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WANL-TME-686

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TEST SPECIFICATION FOR CONTROL DRUM ACTUATOR COMPONENT

(14/WO03)

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TEST SPECIFICATIONS

I. Experiment Identifications

A. Test Plan Reference Number	14/W003
B. Sponsors	WANL
C. Testing Agency	GTR
D. Test Date	February 29, 1964

II. Purpose of the Experiment

The primary goal is to operate the actuator components at near ambient conditions in a nuclear environment. As a secondary goal, the level of operating performance will be examined along with the combined effects of gamma heating and power dissipation. Efforts will be made to determine if localized heating occurs within the components.

The following components will be evaluated:

- A. Torque Motor. Permanent magnet type with rotating armature. The same type previously tested at 140°R.
- B. Potentiometer. Film type previously tested at 140°R.
- C. Piston Seals. DuPont SP type previously tested at 140°R.

III. Drawings

A. Test Items

1. Potentiometer Test

- a. Details 386D681
- b. Details 386D682
- c. Assembly 386D683

2. Torque Motor Test

- a. Details 576F038
- b. Assembly 386D686

3. Piston Seal Test

- a. Details 574F125
- b. Details 574F133
- c. Details 386D687
- d. Assembly 710J113

B. Electrical Single Line - 386D690

C. Hydraulic Single Line - Not Applicable

D. Pneumatic Single Line - 386D689

IV. Equipment List

A. To be provided by NERVA:

- 1. Components (Section II)* mounting brackets, mounting plates and mounting rack with test panels complete for mounting on pallet.
- 2. Potentiometer drive motor, flexible shaft, and mounting.
- 3. Pressure regulator and control for piston seal test.
- 4. Amplifiers and switching to match readout.
- 5. Visicorder 906C and galvanometers.
- 6. Pressure transducers.
- 7. Thermocouples and thermocouple balance, reference, and control units for galvanometer readout.

B. To be provided by tester:

- 1. Cables, pallet to control room.
- 2. Nitrogen supply at 300 psig.
- 3. Shielding for drive motor and regulators
- 4. Hewlett-Packard Function Generator (Model 202).

*Torquemotor, Potentiometer and Piston Seals

V. Test Environment

A. Temperature	~ 540°R, to 800°R Max.
B. Pressure: Internal to components	250 psig Max.
C. Humidity	Not Applicable
D. Vibration	Not Applicable
E. Fast Neutron Flux, >.1 MEV	$3.1 \times 10^{11} \text{ n/cm}^2 \text{ sec}$
F. Thermal Neutron Flux	$6 \times 10^9 \text{ n/cm}^2 \text{ sec}$
G. Gamma Flux	$2.2 \times 10^5 \text{ erg/gm(C)/sec}$
H. Integrated Flux	
1. Fast Neutron, >.1 MEV	$5.58 \times 10^{16} \text{ n/cm}^2$
2. Thermal Neutron	$1.1 \times 10^{15} \text{ n/cm}^2$
3. Gamma	$4 \times 10^{10} \text{ erg/gm(C)}$
I. Fluid Environment	Not Applicable
J. Duration	100 hours

VI. Analytical

A. Predicted Perturbed Flux	83% of Unperturbed Flux
B. Radiation Heating	Sufficient gas flow for cooling is provided to maintain temperatures within the range noted in Section V-A above
C. Activation Levels	

Levels have been calculated from the materials list below and are presented in Table I.

Aluminum	27 lbs
Stainless Steel	5
Brass	1
Hypernik	$\frac{1}{4}$
Alnico No. 5	$\frac{1}{4}$
Inconel X	$\frac{1}{4}$

TABLE I
Calculated Activation Levels

<u>Nuclide</u>	<u>γ Energies (MEV)</u>	<u>Curies After Irradiation(0 Decay)</u>
Na-24	1.37, 2.75	0.54
Mg-27	0.83, 1.01	3.19
Al-28	1.78	27.04
Cr-51	0.32	0.03
V-52	1.44	0.58
Mn-54	0.84	2×10^{-3}
Mn-56	0.84, 1.81, 2.11	2.10
Co-57	1.22, 0.014	0.04
Co-58	0.81, 1.62	0.06
Fe-59	1.10, 1.29	1×10^{-3}
Co-60 ^m	0.059, 1.33	2.10
Co-60	1.17, 1.33	7×10^{-3}
Cu-64	1.34	1.38
Zn-65	1.11	2×10^{-3}
Cu-66	1.04	0.44
Zn-69 ^m	0.44	0.03
Zn-71	0.51	6×10^{-4}
Mo-99	.74, 0.041, 0.78	0.02
Mo-101	0.59, 1.02, 2.08	0.01

VII. Facility Requirements

It will be necessary to examine and photograph all components as soon as possible after the test is completed.

VIII. Dosimetry

Fast neutron and gamma dosimeters at front and rear of experiment are necessary.

IX. Data Handling Requirements

Provide copies of visicorder traces.

X. Test Procedure

Attached.

XI. Hazards

None.

XII. Data Reduction Required

None.

XIII. Disposition of Hardware

A. Hold test items and fixtures for disposition instructions at completion of post-irradiation testing.

B. Return amplifiers and control equipment to WANL at completion of test.

XIV. Shipping and Receiving Instructions

A. All WANL items will be shipped to Mr. B. L. Lanford at GD/FW.

B. Items to be returned to WANL should be marked for Actuator Laboratory, Control Development, Building #5, Attention: Mr. Paul R. Greenaway.

XV. Appendix

None.

TEST PROCEDURE

I. GENERAL

- A. Primary Goal: The primary goal is to operate the actuator components at near ambient temperatures in a nuclear environment. The potentiometer will be rotated at a constant velocity, while operating as a voltage divider. The voltage output and the derivative of the voltage output will be observed for any change in characteristics. The torque motor will be cycled with no load. The frequency response, phase shift, and static gain will be observed. Two piston seals will be operated on a piston in a special cylinder. The dead band will be observed at 25%, 50% and 75% of travel as a measure of friction.
- B. Secondary Goal: As a secondary goal, the components will be screened for hot spots. Cooling gas is provided to attempt to moderate the temperatures.
- C. Operation:
- a. Measurands
 - (1) Primary Goal
 - (a) Voltage
 - (b) Voltage Derivative
 - (c) Event Marker (Rotation)
 - (2) Secondary Goal
 - (a) Coolant Pressure
 - (b) Coolant Inlet Temperature
 - (c) Coolant Exhaust Temperature
 - (d) Potentiometer Body Temperature
 - (e) Temperature of Outside of Chamber

b. Description of Operation: The potentiometer is rotated by an electric motor through a speed reducer and a flexible cable. A flywheel and brake are mounted on the shaft to damp out speed variations in the gears and flexible shaft. The potentiometer is operated as a voltage divider. The voltage output is taken from the wiper to the common side. However, a trace of voltage is not precise enough to observe changes in performance at the level desired. Therefore, the output is also put through a derivative circuit to show the rate of change in the voltage. This output is then amplified to show the very low level of performance that must be observed. A cam operated microswitch was included on the shaft. In case of failure, the microswitch will show whether or not it was due to the drive mechanism or the potentiometer and its circuits.

2. Torque Motor

a. Measurands

(1) Primary Goal

- (a) Torque Motor Current
- (b) Torque Motor Voltage
- (c) Armature Travel

(2) Secondary Goal

- (a) Coolant Pressure
- (b) Coolant Inlet Temperature
- (c) Coolant Exhaust Temperature
- (d) Torque Motor Body Temperature

b. Description of Operation: The torque motor will be operated with no load, in order to eliminate variables external to the motor. The static characteristics will be observed by manually stepping the motor and recording the travel through its entire range. The dynamic characteristics will be measured while commanding the motor with a sine function from 0.5 cps to over 400 cps. Travel will be set for ± 0.001 inch about the median point.

3. Piston Seals

a. Measurands

(1) Primary Goal

(a) Cylinder Drive Gas Pressure

(b) Piston Travel

(2) Secondary Goal

(a) Coolant Pressure

(b) Coolant Inlet Temperature

(c) Coolant Exhaust Temperature

(d) Temperature of Outside of Cylinder

(e) Drive Gas Temperature

b. Description of Operation: The piston seals are fitted on an actuator piston. The piston will operate in a cylinder by gas pressure against a coil spring. The dead band will be measured by slowly reversing direction of travel at several positions in midrange and recording pressure and travel.

D. Operating Instructions:

1. Turn on the pressure transducer power switch.

2. Turn on the nitrogen supply at the regulator to 200 psig.

3. Turn on the visicorder, but do not plug the cable into the rack.
4. Turn on the galvanometer amplifier.
5. Turn on thermocouple reference junction on the back of rack.
6. Turn on switch for potentiometer transducer.
7. Turn the function switch on the potentiometer test panel to pot test position.
8. Set potentiometer drive motor speed control to 15 on the dial, low range, and forward direction. Run the motor for at least 30 seconds before recording data.
9. Turn on the AC switch of the Philbrick 300 VDC Power Supply. Wait 20 seconds, then turn on the DC switch.
10. Set the visicorder paper speed at 2 inch/second.
11. Set the visicorder timing lines at 1 second interval.
12. Plug the visicorder cable into the potentiometer receptacle on the rack.
13. Turn the voltage adjust knob of the pot power supply counter-clockwise to its minimum setting.
14. Turn the pot power supply meter range switch to 10 volts.
15. Turn the pot power supply short circuit current switch to 25 ma.
16. Turn on the pot power supply.
17. Slowly raise the voltage to 10.0 volts.

NOTE: The sudden or rapid application of voltage will overdrive the galvanometer.

18. Turn on the event marker.
19. Record three cycles at 2 inches/second paper speed and three cycles at 10 inches/second paper speed.

NOTE: At the desired motor speed, the voltage and the noise trace will be 4 seconds long each, for 180° of rotation. At this speed,

the deflection of the noise trace will average 2.7 inches.

If the noise deflection should vary significantly from 2.7 inches, the drive motor control may be adjusted slightly to compensate. This will probably have to be done if the pot noise level increases during the test, just to keep the trace on the paper.

20. After the data has been recorded, shut off the event marker, the drive motor, and the potentiometer pressure transducer.
21. Turn on the torque motor pressure transducer.
22. Turn the function switch on the potentiometer test panel to torque motor test position.
23. Turn on the power switch on the lower left-hand side of the torque motor control panel.
24. Turn on the bias voltage on the torque motor control panel.
25. Plug the visicorder cable into the torque motor receptacle on the rack.
26. Operate the command voltage manually and check the visicorder trace for travel.
27. Slowly command the torque motor from one stop to the other stop and back again.
28. Command the torque motor up and back again in 0.5 ma steps, pausing several seconds at each step.
29. Hook up a Hewlett-Packard Function Generator to the signal input jacks of the torque motor control panel.
30. Set the frequency to 0.5 cps and the function to sine wave.
31. Turn the amplitude to zero.

32. Manually command the motor to exactly midpoint of travel.
33. Turn on the signal input switch.
34. Adjust the output control to ± 0.001 inch of travel about the midpoint.
35. Record several cycles at each of the following frequencies: 0.5 cps, 1.0, 5.0, 10.0, 20, 40, 65, 100, 150, 200, 250, 300, 350, 400 and 450. Note the amplitude of the torque motor current trace and try to maintain a constant amplitude as far as is possible. Watch for resonance around 350 cps.
36. Shut off bias voltage, power switch, torque motor pressure transducer, the Philbrick 300 VDC Power Supply, and the function generator.
37. Turn on the cylinder pressure and cylinder coolant pressure transducer,
38. Turn on the LVDT transducer supply.
39. Plug the visicorder cable into the piston seal receptacle on the rack.
40. Turn in the cylinder pressure regulator and check for travel on the visicorder,
41. Slowly move the piston out to 1-1/2 inches travel.
42. Slowly lower the pressure to reverse the direction, and return to zero pressure.
43. Slowly raise the pressure to close to 3/8 inch of piston travel.
44. Turn the cylinder travel control on the galvanometer amplifier to maximum.
45. Slowly raise the pressure to 3/8 inch of piston travel.
46. Slowly reverse direction and return to zero.
47. Turn the cylinder travel control on the galvanometer amplifier back to the original setting.

48. Check the original setting by noting the zero point and the full travel point.
49. Repeat steps 38 through 45, except stop at $3/4$ inch instead of $3/8$ inch.
50. Repeat steps 38 through 45, except stop at $1-1/8$ inch instead of $3/8$ inch.
51. Shut off the cylinder pressure transducer, cylinder coolant pressure transducer, and the LVDT transducer supply.