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WANL-TME-1401

March, 1966

Westinghouse Astronuclear Laboratory

NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING
HELD WITH SNPO AT WANL ON FEBRUARY 25, 1966
(Title Unclassified)

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WANL-TME-1401

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Classification cancelled for change to
by authority of DOC
by H.F.C. TIC, date SEP 10 1975

E. A. DeZubay, Manager
Fluid Flow Laboratory

INFORMATION CATEGORY

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Authorized Classifier Date

W. J. Rowan, Manager
Engineering Mechanics

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SPECIAL REREVIEW FINAL DETERMINATION Class: <u>U</u>	Reviewed	Class.	Date
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Notes of Monthly Development Test Program Review Meeting

Held with SNPO at WANL on February 25, 1966

Attendees:

N. J. Bifano	WANL	H. Murphy	SNPO-C
H. J. Fix	WANL	J. S. Olinger	WANL
W. J. Havener	WANL	W. J. Rowan	WANL
G. Kalvin	SNPO-C	F. D. Retallick	WANL
I. E. Kanter	WANL	R. M. Saccocio	WANL
L. Larson	AGC	J. J. Schreiber	WANL
V. G. Kelly	WANL	D. C. Thompson	WANL
		E. A. Watjen	WANL

The Monthly Development Test Program Review Meeting was held on
February 25, 1966 with SNPO at WANL.

Brief summaries of the tests performed and planned by the Engineering Mechanics
and Fluid Flow Laboratories were distributed to those in attendance. These summaries
are shown on Tables I and II.

The individual tests and facilities were then discussed in the order as shown
in the Tables.

TABLE I
ENGINEERING MECHANICS TEST SCHEDULE

PERFORMED THIS PERIOD

PLANNED NEXT PERIOD

Tests for NRX-A5

EML-61 Hollow Tie Rod Evaluation
EML-69 Reactor Grade Block Tests
EML-75 Pyrotile Friction and Coating Wear Tests
EML-76 Alternate Seal Block Qualification, C. D.
Scram Spring
EML-94 Radial Expansion (Hardware Procurement)

EML-69 Reactor Grade Block Tests
EML-76 Control Drum Scram Spring
EML-78 Dome End Seal Tests
EML-94 Radial Expansion Testing; 162 Keyed Element
Test

Tests for NRX-A6

EML-60 Rearrangement of Core
EML-70 Brazed Tie Rod Collars; Corrosion Protection
Cups; Element Strain Tests
EML-76 Shield Screen Tests
EML-86 Plunger Capsule Seal Leakage Tests, Temp.
Profile Tests
EML-94 Forty-two (42) Keyed Element Tests

EML-60 Fuel Element Porosity Tests & Pinhole Tests
EML-69 Support Block Testing
EML-70 Short Cluster Tests & Element Strain Tests
EML-82 Outer Reflector Screen Insulation Tests
EML-86 Lateral Support System (Hardware
Procurement)

Development Tests

EML-55 Resonant Survey (Planning)
EML-69 Support Block Qualification Testing

EML-61 Graphite Tie Rod (Procurement) & Specimen
Fatigue Tests

Facilities

Furnace Procurement
Thermal Gradient Facility
Vacuum Equipment Procurement

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TABLE II
FLUID FLOW TEST SCHEDULE

PERFORMED THIS PERIOD

PLANNED NEXT PERIOD

Tests for NRX-A4		
HHT-2		
HHT-4	NRX-A4 Cracked Block (36.6 Minutes)	
Tests for NRX-A5		
FFL-18	Single Seal Test - Conducted Flow Visualization Tests	Fit and Run NRX-A6 Scarf Joint
FFL-20	Impedance Ring - Air Flow Tests	
FFL-23	Nozzle End Seals - Modified Fixtures & Tested Each Seal Once	Complete Second Test on Each Seal
FFL-27	Instrument Block - Tested Alternate Design - Purge Boot Assembly Tests Started	Complete Tests on Purge Boot
HHT-2	Single Element Moly-Coated NRX-A5 Elements - 1 Hr. Skirtless Block Tests-With Cups	
HHT-4	Cluster Tests - T/C (39 Minutes) - Skirtless Block (30 Min., 20 Min.) - NRX-A5 Pre-cracked (13 Min.)	Skirtless Block Test to Continue Total to 40 Minutes.
HHT-7	Filler Strip Test - Assembly of Build 4 Test 2	To be Tested
Tests for NRX-A6		
FFL-8	Drum Bearing Impedance - Design Fixture	Fabrication and Flow Test Design Restriction
FFL-29	NRX-A6 Single Seal - Fabrication	Complete Fabrication and Assemble Model
FFL-31	Baffle Effectiveness - Completed Design	Complete Fabrication and Test
HHT-2	Element Life Tests - No Activity	To be Tested
General Development		
HHT-2	Single Element - Product Evaluation	
HHT-6	Gap Test - 84 Coated Specimens Obtained New Molybdenum Can Being Made	Conduct Tests on Uncoated Slots for Pressure Effect, 100 to 400 psi
HHT-7	Filler Strip Test	Test Hot Buffer Build 4 Test 1 With and Without Methane Diluent

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TABLE II (CONTINUED)

PERFORMED THIS PERIOD

PLANNED NEXT PERIOD

Facilities

Large Site Vaporizer - Qualification Test in Progress

Complete Qualification Tests

Thermocouple Furnace - Completed Installation-Started Check-Out

Power Test

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NRX-A4 Tests

HHT-4 Single Cluster Development Tests

Damage to the special NRX-A4 pre-cracked block, which had been tested in January, was again described because complete post-test observations were available. The total equivalent time of the test was calculated at 36.6 minutes at a temperature of 4283°R. Temperatures over 4700°R had been obtained in this test. Post-test inspection of the block showed a high degree of corrosion all around the cracked area in the counterbore.

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NRX-A5 Tests

EML-61 Tie Rod Evaluation Tests

Two hollow instrumented tie rods were subjected to cyclic offset and axial strain at cryogenic conditions simulating extreme startup and shutdown conditions. Three possible combinations of axial and offset cycling were imposed on the rods: (1) constant offset at 0.100 in; axial load of 800 ± 100 lb, (2) cyclic offset from +0.100 to -0.100 in; axial load of 800 ± 100 lb, (3) cyclic offset from 0.100 to -0.100 in; constant axial load of 800 lb. Each combination was tested for 100 cycles. The rods endured the test conditions without damage.

EML-69 Support Block Mechanical and Thermal Tests

Testing was completed on NRX-A5 reactor grade support blocks with the standard component hardware.

Five reactor grade NRX-A5 blocks with pyrofoils and 250 mil thick, 90 mil radius, ATJ support washers were tested at 4300°R . The load was held through warmup, temperature, and cooldown with hydrogen flowing through the counterbore seat area between 1300 and 1400 lb of loading. In two cases the support washers developed circumferential cracks above 1300 lb. This was found to be a function of the bearing area of the graphite loading plunger. The more the load was concentrated on the outside diameter of the pyrographite insulation washer the less tendency there was for the ATJ washer to crack. Loading toward the inner diameter of the insulating washer tends to make the outer support washer circumference roll upward with consequent circular separation toward the middle surface of the washer annulus. The pyrographite washers were rigid enough to resist this tendency.

The cracking developed between 1300 and 1400 lb was slightly lower than that developed with uncoated A5 support blocks with pyrographite washers but about double the strength displayed by blocks of A3 design without pyrofoils.

EML-69 continued

While testing with coated blocks, it was noted that there was a tendency for surface cracks to develop on the upstream half of the block parallel to the flow channels. Sectioning of some of these blocks is being done to determine the extent of depth of these cracks which appeared under a microscope to be least as large in magnitude as those identified in the counterbore seat area. Five coated support blocks were tested at room temperature to develop a threshold load to initiate cracks in the fillet radius area. An ATJ, 250 mil thick support washer with a 90 mil edge radius was used over ten, 10 mil pyrofoils to load the blocks. Standard insulating cups, insulation hardware, molycones and tie rod button were used to complete the load train. Cracks appeared in the blocks at 1700, two at 1800, 1900 and 2000 lb loading and were very fine and partially circumferential.

Production washers with coating defects were tested at room temperature and 1000 lb loading for indications of trouble leading from the coating defect. None was found although it was determined that the coating defects were such that the washer inner diameter was blocked to the free passage of an ordinary pyro sleeve.

EML-75 Friction Tests of Reactor Components

Additional friction and coating wear tests of core peripheral components on pyrotile were performed to assess the significance of the pyrotile corrosion reported last period and obtain additional coating wear and friction data.

The observed pyrotile corrosion was evaluated by measuring the pyrotile weight loss in tests simulating the most severe temperature and relative motion conditions expected during 10 reactor test runs of 10 minute duration. The tests were performed at 4300°R with contact pressures of 15 and 100 psi to simulate the contact pressure conditions expected on the circumferential and transitional pyrotiles. Tests without relative motion were performed to isolate the effect of rubbing on pyrotile weight loss. The weight loss was found to be independent of contact pressure and was about 4 percent with relative motion and 3 percent without

EML-75 continued

relative motion. Since it was found during these tests that the size of the pyrotile surface nodules had an effect on the pyrotile weight loss, testing was also performed to evaluate this effect. The pyrotiles with small surface nodules were found to have a weight loss 50 percent greater than the loss obtained with specimens having large surface nodules. Projection of these test results to reactor operating conditions indicate that the pyrotile corrosion will not be large enough to effect operation during the A5 reactor tests. The results and photographs of the specimens after testing are shown in Figure 1.

The conditions and results of the tests performed to obtain additional data on friction and coating wear are given in Table III. These tests investigated the friction forces developed during reactor assembly as well as the friction and coating wear which would occur during 10 reactor test runs of 10 minute duration. No coating or pyrotile damage was observed in the post-test inspection of these specimens. Variations in coating adherence which was observed in earlier tests is being studied at the present time.

TABLE III

CORE PERIPHERY FRICTION MEASUREMENTS

Interface	Test Environment	Test Temperature °R	Contact Pressure PSI	No. of Cycles	Static Coefficient of Friction
Pyrotile - Coated Filler Strip	Air	535	4	5	.14
"	H ₂	1950	100	10	.10
Pyrotile - Uncoated Filler Strip	Air	535	4	5	.18
"	H ₂	2150	125	10	.15
"	H ₂	2300	150	10	.15

FIGURE 1
PYROTILE SPECIMENS AFTER TESTING
(TEST TEMPERATURE-4300°R)
EML-75

CONTROL DRUM SCRAM SPRING
TORQUE VS ANGULAR DISPLACEMENT

- Notes:
1. Average Torsional Spring Rate ~ 0.037 ft-lb/degree
 2. Data obtained throughout 25 cycles fall within the upper and lower limits of the curve.

FIGURE 2
EML-76

EML-76 Reactor Hardware Static and Dynamic Tests

1. Alternate Seal Block Testing

Thermal cycle fatigue tests and a resonance survey of the alternate NRX-A5 seal block assembly have been completed. These tests were required to prove the ability of this design to contain pressure when subjected to reactor operating environments. The alternate design is similar to the prime design except that a conoseal seal (clamp) is used on final assembly in lieu of stainless steel welds.

Two assemblies of this design were subjected to twelve thermal cycles (-50°F to 320°F) with continuous vibration of 240 cps and 2 g's input acceleration. No loosening of the conoseal seal or other failures were noted during testing. Leak tests of the assemblies after the twelfth cycle indicated the assemblies could contain 200 psi helium gas without leakage.

The resonance survey was performed by a frequency sweep from 10 to 1000 cps at 2 g input acceleration. No significant resonances were observed in this range. This can be attributed to the stiffening effect of the flanges which accept the conoseal. The prime design which does not include these flanges has a resonant frequency at 925 cps. Frequencies greater than 1000 cps are not expected on the NRX-A5 pressure vessel closure during reactor testing.

2. Control Drum Scram Spring

A torque-displacement test of the proposed flight reactor control drum scram spring was performed at ambient conditions with the redesigned spring positioning fitting incorporating a locking key. During the test, no coil rubbing could be observed during the winding and unwinding of the spring from 0 to 190° . No significant changes in the test results were observed after 25 winding and unwinding test cycles. The test results are shown in Figure 2. Additional testing will be performed on the scram springs at reactor operating conditions (200°R). It is conceivable that the material could become

EML-76 continued

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brittle and crack under these conditions.

EML-78 Dome End Seal Tests

Tests will be initiated during the next period on the NRX-A5 dome end seal assembly. The object of these tests is to determine whether the seal assembly will function satisfactorily throughout the cycling expected during the life of the reactor due to differential thermal expansions of the core components.

Procurement of the hardware has been completed and the test rig is being assembled for the test.

EML-94 Buffer Periphery Tests

1. Static Test of the Buffer Periphery

A partial length core is being assembled to demonstrate the adequacy of the A5 design to transmit the axial forces directly into the core. Axial forces applied to the end of each filler strip by hydraulic cylinders will be transmitted into the core through 162 keys at each filler strip location. Each partial element has an integral machined key whereas at the other filler strip positions, the key is brazed to the element. The same process as used for A-5 brazed elements is being used for the test components. This is typical of the design being used for the portion of the buffer periphery being used in A5 reactor.

2. Radial Expansion Tests

Fabrication of the pressure support ring has been completed and assembly of the test setup started. The first test that is scheduled for the next period will simulate the minimum calculated interference in the two buffered periphery sections.

Fuel Element Test Summary

During the period January 27, 1966 through February 23, 1966, a total of 115 tests were made; 41 were Quality Control Tests of Oak Ridge A5 elements, 12 were Quality Control tests of Astrofuel A5 elements, and 62 were special tests.

HHT-2 Single Element Process Development and Evaluation Tests

Two of the special tests were NRX-A4 simulation tests. One of the simulation tests was run at average temperature conditions and the other at maximum temperature conditions. Both tests included temperature oscillations. Lobes and blocks were tested along with the elements.

Ten 60 minute tests were scheduled on NRX-A5 elements. Of these ten, four completed the 60 minute test, four were terminated between 40 and 60 minutes because of actual or insipient failure, two broke in less than 15 minutes.

A total of nine single element tests were performed on molybdenum over-coated elements. Four of these tests were run for a period of 60 minutes, one for 36.5 minutes, and two at zero power for two minutes at full flow and a retest at two minutes at 1B conditions, with the exception that the second element was run with two minute startup and shutdown ramps. The weight losses of the elements which were run for 60 minutes ranged from 19 to 24.5 grams per element. Corrosion of these elements seemed less severe than ordinary elements tested under the same conditions. The weight losses of the two elements after the two minute cold flow tests were 0.3 grams per element. The weight losses of the same two elements after they were retested were 1.9 grams and 2.9 grams, respectively.

Six tests were run with an NRX-A6 skirtless block and pressure welded cup mounted in the diffuser. Although these blocks were actually A6 blocks, they were tested to see if some of them could be used in the A5 reactor. Two of the tests had to be aborted because of a hydrogen leak. Two of the tests were run with all but 18 inner holes of the block covered with a molybdenum-grafoil

shield-seal combination to produce high velocity gas impingement in the cup. The first test was run for 27 minutes and both the cup and the downstream end of the block seemed to be in good condition with no evidence of flaws in the pressure weld. The second test was run for 30 minutes with the block and cup remaining intact although the molybdenum-graphite shield melted out. The final two tests were run at 1B conditions to evaluate the insulating cup of the NRX-A6 design. The first of these tests was a 10 minute plus 10 minute cycle in which the cup became disengaged from the test fixture at some time during the test. In spite of this, the cup remained in fairly good condition. The second test was performed on the same cup but with a different holding mechanism. This test was run for 20 minutes and the cup remained intact throughout.

HHT-4 Single Cluster Development Tests

Two tests using NRX-A5 pre-cracked blocks were performed. The first test was conducted using an NRX-A5 pre-cracked block, ten 10 mil pyrofoil washers and an ATJ support washer with a 90 mil radius on the leading edge. The test was successfully conducted for 13 minutes at full power. A gas temperature of 4300°R was achieved. The block still looks good and will probably be run again. The second test, using an NRX-A5 pre-cracked support block with pyrofoil washers, ATJ support washer and exit gas thermocouple, was completed. The block was tested for 20 minutes at an exit gas temperature of 4300°R. The support block and associated components appeared to be in good condition. The same block was retested for 19.6 minutes giving a total equivalent time of 39.6 minutes at 4283°R. The thermocouple ceased to provide an electromotive voltage five minutes after the start of the second cycle. Structurally, the thermocouple was in good condition after the second cycle. The pyro graphite cup had extensive corrosion.

Six tests were conducted in an effort to test a skirtless block for 40 minutes at 4283°R. The test was set up using a tie rod button thermocouple along with an

exit gas thermocouple. The first block was tested for 20 minutes at 4300°R indicated exit gas temperature. The tie rod button temperature indicated was 1105°R. At the conclusion of the test, all parts appeared to be in excellent condition. A second test using the same block was conducted but was shut down after running for an equivalent time of 10.2 minutes at 4283°R. A tie rod temperature of over 2000°R and substantial arcing made this shutdown necessary. The total equivalent time at 4283°R logged on this block was 30.2 minutes. Post-test examination of the cluster revealed massive bore corrosion in one of the elements slightly above the mid-core station. This element broke and caused overheating of the other fuel elements as well as the center element.

The skirtless block and ATJ protection cup were not severely corroded. The overheating of the elements, however, resulted in large amounts of melted materials being deposited on the support block and accessories bonding them fast.

The other four cluster tests resulted in a total equivalent time at 4283°R of 20.6 minutes on one skirtless block. Arcing near the cold end during the third cycle melted cluster materials which peeled the coating on the protection cup. The last two tests were terminated during start-up because of element fracture and subsequent arcing.

The results of these tests pointed out the need for high quality elements and other reactor grade hardware for the cluster tests as a small failure of one component often results in the failure of the entire cluster.

Tests on the skirtless block will continue in an effort to run one for 40 minutes.

HHT-7 Filler Strip Corrosion Test

A report on Build 1 Test 4, WANL-TME-1300, was released for publication.

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The core for Build 4 Test 2 was assembled and measured for accuracy. It was found that at one of the transition filler strips (between T12A and F12) the gap was too large. The angle of the F12 filler strip was in error in the order of 0.5 degrees. To correct this condition, a new F-11 and F-12 filler strip is being made. Analysis of heater results and Build 4 Test 1 data has yielded corrections in the electrical resistivity which when used in the conduction equation, permit the calculation of the total power required and prediction of a reasonably accurate temperature distribution. A stainless steel reflector has been added to the rig to prevent helium in-flow.

FFL-18 Single Seal NRX-A5 Tests

An A5 seal containing an extra A5 scarf joint with .000 inch ramp clearance and a sharp edge was run against the transparent filler block. Photos of the flow pattern were taken with a high speed strobe light in an attempt to see what was taking place. All the action was not stopped by the rapid exposure time, which was expected, because of the wide range of velocity variations across the seal segment. The photographs, however, do show the areas of leakage very well. Some problems were encountered with reflection of the strobe light off the plexi-glas. More photographs will be taken of the same segment with the flow barriers on the downstream side to eliminate this reflection problem and to better show leakage through each scarf joint.

FFL-20 Inner-Outer Reflector Impedance Ring

Air flow tests are being conducted on the inner impedance ring. The rig is being operated at 85 psig upstream. Tests with reflector annulus gaps of 20 mils and 32 mils and a plunger pin clearance of 490 mils were completed. Testing will be continued with a 290 mil plunger pin clearance and reflector annulus gaps of 20, 32 and 50 mils.

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FFL-23 Nozzle Interface Seal Performance Test

There have been four nozzle interface seal tests performed to date. The data from the test on the first seal indicates that the sealing quality of the seal improves as the pressure drop increases. The second and third seals did not perform the same as the first. There was a steady increase in leakage flow with increased seal pressure differential. This condition continued through the entire flow range of the loop. The flow was limited by the downstream control valve. The highest ΔP that could be obtained across these two seals was approximately 10 psid. The ΔP that could be obtained across the first seal was in excess of 300 psid, this figure being maximum allowable test condition. The performance of the fourth seal initially appeared to be the same as seals two and three. During the test the ΔP across the seal was increased on a steep ramp. This shock sprung or set the seal and after this its performance closely matched that of seal one. When the test was concluded the ΔP was slowly increased to see if the data would repeat. At a differential of approximately 50 psid, the seal again took hold and repeated the original data. It appears from the data that this seal does not start to become effective until the pressure differential is in excess of 50 psid.

FFL-27 NRX-A5 Instrumentation Port Qualification Tests

Six seal plug transition joint welder specimens were helium leak tested to 750 psig with Leak-Tec solution and found to be leak free. Testing of the alternate design instrumentation port seal was completed. All the joints tested were leak tight. The purge boot seal tests have begun. It was found that the bolts on the fixtures must be torqued beyond the recommended 30 to 35 in.-lb. The result of this higher torque was that one fixture seal was satisfactory at ambient temperature at 45 in.-lb of bolt torque and the second fixture seal got progressively worse as the torque was increased, after an initial leak rate check. The tests at cryogenic temperatures on the first fixture were unsatisfactory. Seals specifically fabricated to reactor dimensions are to be tested next.

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NRX-A6 Tests

EML-60 Core Effective Gap Tests

1. Rearranged Core Tests

A flow test was performed to determine if any significant change in gap size distribution exists in different cores. The elements in the Core Effective Gap Test setup were randomly rearranged to form a new core. Flow tests were then performed with helium gas duplicating previous test conditions. No significant change in interelement pressure profile or in the flow rate was measured.

The lateral bundling pressure was varied from 2 to 10 psi at a head pressure of 100 psig and a pressure drop of 35 psi. The new measured flow was .029 lb/sec with a lateral bundling pressure of 10 psi. This compares with the previously measured flow rate of .025 lb/sec under the same conditions.

2. Fuel Element Tests

Porosity tests are being performed on fuel elements at 700 psig pressure utilizing helium gas. To date, 16 furnace corroded 19 hole elements have been tested. It appears from a preliminary evaluation that corrosion increases the porosity of an element.

3. Pinhole Testing

A second pinhole test will be performed on which the effect on interelement flow characteristics of pinholes will be measured. The flow rate through instrumented pinholes and their effect on local interelement pressure profiles will be measured. The bore pressure of each pinhole will be varied so that it is either above or below local interelement pressure.

EML-70 Blockless Support Systems and Components

1. Strength of Brazed Tie Rod Collars

Four additional specimens with two pair of split collars applied to each section of the tie rods were tested for mechanical integrity. The

EML-70 continued

collars were brazed on the rods with a Nicro Prema Braze alloy (82% Au, 18% Ni) by the Aerobrazo Corporation of Cleveland. Each braze was subjected to an X-ray examination by the Materials Department to establish the quality of the braze.

Shear loads were applied to the seven brazed collars and failures occurred in the tie rod adjacent to the collars at loads from 1710 to 1815 lb. The eighth collar was not subjected to the shear test because of deformation in the tie rod in the vicinity of the collar. The rods were undercut in the machining process (preparation of load interface by removing braze fillet and providing a flat surface), therefore, the failure loads were somewhat lower than expected on production-type hardware. The rods were undercut by as much as 0.005 inch; the nominal rod diameter is 0.110 inch.

After the tests were completed the samples were returned to the Materials Department for further metallurgical studies particularly for the purpose of establishing the validity of X-ray examination techniques.

2. Seven Cluster Testing

A series of bundling tests have been completed on the seven cluster test rig assembly. The first series of tests was completed with an undersized element which was reported in the last monthly review. The undersized element was replaced with a standard element and the test was repeated. Both results are shown in Figure 3. It can be seen from the figure that as the bundling pressure increases, the tension on the key of the undersized element decreases. When the undersized element is replaced with a standard sized element, there is a complete re-distribution of strains along the length of all elements. With the standard sized elements, the strains are more uniformly distributed and closely grouped at a given station.

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FIGURE 3

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EML-70 continued

The next step in the test series was to decouple the bundling frame from the seven clusters so that the loads applied to the three keyed elements of the seven clusters were reacted by the tie rods on all seven clusters. This provided a soft frame as compared to the previous tests which had in effect an infinitely rigid frame. With the rigid frame little or no load was transmitted to the tie rods of the seven clusters; it was transmitted through shear to the framework of the bundling assembly. Upon uncoupling the frame, little change resulted on the element strain distributions for each bundling pressure.

The next series of tests was conducted to study the effect of varying the load at two bundling pressures. Bundling pressures of twelve and twenty-one psi were selected as the average reactor bundling pressure is approximately seventeen psi. Four different loading conditions were used including the maximum reactor loading of 88 lb on each of the three elements. The results indicated that as the loading is increased, tension on the keys will increase if the bundling pressure remains at twelve psi. If the bundling pressure is increased to twenty-one psi, there is no tension in the keys under the same loading conditions. In general, the greater the bundling pressure the lower the tension load on the key.

The next series of tests to be conducted on the seven cluster test rig will consist of (1) applying uniform axial loads to each of the seven clusters and (2) superimposing an additional axial load on one or several clusters with the reaction plate decoupled. The effect of bundling pressure on the distribution of loads in tie rods as well as along the length of instrumented elements of the central cluster will be established.

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EML-76 Reactor Hardware Static and Dynamic Tests

1. Shield Screen Tests

Tests of a shield screen design proposed for the NRX-A6 were performed to determine the "blow-out" pressure drop across the screen. This information was required to determine the margin of safety of a plugged screen under the design pressure drop, 20 psi.

In previous reactors a large screen located below the shield covered the top of the core. In NRX-A6 this screen will be eliminated due to the large cost of manufacturing a complicated part. Small flat screens will be installed in the flow holes in the shield in place of the large screen used previously. In response to G. Kalvin's question of filter efficiency, it was pointed out that the net flow area does not change in the new design.

The screen tested had an aluminum ring brazed to its perimeter to prevent extrusion of the screen through the supporting shoulder. A differential pressure of 500 psig was required to rupture the screen. The screen assembly remained supported in place throughout the test. Photographs of the test fixture and screen assembly before and after testing are shown in Figure 4.

EML-86 Lateral Support System Tests

1. Seal Leakage Tests

Leakage tests were conducted to determine the effectiveness of two seal designs for the proposed NRX-A6 plunger capsule. These tests were performed with the capsule-seal assembly mounted in a beryllium test block at ambient and -320°F . See Figure 5.

The results indicated that the design using copper seals with a chamfer on two sides to be the most effective. It contained 200 psi helium gas at ambient and -320°F with a seating torque of 140 in.-lb.

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FIGURE 4
FLOW SCREEN & TEST RIG
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FIGURE 5
CAPSULE SEAL ASSEMBLY
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EML-86 continued

2. Temperature Profile Tests

Heat transfer tests were performed to obtain test data which could be used in the analysis of the temperature profile of the NRX-A6 outer reflector inner surface between cooling holes. The three specimen assemblies shown in Figure 6 were tested. Each simulated the spacer ring-pyrofoil insulation outer reflector interfaces. In one of the assemblies, a uniform pyrofoil insulation thickness of .050 was used. In the second, the same pyrofoil insulation was used but two pyrofoil washers; .010 inches thick and .75 inches in diameter were installed in a 0.030 deep cavity in the simulated seal spacer ring. In the third test, the pyrofoil insulation was deformed into a 0.75 diameter by 0.030 deep cavity in the simulated seal spacer ring; and three 0.010 pyrofoil discs were installed in the resulting depression in the surface of the insulation in contact with the simulated reflector inner surface. The interface pressures were eight psi for the first and third assemblies and ten psi for the second. The test results indicated that the pyrofoil washers and spacer ring cavity in the second assembly reduced the temperature rise between the coolant holes in the simulated reflector inner surface by about 60 percent. The results obtained with the third assembly indicated the pyrofoil washers and spacer ring cavity in the second assembly reduced the temperature rise between the coolant holes in the simulated reflector inner surface by about 60 percent. The results obtained with the third assembly indicated that an essentially isothermal condition can be obtained between cooling holes by deforming the pyrofoil insulation in the spacer ring cavity.

A photograph of the test rig is shown in Figure 7. Heat from the furnace was radiated to a copper bar which conducted the heat to the test specimen. The weight of the copper bar provided a pressure of eight psi at the bar-spacer ring interface. Heat was removed from the test assemblies by flowing water through the coolant holes in the steel bar which simulated the reflector

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FIGURE 6
TEST SPECIMEN CONFIGURATIONS
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FIGURE 7
TEMPERATURE PROFILE TEST RIG
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inner surface. All test components outside the furnace were insulated by one inch thick Transite.

Each test assembly was instrumented with four chromel-alumel thermocouples. A thermocouple installed at the top of the copper heating bar was used to control the power input to the furnace so that the bar would not be heated beyond about 1850°F. Sketches of three configurations with the results of the tests are summarized in Figure 6.

EML-94 Buffer Periphery Tests

1. Static Test of the Buffer Periphery Type Filler Strips

A preliminary static load test was completed on the hot buffer design with 42 keyed partial elements. The NRX-A5 design includes 162 keyed elements. As mentioned in the A5 section, tests of the 162 keyed configuration will be conducted next month when the hardware is available. The information gained from this test which includes the 42 keys is being used in developing the NRX-A6 design philosophy. It provides specific information on the capability of such a configuration.

Loads were applied in increments equivalent to a 22.5 psi pressure drop across the filler strips. After the initial failure occurred at approximately 67.5 psi condition, the forces were redistributed causing successive failures in the adjoining keyed filler strips.

The failure mode indicated that one filler strip per sector failed at a unit tensile stress of 600 to 900 psi just prior to the adjoining two filler strip fracturing. The redistribution of forces caused the shear at a load ranging from 90 to 120 lb on nineteen of the filler strips.

After a keyway is machined in each filler strip, the partial length core will be reassembled for testing. This investigation will demonstrate the adequacy of the design to transmit the axial forces directly into the core with

EML-94 continued

keys at each filler strip position.

HHT-2 Single Element Process Development and Evaluation Tests

Life tests will be made on NRX-A6 elements. No production elements have been received to date.

FFL-8 Control Drum Flow Tests

The fixture drawings for the drum impedance ring to bearing flow test have been signed off. The hardware for fabrication has not been received as yet.

FFL-29 NRX-A6 Single Seal Tests

Design of the seal segments containing extra scarf joints is complete.
Design of hardware to cover follow up information is now in progress.

FFL-31 Baffle Effectiveness

Design and drafting for the test fixture has been completed. Instrumentation drawings cannot be completed until the final design of the test piece is decided.

General Development Tests

EML-55 Resonant Vibration Survey of XECF

Test planning is being carried out to insure that the principle resonances, magnification factors and associated nodal deflections are defined on the XECF. This test will be conducted at the engine test stand to substantiate that during XE full power testing the engine assembly will not be subjected to excessive vibration effects.

EML-61 Tie Rod Evaluation Tests

Graphite tie rods with new designed end construction are being fabricated. Two of the original 1/2 inch graphite tie rods are being machined over a three inch gage length down to 1/4 inch diameter. These will be statically tested at ambient temperature in an effort to measure the full potential strength of the composite. Previously, a rod reduced to 0.350 diameter failed in the end transition zone. Other tie rods with new end construction are being fabricated.

EML-69 Support Block Mechanical and Thermal Tests

A qualification program was undertaken to develop suitable, simplified support block configurations to conduct meaningful tests in the counterbore area without requiring reactor quality blocks for each test. Equivalent cylindrical blocks with a reduced number of flow channels in the outer periphery proved somewhat more resistant to crack initiation than the regular support block under the same conditions. There was a 200 lb spread in values, however, but this is not considered wide enough to mask the effects of any significant improvements which might occur during development testing. During the next period it is planned to conduct a number of tests with washer, foil and block variations in an effort to optimize the relationship.

HHT-2 Single Element Process Development and Evaluation Tests

Four 30 minute corrosion tests were performed with fuel elements from WEFF. These elements were tested at standard MB conditions. Weight losses were approximately 14 grams for the 30 minute test.

Two high temperature tests were also performed. Chuck failure terminated one test, but the second test continued for ten minutes at a surface temperature of 5000°R. The test equipment performed very well under these high temperature conditions.

HHT-6 Interstitial Corrosion Tests

Fabrication and coating of additional test specimens for the two inch isothermal model has been completed. The specimens have been returned to the Machine Shop for milling of the flow slot.

HHT-7 Filler Strip Corrosion Test

Two additional builds with configurations similar to Build 4 Test 1 but with NbC coated filler strips will be assembled. The first build will use a standard flow system while the second build will use a methane injection system. This arrangement will provide information on the relative effectiveness of methane injection.

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Facilities

Installation of the pump vaporizer has been completed and qualification tests are in progress. There have been some problems in the tests because of leaks. Completion of the qualification tests is expected in March.

Installation of the thermocouple furnace has been completed and work on checking it out has started. A full power test is expected to be run soon.

The purchase of the new dewar has not been finalized because of price.

Procurement of equipment for the thermal gradient test facility is underway.

Purchase orders have been placed for the main fixture assembly and the circulating pump.

Quotes were also reviewed for vacuum equipment and furnace facilities.

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