NERVA JOINT DOCUMENT - NJD 16

AEC-NASA SPACE NUCLEAR PROPULSION OFFICE

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**XE-2 Operating Limits Document
Phase IA
May 1968**

MASTER

Prepared by:

**Aerjet - General Corporation
Sacramento, California
and**

**Westinghouse Astronuclear Laboratory
Pittsburgh, Pennsylvania**

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INFORMATION CATEGORY

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E. M. H. Hemmle 5/23/68
AUTHORIZED CLASSIFIER DATE

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1. INTRODUCTION

The purpose of this document is to define the constraints within which XE-2 assembly operations, up to, but not including, central poison wire removal are accomplished at the E-MAD Facility at the Nuclear Rocket Development Station (NRDS). These operations include Receiving and Inspection of XE-2 components, Mechanical and Electrical Assembly of the Engine and Peripheral Poison Wire Removal. The operating limits contained herein specify the administrative and technical boundaries within which the Phase IA Assembly Operations will be performed.

Management Controls define the administrative limits associated with the XE-2 Operations Program. These limits include the required documentation and the documentation approval mechanism. Operational Controls define the boundaries, procedural safeguards and operating safety limits within which operations will be completed.

2. MANAGEMENT CONTROLS

The engineering control documents and the procedures for assembly and checkout operations are prepared by NTO, reviewed by AGC, NTO and WANL cognizant organizations, and approved by AGC and WANL Management. In addition, all engineering operations performed will be conducted in accordance with Reference 1.

Emergency procedures have been established for the E-MAD Facility, Reference 2, and are to be used in conjunction with the SNPO-N, NRDS Emergency Plan, Reference 3, which also contains emergency and evacuation plans for other NRDS areas and off-site areas not under the control of NTO.

An XE Test Specification and Procedure Review Board (TS & PRB) has been established by SNPO-C/AGC/WANL. This board, which includes representatives of SNPO-C, AGC, and WANL is chaired by the AGC Representative and will function for the XE-2 assembly operations. The members of this board, acting as representatives of their respective organizations, will function on the basis of their entire organization's requirements. The responsibilities of the TS & PRB include the review and approval of changes to the Test Specification and all changes to procedures required by the Test Specification except the Test Operating Procedure(s).

3. OPERATIONAL CONTROLS

The operations shall be conducted in accordance with detailed NTO assembly procedures, each of which shall have been appropriately reviewed and approved (see 2, Management Controls) prior to initiation of the operations covered by the procedure.

Specific operational constraints within which operations will be accomplished and which will be incorporated within these procedures as applicable, are delineated in the following sections. No significance should be attached to the order in which the limitations are presented within a given section; unless otherwise noted, limitations are applicable only to the section in which they are presented.

3.1 E-MAD Assembly

The E-MAD Assembly Phase, covered by these operating limits, encompass operations wherein the reactor core may be in either a fully-poisoned or a partially-poisoned condition and these conditions are utilized below as a convenient means of grouping limits for the E-MAD Facility operations. The term "poisoned" refers to the shipping poison wires. Fully-poisoned refers to a full complement of poison wires installed for shipment of the PVARA (Pressure Vessel and Reactor Assembly). This is sufficient to maintain sub-criticality even if the reactor was completely flooded and all control drums rotated to 180°. Partial-poison refers to the central poison wire configuration which is capable of providing a shutdown margin of at least \$2, even if the control drum bank was rotated to the full-out position.

3.1.1 General Limits for All Operations

In all cases, E-MAD assembly operations from reactor receipt and inspection, up to, but not including, central poison wire removal will be subject to the following constraints:

- a) Assembly operations will be performed in accordance with written procedures under the supervision of the Manager, Operations Section, MAD Operations or his designated alternate.
- b) All handling of the reactor and reactor components will be conducted with equipment that has been tested and certified according to requirements in the NTO Health and Safety Manual.
- c) When the reactor is in the Cold Assembly Bay, the E-MAD Process Area Monitoring System (PAMS) and the E-MAD Criticality Alarm System will be continuously functioning to provide reactor monitoring.
- d) Reactor neutron flux will be continuously monitored with an instrument capable of sounding a local alarm.
- e) During assembly, the Manager, Operations Section, MAD Operations, or his designated alternate, will control access and limit the number of personnel to the engine assembly stand area.
- f) Prior to control drum actuator installation, the control drums will be retained in their full-in position by the control drum actuator drive shaft lock assemblies and/or the control drum scram springs, except during operations requiring control drum rotation, in which case, all drums except one must be retained in their full-in position. When the control drum drive shaft lock assemblies are not used, and the control drum actuators have not been installed, only one (1) drive shaft will be available for single drum rotation and checkout. The control drum drive shaft housings will be capped except as required for assembly and control drum checkout. All other control drum drive shafts will be locked in a repository under the supervisory control of the Manager, Operations Section, MAD Operations.

- g) Administrative control of the Control Drum Actuator Keys will include the following:
 - (1) Upon receipt of the control drum actuators at the E-MAD Building, the keys plus spares, are transmitted to the Manager of NTO who will be responsible for their control.
 - (2) Three (3) of the actuator keys will be transferred to the Manager of Engine Test Operations (ETO) for use during the assembly and checkout operations.
 - (3) During or after installation of the control drum actuators, a maximum of three (3) control drum actuator key locks will be unlocked at any time. When actuator checkout operations are not in effect only two (2) key locks will be unlocked.
- h) No more than one control drum will be rotated from the nominal full-in position at any time, and after rotation is completed, it will be verified that the drum has returned to the nominal full-in position. After installation of the control drum actuators only one (1) pneumatic pin lock may be unlocked at any time.
- i) The poison wires in the reactor core will be retained by an approved poison wire retention fixture at all times except when:
 - (1) The reactor is installed in equipment approved for rotation of the XE reactor.
 - (2) The core axis is horizontal or the nozzle end is inclined upward as much as ninety degrees from the horizontal.

- (3) The controls required for engine rotation are locked out.
- (4) An approved support stand prevents downward motion of the poisoned assembly whenever the assembly is not vertical with the nozzle end up.

These conditions having been met, the approved poison wire retention fixture may be removed for approved operations.

- j) All liquids shall be prohibited in an area where the engine assembly is present unless they are:
 - (1) Required in an operation, and
 - (2) Contained in equipment that requires reasonable effort for delivery of the liquid (e.g., plastic squeeze bottles with a capacity of not more than 500 milliliters).
- k) Reflection by personnel and/or equipment in the immediate vicinity of the reactor shall be limited, as required, to maintain a shutdown margin of at least \$2. Immediate vicinity is defined as a 4-ft-thick envelope surrounding the pressure vessel cylinder.

3.1.2 Fully-Poisoned Assembly

- a) All limits in Section 3.1.1 will be followed.
- b) Temporary poison wire removal will be subject to the limitation that the remaining poison wires will maintain the assembly sub-critical, even if flooded with all control drums at 180°. Inverse multiplication measurements will be taken during poison wire removal.

3.1.3 Partially-Poisoned Assembly

- a) All limits in Section 3.1.1 will be followed.
- b) Removal of the peripheral poison wire loading will proceed with authorization from the Manager, NERVA Test Operations, and the Manager, Engine Test Operations, and will be under the management cognizance of the Manager, Engine Test Operations, and under his direct supervision, or under the direct supervision of a person designated by him, who has the background, experience and competence to perform the operation.
- c) During peripheral poison wire removal operations, the number of poison wires removed per increment will not exceed 10% of the initial poison wire content or 10% of the extrapolated number to criticality (to the nearest whole cluster), whichever is less. Inverse multiplication data will be plotted following each poison wire removal increment. A minimum of three (3) detector-scaler units and a neutron source will be used for these operations.
- d) During and following peripheral poison wire removal operations, personnel access and movement of components in the immediate vicinity of the PVARA, i.e., on the Engine Assembly Stand or on the Engine Assembly Maintenance Platform, etc., will be limited to assure a minimum of \$2 shutdown at all times. In any case, the number of personnel shall not exceed seven (7). In assessing the effect of personnel reflection, the reactivity worth of one (1) man will be 11% and 16% respectively, for positions at the reactor periphery and nozzle opening of the pressure vessel.

- e) All openings of the pressure vessel will be sealed against the introduction of extraneous material at all times after the removal of the peripheral poison wires except when actual work is in progress which precludes such protection.
- f) A safety pedestal shall be utilized between the base of the Engine Assembly Stand and the Nozzle Closure Assembly (or Nozzle Throat Plug Closure) for all assembly operations when the test assembly is in the nozzle down attitude. The safety pedestal will also be utilized at all times when the assembly is not pressurized except during approved operations which precludes such protection.

4. REFERENCES

1. NTO-A-0027-Revision 1, "Documentation and Control for Engineering Operations Conducted at NTO Facilities", June 2, 1967.
2. NTO-A-0040-Section 008, "NERVA Test Operations Emergency Plan - E-MAD Complex", March 1967.
3. "Nuclear Rocket Development Station Emergency Plan", April 1964.