Technical

FINAL REPORT
F-C2232-01

Report

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

by

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Prepared for

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King of Prussia, Pennsylvania

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THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
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SUMMARY

A Model SMB-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

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. Preconditioning 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-0 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:	P	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) Torque 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 temperature recorder mounted on the upper right wall, the dual channel pressure recorder mounted directly below and the Limitorque and 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.

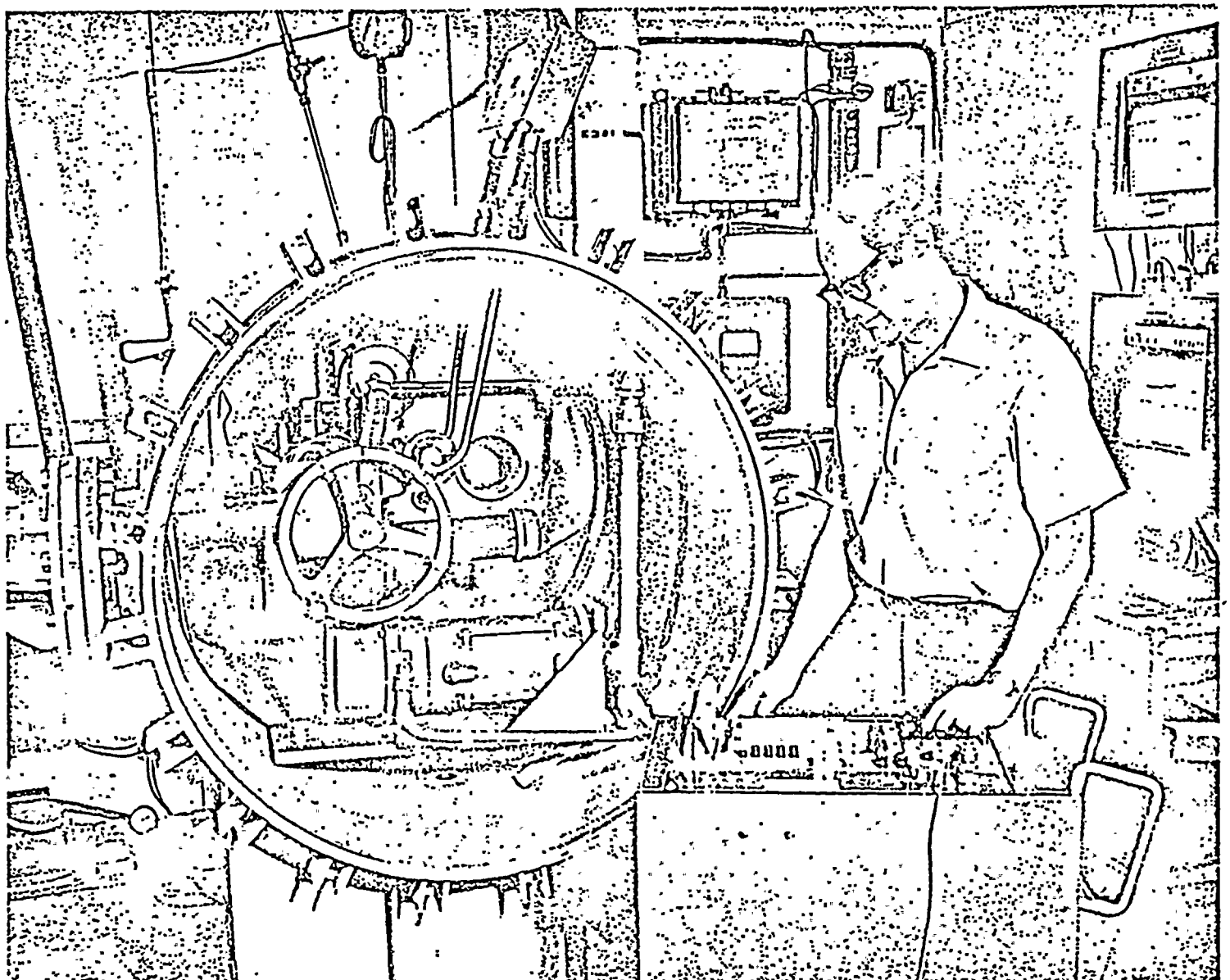


Fig. 1 - Test Facility Before Test

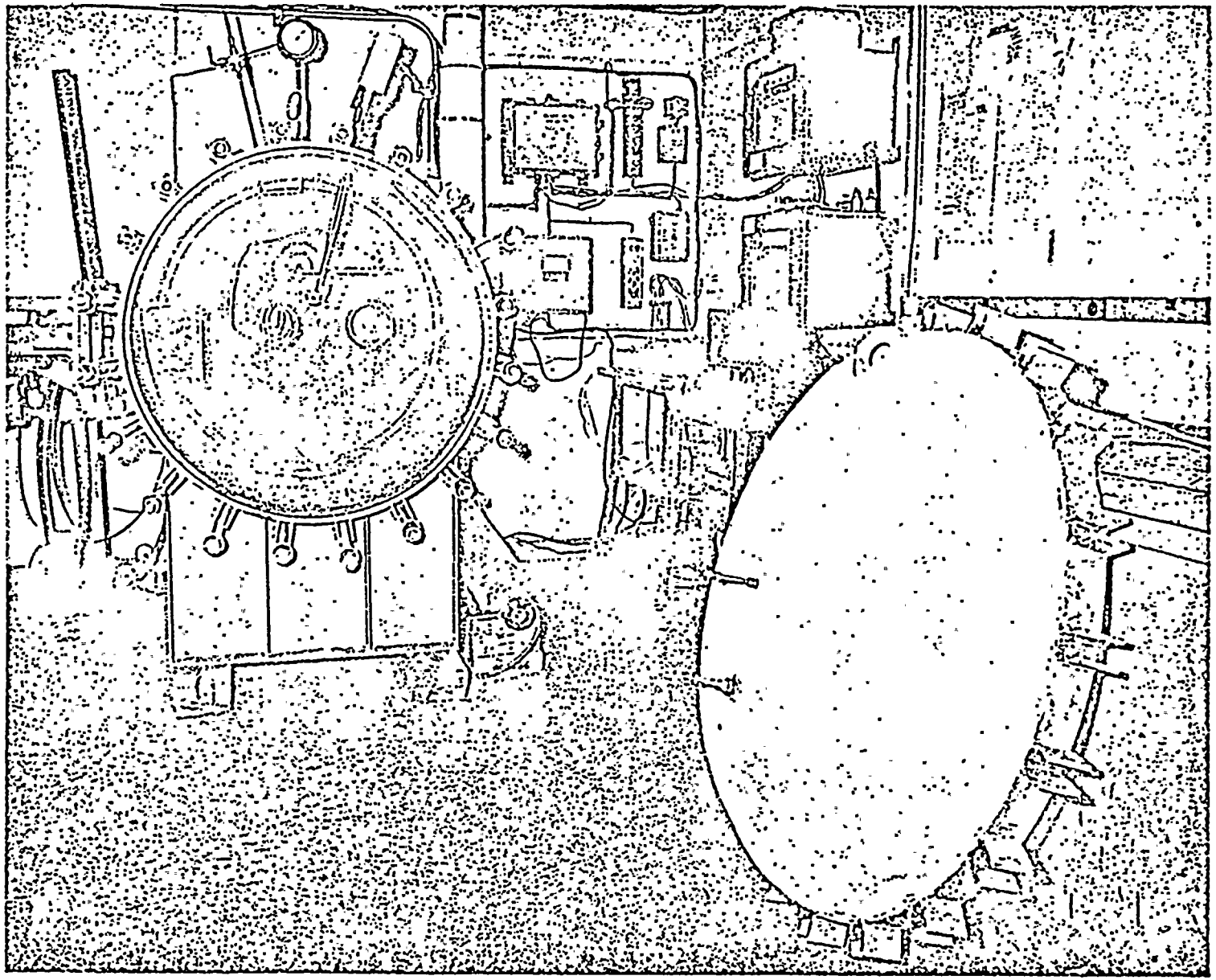


Fig. 2 - Test Facility After Test

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 auxilliary 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 megohmeter 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 megohmeter.

(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.

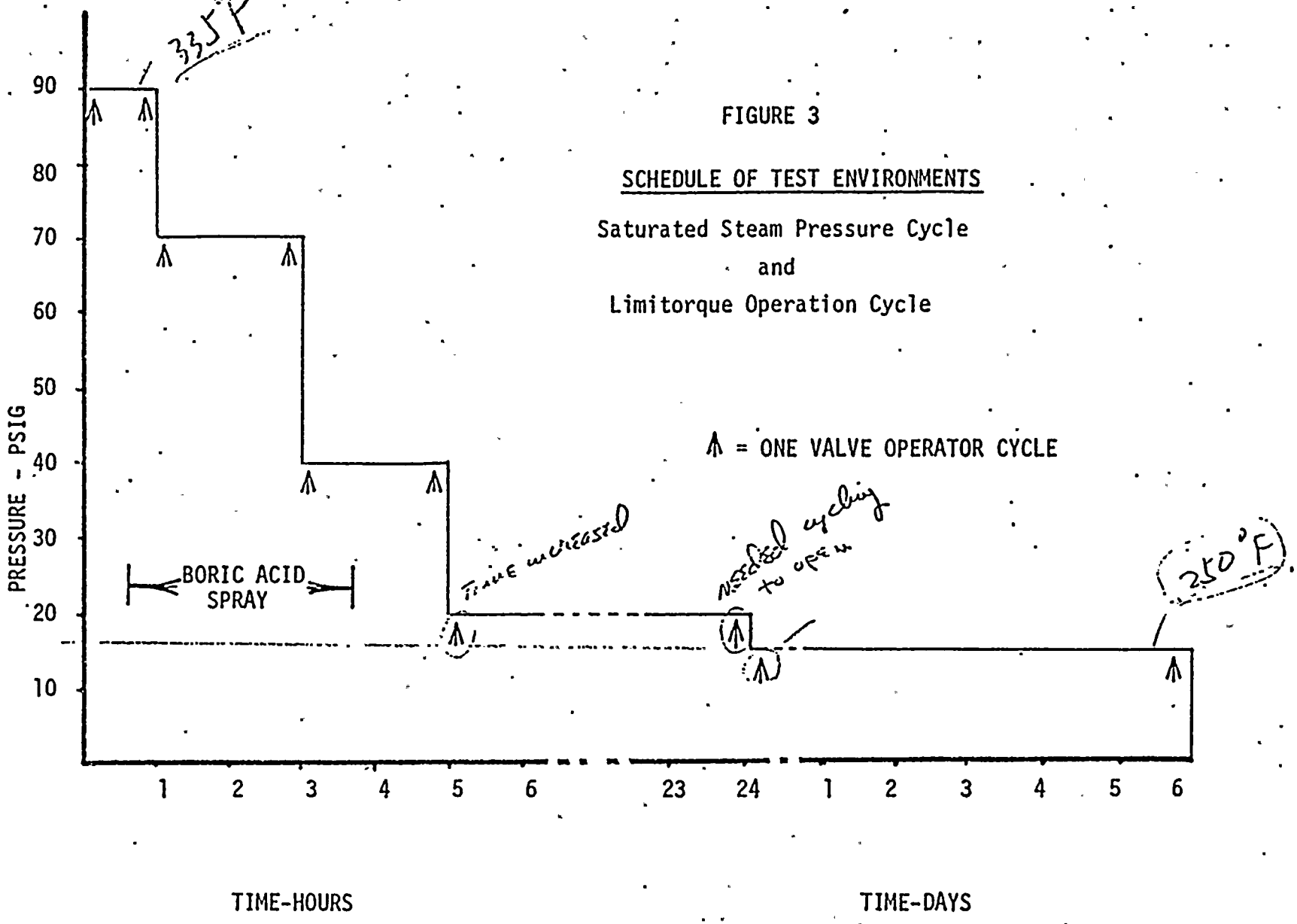
FIGURE 3

SCHEDULE OF TEST ENVIRONMENTS

Saturated Steam Pressure Cycle

and

Limitorque Operation Cycle



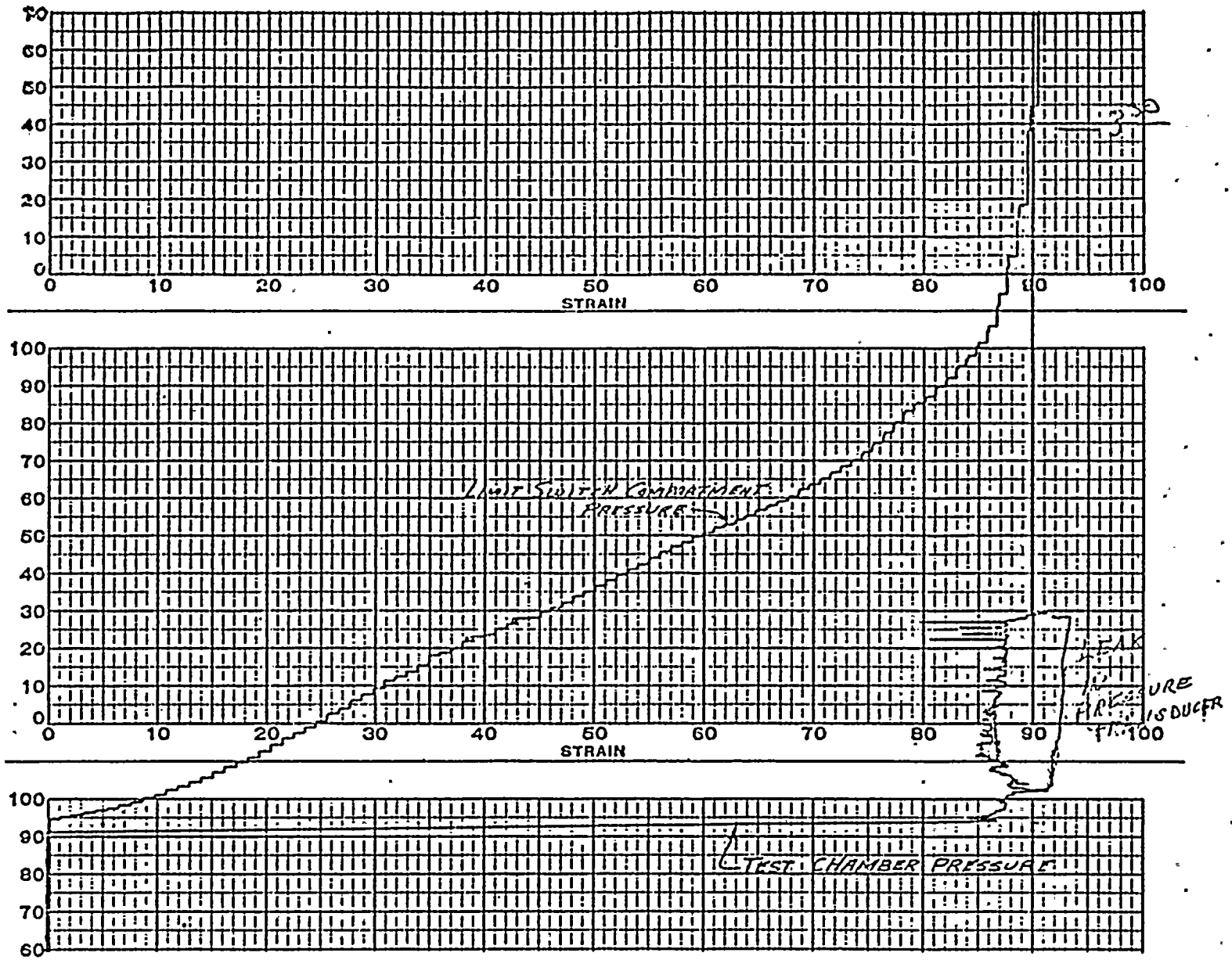


Fig. 4 - Recording of Initial Pressure Rise to 90 psig.

(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) Limitorque 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 preceeding 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) Limitorque 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 well 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 severly 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".

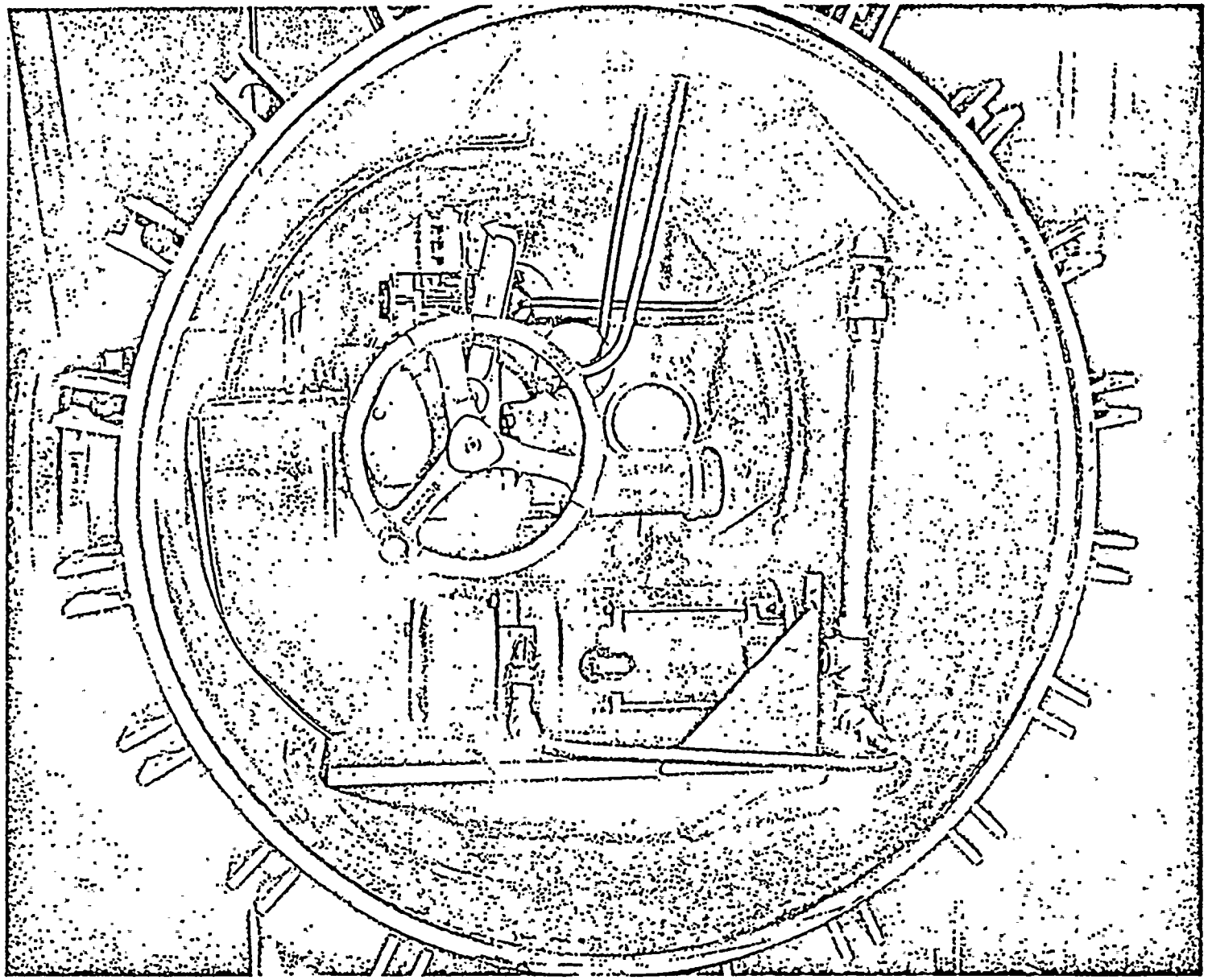


Fig. 5 - Limitorque and Motor-Brake Before Test

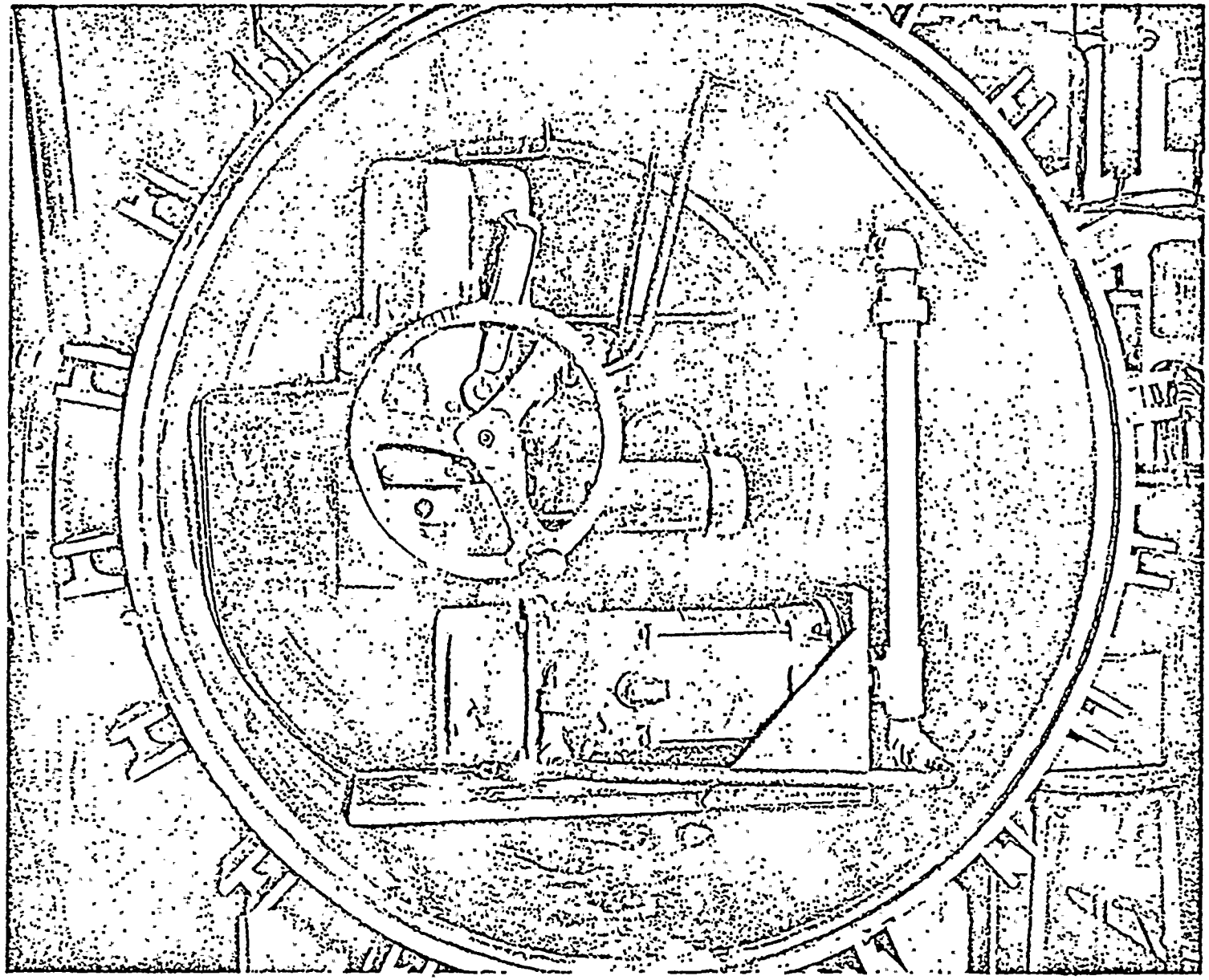


Fig. 6 - Limitorque and Motor-Brake After Test

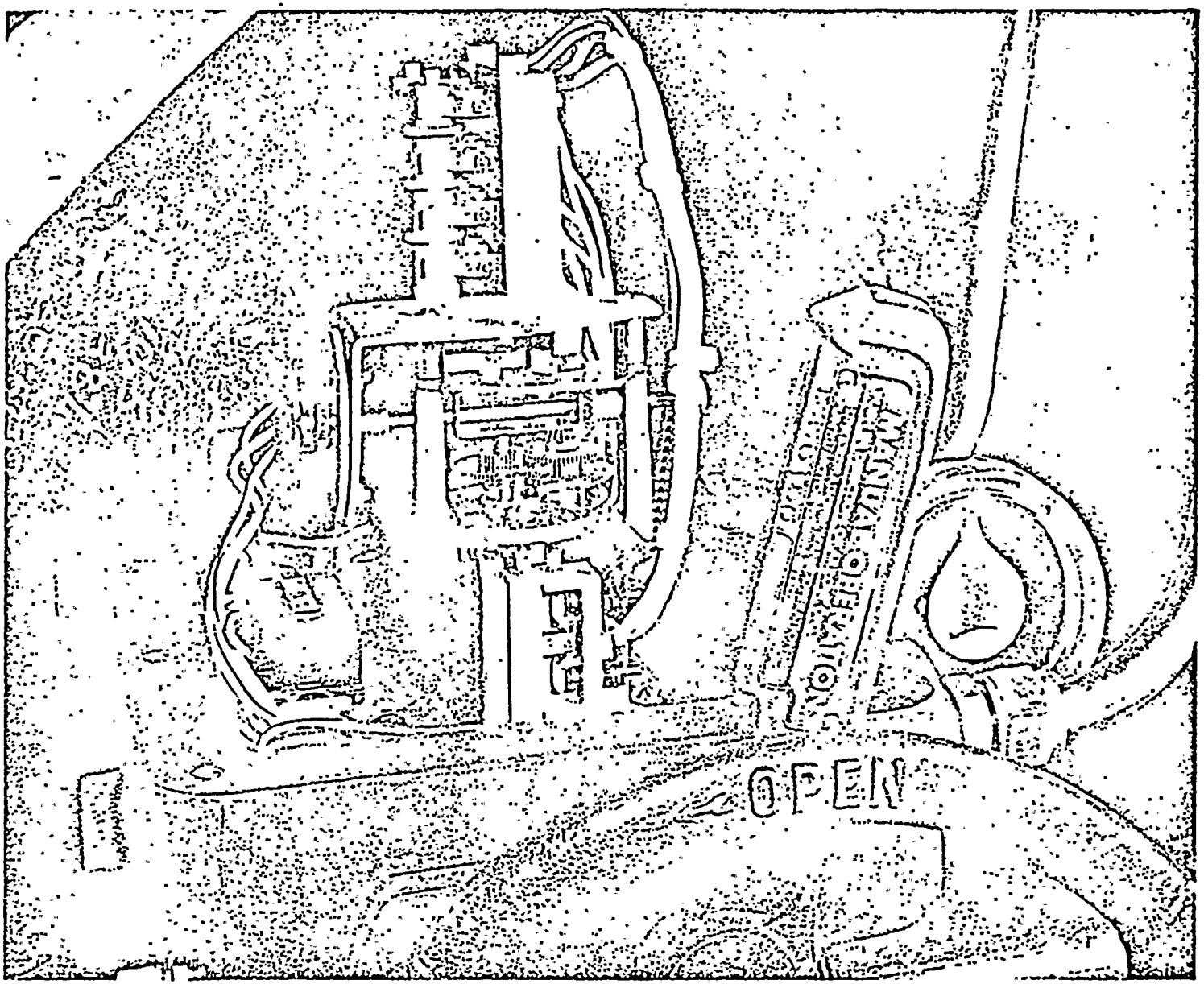


Fig. 7 - Limit Switch Compartment Before Test

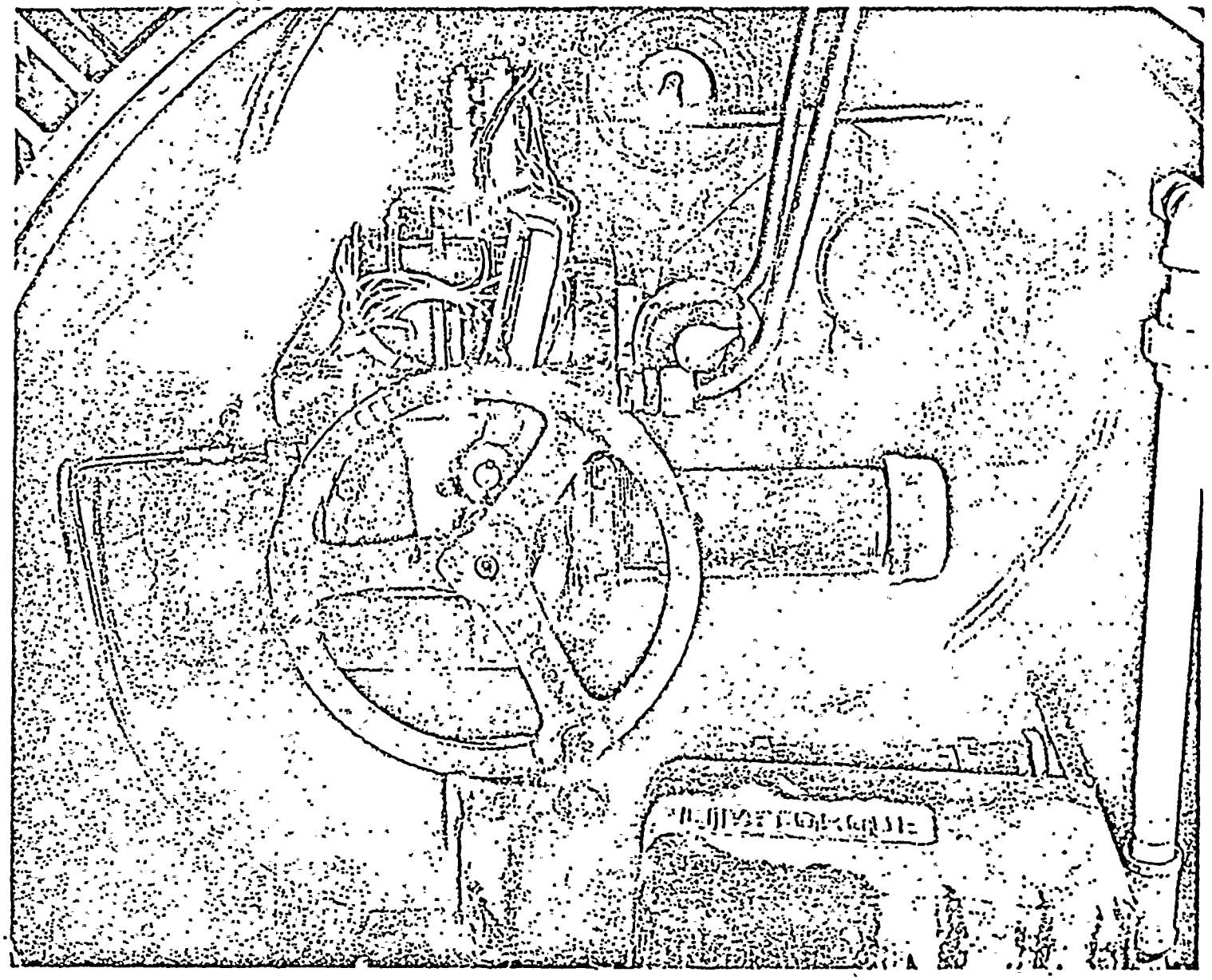


Fig. 8 - Limit Switch Compartment After Test

APPENDIX I

TEST DATA SHEETS

31I-C2232-01 Date Oct. 31, 1968

ENVIRONMENT TEST CYCLE

TEST LEVEL I

Time at Start of Test: 10/31/1401 Hour 1515

Initial Pressure 15 Psig Temp. 142 °F

Pressure Rise Time: 14 Seconds

Chamber: Press. 90 PSIG Temp. 329 °F

Test Unit: Press. 90 Psig Temp. 328 °F

First Test Cycle of Motor: 1521 Hours
at this Level

Start of Boric Acid Spray (40 minutes after Level I)

Time: 1555 Hour _____ Minutes

Boric Acid Flow Rate: 1555 gph

Temp. 70.7 °F ph 7.67

Second Test Cycle of Motor
at this Level: Time: 1610 Hour

End of Level I:

Time: 1615 Hours

Chamber Press. 91 psig Temp. 329 °F

Unit Press. 91 psig Temp. 329 °F

31I-C2232-01

Date Oct. 31, 1968
L. E. Witcher

ENVIRONMENT TEST CYCLE

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

Time Level Reached: 1618 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

31I-C2232-01

Date Oct. 31, 1968
L E. Witcher

ENVIRONMENT TEST CYCLE

TEST LEVEL NO. IV DESIGNATED STEAM PRES'S. 20 PSIG SATURATION TEMP. 259 °F

Time Level Reached: 2022 Hours

Time from Previous Level: 4 Minutes

Chamber Press: 20 psig Temp.: 272 °F

Test Unit: Temp. 271 °F Press. 20 Psig

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

4.7 MO

Boric Acid Spray

Flow Rate none Temp. _____ °F PH _____

i. Nov. 1, 1968

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

End of Level No. _____

Time: 1517 Hour

Chamber Temp. 256 °F Press. 20 Psig.

Unit Temp. 256 °F Press. 20 Psig.

31I-C2232-01

Date Oct. 31, 1968
L.R. Wilcher

ENVIRONMENT TEST CYCLE

TEST LEVEL NO. III — DESIGNATED STEAM PRESS. 40 PSIG — SATURATION TEMP. 287 °F

Time Level Reached: 1820 Hours

Time from Previous Level: 10 Minutes

Chamber Press: 40 psig Temp.: 300 °F

Test Unit: Temp. 287 °F Press. 40 Psig

First Test Cycle of Motor at this Level: Time: 1828 Hours

Boric Acid Spray

Flow Rate 10 gph Temp. 70.7 °F PH 7.62

Acid Spray stopped at 1955 hours

Second Test Cycle of Motor at this Level: Time: 2010 Hours

End of Level No. ____

Time: 2018 Hour

Chamber Temp. 287 °F Press. 41.0 Psig.

Unit Temp. 287 °F Press. 40.5 Psig

31I-C2232-01

Date Nov. 1, 1965
L. E. Witchen

ENVIRONMENT TEST CYCLE

	DESIGNATED		SATURATION	
TEST LEVEL NO. V	STEAM PRESS. 15	PSIG	TEMP. 250	°F

Time Level Reached: 1524 Hours

Time from Previous Level: 7 Minutes

Chamber Press: 15 psig Temp.: 250 °F

Test Unit: Temp. 250 °F Press. 16.2 Psig

First Test Cycle of Motor at this Level: Time: 1528 Hours

5.2 75

This level maintained continously through Nov 7, 1965

Boric Acid Spray

Flow Rate None Temp. _____ °F PH _____

Nov 7, 1965

Second Test Cycle of Motor at this Level: Time: 1528 Hours

End of Level No. Final Test Nov 7, 1965

Time: 1528 Hour

Chamber Temp. 247 °F Press. 14.7 Psig.

Unit Temp. 247 °F Press. 14.5 Psig

APPENDIX II.

Performance Test Data of Limitorque Valve Operator

Table 1, Collected Data.

Table 2, Average and Peak Values.

TABLE 1. #31=C2232-01

PERFORMANCE TEST DATA OF LIMITORQUE VALVE OPERATOR

COLLECTED DATA

Test Pres. Psig	Time	Line 1-2	Volt. 3-1	A-C 3-2	Current 1	Current 3	Pwr. KW	Stg. For-lbs.	Stem Close Seconds	Travel Open Seconds
	10/31									
0	1502	500	512	498	2.86	3.08	.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	287	.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			

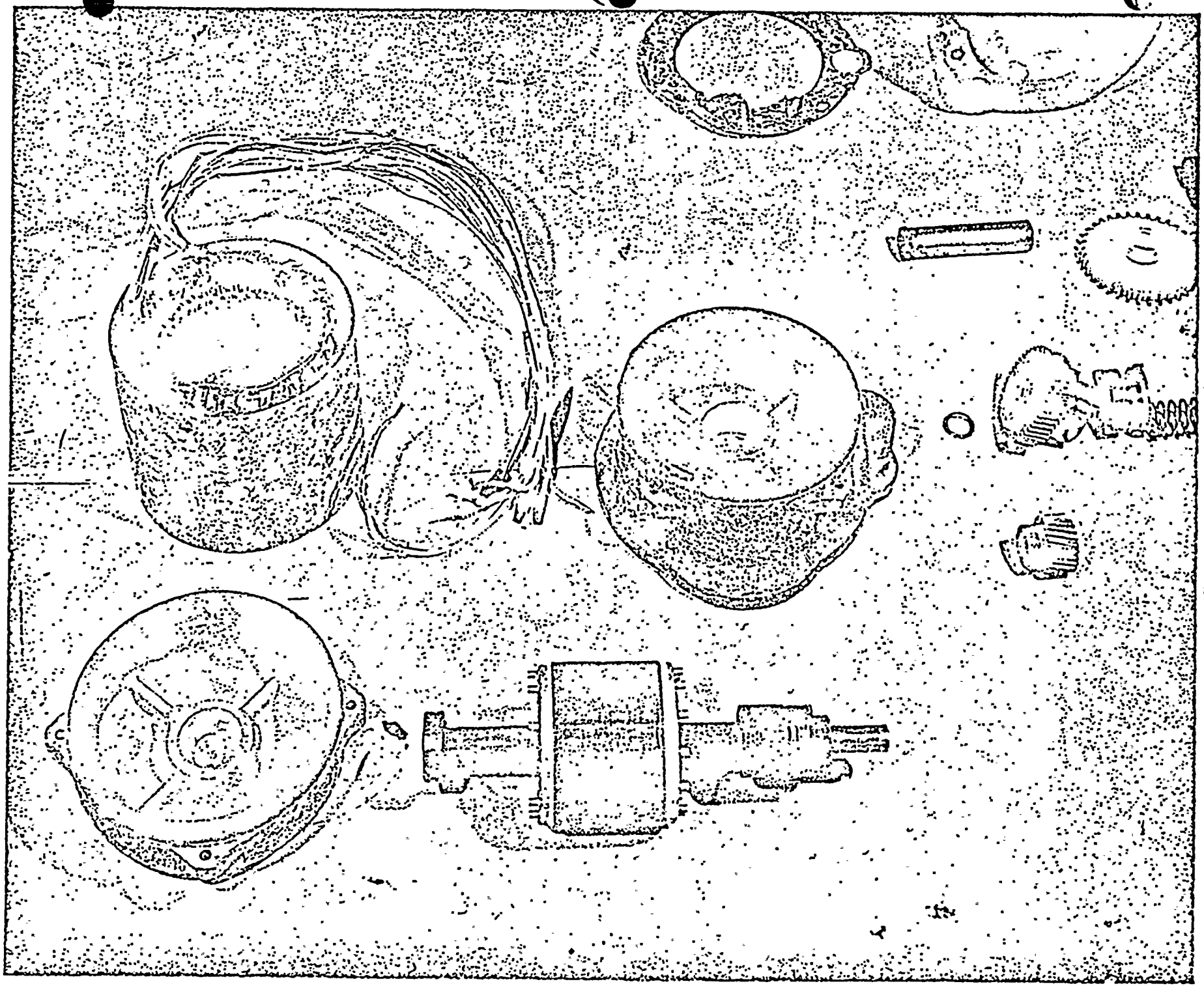
TABLE 2.
Average and Peak Values

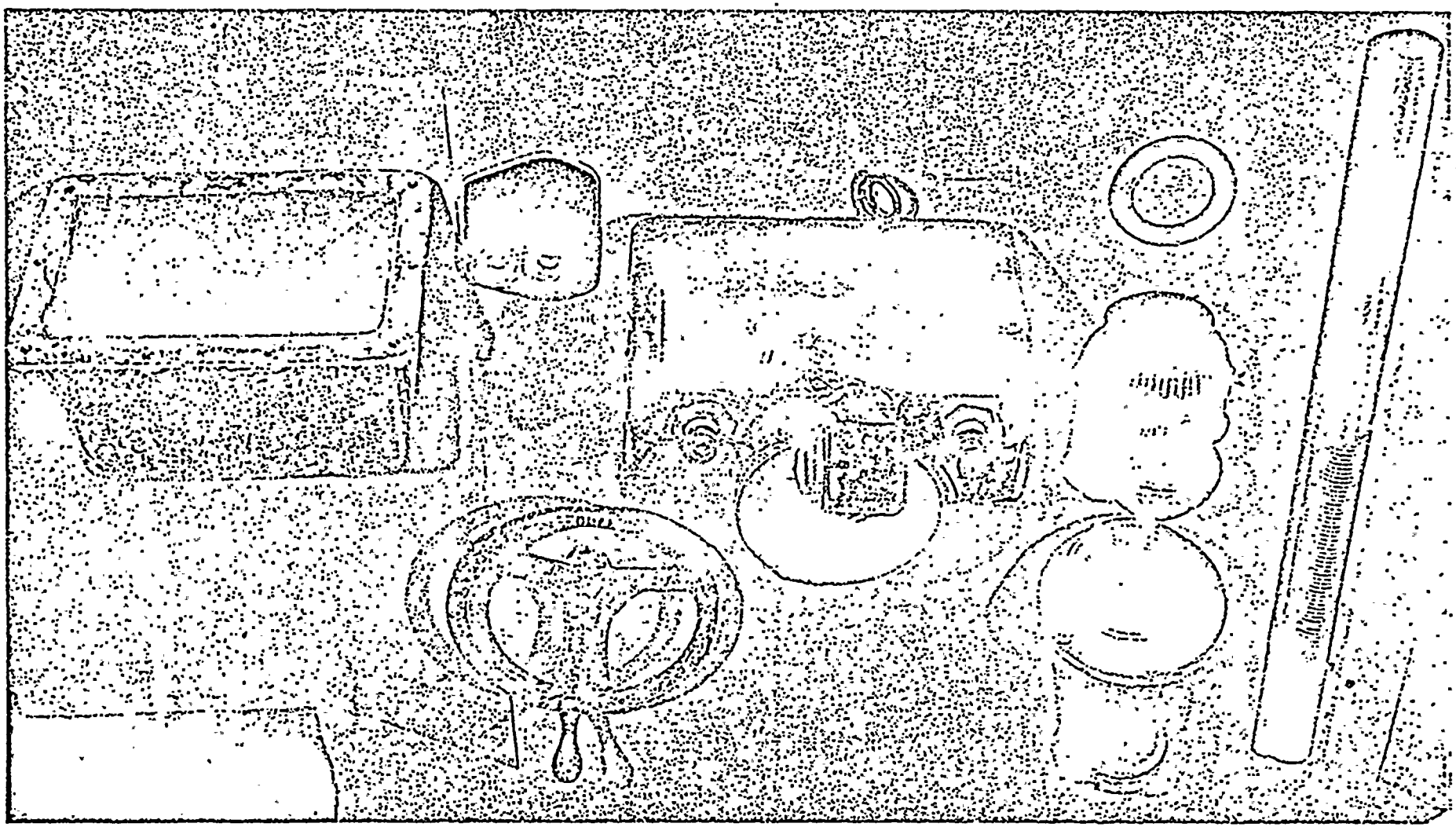
PERFORMANCE TEST OF LIMITORQUE VALVE OPERATOR

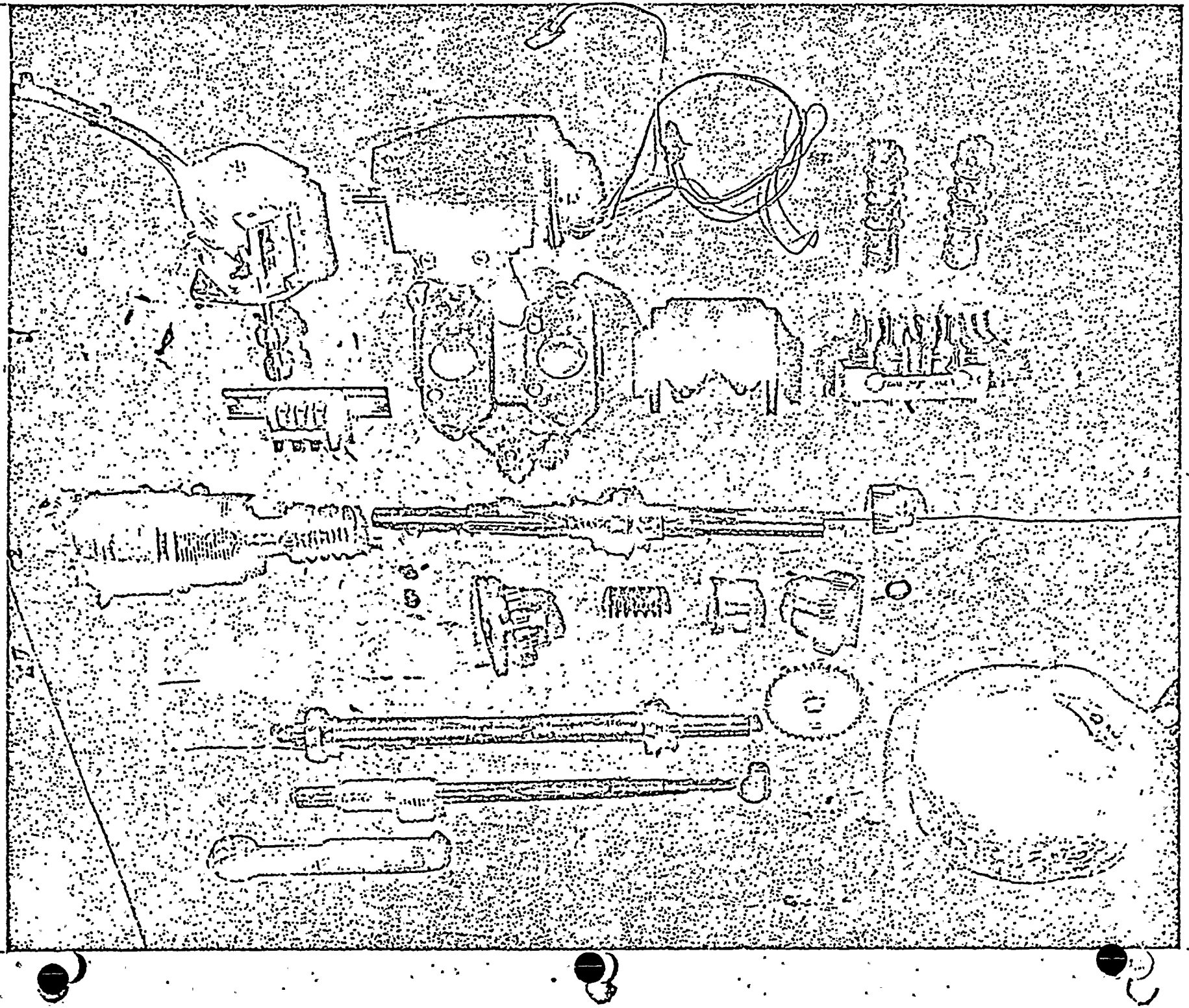
Oct. 31	Test Pressure Psig	Ave. Voltage -3 ϕ	Ave. Current	Peak Current	Power Peak KW
		503.3	2.97	3.40	1.30
		509.3	2.85		.90
	90	506.7	2.92	3.45	1.57
		506.7	2.62		1.15
		504	2.88	Missed	1.54
		504.7	2.76		2.00
	70	503.3	3.01	3.30	1.50
		506.7	2.80		1.40
		509.3	3.00	3.40	1.45
		510	2.89		.85
	40	510.7	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

PHOTOGRAPHS
OF
LIMITORQUE OPERATOR PARTS

DISASSEMBLED AFTER ENVIRONMENTAL TEST







PHILADELPHIA GEAR CORPORATION

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

May 2, 1969

Niagara Mohawk Corporation
300 Electric Building
Buffalo, New York 14203

Attention: Mr. Steve Podkowinski

Subject: Addendum Number I
To Test Report Of Limitorque Valve Actuator
In Nuclear Reactor Containment Environment

Reference: Report of January 2, 1969

Gentlemen:

You previously received a complete test report, dated January 2, entitled:

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

Addendum Number I to this report is submitted for your information. Please include this Addendum Report as part of the original Test Report, dated January 2, 1969.

I trust this Addendum will be circulated among your various Engineers involved with this equipment.

Very truly yours,

PHILADELPHIA GEAR CORPORATION

Edward F. Lawson

Edward F. Lawson, Sales Manager
Limitorque Division

EFL:mb
Incl.