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DOCUMENTATION**

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PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA, PENN. 19406
F SECRETARY
ING & SERVICE
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LIMITORQUE VALVE CONTROL

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

TEST REPORT

600198

F-C 2232-01

JANUARY 2, 1969

NUCLEAR REGULATORY COMMISSION

Docket No. 90-348/364 Official Ex. No. 52
In the matter of ALABAMA POWER CO.
Staff IDENTIFIED 4/14/92
Applicant _____ RECEIVED 2/14/92
Intervenor _____ REJECTED _____
Cont'g Off'r _____
Contractor _____ DATE 1-7-69
Other _____ Witness _____
Reporter _____

I N D E X

SECTION A - NUCLEAR ENVIRONMENTAL TESTS

1. Report Dated January 1969
2. Report F-C3441 Dated September 1972

SECTION B - SEISMIC TEST REPORTS

1. Electric Operators
2. Manual Operators
3. Electric Operators with Manuals

030016

NUCLEAR ENVIRONMENTAL TESTS

1. Test report dated January 2, 1969

Addendum #1

35 Hz. - 5.3 G's (report #2539A-4723, Sept. 1970)

2. Test report #F-C3441 dated September 1972

Appendix "A"

Test Data Log Sheets

Appendix "B"

List of Instruments used in Obtaining
Test Data

Appendix "C"

Radiation Report

Appendix "D"

Seismic Report

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.

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1. PRELIMINARY HEAT TESTS ON COMPONENT PARTS

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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 Limatorque operator gear housing.

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3. PRELIMINARY LIVE STEAM TEST ON ACTUATOR

A complete Limatorque 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 Limatorque 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.

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

030022

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 OPERATION 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.

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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 valve 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.

030024
Test Report No. 2120-4594

REPORT OF TEST ON

PHILADELPHIA GEAR CORPORATION

SMBO-15 LIMITORQUE

Report Writer: *H. F. Soltis*

H. F. Soltis

Test Engineer: *W. A. Black*

W. A. Black

LOCKHEED ELECTRONICS COMPANY

MILITARY SYSTEMS DIVISION PLAINFIELD, NEW JERSEY

Date: July 31, 1968

Approved by: *N. Johnson*

N. Johnson, Supervisor
Environmental Laboratory





PURPOSE OF TEST: To subject the test specimen to the Vibration Test referenced in Philadelphia Gear Corporation Purchase Order No. 600198.

MANUFACTURER: Philadelphia Gear Corporation
King of Prussia, Pa. 030025

SPECIMENS TESTED: SMBO-15 Limitorque
(Reliance Motor S/N 435571-MS)

APPLICABLE DOCUMENTS: Philadelphia Gear Corporation
Purchase Order No. 600198

CASE NUMBER: 24-8041-0594

QUANTITY OF SPECIMENS TESTED: One (1)

SECURITY CLASSIFICATION OF SPECIMENS TESTED: Unclassified

DATE TEST COMPLETED: 7/30/68

TEST CONDUCTED BY: LOCKHEED ELECTRONICS COMPANY
ENVIRONMENTAL LABORATORY

DISPOSITION OF SPECIMENS TESTED: Returned to Franklin Institute, Applied Mechanics Laboratory per the request of Philadelphia Gear Corporation per Lockheed Electronics Company Packing Slip No. 41775 dated 7/31/68.

TEST APPARATUS: Reaction-Type Vibration Machine,
LAB Company Model RVK-72-5000, S/N 51401

Vibration Meter, ME Company
Model M-6, S/N 539

Vibration Pickups, ME Company Type 120,
S/N 14187 (vertical) and S/N 11263
(horizontal)

TEST PROCEDURE: The test specimen was secured to the vibration machine, as shown in Figures 1 and 2, and subjected to five (5) cycles of vibration in both the vertical axis and the horizontal axis with the mounting flange in the horizontal plane.

LEC

Test Report No. 2120-4594TEST PROCEDURE:
(Cont'd)

Each cycle consisted of two (2) minutes of vibration at a frequency of twenty (20) cps. and a acceleration level of one (1) "g", followed by one (1) minute of no vibration.

Visual inspections for evidence of any external physical damage were conducted throughout vibration testing.

TEST RESULTS:

The Vibration Test was completed with no visible evidence of any external physical damage.

RECOMMENDATIONS:

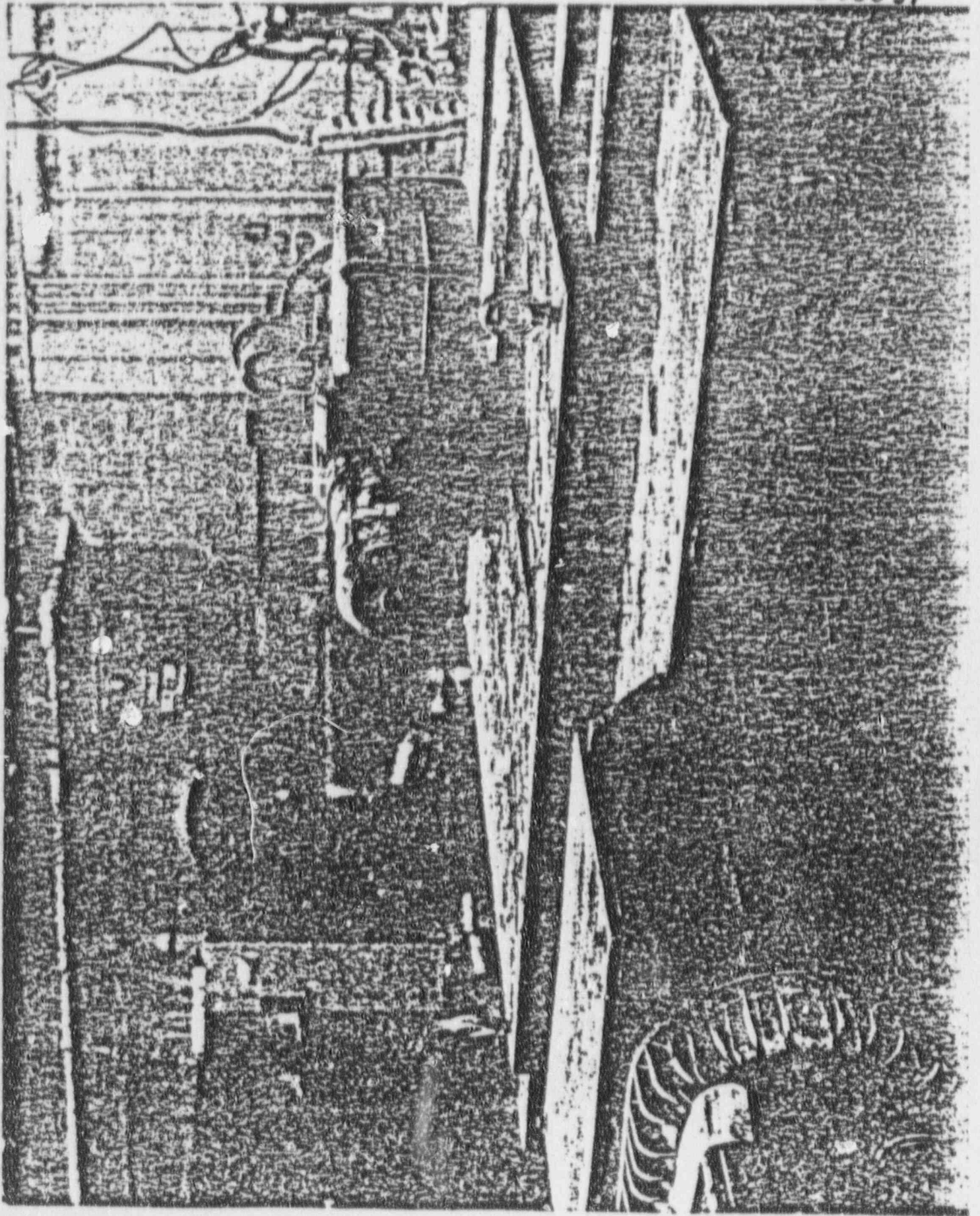
None. Data merely submitted.

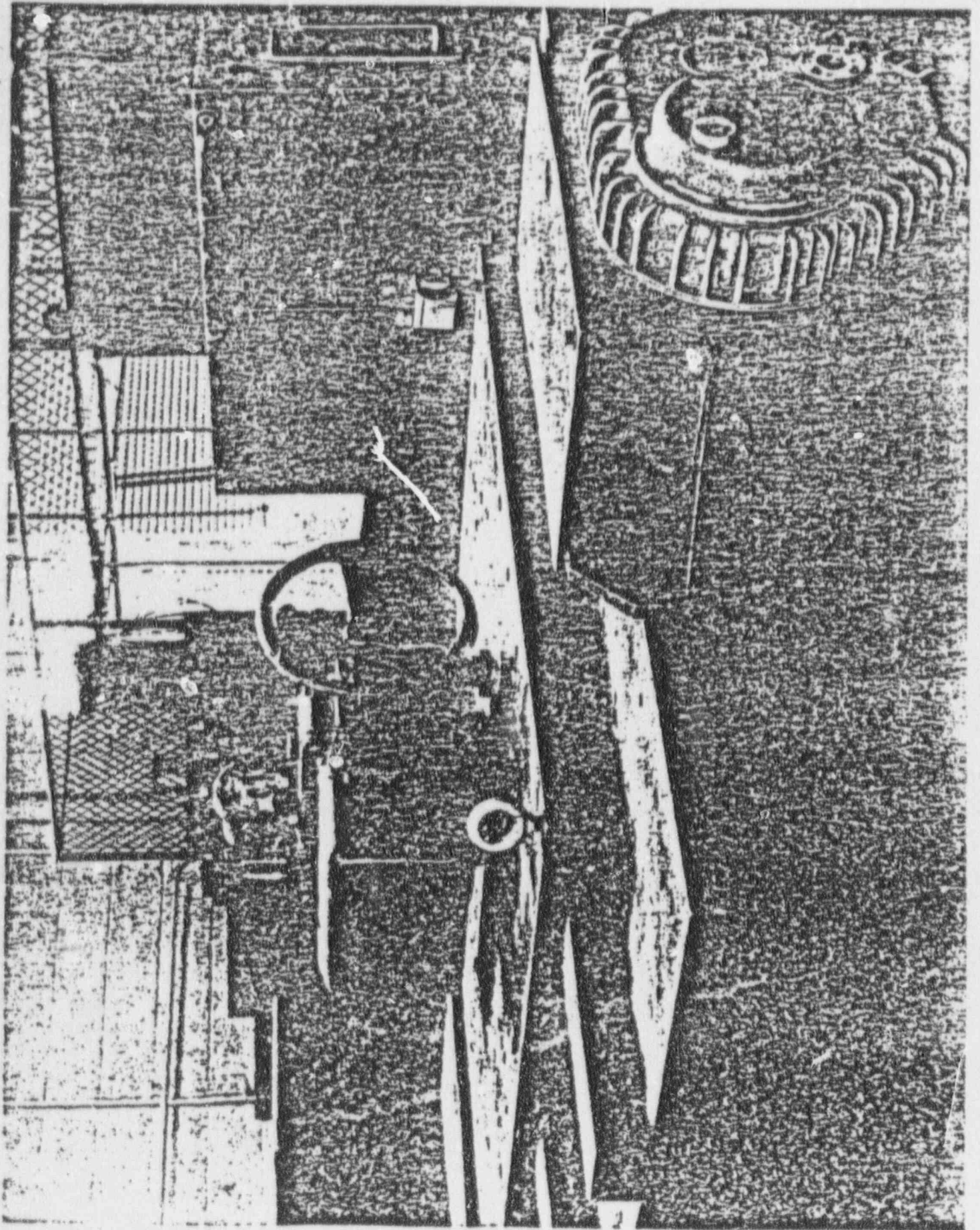
Test Engineer:

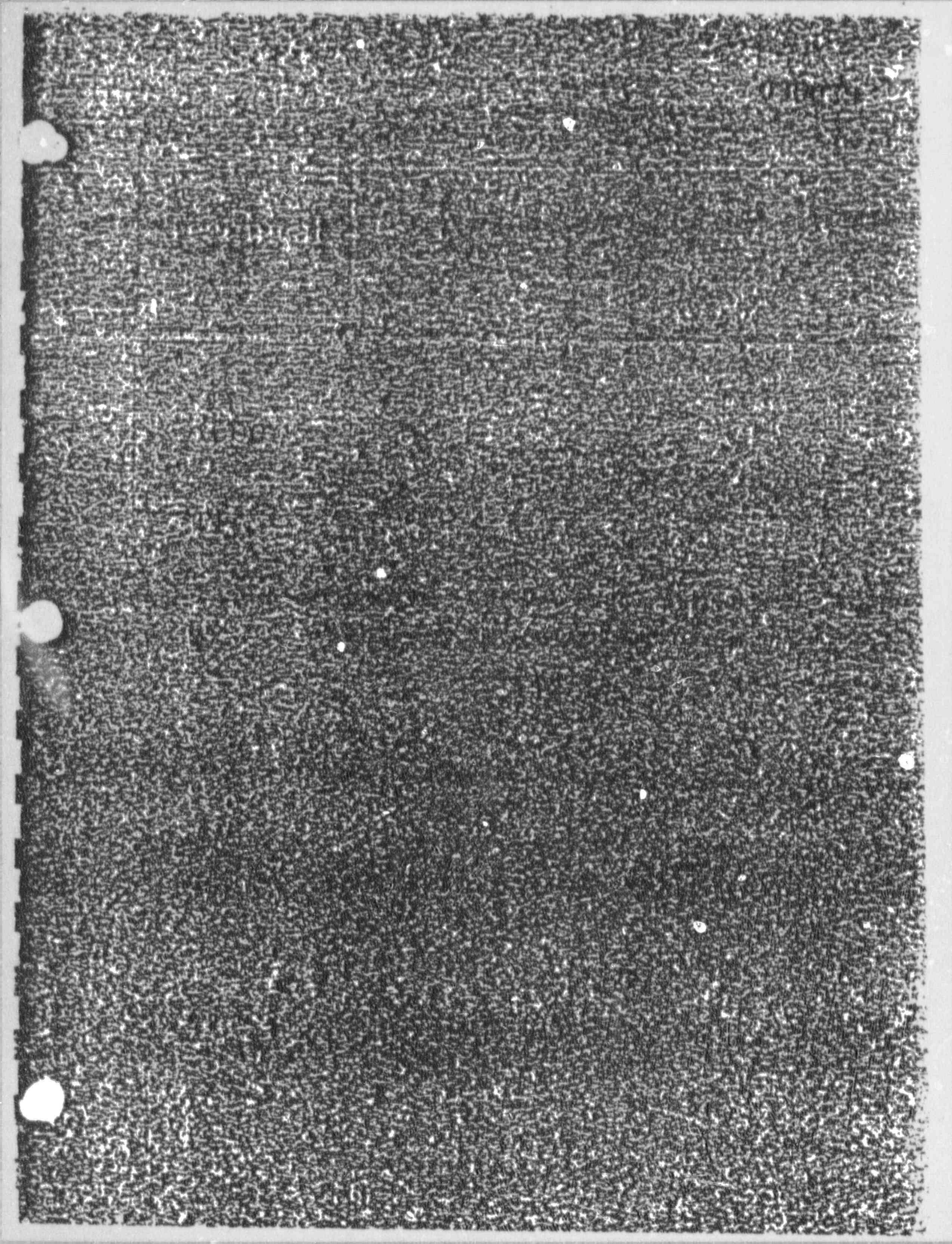


W. A. Black

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FINAL REPORT
F-C2232-01

Report

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

by

R. Cl. de Herrick
LeRoy E. Witcher

Prepared for

*The Philadelphia Gear Corporation
King of Prussia, Pennsylvania*

November, 1968



THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
BENJAMIN FRANKLIN PARKWAY • PHILADELPHIA, PENNA. 19103

CONTENTS

| | |
|--|-----|
| LIST OF FIGURES | 11 |
| LIST OF TABLES | 111 |
| SUMMARY | 1v |
| I. INTRODUCTION | 1 |
| II. EQUIPMENT TESTED | 2 |
| III. TEST DISCUSSION | 4 |
| A. Measurements | 7 |
| B. Test Sequence and Observations | 10 |
| APPENDIX I | 23 |
| Test Data Sheets | |
| APPENDIX II | 29 |
| Performance Test Data of Limitorque Valve Operator | |
| ADDENDUM I | |
| Original Recording of Limitorque Power Consumption | |
| ADDENDUM II | |
| Original Continuous Recording of Test Chamber | |
| ADDENDUM III | |
| Original Recording of Valve Seating Force | |
| ADDENDUM IV | |
| Original Recording of Test Chamber Pressure Reductions | |

LIST OF FIGURES

| <u>Figure No.</u> | | |
|-------------------|--|----|
| 1 | Test Facility Before Test | 5 |
| 2 | Test Facility After Test | 6 |
| 3 | Schedule of Test Environments | 11 |
| 4 | Recording of Initial Pressure Rise to 90 psia. | 12 |
| 5 | Limiter torque and Motor-Brake Before Test | 19 |
| 6 | Limiter torque and Motor-Brake After Test | 20 |
| 7 | Limit Switch Compartment Before Test | 21 |
| 8 | Limit Switch Compartment After Test | 22 |

LIST OF TABLES

| | | |
|---------|--|------------------------|
| Table 1 | Collected Data (Performance Test Data of Limitorque Valve Operator) | Appendix II Page 30 |
| Table 2 | Average and Peak Values (Performance Test Data of Limitorque Valve Operator) | Appendix II Page 31 |

SUMMARY

A Model SM7-0 Limitorque Valve Operator manufactured by The Philadelphia Gear Corporation was tested by The Franklin Institute Research Laboratories for performance under steam and decontaminate environments existing in water-moderated reactor containments following some credible accident. The Limitorque operator plus an additional motor-brake assembly was tested in accordance with Level 4 of the Standard Draft, dated June 7, 1968, prepared by Sub-Committee 2 (Equipment Qualification Testing) of the IEEE/NSG/Technical Committee for Standards.

Actual tests were begun on October 31, 1968 and continued for seven full days.

The Limitorque Valve Operator continued to operate throughout and after the environmental test. It was necessary to sequence start the operator to unseat it from the full closed position after the 20 psi pressure level was reached. The geared limit switch bypass around the open torque switch was apparently set too close to the full closed position. This caused the torque switch to momentarily open and stop the operator before it had unseated the valve stem. It is our understanding that this could be corrected by setting the geared limit bypass switch to trip open after the valve stem is unseated.

The environment did effect the geared limit switch as was evidenced at the end of the first 24 hour period when the Limitorque operator went to the full open position and stopped by the open

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limit torque switch rather than by the open position geared limit switch. Both indicating lights remained on even though the valve stem had been moved to the full open position.

At the end of the seven day environmental exposure, the Limitorque operator closed the valve stem normally, however due to the failure of the geared limit switch, a jumper wire had to be used to bypass the switch to allow the Limitorque operator to open the valve stem fully.

The motor brake assembly operated satisfactorily throughout the test.

I. INTRODUCTION

Following discussions between staff members of The Philadelphia Gear Corporation and The Franklin Institute Research Laboratories (FIRL), an agreement was signed under which FIRL would test a Limitorque valve operator and a separate motor-brake assembly under simulated reactor post-accident environments. This is the final report of that test program.

The conditions simulated for the test were the pressure-temperature-humidity (saturated steam) environments and the chemical environments that could be expected to exist in the containment vessels of water-moderated power reactors following some credible accident such as the rupture of a major reactor piping assembly. The particular conditions simulated are those set forth in the IEEE Standard Draft, dated June 7, 1968, of the IEEE/NSG/Technical Committee for Standards, Subcommittee 2 (Equipment Qualification Testing) as transmitted by Philadelphia Gear letter, Lawson to Witcher (FIRL), on July 16, 1968. The test was made in accordance with the applicable portion of this standard with one exception: the pressure specified to be 5 psi between 24 and 168 hours after test initiation as shown in Figure 3, page 9 of the IEEE standard was changed to be 15 psi. This change was requested by Philadelphia Gear in the letter of July 16, 1968 previously cited.

It must be emphasized that this test program was for the emergency steam and chemical environmental conditions only. Pre-conditioning tests including radiation aging, heat aging, and shock tests were not included in the program at FIRL. Neither were post-test inspections or other acceptance criteria.

II. EQUIPMENT TESTED

The equipment tested was (a) a Limitorque valve operator and (b) a motor-brake assembly as identified and described below.

(a) Name Plate Information of Valve Operator (Test Unit 1)

| | | | |
|---------------|--|--------|---------|
| NAME: | SMB-O Limitorque Valve Operator Order No. 600198 | | |
| MANUFACTURER: | Philadelphia Gear Corporation | | |
| MOTOR: | Reliance Built Torque Motor Identification No. 435571-JTR | | |
| START: | 15 ft.-lb. | | |
| RUN: | 3 ft.-lb. | | |
| TYPE: | F | FRAME: | M56 |
| PHASE: | 3 | RPM: | 1700 |
| CYCLES: | 60 | VOLTS: | 230/460 |
| CODE: | - | AMPS: | 5.6/2.8 |

Temp. Rise at Run Torque of 15 Minutes: 75°C

Type H Insulation

Gear Unit

(b) 1. 1/2 hp Motor with Brake (Test Unit 2)MOTOR

MANUFACTURER: Reliance Electric Company
 3300 10th Street
 Columbus, Indiana

IDENTIFICATION #: 442010-JTR

| | | | |
|--------|------------|--------|---------|
| START: | 15 ft.-lb. | FRAME: | - |
| RUN: | 3 ft.-lb. | RPM: | 1700 |
| TYPE: | - | VOLTS: | 230/460 |
| PHASE: | 3 | AMPS: | 5.6/2.8 |
| CYCLE | 60 | | |
| CODE: | - | | |

Rise at RUN Torque: 75°C (15 minutes)

DINGS MAGNETIC DISC BRAKE

| | | | |
|-------------|------------|--------|-----------------|
| MODEL: | 6-61009-50 | VOLTS: | 230 |
| SERIAL NO : | 157010 | | Continuous Duty |
| TORQUE: | 3 ft.-lb. | | |

III. TEST DISCUSSION

The tests were conducted in an environmental test facility installed at FIRL. Figures 1 and 2 show the central part of the facility including the test chamber with the Limitorque and motor-brake assembly mounted (Figure 1). Both figures show the chamber pressure recorder mounted on the upper right wall, the dual channel pressure recorder mounted directly below and the Limitorque and motor-brake assembly temperature recorder mounted under the right hand table. On the back wall are mounted the Limitorque and motor-brake controls.

Power leads to the motor-brake and the Limitorque are brought from the panel board to a junction box mounted above the vessel. From the junction box, Teflon insulated #12 wire was brought through the vessel wall in Conax feed-through fittings and thence to the Limitorque and the motor-brake.

The Sanborn recorder shown in Figure 1 was used to measure the valve seating force as measured by strain gages on the valve stem guide protruding to the left from the tank.

The facility was pressurized by a two inch steam line from the FIRL building steam mains. The fast pressure rise was achieved by quick-opening valves in the steam line. Subsequent regulation was performed by a Spence regulating valve. In order to achieve the fastest possible rise in steam pressure in the test chamber an additional 2 inch line was placed to the chamber by-passing the regulating valve. This allowed an empty vessel rise from zero gage pressure and 140°F ambient to 90 psig in 8 seconds. Pressure rise time with the Limitorque was somewhat greater as described in the actual test procedure.

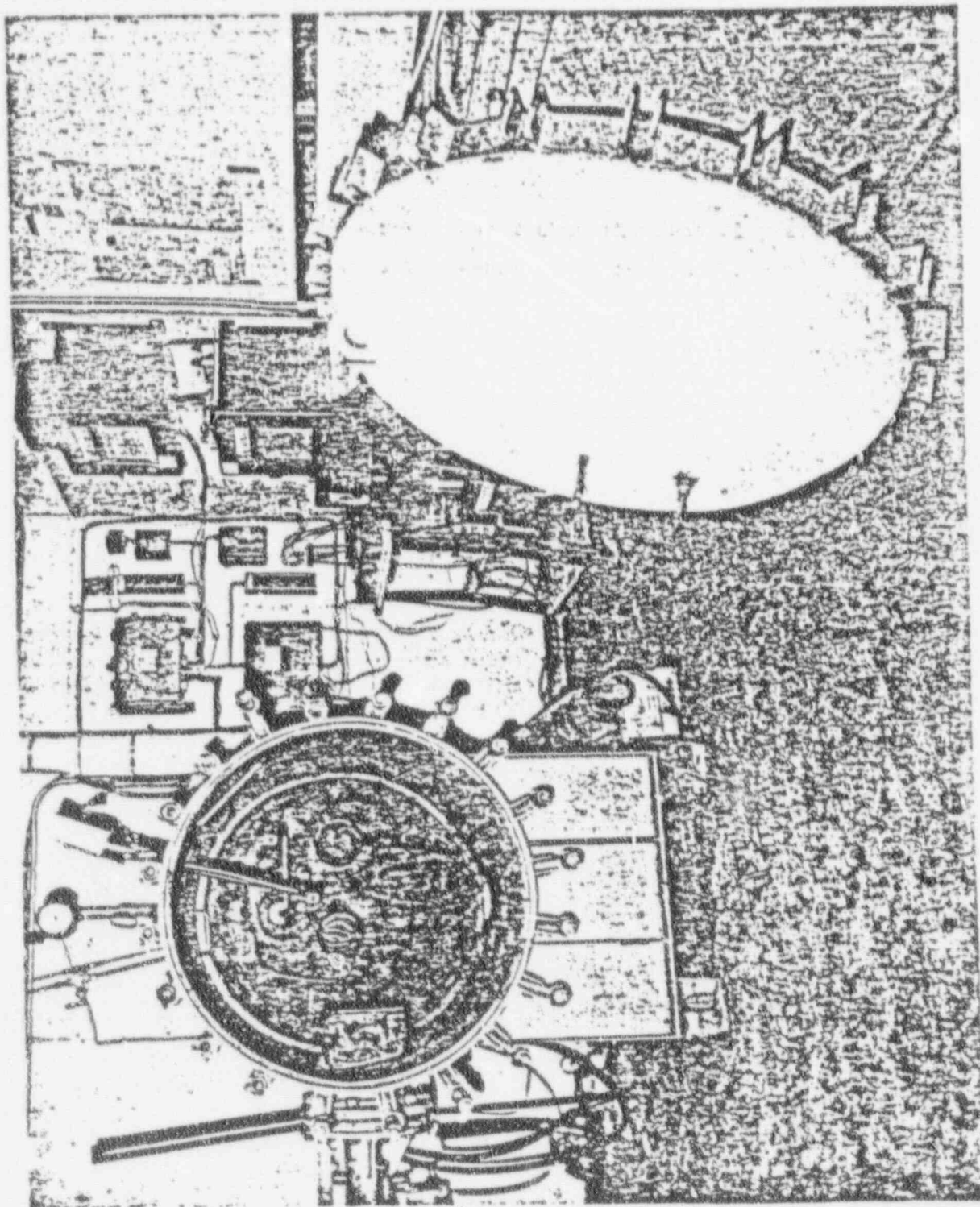


Fig. 2 - Test Facility After Test

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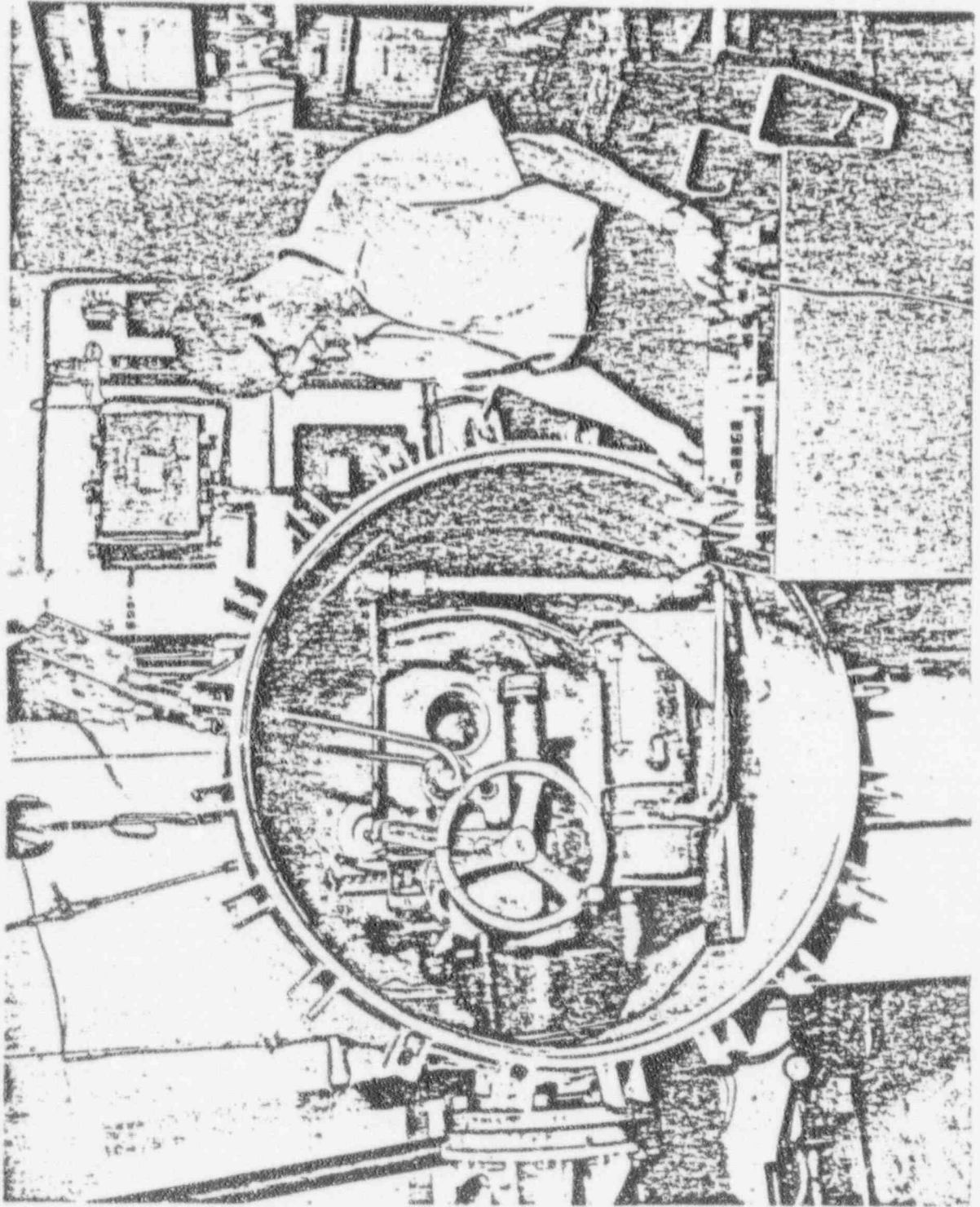


Fig. 1 - Test Facility Before Test

A. MEASUREMENTS(1) Temperature inside unit and limit-switch compartment

Limitorque Operator: Temperature was measured by means of four thermocouples installed in the Limitorque Operator. The valve operator was received by FIRL with three thermocouples already installed in the motor windings. One additional thermocouple was installed by FIRL in the limit-switch compartment.

Motor-Brake Assembly: Temperatures in the brake assembly were also monitored by three thermocouples installed prior to delivery to FIRL. Two were in the motor windings and one was in the brake assembly.

All temperatures in the Limitorque and the motor-brake assembly were recorded by a separate multi-point temperature recorder.

(2) Motor Voltage, Amps, and Watts

A polyphase recording watt meter was used to record the power input to the Limitorque test unit. In addition, three indicating voltmeters and two ammeters were read during each operation of the motors. These data are given in Tables 1 and 2.

No measurements or recordings were made for the motor-brake assembly.

(3) Temperature and Pressure Inside Environmental Chamber

The environment and test chamber temperatures were recorded throughout the seven day test with thermocouples at strategic locations. The temperatures recorded were the chamber steam temperature (1), temperature in the valve operator switching compartment (2), the tank wall temperature (3), and the inlet steam (4).

Pressure was monitored visually by means of a precision mechanical gage and by a pressure transducer for the analog recording of pressure by a two-pen potentiometer recorder. The other pen of the pressure recorder was used in conjunction with another transducer to measure and record pressure in the limit-switch compartment of the Limitorque valve operator.

(4) Boric Acid Concentration and pH of Condensate

In lieu of measuring the concentration and pH of the condensate, a solution of 1.5% (by weight) boric acid in water was prepared and stored in a cooler vat. This solution and only this solution was pumped into the environmental chamber. The condensate was not recirculated, but was drained from the tank overflow as the fresh solution was injected. The boric acid used to simulate the post-accident spray was prepared by dissolving seven pounds of technical grade boric acid (H_3BO_3) in 55 gallons (460 pounds) of demineralized water. The solution was prepared at 80°F to facilitate the solution of the boric acid crystals. A 50% solution of reagent grade sodium hydroxide (NaOH) was used to titrate the boric acid solution to obtain a stable pH of 7.67 as measured with a Beckman pH meter.

Preparation of the solution was made in a stainless steel chiller tank, equipped with a stirrer and cooling controls. The solution was cooled to 21.5°C (70.7°F) for the test. Eight gallons of solution was used to fill the test chamber auxiliary heaters for the pre-heat cycle and to provide a boric acid source for the initial test.

Boric acid flow rate was measured with a Brooks Flow Meter. The solution was then pumped into the spray manifold in the test chamber by a high head centrifugal pump.

(5) Valve Operator Seating Force in Valve Closed Position

The valve operator seating force was measured by a full strain gage bridge on the valve operator external stem drive, which was calibrated by a pre-calibrated load cell. During the test, this force was recorded on one channel of a two-channel Sanborn recorder.

(6) Motor Insulation Resistance Before and After Test

Motor insulation resistance was measured with a megohmmeter at the motor terminals before and after the test. Since power was supplied to the motor with Conax gland power fittings with Teflon insulated wire, the insulation resistance of these leads were also measured with the megohmmeter.

(7) The Limitorque unit was tested with the limit-switch compartment as an integral unit. A transmitting potentiometer indicating the valve stem position was operated throughout the test in addition to the indicator switch for the external "open-close" light.

A check valve replaced a ball-check grease fitting on the gear housing, with the free flow into the test chamber.

B. TEST SEQUENCE AND OBSERVATIONS

(1) Simulation of Long Term Ambient

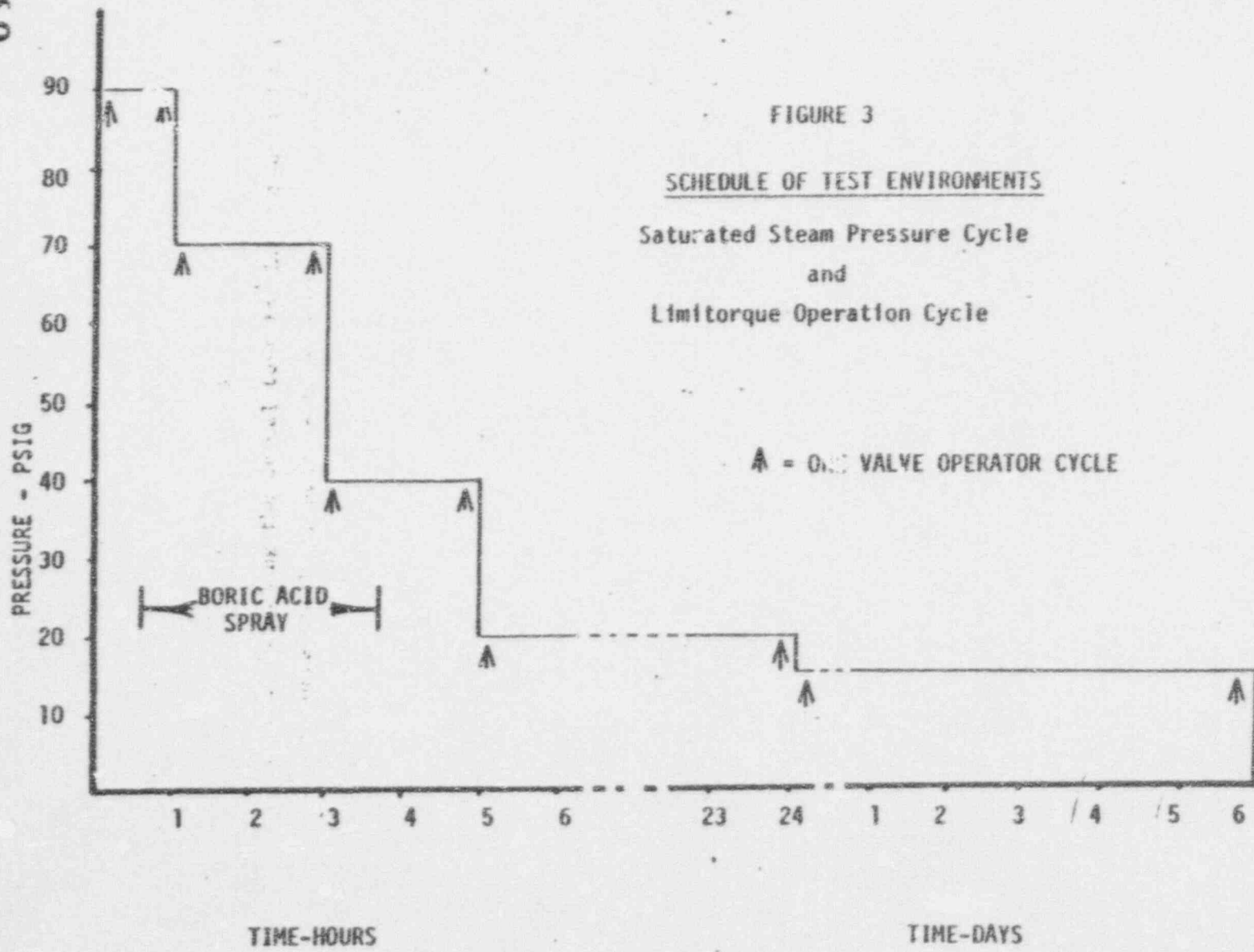
Prior to beginning the actual test the Limitorque and motor brake were slowly brought up to a temperature of 140°F at atmospheric pressure, in order to simulate the long term ambient prior to an accident. This, in our test chamber, was accomplished by periodically introducing a small amount of steam from the mains in addition to heating the condensate in the bottom of the test chamber with the electric heaters.

(2) Start of Test

Upon reaching the 140°F ambient level, the actual test was begun at 3:15 p.m. on October 31, 1968 by suddenly admitting steam to the test chamber. The pressure was brought up to and held at 90 psig, in accordance with Figure 3. The rise time was 14 seconds as recorded by two observers using stop watches and precision gages as reference. A precision mechanical pressure gage was the primary instrument used at this time although pressure transducers were operating with a two-pen recorder for the purposes of recording chamber pressure and limit-switch compartment pressure. Figure 4 shows the pressure rise in both the test chamber and the limit switch compartment of the Limitorque. The recorded pressure variation in chamber pressure upon reaching the 90 psi level was caused by a leak in the pressure transducer at that time.

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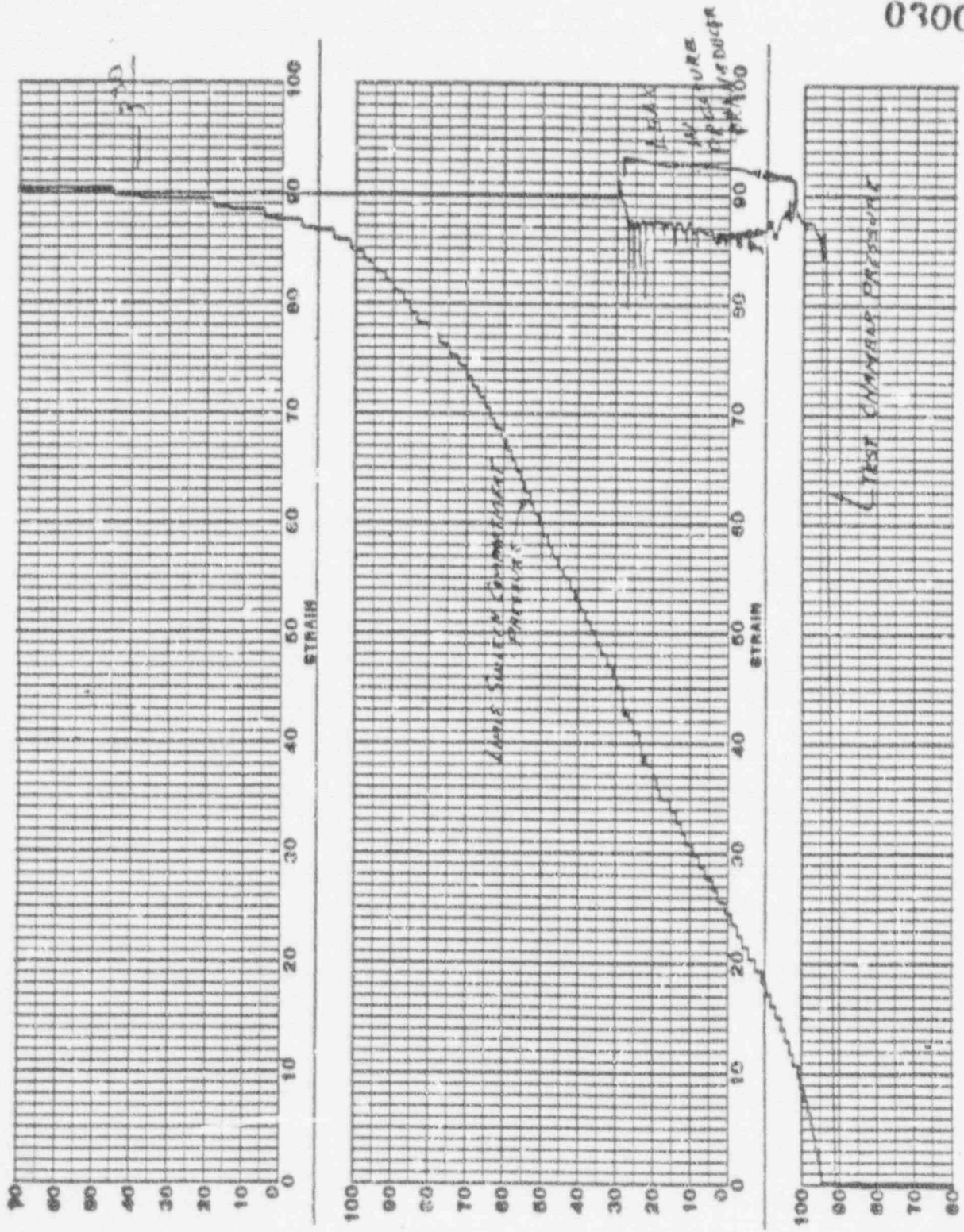


Fig. 4 - Recording of Initial Pressure Rise to 90 psig.

(3) Limitorque Operation

Six minutes after the beginning of the test the Limitorque and motor-brake assembly were each operated through one complete cycle. Operation was normal.

(4) Start Boric Acid Spray

Forty minutes after the start of the test the boric acid spray was started. 1.5% boric acid, buffered with sodium hydroxide to a pH of 7.67, was supplied at 10 gal. per hour in a downward spray pattern over the Limitorque casing and control compartment for the next four hours without interruption.

(5) Limitorque Operation

Fifty-five minutes after the start of the test the Limitorque and the motor-brake were each operated through one complete cycle. Operation was normal.

(6) Pressure Reduced to 70 psig

One hour after the start of the test the pressure was reduced to 70 psig in the test chamber within a period of three minutes.

(7) Limitorque Operation

Seven minutes after reaching the 70 psig saturated steam conditions in the test chamber the Limitorque and motor-brake were again operated through one complete cycle. Operation was normal.

(8) Limitorque Operation

Five minutes before going to the 40 psi level the Limitorque and motor-brake were again operated. Operation was normal.

(9) Pressure Reduced to 40 psig

Three hours after the start of the test the pressure in the test chamber was reduced to 40 psig, by adjusting the regulator valve in the steam supply line and by running cold water through the condenser coils inside the test chamber head. The change from 70 psig to 40 psig was accomplished in five minutes.

(10) Limitorque Operation

Five minutes after reaching the 40 psig saturated steam conditions in the test chamber the Limitorque and the motor-brake were again operated through one cycle. Operation was normal.

(11) Boric Acid Spray Stopped

The boric acid spray which had been supplied continuously for four hours in a spray pattern over the Limitorque was stopped. No further chemical environment was simulated.

(12) Limitorque Operation

Five minutes before the end of the two hour 40 psig saturated steam condition the Limitorque and motor-brake were again operated. Operation was normal.

(13) Pressure Reduced to 20 psig

Five hours after the start of the test the pressure regulator was adjusted from the 40 psig setting to the 20 psig setting. Cooling water was also supplied to the cooling coil in the chamber head. This accomplished the transition from 40 psig to 20 psig in four minutes.

(14) Limitorque Operation

Five minutes after reaching the 20 psig level, the Limitorque and the motor-brake assembly were operated through one complete cycle. The motor-brake assembly operated normally. The Limitorque operated, but its operating characteristics had changed. It closed normally, but to open the unit it was found to be necessary to joggle the open and close buttons in sequence to start up the unit. Once started, it operated satisfactorily, but the opening time was 112 seconds instead of the normal time of 110 seconds. The absence of a peak in motor torque at the end of the opening stroke signified that the opening stroke was stopped as usual by the limit switch.

(15) Limitorque Operation

Nineteen hours after the previous Limitorque operation and five minutes before the end of the 20 psig condition, the units were operated once more. The motor-brake operated normally. The Limitorque closed properly, but upon opening the controls needed to be sequenced rapidly between "open" and "close". As before, once started, the Limitorque operated satisfactorily but this time the recorded rise in torque at the end of the opening stroke signified that the full open limit stop was reached, thus indicating that the preset limit switch failed to stop the opening stroke.

(16) Pressure Reduction to 15 psig

Twenty-four hours after the start of the test the pressure was reduced from 20 to 15 psig. This was accomplished as before by adjusting the regulating valve and running cold water through the cooling coil. Pressure reduction time was

seven minutes. No further change in pressure was made before the end of the test.

(17) Limiterque Operation

The test units were operated five minutes after reaching the 15 psig condition. The motor-brake operated satisfactorily although it appeared to be noisy for a short period of time with the brake released. The Limitorque operated as in the immediately preceding operation (Sequence 15) except that the position limit switches were not operating. The Limitorque operated satisfactorily but it had to be sequenced rapidly between "open" and "close" to unseat the stem when in the closed position.

(18) Limiterque Operation

Six full days (144 hours) passed while the units remained in the 15 psig saturated steam environment before the units were operated once more. The motor-brake operated satisfactorily. The Limitorque closed satisfactorily but this time the unit would not reverse to un-seat the valve stem on the opening cycle. Rapid sequencing of the "open" and "close" buttons as done previously was to no avail and so a jumper was added to the controls on the panel board to reverse the Limitorque. This was successful and the Limitorque opened satisfactorily.

(19) Pressure Reduction to Atmosphere

Following the Limitorque operation of sequence 18 the pressure was reduced to the atmospheric pressure of the lab. This was done by circulating water through the cooling coil in the chamber head and later by slowly pumping cold water into the condensate wall of the chamber.

The cooling operation before venting required approximately thirty minutes.

(20) Condensate Sampling

Before pumping water into the condensate well to cool the test chamber a sample of condensate was drawn and tested for acidity. The condensate had a pH of 8.20 which was believed to represent the pH of the steam from the supply mains (Philadelphia Electric Company). By this time most of the boric acid should have been diluted and carried away by the steam condensate.

(21) Opening of Test Chamber

Approximately one hour after the end of the seven day test (168 hour) cycle the tank was opened to inspect the units under test.

(22) Visual Inspection of Test Units

Figures 5 and 6 show, respectively, the test units immediately before and after the test. It is obvious that the steam and chemical environments had a very corrosive effect upon the units, especially upon the paint. However, as described in this test sequence, the units operated, even to the hand-wheel which was tested and found to be satisfactory.

Figure 6 shows a certain amount of crud in the bottom of the tank. This was found to be (a) grease that had come out of the checkvalve, and (b) the remains of the visual position indicator which had been severely attacked by the environment. The plastic had melted and had apparently foamed.

Figures 7 and 8 show the effect of the environment upon the limit switch compartment. The environment had penetrated the compartment and had lightly attacked certain components. This was evidenced by the previously discussed malfunction of the position limit switches as well as by the visual inspection.

(23) Limitorque Operation

The Limitorque was operated once more before it was removed from the test chamber for return to the Philadelphia Gear Corporation. The operation was as described in sequence. The jumper on the control panel was necessary for reversing the motor from "close" to "open".

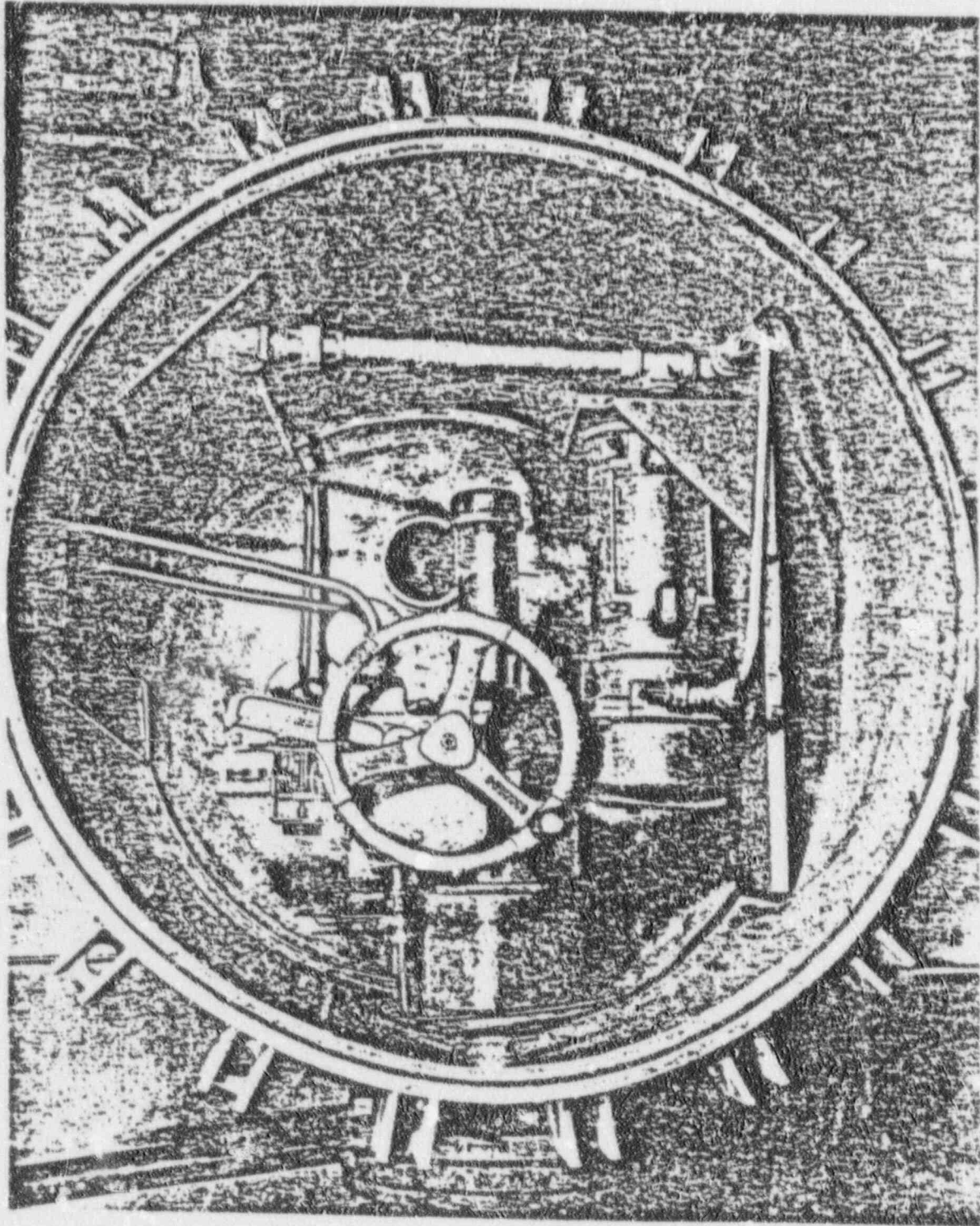


Fig. 5 - Limitorque and Motor-Brake Before Test

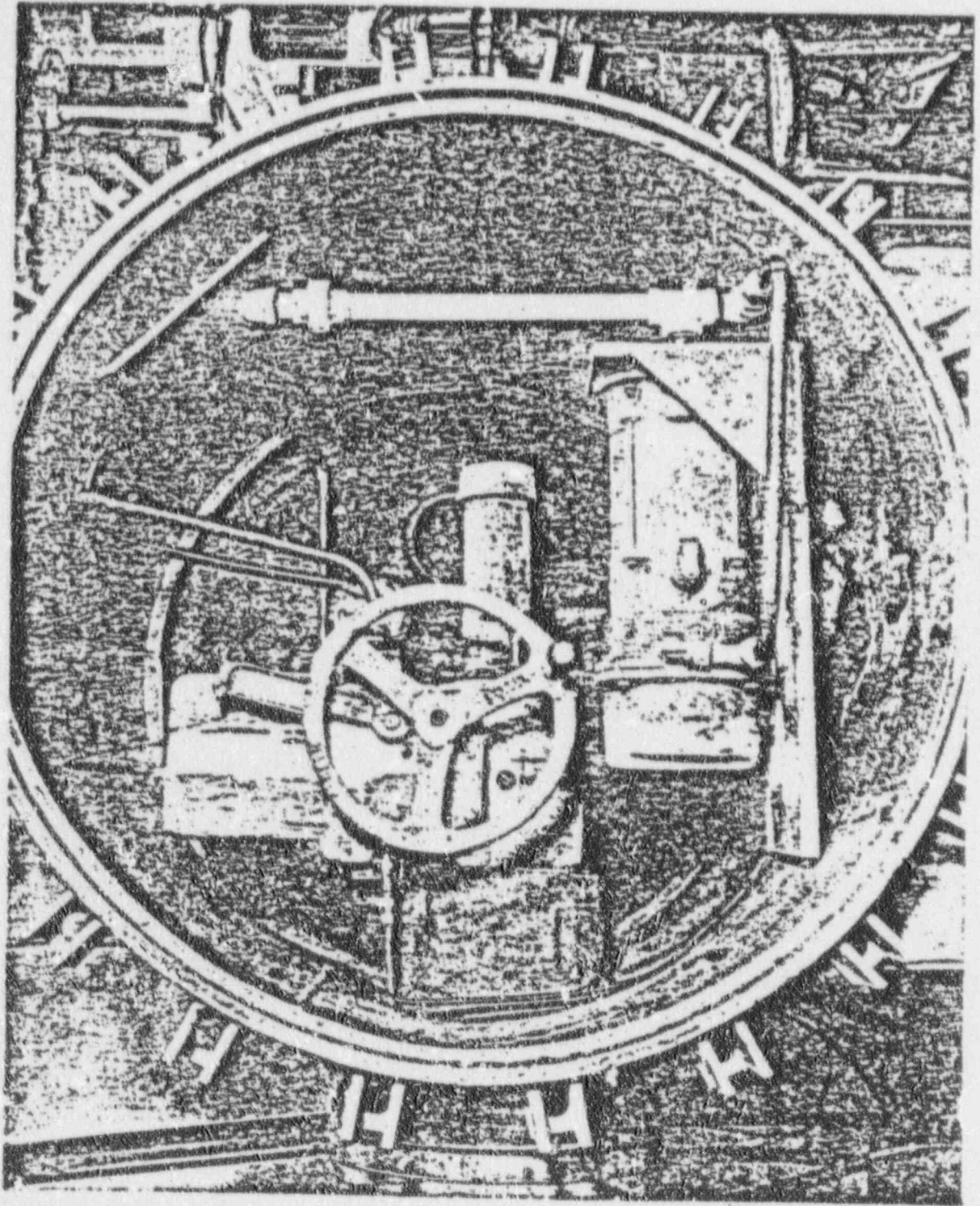


Fig. 6 - Limitorque and Motor-Brake After Test

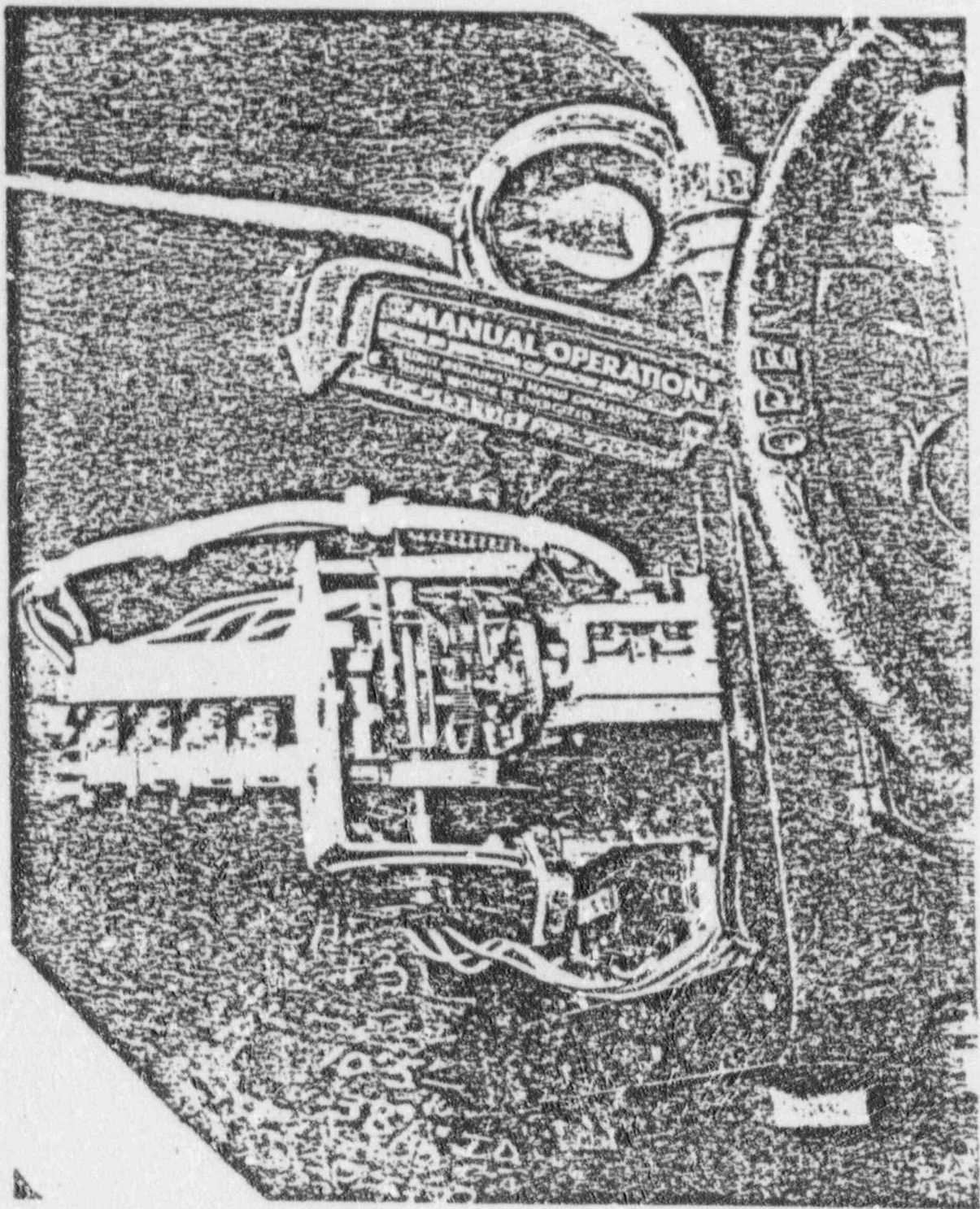


Fig. 7 - Limit Switch Compartment Before Test

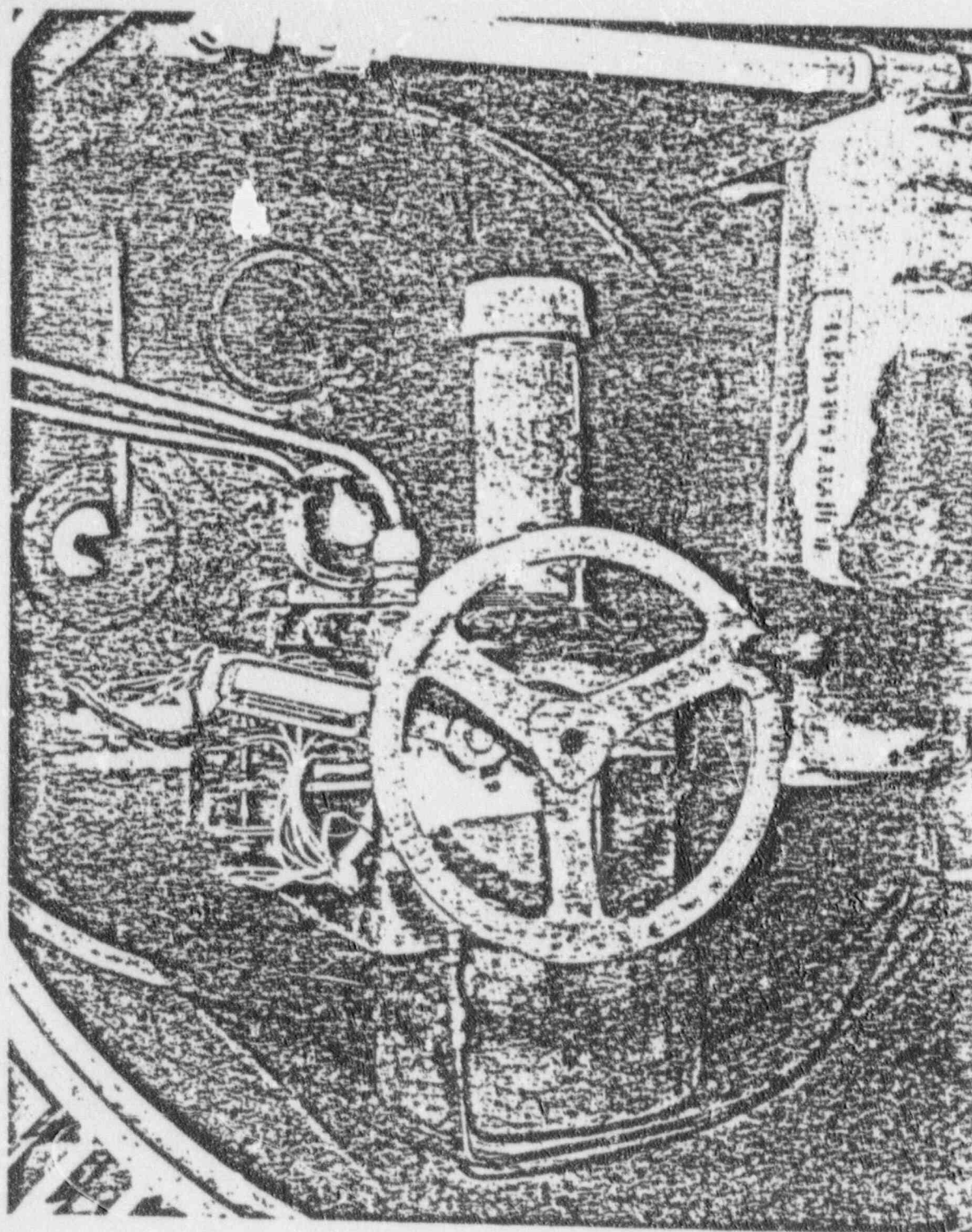


Fig. 8 - Limit Switch Compartment After Test

030058

APPENDIX I

TEST DATA SHEETS

Date Oct. 31, 1968ENVIRONMENT TEST CYCLETEST LEVEL I

030059

Time at Start of Test: 1514 Hour 1515Initial Pressure 15 Psig Temp. 142 °FPressure Rise Time: 14 SecondsChamber: Press. 90 psig Temp. 329 °FTest Unit: Press. 90 Psig Temp. 328 °FFirst Test Cycle of Motor: 1521 Hours
at this LevelStart of Boric Acid Spray (40 minutes per Level I)Time: 1555 Hour _____ MinutesBoric Acid Flow Rate: 1555 gphTemp. 70.7 °F ph 7.87Second Test Cycle of Motor
at this Level:Time: 1610 HoursEnd of Level I:Time: 1615 HoursChamber Press. 91 psigTemp. 329 °FUnit Press. 91 psigTemp. 329 °F

ENVIRONMENT TEST CYCLE

TEST LEVEL NO. II DESIGNATED STEAM PRESS. 70 PSIG SATURATION TEMP. 316

Time Level Reached: 1615 Hours

Air 1.77%

Time from Previous Level: 38 Minutes

Chamber Press: 70 psig Temp.: 312 °F

Test Unit: Temp. 312 °F Press. 70 Psig

First Test Cycle of Motor at this Level: Time: 1625 Hours

Boric Acid Spray

Flow Rate 10 gph Temp. 70.7 °F PH 7.67

Second Test Cycle of Motor at this Level: Time: 1810 Hours

End of Level No. II

Time: 1815 Hour

Chamber Temp. 315 °F

Press. 70 Psig.

Unit Temp. 315 °F

Press. 70 Psig

030051

Date: Oct 31, 1966

L. E. Wilbur

ENVIRONMENT TEST CYCLE

TEST LEVEL NO. IV DESIGNATED STEAM PRESS. 20 PSIG SATURATION TEMP. 259 °F

Time Level Reached: 2022 HoursTime from Previous Level: 4 MinutesChamber Press: 20 psig Temp.: 272 °FTest Unit: Temp. 271 °F Press. 20 Psig

First Test
Cycle of Motor
at this Level: Time: 2035 Hours

4.7ndBoric Acid SprayFlow Rate none Temp. _____ °F PH _____

Nov. 1, 1968

Second Test
Cycle of Motor
at this Level: Time: 1510 Hours

End of Level No. _____Time: 1517 HourChamber Temp. 256 °FPress. 20 Psig.Unit Temp. 256 °FPress. 20 Psig

Date Oct 31, 196
J.P. VitcherENVIRONMENT TEST CYCLETEST LEVEL NO. III DESIGNATED STEAM PRESS. 40 PSIG SATURATION TEMP. 287 °FTime Level Reached: 1820 HoursTime from Previous Level: 10 MinutesChamber Press: 40 psig Temp.: 300 °FTest Unit: Temp. 287 °F Press. 40 PsigFirst Test
Cycle of Motor
at this Level: Time: 1828 HoursBoric Acid SprayFlow Rate 10 gph Temp. 70.7 °F PH 7.62
Acid spray stopped at 1955 hoursSecond Test
Cycle of Motor
at this Level: Time: 2010 HoursEnd of Level No. _____Time: 2018 HourChamber Temp. 287 °FPress. 41.0 Psig.Unit Temp. 287 °FPress. 40.5 Psig

TABLE 1.

#31-C2232-01

070053

PERFORMANCE TEST DATA OF LIMITORQUE VALVE OPERATOR
COLLECTED DATA

| Test Pres. Psig | Time | Line 1-2 | Volt. 3-1 | A-C 3-2 | Current | | Pwr. KW | Stg. For-lbs. | Stem Travel | |
|--------------------|-----------------|-------------|--------------|------------|---------|------|------------|------------------|------------------|------|
| | | | | | 1 | 3 | | | Close Seconds | Open |
| | 10/31 | | | | | | | | | |
| 0 | 1502 | 500 | 512 | 498 | 2.85 | 3.06 | .50 | 16,500 | 110 | |
| | 1506 | 504 | 514 | 498 | 2.75 | 2.95 | .51 | | | 110 |
| 90 | 1521 | 504 | 516 | 500 | 2.85 | 3.00 | .53 | 16,500 | 110 | |
| | 1524 | 504 | 516 | 500 | 2.65 | 2.60 | .60 | | | 110 |
| | 1610 | 500 | 512 | 500 | 2.80 | 2.97 | .51 | 16,500 | 110 | |
| | 1613 | 500 | 514 | 500 | 2.68 | 2.83 | .55 | | 1 | 110 |
| 70 | 1625 | 500 | 514 | 496 | 2.68 | 2.97 | .50 | 16,100 | 110 | |
| | 1628 | 504 | 516 | 500 | 3.05 | 2.89 | .52 | | | 110 |
| | 1810 | 506 | 518 | 504 | 2.73 | 3.07 | .50 | 16,500 | 110 | |
| | 1813 | 508 | 518 | 504 | 2.92 | 2.98 | .56 | 16,500 | | 110 |
| 40 | 1828 | 508 | 520 | 504 | 2.95 | 3.10 | .50 | 16,500 | 110 | |
| | 1831 | 508 | 520 | 504 | 2.84 | 3.00 | .52 | | | 108 |
| | 2010 | 508 | 520 | 504 | 2.98 | 3.10 | .50 | 16,000 | 110 | |
| | 2014 | 508 | 518 | 504 | 2.83 | 3.02 | .51 | | 1 | 107 |
| 20 | 2031 | 508 | 520 | 504 | 2.96 | 3.10 | .50 | 17,000 | 110 | |
| | 2039 | 508 | 520 | 504 | 2.84 | 3.02 | .51 | | | 112 |
| | 11/1 | | | | | | | | | |
| | 1510 | 500 | 514 | 496 | 2.85 | 3.00 | .46 | 17,500 | 110 | |
| | 1513 | 500 | 514 | 496 | 2.70 | 2.87 | .47 | | | 112 |
| 15 | 1528 | 500 | 514 | 496 | 2.84 | 2.98 | .46 | 17,800 | 115 | |
| | 1532 | 500 | 514 | 496 | 2.70 | 2.90 | .50 | | | 118 |
| | 11/7 | | | | | | | | | |
| | 1528 | 498 | 514 | 496 | 2.98 | 2.82 | .43 | 17,200 | 111 | |
| | not recorded | 500 | 514 | 496 | 2.72 | 2.89 | .50 | | | 111 |
| | Final | 500 | 514 | 496 | | | .46 | 17,000 | | |
| | Final | 500 | 514 | 496 | | | .50 | | | |

TABLE 2.
Average and Peak Values

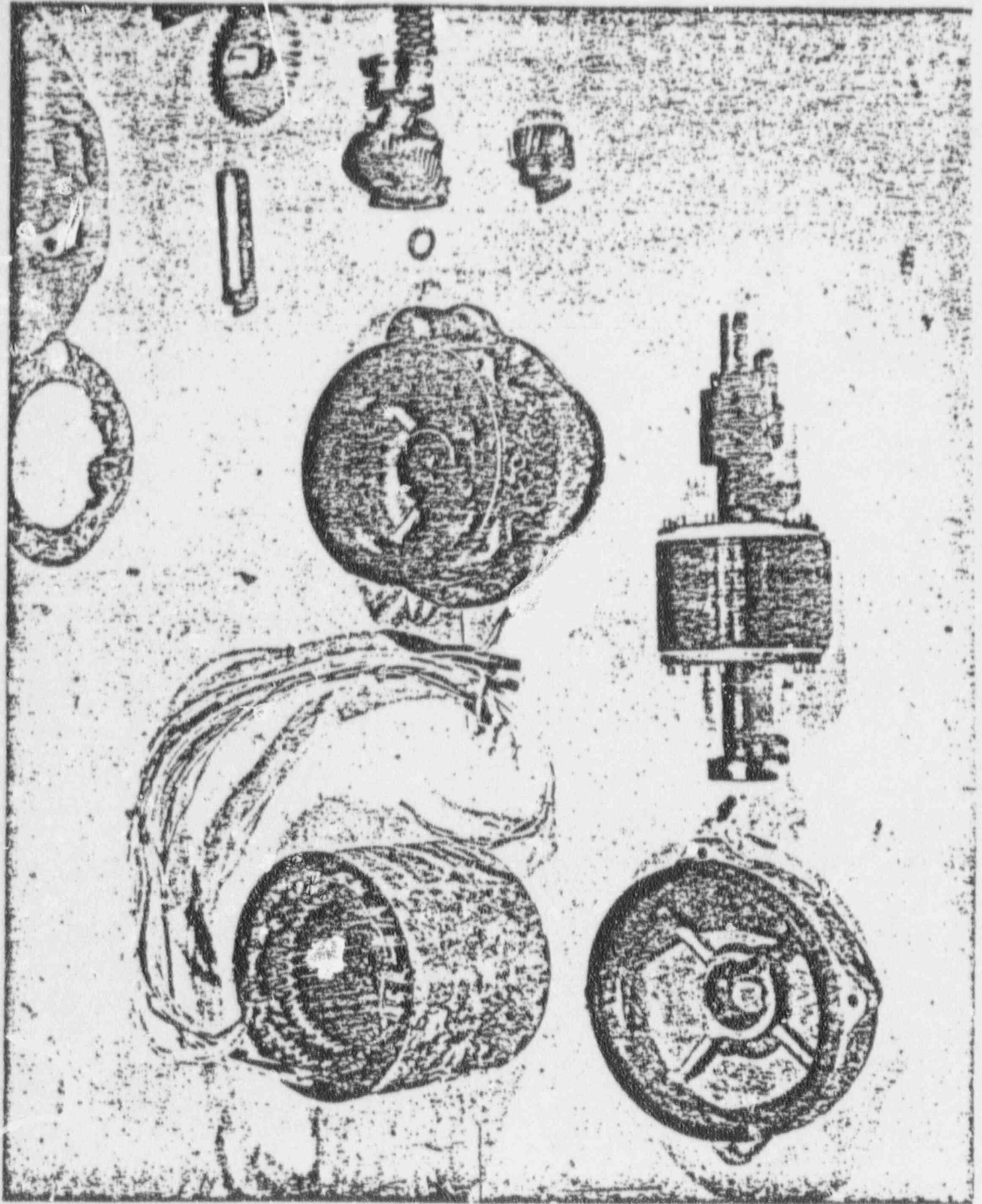
PERFORMANCE TEST OF LIMITORQUE VALVE OPERATOR

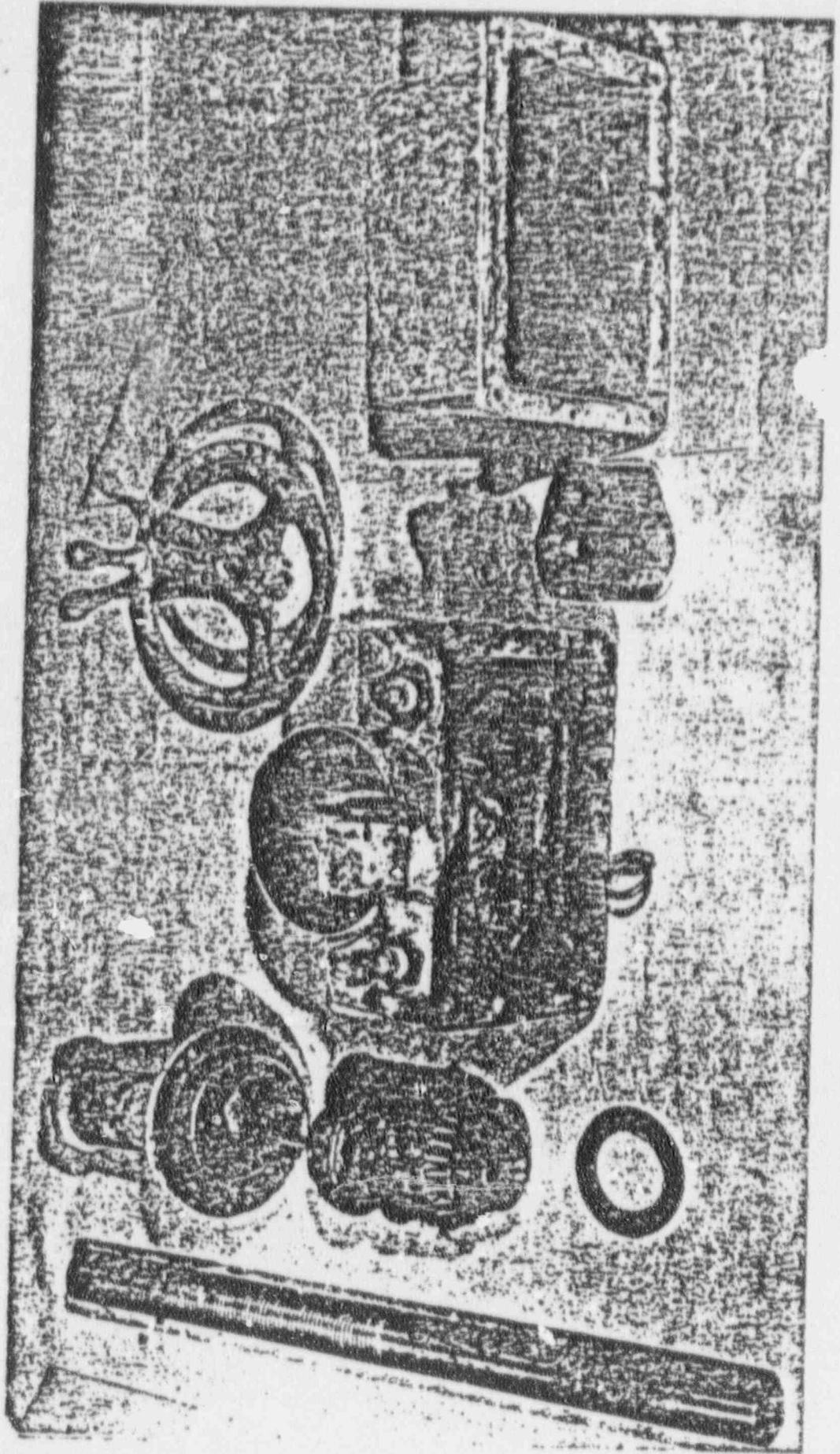
| Oct. 31 | <u>Test Pressure Psig</u> | <u>Ave. Volt- age -3 φ</u> | <u>Ave. Current</u> | <u>Peak Current</u> | <u>Power Peak KW</u> |
|---------|---------------------------|----------------------------|---------------------|---------------------|----------------------|
| | | 503.3 | 2.97 | 3.40 | 1.30 |
| | | 509.3 | 2.85 | | .90 |
| | 90 | 506.7 | 2.92 | 3.45 | 1.57 |
| | | 506.7 | 2.62 | | 1.15 |
| | | 504 | 2.88 | Missed | 1.54 |
| | | 504.7 | 2.76 | | 2.00 |
| | 70 | 503.3 | 3.01 | 3.30 | 1.50 |
| | | 506.7 | 2.80 | | 1.40 |
| | | 509.3 | 3.00 | 3.40 | 1.45 |
| | | 510 | 2.89 | | .85 |
| | 40 | 510.7 | 3.02 | 3.30 | 1.44 |
| | | 510.7 | 2.92 | | .78 |
| | | 510.7 | 3.04 | 3.30 | 1.39 |
| | | 510 | 2.92 | | 1.21 |
| | 20 | 510.7 | 3.03 | 3.40 | 1.45 |
| | | 510.7 | 2.93 | | .76 |
| | | 503.3 | 2.92 | 3.40 | 1.35 |
| | | 503.3 | 2.78 | | 1.09 |
| | 15 | 503.3 | 2.91 | | 1.42 |
| | | 503.3 | 2.80 | | 1.48 |
| | | 503.3 | 2.90 | | 1.52 |
| | | 503.7 | 2.80 | | .88 |
| | Final | 503.7 | | | 1.52 |
| | Final | 507.7 | | | .95 |

030055

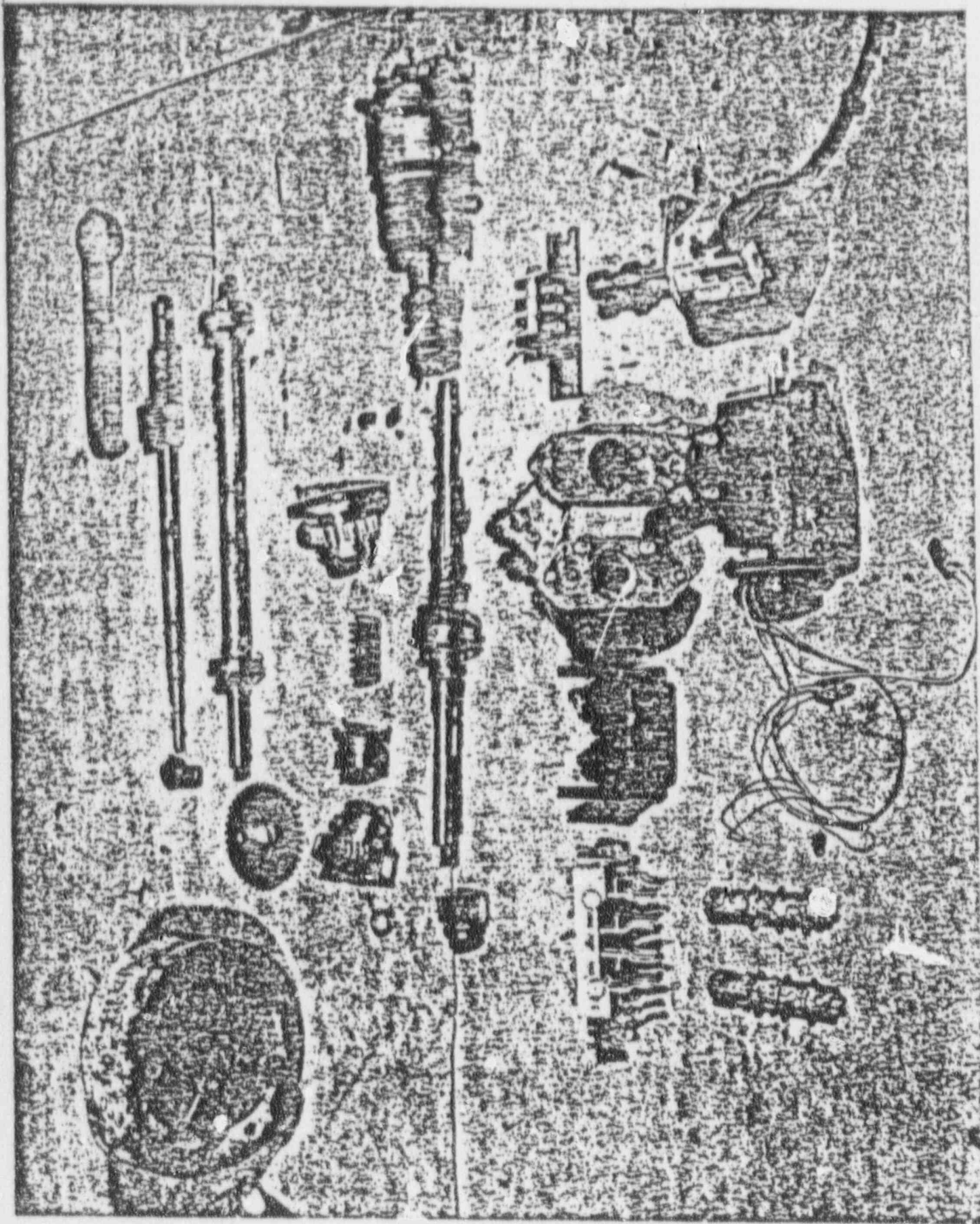
PHOTOGRAPHS
OF
LIMITORQUE OPERATOR PARTS

DISASSEMBLED AFTER ENVIRONMENTAL TEST





850018



030059

ADDENDUM #1

030070

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA, PENNA. 19406

LIMITORQUE VALVE CONTROL

ADDENDUM NUMBER #1
TEST OF LIMITORQUE VALVE OPERATOR
TO MEET GENERAL REQUIREMENTS
OF
AN ELECTRIC VALVE ACTUATOR
IN
NUCLEAR REACTOR CONTAINMENT ENVIRONMENT
REPORT OF JANUARY 2, 1969

- A. SHOCK & VIBRATION TEST
- B. TEST OF LIMIT SWITCH WITH MATERIAL CHANGE

APRIL 29, 1969

A. SHOCK AND VIBRATION TEST:

The Limitorque Operator size SMB-0 with a 15 foot pound, 3 phase, 60 cycle, 440 volt motor, nameplate order #338164 was shipped to Lockheed Electronics Company environmental laboratory and tested on March 10, 1969.

Test Procedure

The test specimen was secured to a vibration machine and subjected to five cycles of vibration in both the vertical axis and the horizontal axis. Each cycle consisted of two minutes of vibration at a frequency of thirty-five (35) cps and an acceleration level of three (3) "G's", followed by one minute of no vibration.

Vibration scans were also conducted in both axis of vibration between five to thirty-five cps to determine the presence of any resonances.

Visual inspections for evidence of any external physical damage were conducted throughout the vibration testing. The vibration test was completed with no visual evidence of any external physical damage. No resonances were detected during the vibration scans.

The above is included in Lockheed Electronics Company Test Report #2268-4618.

April 29, 1969

070072

The previous shock and vibration test of a Limitorque Operator was extended to 1 G and 25 cps. The above test extended the level to 3 G's at 35 cps.

B. TEST OF GEARED LIMIT SWITCH WITH MATERIAL CHANGE:

On the previous test of a Limitorque Operator as submitted January 2, 1969, a failure occurred due to the action of the chemical spray on the material of the gear frame of the geared limit switch. This caused the premature failure of the geared limit switch. The gear frame material has been changed as previously recommended and an additional test of this revised geared limit switch has been conducted at The Franklin Institute Research Laboratories in Philadelphia, Pennsylvania on April 9 through April 16, 1969. The geared limit switch was placed in the same environmental chamber as the previous test and was used in conjunction with starting and stopping an electric motor also in the test chamber. The environment consisted of a seven day test wherein the geared limit switch was exposed to high steam pressure, temperature and chemical environment similar to the previous test.

The new geared limit switch successfully completed the test with no sign of wear or deterioration due to the steam pressure,

April 29, 1969

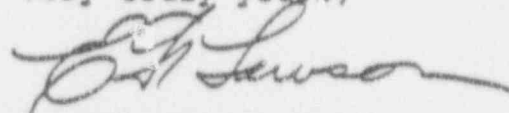
070073
temperature or chemical environment. The test was completely
satisfactory in every respect.

CONCLUSION:

The material change of the geared limit switch has been noted and will be included on all Limitorque Operators subjected to this environmental condition when specified.

This information is submitted as an addendum to our Test Report dated January 2, 1969.

Very truly yours,



Edward F. Lawson
Sales Manager
Limitorque Division

EFL/sls

030074

5.3 G's, 35 Hz.

PHILADELPHIA GEAR CORPORATION

industrial gears • speed reducers • fluid mixers • limitorque valve controls • precision ground gearing

Main Office:
Schuylkill Expressway, Suburban Phila.
KING OF PRUSSIA, PA. 19406
TELEPHONE: 265-3000

030078

SUBJECT: REPORT OF TEST ON LIMITORQUE VALVE CONTROL
SHOCK & VIBRATION UP TO 5.3 G's, 35 Hz

Gentlemen:

On August 20, 1970 a seismic shock and vibration test was conducted on a Limitorque operator size SMB-0-25 suitable for nuclear containment vessel service at the Lockheed Electronics Company in Plainfield, New Jersey.

The Limitorque operator was mounted on a test stand and having a threaded valve stem being driven by the Limitorque operator simulating opening and closing a valve. The Limitorque operator was electrically connected so as to stop at the full close position by means of our torque switch and stop at the full open position by means of our geared limit switch. The Limitorque operator had a 4-train geared limit switch installed and all contacts not being used for motor control were wired to electric indicating lights at a remote panel.

The enclosed Lockheed Test Report shows that this unit successfully completed a 5.3 G shock level at 35 Hz with no discrepancies noted. An exploratory scan of 5 Hz to 35 Hz was made and no critical resonant frequencies were noted on the Limitorque operator. The unit was shocked and vibrated in each of three different axes a total of 2 minutes on, 1 minute off, three times per axis. The unit was operated electrically to both the full open and full close

C30076

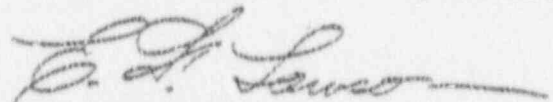
position and all torque switches and limit switches functioned properly. None of the auxiliary limit switches wired to indicating lights ever flickered or indicated they were opening or flickering. All electrical and mechanical devices on the operator worked successfully.

An additional test level of 10 G's at a maximum of 49 Hz was conducted as noted in the test. The Limitorque operator had no defects during the first two minutes of operation at the 10 G level; however, upon starting the second run, the hardware holding the geared limit switch loosened and we decided to discontinue the test. At that time the unit had been subjected to a total of 9 minutes of shock and vibration at 10 G's and 49 Hz.

The enclosed Test Report #2539A-4723 of Lockheed Test Lab. is submitted for your information.

Very truly yours,

PHILADELPHIA GEAR CORPORATION



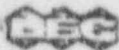
Edward F. Lawson, Sales Manager
Limitorque Division

ak
enc.

Test Report No. 2539A-4723

Issue 2

**REPORT OF TEST
on**LIMITORQUE CORPORATION
GMB-0-25
VALVE OPERATORReport Writer: R. F. Soltis
R. F. SoltisTest Engineer: W. A. Black
W. A. Black**LOCKHEED ELECTRONICS COMPANY**
PLAINFIELD, NEW JERSEYDate: September 23, 1970Approved by: Nat Johnson
N. Johnson, Supervisor
Environmental Laboratory



PURPOSE OF TEST: To subject the test specimen to the Seismic Test referenced in Limatorque Corporation Purchase Order Number 348572, dated 8/6/70.

MANUFACTURER: Limatorque Corporation
5114 Woodall Road
Lynchburg, Virginia 24502

SPECIMENS TESTED: SM3-0-25 Valve Operator

APPLICABLE DOCUMENTS: Limatorque Corporation Purchase Order Number 348572, dated 8/6/70.

CASE NUMBER: 34-8041-0723

QUANTITY OF SPECIMENS TESTED: One (1)

SECURITY CLASSIFICATION OF SPECIMENS TESTED: Unclassified

DATE TEST COMPLETED: 8/20/70

TEST CONDUCTED BY: LOCKHEED ELECTRONICS COMPANY
ENVIRONMENTAL LABORATORY

DISPOSITION OF SPECIMENS TESTED: Returned to Limatorque Corporation per LEC Packing Slip Number 66227, dated 8/24/70.

ABSTRACT: The test specimen was subjected to the Seismic Test referenced in Limatorque Corporation Purchase Order Number 348572, dated 8/6/70.

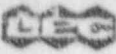
The 5.3G portion of testing was completed with no discrepancies noted.

The 10 G portion of testing was terminated during the second cycle due to noted fatiguing of the gear limit switch mounting hardware.

TEST APPARATUS: Reaction-Type Vibration Machine, LAB Company Model RVH-72-5000, S/N 51401.

Vibration Meter, MB Company Model M-6, S/N 423.

Vibration Pickups, MB Company Type 120, S/N 11263 and Type 124, S/N 14074.



TEST PROCEDURE:

The test specimen was secured to the vibration machine, as shown in Figure 1, and subjected to an exploratory scan over the frequency range of 5 to 31 Hz in two (2) axes. The exploratory scans were followed by three (3) cycles of vibration in each axis. Each cycle consisted of two (2) minutes of vibration at a frequency of 35 Hz and an acceleration level of 5.3G's followed by one (1) minute of no vibration.

The test specimen was then set up as shown in Figure 2 and subjected to the above mentioned test in the third axis. At completion of this test, an additional exploratory scan was performed over the frequency range of 5 to 49 Hz and two (2) cycles were performed at a frequency of 48 Hz and an acceleration level of 10 G's.

The test specimen was energized during testing and all electrical monitoring was performed by Limitorque Corporation personnel.

TEST RESULTS:

The 5.3 G portion of testing was completed with no evidence of any discrepancies noted during either axis of test.

During the exploratory scan of the 10 G portion of testing, the gear limit switch mounting hardware loosened. These screws were tightened prior to the start of the first cycle.

The first cycle at 10 G's was then completed with no discrepancies noted. After approximately one (1) minute of the second cycle, the test was terminated due to fatiguing of the gear limit switch mounting hardware.

For additional information, refer to the five (5) attached data sheets.

RECOMMENDATIONS:

None. Data merely submitted.

Test Engineer: W. A. Black Job
W. A. Black

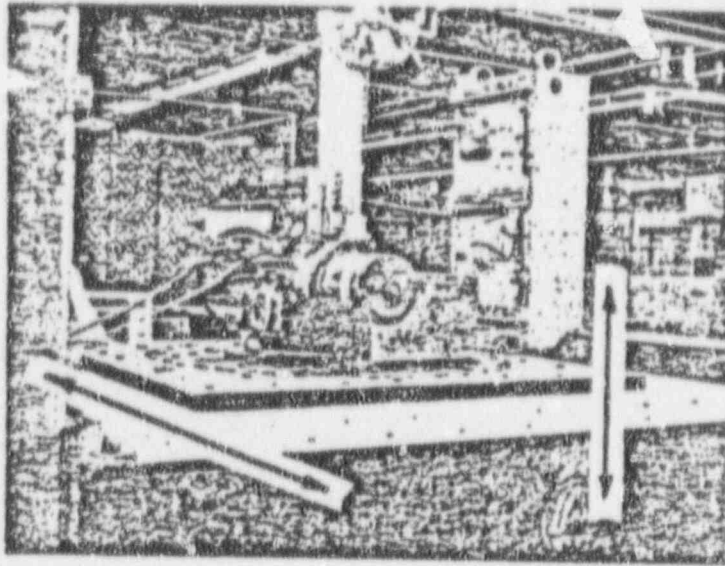


FIGURE 1

VIBRATION TEST SETUP
(HORIZONTAL AND VERTICAL)

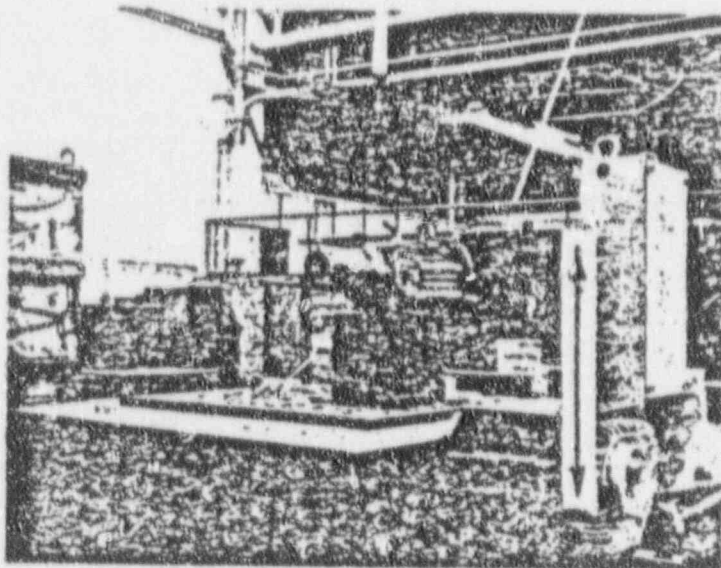


FIGURE 2

VIBRATION TEST SETUP
(VERTICAL)

LOCKHEED ELECTRONICS
 ENVIRONMENTAL LABORATORY DATA SHEET ISSUE 2

070091

Date: 8
 21-70

Specimen Description

SMB-0-25 VIB. OPERATOR
 P111 GEAR

Case: 31
 8044-0793

Technician
 L. J. Perry

Test Condition EXPLORATORY SCAN

SCAN 5-33 CPS. VERTICAL EARTH QUAKE
 VIB. TEST

Test
 Engineer

7/10/68

| VERTICAL | | | |
|----------|------|----|------|
| HR | GRA | LR | GRA |
| 5 | .076 | 32 | .007 |
| 6 | .076 | 33 | .066 |
| 7 | .076 | 34 | .066 |
| 8 | .076 | 35 | .066 |
| 9 | .075 | | |
| 10 | .075 | | |
| 11 | .072 | | |
| 12 | .072 | | |
| 13 | .071 | | |
| 14 | .071 | | |
| 15 | .070 | | |
| 16 | .069 | | |
| 17 | .069 | | |
| 18 | .069 | | |
| 19 | .069 | | |
| 20 | .068 | | |
| 21 | .068 | | |
| 22 | .068 | | |
| 23 | .068 | | |
| 24 | .068 | | |
| 25 | .068 | | |
| 26 | .068 | | |
| 27 | .068 | | |
| 28 | .067 | | |
| 29 | .067 | | |
| 30 | .067 | | |
| 31 | .067 | | |

TOTAL SCAN TIME = 5 MIN.

LOCKHEED ELECTRONICS
 ENVIRONMENTAL LABORATORY DATA SHEET, ISSUE 2

030092

Date: 8
30-70

Specimen Description

5MB-0-25 VALVE OPERATOR
 PHILI SCAR.

Case: 3Y
804-0723

Technician
W. J. Frye

Test Condition

EXPLORATORY SCAN
 HORIZONTAL
 5-35 cps. EARTH QUAKE
 VIB. TEST

Test Engineer

WALL

| HE | HQA | HE | HQA | |
|----|------|----|------|---|
| 5 | .095 | 32 | .084 | Total SCAN TIME = 5 MIN. 5.3 G's |
| 6 | .098 | 33 | .084 | |
| 7 | .096 | 34 | .084 | |
| 8 | .094 | 35 | .084 | |
| 9 | .092 | | | |
| 10 | .092 | | | |
| 11 | .092 | | | |
| 12 | .090 | | | |
| 13 | .090 | | | |
| 14 | .090 | | | |
| 15 | .090 | | | |
| 16 | .088 | | | |
| 17 | .090 | | | |
| 18 | .090 | | | |
| 19 | .088 | | | |
| 20 | .088 | | | |
| 21 | .088 | | | |
| 22 | .085 | | | |
| 23 | .088 | | | |
| 24 | .088 | | | |
| 25 | .088 | | | |
| 26 | .088 | | | |
| 27 | .088 | | | |
| 28 | .086 | | | |
| 29 | .086 | | | |
| 30 | .086 | | | |
| 31 | .086 | | | |

LOCKHEED ELECTRONICS
 ENVIRONMENTAL LABORATORY DATA SHEET ISSUE 2

030093 Date: 8

20-70

Specimen Description 5MB-0-25 VALUE OPERATOR
 PAIR GEAR

Case: 34
 80410703

Technician
 G. J. J. J.

Test Condition EXPLORATORY SCAN
 VERTICAL WITH UNIT STANDING
 0.25 IN. PLATE
 V.I.B. TEST.

Test Engineer

7/20/68

| | | | | | | | Remarks |
|----|--------|-------|--|--|--|--|--------------------------|
| IN | " DIA. | | | | | | Total Scan Time = 3 MIN. |
| 5 | .1 | | | | | | |
| 6 | .1 | | | | | | |
| 7 | .1 | | | | | | |
| 8 | .1 | | | | | | |
| 9 | .095 | | | | | | |
| 10 | .096 | | | | | | |
| 11 | .096 | | | | | | |
| 12 | .094 | | | | | | |
| 13 | .092 | | | | | | |
| 14 | .092 | | | | | | |
| 15 | .092 | | | | | | |
| 16 | .092 | | | | | | |
| 17 | .090 | | | | | | |
| 18 | .090 | | | | | | |
| 19 | .090 | | | | | | |
| 20 | .090 | | | | | | |
| 21 | .090 | | | | | | |
| 22 | .090 | | | | | | |
| 23 | .089 | | | | | | |
| 24 | .088 | | | | | | |
| 25 | .088 | | | | | | |
| 26 | .088 | | | | | | |
| 27 | .088 | | | | | | |
| 28 | .088 | | | | | | |
| 29 | .088 | | | | | | |
| 30 | .086 | | | | | | |
| 31 | .086 | | | | | | |
| 32 | .086 | | | | | | |
| 33 | .086 | | | | | | |
| 34 | .086 | | | | | | |
| 35 | .086 | 5.3 G | | | | | |

LOCKHEED ELECTRONICS
ENVIRONMENTAL LABORATORY DATA SHEET ISSUE 2

030084

Date: 8
2070

Specimen Description

303-0-25 VALVE OPERATOR.
PANEL GEAR.

Case: 87
8-K-0722

Technician
L. J. [unclear]

Test Condition

EXPLORATORY SCAN
VERTICAL WITH UNIT STANDING.
CARTON QUART
VIB. RT.

Test Engineer

W. G. [unclear]

| | | | | | Remarks | | | |
|-----|------|-----|-----|------|--------------------------|--|--|--------|
| LT. | 10A | 10B | 10C | 10D | | | | |
| 5 | 1 | | 39 | .086 | TOTAL SCAN TIME = 7 MIN. | | | |
| 6 | 1 | | 39 | .086 | | | | |
| 7 | 1 | | 40 | .086 | | | | |
| 8 | .075 | | 41 | .086 | | | | |
| 9 | .095 | | 42 | .086 | | | | |
| 10 | .096 | | 42 | .086 | | | | |
| 11 | .095 | | 44 | .086 | | | | |
| 12 | .094 | | 45 | .086 | | | | |
| 13 | .094 | | 46 | .086 | | | | |
| 14 | .095 | | 47 | .086 | | | | |
| 15 | .085 | | 48 | .086 | | | | 10 g's |
| 16 | .086 | | 48 | .086 | | | | 10 g's |
| 17 | .084 | | 50 | | | | | |
| 18 | .084 | | | | | | | |
| 19 | .084 | | | | | | | |
| 20 | .082 | | | | | | | |
| 21 | .082 | | | | | | | |
| 22 | .082 | | | | | | | |
| 23 | .082 | | | | | | | |
| 24 | .082 | | | | | | | |
| 25 | .082 | | | | | | | |
| 26 | .082 | | | | | | | |
| 27 | .082 | | | | | | | |
| 28 | .082 | | | | | | | |
| 29 | .081 | | | | | | | |
| 30 | .086 | | | | | | | |
| 31 | .086 | | | | | | | |
| 32 | .086 | | | | | | | |
| 33 | .082 | | | | | | | |
| 34 | .082 | | | | | | | |
| 35 | .082 | | | | | | | |
| 36 | .086 | | | | | | | |
| 37 | .086 | | | | | | | |

LOCKHEED ELECTRONICS
ENVIRONMENTAL LABORATORY DATA SHEET C30085

Date:
F-20-70

Specimen Description
SMB-0-25
VALVE OPERATOR

Case: 34-
3041-0723

Technician
R. Soltz

Test Condition
CYCLING TEST

Test Engineer

JCS

| AXIS | CYCLE | VIBRATION INPUT | TIME | |
|------|-------|-----------------|---------|--|
| NO. | NO. | G'S | MINUTES | |
| 1 | 1 | 5.3 | 2 | AXIS #1 = VERTICAL VIBRATION AS SHOWN IN FIGURE 1 AXIS #2 = HORIZONTAL VIBRATION AS SHOWN IN FIGURE 2 (PARALLEL TO SHAFT) AXIS #3 = VERTICAL VIBRATION AS SHOWN IN FIGURE 2 5g INPUTS WERE APPLIED AT 25 HZ, 10g INPUTS WERE APPLIED AT 43 HZ |
| | | 0 | 1 | |
| | 2 | 5.3 | 2 | |
| | | 0 | 1 | |
| | 3 | 5.3 | 2 | |
| | | 0 | 1 | |
| 2 | 1 | 5.3 | 2 | TEST STOPPED AT THIS TIME DUE TO FATIGUING OF MOUNTING HARDWARE |
| | | 0 | 1 | |
| | 2 | 5.3 | 2 | |
| | | 0 | 1 | |
| | 3 | 5.3 | 2 | |
| | | 0 | 1 | |
| 3 | 1 | 10.0 | 2 | |
| | | 0 | 1 | |
| | 2 | 10.0 | 1 | |
| | | | | |
| | | | | |
| | | | | |