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Subcontract NP-1

WANL-TME-2710

JUNE 16, 1970

Westinghouse Astronuclear Laboratory

NERVA NUCLEAR SUBSYSTEM

PROPOSED CY 1970 WORK PROGRAM

MODIFICATIONS

MASTER

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Incorporating Change Orders
W70-4, W70-5, W70-6, W70-7,
W70-8, W70-9, W70-10, W70-11.

INFORMATION CATEGORY	
Unclassified	
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LEGEND FOR WORK STATEMENT REVISIONS

In the left margin of each revised work statement page is the key to how each line item was revised and what Change Order caused the revision.

- M If a line item was modified due to a Change Order, but still remains applicable to the program.
- D If a line item was deleted entirely and no longer applies to the program.
- A If a new line item was added and was not in the work program initially.

The Change Order is identified by the dash number (i.e., if the change is caused by W70-6 the number 6 is used); hence, if line item 5 of a given work statement was deleted due to W70-7, then the code in the left margin would be D-7 opposite the number 5.

The letter "E" was used for those changes not directly related to a Change Order. It covers changes required from an editorial standpoint, agreements documented in minutes of meetings, inconsistencies between projects, line items being placed in inappropriate projects, inconsistencies between ANSC and WANL work statements, etc.

SUBCONTRACT NP-1

PREFACE

Pursuant to Article I, Paragraph (e) of Subcontract NP-1, this Supplement W70-B to Appendix B delineates the portions and features of the work provided for in Paragraph (a) of said Article I which the subcontractor shall utilize its best effort to perform during the period October 1, 1969 through September 30, 1970.

- A. The Subcontractor shall comply with the following documents in conducting the work under this subcontract:
1. SNPO document SNPO-NPRD-1, entitled, "NERVA Program Requirements Document", Revision 7, dated January 19, 1970, consisting of fifty (5) pages and Appendix B thereto consisting of ten (10) pages.
 2. SNPO-C-ST1D, "NERVA Engine Specification Tree", dated October 25, 1969.
 3. Structural Design Specification, SNPO-C-1, dated December 19, 1968.
 4. High Pressure Gas Vessel Specification, SNPO-C-3, dated November 1967.
 5. SNPO-C document, entitled, "NERVA Data Item Description", Release No. 2, dated February 1, 1970.
 6. SNPO-C letter entitled, Maturity of Data Items for NSS and NSS Components Design Preliminary Design Review, dated March 4, 1970.
 7. NASA Publication, NPC 200-2, April 1962, as interpreted by WANL Product Assurance Program Plan (Data Item P-017) as approved by Aerojet-General and the Contracting Officer.
 8. NASA Publication, NPC 250-1, July 1963, in accordance with applicable sections of the Reliability Plan (Data Item R-101).
 9. NASA Publication, NHB 5300.4(3A), as interpreted by WANL Quality Workmanship Standard, WANL-QWS-1.
 10. NERVA Configuration Management Plan (Data Item C-018) as approved by the Contracting Officer and the WANL Supplement, TME-1890, dated September 11, 1969.
 11. NERVA Data and Document Management Plan (Data Item C-100) as approved by the Contracting Officer and the WANL Supplement, dated September 30, 1969.

- B. The work program for the remainder of CY70 includes the utilization of Quality Assurance Requirements for Facility and GSE, SNPO-C-4, Revision 1, dated September 1969, as a guide for NRDS facilities only.
- C. The data items referred to in this statement of work, when published, will be consistent with Release No. 4 of the SNPO-C document entitled, "NERVA Data Item Description", dated May 15, 1970. For those data items referred to in this statement of work, but not contained in the above referenced Release No. 4, will be consistent with Data Item Descriptions as published in AGC Report RN-S-0509, dated April 1, 1969.

Data Items cover the entire life cycle of the program and their maturity at the time of submittal for NSS PDR will be only as mature as the design at that time, and as a minimum shall comply with the requirements set forth in SNPO-C letter dated March 4, 1970, entitled, "Maturity of Data Items for NSS and NSS Components Design Preliminary Design Review".

- D. Detailed planning and schedular data (networks, bargraphs, milestone charts, etc.) for the CY 1970 work program shall be prepared and maintained for each project. The project data shall integrate all significant constraining data provided by other projects as well as integrating its own requirements and provide the significant output data required by other projects. This data will be maintained by the Subcontractor and shall be available to Aerojet-General and the Government for review and information as required.
- E. The work program proposed herein does not include parallel efforts for both composite and graphite fuel. The approach to be utilized in developing the data for Engine and NSS PDR is that of carrying graphite fuel in the reference design and conducting impact investigations, where appropriate, on a preliminary basis to ascertain design compatibility between graphite and composite fuel. Specifically, this work program is not consistent with decisions made by SNPO after the meeting held in Washington, June 11, 1970.
- F. The degree of implementation of the data items entitled, "Plans" (P-017, R-101, C-018, C-100) is specified in the appropriate project work statements and is compatible with the overall CY 1970 work program.

G. Contractual Milestones

In the performance of the scope of work defined herein, the following milestones shall be accomplished on or before the dates specified:

<u>No.</u>	<u>Description</u>	<u>Date</u>
1	Complete Trade Studies 713, 714, 716, 717, 757 and 760 to that level permitting Government decisions on the conceptual selection.	Feb. 1970
2	Publish all the Part I Specifications, identified in the Specification Tree, Sections 1, 2 and 3 to establish the Design Requirements Baseline and submit the traceability data which documents the basis of the content of the Specifications. (These specifications are listed herein for convenience.) a. Nuclear Subsystem b. Control Drum Drive Actuator c. Structural Support Coolant Assembly d. Fuel Elements e. Cluster Hardware f. Core Periphery g. Support Plate and Plena h. Internal Shield i. Reflector Assembly j. NSS Instrumentation k. Structural Support Coolant Valve Actuator	April 1970
3	Publish and submit to AGC, the S-057 Design Sheets for NSS controls design requirements for the I&C Specifications	April 1970
4	Provide WANL Management approved drafts of the Trade Study Reports (S-054) specified in the project work statements to support the Engine PDR: (These Trade Study Reports are listed herein for convenience.)	Sept. 1970

<u>No.</u>	<u>Description</u>	<u>Date</u>
	711 NSS Emergency Operating Mode	
	713 Reactivity Control Concepts	
	714 NSS Startup, Shutdown and Throttling	
	716 NSS Parametric Performance Evaluation	
	717 Optimization of Chamber Pressure for NSS	
	719 NSS Anti-Criticality System Requirements	
	751 NERVA Cluster Hardware Concepts	
	752 Core Periphery Concepts	
	754 Control Drum Drive System	
	755 Actuator Trade Study - SSCVA	
	757 Reactor Cooldown Criteria	
	759 Fuel Elements Concepts	
	760 SSCS Concepts	
	761 NERVA Cluster Stem and Hot End Hardware	
	762 Support Plate and Plena Concepts	
	763 Reflector Study	
	764 Electric Actuator Study	
	765 Internal Shield Design Concepts	
5	Issue the XE Thermal and Fluid Flow Data Analysis topical report for input to XE Data Analysis Final Report prepared by AGC.	Mar. 1970
6	Issue final report input to the Shield Trade Study (TS-023).	Apr. 1970
7	Publish T-119 report, WANL-TME-1914, "Radiation Environment in Various Reactor Components".	Aug. 1970
8	Complete installation and checkout of a minimum set of equipment to produce composite fuel element.	Sept. 1970
9	Reactivate WANL Single Element Furnace.	Apr. 1970
10	Complete the Core Periphery Corrosion Resistant Periphery Study Layout for use in the design of component tests.	Apr. 1970
11	Prepare and issue the initial version of the Test Cell "C" T-134.	Sept. 1970

<u>No.</u>	<u>Description</u>	<u>Date</u>
12	Prepare a "Reactor/Facility Compatibility Safety Study".	Aug. 1970
13	Publish drafts of the following four procedures: <ul style="list-style-type: none"> a. Reliability modeling and uncertainty analysis techniques for fuel, reflector, lateral support and axial support b. Monte Carlo techniques in Reliability Analysis c. Mathematical techniques for analysis of propagation of error and analysis of variance d. Design of experiments 	Sept. 1970
14	Complete fuel element order of preference trade study.	June 1970
15	Revise and re-publish specifications listed as contractual milestone no. 2.	July 1970
16	Revise and re-publish the S-057 Design Sheets for NSS controls design requirements for I&C specifications.	July 1970

PROJECT 413 - ENGINE SYSTEM TEST ENGINEERING AND SUPPORT

Suffix b - Technology Engineering

1. Perform post-test predictions for the XE-Prime test series and evaluate the XE Common Analog Model based on comparisons with test data.
2. Analyze the NSS transfer function measurements on the XE-Prime test series.

Suffix f - Development Engineering

1. Maintain digital implementations of the Common Analog Model of the NERVA engine physical systems which include: nuclear subsystem, engine feedsystem, ETS-1 feedsystem and emergency systems. In particular:
 - a. Develop and provide to ANSC improvements in the dynamic models for the nuclear subsystem for use in the Common Analog Model.
 - b. Run digital check problems on a regular basis and participate with ANSC in a comparison of results to provide a crosscheck of the ANSC implementation of the Common Analog Model.
 - c. Provide inputs to and review reports on the NERVA Engine Common Analog Model.
 2. Assist in conducting analyses to support the design and development of the engine reactor control system.
- D-E
- 3.
 4. Provide input to and review the following data items for the Engine Ground Test Mission:
 - a. S-052 Functional Flow Diagrams
 - b. S-053 Requirements Allocation Sheets
 5. Perform early NERVA engine system dynamics analyses using CAM and other models to support reactor design and test planning activities.
 6. Review and comment, where necessary, on the Measurement Requirements List for the E-series tests to ensure fulfillment of systems analysis activities.

PROJECT 451 - NUCLEAR SUBSYSTEM CONTROLS FOR EPIC

Suffix f - Development Engineering

- M-E 1. Prepare, publish and submit to ANSC, S-057 design sheets as recommended NSS controls design requirements and changes as input to the I & C Specifications. Discontinue this effort effective April 15, 1970.
- 2. Review the I & C Specifications
- D-E 3.
- 4. Provide support for the integration of engine and NSS controls design efforts and coordinate this effort with the NSS design.
- M-E 5. Initiate Trade Study 756 to evaluate various NSS control system concepts and to make a recommendation which best satisfies the performance, reliability and safety requirements. Discontinue this effort effective April 1, 1970.
- M-E 6. Prepare and maintain a continuously maturing report describing analyses of (a) NSS controllability, (b) Digital control development, and (c) Controllers for CAM. This report will provide input to the S-102, and when mature, will be a self-contained document for support of NSS PDR.
- M-E 7. Initiate Trade Study 758 to define the NSS safety and diagnostic system concepts. Discontinue this effort effective April 1, 1970.
- M-E 8. Maintain liaison with ANSC and SNPO on the design and development effort related to the reactor control system. Provide input as required for developing, maintaining and evaluating the flight engine control system and related alternate concepts.
- A-E 9. In cooperation with ANSC controls personnel (Project 151) develop concepts and design techniques for NERVA engine digital controls. Develop methods of choosing the state variable feedback vector, develop computer codes as design tools, and investigate alternate ways to use performance indices and operating constraints.
- A-E 10. Define the performance requirements, flight safety and diagnostic requirements, and other constraints imposed on the I & C Subsystem by the NSS. Document these requirements in a design sheet, Data Item S-057, NSS Instrumentation and Control Requirements.

PROJECT 451 - continued

- A-E 11. Perform analyses to verify that the NSS meets its controllability requirements.
- A-E 12. Perform controls analysis and design activities to develop simple analog controllers for use on systems models (CAM, etc.).

PROJECT 711 - NUCLEAR SUBSYSTEM MECHANICAL DESIGN INTEGRATION

Suffix b - Technology Engineering

1. Provide observation of the partial disassembly of the XE Prime test article.
2. Provide input, reporting observations for the Final Engine Test Report.

Suffix f - Development Engineering

M-6	1.	Update and issue the NSS Reference Design.
A-6	a.	Incorporating September 1969 Trade Study results.
A-6	b.	Terminating effort from February 1970 Trade Study recommendations.
A-6	c.	May issue estimated to incorporate recommendations of Change Order W70-6.
	2.	Provide support for preparation of the NSS CEI Specification, Data Item C-002.
M-6	3.	Conduct the design and analysis required for providing ANSC Engine PDR data items and data leading to NSS PDR.
M-6	a.	Prepare the NSS Chapter outlines and integrate the component chapter outlines for the following data items for NSS PDR.
M-6	(1)	E-105 Engineering Data - Design Evaluation (Update NSS Assembly Layout as part of E-105 which incorporates W70-6 June decision.)
M-6	(2)	S-036 Structural Analysis Report
	(3)	S-038 Dynamic Analysis Report
	(4)	S-039 Loads Report
	b.	Provide support for preparation of the following data items:
	(1)	E-106 Engineering Data - Interface Control
	(2)	S-047 Mass Properties Status Report

PROJECT 711 - Continued

- A-6 c. Provide input to ANSC for preparation of Engine PDR Data Items:
 - (1) S-038 Dynamics Loads Report - Provide NSS dynamic model.
 - (2) S-039 Loads Report - Provide NSS nominal steady-state and boost loads at selected major component interfaces.
- 4. Maintain and coordinate all Test Information Sheets for Reactor Design and Structural Design originated tests.
- 5. Maintain continuous development of analytical models and techniques in Structural and Reactor Design disciplines to support the NERVA Development Program.
- 6. Prepare Design Criteria Sheets for the Measurement Requirements List (MRL) as input for updating and as a guide to selection and development of instruments.
- M-6 7. Provide application layouts for instrumentation of NSS components.
- A-6 a. Reflector LVDT's
- A-6 b. Core Exit Gas Thermocouples
- A-6 c. Nuclear Diagnostic Instruments
- A-6 d. Core Temperature Thermocouples
- 8. Provide input and review to the appendices of the Reliability Plan, Data Item R-101, quantitative reliability procedures and R-102, Maintainability Program Plan.
- 9. Provide input and review to establish common reliability methods and procedures throughout the NSS Program in support of the Reliability Methods and Procedures (RMP) currently being developed.
- 10. Prepare definition and procure models and mockups of the NSS and NSS components required for visual aids.
- A-6 11. Study effect on NSS of routing lines through the external shield.

PROJECT 711 - Continued

- A-6 12. Generate NERVA vacuum test requirements and publish a comprehensive Vacuum Testing Program.

- A-6 13. Review existing WANL and other aerospace industry equipment capabilities in terms of the 10^{-9} torr (or less) requirement of SNPO W70-6 and other test conditions. Define applicability of this existing equipment and/or need for additional vacuum capabilities.

- A-6 14. Provide coordination as required with the SNPO, ANSC and WANL organizations regarding progress, procedures and materials involved in vacuum effects testing.

PROJECT 712 - NUCLEAR DESIGN INTEGRATION

Suffix b - Technology Engineering

1. Perform nuclear analysis of the XE-Prime test results and complete the preparation of the topical reports (XE-135 Buildup and Physics Tests).

Suffix f - Development Engineering

1. Provide nuclear input to the data items required to support NSS DRB and PDR.
- D-6 2.
3. Complete the nuclear input to Section 5 (Analysis) and 6 (Conclusions) of the following T-119 Data Items:
 - a. WANL-TME-1909, "PAX-G0 Approach to Critical. "
 - b. WANL-TME-1910, "PAX-G0 Control Drum Spans and Reactivity Coefficients. "
 - c. WANL-TME-1911, "PAX-G0 Power Distribution Measurements. "
 - d. WANL-TME-1916, "PAX-G1 Reflector Worth Measurements. "
 - e. WANL-TME-1917, "PAX-G1 Gross Power Measurements. "
 - f. WANL-TME-1918, "PAX-G1 Reactivity Effect Measurements. "
4. Revise the following test scope documents for PAX-G2 experiments performed in support of R-1:
 - a. S/T 66DW-234, "PAX-G2 Detailed Power Measurements. "
 - b. S/T 59DW-232, "PAX-G2 Control Drum Spans. "
5. Prepare and issue the following planning Test Information Sheets (part 3a) for PAX experiments:
 - a. TIS 6 "PAX-G3 Detailed Power Measurements. "
 - b. TIS 5 "PAX-G3 Control Drum Spans. "

PROJECT 712 - Continued

- c. TIS 7 "Material Reactivity Coefficients in Composite Fuel. "
 - d. TIS 11 "PAX-G2 In-Place Shimming Experiment (ISA). "
- 6. Conduct subsystem and component engineering evaluation of development tests on the following PAX-G2 experiments and analyze the test results to support the preparation of specifications, and the detail design effort subsequent to the NSS PDR:
 - a. "PAX-G2 Detailed Power Measurements. "
 - b. "PAX-G2 Control Drum Spans. "
 - c. "PAX-G2 In-Place Shimming Experiment (ISA). "
- 7. Complete the nuclear input to Section 5 (Analysis) and Section 6 (Conclusions) of the T-119 Data Items for the PAX tests identified in paragraph f. 6.
- 8. Complete predictions for the development tests in the following PAX-G3 experiments:
 - a. "PAX-G3 Detailed Power Measurements. "
 - b. "PAX-G3 Control Drum Spans. "
 - c.
- D
 - 9. Maintain and update analytical models and procedures and evaluate new data supplied by Physics and Math. Prepare and issue codes or data packages to the code centers on codes of general interest. Publish report on WISDM.
 - 10. Provide conceptual nuclear design effort in support of NCX.
- A-6
 - 11. Initiate neutronic analysis of the overall NSS in support of NSS PDR. This analysis is related to the development of a cold-to-hot reactivity feedback model for HCTE fuel and the initiation of a corresponding composite model.
 - 12. Provide conceptual design for the NCX secondary control system.

PROJECT 712 - Continued

- A 13. Initiate predictions for the development tests in the following PAX-G3 experiment:
- a. Material Reactivity Coefficients

Suffix y - PEWEE

1. Provide support for the WANL supplied hardware in the LASL/PEWEE program of assembly, disassembly and post-mortem examination.

PROJECT 713 - THERMAL DESIGN INTEGRATION

Suffix b - Technology Engineering

1. Complete the preparation of topical reports on:
 - a. Temperature Asymmetries at Low Gaseous and Liquid Hydrogen Flows
 - b. Laminar Flow Instability
 - c. Thermal Calibration
 - d. Decay Heat Analysis
 - e. Nuclear Subsystem Steady-State Thermal Performance
 - f. TNT and Test Data Comparisons for Pulse Cooling to provide input to Volume III, Data Analysis Section of the XE Data Analysis Report.

Suffix f - Development Engineering

1. Update the Thermal and Fluid Flow TNT-II model of the reactor reference design to incorporate the ten (10) hour reactor, full flow cycle.
- M-6
2. Support S-001, Systems Analysis Report, preparation by maintaining reactor assembly thermal and fluid flow model current with results of design and analysis studies on:
 - a. NSS Radial Dimension Optimization Study
 - b. Reflector-Nozzle Design Trade Study
 - c. Support Plate Material Selection Study
 - d. Reflector Structural Selection Study
 - e. SSCA and Stem Trade Study
 - f. Lateral Support Concepts Trade Study
 - g. Cold End vs. Hot End Primary Support Cluster Trade Study incorporated per Change Order W70-6.

PROJECT 713 - Continued

M-6	3.	Provide thermal and fluid flow analysis in support of S-039 Loads Report required for DRB and Engine PDR for the new reference design incorporating the changes required by Change Order W70-6, as listed in f. 2 above and document in DRM form.
M-6	4.	Provide thermal and fluid flow startup rated conditions and shutdown environmental data for component conceptual design and analyses on new reference design and for design studies resulting from added studies identified in Change Order W70-6, as listed in f. 2 above and issue environmental data in DRM form.
	5.	Review Data Item C-002 Specifications in support of NSS components.
D-6	6.	
	7.	Develop and improve analytical models and techniques used for thermal, fluid flow and corrosion analyses.
	8.	Maintain and undate materials thermal properties computer subroutines used in thermal and fluid analysis as additional data and uncertainty become available.
	9.	Provide preliminary thermal design input as required to undate MRL.
D-E	10.	
D-E	11.	
A-6	12.	Initiate NSS chapter of Data Item S-031, Thermal and Fluid Flow Analysis Report, including in the analysis results of design changes reflecting the content of Change Order W70-6.

PROJECT 714 - RADIATION AND SHIELDING DESIGN INTEGRATION

Suffix f - Development Engineering

1. Provide radiation input to the data items required to support NSS DRB and PDR.
- M-6 2. Provide ANSC with description of CRAM and sources to support Engine PDR.
- M-6 3. Initiate analysis of the NSS relating to the S-100 Data Item required for NSS PDR.

Preliminary analysis of the effect of Test Cell "C" facility shields on the NSS will be evaluated.
4. Prepare and issue the following Test Information Sheets (part 3. a) for PAX experiments.
 - a. TIS-20, "Measurement of Radiation Streaming through Ducts in Aluminum Material Placed on PAX-G2. "
 - M-E b. TIS-23, "Measurement of Photon Streaming through Ducts in Aluminum using a Co⁶⁰ Source. "
 - c. TIS-24, "Radiation Measurements on PAX using an R-1 Support Plate Segment. "
 - d. TIS-25, "Measurement of the Radiation Environment Internal to the PAX-G3 Reactor. "
5. Revise Test Scope 59DW-269-1, "Control Vane Heating Distribution Experiments. "
6. Prepare Section 5 (Analysis) and Section 6 (Conclusions) of the following T-119 Data Items for PAX experiments:
 - a. WANL-TME-1912, "Nuclear Subsystem Shielding Provision Study. "
 - b. WANL-TME-1914, "Radiation Environment in Various Reactor Components. "
 - c. WANL-TME-1915, "Radiation Environment on CHESH Components. "

PROJECT 714 - Continued

- d. "Control Vane Heating Distribution Experiments. "
- e. "Radiation Measurements on PAX using an R-1 Support Plate Segment. "
- 7. Initiate analysis of PAX experimental results defined in TIS-23.
- 8. Maintain and update NSS analytical models and procedures and evaluate new data supplied by Physics and Math. Coordinate with ANSC on similar methods development activities.
- 9. Review ANSC radiation and shielding design documentation related to NSS.
- 10. Provide radiation environment information to support the design of the R-1 test car and other hardware.
- 11. Perform analysis of after-shutdown radiation environment in support of maintainability studies.
- 12. Provide NSS radiation and shielding input as required for maintaining the ANSC/WANL Reference Design, including the Common Radiation Analysis Model.
- 13. Perform and transmit radiation analysis to fulfill the WANL commitments to the Systems Shield Trade Study (TS-023).
- 14. Provide input to Data Item F-004, Design Criteria Item, per January 1970 date of issuance.

PROJECT 715 - Continued

- g. TIS-20, "Measurement of Radiation Streaming Through Ducts in Aluminum Material Placed on PAX-G2. "
 - h. TIS-25, "Measurement of the Radiation Environment Internal to the PAX-G3 Reactor. "
- A-6 9. Provide conceptual design for the NCX secondary control system.

Suffix g - Development Testing

1. Prepare and publish the test results as T-119 Data Items for the following tests conducted in CY 1969:
 - a. S/T M58DW-216, "PAX-GO Approach to Critical. "
 - b. S/T's 58DW-225 and 66DW-227, "PAX-GO Control Drum Spans and Reactivity Coefficients. "
 - c. S/T's 66DW-226 and 66DW-228, "PAX-GO Power Distribution Measurements. "
 - d. S/T 62DW-268, "Nuclear Subsystem Shielding Provisions Study. "
 - e. S/T M66DW-270, "Radiation Environment in Various Reactor Components. "
 - f. S/T M57DW-271, "Radiation Environment on CHESH Components. "
 - g. S/T's 59DW-229 and 59DW-230, "PAX-G1 Reflector Interchange and Control Drum Spans. "
 - h. S/T 66DW-231, "PAX-G1 Gross Power Measurements. "
 - i. S/T's 66DW-291, 59DW-292 and 59DW-290, "PAX-G1 Reactivity Effect Measurements. "
2. Perform the following experiments and prepare and publish the results as T-119 Data Items:
 - a. S/T 59DW-232, "PAX-G2 Control Drum Spans. "

PROJECT 715 - Continued

- b. S/T 66DW-234, "PAX-G2 Detailed Power Measurements. "
- c. S/T 59DW-269, "Control Vane Heating Distribution Experiments. "
- M-E 3. Perform the following experiments and prepare a DRM documenting the results:
 - D-6 a.
 - D-6 b.
 - c. TIS-24, "Radiation Measurements on PAX Using an R-1 Support Plate Segment. "
 - d. TIS-11, "PAX-G2 In-Place Shimming Experiment (ISA). "
- 4. Initiate the following experiments:
 - a. TIS-07, "Material Reactivity Coefficients in Composite Fuel. "
 - b. TIS-23, "Measurement of Photon Streaming Through Ducts in Aluminum Using a Co-60 Source. "
 - A-6 c. TIS-05, "PAX-G3 Control Drum Spans. "
 - A-6 d. TIS-06, "PAX-G3 Detailed Power Measurements. "

Suffix i - Development Fabrication

- 1. Provide hardware as required to support the tests listed in Suffix g.

PROJECT 717 - NUCLEAR SUBSYSTEM TEST ENGINEERING

Suffix f - Development Engineering

- M-6 1. Initiate work in support of the following Data Items:
- a. Engineering required to plan the demonstration of NSS requirements which are to be confirmed by tests. For CY70 this will be done for two selected NSS primary performance characteristics (e.g., mixed mean chamber inlet temperature and operation at throttled conditions).
 - b. Analysis for the initial input for Trade Study 801.
2. Provide review and input to the Form 9 Data Item Description for T-101, "NERVA Program Test Plan".
3. Provide input to, and review, Data Item T-101, "NERVA Program Test Plan."
4. Perform the functional analysis of the NSS Ground Test Mission employing the systems engineering process. Prepare and issue initial versions of the following Data Items:
- M-E a. S-052 Functional Flow Diagrams
- M-E b. S-053 Requirements Allocations Sheets
- Provide input to the Engine Ground Test Mission S-052 and S-053.
5. Provide initial version of Section 10 of the C-002 Nuclear Subsystem CEI Detail Specification.
6. Define and interpret the analysis to be performed to support the NSS test engineering.
7. Transmit the revised WANL input to Data Item L-003, "Logistics Support Plan".
8. Publish and maintain the reactor test volume of Data Item M-110, "TSE/AGE Plan."
9. Transmit WANL input to introductory volume of Data Item M-110, "TSE/AGE Plan".
10. Perform the activities necessary to define the content and provide a plan to conduct the NSS Demonstration PDR. Coordinate the activities necessary to define the content and conduct of component/subsystem Demonstration PDR. Provide a preliminary agenda and schedule for the conduct of the Demonstration PDR's.

PROJECT 717 - continued

Suffix y - PEWEE/Nuclear Furnace

Effective July 1, 1970:

- A-5 1. Provide facility analyses of the Pewee II and Nuclear Furnace I tests required to assist NTO in the test planning and analyses for these tests.
- A-5 2. Provide WANL input to the Pewee II and Nuclear Furnace I test planning by reviewing Experimental Plan writeups, Summary Test Plans and Control Room Operating Procedures.
- A-5 3. Provide WANL review and assessment of the adequacy of the analysis and planning in preparation for test and facility operations for Pewee II and Nuclear Furnace I.
- A-5 4. Develop the necessary analog computer models to permit analyses of the facility and test operations and malfunction conditions.
- A-5 5. Provide analyses, including analog computer computations, of the Pewee II and Nuclear Furnace I facility checkout tests required to assist NTO in the planning and analyses for these tests.
- A-5 6. Provide review and assessment of the TCC failure mode analysis for facility systems to assist NTO in assuring adequacy of the facility to meet the requirements.
- A-5 7. Review the SAR, SER, and OLD for Pewee II and Nuclear Furnace I.
- A-5 8. Assist NTO in the Test Cell "C" operator training program.
- A-5 9. Participate in the data analysis and reporting following the TCC FEP's.

PROJECT 719 - NSS SYSTEMS ENGINEERING AND ANALYSIS

Suffix f - Development Engineering

1. Operate and maintain hybrid computer implementation of the R-1 Common Analog Model and of models used for systems analysis and control systems evaluation in support of the definition of NSS requirements for flight and ground testing.
- A-6
 - a. Update the R-1 CAM implementation on the analog computer to include the four-valve SSCA and other changes in the SSA and SSCA systems. Run cross checks with digital models to validate these changes. Implement the R-1 24:1 nozzle. Operate the R-1 CAM and assist in developing analysis programs for Systems Analysis tasks, including malfunction analyses, to evaluate the impact of the above changes.
2. Maintain Common Analog Models of the NERVA reactor physical system which includes: NSS, thrust nozzle, ground test feedsystem, and emergency systems.
 - a. Develop and provide to ANSC improvements in the dynamic models for the NSS and emergency systems.
 - b. Review changes to the component models provided by ANSC for use in the Common Analog Models.
 - c. Run digital check problems on a regular basis and participate with ANSC in comparison of results to provide a crosscheck of the WANL implementation of the CAM.
- A-6
 - d. Revise the R-1 CAM to include the four-valve SSCA systems and the 24:1 nozzle. Update the models to reflect selected SSA geometry. Revise models to permit qualitative malfunction analysis.
3. Assist in maintaining the TNT model and maintain NSS input to space environmental models and update these models as required to reflect changes in design parameters.
- A-6
 - a. Incorporate into the TNT model the four-valve SSCA and revisions to the SSA geometry and SSCA. Incorporate changes to the propellant feed-system being made by ANSC in response to Change Order W70-6.

PROJECT 719 - continued

4. Develop improved analytical techniques, methods and models used for performance analysis for the NSS.
- A-E
- a. Maintain and update hydrogen properties and provide uncertainties associated with the hydrogen properties in the temperature range encountered in the NSS. Continue to analyze the effects of para-to-orthohydrogen conversion in the NSS.
5. Assist in conducting systems and performance analysis to support the design and development of the NSS control system, including the control drum actuators and control drum drive system.
 6. Provide the necessary input to maintain the ANSC/WANL performance parameter interfaces between the NERVA engine and the NSS.
 7. Conduct analysis required to define reactor thermal environment in space.
 8. Develop improvements in the systems and performance analysis models on the basis of comparisons with experimental data. Apply the results to updating the CAM and other models as necessary.
 9. Support the operation, maintenance and upgrading of the hybrid computer facility as it relates to Systems Analysis tasks.
 10. Review and contribute to ANSC Systems Engineering documentation.
- A-6
- a. Review and provide input to the Systems Engineering documentation which is developed or revised in accordance with the government trade study decisions.
11. Synthesize and issue input for the following data items as required for Blocks 1-6, levels 1 to 3.
 - a. S-052 Functional Flow Diagrams
 - b. S-053 Requirements Allocation Sheets

PROJECT 719 - continued

- M-E 12. Develop input, compile traceability of requirements, and publish C-002 Specifications (Sections 1-3) for the following:
- a. Nuclear Subsystem (CEI)
 - b. Control Drum Drive Assembly (ECC)
 - c. Structural Support Coolant Assembly (ECC)
 - d. Fuel Elements (ECC)
 - e. Cluster Hardware (ECC)
 - f. Core Periphery (ECC)
 - g. Support Plate and Plena (ECC)
 - h. Internal Shield (ECC)
 - i. Reflector Assembly (ECC)
 - j. NSS Instrumentation (ECC)
 - k. Structural Support Coolant Valve Actuator (ECC)
 - l. NSS Controls (DS)
- M-6 13. Initiate development of input to Section 4 for verifying the requirements in the specifications listed in paragraph 12. Initiate preparation of Section 10 to include obvious requirements for the following specifications:
- a. Nuclear Subsystem
 - b. Control Drum Drive Assembly
 - c. Structural Support Coolant Valve Actuator
14. Review and approve supporting specifications to the Structural Support Coolant Assembly specifications such as:
- a. Structural Support Coolant Valve
 - b. Structural Support Block Valve and Actuator
 - c. Structural Support Coolant Lines

PROJECT 719 - continued

15. Provide a continuing evaluation of Systems Engineering and Design Engineering processes to determine any required reallocation of requirements. Maintain WANL input to Systems Engineering Data Items S-052 and S-053, and all WANL specifications.
- M-6 16. Prepare and publish S-054 Data Items for the following Category B trade studies:
- TS-713 Reactivity Control Concepts
 - TS-714 NSS Startup, Shutdown and Throttling
 - TS-717 Optimization of P_c for NSS
- Prepare and publish Phase I portions of the following Category C trade studies:
- TS-716 NSS Parametric Performance Evaluation
 - TS-757 Reactor Cooldown Criteria
 - TS-760 Structural Support Coolant Supply Concepts
17. Provide input and technical coordination for Data Item S-130, Data Book for Contractors.
18. Review XE Prime Test Data Analysis; Coordinate consideration of pertinent data into trade studies and functional analysis.
19. Prepare and transmit on a continuing basis WANL's input to ANSC for the NERVA Trade Study Report Index.
- M-6 20. Technically coordinate and integrate the WANL NSS Reference Design between appropriate WANL groups and between ANSC on the Engine Reference Design. Compile the NSS Reference Design package to incorporate the results of the Change Order W70-6 component studies and the updated performance analysis data based on the C.O. W70-6 component studies. Review engineering releases, change orders, Engineering Change Proposals and advise the WANL Configuration Control Board.
- M-6 21. Prepare NSS input for Data Item E-106, Engineering Data for Interface Control.

PROJECT 719 - continued

- M-6 22. Participate in the NERVA engine maintainability program. Provide NSS input to the Maintainability Program Plan, R-102, and conduct maintainability analysis on NSS components external to the pressure vessel. Prepare input to Data Item R-201, Maintainability Allocations, Assessment, and Analysis Report for Engine PDR.
23. Provide systems participation in the Environmental Committee with ANSC, MSFC and SNPO-C.
- M-6 24. Prepare NSS input for Data Item S-047, Mass Properties Status Report for Engine PDR.
- M-6 25. Prepare the NSS input for Data Item S-001. The uncertainty on the state points at the entrance to turbine inlet shall be provided that will account for the possible para-to-ortho conversion effects, as well as all other sources of uncertainties.
- A-6 26. Perform and document studies required for SSA Geometry Optimization.
- Perform studies required for the following system trade studies:
- TS-725 NSS Parametric Performance Evaluation Trade Study
 - TS-771 Reactor Cooldown Criteria Trade Study
 - TS-773 Structural Support Coolant Assembly Evaluations Trade Study
- These three trade studies are the renamed Phase II portions of the following three trade studies:
- TS-716 NSS Parametric Performance Evaluation
 - TS-757 Reactor Cooldown Criteria
 - TS-760 Structural Support Coolant Supply Concepts
- A-6 27. Determine the NSS thermal effects of operating a 24:1 nozzle in the R-test series without the use of an ejector duct.

PROJECT 721 - FUEL ELEMENT PRODUCTION

Suffix a - Support

1. Maintain the data processing equipment located at the WNCO Facility.
2. Conduct quarterly fuel inventories as required by the applicable AEC regulations and maintain accountability of all nuclear materials.
3. Maintain procedures and administrative control of Operations to insure safe criticality practices.
4. Coordinate fuel fabrication and quality control activities with those of UCCND: Y-12, LASL and other SNPO-supported activities.
5. Provide fuel beads to UCCND: Y-12.
6. Provide WNCO Test Specifications for matrix and coating for composite test element production.

Suffix f - Development Engineering

1. NSS DRB Data Submittal
 - a. Provide support for preparation of the Fuel Element Specification Data Item, C-002.
 - b. Complete the Trade Study for NERVA Fuel Element Design Concepts No. 759 and publish as Data Item S-054.
 2. NSS and Component PDR Data Submittal
- M-6 a. Initiate Fuel Element Preliminary Design Trade Study as Data Item S-054. This Trade Study shall include: (a) parametric studies on core bundling requirements to optimize core performance and reliability, (b) graphite and composite.
- D-6 b.

PROJECT 721 - Continued

3. Publish Test Information Sheets (part 3.a), and prepare and release drawings as necessary for materials test specimens used to obtain the fuel element materials properties data identified in Projects 781 and 782.
4. Publish Test Information Sheets (part 3.a) for the following key development tests in support of composite fuel element development.
 - a. Friction tests
 - b. Vacuum effects tests
 - c. Matrix properties tests
 - d. Cyclic endurance tests
 - e. Q-Stress tests
 - f. Hydrolysis tests
 - g. Cyclic corrosion endurance tests
 - h. Full X-Section element properties tests
5. Revise Scope of Tests to delete GLFI fuel elements and to incorporate Y-12 HCTE fuel elements (second generation).
6. Maintain continuous development of analytical models and techniques to support the fuel element production.
- M-6 7. Prepare and issue failure mode analysis as input to:
 - a. The Trade Study for NERVA Fuel Element Design Concepts No. 759.
 - b. The Trade Study for NERVA Fuel Element to identify the order of preference between graphite, composite and hybrid designs for the Reference Design.
8. Conduct studies and analysis to develop specifications and procedures required for the fuel element production.

PROJECT 721 - Continued

9. Provide fuel production ordering and control for elements from WNCO and Y-12, including documents such as work orders, drawings, specifications, AR's and VR's.
10. Issue drawings and specifications for composite test element production.
11. Develop and implement a plan to provide the required capital equipment for composite fuel and central element fabrication for:
 - a. A minimum requirement to produce prototype and test development elements.
 - b. Purchase, installation and check-out of a minimum set of production type equipment for composite fuel.
 - c. Order sufficient production inspection and testing equipment for the NCX fuel.
12. Provide the fuel and central support element drawings and specifications for Y-12 pre-production, support and production activities for the HCTE graphite program.
- M-E 13. Perform stress analysis on two (2) corrosion tested "crack-free experiment" elements. Recommend a corrosion testing plan for the remaining five (5) elements.
14. Provide analytical support to the following test activities plan to improve understanding of the performance of the single element furnace.
 - a. Thermal shield temperature measurements.
 - b. Furnace voltage probe measurements.
 - c. Furnace exit gas temperature measurement.
15. Perform detailed thermal and structural analyses of electrical furnace test of composite and graphite fuel elements utilizing the measurements referenced in item 14, above, together with fuel element resistivity, circumferential and axial temperature distribution measurements.

PROJECT 721 - Continued

- 16. Coordinate the Y-12 fuel element program per TD 70-17.
- A-6 17. Complete the Trade Study for NERVA Fuel Element to identify the order of preference between: graphite, composite and hybrid designs for the Reference Design.
- A-6 18. Initiate design evaluation of fuel element behavior under hard vacuum conditions (in DRM format).

Suffix g - Development Testing

- 1. Initiate the testing in support of graphite fuel element development for the test scope documents listed below:
 - a. Determination of Life-Time Cyclic Temperature Capabilities of R-1 Elements (66DT-248) - The purpose of this testing is to determine the sensitivity of R-1 candidate fuel elements to the parameters felt to be most significant with regard to fuel element corrosion.
 - b. Circumferential and Axial Temperature Variation as a Function of Power in Electrical Furnace (66DT-092) - The purpose of this test is to determine the circumferential and axial temperature variation of the element as a function of power level.
 - c. Evaluation of Hydrolysis Characteristics of Candidate NERVA Fuel (66DT-251) - The purpose of these tests is to understand better the fuel element hydrolysis mechanism and to develop effective hydrolysis prevention measures.

Start of the AXF matrix portion of these tests is dependent upon receipt of AXF elements/specimens from Y-12 with a projected delivery date of May 31, 1970. Later Y-12 deliveries may impact on the WANL test schedule but WANL will make every effort to minimize such impact.

- 2. Continue the development of the PyC process for use with full NERVA fuel graphite and composite matrix elements in the following areas:
 - a. Determination of mechanical properties, thermal cycling and corrosion tests effects.

PROJECT 721 - Continued

- b. Determination of the hydrolysis protection afforded by impregnation.
- c. Determination of the decrease in whole body leakage by accurate helium permeability tests.
- 3. Develop hydrocarbon monitoring techniques to evaluate extent of hydrolysis to composite and beaded elements.
- 4. Provide coating support for single element corrosion test hardware.
- 5. Initiate the WANHES single element composite corrosion test program by performing power supply capability check-out tests.
- 6. Reactivate WANL single element furnace for test and hardware development and for analytical support.
- 7. Conduct the WANL Single Element Composite Corrosion Development Test Program.
- 8. Operate WANHES Test Cell "B" to perform corrosion testing on a one shift basis.
- M-E 9. Publish Test Information Sheets (section 3.b) for the Phase I Composite Development Program.
- 10. Provide for corrosion testing of Y-12 HCTE graphite fuel elements (maximum of eight (8) per month) to standard WANL specifications.
- M-E 11. Perform corrosion testing of the five (5) remaining "crack-free experiment" elements in accordance with the test plan from item 13, Suffix f.
- 12. Perform shield temperature, exit gas temperature and voltage probe measurements using the WANL single element furnace.
- 13. Perform simulative corrosion testing of XE-Prime side-by-side and stored elements and evaluate corrosion behavior in comparison with that shown on six (6) XE-Prime elements covered in post-operative studies.

PROJECT 721 - Continued

Suffix i - Fabrication of Development Hardware

1. Continue the process improvement program directed at incorporating proven procedures for increased yield, improved quality and cost reduction into fabrication and testing.
 2. Close out and replace the existing R-1 graphite fuel fabrication and technology program (66DF-293) with a composite fuel element program based on LASL technology. From this program, produce candidate elements for the composite test program.
 3. Evaluate application of current coating technology to composite fuel relative to the corrosion and hydrolysis requirements of the R-1 fuel.
 4. Initiate and pursue a raw material evaluation program for composite fuel.
- M-7
5. Initiate fabrication, inspection and certification associated with products, materials and processes in support of PDR. Elements or test pieces will be provided for Scope of Tests 66DM304, 66DT248, 66DT251, 66DT092, 57DT174, and 66DM258.

Suffix y - PEWEE

1. Publish technical reports on fabrication accomplishments. A TME will be published for Test Specification 3016 effort.
2. Maintain liaison with AGC, SNPO, LASL and Y-12 on the design, analysis and development effort related to fuel elements and central elements.
3. Provide fuel production ordering and control for elements from WNCO and Y-12, including documents such as work orders, drawings, specifications, AR's and VR's.
4. Conduct the following PEWEE Development Tests to the degree consistent with hardware availability and issue DRM's documenting the status:
 - a. Fuel and Central Element Properties, PEWEE-2 (00DE-102) - The purpose of these tests is to determine the structural properties of PEWEE-2 high expansion elements in compression, tension and creep.

PROJECT 721 - Continued

- b. Element Flexure Testing (00DE-158) - These tests are to be used in establishing an analytical relationship between ultimate tensile and ultimate flexural strength of fueled and unfueled elements.
 - c. Heat Generation Rate Adequacy of PEWEE-2 Candidate Elements (00DF-316) - The purpose of these tests is to determine allowable heat generation rates to verify the adequacy of PEWEE-2 candidate elements.
 - d. Fuel Element Hot End Evaluation (00QT-313) - The purpose of these tests is to evaluate the effects of hot gas testing on hot end coating and joint integrity of PEWEE-2 candidate fuel elements.
 - e. Element End Cyclic Capability (00DM-175) - These tests subject PEWEE-2 fuel and central elements to simulated reactor environment to aid in evaluating cyclic effects on tip integrity.
 - f. Fuel and Central Element Property Development (00DM-196) - These tests are used to determine basic materials properties data for fuel and central elements.
- 5. Provide the elements or element test pieces for the tests delineated in item no. 4, above.
 - 6. Provide the fuel element engineering, fabrication, quality control and management activities required to complete the delivery of the PEWEE-2 fuel and continue the engineering post-op evaluation for PEWEE-2.
 - 7. Conduct PEWEE-2 single element pre-production corrosion testing.
 - 8. Conduct PEWEE-2 single element quality control corrosion testing.
 - 9. Supply R-1 type experimental hardware for a PEWEE-2 experiment.
 - 10. Completion of the AXF portion of the tests in items 4 and 8 is dependent upon receipt of AXF elements/specimens from Y-12, which is projected to be May 31, 1970. Later Y-12 deliveries may impact on the WANL schedule, but WANL will make every effort to minimize such impact.

PROJECT 721 - Continued

- A-7 11. Provide the fuel element engineering, fabrication, quality control, and management activities required to complete the fabrication and delivery of the Y-12 AXF PEWEE-2 matrix elements.
- A-7 12. Provide the fuel element engineering, fabrication, quality control, and management activities required to fabricate through graphitization eighteen (18) AXM Code 200 elements for LASL PEWEE-2 segmented elements and 235 AXF back-up elements for the Y-12 PEWEE-2 matrices.
- A-7 13. Provide the required engineering for drawing revisions, scope of test revisions, issuance of ERCO's for coating the Y-12 AXF matrix and producing WNCO AXF backups to these elements through graphitizing.
- A-7 14. Provide quality inspection for the receipt, inspection and release of Y-12 AXF elements, in the as-leached condition, to WNCO.

PROJECT 722 - CLUSTER HARDWARE

Suffix f - Development Engineering

1. NSS DRB Data Submittal

- a. Provide support for preparation of the Cluster Hardware Specification, Data Item C-002.
- b. Complete the Cluster Hardware Concepts Trade Study (TS-751) and the Stem and Hot End Hardware Trade Study (TS-761) and publish as Data Item S-054.

2. NSS and Component PDR Data Submittal

M-6	a. Formulate design arrangements utilizing cold end primary support of the cluster assembly for the present central element cross section. Initiate analytical evaluations of these arrangements in terms of the cluster hardware requirements in preparation for trade study. Initiate trade study to determine relative merits of cold end and hot end cluster support arrangements for R-1 selection.
M-6	b. Provide support for the updating of the Cluster Hardware Specification, Data Item C-002.
3. Issue Test Information Sheets (part 3.a) and prepare and release drawings as necessary for materials test specimens used to obtain the Cluster Hardware material properties data identified in Projects 781, 782 and 787.
 4. Issue Test Information Sheets (part 3.a) for the following key development tests in support of the cluster assembly component development:

	<u>Title</u>	<u>Purpose</u>
M-E	Standoff, Tungsten Cluster Corrosion Test with Stem	To establish structural and cooling adequacy of tungsten hot end hardware and stem assembly, especially in turnaround region.
	High Temperature Overload Test	Determine elevated temperature structural properties.

PROJECT 722 - Continued

<u>Title</u>	<u>Purpose</u>
Hot End Hardware Creep Test	Determine cyclic creep characteristics of hot end hardware at elevated temperatures.
5. Consideration shall be given in the design to provide protection against loss of coolant.	
6. Major emphasis shall be applied in maximizing reactivity swing in the support stems.	
7. Tests shall be conducted to evaluate the effects of cyclic operation as well as material creep.	
8. Evaluate the impact of creep on the overall assembly using creep test data obtained from planned tests.	
9. Consideration shall be given to the utilization of insulation to maximize reactivity swing and minimize effects of radiation.	
10. Failure mode studies and means of prevention shall be part of the development design information.	
11. Provide studies and tests for the purpose of improving coatings necessary for protection of liners from carburization.	
12. Evaluate and report on design employing reversal of flow and placing structural loads on the outer tubes.	
13. Provide enough information on thoriated tungsten used in CHESH designs by PDR to prove that:	
a. fabricability is feasible (by demonstration).	
b. application is feasible.	

PROJECT 722 - Continued

- A-6 14. Cancell all work pertaining to the use of Inconel 718 and Inconel 625 as stem assembly materials. Issue Test Information Sheet for manufacturing development on A-286 stems and liner tubes. Design and make drawings for 24 short length weld specimens capable of pressure testing. Issue Test Information Sheet to initiate pressure testing of A-286 specimen hardware.
- A-6 15. Perform additional work on maximizing reactivity swing in accordance with
D-E Change Order W70-6.
- A-6 16. Perform additional work in support of parametric studies varying stem insulation
D-E for the purpose of maximizing reactivity swing in accordance with Change Order W70-6.
- A-6 17. Perform design work to support the evaluation of the interface conditions between cluster hot end hardware and each of the following types of fuel: high CTE graphite, composite, hybrid.

Suffix g - Development Testing

1. Perform the following key tests in support of the cluster assembly component development. Document and publish the completed test results as indicated:

Title	Purpose
Cluster Attachment Seal Leakage (58DT-151)	Demonstrate adequacy of arrangement and determine expected leakage rates.
NERVA Cluster Corrosion (57DT-174) (Composite Model) (Issue DRM)	Establish structural adequacy of the Hot End Hardware.

PROJECT 725 - CORE PERIPHERY

Suffix f - Development Engineering

1. NSS DRB Data Submittal
 - a. Provide support for preparation of the Core Periphery Specification, Data Item C-002.
 - b. Complete the trade study for NERVA Core Periphery Design Concepts No. 752 and publish as Data Item S-054.
- A-6 c. Perform a periphery thickness requirement study to justify the minimum thickness to be included in the NSS radial dimension optimization study.
- M-6 2. Initiate work leading to the preliminary design trade study for the core periphery.
- M-6 3. Issue Test Information Sheets (part 3a) and prepare and release drawings as necessary for materials test specimens, including corrosion resistant periphery materials, used to obtain the core periphery materials properties data identified in projects 781, 782, and 787. This also includes the Test Information Sheets and drawings required for the following preliminary material evaluation and screening tests performed to identify promising corrosion resistant material candidates.

<u>Title</u>	<u>Purpose</u>
Corrosion Resistant Periphery Materials Thermal and Mechanical Properties Test	To determine selected thermal and mechanical characteristics of corrosion resistant periphery materials.
Insulator Corrosion and Chemical Stability Test (TIS-DT-034)	To evaluate the degradation of corrosion resistant insulator specimens due to corrosion or chemical instability in pure gases.
Corrosion Resistant Periphery Material Manufacturability Test	To evaluate and develop vendor capability to fabricate, machine and coat corrosion resistant periphery materials.

PROJECT 725 - Continued

- M-6 4. Complete a corrosion resistant core periphery study layout for use as an initial reference concept for support of the NSS Reference Design and for use in the early design of component tests. Continue conceptual studies to provide improved corrosion resistant core periphery designs.
- M-6 5. Prepare a plan for the corrosion resistant periphery development and expedite the plan, particularly the procurement phase of the manufacturing feasibility part of the plan. The plan shall include as a minimum, the four most promising materials.
- M-6 6. Issue Test Information Sheets (part 3a) and provide engineering as necessary for the following early development tests in support of the core periphery development. Continue to follow and provide engineering as necessary to support the development tests identified in Suffix g.

<u>Title</u>	<u>Purpose</u>
Corrosion Resistant Periphery Friction Tests (TIS-DE-088)	To measure dynamic and breakaway friction coefficients of friction of selected candidate material interfaces in the corrosion resistant periphery under simulated reactor environments.
Periphery Corrosion Resistant Insulation Axial Flow Impedance Test (TIS-DE-068)	Demonstrate the axial flow impedance of short lengths of flexible corrosion resistant material candidates under cycles of temperature and load.
Metal Wrapper Cyclic Strain and Buckling Test (TIS-DE-094)	To determine the cyclic strain and buckling characteristics of short lengths of the metal wrapper design with simulated core expansions and a range of axial loads.
Corrosion Resistant Insulation Transient Thermal Gradient Test (TIS-DE-092)	To evaluate capability of short lengths of selected corrosion resistant insulation design to withstand temperature gradients under simulated core bundling constraints.

PROJECT 725 - Continued

<u>Title</u>	<u>Purpose</u>
Simplified Full Length Corrosion and Chemical Stability Test of Corrosion Resistant Insulation (TIS-DT-067)	To determine corrosion and chemical stability characteristics of corrosion resistant insulation over full length environmental conditions.
Corrosion Resistant Periphery Thermal and Mechanical Interaction Test (TIS-DT-076)	To determine full length radial and axial movement and interactions of corrosion resistant material and wrapper under simulated core expansion and bundling loads.

D-6 7.

Suffix g - Development Tests

- M-6 1. Perform the following key tests in support of the Core Periphery development. Document and publish the completed test results as indicated.

<u>Title</u>	<u>Purpose</u>
Corrosion Test (64DT-211) (Issue T-119)	Determine corrosion behavior of the insulating layers as affected by high expansion fuel motions.
Corrosion Test (64DT-212) (Issue T-119)	Determine gross effects of corrosion on pyrofoil in a "simulated" reactor configuration.
Periphery Axial Flow Impedance for Comparison of Wrapper Material (64DE-070) (Issue DRM)	Demonstrate that selected wrapper design components will impede axial flow between the wrapper/insulation and the fuel boundary.
Outgassing & Vaporization Effect of Pyrofoil Layers Bonded with Petrolatum (64DE-312) (Issue T-119)	Evaluate outgassing and vaporization of materials during simulated transient conditions.

PROJECT 725 - Continued

<u>Title</u>	<u>Purpose</u>
Thermal Expansion of R-1 Pyrofoil Insulation (64DE-310) (Issue T-119)	Determine cyclic thermal expansion effects of thermalized and re-rolled pyrofoil.
R-1 Coated Interface Friction Test (64DE-098) (Issue DRM)	Determine coefficient of friction between various periphery materials
Pyrofoil Material Ductility Test (Issue DRM)	Determine properties of pyrofoil at various temperatures and strain rates.
Flexing Periphery Wrapper at Simulated Core Expansion (64DE-049) (Issue DRM documenting status at time of cancellation)	Determine capability of wrapper to withstand core expansions.
Periphery Axial Load Test (64DE-073) (Issue T-119)	Determine axial load capability of filler strips and associated hardware.
Measurement of Vapor Pressure of Petrolatum . (64DP-309) (Issue DRM)	Determine rate of vaporization, chemical composition and vapor pressure of petrolatum adhesive.
Five-Inch Axial Length Periphery Evaluation Test (64DT-317) (Issue T-119)	Determine pyrofoil characteristics under rapid decompression.
Cyclic Strain Test (64DT-031) (Issue DRM)	Determine cyclic strain characteristics under rapid decompression.

PROJECT 725 - Continued

	<u>Title</u>	<u>Purpose</u>
	Insulator Corrosion Screening Test (TIS-64DT-034) (Document available results by DRM)	Subject various candidate periphery materials to hydrogen or hydrogen/ methane environment to obtain a relative measure of corrosion resistance.
M-6 2.	Conduct a corrosion resistant periphery component manufacturing techniques program and document the work accomplished by DRM.	
A-6 3.	Initiate design and procurement of long lead hardware in support of the following tests:	
	Corrosion Resistant Periphery Friction Tests (TIS-DE-088)	To measure dynamic and breakaway friction coefficients of friction of selected candidate material interfaces in the corrosion resistant periphery under simulated reactor environments.
	Periphery Corrosion Resistant Insulation Axial Flow Impedance Test (TIS-DE-068)	Demonstrate the axial flow impe- dance of short lengths of flexible corrosion resistant material candi- dates under cycles of temperature and load.
	Metal Wrapper Cyclic Strain and Buckling Test (TIS-DE-094)	To determine the cyclic strain and buckling characteristics of short lengths of the metal wrapper design with simulated core expansions and a range of axial loads.
	Corrosion Resistant Insulation Transient Thermal Gradient Test (TIS-DE-092)	To evaluate capability of short lengths of selected corrosion resistant insula- tion design to withstand temperature gradients under simulated core bundling constraints.

PROJECT 725 - Continued

<u>Title</u>	<u>Purpose</u>
Simplified Full Length Corrosion and Chemical Stability Test of Corrosion Resistant Insulation (TIS-DT-067)	To determine corrosion and chemical stability characteristics of corrosion resistant insulation over full length environmental conditions.
Corrosion Resistant Periphery Thermal and Mechanical Interaction Test (TIS-DT-076)	To determine full length radial and axial movement and interaction of corrosion resistant material and wrapper under simulated core expansion and bundling loads.

Suffix i - Fabrication of Development Hardware

- M-6 1. Provide core periphery components and specimen fabrication for development testing specified in Suffix g.

PROJECT 726 - SUPPORT PLATE AND PLENA

Suffix f - Development Engineering

1. NSS DRB Data Submittal
 - a. Provide support for preparation of the Support Plate and Plena Specification, Data Item C-002.
 - b. Complete the NERVA Support Plate and Plena Design Concepts Trade Study and publish as Data Item S-054 (TS-762).
 2. NSS and Component PDR Data Submittal
 - M-6 a. Initiate the appropriate chapters of the following data items:

E-105	Engineering Data - Design Evaluation
S-031	Thermal and Fluid Flow Analysis Report
M-6 S-036	Structural Analysis Report
S-039	Loads Report
S-110	Radiation Effects Analysis Report
 - M-6 b. Initiate support for preparation of the following data items:

S-100	Radiation and Shielding Analysis Report *
S-101	Nuclear Analysis Report *
 - M-6 c. Initiate effort leading to a DRM documenting the Support Plate and Plena input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
 - M-6 d. Initiate effort leading to a DRM documenting the Support Plate and Plena Failure Mode Analysis as input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
 - M-6 e. Initiate effort leading to the updating of the Support Plate and Plena Specification, Data Item C-002, to include Section 4 and requirements that are a product of the design process and update Section 3 to include the results of engine transient analysis as required.
- M-6 * The Support Plate and Plena Chapter of Data Items S-100 and S-101 will be initiated by Projects 714 and 712, respectively.

PROJECT 726 - continued

3. Issue Test Information Sheets (part 3a), and prepare and release drawings as necessary for materials test specimens used to obtain the Support Plate and Plena materials properties data identified in Projects 781, 782, and 787.
- A-6 4. Formulate design arrangements that will provide increased rigidity to the core support plate using the present basic concept, weight and space characteristics. Evaluate these arrangements against the support plate requirements and issue a DRM documenting the results of the evaluation study.
- A-6 5. Cancel all work pertaining to the use of 2219 aluminum. Select several aluminum alloys suitable to ductile analysis in accordance with SNPO-C-1. Evaluate these alloys against the support plate material requirements and issue a DRM documenting the results of the evaluation selecting the alloy for use in R-1.
- A-6 6. Perform axial optimization study to minimize NSS length.

Suffix g - Development Testing

1. Update and issue revised test plans for the following tests in support of the Support Plate and Plena development:

<u>Title</u>	<u>Purpose</u>
Plena Mixing Test (61 DT-154)	To determine plate wall temperature distribution in stem discharge plenum.
Support Stem Inlet Plenum Test (61 DT-188)	To determine flow impedance of passages in the inlet plenum.

2. Complete modifications to WANHES Test Cell "A" required to support the above tests.
3. Provide engineering, drafting and support services for the conceptual design modification and maintenance of AEC Capital Equipment for WANHES Test Cell "A".

Suffix i - Fabrication Development

1. Provide Support Plate and Plena hardware fabrication for tests listed in Suffix g.

PROJECT 727 - INTERNAL SHIELD

Suffix f - Development Engineering

1. NSS DRB Data Submittal
 - a. Provide support for preparation of the Internal Shield Assembly Specification, Data Item C-002.
 - b. Complete the Internal Shield Design Concepts Trade Study and publish as Data Item S-054 (TS-765).
2. NSS and Component PDR Data Submittal
 - M-6 a. Initiate the appropriate chapters of the following data items:

E-105	Engineering Data - Design Evaluation
S-031	Thermal & Fluid Flow Analysis Report
M-6 S-036	Structural Analysis Report
S-110	Radiation Effects Analysis Report
S-039	Loads Report
 - b. Provide Support for preparation of the following data items:

S-100	Radiation and Shielding Analysis Report *
S-101	Nuclear Analysis Report *
 - M-6 c. Initiate effort leading to a DRM documenting the Internal Shield input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
 - M-6 d. Initiate effort leading to a DRM documenting the Internal Shield Failure Mode Analysis as input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
 - M-6 * The Internal Shield Chapter of Data Items S-100 and S-101 will be initiated by Projects 714 and 712, respectively.

PROJECT 727 - continued

- M-6 e. Initiate effort leading to the updating of the Internal Shield Specification, Data Item C-002, to include Section 4 and requirements that are a product of the design process and update Section 3 to include the results of the engine transient analysis, as required.
3. Issue Test Information Sheets (part 3a), and prepare and release drawings as necessary for materials test specimens used to obtain the Internal Shield materials properties data identified in Projects 781, 782 and 787.
4. Issue Test Information Sheets (part 3a) for the following key development tests in support of the Internal Shield component development.

<u>Title</u>	<u>Purpose</u>
Load Deflection and Vibration Test	Demonstrates load carrying capability of shield supporting structure.
Thermal Shock of Shield Element	Provide information on thermal shock capability of shield material (BATH) with Spec. Grade Material and additional cycles.

- D-11 Flow Characteristics Test
- A-6 5. Issue Test Information Sheets (part 3a) to determine if BATH material can be extruded to final size and shape.
- A-6 6. Issue Test Information Sheets (part 3a) to determine if BATH will withstand high radiation under cryogenic conditions without spalling or cracking.
- A-6 7. Prepare a program plan for implementation of a backup shield material and implement the plan upon receipt of government approval.
- A-6 8. Issue Test Information Sheets (part 3a) and release drawings for alternate shield material test specimens necessary for obtaining the materials properties data.
- A-6 9. Perform an axial optimization study to minimize NSS length.
- A-11 10. Provide effort as required to support the neutron streaming effect experiment being performed at Gulf General Atomics Incorporated.

PROJECT 727 - continued

Suffix g - Development Testing

- M-E 1. Perform the following key tests in support of the shield modules development. Document and issue the test results as Data Item T-119.

<u>Title</u>	<u>Purpose</u>
Thermal Shock of Shield Element (62DT-189)	Provide information on thermal shock capability of shield material (BATH).
Shield Element Corrosion (62DT-190)	Determine effect of shield material in contact with supporting structure material and reactor coolant.

2. Complete the design for procurement of the experimental setup for the following tests:

a. Load Deflection and Vibration Tests

D-11 b.

Suffix i - Fabrication of Development Hardware

1. Provide Internal Shield hardware fabrication for the tests listed in Suffix g.
- A-11 2. Fabricate and make available to Gulf General Atomics Incorporated a BATH test section suitable to represent the plenum supply ducts in the shield.

PROJECT 728- REFLECTOR ASSEMBLY

Suffix f - Development Engineering

1. NSS DRB Data Submittal

- a. Provide support for preparation of the Reflector Assembly Specification, Data Item C-002.
- b. Complete the trade study for NERVA Reflector Assembly Design Concept No. 763 and publish as Data Item S-054.
- A-6 c. Select an aluminum alloy other than 2219 for the aluminum support structure. Document the selection by DRM.
- A-6 d. Size the Aluminum/Beryllium reflector assembly optimizing all parameters to obtain the minimum O.D. Document results in a DRM.
- A-6 e. Determine feasibility of moving the reflector closer to the nozzle/pressure vessel flange. Document results in a DRM.
- A-6 f. Issue a preliminary drawing of the reflector assembly based on an assumptions list for input to the NSS Reference Design.

2. NSS and Component PDR Data Submittal

- M-6 a. Initiate work on the following data items:
 - E-105 Engineering Data - Design Evaluation
 - S-031 Thermal and Fluid Flow Analysis Report
 - S-036 Structural Analysis Report
 - S-039 Loads Report
 - S-110 Radiation Effects Analysis Report
- b. Provide support for preparation of the following data items:
 - S-100 Radiation and Shielding Analysis Report*
 - S-101 Nuclear Analysis Report*

* The Reflector Assembly Chapter of Data Items S-100 and S-101 will be prepared by Projects 714 and 712, respectively.

PROJECT 728 - Continued

- D-6 c.
- M-6 d. Initiate Reflector Assembly Failure Mode Analysis as input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
- D-6 e.
- A-6 f. Provide input to ANSC for a trade study (S-054 data item) of the nozzle-to-reflector joint and seal. Document this input by DRM.
- A-6 g. Initiate a trade study for the lateral support system on designs intended to satisfy vacuum requirements of 10^{-9} torr.
- 3. Issue Test Information Sheets (part 3.a) and prepare and release drawings as necessary for materials test specimens used to obtain the reflector assembly materials properties data identified in Projects 781, 782 and 787.
- M-6 4. Initiate Test Information Sheets (part 3a) for the following key development tests in support of the reflector component development:

<u>Title</u>	<u>Purpose</u>
Attachment of Beryllium Blocks to Cylinder	Verify assembly techniques for attachment of blocks to the reflector cylinder.
Partial Length Reflector and Lateral Support Test	Prove dynamic stability, assembly techniques and static capability.
Reflector Model Buckling Test	To verify buckling loads under external hoop loads.
Flow Characteristics at Reflector Block Interfaces (TIS-DT-071)	Verify coolant flow through the reflector.
Seal Flow Testing Including Scarf Joint TIS-DT-070)	Determine the axial flow and sealing characteristics of the LSS seals.
Capsule Leakage Test (TIS-DE-072)	Experimentally determine material inflow caused by the spring and plunger penetrations in the reflector.

PROJECT 728 - Continued

- A-6 5. Issue Test Information Sheets (part 3a) and prepare and release drawings and provide engineering support as necessary for the following key development tests in support of the reflector component development:

Title	Purpose
Friction Tests of Impregnated or Coated Lateral Support System Components	To investigate ways of maintaining consistent coefficients of friction at the sliding surfaces of the lateral support system for all operating and non-operating conditions.
Vacuum Testing of Control Drum Bearings	To investigate ways of coating or modifying the control drum bearings to operate after being exposed to hard vacuums of 10^{-9} torr.
Post-Vacuum Sliding Characteristics of Various Material Combinations in the Reflector Assembly	To investigate the sliding characteristics of various material combinations after being exposed to hard vacuums of 10^{-9} torr.
Grafoil Inserts Decompression Test	Confirm structural integrity after reactor rate decompression.

Suffix g - Development Testing

1. Perform the following key tests in support of the Reflector Assembly development. Document and issue the completed tests results as indicated:

<u>Title</u>	<u>Purpose</u>
Slotted Be Reflector Thermal Response Test (59DT-171) (Issue DRM)	To verify calculation procedures for structural design

PROJECT 728 - Continued

<u>Title</u>	<u>Purpose</u>
Resistance to Erosion of Grafoil (59DT-119) (Issue T-119)	Determine the resistance of the grafoil insert location between the lateral support system and reflector to erosion from seal leakage flows.
Grafoil Set Test (63DE-205) (Issue T-119)	Determine permanent set of grafoil.
Plunger Pin Friction Test (63DE-214) (Issue T-119)	Determine variation in friction due to cycling.
Friction Coefficients of Graphite (TIS-022) (Initiate testing)	Determine variation in friction due to cycling and partial vacuum.
Biaxial Stress Test (59DE-082) (Issue T-119)	Determine the effect of biaxial stress on the mechanical behaviour of beryllium.

D-6,E 2.

A-6 3. Initiate the design of fixtures for the following key development tests:

<u>Title</u>	<u>Purpose</u>
Friction Tests of Impregnated or Coated Lateral Support System Components	To investigate ways of maintaining consistent coefficients of friction at the sliding surfaces of the lateral support system for all operating and non-operating conditions.
Vacuum Testing of Control Drum Bearings	To investigate ways of coating or modifying the control drum bearings to operate after being exposed to hard vacuums of 10^{-9} torr.

PROJECT 728 - Continued

<u>Title</u>	<u>Purpose</u>
Vacuum Testing of Control Crum Splines	To investigate ways of coating or modifying the control drum splines to operate after being exposed to hard vacuums of 10^{-9} torr.
Post-Vacuum Sliding Charac- teristics of Various Material Combinations in the Reflector Assembly	To investigate the sliding characteristics of various material combinations after being exposed to hard vacuums of 10^{-9} torr.

Suffix i - Fabrication of Development Hardware

1. Provide reflector, control drum and axial support fabrication for development testing specified in Suffix g.
- M-6 2. Initiate procurement of long-lead material required to support the tests specified in item 5, Suffix f.

PROJECT 731 - CONTROL DRUM DRIVE SYSTEM

Suffix b - Technology Engineering

1. Issue the XE actuator test performance input to the XE Final Report.

Suffix f - Development Engineering

1. Complete the selection of the primary control drum drive assembly candidates for conceptual design study. Conduct sufficient design analyses to demonstrate that candidate designs can meet the known requirements and can be manufactured. Complete the selection of the control drum drive assembly for the reference engine.
 2. NSS DRB Data Submittal
 - a. Provide support for preparation of the Control Drum Drive System Specification, Data Item C-002.
 - b. Publish Control Drum Drive System Trade Study No. 754.
 - c. Complete the Control Drum Drive System Design Trade Study No. 764 to support the selection of a single concept for detail design effort.
 - d. Publish the Control Drum Drive System Design Trade Study No. 764.
- M-6 3. NSS and Component PDR Data Items
- a. Prepare DRM's documenting the completion of the following data item chapters:

E-105	Engineering Data - Design Evaluation
S-110	Radiation Effects Analysis Report
 - b. Initiate preparation of analyses in support of the following data items:

S-031	Thermal and Fluid Flow Analysis Report
S-036	Structural Analysis Report
S-039	Loads Report

PROJECT 731 - continued

- c. Provide support for preparation of the following data items:

S-100 Radiation and Shielding Analysis Report *
R-201 Maintainability Allocations, Assessments and Analysis

- d. Issue a DRM documenting the Control Drum Drive System input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
- e. Issue a DRM documenting the Control Drum Drive System Failure Mode Analysis as input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
- f. Provide support for updating of Control Drum Drive System Specification, Data Item C-002, to include Section 4 and requirements that are a product of the design process and update Section 3 to include the results of the engine transient analysis as required.

M-E 4. Initiate design of development test hardware fixtures for prototype feasibility tests.

A-6 5. Conduct preliminary evaluation of effect of hard vacuum (10^9) on CDDS.

Suffix g - Development Testing

1. Perform the following key tests in support of the Control Drum Drive System development:

<u>Title</u>	<u>Title</u>
Perform Testing of CDA Potentiometer Candidates for the NERVA Reactor (TIS 16.1)	This test is to obtain comparative data for the candidate potentiometers and a knowledge of the manufacturer's construction techniques.

- * The Control Drum Drive System chapter of Data Item S-100 will be prepared and published by Project 714.

PROJECT 731 - continued

2. Publish Test Information Sheets (part 3a) for the following key development tests in support of the Control Drum Drive System design.

<u>Title</u>	<u>Title</u>
Actuator Amplifier Evaluation	To evaluate performance characteristics under simulated reactor control system conditions.
Actuator Motor Evaluation	To determine the operating characteristics of the selected motor under dynamic loads and expected environments.
Actuator Transmission Evaluation	To determine the operating characteristics of the selected transmission under dynamic loads and expected environments.
Actuator Feedback Device Evaluation	To determine the operating characteristics of the selected feedback device under dynamic loads and expected environments.
Actuator Housing, Connector and Mounting Test	To determine structural adequacy of housing, mounting and connector under operating pressures, loads and environments.
Development Actuator Test	To determine operating characteristics of a complete actuator assembly. Also performance parameters under expected loads and environments.
Actuator Malfunction Override Device	To determine operating characteristics of an AMOD under expected loads and environments.

Suffix i - Fabrication

1. Initiate fabrication of hardware as required to support the development program specified in Suffix g.

PROJECT 741 - STRUCTURAL SUPPORT COOLANT VALVE ACTUATOR (SSCVA)

Suffix f - Development Engineering

1. Adapt the results of the CDDS Trade Study No. 764 to a design for a SSCVA.
2. NSS DRB Data Submittal:
 - a. Provide support for preparation of the SSCVA Specification, Data Item C-002.
 - b. Publish Trade Study No. 755, Actuator Trade Study - SSCVA, and publish as Data Item S-054.
- M-6 3. NSS and Component PDR Data Items:
 - a. Prepare DRM's documenting the completion of the following data item chapters:

E-105	Engineering Data - Design Evaluation
S-110	Radiation Effects Analysis Report
 - b. Initiate preparation of analyses in support of the following data items:

S-031	Thermal and Fluid Flow Analysis Report
S-036	Structural Analysis Report
S-039	Loads Report
 - c. Provide support for preparation of the following data items:

S-100	Radiation and Shielding Analysis Report*
R-201	Maintainability, Allocations, Assessments and Analysis
 - d. Issue a DRM documenting the SSCVA input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
 - e. Issue a DRM documenting the SSCVA Failure Mode Analysis as input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
 - f. Provide support for updating the SSCVA Specification, Data Item C-002, to include Section 4 and requirements that are a product of the design process and update Section 3 to include the results of the engine transient analysis as required.

*The structural Support Coolant Valve Actuator chapter of Data Item S-100 will be prepared and published by Project 714.

PROJECT 751 - NUCLEAR SUBSYSTEM INSTRUMENTATION

Suffix b - Technology Engineering

1. Review and comment on XE disassembly procedures.
2. Provide engineering support to NRDS during partial disassembly of XE Prime and remain cognizant of WANL instrumentation status.
3. Issue instrumentation chapters for XE Prime Final Report.

Suffix f - Development Engineering

1. Complete the sensor selection and issue DRM for low and medium temperature measurements to meet the requirements of the Nuclear Subsystem Instrumentation C-002 Specification.
- M-6 2. Complete and publish DRM for concept studies to select prime and alternate candidate transducers and systems for development to meet the requirements of the NSS Instrumentation Specification as listed below:
 - a. Strain gages for measurement of strain on components within the nuclear subsystem.
 - b. Thermocouples for measurement of in-core temperatures to meet cyclic and reliability requirements.
 - M-E c. Displacement transducers for measurement of the magnitude and frequency of displacement of NSS components.
 - d. Demodulator for carrier transducers such as LVDT's and variable reluctance devices.
 - e. Thermocouples for measurement of core exit gas temperatures.
 - f. In-vessel neutronic instrumentation for measurement of NSS neutron and gamma flux levels.
 - g. In-vessel absolute and differential pressure transducers for measurement of various NSS pressures.
 - h. Vibration transducers for various NSS acceleration measurements.

PROJECT 751 - Continued

- D-E 3.
- D-6 4.
5. Publish planning TIS (part 3. a) for non-nuclear development testing of candidate transducers and systems selected by the trade studies of 2 above.
6. Prepare input for the C-002 NSS Instrumentation Specification.
- M-6 7. Initiate preparation of the following chapters for the Category "A" and "B" sensors which includes the low and medium temperature sensors, the high temperature in-core material sensor and the high-temperature exit gas sensor. All other sensors/transducers are Category "C" components and will be covered in Trade Study Report TS-792.
- a. E-105 Engineering Data - Design Evaluation
 - b. S-031 Thermal and Fluid Flow Analysis Report
 - c. S-036 Structural Analysis Report
 - d. S-110 Radiation Effects Analysis Report*
- D-6 8.
- A-E 9. Provide support to ANSC on the following interface projects:
- a. Measurement Engineering Plan and Flight Engine MRL.
 - b. Wiring Harness EC 090179.
- A-6 10. Update comparison matrix DRM's of 2 above and sensor selection DRM of 1 above leading toward Trade Study Report TS-792, Data Item S-054, as required to meet the changes per Change Order W70-6 of requirements of the Nuclear Subsystem Instrumentation Specification.

*The Nuclear Subsystem Instrumentation chapter of Data Item S-100 will be prepared and published by Project 714.

PROJECT 751 - Continued

Suffix i - Fabrication of Development Hardware

1. Fabricate partial and completed thermocouples in support of the development testing for exit gas and core material thermocouple measurements.
2. Fabricate strain gage installation in support of installation application development for strain and displacement measurements.
3. Fabricate test fixtures in support of development testing.
4. Fabricate breadboard modules of demodulators in support of LVDT transducer development testing.
5. Fabricate displacement transducer utilizing Rolomite design concept in support of development testing.

PROJECT 781 - NON-FUEL MATERIALS DEVELOPMENT

Suffix f - Development Engineering

1. Execute the WANL sections of the NERVA Reactor Materials Program as defined by Data Item S-131.
 - a. Review all drawings, specifications, AR's, VR's and ERCO's and indicate compliance with materials requirements by sign-off.
 - b. Submit a monthly Materials Data Priority and Maturity Plan.
 - c. Provide ANSC the available statistical quality "A" or "B" materials data on DRM format for quarterly updating of the NERVA Materials Properties Data Book ANSC-2275.
 - d. Prepare and issue information on NERVA reactor materials as part of the NERVA Quarterly Progress Report.
 - e. Maintain liaison with ANSC, LASL, and SNPO on development efforts related to the Materials Program.
 - f. Provide consultation and information on materials to Design for trade studies, DRB and PDR use as required.
2. Write all specifications and maintain the file of materials, process and product specifications.

Suffix g - Development Testing

M-6	1. Perform tests, collect, collate, compile and provide Reactor Design with statistically evaluated materials properties data in accordance with SNPO-C-1, the Reactor Materials Program Plan and related directives. Issue a Data Release Memorandum (DRM) on the following tests as they are completed in accordance with the schedule in the Materials Data Priority and Maturity Plan of June 1970. The degree of completion in CY 1970 of these tests is defined in the Material Property Test Priority and Maturity Plan of June 1970.
M-6	a. DM-240, Inconel 718 Tube and Bar. Terminate work at status of 4/30/70.
M-6	b. DM-242, Ti, 5 Al, 2.5 Sn, Forging. Terminate work at status of 4/30/70.
M-6	c. DM-243, Ti, 5 Al, 2.5 Sn, Bar. Terminate work at status of 4/30/70.

PROJECT 781 - Continued

- d. DM-252, Beryllium, Hot Pressed
 - e. DM-178, Beryllium, Fracture Mechanics
 - f. DM-273, Al 6061 T 651 Plate
 - g. DM-277, A286 Bar
 - D-6 h. DM-220, Boral Sheet
 - M-6 i. DM-180, Control Plate CuB_{10}
 - D-6 j. DM-198, Poison Plate Cubn
 - M-6 k. TIS-A1 6061 61 Forging
 - l. DM-254, 301 Stainless
 - m. DM-219, 304 Stainless
 - M-6 n. Inconel 625. Terminate work at status of 4/30/70.
 - o. DM-332, A286 Tube, Sheet and Strip
 - M-6 p. DM-320, Al 6061T61 Barrel
2. Plan and institute an experimental program to assess the seriousness of the effects of high pressure H_2 on mechanical properties of NERVA reactor materials.
 3. Conclude the investigation of hydrogen-pressure-temperature effects on titanium, 5Al, 2.5 Sn Alloy and report results (DM-179).
 4. Monitor the fuel outgassing studies at ORNL.

Suffix i - Fabrication of Development Hardware

1. Conclude the development of processing procedures for the BATH shielding material with a final report (DM-201).

PROJECT 781 - Continued

2. Conclude the development of processing procedures for the copper-boron control vane and poison plate material with a descriptive report (DM 180, 198)
3. Conclude the orifice-fuel element brazing procedure development with a final report (DM-033).
4. Provide specimens for radiation effects testing in accord with Materials Property Test Priority and Maturity Plan.
- M-6 5. Institute development effort on welding A286 Tubing to the configuration required for NERVA.
- M-6 6. Provide materials evaluation, estimate properties and plan data acquisition for alternate shield material.
- M-6 7. Evaluate alternate spring materials for 301 SS and Inconel 718.

PROJECT 782 - GRAPHITE, COMPOSITES AND FUEL PROPERTIES DEVELOPMENT

Suffix f - Development Engineering

1. Prepare materials input to NERVA Reactor Quarterly Progress Report.
2. Execute the WANL sections of the NERVA Reactor Materials Program as defined by Data Item S-131.

Suffix g - Development Testing

- M-6
1. Perform tests, collect, collate, compile and provide reactor design with statistically evaluated materials properties data in accordance with SNPO-C-1, the Reactor Materials Program Plan, and related directives. Issue a Data Release Memorandum (DRM) on the following tests as they are completed in accordance with the schedule in the Materials Data Priority and Maturity Plan of June 1970. The degree of completion in CY 1970 of these tests is defined in the Materials Data Test Priority and Maturity Plan of June, 1970.
 - a. DM-194, R-1 Hot End Composite Properties
 - b. DM-305, R-1 Hot End Composite Fracture Mechanics
 - c. DM-210, Corrosion Test of Hot End Composites
 - d. DM-206, Pressurized Pyrographite Foil Laminates, Thermal Conductivity
 - e. DM-259, Pyrofoil Laminates Properties
 - f. DM-192, Unlaminated Pyrographite Foil Thermal Conductivity
 - g. DM-224, Flat Pyrofoil, Thermalized Rerolled, Properties
 - h. DM-325, Properties of Tungsten Thoria Extruded Rod
 - i. DM-222, Hard Pyrographite Tile
 - j. DM-223, Graphitite G
 - k. DM-283, ZTA Graphite
 - l. DM-284, PO-3 Graphite

PROJECT 782 - Continued

	m.	DM-304, Fracture Mechanics of Graphite and Central and Fuel Material
M-6	n.	TIS 17, Literature Search, Non-Corrodible Periphery
A-6	o.	TIS 31, ZrC, Preliminary Materials Evaluation Non-Corrodible Periphery
A-6	p.	TIS 33, ZrC/ZrO ₂ Preliminary Materials Evaluation Non-Corrodible Periphery
A-6	q.	TIS 45, ZrO ₂ Preliminary Materials Evaluation Non-Corrodible Periphery
A-6	r.	TIS 48, ZrC Foam, Preliminary Materials Evaluation, Non-Corrodible Periphery
A-6	s.	TIS 50, ThO ₂ Coating, Preliminary Materials Evaluation, Non-Corrodible Periphery
A-6	t.	TIS , Non-Corrodible Materials Screening Test
		1) ZrC modifications
		2) ZrC/ZrO ₂ modifications
		3) Other materials and forms

Suffix i - Fabrication of Development Hardware

	1.	Complete techniques for brazing hot end material combinations, including composite to composite, tungsten to tungsten, tungsten to graphite and tungsten to composite and issue DRM (DM-249).
	2.	Complete a process, either through powder metallurgy, or chemical vapor deposition, for fabricating stable thoriated tungsten hot end components and issue DRM (DM-314).
	3.	Develop a barrier coating capable of preventing the carburization of hot end tungsten components and issue DRM (DM-218).
A-6	4.	Evaluate adequacy of all reactor components to 10 ⁻⁹ torr. Plan program and prepare TIS to determine effect on materials.

PROJECT 782 - Continued

Suffix y - PEWEE

1. Provide support of PEWEE 2 fuel elements quality control and development testing and issue DRM on properties of PEWEE 2 fuel and centrals (DM-196).
2. Issue DRM on the properties of PEWEE 2 composites (DM-221).
3. Issue DRM on the cyclic performance of PEWEE 2 composite/fuel braze joints (DM-175).
4. Plan a program and institute testing of the cyclic tensile behavior and cyclic thermal dilation of high CTE PEWEE 2 vintage fuel (addendum to DM-196).
5. Plan a program and institute testing of the cyclic tensile behavior and cyclic thermal dilation of composite PEWEE 2 vintage fuel from LASL. (New TIS)
6. Plan a program and institute testing of the cyclic tensile behavior and cyclic thermal dilation of PEWEE 2 vintage hot end hardware composite. (addendum to DM-221)
- A-7 7. Expand PEWEE 2 fuel property testing in support of "Q" testing, to include all lower loadings.
- A-7 8. Qualify fuel/composite tip joint for WNCO AXF back-up elements to Y-12 AXF, and thermal cycle shift qualification samples.

PROJECT 787 - continued

- M-E
3. Analyze the results of tests specified in paragraph f.2 on Inconel 718 and retain data for possible later analyses and documentation. Analyze the results of all other tests specified in paragraph f.2 and publish T-119 test reports summarizing and integrating the data where data reports from the test agencies have been received by July 31, 1970.
 4. For the graphite portion of paragraph 2.k, perform the following:
 - a. Sample characterization, ambient and LN₂, for two (2) graphites, A and B, mutually acceptable to WANL and ORNL.
 - b. Provide thermal conductivity specimens of Graphite A and B to ORNL and BNL.
 5. Provide pedigree data for test specimens for inclusion in Radiation Effects Test Specifications and support for procurement/manufacture of test specimens.
 6. Provide consultation to SNPO, ANSC and WANL organizations for radiation effects on material planned for the NERVA NSS.
 7. Issue flash reports immediately following irradiations.
 8. Perform radiation effects analysis on Category "A" and "B" NSS components identified in the NERVA Specification Tree. These analyses shall be documented and issued for the NSS Design PDR in Data Item S-110.
 9. Prepare and publish a Radiation Effects Program Plan as input to the ANSC Program Plan.
 10. Provide status input to ANSC for the Monthly Radiation Effects Progress Report.

Suffix g - Development Testing

1. Provide the necessary support to conduct the irradiation tests specified in Suffix f.

PROJECT 803 - TUBE TRAILER MAINTENANCE/COORDINATION OF SUPPLY OF
GOVERNMENT FURNISHED GASEOUS HELIUM

Suffix a - Support

- D-4 1.
2. Provide two (2) complete semi-annual inspections of each trailer.
- M-E 3. Maintain a current listing of the hydrostatic test date of each trailer. Notify SNPO-C three (3) months prior to the expiration of the test date of any trailer (five years from the last test). This notification will show the trailer serial number and date of the last hydrostatic test to allow for scheduling by the Government of the next required hydrostatic test.
- A-4 4. Provide maintenance and repair services of normal wear and tear to eleven (11) Government-owned gaseous helium (GHe) tube trailers as follows:
- a. Undercarriage maintenance and repair to include tires and tubes, brakes, air and hydraulic lines, landing gear, electrical and lighting systems. Maintain necessary records to verify work accomplished.
- b. Tube bank maintenance and repair to include valves and fittings, manifolds, thermocouples, pressure gauges. Maintain necessary records to verify work accomplished.
- A-4 5. Leak check valves, fittings, and manifold of all filled Government-owned helium trailer upon their receipt at WANL or WANHES. Tag and repair as soon as possible all leaks discovered. Maintain necessary records to verify work accomplished.
- A-4 6. Schedule and dispatch helium trailers to be filled as necessary to insure an adequate, time supply of GHe for WANL/WANHES testing. Coordinate actions of approved common carrier, GHe supplier and various governmental agencies involved, as necessary to insure an adequate, timely supply of GHe.
- A-4 7. Procure GHe on an emergency basis, as necessary, in circumstances where Government-furnished GHe is not available to support critical testing at WANL and/or WANHES.

PROJECT 824 - continued

Suffix γ - PEWEE/Nuclear Furnace

Effective July 1, 1970

- A-5 1. Evaluate TCC capabilities in conjunction with NTO to assist in determining the facility modifications required for Pewee-2 and Nuclear Furnace I tests.
- A-5 2. Provide test engineering review of detailed proposed changes to the TCC facility to assure that the changes are compatible with the overall reactor testing program at TCC.
- A-5 3. Perform control system design and analysis in conjunction with NTO to develop the required facility control systems.
- A-5 4. Perform the analyses required to assist NTO in verifying and documenting that the TCC facility is capable of supporting the planned Pewee-2 and Nuclear Furnace I tests.
- A-5 5. Assist in the development of analog models representing TCC by providing engineering data and by review of the models.

PROJECT 828 - TEST CELL "C" NUCLEAR SUBSYSTEM CONTROL SYSTEM

Suffix f - Development Engineering

1. Provide and maintain an NSS controls program plan and schedule for the R-1 and R-2 tests, consistent with the digital control concepts proposed by Projects 451/151.
2. Develop the systems engineering approach to be used in accomplishing the NSS controls objectives.
- M-E 3. Determine the special requirements for a digital computer and peripheral equipment required for NSS control system development and R-test series operations.
4. Perform preliminary analyses in support of ground test control functional designs.
5. Provide support for the integration of engine and NSS controls design efforts and coordinate this effort with the NSS design.

PROJECT 831 - PLANNING OPERATIONS

Suffix a - Support

1. Provide the planning, evaluation, control, surveillance and reporting of all program schedules, in accordance with Data Items M-101 and M-102.
2. Continue development of the NERVA Program Plan, Data Item M-100.
3. Participate in the planning, evaluation, control and continual surveillance of all program schedules related to the NSS portion of the NERVA Program.
4. Provide and maintain Level III networks for the ECC's through Qualification.
5. Submit Summary Level III networks sixty (60) days after receipt of Government funding, schedule and programmatic guidelines for CY 1971 as follows:
 - a. NSS portion of E-1.
 - b. NSS portion of R-1 and R-2.
6. Provide and maintain the NSS Systems Engineering network through Plans and Programs PDR.
- M-E 7. Provide and maintain Level III networks for all supporting activities and hardware e.g., Trade Studies, GSE, NCX, and the WANHES Facility network, that would interface with the ECC networks, items 4 and 5.
8. Provide a central source for the internal Level IV planning and schedule data for that effort required to be performed in CY 1970 in support of the Level III planning networks. This data shall be maintained at the contractor's plant and shall be available to the Government for audits of the detailed work program as required. Additionally, the data shall be interfaced and traceable to the Level III networks, where applicable.
9. Coordinate and interface the NSS plans and schedules with ANSC and NRDS.
- M-E 10. Provide support for the project sponsors.

PROJECT 837 - Continued

	<u>Title</u>	<u>Purpose</u>
	Core Periphery Hardware Fabrication Process Development (64 DC-238) (Issue DRM)	Develop fabrication techniques for: pyrofoil wrapper strips, adhesive bonded formed pyrofoil laminates, chevron formed pyrolytic graphite shapes, filler strips and mock-up assemblies.
	Core Support Plena Plate Fabrication Process Development (61 DC-245) (Complete test and issue DRM)	Develop techniques for machining, deburring, cleaning and inspection of the plate.
	R-1 Shield Material Fabrication Process Development (62 DC-215) (Conduct test & issue interim DRM's)	Develop adequate manufacturing techniques so that the reference shield material can be fabricated as required to produce the shield elements.
	Reflector Material Fabrication Process Development (59 DC-253) (Issue DRM)	Evaluate the effects of chemical milling, grinding and electrical discharge machining of beryllium material.
	Copper Boron ¹⁰ Control Plates Fabrication Process Development (59 DC-267) (Issue DRM)	Develop manufacturing process for production of copper-boron ¹⁰ (24 weight percent boron ¹⁰) con- trol plates.
	Boral Fabrication Process Development (62 DC-324) (Conduct test and issue DRM)	Evaluate effects of bending, forming dish shapes and welding Boral for possible use in fabrication as future shield components.
A-6	Stem Assembly Manufacturing Development (TIS DC-091.1)	Develop process for manufacturing full length support stems and liner tubes from A-286 material. Develop process for manufacturing support stem assemblies including develop- ment of welding procedures.

PROJECT 837 - Continued

	<u>Title</u>	<u>Purpose</u>
A-6	Development of Manufacturing Techniques to Extrude Bath Material to Size and Shape (TIS DC-080.1)	Conduct a manufacturing development program for extrusion of bath material to ascertain capability of extrusion techniques for generating final size and shape.
A-6	Shield Alternate Material Manufacturing Development	Perform machinability experiments on selected shield backup material.

PROJECT 851 - FLIGHT SAFETY MALFUNCTION STUDIES

Suffix f - Development Engineering

1. Use fault tree analyses to identify and investigate the effects of potential single or combinatory failure modes of the nuclear subsystem that could result in selected undesired events peculiar to engine performance and flight safety. Issue these analyses as DRM's and submit to the prime contractor for consolidation with the engine fault tree model.
 2. Establish the requirements and issue a DRM for the flight termination anti-criticality destruct system. Develop the requirements for the nuclear subsystem during space and missions operations to preclude criticality accidents; this activity shall include an appraisal of the use of an in-flight poison system. Publish Trade Study Report S-054 for Trade Study 719, NSS Anti-Criticality System Requirements.
 3. Participate in the system and component trade studies and other system engineering activities to assure early incorporation of safety requirements in appropriate specifications and design sheets and the identification of safety problem areas that require resolution.
- M-6
4. Conduct overall system failure effects and malfunction analyses using component failure mode analysis and applicable results from other analyses to further aid in the derivation of flight safety requirements on components, the NSS and the engine system; to categorize failures and degradations into engine operational modes; and to establish emergency modes and procedures. Conduct these activities in concert with designers, systems analysts, reliability activities and the prime contractor. Issue results of this analysis as input to Data Item S-103.
 5. Ensure that component and system requirements peculiar to flight safety are presented in appropriate specifications and design sheets and that the results of allied analyses are presented in appropriate Data Items. Prepare Flight Safety Contingency Analysis Worksheets to assist in identifying critical failure modes and to provide data for the updating of Data Item S-103.
 6. Initiate a study to evaluate the transport characteristics of fission products and fuel corrosion products in space and the characteristics of their interaction with space systems. Aid as required in establishing normal engine operational logistics influenced by the release of these products in space.

PROJECT 861 - continued

including surveillance activities at WNCO and Y-12. Audit WNCO and Y-12 certifications and release the hardware.

- A-7 2. Provide additional WANL Quality Engineering effort in support of the receipt, inspection, and release of Y-12 AXF elements.

PROJECT 862 - QUALITY ASSURANCE - NTO

Suffix b - Technology Engineering

- A-E 1. Provide support for disassembly, post-operative and storage activities associated with XE Prime and XE Backup assemblies.

Suffix f - Development Engineering

As part of NTO, provide the following:

- D-E 1.

- a.
- b.
- c.

- D-E 2.

- a.

3. Quality Assurance - NERVA Program

- a. Provide necessary inspection and support for the Dual Mode Pump Program and complete the NTO assembly and checkout log books.
- b. Maintain the Audit Log Report in verification of the ETS-1 baseline drawings and specifications.
- c. Provide support for the modification, repairs and maintenance activities at ETS-1 and E-MAS, including equipment calibration and certification.
- d. Complete the NTO Quality Assurance Plan and provide input to the NTO Management Program Plan.
- e. Provide support for the NRDS flat car brake and coupler modifications performed at E-MAD.

4. Quality Analysis

- a. Establish a computer program and analyze all documented XE testing discrepancies and anomalies to define problem areas and provide data to design activities for subsequent upgrading of facilities.

PROJECT 862 - continued

- b. Establish a computerized failure reporting and corrective action system.
- c. Conduct quality audits on modification and preventative maintenance programs, subcontractor efforts and other NRDS activities.
- d. Participate in a Quality Assurance review of Preliminary Engineering Review (PER) studies for NRDS facilities as required by FEO.

Suffix y - PEWEE/Nuclear Furnace

As part of NTO, provide the following effective July 1, 1970:

- 1. Quality Assurance - LASL Programs*
 - A-E a. Provide support for the Pewee-2 test car and facility flow car assembly and maintain the Pewee-2 Q.A. inspection log.
 - A-E b. Provide support for the Nuclear Furnace I test car and shield buildup.
 - A-5 c. Implement the following programs at Test Cell "C":
 - (1) Failure analysis and discrepancy reporting system.
 - (2) Quality assurance surveillance of test facility modifications.
 - (3) Quality assurance surveillance of facility system checkouts.

*Completion of this item is dependent upon LASL schedules.

PROJECT 863 - continued

2. Provide consultation to systems engineering efforts to assure perceptive reliability evaluations of alternate concepts in support of trade studies requiring reliability evaluation.

Participate in trade study effort, directly, by providing math modeling, probabilistic analysis, System Failure Mode Effects and Criticality Analysis and Reliability ranking methods, where necessary. Issue DRM's to document reliability inputs to system trade study reports.

- M-6
3. Provide consultation on each component design effort to assure perceptive Failure Mode Analysis and probabilistic analysis in design to accommodate NSS PDR. Participate in component trade studies and review component Failure Mode Analysis to assure completeness of design effort and efforts of supporting disciplines. Issue DRM's for Reliability input to Category B trade study reports and for the additional trade studies required by Change Order W70-6.
 4. Provide consultation to Systems Engineering in the determination of NSS operating requirements and in the development of mathematical and statistical techniques for propagation of error analysis. This consultation shall be a means to assure the adequacy of the error analysis in determining the variation in engine state points. Participate in the review of error analysis that determine variation in NSS state points to assure adequacy for the probabilistic design of components.
- M-6
5. Prepare reliability allocations for the reference engine components in support of preparation of specifications. Revise allocations as necessary after DRB in preparation for Engine PDR. Perform reliability modeling for the NSS for the reliability reference mission, including transient and steady-state operations. To the extent practicable, perform reliability predictions for the NSS.
 - a. Issue DRM for allocations and math models as input to DRB specifications.
 - b. Prepare DRM's on NSS math models and equations and reliability predictions for input to NSS chapter of R-202 for Engine PDR.
- M-6
6. Issue DRM continuing system level Failure Mode, Effects and Criticality Analysis (FMECA), including Change Order W70-6 related changes. In conjunction with Safety, perform single failure point (SFP) identification and analysis based on the FMECA. Provide assistance, as required, in establishing optimally selected engine emergency operating modes, emergency procedures, and requirements. This work will be progressively accomplished and coordinated with safety analysis, as required. System FMECA will be transmitted to ANSC for coordination with the corresponding engine analyses and in preparation for Engine PDR.

PROJECT 863 - continued

- M-6 7. Participate in establishing and publishing the detailed procedures and forms required to implement the Trend Data activity. These procedures shall be prepared during the component concept selection activities and embrace component failure mode analyses and error analyses which identify the critical parameters and limits comprising the trend analysis program. These procedures include practices to be followed during design, prior to testing, during tests, and subsequent to testing of parts, components, subsystems, and the engine system. Assist the prime contractor in preparing an index of the procedures and an abstract of each procedure to identify the contents and general scope. Salient trend characteristics shall be published in a DRM.
- M-6 8. Participate in development and review of all materials, components, radiation effects and system test plans to assure proper statistical analysis of reliability data. This task includes the vacuum test program associated with Change Order W70-6.
9. Identify and develop computation procedures and computer programs to assess system reliability from the component reliability predictions and the reliability models of the system. Develop statistical programs, as required, for data analysis. Coordinate and exchange computer programs, as necessary, with the prime contractor.
- D-E 10.
11. Participate on the WANL Malfunction/Failure Reporting, Analysis and Resolution Board. Participate in the failure reporting and corrective action program for reliability purposes.
- M-6 12. Provide data and assistance to support the preparation of other data items pertinent to the reliability effort. Review revised C-002 specifications resulting from Change Order W70-6 changes.

Provide consultation in establishing engine and reactor test facility reliability requirements.

Coordinate reliability efforts with the maintainability effort. Provide systems failure mode effects and criticality analysis and failure probability estimates as input to maintainability effort. Participate in review of maintainability output.

PROJECT 863 - continued

Coordinate reliability program and prepare and participate in status reviews and major presentations with the prime contractor, SNPO, stage and associated contractors. Participate in the resolution of common reliability problems.

13. Conduct reliability training, indoctrination and awareness programs with design, analytical, system and test engineers. Upgrade reliability personnel through education, training and motivation in current and advanced reliability techniques and reliability management principles, using outside consultants, university short courses, symposia and internal training programs. Maintain an awareness and visibility of other exemplary reliability programs throughout the country. A minimum of one (1) training course for personnel performing reliability functions will be conducted.
- M-6 14. Initiate preparation for the R-202, "Reliability Allocation, Assessment and Analysis Report" for the NSS and Category A and B NSS components for NSS PDR. Plan report and coordinate inputs from other groups. Coordinate technical requirements and schedules with ANSC so that the NSS report can be used directly as a chapter of the engine PDR report published by ANSC. The NSS report for NSS PDR will contain component failure mode analyses, models, math equations, predictions, single failure points, and trend characteristics.
15. Provide effort for preparation and coordination of the data item description for the Reliability Test and Evaluation Plan, R-106, based upon finalization of the data item description for T-102.
16. Coordinate revisions to the Reliability Program Plan, R-101, with the prime contractor. Resolve questions of scope and implementation.
- D-E 17.

PROJECT 872 - continued

Suffix γ - PEWEE/Nuclear Furnace

- A-5 1. Assume management of Test Cell "C" facilities and perform the following support effective July 1, 1970:
- a. Initiate implementation of NTO Configuration Management for Test Cell "C" facility.
 - b. Perform test data reduction and analysis for Nuclear Furnace facility checkout, jet pump test and Pewee-2 facility checkout tests and issue test reports.
 - c. Continue preparation of test planning documentation such as experimental plans, reactor test plans, status, board memos, set-up checklists, dry run checklists and control room checklists for Pewee-2 facility checkout test, Pewee-2 tests, Nuclear Furnace facility checkout tests and NF-1 tests.
 - d. Review test, failure mode and malfunction analysis provided by LASL. If necessary, perform, or have performed, additional analysis to meet NTO requirements.
 - e. Define and implement an operator training program to support Pewee-2 and Nuclear Furnace I.
 - f. Perform Pewee-2 and Nuclear Furnace facility checkout test operations and local tests in support of Pewee-2.
 - g. Continue development and documentation of 7094 computer software to support Test Cell "C" data reduction.

PROJECT 873 - MAD BUILDING OPERATIONS - NUCLEAR SUBSYSTEMS

Suffix f - Development Engineering

As part of NTO, perform the following effective July 1, 1970:

- A-5 1. Assume responsibility for LASL rolling stock, including test cars, flat cars and locomotives. Integrate hardware and existing documentation into NTO systems.
- A-5 2. Assume responsibility for accountability of R-MAD severable equipment and GSE, based on current established inventories and locations. Document per NTO procedures.

Suffix y - PEWEE

As a part of NTO, perform the following support:

- 1. Provide support for LASL programs. *
 - M-E a. Complete Pewee-2 Flow Car.
 - b. Complete buildup of NF-1 Test Car.
 - c. Complete assembly of NF-1 Shield.
 - d. Mate Pewee-2 Test Article to Test Car.
- 2. Equipment and Facility Maintenance
 - a. Continue a facility and facility related equipment maintenance program in support of Nuclear Subsystem Operations.
 - b. Complete brake and coupler modifications to LASL Test Cars. *
 - (1) Pewee-2 (T-4)
 - (2) NF-1 (T-3)
 - c. Maintain L-1, L-2, L-3, MCC and Spacer in operating condition to support LASL Test Program.

*Dependent on LASL schedules.

PROJECT 873 - continued

- A-5 3. Assume responsibility for management of the R-MAD facility and associated equipment and perform the following effective July 1, 1970:
- a. Maintain the R-MAD facility in a caretaker mode.
 - b. Initiate Pewee-2 test article/test car mateup operations.
 - c. Continue support to maintain and perform minor modifications in preparation for and operational checkout of Fuel Element Processing (FEP's) in support of Pewee-2.
 - d. Provide input as required to the NTO Test Article and Facility Support Group regarding documentation prepared for assembly operations of LASL test articles and related facility TSE.
 - e. Install and checkout INSIPID camera systems.
 - f. Define requirements for procedural documentation necessary to assume R-MAD management responsibility including safety, security and maintenance of GSE and GFE. Begin preparation of documentation.

NEW

PROJECT 875 - ENGINEERING SUPPORT - TEST CELL "C" AND TEST ARTICLE

As part of NTO, provide the following effective July 1, 1970:

Suffix f - Development Engineering

- A-5 1. Develop a program of priorities and urgencies for systematic verification of TCC Product Configuration Baseline.
- A-5 2. Implement the program of verification of the TCC Product Configuration Baseline, including:
 - a. Specifications
 - b. Drawings
 - c. Supporting Calculations

Suffix y - PEWEE/Nuclear Furnace

- A-5 1. Support Test Cell "C" and E-MAD effort by performing engineering services required to:
 - a. Convert LASL requirements to NTO procedures for test article maintenance, assembly and disassembly.
 - b. Convert LASL requirements to NTO work packages for facility mechanical modifications.
 - c. Support E-MAD and Test Cell "C" in liaison functions with LASL personnel in Los Alamos.
 - d. Supply the engineering design, drafting and analysis effort for TSE and RTS equipment.

PROJECT 975 - CAPITAL EQUIPMENT NOT RELATED TO CONSTRUCTION - NRDS

Suffix h - Development Tooling

1. Design, fabricate and/or procure and install AEC equipment to the extent of the available funding in agreement with the NERVA Nuclear Subsystem AEC Capital Equipment Plan, designated as NERVA Hardware Cost Estimates for Project 975, and as it may be revised, in support of programmatic requirements in accordance with budgetary constraints and existing policies and guidelines for the following:

- a. Complete and issue preliminary design layouts, analysis and Data Item S-136 for the following long-lead RHD equipment:

- (1) Core Disassembly Stand (Line Item 03).
- (2) Core Removal Cage (Line Item 04).
- (3) Reactor Disassembly Stand (Line Item 01).

D-E

(4)

- b. Complete material procurement and fabrication for FEPS modifications (Line Item 02).

Subtask Item Project No. 413
Contract Year 1970

1. Revised Common Analog Model (CAM) for Reference Design
2. Revised 10-Hour NSS Systems Analysis Data Book
3. Provide NSS Input to NETAP (IED 403)
4. Provide initial WANL Input to Engine Test Series Test Information Sheets.
5. WANL Input for P_c Optimization Available (IED 365)
6. Provide initial WANL input to Engine Test Series Ground Test Systems Engineering Functional Analysis S-52, S-53.
7. Provide Updated WANL Input to Engine Test Series Test Information Sheets.

[illegible]

W59995

Subtask Item Project No. 451
Contract Year 1970

SCHEDULES & MILESTONES:

1. Publish and submit to AGC S-57 design sheets for recommended NSS controls design requirements and changes as input to the I & C ECC Specifications.
2. Issue DRM showing status of S-102 input.
3. Issue DRM showing status of digital control development activities.
4. Issue design sheet, Data Item S-057, for NSS requirements on I & C System.

[illegible]

1. Provide input to the final XE-Prime test article final report.
2. Provide update of NSS Reference Design.
3. Provide NSS PDR data item outlines for:
 - E-105 Engineering Data - Design Evaluation Outline
 - Prepare NSS assembly layout incorporating W70-6 June decisions
 - S-036 Structural Analysis Report Outline
 - S-038 Dynamic Analysis Report Outline
 - Provide NSS Dynamic Model Update for ANSC. Engine PDR dynamic system model (based on May NSS Design.)
 - S-039 Loads Report Outline
 - Complete NSS nominal steady state (rated) and boost loads analysis for ANSC Engine PDR based on May NSS Design.
4. Prepare input data to the following data items:
 - E-105 Engineering Data - Interface Control
 - S-047 Mass Properties and Status Report
5. Review existing WANL and other aerospace equipment and designs applicable to NERVA NSS vacuum requirements.
6. Publish a comprehensive vacuum testing program plan.

[illegible]

Subtask Item Project No. 712
Contract Year 1970

SCHEDULES & MILESTONES:

1. Complete the preparation of the XE-Prime Topical Reports (XE-135 Buildup and Physics Tests.)
2. Complete the nuclear input to Section 5 (Analysis) and Section 6 (Conclusions) to the following T-119 Data Items:
 - a. WANL-TME-1909, "PAX-G0 Approach to Critical."
 - b. WANL-TME-1910, "PAX-G0 Control Drum Spans and Reactivity Coefficients."
 - c. WANL-TME-1911, "PAX-G0 Power Distribution Measurements."
 - d. WANL-TME-1916, "PAX-G1 Reflector Worth Measurements."
 - e. WANL-TME-1917, "PAX-G1 Gross Power Measurements."
 - f. WANL-TME-1918, "PAX-G1 Reactivity Effect Measurements."
3. Issue TIS-6.1 (part 3a), "PAX-G3 Detailed Power Measurements."
4. Issue TIS-5.1 (part 3a), "PAX-G3 Control Drum Spans."
5. Issue TIS-7.1 (part 3a), "Material Reactivity Coefficients."
6. Issue TIS-11.1 (part 3a), "Reactivity Worth of ISA Material in PAX-G2."
7. Complete nuclear input to T-119 document on "PAX-G2 Detailed Power Measurements."
8. Complete nuclear input to T-119 document on "PAX-G2 Control Drum Spans."
9. Complete nuclear input to the T-119 document on "PAX-G2 In-Place Shim Experiment (ISA)."

[illegible]

Subtask Item Project No. 712
Contract Year 1970

10. Complete predictions for the "PAX-G3 Detailed Power Measurements."
11. Complete predictions for the "PAX-G3 Control Drum Spans."
12. Initiate nuclear analysis required as input to T-119 Data Item on "Material Reactivity Coefficients."

[illegible]

Subtask Item Project No. 713
Contract Year 1970

1. Issue XE data analysis topical reports for input to XE Data Analysis Final Report.
2. Complete documentation of variable X-Y mesher computer program.
3. Complete TNT-II Thermal and Fluid Flow Reactor Model of 10-hour, full flow cycle reactor assembly.
4. Update TNT-II model consistent with the May Reference Design (940J385, Rev. 0) as a result of design and analysis studies.

[illegible]

Subtask Item Project No. 715
Contract Year 1970

SCHEDULES & MILESTONES:

1. Issue part 3b of T-102 for S/T 59DW-232.
2. Publish T-119 report, WANL-TME-1909, "PAX-GO Approach to Critical".
3. Publish T-119 report, WANL-TME-1910, "PAX-GO Control Drum Spans and Reactivity Coefficient Measurements."
4. Publish T-119 report, WANL-TME-1911, "PAX-GO Power Distribution Measurements."
5. Publish T-119 report, WANL-TME-1916, "PAX-GI Reflector Interchange and Control Drum Spans."
6. Publish T-119 report, WANL-TME-1917, "PAX-GI Gross Power Measurements."
7. Publish T-119 report, WANL-TME-1918, "PAX-GI Reactivity Effect Measurements."
8. Issue part 3 b of T-102 for TIS-23
9. Issue part 3b of T-102 for TIS-24
10. Issue part 3b of T-102 for TIS-11
11. Publish T-119 report, WANL-TME-1915, "Radiation Environment on CHESH Components."
12. Issue part 3b of T-102 for TIS-6.
13. Issue part 3b of T-102 for TIS-5.
14. Issue DRM report on TIS-24 data.
15. Publish T-119 report on S/T 59DW-232 data.
16. Publish T-119 report, WANL-TME-1914, "Radiation Environment in Various Reactor Components."
17. Issue part 3b of T-102 report on TIS-7 "Material Reactivity Coefficients in Composite Fuel."

[illegible]

Subtask Item Project No. 715
Contract Year 1970

18. Publish T-119 report on S/T 66 DW-234.
19. Initiate experiment for TIS-5.
20. Complete part 3b of T-102 for TIS-25.
21. Publish T-119 report for S/T 59DW-269.
22. Initiate experiment for TIS-6.
23. Publish T-119 report, WANL-TME-1912, "NSS Shielding Provision Study."
24. Issue DRM report on TIS-11 Data.
25. Initiate experiment for U and C core reactivity coefficient measurements in PAX-G3 for TIS-7.
26. Initiate experiment for off-reactor shield streaming measurements for few hole configurations consistent with TIS-23.
27. Update facility operating documents and safety analysis required for insertion of a composite fuel into PAX.

[illegible]

Subtask Item Project No. 717
Contract Year 1970

SCHEDULES & MILESTONES:

1. Provide initial draft of two sample VIS for the NSS.
2. Review and input to Form 9 for T-101.
3. Review and input to T-101.
4. Issue initial version of S-52 and S-53
NSS Ground Test Mission.
5. Provide initial version of Section 10 of the NSS
C-2 Specification.
6. Define and interpret the analysis to be performed to
support the NSS verification engineering.
7. Publish and maintain the reactor test volume of Data
Item M-110.
8. Transmit WANL input to Introductory Volume I
of M-110.
9. Provide initial TCC facility and failure mode analyses
for Pewee II.

[illegible]

Subtask Item Project No. 719
Contract Year 1970

1. Preliminary NSS and Component Specs. and Design Sheets (Section 3) Available (IED 432).
2. Preliminary NSS Input to RAS, Level 3 and Lower, Blocks 3-6 Available (IED 417).
3. Revised Common Analog Model for Reference Design Update.
4. Update of NSS Reference Design.
5. Complete NSS Portion of a Common Analysis Model for the Low Range of the Operating Map (eg. for use in Cooldown for Potential Implementation on the Analog Computer) (IED 353).
6. Complete S-054 Data Item for the following Trade Studies (IED 430):
 - a. T. S. 713
 - b. T. S. 714
 - c. T. S. 716
 - d. T. S. 717
 - e. T. S. 757
 - f. T. S. 760
7. Publish NSS CEI and ECC Specifications and Design Sheets.

[illegible]

Subtask Item Project No. 721
Contract Year 1970

1970											
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1. Complete minimum fabrication capability for providing composite elements.
2. Publish the NERVA Fuel Element Design Concepts Trade Study, S-054 for NSS DRB Data Submittal.
3. Initiate the Preliminary Design & Analysis Trade Study, S-054.
4. Issue Test Information Sheets - Development Planning Section.
5. Issue initial Failure Mode Analysis. (Trade Study 759)
6. Issue preliminary drawings and specifications for composite test elements.
7. Revise Scope of Tests for HCTE Graphite Program.
8. Publish DRM on detailed thermal and structural analyses of WANL S/E Furnace.
9. Develop Hydro-Carbon monitoring techniques.
10. Issue DRM documenting status on hydrolysis evaluation of composite fuel.
11. Reactivate WANL Single Element Furnace.
12. Prepare Test Information Sheets, procedural section, for Phase I Composite Development Test.
13. Initiate WANHES Single Element Composite Corrosion Test Program by performing Power Supply Capability Checkout Tests.

14. Complete shield temperature, exit gas temperature and voltage probe measurements on WANL Single Element Furnace.
15. Issue DRM Documenting status of hydrolysis protection of PyC impregnated graphite fuel.
16. Issue DRM documenting status of Helium Permeability Test for PyC impregnated elements.
17. Initiate fabrication of composite elements intended for Phase I Development Composite Test Program.
18. Initiate evaluation of composite fuel raw materials.
19. Initiate shipment of graphite R-1 test components.
20. Deliver initial composite test components for Phase I Composite Development Test Program.
21. Issue DRM's documenting status of the following tests:
 - 00DE-102
 - 00DE-158
 - 00DF-316
 - 00QT-313
 - 00DM-175
 - 00DM-196
22. Complete shipment of WNLO AXM PEWEE-II prime fuel element.
23. Complete shipment of WNLO AXM PEWEE-II PDR components.
24. Complete shipment of WNLO AXF PEWEE-II experimental elements.

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Subtask Item Project No. 721
Contract Year 1970

25. Complete shipment of WNLO AXM & AXF PEWEE-II component test elements and pieces.
26. Complete PEWEE-II prime single element quality control testing.
27. Provide fuel & CSE drawings and specification for Y-12 HCTE Graphite Program.
28. Complete fabrication and shipment of Y-12 PW-2 Prime AXF matrix elements.
29. Complete fabrication through graphitization of a set of backup AXF matrix elements for the Y-12 AXF PW-2 elements.
30. Publish fuel element trade study for choice of reference design fuel.
31. Issue initial failure mode analysis for reference design element selection trade study.

[illegible]

Subtask Item Project No. 722
Contract Year 1970

SCHEDULES & MILESTONES:

1. NSS DRB Data Submittal
 - a. Publish Cluster Hardware Concepts Trade Study S-054.
 - b. Publish Cluster Stem and Hot End Hardware Trade Study S-054.
2. NSS & Component PDR Data.
 - a. Initiate Cluster R-1 Selection Trade Study S-054
3. Complete DRM for NERVA Cluster Corrosion Test (57DT-174) (Composite Model).
4. Complete DRM for R-1 Cluster Support High Temperature Overload Test (57DE-026).
5. Complete Data Item T-119 for Stem Assembly Structural Test (57DE-207).
6. Complete Data Item T-119 for Central Element Pyrofoil Seal Test (58DT-151).
7. Complete Data Item T-119 for Cluster Attachment Seal Leakage Test (58DT-151).

[illegible]

Subtask Item Project No. 722
Contract Year 1970

SCHEDULES & MILESTONES:

8. Complete DRM for R-1 Cluster Support High Temperature Creep Test (58DE-027).
9. Complete Data Item T-119 for Structural Testing of Secondary Support (58DE-217).
10. Complete DRM for NERVA Hot End Hardware Leakage and Strength Test (57DE-159).
11. Complete DRM for R-1 Support Transient Thermal Stress Test (57DE-029).
12. Prepare Test Information Sheet (part 3a) for Tungsten Cluster Corrosion Test with stem.
13. Complete Testing Cluster Corrosion Test (57DT-174) (Tungsten Model).
14. Prepare Test Information Sheet (part 3a) for New High Temperature Overload Test.
15. Prepare Test Information Sheet (part 3a) for New Hot End Hardware Creep Test.
16. Deliver Coated Hardware for Component Test Programs.
17. Complete Testing Threaded Orifice Pullout Test (58DE-160).

[illegible]

Subtask Item Project No. 722
Contract Year 1970

SCHEDULES & MILESTONES:

18. Complete PEWEE-2 Cluster Corrosion Tests
(00DT-038)
(Issue DRM)
19. Complete PEWEE-2 Cluster Support Transient Thermal Stress Test
(00DE-123)
(issue DRM)
20. Complete PEWEE-2 Cluster Support High Temperature Creep Test
(00DE-124)
(issue DRM)
21. Complete PEWEE-2 Brazed Hot End Hardware Strength and Leakage Test
(00DE-191)
(issue DRM)
22. Deliver PEWEE-2 Hot End Hardware.
23. Deliver R-1 Type Experimental Hardware.
24. Issue TIS for A-286 Welding Development.

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Subtask Item Project No. 725
Contract Year 1970

SCHEDULES & MILESTONES:

1. NSS DRB Data Submittal
 - a. Perform periphery thickness optimization study to justify minimum thickness.
 - b. Complete the trade study for Core Periphery Design Concepts No. 752 and publish as Data Item S-054.
2. Complete initial corrosion resistant periphery study layout for use in early design sizing of component tests.
3. Complete Test Information Sheets (part 3a) for the following development tests:
 - a. Corrosion resistant periphery component friction coefficient screening program.
 - b. Corrosion resistant periphery component manufacturing screening program.
 - c. Corrosion resistant periphery materials thermal and mechanical properties screening program.
 - d. Insulator corrosion screening test.
 - e. Periphery Corrosion Resistant Insulation Axial Flow Impedance Test (TIS-DE-068)
 - f. Metal Wrapper Cyclic Strain and Buckling Test (TIS-DE-094)
 - g. Corrosion Resistant Insulation Transient Thermal Gradient Test (TIS -DE-092)
 - h. Simplified Full Length Corrosion and Chemical Stability Test of Corrosion Resistant Insulation (TIS-DT-067)
 - i. Corrosion Resistant Periphery Thermal and Mechanical Interaction Test (TIS-DT-076)

[illegible]

4. Complete Data Item T-119 for Thermal Expansion of R-1 Pyrofoil Insulation (64DE-310)
5. Complete a DRM for Periphery Axial Flow Impedance for Comparison of Wrapper Materials Considered for Use in R-1 (64DE-070)
6. Complete Data Item T-119 for Outgassing and Vaporization Effect of Pyrofoil Layers Bonded with Petrolatum (64DE-312)
7. Complete a DRM for R-1 Coated Interface Friction Test (64DE-098)
8. Complete a DRM for Pyrofoil Material Ductility Test.
9. Complete DRM identifying status at time of cancellation for Flexing Periphery Wrapper at Simulated Core Expansion (64DE-049).
10. Complete Data Item T-119 for Periphery Axial Load Test (64DE-073).
11. Complete a DRM for Measurement of Vapor Pressure of Petrolatum (64DP-309).
12. Complete Data Item T-119 for Core Periphery Corrosion Test (64DT-211).
13. Complete Data Item T-119 for Core Periphery Corrosion Test (64DT-212).
14. Complete DRM for Cyclic Strain Test (64DT-031).
15. Complete DRM Documenting results as available for Insulator Corrosion and Chemical Stability Screening Test (TIS-64DT-034).
16. Initiate Manufacturability and Corrosion and Chemical Stability Screening Testing for Core Periphery Corrosion Resistant Material Candidates.

[illegible]

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Subtask Item Project No. 725
Contract Year 1970

17. Complete DRM Documenting results as available on Corrosion Resistant Material Manufacturability Screening Tests.
18. Complete Data Item T-119 for Five-Inch Axial Length Core Periphery Evaluation Model Test (64DT-317).

[illegible]

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Subtask Item Project No. 726
Contract Year 1970

1. Complete the trade study for the NERVA Support Plate and Plena Design Concepts and publish as Data Item S-054.
2. Complete the Support Plate material selection study and issue DRM.
3. Complete the Support Plate rigidity study and issue DRM.
4. NSS and Component PDR Data Submittal
 - a. Initiate DRM's documenting the completion of the appropriate chapters of the following:
 - E-105 Engineering Data - Design Evaluation
 - S-031 Thermal & Fluid Flow Analysis Report
 - S-036 Structural Analysis Report
 - S-039 Loads Report
 - S-100 Radiation and Shielding Analysis Report
 - S-110 Radiation Effects Analyses Report
 - b. Initiate a DRM documenting the Support Plate and Plena input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
 - c. Initiate a DRM documenting the Failure Mode Analysis as input to R-202, Reliability Allocations, Assessments and Analysis.
5. Complete modifications to Test Cell "A".

[illegible]

Subtask Item Project No. 726
Contract Year 1970

[illegible]

W59995

Subtask Item Project No. 727
Contract Year 1970

SCHEDULES & MILESTONES:

6. Complete the design for procurement of the experimental setup for the following tests:
 - a. Load Deflection and Vibration Test
7. Prepare backup Material Program Plan and submit for SNPO review.
8. Complete Axial Optimization Study
9. Provide Shield Streaming Experiment Test section to Gulf General Atomics

[illegible]

Subtask Item Project No. 727
Contract Year 1970

SCHEDULES & MILESTONES:

1. Complete Conceptual Design Trade Study for Internal Shield and publish as Data Item S-054.
2. NSS & Component PDR Data Submittal
 - a. Initiate DRM's documenting the completion of the appropriate chapter of Data Items:
 - E-105 Engineering Data - Design Evaluation
 - S-031 Thermal & Fluid Flow Analysis Report
 - S-036 Structural Analysis Report
 - S-039 Loads Report
 - S-100 Radiation and Shielding Analysis Report
 - S-110 Radiation Effects Analyses Report
 - b. Prepare a DRM documenting the Internal Shield input to the appropriate chapter of the Mass Properties Status Report, S-047.
 - c. Initiate a DRM documenting the Failure Mode Analysis as input to the Reliability Allocations, Assessments and Analysis Report, R-202.
3. Issue Test Information Sheets (part 3a) for the following tests:
 - a. Load Deflection and Vibration Test
 - b. Thermal Shock of Shield Element Test
 - c. BATH Behavior under Rad. and Cryogenic Environ.
4. Complete Data Item T-119 for the Shield Element Corrosion (62DT-190)
5. Complete Data Item T-119 for the Thermal Shock of Shield Element (62DE-189)

[illegible]

Subtask Item Project No. 728
Contract Year 1970

SCHEDULES & MILESTONES:

1.
 - a. Complete the trade study for NERVA Reflector Assembly Design Concepts No. 763 and publish as Data Item S-054.
 - b. Provide input to ANSC for a Trade Study (S-054 Data Item) of the nozzle-to-reflector joint and seal (Document in DRM for PDR).
 - c. Determine feasibility of moving reflector closer to nozzle/pressure vessel flange (document in DRM for DRB).
 - d. Select aluminum alloy other than 2219 for aluminum structure (Document in DRM for DRB).
 - e. Size Al-Be reflector optimizing all parameters to obtain the minimum O.D. (Document in DRM for DRB).
 - f. Initiate trade study for the lateral support system on designs intended to satisfy vacuum requirements of 10⁻⁹ torr (Document in S-054 for PDR).
2. Initiate Test Information Sheets (part 3a) for the following tests:
 - a. Attachment of beryllium blocks to cylinder.
 - b. Partial length reflector and lateral support test.
 - c. Reflector model buckling test.
 - d. Flow characteristics at reflector block interfaces. (TIS-DT-071).
 - e. Seal flow test including scarf joint. (TIS-DT-070)
 - f. Capsule leakage test. (TIS-DT-072)
3. Issue Test Information Sheet and prepare and release drawings as necessary for the Grafoil Inserts Decompression Test (TIS-DE-072)

[illegible]

Subtask Item	Project No.	728
Contract Year	1970	

SCHEDULES & MILESTONES:

4. Issue Test Information Sheet and prepare and release drawings as necessary for investigating ways of impregnating or coating all components of the present lateral support system so as to maintain consistent coefficients of friction for all operating and non-operating conditions.
5. Issue Test Information Sheet and prepare and release drawings as necessary for investigating ways of modifying the control drum bearings to operate after experiencing hard vacuums of 10-9 torr.
6. Issue Test Information Sheet and prepare and release drawings as necessary for investigating ways of modifying the control drum splines to operate after experiencing hard vacuums of 10-9 torr.
7. Issue Test Information Sheet and prepare and release drawings as necessary for investigating the slipping characteristics of various material combinations in hard vacuums of 10-9 torr.
8. Complete a DRM for Slotted Be Reflector Thermal and Strain Response Test (59DT-171)
9. Complete Data Item T-119 for Resistance to Erosion of Grafoil (59DT-119).
10. Complete Data Item T-119 for Grafoil Set Test (63DE-205).

[illegible]

Subtask Item Project No. 728
Contract Year 1970

SCHEDULES & MILESTONES:

11. Complete Data Item T-119 for Plunger Pin Friction Test (63DE-214).
12. Complete Data Item T-119 for Biaxial Stress Test (59DE-082).
13. Complete Data Item T-119 for Low Frequency Vibration Test of Partial Length Core (63DE-209).
14. Initiate Testing for Friction Coefficients of Graphite Test (TIS-022).
15. Initiate the design of the test fixture for friction test of impregnated or coated lateral support system components.
16. Initiate the design of the test fixture for vacuum testing of control drum bearings.
17. Initiate the design of the test fixture for vacuum testing of control drum splines.
18. Initiate the design of the test fixture for post-vacuum sliding characteristics of various material combinations in the reflector assembly.

[illegible]

1. Complete XE Topical Actuator Report.
2. NSS DRB Data Submittal
 - a. Publish Electric Actuator Trade Study No. 754
 - b. Complete Electric Actuator In-Depth Trade Study No. 764.
3. Final selection and recommendation of Actuator Concept.
4. NSS and Component PDR Data Items.
 - a. Prepare DRM's documenting the completion of the appropriate chapters of the following:

E-105 Engineering Data - Design Evaluation
S-110 Radiation Effects Analyses Report
 - b. Issue a DRM documenting the Control Drum Drive System input to the appropriate chapter of Data Item S-047, Mass Properties Report.
 - c. Issue a DRM documenting the Control Drum Drive System input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
5. Complete TIS (part 3a) for transmission and motor concept.
6. Complete TIS (part 3a) for feedback device.
7. Complete TIS (part 3a) for housing components.
8. Complete TIS(part 3a) for actuator MOD components.

[illegible]

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Subtask Item Project No. 731
Contract Year 1970

SCHEDULES & MILESTONES:

9. Complete TIS (part 3a) for actuator amplifier.
10. Complete TIS (part 3a) for prototype acuator.

[illegible]

Subtask Item Project No. 741
Contract Year 1970

1. Final selection and recommendation of actuator concept. (From CDDS Trade Study No. 764.)
2. NSS DRB Data Submittal
 - a. Publish SSCVA Trade Study 755.
3. NSS and Component PDR Data Items
 - a. Prepare DRM's documenting the completion of the following data item chapters:
E-105 Engineering Data - Design Evaluation
S-110 Radiation Effects Analyses Report
 - b. Issue a DRM documenting the SSCVA input to the appropriate chapter of Data Item S-047, Mass Properties Status Report.
 - c. Issue a DRM documenting the SSCVA input to the appropriate chapter of Data Item R-202, Reliability Allocations, Assessments and Analysis.
4. Complete TIS (part 3a) for SSCVA motor components.
5. Complete TIS (part 3a) for SSCVA transmission components.
6. Complete TIS (part 3a) for SSCVA housing components.
7. Complete TIS (part 3a) for prototype SSCVA actuator.

[illegible]

Subtask Item Project No. 751
Contract Year 1970

SCHEDULES & MILESTONES:

1. Complete Comparison Matrix (Perf. vs. Requirements)

- a. Support Stem Strain Gages (completed)
- b. Core Exit Gas Thermocouples
- c. High Temperature Core Material Thermocouples
- d. Chromel/Alumel Thermocouples
- e. Copper/Constantin Thermocouples
- f. RTT
- g. Pressure
- h. Displacement Instruments
- i. Acceleration
- j. Demodulator Concept
- k. Reflector Material Strain Gages
- l. Neutronics

2. Complete Planning TIS - Development Testing

- a. Support Stem Strain Gages
- b. Core Exit Gas Thermocouples
- c. High Temperature Core Material Thermocouples
- d. Displacement Instruments
- e. Demodulator

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1. Prepare and Issue Data Item S-131.
2. Submit statistical data on DRM format for NERVA Materials Properties Data Book AGC-2275.
3. Issue Materials sections of NERVA Reactor Quarterly Progress Report.
4. Test milestones are defined by Materials Data Priority and Maturity Plan of April 30, 1970.
5. Provide specimens for hydrogen effects evaluation.
6. Issue final report on hydriding of titanium (DM-179)
7. Issue status report on fuel outgassing.
8. Issue report on fracture mechanics of beryllium (DM-178).
9. Issue final report on BATH process development (DM-201).
10. Issue report on copper-boron process development (DM-180, 198).
11. Issue final report on orifice brazing development (DM-033).
12. Provide specimens for radiation effects testing.
13. Issue DRM on Estimated Properties of Alternate Spring Materials.

[illegible]

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Subtask Item Project No. 782
Contract Year 1970

SCHEDULES & MILESTONES:

1. Prepare information for inclusion in Material section of NERVA Reactor Quarterly Progress Report.
2. Test milestones are defined by Materials Data Priority and Maturity Plan of June 30, 1970.
3. Issue DRM on hot end brazing (DM-249).
4. Issue DRM and final report on process development of tungsten (DM-314,318).
5. Issue DRM and final report on tungsten diffusion coating barrier (DM-218).
6. Issue DRM on Pewee-2 fuel (DM-196), including low loading Q test backup data.
7. Issue DRM on Pewee-2 composites (DM-221).
8. Issue DRM on Pewee-2 braze joint (DM-175).
9. Initiate cyclic fuel tests.
10. Issue DRM on estimated adequacy of lateral support and other components for 10^{-9} torr.
11. Issue TIS on friction reduction and testing for 10^{-9} torr.

[illegible]

Subtask Item Project No. 783
Contract Year 1970

SCHEDULES & MILESTONES:

1. Complete Staffing of Advanced Development Group
2. Complete Program Plan
3. Complete Preparation of Test Specifications:
 - a. Pre-Reacted Solid Solution Fuels
 - b. Basic Coating Studies
 - c. New Vapor Deposited Coatings
 - d. High CTE Graphite Flours
 - e. Alternate Binders
 - f. Advanced Graphite Flours
4. Place Subcontract Procurements
 - a. Pre-Reacted Solid Solution Fuels
 - b. Basic Coating Studies
 - c. Advanced Graphite Flours and Binder
5. Conduct Experimental Sample Preparations
 - a. High CTE Graphite Flours
 - b. Pre-Reacted Solid Solution Fuels
 - c. Alternate Binders
 - d. Advanced Graphite Flours
6. Initiate testing and evaluation of samples
7. Program Annual Report

[illegible]

Subtask Item Project No. 787
Contract Year 1970

SCHEDULES & MILESTONES:

1. Issue NERVA Program Plan
2. Issue Inconel 718 Bar RTS
3. Issue Inconel 718 Sheet RTS
4. Issue Inconel 718 Tube RTS
5. Issue A-286 RTS
6. Issue A-286 Test Report
7. Issue Waspalloy RTS
8. Issue Waspalloy Test Report
9. Issue Cu-B¹⁰ RTS
10. Issue SS RTS
11. Issue GTR 20 B RTS
12. Issue GTR 22 RTS

Publish the results of analyses completed by the end of CY70, these analyses will be performed in accord with the requirements of the S-110 data item.

[illegible]

W59995

Subtask Item Project No. 824
Contract Year 1970

SCHEDULES & MILESTONES:

1. Prepare and maintain F-4 for TCC.
2. Provide review and input to Form 9 for F-005.
3. Provide detailed outline of TCC F-005.
4. Provide input to NWECA test program study.
5. Provide input and review for Form 9 for F-003.
6. Prepare input for F-003.
7. Input to NRDS facilities and logistics plan.
8. Provide input to Form 9 for F-007.
9. Perform NERVA NRDS computer requirements study for TCC.
10. Provide input to and review Form 9 for T-134.
11. Prepare and issue initial version of TCC T-134.
12. Define and issue TCC Product Configuration Baseline Requirements.
13. Provide evaluation of TCC capabilities for Pewee II.

[illegible]

Subtask Item Project No. 828
Contract Year 1970

1. Determine the special requirements for a digital computer and peripheral equipment required for NSS Control System development and R-test series operations.

[illegible]

1. (58 DC-202) Orifice
Complete DRM for Orifice Manufacturing
2. (58 DC-203) Poison Plate
Issue Interim DRM for preliminary fab. develop.
Complete test for final fabrication
Issue Final DRM
3. (58 DC-204) Cluster Screen
Issue DRM
Perform Fabrication Test on R-1 Material
4. (58 DC-282) Cluster Shim
Complete Test
Issue DRM
5. (56 DC-274) Stem Assembly
Complete, Thread Rolling Development
Issue Interim DRM
Start Fabrication Test of Support Stems and Liner
Tubes for Alternate Materials
6. (56 DC-288) Hot End Hardware
Complete Preliminary Machining Tests
Issue Interim DRM
Complete Final Machining Tests
7. (64 DC-238) Core Periphery
Issue DRM
8. (61 DC-245) Support Plate/Plena
Issue DRM
9. (61 DC-215) R-1 Shield Material
Issue Interim DRM
Start Final Fabrication Test
10. (59 DC-253) Reflector Material Fabrication
Issue DRM
11. (59 DC-267) Copper Boron¹⁰ Control Plates
Issue DRM

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W59995

Subtask Item Project No.841
Contract Year 1970

SCHEDULES & MILESTONES:

1. Prepare jointly with AGC an evaluation of the "Impact of NERVA Reactor/Engine Testing on Radiological Safety."
2. Prepare a preliminary "Reactor/Facility Compatibility Study."
3. Provide a report of the status of the "Preliminary System Safety Analysis Report" which will be in preparation at the end of CY-70.
4. Issue revised material for Data Item S-019, "NERVA Safety Plan" to maintain the plan current with program status.

[illegible]

Subtask Item Project No. 851
Contract Year 1970

1. Establish Requirements for the Anticriticality Destruct of the NSS for the Launch and Assent Operational Phase.
2. Issue Requirements for Anticriticality Protection During Space and Mission Operations - Trade Study 719.
3. Issue NSS Input to Data Item S-103, "Flight Safety Contingency Analysis Report." This input will consist of the WANL branches of the Fault Tree Model, results of the malfunction analysis and Contingency Analysis Worksheets.
4. Issue revised material for Data Item S-019, "NERVA Safety Plan" to maintain the plan Current with program status.
5. Issue a status report on the study of Space Dispersion of Fission Products.

[illegible]

1. Prepare and integrate NERVA technical reliability procedures:
 - a. Prepare scopes for the 12 procedures below
 - b. Publish drafts of the following 6 procedures
 - 1) Reliability modeling and uncertainty analysis techniques for fuel, reflector, lateral support and axial support
 - 2) Reliability review of test plans
 - 3) Monte Carlo techniques in reliability analysis
 - 4) Mathematical techniques for analysis of propagation of error
 - 5) Design of experiments
 - c. Issue DRM's for the following 6 procedures:
 - 1) Reliability apportionment
 - 2) System and component reliability mathematical model.
 - 3) Determination of applicable strength theory for selected failure modes
 - 4) Parts and materials data reporting and control system
 - 5) Sampling procedures for parts selection & testing
 - 6) Trade study evaluation methods.

[illegible]

Subtask Item Project No. 863
Contract Year 1970

2. Document reliability inputs to Category B system trade study reports and added studies due to C/O W70-6
3. Component trade studies and FMA's
 - a. Issue DRM's for reliability inputs to Category "B" trade study reports for concept selection
 - b. Issue DRM's for reliability input into added Design Trade Studies due to C/O W70-6
4. Reliability allocation, modeling and predictions:
 - a. Issue DRM containing reliability allocations and models for DRB
 - b. Issue DRM on reliability models, math equations and predictions.
5. Issue DRM containing System FMECA for the NSS.
6. Issue DRM containing salient NSS trend characteristics.

[illegible]

Subtask Item Project No. 972
Contract Year 1970

1. Complete the design and modifications to the existing Diamond Mill. (Line Item 76)
2. Release for procurement of equipment (including power supply) (Line Item 82) needed to modify existing 90 element graphitizing furnace. (Line Item 83)
3. Release for procurement raw material preparation equipment. (Line Item 46)
4. Design and release for procurement ventilating hoods and machine enclosures. (Line Item 871)

[illegible]

Subtask Item Project No. 975
Contract Year 1970

1. Complete and issue the preliminary design layouts, analysis and Data Item S-136 for the following RHD equipment:
 - a. Core Disassembly Stand (Line Item 03)
 - b. Core Removal Cage (Line Item 04)
 - c. Reactor Disassembly Stand (Line Item 01)
2. Complete fabrication of FEP's modifications.

[illegible]