core loadings. The average N_{II} and permeation rate, as well as the total Uranium, U_{235} and Sm_{2O_3} contents for this Core as reported herein, was based on the assignment of the 37 fuel elements made by the Compact Systems Division as of this report date. Any change in this assignment involving the surplus fuel elements for the Core may require recalculation of the above four Core characteristics.

NAA-SR-MEMO-10212 PART 1 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - JUNE 1964

AUTHOR: J. D. Whitlock

8-4-64

ABSTRACT: Ten fuel elements have received 6552 hr and three elements have received 240 hr of endurance testing at 1200°F. Six elements have received 1896 hr of endurance tests at 1300°F. The permeation rate of these elements are generally decreasing with time.

NAA-SR-MEMO-10212 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TESTING - JUNE 1964

AUTHOR: J. D. Whitlock

7-13-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-MEMO-9831.

FUEL TESTING

NAA-SR-MEMO-10213 PART I CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, MAY-JUNE 1964
AUTHOR: A. J. Fitzgerald 7-20-64
ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents a detailed listing of pertinent fuel element data - including acceptance (quality control) test results as well as qualification test results.

NAA-SR-MEMO-10213 PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, MAY-JUNE 1964
AUTHOR: A. J. Fitzgerald 7-15-64
ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents IBM listings of all test data accumulated to date. The listings include pertinent element assembly data, acceptance test data, and all qualification test data. The qualification data will be updated periodically.

NAA-SR-MEMO-10502 PART I CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, JULY-SEPTEMBER 1964
AUTHOR: A. J. Fitzgerald 10-22-64
ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents a final listing of pertinent fuel element data - including results of acceptance (quality control) and qualification tests.

NAA-SR-MEMO-10502 PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, JULY-AUGUST 1964
AUTHOR: A. J. Fitzgerald 9-28-64
ABSTRACT: This report consists of two parts. Part I presents an updated summary and analysis of the test data. Part II presents IBM listings of all pertinent assembly acceptance testing and qualification testing data. All qualification tests were completed on August 18, 1964. Therefore, Part II is the final "data package" for the SNAP 10A fuel element qualification test program.

FUEL TESTING

NAA-SR-10578 CONF RD

TITLE: DEVELOPMENTAL TESTS SNAP 10A FUEL ELEMENTS FINAL REPORT

AUTHOR: T. G. Parker, Jr.

3-5-65

ABSTRACT: Tests were performed on eighteen SNAP 10A fuel elements, to establish the effects of mechanical and thermal environments. Response of the fuel elements to test inputs are evaluated, based on changes in hydrogen loss rates. Data from performance tests and destructive analyses of the fuel elements are presented and discussed.

An analysis of fuel element life under reactor conditions is presented. Performance characteristics of the test elements are translated to a flight reactor core, to show the effect on predicted reactor life.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky

12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low N_H - High Sm₂O₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO-10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-10858 CONF RD

TITLE: QUALIFICATION TESTING SNAP 10A FUEL ELEMENTS - FINAL REPORT

AUTHOR: A. J. Fitzgerald

3-15-65

ABSTRACT: An experimental program was performed to demonstrate the reliability of SNAP 10A fuel elements to withstand simulated reactor conditions. This final report summarizes the test data, which show that no significant damage was caused by the prescribed thermal and mechanical tests. Based on the data, the demonstrated reliability, at the 50% confidence level, is 0.6780 for a core load of 37 elements. The reliability is increased to 0.7484, again at the 50% confidence level, when the data from the fuel element environmental test program are included in the reliability analysis. These values are the reliability demonstrated for the fuel elements to withstand thermal cycle, vibration and shock, ramp heating, and one year of thermal endurance.

Based on the test data of the qualification elements, reactor grade elements are expected to lose less than 0.02% hydrogen during one year of reactor operation. This is well below the allowable 0.05% hydrogen loss.

FUEL TESTING

NAA-SR-MEMO-11056 CONF RD

TITLE: SNAP 10A QUALIFICATION FUEL ELEMENTS - DATA PACKAGE

AUTHOR: A. J. Fitzgerald

2-24-65

ABSTRACT: This data package contains all pertinent information (permeation test forms, graphs, microphotographs, etc.) used in the preparation of NAA-SR-9496, "Qualification Testing SNAP 10A Fuel Elements (Interim Report)" and NAA-SR-10858, "Qualification Testing SNAP 10A Fuel Elements (Final Report)".

NAA-SR-MEMO-11057 CONF RD

TITLE: FUEL LOADING - DRY CRITICAL TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

3-25-65

ABSTRACT: Describes the following activities: Load the SNAP 10A FS-5 reactor with a full complement of fuel elements, perform drum calibrations and determine excess reactivity in accordance with specification NA0222-36.

NAA-SR-MEMO-11331 CONF RD

TITLE: SNAP 10A FUEL ELEMENT ENVIRONMENTAL TEST STATUS REPORT, JANUARY-MARCH 1965

AUTHOR: J. L. Isaacs

4-29-65

ABSTRACT: None of the 120 fuel elements being tested in this program had a hydrogen loss (permeation) rate which exceeded the specified failure limit of 2.0 cc (STP)/hr at 1200°F. All elements have now completed pre-endurance testing and at least 2300 hr of the scheduled 1 yr of endurance. In addition, ten elements have completed 1 yr of endurance.

NAA-SR-MEMO-11331 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT, JANUARY-MARCH 1965

AUTHOR: J. L. Isaacs

4-29-65

ABSTRACT: This report contains the data from the fuel element environmental test program.

FUEL TESTING

NAA-SR-MEMO-11459 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT, APRIL-JUNE 1965

AUTHOR: J. L. Isaacs

6-24-65

ABSTRACT: This report contains the data from the fuel element environmental test program.

NAA-SR-11547 CONF RD

TITLE: ENVIRONMENTAL TESTING SNAP 10A FUEL ELEMENTS

AUTHOR: J. L. Isaacs

12-25-65

ABSTRACT: The hydrogen barrier in fuel elements for SNAP 10A reactors has shown good hydrogen retention properties at temperatures over 300°F higher than the maximum design fuel temperature of the reactor (1085°F). In fact, a temperature excursion to 1475°F did not severely damage the hydrogen barrier of any of the 24 fuel elements involved. Thus, the fuel elements have demonstrated a large margin of safety for operation in a SNAP 10A reactor.

REFLECTOR ASSEMBLY

NAA-SR-MEMO-8434 CONF RD

TITLE: 10FSM-1 REFLECTOR ASSEMBLY ACCEPTANCE TEST

AUTHOR: J. B. Tathwell 4-25-63

ABSTRACT: A list of all parts, their respective weights, and tooling assembled to the 10FSM1 reflector are presented. A check of critical clearances before and after the high temperature - high vacuum acceptance test on the reactor vessel-reflector assembly indicate that adequate clearances were maintained in the test environment. An increase in the friction of the coarse drum bearing was found by measuring the torque of the unloaded drums before and after test. The use of such torque measurements in future acceptance testing is recommended as a qualitative means of determining material and/or assembly difficulties.

NAA-SR-9900 CONF RD

TITLE: SNAP 10A REFLECTOR ASSEMBLY

AUTHOR: R. I. Jetter 7-30-64

ABSTRACT: This report presents a design description and discussion of the structural and thermal analysis of the SNAP 10A reflector assembly.

NAA-SR-MEMO-10142 CONF RD

TITLE: EXAMINATION OF SNAP 10 FSM-1 POSITIONING BRACKET AND REFLECTOR HINGE SURFACES

AUTHOR: P. P. King 6-26-64

ABSTRACT: SNAP 10 FSM-1 reflector positioning bolt, reflector positioning bracket, reflector stop and reflector hinge hard surfaces were examined for degradation after the 90 day test sequence. Some minor chipping was observed on the aluminum oxide coated surfaces and some metal transfer occurred between bolt heads and aluminum oxide surfaces. The mating surfaces appear to be in satisfactory condition after tests with no gross damage, which would compromise the mission objectives. Metal transfer will not occur in subsequent systems because Al_2O_3 is substituted for the LC-1A chromium carbide coating.

NAA-SR-MEMO-10161 CONF RD

TITLE: FINAL QUALIFICATION TEST REPORT, SNAP 10A REFLECTOR BEARINGS - PART NUMBER 10FSM1-11039

AUTHOR: H. L. Powell 6-30-64

ABSTRACT: The purpose of the qualification tests is to demonstrate that the SNAP 10A reflector bearings can withstand the environments to which they will be exposed in flight and still operate properly.

REFLECTOR ASSEMBLY

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME IV, COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - REFLECTOR ASSEMBLY AND RADIATION SHIELD

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume IV) is one.

Volume IV contains a description of the component development and qualification test status of the reactor reflector assembly and radiation shield.

NAA-SR-MEMO-10367 CONF RD

TITLE: HIGH HUMIDITY, LOW TEMPERATURE REFLECTOR BEARING TEST, PART NUMBER 10FSM1-11039

AUTHOR: H. L. Powell

8-19-64

ABSTRACT: Three sets of SNAP 10A reflector bearings were tested in order to determine the effect of high vacuum and low temperature on the bearings after exposure to high humidity.

NAA-SR-MEMO-10718 UNCL

TITLE: DETERMINATION OF PROBABILITY OF EJECTION OF REFLECTORS DURING ORBITAL FLIGHT TESTING OF THE SNAP 10A NUCLEAR POWER UNIT

AUTHOR: R. M. Ohlenkamp

2-15-65

ABSTRACT: This report presents a method for the solution of the problem of ascertaining the probability of SNAP 10A reflector ejection and hence, reactor shutdown, after an orbital startup. Conservative solutions are given in tabular and graphical form over the continuous period from launch to 100 yr.

CONTROL DRUM ASSEMBLY

NAA-SR-MEMO-8232 UNCL

TITLE: INTERIM QUALIFICATION TEST REPORT SNAP 10A DRUM RELEASE ACTUATOR
THERMAL CYCLE TESTS

AUTHOR: G. F. Queener 2-4-63

ABSTRACT: The actuators (without squibs) were subjected to 10 thermal cycles from 30°F to 700°F at a pressure of 6×10^{-3} torr or lower. Upon completion of the tests there was no evidence of physical damage to the actuators.

NAA-SR-MEMO-9581 CONF RD

TITLE: SNAP 10A DRUM POSITION DEMODULATOR QUALIFICATION IRRADIATION TEST
(STR 17)

AUTHOR: M. N. Robinson and S. G. Kimble 2-27-64

ABSTRACT: A qualification irradiation test of two demodulators is described. Gamma irradiation to 2×10^7 rad was performed, December 30, 1963, to January 13, 1964, at the AI Co⁶⁰ Gamma Facility. Neutron irradiation to 3×10^{13} nvt (>0.1 Mev) was performed, January 20-23, 1964, at the Shield Test Reactor.

The results of inpile performance tests were presented. Both demodulators exceeded the specified limits on input impedance and coarse and fine output voltages.

NAA-SR-9615 CONF RD

TITLE: SNAP REACTOR CONTROL DRUM DRIVE

AUTHOR: L. G. Kellogg 8-24-64

ABSTRACT: The SNAP 2, 10A, and 8 nuclear systems are designed to provide electrical power on space vehicles. Although each system has different power capabilities, the control-drum-drive components are basically the same.

Development of the various control-drum-drive components and subcomponents from GFY 1962 to mid-GFY 1964 is discussed. The design criteria are outlined for each SNAP system. Comparisons are made between the systems to evaluate their design and operation in the prescribed environment.

The components and subcomponents reviewed are the actuator, controller, bearings, gears, and flexible couplings. Data are presented to describe development of the SNAP 10A reference design and both the reference and backup designs for the SNAP 2 and SNAP 8 systems.

In addition to the integrated control-drum drive reference designs, four possible backup design schemes are also presented for SNAP 2 and SNAP 8. Each scheme is discussed in terms of structural and mechanical design, thermal heating, and nuclear shielding considerations. The concept of a direct-drive actuator mounted above the drum is promising and further study is planned.

A control-drum-drive scheme that provides failsafe scram capabilities for ground testing of the reactor system has been designed and proof tested. The details of this design as it applies to SNAP 8 systems are presented.

CONTROL DRUM ASSEMBLY

NAA-SR-MEMO-9862 UNCL

TITLE: MODIFIED SNAPTRAN 10A/2 -1 STEPPER AND IMPULSE DRIVE SYSTEM CHECK-OUT

AUTHOR: F. C. Dye and R. P. Johnson

4-24-64

ABSTRACT: Acceptance testing of the modified SNAPTRAN 10A/2 -1 drive units was conducted in Canoga Park, California prior to shipment of the machine to the National Reactor Testing Station (NRTS) in Idaho for operation by Phillips Petroleum Company. This machine, which was originally to have been the SNAPTRAN -2 machine, was modified to provide impulse capability and replace the original -1 machine.

The results of the drive system checkout are given in this report and are compared with the design specifications. Drum position versus time curves are presented for typical machine operations. The general performance of the system was considered acceptable.

NAA-SR- 9898, Volume I, CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 1, CONTROL COMPONENTS

AUTHOR: W. J. Kurzeka, Editor

8-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR-MEMO-10252 CONF RD

TITLE: INTERIM QUALIFICATION TEST REPORT - SNAP 10A CONTROL DRUM ACTUATOR

AUTHOR: T. E. Norris and W. E. Burns

7-24-64

ABSTRACT: Eight control drum actuators were received and subjected to acceptance vibration tests. No malfunction nor physical damage was detected during these tests.

Of the eight units received, two were subjected to qualification performance record tests and shipped directly to Battelle Memorial Institute for radiation tests.

Six units were subjected to initial performance record, thermal cycle, vibration, shock, and acceleration tests in accordance with NA0404-006, dated May 7, 1963. Two of the units were also subjected to radio frequency interference tests in

CONTROL DRUM ASSEMBLY

NAA-SR-MEMO-10252 CONF RD (Continued)

ABSTRACT: accordance with applicable sections of MIL-I-26600 (2), Interference Control
(Continued) Requirements, Aeronautical Equipment, Amendment 2, Notice 1, dated June 1, 1962. The six units, which are reported on in this report, successfully completed their assigned test phases. The control drum actuator has met or exceeded the requirements of NA0404-006 through the above mentioned test phases.

NAA-SR-MEMO-10382 CONF RD

TITLE: ACCELERATED OPERATION TESTS FOR SNAP 10A CONTROL DRUM ACTUATOR
S/N 2830 and 2831

AUTHOR: N. L. Ray and J. L. Nummelin 8-25-64

ABSTRACT: Two SNAP 10A control drum actuators, Serial Nos. 2830 and 2831, were subjected to separate series of accelerated operation tests. The tests simulated the operating and environmental conditions to which actuators are subjected in ground and pre-flight testing of reactor systems.

NAA-SR-MEMO-10572 CONF RD

TITLE: SNAPTRAN 10A/2 -1 DRUM CALIBRATION TESTS

AUTHOR: R. P. Johnson 10-14-64

ABSTRACT: Perform detailed drum calibration measurements on the SNAPTRAN 10A/2 -1 reactor to determine the individual stepper and impulse drum worths and to determine the excess and shutdown reactivity values for the machine.

NAA-SR-MEMO-10670 CONF RD

TITLE: FUEL LOADING-DRY CRITICAL TESTS, SNAP 10A FS-4

AUTHOR: W. N. Louie 12-18-64

ABSTRACT: Fuel loading of the S10 FS-4 SNAP unit was initiated on October 21, 1964, in accordance with the loading specification, NA0222-026. There were no major deviations from the loading sequence presented in the specification, and the procedure was followed without any changes to load the full complement of 37 elements.

NAA-SR-MEMO-10717 OUO

TITLE: IRRADIATION QUALIFICATION OF SNAP 10A CONTROL DRUM DRIVE ACTUATORS AND POSITION SENSORS

AUTHOR: M. Warren 12-2-64

ABSTRACT: Two SNAP 10A control drum drive actuators and two control drum position sensors were irradiated to total doses from 1.0 to 5.0×10^{18} nvt >0.1 Mev and from 1.8 to 5.5×10^9 R during a simulated flight operation. The nominal operating temperatures were 700°F for the actuators and 500°F for the position sensors. The environmental pressure ranged from 5×10^{-5} torr to 5×10^{-6} torr, decreasing as the experiment continued. The test components were maintained at the operating temperatures for

CONTROL DRUM ASSEMBLY

NAA-SR-MEMO-10717 OUO (Continued)

ABSTRACT: 2600 hr and received 2183.3 equivalent full power hr, (EFPH), of radiation
(Continued) during the 16 week experiment and was equivalent to a 90 day SNAP reactor operation.

NAA-SR-MEMO-10740 CONF RD

TITLE: TEST REPORT, FINAL QUALIFICATION SNAP 10A LIMIT SWITCH

AUTHOR: W. E. Burns and J. N. Nummelin

11-20-64

ABSTRACT: Seventeen limit switches were utilized in the qualification test program. None of the switches completed their assigned tests. Six of the switches were destroyed due to a test equipment malfunction. The remaining two switches were cracked during the initial performance record test and were not used further in the qualification test program.

NAA-SR-MEMO-10750 CONF RD

TITLE: FINAL COMPONENT QUALIFICATION TEST REPORT - SNAP 10A CONTROL DRUM ACTUATOR SERIAL NOS. 2820 AND 2822 THROUGH 2828

AUTHOR: W. E. Burns

11-24-64

ABSTRACT: Eight Control Drum Actuators, Serial Nos. 2820 and 2822 through 2828, were tested in accordance with Qualification Test Specification NA0404-006. Two Actuators, Serial Nos. 2822 and 2823, successfully completed a 96-day dose rate radiation test with no malfunctions or failures. Serial Nos. 2820 and 2824 through 2828 completed thermal cycle, shock, vibration, and acceleration tests without failure. Serial Nos. 2827 and 2828 completed RFI tests in accordance with applicable sections of MIL-I-26600(2). Actuator Serial Nos. 2820, 2824, 2826, 2827 and 2828 successfully completed the 90-day thermal vacuum endurance test with no malfunctions or failures. Serial No. 2825 experienced a brake coil malfunction after 213 hours of endurance testing. The malfunction was attributed to a manufacturing error in the brake coil. This unit was replaced in the qualification program with Actuator Serial No. 2820.

The control drum actuators are considered to have met the requirements of NA0404-006.

NAA-SR-MEMO-11057 CONF RD

TITLE: FUEL LOADING - DRY CRITICAL TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

3-25-65

ABSTRACT: Describes the following activities: Load the SNAP 10A FS-5 reactor with a full complement of fuel elements, perform drum calibrations and determine excess reactivity in accordance with specification NA0222-36.

CONTROL DRUM ASSEMBLY

NAA-SR-MEMO-11139 CONF RD

TITLE: SNAP 10A CONTROL DRUM POSITION SENSOR DEMODULATOR NE10FS1-24-010
FINAL COMPONENT QUALIFICATION TEST REPORT, SERIAL NOS. 06, 18, 25,
26 AND 29

AUTHOR: B. J. Blau 3-9-65

ABSTRACT: Five SNAP 10A control drum position sensor demodulators were tested to the requirements of Qualification Test Specification NA0403-023. Although the demodulators did not perform in complete accordance with the specification, qualification testing revealed that the component, although having certain limitations, can perform its originally intended diagnostic function.

NAA-SR-MEMO-111306 CONF RD

TITLE: CONTROL DRUM CALIBRATION

AUTHOR: T. L. Langell and H. D. May 3-24-65

ABSTRACT: The reactivity worth at any angular position was near predicted control drum worth curve in the qualification test specification (NR 7561-23). Test results therefore meet the requirements established by the specification. Control drum position indicator calibration curves were plotted showing Datex Precision Position indicator readings vs. flight position sensor outputs.

SAFETY DEVICES (EABRD, TABRD, ETC.)

NAA-SR-MEMO-7754 CONF RD

TITLE: ACTUATION OF THE SNAP 10A END-OF-LIFE SHUTDOWN DEVICE

AUTHOR: J. D. Wilde

9-27-62

ABSTRACT: It is argued that the case of total loss-of-flow is the most conservative basis for evaluating the end-of-life temperature decrease. Temperatures in the body of the end-of-life device will fall from a minimum of 100°F during useful life to 563°F following loss of flow. The difference, approximately 440°F, should be the basis for design and evaluation of the actuator. The ΔT can be increased from 440°F to 495°F by gold coating the inboard side of the NaK line to which the device is attached. This reduces the radiation from the reflector and reduces the temperature of the end-of-life shutdown device.

NAA-SR-MEMO-8244 CONF RD

TITLE: AN EVALUATION OF THE TECHNIQUES FOR END-OF-LIFE SHUTDOWN OF ORBITING SNAP REACTORS

AUTHOR: N. K. Jamison

3-29-63

ABSTRACT: Two techniques for the end-of-life shutdown of orbiting SNAP reactors are presented. One technique consists of two alternative methods for the destruction of the reactor core. This technique (and others) have been investigated during the past year.

NAA-SR- 9231 CONF RD

TITLE: EVALUATION OF AN END-OF-LIFE SHUTDOWN DEVICE FOR NUCLEAR REACTORS

AUTHOR: D. G. Oliver and C. A. Willis

6-26-64

ABSTRACT: It is shown that in many aerospace reactor missions, a reliable shutdown device is required to reduce the potential radiological hazards presented by a reactor that returns from orbit. From preliminary design and development considerations, reactor designs appears feasible without significantly affecting mission operation or power system reliability. It is concluded that development and demonstration efforts should be initiated.

NAA-SR-MEMO-10756 CONF RD

TITLE: QUALIFICATION IRRADIATION OF SNAP 10A ELECTRICALLY ACTUATED BAND RELEASE DEVICES

AUTHOR: M. Warren and P. D. MacEwan

11-30-64

ABSTRACT: Two electrically actuated band release devices (EABRDs) were irradiated at an average temperature of 650 F for 924 hr at an average pressure of about 1×10^{-5} torr. The total dose of about 9.7×10^{18} nvt >0.1 Mev was obtained at a dose rate of about 3.3×10^{12} nv for 819.9 equivalent full power hr of reactor operation. One EABRD was fired during irradiation and required 812 w-sec for separation to occur. Post-irradiation examination of the remaining EABRD showed that no significant creep occurred.

D. NUCLEAR RADIATION SHIELD

SHIELD DESIGN, ANALYSIS, AND TESTING

NAA-SR-MEMO-4985 SECRET RD

TITLE: STATUS OF SNAP SHIELDING

AUTHOR: F. H. Clark

2-17-60

ABSTRACT: This note is intended to present the problems encountered in shielding SNAP systems for satellite application. Section II deals with dose and vehicle constraints - largely outside the purview of the power plant - but considerations which dominate shield design and in rough magnitude determine shield weight. Section III deals with shield design itself and problems associated. Section IV mentions briefly Van Allen radiation.

NAA-SR-MEMO-5103 UNCL

TITLE: EXPERIMENTAL SHIELDING EVALUATION OF THE SETF USING SDR-I AND SNAP 10 AS RADIATION SOURCES

AUTHOR: R. L. Tomlinson

3-29-60

ABSTRACT: The SNAP Environmental Test Facility, which is now under construction, has been designed for the full-power testing of unshielded SNAP reactors in an environment that will approach that of satellite conditions. Special care has been observed in its design to facilitate personnel access to the power test cells in which the reactors will be operated, after a waiting period of 30 days and removal of all portable equipment that has been exposed to the nuclear radiation present during reactor operation at full or fractional power levels. In this regard, many special features have been designed into this facility. This report will deal only with the evaluation of those features concerned with nuclear radiation and shielding as they affect the operation of the SETF.

NAA-SR-MEMO-6937 UNCL

TITLE: SNAP 10A PROGRAM REVISION - SHIELD SPECIFICATION CHANGE

AUTHOR: R. F. Wilson

12-13-61

ABSTRACT: This document is a single sheet which presents the schedule revision for the Non-Nuclear and Nuclear systems in which the first Flight Delivery was changed from January, 1963 to May, 1963.

NAA-SR-MEMO-7385 CONF DI

TITLE: SNAP 10A PSM-1 SHIELD THERMAL TEST

AUTHOR: E. C. Phillips

5-10-62

ABSTRACT: A three phase thermal test was performed on the SNPA 10A PSM-1 shield. Phase I consisted of heating the shield to 800°F for three hours, and cooling the shield at 20°F/hr. Phase II consisted of heating at 20°F/hr to 800°F then cooling at 60°F/hr. Phase III consisted of heating and cooling the shield to and from 800°F at 60°F/hr three times.

SHIELD DESIGN, ANALYSIS, AND TESTING

NAA-SR-MEMO-7608 CONF RD

TITLE: TEMPERATURES OF THE SNAP 10A RADIATION SHIELD

AUTHOR: J. D. Wilde

7-31-62

ABSTRACT: Determines the temperature distribution in the shield and shield casing, both during the startup transient and at steady-state. Repeats for the case of no internal heat generation to determine temperatures during non-nuclear tests. From the results, finds the shield-to-casing clearances in the hot condition and the volume mean temperatures of the can and shield for pressure buildup calculations.

NAA-SR-MEMO-8354 CONF RD

TITLE: PRELIMINARY INVESTIGATION OF AN ALTERNATE HYDRIDE FOR SNAP SHIELDS

AUTHOR: R. S. Hubner

4-2-63

ABSTRACT: To determine from removal theory the relative merits of beryllium hydride as a neutron shield material for SNAP systems.

NAA-SR-MEMO-8768 CONF RD

TITLE: FAST NEUTRON FLUX THROUGH THE SNAP 10A SHIELD AS COMPUTED BY SEVERAL METHODS

AUTHOR: J. A. Belcher and W. M. Farr

7-23-63

ABSTRACT: Fast neutron fluxes through the SNAP 10A shield as computed by several methods are compared. The methods and the codes using the methods are: (1) neutron transport - DTK, (2) neutron diffusion - AIM-6, (3) Monte Carlo - FMC-N, and (4) neutron removal theory - 14-0. These various methods predicted fluxes through the shield which agree reasonably well. On the basis of these analyses and recent Shield Test Facility experiments, a lithium hydride removal cross section of 0.156 cm^{-1} is recommended for use in removal theory code studies of the SNAP 10A shield. Comparable analysis of the SNAP 2 shield indicates that a removal cross section of 0.160 cm^{-1} is valid for use in SNAP 2 shielding studies.

NAA-SR-MEMO-8768 Addendum CONF RD

TITLE: LiH CROSS SECTION DETERMINATION FOR REMOVAL THEORY CODES

AUTHOR: R. D. Anderson, Jr.

7-23-63

ABSTRACT: To correlate a realistic 14-0 code removal cross section with computed fluxes obtained using AIM-6 and DTK nuclear codes.

NAA-SR-MEMO-9013 CONF RD

TITLE: THERMAL CONDUCTIVITY OF SNAP SHIELDS

AUTHOR: N. F. Davies

9-20-63

ABSTRACT: An effective value of the thermal conductivity of a cast lithium hydride shield was determined experimentally with the aid of the TAP-II computer code (Ref. 1).

SHIELD DESIGN, ANALYSIS AND TESTING

NAA-SR-9647 UNCL

TITLE: SNAP 10A RADIATION SHIELD ANALYSIS

AUTHOR: J. A. Belcher, W. A. Flynn and R. J. Thomson

10-15-64

ABSTRACT: The final analysis of the SNAP 10A flight system radiation shield has been completed. This report summarizes the results.

Preliminary analysis of the shield design indicated that the direct penetration dose at the 5-ft diameter reference dose plane 17.5 ft from the lower face of the reactor core would meet the flight design objectives of 10^{12} nvt and 10^7 r for one year of operation. Subsequent analysis indicated that due to scattering effects from the edges of control drums, the NaK piping around the shield, and the thermoelectric converter system, some regions of the dose plane would be exposed to doses beyond the specified limits. However, through judicious placement and hardening of radiation sensitive instruments and the somewhat localized nature of the scattering effects, an increase in shield size for the SNAP 10A flight test was not warranted.

NAA-SR- 9898, Volume II CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 3, SHIELD, GROUND TEST ASSEMBLY, AND MATERIALS APPLICATIONS

AUTHOR: W. J. Kurzeka, Editor

2-10-65

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR- 9901 CONF RD

TITLE: MECHANICAL DESIGN OF THE SNAP 10A RADIATION SHIELD

AUTHOR: J. D. Sutherland

6-30-64

ABSTRACT: The SNAP 10A Radiation Shield is described. The information presented summarizes the results obtained from analytical and test programs which were devised to support the mechanical design of the shield assembly.

SHIELD DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT, VOLUME 4, COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - REFLECTOR ASSEMBLY AND RADIATION SHIELD

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume IV) is one.

Volume IV contains a description of the component development and qualification test status of the reactor reflector assembly and radiation shield.

NAA-SR-MEMO-10766 CONF RD

TITLE: COMPRESSIVE CREEP OF CAST LITHIUM HYDRIDE

AUTHOR: E. C. Phillips 12-2-64

ABSTRACT: Presents the compressive creep properties of cast lithium hydride under loads up to 150 psi and temperatures up to 1100° F.

NAA-SR-MEMO-10794 UNCL

TITLE: DENSITY DETERMINATION OF CAST LITHIUM HYDRIDE, AND CAST LITHIUM HYDRIDE-TUNGSTEN ALLOY OR ZIRCONIUM HYDRIDE AGGREGATES

AUTHOR: F. H. Welch 12-14-64

ABSTRACT: The densities of cast lithium hydride, and cast lithium hydride-tungsten alloy, and cast lithium hydride-zirconium hydride aggregates were determined to be 0.780 \pm 0.001 g/ml, 9.30 \pm 0.21 g/ml, and 3.77 \pm 0.17 g/ml, respectively, using the hydrostatic weighing technique with normal octane substituted for water.

NAA-SR-MEMO-11173 CONF RD

TITLE: EVALUATION OF A CAST LITHIUM HYDRIDE SHIELD BACKFILLED WITH LITHIUM METAL

AUTHOR: J. A. Quealy 3-16-65

ABSTRACT: Preparation, testing, and evaluation of a cast lithium hydride shield containing lithium metal in the voids between the shield vessel and lithium hydride as well as within the cracks and voids inside.

SHIELD DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-11422 CONF RD

TITLE: EFFECTIVE THERMAL CONDUCTIVITY OF A LITHIUM HYDRIDE SHIELD BACK-FILLED WITH LITHIUM METAL

AUTHOR: P. H. Horton

6-3-65

ABSTRACT: An effective value for the bulk thermal conductivity of a cast lithium hydride shield backfilled with lithium metal was determined to be 3.65 ± 0.35 BTU/hr ft $^{\circ}$ F in both the heat up and cool down tests in the temperature range of 700 to 900 $^{\circ}$ F. The thermal conductivity of the same shield, prior to the lithium metal backfill, was determined to be 2.9 BTU/hr ft $^{\circ}$ F for the same temperature range. A 26 percent increase in thermal conductivity was achieved by the lithium backfill of the shield.

NAA-SR-MEMO-11515 CONF RD

TITLE: A MOLD RELEASE FOR CASTING LITHIUM HYDRIDE

AUTHOR: E. C. Phillips

7-30-65

ABSTRACT: Describes a mold release for use in casting lithium hydride. The mold release allows easy separation of the cast lithium hydride from the mold without damage.

E. THERMOELECTRIC CONVERTER

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-3273 SECRET RD

TITLE: TRIP REPORT - VISIT TO MINNESOTA MINING AND MANUFACTURING TO
DISCUSS DIRECT THERMOELECTRIC ENERGY CONVERSION

AUTHOR: D. J. Cockeram

10-30-58

ABSTRACT: The purpose of the visit was to determine the present status of the thermoelectric conversion project.

NAA-SR-MEMO-4167 UNCL

TITLE: THERMOELECTRIC CONVERTER FOR SNAP 10 SYSTEM

AUTHOR: A. W. Thiele

9-28-59

ABSTRACT: This specification delineates the requirements for a thermoelectric conversion device to be used with a nuclear reactor heat source. The SNAP 10 system will provide an auxiliary power unit for space applications. As such, the converter, as part of this system, will be subject to certain unique requirements in regard to weight and environment.

NAA-SR-MEMO-6422 SECRET DI

TITLE: STATUS REPORT ON SNAP-10A ENCAPSULATION PROGRAM

AUTHOR: E. L. Reed

5-17-61

ABSTRACT: The purpose of this interim report is to review the various approaches that have been pursued at AI to date toward the goal of developing a suitable encapsulating material for protecting lead telluride bodies from excessive material loss under the operating conditions specified for the SNAP-10A thermoelectric device. The present SNAP-10A concept requires a thermoelectric device that will operate in a space environment for at least 10,000 hours with less than 10 per cent output degradation. The hot and cold junction operating temperatures in space have been set at 900°F and 600°F, respectively. A combination of p and n type lead telluride bodies has been specified as the thermoelectric material that will be used to generate the prescribed power output of the SNAP-10A device.

NAA-SR-MEMO-6776 CONF DI

TITLE: RESULTS OF ELEMENT PERFORMANCE TESTING THROUGH SEPTEMBER 7, 1961

AUTHOR: J. H. Walter and C. G. Bergdorf

10-6-61

ABSTRACT: The tests consist of operating the elements in a ΔT against a matched load, allowing the measurement and/or calculation of power output, element voltage and element resistance. Some of the tests consist of merely bringing the element up to the desired operating temperatures, recording the data, and terminating the tests. Others are left for extended periods of time to determine the long-term stability of the elements. The data obtained is evaluated by comparing it with the values calculated for the bare material from vendor property curves.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-6901 CONF RD

TITLE: CERAMIC COATINGS FOR LEAD TELLURIDE THERMOELECTRIC ELEMENTS
AUTHOR: D. O. Raleigh 3-1-62
ABSTRACT: A number of preliminary adhesivity experiments, as well as recourse to wettability theory, indicated that lead telluride is difficult to wet with inert, homogeneous melts. A technique was developed.

NAA-SR-MEMO-6966 CONF RD

TITLE: SUMMARY REPORT AI'S EFFORT ON THERMOELECTRIC CONVERTER FOR SNAP 10A
AUTHOR: M. H. Binstock 1-24-62
ABSTRACT: Atomics International undertook the problem of developing methods and proof testing the PbTe vacuum design T/E converter for SNAP 10A system. This report describes the development work, design work, process engineering work, quality assurance program and pilot plant activity which resulted in a successful conclusion to the problem. In addition, performance and environmental testing was done to indicate the problems which still remain to be solved.

NAA-SR-7021 CONF DI

TITLE: DESIGN, ANALYSIS, AND FABRICATION OF THERMOELECTRIC MODULES FOR SNAP 10A
AUTHOR: P. P. King and G. W. Meyers 6-1-62
ABSTRACT: The design, analysis, and fabrication development of lead telluride thermoelectric modules for the SNAP 10A thermoelectric converter are discussed in detail. Two designs were developed that could be fabricated with a high assurance of quality and thermoelectric continuity. Twenty-seven 26-element modules were fabricated during a three-week period, to demonstrate production capabilities and to supply modules of flight configuration for performance testing.

NAA-SR-7036 UNCL

TITLE: PROCESS DEVELOPMENT AND FABRICATION OF PbTe THERMOELECTRIC ELEMENTS
AUTHOR: F. R. Bennett and K. Langrod 10-30-62
ABSTRACT: The development and fabrication of lead telluride pellets, contacted to iron end caps, for use as elements in thermoelectric converters for the SNAP 10A program, is described.

The method adopted consists of contacting, by hot pressing in a controlled atmosphere, 24 pellets simultaneously, using 4-layer, 6-cavity graphite dies.

The optimum hot pressing parameters were found to be 5000 psi at 1550°F for 30 min.

Several thousand elements were produced by this relatively high-volume process, modifying the normally slow and expensive hot pressing by the use of multilayer, multicavity dies and automatic controls.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-7041 CONF DI

TITLE: PERFORMANCE EVALUATION OF PbTe THERMOELECTRIC CONVERTER MODULES

AUTHOR: P. E. Elkins and W. R. McCurnin

2-16-62

ABSTRACT: The Atomics International 4-element modules evaluated in this report were tested at simulated temperature conditions to determine the component integrity and performance characteristics. Three of the four modules evaluated here were heavily instrumented with thermocouples to determine heat transfer characteristics of the components and the brazed joints between the components at simulated temperature conditions. The modules were each tested a total of 310 hr at temperature. The modules were then subjected to a post-test examination which consisted mainly of a metallurgical evaluation of the brazed joints and components in the modules. The performance test results were summarized in tabular and graphical form. The post-test evaluation is summarized in tabular form, and includes photographs of the cross-section of each element in the modules and photomicrographs of some of the components and brazed joints.

NAA-SR-7064 CONF RD

TITLE: ENCAPSULATION OF LEAD TELLURIDE THERMOELECTRIC ELEMENTS

AUTHOR: I. J. Groce and E. L. Reed

6-1-62

ABSTRACT: One thermoelectric material that might be used in the Systems for Nuclear Auxiliary Power (SNAP 10A) converter was lead telluride (PbTe). In order to use PbTe in this converter, under the environmental conditions of 900°F and vacuum, it was necessary to prevent sublimation loss of the PbTe, by encapsulation or some other method, without exceeding a 5% heat shunt or a 1% electrical shunt through the encapsulation material. Several encapsulating methods were tried, including plasma flame spraying of ceramics, sleeves, vapor deposition of ceramics, electro-phoretic deposition of ceramics, coating with heat curing cements, and spraying and firing of enamels.

NAA-SR-7288 UNCL

TITLE: STATISTICAL ANALYSIS OF SNAP 10A THERMOELECTRIC CONVERTER ELEMENT PROCESS DEVELOPMENT VARIABLES

AUTHOR: S. H. Fitch and J. W. Morris

12-15-62

ABSTRACT: Statistical analysis, primarily analysis of variance, is applied to evaluate several factors involved in the development of suitable fabrication and processing techniques for the production of lead telluride thermoelectric elements for the SNAP 10A energy conversion system. The analysis methods are described in some detail as to their application for determining the effects of various processing steps, establishing the value of individual operations, and evaluating the significance of test results. The elimination of unnecessary or detrimental processing steps was accomplished and the number of required tests was substantially reduced by application of these statistical methods to the SNAP 10A production development effort.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-7289 UNCL

TITLE: QUALITY CONTROL PROGRAM FOR SNAP 10A THERMOELECTRIC ELEMENTS

AUTHOR: J. W. Morris and S. H. Fitch

5-9-63

ABSTRACT: The development and implementation of a complete Quality Control Program for thermoelectric elements is described. The program was set up to aid in the fabrication process development of thermoelectric elements and modules for application to the SNAP (Systems for Nuclear Auxiliary power) 10A.

A brief description and historical sketch of the SNAP 10A is presented. The Quality Control Program of material procurement and quality verification, process control, in-process, and acceptance testing is described in detail. The results of the quality control effort are summarized.

NAA-SR-MEMO-7414 CONF DI

TITLE: PbTe THERMOELECTRIC ELEMENT PERFORMANCE TESTING

AUTHOR: R. Roberts

5-22-62

ABSTRACT: The performance as a function of time for various temperature parameters of fifteen thermoelectric PbTe elements is presented in this report. The PbTe n-type elements and the PbSnTe p-type elements were stable whereas the Na-doped PbTe p-type elements degraded with time.

NAA-SR-MEMO-7684 CONF DI

TITLE: RCA THERMOELECTRIC MODULE PERFORMANCE TESTING

AUTHOR: J. C. Cooper

8-31-62

ABSTRACT: These performance tests of RCA thermoelectric modules include steady state operation at design temperatures, thermal cycling and thermal shock, and high temperature operation.

The average power output, normalized to a 280°F ΔT , was 79% of SNAP 10A design power. The original design ΔT was 280°F ; however, the average measured ΔT was 299°F . Normalization to this higher value leads to power output at 91% of design values. The measured rate of change of power output corresponds to 1.52 watts/ $^{\circ}\text{F}$ change in hot junction temperature for the SNAP 10A converter. Average power degradation during these tests was -0.68% per 1000 hr at temperature.

Reference (d) contains the complete data tabulations for these tests. The data is summarized in this NAA-SR Memo. Reference (e) discusses mechanical testing of these modules.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-7685 CONF DI

TITLE: RCA THERMOELECTRIC MODULE MECHANICAL TESTING

AUTHOR: J. Cooper

8-31-62

ABSTRACT: Static load, shock, and vibration tests of thermoelectric modules have been performed. Vibrational responses of A, B, and C modules, and their test fixtures have been measured.

Element breaking loads in tension and under side load ranged from 30 to 255 lb. There is a good correlation between number of cracked elements and average strength of the module.

Of 1990 stack-vibration tests, ten have failed. These failures occurred primarily in the gold to copper diffusion bond near the hot junction on pre-production modules, and in the SiGe element on production units.

A sketch of the module stack assembly (Figure 1) is included for reference.

NAA-SR-MEMO-7686 CONF DI

TITLE: RCA THERMOELECTRIC MODULE TEST DATA

AUTHOR: J. C. Cooper

8-31-62

ABSTRACT: Attached are tabulations of the data obtained from tests of the copper hot-strap thermoelectric modules through August 8, 1962 and the Continuous Log on RCA Modules revised June 29, 1962.

This data is summarized and discussed in TDR #7684 "RCA Thermoelectric Module Performance Testing," and TDR #7685 "RCA Thermoelectric Module Mechanical Testing."

NAA-SR-MEMO-8044 CONF DI

TITLE: RADIATION EFFECTS ON SNAP 10A THERMOELECTRIC MODULES

AUTHOR: S. Friedlander

12-26-62

ABSTRACT: This report includes test data to 11/20/62 on two RCA vacuum converter modules.

The two modules are early developmental types with aluminum hot straps.

In summary, these modules have shown excellent resistance to fast neutron irradiation. Power output (i. e. $\alpha^2 \sigma$) has remained constant up to a neutron flux level of 3×10^{16} nvt.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-10126 CONF DI

TITLE: HIGH TEMPERATURE PERFORMANCE TESTING AND EVALUATION OF TYPE VF MODULES

AUTHOR: S. J. Block and R. M. Willard

6-17-64

ABSTRACT: Three SNAP 10A Type VF modules were placed on performance test at 1100, 1200 and 1300°F, respectively. The testing of the latter two modules was terminated prematurely due to the detrimental effects of numerous thermal cycles and shocks caused by heater failures and power shutdowns. Power output of the modules was within six percent of the predicted values for the high temperature operation. Tensile testing and metallography performed as part of the post-mortem examination indicated that degradation occurred as a result of the high temperatures in the molybdenum equalizer disc, the Au-Ni diffusion bond and, as expected, the radiator bonds.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME V, COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - POWER CONVERSION AND HEAT TRANSFER SYSTEMS

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume V) is one.

Volume V contains a description of the component development and qualification test status of the power conversion system, including the power conversion subsystem; and the heat transfer subsystem, including the pump, expansion compensators, and piping.

NAA-SR-11205 CONF RD

TITLE: SNAP 10A THERMOELECTRIC MODULE POST-MORTEM EXAMINATIONS AND MATERIAL BOND CHARACTERISTICS

AUTHOR: R. M. Willard

12-15-65

ABSTRACT: SNAP 10A 500-w thermoelectric qualification test modules were examined destructively after testing. This report discusses the results of the destructive examination and characterizes the behavior of critical material bonds during testing. In particular, the report describes the effects of prolonged operation (10,000 hr) at temperatures (970 to 1030°F) on the behavior of such material as: SiGe thermoelectric alloy, copper-aluminum diffusion bond, nickel-tungsten-gold diffusion bonds, and molybdenum-alumina brazed bonds. The electron microprobe was used to characterize the performance of the materials.

T/E CONVERTER DESIGN, ANALYSIS AND TESTING

NAA-SR-MEMO-11242 CONF DI

TITLE: INTERIM REPORT ON ADVANCED SNAP 10A MODULE PERFORMANCE

AUTHOR: A. B. Sorkin and J. E. Koch

4-6-65

ABSTRACT: The performance data and analysis of the high temperature modules at an approximate hot junction temperature of 1300°F has been presented. Examination of stacks before and after steady state and thermal cycling tests have shown that problem areas exist in these modules when tested at 1300°F.

NAA-SR-MEMO-11563 CONF RD

TITLE: HIGH TEMPERATURE THERMOELECTRIC PROGRAM DEVELOPMENT STATUS

AUTHOR: J. Walter and R. F. Wilson

8-12-65

ABSTRACT: Principal achievements of 1300°F module development efforts in FY 1965

F. HEAT TRANSFER AND HYDRAULICS

HEAT TRANSFER AND HYDRAULICS DESIGN AND ANALYSIS

NAA-SR-MEMO-4137 SECRET RD

TITLE: ANALYSIS OF A RECTANGULAR FINNED RADIATOR FOR THE SNAP 10

AUTHOR: R. L. Hirsch

7-15-59

ABSTRACT: The radiator for the SNAP 10 consists of a cylindrical base annulus from which rectangular fins project radially. This report describes the two methods that were incorporated to describe heat flow in this body. Because of its simplicity, the first method yielded a useful, early description of the radiator. A later, more detailed analysis indicated that the results of the first work were a little optimistic.

NAA-SR-MEMO-6945 UNCL

TITLE: SNAP 10A CORE HYDRAULIC MODEL TEST RESULTS - LOCAL VELOCITY PROFILES

AUTHOR: R. A. Dutton and D. L. Whitlock

12-29-61

ABSTRACT: An experimental investigation has been made of the variation of local NaK velocity profiles as a function of axial position in the SNAP 10A reactor core. Local velocity measurements appear to be more erratic than average velocity measurements reported in TDR 6944. Evidence is presented which indicates some flattening of the velocity profile near the outlet end of the core. A bottom plenum divider was devised to improve flow stability in the core, but the results continued to be erratic. This is attributed to operation of the reactor at critical and transition Reynolds numbers, and this is known to be undesirable.

NAA-SR-MEMO-9526 CONF RD

TITLE: SNAP 10A REACTOR OUTLET TEMPERATURE BEHAVIOR AT THE START OF THE ACTIVE CONTROL PERIOD

AUTHOR: G. S. Drucker

2-19-64

ABSTRACT: The behavior of the reactor outlet temperature at the start of the active control period was investigated to determine if an over temperature condition exists. Two different sensor cases were considered. Case I is a study of the present temperature sensor switch control. Case II is a study of a possible converter current switch control.

NAA-SR- 9720 CONF RD

TITLE: SNAP 10A PRESTARTUP AND STARTUP PERFORMANCE

AUTHOR: G. S. Drucker and T. J. Boyle

6-30-64

ABSTRACT: Presented are the results of analyses to determine the thermal behavior of the SNAP 10A System in orbit prior to startup, and the nuclear, thermal, and hydraulic behavior of the system during startup. Parameter studies were made to determine the effects of variations from the nominal design conditions on maximum and minimum system temperatures prior to startup and the severity of the startup transient. Also included are the mathematical models used in the digital and analog computer solutions. The analyses results indicate that the SNAP 10A system will meet its prestartup and startup requirements.

HEAT TRANSFER AND HYDRAULICS DESIGN AND ANALYSIS

NAA-SR-9903 CONF RD

TITLE: SNAP 10A REACTOR THERMAL PERFORMANCE

AUTHOR: P. M. Magee, G. E. Dufoe and J. D. Gordon

9-1-64

ABSTRACT: This report summarizes the thermal and hydraulic performance of the SNAP 10A reactor. Nominal and hot element steady-state fuel temperature distributions are presented. Startup transients are analyzed; maximum temperatures and temperature gradients are determined and the resulting stresses investigated.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME V, COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - POWER CONVERSION AND HEAT TRANSFER SYSTEMS

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume V) is one.

Volume V contains a description of the component development and qualification test status of the power conversion system, including the power conversion subsystem; and the heat transfer subsystem, including the pump, expansion compensators, and piping.

PUMP

NAA-SR-MEMO-7258 CONF RD

TITLE: LIQUID METAL PUMP POWERED BY LEAD TELLURIDE THERMOELECTRIC

AUTHOR: K. A. Davis

4-2-62

ABSTRACT: A liquid metal, d. c. conduction pump powered by an integrally mounted lead telluride thermoelectric generator was designed, constructed and tested. One thousand hours of operation was obtained under SNAP 10A conditions in a vacuum environment. The tests demonstrate the feasibility of such a pump along with the advantages and disadvantages of the selected design.

Design criteria, fabrication techniques, test data and an overall analysis of the design are contained herein.

NAA-SR-MEMO-7361 OUO

TITLE: THERMOELECTRIC PUMP ELEMENT TESTING

AUTHOR: G. W. Meyers

5-3-62

ABSTRACT: The attached curves summarize the data taken on 3/4 in. by 3/4 in. sections of pump elements to date. The major portion of the testing has been on the Lead-Tin-Telluride P-type material because the data from the N-type converter elements has shown the N-type material to be very stable. Although the Seebeck was slightly less than the reported data by 3M Co. for the N-type element 530-1, the open circuit voltage and internal resistance have remained constant for over 1000 hours. The scatter in the resistance data is probably due to the accuracy of $\pm 10\mu$ ohms in measuring the resistance rather than fluctuations in the element resistance.

NAA-SR-MEMO-7540 UNCL

TITLE: THERMOELECTRIC PUMP ELEMENT TESTING

AUTHOR: G. W. Meyers

7-2-62

ABSTRACT: The attached performance curves summarize the data to 6-30-62 on the 3/4 in. by 3/4 in. pump elements.

NAA-SR- 9486 CONF DI

TITLE: SNAP 10A THERMOELECTRIC PUMP DEVELOPMENT

AUTHOR: M. Perlow

6-3-64

ABSTRACT: The SNAP 10A system and pump requirements are presented to define the developmental objectives of the thermoelectric pump. Design equations and procedures are included along with operating data and their respective analyses. Fabrication problems are discussed, and the procedure for manufacture of both the elements and the pump assembly is included. Posttest examination by metallographic means was performed on pumps subsequent to 1000°F NaK operation.

PUMP

NAA-SR-MEMO-9712 CONF DI

TITLE: POST TEST EXAMINATION OF SNAP 10A THERMOELECTRIC PUMP NUMBER-017

AUTHOR: W. L. Cockrell and E. L. Reed

4-15-64

ABSTRACT: This pump was the first to embody an iron foil barrier. It showed effective reduction in observable poisoning in the telluride elements. An observed variation in density of the iron powders across the area of these layers suggests need for greater care in distribution of the iron powder across the section prior to compacting the telluride elements. The dimensional observations suggest a study of the tolerances and permissible variation in thickness of radiators prior to assembly. The "N" element copper shoe to aluminum radiator diffusion bonded joints in this pump were poor. Suggestions are made to incorporate a barrier foil between the copper and aluminum to eliminate the formation of brittle intermetallic compounds.

NAA-SR-MEMO-10189 CONF DI

TITLE: THERMOELECTRIC PUMP DEGRADATION

AUTHOR: K. A. Davis

7-7-64

ABSTRACT: The pumping capacity of the SNAP 10A thermoelectric pumps decreases to approximately 80% of their initial rate within the first 2000 hr of operation and generally after this time the degradation is relatively slight. An experiment was conducted to evaluate the factors involved in the degradation. The experiment showed that the degradation is related to the deterioration in electrical and thermal paths and under normal operating conditions, the Seebeck coefficient does not decrease within the 2000-hr time interval.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME V, COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - POWER CONVERSION AND HEAT TRANSFER SYSTEMS

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume V) is one.

Volume V contains a description of the component development and qualification test status of the power conversion system, including the power conversion subsystem; and the heat transfer subsystem, including the pump, expansion compensators, and piping.

NAA-SR-MEMO-10299 CONF DI

TITLE: POST TEST EXAMINATION OF T/E PUMP 10-FSM-1

AUTHOR: E. L. Reed

10-1-64

ABSTRACT: Photographs are exhibited showing the condition of the stainless steel NaK tube after the accident. Photomicrographs are shown and described for each joint and for each component in the N and P type element stack-up. There was little damage to

PUMP

NAA-SR-MEMO-10299 CONF DI (Continued)

ABSTRACT: (Continued) the pump components from the accident except that the P type elements may have been shattered more than usual. There did not appear to be as much contamination in the T/E elements from this pump as has been seen in pumps performance tested for longer periods of time. Some conclusions are drawn and recommendations are made for possibly improving the performance of the SNAP 10A T/E pumps.

NAA-SR-MEMO-10517 CONF DI

TITLE: POST TEST EXAMINATION OF T/E PUMP FQ-3

AUTHOR: E. L. Reed

11-16-64

ABSTRACT: The P-element side of this pump was disconnected from the stainless steel throat section when it was received for examination. An examination was made of the surfaces where the joint failed and cross-sections of these areas were studied. Conclusions are reported for the nature of the braze failure.

Each side of the pump was mounted in Epoxy Casting Compound; then sections were cut, polished and examined under a microscope. The results of the metallographic examinations are reported and photomicrographs are exhibited of typical areas in each element stack-up. Knoop hardness measurements are reported for the phases observed at the interface of the copper to aluminum diffusion bonded joints.

Some conclusions are drawn based upon the observations. Also, some recommendations are made for possibly improving the performance of the SNAP 10A T/E Pumps.

NAA-SR-MEMO-10952 CONF DI

TITLE: POST TEST EXAMINATION OF SNAP 10A T/E PUMP 010

AUTHOR: E. L. Reed

3-11-65

ABSTRACT: T/E Pump 010 was performance tested at 1010° liquid NaK temperature for a total of 10,200 hrs including pre-checkout runs. The throat section was brazed to bond the elements to the copper straps. It was desired to examine the joints and other components in this pump to determine the effect of these fabrication changes.

NAA-SR-MEMO-11225 CONF DI

TITLE: POST TEST EXAMINATION OF P-ELEMENTS IN T/E PUMPS DEV-4 AND DEV-5

AUTHOR: E. L. Reed

4-5-65

ABSTRACT: Photomicrographs of the cold side of the P-elements from T/E Pumps DEV-4 and DEV-5 are exhibited and discussed. The results were not conclusive; but there appeared to be significantly less contamination in the tin-free lead telluride materials from these pumps, than has been observed in the lead tin telluride type of P-elements after comparable periods of performance testing.

NaK

NAA-SR-MEMO-10446 CONF DI

TITLE: SNAP-10A FSM-4 PERFORMANCE ANALYSIS - NaK LOADING AND THERMAL
REFERENCE TEST

AUTHOR: G. E. Berg 9-15-64

ABSTRACT: Data taken during NaK loading and thermal reference testing of the SNAP-10A
FSM-4 non-nuclear ground test system are presented and analyzed. For purposes of
analysis the performance was divided into five categories:

- 1) System temperatures,
- 2) System heat losses,
- 3) Converter electrical performance,
- 4) Pump performance, and
- 5) Flight instrumentation performance.

In each category emphasis was placed on comparison of measured data to predicted
performance and thermal reference performance of the 10FSM-1 and 10FS-1 systems.
In almost every case both FSM-4 performance and agreement with predicted values
were excellent. An average of 509 w was produced at a core outlet temperature of
1011°F. The only important problem was a low converter to ground resistance which
would have caused a very small decrease in power output if the system had been
grounded.

G. STRUCTURE

STRUCTURE DESIGN, ANALYSIS, AND TESTING

NAA-SR-9655 UNCI

TITLE: SNAP 10A STRUCTURAL ANALYSIS

AUTHOR: J. R. Boulanger

7-15-64

ABSTRACT: This report discusses and summarizes all stress analyses done on the SNAP 10A system; it also mentions many of the structural tests which were accomplished. A stress analysis was made on all elements of the primary structure and on all structural components.

NAA-SR-9820 UNCL

TITLE: STRUCTURAL TEST ON THE FINAL SNAP 10A PROTOTYPE SYSTEM (PSM-1A)

AUTHOR: H. L. Henley and W. H. Dauterman

7-15-64

ABSTRACT: This report presents the results of the structural tests which were performed on the S10A-PSM-1A system to qualify the basic structural design for the anticipated launch environment. Included in this report are data from the damping, vibration, shock, acoustic, and static test programs. Testing was performed in accordance with NS10 PSM-1A-00-001, "PSM-1A Structural Test Specification."

NAA-SR-9899 UNCI

TITLE: SNAP 10A REACTOR STRUCTURE

AUTHOR: J. D. Sutherland

8-1-64

ABSTRACT: To demonstrate the integrity of the SNAP 10A reactor structure and to obtain data for verification of design analysis, a structural test program was conducted. Included were static, vibration, and elevated temperature creep tests of the major reactor structural components. The results of this test program are presented and are compared with pertinent design analysis.

EJECTABLE HEAT SHIELD

NAA-SR-10997 UNCL

TITLE: DEVELOPMENT, ACCEPTANCE AND QUALIFICATION TESTING OF THE SNAP 10A
EJECTABLE HEAT SHIELD

AUTHOR: H. L. Sperow 8-31-65

ABSTRACT: The development, acceptance, and qualification tests performed on the SNAP 10A Ejectable Heat Shield and components, the results of those tests, and the conclusions drawn from the results are presented in this report.

The final conclusions made of the completion of the Qualification Program, December 23, 1964, were as follows:

1) The heat shield will maintain the heat exchange fluid within the prescribed limits of 50 to 250°F, thus preventing plugging of the NaK lines during the orbital period before startup of the nuclear reactor.

2) The heat shield will perform satisfactorily provided the outside shield temperatures do not exceed 375°F. The shield will eject from the nuclear power unit when the temperature of the heat exchange fluid at the reactor outlet approaches 275 ±25°F, and will clear all vehicle components.

MOMENTS AND TORQUES

NAA-SR-11207 UNCL

TITLE: MAGNETIC MOMENTS AND VEHICLE TORQUES IN THE SNAP 10A

AUTHOR: T. J. Boyle and R. M. Galantine

10-1-65

ABSTRACT: Small magnetic dipole moments arise in the SNAP 10A nuclear electric power system due principally to the permanent magnet in the electromagnetic pump and current flowing in the thermoelectric converter. The dipole moments interact with the earth's magnetic field to produce torques on the orbiting vehicle. This report describes the nature of these torques, discusses the procedures which have been used to evaluate them, and discusses methods for reducing them.

H. CONTROL AND INSTRUMENTATION

COMPONENT DEVELOPMENT AND TESTING

NAA-SR-MEMO-8198 UNCL

TITLE: RESULTS OF ACCEPTANCE TESTING THE SNAP 10A START UP CONTROLLER

AUTHOR: M. T. Marshall

2-12-63

ABSTRACT: This TDR presents the results of functional tests prior to/and following vibration testing. Controllers 5 through 11 are included in this report.

NAA-SR-MEMO-9581 CONF RD

TITLE: SNAP 10A DRUM POSITION DEMODULATOR QUALIFICATION IRRADIATION TEST (STR 17)

AUTHOR: M. N. Robinson and S. G. Kimble

2-27-64

ABSTRACT: A qualification irradiation test of two demodulators is described. Gamma irradiation to 2×10^7 rad was performed, December 30, 1963, to January 13, 1964, at the AI Co⁶⁰ Gamma Facility. Neutron irradiation to 3×10^{13} nvt (>0.1 Mev) was performed, January 20-23, 1964, at the Shield Test Reactor.

The results of inpile performance tests are presented. Both demodulators exceeded the specified limits on input impedance and coarse and fine output voltages.

NAA-SR-MEMO-9724 CONF RD

TITLE: SNAP 10A STARTUP CONTROLLER ENDURANCE IRRADIATION

AUTHOR: S. G. Kimble

3-26-64

ABSTRACT: This report describes a temperature vacuum irradiation environment test on a SNAP 10A Startup Controller which had been irradiated in an earlier experiment to qualification dose levels (3×10^{13} nvt, 2×10^7 R γ). More extensive measurements were taken in the present test in an effort to study the temperature-dose dependency of the failure point and the mode of failure. Results are presented which indicate operational limits as a function of dose and time.

NAA-SR-MEMO-9746 CONF RD

TITLE: IRRADIATION QUALIFICATION TESTING OF SNAP 10A COMPONENTS

AUTHOR: A. J. Chesavage

2-4-64

ABSTRACT: Selected SNAP 10A components were irradiated to about 10^{14} NVT and 5×10^7 R at an average temperature of 136°F in a nominal vacuum of 2×10^{-5} TORR. The components were operated periodically and the electrical characteristics recorded. Pre-irradiation and post-irradiation tests were conducted.

COMPONENT DEVELOPMENT AND TESTING

NAA-SR-MEMO-9854 CONF RD

TITLE: SNAP 10A ELECTRONIC TEMPERATURE SWITCH QUALIFICATION IRRADIATION TEST

AUTHOR: M. N. Robinson and S. G. Kimble 5-19-64

ABSTRACT: A nuclear radiation environmental test of two switches (Serial numbers 1011 and 1012) is described. The gamma irradiation was performed at the A. I. Co⁶⁰ Gamma Facility, December 4-17, 1963, followed by neutron irradiation at the fission plate of the shield test and irradiation reactor, January 2-6, 1964.

The results of electrical operation tests performed during irradiation are presented and interpreted. The changes observed are well within the repeatability and hysteresis tolerances designated in the equipment specification, indicating fulfillment of the radiation portion of the qualification requirements.

NAA-SR-9898, VOLUME I CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 1, CONTROL COMPONENTS

AUTHOR: W. J. Kurzeka, Editor 8-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also included a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR-9898, VOLUME III CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 3, SHIELD, GROUND TEST ASSEMBLY, AND MATERIALS APPLICATIONS

AUTHOR: W. J. Kurzeka, Editor 2-10-65

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

COMPONENT DEVELOPMENT AND TESTING

NAA-SR-TDR-10037 CONF RD

TITLE: QUALIFICATION IRRADIATION OF SELECTED SNAP 10A INSTRUMENTATION
COMPONENTS, STR #14

AUTHOR: S. G. Kimble

6-9-64

ABSTRACT: The component irradiation described in this report was designed to produce information that could be used to determine irradiation qualification status for SNAP 10A Flight System instrumentation components. The test was conducted in vacuum at temperature in the shield test facility Fission Plate Capsule between November 18, 1963 and December 6, 1963. Tested components were subjected to a total neutron dose of 1×10^{14} nvt (E above one Mev) and a γ dose of 0.025×10^7 R. Results are included in tabular and/or graph form for the components which were instrumented for in-pile data taking.

NAA-SR-MEMO-10205 UNCL

TITLE: RADIATION-INDUCED SURFACE EFFECTS ON SNAP 10A STARTUP CONTROLLER
TRANSISTORS

AUTHOR: M. N. Robinson

7-10-64

ABSTRACT: A gamma irradiation test for potential surface effects on SNAP 10A Startup Controller transistors is described. Measurements of collector leakage current under "use" bias conditions are presented and interpreted. Of the two models tested, the 2N744 transistors showed no discernible surface effects, as determined by this parameter, while the effect on the 2N1072 transistors was below the level which would adversely affect performance of the Controller.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME VI, COMPONENT
DEVELOPMENT AND QUALIFICATION TEST STATUS - CONTROL SYSTEM AND
DIAGNOSTIC INSTRUMENTATION

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume VI) is one.

Volume VI contains a description of the component development and qualification test status of the control subsystem, including the drive motors, controller, reactor temperature control switches, squibs and pin pullers, relay boxes, heat-shield ejection temperature switches, high-temperature wires, low-temperature wires, and connectors; and the diagnostic instrumentation, including position switches, expansion-compensator position switches, drum position transducers and de-modulators, converter voltage divider, converter current shunt, thermocouples, resistance temperature detectors and bridge, and the low-voltage trip device.

COMPONENT DEVELOPMENT AND TESTING

NAA-SR-MEMO-10240 CONF RD

TITLE: SNAP 10A STARTUP CONTROLLER FINAL QUALIFICATION TEST REPORT
AUTHOR: D. A. Checkets and J. L. Nummelin 7-20-64
ABSTRACT: Three SNAP 10A startup controllers were tested through thermal cycle, shock, vibration, acceleration, radiation, radio frequency interference and endurance in accordance with Qualification Test Specification NA0403-018. The controllers completed thermal cycle, shock, vibration, acceleration, radiation and endurance tests with no failures. The controller did not meet all the requirements of the MIL-I-26600 Radio Frequency Interference Test for conducted interference at 150 kc and radiated interference at 150 - 200 kc and 100 mc. These deviations were accepted (TDT 7196) since compatibility problems in the system could be corrected by appropriate shielding, wire routing, or filtering. A noise susceptibility problem discovered during system testing was corrected by the addition of a 6.8 microfarad capacitor external to the controller. No other radio interference problems were encountered during system tests.

The controller has met the requirements of NA0403-018, except for the above approved deviations. As these deviations are not detrimental to system operation, the controller is considered to have successfully completed the component qualification program.

NAA-SR-MEMO-10252 CONF RD

TITLE: INTERIM QUALIFICATION TEST REPORT - SNAP 10A CONTROL DRUM ACTUATOR
AUTHOR: T. E. Norris and W. E. Burns 7-24-64
ABSTRACT: Eight control drum actuators were received and subjected to acceptance vibration tests. No malfunction nor physical damage was detected during these tests.

Of the eight units received, two were subjected to qualification performance record tests and shipped directly to Battelle Memorial Institute for radiation tests.

Six units were subjected to initial performance record, thermal cycle, vibration, shock, and acceleration tests in accordance with NA0404-006, dated May 7, 1963. Two of the units were also subjected to radio frequency interference tests in accordance with applicable sections of MIL-I-26600 (2), Interference Control Requirements, Aeronautical Equipment, Amendment 2, Notice 1, dated June 1, 1962. The six units, which are reported on in this report, successfully completed their assigned test phases. The control drum actuator has met or exceeded the requirements of NA0404-006 through the above mentioned test phases.

NAA-SR-MEMO-10597 CONF RD

TITLE: TEST REPORT - QUALIFICATION SNAP 10A NE10FS1-24-009 ELECTRONIC TEMPERATURE SWITCHES S/N 1011, 1012, 1014, 1015
AUTHOR: N. L. Ray 10-22-64
ABSTRACT: Qualification tests on the SNAP 10A Electronic Temperature Switch in accordance with Test Specification NA0403-029, and the results.

COMPONENT DEVELOPMENT AND TESTING

NAA-SR-MEMO-10541 CONF RD

TITLE: RESULTS OF THE QUALIFICATION IRRADIATION OF SNAP 10A LIMIT SWITCHES
AUTHOR: M. Warren 10-9-64
ABSTRACT: An irradiation experiment was performed in which two SNAP 10A limit switches were maintained at $705 \pm 15^{\circ}\text{F}$ for 1120 hr at a pressure of 7×10^{-6} to 1×10^{-5} Torr. The total fast neutron exposure of about 6.3×10^{18} nvt • 0.1 Mev was obtained at a rate of 2.2×10^{12} nv for 802.3 equivalent full power hours of reactor operation. The total gamma exposure was about 1.8×10^{10} R. The switches were mounted on an aluminum plate such that the plunger of one switch was permanently depressed. In-reactor measurements were made of the contact resistance between the closed pair of contacts and the insulation resistance between the open pair of contacts on each switch.

NAA-SR-MEMO-10610 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS PROGRESS REPORT, JULY 1, 1964 - AUGUST 15, 1964
AUTHOR: J. Brunings 12-15-64
ABSTRACT: This report describes the component qualification progress made in the SNAP 10A program between July 1, 1964, and August 15, 1964, and summarizes the qualification status of all major components in the system. A summary of component qualification test data and qualification status as of July 1, 1964, is presented in NAA-SR-MEMO-10234, "SNAP 10A Qualification Status Report," dated September 21, 1964.

NAA-SR-MEMO-11139 CONF RD

TITLE: SNAP 10A CONTROL DRUM POSITION SENSOR DEMODULATOR NE10FS1-24-010 FINAL COMPONENT QUALIFICATION TEST REPORT. SERIAL NOS. 06, 18, 25, 26 & 29
AUTHOR: B. J. Blau 3-9-65
ABSTRACT: Five SNAP 10A control drum position sensor demodulators were tested to the requirements of Qualification Test Specification NA0403-023. Although the demodulators did not perform in complete accordance with the specification, qualification testing revealed that the component, although having certain limitations, can perform its originally intended diagnostic function.

NAA-SR-11762 UNCL

TITLE: DEVELOPMENT OF A SOLID STATE NEUTRON DETECTOR FOR SNAP 10A
AUTHOR: A. Chesavage 3-25-66
ABSTRACT: Electronic devices, primarily semiconductors, degrade in a nuclear radiation environment. In a reactor environment most of the damage is due to fast neutrons. The lithium hydride shield on SNAP 10A was designed to attenuate the fast neutron exposure at the instrument compartment to a tolerable level. To evaluate shield effectiveness fast neutron detectors were developed. Eight detectors were installed in the SNAP 10A FS-4 flight system. This report discusses the development and in-flight data of these detectors.

NAA-SR-MEMO-12023

I. SAFETY

GENERAL SAFETY

NAA-SR-MEMO-1946 (Addendum 1) SECRET RD

TITLE: SPECIAL PURPOSE POWER PLANT CRITICAL FACILITY SUMMARY HAZARDS REPORT (ADDENDUM 1)

AUTHOR: M. V. Davies

12-1-58

ABSTRACT: The nuclear reactor discussed in the Hazard Report NAA-SR-Memo-1946 (this report will be referred to as HR-1) achieved criticality on October 16, 1957. Since that time there has been considerable information obtained that supplements the original calculations and predictions presented in HR-1. Although the original presentation is sufficiently accurate to describe the current reactor it is deemed advisable to augment the original report. This addendum is to serve the purpose of amplifying the earlier calculations and of presenting experimentally determined operating characteristics of the reactor and associated equipment.

NAA-SR-MEMO-1946 (Addendum 2) SECRET RD

TITLE: SPECIAL PURPOSE POWER PLANT CRITICAL FACILITY SUMMARY HAZARDS REPORT (ADDENDUM 2)

AUTHOR: A. W. Thiele

3-11-59

ABSTRACT: The similarity of the SER critical assembly to the SNAP critical assembly is shown. In the previous report it has been shown that the hazard to personnel from a nuclear accident was not unreasonable. The methods of initiation of an accident will be of the same nature also. The small size of the core with the high neutron leakage makes the assembly quite sensitive to reflector material as a potential accident mechanism.

NAA-SR-MEMO-1946 (Addendum 3) SECRET RD

TITLE: SNAP 10 CRITICAL ASSEMBLY SUMMARY HAZARDS REPORT

AUTHOR: R. E. Wimmer

1-15-60

ABSTRACT: On the basis of the SXC nuclear and transient analysis, and of the experience with the previous two critical assemblies, it is concluded that no additional hazard results from the installation and operation of SXC in the SNAP Critical Facility. The design and analysis of SXC has been based upon the considerable experience, both analytical and experimental, gained from the previous reactors of this type. It is felt that SXC represents the most advanced analysis and the greatest inherent safety yet attained in the critical experiments program.

NAA-SR-MEMO-1946 (Addendum 4) CONF RD

TITLE: SNAP CRITICAL ASSEMBLY -3 (SCA-3) HAZARDS REPORT AND OPERATIONS MANUAL (ADDENDUM 4)

AUTHOR: J. L. Shapiro

7-31-61

ABSTRACT: The analysis of the characteristics, installation, and operation of the SCA-3 in the manner described, shows that the hazard is well within tolerable limits. In particular, the maximum credible accident will, in the most severe case, deposit less than 18 rem in a receptor at the exclusion fence. No significant dosage to off-site personnel will result.

GENERAL SAFETY

NAA-SR-MEMO-4453 SECRET RD

TITLE: FUEL PROCESSING AND HANDLING SAFETY FOR SNAP 10 AND SDR-1
AUTHOR: W. T. Hayes 10-6-59
ABSTRACT: Calculate safe masses of fuel and alloy materials for handling during fuel fabrication and storage. The fuel to be that for the SNAP 10 and the SDR-1 reactors.

NAA-SR-MEMO-5136 UNCL

TITLE: CRITICALITY OF HANDLING SNAP 10 PLATES
AUTHOR: N. Ketzlach 4-1-60
ABSTRACT: The calculated minimum critical number of plates at optimum water-moderation and reflection is nine. Therefore, it is safe to handle four of these plates in any volume independent of the degree of water flooding and water moderation. No other moderator such as beryllium, beryllium oxide, heavy water, or graphite may be present. Safe spacings of groups of four plates may be determined from the criteria previously outlined.

NAA-SR-MEMO-7286 CONF RD

TITLE: ACCEPTANCE TEST FACILITY SAFEGUARDS REPORT
AUTHOR: W. H. Heneveld 4-17-63
ABSTRACT: The purpose of this report is to describe the operation of the Acceptance Test Facility (ATF) and testing of SNAP 10A Auxiliary Power Units (APU) in the facility. A hazards analysis of the facility, with a discussion of maximum credible accidents and consequences, is included. The Acceptance Test program is presented along with those test procedures associated with the reactor operation. This report covers only the tests and operations to be conducted with SNAP 10A systems; acceptance tests of SNAP 2 and 8 systems, which will also be conducted in this facility, will be presented in an addendum to be published at a later date. A separate operation manual, presenting descriptions and detailed test procedures, will be issued prior to operation of the facility.

NAA-SR-MEMO-7846 CONF RD

TITLE: S10FS-1 NUCLEAR QUALIFICATION TEST SUMMARY SAFEGUARDS REPORT, BUILDING 024
AUTHOR: E. A. Licitra 5-10-63
ABSTRACT: The S10FS-1 Nuclear Qualification Test will be the second nuclear test to be conducted in the SNAP Experimental Test Facility (SETF). The SETF environmental hazards report and the S2DS summary safeguards report discuss in detail the hazards associated with the operation of a 50-kw SNAP reactor in Power Test Vault 1 of the SETF (Building 024). These hazards are summarized in a later, more comprehensive report.

GENERAL SAFETY

NAA-SR-9898, VOLUME II CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 2, SAFETY AND DIAGNOSTIC COMPONENTS

AUTHOR: W. J. Kurzeka, Editor

12-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

SNAPSHOT SAFETY

NAA-SR-MEMO-6224 CONF RD

TITLE: SNAPSHOT NUCLEAR FLIGHT SAFETY PROGRAM

AUTHOR: Staff

3-31-61

ABSTRACT: A nuclear flight safety program for the SNAPSHOT program is presented as a preliminary plan. The program is intended to be compatible with the Atomic Energy Commission's responsibility for nuclear materials used in the SNAPSHOT satellite launch series.

Analytical and experimental safety studies are described under three headings: Nuclear Studies, Radiological Safety Studies, and Engineering Design Studies. Program milestones are listed and a description of continuing studies is appended.

NAA-SR-6684 SECRET RD

TITLE: PRELIMINARY SNAP 10A - SNAPSHOT SAFETY REPORT

AUTHOR: M. Huntsinger

2-26-62

ABSTRACT: This preliminary report describes safeguards designed for the first nuclear reactor to be operated in space. Control of nuclear hazards will be effected to allow successful flight tests without risks to operating personnel or the general public. The report is intended for use by safety review and approval agencies within the U. S. Atomic Energy Commission, the U. S. Air Force, and the U. S. Navy Pacific Missile Range (PMR). Joint report preparation has been carried out by the USAF satellite vehicle contractor (Lockheed Missiles and Space Company) and the USAEC nuclear contractor (Atomics International). A final safeguards report which will discuss in detail the unresolved areas indicated in this preliminary report will be issued for approval prior to the early 1963 SNAPSHOT test flight of the SNAP 10A satellite system.

The report scope includes shipment of the reactor system from the manufacturer to Vandenberg Air Force Base, prelaunch testing, transport to the launch pad, countdown, launch and orbit injection, orbital operation, and final atmospheric reentry. Hazards and accident consequences for each operational phase are discussed to show the effectiveness of the planned safety measures.

NAA-SR-MEMO-7399 UNCL

TITLE: SNAPSHOT SAFETY PROGRAM PLAN

AUTHOR: M. F. Huntsinger

6-20-62

ABSTRACT: The SNAPSHOT Safety Program Plan, as described in this document, is formulated to align safety studies performed by separate agencies and their contractors. At the present stage in program development, the plan is principally concerned with the initial SNAPSHOT flight (SNAP 10A).

SNAPSHOT SAFETY

NAA-SR-MEMO-8147 SECRET RD

TITLE: SNAP 10A POWER SYSTEM SHIPMENT SAFEGUARDS REPORT

AUTHOR: R. S. Hart

12-18-63

ABSTRACT: This report describes the operations which will take place in transporting the system from Santa Susanna to the launch pad. All safeguards are detailed as well as the consequences of all possible credible accidents.

NAA-SR-MEMO-8215, PART 7 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS, PART 7, SNAP 10A FLIGHT NUCLEAR SAFETY

AUTHOR: R. G. Courson

5-1-63

ABSTRACT: The potential programming of a nuclear-power system for a space mission invariably involves many questions of nuclear safety and hazards to the general public as well as to the personnel associated with the actual launching. The impending orbital tests of SNAPS 10A and 2 have led to a detailed consideration of these hazards which will be forthcoming in the "Final Safeguards Report - SNAP 10A Flight Tests." Since the majority of these safety conclusions apply to any reactor nuclear-power system, it is desirable to summarize the SNAP 10A considerations to highlight the general considerations which will be applicable to the safety of all nuclear power systems. Since factory-to-flight safety is readily managed by controlled handling procedures, only postlift-off safety is discussed.

NAA-SR-MEMO-8685 UNCL

TITLE: SNAP PRELAUNCH TEST FACILITY SAFEGUARDS REPORT

AUTHOR: B. F. Ureda

12-31-63

ABSTRACT: The objective of this report is to demonstrate that the activity in the SNAP 10A program to be conducted in the SNAP Prelaunch Test Facility (SPTF, Figure 1) at Vandenberg Air Force Base (VAFB) was given sufficient consideration to insure the safety of the operation. Specific consideration was given to the location and design of the facility, selection of operating equipment, limitation of operations to nonnuclear, and definition and control of operating procedures. A hazards analysis of these operations and a discussion of the postulated maximum credible accident and its consequences forms a part of this report.

NAA-SR-10022 (REV) CONF RD

TITLE: FINAL SNAPSHOT SAFEGUARDS REPORT

AUTHOR: Staff

3-20-65

ABSTRACT: This report presents a definition of the nuclear hazards and an evaluation of the potential risks associated with the flight test of the SNAP 10A Nuclear Power Unit from launch to reentry to earth. This safety evaluation of the flight test is grouped into three phases: (a) Launch to orbit injection, (b) Orbit injection until the reactor startup command is given, and (c) Reactor startup to reentry. For each phase the analysis includes a description of the procedures, a definition of potential accidents and potential nuclear hazards, and an evaluation of the potential risk to personnel.

SNAPSHOT SAFETY

NAA-SR-10022, ADDENDUM 1 (REV) CONF RD

TITLE: FINAL SNAPSHOT SAFEGUARDS REPORT, ADDENDUM 1

AUTHOR: Staff

3-20-65

ABSTRACT: This addendum presents information and/or analysis pertinent to the safety of the SNAPSHOT Program which has become available since May 1, 1964, the imposed cutoff for data used in the preparation of the Final SNAPSHOT Safeguards Report.

NAA-SR-MEMO-10246 CONF RD

TITLE: SUMMARY REPORT SNAPSHOT SAFETY

AUTHOR: Staff

8-15-64

ABSTRACT: This report presents a summary of the evaluation of potential hazards associated with the flight test of the SNAP 10A Nuclear Power Unit. The complete factory-to-flight sequence, acceptance test, transport, launch, orbit operation and reentry, is covered. Readers interested in a detailed analysis of any of the flight test program or in details of the calculational methods used in the safety evaluation, are referred to the bibliography at the end of this report.

AEROSPACE SAFETY

NAA-SR-5482 CONF RD

TITLE: EVALUATION OF RADIOLOGICAL HAZARDS DUE TO REENTRY OF SNAP APU
AUTHOR: F. D. Anderson 1-15-61
ABSTRACT: The evaluation of radiological hazards due to the reentry of a SNAP unit was performed to determine the limitations for intact and partial intact reentry as well as for reentry burnup and high altitude dispersal. The evaluation of radiological hazards due to the operational periods from manufacturing through launch of a SNAP unit have been discussed in a report entitled, "SNAP 2 Safety Evaluation Analysis." Reentry burnup and high altitude dispersal of SNAP reactor cores are now being investigated by experimental and analytical studies.

NAA-SR-MEMO-5804 CONF RD

TITLE: RADIOLOGICAL EVALUATION OF SNAP REACTOR DEBRIS DUE TO REENTRY BURNUP
AUTHOR: N. Harris 12-20-60
ABSTRACT: The SNAP system, upon reentering the atmosphere, has been assumed to burn up and completely disintegrate above an altitude of 100,000 ft.
The fission product debris will be dispersed strongly in the horizontal direction while in the stratosphere. A small fraction of the debris will be continuously diffusing through the tropopause into the troposphere with a stratospheric storage half-time of about five years.
Once in the troposphere, the debris will be washed out of the air by rain, within a few weeks. The debris will then enter the biosphere.

NAA-SR-8462 CONF RD

TITLE: AEROSPACE SAFETY RESULTS OF SPECIAL INTEREST TO SNAP 10A FLIGHT TESTS
AUTHOR: K. E. Buttrey 7-15-63
ABSTRACT: Experiments, tests, and analyses were performed under the Aerospace Safety Program to obtain data on potential hazards associated with and to demonstrate the inherent safety of SNAP systems. To date of this report, the program has included: (1) An evaluation of the mechanical and thermochemical changes the SNAP system may undergo during various handling, transportation, and launch accidents. (2) An experimental study to determine the reactivity of SNAP reactors when subjected to various water immersion configurations. (3) A thorough investigation of the behavior of SNAP systems under various nuclear accident conditions. (4) An analytical and experimental program to determine the breakup, ablation, and dispersion characteristics of the reactor assembly and fuel elements during reentry into the earth's atmosphere. (5) Calculation of the release of fission products following a nuclear excursion.

This report describes the results of the Aerospace Safety Program achieved to date which are of special interest to SNAP 10A flight tests.

NAA-SR-MEMO-12023

AEROSPACE SAFETY

NAA-SR-MEMO-9815 CONF RD

TITLE: SELF-WELDING IN SPACE - AEROSPACE SAFETY SURVEY

AUTHOR: H. E. Johnson

4-3-64

ABSTRACT: The purpose of this TDR is to review the general literature on self-welding and to survey the program at Atomics International in order to evaluate the possibility that self-welding of the beryllium reflector to the 316 stainless steel reactor core will occur while the SNAP system is in operation in space. Seizure of the reflector to the reactor will affect the burnup of the system on reentry into the atmosphere.

NAA-SR-MEMO-8972 UNCL

TITLE: SNAP 10A LAUNCH AND REENTRY HAZARDS DUE TO STEADY-STATE OPERATION

AUTHOR: R. E. Alexander

9-1-64

ABSTRACT: The safety analysis performed in support of the SNAP 10A flight tests has included consideration of potential hazards due to quasi steady-state operation of the SNAP 10A reactor under accident conditions. Steady-state operation is considered possible, although highly improbable, following launch pad accidents that could occur during or after fueling of the launch and orbital stage vehicles. In the extremely improbable event that reentry aerodynamic and impact forces fail to render the core permanently subcritical, steady-state operation is again considered possible. Potential radiation hazards due to accidents of this nature are examined in this report.

NAA-SR- 9779 UNCL

TITLE: SNAP FUEL REENTRY BURNUP EXPERIMENT IN A HYPERTHERMAL WIND TUNNEL

AUTHOR: J. W. Baughn

10-15-64

ABSTRACT: Specimens of SNAP fuel material were tested in a simulated reentry environment. This behavior in this environment was observed and is described in this report. This behavior was compared to and agreed with computations using a simple thermal approximation to the fuel material. The behavior was also extrapolated directly to that of an orbital reentry (with release of the reactor fuel rods from the reactor vessel at an altitude of approximately 240,000 ft).

NAA-SR- 9782 CONF RD

TITLE: TOPICAL REPORT, THERMOPHYSICAL PROPERTIES OF SNAP FUELS

AUTHOR: R. E. Taylor and C. J. Ambrose

6-26-64

ABSTRACT: The specific heat, thermal diffusivity, thermal conductivity, electrical resistivity, and thermal expansion of various zirconium-uranium hydrides were measured. Calculations of the specific heat based on this model are within 8% of the experimental results obtained by numerous laboratories on a variety of compositions.

AEROSPACE SAFETY

NAA-SR-MEMO-10774 UNCL

TITLE: THE EXTERNAL RADIATION FIELD HAZARD FROM FALLOUT OF ABLATION PARTICLES FROM SNAP REACTORS

AUTHOR: C. A. Willis

2-15-65

ABSTRACT: The fallout radiation field hazard from reentry burnup of a SNAP reactor is investigated. Since the dose from fallout would be received over an extended period, the overexposure criterion is based on the equivalent residual dose. Maximum fallout concentrations are calculated for both polar and equatorial orbits, and it is shown that these concentrations are not sufficient to produce overexposures. Therefore, it is concluded that reentry burnup of a SNAP 10A reactor would eliminate other radiological hazards without introducing a fallout radiation field hazard.

NAA-SR- 11103 UNCL

TITLE: DISINTEGRATION AND DISPERSION OF THE SNAP 10A REACTOR UPON RETURN FROM SATELLITE ORBIT

AUTHOR: R. D. Elliott

9-1-65

ABSTRACT: A study of the disintegration and dispersion of the SNAP (Systems for Nuclear Auxiliary Power) 10A reactor upon atmospheric reentry from a satellite orbit is described. The flight configuration is that of the SNAP 10A reactor containing NaK coolant and mated to the forward end of the Agena-D vehicle. It is shown that the SNAP 10A/Agena system will be oscillating in an approximately nose-first attitude at the time of reentry. It is concluded that the reactor components will have disintegrated and dispersed at an altitude of not less than 237,000 ft.

NAA-SR-MEMO-11148 UNCL

TITLE: AN ANALYSIS OF THE WORLD POPULATION DENSITY DISTRIBUTION

AUTHOR: G. P. Kenfield and R. M. McAdams

7-16-65

ABSTRACT: An analysis is made of the world's population density distribution to evaluate the potential hazard to the population as a result of the random reentry of a SNAP reactor. A two-part literature survey provided the necessary information presented in the report.

NAA-SR- 11761 UNCL

TITLE: RADIOLOGICAL ASPECTS OF REENTRY BURNUP OF SNAP REACTORS

AUTHOR: C. A. Willis

9-30-65

ABSTRACT: Reentry burnup of SNAP reactors may produce low levels of worldwide fallout. The International Commission on Radiological Protection has recommended a population dose limit of 2 rem in 30 yr. The factors affecting the choice of a population dose criterion are reviewed in this report. These factors include radiological safety history and tradition, radiobiological knowledge, other radiation criteria, and the biological significance of criteria doses. No safety justification is found for reduction of the ICRP limit. This 2-rem in 30-yr dose is well within the range of variation

AEROSPACE SAFETY

NAA-SR-MEMO-11761 (Continued)

ABSTRACT: of natural background radiation. Population safety requirements are satisfied if the (Continued) does is less than the ICRP criterion. Many possible sources of artificial, nonmedical radiation could contribute to the population dose. For planning purposes, it is recommended that one-eighth the population dose, 0.25 rem/30 yr, be taken as the allowable dose from SNAP reactor applications.

J. LAUNCH OPERATIONS

TRANSPORTATION

NAA-SR-MEMO-8147 SECRET RD

TITLE: SNAP 10A POWER SYSTEM SHIPMENT SAFEGUARDS REPORT

AUTHOR: R. S. Hart

12-18-63

ABSTRACT: This report describes the operations which will take place in transporting the system from Santa Susanna to the launch pad. All safeguards are detailed as well as the consequences of all possible credible accidents.

NAA-SR-MEMO-9351 UNCL

TITLE: SNAP 10A SHIPPING PROCEDURES

AUTHOR: H. Newman

11-16-64

ABSTRACT: SNAP 10A Shipping Procedures Manual, Volumes I and II provides procedures and operations relative to the factory-to-flight shipping phases of the SNAP 10A Nuclear Power Unit, manufactured by Atomics International, A division of North American Aviation, Inc., Canoga Park, California.

PRELAUNCH

NAA-SR-MEMO-8685 UNCL

TITLE: SNAP PRELAUNCH TEST FACILITY SAFEGUARDS REPORT

AUTHOR: B. F. Ureda

12-31-63

ABSTRACT: The objective of this report is to demonstrate that the activity in the SNAP 10A program to be conducted in the SNAP Prelaunch Test Facility (SPTF, Figure 1) at Vandenberg Air Force Base (VAFB) was given sufficient consideration to insure the safety of the operation. Specific consideration was given to the location and design of the facility, selection of operating equipment, limitation of operations to non-nuclear, and definition and control of operating procedures. A hazards analysis of these operations and a discussion of the postulated maximum credible accident and its consequences forms a part of this report.

NAA-SR-MEMO-9352 UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A PRELAUNCH OPERATIONS - SPTF

AUTHOR: J. Rocke

2-19-65

ABSTRACT: The purpose of this manual is to provide information and procedures associated with the SNAP 10A prelaunch operations conducted at the SNAP Prelaunch Test Facility (SPTF), building 6527, located at Vandenberg Air Force Base (VAFB).

Activities included in SPTF prelaunch operations are illustrated in the frontspiece flow diagram. These begin upon receipt of the SNAP 10A system at the SPTF and conclude with shipment of the assembled SNAP 10A nuclear power unit (NPU) to the Point Arguello Launch Complex No. 2 (PALC-2). Each phase of the SPTF prelaunch operations program is concerned with preparing the NPU for launch.

NAA-SR-MEMO-9353 UNCL

TITLE: TECHNICAL MANUAL SNAP 10A, SNAP PRELAUNCH TEST FACILITY OPERATIONS, BUILDING 6527, VANDENBERG AIR FORCE BASE

AUTHOR: J. Rocke

12-30-64

ABSTRACT: This manual describes the SNAP Prelaunch Test Facility (SPTF) and the procedures utilized in support of the SNAP 10A prelaunch testing program at Vandenberg Air Force Base (VAFB). The facility is identified as Building 6527 at VAFB, but for purpose of identification in this and companion manuals, it is referred to as the SPTF. The SPTF serves as a base of operations for Atomics International personnel assigned to the SNAPSHOT nuclear power unit (NPU) prelaunch testing program conducted at VAFB. The facility is utilized for receiving storage and non-nuclear testing of the SNAP 10A power systems prior to shipment to the launch complex at the Point Arguello Launch Complex No. 2 (PALC-2). NPU prelaunch operations carried out at VAFB are shown in the Figure 1-1 flow diagram.

PRELAUNCH

NAA-SR-MEMO-9356, VOLUME I UNCL

TITLE: TECHNICAL MANUAL SNAP 10A, VOLUME I - AEROSPACE GROUND EQUIPMENT OPERATION AND MAINTENANCE - MECHANICAL

AUTHOR: H. Newman

1-4-65

ABSTRACT: AGE Operation and Maintenance Manuals, Volumes I and II provide information relative to mechanical and electrical aerospace ground equipment manufactured by Atomics International, a Division of North American Aviation, Canoga Park, California, for use in the SNAPSHOT flight test program.

Volume I contains information about the mechanical equipment used for handling the SNAP 10A Power Unit and the monitoring equipment used during shipping and storage.

NAA-SR-MEMO-9356, VOLUME II UNCL

TITLE: TECHNICAL MANUAL SNAP 10A, VOLUME II - AEROSPACE GROUND EQUIPMENT OPERATION AND MAINTENANCE - ELECTRICAL

AUTHOR: A. Kalish

1-4-65

ABSTRACT: This manual contains operation and service instructions for personnel responsible for the operation and maintenance of Electrical System Test Set TSM-1, Part Nos. 10FS-84019 and 10FS-84020, located at Point Arguello Launch Complex No. 2 (PALC-2) and Electrical System Test Set TSM-2A, Part No. 10FS-84053 located at the SNAP Prelaunch Test Facility (Building 6527), Vandenberg Air Force Base.

NAA-SR-MEMO-9359 UNCL

TITLE: TECHNICAL MANUAL NPU PRELAUNCH OPERATIONS - PALC-2

AUTHOR: J. Rocke

1-31-65

ABSTRACT: This manual presents operations performed by Atomics International (AI) personnel during the launch complex phase of the SNAPSHOT program. Related procedures covering prelaunch preparation of the SNAP 10A nuclear power unit (NPU) at Point Arguello Launch Complex No. 2 (PALC-2) are included.

NAA-SR-MEMO-11462 UNCL

TITLE: SNAPSHOT BRIEFINGS GIVEN AT VANDENBERG AIR FORCE BASE PRIOR TO LAUNCH

AUTHOR: W. F. Heine

6-30-65

ABSTRACT: On April 3, 1965, SNAP 10A, the first nuclear reactor in history to be put into space orbit, was successfully launched at Vandenberg Air Force Base. A few hours later it achieved full criticality in orbit, and operated for 43 days. The SNAP 10A system was developed for the Atomic Energy Commission by Atomics International, a Division of North American Aviation, Inc.

During the several weeks preparatory to the launch, AI gave briefings to Air Force and civilian contractor personnel at the base, and to local public officials. Each section of this report was one of the briefings given, some of them several different times, except for the last section. The last section was a statement of a procedure prepared as guidance for base personnel, but was not given as an oral briefing.

LAUNCH

NAA-SR-MEMO-8972 UNCL

TITLE: SNAP 10A LAUNCH AND REENTRY HAZARDS DUE TO STEADY-STATE
OPERATION

AUTHOR: R. E. Alexander

9-1-64

ABSTRACT: The safety analysis performed in support of the SNAP 10A flight tests has included consideration of potential hazards due to quasi steady-state operation of the SNAP 10A reactor under accident conditions. Steady-state operation is considered possible, although highly improbable, following launch pad accidents that could occur during or after fueling of the launch and orbital stage vehicles. In the extremely improbable event that reentry aerodynamic and impact forces fail to render the core permanently subcritical, steady-state operation is again considered possible. Potential radiation hazards due to accidents of this nature are examined in this report.

K. ORBITAL OPERATIONS

FLIGHT TEST, GENERAL

NAA-SR-MEMO-8244 CONF RD

TITLE: AN EVALUATION OF THE TECHNIQUES FOR END-OF-LIFE SHUTDOWN OF ORBITING SNAP REACTORS

AUTHOR: N. K. Jamison

3-29-63

ABSTRACT: Two techniques for the end-of-life shutdown of orbiting SNAP reactors are presented. One technique consists of two alternative methods for the destruction of the reactor core. This technique (and others) have been investigated during the past year.

NAA-SR-8462 CONF RD

TITLE: AEROSPACE SAFETY RESULTS OF SPECIAL INTEREST TO SNAP 10A FLIGHT TESTS

AUTHOR: K. E. Buttrey

7-15-63

ABSTRACT: Experiments, tests, and analyses were performed under the Aerospace Safety Program to obtain data on potential hazards associated with and to demonstrate the inherent safety of SNAP systems. To date of this report, the program has included:

- 1) An evaluation of the mechanical and thermochemical changes the SNAP system may undergo during various handling, transportation, and launch accidents.
- 2) An experimental study to determine the reactivity of SNAP reactors when subjected to various water immersion configurations.
- 3) A thorough investigation of the behavior of SNAP systems under various nuclear accident conditions.
- 4) An analytical and experimental program to determine the breakup, ablation, and dispersion characteristics of the reactor assembly and fuel elements during reentry into the earth's atmosphere.
- 5) Calculation of the release of fission products following a nuclear excursion.

This report describes the results of the Aerospace Safety Program achieved to date which are of special interest to SNAP 10A flight tests.

NAA-SR- 11642 UNCL

TITLE: THE PREDICTED FISSION PRODUCT DECAY OF SNAPSHOT I

AUTHOR: W. B. Sayer and R. S. Hart

1-15-66

ABSTRACT: SNAPSHOT-I was the first flight test of a direct power conversion system utilizing a nuclear reactor as the heat source. This report shows the calculated fission product inventory formed during the orbital operation of the SNAP 10A reactor and the predicted decay of this activity and the associated gamma radiation levels. A brief system description and summary of the operational phase is included.

FLIGHT TEST, GENERAL

NAA-SR-MEMO-10718 UNCL

TITLE: DETERMINATION OF PROBABILITY OF EJECTION OF REFLECTORS DURING
ORBITAL FLIGHT TESTING OF THE SNAP 10A NUCLEAR POWER UNIT

AUTHOR: R. M. Ohlenkamp 2-15-65

ABSTRACT: This report presents a method for the solution of the problem of ascertaining the probability of SNAP 10A reflector ejection and hence, reactor shutdown, after an orbital startup. Conservative solutions are given in tabular and graphical form over the continuous period from launch to 100 yr.

ORBITAL STARTUP

NAA-SR-MEMO-3886 UNCL

TITLE: EVALUATION OF ORBITAL STARTUP METHODS

AUTHOR: O. P. Steele, III

7-20-59

ABSTRACT: The political implications of a hot reactor falling in a populated area due to launching mishap has placed strong emphasis on orbital startup of the reactor system. To evaluate the weight penalty of orbital startup some of the methods of achieving this have been investigated. This report compares these methods and outlines some of the development problems involved.

NAA-SR-MEMO-5107 CONF RD

TITLE: ORBITAL STARTUP OF SNAP 10 REACTOR

AUTHOR: J. Reichman

3-31-60

ABSTRACT: Startup reactivity control of the SNAP 10 reactor is achieved by separating the reactor into two halves. The two halves are initially separated so that the reactor is sufficiently subcritical to prevent any conceivable nuclear accident. The two halves will be brought together at a predetermined rate by a motorized drive mechanism. The purpose of this report is to determine what rate is to be used to drive the halves together.

MALFUNCTION

NAA-SR-MEMO-7877 CONF RD

TITLE: THERMO-PHYSICS TECHNICAL NOTE NO. 14: SNAP 10A REACTOR TEMPERATURES AND POWER DECAY IN SPACE FOR ZERO NaK FLOW AND LOSS OF NaK

AUTHOR: S. R. Fields 10-11-62

ABSTRACT: The steady-state temperatures of the SNAP 10A reactor in orbit following complete loss of NaK have been calculated at various power levels for full sun and dark sky conditions. The results of the heat transfer analysis were used to determine the reactor power decay. In addition, the power decay calculations of a previous analysis were modified to include the effect of fuel burnup.

NAA-SR-MEMO-11635 UNCL

TITLE: SNAPSHOT FAILURE ANALYSIS REPORT - JOINT LMSC/AI FINAL FAILURE REPORT

AUTHOR: J. F. Pohlman, General Editor 9-30-65

ABSTRACT: This report presents the combined efforts of the Snapshot Program staffs of the Lockheed Missiles & Space Company and the Atomics International Division of North American Aviation, Inc., to determine the cause of shutdown of the SNAP 10A/Agena spacecraft after 43 days of singularly successful orbital operation. A brief history of the operating characteristics of the spacecraft up to the time of failure is included to provide a background helpful to a fuller understanding of the failure analysis.

REENTRY

NAA-SR-MEMO-4100 SECRET RD

TITLE: SNAP 10 REENTRY

AUTHOR: R. L. Hirsch

7-9-59

ABSTRACT: In order to vaporize a SNAP 10 fuel element above sixty thousand feet about 28% of its kinetic energy must be utilized to heat the body. Vaporization is desirable but not necessarily a requisite for high altitude dispersion. This is because locally melted material which is removed from the element by the high velocity air stream may very well support its own combustion once it is free of the main body. Since the scope of this study was rather limited, the effects of these and other rather important phenomena could not be evaluated.

NAA-SR-5482 CONF RD

TITLE: EVALUATION OF RADIOLOGICAL HAZARDS DUE TO REENTRY OF SNAP APU

AUTHOR: F. D. Anderson

1-15-61

ABSTRACT: The evaluation of radiological hazards due to the reentry of a SNAP unit was performed to determine the limitations for intact and partial intact reentry as well as for reentry burnup and high altitude dispersal. The evaluation of radiological hazards due to the operational periods from manufacturing through launch of a SNAP unit have been discussed in a report entitled, "SNAP 2 Safety Evaluation Analysis." Reentry burnup and high altitude dispersal of SNAP reactor cores are now being investigated by experimental and analytical studies.

NAA-SR-MEMO-5804 CONF RD

TITLE: RADIOLOGICAL EVALUATION OF SNAP REACTOR DEBRIS DUE TO REENTRY BURNUP

AUTHOR: N. Harris

12-20-60

ABSTRACT: The SNAP system, upon reentering the atmosphere, has been assumed to burn up and completely disintegrate above an altitude of 100,000 ft.

The fission product debris will be dispersed strongly in the horizontal direction while in the stratosphere. A small fraction of the debris will be continuously diffusing through the tropopause into the troposphere with a stratospheric storage half-time of about five years.

Once in the troposphere, the debris will be washed out of the air by rain, within a few weeks. The debris will then enter the biosphere.

REENTRY

NAA-SR-MEMO-8972 UNCL

TITLE: SNAP 10A LAUNCH AND REENTRY HAZARDS DUE TO STEADY-STATE OPERATION

AUTHOR: R. E. Alexander

9-1-64

ABSTRACT: The safety analysis performed in support of the SNAP 10A flight tests has included consideration of potential hazards due to quasi steady-state operation of the SNAP 10A reactor under accident conditions. Steady-state operation is considered possible, although highly improbable, following launch pad accidents that could occur during or after fueling of the launch and orbital stage vehicles. In the extremely improbable event that reentry aerodynamic and impact forces fail to render the core permanently subcritical, steady-state operation is again considered possible. Potential radiation hazards due to accidents of this nature are examined in this report.

NAA-SR-9723 UNCL

TITLE: BEHAVIOR OF SNAP 10A DURING ORBITAL REENTRY

AUTHOR: D. K. Nelson

7-15-64

ABSTRACT: This report presents an analysis of the SNAP 10A power system during orbital reentry to gain information regarding the ablation of various nuclear reactor components. The SNAP 10A power system used thermoelectric elements to convert the heat developed by a compact nuclear reactor into electrical energy. The initial point in the analysis occurs, after system operation in space, at an altitude in the process of satellite orbit decay where the satellite will not make another complete circuit of the earth. The analysis considered an oblate rotating earth.

NAA-SR-9779 UNCL

TITLE: SNAP FUEL REENTRY BURNUP EXPERIMENT IN A HYPERTHERMAL WIND TUNNEL

AUTHOR: J. W. Baughn

10-15-64

ABSTRACT: Specimens of SNAP fuel material were tested in a simulated reentry environment. This behavior in this environment was observed and is described in this report. This behavior was compared to and agreed with computations using a simple thermal approximation to the fuel material. The behavior was also extrapolated directly to that of an orbital reentry (with release of the reactor fuel rods from the reactor vessel at an altitude of approximately 240,000 ft).

NAA-SR-MEMO-10774 UNCL

TITLE: THE EXTERNAL RADIATION FIELD HAZARD FROM FALLOUT OF ABLATION PARTICLES FROM SNAP REACTORS

AUTHOR: C. A. Willis

2-15-65

ABSTRACT: The fallout radiation field hazard from reentry burnup of a SNAP reactor is investigated. Since the dose from fallout would be received over an extended period, the overexposure criterion is based on the equivalent residual dose. Maximum fallout concentrations are calculated for both polar and equatorial orbits, and it is shown that these concentrations are not sufficient to produce overexposures. Therefore, it is concluded that reentry burnup of a SNAP 10A reactor would eliminate other radiological hazards without introducing a fallout radiation field hazard.

REENTRY

NAA-SR-11103 UNCL

TITLE: DISINTEGRATION AND DISPERSION OF THE SNAP 10A REACTOR UPON RETURN FROM SATELLITE ORBIT

AUTHOR: R. D. Elliott

9-1-65

ABSTRACT: A study of the disintegration and dispersion of the SNAP (Systems for Nuclear Auxiliary Power) 10A reactor upon atmospheric reentry from a satellite orbit is described. The flight configuration is that of the SNAP 10A reactor containing NaK coolant and mated to the forward end of the Agena-D vehicle. It is shown that the SNAP 10A/Agena system will be oscillating in an approximately nose-first attitude at the time of reentry. It is concluded that the reactor components will have disintegrated and dispersed at an altitude of not less than 237,000 ft.

NAA-SR-MEMO-11148 UNCL

TITLE: AN ANALYSIS OF THE WORLD POPULATION DENSITY DISTRIBUTION

AUTHOR: G. P. Kenfield and R. M. McAdams

7-16-65

ABSTRACT: An analysis is made of the world's population distribution to evaluate the potential hazard to the population as a result of the random reentry of a SNAP reactor. A two-part literature survey provided the necessary information presented in the report.

NAA-SR-11761 UNCL

TITLE: RADIOLOGICAL ASPECTS OF REENTRY BURNUP OF SNAP REACTORS

AUTHOR: C. A. Willis

3-25-66

ABSTRACT: Reentry burnup of SNAP reactors may produce low levels of worldwide fallout. The International Commission on Radiological Protection has recommended a population dose limit of 2 rem in 30 yr. The factors affecting the choice of a population dose criterion are reviewed in this report. These factors include radiological safety history and tradition, radiobiological knowledge, other radiation criteria, and the biological significance of criteria doses. No safety justification is found for reduction of the ICRP limit. This 2-rem in 30-yr dose is well within the range of variation of natural background radiation. Population safety requirements are satisfied if the dose is less than the ICRP criterion. Many possible sources of artificial, nonmedical radiation could contribute to the population dose. For planning purposes, it is recommended that one-eighth the population dose, 0.25 rem/30 yr, be taken as the allowable dose from SNAP reactor applications.

L. FACILITIES

FACILITIES, GENERAL

NAA-SR-MEMO-4169 UNCL

TITLE: SNAP AUTHORIZED PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

NAA-SR-MEMO-4170 UNCL

TITLE: SNAP PROPOSED PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

NAA-SR-MEMO-4171 UNCL

TITLE: SNAP POTENTIAL PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal years 1960, 1961, and 1962.

NAA-SR-MEMO-5103 UNCL

TITLE: EXPERIMENTAL SHIELDING EVALUATION OF THE SETF USING SDR-I AND SNAP 10 AS RADIATION SOURCES

AUTHOR: R. L. Tomlinson

3-29-60

ABSTRACT: The SNAP Environmental Test Facility, which is now under construction, has been designed for the full-power testing of unshielded SNAP reactors in an environment that will approach that of satellite conditions. Special care has been observed in its design to facilitate personnel access to the power test cells in which the reactors will be operated, after a waiting period of 30 days and removal of all portable equipment that has been exposed to the nuclear radiation present during reactor operation at full or fractional power levels. In this regard, many special features have been designed into this facility. This report will deal only with the evaluation of those features concerned with nuclear radiation and shielding as they affect the operation of the SETF.

FACILITIES, GENERAL

NAA-SR-MEMO-6115 REVISION 1 UNCL

TITLE: OPERATION MANUAL FOR SNAP ENVIRONMENTAL TEST FACILITY BUILDING NO. 024

AUTHOR: H. V. Lee

5-5-61

ABSTRACT: SNAP Environmental Test Facility (SETF) has been built to accommodate the testing of this Compact Power System (SNAP 2). This system shall be tested under controlled environmental conditions. The necessary shielding, inert gas (nitrogen) atmosphere, pressure, and temperature controls are provided with this facility.

This document has been prepared to instruct the operating personnel how to safely perform the tasks of operating the systems within this facility.

NAA-SR-MEMO-7286 REVISION 2 CONF RD

TITLE: ACCEPTANCE TEST FACILITY SAFEGUARDS REPORT

AUTHOR: W. H. Heneveld

4-17-63

ABSTRACT: The purpose of this report is to describe the operation of the Acceptance Test Facility (ATF) and testing of SNAP 10A Auxiliary Power Units (APU) in the facility. A hazards analysis of the facility, with a discussion of maximum credible accidents and consequences, is included. The Acceptance Test program is presented along with those test procedures associated with the reactor operation. This report covers only the tests and operations to be conducted with SNAP 10A systems; acceptance tests of SNAP 2 and 8 systems, which will also be conducted in this facility, will be presented in an addendum to be published at a later date. A separate operation manual, presenting descriptions and detailed test procedures, will be issued prior to operation of the facility.

NAA-SR-MEMO-7846 CONF RD

TITLE: S10FS-1 NUCLEAR QUALIFICATION TEST SUMMARY SAFEGUARDS REPORT, BUILDING 024

AUTHOR: E. A. Licitra

5-10-63

ABSTRACT: The S10FS-1 Nuclear Qualification Test will be the second nuclear test to be conducted in the SNAP Experimental Test Facility (SETF). The SETF environmental hazards report and the S2DS summary safeguards report discuss in detail the hazards associated with the operation of a 50-kw SNAP reactor in Power Test Vault 1 of the SETF (Building 024). These hazards are summarized in a later, more comprehensive report.

FACILITIES, GENERAL

NAA-SR-MEMO-8685 UNCL

TITLE: SNAP PRELAUNCH TEST FACILITY SAFEGUARDS REPORT

AUTHOR: B. F. Ureda

12-31-63

ABSTRACT: The objective of this report is to demonstrate that the activity in the SNAP 10A program to be conducted in the SNAP Prelaunch Test Facility (SPTF, Figure 1) at Vandenberg Air Force Base (VAFB) was given sufficient consideration to insure the safety of the operation. Specific consideration was given to the location and design of the facility, selection of operating equipment, limitation of operations to non-nuclear, and definition and control of operating procedures. A hazards analysis of these operations and a discussion of the postulated maximum credible accident and its consequences forms a part of this report.

NAA-SR-MEMO-9352 UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A PRELAUNCH OPERATIONS - SPTF

AUTHOR: J. Rocke

2-19-65

ABSTRACT: The purpose of this manual is to provide information and procedures associated with the SNAP 10A prelaunch operations conducted at the SNAP Prelaunch Test Facility (SPTF), building 6527, located at Vandenberg Air Force Base (VAFB).

Activities included in SPTF prelaunch operations are illustrated in the frontispiece flow diagram. These begin upon receipt of the SNAP 10A system at the SPTF and conclude with shipment of the assembled SNAP 10A nuclear power unit (NPU) to the Point Arguello Launch Complex No. 2 (PALC-2). Each phase of the SPTF prelaunch operations program is concerned with preparing the NPU for launch.

NAA-SR-MEMO-9353 UNCL

TITLE: TECHNICAL MANUAL SNAP 10A SNAP PRELAUNCH TEST FACILITY OPERATIONS
BUILDING 6527 VANDENBERG AIR FORCE BASE

AUTHOR: J. Rocke

12-30-64

ABSTRACT: This manual describes the SNAP Prelaunch Test Facility (SPTF) and the procedures utilized in support of the SNAP 10A prelaunch testing program at Vandenberg Air Force Base (VAFB). The facility is identified as Building 6527 at VAFB, but for purpose of identification in this and companion manuals, it is referred to as the SPTF. The SPTF serves as a base of operations for Atomics International personnel assigned to the SNAPSHOT nuclear power unit (NPU) prelaunch testing program conducted at VAFB. The facility is utilized for receiving storage and non-nuclear testing of the SNAP 10A power systems prior to shipment to the launch complex at the Point Arguello Launch Complex No. 2 (PALC-2). NPU prelaunch operations carried out at VAFB are shown in the Figure 1-1 flow diagram.

FACILITIES, GENERAL

NAA-SR-MEMO-10716 UNCL

TITLE: SNAP INSTRUMENT COMPONENT TEST LABORATORY, BUILDING 066

AUTHOR: J. F. Rumer 11-13-64

ABSTRACT: The SNAP 10A Instrument Component Test Laboratory is capable of accepting complete responsibility for component qualification testing. Services which can be performed are: preparation of test specifications, performance of environmental testing and measurement of component electrical characteristics, preparation of test reports, analysis of failure or degradation data and recommendation of changes in component construction which will provide greater reliability. Environmental simulation equipment available in the facility is primarily of the thermal-vacuum type. When mechanical environments, i. e., vibration, shock, acceleration are required as part of a component test program these tests are sub-contracted. The Qualification and Test Unit, however, maintains responsibility for test control, data collecting and reporting of test results.

II. NUMERICAL INDEX

NAA-SR-MEMO-1946 (Addendum 1) SECRET RD

TITLE: SPECIAL PURPOSE POWER PLANT CRITICAL FACILITY SUMMARY
HAZARDS REPORT (Addendum 1)

AUTHOR: M. V. Davies

12-1-58

ABSTRACT: The nuclear reactor discussed in the Hazard Report NAA-SR-Memo-1946 (this report will be referred to as HR-1) achieved criticality on October 16, 1957. Since that time there has been considerable information obtained that supplements the original calculations and predictions presented in HR-1. Although the original presentation is sufficiently accurate to describe the current reactor it is deemed advisable to augment the original report. This addendum is to serve the purpose of amplifying the earlier calculations and of presenting experimentally determined operating characteristics of the reactor and associated equipment.

NAA-SR-MEMO-1946 (Addendum 2) SECRET RD

TITLE: SPECIAL PURPOSE POWER PLANT CRITICAL FACILITY SUMMARY
HAZARDS REPORT (Addendum 2)

AUTHOR: A. W. Thiele

3-11-59

ABSTRACT: The similarity of the SER critical assembly to the SNAP critical assembly is shown. In the previous report it has been shown that the hazard to personnel from a nuclear accident was not unreasonable. The methods of initiation of an accident will be of the same nature also. The small size of the core with the high neutron leakage makes the assembly quite sensitive to reflector material as a potential accident mechanism.

NAA-SR-MEMO-1946 (Addendum 3) SECRET RD

TITLE: SNAP 10 CRITICAL ASSEMBLY SUMMARY HAZARDS REPORT

AUTHOR: R. E. Wimmer

1-15-60

ABSTRACT: On the basis of the SXC nuclear and transient analysis, and of the experience with the previous two critical assemblies, it is concluded that no additional hazard results from the installation and operation of SXC in the SNAP Critical Facility. The design and analysis of SXC has been based upon the considerable experience, both analytical and experimental, gained from the previous reactors of this type. It is felt that SXC represents the most advanced analysis and the greatest inherent safety yet attained in the critical experiments program.

NAA-SR-MEMO-1946 (Addendum 4) CONF RD

TITLE: SNAP CRITICAL ASSEMBLY-3 (SCA-3) HAZARDS REPORT AND OPERATIONS
MANUAL (Addendum 4)

AUTHOR: J. L. Shapiro

7-31-61

ABSTRACT: The analysis of the characteristics, installation, and operation of the SCA-3 in the manner described, shows that the hazard is well within tolerable limits. In particular, the maximum credible accident will, in the most severe case, deposit less than 18 rem in a receptor at the exclusion fence. No significant dosage to off-site personnel will result.

NAA-SR-MEMO-3273 SECRET RD

TITLE: TRIP REPORT - VISIT TO MINNESOTA MINING AND MANUFACTURING TO
DISCUSS DIRECT THERMOELECTRIC ENERGY CONVERSION

AUTHOR: D. J. Cockeram 10-30-58

ABSTRACT: The purpose of the visit was to determine the present status of the thermoelectric conversion project.

NAA-SR-MEMO-3794 SECRET RD

TITLE: BERYLLIUM REPLACEMENT IN THE SNAP X REACTOR

AUTHOR: C. M. Podeweltz 4-23-59

ABSTRACT: The results indicate that a considerable reduction in ΔT can be obtained without incurring too large a penalty in increased reactor weight, up to volume fractions of 25% - 35% beryllium. Larger fractions of beryllium further reduce the ΔT , but the weight increases much more rapidly than at first. Once it is determined what reduction in radiator and structure weight will be effected by the reductions in ΔT , an optimum fraction of beryllium can be chosen.

NAA-SR-MEMO-3886 UNCL

TITLE: EVALUATION OF ORBITAL STARTUP METHODS

AUTHOR: O. P. Steele, III 7-20-59

ABSTRACT: The political implications of a hot reactor falling in a populated area due to launching mishap has placed strong emphasis on orbital startup of the reactor system. To evaluate the weight penalty of orbital startup some of the methods of achieving this have been investigated. This report compares these methods and outlines some of the development problems involved.

NAA-SR-MEMO-4045 SECRET RD

TITLE: MINIMUM WEIGHT UNIT SHIELD FOR A COMPACT POWER REACTOR

AUTHOR: V. Keshishian 6-26-59

ABSTRACT: Preliminary calculations of the shield requirements indicate that a dose restraint of 2.5 mrem/hr at 100 ft can be met with a shield weighing approximately 55,000 lb and contained within a diameter of 10 ft.

NAA-SR-MEMO-4100 SECRET RD

TITLE: SNAP 10 REENTRY

AUTHOR: R. L. Hirsch

7-9-59

ABSTRACT: In order to vaporize a SNAP 10 fuel element above sixty thousand feet about 28% of its kinetic energy must be utilized to heat the body. Vaporization is desirable but not necessarily a requisite for high altitude dispersion. This is because locally melted material which is removed from the element by the high velocity air stream may very well support its own combustion once it is free of the main body. Since the scope of this study was rather limited, the effects of these and other rather important phenomena could not be evaluated.

NAA-SR-MEMO-4137 SECRET RD

TITLE: ANALYSIS OF A RECTANGULAR FINNED RADIATOR FOR THE SNAP 10

AUTHOR: R. L. Hirsch

7-15-59

ABSTRACT: The radiator for the SNAP 10 consists of a cylindrical base annulus from which rectangular fins project radially. This report describes the two methods that were incorporated to describe heat flow in this body. Because of its simplicity, the first method yielded a useful, early description of the radiator. A later, more detailed analysis indicated that the results of the first work were a little optimistic.

NAA-SR-MEMO-4167 Rev 1 UNCL

TITLE: THERMOELECTRIC CONVERTER FOR SNAP 10 SYSTEM

AUTHOR: A. W. Thiele

9-28-59

ABSTRACT: This specification delineates the requirements for a thermoelectric conversion device to be used with a nuclear reactor heat source. The SNAP '10 system will provide an auxiliary power unit for space applications. As such, the converter, as part of this system, will be subject to certain unique requirements in regard to weight and environment.

NAA-SR-MEMO-4169 UNCL

TITLE: SNAP AUTHORIZED PROGRAM FACILITY PLANNING SUMMARY

AUTHOR: Staff

8-3-59

ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

NAA-SR-MEMO-4170 UNCL

TITLE: SNAP PROPOSED PROGRAM FACILITY PLANNING SUMMARY
AUTHOR: Staff 8-3-59
ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

NAA-SR-MEMO-4171 OUO

TITLE: SNAP POTENTIAL PROGRAM FACILITY PLANNING SUMMARY
AUTHOR: Staff 8-3-59
ABSTRACT: The proposed facility requirements as presented in this report are based on the SNAP Program Assumptions as indicated by Exhibit "A". The dollar values as indicated are estimated costs of new facilities to be funded in Government Fiscal Years 1960, 1961, and 1962.

NAA-SR-MEMO-4175 SECRET RD

TITLE: FUEL REQUIREMENTS FOR SNAP X PROGRAM
AUTHOR: A. W. Thiele 7-29-59
ABSTRACT: The fuel for SNAP X will be in the shape of right circular cylinders. The information presented represents the present state of the reactor design, and may be subject to revision.

NAA-SR-MEMO-4221 SECRET RD

TITLE: SNAP X SYSTEMS ANALYSIS PROGRAM
AUTHOR: A. E. Tucker 8-5-59
ABSTRACT: The activities and completion dates for the initial SNAP X systems analysis study.

NAA-SR-MEMO-4338 SECRET RD

TITLE: NEUTRON STREAMING EFFECTS IN THE SNAP CRITICAL ASSEMBLY
AUTHOR: L. I. Moss 9-3-59
ABSTRACT: For the design of SNAP X it is necessary to know the reactivity worths of air gaps and of various materials in these gaps. For this purpose, an experiment has been performed on the SNAP critical assembly.

NAA-SR-MEMO-4453 SECRET RD

TITLE: FUEL PROCESSING AND HANDLING SAFETY FOR SNAP 10 AND SDR-1

AUTHOR: W. T. Hayes

10-6-59

ABSTRACT: Calculate safe masses of fuel and alloy materials for handling during fuel fabrication and storage. The fuel to be that for the SNAP 10 and the SDR-1 reactors.

NAA-SR-MEMO-4477 SECRET RD

TITLE: FEASIBILITY REPORT FOR FABRICATION OF SNAP 10 FUEL ELEMENTS

AUTHOR: R. R. Turk and P. S. Drennan

11-2-59

ABSTRACT: A total of thirty-two (32) hydrided alloy fuel elements are to be produced from zirconium and uranium raw materials. The process consists of compacting and arc melting the component materials to form an initial alloy ingot, sectioning of the ingots into slugs and canning of the slugs, forging the slugs into discs, decanning and machining of the discs, hydriding and grinding.

NAA-SR-MEMO-4573 SECRET RD

TITLE: FUEL ELEMENTS FOR SNAP 10 PROGRAM

AUTHOR: A. W. Thiele

10-28-59

ABSTRACT: Presents the requirements for fuel elements for the SNAP 10 program.

NAA-SR-MEMO-4599 SECRET RD

TITLE: THERMAL STRESS PROBLEM AREAS IN THE SNAP 10 REACTOR

AUTHOR: R. A. Stone

11-2-59

ABSTRACT: Describes the approach to the known problem areas existing at the time.

NAA-SR-MEMO-4606 SECRET RD

TITLE: SNAP 10 POWER TEST COOLING

AUTHOR: H. N. Rosenberg

11-5-59

ABSTRACT: A maximum air velocity of 1.5 ft/sec will be required for cooling the SNAP 10 Power Test Reactor. This could be provided with a 1 ft² annular duct around the bottom of the reactor, and, with safety, a 200 standard CFM blower. Care should be taken to assure a high emissivity, oxidized surface on the reactor container because of the importance of radiation in the cooling.

NAA-SR-MEMO-4663 SECRET RD

TITLE: RECOMMENDATIONS ON CLADDING MATERIALS FOR THE SNAP 10 REACTOR
AUTHOR: C. J. Romero 11-17-59
ABSTRACT: For purposes of ease of assembly it would be best to use an available material that can be fabricated into a container with the lowest coefficient of thermal expansion. Hastelloy B appears satisfactory for these and other reasons. Considering difficulty of fabrication, Hastelloy N would be the next choice. Other materials do not lend themselves to this application.

The tolerances and dimensions of the container for assembly depend on the material used. It appears that containers for the SNAP 10 could be fabricated by spinning, deep drawing, rubber die forming, or explosive forming. The choice of method is dependent on hardenability of the material, availability of vendor facilities and experience, and general economics.

NAA-SR-MEMO-4718 SECRET RD

TITLE: PRELIMINARY QUALITY CONTROL DATA SHEETS FOR SDR-1 AND SNAP 10 FUEL ELEMENTS
AUTHOR: H. Taketani 12-14-59
ABSTRACT: For long range planning, preliminary quality control specifications for SDR-1 and SNAP 10 fuel element need to be written down and examined.

NAA-SR-MEMO-4739 SECRET RD

TITLE: TRANSIENT RESPONSE OF SNAP 10 TO STEP CHANGES IN REACTIVITY
AUTHOR: J. Reichman 12-11-59
ABSTRACT: Equations are developed to determine energy release, peak powers and the time to reach peak power for step reactivity changes greater than one dollar. These equations can be readily used to recalculate these variables when more accurate values are available for the SNAP 10 reactor parameters.

NAA-SR-MEMO-4839 SECRET RD

TITLE: SER - STATUS REPORT FOR PERIOD BEGINNING 0000 HOURS ON 12/27/59 AND ENDING 1/2/60
AUTHOR: R. R. Eggleston 1-26-60
ABSTRACT: Describes tasks completed during the period indicated.

NAA-SR-MEMO-4889 SECRET RD

TITLE: SNAP SPACE POWER PROGRESS

AUTHOR: Staff

2-13-60

ABSTRACT: The current AEC program proceeding at Atomics International has been planned so as to serve as the basis of such an AEC space reactor development program. The existing program consists of advanced technology studies, the 300 w thermoelectric SNAP 10 system development, and the 3000 w turboelectric SNAP 2 system development. The 30,000 w turboelectric SNAP 8 reactor is currently being initiated. The subsequent programs should consist of a 300,000 w system, a 1 to 3 Mw system, and ultimately a 10 to 30 Mw system.

NAA-SR-MEMO-4930 SECRET RD

TITLE: TENTATIVE APU DELIVERY AND TEST SCHEDULE

AUTHOR: R. L. Wallerstedt

2-1-60

ABSTRACT: In order that a comprehensive APU program can be implemented at AI and at TRW, the tentative delivery and test schedule has been prepared covering FY 1961, 1962, and 1963.

NAA-SR-MEMO-4975 SECRET RD

TITLE: SPACE NUCLEAR POWER REQUIREMENTS

AUTHOR: Staff

2-15-60

ABSTRACT: In order to achieve a reasonable space reactor development program, the requirement for such a program should be recognized and voiced now. Full support must be provided for the existing SNAP program to develop the capability, technology, and flight hardware necessary to support the national space effort.

NAA-SR-MEMO-4985

TITLE: STATUS OF SNAP SHIELDING

AUTHOR: F. H. Clark

2-17-60

ABSTRACT: This note is intended to present the problems encountered in shielding SNAP systems for satellite application. Section II deals with dose and vehicle constraints - largely outside the purview of the power plant - but considerations which dominate shield design and in rough magnitude determine shield weight. Section III deals with shield design itself and problems associated. Section IV mentions briefly Van Allen radiation.

NAA-SR-MEMO-4992 SECRET RD

TITLE: EFFECTS OF SNAP 10 PARAMETER CHANGES UPON ELECTRICAL POWER
OUTPUT

AUTHOR: J. Reichman

2-19-60

ABSTRACT: During operation, the SNAP 10 reactor system will undergo a series of normal changes in parameters that will cause the electrical power output to vary. While these changes will be occurring simultaneously, each at an unknown rate, the separate effects upon the power output can be determined and thus give an estimate of their relative importance. It is the purpose of this TDR to consider these effects separately and determine the power change.

NAA-SR-MEMO-5027 SECRET RD

TITLE: ESTIMATE OF SNAP 10 POWER COEFFICIENT OF REACTIVITY AND REACTIVITY
CHANGE IN GOING TO FULL POWER

AUTHOR: W. T. Hayes

3-1-60

ABSTRACT: A calculation of the power coefficient of reactivity for the SNAP 10 reactor at rated power (~10-13 kw) and of the total change in reactivity in going to full power state from start-up is of importance in the design of the system. These two quantities are estimated using one group perturbation theory.

NAA-SR-MEMO-5103 UNCL

TITLE: EXPERIMENTAL SHIELDING EVALUATION OF THE SETF USING SDR-I AND
SNAP 10 AS RADIATION SOURCES

AUTHOR: R. L. Tomlinson

3-29-60

ABSTRACT: The SNAP Environmental Test Facility, which is now under construction, has been designed for the full-power testing of unshielded SNAP reactors in an environment that will approach that of satellite conditions. Special care has been observed in its design to facilitate personnel access to the power test cells in which the reactors will be operated, after a waiting period of 30 days and removal of all portable equipment that has been exposed to the nuclear radiation present during reactor operation at full or fractional power levels. In this regard, many special features have been designed into this facility. This report will deal only with the evaluation of those features concerned with nuclear radiation and shielding as they affect the operation of the SETF.

NAA-SR-MEMO-5107 CONF RD

TITLE: ORBITAL STARTUP OF SNAP 10 REACTOR

AUTHOR: J. Reichman

3-31-60

ABSTRACT: Startup reactivity control of the SNAP 10 reactor is achieved by separating the reactor into two halves. The two halves are initially separated so that the reactor is sufficiently subcritical to prevent any conceivable nuclear accident. The two halves will be brought together at a predetermined rate by a motorized drive mechanism. The purpose of this report is to determine what rate is to be used to drive the halves together.

NAA-SR-MEMO-5136 UNCL

TITLE: CRITICALITY OF HANDLING SNAP 10 PLATES

AUTHOR: N. Ketzlach

4-1-60

ABSTRACT: The calculated minimum critical number of plates at optimum water-moderation and reflection is nine. Therefore, it is safe to handle four of these plates in any volume independent of the degree of water flooding and water moderation. No other moderator such as beryllium, beryllium oxide, heavy water, or graphite may be present. Safe spacings of groups of four plates may be determined from the criteria previously outlined.

NAA-SR-MEMO-5315 SECRET RD

TITLE: THE SNAP 10 CRITICAL ASSEMBLIES

AUTHOR: C. M. Podeweltz

5-24-60

ABSTRACT: Estimation of the critical dimensions for the SNAP 10 critical assemblies.

NAA-SR-MEMO-5359 UNCL

TITLE: FEASIBILITY STUDY OF A CONVECTION COOLED SNAP 10 SYSTEM

AUTHOR: A. W. Thiele

6-6-60

ABSTRACT: The basic requirements of the SNAP 10 system were formulated in the Spring of 1959 and presented in the Project Proposal for FY 60 as Project 2100 of NAA-SR-3613, June 1959.

NAA-SR-5482 CONF RD

TITLE: EVALUATION OF RADIOLOGICAL HAZARDS DUE TO REENTRY OF SNAP APU

AUTHOR: F. D. Anderson

1-15-61

ABSTRACT: The evaluation of radiological hazards due to the reentry of a SNAP unit was performed to determine the limitations for intact and partial intact reentry as well as for reentry burnup and high altitude dispersal. The evaluation of radiological hazards due to the operational periods from manufacturing through launch of a SNAP unit have been discussed in a report entitled, "SNAP 2 Safety Evaluation Analysis." Reentry burnup and high altitude dispersal of SNAP reactor cores are now being investigated by experimental and analytical studies.

NAA-SR-MEMO-5581 SECRET RD

TITLE: MEETING WITH LOCKHEED MISSILE AND SPACE DIVISION PERSONNEL,
AUGUST 3, 1960 - SNAP 10 FLIGHT TEST PROGRAM

AUTHOR: A. W. Thiele

8-10-60

ABSTRACT: AI visited Lockheed Missile and Space Division (LMSD) at Sunnyvale, California to discuss problems related to the flight test program for the SNAP 10 system.

NAA-SR-5648 SECRET

TITLE: PROCESSING OF SNAP-10 FUEL ELEMENTS

AUTHOR: P. S. Drennan and H. Taketani

11-1-61

ABSTRACT: Describes the processing cycle and techniques developed for the processing of fuel rods for the SNAP-10 reactor.

NAA-SR-5650 CONF RD

TITLE: NUCLEAR SPACE POWER SYSTEMS

AUTHOR: R. A. Stone

4-1-61

ABSTRACT: This report presents a detailed description of the nuclear space power systems presently under development. In addition, weight and performance estimates are given for higher power and more advanced nuclear systems employing thermoelectric, turboelectric and thermionic power conversion methods. Various aspects of reactor design are discussed with respect to inherent limitations and system requirements. Many problems which are common to all nuclear systems such as shielding, reliability, heat rejection, safety, and operational considerations are presented in some detail.

NAA-SR-MEMO-5804 CONF RD

TITLE: RADIOLOGICAL EVALUATION OF SNAP REACTOR DEBRIS DUE TO REENTRY BURNUP

AUTHOR: N. Harris

12-20-60

ABSTRACT: The SNAP system, upon reentering the atmosphere, has been assumed to burn up and completely disintegrate above an altitude of 100,000 ft.

The fission product debris will be dispersed strongly in the horizontal direction while in the stratosphere. A small fraction of the debris will be continuously diffusing through the tropopause into the troposphere with a stratospheric storage half-time of about five years.

Once in the troposphere, the debris will be washed out of the air by rain, within a few weeks. The debris will then enter the biosphere.

NAA-SR-MEMO-5899 UNCL

TITLE: SNAP 10 FY 62 - 63 PROGRAM PLANNING GUIDE

AUTHOR: A. W. Thiele

11-21-60

ABSTRACT: Outlines all phases of the SNAP 10 Program for the fiscal year as indicated.

NAA-SR-MEMO-5908 SECRET RD

TITLE: DISCUSSION OF SNAP X WITH LOCKHEED - 5/5/59

AUTHOR: A. W. Thiele

5-22-59

ABSTRACT: A meeting of Lockheed and Atomics International personnel was held at Palo Alto on May 5, 1959, to discuss the application of the SNAP X APU. The current specifications of the SNAP X system were presented and, from the response and questions asked, were received in a favorable manner.

NAA-SR-MEMO-6067 UNCL

TITLE: PLAN OF ACTION (FOR HYDRIDING DEVELOPMENT)

AUTHOR: H. G. Weidberg

1-23-61

ABSTRACT: A hydriding mechanism is postulated based on available knowledge. Through a series of experiments, this postulate will be proved or disproved. It is expected that some insight into the hydriding mechanism will be obtained.

NAA-SR-MEMO-6115 REVISION 1 UNCL

TITLE: OPERATION MANUAL FOR SNAP ENVIRONMENTAL TEST FACILITY
BUILDING NO. 024

AUTHOR: H. V. Lee

5-5-61

ABSTRACT: SNAP Environmental Test Facility (SETF) has been built to accommodate the testing of this Compact Power System (SNAP 2). This system shall be tested under controlled environmental conditions. The necessary shielding, inert gas (nitrogen) atmosphere, pressure, and temperature controls are provided with this facility.

This document has been prepared to instruct the operating personnel how to safely perform the tasks of operating the systems within this facility.

NAA-SR-MEMO-6133 UNCL

TITLE: SNAP 10A SYSTEM SCHEDULES

AUTHOR: A. W. Thiele

2-15-61

ABSTRACT: The consequences of the revised SNAPSHOT schedule were discussed with H. H. Greenfield of Lockheed and the following delivery dates were proposed for mutual consideration:

S-10-PSM-2 (Electrical Simulator)

No date established; our recommended delivery date is April, 1962

NAA-SR-MEMO-6133 UNCL (Continued)

ABSTRACT: S-10-FSM-2 (Mechanical Mockup)
(Continued) July, 1962
A second mechanical mockup may be required if there is only four months between flights as there is approximately five months of integration and testing work on each vehicle.

S-10-FS-2 (First flight system)
January, 1963 delivery
April, 1963 flight

S-10-FS-3 (Second flight system)
March, 1963 delivery
August, 1963 flight
Delivery of this unit in March will meet the requirement for a backup for the first flight. A backup for the second flight was not discussed.

A schedule for the design, fabrication, assembly, and test of these systems as well as the test system for use at AI has been prepared for comment.

NAA-SR-MEMO-6224 CONF RD

TITLE: SNAPSHOT NUCLEAR FLIGHT SAFETY PROGRAM
AUTHOR: Staff 3-31-61

ABSTRACT: A nuclear flight safety program for the SNAPSHOT program is presented as a preliminary plan. The program is intended to be compatible with the Atomic Energy Commission's responsibility for nuclear materials used in the SNAPSHOT satellite launch series.

Analytical and experimental safety studies are described under three headings: Nuclear Studies, Radiological Safety Studies, and Engineering Design Studies. Program milestones are listed and a description of continuing studies is appended.

NAA-SR-6263 SECRET RD

TITLE: PRELIMINARY DESIGN STUDY OF THE SNAP 10A DIRECT CONVERSION NUCLEAR AUXILIARY POWER UNIT

AUTHOR: J. L. Johnson 6-20-61

ABSTRACT: The SNAP 10A concept was first proposed in a report entitled, "Feasibility Study of a Convection Cooled SNAP 10 System." A power source is described therein, using a SNAP 2 reactor, an array of thermoelectric elements, and a heat transfer loop, which could produce 300 w of electrical energy. Since that time, a need has arisen for a 500 w electrical power source for a space mission. The requirements for this mission are summarized and design parameters outlined.

NAA-SR-MEMO-6367 CONF RD

TITLE: MEETING WITH LOCKHEED MISSILES AND SPACE DIVISION, APRIL 11 AND 12, 1961

AUTHOR: A. W. Thiele

5-1-61

ABSTRACT: A meeting was held with representatives of Lockheed Aircraft Corporation April 11 and 12, to discuss problems associated with the SNAPSHOT program.

NAA-SR-MEMO-6422 SECRET DI

TITLE: STATUS REPORT ON SNAP-10A ENCAPSULATION PROGRAM

AUTHOR: E. L. Reed

5-17-61

ABSTRACT: The purpose of this interim report is to review the various approaches that have been pursued at AI to date toward the goal of developing a suitable encapsulating material for protecting lead telluride bodies from excessive material loss under the operating conditions specified for the SNAP-10A thermoelectric device. The present SNAP-10A concept requires a thermoelectric device that will operate in a space environment for at least 10,000 hr with less than 10% output degradation. The hot and cold junction operating temperatures in space have been set at 900°F and 600°F, respectively. A combination of p and n type lead telluride bodies has been specified as the thermoelectric material that will be used to generate the prescribed power output of the SNAP-10A device.

NAA-SR-MEMO-6444 SECRET DI

TITLE: TRIP REPORT TO LOCKHEED, CALIFORNIA DIVISION - MONDAY, MAY 15, 1961

AUTHOR: R. A. Stone

5-23-61

ABSTRACT: On Monday, May 15, 1961 a meeting was held at Lockheed to discuss applications of SNAP reactors.

NAA-SR-MEMO-6564 UNCL

TITLE: SNAP 10A PROGRAM MILESTONE CHARTS

AUTHOR: J. W. Tait

6-29-61

ABSTRACT: The SNAP 10A Program Milestone Charts are attached.

These charts have been reviewed and approved by the Department Director, Chief Project Engineer - SNAP 10A - and the Chief Project Engineer - SNAPSHOT.

Program Milestone status will be reported on a monthly basis to the AEC.

NAA-SR-MEMO-6599 CONF RD

TITLE: A RELIABILITY IMPROVEMENT PROGRAM PLANNING REPORT FOR THE SNAP 10A SPACE NUCLEAR POWER UNIT

AUTHOR: M. G. Coombs, C. K. Smith and L. A. Wilson 3-14-61

ABSTRACT: To obtain necessary economic information on the cost of achieving a given reliability, three different programs are considered in addition to the existing R&D program.

NAA-SR-MEMO-6612 UNCL

TITLE: SNAPSHOT PLANNING SCHEDULE

AUTHOR: R. L. Wallerstedt and J. E. Gackle 7-25-61

ABSTRACT: The first draft of the SNAPSHOT planning schedule for use by the various AI administrative departments.

NAA-SR-MEMO-6645 CONF RD

TITLE: SPECIFICATIONS FOR ALLOYING AND FORMING SNAP 10A AND 2 FUEL MATERIALS

AUTHOR: T. S. Kirsch 8-9-63

ABSTRACT: This Memo describes the SNAP 10A-2 melting and forming process used by Atomics International, from compacting to final extrusion.

NAA-SR-MEMO-6652 CONF RD

TITLE: FISCAL YEAR 1962-63 SNAP 10A PROGRAM PROPOSAL

AUTHOR: Staff 8-15-61

ABSTRACT: The purpose of this document is to present information regarding the need for additional funds in FY 1962 for the SNAP 10A Program.

NAA-SR- 6684 CONF RD

TITLE: PRELIMINARY SNAP 10A-SNAPSHOT SAFETY REPORT

AUTHOR: M. Huntsinger 2-26-62

ABSTRACT: This preliminary report describes safeguards designed for the first nuclear reactor to be operated in space. Control of nuclear hazards will be effected to allow successful flight tests without risks to operating personnel or the general public. The report is intended for use by safety review and approval agencies within the U. S. Atomic Energy Commission, the U. S. Air Force, and the U. S. Navy Pacific Missile Range (PMR). Joint report preparation has been carried out by the USAF satellite vehicle contractor (Lockheed Missiles and Space Company) and the USAEC nuclear contractor (Atomics International). A final safeguards report which will discuss in detail the unresolved areas indicated in this preliminary report will be issued for approval prior to the early 1963 SNAPSHOT test flight of the SNAP 10A satellite system.

The report scope includes shipment of the reactor system from the manufacturer to Vandenberg Air Force Base, prelaunch testing, transport to the launch pad,

NAA-SR- 6684 CONF RD (Continued)

ABSTRACT: countdown, launch and orbit injection, orbital operation, and final atmospheric reentry. Hazards and accident consequences for each operational phase are discussed to show the effectiveness of the planned safety measures.
(Continued)

NAA-SR-MEMO-6721 CONF RD

TITLE: SNAP 10A TOTAL SYSTEM SIMULATION

AUTHOR: P. Pekrul

10-3-61

ABSTRACT: The purpose of this report is to describe and explain the results from an analytical model of the total SNAP 10A Vacuum System.

- 1) Simulation of the entire SNAP 10 APU.
- 2) Establish control system specifications.
- 3) Obtain system transient and stability information.
- 4) Evaluate electrical load and environmental effects on the system.
- 5) Establish programmer requirements.

NAA-SR-MEMO-6725 OUO

TITLE: SNAP 10A PREPOISONING

AUTHOR: H. Baucom

9-6-61

ABSTRACT: The long term control requirements for SNAP 10A may be minimized through the use of a burnable poison. It is recommended that natural samarium oxide be mixed homogeneously in the ceramic hydrogen barrier material throughout the total length of the fuel element. The specification is $6.6 \pm 10\%$ mg of natural Sm_2O_3 per linear inch of fuel rod per fuel rod. This corresponds to about 3 gm Sm_2O_3 in the SNAP 10A reactor.

NAA-SR-MEMO-6754 UNCL

TITLE: SUMMARY OF SHOCK VIBRATION AND LEAK TESTING OF SNAP 2-10 NORMAL URANIUM FUEL ELEMENTS

AUTHOR: L. E. Manners

9-13-61

ABSTRACT: The fuel elements reported on the attached chart were subjected to the SNAP 10A vibration and shock tests. All elements were tested singly in air and one group of seven was retested as a cluster in a water-filled fixture.

NAA-SR-MEMO-6776 CONF DI

TITLE: RESULTS OF ELEMENT PERFORMANCE TESTING THROUGH SEPTEMBER 7, 1961

AUTHOR: J. H. Walter and C. G. Bergdorf

10-6-61

ABSTRACT: The tests consist of operating the elements in a ΔT against a matched load, allowing the measurement and/or calculation of power output, element voltage and element resistance. Some of the tests consist of merely bringing the element up to the desired operating temperatures, recording the data, and terminating the tests. Others are left for extended periods of time to determine the long-term stability of the elements. The data obtained is evaluated by comparing it with the values calculated for the bare material from vendor property curves.

NAA-SR-MEMO-6898 CONF RD

TITLE: SNAPSHOT FLIGHT UNITS

AUTHOR: R. Balent

11-29-61

ABSTRACT: Because of the possibility of a delay in the SNAP 2 program, as evidenced by TRW failure to qualify the power conversion unit, some early planning with regard to the effect on the SNAPSHOT program should be made. In reviewing the Air Force document, WDLPS-69, issued April 17, 1961, entitled "Nuclear Auxiliary Power Orbital Tests (SNAPSHOT)", following are some remarks which are worth reviewing in light of possible schedule slippage.

NAA-SR- 6901 CONF RD

TITLE: CERAMIC COATINGS FOR LEAD TELLURIDE THERMOELECTRIC ELEMENTS

AUTHOR: D. O. Raleigh

3-1-62

ABSTRACT: A number of preliminary adhesion experiments, as well as recourse to wettability theory, indicated that lead telluride is difficult to wet with inert, homogeneous melts. A technique was developed.

NAA-SR-MEMO-6936 CONF RD

TITLE: PROCEDURES FOR QUALIFICATION TESTING OF SNAP 2/10A FUEL ELEMENTS

AUTHOR: T. G. Parker, Jr.

12-12-61

ABSTRACT: Initial draft of the qualification test specification for the SNAP 2/10A fuel elements.

NAA-SR-MEMO-6937 UNCL

TITLE: SNAP 10A PROGRAM REVISION - SHIELD SPECIFICATION CHANGE

AUTHOR: R. F. Wilson

12-13-61

ABSTRACT: This document is a single sheet which presents the schedule revision for the Non-Nuclear and Nuclear systems in which the first Flight Delivery was changed from January, 1963 to May, 1963.

NAA-SR-MEMO-6945 UNCL

TITLE: SNAP 10A CORE HYDRAULIC MODEL TEST RESULTS - LOCAL VELOCITY PROFILES

AUTHOR: R. A. Dutton and D. L. Whitlock

12-29-61

ABSTRACT: An experimental investigation has been made of the variation of local NaK velocity profiles as a function of axial position in the SNAP 10A reactor core. Local velocity measurements appear to be more erratic than average velocity measurements reported in TDR 6944. Evidence is presented which indicates some flattening of the velocity profile near the outlet end of the core. A bottom plenum divider was devised to improve flow stability in the core, but the results continued to be erratic. This is attributed to operation of the reactor at critical and transition Reynolds numbers, and this is known to be undesirable.

NAA-SR-MEMO-6966 CONF RD

TITLE: SUMMARY REPORT AI'S EFFORT ON THERMOELECTRIC CONVERTER FOR SNAP 10A

AUTHOR: M. H. Binstock

1-24-62

ABSTRACT: Atomics International undertook the problem of developing methods and proof testing the PbTe vacuum design T/E converter for SNAP 10A system. This report describes the development work, design work, process engineering work, quality assurance program and pilot plant activity which resulted in a successful conclusion to the problem. In addition, performance and environmental testing was done to indicate the problems which still remain to be solved.

NAA-SR-7021 CONF DI

TITLE: DESIGN, ANALYSIS, AND FABRICATION OF THERMOELECTRIC MODULES FOR SNAP 10A

AUTHOR: P. P. King and G. W. Meyers

6-1-62

ABSTRACT: The design, analysis, and fabrication development of lead telluride thermoelectric modules for the SNAP 10A thermoelectric converter are discussed in detail. Two designs were developed that could be fabricated with a high assurance of quality and thermoelectric continuity. Twenty-seven 26-element modules were fabricated during a three-week period, to demonstrate production capabilities and to supply modules of flight configuration for performance testing.

NAA-SR-7036 UNCL

TITLE: PROCESS DEVELOPMENT AND FABRICATION OF PbTe THERMOELECTRIC ELEMENTS

AUTHOR: F. R. Bennett and K. Langrod

10-30-62

ABSTRACT: The development and fabrication of lead telluride pellets, contacted to iron end caps, for use as elements in thermoelectric converters for the SNAP 10A program, is described.

The method adopted consists of contacting, by hot pressing in a controlled atmosphere, 24 pellets simultaneously, using 4-layer, 6-cavity graphite dies.

NAA-SR- 7036 UNCL (Continued)

ABSTRACT: The optimum hot pressing parameters were found to be 5000 psi at 1550° F for (Continued) 30 min.

Several thousand elements were produced by this relatively high-volume process, modifying the normally slow and expensive hot pressing by the use of multilayer, multicavity dies and automatic controls.

NAA-SR-MEMO-7041 CONF DI

TITLE: PERFORMANCE EVALUATION OF PbTe THERMOELECTRIC CONVERTER MODULES

AUTHOR: P. E. Elkins and W. R. McCurnin

2-16-62

ABSTRACT: The Atomics International 4-element modules evaluated in this report were tested at simulated temperature conditions to determine the component integrity and performance characteristics. Three of the four modules evaluated here were heavily instrumented with thermocouples to determine heat transfer characteristics of the components and the brazed joints between the components at simulated temperature conditions. The modules were each tested a total of 310 hr at temperature. The modules were then subjected to a post-test examination which consisted mainly of a metallurgical evaluation of the brazed joints and components in the modules. The performance test results are summarized in tabular and graphical form. The post-test evaluation is summarized in tabular form, and includes photographs of the cross-section of each element in the modules and photomicrographs of some of the components and brazed joints.

NAA-SR- 7064 CONF RD

TITLE: ENCAPSULATION OF LEAD TELLURIDE THERMOELECTRIC ELEMENTS

AUTHOR: I. J. Groce and E. L. Reed

6-1-62

ABSTRACT: One thermoelectric material that might be used in the Systems for Nuclear Auxiliary Power (SNAP 10A) converter was lead telluride (PbTe). In order to use PbTe in this converter, under the environmental conditions of 900° F and vacuum, it was necessary to prevent sublimation loss of the PbTe, by encapsulation or some other method, without exceeding a 5% heat shunt or a 1% electrical shunt through the encapsulation material. Several encapsulating methods were tried, including plasma flame spraying of ceramics, sleeves, vapor deposition of ceramics, electrophoretic deposition of ceramics, coating with heat curing cements, and spraying and firing of enamels.

NAA-SR-MEMO-7166 UNCL

TITLE: PRESSING SNAP 2 AND 10 FUEL ROD ASSEMBLIES

AUTHOR: C. J. Ambrose

2-26-62

ABSTRACT: Feasibility of pressing the SNAP 2 and 10 fuel rod assemblies to increase production and improve heat transfer.

NAA-SR-MEMO-7217 CONF RD

TITLE: COMPATIBILITY STUDIES OF SOME SNAP 2/10A FUEL ELEMENT MATERIALS

AUTHOR: L. B. Lundberg

3-13-62

ABSTRACT: Pieces of beryllium, chrome-plated beryllium and beryllium plasma-arc-coated with alumina (Al_2O_3), beryllia (BeO), zirconia (ZrO_2) and thoria (ThO_2) were placed in contact with a coating, which had been applied to a chromized Hastelloy N substrate and tested for 1000 hr at 1300° F in a hydrogen atmosphere.

NAA-SR-MEMO-7258 CONF RD

TITLE: LIQUID METAL PUMP POWERED BY LEAD TELLURIDE THERMOELECTRIC

AUTHOR: K. A. Davis

4-2-62

ABSTRACT: A liquid metal, dc conduction pump powered by an integrally mounted lead telluride thermoelectric generator was designed, constructed and tested. One thousand hours of operation was obtained under SNAP 10A conditions in a vacuum environment. The tests demonstrate the feasibility of such a pump along with the advantages and disadvantages of the selected design.

Design criteria, fabrication techniques, test data and an overall analysis of the design are contained herein.

NAA-SR-MEMO-7286 CONF RD

TITLE: ACCEPTANCE TEST FACILITY SAFEGUARDS REPORT

AUTHOR: W. H. Heneveld

4-17-63

ABSTRACT: The purpose of this report is to describe the operation of the Acceptance Test Facility (ATF) and testing of SNAP 10A Auxiliary Power Units (APU) in the facility. A hazards analysis of the facility, with a discussion of maximum credible accidents and consequences, is included. The Acceptance Test program is presented along with those test procedures associated with the reactor operation. This report covers only the tests and operations to be conducted with SNAP 10A systems; acceptance tests of SNAP 2 and 8 systems, which will also be conducted in this facility, will be presented in an addendum to be published at a later date. A separate operation manual, presenting descriptions and detailed test procedures, will be issued prior to operation of the facility.

NAA-SR-7288 UNCL

TITLE: STATISTICAL ANALYSIS OF SNAP 10A THERMOELECTRIC CONVERTER ELEMENT PROCESS DEVELOPMENT VARIABLES

AUTHOR: S. H. Fitch and J. W. Morris

12-15-62

ABSTRACT: Statistical analysis, primarily analysis of variance, is applied to evaluate several factors involved in the development of suitable fabrication and processing techniques for the production of lead telluride thermoelectric elements for the SNAP 10A energy conversion system. The analysis methods are described in some detail as to their application for determining the effects of various processing steps, establishing the value of individual operations, and evaluating the significance of test results. The elimination of unnecessary or detrimental processing steps was accomplished and the number of required tests was substantially reduced by application of these statistical methods to the SNAP 10A production development effort.

NAA-SR-MEMO-7289 UNCL

TITLE: QUALITY CONTROL PROGRAM FOR SNAP 10A THERMOELECTRIC ELEMENTS
AUTHOR: J. W. Morris and S. H. Fitch 5-9-63
ABSTRACT: The development and implementation of a complete Quality Control Program for thermoelectric elements is described. The program was set up to aid in the fabrication process development of thermoelectric elements and modules for application to the SNAP (Systems for Nuclear Auxiliary power) 10A.

A brief description and historical sketch of the SNAP 10A is presented. The Quality Control Program of material procurement and quality verification, process control, in-process, and acceptance testing is described in detail. The results of the quality control effort are summarized.

NAA-SR-MEMO-7295 UNCL

TITLE: PSM-2 SNAP 10A ANALOG SIMULATOR OPERATIONS MANUAL
AUTHOR: A. C. Loisberg 4-24-62
ABSTRACT: The SNAP-10A-PSM-2 Analog Simulator will provide a power source having dynamic and static characteristics equivalent to the thermoelectric converter on the SNAP-10A system. The design requirements for the Analog Simulator are per PSM-2 system description #SD-10A-200-1.

NAA-SR-MEMO-7317 CONF RD

TITLE: FUEL CLADDING DEVELOPMENT FOR SNAP REACTORS
AUTHOR: W. F. Dennison 4-17-62
ABSTRACT: Cladding development for SNAP 2, 8, and 10A has been in progress at Atomics International since 1958. As major steps within the program, two core loadings, the SER and the S-2DR were fabricated. The SNAP Experimental Reactor (SER) start operation in the fall of 1959 and operated for the equivalent of half a full power year before completion of planned experimental studies. The second in the series of SNAP-2 reactors, the S-2DR, began power operations about a year ago and is still active.

NAA-SR-MEMO-7361 OUO

TITLE: THERMOELECTRIC PUMP ELEMENT TESTING
AUTHOR: G. W. Meyers 5-3-62
ABSTRACT: The attached curves summarize the data taken on 3/4 in. by 3/4 in. sections of pump elements to date. The major portion of the testing has been on the Lead-Tin-Telluride P-type material because the data from the N-type converter elements has shown the N-type material to be very stable. Although the Seebeck was slightly less than the reported data by 3M Co. (Minnesota Mining and Manufacturing Co.) for the N-type element 530-1, the open circuit voltage and internal resistance have remained constant for over 1000 hr. The scatter in the resistance data is probably due to the accuracy of $\pm 10 \mu$ ohms in measuring the resistance rather than fluctuations in the element resistance.

NAA-SR-MEMO-7385 CONF DF

TITLE: SNAP 10A PSM-1 SHIELD THERMAL TEST

AUTHOR: E. C. Phillips

5-10-62

ABSTRACT: A three phase thermal test was performed on the SNAP 10A PSM-1 shield. Phase I consisted of heating the shield to 800°F at 60°F/hr, maintaining the shield at 800°F for three hours, and cooling the shield at 20°F/hr. Phase II consisted of heating at 20°F/hr to 800°F then cooling at 60°F/hr. Phase III consisted of heating and cooling the shield to and from 800°F at 60°F/hr three times.

NAA-SR-MEMO-7392 CONF RD

TITLE: HISTORY OF SNAP 2/10A FUEL ELEMENT LEAK RATES

AUTHOR: J. K. Balkwill

5-14-62

ABSTRACT: Prompted by our current concern with the production of low-leakage SNAP 10A fuel elements, I have tried to put down a historical summary of what hydrogen leak rates have been in the past, where they may be expected to be in the future, and why the project expects us to meet their design leak rate.

NAA-SR-MEMO-7399 UNCL

TITLE: SNAPSHOT SAFETY PROGRAM PLAN

AUTHOR: M. F. Huntsinger

6-20-62

ABSTRACT: The SNAPSHOT Safety Program Plan, as described in this document, is formulated to align safety studies performed by separate agencies and their contractors. At the present stage in program development, the plan is principally concerned with the initial SNAPSHOT flight (SNAP 10A).

NAA-SR-MEMO-7414 CONF DI

TITLE: PbTe THERMOELECTRIC ELEMENT PERFORMANCE TESTING

AUTHOR: R. Roberts

5-22-62

ABSTRACT: The performance as a function of time for various temperature parameters of fifteen thermoelectric PbTe elements is presented in this report. The PbTe n-type elements and the PbSnTe p-type elements were stable whereas the Na-doped PbTe p-type elements degraded with time.

NAA-SR-MEMO-7540 UNCL

TITLE: THERMOELECTRIC PUMP ELEMENT TESTING

AUTHOR: G. W. Meyers

7-2-62

ABSTRACT: The attached performance curves summarize the data to 6/30/62 on the 3/4 in. by 3/4 in. pump elements.

NAA-SR-MEMO-7550 UNCL

TITLE: SNAP 10A SNAPSHOT PROGRAM DEVELOPMENT

AUTHOR: R. F. Wilson

7-10-62

ABSTRACT: The purpose of this document is to outline the ground rules for the component and system development program which will result in a flight SNAP 10A to meet the goals which have been set up for the SNAPSHOT program. From this development plan, a set of detailed component and system testing plans can be formulated. These detailed plans must then reflect all of the ground rules set forth in this section. It is recognized that many of the component development programs are well advanced and some have been planned in detail. It is expected, where necessary, that all of these test plans will be reviewed and revised as necessary so as to reflect the guidance contained herein.

NAA-SR-MEMO-7593 CONF RD

TITLE: SNAP 2/10A REACTOR DEVELOPMENT PLAN

AUTHOR: J. Susnir

9-1-62

ABSTRACT: Various aspects of the SNAP 2/10A reactor development program are discussed. These include discussions of reactor concepts, design parameters, performance objectives, reliability goals, and developmental schedules. It is noted that, except for power generation concepts, the design of SNAP 2 is identical to that of SNAP 10A. The power generation systems differ due to the higher temperature and power requirements of the SNAP 2 reactor. Reliability goals established by the customer are outlined for the SNAP 10A system; no reliability goals have been set to date for the SNAP 2 system. Component and systems tests to be utilized to demonstrate the feasibility of the reactor design are described, including descriptions of the nuclear experiments and the reactor experiments. The nuclear experiments will be conducted on the SNAP critical assemblies and the shield test facility; the reactor experiments will provide tests of the experimental and developmental reactors. Systems tests of the mockup assemblies and the flight system assembly are described. Delivery schedules of flight test systems of both SNAP 2 and SNAP 10A reactors are outlined.

NAA-SR-MEMO-7608 CONF RD

TITLE: TEMPERATURES OF THE SNAP 10A RADIATION SHIELD

AUTHOR: J. D. Wilde

7-31-62

ABSTRACT: Determines the temperature distribution in the shield and shield casing, both during the startup transient and at steady-state. Repeats for the case of no internal heat generation to determine temperatures during non-nuclear tests. From the results, finds the shield-to-casing clearances in the hot condition and the volume mean temperatures of the can and shield for pressure buildup calculations.

NAA-SR-MEMO-7645 CONF DI

TITLE: FLIGHT TEST PROGRAM DEVELOPMENT PLAN

AUTHOR: R. Wallerstedt

11-12-62

ABSTRACT: The purpose of this document is to outline the ground rules for the component and system development program which will result in a flight SNAP 2 to meet the goals which have been set up for the program. From this development plan, a set of detailed component and system testing plans can be formulated. These detailed plans must then reflect all of the ground rules set forth in this section. It is recognized that many of the component development programs are well advanced and some have been planned in detail. It is expected, where necessary, that all of these test plans will be reviewed and revised as necessary to reflect the guidance contained herein.

NAA-SR-MEMO-7652 UNCL

TITLE: NUCLEAR SPACE POWER SYSTEMS - THE SNAP REACTORS

AUTHOR: R. E. Wimmer

2-1-62

ABSTRACT: There is a rapidly increasing demand for electric power for space missions. The SNAP reactors are intended to answer part of this demand. Schedule and characteristics are given for the systems under development, and feasible extensions of the present technology are indicated. Comparison of various power systems shows nuclear reactors to be most attractive for high-power, long-duration missions. Interaction of payload and reactor must be considered, and appreciable weight savings may be realized by careful system integration.

NAA-SR-MEMO-7671 CONF RD

TITLE: SNAP 2-10A CUP DEVELOPMENT

AUTHOR: W. F. Dennison

9-5-62

ABSTRACT: Development of the cup for SNAP 2-10A fuel elements is described.

NAA-SR-MEMO-7684 CONF DI

TITLE: RCA Thermoelectric Module Performance Testing

AUTHOR: J. C. Cooper

8-31-62

ABSTRACT: These performance tests of RCA thermoelectric modules include steady state operation at design temperatures, thermal cycling and thermal shock, and high temperature operation.

The average power output, normalized to a 280° F ΔT , was 79% of SNAP 10A design power. The original design ΔT was 280° F; however, the average measured ΔT was 299° F. Normalization to this higher value leads to power output at 91% of design values. The measured rate of change of power output corresponds to 1.52 w/ $^{\circ}$ F change in hot junction temperature for the SNAP 10A converter. Average power degradation during these tests was -0.68% per 1000 hr at temperature.

Reference (d) contains the complete data tabulations for these tests. The data is summarized in this NAA-SR Memo. Reference (e) discusses mechanical testing of these modules.

NAA-SR-MEMO-12023

NAA-SR-MEMO-7685 CONF DI

TITLE: RCA THERMOELECTRIC MODULE MECHANICAL TESTING

AUTHOR: J. Cooper

8-31-62

ABSTRACT: Static load, shock, and vibration tests of thermoelectric modules have been performed. Vibrational responses of A, B, and C modules, and their test fixtures have been measured.

Element breaking loads in tension and under side load ranged from 30 to 255 lb. There is a good correlation between number of cracked elements and average strength of the module.

Of 1990 stack-vibration tests, ten have failed. These failures occurred primarily in the gold to copper diffusion bond near the hot junction on pre-production modules, and in the SiGe element on production units.

A sketch of the module stack assembly (Figure 1) is included for reference.

NAA-SR-MEMO-7686 CONF DI

TITLE: RCA THERMOELECTRIC MODULE TEST DATA

AUTHOR: J. C. Cooper

8-31-62

ABSTRACT: Attached are tabulations of the data obtained from tests of the copper hot-strap thermoelectric modules through August 8, 1962 and the Continuous Log on RCA Modules revised June 29, 1962.

This data is summarized and discussed in TDR #7684 "RCA Thermoelectric Module Performance Testing," and TDR #7685 "RCA Thermoelectric Module Mechanical Testing."

NAA-SR-MEMO-7734 CONF RD

TITLE: PERMEATION - TEMPERATURE CORRELATION FOR SNAP 10A FUEL ELEMENTS

AUTHOR: A. J. Fitzgerald and J. G. Spraul

9-19-62

ABSTRACT: Eight SNAP 10A fuel elements which contained normal uranium were used for this program. These elements had passed quality assurance tests prior to their use in this program. Each element was permeation tested several times over the temperature range of 900°F to 1200°F.

NAA-SR-MEMO-7754 CONF RD

TITLE: ACTUATION OF THE SNAP 10A END-OF-LIFE SHUTDOWN DEVICE

AUTHOR: J. D. Wilde

9-27-62

ABSTRACT: It is argued that the case of total loss-of-flow is the most conservative basis for evaluating the end-of-life temperature decrease. Temperatures in the body of the end-of-life device will fall from a minimum of 1000°F during useful life to 563°F following loss of flow. The difference, approximately 440°F, should be the basis for design and evaluation of the actuator. The ΔT can be increased from 440°F to 495°F by gold coating the inboard side of the NaK line to which the device is attached. This reduces the radiation from the reflector and reduces the temperature of the end-of-life shutdown device.

NAA-SR-MEMO-7810 CONF RD

TITLE: SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGE

AUTHOR: W. E. Nagel, Ted Baker and Joe Fitzgerald

10-15-62

ABSTRACT: This document contains the complete data on fabrication and testing of fuel elements delivered for system use.

NAA-SR-MEMO-7846 CONF RD

TITLE: S10FS-1 NUCLEAR QUALIFICATION TEST SUMMARY SAFEGUARDS REPORT, BUILDING 024

AUTHOR: E. A. Licitra

5-10-63

ABSTRACT: The S10FS-1 Nuclear Qualification Test will be the second nuclear test to be conducted in the SNAP Experimental Test Facility (SETF). The SETF environmental hazards report and the S2DS summary safeguards report discuss in detail the hazards associated with the operation of a 50-kw SNAP reactor in Power Test Vault 1 of the SETF (Building 024). These hazards are summarized in a later, more comprehensive report.

NAA-SR-MEMO-7877 CONF RD

TITLE: THERMO-PHYSICS TECHNICAL NOTE NO. 14: SNAP 10A REACTOR TEMPERATURES AND POWER DECAY IN SPACE FOR ZERO NaK FLOW AND LOSS OF NaK

AUTHOR: S. R. Fields

10-11-62

ABSTRACT: The steady-state temperatures of the SNAP 10A reactor in orbit following complete loss of NaK have been calculated at various power levels for full sun and dark sky conditions. The results of the heat transfer analysis were used to determine the reactor power decay. In addition, the power decay calculations of a previous analysis were modified to include the effect of fuel burnup.

NAA-SR-MEMO-7886 CONF RD

TITLE: SNAP 10A POWER UNIT

AUTHOR: L. L. Bixson

6-30-64

ABSTRACT: A conceptual drawing of the SNAP 10A system is shown in Figure 1 and the engineering drawing in Figure 2. The reactor is typical of the zirconium hydride-uranium fueled SNAP type. The fuel chosen gives a high hydrogen density and hence small overall size and weight, and achieves the relative control simplicity typical of thermal neutron spectrum systems. The reactor core is reflected by beryllium and is controlled by four semicylindrical control drums operating in the reflector. These drums function by varying the neutron leakage flux. Sodium-potassium (NaK-78) coolant circulates through the core, entering at 859°F and exiting at 987°F. The overall reactor power required is 39.5 kw. This particular reactor type possesses a strong negative temperature coefficient which is used for inherent control and stability over the operating lifetime thus eliminating the need for continuous control drum actuation. This static, or inherent, control system is possible because of the low power rating of the reactor, which results in negligible reactivity shift due to fuel burnup, and low reactor temperatures, which minimize the dissociation and subsequent loss of hydrogen from the fuel.

NAA-SR-MEMO-12023

NAA-SR-MEMO-7951 CONF RD

TITLE: ELECTROMAGNETIC INTERFERENCE TEST OF FSEM-2 APU SYSTEM

AUTHOR: W. Holsborg and J. L. Johnson

11-8-62

ABSTRACT: This TDR describes the conducted electromagnetic interference test as prescribed by the Military Specification MIL-I-26600 (USAF) Amendment 2 performed on the FSEM-2 APU system.

The results of this test indicate that the test specimen generates interference in excess of the prescribed limits of MIL-I-26600.

NAA-SR-MEMO-7987 SECRET DI

TITLE: SNAP FIVE-YEAR FACILITIES PLAN AT ATOMICS INTERNATIONAL

AUTHOR: Staff

1-15-63

ABSTRACT: This report outlines a 5-Year Facilities Program to support the Systems for Nuclear Auxiliary Power (SNAP) Research and Development Programs at Atomics International.

NAA-SR-MEMO-8044 CONF DI

TITLE: RADIATION EFFECTS ON SNAP 10A THERMOELECTRIC MODULES

AUTHOR: S. Friedlander

12-26-62

ABSTRACT: This report includes test data to 11/20/62 on two RCA vacuum converter modules.

The two modules are early developmental types with aluminum hot straps.

In summary, these modules have shown excellent resistance to fast neutron irradiation. Power output (i. e. $\alpha^2\sigma$) has remained constant up to a neutron flux level of 3×10^{16} nvt.

NAA-SR-MEMO-8147 SECRET RD

TITLE: SNAP 10A POWER SYSTEM SHIPMENT SAFEGUARDS REPORT

AUTHOR: R. S. Hart

12-18-63

ABSTRACT: This report describes the operations which will take place in transporting the system from Santa Susanna to the launch pad. All safeguards are detailed as well as the consequences of all possible credible accidents.

NAA-SR-MEMO-8155 CONF RD

TITLE: EFFECT OF EXCESSIVELY HIGH TEMPERATURE ON SNAP 10A FUEL ELEMENTS

AUTHOR: T. G. Parker

1-25-63

ABSTRACT: Two SNAP 10A fuel elements (normal uranium) were subjected to temperatures in excess of normal operating temperature to determine:

- 1) Maximum temperature without damaging fuel element,
- 2) Temperature at which the cladding yields,
- 3) Temperature at which the ceramic hydrogen barrier fails.

NAA-SR-MEMO-8198 UNCL

TITLE: RESULTS OF ACCEPTANCE TESTING THE SNAP 10A START UP CONTROLLER

AUTHOR: M. T. Marshall

2-12-63

ABSTRACT: This TDR presents the results of functional tests prior to/and following vibration testing. Controllers 5 through 11 are included in this report.

NAA-SR-MEMO-8210 SECRET RD

TITLE: SHORT SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGES

AUTHOR: Staff

2-14-63

ABSTRACT: A compilation of inspection and test data sheets.

NAA-SR-MEMO-8211 CONF RD

TITLE: SNAP 10A FUEL ELEMENT TEMPERATURES, CLEARANCES, THERMAL STRESSES DURING ORBITAL STARTUP

AUTHOR: J. D. Wilde

2-18-63

ABSTRACT: The most severe transient to which the SNAP 10A fuel elements are normally exposed is the orbital startup. Temperature distributions in the fuel, clad, and fuel element end caps were found for the transient power, flow and inlet temperature curves from the Startup System Description.

NAA-SR-MEMO-8215 PART 1 CONF DI

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS, PART 1
SPACE POWER REQUIREMENTS AND DEVELOPMENT PHILOSOPHY

AUTHOR: R. Balent and B. B. Chew

3-15-63

ABSTRACT: Available projections of the National Space Program have been reviewed to evaluate areas of SNAP nuclear power application. Results of this review indicate approximately 100 missions between 1965 and 1975 can advantageously use nuclear auxiliary power; all but a very few are in the power range of 500 w to 35 kwe. Missions using more than 100 kwe power are not expected to occur until after 1975, and are dependent upon very large boosters not now firmly programmed.

NAA-SR-MEMO-8215 PART 1A SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS
PART 1A, SNAP 2/10A REACTOR

AUTHOR: J. Susrir

3-15-63

ABSTRACT: A summation of activities to date on the program, together with plans for future activities.

NAA-SR-MEMO-8215 PART 2 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 2, SNAP 10A

AUTHOR: R. F. Wilson

3-15-63

ABSTRACT: SNAP 10A is a nuclear reactor auxiliary power unit being developed to provide a minimum of 500 electrical watts at 28.5 vdc for a period of one year in a space environment. As presently scheduled, the SNAP 10A system will be the first reactor-powered electrical system to be flight tested in earth orbit. The SNAP 10A Program is directed toward the early exploitation of both the technical and operational aspects of such a device.

NAA-SR-MEMO-8215 PART 7 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 7, SNAP 10A FLIGHT NUCLEAR SAFETY

AUTHOR: R. G. Courson

5-1-63

ABSTRACT: The potential programming of a nuclear-power system for a space mission invariably involves many questions of nuclear safety and hazards to the general public as well as to the personnel associated with the actual launching. The impending orbital tests of SNAPS 10A and 2 have led to a detailed consideration of these hazards which will be forthcoming in the "Final Safeguards Report - SNAP 10A Flight Tests." Since the majority of these safety conclusions apply to any reactor nuclear-power system, it is desirable to summarize the SNAP 10A considerations to highlight the general considerations which will be applicable to the safety of all nuclear power systems. Since factory-to-flight safety is readily managed by controlled handling procedures, only post lift-off safety is discussed.

NAA-SR-MEMO-8215 PART 9 CONF RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 9 NUCLEAR SYSTEM RELIABILITY REQUIREMENTS

AUTHOR: J. E. Brunings

7-1-63

ABSTRACT: The successful development of nuclear power units for space application is contingent upon the achievement of an appropriate level of reliability consistent with each phase of the development program. The initial phase of the SNAP 10A and 2 program is oriented to achieve at least one successful flight demonstration. An optimum flight demonstration program occurs for the SNAP 10A System when the power system reliability is developed to about 0.55 at the time of the initial flight test. This results in a predicted probability of flight test success of 0.33 and most likely requires three flight tests to achieve at least one successful demonstration.

NAA-SR-MEMO-8215 PART 10 SECRET RD

TITLE: SNAP (SYSTEMS FOR NUCLEAR AUXILIARY POWER) TECHNICAL BRIEFS,
PART 10, PROGRAM COSTS

AUTHOR: R. Balent and W. D. Ambrose

4-5-63

ABSTRACT: Total costs (actual + projected) for ground demonstration, first flight demonstration and limited one-year life testing for the AEC SNAP 10A, 2, and 8 programs for the time period 1956 to 1969 are estimated to be \$350,000,000. Estimated costs for operational development and follow-on phases for these projects which will establish initial operational status for a family of nuclear APU's within the power range of 500 w to 50-100 kwe is \$250,000,000. These amounts do not include the cost of launch vehicles or launch support for the flight test phases, reliability demonstration, or the production phases.

In addition to the development costs by phases, typical SNAP unit costs for production rates of 3 per year and 10 per year are given for three power categories. Also, costs in orbit for typical 1, 10, and 100 kw units are developed.

NAA-SR-MEMO-8232 UNCL

TITLE: INTERIM QUALIFICATION TEST REPORT SNAP 10A DRUM RELEASE ACTUATOR
THERMAL CYCLE TESTS

AUTHOR: G. F. Queener

2-4-63

ABSTRACT: The actuators (without squibs) were subjected to 10 thermal cycles from 30° F to 700° F at a pressure of 6×10^{-3} torr or lower. Upon completion of the tests there was no evidence of physical damage to the actuators.

NAA-SR-MEMO-8244 CONF RD

TITLE: AN EVALUATION OF THE TECHNIQUES FOR END-OF-LIFE SHUTDOWN OF ORBITING SNAP REACTORS

AUTHOR: N. K. Jamison 3-29-63

ABSTRACT: Two techniques for the end-of-life shutdown of orbiting SNAP reactors are presented. One technique consists of two alternative methods for the destruction of the reactor core. This technique (and others) have been investigated during the past year.

NAA-SR-MEMO-8251 SECRET RD

TITLE: INTENTIONAL RUPTURE OF A SNAP 2/10A FUEL ELEMENT

AUTHOR: W. F. Dennison 2-11-63

ABSTRACT: An instrumented SNAP 2/10A fuel element was gradually heated in an evacuated autoclave until the internal H₂ pressure caused the cladding to burst. This element failed at 1738 °F at an internal pressure of 900 psig. Within overall experimental error (composition of the fuel rod, temperature and pressure measurements, etc.), the values obtained in this test agree with literature data.

NAA-SR-MEMO-8272 SECRET RD

TITLE: SNAP 10A FS-1 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: D. C. Campbell 2-15-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-1 Core. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-8325 CONF RD

TITLE: 10FS-1 ACCIDENT ANALYSIS

AUTHOR: D. F. Paddleford and R. W. Winson 3-19-63

ABSTRACT: Power and energy transients are presented for accidents corresponding to the insertion of 1, 2, and 4 control drums simultaneously into the reactor at the maximum insertion rate. These transients were obtained for the case of "hot" (70 °F) and "cold" (800 °F) initial conditions with no coolant flow through the reactor.

NAA-SR-MEMO-8354 CONF RD

TITLE: PRELIMINARY INVESTIGATION OF AN ALTERNATE HYDRIDE FOR SNAP SHIELDS
AUTHOR: R. S. Hubner 4-2-63
ABSTRACT: To determine from removal theory the relative merits of beryllium hydride as a neutron shield material for SNAP systems.

NAA-SR- 8399 UNCL

TITLE: SNAP 10A-PSM-1 TEST RESULTS
AUTHOR: R. M. Oliva 7-15-64
ABSTRACT: On November 14, 1961, an environmental test program commenced on the first SNAP 10A system structure, S10A-PSM-1. The object of this test was to subject the test vehicle to specified vibration, shock, and acceleration inputs and thereby determine various structural characteristics, such as major resonant frequencies, damping rates, magnification factors at various vehicle locations, stress levels at various preselected points, and deflections of structure and components under static (acceleration) loads. The results of these tests would be useful in verifying the integrity of the design tested and would yield information invaluable to the analysis and design of this and future SNAP 10A systems.

NAA-SR-8414 UNCL

TITLE: BOOMER - A DIGITAL PROGRAM FOR EVALUATION THE THERMAL AND KINETICS RESPONSE OF A SNAP 2/10A REACTOR
AUTHOR: R. W. Winson 5-31-64
ABSTRACT: A mathematical model of the SNAP 2/10A reactor was developed describing the reactor kinetics, heat transfer, and hydrogen diffusion within the reactor core. This theoretical model was then modified, on the basis of current test data, to realistically predict the transient response of the reactor. The model was then programmed into a digital code called BOOMER. The development of this code is described in detail in this report.

NAA-SR-MEMO-8434 CONF RD

TITLE: 10FSM-1 REFLECTOR ASSEMBLY ACCEPTANCE TEST
AUTHOR: J. B. Tathwell 4-25-63
ABSTRACT: A list of all parts, their respective weights, and tooling assembled to the 10FSM1 reflector are presented. A check of critical clearances before and after the high temperature - high vacuum acceptance test on the reactor vessel-reflector assembly indicate that adequate clearances were maintained in the test environment. An increase in the friction of the coarse drum bearing was found by measuring the torque of the unloaded drums before and after test. The use of such torque measurements in future acceptance testing is recommended as a qualitative means of determining material and/or assembly difficulties.

NAA-SR-MEMO-8446 CONF RD

TITLE: RADIATION DAMAGE EFFECTS ON SNAP 10A COMPONENTS SUMMARY

AUTHOR: John E. Stewart

4-30-63

ABSTRACT: The components on SNAP 10A which have a predominant influence on system life include the reactor and fuel elements, the thermoelectric pump and the SiGe thermoelectric power conversion unit. Radiation damage rate and the evaluation on each of these components indicates very high probability of operation for one year or more as influenced by nuclear environment.

NAA-SR-MEMO-8462 CONF RD

TITLE: AEROSPACE SAFETY RESULTS OF SPECIAL INTEREST TO SNAP 10A FLIGHT TESTS

AUTHOR: K. E. Buttrey

7-15-63

ABSTRACT: Experiments, tests, and analyses were performed under the Aerospace Safety Program to obtain data on potential hazards associated with and to demonstrate the inherent safety of SNAP systems. To date of this report, the program has included:

- 1) An evaluation of the mechanical and thermochemical changes the SNAP system may undergo during various handling, transportation, and launch accidents.
- 2) An experimental study to determine the reactivity of SNAP reactors when subjected to various water immersion configurations.
- 3) A thorough investigation of the behavior of SNAP systems under various nuclear accident conditions.
- 4) An analytical and experimental program to determine the breakup, ablation, and dispersion characteristics of the reactor assembly and fuel elements during reentry into the earth's atmosphere.
- 5) Calculation of the release of fission products following a nuclear excursion.

This report describes the results of the Aerospace Safety Program achieved to date which are of special interest to SNAP 10A flight tests.

NAA-SR-MEMO-8469 CONF RD

TITLE: SNAP 10A NORMAL FUEL ELEMENT DATA PACKAGES

AUTHOR: Staff

5-9-63

ABSTRACT: Contains copies of test data sheets for 57 SNAP 10A normal fuel elements completed during the period of September, 1962 through February, 1963.

NAA-SR-8476 SECRET

TITLE: ENVIRONMENTAL TESTING OF SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: T. G. Parker, Jr.

ABSTRACT: Eight SNAP 10A fuel elements (normal uranium) were vibrated and shocked at levels more severe than required for qualification for flight conditions. Hydrogen permeation measurements were made, before and after the mechanical inputs, to determine whether the elements were damaged. The elements are presently undergoing thermal endurance test at 1100°F. Future work with these elements is outlined. Specific results of the testing to date are classified, and are given in the body of the report.

NAA-SR- 8613 CONF RD

TITLE: FINAL REPORT ON THE SNAP 10A CRITICAL ASSEMBLY STUDIES

AUTHOR: D. Clifford

4-29-64

ABSTRACT: A detailed experimental program conducted on the SCA-4C reactor assembly has yielded extensive design information for the SNAP 2/10A flight reactor. The experiments were primarily concerned with core reactivity and buckling measurements, and external reflector studies. The core measurements showed how control of hydrogen and beryllium in the fuel region could be used to control the excess reactivity of the system without excessive flux perturbations. The reflector thickness could be used as a fine adjustment of system reactivity. Data on shutdown margins and drum control were also provided. Additionally, other core parameters and various component and human mockups were studied in an effort to ascertain reactivity worths of core components and possible environmental effects on the system.

NAA-SR-MEMO-8679, Revision 1 SECRET RD

TITLE: SNAP 10A REACTOR DESIGN SUMMARY

AUTHOR: W. W. Davis

10-26-64

ABSTRACT: An updated description of the SNAP 10A reactor subsystem is presented. Design details of the principal assemblies which constitute the reactor subsystem are discussed. System behavior for abnormal conditions such as disassembly during re-entry, operation in rain filled craters, and long term operation in space are included.

NAA-SR-MEMO-8685 UNCL

TITLE: SNAP PRELAUNCH TEST FACILITY SAFEGUARDS REPORT

AUTHOR: B. F. Ureda

12-31-63

ABSTRACT: The objective of this report is to demonstrate that the activity in the SNAP 10A program to be conducted in the SNAP Prelaunch Test Facility (SPTF, Figure 1) at Vandenberg Air Force Base (VAFB) was given sufficient consideration to insure the safety of the operation. Specific consideration was given to the location and design of the facility, selection of operating equipment, limitation of operations to non-nuclear, and definition and control of operating procedures. A hazards analysis of these operations and a discussion of the postulated maximum credible accident and its consequences forms a part of this report.

NAA-SR-MEMO-8768 CONF RD

TITLE: FAST NEUTRON FLUX THROUGH THE SNAP 10A SHIELD AS COMPUTED BY
SEVERAL METHODS

AUTHOR: J. A. Belcher and W. M. Farr

7-23-63

ABSTRACT: Fast neutron fluxes through the SNAP 10A shield as computed by several methods are compared. The methods and the codes using the methods are:

- 1) Neutron transport - DTK,
- 2) Neutron diffusion - AIM-6,
- 3) Monte Carlo - FMC-N, and
- 4) Neutron removal theory - 14-0.

These various methods predicted fluxes through the shield which agree reasonably well. On the basis of these analyses and recent Shield Test Facility experiments, a lithium hydride removal cross section of 0.156 cm^{-1} is recommended for use in removal theory code studies of the SNAP 10A shield. Comparable analysis of the SNAP 2 shield indicates that a removal cross section of 0.160 cm^{-1} is valid for use in SNAP 2 shielding studies.

NAA-SR-MEMO-8768 Addendum CONF RD

TITLE: LiH CROSS SECTION DETERMINATION FOR REMOVAL THEORY CODES

AUTHOR: R. D. Anderson, Jr.

7-23-63

ABSTRACT: To correlate a realistic 14-0 code removal cross section with computed fluxes obtained using AIM-6 and DTK nuclear codes.

NAA-SR-MEMO-8809 SECRET RD

TITLE: SNAP 10A FS-3, -4 AND -5 FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

7-25-63

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the SNAP 10A FS-3, -4 and -5 Cores. The Fabrication Process Sheets describe specific fabrication operations in detail. The Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-8818 SECRET RD

TITLE: 2-kw SNAP 10A DEVELOPMENT PROGRAM

AUTHOR: R. F. Wilson

8-14-63

ABSTRACT: The purpose of this document is to guide the work required to develop a follow-on SNAP 10A system capable of producing between 2 and 3 electrical kw, and to define the sequence and timing of the various phases of work as they interrelate with each other and with the overall development schedule and technical progress. The program described encompasses the development of 1300°F components, engineering, and ground testing of a 2 kwe system, utilizing the 1200°F SNAP 2 reactor and shield, and flight testing two 2-kwe systems. The reference system has a radiator area of about 120 ft² and a weight of about 1400 lb. The 1300°F components will allow the same system to grow to 3 kw with the incorporation of SNAP 8 technology into the SNAP 2 reactor.

NAA-SR-MEMO-8851 SECRET RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - JULY 1963

AUTHOR: D. H. Stone and T. G. Parker, Jr.

8-7-63

ABSTRACT: Results to date indicate little or no effect of environmental inputs on SNAP 10A fuel elements. Testing is done in accordance with procedures outlined in NAO 422-005, "SNAP 10A Fuel Element Environmental Test Specification."

NAA-SR-MEMO-8972 UNCL

TITLE: SNAP 10A LAUNCH AND REENTRY HAZARDS DUE TO STEADY-STATE OPERATION

AUTHOR: R. E. Alexander

9-1-64

ABSTRACT: The safety analysis performed in support of the SNAP 10A flight tests has included consideration of potential hazards due to quasi steady-state operation of the SNAP 10A reactor under accident conditions. Steady-state operation is considered possible, although highly improbable, following launch pad accidents that could occur during or after fueling of the launch and orbital stage vehicles. In the extremely improbable event that reentry aerodynamic and impact forces fail to render the core permanently subcritical, steady-state operation is again considered possible. Potential radiation hazards due to accidents of this nature are examined in this report.

NAA-SR- 9007 SECRET

TITLE: SNAP FUEL AND CORE MATERIALS COMPATIBILITY SCREENING TESTS

AUTHOR: L. B. Lundberg

3-1-64

ABSTRACT: Screening tests have been performed to determine the compatibility of many of the materials in contact with each other in the SNAP 10A/2 and SNAP 8 reactor cores. In some cases of known incompatibility, reaction barriers were studied. The tests involved placing small samples of the materials under consideration in intimate contact at temperatures from 1200 to 1450°F for periods up to 1000 hr in environments similar to those encountered in the particular reactor. The mutual compatibility of the sample materials was determined by metallographic examination. Reactions were observed between the following components: fuel and the bare cladding (without hydrogen barrier); fuel cladding and the SNAP 2 beryllium internal radial reflector; and several fuel element thermal bond materials and both the fuel

NAA-SR- 9007 SECRET (Continued)

ABSTRACT: (Continued) and the enamel hydrogen barrier. Reaction barriers for fuel cladding and the SNAP 2 beryllium internal radial reflector were examined, but none were found to be effective. The majority of the suggested reactor core materials were found compatible in this study.

NAA-SR-MEMO-9013 CONF RD

TITLE: THERMAL CONDUCTIVITY OF SNAP SHIELDS

AUTHOR: N. F. Davies 9-20-63

ABSTRACT: An effective value for the thermal conductivity of a cast lithium hydride shield was determined experimentally with the aid of the TAP-II computer code (Ref. 1).

NAA-SR-MEMO-9113 UNCL

TITLE: IRRADIATION OF SNAP ELECTRONICS COMPONENTS IN THE SHIELD TEST REACTORS EXPERIMENTS 1 - 8

AUTHOR: S. G. Kimble and D. M. Walker 8-21-63

ABSTRACT: Eight irradiation experiments were performed in the AI SNAP Shield Test Reactor (STR) to provide information required for the development of electronic control and instrumentation components for SNAP systems. Where gamma damage was expected to be significant, parts were pre-gamma dosed to the desired level before neutron irradiation at the low-gamma STR. In-pile data was generated for electronic parts, subassemblies, and whole components held at controlled temperatures during test. This effort was primarily for screening and special effects studies supporting the program of irradiations of statistical-size samples of SNAP parts at the Batelle Research Reactor.

NAA-SR- 9136 SECRET

TITLE: ENVIRONMENTAL TESTING OF PROTOTYPE SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: T. G. Parker, Jr. 3-15-64

ABSTRACT: Ten prototype SNAP 10A fuel elements (normal uranium) were vibrated and shocked several times, at levels more severe than required for qualification for flight conditions. Hydrogen permeation measurements were made, before and after each cycle of the mechanical inputs, to determine whether the elements were damaged. The elements have undergone endurance test at 1200°F, and are now undergoing endurance test at 1300°F. Future work with these elements is outlined. Specific results of the testing to date, which are classified, are given in the body of the report.

NAA-SR-MEMO-9217 CONF RD

TITLE: S-10-FS-4 FUEL CALIBRATION WITH BARE CLADDING

AUTHOR: D. W. Clifford

11-18-63

ABSTRACT: The SCA-4A reactor assembly was employed to measure closely the reactivity worth of each FS-4 fuel rod in a reference configuration. Subsequently, a full core loading of 37 FS-4 rods was measured in the 4A machine with the S-10-FS-1 reflector configuration.

NAA-SR-9231 CONF RD

TITLE: EVALUATION OF AN END-OF-LIFE SHUTDOWN DEVICE FOR NUCLEAR REACTORS

AUTHOR: D. G. Oliver and C. A. Willis

6-26-64

ABSTRACT: It is shown that in many aerospace reactor missions, a reliable shutdown device is required to reduce the potential radiological hazards presented by a reactor that returns from orbit. From preliminary design and development considerations, reactor designs appears feasible without significantly affecting mission operation or power system reliability. It is concluded that development and demonstration efforts should be initiated.

NAA-SR-9280 UNCI

TITLE: THERMAL TESTING OF THE SNAP 10A PROTOTYPE SYSTEM (PSM-3)

AUTHOR: W. F. Marten and J. H. Van Osdol

7-15-64

ABSTRACT: From April 18, 1962 through October 11, 1962, the SNAP 10A PSM-3 non-nuclear test vehicle underwent thermal, electrical, and hydraulic tests at the Santa Susana Test Facility of Atomics International located in Chatsworth, California. This report defines the test vehicle and facilities, describes the tests and their objectives, and presents an evaluation of the tests. In general, the SNAP 10A PSM-3 test vehicle met its design goals.

NAA-SR-MEMO-9351 UNCL

TITLE: SNAP 10A SHIPPING PROCEDURES

AUTHOR: H. Newman

11-16-64

ABSTRACT: SNAP 10A Shipping Procedures Manual, Volumes I and II provides procedures and operations relative to the factory-to-flight shipping phases of the SNAP 10A Nuclear Power Unit, manufactured by Atomics International, A Division of North American Aviation, Inc., Canoga Park, California.

NAA-SR-MEMO-9352 UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A PRELAUNCH OPERATIONS - SPTF

AUTHOR: J. Rocke

2-19-65

ABSTRACT: The purpose of this manual is to provide information and procedures associated with the SNAP 10A prelaunch operations conducted at the SNAP Prelaunch Test Facility (SPTF), building 6527, located at Vandenberg Air Force Base (VAFB).

Activities included in SPTF prelaunch operations are illustrated in the frontispiece flow diagram. These begin upon receipt of the SNAP 10A system at the SPTF and conclude with shipment of the assembled SNAP 10A nuclear power unit (NPU) to the Point Arguello Launch Complex No. 2 (PALC-2). Each phase of the SPTF prelaunch operations program is concerned with preparing the NPU for launch.

NAA-SR-MEMO-9353 UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A, SNAP PRELAUNCH TEST FACILITY OPERATIONS BUILDING 6527 VANDENBERG AIR FORCE BASE

AUTHOR: J. Rocke

12-30-64

ABSTRACT: This manual describes the SNAP Prelaunch Test Facility (SPTF) and the procedures utilized in support of the SNAP 10A prelaunch testing program at Vandenberg Air Force Base (VAFB). The facility is identified as Building 6527 at VAFB, but for purpose of identification in this and companion manuals, it is referred to as the SPTF. The SPTF serves as a base of operations for Atomics International personnel assigned to the SNAPSHOT nuclear power unit (NPU) prelaunch testing program conducted at VAFB. The facility is utilized for receiving storage and non-nuclear testing of the SNAP 10A power systems prior to shipment to the launch complex at the Point Arguello Launch Complex No. 2 (PALC-2). NPU prelaunch operations carried out at VAFV are shown in the Figure 1-1 flow diagram.

NAA-SR-MEMO-9356 VOLUME I UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A, VOLUME I - AEROSPACE GROUND EQUIPMENT OPERATION AND MAINTENANCE - MECHANICAL

AUTHOR: H. Newman

1-4-65

ABSTRACT: AGE Operation and Maintenance Manuals, Volumes I and II provide information relative to mechanical and electrical aerospace ground equipment manufactured by Atomics International, a Division of North American Aviation, Canoga Park, California, for use in the SNAPSHOT flight test program.

Volume I contains information about the mechanical equipment used for handling the SNAP 10A Power Unit and the monitoring equipment used during shipping and storage.

NAA-SR-MEMO-9356 VOLUME II UNCL

TITLE: TECHNICAL MANUAL, SNAP 10A, VOLUME II - AEROSPACE GROUND EQUIPMENT OPERATION AND MAINTENANCE - ELECTRICAL

AUTHOR: A. Kalish

1-4-65

ABSTRACT: This manual contains operation and service instructions for personnel responsible for the operation and maintenance of Electrical System Test Set TSM-1, Part Nos. 10FS-84019 and 10FS-84020, located at Point Arguello Launch Complex No. 2 (PALC-2) and Electrical System Test Set TSM-2A, Part No. 10FS-84053 located at the SNAP Prelaunch Test Facility (Building 6527), Vandenberg Air Force Base.

NAA-SR-MEMO-12023

NAA-SR-MEMO-9359 UNCL

TITLE: TECHNICAL MANUAL, NPU PRELAUNCH OPERATIONS - PALC-2

AUTHOR: J. Rocke

1-31-65

ABSTRACT: This manual presents operations performed by Atomics International (AI) personnel during the launch complex phase of the SNAPSHOT program. Related procedures covering prelaunch preparation of the SNAP 10A nuclear power unit (NPU) at Point Arguello Launch Complex No. 2 (PALC-2) are included.

NAA-SR-MEMO-9440 UNCL

TITLE: FSM-I - A DATA REDUCTION PROGRAM

AUTHOR: R. J. Mikell and G. T. Chang

3-25-64

ABSTRACT: The FSM-I data reduction program consists of three parts.

Part I is a data reduction and analysis program which performs statistical calculations and numerical analysis of data gathered on punched paper tape. The signals to the paper tape punch are obtained from reactor instrumentation. One of the output media from Part I is a magnetic tape. This tape is used as the input to Part II.

Part II is the IBSYS sort program. This program takes the output magnetic tapes generated by Part I, sorts and merges the data, and, if desired, deletes records from the sorted and merged tapes. This is done to order an update a history tape of accumulated test runs processed by Part I. This accumulated history tape then becomes the input to Part III.

Part III is a normalizing and graphical display program. In this portion of the FSM-I package, plots of the various parameters which describe the system's performance are obtained.

NAA-SR-9486 CONF DI

TITLE: SNAP 10A THERMOELECTRIC PUMP DEVELOPMENT

AUTHOR: M. Perlow

6-3-64

ABSTRACT: The SNAP 10A system and pump requirements are presented to define the developmental objectives of the thermoelectric pump. Design equations and procedures are included along with operating data and their respective analyses. Fabrication problems are discussed, and the procedure for manufacture of both the elements and the pump assembly is included. Post test examination by metallographic means was performed on pumps subsequent to 1000°F NaK operation.

NAA-SR- 9496 SECRET RD

TITLE: QUALIFICATION TESTING SNAP 10A FUEL ELEMENTS (INTERIM REPORT)

AUTHOR: A. J. Fitzgerald

6-15-64

ABSTRACT: An experimental program is being performed to demonstrate the reliability of SNAP 10A fuel elements to withstand simulated reactor conditions. This interim report shows the effects of thermal and mechanical inputs on the hydrogen permeation of the fuel elements. Based on the available test data, demonstrated reliability of the fuel elements is given for the prescribed inputs, including 90 days of thermal endurance. Results of this program are classified, and are given in the body of the report.

NAA-SR-MEMO-9514 CONF RD

TITLE: LONG TERM SNAP 10A REACTOR OPERATION ANALYSIS

AUTHOR: W. R. Lahs

2-7-64

ABSTRACT: This report presents the description and results of the long term reactor operation code used to solve the above problem. The code represents the heat transfer and fluid flow in a five node reactor representation coupled with a radiator heat transfer equation and a reactivity relationship. The model is solved at discrete points in time based on the assumption that for the operating histories considered, time dependent terms involving changes in heat capacities can be neglected without significant error. The code does not solve for any power or temperature transients but instead calculates reactor temperatures and powers under conditions of relatively slow coolant flow and/or radiator emissivity coating degradations. A 0.1 year time increment is generally used between calculation points; however, a 0.01 year increment is sometimes used to eliminate convergence problems. Assuming the SNAP 10A system with time dependent NaK flow and emissivity coating degradation as input data, the resulting reactor inlet and outlet coolant temperatures and the reactor power are presented as a function of time.

NAA-SR-MEMO-9526 CONF RD

TITLE: SNAP 10A REACTOR OUTLET TEMPERATURE BEHAVIOR AT THE START OF THE ACTIVE CONTROL PERIOD

AUTHOR: G. S. Drucker

2-19-64

ABSTRACT: The behavior of the reactor outlet temperature at the start of the active control period was investigated to determine if an over temperature condition exists. Two different sensor cases were considered. Case I is a study of the present temperature sensor switch control. Case II is a study of a possible converter current switch control.

NAA-SR-MEMO-9551 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - JANUARY 1964

AUTHOR: J. D. Whitlock

2-19-64

ABSTRACT: Ten fuel elements have received 2928 hr of endurance test at 1200°F after receiving

- 1) Thermal cycles,
- 2) High level vibration and shock,
- 3) Isothermal ramp heating.

NAA-SR-MEMO-9565 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT QUALIFICATION TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-4-64

ABSTRACT: Deck No. 9w-037 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element qualification testing data reduction. This report defines the required input data format and describes the program output.

NAA-SR-MEMO-9566 CONF RD

TITLE: FORTRAN PROGRAM FOR SNAP 10A FUEL ELEMENT EXPLORATORY TESTING DATA REDUCTION

AUTHOR: M. E. Nathan

3-6-64

ABSTRACT: Deck No. 9W-038 SECRET Restricted Data has been placed on file with Data Processing, Dept. 792, for SNAP 10A fuel element exploratory testing data reduction. This report defines the required input data format and describes the program output.

NAA-SR-MEMO-9581 CONF RD

TITLE: SNAP 10A DRUM POSITION DEMODULATOR QUALIFICATION IRRADIATION TEST (STR 17)

AUTHOR: M. N. Robinson and S. G. Kimble

2-27-64

ABSTRACT: A qualification irradiation test of two demodulators is described. Gamma irradiation to 2×10^7 rad was performed, December 30, 1963, to January 13, 1964, at the AI Co⁶⁰ Gamma Facility. Neutron irradiation to 3×10^{13} nvt (> 0.1 Mev) was performed, January 20-23, 1964, at the Shield Test Reactor.

The results of inpile performance tests are presented. Both demodulators exceeded the specified limits on input impedance and coarse and fine output voltages.

NAA-SR-MEMO-9589 CONF RD

TITLE: TRANCORE-10A: A DIGITAL PROGRAM EVALUATING TRANSIENT TEMPERATURES WITHIN THE SNAP 10A REACTOR CORE

AUTHOR: P. M. Magee

3-5-64

ABSTRACT: A mathematical model has been developed which describes the reactor kinetics, core heat transfer and thermoelectric pump performance of the SNAP 10A system. From the model, a digital computer code, "TRANCORE-10A", has been prepared which predicts transient temperatures within the reactor core. The code can be used to investigate a wide variety of reactor operational behavior: steady-state, startup, scram, loss of coolant flow, etc. It has been used extensively to predict startup transients. However, the code cannot be used to evaluate the effects of rapid reactivity changes, i. e., operation near prompt critical.

NAA-SR- 9615 CONF RD

TITLE: SNAP REACTOR CONTROL DRUM DRIVE

AUTHOR: L. G. Kellogg

8-24-64

ABSTRACT: The SNAP 2, 10A, and 8 nuclear systems are designed to provide electrical power on space vehicles. Although each system has different power capabilities, the control-drum-drive components are basically the same.

Development of the various control-drum-drive components and subcomponents from GFY 1962 to mid-GFY 1964 is discussed. The design criteria are outlined for each SNAP system. Comparisons are made between the systems to evaluate their design and operation in the prescribed environment.

The components and subcomponents reviewed are the actuator, controller, bearings, gears, and flexible couplings. Data are presented to describe development of the SNAP 10A reference design and both the reference and backup designs for the SNAP 2 and SNAP 8 systems.

In addition to the integrated control-drum drive reference designs, four possible backup design schemes are also presented for SNAP 2 and SNAP 8. Each scheme is discussed in terms of structural and mechanical design, thermal heating, and nuclear shielding considerations. The concept of a direct-drive actuator mounted above the drum is promising and further study is planned.

A control-drum-drive scheme that provides failsafe scram capabilities for ground testing of the reactor system has been designed and proof tested. The details of this design as it applies to SNAP 8 systems are presented.

NAA-SR- 9634 UNCL

TITLE: LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRICAL AND ELECTRONIC COMPONENTS (BMI-LF-3)

AUTHOR: M. N. Robinson, S. G. Kimble and D. M. Walker

2-14-64

ABSTRACT: This report describes screening tests of nuclear radiation effects on electrical and electronic components for the SNAP 2 and 8 control systems.

Five transistor models, three capacitor types, and several encapsulation materials were irradiated to 10^{16} nvt (>0.1 Mev) and 4×10^8 r (gamma). The components were maintained at a temperature of 140 °F and a vacuum of 5×10^{-4} Torr. Measurements were taken of electrical characteristics during irradiation, and the resulting degradation curves were plotted by computer.

NAA-SR- 9647 UNCL

TITLE: SNAP 10A RADIATION SHIELD ANALYSIS

AUTHOR: J. A. Belcher, W. A. Flynn and R. J. Thomson

10-15-64

ABSTRACT: The final analysis of the SNAP 10A flight system radiation shield has been completed. This report summarizes the results.

Preliminary analysis of the shield design indicated that the direct penetration dose at the 5-ft diameter reference dose plane 17.5 ft from the lower face of the reactor core would meet the flight design objectives of 10^{12} nvt and 10^7 r for one year of operation. Subsequent analysis indicated that due to scattering effects from the edges of control drums, the NaK piping around the shield, and the thermoelectric converter system, some regions of the dose plane would be exposed to doses beyond the specified limits. However, through judicious placement and hardening of radiation sensitive instruments and the somewhat localized nature of the scattering effects, an increase in shield size for the SNAP 10A flight test was not warranted.

NAA-SR-MEMO-9652 CONF DI

TITLE: S10A FSM-1 MAXIMUM POWER TRANSFER TEST

AUTHOR: R. Morberg

3-12-64

ABSTRACT: The enclosed data was derived from tests conducted on the S10A FSM-1 Power System during the 90 Day Test. The maximum power transfer tests were conducted on a programmed schedule beginning on October 30, 1963 and ending January 17, 1964.

NAA-SR-MEMO-9654 CONF RD

TITLE: STUDIES OF SURFACES AND INTERFACES OF SNAP FUEL ELEMENTS

AUTHOR: L. Maisel

3-12-64

ABSTRACT: An oxidation kinetic study of chromized Hastelloy N was performed with surface identifications by X-ray diffraction; a complete metallographic examination of the surface formations was conducted for chromized Hastelloy N. The concentration profile of chromium in chromized Hastelloy N was also determined.

NAA-SR- 9655 UNCL

TITLE: SNAP 10A STRUCTURAL ANALYSIS

AUTHOR: J. R. Boulanger

7-15-64

ABSTRACT: This report discusses and summarizes all stress analyses done on the SNAP 10A system; it also mentions many of the structural tests which were accomplished. A stress analysis was made on all elements of the primary structure and on all structural components.

NAA-SR-MEMO-9712 CONF DI

TITLE: POST TEST EXAMINATION OF SNAP 10A THERMOELECTRIC PUMP NUMBER - 017

AUTHOR: W. L. Cockrell and E. L. Reed

4-15-64

ABSTRACT: This pump was the first to embody an iron foil barrier. It showed effective reduction in observable poisoning in the telluride elements. An observed variation in density of the iron powders across the area of these layers suggests need for greater care in distribution of the iron powder across the section prior to compacting the telluride elements. The dimensional observations suggest a study of the tolerances and permissible variation in thickness of radiators prior to assembly. The "N" element copper shoe to aluminum radiator diffusion bonded joints in this pump were poor. Suggestions are made to incorporate a barrier foil between the copper and aluminum to eliminate the formation of brittle intermetallic compounds.

NAA-SR-9720 CONF RD

TITLE: SNAP 10A PRESTARTUP AND STARTUP PERFORMANCE

AUTHOR: G. S. Drucker and T. J. Boyle

6-30-64

ABSTRACT: Presented are the results of analyses to determine the thermal behavior of the SNAP 10A System in orbit prior to startup, and the nuclear, thermal, and hydraulic behavior of the system during startup. Parameter studies were made to determine the effects of variations from the nominal design conditions on maximum and minimum system temperatures prior to startup and the severity of the startup transient. Also included are the mathematical models used in the digital and analog computer solutions. The analyses results indicate that the SNAP 10A system will meet its pre-startup and startup requirements.

NAA-SR- 9723 UNCL

TITLE: BEHAVIOR OF SNAP 10A DURING ORBITAL REENTRY

AUTHOR: D. K. Nelson

7-15-64

ABSTRACT: This report presents an analysis of the SNAP 10A power system during orbital reentry to gain information regarding the ablation of various nuclear reactor components. The SNAP 10A power system uses thermoelectric elements to convert the heat developed by a compact nuclear reactor into electrical energy. The initial point in the analysis occurs, after system operation in space, at an altitude in the process of satellite orbit decay where the satellite will not make another completed circuit of the earth. The analysis considered an oblate rotating earth.

NAA-SR-MEMO-9724 CONF RD

TITLE: SNAP 10A STARTUP CONTROLLER ENDURANCE IRRADIATION

AUTHOR: S. G. Kimble

3-26-64

ABSTRACT: This report describes a temperature vacuum irradiation environment test on a SNAP 10A Startup Controller which had been irradiated in an earlier experiment to qualification dose levels (3×10^{13} nvt, 2×10^7 RY). More extensive measurements were taken in the present test in an effort to study the temperature-dose dependency of the failure point and the mode of failure. Results are presented which indicate operational limits as a function of dose and time.

NAA-SR-MEMO-9746 CONF RD

TITLE: IRRADIATION QUALIFICATION TESTING OF SNAP 10A COMPONENTS

AUTHOR: A. J. Chesavage

2-4-64

ABSTRACT: Selected SNAP 10A components were irradiated to about 10^{14} NVT and 5×10^7 R at an average temperature of 136°F in a nominal vacuum of 2×10^{-5} TORR. The components were operated periodically and the electrical characteristics recorded. Pre-irradiation and post-irradiation tests were conducted.

NAA-SR-9779 UNCL.

TITLE: SNAP FUEL REENTRY BURNUP EXPERIMENT IN A HYPERTHERMAL WIND TUNNEL

AUTHOR: J. W. Baughn

10-15-64

ABSTRACT: Specimens of SNAP fuel material were tested in a simulated reentry environment. This behavior in this environment was observed and is described in this report. This behavior was compared to and agreed with computations using a simple thermal approximation to the fuel material. The behavior was also extrapolated directly to that of an orbital reentry (with release of the reactor fuel rods from the reactor vessel at an altitude of approximately 240,000 ft).

NAA-SR-9782 CONF RD

TITLE: TOPICAL REPORT, THERMOPHYSICAL PROPERTIES OF SNAP FUELS

AUTHOR: R. E. Taylor and C. J. Ambrose

6-26-64

ABSTRACT: The specific heat, thermal diffusivity, thermal conductivity, electrical resistivity, and thermal expansion of various zirconium-uranium hydrides were measured. Calculations of the specific heat based on this model are within 8% of the experimental results obtained by numerous laboratories on a variety of compositions.

NAA-SR-MEMO-9786 UNCL

TITLE: SNAP 10A DEVELOPMENT REACTOR MOCKUP TEST PROGRAM SUMMARY

AUTHOR: R. H. Prowett

10-1-64

ABSTRACT: The SNAP 10A (Space Nuclear Auxiliary Power) Program at Atomics International was inaugurated by the United States Atomic Energy Commission to:

- 1) Demonstrate the usefulness of nuclear power for space applications,
- 2) Verify that nuclear space power can be used safely, and
- 3) Obtain technical information that will enhance the application of current systems and further the development of the larger and more complex systems required for the future.

NAA-SR-MEMO-9807 CONF DI

TITLE: SNAP 10A FSM-1 SHUTDOWN PERFORMANCE

AUTHOR: G. E. Berg

4-13-64

ABSTRACT: Data taken during the shutdown of the SNAP 10A FSM-1 system test is presented and analyzed. In analyzing shutdown performance, the system was divided into four categories:

- 1) Thermal,
- 2) Converter electrical,
- 3) Pump, and
- 4) Expansion compensator.

In each category emphasis was placed on comparison of shutdown to thermal reference data and any departures from expected behavior. Generally, system and component performance was satisfactory and conformed to expected behavior.

NAA-SR-MEMO-9808 CONF RD

TITLE: FSM-1 STARTUP TEST RESULTS

AUTHOR: G. H. Parker

2-26-64

ABSTRACT: The results of the SNAP 10A FSM-1 startup tests are presented with an evaluation and comparison with expected transient performance. A chronology is given for the major milestones in planning the tests as well as the major events in the conduct of the tests.

NAA-SR-MEMO-9811 UNCL

TITLE: NUCLEAR RADIATION EFFECTS ON SEMICONDUCTOR DEVICES (STR #19)

AUTHOR: M. N. Robinson

4-16-64

ABSTRACT: Radiation effects on the electrical characteristics of five transistor types, two Zener diode models, one power diode model, and two Thyrite samples, in a simulated reactor environment, are evaluated. The devices were irradiated to 2×10^7 R (gamma) at the AI Co⁶⁰ Gamma Facility, followed by neutron irradiation to 7.2×10^{13} nvt at the Shield Test and Irradiation Reactor (STIR).

The critical electrical parameters were measured during irradiation, and the resulting degradation curves are presented and interpreted.

NAA-SR-MEMO-9815 CONF RD

TITLE: SELF-WELDING IN SPACE - AEROSPACE SAFETY SURVEY

AUTHOR: H. E. Johnson

4-3-64

ABSTRACT: The purpose of this TDR is to review the general literature on self-welding and to survey the program at Atomics International in order to evaluate the possibility that self-welding of the beryllium reflector to the 316 stainless steel reactor core will occur while the SNAP system is in operation in space. Seizure of the reflector to the reactor will affect the burnup of the system on reentry into the atmosphere.

NAA-SR-9820 UNCL

TITLE: STRUCTURAL TEST ON THE FINAL SNAP 10A PROTOTYPE SYSTEM (PSM-1A)

AUTHOR: H. L. Henley and W. H. Dauterman

7-15-64

ABSTRACT: This report presents the results of the structural tests which were performed on the S10A-PSM-1A system to qualify the basic structural design for the anticipated launch environment. Included in this report are data from the damping, vibration, shock, acoustic, and static test programs. Testing was performed in accordance with NS10 PSM-1A-00-001, "PSM-1A Structural Test Specification."

NAA-SR-MEMO-9831 Part 1 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT, FEBRUARY - MARCH 1964

AUTHOR: J. D. Whitlock

4-22-64

ABSTRACT: Ten fuel elements have completed 4440 hr of endurance testing at 1200° F after receiving:

- 1) Thermal cycling,
- 2) High level vibration and shock,
- 3) Isothermal ramp heating.

NAA-SR-MEMO-9831 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - FEBRUARY-MARCH 1964
AUTHOR: J. D. Whitlock 5-5-64
ABSTRACT: This report contains the data from the fuel element environmental test program.

NAA-SR-MEMO-9839 UNCL

TITLE: REACTOR THERMOELECTRIC SPACE POWER
AUTHOR: J. Stewart 4-15-64
ABSTRACT: The SNAP 10A (Space Nuclear Auxiliary Power) Program at Atomics International was inaugurated by the United States Atomic Energy Commission to:

- 1) Demonstrate the usefulness of nuclear power for space applications,
- 2) Verify that nuclear space power can be used safely, and
- 3) Obtain technical information that will enhance the application of current systems and further the development of the larger and more complex systems required for the future.

NAA-SR-MEMO-9854 CONF RD

TITLE: SNAP 10A ELECTRONIC TEMPERATURE SWITCH QUALIFICATION IRRADIATION TEST
AUTHOR: M. N. Robinson and S. G. Kimble 5-19-64
ABSTRACT: A nuclear radiation environmental test of two switches (Serial numbers 1011 and 1012) is described. The gamma irradiation was performed at the AI Co⁶⁰ Gamma Facility, December 4-17, 1963, followed by neutron irradiation at the fission plate of the shield test and irradiation reactor, January 2-6, 1964.
The results of electrical operation tests performed during irradiation are presented and interpreted. The changes observed are well within the repeatability and hysteresis tolerances designated in the equipment specification, indicating fulfillment of the radiation portion of the qualification requirements.

NAA-SR-MEMO-9855 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR FIRST DELIVERY
AUTHOR: W. Sawicky 4-28-64
ABSTRACT: Certifications, test and inspection results, and copies of all waivers for the forty 6.35 nominal N_H and ten 6.0 nominal N_HI fuel elements delivered for the FS-1 Core are given herein. In addition, all pertinent aspects of the test and inspection operations are discussed.

NAA-SR-MEMO-9862 UNCL

TITLE: MODIFIED SNAPTRAN 10A/2 -1 STEPPER AND IMPULSE DRIVE SYSTEM
CHECKOUT

AUTHOR: F. C. Dye and R. P. Johnson

4-24-64

ABSTRACT: Acceptance testing of the modified SNAPTRAN 10A/2 -1 drive units was conducted in Canoga Park, California prior to shipment of the machine to the National Reactor Testing Station (NRTS) in Idaho for operation by Phillips Petroleum Company. This machine, which was originally to have been the SNAPTRAN -2 machine, was modified to provide impulse capability and replace the original -1 machine.

The results of the drive system checkout are given in this report and are compared with the design specifications. Drum position versus time curves are presented for typical machine operations. The general performance of the system was considered acceptable.

NAA-SR- 9893 UNCL

TITLE: SNAP 10A/AGENA ELECTRICAL MOCKUP TEST (S10A/FSEM-2)

AUTHOR: M. J. Teresa

7-30-64

ABSTRACT: A test program to establish preflight confidence in SNAP 10A and Agena electrical systems was conducted at LMSC's Sunnyvale facility between November 1962 and June 1963. The tests were performed with an electrical mockup of the NPU, designated FSEM-2, and an Agena development test vehicle or functional mockup (FMU). Final checkout of Agena subsystems extended into early May 1963. During the month of May integrated systems tests were conducted with the FSEM-2/FMU. The two mockups were programmed through a simulated sequence of operation from prelaunch to end of life.

NAA-SR- 9894 UNCL

TITLE: DEVELOPMENT OF HIGH-TEMPERATURE ELECTRICAL GROUND TEST HEATERS
FOR THE SNAP 10A PROGRAM

AUTHOR: R. Blevitt, G. Paine and S. Sudar

3-1-65

ABSTRACT: The development and qualification of the system acceptance test heaters and the reactor simulator heater are described in this progress report.

NAA-SR- 9898, Volume I CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 1, CONTROL COMPONENTS

AUTHOR: W. J. Kurzeka, Editor 8-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR- 9898, Volume II CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 2, SAFETY AND DIAGNOSTIC COMPONENTS

AUTHOR: W. J. Kurzeka, Editor 12-31-64

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

Volume II discusses safety and diagnostic components.

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR- 9898, Volume III CONF RD

TITLE: SNAP 10A COMPONENT DEVELOPMENT SUMMARY, VOLUME 3, SHIELD, GROUND TEST ASSEMBLY, AND MATERIALS APPLICATIONS

AUTHOR: W. J. Kurzeka, Editor 2-10-65

ABSTRACT: The three-volume report summarizes the design, development, and test of components used on the SNAP 10A Reactor for control, safety, operational diagnosis, and radiation shielding. It also includes a summary of developmental efforts for a ground test attachment assembly and discusses various materials and processes pertinent to the program.

Volume I describes the design, development, and test of the control components including the controller, temperature sensor switch, actuator, and control drive components.

NAA-SR- 9898, Volume III CONF RD (Continued)

ABSTRACT: Volume II discusses safety and diagnostic components.
(Continued)

Volume III discusses the shield, ground test drum, drive assembly, and materials applications.

NAA-SR- 9899 UNCI.

TITLE: SNAP 10A REACTORS STRUCTURE

AUTHOR: J. D. Sutherland

8-1-64

ABSTRACT: To demonstrate the integrity of the SNAP 10A reactor structure and to obtain data for verification of design analysis, a structural test program was conducted. Included were static, vibration, and elevated temperature creep tests of the major reactor structural components. The results of this test program are presented and are compared with pertinent design analysis.

NAA-SR- 9900 CONF RD

TITLE: SNAP 10A REFLECTOR ASSEMBLY

AUTHOR: R. I. Jetter

7-30-64

ABSTRACT: This report presents a design description and discussion of the structural and thermal analysis of the SNAP 10A reflector assembly.

NAA-SR- 9901 CONF RD

TITLE: MECHANICAL DESIGN OF THE SNAP 10A RADIATION SHIELD

AUTHOR: J. D. Sutherland

6-30-64

ABSTRACT: The SNAP 10A Radiation Shield is described. The information presented summarizes the results obtained from analytical and test programs which were devised to support the mechanical design of the shield assembly.

NAA-SR-9903 CONF RD

TITLE: SNAP 10A REACTOR THERMAL PERFORMANCE

AUTHOR: P. M. Magee, G. E. Dufoe and J. D. Gordon

9-1-64

ABSTRACT: This report summarizes the thermal and hydraulic performance of the SNAP 10A reactor. Nominal and hot element steady-state fuel temperature distributions are presented. Startup transients are analyzed; maximum temperatures and temperature gradients are determined and the resulting stresses investigated.

NAA-SR-MEMO-9926 CONF RD

TITLE: SNAP 10A FS-1 CORE-FUEL ELEMENT DATA PACKAGES FOR SECOND DELIVERY

AUTHOR: W. Sawicky

5-8-64

ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A Nuclear Ground Test Reactor are given herein. In addition, pertinent aspects of test and inspection operation are discussed. This discussion includes changes in NH_4 , carbon, Sm_2O_3 , shock and vibration requirements which were not reflected in formalized specification changes. Descriptions are given of sampling methods data analysis and test operations for the more critical fuel element parameters.

NAA-SR-MEMO-9927 CONF RD

TITLE: METHOD FOR DETERMINING THE CONTENT AND DISTRIBUTION OF SAMARIUM POISON IN SNAP 10A FUEL ELEMENTS

AUTHOR: T. L. Iliff

6-8-64

ABSTRACT: This report describes the methods developed and used for controlling and determining the amount and distribution of samarium poison in fuel elements for the SNAP 10A FS and SNAPTRAN Reactor Systems. The major problems encountered, some of the limitations of these methods, and recommendations for improvements in the fuel element samarium determination and manufacturing processing are presented.

NAA-SR-MEMO-9971 - PART 1 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST MONTHLY REPORT - APRIL 1964

AUTHOR: J. D. Whitlock

5-25-64

ABSTRACT: Sixteen fuel elements are undergoing endurance testing after receiving

- 1) Thermal cycle inputs,
- 2) High level vibration and shock, and
- 3) Ramp heat inputs.

NAA-SR-MEMO-9971 - PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - APRIL 1964

AUTHOR: J. D. Whitlock

5-22-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-Memo-9831.

NAA-SR-MEMO-10016 PART 1 SECRET RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, MARCH-APRIL, 1964

AUTHOR: A. J. Fitzgerald

6-9-64

ABSTRACT: This report consists of 2 parts. Part I presents a summary of the test data and the analysis of the results obtained. Part II presents a complete listing of pertinent fuel element data - including acceptance (quality control) tests as well as qualification test results.

NAA-SR-MEMO-10016, PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, MARCH-APRIL, 1964

AUTHOR: A. J. Fitzgerald

6-12-64

ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents IBM listings of all test data accumulated to date. The listings include pertinent element assembly data, acceptance test data, and all qualification test data. The qualification data will be updated periodically.

NAA-SR-10022 (REV) CONF RD

TITLE: FINAL SNAPSHOT SAFEGUARDS REPORT

AUTHOR: Staff

3-20-65

ABSTRACT: This report presents a definition of the nuclear hazards and an evaluation of the potential risks associated with the flight test of the SNAP 10A Nuclear Power Unit from launch to reentry to earth. This safety evaluation of the flight test is grouped into three phases: (a) Launch to orbit injection, (b) Orbit injection until the reactor startup command is given, and (c) Reactor startup to reentry. For each phase the analysis includes a description of the procedures, a definition of potential accidents and potential nuclear hazards, and an evaluation of the potential risk to personnel.

NAA-SR-10022 (REV) CONF RD

TITLE: FINAL SNAPSHOT SAFEGUARDS REPORT, ADDENDUM 1

AUTHOR: Staff

3-20-65

ABSTRACT: This addendum presents information and/or analysis pertinent to the safety of the SNAPSHOT Program which has become available since May 1, 1964, the imposed cutoff for data used in the preparation of the Final SNAPSHOT Safeguards Report.

NAA-SR-MEMO-10033 CONF RD

TITLE: SNAP 10A FS-3 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky

6-11-64

ABSTRACT: Certifications, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-3 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, -3 and -4 core loadings. The 128 fuel elements for the FS-1, FS-3 and FS-4

NAA-SR-MEMO-10033 CONF RD (Continued)

ABSTRACT: cores were originally produced and designated for the FS-3, FS-4 and FS-5 cores.
(Continued) The reassignment of these fuel elements to the FS-1, FS-3 and FS-4 Reactor Systems occurred after their delivery to the Compact Systems Division. Therefore, all records and correspondence during production reflect the earlier system assignment and must be taken into consideration during any future examination of original data records.

NAA-SR-MEMO-10037 CONF RD

TITLE: QUALIFICATION IRRADIATION OF SELECTED SNAP 10A INSTRUMENTATION COMPONENTS. STR #14

AUTHOR: S. G. Kimble 6-9-64

ABSTRACT: The component irradiation described in this report was designed to produce information that could be used to determine irradiation qualification status for SNAP 10A Flight System instrumentation components. The test was conducted in vacuum at temperature in the shield test facility Fission Plate Capsule between November 18, 1963 and December 6, 1963. Tested components were subjected to a total neutron dose of 1×10^{14} nvt (E above one Mev) and a γ dose of 0.025×10^7 R. Results are included in tabular and/or graph form for the components which were instrumented for in-pile data taking.

NAA-SR-MEMO-10076 UNCL

TITLE: SNAPTRAN 2/10A -1 ACCEPTANCE TEST RESULTS

AUTHOR: R. K. Stitt 10-31-63

ABSTRACT: Mechanical checkout and acceptance tests on the SNAPTRAN 2/10A -1 machine at AI prior to its shipment to NRTS for transient testing.

NAA-SR-MEMO-10080 OUO

TITLE: RESISTANCE DEGRADATION OF ELECTRICAL INSULATION, AT VACUUM AND ELEVATED TEMPERATURE, AS A RESULT OF EQUIPMENT OIL DEPOSITION

AUTHOR: W. G. Long 6-12-64

ABSTRACT: The Developmental effort on the cable harness and coil techniques programs includes life-testing components at high temperature and vacuum. Back-streaming of oil from diffusion and roughing pumps in these tests has contributed to erroneous values of insulation resistance (I. R.). Under vacuum at elevated temperatures, the oil deposited on the test specimen carbonizes and creates a low resistance current leakage path.

To isolate the variables associated with testing in different types of equipment, tests were conducted in:

- 1) Untrapped oil diffusion systems,
- 2) Oil diffusion systems employing liquid nitrogen on water cooled baffles above the diffusion pump, and
- 3) An ionization pumping system. Oil contamination is not a factor in ion-pumping systems and the samples can be considered contaminant-free.

NAA-SR-MEMO-10126 CONF DI

TITLE: HIGH TEMPERATURE PERFORMANCE TESTING AND EVALUATION OF TYPE VF MODULES

AUTHOR: S. J. Block and R. M. Willard

6-17-64

ABSTRACT: Three SNAP 10A Type VF modules were placed on performance test at 1100, 1200 and 1300°F, respectively. The testing of the latter two modules was terminated prematurely due to the detrimental effects of numerous thermal cycles and shocks caused by heater failures and power shutdowns. Power output of the modules was within six percent of the predicted values for the high temperature operation. Tensile testing and metallography performed as part of the post-mortem examination indicated that degradation occurred as a result of the high temperatures in the molybdenum equilizer disc, the Au-Ni diffusion bond and, as expected, the radiator bonds.

NAA-SR-MEMO-10128 PART I CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - MAY, 1964

AUTHOR: J. D. Whitlock

6-22-64

ABSTRACT: Ten fuel elements have received 5712 hr of endurance testing at 1200°F after receiving:

- 1) Thermal cycling,
- 2) High level vibration and shock, and
- 3) Isothermal ramp heating.

Six fuel elements have received 1032 hr of endurance testing at 1300°F after receiving 1 and 2 above and gradient ramp heating.

NAA-SR-MEMO-10128 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TESTING - MAY, 1964

AUTHOR: J. D. Whitlock

6-17-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-MEMO-9831.

NAA-SR-MEMO-10142 CONF RD

TITLE: EXAMINATION OF SNAP 10 FSM-1 POSITIONING BRACKET AND REFLECTOR HINGE SURFACES

AUTHOR: P. P. King

6-26-64

ABSTRACT: SNAP 10 FSM-1 reflector positioning bolt, reflector positioning bracket, reflector stop and reflector hinge hard surfaces were examined for degradation after the 90 day test sequence. Some minor chipping was observed on the aluminum oxide coated surfaces and some metal transfer occurred between bolt heads and aluminum oxide surfaces. The mating surfaces appear to be in satisfactory condition after tests with no gross damage, which would compromise the mission objectives. Metal transfer will not occur in subsequent systems because Al_2O_3 is substituted for the LC-1A chromium carbide coating.

NAA-SR-MEMO-10161 CONF RD

TITLE: FINAL QUALIFICATION TEST REPORT, SNAP 10A REFLECTOR BEARINGS -
PART NUMBER 10FSMI-11039

AUTHOR: H. L. Powell 6-30-64

ABSTRACT: The purpose of the qualification tests is to demonstrate that the SNAP 10A reflector bearings can withstand the environments to which they will be exposed in flight and still operate properly.

NAA-SR-MEMO-10189 CONF DI

TITLE: THERMOELECTRIC PUMP DEGRADATION

AUTHOR: K. A. Davis 7-7-64

ABSTRACT: The pumping capacity of the SNAP 10A thermoelectric pumps decreases to approximately 80% of their initial rate within the first 2000 hr of operation and generally after this time the degradation is relatively slight. An experiment was conducted to evaluate the factors involved in the degradation. The experiment showed that the degradation is related to the deterioration in electrical and thermal paths and under normal operating conditions, the Seebeck coefficient does not decrease within the 2000-hr time interval.

NAA-SR-MEMO-10205 UNCL

TITLE: RADIATION-INDUCED SURFACE EFFECTS ON SNAP 10A STARTUP CONTROLLER TRANSISTORS

AUTHOR: M. N. Robinson 7-10-64

ABSTRACT: A gamma irradiation test for potential surface effects on SNAP 10A Startup Controller transistors is described. Measurements of collector leakage current under "use" bias conditions are presented and interpreted. Of the two models tested, the 2N744 transistors showed no discernible surface effects, as determined by this parameter, while the effect on the 2N1072 transistors was below the level which would adversely affect performance of the Controller.

NAA-SR-MEMO-10208 CONF RD

TITLE: SNAP 10A FS-4 CORE-FUEL ELEMENT DATA PACKAGES

AUTHOR: W. Sawicky 7-13-64

ABSTRACT: Certification, test and inspection results and copies of all waivers, for the forty fuel elements delivered for the SNAP 10A FS-4 Core are given herein. These fuel elements were selected, by the Compact Systems Division, on the basis of equal reactivity among the three cores, from the 128 fuel elements delivered for the FS-1, FS-3 and FS-4 Core loadings. The average N_H and permeation rate, as well as the total Uranium, U_{235} and Sm_2O_3 contents for this Core as reported herein, was based on the assignment of the 37 fuel elements made by the Compact Systems Division as of this report date. Any change in this assignment involving the surplus fuel elements for the Core may require recalculation of the above four Core characteristics.

NAA-SR-MEMO-10212 PART 1 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT - JUNE, 1964

AUTHOR: J. D. Whitlock

8-4-64

ABSTRACT: Ten fuel elements have received 6552 hr and three elements have received 240 hr of endurance testing at 1200°F. Six elements have received 1896 hr of endurance tests at 1300°F. The permeation rate of these elements are generally decreasing with time.

NAA-SR-MEMO-10212 PART 2 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TESTING - JUNE, 1964

AUTHOR: J. D. Whitlock

7-13-64

ABSTRACT: This report contains the data from the fuel element environmental test program. The nomenclature is given in Part 2 of NAA-SR-MEMO-9831.

NAA-SR-MEMO-10213 PART I CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, MAY-JUNE, 1964

AUTHOR: A. J. Fitzgerald

7-20-64

ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents a detailed listing of pertinent fuel element data - including acceptance (quality control) test results as well as qualification test results.

NAA-SR-MEMO-10213 PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, MAY-JUNE, 1964

AUTHOR: A. J. Fitzgerald

7-15-64

ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents IBM listings of all test data accumulated to date. The listings include pertinent element assembly data, acceptance test data, and all qualification test data. The qualification data will be updated periodically.

NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME IV COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - REFLECTOR ASSEMBLY AND RADIATION SHIELD

AUTHOR: J. Brunings

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume IV) is one.

Volume IV contains a description of the component development and qualification test status of the reactor reflector assembly and radiation shield.

Draft
NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME VI COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - CONTROL SYSTEM AND DIAGNOSTIC INSTRUMENTATION

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume VI) is one.

Volume VI contains a description of the component development and qualification test status of the control subsystem, including the drive motors, controller, reactor temperature control switches, squibs and pin pullers, relay boxes, heat-shield ejection temperature switches, high-temperature wires, low-temperature wires, and connectors; and the diagnostic instrumentation, including position switches, expansion-compensator position switches, drum position transducers and demodulators, converter voltage divider, converter current shunt, thermocouples, resistance temperature detectors and bridge, and the low-voltage trip device.

NAA-SR-MEMO-10234 CONF RD *Draft*

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME V COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - POWER CONVERSION AND HEAT TRANSFER SYSTEMS

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume V) is one.

Volume V contains a description of the component development and qualification test status of the power conversion system, including the power conversion subsystem; and the heat transfer subsystem, including the pump, expansion compensators, and piping.

NAA-SR-MEMO-10234 CONF RD *Draft*

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME I INTRODUCTION, SUMMARY, AND DEVELOPMENT AND QUALIFICATION PROGRAM

AUTHOR: J. Brunings 9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume I) is one.

Volume I contains an introduction and a summary of the component qualification status and test data, and a description of the development and qualification program. Included in the latter are descriptions of the component qualification program, and the FSEM-2, FSEM-3, FS-1, and FSM-4 test programs.

Diry #
NAA-SR-MEMO-10234 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS REPORT: VOLUME III COMPONENT DEVELOPMENT AND QUALIFICATION TEST STATUS - REACTOR FUEL

AUTHOR: Staff

9-21-64

ABSTRACT: The SNAP 10A Qualification Status Report, NAA-SR-MEMO-10234, comprises six volumes, of which this volume (Volume III) is one.

It contains a description of the component development and qualification test status of the reactor fuel.

NAA-SR-MEMO-10240 CONF RD

TITLE: SNAP 10A STARTUP CONTROLLER FINAL QUALIFICATION TEST REPORT

AUTHOR: D. A. Checketts and J. L. Nummelin

7-20-64

ABSTRACT: Three SNAP 10A startup controllers were tested through thermal cycle, shock, vibration, acceleration, radiation, radio frequency interference and endurance in accordance with Qualification Test Specification NA0403-018. The controllers completed thermal cycle, shock, vibration, acceleration, radiation and endurance tests with no failures. The controller did not meet all the requirements of the MIL-I-26600 Radio Frequency Interference Test for conducted interference at 150 kc and radiated interference at 150 - 200 kc and 100 mc. These deviations were accepted (TDT 7196) since compatibility problems in the system could be corrected by appropriate shielding, wire routing, or filtering. A noise susceptibility problem discovered during system testing was corrected by the addition of a 6.8 microfarad capacitor external to the controller. No other radio interference problems were encountered during system tests.

The controller has met the requirements of NA0403-018, except for the above approved deviations. As these deviations are not detrimental to system operation, the controller is considered to have successfully completed the component qualification program.

NAA-SR-MEMO-10246 CONF RD

TITLE: SUMMARY REPORT SNAPSHOT SAFETY

AUTHOR: Staff

8-15-64

ABSTRACT: This report presents a summary of the evaluation of potential hazards associated with the flight test of the SNAP 10A Nuclear Power Unit. The complete factory-to-flight sequence, acceptance test, transport, launch, orbit operation and reentry, is covered. Readers interested in a detailed analysis of any of the flight test program or in details of the calculational methods used in the safety evaluation, are referred to the bibliography at the end of this report.

NAA-SR-MEMO-10252 CONF RD

TITLE: INTERIM QUALIFICATION TEST REPORT - SNAP 10A CONTROL DRUM ACTUATOR

AUTHOR: T. E. Norris and W. E. Burns

7-24-64

ABSTRACT: Eight control drum actuators were received and subjected to acceptance vibration tests. No malfunction nor physical damage was detected during these tests.

Of the eight units received, two were subjected to qualification performance record tests and shipped directly to Battelle Memorial Institute for radiation tests.

Six units were subjected to initial performance record, thermal cycle, vibration, shock, and acceleration tests in accordance with NA0404-006, dated May 7, 1963. Two of the units were also subjected to radio frequency interference tests in accordance with applicable sections of MIL-I-26600 (2), Interference Control Requirements, Aeronautical Equipment, Amendment 2, Notice 1, dated June 1, 1962. The six units, which are reported on in this report, successfully completed their assigned test phases. The control drum actuator has met or exceeded the requirements of NA0404-006 through the above mentioned test phases.

NAA-SR-MEMO-10278 CONF DI

TITLE: SNAP 10A FSM-4 TEST STATUS

AUTHOR: J. Brunings and W. Vaughn

9-15-64

ABSTRACT: This report describes the FSM-4 system test program, schedule, and test objectives. An evaluation of the system test reliability is summarized based on component test data available as of June 1, 1964.

NAA-SR- 10284 UNCL

TITLE: LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRONIC COMPONENTS (BML-LF-2)

AUTHOR: M. N. Robinson, S. G. Kimble, N. F. Davies and D. M. Walker

4-20-65

ABSTRACT: The second of a series of irradiation experiments on electronic devices intended for SNAP reactor control systems is described.

Several diode and transistor types, sensitizers, capacitors, and an oscillator from a prototype SNAP 10A Startup Controller were irradiated to 3×10^{15} nvt (>0.1 Mev) and 5×10^8 r (gamma) at the Battelle Memorial Institute Research Reactor.

Results are presented of in-pile measurements of the critical electrical characteristics, in the form of graphs produced automatically by a computer peripheral plotting facility.

NAA-SR-MEMO-10299 CONF DI

TITLE: POST TEST EXAMINATION OF T/E PUMP 10-FSM-1

AUTHOR: E. L. Reed

10-1-64

ABSTRACT: Photographs are exhibited showing the condition of the stainless steel NaK tube after the accident. Photomicrographs are shown and described for each joint and for each component in the N and P type element stack-up. There was little damage to the pump components from the accident except that the P type elements may have been shattered more than usual. There did not appear to be as much contamination in the T/E elements from this pump as has been seen in pumps performance tested for longer periods of time. Some conclusions are drawn and recommendations are made for possibly improving the performance of the SNAP 10A T/E pumps.

NAA-SR-MEMO-10301 UNCL

TITLE: SNAP 10A FS-1 RELIABILITY EVALUATION

AUTHOR: S. Miner

8-14-64

ABSTRACT: Documentation of a verbal presentation on S10FS-1 reliability made to the AEC in May, 1964.

NAA-SR-MEMO-10367 CONF RD

TITLE: HIGH HUMIDITY, LOW TEMPERATURE REFLECTOR BEARING TEST, PART NUMBER 10FSM1-11039

AUTHOR: H. L. Powell

8-19-64

ABSTRACT: Three sets of SNAP 10A reflector bearings were tested in order to determine the effect of high vacuum and low temperature on the bearings after exposure to high humidity.

NAA-SR-MEMO-10382 CONF RD

TITLE: ACCELERATED OPERATION TESTS FOR SNAP 10A CONTROL DRUM ACTUATOR S/N 2830 AND 2831

AUTHOR: N. L. Ray and J. L. Nummelin

8-25-64

ABSTRACT: Two SNAP 10A control drum actuators, Serial Nos. 2830 and 2831, were subjected to separate series of accelerated operation tests. The tests simulated the operating and environmental conditions to which actuators are subjected in ground and pre-flight testing of reactor systems.

NAA-SR-MEMO-10391 UNCL

TITLE: EFFECT OF FOSTERSEAL RESIN ON SUPERTEMP CABLE SAMPLES

AUTHOR: W. G. Long

9-18-64

ABSTRACT: Cable samples with and without Fosterseal resin were tested at 10^{-5} torr at 900, 1100, and 1300°. The 1300°F tests were terminated after 200 hr due to the rapid decrease in insulation resistance. The 900° and 1100°F tests showed only a slight effect due to the addition of Fosterseal. These tests were continued for 1000 hr.

The most pronounced effect produced in this test was the decomposition of the Fosterseal during initial startup.

NAA-SR-MEMO-10446 UNCL

TITLE: SNAP-10A FSM-4 PERFORMANCE ANALYSIS - NaK LOADING AND THERMAL REFERENCE TEST

AUTHOR: G. E. Berg

9-15-64

ABSTRACT: Data taken during NaK loading and thermal reference testing of the SNAP-10A FSM-4 non-nuclear ground test system are presented and analyzed. For purposes of analysis the performance was divided into five categories:

- 1) System temperatures,
- 2) System heat losses,
- 3) Converter electrical performance,
- 4) Pump performance, and
- 5) Flight instrumentation performance.

In each category emphasis was placed on comparison of measured data to predicted performance and thermal reference performance of the 10FSM-1 and 10FS-1 systems. In almost every case both FSM-4 performance and agreement with predicted values were excellent. An average of 509 w was produced at a core outlet temperature of 1011°F. The only important problem was a low converter to ground resistance which would have caused a very small decrease in power output if the system had been grounded.

NAA-SR-MEMO-10476 CONF RD

TITLE: INTERIM SNAP 10A/2 REACTOR ISOTHERMAL FUEL TEMPERATURE COEFFICIENT

AUTHOR: E. M. Faelteon and L. D. Swenson

9-24-64

ABSTRACT: The total isothermal fuel temperature coefficient consisting of a fuel expansion coefficient and a spectral coefficient has been calculated for the SNAP 10A and Interim SNAP 10A/2 Reactors. The fuel expansion coefficient takes into account fuel density changes as a function of temperature while the spectral coefficient considers changes in the nuclear cross sections with temperature.

NAA-SR-MEMO-10502 PART I CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION STATUS REPORT, JULY-SEPTEMBER, 1964

AUTHOR: A. J. Fitzgerald

10-22-64

ABSTRACT: This report consists of two parts. Part I presents a summary and analysis of the test data. Part II presents a final listing of pertinent fuel element data - including results of acceptance (quality control) and qualification tests.

NAA-SR-MEMO-10502 PART II CONF RD

TITLE: SNAP 10A FUEL ELEMENT QUALIFICATION PROGRAM STATUS REPORT, JULY-AUGUST, 1964

AUTHOR: A. J. Fitzgerald

9-28-64

ABSTRACT: This report consists of two parts. Part I presents an updated summary and analysis of the test data. Part II presents IBM listings of all pertinent assembly acceptance testing and qualification testing data. All qualification tests were completed on August 18, 1964. Therefore, Part II is the final "data package" for the SNAP 10A fuel element qualification test program.

NAA-SR-MEMO-10517 CONF DI

TITLE: POST TEST EXAMINATION OF T/E PUMP FQ-3

AUTHOR: E. L. Reed

11-16-64

ABSTRACT: The P-element side of this pump was disconnected from the stainless steel throat section when it was received for examination. An examination was made of the surfaces where the joint failed and cross-sections of these areas were studied. Conclusions are reported for the nature of the braze failure.

Each side of the pump was mounted in Epoxy Casting Compound; then sections were cut, polished and examined under a microscope. The results of the metallographic examinations are reported and photomicrographs are exhibited of typical areas in each element stack-up. Knoop hardness measurements are reported for the phases observed at the interface of the copper to aluminum diffusion bonded joints.

Some conclusions are drawn based upon the observations. Also, some recommendations are made for possibly improving the performance of the SNAP 10A T/E Pumps.

NAA-SR-MEMO-10539 CONF RD

TITLE: SNAP 10A LOW N_H ELEMENTS FABRICATION PROCESS SHEETS AND AUXILIARY FORMS

AUTHOR: J. R. Armstrong

10-7-64

ABSTRACT: This report contains the Fabrication Process Sheets and Auxiliary Forms used during fabrication of the low N_H SNAP 10A elements. The Fabrication Process Sheets describe specific fabrication operations in detail, while the Auxiliary Forms indicate the type of information recorded as permanent fabrication data.

NAA-SR-MEMO-10541 CONF RD

TITLE: RESULTS OF THE QUALIFICATION IRRADIATION OF SNAP 10A LIMIT SWITCHES

AUTHOR: M. Warren

10-9-64

ABSTRACT: An irradiation experiment was performed in which two SNAP 10A limit switches were maintained at $705 \pm 15^\circ\text{F}$ for 1120 hr at a pressure of 7×10^{-6} to 1×10^{-5} Torr. The total fast neutron exposure of about 6.3×10^{18} nvt > 0.1 Mev was obtained at a rate of 2.2×10^{12} nv for 802.3 equivalent full power hours of reactor operation. The total gamma exposure was about 1.8×10^{10} R. The switches were mounted on an aluminum plate such that the plunger of one switch was permanently depressed. In-reactor measurements were made of the contact resistance between the closed pair of contacts and the insulation resistance between the open pair of contacts on each switch.

NAA-SR-MEMO-10542 CONF RD

TITLE: FAILURE ANALYSIS OF SNAP 10A FS-1 FUEL ELEMENT NO. E-0343

AUTHOR: W. Sawicky

10-8-64

ABSTRACT: Determine the cause of the excessive hydrogen leak rate from Fuel Element No. E-0343, as the result of the FS-1 System test.

NAA-SR-MEMO-10572 CONF RD

TITLE: SNAPTRAN 10A/2 -1 DRUM CALIBRATION TESTS

AUTHOR: R. P. Johnson

10-14-64

ABSTRACT: Perform detailed drum calibration measurements on the SNAPTRAN 10A/2 -1 reactor to determine the individual stepper and impulse drum worths and to determine the excess and shutdown reactivity values for the machine.

NAA-SR- 10578 CONF RD

TITLE: DEVELOPMENTAL TESTS SNAP 10A FUEL ELEMENTS FINAL REPORT

AUTHOR: T. G. Parker, Jr.

3-5-65

ABSTRACT: Tests were performed on eighteen SNAP 10A fuel elements, to establish the effects of mechanical and thermal environments. Response of the fuel elements to test inputs are evaluated, based on changes in hydrogen loss rates. Data from performance tests and destructive analyses of the fuel elements are presented and discussed.

An analysis of fuel element life under reactor conditions is presented. Performance characteristics of the test elements are translated to a flight reactor core, to show the effect on predicted reactor life.

NAA-SR-MEMO-10580 CONF RD

TITLE: A STUDY OF NEUTRON POISON EFFECTIVENESS IN A WATER-FLOODED SNAP 10A CORE DUE TO NEUTRON SPECTRAL CHANGES

AUTHOR: R. H. Norman and D. G. Oliver

10-19-64

ABSTRACT: This report presents the reactivity effects of several possible poison loadings that will insure subcriticality in the bare SNAP 10A core in a water environment.

NAA-SR-MEMO-10597 CONF RD

TITLE: TEST REPORT - QUALIFICATION SNAP 10A NE10FS1-24-009 ELECTRONIC TEMPERATURE SWITCHES S/N 1011, 1012, 1014, 1015

AUTHOR: N. L. Ray

10-22-64

ABSTRACT: Qualification tests on the SNAP 10A Electronic Temperature Switch in accordance with Test Specification NA0403-029, and the results.

NAA-SR-MEMO-10605 UNCL

TITLE: SNAPSHOT NUCLEAR POWER FOR SPACE

AUTHOR: W. F. Heine

11-25-64

ABSTRACT: The objectives of the SNAPSHOT program are to demonstrate the utility of nuclear reactor power systems for space application, and to obtain technical information for utilization and further development of these systems. Light weight, reliable sources of electrical power such as these are a major requirement for the expansion of space exploration.

NAA-SR-MEMO-10610 CONF RD

TITLE: SNAP 10A QUALIFICATION STATUS PROGRESS REPORT - JULY 1, 1964-
AUGUST 15, 1964

AUTHOR: J. Brunings

12-15-64

ABSTRACT: This report describes the component qualification progress made in the SNAP 10A program between July 1, 1964, and August 15, 1964, and summarizes the qualification status of all major components in the system. A summary of component qualification test data and qualification status as of July 1, 1964, is presented in NAA-SR-MEMO-10234, "SNAP 10A Qualification Status Report," dated September 21, 1964.

NAA-SR-MEMO-10670 CONF RD

TITLE: FUEL LOADING-DRY CRITICAL TESTS, SNAP 10A FS-4

AUTHOR: W. N. Louie

12-18-64

ABSTRACT: Fuel loading of the S10 FS-4 SNAP unit was initiated on October 21, 1964, in accordance with the loading specification, NA0222-026. There were no major deviations from the loading sequence presented in the specification, and the procedure was followed without any changes to load the full complement of 37 elements.

NAA-SR-MEMO-10673 CONF RD

TITLE: THERMAL REFERENCE TEST, SNAP 10A FS-4

AUTHOR: W. C. Christensen

2-2-65

ABSTRACT: The SNAP 10A, FS-4 flight system was tested following the listed specifications, in accordance with the Flight System Configuration and Acceptance Test Requirement specifications.

NAA-SR-MEMO-10716 UNCL

TITLE: SNAP INSTRUMENT COMPONENT TEST LABORATORY BUILDING 066

AUTHOR: J. F. Rumer

11-13-64

ABSTRACT: The SNAP 10A Instrument Component Test Laboratory is capable of accepting complete responsibility for component qualification testing. Services which can be performed are: preparation of test specifications, performance of environmental testing and measurement of component electrical characteristics, preparation of test reports, analysis of failure or degradation data and recommendation of changes in component construction which will provide greater reliability. Environmental simulation equipment available in the facility is primarily of the thermal-vacuum type. When mechanical environments, i. e., vibration, shock, acceleration are required as part of a component test program these tests are sub-contracted. The Qualification and Test Unit, however, maintains responsibility for test control, data collecting and reporting of test results.

NAA-SR-MEMO-10717 OUO

TITLE: IRRADIATION QUALIFICATION OF SNAP 10A CONTROL DRUM DRIVE ACTUATORS AND POSITION SENSORS

AUTHOR: M. Warren

12-2-64

ABSTRACT: Two SNAP 10A control drum drive actuators and two control drum position sensors were irradiated to total doses from 1.0 to 5.0×10^{18} nvt > 0.1 Mev and from 1.8 to 5.5×10^9 R during a simulated flight operation. The nominal operating temperatures were 700°F for the actuators and 500°F for the position sensors. The environmental pressure ranged from 5×10^{-5} torr to 5×10^{-6} torr, decreasing as the experiment continued. The test components were maintained at the operating temperatures for 2600 hr and received 2183.3 equivalent full power hours, (EFPH), of radiation during the 16 week experiment and was equivalent to a 90 day SNAP reactor operation.

NAA-SR-MEMO-10718 UNCL

TITLE: DETERMINATION OF PROBABILITY OF EJECTION OF REFLECTORS DURING ORBITAL FLIGHT TESTING OF THE SNAP 10A NUCLEAR POWER UNIT

AUTHOR: R. M. Ohlenkamp

2-15-65

ABSTRACT: This report presents a method for the solution of the problem of ascertaining the probability of SNAP 10A reflector ejection and hence, reactor shutdown, after an orbital startup. Conservative solutions are given in tabular and graphical form over the continuous period from launch to 100 years.

NAA-SR- 10735 UNCL

TITLE: SNAP 10A FLIGHT SYSTEM PROTOTYPE (FSM-1) PERFORMANCE

AUTHOR: L. L. Bixson

5-15-65

ABSTRACT: A summary and evaluation of the thermal tests performed on the SNAP 10A, FSM-1 thermoelectric power conversion system is presented. The unit was a developmental, nonnuclear, full-scale version of the nuclear-powered flight system. The overall results of the tests verified the validity of the flight system design. Reactor heat was developed by an electrical core heater. Liquid metal coolant pumped through the reactor core by a thermoelectrically-driven, electromagnetic pump was maintained at an average temperature of over 920°F for more than 90 days. During this period a total of 831 kwh of energy was generated by the thermoelectric converter at an average power level of 400 w. The test was performed in a vacuum environment to simulate the heat transfer characteristics encountered in space. Additional tests simulated conditions and the sequence of events from ground launch to nuclear startup in earth orbit.

NAA-SR-MEMO-10740 CONF RD

TITLE: TEST REPORT, FINAL QUALIFICATION SNAP 10A LIMIT SWITCH

AUTHOR: W. E. Burns and J. N. Nummelin

11-20-64

ABSTRACT: Seventeen limit switches were utilized in the qualification test program. Nine of the switches completed their assigned tests. Six of the switches were destroyed due to a test equipment malfunction. The remaining two switches were cracked during the initial performance record test and were not used further in the qualification test program.

NAA-SR-MEMO-10756 OUO

TITLE: QUALIFICATION IRRADIATION OF SNAP 10A ELECTRICALLY ACTUATED BAND RELEASE DEVICES

AUTHOR: M. Warren and P. D. MacEwan

11-30-64

ABSTRACT: Two electrically actuated band release devices (EABRDs) were irradiated at an average temperature of 650°F for 924 hr at an average pressure of about 1×10^{-5} torr. The total dose of about 9.7×10^{18} nvt > 0.1 Mev was obtained at a dose rate of about 3.3×10^{12} nv for 819.9 equivalent full power hours of reactor operation. One EABRD was fired during irradiation and required 812 w-sec for separation to occur. Post-irradiation examination of the remaining EABRD showed that no significant creep occurred.

NAA-SR-MEMO-10750 CONF RD

TITLE: FINAL COMPONENT QUALIFICATION TEST REPORT - SNAP 10A CONTROL DRUM ACTUATOR SERIAL NOS. 2820 AND 2822 THROUGH 2828

AUTHOR: W. E. Burns

11-24-64

ABSTRACT: Eight Control Drum Actuators, Serial Nos. 2820 and 2822 through 2828, were tested in accordance with Qualification Test Specification NA0404-006. Two Actuators, Serial Nos. 2822 and 2823, successfully completed a 96-day dose rate radiation test with no malfunctions or failures. Serial Nos. 2820 and 2824 through 2828 completed thermal cycle, shock, vibration, and acceleration tests without failure. Serial Nos. 2827 and 2828 completed RFI tests in accordance with applicable sections of MIL-I-26600(2). Actuator Serial Nos. 2820, 2824, 2826, 2827 and 2828 successfully completed the 90-day thermal vacuum endurance test with no malfunctions or failures. Serial No. 2825 experienced a brake coil malfunction after 213 hr of endurance testing. The malfunction was attributed to a manufacturing error in the brake coil. This unit was replaced in the qualification program with Actuator Serial No. 2820.

The control drum actuators are considered to have met the requirements of NA0404-006.

NAA-SR-MEMO-12023

NAA-SR-MEMO-10759 CONF RD

TITLE: SNAP 10A REACTOR HYDROGEN REDISTRIBUTION

AUTHOR: N. K. Simon

12-1-64

ABSTRACT: SCA-4A critical assembly hydrogen worth data is combined with results of HYTRAN-II hydrogen distribution calculations to determine the equilibrium hydrogen redistribution in SNAP 10A reactors. Experimental worth values are compared with a previously assumed flux-squared worth curve. HYTRAN-II runs were made for each core position at minimum, nominal, and maximum values of redistribution parameters to illustrate the major part of the uncertainty in redistribution worth.

NAA-SR-MEMO-10766 CONF RD

TITLE: COMPRESSIVE CREEP OF CAST LITHIUM HYDRIDE

AUTHOR: E. C. Phillips

12-2-64

ABSTRACT: Presents the compressive creep properties of cast lithium hydride under loads up to 150 psi and temperatures up to 1100°F.

NAA-SR-MEMO-10767 UNCL

TITLE: TEST CONTROL DEVICES - SNAP 10A VIBRATION TEST PROGRAM

AUTHOR: R. M. Oliva and E. L. Gardner

12-10-64

ABSTRACT: The solutions to various test control problems are recorded in this paper which discusses the input, response, and safety control devices employed during vibration testing on past and current SNAP 10A vehicles. Each device's description, function, and operation are discussed in detail.

This paper was prepared for presentation at the 34th Symposium on Shock, Vibration, and Associated Environments which was held in Pacific Grove, California on October 13-15, 1964.

NAA-SR-MEMO-10774 UNCL

TITLE: THE EXTERNAL RADIATION FIELD HAZARD FROM FALLOUT OF ABLATION PARTICLES FROM SNAP REACTORS

AUTHOR: C. A. Willis

2-15-65

ABSTRACT: The fallout radiation field hazard from reentry burnup of a SNAP reactor is investigated. Since the dose from fallout would be received over an extended period, the overexposure criterion is based on the equivalent residual dose. Maximum fallout concentrations are calculated for both polar and equatorial orbits, and it is shown that these concentrations are not sufficient to produce overexposures. Therefore, it is concluded that reentry burnup of a SNAP 10A reactor would eliminate other radiological hazards without introducing a fallout radiation field hazard.

NAA-SR-MEMO-10794 UNCL

TITLE: DENSITY DETERMINATION OF CAST LITHIUM HYDRIDE, AND CAST LITHIUM HYDRIDE-TUNGSTEN ALLOY OR ZIRCONIUM HYDRIDE AGGREGATES

AUTHOR: F. H. Welch 12-14-64

ABSTRACT: The densities of cast lithium hydride, and cast lithium hydride-tungsten alloy, and cast lithium hydride-zirconium hydride aggregates were determined to be 0.780 ± 0.001 g/ml, 9.30 ± 0.21 g/ml, and 3.77 ± 0.17 g/ml, respectively, using the hydrostatic weighing technique with normal octane substituted for water.

NAA-SR-MEMO-10815 CONF RD

TITLE: ADDENDUM TO SNAP 10A FS-1, FS-3 AND FS-4 FUEL DATA PACKAGES FOR FS-3, FS-4 AND FS-5 SYSTEMS

AUTHOR: W. Sawicky 12-29-64

ABSTRACT: Subsequent to the production of the fuel and issuance of data packages for the FS-1, FS-3 and FS-4 System fuel elements, certain changes occurred that required some additional fuel elements, retesting of some existing fuel elements, and reassignment of the elements to the FS-3, FS-4 and FS-5 Systems. This report is an addendum to the original FS-1, FS-3 and FS-4 fuel element data reports which up-dates the data where retesting was performed, and gives test and inspection results for the additional fuel elements fabricated. The additional fuel was the Low N_H - High Sm₂O₃ elements.

The original data report numbers are NAA-SR-MEMO-9926 (FS-1 fuel), NAA-SR-MEMO-10033 (FS-3 fuel), and NAA-SR-MEMO-10208 (FS-4 fuel).

NAA-SR-MEMO-10818 CONF RD

TITLE: PERFORMANCE CAPABILITIES OF SNAP 10A/2-SNAP10B REACTORS UNDER STATIC CONTROL

AUTHOR: D. J. McGoff and K. R. Birney 12-14-64

ABSTRACT: An analysis of the Temperature-Power-Lifetime capabilities of the SNAP 10A, SNAP 10B Basic, and two versions of the Advanced SNAP 10B Reactors was performed. Reactivity, heat transfer, material, and temperature-drift-uncertainty limitations were considered.

NAA-SR-10856 UNCL

TITLE: COMPARISON OF NEUTRON AND GAMMA RADIATION DAMAGE IN SEMI-CONDUCTORS

AUTHOR: M. N. Robinson 6-15-65

ABSTRACT: Calculations are presented which relate the damages produced in silicon semiconductors by SNAP (Systems for Nuclear Auxiliary Power) reactor neutrons and gammas. Design dose levels are derived for SNAP payload components, consistent both with this relation and with the necessity of minimizing shield weight.

NAA-SR-10858 CONF RD

TITLE: QUALIFICATION TESTING SNAP 10A FUEL ELEMENTS - FINAL REPORT

AUTHOR: A. J. Fitzgerald

3-15-65

ABSTRACT: An experimental program was performed to demonstrate the reliability of SNAP 10A fuel elements to withstand simulated reactor conditions. This final report summarizes the test data, which show that no significant damage was caused by the prescribed thermal and mechanical tests. Based on the data, the demonstrated reliability, at the 50% confidence level, is 0.6780 for a core load of 37 elements. The reliability is increased to 0.7484, again at the 50% confidence level, when the data from the fuel element environmental test program are included in the reliability analysis. These values are the reliability demonstrated for the fuel elements to withstand thermal cycle, vibration and shock, ramp heating, and one year of thermal endurance.

Based on the test data of the qualification elements, reactor grade elements are expected to lose less than 0.02% hydrogen during one year of reactor operation. This is well below the allowable 0.05% hydrogen loss.

NAA-SR-MEMO-10909 CONF RD

TITLE: TEST PROCEDURE 10FS3-050 "WET CRITICAL AND NUCLEAR ACCEPTANCE TEST"

AUTHOR: D. S. Brinkman

10-12-65

ABSTRACT: Results of Test Procedure 10FS3-050 "Wet Critical and Nuclear Acceptance Test."

NAA-SR-MEMO-10913 UNCL

TITLE: HISTORY ANALYSIS PROGRAM FOR FSM-4, FS-3, AND FLAP-4

AUTHOR: R. J. Mikell and G. T. Chang

9-1-65

ABSTRACT: This History Analysis Program is a data handling, display and analysis program. This program is made up of several subroutines which may be optioned singly or in combinations to examine data generated by the following SNAP data reduction and analysis programs for FSM-4, FS-3, and FLAP-4. The data used by the History Analysis Program is an accumulation of runs from daily acquisitions of the above three SNAP systems. The available options may be found in the Purpose sections. Other options may be added.

NAA-SR-MEMO-10926 CONF RD

TITLE: PERFORMANCE CAPABILITIES OF THE SNAP 10A/2 REACTOR UNDER ACTIVE CONTROL

AUTHOR: D. J. McGoff and K. R. Birney

1-18-65

ABSTRACT: An analysis of the Temperature-Power-Lifetime capabilities of the SNAP 10A/2 reactor core under active control was performed. Reactivity, heat transfer, and material limitations were considered.

NAA-SR-MEMO-10952 CONF DI

TITLE: POST TEST EXAMINATION OF SNAP 10A T/E PUMP 010

AUTHOR: E. L. Reed

3-11-65

ABSTRACT: T/E Pump 010 was performance tested at 1010° liquid NaK temperature for a total of 10,200 hr including pre-checkout runs. The throat section was brazed to bond the elements to the copper straps. It was desired to examine the joints and other components in this pump to determine the effect of these fabrication changes.

NAA-SR-10997 UNCI

TITLE: DEVELOPMENT, ACCEPTANCE AND QUALIFICATION TESTING OF THE SNAP 10A EJECTABLE HEAT SHIELD

AUTHOR: H. L. Sperow

8-31-65

ABSTRACT: The development, acceptance, and qualification tests performed on the SNAP 10A Ejectable Heat Shield and components, the results of those tests, and the conclusions drawn from the results are presented in this report.

The final conclusions made of the completion of the Qualification Program, December 23, 1964, were as follows:

- 1) The heat shield will maintain the heat exchange fluid within the prescribed limits of 50 to 250°F, thus preventing plugging of the NaK lines during the orbital period before startup of the nuclear reactor.
- 2) The heat shield will perform satisfactorily provided the outside shield temperatures do not exceed 375°F. The shield will eject from the nuclear power unit when the temperature of the heat exchange fluid at the reactor outlet approaches 275 ± 25°F, and will clear all vehicle components.

NAA-SR-MEMO-11056 CONF RD

TITLE: SNAP 10A QUALIFICATION FUEL ELEMENTS - DATA PACKAGE

AUTHOR: A. J. Fitzgerald

2-24-65

ABSTRACT: This data package contains all pertinent information (permeation test forms, graphs, microphotographs, etc.) used in the preparation of NAA-SR-9496, "Qualification Testing SNAP 10A Fuel Elements (Interim Report)" and NAA-SR-10858, "Qualification Testing SNAP 10A Fuel Elements (Final Report)".

NAA-SR-MEMO-11057 CONF RD

TITLE: FUEL LOADING - DRY CRITICAL TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

3-25-65

ABSTRACT: Describes the following activities: Load the SNAP 10A FS-5 reactor with a full complement of fuel elements, perform drum calibrations and determine excess reactivity in accordance with specification NA0222-36.

NAA-SR-MEMO-11058 CONF RD

TITLE: WET CRITICAL AND THERMAL REFERENCE TESTS, SNAP 10A FS-5

AUTHOR: R. E. Bedford

10-12-65

ABSTRACT: Data taken during Wet Critical and Thermal Reference Testing of the SNAP 10A FS-5 flight system are presented. In addition, the results of both hot and cold control drum calibrations are included. Where appropriate, a comparison of the measured data with the performance of the 10FSM-4 and 10FS-4 systems is presented. The performance of FS-5 system and agreement with system requirements was, in most instances, excellent. When corrected to normal converter connections, the power output was 512 w at a reactor outlet temperature of 1025°F. Nuclear performance was as expected. The major deviation from system requirements was a low NaK flow of 12.9 gpm instead of the required 13.0 gpm.

NAA-SR-11103 UNCL

TITLE: DISINTEGRATION AND DISPERSION OF THE SNAP 10A REACTOR UPON RETURN FROM SATELLITE ORBIT

AUTHOR: R. D. Elliott

9-1-65

ABSTRACT: A study of the disintegration and dispersion of the SNAP (Systems for Nuclear Auxiliary Power) 10A reactor upon atmospheric reentry from a satellite orbit is described. The flight configuration is that of the SNAP 10A reactor containing NaK coolant and mated to the forward end of the Agena-D vehicle. It is shown that the SNAP 10A/Agena system will be oscillating in an approximately nose-first attitude at the time of reentry. It is concluded that the reactor components will have disintegrated and dispersed at an altitude of not less than 237,000 ft.

NAA-SR-11129 UNCL

TITLE: SNAP 10A FSEM-3 AGENA COMPATIBILITY TEST

AUTHOR: M. Teresa

6-15-65

ABSTRACT: This report summarizes the results of SNAP 10A/Agena developmental testing and final vehicle systems tests. Developmental testing was performed with the SNAP 10A FSEM-3 payload electrical simulator and an Agena Functional Mockup. FSEM-3 was utilized during vehicle systems testing prior to shipment of the Agena to the launch site.

NAA-SR-MEMO-11139 CONF RD

TITLE: SNAP 10A CONTROL DRUM POSITION SENSOR DEMODULATOR NE10FS1-24-010 FINAL COMPONENT QUALIFICATION TEST REPORT, SERIAL NOS. 06, 18, 25, 26 AND 29

AUTHOR: Barry J. Blau

3-9-65

ABSTRACT: Five SNAP 10A control drum position sensor demodulators were tested to the requirements of Qualification Test Specification NA0403-023. Although the demodulators did not perform in complete accordance with the specification, qualification testing revealed that the component, although having certain limitations, can perform its originally intended diagnostic function.

NAA-SR-MEMO-11148 UNCL

TITLE: AN ANALYSIS OF THE WORLD POPULATION DENSITY DISTRIBUTION

AUTHOR: G. P. Kenfield and R. M. McAdams

7-16-65

ABSTRACT: An analysis is made of the world's population density distribution to evaluate the potential hazard to the population as a result of the random reentry of a SNAP reactor. A two-part literature survey provided the necessary information presented in the report.

NAA-SR-MEMO-11149 UNCL

TITLE: PROPERTIES OF CLADDING MATERIALS FOR SNAP HYDRIDE REACTORS

AUTHOR: G. F. Burdi

3-22-65

ABSTRACT: This report has been published to increase the usability of previously collected and classified information by distributing this compiled information in an unclassified report. This report contains currently available property data on potential cladding materials for SNAP hydride reactors and was compiled under the direction of the Atomics International SNAP General Supporting Technology Program.

NAA-SR-MEMO-11173 CONF RD

TITLE: EVALUATION OF A CAST LITHIUM HYDRIDE SHIELD BACKFILLED WITH LITHIUM METAL

AUTHOR: J. A. Cuealy

3-16-65

ABSTRACT: Preparation, testing, and evaluation of a cast lithium hydride shield containing lithium metal in the voids between the shield vessel and lithium hydride as well as within the cracks and voids inside.

NAA-SR-MEMO-12023

NAA-SR-11205 CONF RD

TITLE: SNAP 10A THERMOELECTRIC MODULE POST-MORTEM EXAMINATIONS AND MATERIAL BOND CHARACTERISTICS

AUTHOR: R. M. Willard

12-15-65

ABSTRACT: SNAP 10A 500-w thermoelectric qualification test modules were examined destructively after testing. This report discusses the results of the destructive examination and characterizes the behavior of critical material bonds during testing. In particular, the report describes the effects of prolonged operation (10,000 hr) at temperatures (970 to 1030°F) on the behavior of such materials as: SiGe thermoelectric alloy, copper-aluminum diffusion bonds, nickel-tungsten-gold diffusion bonds, and molybdenum-alumina brazed bonds. The electron microprobe was used to characterize the performance of the materials.

NAA-SR-11206 CONF RD

TITLE: PRELIMINARY TEST RESULTS - SNAP 10A FS-3

AUTHOR: S. Miner, L. Bixon and D. Brinkman

9-1-65

ABSTRACT: The S10FS-3 was the first SNAP 10A flight system to undergo the complete SNAP 10A test program. Following successful completion of shock and vibration testing, the system was loaded with fuel and NaK. The system was then thermal and nuclear acceptance tested and brought up to full-power operation at design conditions. This report covers the acceptance testing and the first 90 days of power operation tests which have been successfully completed at design conditions in a simulated space environment.

NAA-SR-11207 UNCL

TITLE: MAGNETIC MOMENTS AND VEHICLE TORQUES IN THE SNAP 10A

AUTHOR: T. J. Boyle and R. M. Galantine

10-1-65

ABSTRACT: Small magnetic dipole moments arise in the SNAP 10A nuclear electric power system due principally to the permanent magnet in the electromagnetic pump and current flowing in the thermoelectric converter. The dipole moments interact with the earth's magnetic field to produce torques on the orbiting vehicle. This report describes the nature of these torques, discusses the procedures which have been used to evaluate them, and discusses methods for reducing them.

NAA-SR-MEMO-11225 CONF DI

TITLE: POST TEST EXAMINATION OF P-ELEMENTS IN T/E PUMPS DEV-4 AND DEV-5

AUTHOR: E. L. Reed

4-5-65

ABSTRACT: Photomicrographs of the cold side of the P-elements from T/E Pumps DEV-4 and DEV-5 are exhibited and discussed. The results were not conclusive; but there appeared to be significantly less contamination in the tin-free lead telluride materials from these pumps, than has been observed in the lead tin telluride type of P-elements after comparable periods of performance testing.

NAA-SR-MEMO-11240 UNCL

TITLE: S10A FSM-1 SYSTEM TEST DATA LIBRARY, VOLUMES I, II, III, AND IV

AUTHOR: W. F. Marten

3-18-65

ABSTRACT: The following list summarizes the S10A FSM-1 data and associated documents which are on file in volume form in a system test data library being maintained in Building 037, Santa Susana, by D/722-251.

- 1) Assembly records - complete history of assembly phase including identification of components, inspection coverage and system checkout.
- 2) Shock and Vibration Test Records - complete history of shock and vibration testing including all mechanical and electrical check sheets, performance evaluation and test discrepancies.
- 3) Thermal Test Records - includes all test specifications, test reports, operating discrepancies and periodically conducted check sheets.
- 4) Thermal Test Data Collected - includes all original data logger sheets and original system performance curves generated during the thermal testing from August 23, 1963 to January 17, 1964.

NAA-SR-MEMO-11242 CONF DI

TITLE: INTERIM REPORT ON ADVANCED SNAP 10A MODULE PERFORMANCE

AUTHOR: A. B. Sorkin and J. F. Koch

4-6-65

ABSTRACT: The performance data and analysis of the high temperature modules at an approximate hot junction temperature of 1300°F has been presented. Examination of stacks before and after steady state and thermal cycling tests have shown that problem areas exist in these modules when tested at 1300°F.

NAA-SR-MEMO-11306 CONF RD

TITLE: CONTROL DRUM CALIBRATION

AUTHOR: T. L. Langell and H. D. May

3-24-65

ABSTRACT: The reactivity worth at any angular position was near predicted control drum worth curve in the qualification test specification (NR 7561-23). Test results therefore meet the requirements established by the specification. Control drum position indicator calibration curves were plotted showing Datex Precision Position indicator readings vs. flight position sensor outputs.

NAA-SR-MEMO-11331 CONF RD

TITLE: SNAP 10A FUEL ELEMENT ENVIRONMENTAL TEST STATUS REPORT, JANUARY - MARCH, 1965

AUTHOR: J. L. Isaacs 4-29-65

ABSTRACT: None of the 120 fuel elements being tested in this program had a hydrogen loss (permeation) rate which exceeded the specified failure limit of 2.0 cc (STP)/hr at 1200 F. All elements have now completed pre-endurance testing and at least 2300 hr of the scheduled 1 yr of endurance. In addition, ten elements have completed 1 yr of endurance.

NAA-SR-MEMO-11331 CONF RD *D.H.W.*

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT, JANUARY - MARCH, 1965

AUTHOR: J. L. Isaacs 4-29-65

ABSTRACT: This report contains the data from the fuel element environmental test program.

NAA-SR-11400 CONF RD

TITLE: FUSAk - A COMPUTING CODE FOR THEORETICAL EVALUATION OF SNAP 8 AND SNAP 10A FUEL ELEMENT PERFORMANCE DURING REACTOR OPERATION

AUTHOR: M. E. Nathan 11-1-65

ABSTRACT: The FUSAk computing code, developed for rigorous analysis of performance of SNAP 8 and SNAPA fuel elements under any mode of reactor operating conditions, is described. A FUSAk computation for a particular fuel element of a SNAP reactor core evaluates hydrogen redistribution equilibrium dissociation pressure and hydrogen permeation for selected time steps.

NAA-SR-MEMO-11422 CONF RD

TITLE: EFFECTIVE THERMAL CONDUCTIVITY OF A LITHIUM HYDRIDE SHIELD BACK-FILLED WITH LITHIUM METAL

AUTHOR: P. H. Horton 6-3-65

ABSTRACT: An effective value for the bulk thermal conductivity of a cast lithium hydride shield backfilled with lithium metal was determined to be 3.65 ± 0.35 BTU/hr ft $^{\circ}$ F in both the heat up and cool down tests in the temperature range of 700 to 900 $^{\circ}$ F. The thermal conductivity of the same shield, prior to the lithium metal backfill, was determined to be 2.9 BTU/hr ft $^{\circ}$ F for the same temperature range. A 26% increase in thermal conductivity was achieved by the lithium backfill of the shield.

NAA-SR-MEMO-11459 CONF RD

TITLE: SNAP 10A ENVIRONMENTAL TEST STATUS REPORT APRIL-JUNE, 1965

AUTHOR: J. L. Isaacs 6-24-65

ABSTRACT: This report contains the data from the fuel element environmental test program.

NAA-SR-MEMO-11462 UNCL

TITLE: SNAPSHOT BRIEFINGS GIVEN AT VANDENBERG AIR FORCE BASE PRIOR TO LAUNCH

AUTHOR: W. F. Heine

6-30-65

ABSTRACT: On April 3, 1965, SNAP 10A, the first nuclear reactor in history to be put into space orbit, was successfully launched at Vandenberg Air Force Base. A few hours later it achieved full criticality in orbit, and operated for 43 days. The SNAP 10A system was developed for the Atomic Energy Commission by Atomics International, a Division of North American Aviation, Inc.

During the several weeks preparatory to the launch, AI gave briefings to Air Force and civilian contractor personnel at the base, and to local public officials. Each section of this report was one of the briefings given, some of them several different times, except for the last section. The last section was a statement of a procedure prepared as guidance for base personnel, but was not given as an oral briefing.

NAA-SR-MEMO-11515 CONF RD

TITLE: A MOLD RELEASE FOR CASTING LITHIUM HYDRIDE

AUTHOR: E. C. Phillips

7-30-65

ABSTRACT: Describes a mold release for use in casting lithium hydride. The mold release allows easy separation of the cast lithium hydride from the mold without damage.

NAA-SR-11547 CONF RD

TITLE: ENVIRONMENTAL TESTING SNAP 10A FUEL ELEMENTS

AUTHOR: J. L. Isaacs

12-25-65

ABSTRACT: The hydrogen barrier in fuel elements for SNAP 10A reactors has shown good hydrogen retention properties at temperatures over 300°F higher than the maximum design fuel temperature of the reactor (1085°F). In fact, a temperature excursion to 1475°F did not severely damage the hydrogen barrier of any of the 24 fuel elements involved. Thus, the fuel elements have demonstrated a large margin of safety for operation in a SNAP 10A reactor.

NAA-SR-MEMO-11563 CONF DI

TITLE: HIGH TEMPERATURE THERMOELECTRIC PROGRAM DEVELOPMENT STATUS

AUTHOR: J. Walter and R. F. Wilson

8-12-65

ABSTRACT: Principal achievements of 1300°F module development efforts in FY 1965.

NAA-SR-MEMO-11635 UNCL

TITLE: SNAPSHOT FAILURE ANALYSIS REPORT - JOINT LMSC/AI FINAL FAILURE REPORT

AUTHOR: J. F. Pohlman, General Editor

9-30-65

ABSTRACT: This report presents the combined efforts of the SNAPSHOT Program staffs of the Lockheed Missiles & Space Company and the Atomics International Division of North American Aviation, Inc., to determine the cause of shutdown of the SNAP 10A/Agena spacecraft after 43 days of singularly successful orbital operation. A brief history of the operating characteristics of the spacecraft up to the time of failure is included to provide a background helpful to a fuller understanding of the failure analysis.

NAA-SR-11642 UNCL

TITLE: THE PREDICTED FISSION PRODUCT DECAY OF SNAPSHOT I

AUTHOR: W. B. Sayer and R. S. Hart

1-15-66

ABSTRACT: SNAPSHOT-I was the first flight test of a direct power conversion system utilizing a nuclear reactor as the heat source. This report shows the calculated fission product inventory formed during the orbital operation of the SNAP 10A reactor and the predicted decay of this activity and the associated gamma radiation levels. A brief system description and summary of the operational phase is included.

NAA-SR-11761 UNCL

TITLE: RADIOLOGICAL ASPECTS OF REENTRY BURNUP OF SNAP REACTORS

AUTHOR: C. A. Willis

3-25-66

ABSTRACT: Reentry burnup of SNAP reactors may produce low levels of worldwide fallout. The International Commission on Radiological Protection has recommended a population dose limit of 2 rem in 30 yr. The factors affecting the choice of a population dose criterion are reviewed in this report. These factors include radiological safety history and tradition, radiobiological knowledge, other radiation criteria, and the biological significance of criteria doses. No safety justification is found for reduction of the ICRP limit. This 2-rem in 30-yr dose is well within the range of variation of natural background radiation. Population safety requirements are satisfied if the dose is less than the ICRP criterion. Many possible sources of artificial, nonmedical radiation could contribute to the population dose. For planning purposes, it is recommended that one-eighth the population dose, 0.25 rem/30 yr, be taken as the allowable dose from SNAP reactor applications.

NAA-SR-11762 UNCL

TITLE: DEVELOPMENT OF A SOLID STATE NEUTRON DETECTOR FOR SNAP 10A

AUTHOR: A. Chesavage

3-25-66

ABSTRACT: Electronic devices, primarily semiconductors, degrade in a nuclear radiation environment. In a reactor environment most of the damage is due to fast neutrons. The lithium hydride shield on SNAP 10A was designed to attenuate the fast neutron exposure at the instrument compartment to a tolerable level. To evaluate shield effectiveness fast neutron detectors were developed. Eight detectors were installed in the SNAP 10A FS-4 flight system. This report discusses the development and in-flight data of these detectors.

III. SNAP 10A PAPERS

SNAP 10A PAPERS

TITLE: SPACE NUCLEAR POWER CONVERSION SYSTEM
AUTHOR: C. E. Johnson, M. G. Coombs and R. L. Hirsch (AI)
PRESENTED: NAE-CON-IRE, May 2, 1959

TITLE: ATOMS IN SPACE
AUTHOR: Staff
PRESENTED: Nucleonics, July 1960

TITLE: THE PRACTICAL APPLICATION OF SPACE NUCLEAR POWER IN THE 1960's
AUTHOR: J. R. Wetch, H. M. Dieckamp (AI) and Lt. Col. G. M. Anderson (USAF)
PRESENTED: International Astronautical Congress, August 1960, Stockholm, Sweden

TITLE: THE SNAP 2 CONCEPT
AUTHOR: H. M. Dieckamp (AI)
PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: STATUS OF THE SNAP 2 REACTOR
AUTHOR: R. D. Keen and R. E. Eggleston (AI)
PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: SNAP 2 POWER CONVERSION STATUS
AUTHOR: D. L. Southam (Thompson Ramo Woolridge)
PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: SNAP THERMOELECTRIC SYSTEMS
AUTHOR: A. W. Thiele and M. G. Coombs (AI)
PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

SNAP 10A PAPERS

TITLE: SNAP 2 SYSTEM AND VEHICLE INTEGRATION

AUTHOR: D. J. Cockeram and R. L. Wallerstedt (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: EVALUATION OF SNAP SAFETY FOR SPACE REACTOR APPLICATION

AUTHOR: F. D. Anderson and J. G. Lundholm, Jr. (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF A THERMIONIC CONVERSION REACTOR

AUTHOR: R. L. Hirsch and J. W. Holland (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: THE EXPERIMENTAL AND ANALYTICAL PROGRAMS FOR REENTRY BURNUP OF SNAP REACTORS

AUTHOR: P. D. Cohn (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: SHIELD DESIGN FOR SNAP REACTORS

AUTHOR: V. Keshishian (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

TITLE: THE APPLICATION OF SNAP UNITS IN CURRENT SPACE VEHICLES

AUTHOR: J. R. Wetch and J. G. Lundholm, Jr. (AI)

PRESENTED: ARS Space Power Systems Conference, Santa Monica, California, September 27-30, 1960

SNAP 10A PAPERS

TITLE: THE SNAP PROGRAM PRESENT STATUS AND FUTURE PROSPECTS
AUTHOR: Lt. Col. G. M. Anderson (USAF)
PRESENTED: Atomics Industrial Forum, December 1960

TITLE: COMPACT REACTORS FOR SPACE POWER
AUTHOR: H. M. Dieckamp, R. Balent and J. R. Wetch (AI)
PRESENTED: Nucleonics, April 1961, p. 73

TITLE: SUMMARY OF SNAP NUCLEAR SPACE POWER SYSTEMS
AUTHOR: E. B. Baumeister (AI)
PRESENTED: ARS-61-SA-52, June 1961

TITLE: SPACE REACTOR POWER
AUTHOR: J. R. Wetch and M. G. Coombs (AI)
PRESENTED: American Rocket Society, Space Flight Report to Nation, October 9-15, 1961

TITLE: NUCLEAR AUXILIARY POWER - WATTS TO MEGAWATTS - SNAP
AUTHOR: R. Balent (AI)
PRESENTED: International Symposium on Aerospace Nuclear Propulsion, October 23-27, 1961, Las Vegas, Nevada

TITLE: REACTOR POWER FOR COMMUNICATIONS SATELLITES
AUTHOR: A. B. Martin (AI)
PRESENTED: Annual Conference of the Atomic Industrial Forum, November 6-8, 1961, Chicago, Illinois

TITLE: HAZARDS ASSOCIATED WITH NUCLEAR POWER REACTORS IN SPACE APPLICATIONS
AUTHOR: P. G. Lafyatis
PRESENTED: ARS Paper 1754-61

SNAP 10A PAPERS

TITLE: SNAP II ROTATIONAL SPEED CONTROL

AUTHOR: W. E. Dauterman and E. J. Viton (AI)

PRESENTED: IRE Trans on Nucl Sci, January 1962, p. 151

TITLE: NUCLEAR SPACE POWER SYSTEMS - THE SNAP REACTORS

AUTHOR: R. E. Wimmer (AI)

PRESENTED: AIEE Winter Meeting, New York, February 1962

TITLE: PRECISION NONDESTRUCTIVE TESTING OF THERMOELECTRIC MATERIALS

AUTHOR: S. H. Fitch, J. W. Morris (AI)

PRESENTED: Spring National Convention of the Society for Nondestructive Testing, April 9-13, 1962, Cleveland, Ohio

TITLE: NUCLEAR REACTOR POWER SOURCES

AUTHOR: C. K. Smith (AI)

PRESENTED: 16th Annual Power Sources Conference, May 22-24, 1962, Red Bank, New Jersey

TITLE: NUCLEAR REACTOR SPACE POWER SYSTEMS

AUTHOR: J. R. Wetch and M. G. Coombs (AI)

PRESENTED: AIEE Aerospace Technical Conference, June 17-22, 1962, Denver, Colorado

TITLE: FLIGHT TEST CRITERIA FOR REENTERING SNAP SYSTEM

AUTHOR: Staff (SID Div of NAA)

PRESENTED: AFSWC-TDR-62-83, November 1962

TITLE: STATIC NUCLEAR THERMOELECTRIC SYSTEM FOR SPACE

AUTHOR: P. E. Kueser (Westinghouse)

PRESENTED: Appl. Ind., No. 64, 402-5 (January 1963)

SNAP 10A PAPERS

TITLE: SAFETY ANALYSIS REPORT - SNAPTRAN 2/10A-1 SAFETY TESTS
AUTHOR: F. L. Bentzen (Phillips Petroleum) and R. L. DeHerman (AI)
PRESENTED: IDO-16825, January 28, 1963

TITLE: REENTRY FLIGHT DEMONSTRATION NO. ONE (RFD-1): FINAL SNAP 10A
SAFETY FLIGHT TEST PLAN
AUTHOR: C. E. Erickson, et al (Sandia Corp.)
PRESENTED: SC-RR-64-501, March 1963

TITLE: NUCLEAR REACTOR SYSTEMS
AUTHOR: G. Montgomery Anderson (AEC)
PRESENTED: Astronautics & Aerospace Eng., May 1963

TITLE: ORBITAL TESTING OF SNAP SYSTEMS
AUTHOR: G. E. Austin, Lt. Col., USAF
PRESENTED: Astronautics & Aerospace Eng., May 1963

TITLE: NUCLEAR REACTOR SYSTEMS
AUTHOR: G. M. Anderson, Lt. Col., USAF
PRESENTED: Astronautics & Aerospace Engineering, May 1963

TITLE: ORBITAL TESTING OF SNAP SYSTEMS
AUTHOR: Lt. Col. G. E. Austin, USAF
PRESENTED: Astronautics & Aerospace Engineering, May 1963

TITLE: SNAP 10A ELECTRONICS IRRADIATION PROGRAM SUMMARY
AUTHOR: D. M. Walker and J. D. Howell (AI)
PRESENTED: IEEE Summer General Meeting, June 16-21, 1963, Toronto, Canada

SNAP 10A PAPERS

TITLE: NUCLEAR RADIATION EFFECTS ON POTENTIAL NUCLEAR SPACECRAFT THERMAL CONTROL MATERIALS

AUTHOR: J. E. Gilligan (Lockheed)

PRESENTED: American Nuclear Society Meeting, November 1963, New York

TITLE: EXPERIMENTS WITH WATER-REFLECTED, UNDERMODULATED, ZIRCONIUM HYDRIDE CRITICAL ASSEMBLIES

AUTHOR: L. I. Moss (AI)

PRESENTED: TID-18880, 1963

TITLE: AN EVALUATION OF SYSTEMS FOR NUCLEAR AUXILIARY POWER

AUTHOR: U. S. Atomic Energy Commission

PRESENTED: TID-20079, January 1964

TITLE: SNAPTRAN 2/10A-3 POST DESTRUCTIVE TEST REACTOR EXAMINATION, CLEANUP, AND SAFETY CONSIDERATIONS

AUTHOR: R. D. Fletcher (Phillips Petroleum)

PRESENTED: IDO-17071, January 1964

TITLE: ANALYTICAL STUDIES OF BERYLLIUM ABLATION AND DISPERSION DURING REENTRY

AUTHOR: A. L. Feild, Jr. (Westinghouse)

PRESENTED: Journ. Spacecraft Rockets, January-February 1964

TITLE: STEP PROJECT

AUTHOR: Phillips Petroleum Co.

PRESENTED: Quarterly Technical Report, Period Ending June 1963, Issued March 1964

TITLE: HIGH TEMPERATURE DIRECT CONVERSION REACTOR "ROMASHKA"

AUTHOR: Russian authors

PRESENTED: 3rd UN International Conference on the Peaceful Uses of Atomic Energy, May 1964

SNAP 10A PAPERS

TITLE: REENTRY FLIGHT DEMONSTRATION NO. 1 (RFD-1): DESIGN, DEVELOPMENT AND PERFORMANCE OF THE REENTRY VEHICLE

AUTHOR: C. E. Erickson, et al, (Sandia Corp.)

PRESENTED: SC-RR-64-511, May 1964

TITLE: QUALIFYING THE SNAP 10A CONTROL AND REFLECTOR ASSEMBLY

AUTHOR: R. A. Johnson (AI)

PRESENTED: Transactions of Amer. Nucl. Society, 7:130-1 (June 1964)

TITLE: ENVIRONMENTAL TESTING OF THE SNAP 10A SAFETY FLIGHT VEHICLE

AUTHOR: D. L. Krenz (Sandia Corp.)

PRESENTED: Aerospace Reliability and Maintainability Conference, June-July 1964, Washington, D. C.

TITLE: SNAPTRAN 2/10A-3 PHOTOGRAPHY

AUTHOR: Edgerton, Germeshausen, and Grier, Inc.

PRESENTED: EGG-1183-1071, July 1964

TITLE: MATERIALS TESTING REACTOR QUARTERLY REPORT, JANUARY-MARCH 1964

AUTHOR: Phillips Petroleum

PRESENTED: IDO-16994, August 1964

TITLE: NUCLEAR SPACE POWER SYSTEMS

AUTHOR: H. M. Dieckamp (AI)

PRESENTED: AI internal paper, September 1964

TITLE: REACTOR DIRECT CONVERSION UNITS

AUTHOR: H. M. Dieckamp (AI)

PRESENTED: 3rd U. N. Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland September 1964

SNAP 10A PAPERS

TITLE: REENTRY FLIGHT DEMONS NO. 1 (RFD-1): DATA BOOK
AUTHOR: C. E. Erickson (Sandia Corp.)
PRESENTED: SC-RR-64-502, September 1964

TITLE: AN INSTRUMENT FOR THE MEASUREMENT OF T/E CONVERTER RESISTANCE
AUTHOR: D. J. Sobo (AI)
PRESENTED: ISA, New York, October 1964

TITLE: USE OF ENERGY DENSITY MEASUREMENTS TO CALIBRATE NUCLEAR
DETECTORS DURING THE SNAPTRAN-3 DESTRUCTIVE EXPERIMENTS
AUTHOR: D. F. Paddleford, et al (AI)
PRESENTED: Trans. Am. Nucl. Soc., 7:384 (November 1964)

TITLE: SNAPTRAN 2/10A-3 DESTRUCTIVE TEST RESULTS
AUTHOR: W. E. Kessler, et al (Phillips Petroleum)
PRESENTED: Trans. Am. Nucl. Soc., 7:383 (November 1964)

TITLE: DESIGN AND FABRICATION OF SNAP REACTOR VESSELS
AUTHOR: T. L. Anderson and I. A. Awtamow (AI)
PRESENTED: Am. Soc. of Mech. Eng. Winter Meeting, November-December 1964, New York

TITLE: DESIGN OF THE SNAP 10A REACTOR
AUTHOR: A. W. Dalcher and J. D. Southerland (AI)
PRESENTED: Society of Automotive Engineers, 1964, New York

TITLE: SPACE POWER SYSTEMS STATE OF THE ART
AUTHOR: G. Szego
PRESENTED: AIAA Paper #64-525 (1964)

SNAP 10A PAPERS

TITLE: BEHAVIOR OF SNAP 10A DURING ORBITAL REENTRY
AUTHOR: D. K. Nelson (AI)
PRESENTED: American Institute of Aeronautics & Astronautics, 1964, Paper No. 64-473

TITLE: RADIOLOGICAL ASPECTS OF SNAPTRAN 2/10A-3 DESTRUCTIVE TESTS
AUTHOR: O. L. Cordes, et al (Phillips Petroleum)
PRESENTED: IDO-17038 (1964)

TITLE: SNAPTRAN 2/10A-3 DESTRUCTIVE TEST RESULTS
AUTHOR: W. E. Kessler, et al (Phillips Petroleum)
PRESENTED: IDO-17019, January 1965

TITLE: RADIATION TOLERANT STARTUP CONTROLLER FOR SNAP 10A
AUTHOR: R. H. Wagner (Bendix Corp.)
PRESENTED: IEEE Trans. on Nucl. Sci., February 1965

TITLE: SNAP REACTOR CONTROL DRUM ACTUATORS
AUTHOR: I. Rowe (AI)
PRESENTED: IEEE Trans. on Nucl. Sci., February 1965

TITLE: STEP PROJECT QUARTERLY REPORT, OCTOBER-DECEMBER 1963
AUTHOR: E. R. Oetken (Phillips Petroleum)
PRESENTED: IDO-17058 March 1965

TITLE: DEVELOPMENT OF SNAP 10A EXPANSION COMPENSATOR
AUTHOR: S. Sudar (AI)
PRESENTED: Trans. of Amer. Nucl. Soc., 8:149 (May 1965)

SNAP 10A PAPERS

TITLE: DEVELOPMENT OF HIGH FLUX RADIANT HEATERS FOR THE SNAP 10A GROUND TEST PROGRAM

AUTHOR: R. Blevitt (AI)

PRESENTED: Trans. of Amer. Nucl. Soc., 8:150-1 (May 1965)

TITLE: HYDROGEN REDISTRIBUTION IN THE SNAP 10A REACTOR

AUTHOR: N. K. Simon (AI)

PRESENTED: Trans. of Amer. Nucl. Soc., 8:152-3 (May 1965)

TITLE: SNAP 10A REACTOR ANALYSIS

AUTHOR: J. P. Hawley and W. A. Flynn (AI)

PRESENTED: Trans. of Amer. Nucl. Soc., 8:160 (May 1965)

TITLE: THE DEVELOPMENT OF THE SNAP 10A THERMOELECTRIC PUMP

AUTHOR: M. A. Perlow and K. A. Davis (AI)

PRESENTED: Trans. of Amer. Nucl. Soc., 8:160-1 (May 1965)

TITLE: SNAPSHOT: HISTORIC FIRST IN SPACE

AUTHOR: Staff

PRESENTED: Nucleonics, 23: No. 6, 43-8 (June 1965)

TITLE: AUTOMATIC STARTUP AND OPERATION OF SNAP 10A FLIGHT SYSTEM IN A SIMULATED SPACE ENVIRONMENT

AUTHOR: D. S. Brinkman and P. J. Pekrul (AI)

PRESENTED: American Nucl. Society, July 28-30, 1965, Jackson Hole, Wyoming

TITLE: SAFETY ANALYSIS REPORT, SNAPTRAN 2/10A-1 AND -2 SAFETY TESTS

AUTHOR: W. J. Neal (Phillips Petroleum)

PRESENTED: IDO-17076, October 1965

SNAP 10A PAPERS

TITLE: WHAT HAPPENED TO SNAP-10A?

AUTHOR: R. F. Wilson and H. M. Dieckamp (AI)

PRESENTED: Astronaut, Aeronaut., 3:60-5 (October 1965)

TITLE: SNAPSHOT PROGRAM RELIABILITY LIFE TEST

AUTHOR: Staff (Lockheed)

PRESENTED: TID-22416, October 1965

TITLE: SNAP 10A FLIGHT VEHICLE NUCLEAR ENVIRONMENT AND RADIATION EFFECTS

AUTHOR: C. M. Bennett et al, (Lockheed)

PRESENTED: TID-22418, October 1965

TITLE: SNAP 10A, FIRST REACTOR IN SPACE

AUTHOR: R. A. Johnson, W. T. Morgan and S. R. Rocklin (AI)

PRESENTED: SAE National Aeronautic & Space Engineering & Manufacturing Meeting, Los Angeles, October 1965

TITLE: SNAPSHOT LAUNCH OPERATIONS

AUTHOR: B. F. Ureda (AI)

PRESENTED: 12th Nuclear Science Symposium, October 18-20, 1965, San Francisco, California

TITLE: SNAP 10A INSTRUMENTATION AND CONTROL DEVELOPMENT AND TESTING

AUTHOR: A. K. Smith and D. Zerbel (AI)

PRESENTED: 12th Nuclear Science Symposium, October 18-20, 1965, San Francisco, California

TITLE: DEVELOPMENT OF THE CONTROL SYSTEM FOR SNAP REACTORS

AUTHOR: O. P. Steele, III, L. G. Kellogg and W. G. Dewart (AI)

PRESENTED: 12th Nuclear Science Symposium, October 1965, San Francisco, California

TITLE: ANALYSIS OF SNAP 10A/2 KINETIC BEHAVIOR USING PULSE REACTIVITY EXCITATIONS

AUTHOR: W. E. Kessler (Phillips Petroleum)

PRESENTED: Trans. Amer. Nucl. Soc., 8:495 (November 1965)

SNAP 10A PAPERS

TITLE: STATIC CONTROL OF SNAP REACTORS

AUTHOR: R. A. Johnson and D. J. McGoff (AI)

PRESENTED: Trans. Amer. Nucl. Soc., 8:527 (November 1965)

TITLE: REENTRY BURNUP OF SNAP 10A REACTOR FUEL ELEMENTS

AUTHOR: A. W. Barsell and K. Y. Eng (AI)

PRESENTED: Trans. Amer. Nucl. Soc., 8:545-6 (November 1965)

TITLE: FISSION PRODUCT RELEASE FROM IRRADIATED URANIUM-ZIRCONIUM-HYDRIDE SNAP FUEL

AUTHOR: W. M. Cegelski (AI)

PRESENTED: Trans. Amer. Nucl. Soc., 8:547 (November 1965)

TITLE: DEVELOPMENT OF A RADIATION TOLERANT ALL SOLID STATE TRACKING AND COMMAND SYSTEM

AUTHOR: E. A. Smith

PRESENTED: Joint Am. Nucl. Soc. and Am. Soc. for Testing Mat'l's. Conf. on Radiation Effects on Electronics, Syracuse, New York (1965)

TITLE: THERMOELECTRIC TECHNOLOGY FOR SPACE-POWER SYSTEMS

AUTHOR: R. L. Klem and W. J. Helwig (RCA)

PRESENTED: Amer. Inst. of Aero & Astro, 1965, San Francisco, California

TITLE: OTHER REACTORS

AUTHOR: Staff

PRESENTED: Power Reactor Technology, 8:No. 1, 103-7 (Winter 1964-65)

TITLE: IRRADIATION OF SNAP SYSTEM ELECTRICAL DEVICES IN A HIGH-TEMPERATURE VACUUM ENVIRONMENT

AUTHOR: S. J. Basham, et al (Battelle Memorial Inst.)

PRESENTED: BMI-X-10120 (1965)

SNAP 10A PAPERS

TITLE: INSTRUMENT COMPONENT AND SYSTEMS DEVELOPMENT
AUTHOR: T. J. Boland (Phillips Petroleum)
PRESENTED: IDO-17112, 1965

TITLE: INSTRUMENTATION ANALYSIS
AUTHOR: N. Wilde (Phillips Petroleum)
PRESENTED: IDO-17112, 1965

TITLE: FISSION PRODUCT DISPERSION AND RELEASE FROM THE SNAPTRAN 2/10A-3
DESTRUCTIVE TEST
AUTHOR: O. L. Cordes (Phillips Petroleum)
PRESENTED: CONF-650407 (1965)

TITLE: POST-TEST PHYSICAL, CHEMICAL, AND METALLURGICAL ANALYSIS OF
SNAPTRAN-3 FUEL
AUTHOR: R. D. Fletcher (Phillips Petroleum)
PRESENTED: IDO-17065 (1965)

TITLE: SNAP 10A FLIGHT TEST EXPERIENCE
AUTHOR: A. B. Martin, H. M. Dieckamp and R. F. Wilson (AI)
PRESENTED: AI internal paper, Fall of 1965

TITLE: SNAP REACTOR TRANSIENT TEST MACHINE
AUTHOR: T. L. Anderson, et al (AI)
PRESENTED: ASME Annual Winter Meeting, Chicago, 1965

TITLE: SNAP 10A REACTOR OPERATION
AUTHOR: J. P. Hawley (AI)
PRESENTED: ASME Annual Winter Meeting, Chicago, 1965

SNAP 10A PAPERS

TITLE: SNAP 10A DESIGN, DEVELOPMENT, AND FLIGHT TEST

AUTHOR: R. F. Wilson, H. M. Dieckamp and D. J. Cockeram (AI)

PRESENTED: Amer. Inst. of Aero. & Astro., 1965, San Francisco, California

TITLE: RADIATION DOSIMETERS DEVELOPED FOR SNAP 10A FLIGHT TEST

AUTHOR: W. G. Kruse (Lockheed)

PRESENTED: IEEE Transactions on Nuclear Science, February 1966

TITLE: GROUND TESTING OF THE SNAP 10A/AGENA SPACE SYSTEM

AUTHOR: J. F. Pohlman (Lockheed)

PRESENTED: IEEE Trans. on Nucl. Sci., February 1966

TITLE: SNAP ENVIRONMENT SIMULATION PROBLEMS

AUTHOR: W. G. Long, N. F. Davies and M. Warren

PRESENTED: IEEE Transactions on Nuclear Science, February 1966

TITLE: CONTROLLED DE-ORBIT

AUTHOR: J. A. Leonard and W. W. Joseph (Sandia Corp.)

PRESENTED: SC-RR-65-472, March 1966

TITLE: ENVIRONMENTAL TESTING OF SNAP 10A INSTRUMENTATION

AUTHOR: J. L. Johnson (AI)

PRESENTED: 12th Annual Inst. of Environmental Sciences Technical Meeting and Equipment Exposition, April 13-15, 1966, San Diego, California

TITLE: DESIGN AND TESTING OF THE SNAP 10A T/E POWER CONVERSION SYSTEM

AUTHOR: S. Rocklin

PRESENTED: Thermoelectric Specialists Conference, AIEE/IEEE, May 17-19, 1966, Washington, D. C.

TITLE: SNAP 10A - A STATUS REPORT

AUTHOR: R. F. Wilson (AI)

PRESENTED: Space Power Systems Engineering, 1966

IV. SNAP PROGRESS REPORTS

PROGRESS REPORTS

NAA-SR-1965 SECRET

TITLE: NUCLEAR AUXILIARY POWER UNIT QUARTERLY PROGRESS REPORT FOR JANUARY-MARCH 1957

AUTHOR: J. R. Wetch

9-1-57

NAA-SR-2126 SECRET

TITLE: NUCLEAR AUXILIARY POWER UNIT QUARTERLY PROGRESS REPORT FOR APRIL-JUNE 1957

AUTHOR: Staff

10-1-57

NAA-SR-MEMO-2377 SECRET RD

TITLE: BI-MONTHLY PROGRESS REPORT ON SNAP 2 - COMPONENTS RADIATION TESTS FROM OCTOBER-NOVEMBER 1957

AUTHOR: W. McCarty

12-3-57

NAA-SR-MEMO-2378 SECRET RD

TITLE: BI-MONTHLY PROGRESS SNAP 2 PROGRESS REPORT FROM OCTOBER 1 TO NOVEMBER 30, 1957

AUTHOR: J. Crowe, S. Rocklin and M. Scherb

12-3-57

NAA-SR-2385 SECRET RD

TITLE: NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT PROGRAM SNAP 2 BI-MONTHLY PROGRESS REPORT FOR OCTOBER-NOVEMBER 1957

AUTHOR: Staff

1-1-58

NAA-SR-2402 SECRET

TITLE: ANNUAL TECHNICAL REPORT. SNAP 2 PROGRAM. JANUARY 1957 TO JANUARY 1958

AUTHOR: Staff

5-1-58

NAA-SR-2555 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, DECEMBER 1957-JANUARY 1958

AUTHOR: H. M. Dieckamp and J. R. Wetch

3-1-58

PROGRESS REPORTS

NAA-SR-2715 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, FEBRUARY-MARCH 1958

AUTHOR: H. M. Dieckamp and J. R. Wetch

3-15-58

NAA-SR-2863 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, APRIL-MAY 1958

AUTHOR: H. M. Dieckamp

7-1-58

NAA-SR-3048 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JUNE-JULY 1958

AUTHOR: H. M. Dieckamp

10-1-58

NAA-SR-3216 SECRET RD

TITLE: NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT SNAP 2 PROGRAM. BI-MONTHLY PROGRESS REPORT FOR AUGUST-SEPTEMBER 1958

AUTHOR: H. Dieckamp

11-1-58

NAA-SR-MEMO-3399 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-NOVEMBER 1958

AUTHOR: H. M. Dieckamp

1-1-59

NAA-SR-3443 SECRET

TITLE: SNAP 2 PROGRESS REPORT NUMBER 1

AUTHOR: Staff

1-59

NAA-SR-3589 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, DECEMBER 1958-JANUARY 1959

AUTHOR: H. M. Dieckamp

3-59

PROGRESS REPORTS

NAA-SR-3745 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, FEBRUARY-MARCH 1959

AUTHOR: H. M. Dieckamp

5-1-59

NAA-SR-3983 SECRET

TITLE: SNAP 2 PROGRESS REPORT NUMBER 2

AUTHOR: Staff

6-59

NAA-SR-MEMO-4002 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, APRIL-MAY 1959

AUTHOR: H. M. Dieckamp

7-15-59

NAA-SR-4326 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JUNE-JULY 1959

AUTHOR: H. M. Dieckamp

10-15-59

NAA-SR-4584 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, AUGUST-SEPTEMBER 1959

AUTHOR: H. M. Dieckamp

12-1-59

NAA-SR-4767 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-NOVEMBER 1959

AUTHOR: H. M. Dieckamp

1-15-60

NAA-SR-MEMO-4953 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, DECEMBER 1959-JANUARY 1960

AUTHOR: H. M. Dieckamp

3-1-60

PROGRESS REPORTS

NAA-SR-5225 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP), FEBRUARY-MARCH 1960

AUTHOR: H. M. Dieckamp

NAA-SR-5450 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP), APRIL-MAY 1960

AUTHOR: R. L. Wallerstedt 8-15-60

NAA-SR-5691 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JUNE-JULY 1960

AUTHOR: R. L. Wallerstedt 1-10-60

NAA-SR-5693 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 10 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JUNE-JULY 1960

AUTHOR: A. W. Thiele 1-10-61

NAA-SR-5629 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, AUGUST-SEPTEMBER 1960

AUTHOR: R. L. Wallerstedt 1-15-61

NAA-SR-5931 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 10 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, AUGUST-SEPTEMBER 1960

AUTHOR: A. W. Thiele 1-15-61

NAA-SR-6021 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-NOVEMBER 1960

AUTHOR: R. L. Wallerstedt 3-1-61

PROGRESS REPORTS

NAA-SR-6023 SECRET

TITLE: BI-MONTHLY PROGRESS REPORT, SNAP 10 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-NOVEMBER 1960

AUTHOR: A. W. Thiele

3-1-61

NAA-SR-6292 SECRET

TITLE: PROGRESS REPORT, SNAP 2 NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, DECEMBER 1960-MARCH 1961

AUTHOR: R. L. Wallerstedt

6-15-61

NAA-SR-6294 SECRET

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, DECEMBER 1960-MARCH 1961

AUTHOR: A. W. Thiele

6-15-61

NAA-SR-6693 SECRET

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, APRIL-JUNE 1961

AUTHOR: R. F. Wilson and H. Dieckamp

11-15-61

NAA-SR-6694 SECRET

TITLE: PROGRESS REPORT, SNAP 2/10A REACTOR, APRIL-JUNE 1961

AUTHOR: W. Haussler

12-1-61

NAA-SR-6793 SECRET

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JULY-SEPTEMBER 1961

AUTHOR: R. F. Wilson and H. Dieckamp

2-1-62

NAA-SR-6794 SECRET

TITLE: PROGRESS REPORT, SNAP 2/10A REACTOR, JULY-SEPTEMBER 1961

AUTHOR: W. Haussler

2-15-62

PROGRESS REPORTS

NAA-SR-6993 SECRET

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-DECEMBER 1961

AUTHOR: R. F. Wilson and H. Dieckamp

3-26-62

NAA-SR-6994 SECRET

TITLE: PROGRESS REPORT, SNAP 2/10A REACTOR, OCTOBER-DECEMBER 1961

AUTHOR: W. Haussler

6-30-62

NAA-SR-7193 SECRET

TITLE: PROGRESS REPORT FOR SNAP 10A, JANUARY-MARCH 1962

AUTHOR: R. F. Wilson

12-28-62

NAA-SR-7194 SECRET

TITLE: ATOMICS QUARTERLY INTERNATIONAL PROGRESS REPORT, SNAP 2/10 REACTOR, JANUARY-MARCH 1962

AUTHOR: J. Susnir

10-26-62

NAA-SR-7493 CONFIDENTIAL

TITLE: QUARTERLY PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, APRIL-JUNE 1962

AUTHOR: Staff

2-7-63

NAA-SR-7793 CONFIDENTIAL

TITLE: QUARTERLY PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, JULY-SEPTEMBER 1962

AUTHOR: R. F. Wilson

2-15-63

NAA-SR-7794 SECRET

TITLE: SNAP 2/10A PROGRESS REPORT FOR JULY-SEPTEMBER

AUTHOR: J. Susnir

4-22-63

PROGRESS REPORTS

NAA-SR-8093 CONFIDENTIAL

TITLE: QUARTERLY PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-DECEMBER 1962

AUTHOR: R. F. Wilson

4-1-63

NAA-SR-8094 SECRET RD

TITLE: SNAP 2/10A REACTOR QUARTERLY PROGRESS REPORT FOR OCTOBER-DECEMBER 1962

AUTHOR: J. Susnir

5-7-63

NAA-SR-8393 SECRET

TITLE: SNAP 10A QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1963

AUTHOR: R. F. Wilson

5-31-63

NAA-SR-8394 SECRET RD

TITLE: SNAP 2/10A REACTOR QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1963

AUTHOR: J. Susnir

6-7-63

NAA-SR-8693 SECRET RD

TITLE: SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT QUARTERLY PROGRESS REPORT, APRIL-JUNE 1963

AUTHOR: D. Sedgley

9-20-63

NAA-SR-8694 SECRET RD

TITLE: SNAP 10A/2 REACTOR QUARTERLY PROGRESS REPORT, APRIL-JUNE 1963

AUTHOR: J. Susnir

10-9-63

NAA-SR-8993 SECRET RD

TITLE: SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1963

AUTHOR: D. Sedgley

11-15-63

PROGRESS REPORTS

NAA-SR-8994 SECRET RD

TITLE: SNAP 10A REACTOR QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1963

AUTHOR: R. J. Gimera and R. A. Johnson

11-15-63

NAA-SR-9293 CONFIDENTIAL DI

TITLE: SNAP 10A PROGRESS REPORT, OCTOBER-DECEMBER 1963

AUTHOR: Staff

2-21-64

NAA-SR-9394 SECRET RD

TITLE: SNAP 10A REACTOR PROGRESS REPORT, OCTOBER 1963-JANUARY 1964

AUTHOR: R. J. Gimera and R. A. Johnson

3-16-64

NAA-SR-9593 CONFIDENTIAL DI

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT SYSTEM, JANUARY-MARCH 1964

AUTHOR: Staff

5-15-64

NAA-SR-9594 SECRET RD

TITLE: PROGRESS REPORT, SNAP 10A REACTOR, FEBRUARY-APRIL 1964

AUTHOR: Staff

6-4-64

NAA-SR-9993 GRD

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT SYSTEM, APRIL-JUNE 1964

AUTHOR: J. Brunings

11-20-64

NAA-SR-10793 CONFIDENTIAL DI

TITLE: PROGRESS REPORT, SNAP 10A NUCLEAR AUXILIARY POWER UNIT DEVELOPMENT, OCTOBER-DECEMBER 1964

AUTHOR: J. Brunings

3-17-65

PROGRESS REPORTS

NAA-SR-11093 CONFIDENTIAL

TITLE: PROGRESS REPORT, SNAP 10A, JANUARY-MARCH 1965

AUTHOR: Staff

6-15-65

NAA-SR-11493 CONFIDENTIAL

TITLE: SNAP 10A QUARTERLY PROGRESS REPORT, APRIL-JUNE 1965

AUTHOR: Staff

10-21-65

NAA-SR-11693 CONFIDENTIAL

TITLE: SNAP 10A PROGRESS REPORT, JULY-SEPTEMBER 1965

AUTHOR: D. W. Staub

12-29-65

NAA-SR-11757 CONFIDENTIAL

TITLE: PROGRESS REPORT, SNAP 10A, OCTOBER-NOVEMBER 1965

AUTHOR: R. F. Wilson

3-2-66

NAA-SR-MLMQ-1202