Process

WANL-TME-1505

September 8, 1966

Westinghouse Astronuclear Laboratory

AGC/WANL OPERATION MANUAL

SECTION III

TECHNICAL INTERFACES(u)

REFERENCE

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

WANL-TME-1505
September 8, 1966

Westinghouse Astronuclear Laboratory

AGC/WANL OPERATION MANUAL
SECTION III
TECHNICAL INTERFACES(u)

INFORMATION CATEGORY

Unclassified

BS/Reich

9-8-66

AUTHORIZED CLASSIFIER

DATE

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

A. Introduction and Description of Scope of Section

The purpose of this section of the Westinghouse/Aerojet Operational Procedure Manual is to delineate the responsibilities and to define the decision authority of the two organizations in the technical areas and to describe the interfaces that exist by the nature of the close relationship between the efforts of the two organizations in conducting the NERVA Program as implemented by Contract SNP-1 and Subcontract NP-1, and any follow-on contracts as well as to define the method of operation in the technical areas in the Rover Program.

It is not the intent of this document to detail all functions and responsibilities of Westinghouse and Aerojet nor to detail the relationship between Westinghouse/Aerojet and SNPO and with the various other participants in the complete Rover Program. Rather it is the intent to define the various interfaces between Westinghouse and Aerojet and their respective authorities and responsibilities and to provide guidelines to the Aerojet and Westinghouse technical managers, supervisors, and personnel for their guidance in conducting the NERVA Program and for interfacing with SNPO and with other Rover Program participants.

The scope of the agreements covered by this section includes all technical and programmatic interface aspects of the NERVA Program excluding only those items covered in the administrative and NTO sections of this Operational Procedure Manual.

B. Technical Interface Policy Board

The Technical Interface Policy Board will be established for the purpose of providing policy guidelines and management philosophy in the conduct of the NERVA Program. It will also act as a Board of Appeals in settling disputes arising between the organizations.

The presentation of a disagreement concerning the interpretation of this document to the Policy Committee should be done only after a thorough attempt has been made by the line organization to resolve the misunderstanding.

Membership

Two members plus two alternates will be appointed from each of the respective organizations. The Aerojet-General Corporation representatives will be appointed by the NERVA Program Director (Aerojet) and the Westinghouse members will be appointed by the Associate NERVA Program Director (Westinghouse).

Charter

All recommended changes to the interface agreements contained in this document will be reviewed by the respective organizations prior to submittal to the Technical Interface Policy Board. The proposed revisions will be submitted by the Aerojet/Westinghouse board member as appropriate. The members of the board will collect information on any complaints of interface violation from the respective organizations and then will call a meeting of the committee for discussion and resolution. Members of the committee will act as representatives of respective organizations with full authority to approve or disapprove any agreements. Board members will maintain communications with all cognizant subdivisions of their parent organization and assure that all commitments are understood by affected personnel in the parent organization and whenever possible before signifying approval or disapproval.

Acceptance by the committee shall require unanimous approval of the members. All agreements and actions shall be documented and signed by the members. In the event agreement cannot be reached, the board will present the case of the NERVA Program Director for final resolution (see Section I).

Agreements reached by the Technical Interface Policy Board which modify, change, or add to the basic Aerojet/Westinghouse agreement will be submitted as described in Section 1C of this basic agreement for ratification and inclusion into the basic agreement.

C. Definition

Because of the technical requirements of the overall NERVA systems, Aerojet has a responsibility in all areas of development whereas Westinghouse has a responsibility in the areas of the nuclear subsystem. Aerojet's interest in certain areas of Westinghouse's effort is limited to monitoring and surveillance in order to assess the impact of technical problems and progress in the nuclear subsystem upon the performance of the overall program.

In order to further clarify the Aerojet/Westinghouse technical relationship, there will be used in this section certain items describing the responsibilities and authorities of the two organizations in the interface areas. These terms and their definitions as used in subsequent paragraphs are as follows:

1. Primary Responsibility

Primary responsibility implies the right to proceed with design and development decisions and customer discussions, subject to contractual provisions, established programmatic approvals, and approved interface control documents such as statepoint diagram, mechanical interface control drawings, etc. The party with primary responsibility will keep the other informed to allow him to discharge his own areas of responsibility.

2. Lead Responsibility

This term is used to designate responsibility in specific interface areas between the two companies, in which both participate or in which the actions of either one affects the efforts of the other. The organization having lead responsibility will take the initiative in planning, implementation, coordination, documentation, and other aspects of the accomplishment of the technical objectives of those areas. The burden of proof in the event of disagreement with technical decisions in areas in which one organization is designated "lead" will rest with the other party.

D. Rules for Establishing Detailed Interface Agreements

In a broad sense the Aerojet-General Corporation is responsible for the overall engine design, system performance and compatibility with the vehicle. The Westinghouse Electric Corporation is responsible for the design and development of the nuclear subsystem as established by engine system requirements. The Westinghouse Electric Corporation is also responsible for nuclear safety analyses.

The nuclear subsystem is composed of all the equipment within the pressure vessel, such as the reactor, shield, reflector, etc., and the associated reactor control equipment. The nuclear subsystem also includes neutron detectors and any equipment specifically nuclear in nature or specifically required for reactor control.

The nuclear subsystem will also include any components or equipment specifically nuclear in nature that may be identified in future NERVA requirements.

In the area of radiation analysis, a common model will be developed which will include radiation sources from the nuclear subsystem, to be provided by Westinghouse, and from the remainder of the engine, module, and test stand, to be provided by Aerojet. Westinghouse will have primary responsibility for the design of the internal shield and for calculating radiation heating, and radiation effects to Westinghouse supplied components. Aerojet will have primary responsibility for design of any engine shields required external to the reactor pressure vessel for specifying design criteria of the internal shield and for calculating and determining the effects of radiation heating and radiation damage to all non-nuclear subsystem components, module, and engine test facilities. Westinghouse will have primary responsibility for the design of any reactor test facility shields required external to the reactor and for determining the effects of radiation heating and radiation damage to the reactor test facility.

In the area of ground support equipment, where overall system functions are to be performed, the responsibility for design and furnishing of support and handling equipment will be an Aerojet lead responsibility. Where portions of this support equipment are identifiable to the nuclear subsystem, those identifiable items will be designed and furnished by Westinghouse as a primary responsibility compatible with system constraints and interface agreements. That support and handling equipment required for the nuclear subsystem will be designed and furnished as a primary responsibility of Westinghouse. All other equipment will be designed and provided as a primary responsibility of Aerojet.

Aerojet will have lead responsibility for engine system tests. Westinghouse will have lead responsibility for reactor development system tests. Aerojet will, however, maintain a responsibility for certain functional areas during reactor development tests when the decisions made in those areas have a significant effect on the engine system development. Aerojet will therefore maintain at all times lead responsibility for mechanical interface control, fluid flow statepoint control, overall safety, quality control, and engine systems analysis. Westinghouse will maintain primary responsibility for the mechanical, nuclear and thermal design for all nuclear subsystem components, for nuclear safety analyses and for the nuclear subsystem portion of systems analyses.

In instrumentation, primary responsibility for any instrument is assigned to the organization having primary responsibility for the component in which the parameter of interest is to be measured. In the event such instrumentation requires mechanical, electrical or fluid interfaces with components provided by the other corporation, the lead responsibility for resolving interfaces rests with the corporation having primary responsibility for the instrument. Lead responsibility for the design of any instrument rests with the corporation responsible for the engine end item component to which the instrument is mounted or attached.

In materials development and radiation effects, Aerojet will have primary responsibility for those programs which are principally related to the engine system components development. Westinghouse will have primary responsibility for those programs which are principally related to the development of nuclear subsystem components. Aerojet will maintain lead responsibility for radiation effects coordination and program integration. Aerojet will maintain lead responsibility for compilation and issuance of materials and radiation effects data books.

In flight safety including countermeasure systems, Aerojet will have primary responsibility for the design of non-nuclear countermeasure and destruct system not located within the nuclear subsystem and the integration of engine destruct criteria and requirement with stage and/or module design or requirements. Aerojet will also have primary responsibility for the interface control of the countermeasure destruct system and for the design and provision of the system for disposal of the anti-criticality subsystem. Westinghouse will have primary responsibility for the development of malfunction and accident analyses leading to potential nuclear hazards; determination of resultant performance and integrity of nuclear subsystem following malfunction as well as prediction and experimental determination of nuclear source term; propose design changes to nuclear subsystem and stage; analyze procedures and mission modes to minimize hazards; propose flight tests to demonstrate safety; analysis of effectiveness of all proposed countermeasures and disposal methods to minimize hazards to life in earth environments and to crew in space; determination of nuclear requirements for any proposed nuclear destruct devices located within the nuclear subsystem, including devices for insertion or withdrawal of nuclear poison or moderator.

The NERVA engine control system will be a lead responsibility of Aerojet. Westinghouse will have primary responsibility for the reactor control subsystem. Westinghouse will continue development and provisioning on the chamber temperature control loop. Responsibility for packaging, further development and provisioning in the NE Series will be determined at a later date.

Westinghouse will have lead responsibility for the structural coolant control system up to and including flow control valve, actuator, and associated control systems. Aerojet will supply the flow control valve. If valve actuator requirements are met by a reasonable modification of an actuator supplied by Aerojet for other NERVA requirements an evaluation of using such an actuator will be made before Westinghouse develops a different actuator.

AGC/WANL NRX/NR INTERFACES

NRX/NR RADIATION ANALYSIS INTERFACE

- A. A geometrical, atom density and source strength analysis model would be prepared by Westinghouse and Aerojet and would include a two dimensional diagram of the reactor and facility. Westinghouse would provide the data for the nuclear subsystem and for the facility, and Aerojet would provide the data for the above for the pressure vessel and nozzle and other Aerojet components.
- B. Aerojet will have primary responsibility for calculating the radiation heating, radiation environment and activation throughout the pressure vessel and nozzle and other Aerojet components.
- C. Westinghouse will have primary responsibility for calculating the radiation heating, radiation environment and activation throughout the nuclear subsystem and the facility.
- D. Westinghouse will have primary responsibility for the design of any reactor test facility shields.
- E. Aerojet will have primary responsibility for the definition of measurement of radiation heating and radiation environment for the reactor pressure vessel, nozzle and other Aerojet components.
- F. Westinghouse will have primary responsibility for the definition of measurements of radiation heating and radiation environment in and surrounding the nuclear subsystem.
- G. NERVA Test Operations will be responsible for mounting, recovery, data processing and reporting the results of the radiation heating and environment experiments.

NRX/NR NUCLEAR SAFETY ANALYSIS AND EVALUATION

- A. The preparation as relates to format and content of the SAR and SER's for the NRX and NR program will be continued as already established for the NRX tests.
- B. All requests for approval by Westinghouse for the conduct of NRX and NR tests will be submitted to Aerojet who will in turn submit them to SNPO for approval.
- C. A safety committee will be established to review the NRX and NR test series with participation by Westinghouse and Aerojet personnel under Westinghouse chairmanship.
- D. The nuclear safety analysis and evaluation of the nuclear hazards is the primary responsibility of Westinghouse.
- E. The SAR, SER and OLD will contain Aerojet and Westinghouse inputs and will be issued by Westinghouse.

RADIATION EFFECTS (NRX, NR, XE, NE)

Aerojet will have primary responsibility for those programs which are principally related to the engine system components developments. Westinghouse will have primary responsibility for those programs which are principally related to the development of nuclear subsystem components.

Westinghouse will have primary responsibility for all radiation tests to be conducted at the Plum Brook Reactor Facility and all NERVA facility additions or modifications. This responsibility will include scheduling, planning and the design and fabrication of all test fixtures and associated hardware; the generation of all analyses and operational procedures associated with the safe and proper operation of these tests and the production of test data. For Aerojet tests, Aerojet will have the lead responsibility for supplying the test items and for the generation of the test report.

	<u>Westinghouse Tests</u>	<u>Aerojet Tests</u>
Test Plan	W	AGC
Preliminary Test Spec.	W	AGC
Final Test Spec.	W	AGC
Design Manual and Safety Analysis	W	W
Data Report	W	W
Test Report	W	AGC

For NARF tests, WANL will assume primary responsibility for the design and fabrication of test fixturing for the WANL tests and AGC will assume primary responsibility in this area for AGC tests. AGC will maintain overall responsibility in the scheduling of NARF tests. The same documentation requirements as for a PB test remain in effect for NARF tests except that GD/FW assumes responsibility for design manual and safety reports and data reports for all tests conducted at NARF.

For side-by-side tests at NRDS, WANL will assume primary responsibility for all tests planned in conjunction with NRX and NR. WANL will supply test items and fixturing for WANL tests and AGC will supply these for AGC tests. AGC will supply WANL with

documentation and analyses necessary to prove that AGC tests can be performed safely and properly side-by-side with these reactor tests.

For side-by-side tests associated with XE and NE, AGC will assume primary responsibility and WANL will supply the documentation and analyses necessary to prove that WANL tests can be performed safely and properly side-by-side with these engine tests. WANL will supply the test items and fixturing for WANL tests and AGC will supply these for AGC tests.

TEST ARTICLE INTERFACE

NRX/NR

<u>Interface</u>	<u>Responsibility</u>	<u>Governing Document</u>
1. Test Article - NRX/NR Assembly	WANL-AGC Review	WANL Test Specification
1.1 Interface Control Drawing	AGC-WANL Review	AGC Drawing
1.1.1 Reactor & Shield to Pressure Vessel		
1.1.2 Test Car & Propellant Line to Pressure Vessel		
1.1.3 Control Rod Assembly to Pressure Vessel		
1.1.4 Instrumentation & Control Hardware to Test Assembly (As Applicable)		
1.1.5 Shipping & Handling Hardware to Pressure Vessel		
1.1.6 360° Shield to Test Assembly		
1.1.7 Remote Disassembly Hardware to Test Assembly		
1.1.8 Reactor to Pressure Vessel State Point Interface Parameters		
1.2 Test Assembly Drawings	WANL with AGC Review	WANL Drawing

SYSTEMS AND DATA ANALYSIS - NRX/NR

1. WANL will have lead responsibility for systems and data analysis of NRX and NR tests.

This encompasses:

- a. Development and updating of common analysis models.
- b. Issuance of reports describing common analysis models.
- c. Providing the major input to fluid flow steady-state point interface control documents.
- d. Performance of analog and digital system performance predictions.
- e. Issuance of official test predictions reports.
- f. Participation in on-test-site teams to evaluate the adequacy of data acquisition systems.
- g. Organization of on-test-site teams for early post-test data evaluations.
- h. Determination of component and subsystem constraints affecting system operation.
- i. Detailed analysis of test data for evaluation of system performance and validation of common analysis models.
- j. Establishment of special measurement requirements for systems analysis purposes.
- k. Processing of wideband test data.

2. AGC and WANL will jointly participate in the development, evaluation and updating of the common analysis models for the NRX and NR systems with WANL concentrating on the nuclear subsystem, test facility, and emergency systems, and AGC concentrating on the non-nuclear components of the test assembly. Evaluation and updating of the common analysis models for each of these systems will be based upon analytical and experimental data comparisons. These models will be augmented by additional capacity at each organization for more detailed evaluation of components and subsystems for which WANL and AGC has responsibility. The common models for each system will be maintained on a current basis at both AGC and WANL by transfer of information on the modifications to equations and coefficients from the responsible component design organization to the other party. These proposed modifications will be signed off by a designated manager of the originating

organization. The modified equations will be regarded as the basis for official predictions of system performance after (a) they have been implemented at both AGC and WANL, (b) a set of agreed-to-check problems have been run at both organizations to provide a cross-check of the revised model, and (c) the recipient organization acknowledges, over the signature of the designated manager, receipt of the proposed revisions, consistency of these revisions with other parts of the model, and the achievement of reasonable agreement between the results of the common check problems as run at AGC and WANL.

3. WANL will issue reports describing the common analysis models for NRX and NR. These will include, at a minimum, (a) a preliminary model report at the time of initial formulation of the complete model for a given system, and (b) a final model report describing the model as used for official predictions of test performance, including a flow schematic of the system, a complete list of equations and coefficients, a discussion of modifications made from the preliminary model, results of the check problems run, and illustrative system performance predictions made using the model.
4. A fluid flow state point interface control document will be established for all NRX and NR systems with the objective of providing mutually agreed upon, current, steady-state fluid flow interface conditions at various operating levels to provide a common basis for detailed component or subsystem design and for steady-state checks of the common analog and digital models for each system. The state point interface control document and the common models for each system will be maintained compatible with each other. WANL will issue preliminary, unofficial interface control documents (ICD) for each test and forward to AGC. After sign-off acceptance by AGC and WANL, AGC will issue an official ICD. Changes to an ICD may be proposed by either organization, using an interface change order request (ICOR) form. Sign-off acceptance of an ICOR by both organizations requires a change in the ICD for the given system. Any change in the ICD will reference the ICOR authorizing the change.

5. AGC and WANL will use the common analysis models for all official test predictions of the NRX and NR systems with WANL emphasizing the performance of the nuclear subsystem and the test facility, and AGC emphasizing the performance of the non-nuclear components of the test assembly.
6. WANL and AGC will both provide input to the official test predictions reports for NRX and NR with WANL having responsibility for editing and issuing these reports.
7. AGC and WANL will both participate in joint Test Site team efforts to evaluate the adequacy of the data acquisition systems for NRX and NR.
8. WANL and AGC will both participate in joint, on-test-site, post-test data evaluation efforts, such as Data Review Team, Test Diagnostic Team, DRAGON Team, etc., with WANL having responsibility for organizing these teams for NRX and NR.
9. Each organization will provide and maintain on a current basis component and subsystem constraints in their area of responsibility that affect system operation.
10. Each organization will have responsibility for analyzing the data from NRX and NR tests to evaluate system performance and to assess the validity of the common analog and common digital models used for pre-test predictions with WANL emphasizing the performance of the nuclear subsystem and the test facility, and AGC emphasizing the performance of the non-nuclear components of the test assembly.
11. Both organizations will have responsibility for requesting special measurements during the NRX and NR test series to provide data required for systems analysis purposes. This will include the responsibility for specifying necessary instrumentation and data acquisition equipment.
12. WANL will process wideband test data, using the WANL Data Converter and special computer codes developed for this purpose, and will make the processed data available to AGC for analysis purposes.

TEST DOCUMENTATION - NRX AND NR

The responsibilities for key test documentation for NRX and NR are defined in Table I below.

TABLE I				
<u>NRX & NR Documents</u>	<u>Input & Details Prepared by:</u>	<u>Prepared & Issued by:</u>	<u>Reviewed by:</u>	<u>Approved by:</u>
<u>Engineering Control Document</u>				
1. Test Plan	AGC/WANL	WANL	AGC/WANL/ SNPO-C/NTO	AGC/SNPO-C
2. Measurement Re- quirements List	AGC/WANL	WANL	AGC/WANL/ SNPO-C/NTO	AGC/SNPO-C
3. Test Specification	AGC/WANL/ NTO	WANL	AGC/WANL/ SNPO-C/NTO	AGC/SNPO-C
4. Operational Sup- port Plan	AGC/WANL	WANL	AGC/WANL/ SNPO-C	AGC/SNPO-C
5. Final Test Report	WANL	WANL	AGC	NA
<u>NTO Documents</u>				
1. Program Require- ments	AGC/WANL/ NTO	NTO	AGC/WANL/ SNPO-C	SNPO-C
2. Test Article Assem- bly & Test Procedures				
A. Receiving In- spection	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/ SNPO-N	AGC/WANL
B. Assembly Pro- cedures	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/ SNPO-N	AGC/WANL
C. Mateup & Final Checkout Pro- cedures	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/ SNPO-N	AGC/WANL

D. Support Operational Requirements Document (SORD)	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/SNPO-N	NA
E. Control Room Operating Procedures	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/SNPO-N	Test Review Board
F. Post Test Procedures	NTO/AGC/ WANL	NTO	AGC/WANL/ SNPO-C/SNPO-N	AGC/WANL
3. Test Car Assy. Procedures	WANL	WANL	AGC/WANL/ SNPO-C/SNPO-N/ NTO	NTO
4. A. Assembly Report	NTO	NTO	AGC/WANL/ SNPO-C	NA
B. Post Test Report	NTO	NTO	AGC/WANL/ SNPO-C	NA
5. NTO Quality Control	AGC/WANL/ SNPO-C/NTO	NTO	AGC/WANL/ SNPO-C	NA
6. 8 Hour Test Report	NTO	NTO	NA	NA
7. 3-Day Report	NTO	NTO	NA	NA
8. NTO Test Report	NTO	NTO	AGC/WANL/ SNPO-C	NA
9. Standard Facility and/or Equipment Operating Procedure	NTO	NTO	AGC/WANL/ SNPO-C	
10. Test Cycle Schedule	NTO	NTO	NA	NA
11. Material Disposition	NTO	NTO	NA	NA

NA = NOT APPLICABLE

MEASUREMENTS REQUIREMENTS LIST - NRX/NR

PHASE I From Formulation of In-House Instrumentation Requirements Through Approval of Joint MRL by SNPO-C.

AGC will prepare in-house their requirements and transmit them to PERT date to WANL via card deck and printout.

For the first preliminary Joint MRL, WANL will combine the AGC requirements without change with the WANL requirements and issue printout to AGC and NTO only in accordance with the PERT date.

WANL will call a meeting of AGC, WANL, and NTO representatives to resolve any problems. This meeting will conclude with an AGC and WANL representative signing off a copy of the first preliminary Joint MRL marked to indicate any changes which have mutual concurrence. Copies of this signed MRL will be distributed to each organization.

WANL will use the original signed copy to prepare a second preliminary Joint MRL for distribution to AGC, WANL, and NTO only.

AGC, WANL, and NTO will review the second preliminary Joint MRL, subsequent changes having joint concurrence will be added to the MRL. Such agreements will be confirmed in writing.

WANL will issue the MRL to SNPO-C for approval by established PERT date with copies to AGC and NTO.

PHASE II From SNPO-C Approval of the MRL to Convening of the TS & PRB

II. 1 For AGC or NTO Change Requests

AGC will notify WANL of measurement change request by telecon and subsequently send signed MCR to WANL.

If WANL concurs with MCR, WANL will sign MCR and transmit to SNPO-C for approval, with copies to AGC and NTO.

In case of NTO requests, NTO will send request to WANL with information copy to AGC. If WANL concurs, WANL sends to AGC for approval. Upon receipt of AGC approval, WANL sends MCR to SNPO-C. Lack of concurrence on part of WANL or AGC would be handled as above.

If WANL does not concur with an AGC, MCR, WANL will telecon AGC and resolve differences. Once the differences are resolved, AGC will issue revised MCR and send to WANL for approval. If WANL concurs, WANL signs MCR and sends to SNPO-C with copies to AGC and NTO.

SNPO-C will approve or disapprove and transmit comments via TLX to AGC and WANL: If approved, WANL will revise the MRL accordingly. If disapproved, further action will be left to the originator.

NOTE - The above procedure applies to those measurements which require joint MCR approval as noted by the MRL. For other AGC MCR's, AGC sends MCR to WANL who transmits to SNPO-C for approval, copy to NTO.

PHASE II From SNPO-C Approval of the MRL to Convening of the TS and PRB
(Continued)

II. 2 For WANL Change Requests

WANL will transmit measurement change request MCR to AGC.

If AGC concurs with MCR, AGC will sign and return to WANL, WANL will transmit to SNPO-C with copies to AGC and NTO.

If AGC does not concur, AGC will telecon WANL and the differences will be resolved. Once the differences are resolved, AGC will revise MCR, sign and transmit to WANL. If WANL approves modified MCR, WANL will sign and transmit to SNPO-C with copies to AGC and NTO.

SNPO-C will approve or disapprove and transmit comments via TLX to AGC and WANL. If approved, WANL will revise the MRL accordingly. If disapproved, further action will be left to the originator.

NOTE - The above procedure applies to those measurements which require joint MCR approval as noted by the MRL. For other WANL MCR's, WANL transmits to SNPO-C for approval with copies to AGC and NTO.

PHASE III From Convening of the TS and PRB to the End of the Test Series

AGC, WANL or NTO will transmit MCR to the NTO Data Group with information copies to AGC, WANL, SNPO-C and individual review board members. Coordination of reviews will be in accordance with Board Charter.

NTO will present the change request to the Review Board for action.

Following Review Board action, the Review Board secretary will immediately TWX resolution to WANL, AGC, and SNPO-C followed by transmittal of signed off MCR to WANL.

GROUND SUPPORT EQUIPMENT AND FACILITIES - NRX/NR

A. Ground Support Equipment

1. Preparation and issuance of the test assembly drawings, installation drawings, and assembly procedures for each reactor is a primary WANL responsibility.
2. Primary responsibility for the test car and GSE to support the nuclear subsystem rests with WANL.
3. Preparation and issuance of the provisioning list for each reactor is a primary WANL responsibility. Identification of the cognizant design agency is made on the P/L.
4. Primary responsibility for GSE to support AGC supplied hardware, as well as the identification of the need, is an AGC responsibility.
5. WANL effects the necessary liaison through NTO management with the NRDS Facility Manager covering GSE.

B. Facilities Engineering

1. WANL serves as the control for all facilities modifications and additions.
2. Functional requirements for facility modifications may be issued by Aerojet, Westinghouse or NTO.
3. WANL will provide design specifications for all modifications.
4. All detail designs for facility modifications are prepared either by WANL or by NTO with WANL sign-off approval on code 1 drawings.
5. AGC will receive copies of all facility modifications, additions and deletions in accordance with WANL and NTO correspondence procedures.

CONTROL SYSTEMS AND INSTRUMENTATION - NRX/NR

1. WANL will have lead responsibility for the overall control system design for all reactor system tests, and primary responsibility for the reactor control subsystems.
2. WANL will be responsible for:
 - a. Negotiation of technical interfaces with LASL on Test Cell C.
 - b. Development and documentation of system requirements imposed on Test Cell C.
 - c. Development and documentation of detailed design criteria for the design of each new unit or unit requiring modification in Test Cell C.
 - d. Detail design of and the manufacture or sub-contracting for manufacture of each new unit or unit requiring modification in Test Cell C.
 - e. Installation and checkout of the new units or modified units at NRDS in accordance with NTO/WANL agreements.
 - f. The incorporation of any controls tests or instrumentation tests requested by AGC into the test specification. (All control concept development and modifications will be accomplished by issuance of functional requirements in a manner similar to that used for facility modifications.)
3. The WANL instrument committee will review and approve all measurements, both AGC and WANL, from standpoint of system capability.
4. WANL will specify termination of wires in the test car for both AGC and WANL instrumentation.
5. WANL will be responsible for processing of wide-band analog test data including digitizing and computer programming.
6. WANL will keep AGC informed of all instrumentation and control progress and plans by sending information copies of the following documents:
 - a. All functional requests
 - b. System and chassis drawings
 - c. All design and analysis reports

7. Reactor Control Actuators
- a. Westinghouse will have lead responsibility for both the control drum and structural coolant control systems.
 - b. The control drum actuator requirements, type of actuator, and control system will be a Westinghouse responsibility. Westinghouse will provide the actuator for this application.
 - c. The structural coolant control actuator, flow control valve, and control system will be a Westinghouse responsibility. Aerojet will supply the flow control valve to meet Westinghouse requirements. Westinghouse will provide the control system and will also provide the valve actuator unless the valve actuator requirements are met by a reasonable modification of an actuator supplied by Aerojet for other NERVA requirements. An evaluation of using such an actuator will be made by Westinghouse before Westinghouse develops a different actuator.
 - d. Definition of all installation and checkout procedures associated with both reactor control actuation systems shall be a Westinghouse responsibility.

AGC/WANL XE/NE INTERFACES

RADIATION ANALYSIS INTERFACE - XE/NE

- A. A geometrical, atom density and source strength analysis model will be prepared by Aerojet and Westinghouse and will include a two dimensional diagram of the nuclear subsystem, engine module and facility. Aerojet will provide the data for the above for the engine, module and test stand. Westinghouse will provide the data for the above for the nuclear subsystem.
- B. Aerojet will have primary responsibility for design of engine shields required external to the reactor pressure vessel.
- C. Aerojet will have primary responsibility for calculation of radiation heating and radiation environment and activation throughout the non-nuclear subsystem components, module and engine test facility.
- D. Aerojet will specify the design criteria of the internal shields including, for example, limitations on radiation heating and radiation environment on the engine components and allowable total propellant heating in the module and the allowable temperature rise in the propellant.
- E. Westinghouse will have primary responsibility for design of the internal shield. Westinghouse will have primary responsibility to verify that the shield meets the design criteria specified by Aerojet.
- F. Westinghouse will have primary responsibility for calculation of radiation heating and radiation environment and activation throughout the nuclear subsystem and other Westinghouse supplied components.
- G. Aerojet will have primary responsibility for the definition of measurements of radiation heating and radiation environment throughout the non-nuclear subsystem, module and engine test facility.

- H. Westinghouse will have primary responsibility for definition of measurements of radiation heating and radiation environment throughout the nuclear subsystem and at positions required to evaluate the shield performance.
- I. Westinghouse will have primary responsibility for evaluating the effect of facility shields and engine shields external to the reactor pressure vessel on nuclear subsystem reactivity and heating.
- J. Mounting, recovery, data processing and reporting of radiation heating and environment experiments will be performed by NTO.

NUCLEAR SAFETY ANALYSIS AND EVALUATION - XE/NE

- A. The preparation as relates to format and content of the SAR and SER's for the XE and NE program will be continued as already established for NRX tests.
- B. All requests for approval by Aerojet for the conduct of XE and NE engine tests will be first submitted to Westinghouse for their comments and recommendations, prior to submittal of this request to SNPO.
- C. A safety committee will be established to review the XE and NE test series with participation by Westinghouse and Aerojet personnel under Aerojet chairmanship.
- D. The nuclear safety analysis and evaluation of the nuclear hazards is the primary responsibility of Westinghouse.
- E. The SAR, SER and OLD will contain Aerojet and Westinghouse inputs and will be issued as joint documents, published by Westinghouse and submitted to the government by Aerojet. Concurrence on all parts of the report will be achieved by both Westinghouse and Aerojet prior to issuance.

The responsibilities for preparation of the various sections of the SAR and SER are as indicated below:

	<u>Prepared By:</u>
1. Introduction	Joint
2. Organization	Aerojet
3. Site Description (if required)	Westinghouse
4. Facility Design	Aerojet

5.	Test Assembly	Joint
6.	Operation	Joint
7.	Radiation Environment	Westinghouse
8.	Safety Evaluation	Westinghouse

Aerojet will retain primary responsibility for the safety of facilities and equipment and non-nuclear safety of personnel. Westinghouse will support Aerojet in this responsibility as appropriate.

RADIATION EFFECTS - NRX/NR/XE/NE

TEST ARTICLE INTERFACE - XE/NE

<u>Interface</u>	<u>Responsibility</u>	<u>Governing Document</u>
1. Test Article - XE/NE	AGC-WANL Review	Applicable Eng. Spec.
1.1 Interface Control Drawing	AGC-WANL Review	AGC Dwg. _____
1.2 Engine Assembly Specification		
1.2.1 Core to Pressure Vessel	WANL with AGC Approval	Assembly Specification
1.2.2 Nozzle to Pressure Vessel	AGC with WANL Approval	Assembly Specification
1.2.3 Actuator Assembly to Engine	WANL with AGC Approval	Assembly Specification

SYSTEMS AND DATA ANALYSIS - XE/NE

1. AGC will have lead responsibility for systems and data analysis of XE and NE tests.

This encompasses:

- a. Development and updating of common analysis models.
- b. Issuance of reports describing common analysis models.
- c. Establishment and updating of fluid flow steady-state point interface control documents.
- d. Performance of analog and digital system performance predictions.
- e. Issuance of test prediction reports.
- f. Participation in on-test-site teams to evaluate the adequacy of data acquisition systems.
- g. Organization of on-test-site teams for early post-test data evaluations.
- h. Determination of component and subsystem constraints affecting system operation.
- i. Detailed analysis of test data for evaluation of system performance and validation of common analysis models.
- j. Establishment of special measurement requirements for systems analysis purposes.

2. AGC and WANL will jointly participate in the development, evaluation and updating of the common analysis models for the XE and NE systems with WANL concentrating on the nuclear subsystem, and AGC concentrating on the non-nuclear components of the test assembly, the test facility, and the emergency systems. Evaluation and updating of the common analysis models for each of these systems will be based upon analytical and experimental data comparisons. These models will be augmented by additional capacity at each organization for more detailed evaluation of components and subsystems for which WANL or AGC has responsibility. The common models for each system will be maintained on a current basis at both AGC and WANL by transfer of information on the modifications to equations and coefficients from the responsible component design organization to the other party. These proposed modifications will be signed off by a designated manager of the originating organization. The modified equations will be regarded as the basis for official predictions of system performance after

(a) they have been implemented at both AGC and WANL, (b) a set of agreed-to check problems have been run at both organizations to provide a cross-check of the revised model, and (c) the recipient organization acknowledges, over the signature of the designated manager, receipt of the proposed revisions, consistency of these revisions with other parts of the model, and the achievement of reasonable agreement between the results of the common check problems as run at AGC and at WANL.

3. AGC will issue reports describing the common analysis models for XE and NE. These will include, at a minimum, (a) a preliminary model report at the time of initial formulation of the complete model for a given system, and (b) a final model report describing the model as used for official predictions of test performance, including a flow schematic of the system, a complete list of equations and coefficients, a discussion of modifications made from the preliminary model, results of the check problems run, and illustrative system performance predictions made using the model.

4. A fluid flow state point interface control document will be established for all XE and NE systems with the objective of providing mutually agreed upon, current, steady-state fluid flow interface conditions at various operating levels to provide a common basis for detailed component or subsystem design and for steady-state checks of the common analog and digital models for each system. The state point interface control document and the common models for each system will be maintained compatible with each other. AGC will issue preliminary, unofficial interface control documents (ICD) for each test and forward to WANL. After signoff acceptance by AGC and WANL, AGC will issue an official ICD. Changes to an ICD may be proposed by either organization, using an interface change order request (ICOR) form. Sign-off acceptance of an ICOR by both organizations requires a change in the ICD for the given system. Any change in the ICD will reference the ICOR authorizing the change.

5. AGC and WANL will use the common analysis models for all official test predictions of the XE and NE systems with WANL emphasizing the performance of the nuclear subsystem, and AGC emphasizing the performance of the non-nuclear components of the test assembly, the test facility, and the emergency systems.

6. WANL and AGC will both provide input to the official test predictions reports for XE and NE with AGC having responsibility for editing and issuing these reports.
7. AGC and WANL will both participate in joint Test Site team efforts to evaluate the adequacy of the data acquisition systems for XE and NE.
8. WANL and AGC will both participate in joint, on-test-site, post-test data evaluation efforts, such as Data Review Team, Test Diagnostic Team, DRAGON Team, etc., with AGC having responsibility for organizing these teams for XE and NE.
9. Each organization will provide and maintain on a current basis component and sub-system constraints in their area of responsibility that affect system operation.
10. Each organization will have responsibility for analyzing the data from XE and NE tests to evaluate system performance and to assess the validity of the common analog and common digital models used for pre-test predictions with WANL emphasizing the performance of the nuclear subsystem, and AGC emphasizing the performance of the non-nuclear components of the test assembly, the test facility, and the emergency systems.
11. Both organizations will have responsibility for requesting special measurements during the XE and NE test series to provide data required for systems analysis purposes. This will include the responsibility for specifying necessary instrumentation and data acquisition equipment.
12. WANL will process wideband test data, using the WANL Data Converter and special computer codes developed for this purpose, and will make the processed data available for AGC for analysis purposes.

TEST DOCUMENTATION XE AND NE

The responsibilities for the key test documents for XE and NE tests are given in Table II.

TABLE II
XECF/XE/NE DOCUMENTATION SUMMARY

Documents	Inputs and Details	Prepared, Issued By	Initial Draft Review & Concur	Review of Final Draft By	Approved By
A. Operational Control Documents					
1. XECF Test Plan	AGC/NT0/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
2. XE/NE Test Plan	AGC/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
3. XECF Test Specification	AGC/NT0/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
4. XE/NE Test Specification	AGC/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
5. XE/NE Design Specification	AGC/WANL	AGC	WANL	AGC/WANL/SNPO-C	SNPO-C
6. Operational Support Plan	AGC/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
7. XECF MRL	AGC/NT0/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
8. XE/NE MRL	AGC/NT0/WANL	AGC	WANL	AGC/NT0/WANL/SNPO-C	SNPO-C
9. Final Test Report	AGC/WANL	AGC	WANL	AGC	---
10. Topical Test Reports	AGC/WANL	Originating	Originating	N/A	N/A
11. Operating Limits Document	WANL/AGC/NT0			AGC/WANL/NT0/SNPO-C	SNPO-C
12. Safety Analysis Report	AGC/NT0/WANL			AGC/NT0/WANL/SNPO-C	SNPO-C *
13. Safety Evaluation Report	AGC/NT0/WANL			AGC/NT0/WANL/SNPO-C	SNPO-C *
B. NTO Documents					
1. Program Requirements	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C	SNPO-C
2. XECF and XE/NE Procedures					
a. Receiving Inspection Procedures					
(1) Non-nuclear Components	AGC/NT0/ACFI	NT0		AGC/NT0/SNPO-C/SNPO-N	AGC
(2) Nuclear Components	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(3) Control Drum Actuators	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
b. Assembly Procedures					
(1) Test Stand Adapter Install.	AGC/NT0	NT0		AGC/NT0/SNPO-C/SNPO-N	AGC
(2) XECF Assembly	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(3) XE/NE Assembly	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(4) EIV/MCC Assembly and Checkout	AGC/NT0	NT0		AGC/NT0/SNPO-N	SNPO-N

N/A = Not Applicable.

* SNPO-C will obtain all other agency approvals.

TABLE II (Continued)

Documents	Inputs and Details	Prepared, Issued By	Initial Draft Review & Concur	Review of Final Draft By	Approved By
B. NTO Documents (Cont'd)					
c. Test Preparation Procedures					
(1) XECF Test Preparation	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(2) XE/NE Test Preparation	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(3) XECF Installation	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(4) XE/NE Installation	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
d. Control Room Operating Procedures					
(1) Initial Criticality and Drum Calibration Tests	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	TRB
(2) Neutronic System Cal.	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	TRB
(3) All XECF Test Phases	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	TRB
(4) All XE/NE Test Phases	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	TRB
e. Removal/Disassembly Procedures					
(1) XECF Removal	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(2) XE/NE Removal	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(3) XECF Transfer to E-MAD	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(4) XE/NE Transfer to E-MAD	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(5) XECF Post-Test Disassembly	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(6) XE/NE Post-Test Disassembly	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
(7) XECF Post-Test Inspection	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(8) XE/NE Post-Test Inspection	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
f. Post Operative Examination					
(1) XECF Procedures	AGC/NT0/WANL	NT0		AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL
(2) XE/NE Procedures	AGC/NT0/WANL	NT0		AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL
3. Post-Test Report	NT0	NT0		AGC/WANL/SNPO-C	N/A
4. 8-Hour Test Report	NT0	NT0		N/A	N/A
5. 3-Day Test Report	NT0	NT0		N/A	N/A
6. Data Report	NT0	NT0		AGC/WANL/SNPO-C	N/A
7. Std Facility Oper. Proc.	NT0	NT0		AGC/WANL/SNPO-C	N/A
8. Test Cycle Schedule	NT0	NT0		N/A	N/A
9. Material Disposition Reports	NT0	NT0		N/A	N/A

MEASUREMENTS REQUIREMENTS LIST - XE AND NE

PHASE I From Formulation of In-House Instrumentation Requirements Through Approval of Joint MRL by SNPO-C

WANL will prepare in-house their requirements and transmit them by PERT date to AGC via card deck and printout.

For the first preliminary Joint MRL, AGC will combine the WANL requirements without change with the AGC requirements and issue printout to WANL and NTO only in accordance with the PERT date.

AGC will call a meeting of WANL, AGC and NTO representatives to resolve any problems. This meeting will conclude with a WANL and AGC representative signing off a copy of the first preliminary Joint MRL marked to indicate any changes which have mutual concurrence. Copies of this signed MRL will be distributed to each organization.

AGC will use the original signed copy to prepare a second preliminary Joint MRL for distribution to WANL, AGC, and NTO only.

WANL, AGC, and NTO will review the second preliminary Joint MRL, subsequent changes having joint concurrence will be added to the MRL. Such agreements will be confirmed in writing.

AGC will issue the MRL to SNPO-C for approval by established PERT date with copies to WANL and NTO.

PHASE II From SNPO-C Approval of the MRL to Convening of the TS & PRB

II.1 For WANL or NTO Change Requests

WANL will notify AGC of measurement change request by telecon and subsequently send signed MCR to AGC.

If AGC concurs with MCR, AGC will sign MCR and transmit to SNPO-C for approval, with copies to WANL and NTO.

In the case of NTO requests, NTO will send request to AGC with information copy to WANL. If AGC concurs, AGC sends to

If AGC does not concur with an WANL MCR, AGC will telecon WANL and resolve differences. Once the differences are resolved, WANL will issue revised MCR and send to AGC for approval. If AGC concurs, AGC signs MCR and sends to SNPO-C with copies to WANL and NTO.

WANL for approval. Upon receipt of WANL approval, AGC sends MCR to SNPO-C. Lack of concurrence on part of AGC or WANL would be handled as above.

SNPO-C will approve or disapprove and transmit comments via TLX to WANL and AGC: If approved, AGC will revise the MRL accordingly. If disapproved, further action will be left to the originator.

NOTE - The above procedure applies to those measurements which require joint MCR approval as noted by the MRL. For other WANL MCR's, WANL sends MCR to AGC who transmits to SNPO-C for approval, copy to NTO.

II.2 For AGC Change Requests

AGC will transmit measurement change request MCR to WANL.

If WANL concurs with MCR, WANL will sign and return to AGC, AGC will transmit to SNPO-C with copies to WANL and NTO.

If WANL does not concur, WANL will telecon AGC and the differences will be resolved. Once the differences are resolved, WANL will revise MCR, sign and transmit to AGC. If AGC approves modified MCR, AGC will sign and transmit to SNPO-C with copies to WANL and NTO.

SNPO-C will approve or disapprove and transmit comments via TLX to WANL and AGC. If approved, AGC will revise the MRL accordingly. If disapproved, further action will be left to the originator.

NOTE - The above procedure applies to those measurements which require joint MCR approval as noted by the MRL. For other AGC MCR's, AGC transmits to SNPO-C for approval with copies to WANL and NTO.

PHASE III From Convening of the TS & PRB to the End of the Test Series

WANL, AGC or NTO will transmit MCR to the NTO Data Group with information copies to WANL, AGC, SNPO-C and individual review board members. Coordination of reviews will be in accordance with Board Charter.

NTD will present the change request to the Review Board for action.

Following Review Board action, the Review Board secretary will immediately TWX resolution to AGC, WANL, and SNPO-C followed by transmittal of signed off MCR to AGC.

AGC will incorporate the resolution into the following issue of the MRL.

GROUND SUPPORT EQUIPMENT AND FACILITIES - XE/NE

A. Ground Support Equipment

1. The XE and NE Support Equipment System will make maximum use of existing NERVA support equipment.
2. Where over-all engine system functions are to be performed, the lead design responsibility involved in the support equipment will be an AGC responsibility. Where portions of this support equipment are identifiable to the nuclear subsystem, those identifiable elements will be designed and furnished by WANL.
3. Where it is possible and economical, dual function support equipment will be provided. If the major use of this equipment is in support of the nuclear subsystem, lead responsibility will be assigned to WANL. If the major use is in support of non-nuclear hardware, lead responsibility will be assigned to AGC.
4. It shall be the responsibility of the cognizant designer to assure all interface requirements are met, such as mechanical, functional, or electrical.

B. Facilities Engineering

The engines will be tested in ETS-1& E/STS 2-3 and handled in the E-MAD, and AGC will have primary engineering responsibility for the facilities. Specifically, the following apply:

1. Functional requirements for modifications to the facilities may be issued by WANL, AGC or NTO.
2. Design specifications for changes will be issued by AGC.
3. Assistance in preparing the engineering design will be provided by WANL on items affecting the nuclear subsystem.
4. WANL will review all changes proposed by AGC or NTO. If the changes directly affect the nuclear subsystem, WANL will concur on the engineering design.

XE ENGINE CONTROL SYSTEM INTERFACES

1. AGC will have lead responsibility for the overall engine control system. WANL, as the principal subcontractor will have primary responsibility for control of the nuclear sub-system. Assignment of responsibility shall be in accordance with Figure 3. WANL equipment responsibility is shown inside the dotted line.
2. Engine control system requirements and performance will be coordinated between AGC and WANL to insure that fixed plant constraints are satisfied. All control concept development and modifications will be accomplished by issuance of functional requirements in a manner similar to that used for facility modifications.
3. Drum Actuator Interfaces
 - a. The control drum actuator requirement shall be determined by WANL with concurrence of AGC.
 - b. The type and method of actuators shall be a WANL responsibility with concurrence of AGC.
 - c. Mechanical and electrical interfaces shall be in accordance with the test article interface agreements.
 - d. It shall be a WANL responsibility to define all installation and checkout procedures associated with the control drum actuation system.
4. Engine Nuclear Instrumentation
 - a. The location of the nuclear instrumentation shall be a WANL responsibility with AGC input and concurrence.
 - b. The disconnects associated with the nuclear instrumentation shall be selected and supplied by WANL.
 - c. The neutron detectors, cannister assemblies, and cabling shall be selected and supplied by WANL.
 - d. It shall be a WANL responsibility to define all installation and checkout procedures associated with the nuclear instrumentation.

5. Control System Modifications

AGC, WANL and NTO can recommend modifications to the engine control system. Where concurrence is reached on the desirability and necessity of the modification, the design shall be a responsibility of the party responsible initially for that part of the system. If field modifications are made, these shall be implemented by NTO with checkout procedures defined by the responsible party and approved by the others. Where new equipment must be supplied, these shall be fabricated and/or procured by the responsible party.

6. Control Drawings

AGC shall have responsibility for the top assembly drawing for the entire engine control system. This drawing shall reference Westinghouse drawings for Westinghouse supplied component subsystems and systems. The referenced Westinghouse drawings shall serve as control drawings for the procurement, installation and checkout of the Westinghouse supplied equipment.

7. Cabling (with exception of nuclear instrumentation)

Since cabling between portions of the WANL supplied control system is being provided by AGC, the provisioning of any hardware by AGC that is in the WANL supplied control loops must meet with WANL approval.

Figure 3. X-Engine Control System Interface

ETS-1 TEST STAND CONTROL SYSTEM INTERFACES - XE

A. Test Stand Control System - Established Interfaces

The current established interface responsibilities are as follows:

1. REON TSCS Projects has the primary responsibility for the following:
 - a. Overall system design of the Test Stand Control System.
 - b. Negotiation and approval of all TSCS interfaces with Aerojet XE Projects, Aerojet Engine Controls and NRDS ETS-1 Facilities (NTO).
 - c. Development, approval and documentation of system requirements imposed on the TSCS (includes all system drawings and the top assembly drawing). Aerojet system drawings will reference Westinghouse drawings for Westinghouse supplied subsystems. Aerojet will reproduce those portions of Westinghouse drawings required to make the system drawings useful.
 - d. Development or approval and documentation of detailed design criteria for the design of each unit within the TSCS.
 - e. Detail design of the TSCS and subcontracting the design or manufacturing of any of the TSCS units.
 - f. Checkout and acceptance test of the overall system at Sacramento.
 - g. Installation and checkout of the deliverable systems at NRDS.
 - h. Responsible for all modifications requested by Aerojet, Westinghouse, and NTO to the TSCS.
2. WANL responsibilities include the following:
 - a. Detailed design of individual units in strict compliance with design criteria imposed by Aerojet TSCS Projects in the form of system functional requirements documents, Aerojet system drawings, and NDC-118A.

- b. Fabrication and delivery of the units assigned to Westinghouse.
- c. Participate in system design efforts called for by Aerojet TSCS Projects. Westinghouse is responsible for design and fabrication/procurement responsibility for the nuclear subsystem.
- d. Additional equipment assignments to Westinghouse other than the items listed below are subject to negotiation and approval by Aerojet.
- e. Equipment responsibilities are assigned as shown in Figure 4.
- f. Participate in checkout and acceptance test of the TSCS at Sacramento as called for by Aerojet TSCS Projects.
- g. Participate in the installation and checkout of the deliverable system at NRDS as called for by Aerojet TSCS Projects.
- h. Responsible for accomplishing modifications, requested by Aerojet TSCS Projects, to the WANL supplied equipment.
- i. Westinghouse drawings referenced on Aerojet system drawings shall serve as control drawings for procurement, installation, checkout and modifications of the Westinghouse supplied equipment.

NOTE: All units assigned to WANL are listed below:

TSCS UNITS

- *01 Control Room Recorders
- *02 Setup Panel
- *02 Printer System
- *06 Lead Reactor Engineer Console
- *07 Assistant Test Engineer Console
- *08 Chief Test Engineer Console
- *09 Test Stand Engineer Console
- *10 Assistant Stand Engineer Console
- *30 Control Point Console Equipment Racks
- 44-46 Test Stand Nuclear Instrumentation
- *58-61 Test Simulation System
- *62 Data Isolation
- *62 Data Calibration and Channel Identification
- *63 Engine Safety System
- *64-65 Checkout System
- *66 Process System Controller
- *67 Terminal Rack
- *67 Switching Unit
- *68-70 Signal Conditioning
- * System Cabling

- Two of the panels are provided by WANL. REON provides the remaining two panels and the console and interfaces.
- Panels provided by WANL. Consoles and interfaces provided by REON.
- WANL provides a subassembly of this unit. Reactor Safety Logic Subassembly. REON provides top assembly.
- WANL provides one frequency analyzer and frequency analyzer programmer assembly.
- Being considered by REON TSCS Projects for procurement as a commercial item.

*Equipment provided by REON.

Figure 4. TSCS Equipment Interfaces

NERVA ENGINE CONTROL SYSTEM INTERFACES - XE/NE

1. AGC will have lead responsibility for the overall engine control system. WANL will have primary responsibility for control of the nuclear subsystem. Assignment of responsibility shall be in accordance with Figure 3. WANL equipment responsibility is shown inside the dotted line.
2. Engine control system requirements and performance will be coordinated between AGC and WANL to insure that fixed plant constraints are satisfied. All control concept development and modification will be accomplished by issuance of functional requirements in a manner similar to that used for facility modifications.
3. Reactor Control Actuators
 - a. Westinghouse will have lead responsibility for both the control drum and structural coolant control systems.
 - b. The control drum actuator requirements, type of actuator, and control system will be a Westinghouse responsibility. Westinghouse will provide the actuator for this application.
 - c. The structural coolant control actuator, flow control valve, and control system will be a Westinghouse responsibility. Aerojet will supply the flow control valve to meet Westinghouse requirements. Westinghouse will provide the control system and will also provide the valve actuator unless the valve actuator requirements are met by a reasonable modification of an actuator supplied by Aerojet for other NERVA requirements. An evaluation of using such an actuator will be made by Westinghouse before Westinghouse develops a different actuator.
 - d. Definition of all installation and checkout procedures associated with both reactor control actuator systems shall be a Westinghouse responsibility.
4. Engine Nuclear Instrumentation
 - a. The location of the nuclear instrumentation shall be a Westinghouse responsibility with Aerojet input and concurrence.

- b. The disconnects associated with the nuclear instrumentation shall be selected and supplied by Westinghouse.
- c. The neutron detectors, cannister assemblies, and cabling shall be selected and supplied by Westinghouse.
- d. It shall be a Westinghouse responsibility to define all installation and checkout procedures associated with the nuclear instrumentation.

5. Control System Modifications

Aerojet, Westinghouse and NTO can recommend modifications to the engine control system. Where concurrence is reached on the desirability and necessity of the modification, the design shall be a responsibility of the party responsible initially for that part of the system. If field modifications are made, these shall be implemented by NTO with checkout procedures defined by the responsible party and approved by the others. Where new equipment must be supplied, these shall be fabricated and/or procured by the responsible party.

6. Control Drawings

Aerojet shall have responsibility for the top assembly drawing for the entire engine control system. This drawing shall reference Westinghouse drawings for Westinghouse supplied component subsystems and systems. The referenced Westinghouse drawings shall serve as control drawings for the procurement, installation and checkout of the Westinghouse supplied equipment.

7. Cabling (with exception of nuclear instrumentation)

Since cabling between portions of the Westinghouse supplied control system is being provided by Aerojet, the provisioning of any hardware by Aerojet that is in the Westinghouse supplied control loops must meet with Westinghouse approval.

ESTS-2/3 TEST CONTROL AND SIMULATION INTERFACES - NE

Test Control and Simulation System

1. Aerojet TCSS Projects has the primary responsibility for the following:
 - a. Overall system design of the Test Control and Simulation System.
 - b. Negotiation and approval of all TCSS interfaces with REON NE Projects, Aerojet Engine Controls and NRDS ESTS-2/3 Facilities.
 - c. Development, approval and documentation of system requirements imposed on the TCSS (includes all system drawings and the top assembly drawing).
Aerojet system drawings will reference Westinghouse drawings for Westinghouse supplied subsystems. Aerojet will reproduce those portions of Westinghouse drawings required to make the system drawings useful.
 - d. Development or approval and documentation of detailed design criteria for the design of each unit within the TCSS.
 - e. Detail design of the TCSS and subcontracting the design or manufacturing of any of the TCSS units.
 - f. Checkout and acceptance test of the overall system at Sacramento.
 - g. Installation and checkout of the deliverable system at NRDS.
 - h. Responsible for all modifications requested by Aerojet, Westinghouse, NTO, or others to the TCSS.
2. Responsibilities assigned to Westinghouse by Aerojet include the following:
 - a. Detailed design of individual units in strict compliance with design criteria imposed by Aerojet Projects in the form of system functional requirements documents, Aerojet system drawings, and the Design Criteria Document.
 - b. Fabrication and delivery of the units assigned to Westinghouse.
 - c. Participate in system design efforts called for by Aerojet TCSS Projects.
Westinghouse will be assigned design and fabrication/procurement responsibility for the nuclear subsystem.
 - d. Additional equipment assignments to Westinghouse other than the items listed below are subject to negotiation and approval by Aerojet.

- e. Participate in checkout and acceptance test of the TCSS at Sacramento as called for by Aerojet TCSS Projects.
- f. Participate in the installation and checkout of the deliverable system at NRDS as called for by Aerojet TCSS Projects.
- g. Responsible for accomplishing modifications, requested by Aerojet TCSS Projects, to the WANL supplied equipment.
- h. Westinghouse drawings referenced on REON system drawings shall serve as control drawings for procurement, installation, checkout and modifications of the Westinghouse supplied equipment.

Figure 5.

TEST ARTICLE INSTRUMENTATION - XE/NE

- A. Aerojet will issue and control the Measurement Requirements List. Westinghouse will furnish information in an acceptable format to Aerojet, who will incorporate it with their information and publish the list.
- B. Aerojet and Westinghouse will be responsible respectively for providing transducers and mounting hardware for all measurements which require mounting on hardware furnished by each organization respectively, except that Westinghouse will be responsible and provide hardware for measurements that provide neutronic data on the nuclear subsystem. Westinghouse is responsible for pre-conditioning systems (demodulators, charge amplifiers, etc.) for all Westinghouse supplied measurements.
- C. Westinghouse is responsible for analysis of and prediction of performance of Westinghouse supplied measurements, as well as for the calibration, proof testing, qualification, and development of such instrumentation. Analysis and prediction of performance are to include the performance of the data acquisition channels to which the WANL supplied instrumentation is connected.

FLIGHT SAFETY - XE/NE

Westinghouse will have lead responsibility in the following areas:

1. Development of malfunction and accident analyses leading to potential nuclear hazards.
2. Determination of resultant performance and integrity of nuclear subsystem following malfunctions as well as prediction and experimental determination of nuclear source term. Propose design changes to nuclear subsystem and stage. Analyze procedures to minimize hazards. Analyze missions provided to Westinghouse to determine means of minimizing hazards. Propose flight tests to demonstrate safety.
3. Analysis of effectiveness of all proposed countermeasures and disposal methods to minimize hazards to life in earth environments and to crew in space.
4. Determination of nuclear requirements for any proposed nuclear destruct device.
5. Design and provision of any portions of anti-criticality or nuclear destruct devices located within the nuclear subsystem, including devices for insertion or withdrawal of nuclear poison or moderator.

Aerojet will have lead responsibility in the following areas:

1. Design of non-nuclear countermeasure and destruct system not located within the nuclear subsystem.
2. Integration of engine destruct criteria and requirement with stage and/or module design or requirement.
3. Interface control of the countermeasure destruct system.
4. Design and provision of the system for disposal of the anti-criticality subsystem.