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Astronuclear
Laboratory

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\\ PRELIMINARY TEST SPECIFICATION FOR
NEUTRON DETECTOR TEST
TO BE IRRADIATED AT THE PLUM BROOK REACTOR
(21/WO03)

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PRELIMINARY TEST SPECIFICATION FOR
NEUTRON DETECTOR TEST
TO BE IRRADIATED AT THE PLUM BROOK REACTOR
(21/W003)

I. EXPERIMENT IDENTIFICATION

A. Test Plan Reference No.	21/W003
B. Sponsor	WANL
C. Test Agency	PBRF
D. Test Date	September, 1965

II. PURPOSE OF THE EXPERIMENT

To evaluate performance of Westinghouse Type WX5406 Fission Counter and RMS Log Power Amplifier system over a range of neutron flux similar to what will be experienced in NERVA Engine or NRX reactor applications. In addition, one type WX5362 ion chamber will be operated at high neutron flux to gain better knowledge of operating capability at high power.

III. DRAWINGS

A. Test Item	To be supplied with Final Test Specification
B. Electrical Single Line	Figure 1
C. Pneumatic Single Line	Not Applicable
D. Hydraulic Single Line	Not Applicable
E. Dosimeters	Figure 2, WANL Drawing No. 387D519
F. Milletron Drawing A1193	Figure 3

IV. EQUIPMENT LIST

A. To be provided by WANL Instrumentation Laboratory

1. Test fixture including the following materials:
 - a. One (1) Fission Counter, Westinghouse Type WX5406
 - b. One (1) Ion Chamber, Westinghouse Type WX5362
 - c. Four (4) Copper-Constantan Thermocouples
 - d. Four (4) Neutron Dosimeters
 - e. All required signal and control leads
2. Instrumentation including the following equipment:
 - a. One (1) Milletron A.C. Ion Chamber Instrument Type NAC-1M
 - b. Two (2) Picoammeters, Keithley Type 600A or equivalent
 - c. One (1) square wave generator Tektronix 105 or equivalent
 - d. One (1) Power Supply, Fluke Model 407 or equivalent
 - e. One (1) Power Supply, Keithley Model 241 or equivalent
 - f. One (1) Multimeter, Simpson Type 269
 - g. One (1) Oscilloscope, Tektronix 541A or equivalent
 - h. One (1) Attenuator, Kay Electric Model 30 or equivalent

V. TEST ENVIRONMENT

A. Temperature	125°F (Ambient Water Temperature)
B. Pressure	135 psi, External (Nominal Inlet Water Pressure)
C. Humidity	Fixture Submerged in Coolant Water
D. Vibration	None

E. Fast Neutron Flux (Max)	1×10^{12} n/cm ² sec (E > 1 Mev)
F. Thermal Neutron Flux (Max)	1×10^{13} n/cm ² sec (E < 0.48 ev)
G. Gamma Flux (Max)	4.9×10^9 erg/g(C)hr
H. Integrated Fluxes	
Neutron Fast	5.0×10^{17} n/cm ²
Neutron Thermal	5.0×10^{18} n/cm ²
Gamma	6.9×10^{11} erg/g(C)
I. Fluid Environment	Water
J. Duration	See X.E.

VI. ANALYTICAL

Analysis of the heating rate and radioisotope inventory will be supplied in the Final Test Specification.

VII. FACILITY REQUIREMENTS

A. Electrical	115 VAC 60 CPS
B. Pneumatic	None
C. Hydraulic	Primary Coolant Water
D. Special Fluids	None
E. Special Shielding	None

VIII. DOSIMETRY

Four (4) neutron dosimeters shown by WANL Drawing 387D519 will be mounted in the test fixture. The dosimeters will include aluminum-cobalt wires, bare and cadmium covered for thermal and epithermal flux measurements, and sulfur for fast flux measurements. Two dosimeters shall be mounted near each test specimen.

IX. DATA HANDLING REQUIREMENTS

Test data shall be read and manually recorded by WANL personnel.

X. TEST PROCEDURE

A. System Description1. Test Specimens

The neutron detectors described below will be tested.

Manufacturer

Westinghouse, Tube Division

Fission Counter Type
Model WX5406

Ion Chamber WX5362

2. System Operation and Measurement Techniquea. Warm Up

All instrumentation shall be warmed up for a minimum of one-half hour prior to calibration or data taking.

b. Data System Operation

- (1) Align the RMS meter per Milletron Drawing A1193.
- (2) Adjust voltage of Power Supply 241 to 1000 volts.
- (3) Adjust positive voltage of Power Supply 407 to 250 volts.
- (4) Adjust negative (compensation) voltage of Power Supply 407 to 217 volts.
- (5) Note readings of picoammeters. The WX5362 current should be less than 1×10^{-11} ampere, when test specimens are not in radiation, and the WX5406 should be approximately 1×10^{-8} ampere.

B. Laboratory Tests

With fission counter and ion chamber mounted in the test fixture and in accordance with paragraphs X.A.2.a and X.A.2.b, complete a data run.

If significant errors in the data are observed, correct the fault before proceeding.

C. WANL Test Loop

Repeat the procedure described in Section X.B at the following times:

1. Prior to introduction of water
2. At the beginning of normal loop operation
3. At two hour intervals
4. After completion of the test loop operation

D. Pre-Irradiation Tests

Repeat the procedures described in Section X.B at the following times:

1. Prior to insertion of test fixture in the capsule
2. After the test fixture is installed in the capsule. Compare measured data to WANL test loop data. Correct for, or explain any significant differences in measured data.

E. Irradiation Tests

1. The nominal maximum internal temperature for the test specimens is 500°F, and it is desired to operate below this value. The exact power level of the reactor required to keep the test specimen below this temperature cannot be specified at this time. The fixture shall, therefore, be inserted by the charging machine prior to reactor start-up to a point corresponding to 10^{13} nv (thermal) at 60 MW. The test shall be completed at the constant reactor power level at which the highest test specimen case temperature stabilizes at the nominal maximum or WX5362 ion chamber current is maximum. The tolerance on this value shall be $\pm 5\%$. Since the power level depends on maximum case temperature and maximum detector current the test duration shall be variable. The test procedures are discussed more fully in the following two paragraphs X.E.2 and X.E.3.

2. Increasing Reactor Power Level

Measure and record data, as described in Section X.B, at each reactor power increase. Power increases shall be 50% of a decade step over lower decades, and 25% of a decade step in the top three decades. Plot the test specimen case temperature at each step to provide a basis for power increase. When the highest test specimen case temperature reaches 500 $\pm 30^\circ\text{F}$, do not increase power further. Complete the

test at this reactor power level unless directed otherwise by the cognizant test engineer. To allow the temperature of the test specimen to stabilize, the corresponding data run shall begin a minimum of ten minutes after each step increase in reactor power. Do not increase reactor power beyond the point where the current from the WX5362 ion chamber is one milliamper.

3. Constant Reactor Power

Repeat all measurements described in Section X.B and record data one time each two hours during the constant power part of the test. Constant power is considered that reactor power at which the highest specimen case temperature is stabilized at $500 \pm 30^\circ\text{F}$ or the WX5362 ion chamber current is at its maximum of one milliamper. The length of test shall depend on the flux level corresponding to the constant reactor power. The integrated thermal flux shall be 5×10^{18} NVT. A table relating test time to constant fixture position will be included in the final test specification. After the constant reactor power level is determined, the saturation characteristics of both test specimens shall be determined by varying the power supply voltage and plotting this voltage vs. the corresponding picoammeter reading.

4. Post-Irradiation Procedure

a. Measurements

Repeat all measurements described in Section X.B after the test fixture has been moved from HT-1 to the quadrant water.

b. WX5406 Fission Counter and WX5362 Ion Chamber

It is desirable to salvage the WX5406 fission counter and WX5362 ion chamber for future use provided that additional hazards are not involved in their removal and/or that their activation is sufficiently low.

c. Defective Test Specimen (WX5406 Counter or WX5362 Ion Chamber)

Examination of test specimens which fail during test will be made at discretion of the cognizant test engineer.

XI. HAZARDS

A complete evaluation of hazards will be made in the Design Manual and Hazards Report which will be issued prior to the irradiation.

XII. DATA REDUCTION REQUIRED

None

XIII. DISPOSITION OF HARDWARE

A. Test Item

Hold test fixture and fission counter in dry storage at PBRF until they can be safely handled without special precaution. Return them to WANL.

B. WANL Supplied Test Equipment

Return test equipment supplied by WANL, Large, upon conclusion of test.

XIV. SHIPPING INSTRUCTIONS

Ship the test item and test equipment to E. Llewellyn, Plum Brook. Return the test equipment to WANL, Large.

Test Specimen 1
WX5406

Figure 1. Electrical Single Line Neutron Detector Test Set

REVISIONS			
REV	ZONE	DESCRIPTION	DATE
B		REDESIGNED & REDRAWN D SPEC 751323 AR RLN 8 3-64	2/1/65
C		CHANGED SPACER IT#4 FROM AL FOL 00 F TO AL WIRE 100 H B D SPEC 751323 CG KDS 2 25 65	2/25/65
D		DELETED QUARTZ COVERED FROM DESCRIPTION OF ITEM 7 N LIST OF MATERIALS D 4 CHANGED PICTURE OF ITEM 7 D SPEC 75 323 CH P FOLMAR 3 4 65	3/5/65

- PURCHASE FROM WILLIAMS & CO PITTSBURGH, PA OR APPROVED EQUAL.
- NUCLEAR SCIENCE & ENGR CORP PITTSBURGH 36 PA OR APPROVED EQUAL COMPLETE 5 KIT

1	7	WIRE (CADMIUM COVERED)	387D519H07 DAL COBALT				
1	6	PELLET (QUARTZ COVERED)	387D519H06 SULFUR				
1	5	WIRE (QUARTZ COVERED)	387D519H05 BIAL COBALT				
4	4	WIRE SPACER (600 X 1/4)	387D519H04 AL			100 H B	
AR	3	WIRE 0.035 DIA	387D519H03 SST			316	
2	2	END SCREW	387D519H02B AL			GOGI-TG	
1	1	TUBE	387D519H01B AL			GOGI-TG	
LIST OF MATERIALS							
WESTINGHOUSE ELECTRIC CORPORATION				Nuclear Laboratory			
CAPSULE DOSIMETER ARR				FOR PBRF & NSEC (WANL)			
P204517		PART IDENT		CODE IDENT NO		DWS NO	
P204506		MFG NFO		14683		D	
SPEC		TYPE		J COOMBE		10 7-63	
751323-P		PPL NO		SCALE 2 1		BY ACT BY CAC	

Figure 2

1. Connect a noise signal (or 100 cycle AC signal) to the input connector.
2. Adjust input amplitude to make voltage at TP3 = 5 volts. It may be necessary to adjust the gain and meter gain potentiometers to accomplish this.
3. Adjust the meter set potentiometer to make the meter read full scale. Lock the meter set potentiometer. Adjust the recorder set to make recorder read full scale, if desired, at this time. Lock recorder set potentiometer.
4. Adjust input level and/or gain control to make TP2 = 5.25 volts. Adjust meter gain to make meter read full scale, or TP3 = 5 volts.
5. Set input level to make TP2 = 6 millivolts. Adjust zero potentiometer to make meter read zero.
6. Repeat Steps 4 and 5 several times to assure that zero and full scale readings are exact.
7. Connect ionization chamber via LPA preamplifier (supplied) if necessary. Adjust the gain control to make TP2 = 5 volts when reactor is at full power.
8. Lock all potentiometers upon conclusion of alignment.

Figure 3. AC Ion Chamber Channel - NAC-1M
(Milletron Drawing A-1193)