REON

SACRAMENTO PLANT

REPORT NO. RN-DR-0071

AGC/WANL XE INTERFACES

MASTER

OCTOBER 1965

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ROCKET ENGINE OPERATIONS - NUCLEAR

OCTOBER 1965

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AEROJET - GENERAL CORPORATION
A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

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INTRODUCTION

Major XE interfaces have been agreed to by Aerojet-General Corporation and Westinghouse Electric Corporation in the following areas. These interface agreements should be thoroughly understood and every effort made to conform with the written words and the intent of these agreements. As additional interfaces are developed or changes made to the enclosed agreements, they will be distributed and should be added to this booklet.

- I. Safety Analysis and Evaluation
- II. Test Planning
- III. Test Article
- IV. Control Systems and Instrumentation
- V. Ground Support Equipment and Facilities
- VI. Systems and Data Analysis

I. SAFETY ANALYSIS AND EVALUATION

SAFETY ANALYSIS AND EVALUATION

- A. The preparation as relates to format and content of the SAR and SER's for the XE Program should be continued on the pattern established for NRX tests.
- B. AGC will retain prime responsibility for the safety of facilities and equipment and non-nuclear safety of personnel. Westinghouse will support AGC in this responsibility to the degree necessary.
- C. All requests for approval by AGC for the conduct of engine tests will be first submitted to Westinghouse for their comments and recommendations, prior to submittal of this request to SNPO.
- D. A safety committee will be established with participation by Westinghouse and AGC personnel under AGC chairmanship.
- E. The nuclear safety analysis and evaluation of the nuclear hazards is the responsibility of Westinghouse.

The SAR, SER and OLD will contain AGC and Westinghouse inputs and will be issued as joint documents, published by Westinghouse and submitted to the government by AGC.

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	AGC
3. Site Description	Westinghouse
4. Facility Design	AGC
5. Test Assembly	Joint
6. Operation	Joint
7. Radiation Environment	Westinghouse
8. Safety Evaluation	Westinghouse

Concurrence on all parts of the report will be achieved by both Westinghouse and AGC prior to issuance.

II. TEST PLANNING

Documents	Inputs and Details	Prepared, Issued By	Initial Draft Review & Concur	Review of Final Draft By	Approved By	Scheduled Issue (Weeks prior to XE-1 Test Date)		Exceptions Approved By
						Review Cys	Formal Cys	
A. Operational Control Documents								
1. XECF Test Plan	AGC/NTD/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-52	T-45	
2. XE-1 Test Plan	AGC/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-52	T-45	
3. XECF Test Specification	AGC/NTD/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-37	T-26	TRB, TS&PRB (1)
4. XE-1 Test Specification	AGC/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-22	T-16	
5. XE Design Specification	AGC/WANL	AGC	WANL	AGC/WANL/SNPO-C	SNPO-C	T-36	Issued Periodically	TRB, TS&PRB (1)
6. Operational Support Plan	AGC/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-48	T-26	
7. XECF MRL	AGC/NTD/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-55	Issued Periodically	
8. XE-1 MRL	AGC/NTD/WANL	AGC	WANL	AGC/NTD/WANL/SNPO-C	SNPO-C	T-50	Issued Periodically	
9. XE-1 System Test Prediction Rep	AGC/WANL	AGC	WANL	AGC/WANL	—	T-40	T-12	
10. XE-1 Nuclear Subsystem Prediction Rep	WANL	WANL	AGC	AGC/WANL	—	T-40	T-12	
11. Final Test Report	AGC/WANL	AGC	WANL	AGC	—		$T_f + 18^{(2)}$	
12. Topical Test Reports	AGC/WANL	Originating Org.	N.R.		N.R.		$T_f + 12^{(2,3)}$	

(1) TRB is responsible for changes to Operational Section of the Test Specification during test period. All other changes responsibility of TS&PRB.

(2) T_f is the final test in series.

(3) To be included in bibliography of final test report, issue date must be prior to $T_f + 12$.

FIGURE 1
XECF/XE DOCUMENTATION SUMMARY

Documents	Inputs and Details	Prepared and Issued By	Review of Final Draft By	Approved By	Scheduled Issue (Weeks prior to XE-1 Test Date)		Exceptions Approved By
					Review Cys	Formal Cys	
A. Operational Control Documents (Cont'd)							
13. Operating Limits Document	WANL/AGC/NTO		AGC/WANL/NTO/SNPO-C	SNPO-C	T-12	T-7	
14. Safety Analysis Report	AGC/NTO/WANL		AGC/NTO/WANL/SNPO-C	SNPO-C ⁽²⁾	T-18	T-12	
15. Safety Evaluation Report	AGC/NTO/WANL		AGC/NTO/WANL/SNPO-C	SNPO-C ⁽²⁾	T-12	T-7	
B. NTO Documents							
1. Program Requirements	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C	SNPO-C			
2. XECF and XE-1 Procedures							
a. Receiving Inspection Procedures							
(1) Non-nuclear Components	AGC/NTO/ACFI	NTO	AGC/NTO/SNPO-C/SNPO-N	AGC	T-40	T-30	
(2) Nuclear Components	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C/SNPO-N	AGC/WANL	T-40	T-30	
(3) Control Drum Actuators	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C/SNPO-N	AGC/WANL	T-40	T-30	
b. Assembly Procedures							
(1) Test Stand Adapter Install.	AGC/NTO	NTO	AGC/NTO/SNPO-C/SNPO-N	AGC	T-40	T-30	
(2) XECF Assembly	AGC/NTO/WANL	NTO	AGC/NTO/SNPO-C/SNPO-N/WANL	AGC/WANL	T-40	T-30	
(3) XE-1 Assembly	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C/SNPO-N	AGC/WANL	T-40	T-30	
(4) EIV/MCC Assembly and Checkout	AGC/NTO	NTO	AGC/NTO/SNPO-N	SNPO-N	T-40	T-50	
c. Test Preparation Procedures							
(1) XECF Test Preparation	AGC/NTO/WANL	NTO	AGC/NTO/SNPO-C/SNPO-N/WANL	AGC/WANL	T-35	T-30	
(2) XE-1 Test Preparation	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C/SNPO-N	AGC/WANL	T-25	T-20	
(3) XECF Installation	AGC/NTO/WANL	NTO	AGC/NTO/SNPO-C/SNPO-N/WANL	AGC/WANL	T-20	T-15	
(4) XE-1 Installation	AGC/NTO/WANL	NTO	AGC/NTO/WANL/SNPO-C/SNPO-N	AGC/WANL	T-10	T-5	

FIGURE 1 (cont'd)
XECF/XE DOCUMENTATION SUMMARY

Documents	Inputs and Details	Prepared and Issued By	Review of Final Draft By	Approved By	Scheduled Issue (Weeks prior to XE-1 Test Date)		Exceptions Approved By
					Review Cys	Formal Cys	
B. NTO Documents (Cont'd)							
2. XECF and XE-1 Procedures (Cont'd)							
d. Control Room Operating Procedures							
(1) Initial Criticality and Drum Calibration Tests	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	TRB	R-4 days ⁽⁴⁾	R-2 days	TRB
(2) Neutronic System Cal.	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	TRB	R-4 days	R-2 days	TRB
(3) All XECF Test Phases	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	TRB	R-4 days	R-2 days	TRB
(4) All XE-1 Test Phases	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	TRB	R-4 days	R-2 days	TRB
e. Removal/Disassembly Procedures							
(1) XECF Removal	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL	T-25	T-20	TS&PRB
(2) XE-1 Removal	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL	T-15	T-10	TS&PRB
(3) XECF Transfer to E-MAD	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL	T-35	T-30	TS&PRB
(4) XE-1 Transfer to E-MAD	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL	T-25	T-20	TS&PRB
(5) XECF Post-Test Disassembly	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL			TS&PRB
(6) XE-1 Post-Test Disassembly	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL			TS&PRB
(7) XECF Post-Test Inspection	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL			TS&PRB
(8) XE-1 Post-Test Inspection	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL			TS&PRB
f. Post Operative Examination							
(1) XECF Procedures	AGC/NT0/WANL	NT0	AGC/NT0/SNPO-C/SNPO-N/WANL	AGC/WANL			TS&PRB
(2) XE-1 Procedures	AGC/NT0/WANL	NT0	AGC/NT0/WANL/SNPO-C/SNPO-N	AGC/WANL			TS&PRB
3. Post-Test Report		NT0	AGC/WANL/SNPO-C			T _f +12	
4. 8-Hour Test Report	NT0	NT0				R+8 hours	
5. 3-Day Test Report	NT0	NT0				R+3 days	

FIGURE 1 (cont'd)
XECF/XE DOCUMENTATION SUMMARY

Documents	Inputs and Details	Prepared and Issued By	Review of Final Draft By	Approved By	Scheduled Issue (Weeks prior to XE-1 Test Date)		Exceptions Approved By
					Review Cys	Formal Cys	
6. Data Report	NTD	NTD	AGC/WANL/SNPO-C			T_p+5	
7. Std Facility Oper. Proc.	NTD	NTD	AGC/WANL/SNPO-C				
8. Test Cycle Schedule	NTD	NTD					
9. Material Disposition Reports	NTD	NTD					

(1) TRB is responsible for changes to Operational Section of the Test Specification during test period. All other changes responsibility of TS&PRB.

(2) SNPO-C will obtain all other agency approvals necessary.

(3) T_f is the final test in series.

(4) R is run day for specific test. R_1 is run day for first test, R_2 for second, etc.

FIGURE 1 (cont'd)
XECF/XE DOCUMENTATION SUMMARY

III. TEST ARTICLE

TEST ARTICLE INSTRUMENTATION

- A. AGC will issue and control the Measurement Requirements List. WANL will furnish information in an acceptable format to AGC, who will incorporate it with their information and publish the list.
- B. AGC and WANL 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 WANL will be responsible and provide hardware for measurements that provide neutronic data on the nuclear subsystem.

FIGURE 2
AGC/WANL TEST ARTICLE INTERFACE

<u>Interface</u>	<u>Responsibility</u>	<u>Governing Document</u>	<u>Remarks</u>
1. Test Article - XE Engine	AGC-WANL Review	AGC 90016	XE Engine Specification
1.1 Interface Control Drawing	Per PD 150	*AGC Dwg. _____	
1.2 Engine Assembly Specification			
1.2.1 Core to Pressure Vessel	WANL with AGC Approval	Assembly Specification	Any changes to procedure must be approved by X-Engine Test Specification and Procedure Review Board
1.2.2 Nozzle to Pressure Vessel	AGC with WANL Review	Assembly Specification	Any changes to procedure must be approved by X-Engine Test Specification and Review Board
1.2.3 Actuator Assembly to Shield	WANL with AGC Approval	Assembly Specification	Any changes to procedure must be approved by X-Engine Test Specification and Procedure Review Board

*Drawing number to be supplied when available.

IV. CONTROL SYSTEMS AND INSTRUMENTATION

ENGINE CONTROL SYSTEM INTERFACES

A. Interfaces Agreed to by AGC and WANL

1. AGC, as the NERVA engine prime contractor, will be responsible for the overall engine control system. WANL, as the principal subcontractor will be responsible 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. The design criteria for the nuclear subsystem will be supplied by AGC.
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 actuator 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.

— — — THIS DIAGRAM SHOULD NOT BE INTERPRETED THAT THIS PIECE OF EQUIPMENT IS ACTUALLY NEEDED.

FIGURE 3
X-ENGINE CONTROL SYSTEM INTERFACE

TEST STAND CONTROL SYSTEM INTERFACES

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 REON XE Projects, REON 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). REON system drawings will reference Westinghouse drawings for Westinghouse supplied subsystems. REON 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 system at NRDS.
 - h. Responsible for all modifications requested by AGC, WANL, and NTO to the TSCS.
2. Responsibilities assigned to WANL by REON include the following:
 - a. Detailed design of individual units in strict compliance with design criteria imposed by REON TSCS Projects in the form of system functional requirements documents, REON system drawings, and NDC-118.

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

ORIGINAL REVIEWED AND AGREED UPON BY:

E. A. Sheridan, AGC

W. R. Morris, WANL

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 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

- ① Two of the panels are provided by WANL. REON provides the remaining two (2) panels and the console and interfaces.
- ② Panels provided by WANL. Consoles and interfaces provided by REON.
- ③ WANL provides a subassembly of this unit. Reactor Safety Logic Subassembly. REON provides top assembly.
- ④ WANL provides one (1) frequency analyzer and frequency analyzer programmer assembly.
- ⑤ Being considered by REON TSCS Projects for procurement as a commercial item.
- * Equipment provided by REON.

FIGURE 4
TSCS EQUIPMENT INTERFACES

V. GROUND SUPPORT EQUIPMENT AND FACILITIES

GROUND SUPPORT EQUIPMENT AND FACILITIES

A. Ground Support Equipment

1. The XE 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 compatible with system constraints and interfaces.
3. As established by the Operational Support Plan, equipment required to support the nuclear subsystem will be designed and furnished by Westinghouse. All other support equipment will be designed and furnished by AGC.
4. 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 or if the support of nuclear and non-nuclear components is of equal importance, lead responsibility will be assigned to AGC.
5. It shall be the obligation of the cognizant designer to assure all interface requirements such as mechanical, functional, or electrical are met.

B. Facilities Engineering

The experimental engines will be tested in ETS-1 and handled in the E-MAD, and AGC will have prime engineering responsibility for the facilities. Specifically, the following apply:

1. Functional requirements for modifications to the facilities may be proposed by WANL, AGC or NTO.
2. Design specifications for changes will be issued by AGC.

3. Engineering drawings for the design change will be released by AGC. Assistance in preparing the engineering design will be provided by WANL on items affecting the nuclear subsystem.
4. WANL will review and comment on all changes proposed by AGC, WANL or NTO. If the changes directly affect the nuclear subsystem, WANL will concur on the engineering design. AGC will determine which changes fall in the latter category.

C. Test Article

See Section III for interface agreement.

D. Test Planning

See Section II for interface agreement.

VI. SYSTEMS AND DATA ANALYSIS

SYSTEMS AND DATA ANALYSIS

- A. AGC and WANL will jointly participate in the development, evaluation and updating of the common analog model of the XE engine, with WANL concentrating on the nuclear subsystem in accordance with previous agreements, shown below* on the basis of analytical and experimental data comparisons.
- B. Perform studies of problems related to behavior of the test system with emphasis on the nuclear subsystem (WANL) and engine system (AGC).
- C. Support AGC in joint, on-test-site, post-test data evaluation efforts (e.g., DRAGON).
- D. Support AGC in joint test site data acquisition system evaluations.
- E. Each organization will provide and maintain on a current basis, subsystem and component constraints that affect system operation.

* Note: "Ref.: March 18, 1965, Systems Analysis Agreement, Item 1, W. D. Stinnett, W. H. Arnold."

"As related to analog analysis, it is agreed that a single mathematical analog model will be established at WANL and AGC. This model will be augmented by additional capacity at each organization for more detailed evaluation of components and subsystems for which WANL or AGC has responsibility. This model will be maintained on a current basis by transfer of information on the modifications to equations and coefficients from the responsible component design organization to the other party. A common problem will be run on a regular basis to provide a cross check of the analog model."