

PHILADELPHIA GEAR CORPORATION  
KING OF PRUSSIA, PENN. 19406

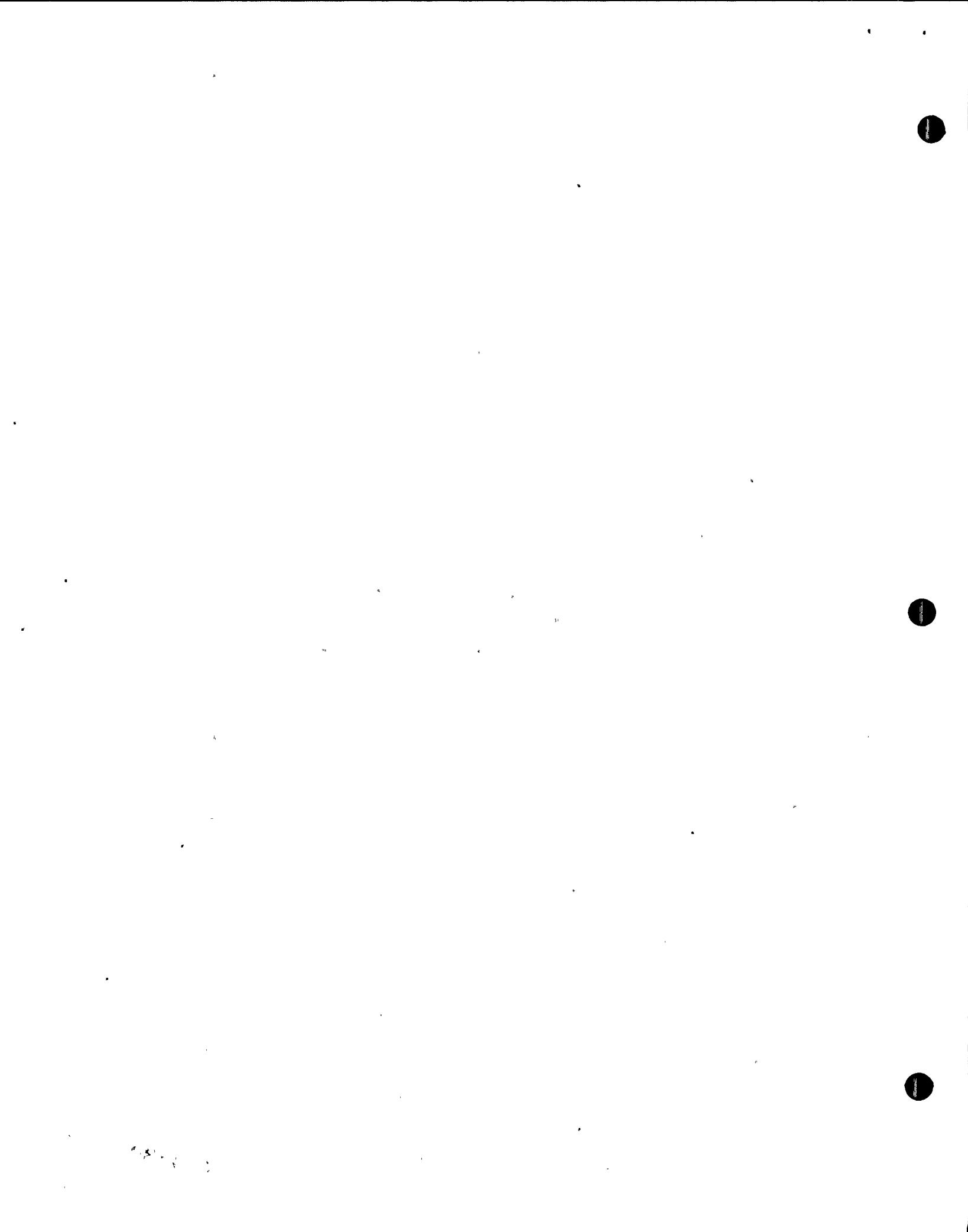
LIMITORQUE VALVE CONTROL

TEST OF LIMITORQUE VALVE OPERATOR  
TO MEET GENERAL REQUIREMENTS  
OF  
AN ELECTRIC VALVE ACTUATOR  
IN  
NUCLEAR REACTOR CONTAINMENT ENVIRONMENT

TEST REPORT

JANUARY 2, 1969

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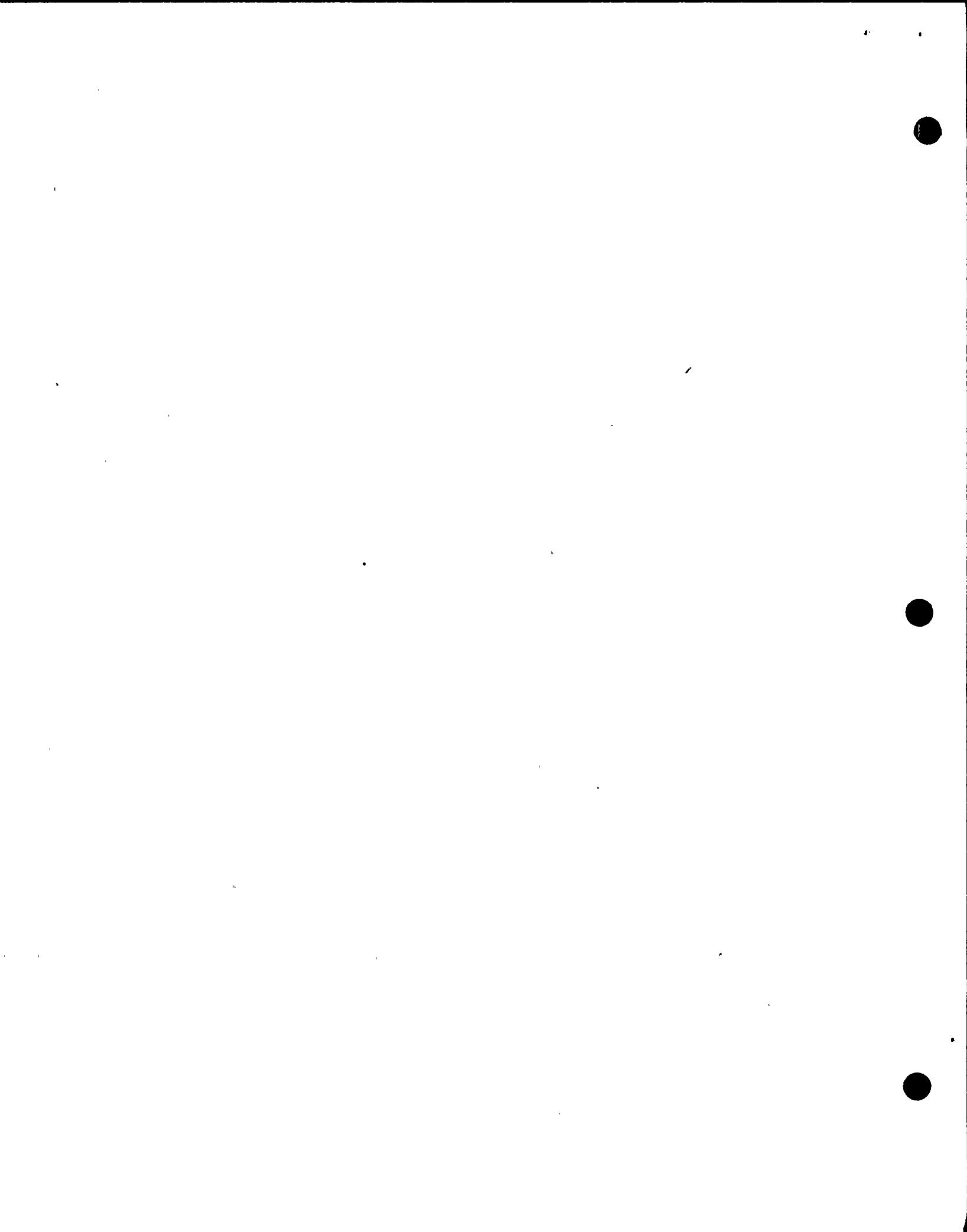
TEST REPORT - JANUARY 2, 1969

ENGINEERING ORDER NO. 600198

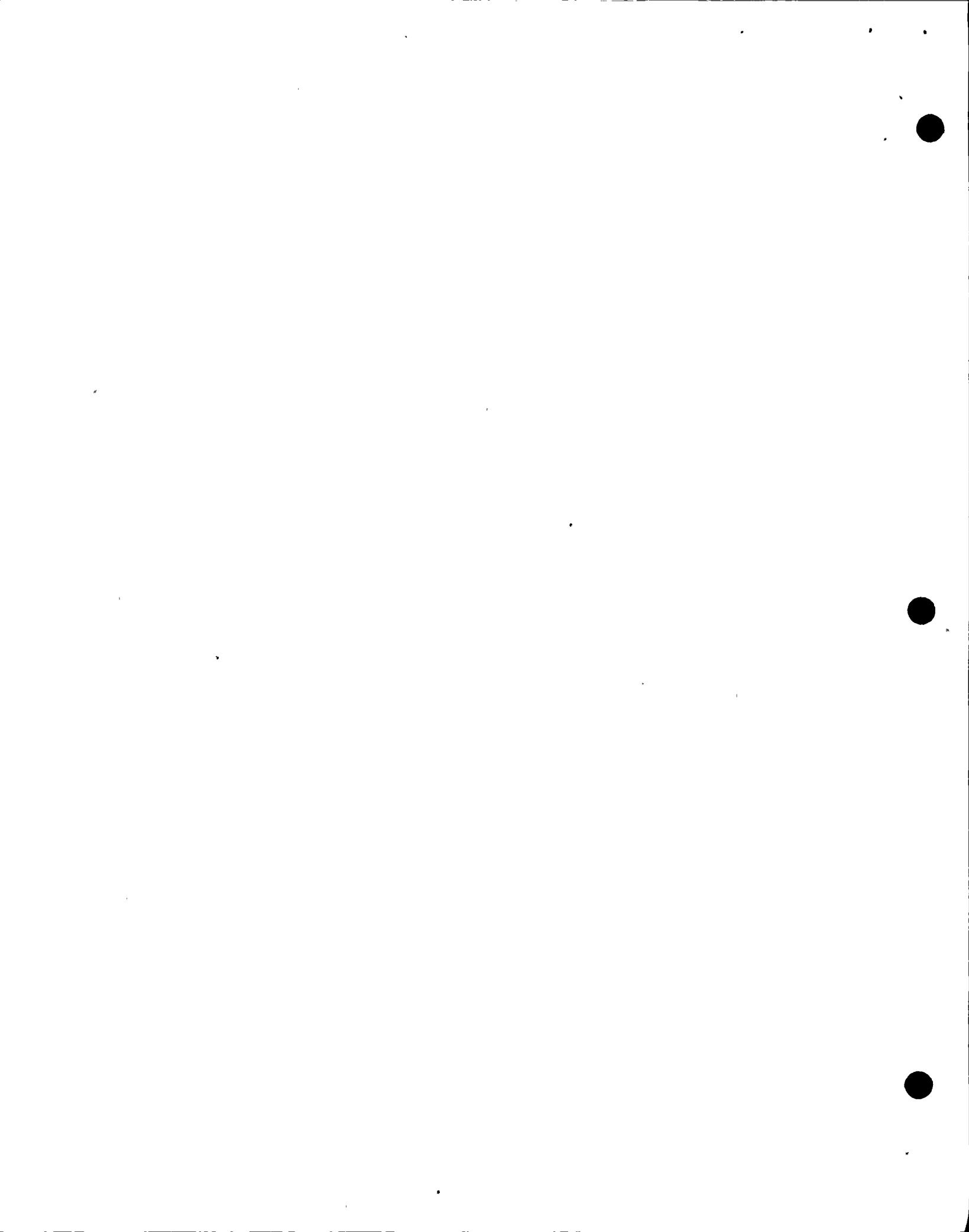
The Limitorque valve operator tested was Model SMB-0 with a 15 foot pound, 3 phase, 60 cycle, 440 volt motor, with special high temperature motor insulation and high temperature resistant non-metallic components, to withstand the contemplated steam pressure, high temperature and chemical conditions expected in the event of a nuclear reactor failure within the containment vessel. The Limitorque operator was wired for a torque seating control for closing direction and position limiting control for open direction. A 2 3/8" diameter by 1/4" pitch, 1/4" lead, left hand stem was used to simulate the stem of a valve being opened and closed. The speed of operation was approximately 6" per minute over a 12" travel. The designed seating thrust to be exerted on the stem by the Limitorque valve control was 16,500 pounds of thrust in the closed position of the valve stem. A slide wire electric position transmitter was also installed and connected to a remote position receiver outside the test chamber.

TESTS TO BE PERFORMED ON OPERATOR

1. Preliminary heat tests on component parts.
2. Preliminary heat tests on actuator.
3. Preliminary live steam test on actuator.
4. Heat aging test of electric motor and electric motor with brake.



5. Shock and vibration test of actuator to simulate seismic conditions.
6. 150 life cycle test of actuator producing approximately 16,500 pounds of thrust.
7. Test of Limitorque valve operator and electric brake motor under a simulated reactor containment post-accident steam and chemical environment.



1. PRELIMINARY HEAT TESTS ON COMPONENT PARTS

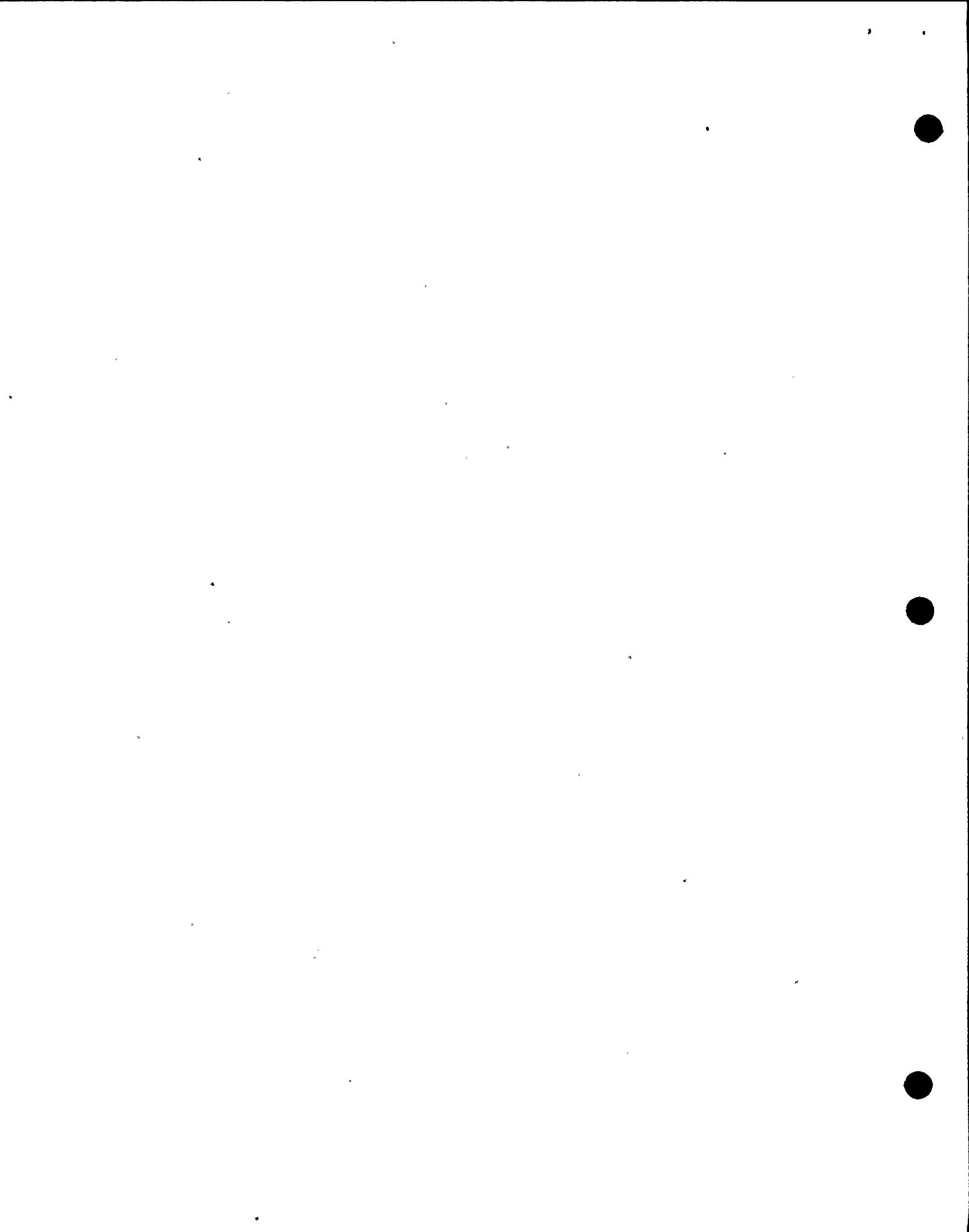
The standard Limitorque operator geared limit switch and torque switch was subjected to a dry heat test for approximately 16 hours at a temperature of 375°F. Periodically during this test, the switches were removed from the oven and actuated by hand. The operation was satisfactory and no malfunctions occurred. All parts functioned freely and there was no binding, jamming, nor abnormal distortion of parts. The test was successful in all respects.

2. PRELIMINARY HEAT TESTS ON ACTUATOR

A completely assembled and operational Limitorque operator was placed in an oven where the temperature was maintained at approximately 325°F. for a duration of 12 hours. The unit was electrically operated every thirty minutes for a period of approximately two minutes per cycle and using the geared limit switches to stop the actuator at the full open and full closed position of travel. Indicating light circuits were also wired to the geared limit switches.

The test was successful in every respect. There were no malfunctions of the operator and upon inspection of the component parts used, there was no noticeable deterioration or wear.

The lubricant used in the geared limit switch did become hard and caked, however the lubricant used in the Limitorque



gear housing remained pliable and had its original consistency.

It was determined that the grease in the geared limit switch gear housing should be changed to the same grease as in the Limitorque operator gear housing.

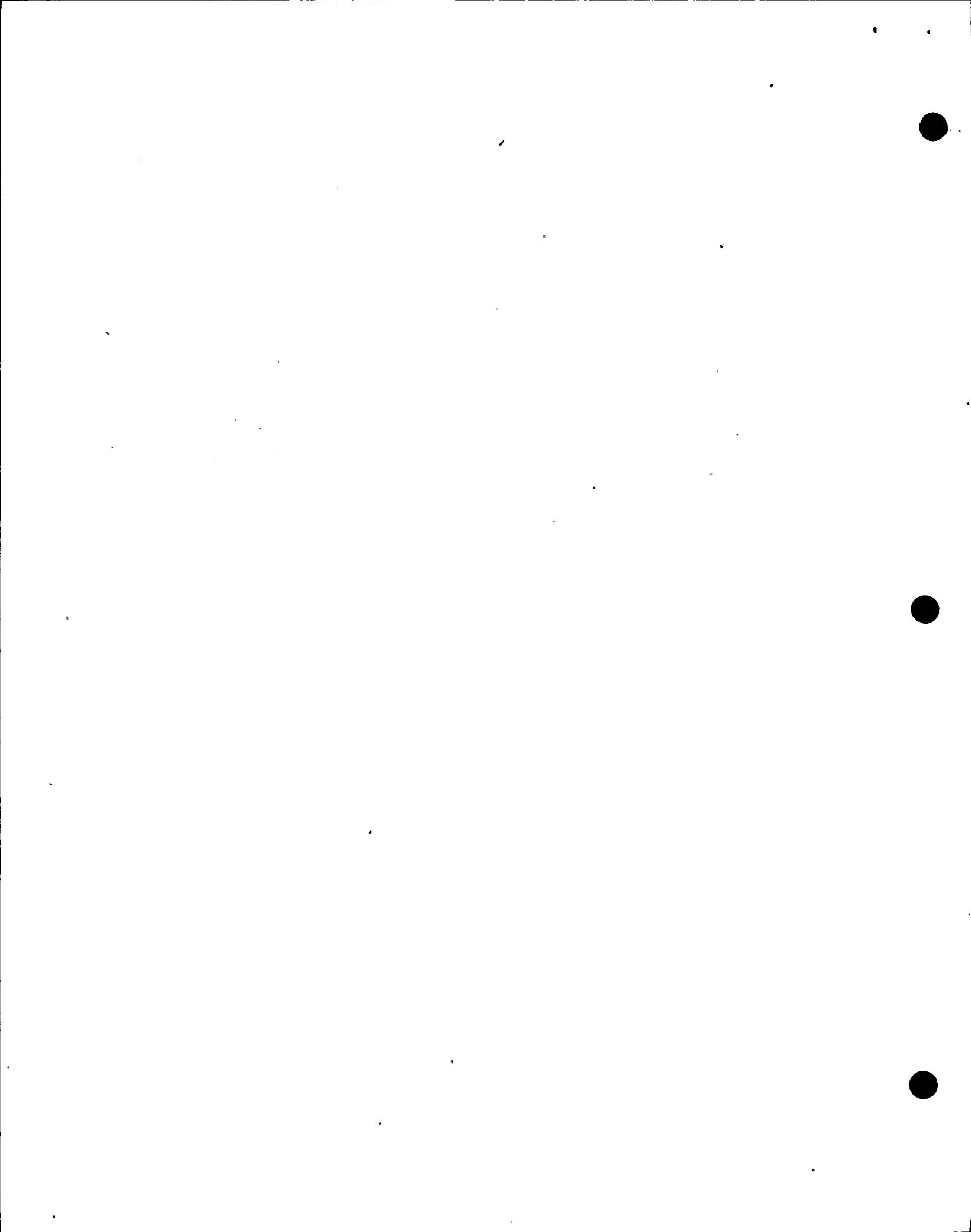
3. PRELIMINARY LIVE STEAM TEST ON ACTUATOR

A complete Limitorque actuator was set up for electrical operation and live steam was piped into the conduit taps on the top of the limit switch compartment. One of the bottom conduit taps was left open to drain off any condensate. The operator was set up on a timer basis for operation over a period of approximately nine hours and operating every thirty minutes for two minutes per cycle. During this test, the live steam in the switch compartment seemed to have no effect whatever on the function of the limit switches in their control of the operator at the full open and full closed position of travel. In addition, the limit switches were wired up to indicating lights which operated satisfactorily.

The test was successful and there was no noticeable effect on the function of any of the parts in the limit switch compartment.

4. HEAT AGING TEST OF ELECTRIC MOTOR AND ELECTRIC MOTOR WITH BRAKE

The electric motor for the Limitorque operator to be used in the environment test and another electric motor equipped with a disk type brake were subjected to a heat aging test.

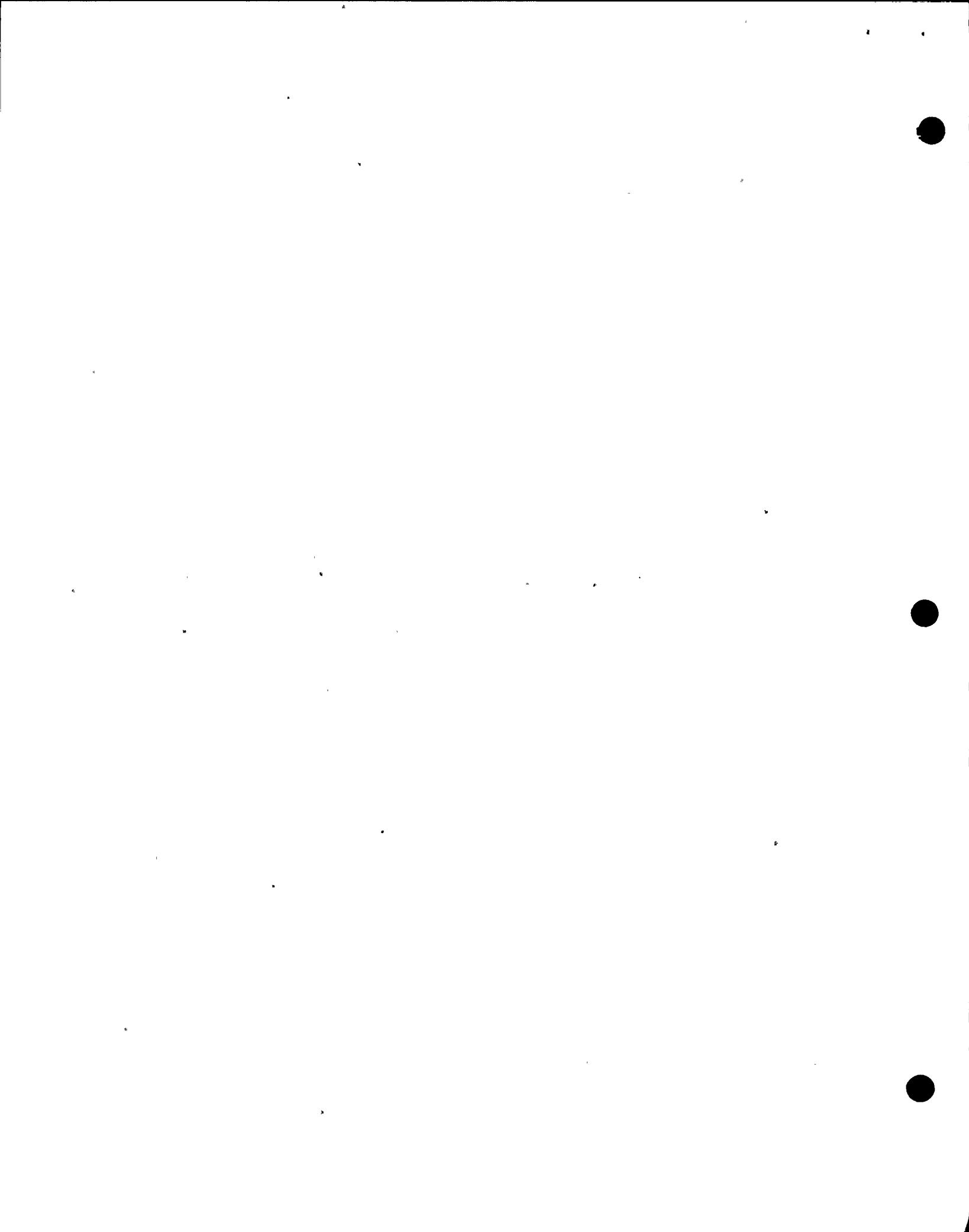


Both electric motors were sent to Reliance Electric Co. for heat age testing. This test consisted of baking the motors at a temperature of 180°C. for a total of 100 hours to simulate aging the motor to a 40 year life expectancy. Motor insulation checks were made and found to be within normal limits. There were no adverse effects on the motors and motor insulation resistance measured infinity to ground.

#### 5. SHOCK AND VIBRATION TEST OF ACTUATOR TO SIMULATE SEISMIC CONDITIONS

The Limitorque operator to be used in the environment test was shipped complete to the Lockheed Electronics Co., in Plainfield, New Jersey, for shock and vibration testing to simulate seismic conditions. A copy of this report is enclosed herewith. The test basically consisted of mounting the Limitorque operator on a shock and vibration table to test it at 20 cycles per second vibration at 1G load for a period of two minutes on - one minute off. This would constitute one cycle. The cycle was repeated five times in both the vertical and horizontal axis of the operator. The actual test report and photographs are included here.

The test was successful and there was no noticeable effect whatsoever on the Limitorque operator.



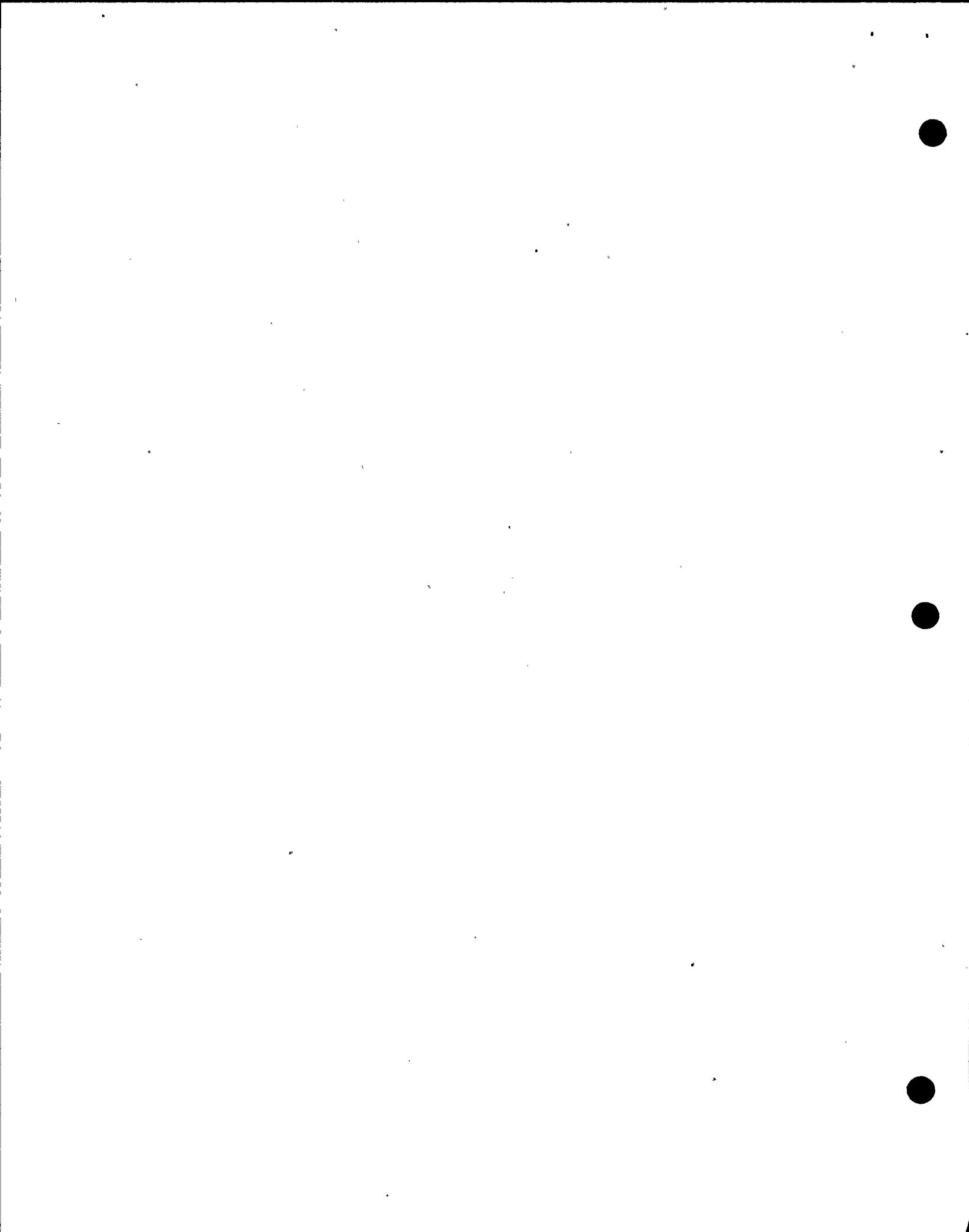
6. 150 LIFE CYCLE TEST OF LIMITORQUE OPERATOR PRODUCING APPROXIMATELY 16,500 POUNDS THRUST

The Limitorque operator was shipped to the Franklin Institute Research Laboratories, Philadelphia, Pennsylvania. The operator was mounted on a stand inside the test chamber and a 150 cycle load test was made on the unit. This test consisted of stroking the 2 3/8" diameter valve stem a total of approximately 12 inches in two minutes. The valve stem in the full closed position produced a thrust of 16,500 pounds on a rigid plate securely bolted to the test chamber. The thrust was measured by the same strain-gauge recording instrument used in the actual environmental test conducted by the Franklin Institute. The unit was wired up so that the closing direction and the open position geared limit switch stopped the unit in the full open position. The speed of travel was 6 inches per minute.

After the life cycle testing was completed, the unit was inspected and found to be in excellent condition. There was no noticeable wear on any of the parts. The same electric motor which had been heat age tested at Reliance Electric Co. was used for this life Cycle test. There was no noticeable adverse effect on the electric motor and it functioned properly.

7. TEST OF LIMITORQUE VALVE OPERATOR UNDER SIMULATED REACTOR CONTAINMENT POST-ACCIDENT STEAM AND CHEMICAL ENVIRONMENT

The attached report of the Franklin Institute Research Laboratories describes the actual testing under this environ-



mental condition.

After the test was completed, the Limitorque operator was shipped back to Philadelphia Gear Corporation, King of Prussia, Pennsylvania where it was disassembled and all parts were inspected. Photographs are included showing the various parts of the operator. All parts, including the electric motor, slide were position transmitter, seals, bearings, gears, and shafts, were inspected and no noticeable wear was noted. However, the gear frame of the geared limit switch had corroded and caused a minor failure.

The geared limit switch frame had been attacked by the boric acid in the steam atmosphere. This caused the gear frame to corrode and resulted in binding up of the shafts of the geared limit switch where they extend through the geared limit switch housing. This caused the malfunction of the switch as described in the Franklin Institute Research Laboratories' Report. A material change has been instituted to correct this corrosive action of the material used in that particular switch. On all present orders being processed, and on all future units to be shipped to meet environmental conditions such as this, the gear frame housing of the geared limit switch will be a bronze material which is not subject to corrosion by boric acid solutions. The motor insulation resistance after all testing was 1,000 megohms across all three motor terminals to ground at 500 volts.

