CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

✓ SNPO-C
Records

MASTER

WANL-TME-1856

Westinghouse Astronuclear Laboratory

NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING
HELD WITH SNPO AT WANL ON AUGUST 27, 1968
(Title Unclassified)

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

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.

**CONFIDENTIAL
RESTRICTED DATA**
Atomic Energy Act - 1954

NOTICE

This report contains information of a preliminary nature and was prepared primarily for internal use at the originating installation. It is subject to revision or correction and therefore does not represent a final report. It is passed to the recipient in confidence and should not be abstracted or further disclosed without the approval of the originating installation or USERDA Technical Information Center, Oak Ridge, TN 37830

Astronuclear
Laboratory

WANL-TME-1856

50
NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING
HELD WITH SNPO AT WANL ON AUGUST 27, 1968
(Title Unclassified)

MASTER

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.

Classification cancelled (or changed to) DOT
by authority of H.F.C. TIC, date SEP 11 1973
by _____

Westinghouse Electric Corporation
Astronuclear Laboratory
P. O. Box 19864
Pittsburgh, Pennsylvania 15236

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

E. A. DeZubay, Manager
Thermo-Flow Laboratory

V. O. Harves, Manager
Engineering Mechanics

GROUP - 1 Excluded From Automatic
Downgrading & Declassification.

INFORMATION CATEGORY

Confidential - RD

Authorized Classifier Date

SPECIAL REVIEW DETERMINATION	Reviewers	Class.	Date
	KAW	U	4-8-82
Class: <u>U</u>			

**CONFIDENTIAL
RESTRICTED DATA**
Atomic Energy Act - 1954

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

(This Page is Unclassified)

WANL-TME-1856

NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING
HELD WITH SNPO AT WANL ON AUGUST 27, 1968
(U)

Attendees:

P. Cherish	WANL	C. L. Meuche	WANL
J. Daniel	AGC	N. P. Morris	WANL
S. L. Davidson	WANL	D. J. Mueller	WANL
R. N. Eichbauer	WANL	R. J. Muth	WANL
N. J. Ettenson	WANL	N. A. Norman	AGC
H. J. Fix	WANL	R. L. Oelrich	WANL
R. A. Gualdoni	SNPO-C	B. H. Stahl	WANL
T. O. Harves	WANL	F. G. Tauch	WANL
G. A. Kalvin, Jr.	SNPO-C	B. C. Wells	WANL

The Monthly Development Test Program Review Meeting was held on
August 27, 1968.

This report is divided into two discrete sections. The first section covers the activities of the Thermo-Flow Laboratory and the second, those of the Engineering Mechanics Laboratory. Table I of each section lists the tests performed during the reporting period and those planned for the next period. Discussions of the individual tests follow.

(This Page is Unclassified)

WANL-TME-1856

SECTION A

MONTHLY REVIEW OF THERMO-FLOW LABORATORY TESTS

TABLE I

THERMO-FLOW LABORATORY TEST SCHEDULE

PERFORMED THIS PERIOD (July 15 - August 27)

PLANNED NEXT PERIOD (August 28-Sept.)

Tests for NRX-A6		
TFL-3. a	Control Drum Flow Test - TME issued.	No activity.
TFL-3. f	Reflector Thermal Transient Test - Continue testing.	Complete testing.
Tests for PW-1		
TFL-1. a	Single Cluster Tests	
	TFL-1. a. 27c PW-1 Test (Pedestal II).	Complete one hour PW-1 composite hot end
	TFL-1. a. 28a Dev. tests using XE-2 elements for PW-1 temperature.	hardware (Pedestal III).
	TFL-1. a. 29a,b,c,d,e PW-1 Test (Pedestal III).	LASL Exit Gas Thermocouple.
Tests for R-1		
TFL-1. e	Support Stem Impedance - Continue design.	Complete design.
TFL-2. a	Core Periphery Test - TFL-2. a. 0004a.	Continue to assemble wrapper.
	Assembly of model started.	
	Final assembly of inner core/simulated element assembly completed, including dimensional measurements.	
	Wrapper assembly started, nine layers of Z-liners installed.	
TFL-4. b	Support Plate Plug Leak Test - Initiated design.	Fabrication.
TFL-4. d	Pressure Vessel Instrumentation Port Transition - Initiated design.	Fabrication.
TFL-6. d	Flow Tube Spool Seal Leak Test - Cancelled.	
General Development Tests		
TFL-1. b	Single Element Tests, Total - 132 (1.2476 to 1.2606)	High expansion matrix development elements, "Q" coat development tests, and
	6 - Phase IV-B elements.	chuck and furnace development tests.
	10 - Phase YFE Y-12 flow evaluation tests.	
	6 - Phase I-Da "Q" coat development tests.	

(This Page is Unclassified)

THERMO-FLOW LABORATORY TEST SCHEDULE (Continued)

PERFORMED THIS PERIOD (July 15 - August 27)

PLANNED NEXT PERIOD (August 28-Sept.)

General Development Tests (Continued)

TFL-1.b Single Element Tests (Continued)

- 10 - Phase TS-3002 extruded to size element tests.
- 18 - Phase TS-3013 "Q" coat development tests.
- 6 - Phase QCD Y-12 "Q" coat development tests.
- 37 - Phase YII GA, Y-12 high expansion tests.
- 5 - Phase CTS "X" coat salt qualification tests.
- 6 - Phase LMY LASL matrix Y-12 coated element tests.
- 5 - Phase SxS XE-2 side-by-side element tests.
- 3 - Phase PW-1 PEWEE-1 element tests.
- 4 - Phase LQ LASL matrix "Q" development tests.
- 4 - Phase FOX PEWEE-1 hydrolyzed elements.
- 11 - Test and chuck development tests.
- 1 - Test of XE-2 type element with low helium pressure.

TFL-5.b Interstitial Corrosion - Tests on Pyrofoil.

Continue testing.

Facilities

WANL LH₂ Facility.

WANHES LH₂ Facility.

FS-1 installation 85% complete - cluster testing continues to retard this activity.

Continue FS-1 installation.

Water injection system for single element furnace. Four check-out tests conducted and modifications to system completed.

Conduct additional tests to evaluate filter and overall system performance.

Single element sonic orifice tests. Sonic orifice tests conducted to check hydrogen flow rates at WANL, WANHES, and LASL. Data indicates good agreement.

No further tests planned.

A3

(This Page is Unclassified)

(This Page is Unclassified)

TESTS FOR NRX-A6

(This Page is Unclassified)

WANL-TME-1856

TFL-3. a Control Drum Flow Tests

WANL-TME-1795, "NRX-A6 Control Drum Flow Tests", dated July 11, 1968, has been issued.

TFL-3. f Reflector Thermal Transient Test

A fourth test (Run 4) was conducted on the reflector ring. In addition to the original thermocouple locations, thermocouples were placed inside the reflector coolant holes at three (3) theta locations, azimuthally around the ring. These thermocouples were specifically located in the inner web region. No thermocouples were placed on the reflector inside diameter since additional tests indicated that they were reading high. Thermocouples were also placed axially along the ring at $\Theta = 60^\circ$. The taped data printouts were received by Thermo-Flow Laboratory. The data along with sketches showing the thermocouple locations was delivered to cognizant Thermal Design engineers and is being analyzed. Additional testing should be expected.

(This Page is Unclassified)

WANL-TME-1856

TESTS FOR PW-1

TFL-1.a Single Cluster Development Tests

Seven tests were conducted during this reporting period.

Test No. TFL-1.a.0028a was conducted on July 17, 1968. This was a check-out cluster model consisting of XE-2, low void, outside diameter coated elements at PW-1 conditions; also incorporated was a redesigned cold end. Test goals included 20 minutes of test time and a fast power ramp to minimize element corrosion during start-up. The test completed 15.5 minutes at steady state with some 90 percent of power applied in a 1.25 minute ramp. Steady state temperatures were recorded at 4.5 minutes. Since this test was considered generally successful, redesign changes were made in the new cold end support hardware to further improve them.

Test No. TFL-1.a.0027c was conducted on July 29, 1968. The configuration was PEWEE-1 with low void XE-2 elements in the cluster. The test was aborted at approximately 129 volts while trying to adjust power.

Post test examination indicated corrosion of the elements which exposed the bores in the region of maximum temperature and caused an abrupt abortion of the test. An internal furnace electrode water leak possibly caused the accelerated corrosion of the fuel elements.

The pedestal (II) was cracked during this test and two of the alignment pins were lost; therefore, it was decided to discontinue testing this piece (with 12 minutes steady state time on it) and have a new pedestal (III), tapered washer, and outer sleeve brazed together for testing.

The newly designed cold end hardware was quite good in appearance and no damage to the model or any support components could be related to the fast power ramp used.

PEWEE-I test number TFL-1.a.0029a was conducted on August 2, 1968 using the new pedestal (III) and other hot end hardware components. The test was aborted at approximately 125 volts of the power ramp, (i. e. just prior to attaining

TFL-1.a Single Cluster Development Tests (Continued)

steady state conditions) due to indications of an open circuit and slight arcing. Upon opening the furnace it was observed that the braided copper arc suppressors had overheated and broken loose from the furnace electrode due to poor attachment. The overheating appeared to have been localized in the surface contact area. No damage to the cluster model or support hardware occurred. There was minor damage to the upper furnace parts. Engineering surveillance of the installation of the cluster was increased to prevent a reoccurrence of the above. Another precaution planned for future builds is to pre-align the cold end cluster chuck and braided conductors to avoid awkward or "make shift" furnace installations that contribute to possible failures.

As a result of the damage to the furnace, the top end was disassembled, weld repairs made and the furnace reassembled. In reassembly, a new insulator ring (between electrode and instrument ring) was installed, and pressure checking revealed a serious hydrogen leak. Considerable time was spent determining and correcting this furnace electrode - insulator design problem. Detailed measurements of the two insulator grooves (that accept the male pilots of the electrode and instrument rings) revealed that actual interference was occurring both radially and axially. Enlarging of the grooves by machining completely eliminated the leak problem in the top end of the furnace.

PEWEE-I test numbers TFL-1.a. 0029b and TFL-1.a. 0029c were conducted on August 16 and 19 respectively with steady state test times of 7.7 and 12.2 minutes. Both tests were terminated because of element failure. Test number TFL-1.a. 0029c was performed with a 20 psi helium furnace overpressure (helium to hydrogen pressure differential). Future tests will be conducted with progressively higher helium over pressures which will tend to lengthen test times by reducing element corrosion at the elevated PEWEE exit gas temperatures. However, helium leakage through the hot end chuck could lower block temperatures and reduce

(This Page is Unclassified)

WANL-TME-1856

TFL-1.a Single Cluster Development Tests (Continued)

hydrogen corrosion of the test pieces which would be undesirable. At this point it appeared that typical run times for the XE-2 elements being used for PEWEE-1 hot end hardware testing will be on the order of 10 minutes.

Based on these test results, it appears that efforts to improve installation and facility procedures were successful and the cluster model hardware problems seem to be solved. Some minor problems remain with the beryllium oxide (BeO) insulators on the central elements which can probably be corrected with dimensional changes. BeO insulators are being ordered with slightly thinner wall sections and lower density specifications to try to reduce the effects of thermal shock that may be causing their cracking.

PEWEE-1 test numbers TFL-1.a.0029d and TFL-1.a.0029e were performed on August 21 and 26 with steady state times of 11.3 and 4.8 minutes. The TFL-1.a.0029d test was terminated due to the melting of the hydrogen inlet pressure instrument line; several more minutes could probably have been obtained except for this but significant element corrosion was in progress. The TFL-1.a.0029e test was terminated due to a reversal of the pressure ratio of the furnace helium pressure to cluster model inlet hydrogen pressure. Total time on the reactor grade support pieces is now 36.0 minutes, which has been obtained over five cycles of testing.

Astronuclear
Laboratory

WANL-TME-1856

(This Page is Unclassified)

TESTS FOR R-1

TFL-1. e Support Stem Impedance Test

(U) The purpose of the Stem Assembly Manufacturing Process and Development Test is to obtain flow impedance characteristics of manufactured stem assemblies and to verify analytical methods of predicting flow impedances in a stem assembly. Five stem assemblies will be tested. The stem assembly test fixture is shown in Figure 1. The stem assemblies are available. Presently the model is in Drafting and fabrication of the test hardware should begin before the next report period.

(C-RD) The purpose of the Stem Orificing Impedance Test is to determine the steady state performance of the present stem orificing and turn-around arrangement and to establish flow impedance characteristics of various orifice sizes. Tests will be conducted with hydrogen at 750, 800, and 850 psia at temperatures of 480, 240, and 160°R. Presently the model is in Drafting. Fabrication of the fixture should begin before the next report period.

TFL-2. a Core Periphery Test

(U) Tooling fixtures for making the Z-liners for model TFL-2. a. 0004a were received by Thermo-Flow Laboratory. Work was immediately started to develop techniques for making the liners. Sample pieces were first fabricated under the supervision of Manufacturing Engineering and Advanced Reactor Design personnel to demonstrate the recommended technique for fabricating the liners. During this demonstration, problems encountered included locating the flat foil strip before forming the adherence of the foil to the die set after forming, and inability to rotate the fixture easily. The following actions were taken to resolve these problems. A locating T-bar was made to hold the flat strip in position prior to making the first bend. After experimenting with several release agents, acetone was finally selected as the best anti-adherence agent. After each forming operation, tile die sets were cleaned to prevent the adherence of foil to the die. To facilitate rotating the forming tool, two turning fixtures made by the supplier were installed. A safety chain was installed to prevent separation and falling of

FIGURE 1
SUPPORT STEM IMPEDANCE TEST MODEL

TFL-2.a Core Periphery Test (Continued)

- (U) the free side of the forming tool. During the demonstration phase, three layers of Z-liners were formed, cut, and installed on the aluminum mock-up core. Personnel, both Thermo-Flow Laboratory and Reactor Assembly, were oriented on each fabrication phase to become familiar with each operation.
- (C-RD) Following this orientation phase, the fabrication and final assembly of the wrapper to the TFL-2.a. 0004 core was started. The wrapper is being installed on a best effort basis. Nine of the 33 layers of Z-liners have been fabricated and installed on the core. A minimum gap range of 0 to 10 mils somewhere along the axial length is being maintained. This gap generally exists near the inlet plane of the model. The maximum gap which is being allowed, other than the range specified by the minimum requirement is 30 mils. Problems which are currently plaguing the assembly are (a) mid-plane gap exceeding 30 mil limitations and (b) thickness variations of foil being on the plus side of nominal. Both these conditions tend to prevent a production type of assembly operation. The mid-plane gap is attributed to a 12 mil bow which is inherent in the tooling fixture. In order to maintain the gaps specified, the foil thickness variations requires changing the leg width dimension when cutting the foil.
- (U) To determine dimensional variations, 1/2 inch wide quality control test samples were formed simultaneously with the Z-liners for layers 1 and 2 and were placed in capsules for further inspections. Dimensional inspections were performed on the test samples from layer 1 and the data is presently being reviewed.
- (U) Sizing of the seal segment flow holes for the helium test, TFL-2.a. 0004a was completed. A work order was released to our machine shop to modify existing parts from machined blanks.
- (U) A schedule of event completion is being prepared, using the following events:

TFL-2. a Core Periphery Test (Continued)

1. Wrapper Sub-Assembly.
2. Core Sub-Assembly.
3. Reflector Sub-Assembly.
4. Model Assembly.
5. Furnace Installation and Instrumentation.
6. Facility Completion and Checkout.

Calendar dates will be established after the manpower level, and their skills have been assessed.

TFL-4. b Support Plate Plug Leak Test

The purpose of this test is to evaluate candidate seal plug configurations that can be used to seal the radially drilled holes in the combined core support/plena plate. Data from this test will help in the selection of a suitable seal plug design. Three types of plugs will be tested.

The seal plug candidates are as follows: straight body plug, grooved body plug, and "Lee" plug. The tests will be conducted in a hydrogen environment at 140°R and 530°R. Internal pressure will be 900 psi with a 300 psid drop across the plug. Leakage rates will be determined by measuring the adiabatic pressure rise in the external plenum as a function of time. Leak rates are expected to be low; however, the maximum allowable leak rate is 0.002 lb/sec. The test fixture is shown in Figure 2. Twelve aluminum test blocks will be utilized with four plugs of each plug type during the tests. Fabrication of the test fixture will begin during the next report period.

TFL-4. d Pressure Vessel Instrumentation Port Transition

The purpose of this test is to determine whether the anticipated reactor temperature and pressure ramps will have any effect on the co-extruded transition and/or its associated hardware. Particular attention will be paid to weldments.

612600-1D

FIGURE 2
 SUPPORT PLATE PLUG LEAK TEST FIXTURE

TFL-4. d Pressure Vessel Instrumentation Port Transition (Continued)

The test will consist of hydrostatic pressure check to failure, pressure/thermal gradients test for leakage and pressure/thermal cycling effects for leakage.

Some of the test hardware is available; however, most will require fabrication. Drawings are completed and fabrication will begin during the next report period. Figure 3 shows a cross-section of the model.

The purpose of the Pressure Vessel Transition Weld Study Test is to determine if the temperature created by welding will have any effect on the instrumentation lead braze or co-extruded transition.

The transition and seal block will be thermally monitored during the welding operation to ascertain that heat generated during welding will not exceed the transition or braze limitations. Thermocouples will be oriented in an axial and transverse pattern so that a temperature profile may be plotted.

The test is being delayed due to the lack of the vendor produced co-extruded transition hardware. The other test hardware is completed. The test should be conducted before the next report period.

TFL-6. d Flow Tube Spool Seal Leak Test

Effort has been discontinued on the Flow Tube Spool Seal Leak Test.

612600-2B

FIGURE 3

PRESSURE VESSEL INSTRUMENTATION PORT TRANSITION MODEL

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

(This Page is Unclassified)

Astronuclear
Laboratory

WANL-TME-1856

GENERAL DEVELOPMENT TESTS

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

A18

TFL-1.b Single Element Process Development and Evaluation Tests

- (U) One hundred thirty-two single element corrosion tests were conducted during this period.
- (U) Six Phase IV-B elements were corrosion tested at R1.07 conditions, and ten Phase YFE, Y-12, flour evaluation tests were conducted at R1.07 or D1.01 conditions.
- (U) Twenty-four "Q" coat development tests were conducted at R1.07 or D1.01 conditions. Six elements were from Phase I-Dc and eighteen from Phase TS-3013.
- (U) Ten Phase TS-3002, extruded to size, elements were corrosion tested at R1.07 or D1.01 conditions.
- (U) Six corrosion tests were conducted at R1.07 or D1.01 conditions on elements from Phase QCD, Y-12 "Q" coat development.
- (U) Thirty-seven Phase YII-Ga, Y-12 high expansion matrix elements were tested at R1.07 or D1.01 conditions.
- (U) Five Phase CTX, "X" coat salt qualification elements were tested at A6.04 conditions, and six tests were conducted at R1.07 or D1.01 conditions on elements from Phase LMY, LASL matrix with Y-12 coatings.
- (U) Five Phase SxS, XE-2 side by side, elements and three Phase PW-1, PEWEE-1, elements were tested at A6.04 conditions.
- (U) Four Phase LQ, LASL matrix "Q" development, elements were tested at R1.07 conditions.
- (U) Four tests at A6.04 conditions were conducted on Phase FOX, PEWEE-1 follow-on experiments of hydrolzed elements.
- (U) Eleven test and chuck development tests were completed, and one test was conducted with an XE-2 type element at a low helium atmosphere pressure.

TFL-5.b Interstitial Corrosion Tests

- (C-RD) Two specimens simulating a 0.0055 inch "Grafoil" wrapper opposite a 0.005 inch thick filler strip gap were tested at the following conditions with the following results:

TFL-5. b Interstitial Corrosion Tests (Continued)

(C-RD)	Test No. TFL-5. b.	044	045
	Test Time (min)	30	15
	Inlet Pressure (psig)	575	570
	Flow Rate (lb/sec)	0.297×10^{-4}	0.908×10^{-4}
	Material Temperature ($^{\circ}$ R)	3494	3508
	Initial Coupon Weight (gms)	0.1880	0.1860
	Final Coupon Weight (gms)	0.1498	0.1540

(U) During the ramp to temperature, while testing TFL-5. b. 044, the increase in specimen pressure differential reduced the pressure differential across the outlet valve and made it restrictive. By the time test temperature was reached, the flow had been reduced to approximately 1/3 of its original value. Due to this flow reduction, the test time was increased from 15 to 30 minutes.

(C-RD) Examination of the specimen after test shows through corrosion for the full length of the coupon extending up to approximately 0.08 inches on each side of the 120 degree bend. Corrosion was also present on the inlet and outlet edge of the coupon. No corrosion was present on the coupon edges. Figure 4 shows the coupon in the window after test. Figure 5 shows the specimen with the holder halves and flow slot after test.

(C-RD) The flow slot section of the coupon holder was split axially and examined. Each side of the flow slot showed corrosion. The pattern is bounded on the inlet and outlet of the slot by 0.200 inches of coated graphite and by 0.150 inches of coated graphite on the open "Grafoil" edge of the flow slot. The depth of the slot increased from 0.250 inches to 0.300 inches maximum. The depth of corrosion perpendicular to the sides of the flow slot reached a maximum of 0.045 inches. Figure 6 shows the sides of the split flow slot.

(C-RD) Examination of specimen no. TFL-5. b. 045 after test shows corrosion on all edges and opposite the flow slot for the full length of the coupon. The greatest

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

Astronuclear
Laboratory

WANL-TME-1856

FIGURE 4

COUPON IN WINDOW AFTER TEST

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

FIGURE 5
COUPON WITH HOLDER HALVES AND FLOW SLOT AFTER TEST

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

WANL-TME-1856

FIGURE 6

TESTED SECTIONED 0.006 INCH WIDE FLOW SLOT
SHOWING COATING EFFECTIVENESS

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

TFL-5. b Interstitial Corrosion Tests (Continued)

(C-RD) area of damage opposite the flow slot was on the half toward the exit end. This damage showed up in the form of a wider and deeper corrosion area with multiple through holes. Figure 7 shows the coupon in the fixture windows. Figure 8 shows the specimen with the holder and flow slot after test. The flow slot was split, examined, and found to have a corrosion pattern typical of the other slot examined, but not as extensive.

(U) Comparing these two tests, it can be seen that the coupon weight losses are within 0.0062 gms. The differences between the two tests can be seen in the flow rate and time entries in the data table. The damage to coupon no. 044 was localized to the flow slot area where the damage to coupon no. 045 was distributed over all edges plus the flow slot area.

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

Astronuclear
Laboratory

WANL-TME-1856

FIGURE 7

COUPON IN FIXTURE WINDOW AFTER TEST

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

A25

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

Astronuclear
Laboratory

WANL-TME-1856

FIGURE 8

COUPON WITH HOLDER HALVES AND FLOW SLOT AFTER TEST

CONFIDENTIAL
RESTRICTED DATA

Atomic Energy Act - 1954

A26

(This Page is Unclassified)

WANL-TME-1856

FACILITIES

WANL Liquid Hydrogen Facility

The procedures for the WANL Liquid Hydrogen Facility were completed. These procedures included the following:

- A. Fill Procedure for the 5,000 Gallon Dewar.
- B. Paul Chemical and 5,000 Gallon Dewar Run Procedure.
- C. Cryosonics and 5,000 Gallon Dewar Run Procedure.

A WANL safety review was conducted and the procedures are being modified. The procedures will then be submitted to SNPO prior to operation.

WANHES Liquid Hydrogen Facility

It has now been established that a commercial water line will be installed between the WAPD and WANHES Sites at Waltz Mills, Penna. With this decision made, the drawings and specification of the deluge system and other work for the liquid hydrogen storage area were changed to eliminate the proposed water tank and fire pump and to provide for connection of the deluge system to the water main that will exist at the WANHES site. This project will be rebid shortly. In connection with this same project, the order for the cryogenic connections between the liquid hydrogen storage tank and the Paul vaporizer has been placed and the vendor has submitted all but the drawings for customer approval prior to manufacture.

FS-1 Installation

The FS-1 Core Periphery Facility is about 85% complete. Again in this reporting period little construction work was conducted as technician manpower was assigned to the PEWEE cluster test program, to conduct seven tests. Work items performed included: completion of the bus bar extension, installation of the hydrogen flare stack ignition system, installation of additional hydrogen and helium flow loop pneumatics control signal lines and calibration of transmitters and recorders. Valve trim sizing for the flow loop with plots of flow range capabilities was completed.

Water Injection System for Single Element Furnace

Four checkout tests were conducted with the water injection system for the single element furnace. Two tests were at 850 KW, 600 scfm hydrogen flow at 435 psig exit pressure and the last two were at the same conditions except with an exit pressure of 560 psig. Stable operation was attained except on power up ramps. A derivative unit is to be installed to improve water flow after an additional part of the order is received.

A two, stainless steel filter system was installed to decrease pressure drop, and a deionized water supply was obtained and installed to eliminate plugging of the filters with minerals. Graphite parts breakage during tests has apparently been eliminated through use of modified parts.

Plans for next period include conducting additional checkout tests for evaluation of filter and overall system performance.

Single Element Sonic Orifice Flow Tests

A sonic orifice and orifice flow section was fabricated and installed at WANL. Flow tests were conducted at WANL and WANHES, with the identical orifice flow section to determine if measured hydrogen flows differed. The orifice section was then sent to LASL and after re-calibration of their hydrogen flow measuring system was completed, sonic orifice flow tests were conducted. An evaluation of the data indicates good agreement among the flow measuring systems at all three sites.

(This Page is Unclassified)

WANL-TME-1856

SECTION B
MONTHLY REVIEW OF ENGINEERING MECHANICS TESTS

TABLE I

ENGINEERING MECHANICS LABORATORY	
<u>PERFORMED THIS PERIOD</u> (July 18, 1968 - August 27, 1968)	<u>PLANNED NEXT PERIOD</u> (August 27, 1968 - September 30, 1968)
TESTS IN SUPPORT OF R-1	
<u>REFLECTOR SYSTEM TESTS</u> A.3 Reflector Radial Seal Development Tests A.4 Ganged Drum Drive System <u>FUEL ELEMENT TESTS</u> B.1 Fuel Element Compression Tests B.1 Fuel Element Tension Tests <u>AXIAL SUPPORT SYSTEM TESTS</u> C.1 Room Temperature Short Cluster Tests C.1 Thermal Cycling Tests C.5 Secondary Support Evaluation Test <u>CORE PERIPHERY TESTING</u> E.1 Axial Differential Pressure Tests <u>SHIELD</u> M.1 Shield Element Thermal Shock Test <u>ANTICRITICALITY POISON SYSTEM TEST</u> J.1 Poison Wire Ocean Water Corrosion Test	<u>REFLECTOR SYSTEM TESTS</u> A.4 Ganged Drive Band Tensile Tests A.4 Ganged Drive Band Fatigue Tests A.4 Three Drum System Titanium Band Tests <u>FUEL ELEMENT TESTS</u> B.1 Continue B.1 Continue <u>AXIAL SUPPORT SYSTEM TESTS</u> C.3 Interface Friction Tests <u>CORE PERIPHERY TESTING</u> E.1 Continue <u>SHIELD</u> <u>ANTICRITICALITY POISON SYSTEM TEST</u> J.1 Continue

B2

(This Page is Unclassified)

WANL-TME-1856

TABLE I (continued)

<u>PERFORMED THIS PERIOD</u> (July 18, 1968 - August 27, 1968)	<u>PLANNED NEXT PERIOD</u> (August 27, 1968 - September 30, 1968)
TESTS IN SUPPORT OF R-1	
<u>SUPPORT STEM TESTS</u>	<u>SUPPORT STEM TESTS</u>
L.2 Stem Manufacturing Process & Axial Load Test	L.2 Continue
TESTS IN SUPPORT OF NRX & XE	
XE Calorimeter Support Vibration Test	
XE Gamma Rate Sensor Vibration Test	
Calibration of Tie Rods for FFL Tests	

(This Page is Unclassified)

WANL-TME-1856

(This Page is Unclassified)

WANL-TME-1856

TESTS IN SUPPORT OF R-1

REFLECTOR SYSTEM TESTS

EML-A.3 Reflector Radial Seal Development Tests

(U) Tests of a candidate reflector radial seal were performed to determine flange separation leakage at anticipated pressure differentials that would occur during reactor operation. The seal was a modified double omega type (Model No. SF-10000-6-G-AG DSD Company, Hamden, Conn.).

(U) The seal was installed in mating grooves of two heavy flanges and leak tests using helium gas were performed with and without flange separation. Figure 1.

(U) With no flange separation, seal leakage was measured for 100, 200, 250 and 275 psi pressure differentials. The maximum leakage occurred at the 275 psi pressure differential and was 9 SCFH.

(U) For a flange separation of 0.005 inches, leakage in excess of 250 SCFH for 15 psi pressure differential occurred. As this leakage was excessive even at low differential pressure levels, no additional testing will be performed on this type of seal.

EML-A.4 Ganged Drum Drive System

(U) Spot welded band specimens were tested to failure at ambient and 140°R temperatures to determine the strength of the spot weld joint. Specimens were made of reactor grade titanium band material and were spot welded according to weld specification MIL-W-6858-C class B. Welding was done by the vendor who welded the bands for the 3 drum test fixture.

(This Page is Unclassified)

WANL-TME-1856

FIGURE 1
REFLECTOR RADIAL SEAL TEST FIXTURE
EML-A.3

(U) The specimens were loaded by pulling around a saddle fixture to simulate the fit up between band and decoupler hub of the R-1 configuration. Figure 2.

(U) Seven specimens each were tested at ambient temperature and 140°R. Ultimate loads ranged from 1270 to 1445 pounds and from 2117 to 2525 pounds for ambient and 140°R temperature conditions respectively.

(U) Failure occurred in the material away from the spot welded area in all cases but one. In that one specimen, tested at 140°R, the failure line ran adjacent to one spot weld but did not penetrate the weld area. Figures 3 and 4.

(U) Test results to date indicate a substantial load margin over that anticipated in reactor operation.

FUEL ELEMENT TESTS

EML-B.1 Fuel Element Compression Test

(C-RD) During this period, compression/creep testing of PEWEE II central elements was initiated. In these tests, three inch specimens were subjected to axial compressive loads of 900 lbs for 75 minutes at temperatures of 4300°R, 4600°R, and 4900°R. As in previous tests of this type, the specimens were brought to temperature under minimum load, then at temperature the test load was rapidly applied (minimum to test load in about five seconds) and held for the test period. During the test, specimen deflections were monitored by the Optron Optical Extensometer.

(C-RD) The first specimen tested was a Y-12, PEWEE I type element. At 4300°R, the indicated creep strain under load was 0.0036 in/in; the measured decrease in overall length was 0.0112 in; the measured increase across the flats was 0.0009 in. At 4600°R, the indicated creep strain under load was

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

(This Page is Unclassified)

WANL-TME-1856

FIGURE 2
BAND SPOTWELD TEST FIXTURE
EML-A.4

CONFIDENTIAL
RESTRICTED DATA
Atomic Energy Act - 1954

(This Page is Unclassified)

WANL-TME-1856

FIGURE 3
BAND SPOT WELD SPECIMENS
ROOM TEMPERATURE TEST
EML-A.4

(This Page is Unclassified)

WANL-TME-1856

FIGURE 4
BAND SPOT WELD SPECIMENS
LIQUID NITROGEN TEST
EML-A.4

(C-RD) 0.0090 in/in; the measured decrease in overall length was 0.0308 in; the measured increase across flats was 0.0030 in. At 4900^oR, the indicated creep strain under load was 0.0272 in/in; the measured decrease in overall length was 0.0879 in; the measured increase across flats was 0.0067 in. The test at 4900^oR was terminated after approximately 64 minutes when the sight ports became clogged with bits of furnace insulation.

(U) The furnace has been repaired, and the tests of the remaining three element types will be completed in the next period.

EML-B.1 Fuel Element Tension Test

(U) During this period, four specimens taken from a single uncoated fuel element were tested at room temperature in the short bundling(friction lock-up) test fixture. This test was performed in an attempt to establish a base point for comparing ultimate strain values for other types of fuel elements and various coatings.

(C-RD) The results of this test were: The specimen taken between Stations 8.5 and 18.5 failed at 2480 microstrain; Stations 19 to 29 failed at 2240 microstrain; Stations 29.5 to 39.5 failed at 2510 microstrain; and Stations 40 to 50 failed at 2460 microstrains.

(C-RD) In comparison, the elements coated by the LASL GEM plus GED coating process had an average strain at failure of 2160 microstrain; PEWEE I GEM coated elements had an average strain at failure of 2175 microstrain; PEWEE I GED coated elements did not fail under strains in excess of 4000 microstrain. As a further comparison, bore coated A-5 fuel elements had an average strain at failure of 2315 microstrain.

(U) Although it appears from the above data that GED coated elements are much stronger than GEM coated elements, the probable explanation for the higher values obtained for GED coated elements is due to the smoother surface of the GED elements which prevented friction lockup of the tested element, and subsequently, the strain transfer. Further testing of GED coated elements is in progress.

AXIAL SUPPORT SYSTEM TESTS

EML-C.1 Room Temperature Short Cluster Tests

(U) During this period, two room temperature cluster tests were performed to determine the behavior of hot end support hardware. Testing consisted of loading the support hardware through the central element until failure of either the support hardware or the central element. A total of four tests were performed in all. Results of the first two tests were given in previous monthly reports. However, the results of all four tests are summarized in Table II for completeness. As seen by the table, Test 1 and 2 utilized non-reactor grade components, whereas Test 3 and 4 were run with reactor grade hardware.

(C-RD) Test Number 3, which failed at 1900 lbs occurred in the central element on a surface where the central element reacted the load in the test fixture. Since this surface had been sectioned to fit into the test rig, it is believed that premature failure was the result of central element weakening by cutting operations. The hot end hardware was not damaged.

(C-RD) Test No. 4 failed at 3900 lbs. This failure occurred in the pyrolytic cup and washer, both of which were cracked. However, the carbide components remained intact and there was no visible damage to the central element.

(See Figure 5).

TABLE II

SUMMARY OF ROOM TEMPERATURE LOAD TESTS

<u>Test Number</u>	<u>Results</u>
1	Failure occurred at 2700 lbs. load in substitute hardware. (Substitute pyrographite washers.) Non-Reactor grade
2	Failure occurred at 1200 lbs. load in substitute hardware. Non-Reactor grade.
3	Failure occurred at 1900 lbs. in central element. Hot end hardware was in good condition. Hardware was reactor grade.
4	Failure occurred at 3900 lbs. in the Pyrographite cup and washer. Hardware was reactor grade.

FIGURE 5
POST-TEST CONDITION OF HOT END
HARDWARE FROM TEST NUMBER 4
EML-C.1

(U) Leakage tests performed on the pyrofoil seals before load tests were run gave a maximum leakage of 1.8 standard cubic centimeters per minute at 10 psig pressure for Test Number 3, and 23.0 standard cubic centimeters per minute at 10 psig for Test Number 4. Both of these rates are small and would be further diminished at elevated temperature due to increased volume and viscosity of the gas.

AXIAL SUPPORT SYSTEM TESTS

EML-C.1 Thermal Cycling Tests

(C-RD) The metallographic results on fuel element tips subjected to the Thermal Cycle Testing have indicated that axial cracks in the coating are numerous, but in general, penetrate only the coating or in the worst conditions extended seven to 10 mils into the carbide wall. Examination of the tops from elements subjected to Thermo-Flow Laboratory cluster tests showed evidence of a small amount of corrosion in the material adjacent to the cracks, but no apparent structural damage.

(C-RD) Another type of damage uncovered by metallographic examination indicated that occasionally the tip brazing operation produces cracks in the transition section of graphite. During subsequent coating operations, these cracks fill in and are essentially plugged.

EML-C.5 Secondary Element Support Evaluation Test

(U) A series of static tests were performed to determine the strength of two types of fuel element attachment arrangements, Design A & B in Figure 6.

DESIGN A

DESIGN B

FIGURE 6
TYPE OF FAILURE
EML-C.5

An 0.174 inch diameter pin was installed across an unfueled element 3/4 inch from the end and perpendicular to the centerline of the element.

- (C-RD) Silastic adhesive was used to secure the pin to the element. Seven radial holes were drilled through the pin such that the flowholes were not blocked. The pin protruded from the face of the element 1/4 inch on one side.

The projecting pin fit through a 0.180 inch diameter hole in an 0.030 inch thick stainless steel strap placed against the face of the element.

(C-RD) Tensile loads were applied until the element failed at 112 lbs.

- (C-RD) Design B consisted of an unfueled element section with the center hole drilled and threaded to accept a standard no. 8-32 socket head cap screw. Silastic adhesive was placed on the threads of the specimen and the screw was engaged to a depth of 3/4 inch. No adhesive or lubricant was used on the second specimen. Tensile loads were applied to the heads of the socket head cap screws until failures of the specimens occurred at loads of 470 lbs and 495 lbs.

CORE PERIPHERY TESTING

EML-E.1 Axial Differential Pressure Tests

- (U) A series of three tests was performed to determine axial peripheral gas flow through a saw tooth configuration containing 28 layers of grafoil sheets. The layers contained axial gaps approximately 0 - 10 mils wide. Tests were performed from ambient to 4800°R, and employed grafoil from a previous test to gain experience in the cutting and folding operations. The test setup is shown in Figure 7 , ready for assembly into the furnace.

- (U) The results indicated that gas leakage increased slightly during each of the three temperature cycles. Post-test examination following the third cycle revealed the sheets were in good condition, but the test fixture showed slight pitting in the "V"'s of the sawteeth.

- (U) Further tests will be made during the next period with fresh grafoil material and more closely controlled axial gaps. The "On-flats" configuration will also be tested.

FIGURE 7
TEST SETUP READY FOR ASSEMBLY INTO FURNACE
EML-E.1

SHIELD

EML-M.1 Shield Element Thermal Shock Test

(U) A test of a shield element specimen was performed to determine if cracking of the shield material would occur during reactor startup or other severe thermal shock conditions. The test was performed by rapidly chilling the surface of the specimen by a flow of high pressure cryogenic gaseous helium at 150°R temperature. The specimen was Al-TiH-B₄C material, and was 15/16 inches in diameter and 11-1/2 inches long.

(U) Two tests were performed at helium gas flow rates of approximately 0.2 lbs/sec and 5 lbs/sec.

(U) Visual inspection after each test revealed that the thermal shock did not damage the specimen.

ANTICRITICALITY POISON SYSTEM TEST

EML-J.1 Poison Wire Ocean Water Corrosion Test

(U) A development test program is in progress to determine the corrosive effects of ocean water on the poison wire materials.

(U) Two additional poison wires, each consisting of a Ti6Al-4V central wire, boron beads and a spray coated teflon-S sheath have been immersed for 30 days in a substitute of ocean water mixture. Central wire samples of Inconel 718, Ti6Al-4V and stainless steels 304A and 304B were also

subjected to this immersion test. The test was performed at room temperature with slight agitations being periodically applied to the water mixture.

- (U) The substitute ocean water mixture was prepared in accordance with ASTM Specification D1141-52, Section 4. This water mixture consists of concentrations of organic salts, as listed in WANL-TME-1831. The reagent water used in the preparation of the mixture was determined to have a total matter content and electrical conductivity meeting the requirements of ASTM Specification D1193-66.

- (U) The corrosive effects of the substitute ocean water are to be evaluated from weights, diameter measurements and photographs of the poison wires before and after the immersion period. Tension tests will also be performed on the poison central wire samples.

- (U) Evidence of galvanic corrosion was observable in poison wires previously tested. These wires consisted of a stainless steel 304A central wire, boron beads and a shrinkable teflon sheath. Diameter measurements along the wires revealed smaller average diameters after the immersion period. No weight change was noticed.

SUPPORT STEM TESTS

EML-L.2 Stem Manufacturing Process & Axial Load Test

- (U) Static tests at ambient conditions were performed on full-length support stems. The test results will be used to evaluate manufacturing techniques and to determine the strength of alternate materials for use in three candidate designs.

- (C-RD) The first series of tests was performed on six specimens (388D267 H01) fabricated from conventional tube processing methods (PDS 30043-2).

The basic bar stock was age-hardenable nickel-chromium-iron containing a minimum of 50% nickel. This group of stems had a wall thickness of 10 mils with an outside diameter of 0.320 inches and a length of 76.2 inches.

(CRD)

The test arrangement in the universal testing machine is shown in Figure 8 . Output signals from 12 strain gages were recorded as the H01 stem was loaded to 800 lbs. Eight specimens to the H01 design failed at loads ranging from 2140 to 2310 lbs. Five of these had previously been cycled 50 times to a load of 653 lbs without being damaged.

(CRD)

The second series of tests were performed on two stems (388D267 H02) made from centerless ground bar stock (PDS 30043-1). The material, outside diameter and wall thickness were the same as for the first group but the length was 78.0 inches. One stem with strain gages was loaded 50 times to 593 lbs. This cyclic test was repeated on a second specimen prior to applying a failure load of 1840 lbs.

(U)

The tests have shown that neither stem design is damaged by applying the static operational loads. Failures did occur at levels in excess of 3 times these values.

**CONFIDENTIAL
RESTRICTED DATA**

Atomic Energy Act - 1954

(This Page is Unclassified)

Astronuclear
Laboratory

WANL-TME-1856

FIGURE 8
STATIC TEST OF FULL-LENGTH STEM
IN UNIVERSAL TEST MACHINE
EML-L.2

**CONFIDENTIAL
RESTRICTED DATA**

Atomic Energy Act - 1954

(This Page is Unclassified)

TESTS IN SUPPORT OF NRX & XE

XE Calorimeter Support Design Vibration Test

(U) Tests at ambient conditions were performed to determine the ability of the calorimeter support to survive a vibration loading.

(U) The calorimeter support with a calorimeter attached was bolted to a fixture plate and vibrated along three mutually perpendicular axes. A typical test setup is shown in Figure 9. Exploratory, investigative and resonance dwell tests (Table 3) were conducted for a total elapsed time of 100 minutes. The exploratory tests were of three minutes duration in each of the three directions, and the investigative tests were seven minute sweeps over the frequency range from five cps to 1000 cps.

(U) Ten strain gages were used to monitor the strains at critical locations on the calorimeter support and the calorimeter. A summary of the resonance frequencies and the maximum strains are shown in the table.

(U)

TABLE III

<u>Test Direction</u>	<u>Input Level g's</u>	<u>Frequency cps</u>	<u>Max.Strain in 5052-H32 Matl. μ inch/inch</u>	<u>Dwell Duration min.</u>
X	10	428	3000	10
Y	10	205	500	10
Y	10	415	2000	10
Y	2	154	1200	10
Z	2	59	1400	10
Z	10	450	600	10
Z	10	637	400	10

(U) The calorimeter support revealed no damage, and the entire assembly remained intact. The unit was returned to the Electronics and Instrumentation group for an operational inspection.

(This Page is Unclassified)

FIGURE 9
TEST SETUP FOR VIBRATION TESTING OF XE CALORIMETER

EML-G.4 XE-2 Gamma Rate Sensor Vibration Test

(U) Tests at ambient conditions were performed to determine the ability of the gamma rate sensor and support bracket to survive vibrations in the frequency range from 5 to 100 cps. The maximum acceleration levels applied were 10 g's. The support bracket with the sensor attached (Figure 10) was bolted to a base plate and vibrated in three mutually perpendicular directions. Four strain gages were used to monitor strains at the critical locations on the support bracket. Exploratory, investigative and resonance dwell tests (Table 4) were conducted for a total elapsed time of 60 minutes. Resonances occurred at 212, 560 and 880 cps. The largest strain of 250 microinches per inch was recorded at 212 cps.

(U) There was no noticeable damage to the gamma rate sensor or the support bracket as a result of the vibration tests.

TABLE IV**Test Conditions for Vibrating the XE Calorimeter and Gamma Rate Sensor**

(U)

- A. Exploratory Test
 - 5 to 10 cps at 0.10 in double amplitude
 - 10 to 1000 cps at ± 1 g input
- B. Investigative Test
 - 7 minute sweep
 - 5 to 20 cps at 0.10 in double amplitude
 - 20 to 180 cps at ± 2 g's input
 - 180 to 400 cps at 0.00122 in double amplitude
 - 400 to 1000 cps at ± 10 g's input
- C. Resonance Dwell Test
 - Frequencies and input levels determined in the investigative test.
 - Dwell for 10 minutes at each resonance.

(This Page is Unclassified)

FIGURE 10
VIBRATION TEST OF XE-2 GAMMA RATE SENSOR
EML-G.4

Instrumentation & Calibration of Tie Rods for the TFL

(U)

Two Inconel 718 tie rods (Part no. 945 C568 H01K) were instrumented and calibrated for the Thermal-Flow Laboratory. This instrumentation will permit monitoring of tie rod loads during hydrogen corrosion tests of hot end hardware. Axial tensile loads from zero to 600 lbs were applied and the resulting strains recorded. Calibration factors and resistance substitution values were supplied. Eighteen more rods will be similarly instrumented and calibrated.