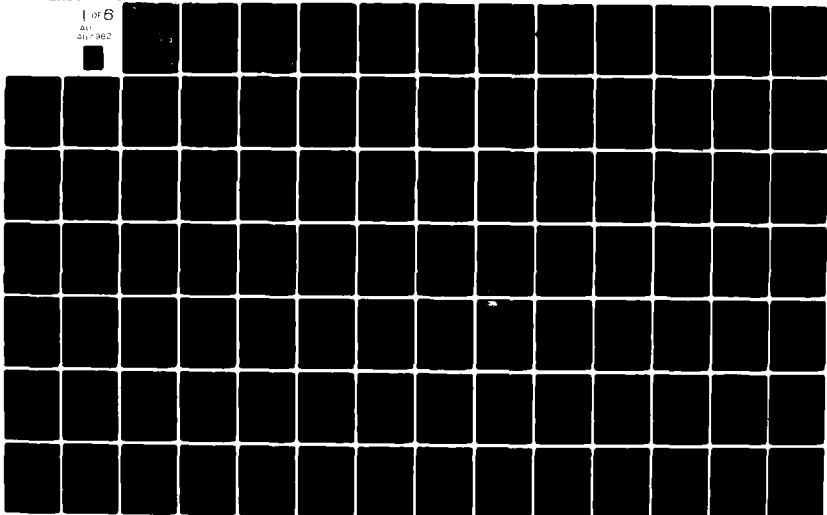


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BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
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BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS  
ON FIXED DISPLACEMENT HYDRAULIC FLUID POWER  
VANE PUMPS

Testing was conducted at the Milwaukee School of Engineering by the Fluid Power Institute for US Army MERADCOM under contract DAAK70-81-C-0002 from December 1980 through April 1982

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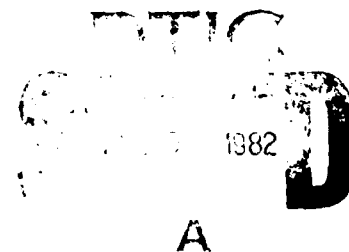
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Milwaukee, Wisconsin



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19. SUPPLEMENTARY NOTES  
Final technical report

20. KEY WORDS (Continue on reverse side if necessary and identify by block number)  
Hydraulic Fluid Power Vane Pumps      Thermal Stability Tests  
Break-In and Performance Tests  
Accelerated Life Tests  
1000 Hour Endurance Tests

21. ABSTRACT (Continue on reverse side if necessary and identify by block number)  
This report summarizes the results obtained in evaluating 21 vane pumps from three different manufacturers on overall performance, accelerated life, 1000 hour endurance and thermal stability tests.

REPORT OF INVENTIONS  
 (Submitted to Patent Office)

DD FORM 100, MAR 1967

This form (in triplicate) is for use in submitting INTERIM and FINAL reports to the Contracting Officer.

An INTERIM report shall be submitted at least every twelve months, commencing with the date of the contract, and should include only those inventions and subcontracts which the information requested below has not previously been reported.

A FINAL report shall be submitted as soon as practicable after the work under the contract is completed. It shall include a summary of all inventions reported by the contractor since the last INTERIM report, including all inventions previously reported and any inventions since the last INTERIM report which the information requested below has not previously been reported.

1. NAME AND ADDRESS OF CONTRACTOR (Include ZIP Code) Milwaukee School of Engineering, Fluid Power Institute 1025 North Milwaukee Street Milwaukee, Wisconsin 53217	2. CONTRACT NUMBER DAH073-02-1-0002 DATE OF DELETION (if any) 3. INTERIM REPORT
---	--

SECTION I - INVENTIONS (Include Invention Name and Date of Invention)

A. INVENTION DATA (Listed below are all inventions required to be reported)	B. PATENT APPLICATION	C. CONTRACTOR HAS FILED OR IS FILING APPLICATION	D. YES		E. NO	
			YES	NO	YES	NO
NAME OF INVENTOR	TITLE OF INVENTION	INDICATE SERIAL NUMBER, INVENTOR, OR CONTRACTOR OR INCLUDE IDENTIFICATION NUMBER				
None	None	None				

SECTION II - SUBCONTRACTS (Include Name and Date)

A. LISTED BELOW IS INFORMAL OR REQUIRED CONTRACT INFORMATION FOR SUBCONTRACTS WHICH HAVE BEEN	B. CONTRACT NUMBER	C. DATE SUBCONTRACT WAS FURNISHED TO CONTRACTING OFFICE	D. DATE SUBMITTED TO CONTRACTING OFFICE
NAME AND ADDRESS OF SUBCONTRACTOR (Include ZIP Code)			
None		None	None

CONTRACTOR CERTIFIES THAT THIS REPORT OF INVENTIONS IS TRUE AND CORRECT TO THE BEST OF THE CONTRACTOR'S KNOWLEDGE AND BELIEF.

DATE 7-15-82	NAME AND TITLE OF AUTHORIZED REPRESENTATIVE Thomas S. Wanke Director, Fluid Power Institute	SIGNATURE <i>Thomas S. Wanke</i>
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SIGNATURE PAGE

The undersigned testify that to the best of their knowledge that the data contained in this report was collected using the referenced instrumentation and that testing and data collection utilized good laboratory technique.

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## INTRODUCTION

This report contains the results obtained from evaluating twenty-one positive displacement hydraulic fluid power pressure balanced vane pumps under contract #DAAK70-81-C-0002 from December 1980 through April 1982. The evaluation program consisted of the following major parts:

1. Industry Surveys
2. Break-in and Performance Tests
3. Endurance Tests
4. Thermal Stability Tests

The U.S. hydraulic fluid power pump manufacturers were surveyed to determine their break-in procedures on vane pumps and their thermal stability test procedures on various types of pumps ie. (gear, vane, piston). The survey results were summarized and used to develop a universal break-in procedure for vane pumps and universal thermal stability test procedure for pumps in general.

Seven vane pumps each from three different manufacturers; Vickers, Denison and Rexroth were tested according to the universal break-in procedure after which they were performance tested at multiple speeds, pressures, and temperatures to determine overall efficiency characteristics. One pump from each manufacturer was broken-in using oil contaminated with AC Fine Test Dust to determine if the contamination would effect break-in and performance characteristics. The remaining six pumps from each manufacturer were broken-in on clean oil.

The pumps broken-in on clean oil were subjected to one of two types of endurance tests. The first test was 500,000 cycles in length and lasted 140 hours. The pump's outlet pressure was cycled from 200 psi to 115 percent of rated pressure at rate of 60 hertz. The other test was 1000 hours in length and the outlet pressure was cycled from 200 psi to rated pressure at a rate of 60 hertz. Both endurance tests ran with a contamination level of less than 100 particles per millilitre greater than 10 micrometres.

The performance tests were conducted in accordance with NFPA T3.9.17R1 Draft 5 dated March 20, 1980. The 1000 hour endurance test was conducted in accordance with MIL-P52675 dated January 15, 1970. The other endurance test was conducted in accordance with MERADCOM test procedure "Method of Establishing the Durability of a Fixed Displacement Fluid Power Pump Tested in Lots" dated February 1980. These test procedures are included in appendicies in this report.

The pumps evaluated in this test program had the following ratings:

Pressure: 2500 → 3000 psi  
Displacement: 2.73 in<sup>3</sup>/rev → 3.05 in<sup>3</sup>/rev  
Speed: 1800 rpm → 2800 rpm

The test fixtures, equipment, instrumentation, and instrument calibration procedures utilized in this program are the same as the ones developed under contract DAAK70-77-C-0214, "Gear Pump Studies".

## BREAK-IN PROCEDURE SURVEY SUMMARY

The January 1981 Hydraulics and Pneumatics Designers Guide to Fluid Power Products was used to determine the companies to be surveyed. Originally 17 companies were surveyed. Follow up telephone calls revealed that 8 of the 17 companies actually manufactured their own vane pumps. The remaining companies were distributors or they purchased another company's pump and put their own name on it. Six of the 8 companies who are manufacturers responded to the survey which is 75%. One of the six respondents said all of their procedures were proprietary and, therefore, he could not reveal any information.

Only two of the six survey returns described break-in procedures which is 33.3%. One was a production acceptance test at 1200 and 1800 rpm from 0 to maximum pressure (not cycling) using a special fluid. The other procedure was also a production test which consisted of measuring flow at rated speed and pressure then dropping the pressure to 100 psi and measuring flow again. Then the speed is dropped to 600 rpm and the flow is measured at 1500 psi. The complete test lasts approximately 45 seconds. It is performed with SAE 10W oil at 130 and 180°F.

## BREAK-IN PROCEDURE SURVEY STATISTICAL RESULTS

Note: NA stands for No Answer.

### 1.0 Break-In Procedure General

1.1 Do you have a criterion for determining the point at which a pump is satisfactorily broken in?

YES	17%	NO	50%	NA	33%
-----	-----	----	-----	----	-----

1.2 Is your procedure based on developmental or laboratory studies?

Developmental	YES	33%	NO	0%	NA	67%
Laboratory	YES	17%	NO	17%	NA	66%

1.3 Has your procedure evolved over time and experience with product?

YES	33%	NO	0%	NA	67%
-----	-----	----	----	----	-----

1.4 Was your procedure arbitrarily arrived at?

YES	17%	NO	17%	NA	66%
-----	-----	----	-----	----	-----

1.5 Are identical procedures used in production prior to pro. shipment and in the service department?

YES	33%	NO	0%	NA	67%
-----	-----	----	----	----	-----

1.6 Do your engineering department recommendations or laboratory test procedures differ from 1.5 above?

YES	17%	NO	17%	NA	66%
-----	-----	----	-----	----	-----

### 2.0 Break-In Procedure Specifications

2.1 Do you conduct your pump break-in at:

Constant Pressure	YES	17%	NO	33%	NA	50%
Constant Speed	YES	33%	NO	17%	NA	50%
Constant Torque	YES	0%	NO	33%	NA	67%

2.2 Do you have contamination sensitivity test results on your pumps?

YES	17%	NO	33%	NA	50%
-----	-----	----	-----	----	-----

2.3 Do you have different break-in procedures for different Vane pump design features such as bearing types, bearing mounts, shaft seal types, and pressure loaded wear plates?

YES	0%	NO	67%	NA	33%
-----	----	----	-----	----	-----

3.0 Are you willing to submit to MSOE an oil sample from your break-in test stand for contamination particle counting and water content in exchange for the fluid analysis results at no charge to you?

YES 33% NO 17% NA 50%

5.0 Vane Pump Design Features	<u>YES</u>	<u>NO</u>	<u>NA</u>
Needle Bearings	17%	0%	83%
Roller Bearings	0%	0%	100%
Hydrodynamic Plain Bearings	17%	0%	83%
T.F.E. Plain Bearings Steel Backed	33%	0%	67%
T.F.E. Plain Bearings Filament Wound	0%	0%	100%
Resilient Shaft Seal	33%	0%	67%
Mechanical Shaft Seal	17%	0%	83%
Press Fit Bearing Mount	33%	0%	67%
Self-Aligning Bearing Mount	0%	0%	100%
Pressure Loaded Wear Plates	33%	0%	67%

6.0 Do you currently manufacture?

6.1 Fixed displacement vane pumps

YES 50% NO 17% NA 33%

6.2 Variable displacement vane pumps

YES 17% NO 50% NA 33%

7.0 Do you currently manufacture a fixed displacement vane pump in accordance with the following:

7.1 3 in<sup>3</sup>/rev displacement:

YES 33% NO 33% NA 34%

7.2 2500 - 3000 psi continuous pressure:

YES 33% NO 33% NA 34%

7.3 2500 - 3000 rpm continuous speed:

YES 33% NO 33% NA 34%

8.0 If you answered no to any questions in section 7, what are your ratings?

8.1 Displacement	0-2 in <sup>3</sup> /rev variable displacement	2.7
Pressure rating	2000, 1000	
Speed rating	1800 → 2400, 1000	

## BREAK-IN PROCEDURE FOR FIXED DISPLACEMENT VANE PUMP

The break-in procedure was developed using responses from a survey of vane pump manufacturers. The original survey is in Appendix A of this report.

1. Install the test pump in the Break-in and Performance test circuit.
2. Bring system temperature up to 120°F and verify system contamination level to be less than 100 particles per millilitre greater than ten microns.
3. Start the test pump and increase speed to manufacturers rated in less than one minute with the outlet pressure less than 250 psi.
4. Load the pump at the following pressure increments and time intervals. Set speed initially at manufacturers rated speed and minimum pressure which is less than 250 psi. Do not readjust the speed at each load pressure.
  - Minimum pressure for 2 minutes
  - 25% of continuous rated pressure for 2 minutes
  - Minimum pressure for 2 minutes
  - 50% of continuous rated pressure for 2 minutes
  - Minimum pressure for 2 minutes
  - 75% of continuous rated pressure for 2 minutes
  - Minimum pressure for 2 minutes
  - 100% of continuous rated pressure for 2 minutes
  - Minimum pressure for 2 minutesAt each data point, record inlet and outlet pressures and temperatures, input speed and torque and output flowrate.
5. Run the pump for three hours at maximum rated speed and maximum continuous rated outlet pressure. Record inlet and outlet temperatures and pressures, input speed and torque, and output flowrate every five minutes to determine changes in overall efficiency.
6. At test completion, take an oil sample and verify that the contamination level is less than 100 particles per millilitre greater than 10 microns.

CONTAMINATED OIL BREAK-IN PROCEDURE

One of the seven pumps from each manufacturer were broken in on contaminated oil. The oil was contaminated using AC Fine Test Dust to a level of 800 to 1000 particles per millilitre at ten micrometers. All other break-in procedures were identical to procedures mentioned on the previous page.

POWER CONVERSION TEST PROCEDURE FOR  
FIXED DISPLACEMENT VANE PUMPS

The pumps were tested in accordance with NFPA specification T3.9.17R1 which is included in appendix C of this report.

The pumps were tested using MIL 2104C grade 10 oil at two inlet temperatures, 120°F and 180°F. The tests were conducted at six outlet pressures, from 100% of manufacturers rated, to a minimum of 250 psi or less, in 20% increments. The tests were also conducted at five speeds, ranging from maximum rated speed, to 20% of maximum rated speed, in 20% increments. The pumps were run at each speed, with outlet pressure being varied from maximum to minimum, this produced a maximum of 30 data points at each temperature. Due to unstable conditions in the pump, some of the pumps could not be run at 20% of rated speed.



SUMMARIZED OVERALL EFFICIENCIES FOR  
THREE HOUR BREAK-IN TEST

The initial and final overall efficiencies do not necessarily represent the highest and lowest values obtained during the test. The averages shown were obtained using all the efficiencies calculated in the test, not just the initial and final.

A positive change indicates a higher overall efficiency at the end of the test, a negative charge indicates a lower overall efficiency at the end of the test.

MANUFACTURER CODE	FPI PUMP NUMBER	OVERALL EFFICIENCY			
		INITIAL	FINAL	AVERAGE	CHANGE
M1	348	80.18%	77.68%	77.95%	-2.5%
	349	81.26%	79.52%	79.85%	-1.74%
	350 *	77.26%	72.71%	72.74%	-4.55%
	351	81.39%	78.17%	80.43%	-3.22%
	352	81.61%	79.51%	79.78%	-2.1%
	353	79.65%	81.02%	80.37%	+1.37%
	354	82.06%	79.29%	79.39%	-2.77%
M2	355	83.15%	81.76%	82.04%	-1.39%
	356	82.99%	81.45%	82.12%	-1.54%
	357	81.17%	75.27%	79.07%	-5.9%
	358	83.41%	81.50%	82.23%	-1.91%
	359 *	81.06%	79.62%	81.22%	-1.44%
	360	78.61%	77%	77.6%	+ .39%
	361	78.79%	79.09%	79.89%	+0.3%
M3	362 *	79.43%	80.06%	79.14%	+0.63%
	363	82.42%	78.26%	80.66%	-4.16%
	364	81.02%	77.39%	78.02%	-3.63%
	365	75.29%	73.86%	73.37%	-1.43%
	366	81.05%	81.46%	81.83%	+0.41%
	367	80.25%	79.67%	80.13%	-0.58%
	368	77.95%	76.44%	77.17%	-1.51%

\* Pump broken in on dirty oil

SUMMARIZED OVERALL EFFICIENCIES AND SIMPLE DISPLACEMENT

POWER CONVERSION TEST

\*Data for pump #367 at 180° was not available due to a malfunction in the torque shaft. This caused erroneous efficiencies and displacement calculations. Therefore the data was omitted.

Manufacture Code	FPI Pump Number	120°F			180°F		
		Min. Overall Eff.	Max. Overall Eff.	Simple Displ. in <sup>3</sup> /rev.	Min. Overall Eff.	Max. Overall Eff.	Simple Displ. in <sup>3</sup> /rev.
M1	348	57.1%	88.1%	2.72	44%	85.3%	3.0
	349	57.5%	94.1%	2.75	42.3%	80.7%	2.75
	350 **	35.2%	77.7%	2.64	26.3%	69.1%	2.49
	351	58.7%	95.2%	2.73	35.7%	82.3%	2.67
	352	54%	92%	2.75	41.7%	81.1%	2.68
	353	50.6%	90.1%	2.74	24.6%	73.4%	2.62
	354	55.5%	89.4%	2.75	40.2%	81%	2.67
M2	355	58.9%	95.5%	2.77	51.8%	96.6%	2.72
	356	34.2%	88.3%	2.87	46.5%	91.5%	2.8
	357	40.2%	93.5%	2.74	24.8%	80.3%	2.71
	358	56.2%	96.7%	2.77	29%	82.3%	2.72
	359 **	51.7%	95.2%	2.77	26.3%	84%	2.74
	360	47.4%	83.6%	2.8	26.6%	80.8%	2.76
	361	52.8%	87.6%	2.84	27.3%	90.2%	2.8
M3	362 **	56.2%	81.8%	2.90	39.6%	78.9%	2.91
	363	59.9%	82.9%	2.94	55.2%	80%	2.9
	364	65.1%	84.8%	2.96	55.3%	84%	2.93
	365	48.5%	90%	2.98	53%	95.6%	2.89
	366	67.6%	88.6%	2.99	59.4%	92%	2.92
	367	38.4%	77.5%	3.0	*	*	*
	368	55.5%	79.4%	2.86	48.5%	79.9%	2.9

\*\* Pumps broken in on dirty oil

## BREAK-IN AND PERFORMANCE TEST OBSERVATIONS AND CONCLUSIONS

1. Sixteen of the twenty-one pumps had a decrease in overall efficiency at the end of the three hour break-in test. The drop in efficiency ranged from .058 to 5.9 percent. The remaining five pumps had an increase in overall efficiency at the end of the test. The increase in efficiency ranged from 0.30 to 1.43 percent.
2. One pump from Manufacturer M1, two pumps from Manufacturer M2, and two pumps from Manufacturer M3 had an increase in overall efficiency during the three hour break-in test.
3. The decrease in overall efficiency for all three manufacturers is due to a decrease in flowrate during the three hour test. The increase in overall efficiency for all three manufacturers is due to an increase in flowrate during the break-in test.
4. The change in flow can be caused by speed, pressure and temperature changes. During the three hour break-in test, the pressure and temperature were controlled closer to the target values as compared to the speed which varied by as much as 50 rpm. The variation in speed could account for as much as a 2 percent change in flow. Therefore, overall efficiency changes either plus or minus could be caused in part by variations in the test parameters and not a change in the operating characteristics in the pump.
5. It is the opinion of the writer that part of the overall efficiency change is caused by variations in test parameters, and part is caused by changes in pump operating characteristics.
6. The pumps broken in on contaminated oil from Manufacturers M1 and M2 had decreases in overall efficiency during the three hour break-in test. The pump from Manufacturer M3 had increased in overall efficiency which is small in comparison to the amount of decrease in overall efficiency which occurred in the other two pumps broken in on contaminated oil. The contaminated oil apparently created better sealing surfaces in the pump increasing volumetric efficiency.
7. The decrease in overall efficiency for Manufacturer M1's pump broken in on contaminated oil was the largest of all of M1's pumps and was caused by a decrease in flowrate. This pump also had the lowest overall efficiency of all of the M1 pumps. The contaminated oil apparently caused an irreversible decrease in volumetric efficiency.
8. The decrease in overall efficiency for the M2 pump broken in on contaminated oil was in the mid range of the M2 pump's efficiency change. Therefore, the contaminated oil apparently had no effects on efficiency.
9. The effects of contaminated oil during break-in are apparently dependant upon manufacturer's design, materials and production quality because the contaminated oil affected each manufacturer's pump in a different way.

10. Manufacturer M2 had consistently higher efficiencies than M1 and M3 at the start and finish of the three hour break-in test.
11. Manufacturer M2 also had consistently higher efficiencies on the power conversion test at both inlet temperatures.
12. For the twenty-one vane pumps tested the maximum overall efficiency varied from 77.5 to 96.7 percent at 120°F inlet temperature. At 180°F inlet temperature the maximum overall efficiency varied from 69.1 to 96.6 percent. The oil used in this test had a viscosity at 180°F lower than the minimum recommended by all three manufacturers. That is the reason why the efficiencies are lower at the high temperature.
13. Manufacturer M1's maximum overall efficiencies varied from 79.6 to 82.1 percent at 120°F inlet temperature and 77.9 to 80.4 percent at 180°F temperature. The pump broken in on contaminated oil was omitted from this analysis because it's efficiency was not representative of the other pumps. The range of efficiency at 120°F was 7.1 percent and 11.9 percent at 180°F. This was the smallest range of efficiencies for the three manufacturers.
14. Manufacturer M2's maximum overall efficiencies varied from 87.6 to 96.7 percent at 120°F inlet temperature and 80.3 to 96.6 percent at 180°F temperature. The range of efficiency at 120°F was 13.1 percent and 16.3 percent at 180°F. This was the greatest range of efficiencies for the three manufacturers.
15. Manufacturer M3's maximum overall efficiencies varied from 77.5 to 90 percent at 120°F inlet temperature and 78.9 to 95.6 percent at 180°F temperature. The range of efficiency was 12.5 percent at 120°F and 15.7 percent at 180°F.
16. For all three manufacturers, the range of maximum overall efficiencies were greater at 180°F than at 120°F inlet temperature. This condition is probably due to the oil's viscosity being lower than all three manufacturers minimum recommended.
17. Three pumps from Manufacturer M2 and two pumps from Manufacturer M3 had higher efficiencies at 180°F than at 120°F. The greatest increase was 5.6 percent and the smallest increase was 0.5 percent. The tabulated data showed a decrease in torque at 180°F as compared to the values at 120°F. This condition could explain the higher efficiencies.
18. All of manufacturer M2's pumps had a greater calculated displacement than was published in the catalog by the manufacturer. Apparently this manufacturer uses a worst case situation to rate their pumps.
19. The graphs of outlet flow verses differential pressure are linear functions for all of the pumps at both temperatures. For all of the pumps, the slope of the outlet flow differential pressure characteristics is the same for the different speeds.
20. Overall efficiency varies considerably at different temperatures, speeds and pressures for all pumps tested. At lower speeds and higher pressures the efficiency was lower than at higher speeds and medium pressures.

21. For most of the M1 pumps the highest efficiency at both inlet temperatures and all input speeds occurred at 1200 psi. The efficiency was approximately the same at all input speeds and both inlet temperatures when the pressure was 600 psi.
22. For most of the M2 pumps the highest efficiency at both inlet temperatures and all input speeds also occurred at 1200 psi. The efficiency was also approximately the same at all input speeds and both inlet temperatures when the pressure was 600 psi.
23. For the M3 pumps the highest efficiency was recorded at various pressures for both inlet temperatures. No trends could be observed. However, the efficiency was approximately the same at all input speeds and both inlet temperatures when the pressure was 500 psi for most of the pumps.
24. Manufacturer M3 pumps experienced a metallic rattling noise at lower speeds during the power conversion test. However, this condition did not effect the performance characteristics of the pumps. The manufacturer was contacted and their conclusion was that there was low oil viscosity, high inlet vacuum or air in the oil. However, none of these conditions were present. The other manufacturers pumps ran quietly on the same test setup.

### BREAK-IN AND PERFORMANCE TEST RECOMMENDATIONS

1. More break-in testing should be conducted to determine if the three hour run should be deleted or lengthened. Sixteen of the twenty-one pumps experienced irreversible flow degradation while the other five experienced increased flow. Apparently the three hour run has a detrimental effect on most of the pumps and therefore it should be deleted. Or, it should be shortened or lengthened until the pump experiences a certain percent increase or decrease in flowrate.
2. Conduct the three hour break-in test at a higher inlet temperature of 160 to 170°F rather than 120°F to determine the effects on overall efficiency.
3. Break-in more pumps on contaminated oil to determine the statistical analysis of the effects.
4. When using 10W oil for the power conversion tests, the 180°F inlet temperature should be lowered so that the pumps are tested with viscosity in the range recommended by the manufacturer.
5. Contact the manufacturers especially M2, to determine how they establish their volumetric displacement ratings.
6. Because the overall efficiency varies considerably with speed and pressure, manufacturers should be requested to present efficiency values at various operating conditions.

## BRIEF ACCELERATED LIFE AND ENDURANCE TEST PROCEDURES

Fifteen vane pumps, six pumps from Manufacturer M1, six pumps from Manufacturer M2, and three pumps from Manufacturer M3 were tested in five lots of 3 each. All manufacturers pumps which were tested are similar in key parameters with the exception of M3. The three pumps in each lot were all tested simultaneously on the same test rig and connected to a common reservoir. The tests consisted of cyclic endurance running at the same contamination level and the same cycle rate in accordance with Appendix K. The pressure cycle rate for the Accelerated Life Test and the 1000 Hour Endurance Test were the same, 1 cycle/per second. The contamination level was held to less than 100 particle per millilitre at 10 um for both the Accelerated Life Test and the 1000 Hour Endurance Test.

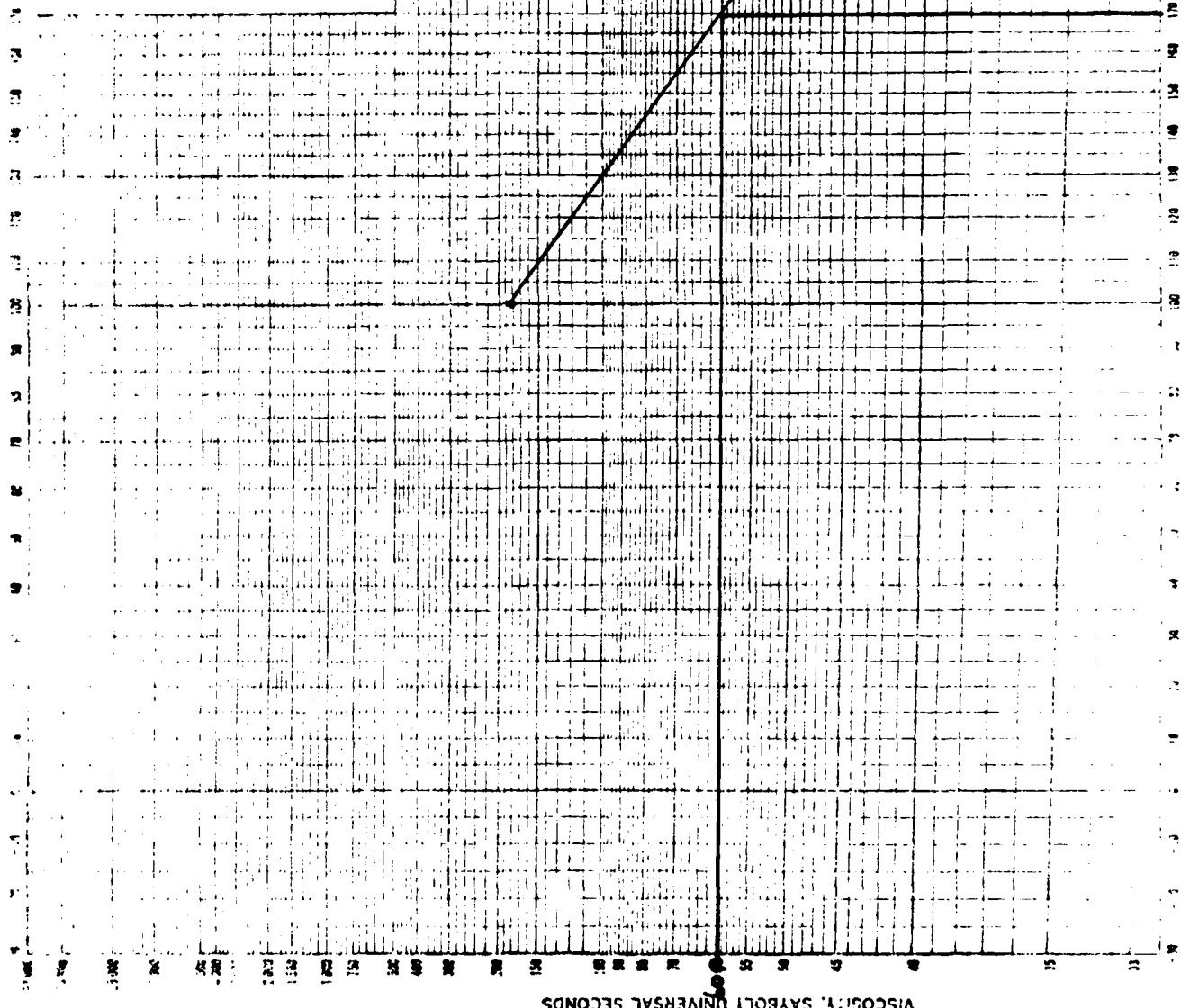
For purposes of the test, all pumps were assumed to have identical ratings of 3000 psi, 2700 rpm and approximately 3 in<sup>3</sup>/rev. displacement. It should be noted that with the above assumptions, Manufacturer M3's pump differed in only one parameter which was speed. The rating was 1800 rpm. All three manufacturers required a minimum of 60 SSU oil viscosity at the pump inlet. Both the Accelerated Life Test and the 1000 Hour Endurance Test specified SAE 10W motor oil which was 60 SSU at 170°F. The viscosity chart is included in this section of the report for verification of the above statement.

Therefore, the inlet temperature was held at 170°F ± 5°F throughout both the Accelerated Life and 1000 Hour Endurance Test. Throughout the duration of the test, the parameters listed in Appendix K were monitored at one hour intervals.

The detailed test procedures and circuit schematics are in Appendices K and M respectively.

Prior to the Accelerated Life and Endurance Tests, a power conversion test was conducted at 120°F and 180°F on the eighteen pumps that were broken in with clean oil. Power conversion tests were also run on the 3 pumps broken in with dirty oil. On one test specimen from Manufacturer M3, subsequent calculations revealed that the measured data was seriously in error and the test could not be rerun. Consequently; there are valid power conversion results from only twenty of the twenty-one test specimens. Two, of the eighteen pumps, from Manufacturer M3 broken in on clean oil were sent to, Commander USA MERADCOM at Fort Belvoir, VA USA, for further testing.

TEMPERAT. DEGREES FAHRENHEIT



TEMPERATURE, DEGREES FAHRENHEIT

STANDARD VISCOSITY TEMPERATURE  
 FOR ALL PETROLEUM PRODUCTS  
 SHEET 100 UNIVERSAL VISCOSITY AND INDEX

U.S. Army MERADCOM Vane Pump Survey  
 Mobil Delvac 1210

100° = 184.3 SSU  
 210° = 45.9 SSU

10/13/81 Michael W. Wat

VISCOSITY, SAYBOLT UNIVERSAL SECONDS



TABULATED DURABILITY TEST RESULTS

Test Type	Pump Mfg.	Pump Code #	Beginning Flow Rate	Ending Flow Rate	Percent Change	Completed Cycles/Hrs.	Type of Failure
Durability: Clean Oil < 100 particles per ml at 10 um	M1	348	22.97	22.45	-2.3	558,000 155	Test completed No failure
	M1	349	25.76	23.99	-6.9	558,000 155	Test completed No failure
	M1	351	24.21	16.68	-24.5	217,000 60	Port plate fatigue due to excessive wear
Durability: Clean Oil < 100 particles per ml at 10 um	M2	355	26.33	27.64	+5.0	554,400 154	Test completed No failure
	M2	358	24.46	26.29	+7.5	554,400 154	Test completed No failure
	M2	361	24.24	26.54	+9.5	554,400 154	Test completed No failure
Durability: Clean Oil < 100 particles per ml at 10 um	M2	356	23.50	24.69	+5.1	504,000 140	Test completed No failure
	M1	354	24.11	24.77	+2.74	504,000 140	Test completed No failure
	M1	353	21.6	20.19	-6.5	504,000 140	Test completed No failure
Durability: Clean Oil < 100 particles per ml at 10 um	M3	364	21.67	22.4	+3.4	500,000 140	Test completed No failure
	M3	366	19.70	19.3	-2	500,000 140	Test completed No failure
	M3	367	19	18.77	-1.2	500,000 140	Test completed No failure

TABULATED ENDURANCE TEST RESULTS

Test Type	Pump Mfg.	Pump Code #	Beginning Flow Rate	Ending Flow Rate	Percent Change	Completed Cycles/Hr.	Type of Failure
Endurance: Clean Oil < 100 particles ml at 10 um	M2	357	26.21	31.7	+ 21%	3,614,400 1004	Test completed No failure
	M2	360	28.07	31.6	+ 12.6%	3,614,400 1004	Test completed No failure
	M1	352	24.91	18.27	-26.7	1,018,800 283	Pump fatigue due to excessive wear

## DURABILITY AND ENDURANCE TEST OBSERVATIONS AND CONCLUSIONS

1. All of the M1 pumps tested showed substantial decreases in flow during both life tests. The decreases ranged from 2.3 to 26.7 percent.
2. Manufacturer M1 had two catastrophic failures, one on the Accelerated Life Test and one on the 1000 Hour Test. Both failures were the same and were due to fatigue of the port plates which caused increased leakage. The pumps were removed from the test when the flow decreased 24.5 to 26.7 percent respectively.
3. All of the M2 pumps tested showed consistent increase in flow during both life tests. The increases ranged from 5.1 to 9.5 percent on the Accelerated Life Tests and 12.6 to 21 percent on the 1000 Hour Test. The longer the pump runs the higher the flowrate under these conditions.
4. Two of the M3 pumps tested on the Accelerated Life Test had minor decreases in flow at the end of the test. The decrease ranged from 1.2 to 2 percent. The other M3 pump had a 3.4 percent increase in flow at the end of the test.
5. When the M1 pumps were disassembled and inspected it was found that the side plates experienced moderate to extensive scoring. This condition caused the flowrate to decrease in all pumps. The shaft end ball bearings were pitted and the bronze sleeve bearings experienced some wear. The two pumps that catastrophically failed had severe side plate scoring, bearing wear, ridges in the cam ring, vane wear, and rotor scoring. The pump that failed on the 1000 Hour Test had numerous surface cracks and one through crack in the cam ring.
6. When the M2 pumps were disassembled and inspected it was found that the side plates experienced minor scoring. The shaft end ball bearings had pitting and the bronze sleeve bearings experienced some wear. The only difference in wear between the pumps on the Accelerated Life Test and the 1000 Hour Test was bearing wear. The bearings from the 1000 Hour Test pumps were scored and pitted more severely than the ones from the Accelerated Life Test.
7. When the M3 pumps were disassembled and inspected it was found that minor scoring occurred on the side plates. No wear was observed on the bearings.
8. In comparison of manufacturers, M1 pumps experienced the highest wear on the life Tests and M3 pumps the lowest wear.

### DURABILITY AND ENDURANCE TEST RECOMMENDATIONS

1. More testing should be conducted using Manufacturer M1's pumps so that correlations can be made between failures on the Accelerated and 1000 Hour Life Tests.
2. More of Manufacturer M1's pumps should be run on the 1000 Hour Test with clean oil to increase the reliability of the data because only one pump was run which failed at 283 hours.
3. Testing should be conducted using Manufacturer M1's pumps with contaminated oil to determine if the mode of failure changes.
4. Testing should be conducted using Manufacturer M2's pumps with contaminated oil to determine if failures will occur and what the mode of failure is. Also if the mode of failure would be the same between the Accelerated Life and 1000 Hour Tests.
5. More of Manufacturer M3's pumps should be run on Accelerated Life Tests because two pumps experienced slight decreases in flowrate while one pump experienced a moderate increase flow.
6. Manufacturer M3's pumps should be run on the 1000 Hour Test to determine if failure occurs and compare results to the Accelerated Life Tests.
7. Testing should be conducted using Manufacturer M3's pumps on contaminated oil for both the Accelerated Life and 1000 Hour Tests to determine failure modes if any and correlations between them.

## THERMAL STABILITY INTRODUCTION AND DEFINITION

In certain types of mobile equipment where hydraulic pumps are driven by internal combustion engines which run at various speeds, conditions may exist where the operation is required to move the load while the engine is idling. In some instances the combination of low pump speed and high outlet pressure cause the pump to overheat and possibly even burn-up.

An idea evolved to determine if a universal test procedure could be developed to predict if the pump could operate effectively under low speed high pressure conditions.

Thermal stability can be defined as a point where the combination of high outlet pressure and slow rotational speed of the pump causes the outlet temperature to run away burning up the pump in a matter of minutes while the inlet temperature is held constant. In other words, what is the minimum rotational speed of the pump at a certain outlet pressure that produces enough flow through the pump to prevent it from overheating and burning up.

A survey was developed and sent out to forty U.S. manufacturers of hydraulic pumps to determine if they had similar problems with their pumps and if they had any procedures to test for thermal stability.

## THERMAL STABILITY SURVEY SUMMARY

The January 1981 Hydraulics and Pneumatics Designers Guide for Fluid Power Products was used to determine which companies would be surveyed. Surveys were sent to any company which manufactured either one or more of the following types of pumps: internal and external gear, vane, piston both fixed and variable displacements. Of the 74 companies originally surveyed only 40 of them actually manufactured and tested their own pumps. The remaining companies manufactured specialty pumps for applications outside fluid power or they bought pumps from other companies and put their own name on them.

Of the 40 surveys mailed, 34 of them were returned which is 85%. Three of the 34 returns described thermal stability test procedures which is 8.8%.

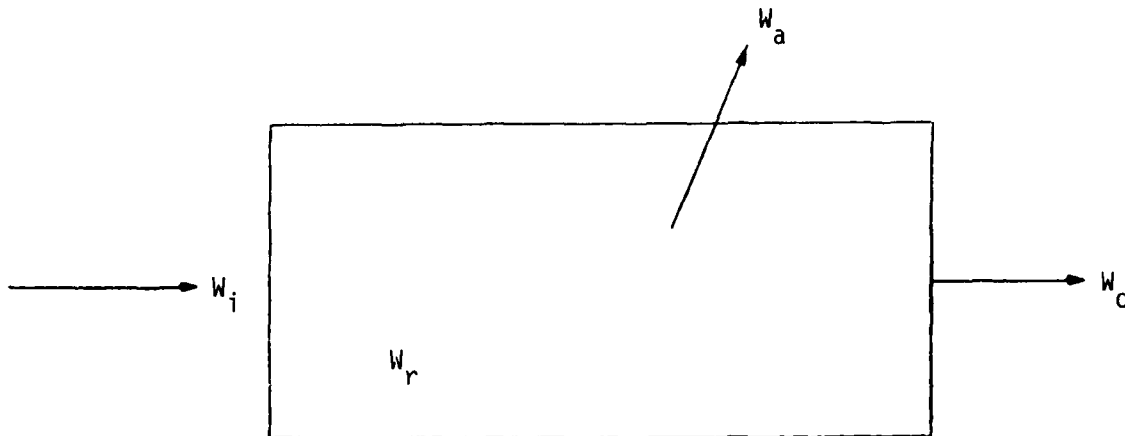
One respondent said they have a thermal stability test procedure and they use it when necessary at 180 and 225°F. However, he did not indicate what the procedure was and under what circumstances it is performed. He also mentioned that thermal stability is usually not a problem on externally drained pumps. He commented further stating that piston pumps and gear pumps with external drains and anti-friction bearings have no minimum speed except that which is required to produce the required pressure and flow usually 50-60 rpm for piston pumps at 5000 psi and 300 rpm for gear pumps at 3000 psi.

Another respondent said their procedure is performed at 120, 180 and 225 F in the following manner. First determine the pump's output flow at the desired speed in question, 120°F and 100 psi. Then determine pump's output flow at same speed used previously at temperature and outlet pressure in question. Calculate the volumetric efficiency by using the ratio of the two flowrates. If the volumetric efficiency is less than 35% the pump is considered thermally unstable.

The other respondent said their procedure is performed up to 220°F but did not indicate any other incremental temperatures. It is conducted as follows, run pump at 600 rpm hold inlet temperature constant, load pump to specific pressure under continuous load and monitor temperature rise and flowrate to determine temperature stabilization point or until loss of control occurs.

The remaining questions were answered as follows. One hundred percent of the respondents said their procedure was based on developmental and laboratory studies and that it evolved over time and experience with the product. None of the procedures were arbitrarily arrived at and none were run at one temperature. Sixty-seven percent said they use the same procedure for different types of pumps. Fifty percent of the responses indicated that a universal thermal stability test procedure would benefit their company. Fifty percent also indicated that they would use the universal procedure to qualify their company's pumps.

## MATHEMATICAL ENERGY BALANCE OF A HYDRAULIC PUMP



Symbols and Definitions:

$W_i$  - input energy into pump BTU's/min  
 $W_i = \text{Hp in} \times 42.44 \frac{\text{BTU's/min}}{\text{Hp}}$

$W_o$  - output energy of pump BTU's/min  
 $W_o = \text{Hp out} \times 42.44 \frac{\text{BTU's/min}}{\text{Hp}} + 8.34 (Q_o) (S_g) (C) (T_d)$

where  $Q_o$  outlet flow gpm

$T_d$  = Temperature difference across the pump °F ( $T_o - T_i$ )

$S_g$  specific gravity of the oil

$C$  specific heat of the oil  $\frac{\text{BTUs}}{\text{lb}^\circ\text{F}}$

8.34 is a constant to convert gallons to pounds

$W_a$  - energy lost to surrounding environment BTU's/min

$$W_a = UA (T_a - T_e)$$

where  $U$  = overall heat transfer coefficient  $\frac{\text{BTU's}}{\text{Hr.Ft.}^2^\circ\text{F}}$

U for cast iron = 1.78 from Hydraulic Power by Walter Ernst

A = surface area of pump (ft<sup>2</sup>)

T<sub>d</sub> = average of pump inlet and outlet oil temperatures °F

T<sub>e</sub> = temperature of surrounding environment °F

W<sub>r</sub> = energy converted to heat because of pump inefficiencies BTU's/min

$$W_r = W_i - W_o - W_a$$

W<sub>r</sub> is made up of two components

1. Mechanical friction
2. Leakage

$$W_r = W_f + W_l$$

where W<sub>f</sub> = heat energy of mechanical friction BTU's/min

W<sub>l</sub> = heat energy of leakage BTU's/min

$$W_l = (8.34) Q_l (S_g) (C) (T_d)$$

where Q<sub>l</sub> = leakage flow in GPM

S<sub>g</sub> = specific gravity of the oil

C = specific heat of the oil in BTU's/16°F

C =  $\frac{.5 \text{ BTUs}}{16^\circ\text{F}}$  for Mobil Delvac 1210

T<sub>d</sub> = Temperature differential across the pump °F (T<sub>o</sub> - T<sub>i</sub>)

8.34 is a constant to convert gal/min into pounds/min

energy balance

$$W_i - W_o - W_a - W_r = 0$$



## THERMAL STABILITY TEST PROCEDURE

1. Install the pump in a test circuit where the following parameters can be measured.
  - a) inlet and outlet temperature
  - b) inlet and outlet pressure
  - c) input speed and torque
  - d) outlet flowrate

The temperature measuring devices must be installed as close as possible to the pump housing for accurate temperature measurement. The outlet temperature probe location is most critical. It is best to install it inside the housing to measure the temperature inside the pump. If the outlet temperature probe is installed in the plumbing it will not record the actual pump temperature when the flow drops down at the low speeds. Testing has shown a substantial difference in outlet temperature between a probe mounted in the plumbing and one mounted in the housing when the pump starts running into thermal instability. The probe in the plumbing indicates a lower temperature than the one in the housing.

2. The test was conducted at two inlet oil temperatures, 120 and 180°F.
3. The pump was run at rated pressure. This would be the severest condition in the field and it would yield a higher minimum speed.
4. With the pump running at 1000 rpm and rated pressure, record the parameters listed in (1) above.
5. Decrease the speed in 100 rpm increments recording the parameters previously mentioned at each speed increment.
6. Discontinue testing when 400 rpm is reached or when the outlet temperature becomes unstable. Four hundred rpm was picked as a minimum because most engine idle speeds are well above this value. The outlet temperature is considered unstable at a given test point when it does not remain constant for three consecutive readings taken at twenty second intervals.
7. At each data point calculate input and output horsepower, leakage flow volumetric efficiency and temperature differential across the pump.

It must be noted that this may be a destructive test that will cause irreversible damage to the pump. Outlet temperatures can be in excess of 350°F. Some of the pumps tested showed signs of permanent damage after being subjected to this procedure and some pumps showed no signs of permanent damage.

The above procedure was used to test six pumps for thermal stability. Three were vane pumps broken in on dirty oil from this contract M1350, M2359 and M3362. The other three were gear pumps broken in on dirty oil from contract DAAK70-77-C-0214. Data is included for five of the pumps. The data from the

sixth pump M1350 vane pump was omitted because the pump burnt up so fast that data could not be recorded. The pump was completely destroyed.

Graphs of volumetric efficiency verses speed and volumetric efficiency verses differential temperature were plotted to determine what relationships exist if any. Energy balance calculations will be done for the final report to verify the mathematical model if time and funding are adequate.

DATA TABLES FOR THERMAL STABILITY TEST

It should be noted that the differential temperature is the difference in temperature between the inlet port and the outlet port of the pump.

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MILWAUKEE SCHOOL OF ENGINEERING

TEST U.S. Army MERADCOM  
Thermal Stability Test

PROJECT NO. 50422

DATE 3-14-70

TECHNICIAN P.H.

DESCRIPTION \_\_\_\_\_

COMMENTS Vane Pump FPI #M2359  
Volumetric Displacement 2.73 in<sup>3</sup>/rev

INSTRUMENTATION \_\_\_\_\_

Inlet Temperature 120°

Speed in RPM	Diff. Temp. °F	Diff. Press. PSID	Outlet Flow GPM	Leakage Flow GPM	Vol. Eff.	HP In	HP Out
795	16.2	2974	6.11	3.45	64%	17.8	10.6
700	19.8	3011	4.9	3.52	58%	15.81	8.61
600	24.8	2988	4.13	3.08	57%	13.63	3.08
555	33.1	2996	2.97	3.7	45%	12.6	5.2
496	57.2	2942	1.02	4.94	17%	11.39	1.75

Inlet Temperature 180°

798	42.5	3009	3.7	5.9	39%	18.26	6.5
688	38.1	2914	1.33	6.94	16%	15.33	2.26
607	120.6	2937	.415	6.89	6%	13.85	.71

FLUID POWER INSTITUTE  
MILWAUKEE SCHOOL OF ENGINEERING

TEST U.S. Army MERADCOM  
Thermal Stability Test

PROJECT NO. 50423

DATE 2-22-82

TECHNICIAN P.H.

DESCRIPTION \_\_\_\_\_

INSTRUMENTATION \_\_\_\_\_

COMMENTS Vane Pump FPI #M3362

Volumetric displacement 3.05 in<sup>3</sup>/rev

Inlet Temperature 120°

Speed in RPM	Diff. Temp. °F	Diff. Press. PSID	Outlet Flow GPM	Leakage Flow GPM	Vol. Eff. %	HP In	HP Out
911	10.5	2495	8.87	3.16	74%	18.44	12.91
792	13.7	2506	6.58	3.88	63%	15.78	9.62
701	18.8	2459	5.12	4.14	55%	14.19	7.35
598	26.8	2561	3.45	4.45	44%	12.13	5.16
533	40.4	2525	2.37	4.67	34%	10.55	3.5

Inlet Temperature 180°

902	16.7	2521	6.72	5.19	56%	18.25	9.9
810	22.5	2525	4.71	5.98	44%	16.34	6.9
702	32.8	2493	2.81	6.46	30%	14.21	4.1
596	62.7	2506	1.24	6.63	16%	12.26	1.8
505	137.4	2360	.4	6.27	6%	10.54	.55

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MILWAUKEE SCHOOL OF ENGINEERING

TEST U.S. Army MERADCOM  
Thermal Stability Test

PROJECT NO. 5-423

DATE 3-12-52

TECHNICIAN P.L.

DESCRIPTION \_\_\_\_\_

INSTRUMENTATION \_\_\_\_\_

COMMENTS Gear Pump #1  
Volumetric displacement 2.8 in<sup>3</sup>/rev

Inlet Temperature 120°

Speed in RPM	Diff. Temp. °F	Diff. Press. PSID	Outlet Flow GPM	Leakage Flow GPM	Vol. Eff. %	HP In	HP Out
807	12	2516	7.05	2.73	72%	15.54	10.4
701	14.4	2514	5.66	2.84	67%	13.47	8.3
602	16.8	2500	4.45	2.85	61%	11.47	6.5
512	22.5	2500	2.13	4.08	34%	10	3.1

Inlet Temperature 180°

804	17.8	2527	5.73	4.02	59%	15.91	8.45
698	21.2	2510	3.95	4.47	47%	13.77	5.8
605	29.1	2524	1.77	5.56	24%	12.23	2.61
498	49.6	2494	1.65	4.39	27%	10.33	2.4
464	73	2482	.79	4.83	14%	9.68	1.14

FLUID POWER INSTITUTE  
MILWAUKEE SCHOOL OF ENGINEERING

TEST U.S. Army MERADCOM \_\_\_\_\_

Thermal Stability Test \_\_\_\_\_

PROJECT NO. 50423

DATE 2-24-82

TECHNICIAN P.H.

DESCRIPTION \_\_\_\_\_

COMMENTS Gear Pump #2 \_\_\_\_\_

Volumetric displacement 3.16 in<sup>3</sup>/rev \_\_\_\_\_

INSTRUMENTATION \_\_\_\_\_

Inlet Temperature 120°

Speed in RPM	Diff. Temp. °F	Diff. Press. PSI	Outlet Flow GPM	Leakage Flow GPM	Vol. Eff. %	HP In	HP Out
906	12.8	3010	9.34	3.05	75%	22.9	16.4
801	15.3	2997	7.76	3.2	71%	20.22	13.97
699	17.8	2999	6.17	3.39	65%	17.76	10.8
601	22.2	2992	3.99	4.23	49%	15.12	6.96
531	28.1	3026	3.57	3.69	49%	13.88	6.3
Inlet Temperature 180°							
900	15.5	2973	8.13	4.18	66%	22.57	14.1
802	19.3	3045	6.63	4.34	60%	20.66	11.78
702	23.8	2991	4.96	4.64	52%	18.2	8.66
602	29.6	2988	2.3	5.9	28%	15.3	4.01
499	45.3	2949	2.26	4.57	33%	13.08	3.89

FLUID POWER INSTITUTE  
MILWAUKEE SCHOOL OF ENGINEERING

TEST U.S. Army MERADCOM  
Thermal Stability Test

PROJECT NO. 500

DATE 11/11/57

TECHNICIAN

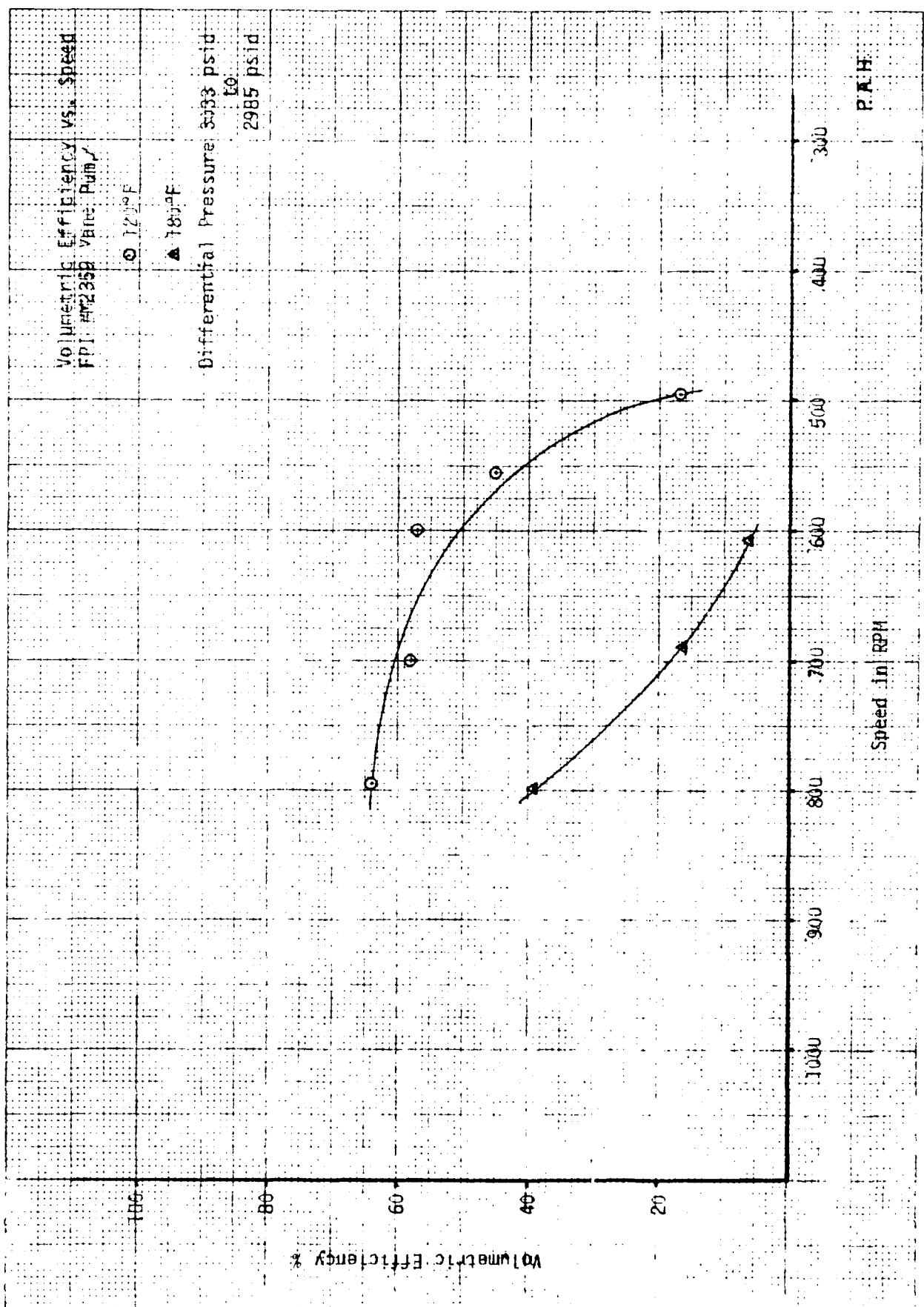
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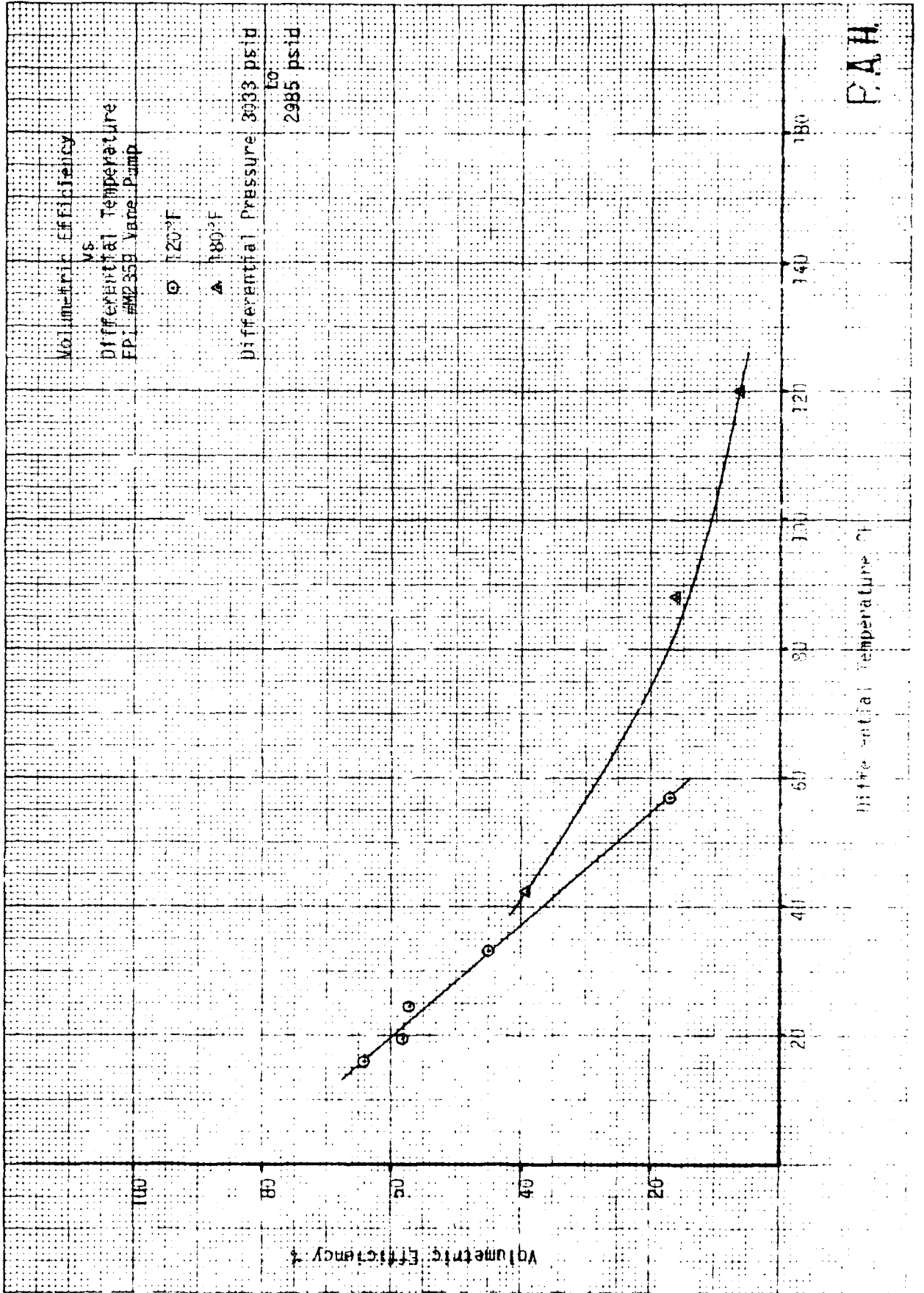
INSTRUMENTATION

COMMENTS Gear Pump #3  
Volumetric displacement 2.94 in<sup>3</sup>/rev

Inlet Temperature 120°							
Speed in rpm	Diff. Temp. °F	Diff. Press. PSID	Outlet Flow GPM	Leakage Flow GPM	Vol. Eff. %	HP In	HP Out
803	23.7	2991	5.45	4.77	53%	18.45	9.51
698	33.8	2945	3.85	5.03	43%	16.27	6.62
602	56.5	3080	2.24	5.42	29%	14.17	4.03
504	146.5	3151	.66	5.75	10%	12.15	1.18
Inlet Temperature 80°							
801	34	3019	4.19	6	41%	19.17	7.38
706	45	2869	2.99	5.98	33%	15.99	5
602	91.4	3069	1.34	6.32	18%	14.36	2.4
478	163	2539	0	6.08	0	7.81	0

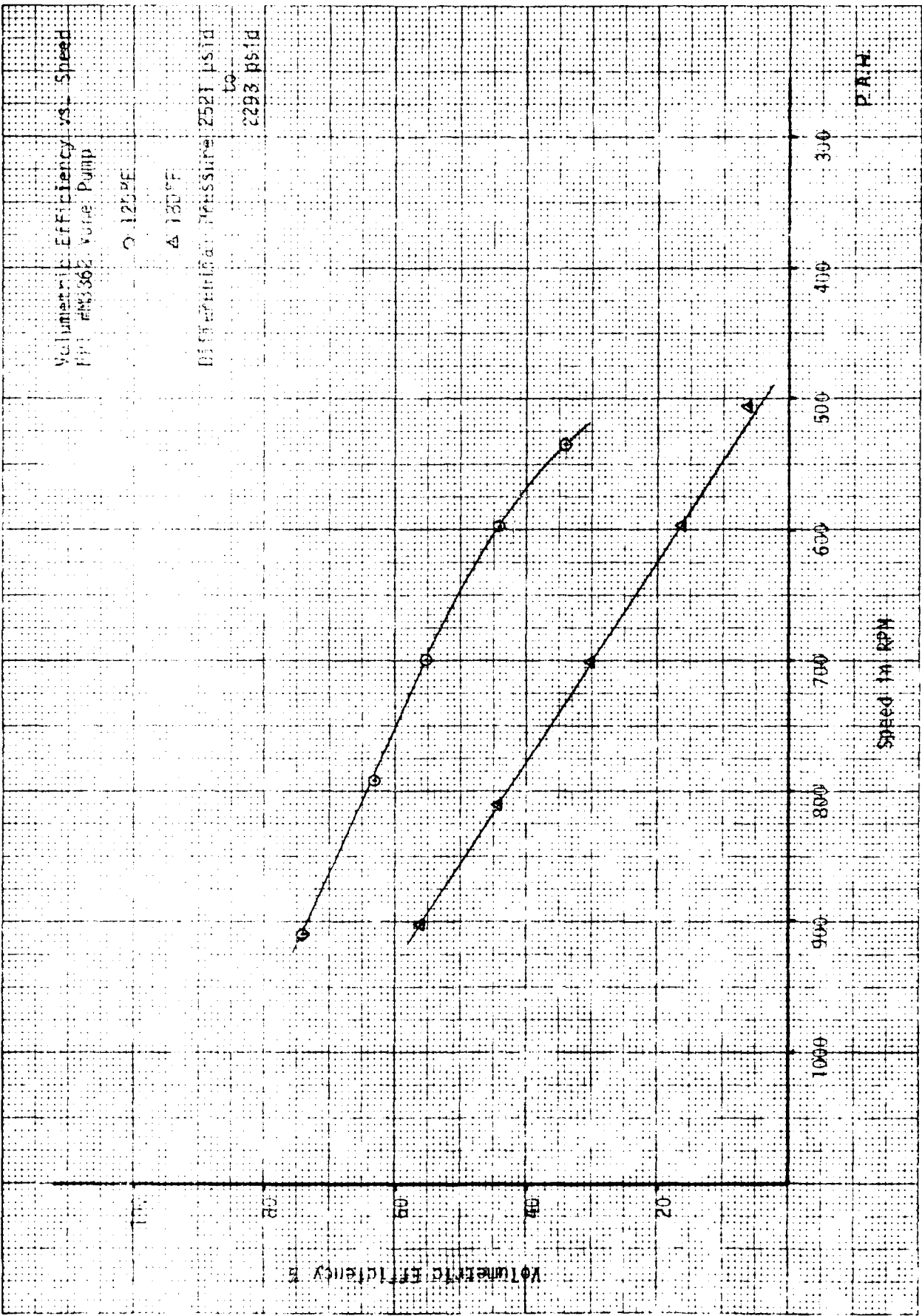


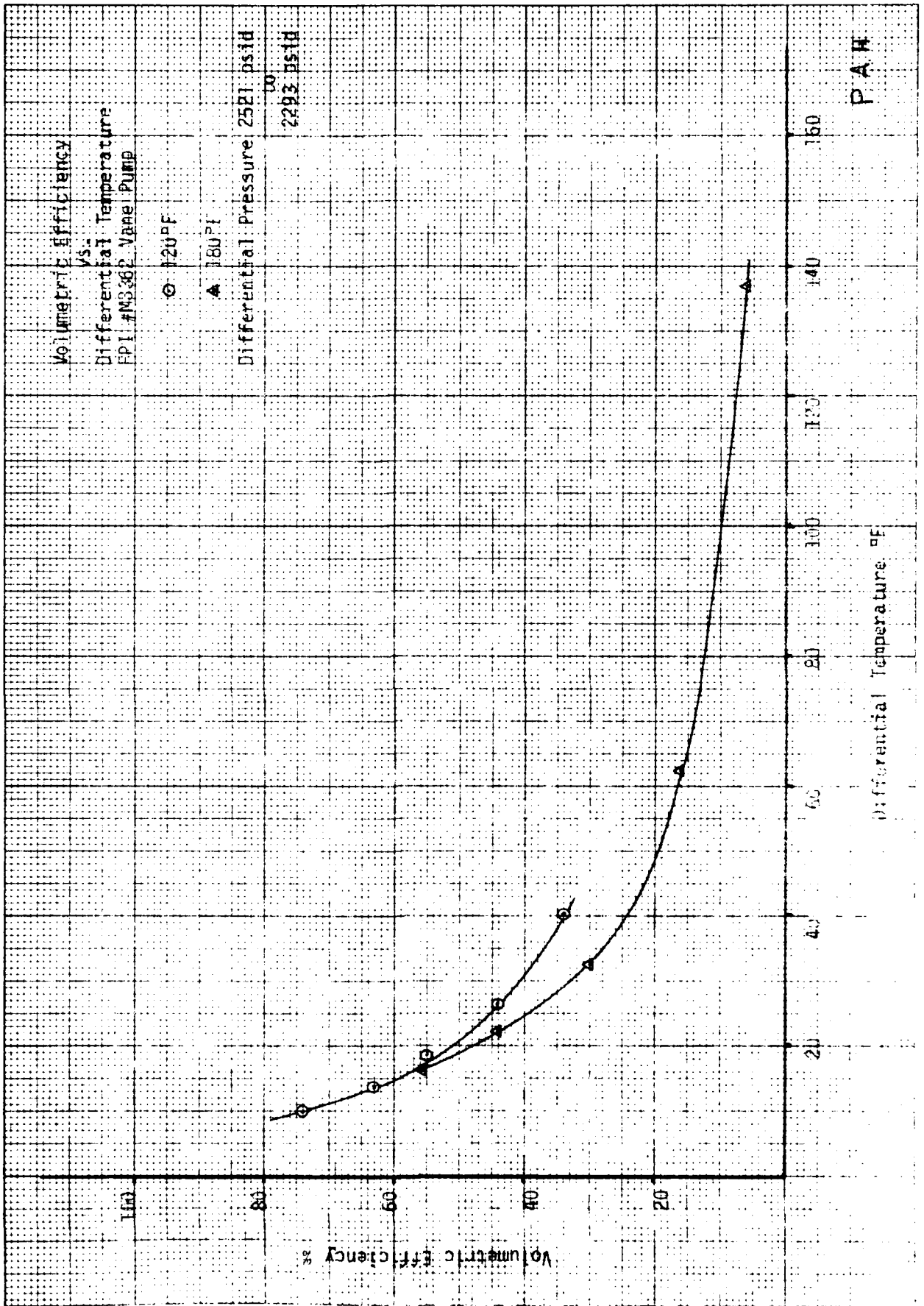




P.A.H.

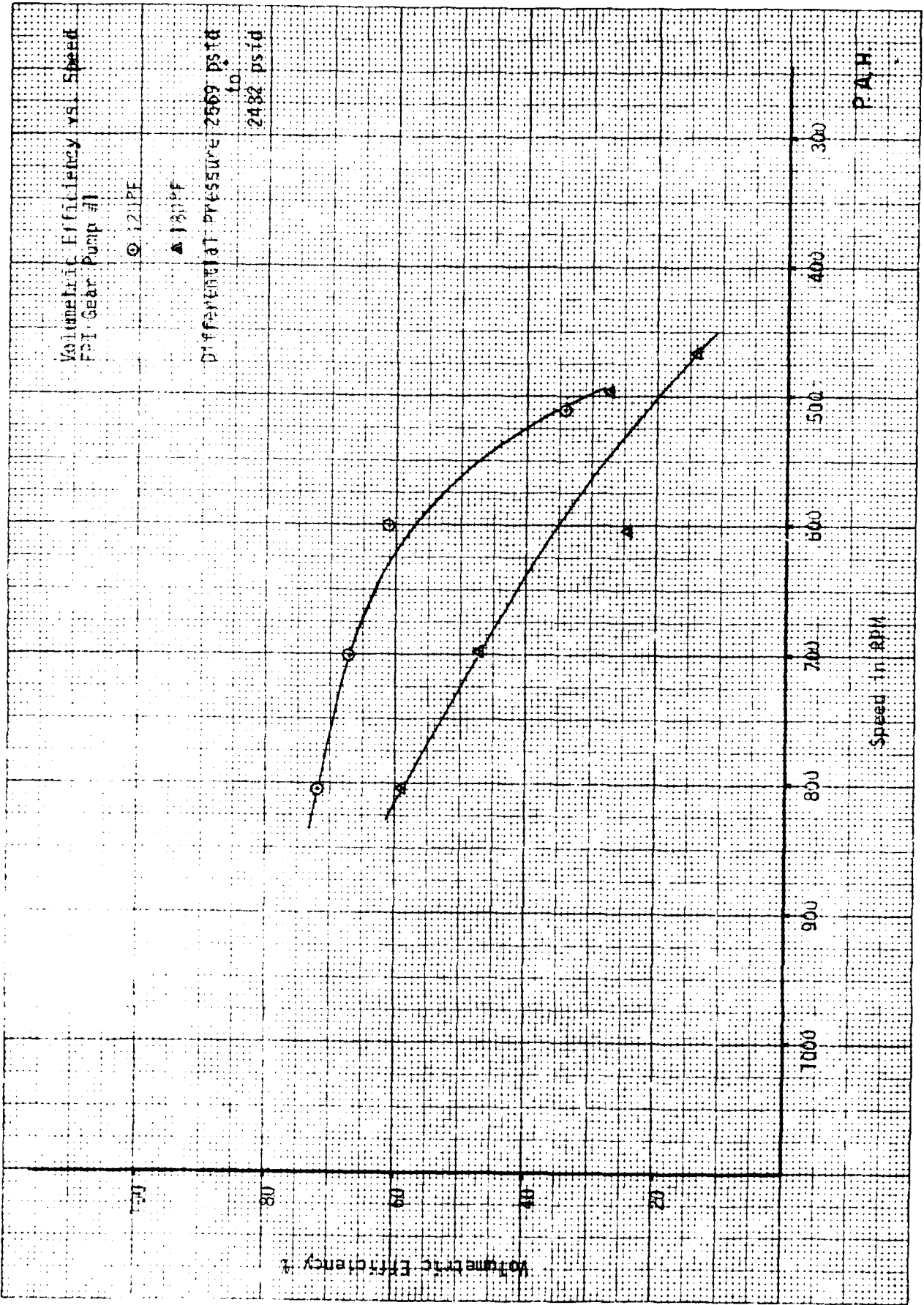


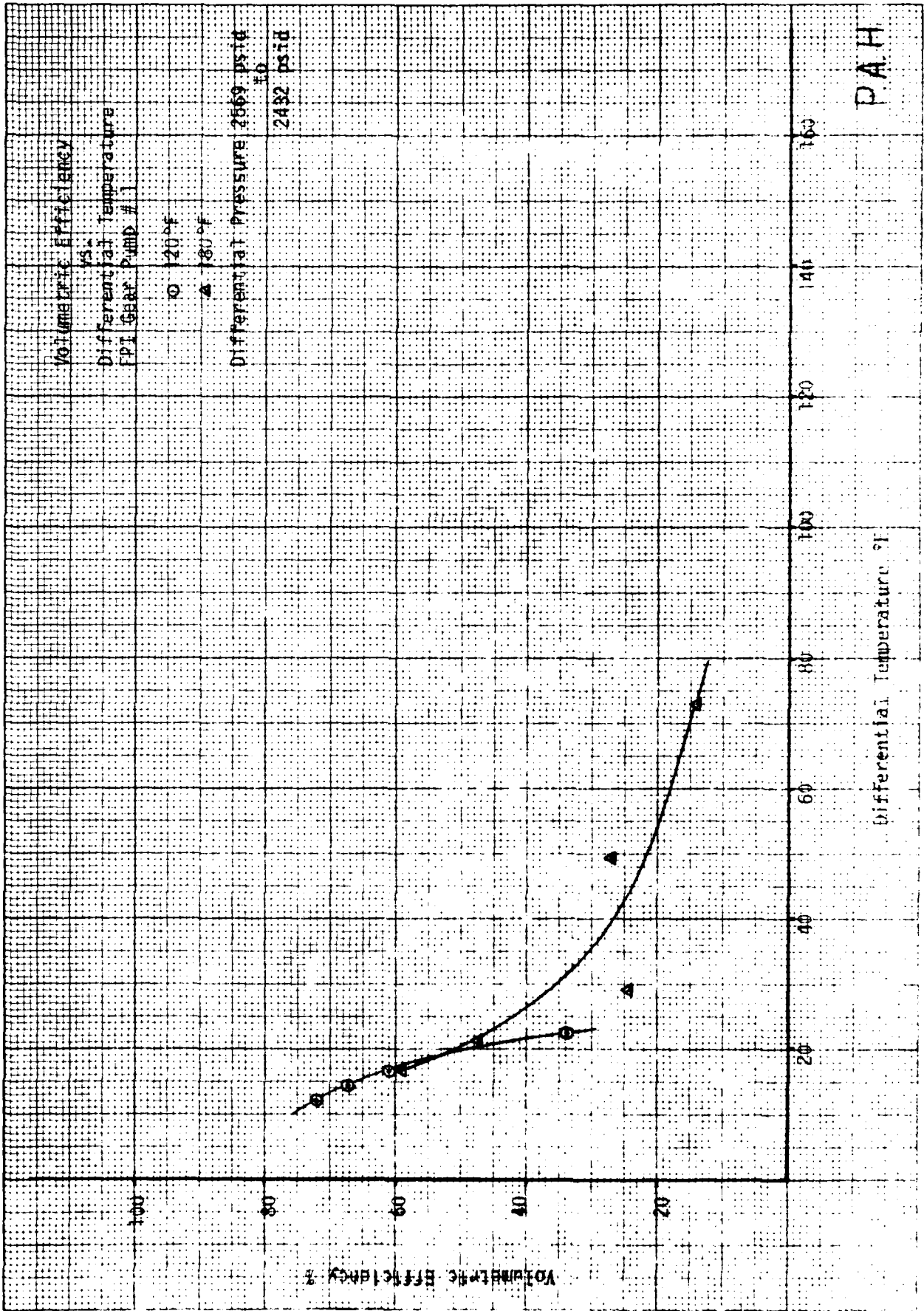


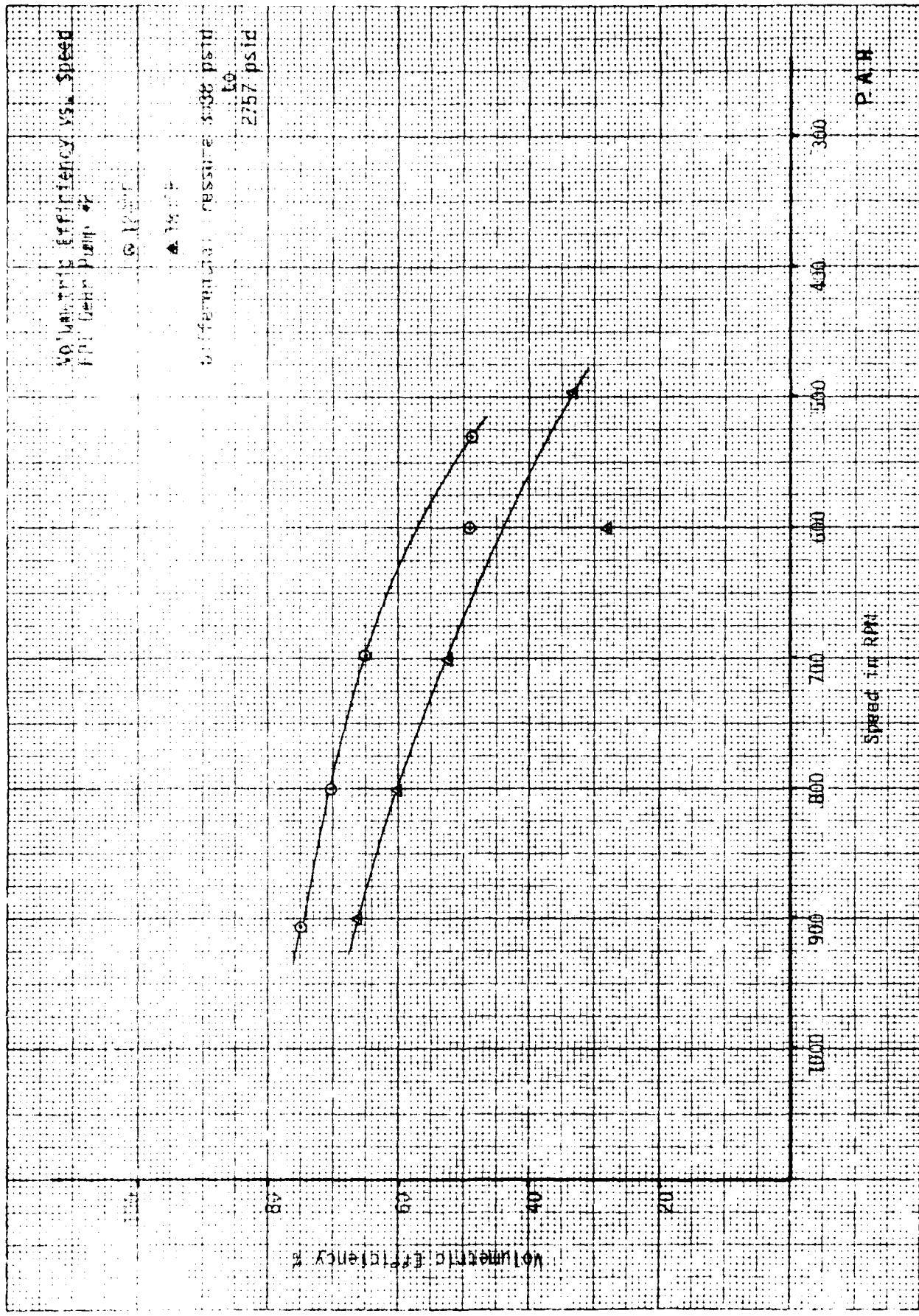


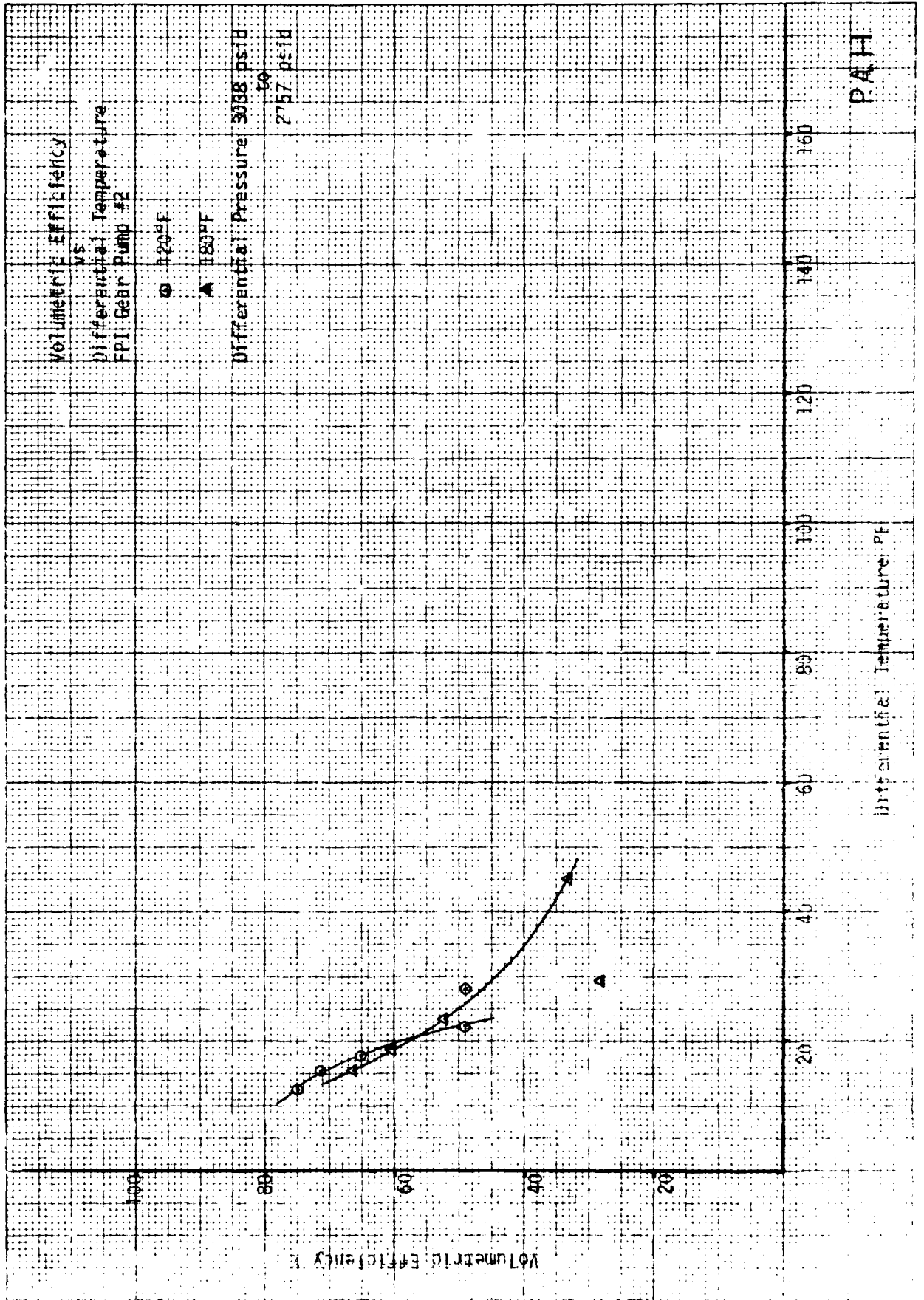
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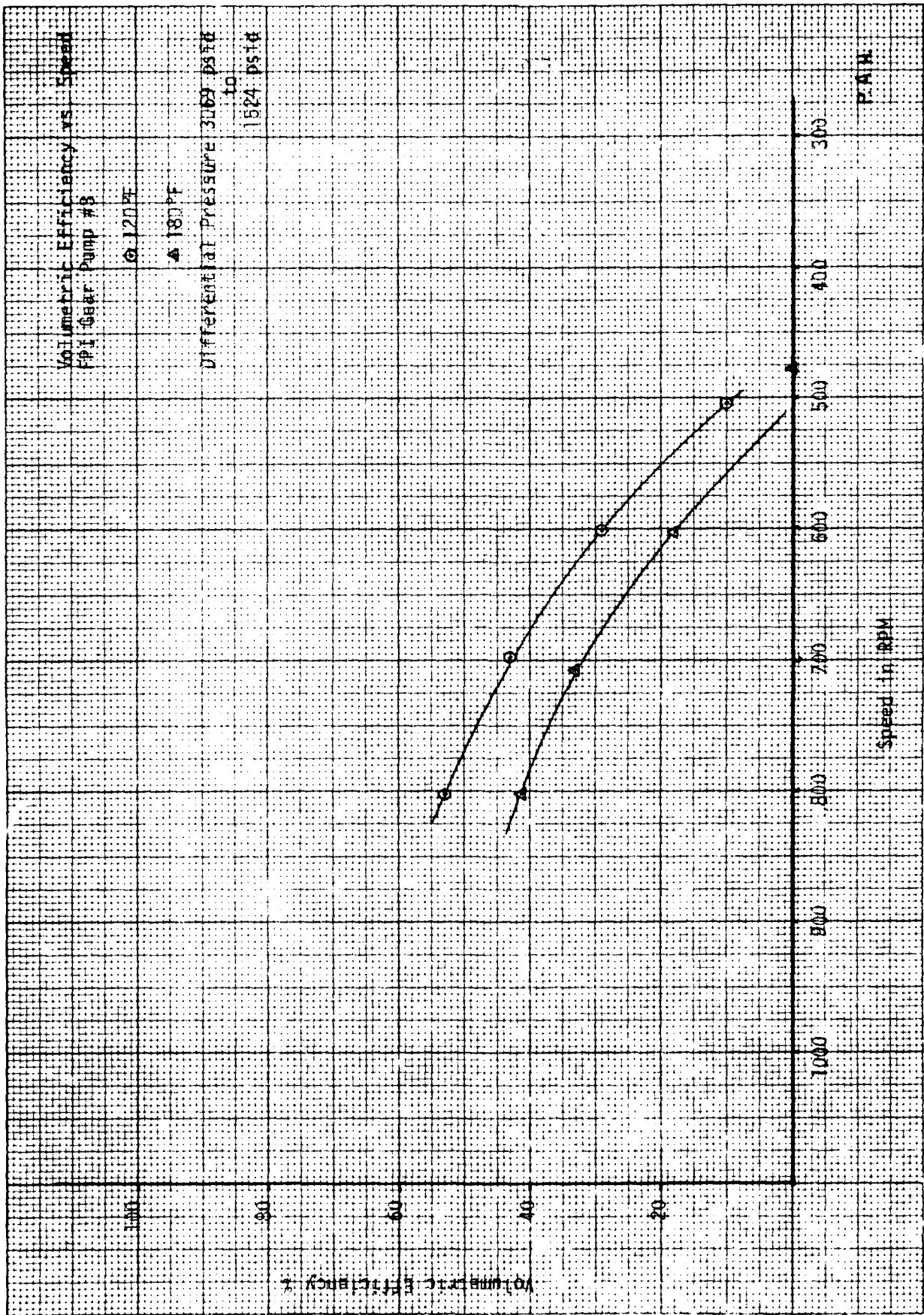


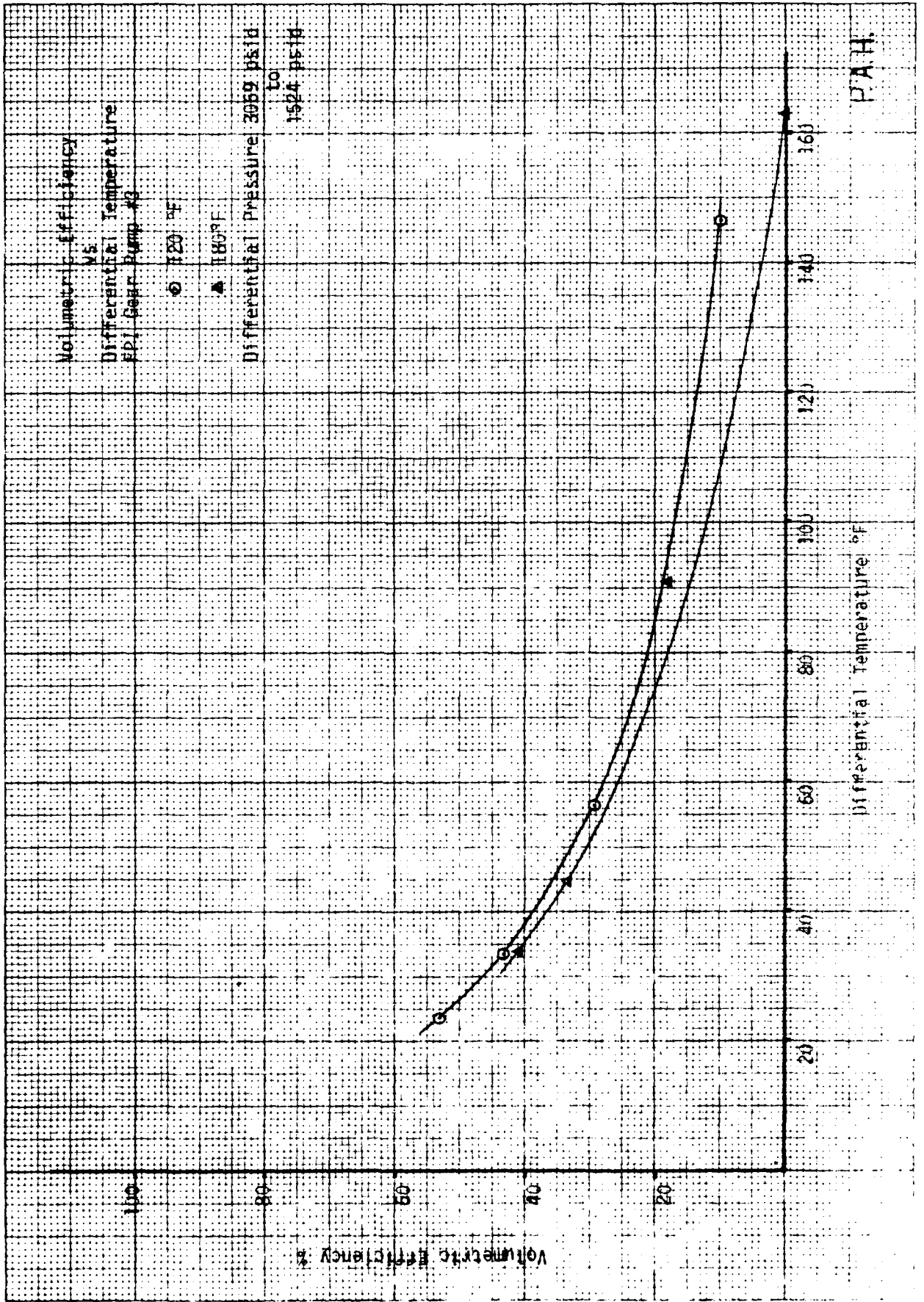












## THERMAL STABILITY TEST OBSERVATIONS AND CONCLUSIONS

1. The three gear pumps and one of the vane pumps have a somewhat linear relationship between volumetric efficiency and speed. As speed increases so does volumetric efficiency.
2. The slope of the curve described in observation number one is the same at 180 and 120°F inlet temperatures for each of the given pumps. However the pumps as a whole do not exhibit the same slope.
3. For all pumps, the volumetric efficiency is lower at 180°F than 120°F inlet temperature at the same speed.
4. For all pumps tested, there is a somewhat linear relationship between volumetric efficiency and differential temperature, until such a point where the temperature begins to rapidly increase with little or no decrease in volumetric efficiency. The curve approaches the horizontal axis.
5. In the linear region of the volumetric efficiency verses differential temperature graphs, the same volumetric efficiency gives the same temperature differential at both inlet temperatures for each pump. This indicates that thermal stability is more dependent on volumetric efficiency rather than inlet temperature. However, the inlet temperature also effects the volumetric efficiency as previously stated.
6. For all of the pumps tested, the same volumetric efficiency did not yield the same temperature differential. Example at 40 percent volumetric efficiency the temperature differential ranged from 25 to 41°F with 32°F being the average value. This disparity increased at the lower volumetric efficiencies where the pumps were operating thermally unstable.
7. The non-linearity in the volumetric efficiency verses temperature differential graphs seems to start between the 30 to 40 percent volumetric efficiency level. This was the case in four of the five pumps tested.
8. It appears that the pump can be considered thermally stable if the volumetric efficiency is greater than 35 to 40 percent.
9. It is the opinion of the writer that if the energy balance was conducted on these five pumps thermal stability could be predicted by the difference of the output energy minus the energy lost inside the pump because of inefficiency. If the output energy is greater than the internal losses, the pump would be thermally stable. If the output energy is less than the internal losses, the pump would be unstable and burn itself up.
10. Even though the differential pressure is fairly constant, the leakage rate is changing at the different speeds for each pump. At the lower speeds the leakage is greater. The temperature differential is also greater at the lower speeds. The temperature probably effects leakage more than does the speed, especially when the temperature is in excess of 250°F, the viscosity is very low.

11. It is the writer's opinion that the pump is thermally unstable when the differential temperature is greater than 50°F. This condition occurred in four of the five pumps tested under the following conditions:

Speed range: 688 → 496 rpm with 580 rpm as an average.

Volumetric efficiency range: 29 to 16% with 21% as an average.

Differential temperature range: 49.6 to 91.4°F with 67.5°F as an average.

The thermal instability occurred at a speed approximately equivalent to that of idle on internal combustion engines.

### THERMAL STABILITY TEST RECOMMENDATIONS

1. Because of disparities in the data more testing is required on different types of pumps i.e. gear, vane, piston, also on pumps made of different materials. This will give a better statistical analysis of the test data and help in determining correlations between test parameters.
2. Testing should be conducted at other inlet temperatures to determine if the volumetric efficiency verses differential temperature characteristics are constant between different pumps.
3. Testing should be conducted to determine if speed or temperature differential have the greatest effects on leakage.
4. Determine the energy balance characteristics to see if any correlations can be made between energy balance, volumetric efficiency, differential temperature and thermal stability.
5. Distribute the test procedure to the U.S. Fluid Power Industry to get their reactions and inputs.

APPENDIX A  
ORIGINAL BREAK-IN PROCEDURE SURVEY

VANE PUMP BREAK-IN SURVEY MAILING LIST

Revised 3/23/81

Abex Denison Div. 1220 Dublin Rd. Columbus, OH 43216	R. Smilges Dr. Eng. Vane & Valve Products	614/481/7341
Continental Hydraulics Div. 12520 Quentin Avenue South Savage, MN 55378	A.D. Mills Chief Engineer	612/894/8900 Ext. 221
Federal Brase Mfg. Co. 165 Cedar St. Corning, NY 14830	James Dugan	607/732/6620
Gresen Mfg. Co. Box 313, 600 Hoover St., N.E. Minneapolis, MN 55413	Bob Olen Mgr. of Engineering	612/623/1960
Parker Hannifin Corp. Ind. Hyd. Div. 100 Parker Dr. Ostego, MI 49078	John Wright	616/694/9411
Rexnord Inc. Hyd. Components Div. Racine, WI 53401	Gary A. Smith Chief Engineer-Pumps	414/554/7100
Rexroth Corp. 2315 City Line Rd. Box 2407 Bethlehem, PA 18018	Ted Lincoln Industrial Hyd. Div.	215/694/8300
Sperry Vickers 1401 Crooks Rd. Troy, MI 48084	Ashir Ahmed Section Head Vane Pumps	313/280/2244

January 28, 1981

Mr. Tom Kendall  
Chief Engineer  
Abex Denison Div.  
1220 Dublin Rd.  
Columbus, OH 43216

Dear Mr. Kendall:

The Milwaukee School of Engineering has been contracted by the US Army MERADCOM to investigate the degree to which pump overall efficiency migrates during the first few hours of a pump's life. Ultimately, we will be attempting to establish a criterion which will confirm that a pump has been satisfactorily broken in. As it stands now, the US Army has found that pumps can fail their qualification tests for overall efficiency when the efficiency tests are conducted prematurely. A criterion for satisfactory break-in would eliminate that problem. But before we reach that point, we would like to know more about your break-in procedures on vane pumps. That's the reason for the enclosed survey.

Realizing that some of the information may be proprietary, I want to give you my personal assurances that the specific results of your response will be held in the strictest of confidence. The Army has requested and will receive only a statistical summary of the individual returns.

If you would take a few minutes to complete the enclosed survey questionnaire regarding your break-in procedures of hydraulic vane pumps, we will send you a copy of the summary and the proposed vane pump break-in procedure that was developed from the survey responses. Please return your response before February 23, 1981.

Your help is greatly appreciated.

Sincerely,

Thomas S. Wanke  
DIRECTOR, FLUID POWER INSTITUTE

TSW:wp

Encls.



## BACKGROUND INFORMATION ON BREAK-IN AND OVERALL EFFICIENCY

### Observations by the Army

Recent QPL tests on commercially available pumps have uncovered disturbing result:

The initial overall efficiency of sample pumps varied from a value below the minimum acceptable level to a value above the minimum acceptable level when tested by a single test agency and wherein the only known variable was the time at which the tests were conducted.

### Benefits of the Program

The M.S.O.E. Fluid Power Institute has contracted with the Army to research this finding in greater detail and provide insight into their basis. Some of the benefits of this program are:

- a. To provide an evaluation of the degree to which overall pump efficiency migrates during the first few hours of a pump's life.
- B. To provide an evaluation of the degree to which contamination affects the break-in rate.
- C. To gain a knowledge of the expected spread in efficiencies among a sample lot of commercial pumps within one manufacturer's sample.
- D. To determine what length of operational time must pass in order for the overall efficiency to cease its migration, if indeed it does cease.
- E. Provide data for updating and validating NFPA/T3.9.17.

Summary (These are the writer's conclusions based upon discussions with the Army and are not necessarily US Army official policy)

According to representatives of the US Army Mobility Equipment Research and Development Command (MERADCOM), they are expending considerable resources to convert from purely military procurement specifications to a combination of Military Specifications and Commercial Industrial Standards. This new approach to product qualification would have the Military Specifications carry the criteria for acceptance while the industrial standard would carry the test procedure. This writer can envision that a clause in a future Military Specification may read as follows:

"Minimum overall efficiency is 80% when pump is tested in accordance with NFPA T3.9.17"

The Army's motivation is to encourage more vendors to seek qualification through utilization of industrial standards.

VANE PUMP BREAK-IN PROCEDURE SURVEY

MSOE FLUID POWER INSTITUTE

\* Complete and return by 23 Feb., 1981 \*

Instructions:

Please circle the appropriate response to the following questions and/or fill in the required information. Additional data is requested in the attached chart.

1.0 Break-In Procedure General

1.1 Do you have a criterion for determining the point at which a pump is satisfactorily broken in?

YES NO

1.2 Is your procedure based on developmental or laboratory studies?

Developmental	YES	NO
Laboratory	YES	NO

1.3 Has your procedure evolved over time and experience with product?

YES NO

1.4 Was your procedure arbitrarily arrived at?

YES NO

1.5 Are identical procedures used in production prior to product shipment and in the service department?

YES NO

1.6 Do your engineering department recommendations or laboratory test procedures differ from 1.5 above?

YES NO

2.0 Break-In Procedure Specifications

2.1 Do you conduct your pump break-in at:

Constant Pressure	YES	NO
Constant Speed	YES	NO
Constant Torque	YES	NO

2.2 Do you have contamination sensitivity test results on your pumps?

YES NO

2.3 Do you have different break-in procedures for different Vane pump design features such as bearing types, bearing mounts, shaft seal types, and pressure loaded wear plates?

YES NO

If yes, how many different break-in procedures do you use?

VANE PUMP BREAK-IN PROCEDURE

2.4 (Fill out each different break-in procedure you recommend to prepare a sample Vane pump for one-time qualification test.)

Product Description: \_\_\_\_\_

Special Fluid: \_\_\_\_\_

Contamination Level Limits: \_\_\_\_\_

Additives (Lubricity): \_\_\_\_\_

Additives (Abrasion): \_\_\_\_\_

Water Content Limit: \_\_\_\_\_

Procedure (Describe each different Vane pump break-in procedure you use and state the important design features which set this one apart from the others - Be sure to include information regarding range of variable conditions, ie. speed, pressure, torque, on and off time, and total elapsed time of procedure. Use extra pages if needed.)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

VANE PUMP BREAK-IN PROCEDURE SURVEY

3.0 Are you willing to submit to MSOE an oil sample from your break-in test stand for contamination particle counting and water content in exchange for the fluid analysis results at no charge to you?

YES

NO

(If you check yes, we will send you a clean bottle.)

4.0 The research program consists primarily of testing the overall efficiency of 21 hydraulic Vane pumps during the first few hours of the pump's lives, that is, during the break-in period. A uniform break-in procedure will be devised based upon the results of this survey. Later, selected manufacturers' Vane pumps will be purchased for the test program.

5.0 Vane Pump Design Features

Needle Bearings	_____
Roller Bearings	_____
Hydrodynamic Plain Bearings	_____
T.F.E. Plain Bearings Steel Backed	_____
T.F.E. Plain Bearings Filament Wound	_____
Resilient Shaft Seal	_____
Press Fit Bearing Mount	_____
Self Aligning Bearing Mount	_____
Pressure Loaded Wear Plates	_____

6.0 Do you currently manufacture?

6.1 Fixed displacement vane pumps

YES NO

6.2 Variable displacement vane pumps

YES NO

7.0 Do you currently manufacture a fixed displacement vane pump in accordance with the following:

7.1 3 in<sup>3</sup>/rev displacement:

YES NO

7.2 2500 - 3000 psi continuous pressure:

YES NO

7.3 2500 - 3000 rpm continuous speed:

YES NO

8.0 If you answered no to any questions in section 7, what are your ratings?

8.1 Displacement \_\_\_\_\_

8.2 Pressure rating \_\_\_\_\_

8.3 Speed rating \_\_\_\_\_

VANE PUMP BREAK-IN PROCEDURE SURVEY

Thank you for your interest in our project and any recommendations or guidance your experts make regarding this inquiry. Additional comments may be attached if desired.

A statistical summary of the survey and the proposed universal break-in test procedure will be distributed to the respondents. The confidentiality of the individual companies will be maintained.

If any questions should arise, please contact us.

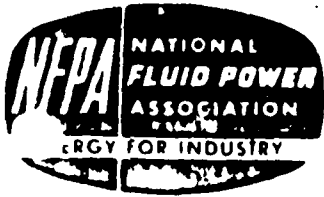
\_\_\_\_\_  
(Company)

\_\_\_\_\_  
(Name & Title of Respondent)

\_\_\_\_\_  
(Phone Number)

\_\_\_\_\_  
(Date)

APPENDIX B  
POWER CONVERSION TEST PROCEDURE NFPA T3.9.17R1



**Method of Testing and Presenting  
Basic Performance Data for  
Positive Displacement  
Hydraulic Fluid Power  
Pumps**

T3.9.17R1

DRAFT #5

20 MARCH, 1980

Sponsor

National Fluid Power Association, Inc.



ANSI/B93.27-1973

T3.9.17R1  
Draft #5  
20 March, 1980

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C. A. Nazian  
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Paul Hopler (Alternate)

**INDIVIDUAL MEMBERS**

Prof. Ernest C. Fitch, Jr.  
Prof. Jack Johnson

**REFERENCES**

1. American National Standard Glossary of Terms for Fluid Power, ANSI/B93.2-1971, and Supplements thereto. (ISO/TC 131/SC 1 (USA-2) 3).
2. International Standard Graphical Symbols for Hydraulic and Pneumatic Equipment and Accessories for Fluid Power Transmission, ISO/R 1219-1970. Agrees with ANSI/Y32.10-1967.
3. American National Standard Fluid Power Diagrams, ANSI/Y11.17-1967.
4. American National Standard Graphic Symbols for Fluid Power Diagrams, ANSI/Y32.10-1967. (ISO/R 1219-1970.)
5. International Standard Rules for the Use of Units of the International System of Units and a Selection of the Decimal Multiples and Sub-Multiples of SI Units, ISO/R 1000-1973.
6. Draft International Standard - Fluid Power System and Components - Nominal Pressures, ISO/DIS 2944.
7. American Society for Testing and Materials Standard Method for Calculating Viscosity Index from Kinematic Viscosity, ASTM/D2270-1977.
8. American Society for Testing and Materials Standard Method of Test for Viscosity of Transparent and Opaque Liquids, ASTM/D445-1977.
9. National Fluid Power Association Recommended Standard, Fluid Power for Hydraulic Fluid Power Systems, NFPA 112, 1977.

## FOREWORD

T3.9.17R1  
Draft #5  
20 March, 1980

(This Foreword is not part of American National Standard Method of Testing and Presenting Basic Performance Data for Positive Displacement Hydraulic Fluid Power Pumps and Motors, ANSI/B93.27-1973.)

In 1964, producers and users of hydraulic fluid power pumps and motors expressed the need for more meaningful, consistent and accurate means for determining and expressing component performance capabilities. The only existing standards were limited in scope to components used only on mobile equipment. Upon request to the NFPA Technical Board, projects were authorized and assigned to the NFPA Pump and Motor Section.

At the outset, work was divided into two parts: "Methods of Test" and "Methods of Rating". Drafting of the interrelated documents progressed at a somewhat parallel pace. Drafting was completed in late 1967. The separate documents were simultaneously submitted to general industry review. Separate review and modification progressed until 1970, when it was agreed that the documents should be editorially combined. To facilitate international acceptance, the Secretary was also directed to incorporate, wherever possible, material resulting from International Standardization actions. Also, the basic research at Oklahoma State University and the standards actions of the Society of Automotive Engineers and the British Standards Institute were to be taken into account.

The combined and revised draft was completed on 23 November 1970. It was circulated for comments and improved during the 15 December meeting. Balloting was undertaken on 18 December 1970.

The ballot, which closed on 15 January 1971, was concluded successfully thru editorial clarifications. One clarification is noteworthy: the original test for structural integrity called for a test at 115 percent of manufacturer's maximum rated output pressure; it is now 115 percent of MAOP (maximum allowable operating pressure).

On 20 January 1971, the Technical Board judged that all negative ballots and comments had been resolved -- and recommended approval. Approval as an NFPA Recommended Standard was granted by the Board of Directors on 21 January 1971. Editorial action was completed on 31 August 1971.

Members of the NFPA Project Group that prepared this standard are listed on page 4.

On 30 December 1971, the NFPA Recommended Standard was submitted to ANSI Standards Committee B93 for promulgation as an ANSI Standard. Favorable ballot was concluded on 28 February 1972. Approval by the ANSI Board of Standards Review was granted on 7 March 1973.

The membership roster for Standards Committee B93 at the time of approval is listed on page 4.

Members of the NFPA Project Group that developed this standard included

Christensen, Norm	Project Co-Chairman	Denison, Inc.
Graham, MacKellar	Project Co-Chairman	Sperry Vickers
Olson, John	Section Chairman	Applied Power
Czarnecki, George	Section Vice Chairman	General Turbine Inc.
Mills, A. D.	Section Secretary	Continental Hydraulics
Morgan, James I.	Secretariat	National Fluid Power Assn.
Chenoweth, R.		Denison Division
Englander, R.		Tyrone Hydraulics
Freeze, G.		Cessna Aircraft Co.
Funk, C.		Eaton Corp.
Kay, R.		Sperry Vickers
Olen, R.		HUSCO
Ratkay, E.		Commercial Shearing
Sanders, M.		Tyrone Hydraulics
Schwary, R.		Hydreco

On 28 February 1972 Standards Committee B93 was comprised of the following:

John J. Pippenger, Chairman; Otto J. Maha, Vice Chairman; James I. Morgan, Co-Secretary; J. C. Crawford, Co-Secretary.

**AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS**

E. H. Fletcher

**AMERICAN SOCIETY OF LUBRICATION ENGINEERS**

Howard Kaufman

**AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

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**AMERICAN SOCIETY FOR TESTING AND MATERIALS**

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Reino Mustonen

**CONSTRUCTION INDUSTRY MANUFACTURERS ASSOCIATION**

Glenn Stewart  
H. T. Larmore (Alternate)

METHOD OF TESTING AND PRESENTING BASIC PERFORMANCE DATA FOR  
POSITIVE DISPLACEMENT HYDRAULIC FLUID POWER PUMPS

INTRODUCTION

In hydraulic fluid power systems, power is transmitted and controlled thru a liquid under pressure within an enclosed circuit. Pumps are components which convert rotary mechanical power into fluid power.

With very few exceptions, all fluid power pumps are of the positive displacement type. That is, they have internal sealing means which makes them capable of maintaining a relatively constant ratio between rotational speed and fluid flow over wide pressure ranges. They generally utilize gears, vanes, or pistons. Non-positive displacement pumps, such as centrifugal or turbine types, are seldom associated with fluid power systems.

Pumps are available either as "fixed" or "variable" displacement types. Fixed displacement pumps have pre-selected internal geometries which maintain a constant volume of liquid passing thru the pump per revolution of the pump's shaft. Variable displacement pumps have means for changing the internal geometries so that the volume of liquid passing thru the pump per revolution of the pump's shaft can be changed.

1. SCOPE

To include basic methods of test, and methods for presenting the following performance data for rotary positive displacement hydraulic fluid power pumps used in industrial, mobile, and marine applications:

1.1 Pumps

- 1.1.1 Volumetric displacement
- 1.1.2 Output flow
- 1.1.3 Power input
- 1.1.4 Overall efficiency
- 1.1.5 Fluid inlet pressure requirements
- 1.1.6 Volumetric efficiency
- 1.1.7 Mechanical efficiency

This recommended standard also applies to variable displacement pumps when tested under fixed displacement conditions.

In addition to the basic requirements of this recommended standard, other performance information may be necessary to accommodate individual application requirements.

- 1.2 Excludes pumps which contain integral valving. (?)
- 1.3 Method of test applies only to the laboratory, not the production line or field. (16 January, 1980)

2. PURPOSE

To provide a uniform and accurate means for determining and expressing pump performance capabilities in a standard form; to guide the establishment of meaningful ratings; and to aid in accomplishing optimum component application.

3. TERMS

(For definition of terms not herein defined, see Reference No. 1)

- 3.1 Test Parameter: Any one of several physical quantities which are used to assess the performance of a pump but which are controlled at predetermined values throughout the course of a test. Synonym: Independent Variable, Controlled Variable.
- 3.2 Target Value: A predetermined value for a particular Test Parameter. The test procedure requires the setting in of the Test Parameters at values which are very near the predetermined values.
- 3.3 Observation: A record of all measured data, both dependent and independent variables, at any one combination of Parameter Values (Target Values).
- 3.4 Base Operating Condition: A specific operating point during which time all Test Parameters are set to their rated values as recommended by the pump's manufacturer.

4. GRAPHIC SYMBOLS

Graphic symbols used herein are in accordance with References No. 2, 3, and 4. Where References No. 3 and 4 are not in agreement with No. 2, Reference No. 2 governs.

## 5. LITERAL SYMBOLS

### 5.1 Physical Quantity Symbols

<u>Symbol</u>		<u>Meaning</u>	<u>US Units of Measure</u>	<u>SI Units of Measure</u>
<u>Steady State</u>	<u>Transient</u>			
Q	q	Flow	Gallons per minute	Liter per minute
H	h	Efficiency	percent	percent
T	t	Torque	lbs-in	newton-meter
P	p	Pressure	PSI	bar
N	n	Rotational Speed	RPM	RPM
W	w	Power	Horsepower	Kilowatt
D	d	Displacement	in <sup>3</sup> /rev	cc per rev
θ	θ	Temperature	°F	°C

### 5.2 Identifier Subscript Symbols

<u>Symbol</u>	<u>Meaning</u>
i	Ideal, based on design info rather than test data
I	Input
b	At base Conditions
T	Total or Overall
O	Output
V	Volumetric Used with efficiencies only
M	Mechanical
L	Leakage or loss, depending upon associated Quantity Symbol
a	Actual, based on test data as opposed to ideal
p	Pump
D	Differential Used for pressure only
A	Average
e	Effective

## 6. UNITS

- 6.1 The International System of Units (SI) is used in accordance with Reference No. 5.
- 6.2 Approximate conversions to "customary US" units are given for information purposes. These appear in parentheses after their SI counterpart, or separate, as in the case of formulas and graphs. Conversion is based upon the "total implied precision" principle.
- 6.3 Use the SI units on all graphs and data. (The use of customary US equivalents is optional.)

## 7. GENERAL PROCEDURES

### 7.1 Pumps

- 7.1.1 Select and set up all test apparatus per section 8.
- 7.1.2 Run all tests per section 10.
- 7.1.3 Using data from section 10, make calculations per section 11.
- 7.1.4 Using data from section 10 and calculations from section 11, present data per clauses 12.1 and 12.2.

## 8. TEST EQUIPMENT SELECTION AND GENERAL SET-UP

8.1 For the Power Conversion Tests, set up the circuit as in Figure 1.

### 8.2 Fluid

#### 8.2.1 Select a fluid:

- 8.2.1.1 Which is Newtonian, that is, one that does not contain polymeric materials used as thickeners or viscosity index improvers.
- 8.2.1.2 Which has viscosity characteristics which are within the limits shown in Table 1 or Table 2.



TABLE 1

US UNITS

Viscosity must be between these limits		SAE Grade	MIL-L-2104 Grade	Recommendation on Usage
At 104°F	At 212°F			
160 and 240 SUS	46 and 51 SUS	10	10	Preferred
240 and 460 SUS	51 and 58 SUS	20		Not Preferred
460 and 725 SUS	48 and 69 SUS	30	30	Not Preferred
725 and 1050 SUS	69 and 85 SUS	40	40	Not Preferred
1050 and 1650 SUS	85 and 110 SUS	50	50	Not Preferred

TABLE 2

ISO UNITS

Viscosity in CST must be between these limits		SAE Grade	MIL-L-2104 Grade	Recommendation on Usage
At 40°C	At 100°C			
34 - 51	6.0 - 7.6	10	10	Preferred
51 - 99	7.6 - 9.6	20	N/A	Non Preferred
99 - 156	9.6 - 12.7	30	30	Non Preferred
156 - 226	12.7 - 16.8	40	40	Non Preferred
226 - 356	16.8 - 22.7	50	50	Non Preferred

8.2.1.3 Which is "Not Preferred" only when the pump's Manufacturer declares that the preferred viscosities are too low for the safety of the pump.

8.2.2 Verify the viscosity by measuring it in accordance with Reference No. 8.

8.2.3 Filtration: The position, number and specific description of filters used in the test circuit shall provide a standard of filtration approved by the pump manufacturer and shall be stated. (27 March, 1979)

### 8.3 Working Instruments

8.3.1 Select Working Instruments which meet the requirements of the applicable annexes to this standard (Note: NFPA/T2.12 and ISO/TC-131/SC-8/WG-3 are developing these annexes).

### 8.4 Pressure Taps

8.4.1 Select a pressure tap which can be evaluated in accordance with the applicable Annexes to this standard.

8.4.2 Install the pressure tap in locations which agree with Figure 1.

8.5 Size and select all other test equipment to be compatible with the applicable limits entered on the Designated Information Sheet.

8.6 Install necessary safety devices to protect both equipment and personnel.

8.7 Use plumbing and circuit construction techniques to ensure that no entrained air enters the pump inlet port.

8.7.1 Use inlet plumbing which is the same size as that which the pump has.

8.7.2 There can be no changes in inlet plumbing size within 10 inlet pipe inside diameters.

## 9. PRE-TEST DATA

### 9.1 Power Conversion Test

9.1.1 Using fluid and pump manufacturers' information, determine items 1 through 8B on the Designated Information Sheet.

9.1.2 Measure the viscosity of the fluid in accordance with Reference No. 8; record on 8C of the Designated Information Sheet.

9.1.3 Determine the viscosity index in accordance with Reference 7; record on 8D of the Designated Information Sheet.

9.1.4 Determine the Target Values using both pump manufacturer's information and the following selection criteria:

9.1.4.1 For variable displacement pumps, use 100%, 75%, 50% and 25% of maximum geometric displacement. Enter the displacement values on Line 9A of the Designated Information Sheet. For fixed displacement pumps, use 100% only.

- 9.1.4.2 For shaft speeds, use 100%, 80%, 60%, 40% and 20% of rated speed. Enter these speed values on Line 9B of the Designated Information Sheet.
- 9.1.4.3 For inlet pressures, use the manufacturer's recommended minimum. Enter this pressure value on Line 9C of the Designated Information Sheet.
- 9.1.4.4 For outlet pressures, use 100%, 80%, 60%, 40%, 20% of base pressure and minimum output pressure. Minimum output pressure must be less than 10% of rated pressure. Enter these pressure values on Line 9D of the Designated Information Sheet.
- 9.1.4.5 Using the standard viscosity chart of the fluid selected in clause 8.2.1.2, determine the upper and lower target values for temperature so that the two Target Viscosities meet the requirements as given on the applicable line below:

TABLE 3

SAE Grade of Fluid	MIL-L-2104 Grade of Fluid	Low Temperature Target Viscosity in CST (SUS)	High Temperature Target Viscosity in CST (SUS)
10	10	27.4 (130)	9.9 (59)
20	N/A		
30	30	70.1 (325)	18.0 (90)
40	40	101.4 (470)	25.0 (120)
50	50	151 (700)	33.9 (160)

- A. Enter both resulting temperatures on Line 9E of the Designated Information Sheet as the two Target Values for the Power Conversion Test.
  - B. Enter the two applicable Target Viscosities on Line 9F of the Designated Information Sheet.
- 9.1.6 Estimate the Maximum Expected Values of the Test Variables using the following formulas (Note: The formulas are only estimates to aid in selecting equipment, they do not assure that actual safe limits will be achieved):

9.1.5.1 For Maximum Expected Outlet Flow, use

$$Q_{\max} = \frac{(\text{Design Displacement}) \times (\text{Rated Speed})}{231} \text{ GPM}$$

Enter this value on Line 10A of the Designated Information Sheet.

9.1.5.2 For input Torque, use

$$T_{\max} = \frac{1.4 \times (\text{Rated Pressure}) \times (\text{Design Displacement})}{2\pi} \text{ LB-IN}$$

Enter this value on Line 10B of the Designated Information Sheet.

9.1.5.3 For Case Drain Flow, use 20% of Maximum Expected outlet flow. Enter this value on Line 10C of the Designated Information Sheet.

9.1.5.4 For Input Power, use

$$W_{\max} = \frac{(\text{Rated Speed}) \times T_{\max}}{63024} \text{ HP}$$

Enter this value on Line 10D of the Designated Information Sheet.

## 9.2 Evaluation of Measurement Error

9.2.1 Evaluate the Measurement Error in accordance with the applicable Annexes of this Standard (Note: NFPA/T2.12 and ISO/TC-131/SC-8/WG-3 are preparing these annexes). Enter on Desig. Info. Sheet.

9.2.2 Using Table 4:

9.2.2.1 Select a Measurement Accuracy Class for each measured variable.

9.2.2.2 Using the "Basis/Units" column in Table 4 and the specific conditions of this test, determine the Maximum Allowed Error in the units of measure as follows:

A. Shaft Speed MAE =

$$\frac{(\text{Maximum Test Speed}) \times (\% \text{ From Table 4})}{100}$$

B. Inlet Pressure Below Atmosphere MAE =  
Selected Value from Table 4

C. Inlet Pressure Below Atmosphere or up to 1 bar above Atmosphere MAE =  
Selected value from Table 4

D. Outlet Pressure MAE =

$$\frac{(\text{Maximum Test Pressure}) \times (\% \text{ From Table 4})}{100}$$

E. Inlet Temperature MAE =  
Selected Value from Table 4

F. Outlet Flow MAE =

$$\frac{(\text{Maximum Test Flow}) \times (\% \text{ From Table 4})}{100}$$

G. Input Torque MAE =  
$$\frac{(\text{Maximum Test Torque}) \times (\% \text{ From Table 4})}{100}$$

H. Case Drain Flow MAE =  
$$\frac{(\text{Maximum Test Case Drain Flow}) \times (\% \text{ From Table 4})}{100}$$

9.2.2.3 Enter the above values on the corresponding lines of section II of the Designated Information Sheet under the column headed "Max Allowed Error".

Please Take Notice: When Maximum Allowable Error is evaluated correctly, the values are in the units of measure, not percentages.

9.2.3 Compare the Maximum Allowable Errors from 9.2.2 to the Actual Measurement Error from 9.2.1. If the Actual exceeds the Allowable, then a different Class of Accuracy must be selected, or a different measurement method must be employed.

TABLE 4  
 MEASUREMENT ACCURACY REQUIREMENTS FOR POWER CONVERSION TESTING OF A HYDRAULIC PUMP  
 (19 September, 1979)

Variable	Maximum Allowed Error For The Given Class of Measurement*			Basis/Units
	A	B	C	
Shaft Speed	± 0.5	± 1.0	± 2.0	Percent of Maximum Measured Value
Inlet Pressure When it is Below Atmosphere of up to 1 bar above Atmosphere	± 1.5	± 3.0	± 6.0	Kilopascal
Inlet Pressure above 1 bar	± 0.8	± 1.5	± 3.0	Percent of Maximum Measured Inlet Pressure
Outlet Pressure	± .8	± 1.5	± 3.0	Percent of Maximum Measured Outlet Pressure
Inlet Temperature	± .5	± 1	± 2	Degrees C
Outlet Flow	± 0.8	± 1.5	± 3.0	Percent of Maximum Measured Outlet Flow
Input Torque	± .8	± 1.5	± 3	Percent of Maximum Measured Input Torque
Case Drain Flow	± 1.0	± 2.0	± 4.0	Percent of Maximum Measured Case Drain Flow

\* These values represent the maximum allowed errors in the final data (not just the instrument) when the errors are evaluated in accordance with the applicable annexes of this standard (Note: These annexes are being prepared by NFPA/T2.12 and ISO/TC-131/SC-8/WG-3).

DESIGNATED INFORMATION SHEET

HYDRAULIC FLUID POWER PUMP TESTS NFPA T3.9.17

1. Manufacturer: \_\_\_\_\_
2. Model: \_\_\_\_\_
3. Serial No.: \_\_\_\_\_
4. Pumping Principle: \_\_\_\_\_
5. Rated Pressure: \_\_\_\_\_
6. Rated Speed: \_\_\_\_\_
7. Design Displacement: \_\_\_\_\_
8. Fluid: \_\_\_\_\_
  - A. Manufacturer: \_\_\_\_\_
  - B. Type: \_\_\_\_\_
  - C. Viscosity at 100°F: \_\_\_\_\_
  - D. Viscosity Index: \_\_\_\_\_
  - E. Additives: \_\_\_\_\_
  - F. Specific Gravity: \_\_\_\_\_
  - G. Bulk Modulus: \_\_\_\_\_
  - H. Temp Coef of Expansion: \_\_\_\_\_
9. Target Values - Power Conversion Test
  - A. Displacements: 100% = \_\_\_\_\_, 75% = \_\_\_\_\_, 50% = \_\_\_\_\_, 25% = \_\_\_\_\_
  - B. Shaft Speeds: 100% = \_\_\_\_\_, 80% = \_\_\_\_\_, 60% = \_\_\_\_\_, 40% = \_\_\_\_\_, 20% = \_\_\_\_\_
  - C. Inlet Pressures: \_\_\_\_\_
  - D. Outlet Pressures: 100% = \_\_\_\_\_, 80% = \_\_\_\_\_, 60% = \_\_\_\_\_, 40% = \_\_\_\_\_, 20% = \_\_\_\_\_, Min = \_\_\_\_\_ < 10% Rated Pressure
  - E. Inlet Fluid Temperatures: \_\_\_\_\_
  - F. Viscosities: \_\_\_\_\_
  - G. Directions of Rotation: \_\_\_\_\_
10. Maximum Expected Values of the Test Variables - Power Conversion Test
  - A. Outlet Flow: \_\_\_\_\_
  - B. Input Torque: \_\_\_\_\_
  - C. Case Drain Flow: \_\_\_\_\_
  - D. Input Power: \_\_\_\_\_
11. Error Evaluations - Power Conversion Test

Parameter	Measurement Class	Max. Allowed Measurement Error (From Table 4)	Actual Measurement Error (From Cl. 9.2.1)
A. Shaft Speed	_____	_____	_____
B. Inlet Pressure (Low)	_____	_____	_____
C. Inlet Pressure (High)	_____	_____	_____
D. Outlet Pressure	_____	_____	_____
E. Inlet Temperature	_____	_____	_____
F. Outlet Flow	_____	_____	_____
G. Input Torque	_____	_____	_____
H. Case Drain Flow	_____	_____	_____

12. Total Number of Observations: \_\_\_\_\_
13. Testing Agency: \_\_\_\_\_

10. PUMP TEST PROCEDURES

- 10.1 Install the test pump in the test rig shown in Figure 1.
- 10.2 Break-in the pump in accordance with manufacturer's recommendations.
- 10.3 Power Conversion Test
  - 10.3.1 Iterate parameters, ie, speed, inlet pressure, outlet pressure, inlet temperature and pump displacement through all applicable Target Values as recorded on the Designated Information Sheet and in all applicable combinations.
  - 10.3.2 Control the individual Target Values within the limits required in Table 5 (Note: for variable displacement pumps it is recommended that displacement be the slowest changing parameter in order to minimize the problem of returning to a given Target Value after changing displacement and further, it is recommended that the stroking control be locked into a position for a given Target Value).
  - 10.3.3 Record data per Chart 2 for all individual combinations of Target Values.
    - 10.3.3.1 Do not record Target Values, instead record their corresponding actual measured values of the Parameters.
      - 10.3.3.1.1 For pressure Target Values, be sure to set the outlet gauge pressure to a value that puts the pump differential pressure to the Target Value. This will depend upon the inlet pressure at each observation.
    - 10.3.3.2 Take readings only after all parameters and test variables have stabilized within the limits of Table 5 for at least 5 seconds.



TABLE 5 - PARAMETER REGULATION REQUIREMENTS  
 HYDRAULIC FLUID POWER PUMP TESTS

	PARAMETER CONTROL
Parameter Name	Control the Parameter within the following tolerances
Shaft Speed	± 0.5% of Rated Speed
Inlet Pressure Below Atmospheric	± 0.25 in Hg
Inlet Pressure Above Atmospheric	± 1% of Maximum Measured Inlet Pressure
Inlet Temperature	± 1.0°C (+ 2°F)
Outlet Pressure	± 1% of Maximum measured Outlet Pressure

CHART - 2 POWER CONVERSION DATA  
 HYDRAULIC FLUID POWER PUMP TEST  
 POWER CONVERSION TEST

Date \_\_\_\_\_

Technician \_\_\_\_\_

T3.9.17R1  
 Draft #5  
 20 March, 1980

PUMP DISPLACEMENT IN CC/REV (CU-IN/REV)	INLET TEMP IN °C (°F)	SHAFT SPEED IN RPM	INLET PRESSURE IN BAR (PSIG)	OUTLET PRESSURE IN BAR (PSIG)	INPUT TORQUE IN N-M (IN-LB)	OUTLET FLOW IN L/M (GPM)	CASE DRAIN FLOW IN L/M (GPM)
D	$\theta_I$	$N_I$	$P_I$	$P_O$	$T_I$	$Q_O$	$Q_L$

## 11. PUMP CALCULATIONS

- 11.1 When the optional flowmeter location downstream of the load valve is used (see figure 1), flow data may have to be corrected to the pump outlet using the following formula:

$$Q_{oe} = Q_F \left[ 1 - \frac{(P_o - P_F)}{K_T} + \gamma (\theta_o - \theta_F) \right],$$

Explanation of symbols:

$Q_{oe}$  is the effective flow at the high pressure outlet port.

$Q_F$  is the flow as measured in the optional location.

$P_o$  is the measured outlet pressure.

$P_F$  is the inlet pressure to the flowmeter.

$K_T$  is the isothermal secant bulk modulus as supplied by the fluid manufacturer.

$\gamma$  is the cubic coefficient of thermal expansion as supplied by the fluid manufacturer.

The correction formula must be applied if, when the difference between  $Q_{oe}$  and  $Q_F$  is added to the Actual Measurement Error, the result exceeds the Maximum Allowable Error. If the Maximum is not exceeded, then the correction is not necessary then:

$$Q_{oe} = Q_F$$

- 11.2 In order to compensate for the inevitable fact that Target Values cannot be perfectly acquired during the test and further, to compensate for the graphical irregularities which accompany imperfect target acquisition, it is permissible to adjust the torque and flow data to values that would have existed had target acquisition been perfect. the following formulas apply as first approximations:

$$Q_{Adj} = Q_{oe} \times \frac{N_{Target}}{N_{Actual}}$$

which applies only if the actual speed differs from the Target Speed by no more than 10% of Maximum Test Speed, and

$$T_{Adj} = T_{oe} \times \frac{P_{Target}}{P_{Actual}}$$

which applies only if the actual pressure differs from the Target pressure by no more than 5% of the maximum test pressure.

11.3 Calculate the pump input power:

$$W_I \text{ (Watts)} = 0.105 T_I(n-m) \times N_I(\text{rpm})$$

$$W_I \text{ (HP)} = T_I(\text{in-lb}) \times N_I(\text{rpm})/63024$$

11.4 Calculate pump output power:

$$W_O \text{ (Watts)} = 1.67 \times [P_O - P_I](\text{bar}) \times Q_{Oe}(\text{L/Min})$$

$$W_O \text{ (HP)} = [P_O - P_I](\text{psi}) \times Q_{Oe}(\text{gpm})/1714$$

11.5 Calculate overall efficiency

$$H_T = \frac{W_O}{W_I}$$

11.6 Determine the Actual Displacement

11.6.1 Separate Power Conversion Test data by displacement and temperature, that is, so that each individual displacement-temperature combination forms a single block of data. For each of those blocks, carry out the following three steps:

11.6.1.1 Calculate the Simple Displacement:

Simple Displacement (cc/rev) =

$$1000 \times Q_{Oe}(\text{L/Min})/N_I(\text{rpm})$$

Simple Displacement (cu-in/rev) =

$$231 \times Q_{Oe}(\text{gpm})/N_I(\text{rpm})$$

for all observations in each of the data blocks formed in 11.6.1.

11.6.1.2 Scan all data in each block and select the maximum value of the Simple Displacement as the Actual Displacement:

$$D_a = \text{Max} [\text{Simple Displacement}]$$

11.6.1.3 Repeat 11.6.1.1 and 11.6.1.2 for each temperature-displacement data block

11.7 Determine the Volumetric Efficiency:

11.7.1 For each displacement-temperature combination, calculate the Ideal Flow using the displacement found in 11.6.1.2:

$$Q_{O_i}(\text{L/Min}) = D_a(\text{cc/rev}) \times N_I(\text{rpm})/1000$$

$$Q_{O_i}(\text{gpm}) = D_a(\text{cu-in/rev}) \times N_I(\text{rpm})/1000$$

for each observation.

11.7.2 Calculate the Volumetric Efficiency:

$$H_V = \frac{Q_{oe}}{Q_{oi}}$$

11.7.3 Determine the volumetric efficiency at the base operating condition:

$$H_{Vb} = \frac{Q_{oeb}}{Q_{oib}}$$

where  $Q_{oeb}$  is the effective output flow at base conditions and  $Q_{oib}$  is Ideal Flow calculated using base speed.

11.7.4 Determine the volumetric efficiency at the base operating condition:

$$H_{Vb} = \frac{Q_{oab}}{Q_{oib}}$$

where  $Q_{oab}$  is the actual flow when the pump was operated under the condition of rated speed, rated temperature, maximum displacement, rated inlet pressure and rated outlet pressure;  $Q_{oib}$  is the ideal flow at base condition which was found in 11.7.1 using rated speed for  $N_I$ .

11.8 Determine the Mechanical Efficiency:

11.8.1 For each displacement setting, calculate the Ideal Input Torque using the displacement as determined in 11.6.3:

$$T_{Ii}(n-m) = D_a(cc/rev) \times [P_o - P_I](bar)/2000\pi$$

$$T_{Ii}(in-lb) = D_a(cu-in/rev) \times [P_o - P_I](psi)/2\pi$$

where  $P_o$  and  $P_I$  are measured values taken from the Power Conversion Test and  $P_I$  is a negative value when the inlet pressure is below atmospheric.

11.8.2 Calculate the Mechanical Efficiency:

$$H_M = \frac{T_{Ii}}{T_{Ia}}$$

- 11.8.3 Determine the Mechanical Efficiency at the base operating condition:

$$H_M = \frac{T_{Iib}}{T_{Iab}}$$

where  $T_{Iab}$  is the actual torque measured when the pump was operated under the condition of rated speed, rated temperature, maximum displacement, rated inlet pressure and rated outlet pressure;  $T_{Iib}$  is the ideal torque which was found in 11.8.1 using rated values for  $P_o$  and  $P_I$ .

## 12. TEST DATA PRESENTATION

When describing pump performance in accordance with this standard, the following data shall be provided.

- 12.1 Provide all information contained on the Designated Information Sheet.

- 12.2 Provide all test data results as described in 12.2.1 and 12.2.2

- 12.2.1 For each displacement setting, plot graphically (see figure 2) pump performance versus pump pressure differential ( $P_o - P_I$ ) at a constant pump speed ( $N_I$ ).

12.2.1.1 Overall efficiency ( $H_T$ ) versus pressure differential ( $P_o - P_I$ ) with test temperature ( $\theta$ ) as a parameter.

12.2.1.2 Flow output ( $Q_o$ ) versus pressure differential ( $P_o - P_I$ ) with test temperature ( $\theta$ ) as a parameter.

12.2.1.3 Horsepower input ( $W_I$ ) versus pressure differential ( $P_o - P_I$ ) with test temperature ( $\theta$ ) as a parameter.

12.2.1.4 Repeat 12.2.1 for each displacement setting and pump speed combination.

- 12.2.2 For each displacement setting, plot graphically (see figure 3) pump performance versus pump speed ( $N_I$ ) at a constant test temperature ( $\theta$ )

12.2.2.1 Flow output ( $Q_o$ ) versus pump speed ( $N_I$ ) with pressure differential ( $P_o - P_I$ ) as a parameter.

12.2.2.2 Overall efficiency ( $H_T$ ) versus pump speed ( $N_I$ ) with pressure differential ( $P_o - P_I$ ) as a parameter.

12.2.2.3 Horsepower input ( $W_I$ ) versus pump speed ( $N_I$ ) with pressure differential ( $P_o - P_I$ ) as a parameter.

12.2.2.4 Repeat 12.2.2 for each displacement setting  
and test temperature combination.

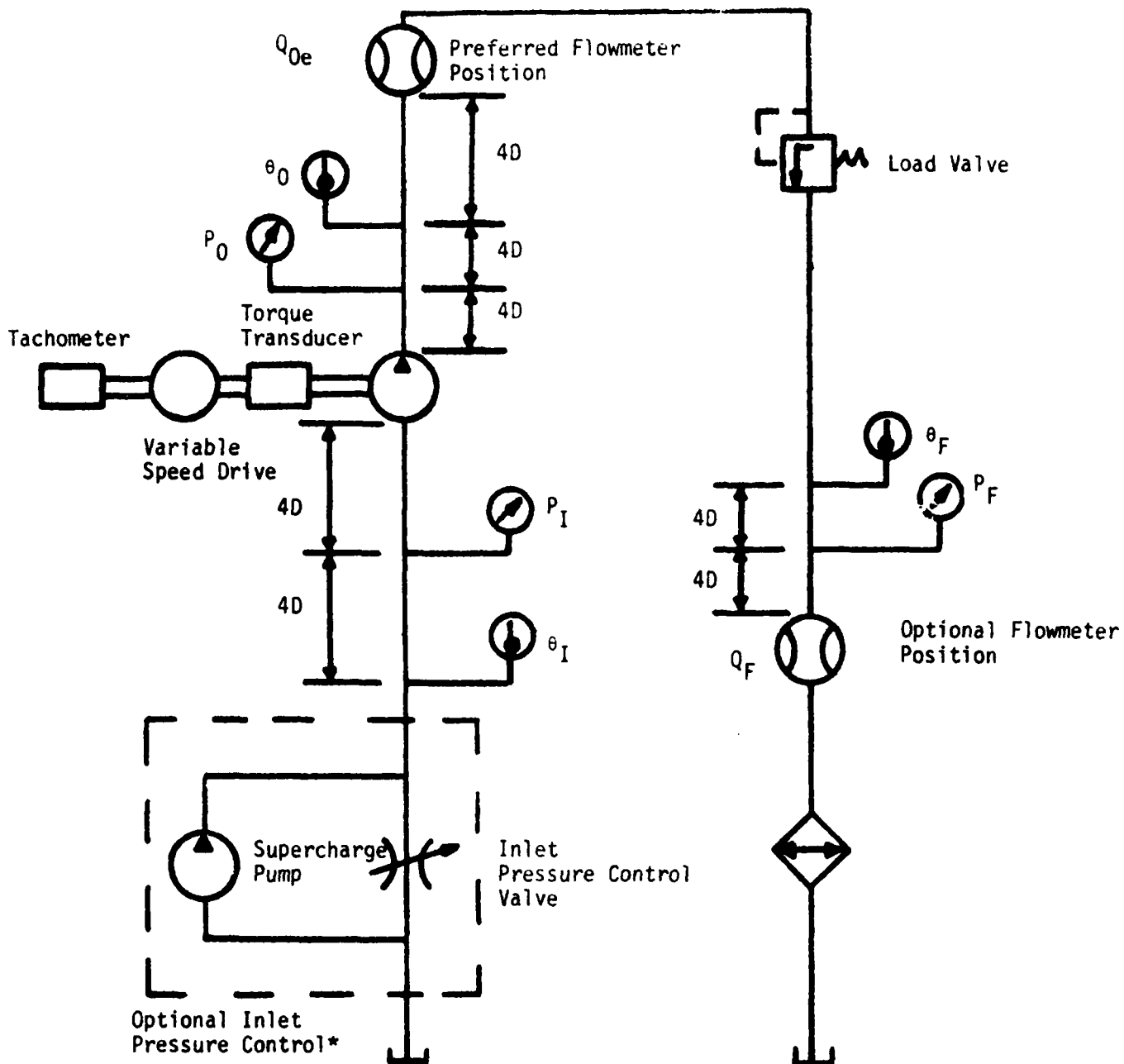
12.3 Graphing of several variables on one set of axes is allowed.

14. IDENTIFICATION

The use of the following statement in catalogues and sales literature prepared by those electing to comply with this voluntary standard is strongly recommended:

14.1 "Performance data obtained and presented per NFPA Recommended Standard T3.9.17-19XX".

FIGURE 1



\* If positive inlet pressures are required, the supercharge pump can be used.  
 If very low inlet pressures are required, only the load valve may be necessary.

Note 1: See clause 8.2.3 for filtration requirements

Note 2: When the Optional Flowmeter position is used, it may be necessary to correct for differences in pressure between the preferred and optional positions. See Clause 11.1 for specific procedures and criteria.



ANNEX A

A GLOSSARY OF TERMS IN SUPPORT OF TESTING IN A HYDRAULIC  
FLUID POWER LABORATORY

1.0 Purpose:

To set forth those terms and their definitions needed to understand the technology associated with accurate measurement of the physical variables encountered in the assessment of fluid power equipment.

2.0 Scope:

2.1 Includes terms used for understanding calibration of instruments.

2.2 Includes terms used for understanding measurement of physical variables in fluid power systems.

3.0 References:

#### 4. TERMS AND DEFINITIONS

- 4.1 Agency: Any person or organization or part, section, department or division of an organization which maintains equipment and supporting records for the purpose of engaging in any or all of the following:
- A. Calibration of Reference Standards
  - B. Calibration of Working Instruments
  - C. Testing of Fluid Power Equipment.
- 4.2 Calibration: The process of comparing a first Reference Standard to a second Reference Standard or Working Instrument Reference Standard or Working Instrument.
- 4.3 Calibration Situation: That time when a Working Instrument is Calibrated against a Reference Standard.
- 4.4 Certificate: A written statement by a Certified Calibration Agency that a calibration has been carried out in accordance with this standard.
- 4.5 Certified Calibration: The process of comparing a Certified Reference Standard to another Reference Standard or Working Instrument and providing supporting documentation in accordance with this standard.
- 4.6 Certified Calibration Agency: Any Agency which maintains Reference Standards and supporting documentation in accordance with this standard.
- 4.7 Certification Lineage: That path which traces the calibration of an instrument to the Ultimate Reference Standard.
- 4.8 Dummy Calibration: A process whereby a signal to a transducer is simulated electronically in order to facilitate the return of electronic gains to the levels used during Calibration. Use of Dummy Calibration is not a substitute for Verification or Calibration.
- 4.9 Environmental Factors: Any physical variable other than the <sup>measurand which affects</sup> output of an Instrument. In a pressure transducer, for instance, temperature may cause a span or zero shift, making temperature an Environmental Factor affecting the pressure measurement. In another case, pressure may affect a temperature transducer, making pressure the Environmental Factor.
- 4.10 Error: The estimated uncertainty surrounding a given measurement which establishes the boundaries within which the true value lies relative to the Indicated Value.
- 4.11 Error Contribution: An estimate of that amount of uncertainty which contributes to the Total Error and is attributable to a single error producing phenomenon.
- 4.12 Indicated Value: The best estimate of a value based upon the human interpretation of a readout device. Synonym: Reading
- 4.13 Instrument: Any device used for measurement.

- 4.14 Mathematical Model: A graph, chart or equation which relates the indicated Value to the value of the measurand.
- 4.15 Measurement Situation: That time when a Testing Agency incorporates Working Instruments in the testing of fluid power components and/or systems.
- 4.16 Physical Standards Laboratory: That agency which is recognized by a national government as capable of maintaining Ultimate Reference Standards.
- 4.17 Pressure Measurement System: All those devices which are interconnected between the system, the pressure of which is to be measured, and the final readout device.
- 4.18 Pressure Transducer: Any device which senses fluid pressure and converts it to an electrical signal.
- 4.19 Random Error: An error which has no known physical cause and is completely unpredictable except within some bounds.
- 4.20 Readability: A generic term used to describe the ability of a human observer to assign a digital quantity to the value displayed on a Readout Device.
- 4.21 Readability Error: The error caused by the inability to assign an unlimited number of digits to the output of an instrument.
- 4.22 Readout Device: That mechanism which ultimately displays the value of a physical variable within a system in a form upon which logical decisions can be made.
- 4.23 Reference Standard: A measuring system which is used only to calibrate other measuring devices and/or systems.
- 4.24 Reference Standard, Intermediate: A Reference Standard maintained by any person or organization other than the Physical Standards Laboratory and which has been certified in accordance with this standard.
- 4.25 Reference Standard, Laboratory: A Reference Standard which is permitted between the Ultimate and/or Intermediate References in certain special cases, criteria for which are contained in this standard.
- 4.26 Reference Standard, Ultimate: That Reference Standard maintained by the Physical Standards Laboratory. The most authoritative Reference Standard in a given country.
- 4.27 Reference Value: The best estimate of the actual value of a physical variable experienced by an instrument during its calibration, taking into account corrections in fluid column height and calibration corrections for the Reference Standard. It should not be confused with the true value which can never be known exactly.
- 4.28 Second Order Error: The error induced in the determination of a measured quantity caused by a measurement error in an Environmental Factor which is going to be used to make a correction to the basic measured quantity.

4.29 Snubber: A hydraulic restriction deliberately placed between the source of pressure to be measured and the pressure transducer for the purpose of damping pressure pulsations.

4.30 Static Pressure: That pressure in a line which does not include effects due to fluid momentum.

4.31 Steady-State: An operating condition in a hydraulic system which is characterized by the fact that

$$\int_{t_1 + 2\pi k}^{t_1 + 2\pi k} p(t) dt = \int_{t_2}^{t_2 + 2\pi k} p(t) dt$$

and where  $t_1$  and  $t_2$  are arbitrary and  $k$  is an integer multiple of the period of the fundamental frequency of the pulsation.

4.32 Symmetry Test: A test conducted on a Snubber for the purpose of determining the extent to which its reverse pressure-flow characteristic agrees with its forward pressure-flow characteristic for the further purpose of assessing its Error Contribution. See Section 4 for details.

4.33 Systematic Error: A repeatable error which is caused by a physical phenomenon which, if sufficient experimental evidence exists, can be eliminated.

4.34 Testing Agency: Any Agency which conducts tests on Fluid Power Equipment.

4.35 Total Error: The total estimated uncertainty in the value of a measured quantity caused by the combined effect of all Error Contributing phenomena.

4.36 Verification, Working Instrument: An abbreviated calibration procedure carried out at specified intervals between Certified Calibrations.

4.37 Working Instrument: A measuring system, which includes interconnecting linkages, any necessary signal conditioning and signal processing and the readout device, which is used by the Testing Agency while conducting tests on Fluid Power Equipment.

## ANNEX B

### RECOMMENDED METHOD FOR CALIBRATING WORKING INSTRUMENTS FOR USE IN TESTING FLUID POWER EQUIPMENT

- 1.0 Purpose: To set forth the calibration procedures of Working Instruments used in fluid power measurements.
- 2.0 Scope:
  - 2.1 To include requirements of Reference Standards.
  - 2.2 To include requirements of Working Instruments.
  - 2.3 To include procedures for calibrating Working Instruments.
  - 2.4 To include the requirements of the Working Instrument's Label.
- 3.0 Definitions:
  - 3.1 Refer to Annex A
  - 3.2 All terms used in this standard which are capitalized are defined in Annex A.
- 4.0 General Procedures
  - 4.1 Select a Reference Standard per clause 5.0.
  - 4.2 Calibrate the Working Instrument per clause 6.0.
  - 4.3 Prepare an Instrument Label per clause 7.0.
- 5.0 Select a Reference Standard:
  - 5.1 Which is certified to have been, itself, traceably calibrated within the intervals given in Table 1.
  - 5.2 Which is free of physical damage except as noted on its certificate.
  - 5.3 Which has had its total error evaluated and certified.
  - 5.4 Mount the Reference Standard in an attitude indicated on its Certificate, or in that attitude recommended by its manufacturer.
- 6.0 Calibrate the Working Instrument at the applicable frequency given in Table 2.
  - 6.1 Select a Working Instrument which is free from physical damage.
    - 6.1.1 Mount the Working Instrument in an attitude recommended by the manufacturer or in an attitude expected in the Measurement situation.
    - 6.1.2 Make zero value checks with the Working Instrument physically uncoupled from any possible loading effects.

6.1.3 Collect calibration data.

- 6.1.3.1 Couple the Working Instrument to the Reference Standard.
- 6.1.3.2 For Working Instruments which are subject to hysteresis effects due to, for instance, material characteristics or static friction, carry out the calibration for both increasing and decreasing Reference Values.
- 6.1.3.3 Take advantage of any correction charts or mathematical models which may have resulted from Calibration of the Reference Standard which are needed to confine the Reference Standard's Total Error to the Certified amount.
- 6.1.3.4 Make corrections to the Reference Values for any other Systematic Errors when the relationships with other physical variables are known and the physical variables themselves are known (measured) at the time of Working Instrument Calibration and if the effects of the Systematic Errors will otherwise be significant.
- 6.1.3.5 Record data:
  - A. Reference value, after any corrections as may be applicable from the two previous clauses.
  - B. Indicated Value from the Working Instrument.
- 6.1.3.6 Repeat 6.1.3.5 for at least five trials and use at least 10 calibration points for each. Use the same set of Reference values during each trial.
- 6.1.3.7 Make note of anything unusual about the physical appearance of the instrument.
- 6.1.3.8 Sign the calibration data sheets and place them into a safe, permanent file. This record is the Working Instrument's Certificate.

7.0 Instrument Label

- 7.1 Prepare a Label for the Instrument which will identify and have room for the following data:
  - 7.1.1 Date of the next scheduled Calibration as required in Table 2 of this Annex in order to remain in Certification.
  - 7.1.2 Total Error of the Reference Standard used in Calibrating the Working Instrument.
  - 7.1.3 Calibration Error of the Working Instrument as determined after development of a Mathematical Model in accordance with Annex D.
  - 7.1.4 Readability Error as determined in accordance with Annex E.

- 7.1.5 Working Instrument Identification
  - 7.1.6 Identification of the person responsible for the Calibration of the Working Instrument.
  - 7.2 Enter the date of the next required calibration on the Label in the appropriate place.
  - 7.3 Enter the Total Error of the Reference Standard on the Label in the appropriate place.
    - 7.3.1 If the Total Error is stated in terms of the Maximum or full-scale value, use that value.
    - 7.3.2 If the Total Error is stated in terms of the Indicated Value (Reading), use a value determined from that and the full-scale value of the Working Instrument being calibrated.
  - 7.4 Affix the Label to the Instrument's Readout Device in a manner which will discourage its inadvertent removal and yet will not interfere with reading.
- 8.0 Propose a Mathematical Model of the Working Instrument in accordance with Annex D.

## FREQUENCY OF CALIBRATION - REFERENCE STANDARDS

Variable/Type of Standard	Frequency of Calibration
<b>TORQUE:</b>	
Strain Gage.....	Every four years
Force and Distance.....	Every five years
<b>PRESSURE:</b>	
Master Guages.....	Every two years
Dead Weight Testers.....	Every ten years
Strain Gage.....	Every two years
Other Transducers.....	Every two years
Liquid Manometers.....	Liquid properties every five years height every 10 years
<b>FLOW:</b>	
Positive Displacement Reference Meters.....	Every five years
Turbine Reference Meters.....	Every two years
Volume and Time Provers.....	Every ten years
Weight and Time Provers.....	Every ten years
<b>SPEED:</b>	
Electronic Digital Frequency Meters.....	Every year
Stroboscopes.....	Each use
Reference Tachometer.....	Every two years
<b>TEMPERATURE:</b>	
Mercury in Glass.....	Every five years
Thermocouple.....	Every year
Bimetal.....	Each Use
Gas Filled.....	Each Use
<b>FORCE:</b>	
Dead Weights.....	Every ten years
Load Cells.....	Every two years
Balance Scales.....	Every year
<b>DISTANCE:</b>	
Gauge Blocks.....	Every ten years
Tapes.....	Every ten years
Micrometers.....	Every two years
<b>TIME:</b>	
Electronic Digital Timers.....	Every year
Chronometers, Mechanical.....	Every six months
Chronometers, Electro-Mechanical.....	Every year



TABLE 2

FREQUENCY OF CALIBRATION - WORKING INSTRUMENTS

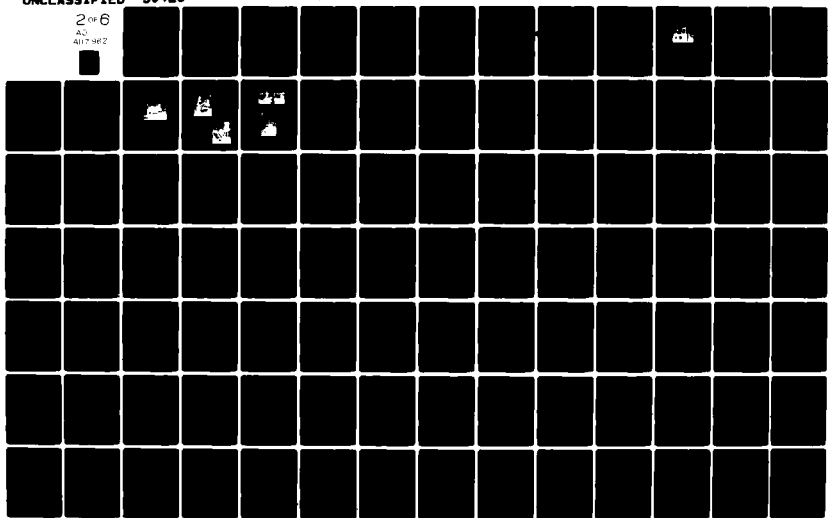
Variable/Type of Working Instrument	Frequency of Calibration
TORQUE:	
Strain Gage.....	24 Months
Calibrated Motor.....	12 Months
Cradled Dynamometer.....	10 Months
PRESSURE:	
All Types.....	12 Months
FLOW:	
All Types.....	12 Months
SPEED:	
Mechanical Tachometers.....	6 Months
DC Electrical Generators.....	6 Months
Electronical Digital Frequency Meters.....	2 Months
Other Types.....	6 Months
TEMPERATURE:	
All Types.....	12 Months
FORCE:	
Dead Weights.....	10 Years
Balance Scales.....	6 Months
Load Cells.....	6 Months
Other Types.....	6 Months
DISTANCE:	
Gauge Blocks.....	2 Years
Tapes.....	5 Years
Micrometers.....	2 Months
TIME:	
All Types.....	2 Months

AD-A117 962

MILWAUKEE SCHOOL OF ENGINEERING WI FLUID POWER INST F/8 13/11  
BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
JUL 82 DAAK70-81-C-0002  
50423 NL

UNCLASSIFIED

2 of 6  
AD  
A117 962



ANNEX C

RECOMMENDED METHOD FOR DETERMINING AN INSTRUMENT'S CALIBRATION  
ERROR THROUGH DEVELOPMENT OF A SUITABLE MATHEMATICAL MODEL

1.0 Purpose:

- 1.1 To set forth the procedures for driving mathematical models of a Working Instrument and, when applicable, to evaluate effects of Environmental Factors.
- 1.2 To determine the Calibration Error of a Working Instrument.
- 1.3 To set forth procedures which can be used to bring an instrument's Calibration Error to approach its limit of non-repeatability.
- 1.4 To determine the value of Calibration Error to be entered on the Instrument's Label.

2.0 Scope:

- 2.1 To include four different models.
- 2.2 To include methods of dealing with Environmental Factors.

3.0 Definitions:

- 3.1 Refer to Annex A.
- 3.2 All terms used in this Standard which are capitalized are defined in Annex A.

4.0 General Procedures

- 4.1 Select a suitable Mathematical Model from one of the four in clauses 5.0, 6.0, 7.0 or 8.0 (Note: The amount of Calibration Error in most Instruments will depend upon the Model Selected. Higher order Models will yield smaller errors.)
- 4.2 Evaluate the Model in accordance with the applicable clauses.
- 4.3 Enter the Calibration Error, as evaluated in the applicable clause, on the Instrument's Label.

5.0 First Order Mathematical Model

- 5.1 A First Order Mathematical Model makes direct use of the Indicated Value of a Readout Device without resorting to any corrections. The Instrument and Readout Device are the model.
- 5.2 Evaluate the Calibration Error
  - 5.2.1 Use the Calibration data as recorded using Annex C.

5.2.2 Scan all data from all five calibration trials and determine the maximum deviation between the Indicated Value and the Reference Value regardless of where in the range the maximum appears. Enter this deviation as the Calibration Error on the Instrument's Label.

5.3 Implement the Model by using as indicated on the Readout Device.

#### 6.0 Second Order Mathematical Model

6.1 A Second Order Mathematical Model assumes that the Indicated Value is related to the actual value of a physical variable and any influencing Environmental Factors through a formula of the form:

$$\text{Actual Value} = b_0 + \sum_{k=1}^m b_k (\text{Indicated Value})^k + \sum_{i=1}^n a_i f(E_i)$$

where  $E_i$  is one of  $n$  influencing Environmental Factors,  $f(E_i)$  is the functional manner in which  $E_i$  affects the measurement of the actual value and  $a_i$  is a linear coefficient which affects the degree of effect.

6.2 Determine  $f(E_i)$  by any one or combination of the following methods:

6.2.1 Use acceptable theories.

6.2.2 Use empirical data as measured during controlled experiments during Working Instrument Calibration.

6.2.3 Use manufacturer's data, such as, for instance, zero shift due to temperature, or span shift due to viscosity, etc.

6.2.4 Ignore Environmental Factors when they are brought into sufficient agreement in the Measurement Situation with the values that existed during the Calibration Situation.

6.2.5 Ignore Environmental Factors which are known to have an insignificant influence upon the Indicated Value.

6.3 Evaluate  $b_0$ ,  $b_k$  and  $a_i$  using linear regression on all data from all trials of calibration as conducted in Annex C.

6.4 Scan all data and find the maximum absolute value of the deviation between the Indicated Value and the value predicted by the derived mathematical model for each of the Reference Values as used in the Calibration of the Working Instrument. Enter this maximum deviation as the Calibration Error on the Instrument's Label regardless where in the range the maximum deviation may have occurred.

6.5 Implement the Mathematical Model by substituting the Indicated Values and values of the Environmental Factors measured during the Measurement Situation into the formula. That result is the estimate of the actual value at measurement time. Its Calibration Error is the amount recorded in clause 6.4.

#### 7.0 Third Order Mathematical Model

7.1 A Third Order Mathematical Model makes use of a point-to-point correction under the assumption that corrections are linear when Indicated Values taken in the Measurement Situation lie between data points used during the Calibration Situation.

7.2 Evaluate the Calibration Error.

7.2.1 For each Reference Value used during Calibration in accordance with Annex C and for each of the five trials, calculate the errors as:

Reference Value - Indicated Value

7.2.2 For each Reference Value, calculate the average over the five trials of the errors found in 7.2.1.

7.2.3 Calculate the differences between the errors found in 7.2.1 and the averages found in 7.2.2 for all Reference Values and all trials.

7.2.4 Scan all values found in 7.2.3 and find the maximum absolute value. Enter this as the Calibration Error, on the Instrument's Label regardless of where in the range it may have occurred.

7.2.5 Implement the Mathematical Model by constructing a graph of the averages found in clause 7.2.2 vs. the average Indicated Value (as averaged over the five trials for each Reference Value. Note: If the average Indicated Value deviates from its corresponding Reference Value by 1% or less, the Reference Value may be substituted for the average with minimal adverse effect.)

7.2.5.1 In the Measurement Situation, enter each Indicated Value into the abscissa, then add the resulting ordinate value to the Indicated Value in order to obtain the best estimate of the actual value.

7.2.5.2 Assume linear interpolation between discreet data entries.

7.2.5.3 Take Environmental Factors into account by: A. An alternate mathematical model which includes their effects. B. Using instruments which have insignificant influence by Environmental Factors. C. Controlling Environmental Factors during the Measurement Situation to be in significant agreement with their values during calibration.

## 8.0 Fourth Order Mathematical Model

- 8.1 A Fourth Order Mathematical Model accommodates complex mathematical functions which relate the actual value to the Indicated Value and any influencing Environmental Factors. It has no specific general form.
- 8.2 Determine the general form of the mathematical relationship using any one or combination of the following means.
  - 8.2.1 Use accepted theories.
  - 8.2.2 Use empirical data as determined during controlled experiments on the instrument.
  - 8.2.3 Use manufacturer's data, such as, for instance, zero shift due to temperature, or span shift due to viscosity, etc.
  - 8.2.4 Ignore Environmental Factors when they are brought into sufficient agreement in the Measurement Situation with the values that existed during the Calibration Situation.
  - 8.2.5 Ignore Environmental Factors which are known to have an insignificant influence upon the Indicated Value.
- 8.3 Evaluate the coefficients in the Mathematical Model using least squares fitting methods applied to all data taken from calibration in accordance with Annex C.
- 8.4 Scan all data and find the maximum absolute value of the deviation between the Indicated Value and the value predicted by the derived mathematical model for each of the Reference Values as used in the Calibration of the Working Instrument. Enter this maximum deviation as the Calibration Error on the Instrument's Label regardless where in the range the maximum deviation may have occurred.
- 8.5 Implement the Mathematical Model by substituting the Indicated Values and values of the Environmental Factors measured during the Measurement Situation into the formula. That result is the estimate of the actual value at measurement time. Its Calibration Error is the amount recorded in clause 6.4.

ANNEX D

RECOMMEND PROCEDURE FOR EVALUATING READABILITY  
ERROR OF READOUT DEVICES USED IN FLUID POWER TESTING

1.0 Purpose: To set forth the procedure for determining the amount of error contributed because of the inability to assign an unlimited number of digits to the indicated value of a measured quantity.

2.0 Scope:

2.1 Includes both analog and digital Readout Devices.

3.0 Evaluation of Readability Error Factor.

3.1 Analog Readout Devices

3.1.1 The Readability Error (RE) for a Readout Device equipped with a pointer shall be calculated using:

$$RE = \frac{\text{Value of the Smallest Scale Division}}{[RF_1 \times RF_2 + 2.0]}$$

Where  $RF_1$  and  $RF_2$  are determined from properties of the Readout Device as follows:

3.1.1.1 The Readout Device shall be equipped with a parallax error minimizing feature.

3.1.1.2 Determine within 10%, the width of the smallest scale division in mm (W)

Calculate  $RF_1$  with the formula:

$$RF_1 = 3(1 - e^{0.5 - 1.1W}) \quad W \geq 0.5 \text{ mm}$$

$$RF_1 = 0.0 \quad W < 0.5 \text{ mm}$$

3.1.1.3 Estimate the width of the pointer to the nearest 0.25 mm in the region on the pointer where the reading is interpreted. Divide the width of the smallest scale division found in 3.1.2.2 by the pointer width to form the ratio,  $\alpha$ .

Calculate  $RF_2$  with the formula:

$$RF_2 = 1 - e^{0.6(1-\alpha)} \quad \alpha \geq 1.0$$

$$RF_2 = 0 \quad \alpha < 1.0$$

3.1.1.4 Calculate the Readability Error for the Readout Device with the Formula:

$$RE = \frac{\text{Value of the Smallest Scale Division}}{[RF_1 \times RF_2 + 2.0]}$$

3.1.2 The overall Readability Factor for a Readout Device having a moving column, such as is the case with a liquid manometer, shall be calculated using:

$$RE = \frac{2x \text{ Value of the Smallest Scale Division}}{RF_1 + 2.0}$$

Where  $RF_1$  is determined as in clause 3.1.1.2

### 3.2 Digital Readout Devices

3.2.1 The Readability Error shall be calculated using the formula:

RE = Smallest Change in the Least Significant Digit

3.2.1.1 Take into account the fact that by design, the least significant digit in some Digital Readout Devices does not have 10 discreet integer levels. Use the value of the smallest integer change possible for the particular readout.

### 4.0 Readout Device Labels

4.1 Enter the overall Readability Error, as determined in clause 3.1.1.3, 3.1.2 or clause 3.1.1, into the Readout Device's Label.

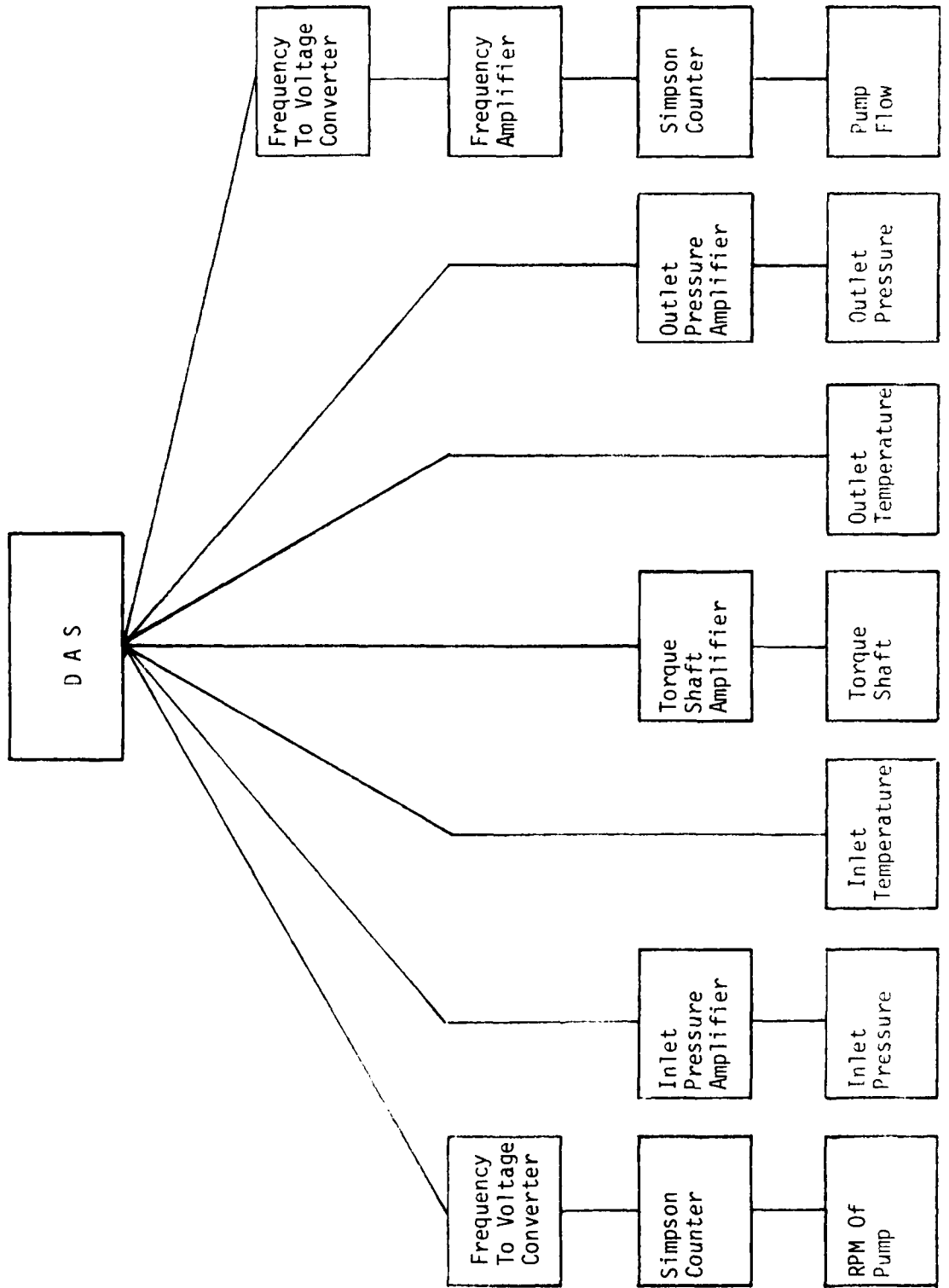


APPENDIX C  
INSTRUMENTATION  
BREAK-IN AND POWER CONVERSION TEST

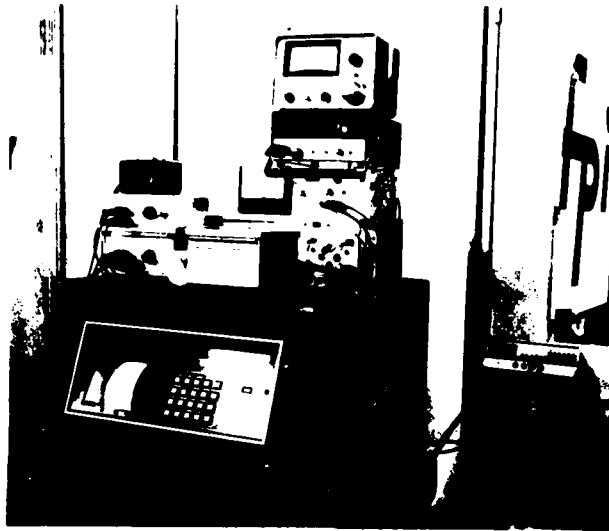
## INSTRUMENTATION

The instrumentation, calibration methods and procedures used in this contract, can be referenced to Part 2, of report number 50560, contract DAAK70-77-C-0214, dated November 12, 1979. The traceability statement for measurement of flow, pressure, and temperature are also found in Part 2 of the above mentioned report.

BLOCK DIAGRAM OF INSTRUMENTATION SYSTEM



## TEST INSTRUMENTATION

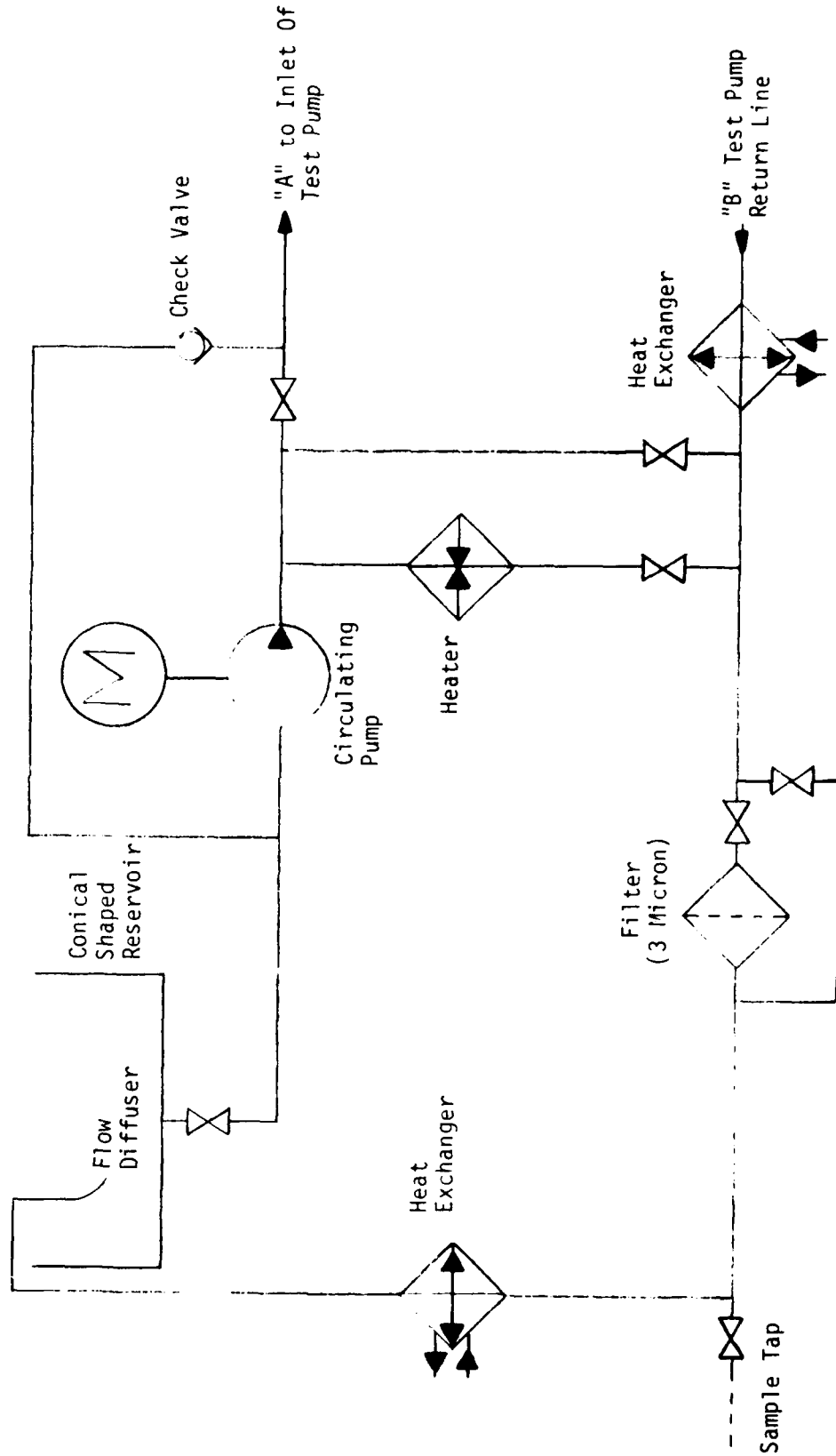


Data Acquisition System (DAS) and Supporting Instrumentation.

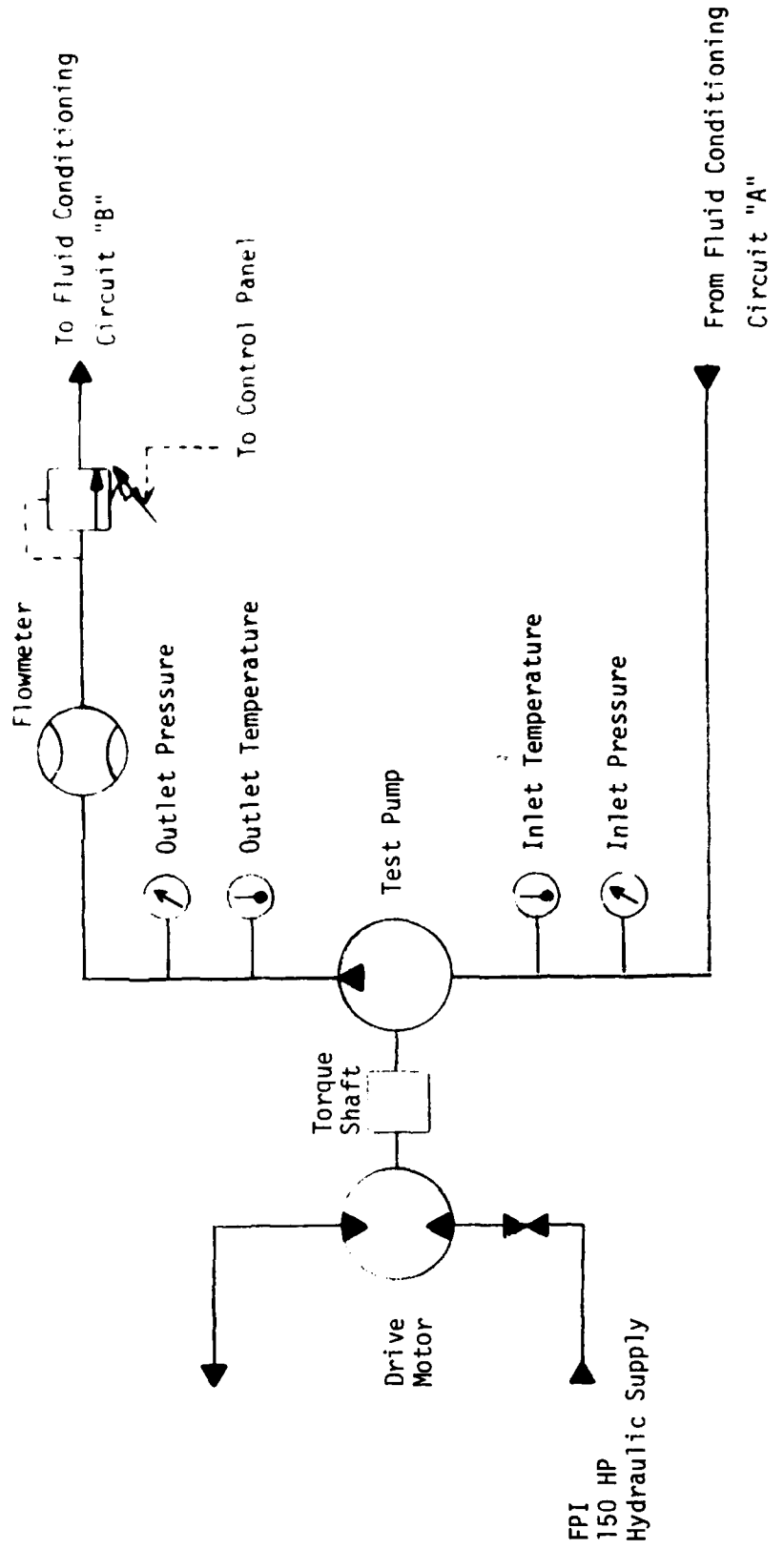
DAS is mounted in black cabinet with all connections in front. Torque shaft amplifier, Pace and Viatran pressure transducer power supplies and frequency counter used to monitor test pump RPM. Also shown are two frequency to voltage converters, and control box for 150 HP supply.

APPENDIX D  
CIRCUIT SCHEMATICS  
BREAK-IN AND POWER CONVERSION TEST

FLUID CONDITIONING CIRCUIT  
BREAK-IN AND PERFORMANCE TESTS



BREAK-IN AND PERFORMANCE TEST CIRCUIT

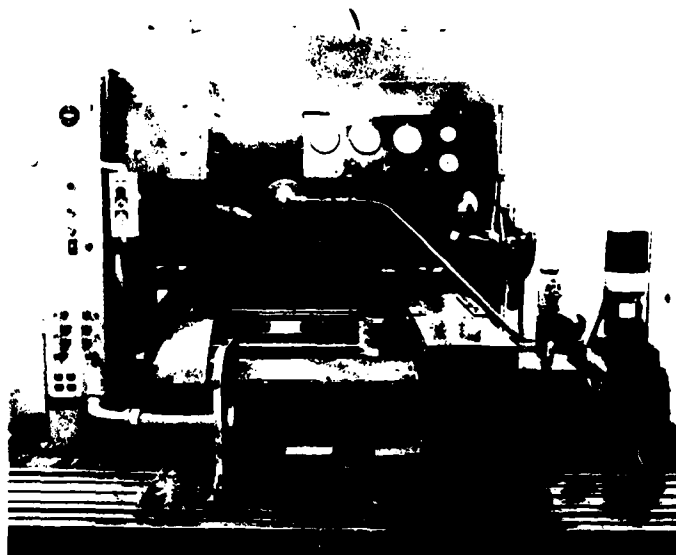


APPENDIX E  
TEST SET-UP PHOTOGRAPHS  
BREAK-IN AND POWER CONVERSION TEST



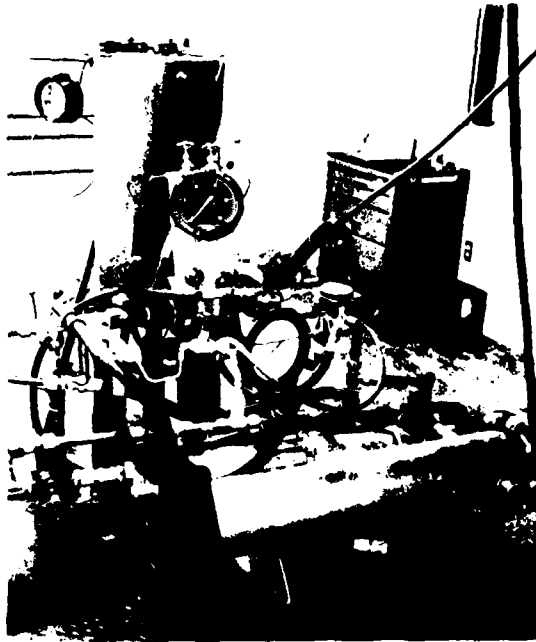
## HYDRAULIC POWER SUPPLY

FPI 150 HP Variable Volume Hydraulic Supply



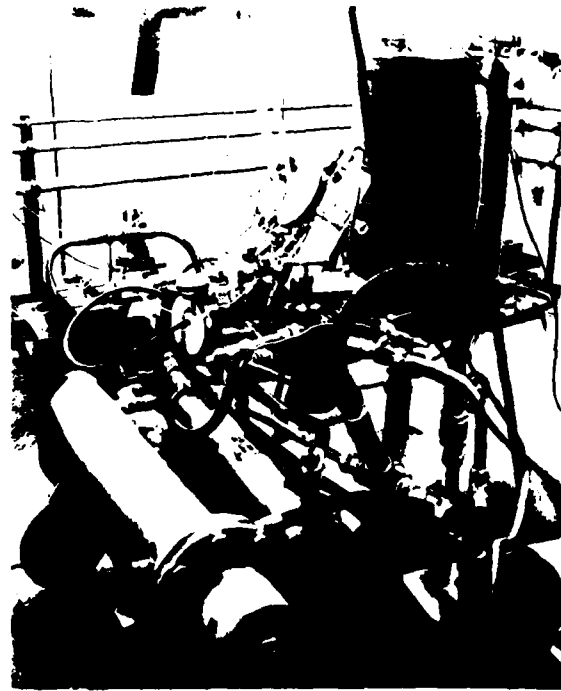
Shown is reservoir, control panel, electric drive motor, variable displacement hydraulic pump and electric servo control on top of pump. This system was used along with a hydraulic motor to drive the test pump.

## FLUID CONDITIONING SYSTEM

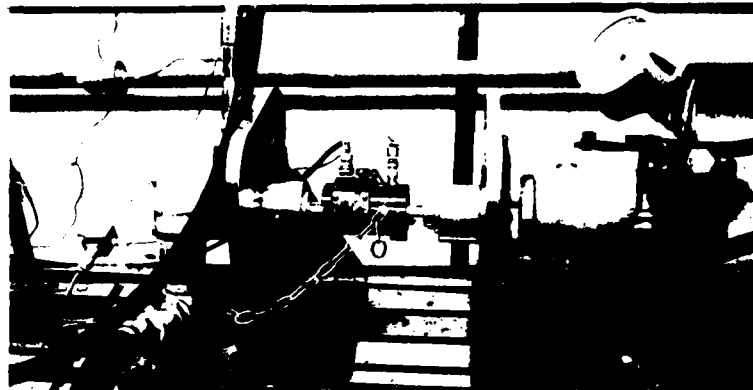


Fluid conditioning system consisting of reservoir with conically shaped bottom, filter strainer, heat exchanger, and electric heater.

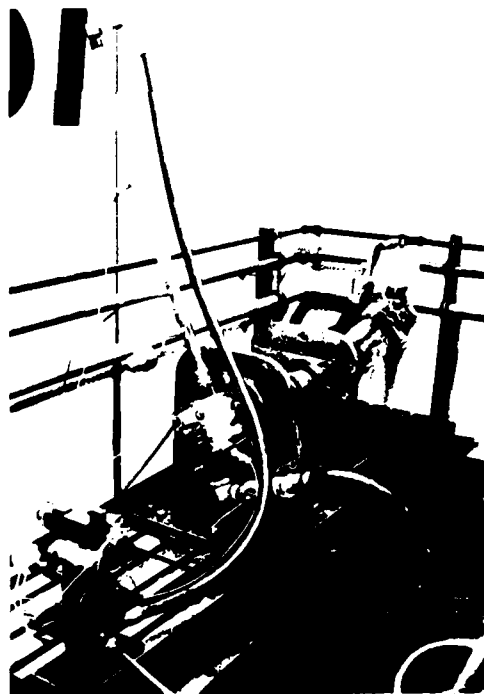
Plumbing and various valves used to control the direction of flow in the system. In lower right hand corner is a centrifugal pump used to supercharge the test pump and move fluid through the conditioning circuit.



TEST CIRCUIT AND COMPONENTS



Test bed showing hydraulic drive motor on right, torque shaft in center used to measure input torque, and test pump on left showing various transducers and thermocouples.



In lower left hand corner is solenoid controlled relief valve used to load test pump. The turbine flow meter can be seen in left center of photograph.

APPENDIX F  
CYCLIC BREAK-IN DATA

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1348

M1348CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	UCL EFF (%)	MECH EFF (%)
0.00	124.90	281.15	2698.00	198.20	21.17	61.34	98.87	62.54
1.50	125.10	742.97	2664.00	412.80	20.66	75.95	95.71	79.35
3.00	124.50	1486.54	2616.00	762.20	20.16	88.34	93.42	85.98
4.68	129.20	2239.25	2566.00	1108.20	19.63	81.84	98.96	89.88
6.03	132.30	2993.58	2512.00	1458.20	18.97	79.56	82.89	90.51

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1349

M1349CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WU EFF (%)	MCH EFF (%)
0.00	124.60	298.45	2698.00	211.60	21.29	61.35	90.64	62.18
0.83	124.80	739.38	2667.00	418.40	20.93	75.57	96.99	77.91
2.45	126.80	1581.19	2619.00	775.20	20.38	88.61	94.40	85.37
4.77	131.70	2238.68	2568.00	1104.20	19.69	81.55	91.23	89.38
6.23	129.60	3000.77	2518.00	1455.80	19.23	88.98	89.10	90.87

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1350

M1350CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	VOL EFF (%)	MECH EFF (%)
0.00	116.00	197.00	2700.00	165.40	20.05	50.96	96.60	52.74
2.43	177.00	737.67	2666.00	413.00	20.29	73.09	94.00	78.59
6.47	176.60	1474.07	2629.00	752.40	19.68	78.75	91.17	86.37
10.05	175.00	2235.77	2506.00	1109.20	19.00	78.77	88.03	88.04
15.63	133.40	2979.21	2530.00	1447.00	18.18	76.47	84.77	90.77

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1351

M1351CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OUFR ALL EFF(%)	WQ EFF (%)	MECH EFF (%)
0.00	118.60	294.01	2701.00	209.20	21.07	60.48	97.60	61.96
0.48	120.20	770.07	2671.00	402.60	20.65	75.45	95.67	78.05
3.28	126.10	1493.97	2620.00	752.00	20.00	81.16	92.65	87.50
4.38	126.10	2244.00	2574.00	1000.00	19.52	82.23	90.41	90.93
6.20	131.00	3002.63	2522.00	1434.20	18.05	80.60	87.31	92.30



CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1352

M1352CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WOL EFF (%)	MECH EFF (%)
0.00	118.80	287.26	2700.00	206.40	21.31	60.59	90.74	61.36
0.67	125.10	743.16	2665.00	415.40	20.90	76.40	96.85	78.87
1.00	126.50	1482.67	2619.00	757.60	20.39	81.52	94.46	86.28
3.37	127.90	2238.47	2568.00	1104.40	19.82	82.08	91.85	89.36
4.30	130.20	2984.40	2521.00	1444.40	19.26	81.29	89.23	91.09

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1353

M1353CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WHL EFF (%)	MECH EFF (%)
0.00	119.00	291.07	2702.00	200.40	21.41	61.00	99.17	61.57
0.40	121.90	732.13	2671.00	412.20	20.97	76.00	97.14	78.30
1.33	124.10	1406.31	2622.00	762.00	20.37	80.00	94.14	85.90
2.52	128.30	2234.51	2577.00	1094.60	19.40	81.27	90.24	90.00
3.12	129.10	2909.68	2529.00	1440.00	18.00	80.00	87.47	91.53

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M1354

M1354CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS. PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WHL EFF (%)	MECH EFF (%)
0.00	125.20	291.50	2699.00	211.20	21.32	60.14	98.79	60.87
0.30	124.90	740.97	2668.00	420.40	20.93	75.34	96.95	77.20
1.20	126.10	1487.05	2627.00	770.60	20.76	80.26	94.33	85.07
2.00	127.60	2235.41	2586.00	1099.40	19.74	81.99	91.45	89.64
5.15	130.30	2991.40	2534.00	1453.00	19.26	88.98	89.21	90.76

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2355

M2355CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WU EFF (%)	MECH EFF (%)
0.00	121.90	305.01	2815.00	202.60	33.51	66.25	101.27	65.41
1.55	118.90	738.81	2777.00	405.00	32.94	78.90	99.53	79.26
3.43	124.80	1480.62	2717.00	745.60	32.11	83.75	97.05	86.28
6.07	127.30	2239.50	2675.00	1091.00	31.15	83.96	94.17	89.19
10.00	132.70	3022.09	2630.00	1449.60	29.87	81.77	90.25	90.50

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2356

M2356CB

TIME MIN	OUT FT TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WU EFF (%)	MECH EFF (%)
0.00	125.20	278.56	2806.00	154.40	34.35	66.77	103.79	64.32
2.70	119.00	253.20	2766.00	407.20	33.58	81.56	101.47	80.37
5.77	129.10	1483.86	2713.00	753.20	32.64	84.44	98.63	85.60
8.88	124.40	2261.43	2653.00	1120.40	31.76	84.19	95.98	87.70
11.80	129.30	3036.17	2588.00	1494.60	30.88	82.16	93.87	88.26

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2357

M2357CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WU EFF (%)	MCH EFF (%)
0.00	123.90	189.14	2885.00	188.00	33.94	46.83	102.56	45.66
2.38	127.20	768.96	2745.00	443.80	34.00	76.55	102.74	74.50
5.65	123.80	1478.73	2688.00	785.40	32.41	88.13	97.94	81.80
13.02	131.20	2246.45	2606.00	1131.00	31.34	81.75	94.71	86.30
19.13	130.50	3050.04	2576.00	1565.00	30.73	81.78	92.86	88.65

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2358

M2358CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF (%)	WQ EFF (%)	MECH EFF (%)
0.00	124.90	315.53	2804.00	198.40	33.56	70.10	101.42	69.10
1.77	120.50	736.11	2775.00	394.00	33.12	81.25	100.07	81.19
4.58	124.40	1487.58	2728.00	737.00	32.20	85.36	97.31	87.70
7.33	123.00	2233.75	2684.00	1084.00	31.21	84.40	94.32	89.47
10.90	127.40	2906.90	2637.00	1426.00	30.09	82.78	90.94	91.01

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2359

M2359CB

TIME MIN	QUM FT TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	UNI EFF (%)	MECH EFF (%)
0.00	122.10	246.09	2812.00	173.40	33.67	62.74	101.74	61.66
1.83	118.50	740.24	2765.00	400.00	33.18	80.47	100.26	80.25
6.53	120.00	1490.30	2712.00	747.00	32.30	84.74	97.84	86.59
10.12	124.30	2277.92	2659.00	1065.00	31.52	84.93	95.25	89.15
16.77	128.20	2994.35	2619.00	1434.00	30.33	83.11	91.64	90.68



CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2360

M2360CE

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	VOI EFF (%)	MECH EFF (%)
0.00	126.40	215.22	2803.00	151.60	33.67	62.78	101.76	61.00
2.62	122.50	762.94	2745.00	413.00	32.33	78.43	97.70	80.76
9.23	127.40	1492.59	2672.00	759.00	30.85	79.66	93.22	85.44
12.33	133.50	2252.28	2624.00	1117.40	29.76	78.76	89.92	82.58
16.05	134.90	3030.05	2582.00	1471.00	28.48	77.05	86.00	89.56

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M2361

M2361CB

TIME MIN	INLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	VOL EFF (%)	MECH EFF (%)
0.00	126.00	215.32	2797.00	149.00	34.27	64.94	103.40	62.79
1.28	114.00	267.27	2745.00	421.00	33.21	79.49	100.37	79.19
5.23	130.20	1466.13	2690.00	749.00	31.81	81.77	96.17	85.05
8.03	133.20	2230.27	2628.00	1107.40	30.29	80.40	91.54	87.02
14.23	136.40	2924.02	2566.00	1430.00	28.05	77.01	87.18	80.32

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3362

M3362CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	UOI EFF (%)	MECH EFF (%)
0.00	117.20	170.13	1804.00	135.20	27.32	57.38	93.92	61.00
2.00	120.20	610.90	1769.00	357.60	21.00	76.07	91.72	82.93
6.28	126.20	1229.10	1720.00	666.00	21.06	79.32	88.63	89.48
10.42	122.50	1049.26	1675.00	955.00	20.54	77.90	86.40	90.15
15.47	127.70	2510.13	1627.00	1326.00	19.96	77.20	84.00	91.89

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3363

M3363CB

TIME MIN	(OUTLET TEMP(F))	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF (%)	VOL. EFF (%)	MECH EFF (%)
0.00	121.60	274.77	1806.00	173.00	22.81	60.77	95.99	62.78
3.68	127.10	606.77	1743.00	366.00	22.36	75.77	94.07	80.48
6.55	126.00	1736.99	1641.00	681.00	21.61	80.09	90.93	88.07
10.30	122.70	1850.10	1693.00	994.00	21.30	81.39	89.63	90.79
14.48	125.10	2491.97	1648.00	1317.60	20.83	80.47	87.63	91.81

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3364

M3364CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	VOL EFF (%)	MECH EFF (%)
0.00	122.70	223.40	1789.00	157.00	23.03	66.95	96.91	69.07
0.90	120.10	629.52	1745.00	375.00	22.39	76.61	94.19	81.32
2.65	124.20	1252.17	1683.00	699.00	21.84	79.93	91.90	86.96
5.83	128.20	1879.36	1647.00	1020.00	21.19	79.77	89.17	89.39
7.82	128.50	2523.45	1603.00	1358.00	20.61	78.70	86.74	90.15

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3365

M3365CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	UCL EFF (%)	MECH EFF (%)
0.00	122.40	211.63	1804.00	172.40	23.20	58.17	97.61	59.59
2.45	126.50	600.29	1773.00	383.00	22.65	72.36	96.29	75.97
6.10	111.10	1240.05	1716.00	760.00	21.89	73.37	92.17	79.63
10.38	123.20	1854.30	1669.00	1072.00	21.61	76.35	90.97	85.97
13.97	132.10	2494.62	1622.00	1428.00	20.86	74.41	82.77	84.76

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3366

M3366CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WQ EFF (%)	MECH EFF (%)
0.00	122.00	241.06	1006.00	175.00	23.28	65.51	97.95	66.97
1.68	127.60	620.00	1775.00	366.00	22.05	79.00	96.15	82.23
7.55	124.40	1219.50	1720.00	600.20	22.20	80.35	93.40	86.07
9.53	125.50	1871.35	1674.00	1018.40	21.68	81.38	91.27	89.20
14.53	134.30	2494.54	1627.00	1350.00	21.29	80.31	89.50	89.64

CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3367

M3367CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	ADJ FLOW GPM	OVER ALL EFF(%)	WQ EFF (%)	MECH EFF (%)
0.00	128.70	182.70	1804.00	146.40	73.29	59.38	98.00	68.50
1.02	124.00	614.34	1771.00	373.40	77.64	76.00	95.24	79.86
5.47	128.90	1283.70	1720.00	668.00	71.90	80.92	92.50	87.47
13.77	131.60	1875.43	1661.00	1009.20	71.77	80.56	89.79	90.21
16.50	133.20	2478.03	1615.00	1319.40	70.91	80.22	87.97	91.17



CYCLIC BREAK-IN TEST DATA  
FOR PUMP NUMBER M3368

M3368CB

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	SPEED RPM	TORQUE IN-LB	FOJ FLOW GPM	OVER ALL EFF(%)	WOL EFF (%)	MECH EFF (%)
0.00	123.00	216.16	1804.00	158.40	22.74	63.39	95.67	66.24
1.73	119.40	600.50	1776.00	364.00	22.18	75.74	93.32	81.15
4.07	123.50	1243.52	1735.00	693.60	21.66	79.32	91.13	87.03
7.45	127.50	1852.52	1697.00	1010.60	21.05	78.84	88.59	88.98
11.50	128.00	2485.74	1654.00	1331.40	20.37	77.68	85.70	90.63

APPENDIX G  
THREE HOUR RUN DATA

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1348 RUN AT RATED PRESSURE AND SPEED

M13483H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERSILL FT(%)	WATER EFF (%)	HEAD EFF (%)
0.00	133.60	3012.12	1461.60	2713.00	28.71	80.18	88.24	90.95
4.93	132.70	3001.82	1461.80	2715.00	28.57	79.47	87.76	90.83
9.96	132.70	2992.57	1455.60	2726.00	28.58	79.25	87.42	90.64
14.93	132.40	2997.06	1461.80	2700.00	28.10	78.46	86.79	90.39
19.95	132.50	2981.97	1456.20	2689.00	27.68	77.50	85.83	90.20
24.92	132.60	2983.05	1454.20	2706.00	27.71	77.25	85.41	90.43
29.92	132.60	2998.81	1450.60	2706.00	27.54	77.37	84.88	90.14
34.92	133.10	3007.46	1459.40	2727.00	27.65	76.97	84.71	90.05
39.93	133.40	2996.65	1459.60	2731.00	27.77	76.76	84.00	90.01
44.92	134.20	3007.29	1454.80	2739.00	27.73	76.95	84.47	91.13
49.93	133.90	3001.87	1455.20	2691.00	27.36	77.12	84.79	90.94
54.93	133.50	3003.68	1455.20	2679.00	27.58	78.13	85.84	91.00
59.93	134.30	3003.40	1468.40	2707.00	27.92	77.57	86.01	90.17
64.92	134.80	3009.84	1461.80	2700.00	27.91	78.25	86.19	90.77
69.92	135.80	3014.63	1466.40	2712.00	28.06	78.21	86.28	90.82
74.92	136.20	3012.09	1459.80	2722.00	28.02	78.09	85.83	90.90
79.93	136.40	3010.60	1463.40	2733.00	28.19	78.03	86.02	90.76
84.93	136.60	3006.36	1465.00	2738.00	28.29	77.95	86.15	90.47
89.92	135.80	3018.03	1464.40	2730.00	28.16	78.18	86.03	90.11
94.92	135.80	3016.18	1467.40	2721.00	28.12	78.09	86.17	90.62
99.92	135.40	3012.91	1465.40	2712.00	27.97	77.98	86.02	90.64
104.93	136.00	3011.60	1460.60	2713.00	27.94	78.09	85.90	90.80
109.93	136.60	3004.21	1465.60	2724.00	28.18	77.97	86.27	90.87
114.93	136.80	3015.37	1465.20	2735.00	28.03	77.54	85.45	90.73
119.92	136.90	3014.87	1457.00	2741.00	28.31	78.59	86.14	91.22
124.93	136.60	3008.47	1466.00	2713.00	27.96	77.75	85.93	90.42
129.93	135.20	3012.89	1465.20	2705.00	27.91	78.03	86.06	90.85
134.93	135.30	3003.77	1459.40	2692.00	27.74	77.98	85.92	90.74
139.93	134.20	3002.33	1462.20	2682.00	27.61	77.73	85.86	90.52
144.93	135.40	3012.40	1457.00	2685.00	27.61	78.19	85.76	91.15
149.92	135.20	3003.50	1460.60	2699.00	27.71	77.64	85.63	90.66
154.92	136.00	3005.04	1466.20	2706.00	27.90	77.70	85.98	90.86
159.92	134.30	3005.56	1461.80	2712.00	28.00	78.05	86.09	90.64
164.93	133.50	3007.00	1460.80	2709.00	27.89	77.92	85.85	90.25
169.93	133.40	3003.23	1462.80	2698.00	27.76	77.68	85.81	90.51
174.93	133.20	3003.37	1466.60	2685.00	27.70	77.68	86.03	90.26

THE AVERAGE FLOW IS: 27.9463 GPM  
 THE AVERAGE SPEED IS: 2710.86 RPM  
 THE AVERAGE TORQUE IS: 1461.25 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1348

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3005.61 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .802472 GPM  
MEASURED SPEED IS: 45.0518 RPM  
MEASURED TORQUE IS: 11.6271 IN-LB  
DIFFERENTIAL PRESSURE IS: 21.7564 PSID

THE MAX. OVERALL EFFICIENCY IS: 80.1833  
THE MIN. OVERALL EFFICIENCY IS: 76.7614  
THE AVERAGE OVERALL EFFICIENCY IS: 77.9532

THE MAX. VOLUMETRIC EFFICIENCY IS: 88.241  
THE MIN. VOLUMETRIC EFFICIENCY IS: 84.4226  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 85.952

THE MAX. MECHANICAL EFFICIENCY IS: 91.2238  
THE MIN. MECHANICAL EFFICIENCY IS: 90.1712  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.6795

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1349 RUN AT RATED PRESSURE AND SPEED

M13493H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WGT EFF (%)	MECH EFF (%)
0.00	134.70	2968.49	1448.40	2690.00	29.00	81.26	89.92	90.35
4.00	134.90	2997.94	1456.00	2693.00	28.92	81.60	89.87	90.77
10.00	135.10	2991.46	1446.40	2673.00	28.74	81.76	89.66	91.18
14.00	131.60	3061.36	1493.60	2703.00	29.14	81.74	89.90	90.36
20.00	131.60	2995.08	1452.60	2701.00	29.06	81.56	89.71	90.90
24.00	132.00	2993.54	1457.20	2710.00	29.00	80.83	89.73	90.57
30.00	132.20	2991.77	1452.60	2709.00	28.82	80.55	88.70	90.80
34.00	132.60	2998.40	1453.20	2703.00	28.64	80.40	88.37	90.96
40.00	132.60	2992.83	1448.00	2689.00	28.73	79.75	87.55	91.07
44.00	132.50	2989.62	1446.40	2678.00	28.60	79.51	87.24	91.17
50.00	133.20	2968.87	1454.00	2723.00	28.10	77.96	86.06	90.57
54.00	133.20	2994.46	1444.00	2714.00	27.88	78.32	85.66	91.42
60.00	133.50	2994.63	1446.00	2718.00	27.91	78.20	85.64	91.30
64.00	133.20	2992.13	1455.20	2719.00	28.86	80.25	88.52	90.65
70.00	133.10	3002.47	1453.00	2700.00	28.35	79.77	87.55	91.10
74.00	132.00	2973.45	1449.40	2691.00	28.45	79.74	88.15	90.44
80.00	133.10	3001.40	1459.00	2695.00	28.35	79.54	87.73	90.64
84.00	133.60	3014.99	1459.00	2703.00	28.41	79.87	87.66	91.10
89.00	134.10	3016.89	1456.00	2713.00	28.51	80.01	87.62	91.30
94.00	134.50	3012.86	1453.20	2724.00	28.54	79.88	87.30	91.40
99.00	134.60	3007.21	1459.00	2731.00	28.61	79.35	87.36	90.82
104.00	134.20	3013.86	1464.60	2721.00	28.50	79.25	87.34	90.72
109.00	134.10	3009.28	1463.60	2710.00	28.48	79.46	87.63	90.66
114.00	134.00	3012.81	1459.40	2699.00	28.34	79.69	87.55	91.01
119.00	134.20	3005.21	1459.40	2704.00	28.35	79.40	87.44	90.78
124.00	134.60	3005.84	1461.40	2715.00	28.49	79.37	87.51	90.68
129.00	134.90	3005.93	1460.40	2723.00	28.60	79.49	87.59	90.74
134.00	134.90	3010.97	1463.20	2720.00	28.51	79.31	87.41	90.72
139.00	134.50	3012.66	1459.00	2716.00	28.57	79.83	87.73	90.98
144.00	133.00	3007.17	1450.60	2706.00	28.36	79.89	87.40	91.39
149.00	133.40	2998.41	1452.00	2693.00	28.25	79.60	87.47	90.99
154.00	133.20	3006.73	1455.00	2692.00	28.25	79.68	87.50	91.05
159.00	133.00	2996.90	1457.40	2704.00	28.38	79.36	87.52	90.66
164.00	134.00	3002.68	1453.60	2713.00	28.51	79.95	87.64	91.22
169.00	134.00	3006.13	1454.00	2723.00	28.52	79.22	87.49	91.10
174.00	133.00	3000.56	1453.00	2691.00	28.20	79.52	87.38	90.99

THE AVERAGE FLOW IS: 28.4961 GPM  
 THE AVERAGE SPEED IS: 2705.56 RPM  
 THE AVERAGE TORQUE IS: 1456.02 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1349

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3002.24 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .811472 GPM  
MEASURED SPEED IS: 37.2958 RPM  
MEASURED TORQUE IS: 21.946 IN-LB  
DIFFERENTIAL PRESSURE IS: 39.1688 PSID

THE MAX. OVERALL EFFICIENCY IS: 81.7597  
THE MIN. OVERALL EFFICIENCY IS: 77.9587  
THE AVERAGE OVERALL EFFICIENCY IS: 79.8574

THE MAX. VOLUMETRIC EFFICIENCY IS: 89.9162  
THE MIN. VOLUMETRIC EFFICIENCY IS: 85.6364  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 87.8359

THE MAX. MECHANICAL EFFICIENCY IS: 91.4219  
THE MIN. MECHANICAL EFFICIENCY IS: 90.3537  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.9033

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1350 RUN AT RATED PRESSURE AND SPEED.

M13503H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF(%)	WGT EFF (%)	MFCB EFF (%)
0.00	127.40	3011.95	1466.00	2720.00	27.83	77.26	85.33	90.52
5.00	130.20	3002.46	1460.40	2715.00	27.61	76.88	84.80	90.64
10.00	127.40	2992.37	1456.80	2710.00	27.50	76.64	84.62	90.56
15.00	129.00	3025.73	1473.60	2704.00	26.87	75.80	82.87	90.52
20.00	128.70	2957.50	1434.40	2696.00	26.53	74.54	81.99	90.50
25.00	131.00	2995.90	1450.00	2690.00	26.14	73.19	80.78	90.50
30.00	131.20	2983.76	1457.00	2716.00	26.83	72.13	79.93	90.23
35.00	131.20	3027.01	1465.20	2734.00	26.86	72.41	79.50	91.00
40.00	131.00	3013.15	1467.00	2706.00	25.77	71.68	79.19	90.50
45.00	130.50	3018.30	1461.00	2705.00	25.92	72.78	79.90	91.00
50.00	131.10	3039.35	1480.60	2707.00	25.95	72.36	79.94	90.50
55.00	131.00	2996.44	1461.60	2700.00	26.05	72.74	80.47	90.30
60.00	131.10	2989.88	1470.40	2707.00	25.81	71.30	79.52	89.64
65.00	131.60	3027.19	1469.00	2721.00	25.70	71.44	78.76	90.70
70.00	131.60	2998.90	1464.60	2777.00	25.84	71.48	79.17	90.27
75.00	131.60	2991.68	1470.20	2775.00	25.90	71.11	79.26	89.71
80.00	131.30	2980.00	1468.20	2775.00	25.85	70.80	79.11	89.48
85.00	130.90	3009.28	1466.40	2712.00	25.84	71.90	79.46	90.47
90.00	132.00	3029.43	1469.80	2773.00	26.30	73.19	80.53	90.87
95.00	132.00	3037.25	1487.40	2740.00	26.30	72.30	80.30	90.60
100.00	132.10	3000.87	1450.00	2705.00	26.21	73.32	80.79	90.24
105.00	131.70	3006.73	1463.60	2690.00	26.45	74.04	81.74	90.50
110.00	131.10	2979.59	1453.00	2680.00	26.22	73.56	81.35	90.40
115.00	131.40	2975.40	1457.00	2701.00	26.51	73.71	81.86	90.85
120.00	133.60	3062.49	1487.60	2730.00	26.11	72.39	79.75	90.76
125.00	134.50	3033.50	1492.20	2746.00	26.30	71.58	79.86	89.62
130.00	134.70	3052.12	1483.00	2743.00	26.14	72.00	79.47	90.60
135.00	134.30	3034.16	1479.60	2734.00	26.49	73.05	80.79	90.41
140.00	133.90	3020.88	1472.00	2777.00	26.33	72.95	80.67	90.40
145.00	133.60	3032.74	1472.40	2721.00	25.63	71.33	78.54	90.80
150.00	134.20	3023.12	1480.20	2729.00	25.77	70.92	78.75	90.04
155.00	134.50	3043.16	1482.60	2742.00	26.46	72.83	80.47	90.49
160.00	134.90	3020.17	1491.60	2732.00	25.91	71.64	78.93	90.24
165.00	134.90	3077.13	1494.40	2777.00	25.56	70.97	78.16	90.20
170.00	133.90	3015.93	1471.00	2715.00	25.37	70.44	77.91	90.39
175.00	133.60	3010.25	1464.40	2714.00	26.11	72.71	80.22	90.60

THE AVERAGE FLOW IS: 26.2046 GPM  
 THE AVERAGE SPEED IS: 2717.83 RPM  
 THE AVERAGE TORQUE IS: 1469.84 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1350

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3015.58 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 1.43617 GPM  
MEASURED SPEED IS: 38.9641 RPM  
MEASURED TORQUE IS: 33.4331 IN-LB  
DIFFERENTIAL PRESSURE IS: 71.466 PSID

THE MAX. OVERALL EFFICIENCY IS: 77.2627  
THE MIN. OVERALL EFFICIENCY IS: 70.4357  
THE AVERAGE OVERALL EFFICIENCY IS: 72.7414

THE MAX. VOLUMETRIC EFFICIENCY IS: 85.3343  
THE MIN. VOLUMETRIC EFFICIENCY IS: 77.9138  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 80.4087

THE MAX. MECHANICAL EFFICIENCY IS: 91.0785  
THE MIN. MECHANICAL EFFICIENCY IS: 89.4808  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.4488



THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1351 RUN AT RATED PRESSURE AND SPEED

M13513H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	CURBALL EFF (%)	UOI EFF (%)	MECH EFF (%)
0.00	135.70	3015.80	1438.60	2697.00	28.48	81.39	88.05	92.42
13.60	128.70	3041.60	1456.40	2704.00	28.78	81.74	88.76	92.67
17.70	129.30	3041.57	1458.60	2777.00	28.90	81.47	88.55	91.93
22.70	130.60	3038.60	1452.60	2737.00	29.02	81.53	88.41	92.21
27.70	130.60	3034.15	1449.00	2704.00	27.66	78.76	85.30	92.31
32.70	130.70	3031.43	1448.00	2700.00	27.39	78.09	84.60	92.29
37.70	130.10	3028.40	1443.60	2689.00	27.10	77.73	84.03	92.48
42.60	129.90	3016.35	1443.00	2677.00	27.45	78.81	85.51	92.15
47.60	130.10	3020.64	1442.40	2674.00	27.22	78.39	84.90	92.32
52.60	130.40	3027.77	1440.20	2695.00	27.17	77.65	83.90	92.53
57.60	130.50	3027.22	1435.00	2706.00	27.07	77.36	83.35	92.60
62.70	130.00	3023.07	1433.00	2724.00	27.42	78.07	83.93	93.00
67.70	130.60	3013.45	1437.60	2718.00	28.04	79.52	86.04	92.41
72.70	130.30	3019.06	1435.00	2707.00	27.47	78.50	84.62	92.75
77.70	130.10	3022.90	1438.00	2695.00	29.35	84.18	90.02	92.68
82.60	130.30	3016.35	1436.00	2696.00	29.47	84.38	91.15	92.53
87.60	130.90	3018.04	1442.20	2710.00	28.21	80.09	86.79	92.76
92.60	131.10	3028.87	1442.00	2717.00	30.81	87.57	94.55	92.60
97.70	131.30	3022.96	1440.00	2725.00	32.26	91.37	98.71	92.55
102.70	131.30	3019.94	1442.40	2721.00	29.52	83.68	90.64	92.70
107.70	131.00	3024.14	1440.20	2710.00	29.54	84.16	90.90	92.52
112.60	130.60	3024.00	1438.60	2690.00	30.00	86.19	92.90	92.62
117.60	130.00	3020.56	1436.40	2696.00	31.31	89.00	96.05	92.71
122.70	130.70	3022.09	1443.40	2710.00	27.41	77.87	84.35	92.70
127.70	131.00	3022.30	1441.40	2719.00	27.29	78.80	85.23	92.44
132.72	131.30	3028.51	1440.60	2731.00	27.64	78.22	84.39	92.68
137.60	131.00	3025.90	1435.60	2727.00	27.30	77.50	83.49	92.92
142.60	131.10	3022.43	1442.40	2715.00	27.51	78.06	84.48	92.30
147.70	131.00	3019.60	1450.00	2707.00	27.78	78.55	85.59	91.76
152.70	131.30	3023.34	1441.00	2706.00	27.81	79.25	85.22	92.44
157.60	131.60	3024.37	1442.60	2720.00	28.16	79.02	86.35	92.42
162.60	132.00	3019.05	1445.20	2720.00	27.19	76.56	83.12	92.10
167.60	132.20	3027.43	1444.00	2739.00	27.38	77.07	83.32	92.43
172.70	131.70	3024.02	1443.60	2733.00	27.24	76.00	83.12	92.32
177.70	131.50	3027.27	1440.00	2727.00	27.55	78.21	84.42	92.63
182.60	131.30	3024.09	1446.00	2710.00	27.55	78.12	84.29	92.12

THE AVERAGE FLOW IS: 28.2782 GPM  
 THE AVERAGE SPEED IS: 2710.86 RPM  
 THE AVERAGE TORQUE IS: 1442.49 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1351

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3024.42 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 3.40385 GPM  
MEASURED SPEED IS: 41.1493 RPM  
MEASURED TORQUE IS: 15.101 IN-LB  
DIFFERENTIAL PRESSURE IS: 17.4987 PSID

THE MAX. OVERALL EFFICIENCY IS: 91.3726  
THE MIN. OVERALL EFFICIENCY IS: 76.5585  
THE AVERAGE OVERALL EFFICIENCY IS: 80.4261

THE MAX. VOLUMETRIC EFFICIENCY IS: 98.7134  
THE MIN. VOLUMETRIC EFFICIENCY IS: 83.1153  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 86.9937

THE MAX. MECHANICAL EFFICIENCY IS: 93.0039  
THE MIN. MECHANICAL EFFICIENCY IS: 91.7573  
THE AVERAGE MECHANICAL EFFICIENCY IS: 92.434

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1352 RUN AT RATED PRESSURE AND SPEED

M13523H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERSHOOT EFF(%)	WGT EFF (%)	MECH EFF (%)
0.00	128.60	2996.44	1456.00	2683.00	28.95	81.61	89.98	90.68
5.00	129.90	2994.19	1455.00	2705.00	29.17	81.59	89.92	90.77
10.00	131.50	2995.95	1460.00	2734.00	29.50	81.40	89.97	90.47
15.00	131.90	2990.88	1450.40	2718.00	29.14	80.83	89.39	90.41
20.00	132.30	2989.81	1457.40	2728.00	29.17	80.51	89.61	90.44
25.00	132.70	2988.44	1453.00	2709.00	28.77	80.13	88.41	90.67
30.00	132.10	2985.39	1451.00	2702.00	28.47	79.54	87.73	90.66
35.00	132.70	2981.04	1456.20	2691.00	28.17	78.82	87.30	90.77
40.00	132.70	2997.60	1451.40	2683.00	27.92	79.03	86.79	91.05
45.00	132.90	3001.50	1446.60	2726.00	28.28	79.14	86.50	91.47
50.00	133.20	2998.30	1447.20	2731.00	28.58	80.00	87.77	91.65
55.00	133.00	2995.75	1445.00	2751.00	28.41	78.73	86.13	91.40
60.00	134.00	2999.67	1445.20	2758.00	28.45	78.74	86.04	91.50
65.00	132.90	2988.47	1447.40	2700.00	28.15	79.15	86.94	91.07
70.00	132.40	2997.43	1446.40	2689.00	28.16	79.81	87.34	91.36
75.00	132.30	2992.47	1444.60	2682.00	28.26	80.32	87.94	91.37
80.00	133.10	3005.34	1450.00	2729.00	28.62	79.93	87.46	91.37
85.00	133.30	3001.17	1451.00	2701.00	28.30	79.69	87.38	91.10
90.00	133.70	2998.73	1449.20	2709.00	28.44	79.85	87.53	91.21
95.00	133.60	2995.09	1450.40	2716.00	28.46	79.57	87.39	91.04
100.00	133.70	3001.29	1444.20	2709.00	28.36	79.99	87.29	91.67
105.00	133.00	2996.01	1450.00	2697.00	28.20	79.44	87.20	91.00
110.00	133.70	2989.14	1447.00	2685.00	28.30	80.06	87.90	91.07
115.00	133.00	2994.83	1451.60	2691.00	28.15	79.36	87.24	90.95
120.00	134.00	2999.76	1454.40	2704.00	28.26	79.26	87.16	90.93
125.00	134.40	2997.14	1451.00	2717.00	28.31	79.23	87.04	91.01
130.00	134.60	2998.43	1448.00	2715.00	28.27	79.29	86.84	91.29
135.00	134.30	2998.57	1454.60	2709.00	28.41	79.49	87.45	90.88
140.00	134.30	3000.14	1449.40	2698.00	28.26	79.73	87.36	91.25
145.00	134.20	3001.19	1442.00	2689.00	28.07	79.90	87.07	91.25
150.00	134.40	3000.71	1448.40	2716.00	28.37	79.58	87.11	91.37
155.00	134.90	3003.97	1448.40	2727.00	28.53	79.79	87.25	91.43
160.00	135.10	2999.53	1446.60	2720.00	28.46	79.78	87.26	91.41
165.00	135.40	3000.52	1447.00	2729.00	28.52	79.69	87.16	91.47
170.00	135.60	3002.18	1450.60	2723.00	28.47	79.57	87.20	91.24
175.00	135.00	2999.47	1448.60	2717.00	28.32	79.51	87.00	91.20

THE AVERAGE FLOW IS: 28.4585 GPM  
 THE AVERAGE SPEED IS: 2710.58 RPM  
 THE AVERAGE TORQUE IS: 1450.04 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1352

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2996.58 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .892222 GPM  
MEASURED SPEED IS: 49.2194 RPM  
MEASURED TORQUE IS: 11.925 IN-LB  
DIFFERENTIAL PRESSURE IS: 14.046 PSID

THE MAX. OVERALL EFFICIENCY IS: 81.6057  
THE MIN. OVERALL EFFICIENCY IS: 78.7347  
THE AVERAGE OVERALL EFFICIENCY IS: 79.7804

THE MAX. VOLUMETRIC EFFICIENCY IS: 89.9798  
THE MIN. VOLUMETRIC EFFICIENCY IS: 86.0362  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 87.5564

THE MAX. MECHANICAL EFFICIENCY IS: 91.7544  
THE MIN. MECHANICAL EFFICIENCY IS: 90.2739  
THE AVERAGE MECHANICAL EFFICIENCY IS: 91.1066

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1353 RUN AT RATED PRESSURE AND SPEED

M13533H

TIME MIN	QUM FT TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WU EFF (%)	MCH EFF (%)
0.00	130.90	2996.69	1459.20	2701.00	28.49	79.65	87.97	90.54
4.98	128.10	2992.41	1461.00	2703.00	28.57	79.57	88.15	90.75
9.98	129.00	2986.60	1460.40	2692.00	28.41	79.37	88.02	90.10
14.98	130.30	3005.61	1452.60	2711.00	28.50	79.99	87.68	91.77
20.00	132.40	2998.14	1454.40	2726.00	28.53	79.34	87.28	90.88
25.00	133.00	2995.15	1450.20	2744.00	28.40	78.61	86.32	91.05
30.00	134.00	3004.43	1452.00	2722.00	28.05	78.37	85.94	91.17
35.00	134.10	2996.72	1451.20	2716.00	27.62	77.23	84.82	91.04
40.02	133.90	2999.90	1453.00	2709.00	27.47	76.83	84.40	91.02
44.98	134.00	3005.53	1450.60	2704.00	28.46	80.19	87.28	91.34
49.98	134.60	2976.75	1456.40	2713.00	28.60	79.24	87.92	90.11
54.98	135.30	3013.75	1451.40	2730.00	27.57	77.11	84.22	91.54
60.00	135.00	3013.28	1455.40	2741.00	27.71	76.96	84.31	91.28
65.00	136.10	3012.90	1449.00	2750.00	28.50	79.19	86.42	91.02
70.00	135.40	3007.66	1456.00	2711.00	27.84	77.96	85.64	91.02
75.00	135.30	3005.58	1451.60	2704.00	32.91	92.66	101.50	91.28
79.98	135.20	3004.13	1448.00	2688.00	32.51	92.22	100.87	91.41
84.98	135.70	3004.00	1452.20	2698.00	29.42	82.97	90.94	91.27
89.98	136.00	3012.29	1451.20	2724.00	28.04	80.83	88.30	91.53
94.98	136.20	3009.96	1455.40	2732.00	28.55	79.48	87.16	91.18
100.00	136.20	3011.02	1459.00	2742.00	28.26	78.22	85.96	90.90
105.00	136.00	3013.24	1454.20	2711.00	28.47	80.00	87.56	91.35
110.00	135.30	3014.77	1457.40	2698.00	28.86	81.36	89.20	91.20
114.98	135.30	3011.96	1455.00	2689.00	28.32	80.18	87.04	91.26
119.98	135.00	3019.35	1456.60	2701.00	28.98	81.77	89.46	91.38
124.98	136.10	3015.13	1457.60	2712.00	28.55	80.00	87.29	91.19
129.98	136.10	3020.57	1457.00	2723.00	28.83	80.67	88.29	91.35
135.00	136.40	3010.89	1463.20	2726.00	28.84	80.04	88.22	90.72
140.00	135.70	3012.32	1462.40	2720.00	28.15	78.38	86.30	90.81
145.00	135.20	3013.04	1456.00	2709.00	28.93	81.29	89.07	91.26
149.98	135.00	3013.95	1458.20	2697.00	29.06	81.89	89.06	91.12
154.98	135.60	3014.32	1463.20	2709.00	28.43	79.49	87.51	90.82
159.98	136.40	3013.31	1460.40	2720.00	28.71	80.09	88.04	90.96
164.98	136.40	3011.04	1458.00	2720.00	28.43	79.11	86.90	91.02
169.98	136.60	3015.24	1462.00	2708.00	29.27	81.91	90.12	90.82
175.00	135.40	3015.71	1463.40	2705.00	28.92	81.02	89.12	90.85

THE AVERAGE FLOW IS: 28.7204 GPM  
 THE AVERAGE SPEED IS: 2714.36 RPM  
 THE AVERAGE TORQUE IS: 1456.14 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1353

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3007.51 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 2.86276 GPM  
MEASURED SPEED IS: 41.3722 RPM  
MEASURED TORQUE IS: 11.4064 IN-LB  
DIFFERENTIAL PRESSURE IS: 25.0524 PSID

THE MAX. OVERALL EFFICIENCY IS: 92.6626  
THE MIN. OVERALL EFFICIENCY IS: 76.8313  
THE AVERAGE OVERALL EFFICIENCY IS: 80.3691

THE MAX. VOLUMETRIC EFFICIENCY IS: 101.497  
THE MIN. VOLUMETRIC EFFICIENCY IS: 84.2244  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 88.248

THE MAX. MECHANICAL EFFICIENCY IS: 91.6169  
THE MIN. MECHANICAL EFFICIENCY IS: 90.1074  
THE AVERAGE MECHANICAL EFFICIENCY IS: 91.0552

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M1354 RUN TO DATE 10 22 50 AND 11 22 50

M13543H

TIME MIN	QUMFT TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERSILL EFF(%)	UCL EFF (%)	NECR EFF (%)
0.00	127.70	2992.70	1456.40	2696.00	29.30	80.00	90.57	90.59
4.00	129.00	2992.76	1454.40	2698.00	29.17	81.66	90.60	90.70
9.00	129.40	2990.50	1452.20	2700.00	29.07	81.38	89.63	90.79
14.00	129.80	2981.81	1452.40	2696.00	28.61	80.10	88.48	90.51
19.00	131.40	3000.04	1451.40	2717.00	28.63	80.69	87.88	91.13
25.00	132.20	2998.76	1453.00	2734.00	28.58	79.32	87.18	90.97
30.00	132.40	3001.67	1445.40	2710.00	28.05	79.04	86.32	91.55
35.00	132.10	2989.70	1444.20	2705.00	28.03	78.87	86.40	91.26
40.00	132.10	2887.53	1447.00	2700.00	27.95	78.96	86.32	87.97
44.00	131.90	2952.19	1451.00	2692.00	28.33	78.77	87.75	89.70
49.00	132.00	3001.78	1449.00	2685.00	28.08	79.61	87.77	91.26
54.00	132.70	3006.78	1453.60	2701.00	28.18	79.36	87.01	91.19
59.00	133.10	3004.10	1462.40	2716.00	28.48	79.77	87.46	90.56
65.00	133.20	3009.87	1456.20	2704.00	28.33	79.63	87.38	91.17
70.00	132.30	3011.45	1455.00	2698.00	28.77	79.71	87.39	91.20
75.00	132.20	3002.51	1456.40	2688.00	28.17	79.45	87.40	90.89
79.00	132.20	3006.47	1452.40	2701.00	28.21	79.49	87.09	91.26
84.00	132.20	3002.91	1457.60	2705.00	28.54	79.97	87.98	90.82
89.00	133.50	3010.93	1460.00	2721.00	28.35	78.97	86.89	90.87
94.00	133.40	3014.17	1459.20	2724.00	28.50	79.47	87.26	91.07
99.00	133.40	3007.70	1462.40	2726.00	28.41	78.80	86.90	90.67
104.00	132.90	3005.23	1460.20	2703.00	28.15	78.82	86.86	90.73
110.00	132.20	3005.70	1456.20	2690.00	28.16	79.45	87.30	91.00
115.00	132.40	3012.83	1460.00	2680.00	27.99	79.19	87.08	90.97
120.00	133.00	3007.14	1457.60	2691.00	28.13	79.29	87.16	90.95
125.00	133.10	3009.25	1454.00	2697.00	28.21	79.54	87.21	91.19
130.00	133.20	3011.19	1461.20	2707.00	28.27	78.99	86.93	90.85
134.00	133.10	3007.66	1459.60	2702.00	28.26	79.74	87.21	90.84
139.00	133.00	3000.10	1465.00	2689.00	28.11	78.68	87.18	90.23
144.00	132.60	3000.29	1463.00	2697.00	28.18	79.00	87.17	90.67
149.00	133.20	3013.36	1460.00	2710.00	28.30	78.98	86.82	90.95
155.00	134.00	3009.86	1461.20	2727.00	28.60	79.44	87.47	90.81
160.00	134.20	3009.94	1464.60	2740.00	28.97	79.75	88.00	90.60
165.00	133.20	3002.15	1462.00	2702.00	28.16	78.69	86.91	90.53
170.00	133.00	3005.51	1459.20	2693.00	28.19	79.28	87.30	90.80
175.00	132.20	3005.90	1458.00	2691.00	28.02	79.17	87.14	90.84
180.00	133.20	3010.11	1457.40	2716.00	28.36	79.29	87.67	91.05

THE AVERAGE FLOW IS: 28.3532 GPM  
 THE AVERAGE SPEED IS: 2704.11 RPM  
 THE AVERAGE TORQUE IS: 1456.68 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M1354

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2999.72 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .859779 GPM  
MEASURED SPEED IS: 38.739 RPM  
MEASURED TORQUE IS: 14.0293 IN-LB  
DIFFERENTIAL PRESSURE IS: 59.1206 PSID

THE MAX. OVERALL EFFICIENCY IS: 82.0616  
THE MIN. OVERALL EFFICIENCY IS: 75.9534  
THE AVERAGE OVERALL EFFICIENCY IS: 79.3962

THE MAX. VOLUMETRIC EFFICIENCY IS: 90.5707  
THE MIN. VOLUMETRIC EFFICIENCY IS: 86.3216  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 87.4405

THE MAX. MECHANICAL EFFICIENCY IS: 91.5533  
THE MIN. MECHANICAL EFFICIENCY IS: 87.9745  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.7854



THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2355 RUN AT RATED PRESSURE AND SPEED

M23553H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WGT EFF (%)	MECH EFF (%)
0.00	176.60	2991.86	1439.60	2887.00	30.54	83.15	92.06	96.30
5.00	176.60	2995.35	1438.00	2798.00	30.31	82.96	91.65	96.70
9.00	176.90	2967.44	1437.60	2795.00	30.67	82.71	91.04	96.79
14.00	177.70	3005.98	1442.00	2809.00	30.14	82.70	90.79	96.52
19.00	178.40	3003.70	1438.60	2823.00	30.03	81.67	90.01	96.72
25.00	178.60	2995.39	1436.20	2820.00	29.83	81.11	89.49	96.62
30.00	178.00	3001.00	1437.20	2816.00	29.00	81.75	89.54	96.73
35.00	178.00	3003.35	1441.20	2810.00	30.14	82.70	90.77	96.54
40.00	178.70	3000.03	1439.60	2801.00	30.13	82.43	91.03	96.55
44.00	178.90	2998.90	1441.00	2807.00	30.18	82.73	90.98	96.57
49.00	179.30	2995.74	1443.20	2821.00	30.27	81.90	90.79	96.19
54.00	179.00	3004.75	1446.40	2828.00	30.31	81.87	90.69	96.26
60.00	179.40	2996.64	1442.00	2810.00	30.18	82.00	90.89	96.29
65.00	178.90	2994.99	1436.00	2776.00	30.02	82.92	91.49	96.62
70.00	179.00	3002.51	1443.40	2814.00	30.21	82.12	90.85	96.38
75.00	179.00	2995.10	1441.40	2802.00	30.12	82.13	90.96	96.20
79.00	129.60	3001.16	1443.00	2816.00	30.23	82.05	90.83	96.32
84.00	130.00	3001.27	1443.60	2825.00	30.36	82.16	90.94	96.33
89.00	130.30	2994.16	1442.40	2832.00	30.44	82.05	90.96	96.19
95.00	129.40	3006.00	1444.20	2829.00	30.43	82.33	91.03	96.44
100.00	129.40	3005.56	1441.20	2818.00	30.24	82.29	90.80	96.61
105.00	128.70	2992.30	1443.40	2806.00	30.15	81.90	90.91	96.67
109.00	124.40	3008.43	1450.20	2818.00	30.52	82.60	91.63	96.14
114.00	128.00	3000.33	1440.00	2826.00	30.49	82.67	91.30	96.52
119.00	129.40	3002.46	1442.00	2834.00	30.38	82.02	90.70	96.42
124.00	129.40	2994.14	1446.20	2843.00	30.46	81.57	90.67	89.90
130.00	128.00	2994.29	1446.00	2822.00	30.23	81.56	90.64	89.97
135.00	128.70	2998.91	1445.00	2811.00	30.16	81.87	90.70	90.17
140.00	128.60	2998.19	1447.40	2800.00	30.01	81.36	90.69	89.70
144.00	129.20	2998.33	1445.20	2823.00	30.27	81.79	90.72	90.14
150.00	129.20	2994.22	1446.00	2835.00	30.44	81.76	90.87	89.92
154.00	129.40	3003.63	1447.60	2844.00	30.50	81.83	90.76	90.15
159.00	129.40	3002.21	1452.20	2831.00	30.35	81.50	90.72	89.82
164.00	128.00	3001.23	1446.20	2824.00	30.35	82.02	90.93	90.18
170.00	128.70	2997.23	1446.20	2814.00	30.25	81.93	90.97	90.05
175.00	128.60	2996.82	1446.00	2800.00	30.04	81.76	90.78	90.05

THE AVERAGE FLOW IS: 30.2383 GPM  
 THE AVERAGE SPEED IS: 2816.33 RPM  
 THE AVERAGE TORQUE IS: 1443.07 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2355

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2998.73 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .487382 GPM  
MEASURED SPEED IS: 37.7624 RPM  
MEASURED TORQUE IS: 10.0416 IN-LB  
DIFFERENTIAL PRESSURE IS: 13.4284 PSID

THE MAX. OVERALL EFFICIENCY IS: 83.1462  
THE MIN. OVERALL EFFICIENCY IS: 81.1122  
THE AVERAGE OVERALL EFFICIENCY IS: 82.0407

THE MAX. VOLUMETRIC EFFICIENCY IS: 92.0641  
THE MIN. VOLUMETRIC EFFICIENCY IS: 89.4943  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 90.8504

THE MAX. MECHANICAL EFFICIENCY IS: 90.7257  
THE MIN. MECHANICAL EFFICIENCY IS: 89.7018  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.2886

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2356 RUN AT RATED PRESSURE AND SPEED

M23563H

TIME MIN	CHL FT TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WGT LBS	NET LBS
0.00	132.50	3032.40	1473.40	7799.00	30.69	82.99	92.79	89.42
5.00	135.90	3039.05	1482.00	7824.00	31.02	82.77	92.94	89.86
10.00	136.90	3062.91	1482.00	7841.00	31.18	83.35	92.86	89.75
15.00	134.50	3060.36	1491.60	7851.00	31.35	82.68	93.04	89.85
20.00	134.90	3060.90	1495.00	7854.00	31.45	82.92	93.75	89.91
25.00	133.00	3050.09	1486.40	7840.00	31.25	83.80	93.10	89.16
30.00	131.30	3069.04	1502.40	7819.00	30.95	82.99	92.89	89.75
35.00	129.70	3067.70	1489.00	7817.00	30.84	82.94	92.64	89.52
40.00	134.00	3048.43	1484.00	7838.00	30.95	82.37	92.28	89.25
45.00	133.70	3078.74	1500.20	7855.00	31.05	82.00	92.04	89.17
50.00	130.00	2977.21	1421.00	7815.00	30.60	82.19	91.97	89.35
55.00	134.90	3039.06	1473.00	7801.00	30.30	82.03	91.54	89.50
60.00	129.10	2895.39	1395.60	7804.00	30.36	82.60	91.62	89.14
65.00	131.60	2882.94	1396.60	7785.00	30.17	82.72	91.66	89.69
70.00	134.00	2979.12	1443.20	7792.00	30.17	82.83	91.44	89.69
75.00	129.90	2926.36	1427.60	7808.00	30.34	81.43	91.41	89.06
80.00	134.00	2955.51	1432.60	7819.00	30.41	81.83	91.77	89.04
85.00	131.30	2991.72	1457.00	7818.00	30.44	81.52	91.41	89.17
90.00	131.00	2969.42	1435.60	7808.00	30.30	82.06	91.29	89.82
95.00	134.30	3021.92	1460.60	7786.00	29.96	81.81	90.99	89.90
100.00	131.20	3052.06	1478.00	7778.00	29.89	81.66	91.05	89.12
105.00	133.10	3053.69	1471.20	7796.00	29.98	81.83	90.73	89.19
110.00	132.10	3012.93	1456.00	7807.00	30.28	82.05	91.29	89.88
115.00	131.40	3005.59	1449.00	7823.00	30.53	82.49	91.52	89.12
120.00	132.20	3017.00	1458.20	7820.00	30.32	81.95	91.13	89.82
125.00	130.40	3030.30	1474.20	7825.00	30.19	81.34	91.06	89.31
130.00	132.10	2915.89	1421.00	7798.00	30.20	81.39	91.32	89.11
135.00	133.00	2904.81	1411.40	7803.00	30.29	81.28	91.44	89.42
140.00	130.20	2989.28	1438.00	7811.00	30.26	82.26	91.09	89.29
145.00	133.10	2981.24	1448.00	7820.00	30.30	82.00	91.16	89.30
150.00	131.60	3049.84	1473.00	7822.00	30.41	82.00	91.18	89.21
155.00	129.90	3049.55	1478.60	7814.00	30.36	81.82	91.28	89.61
160.00	134.30	3033.77	1472.00	7800.00	30.18	81.63	91.19	89.50
165.00	129.90	3022.99	1474.00	7782.00	29.95	81.31	91.08	89.28
170.00	134.50	3022.74	1486.40	7789.00	30.03	81.96	91.10	89.25
175.00	131.30	3000.70	1460.00	7821.00	30.21	81.40	90.62	89.80
180.00	134.50	3000.00	1462.30	7812.00	30.41	81.42	91.33	89.12

TIME TO FILL TANK 12.00 MIN  
 TIME TO FILL TANK 12.00 MIN  
 TIME TO FILL TANK 12.00 MIN

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2356

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3007.87 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 1.11131 GPM  
MEASURED SPEED IS: 52.3431 RPM  
MEASURED TORQUE IS: 79.5369 IN-LB  
DIFFERENTIAL PRESSURE IS: 155.683 PSID

THE MAX. OVERALL EFFICIENCY IS: 83.3521  
THE MIN. OVERALL EFFICIENCY IS: 81.3094  
THE AVERAGE OVERALL EFFICIENCY IS: 82.1171

THE MAX. VOLUMETRIC EFFICIENCY IS: 93.2489  
THE MIN. VOLUMETRIC EFFICIENCY IS: 90.6234  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 91.676

THE MAX. MECHANICAL EFFICIENCY IS: 90.286  
THE MIN. MECHANICAL EFFICIENCY IS: 88.8547  
THE AVERAGE MECHANICAL EFFICIENCY IS: 89.5603

THREE HOUR PERFORMANCE TEST

PUMP NUMBER 112017 RUN AT RATED PRESSURE AND SPEED

M23573H

TIME MIN	OUTLET TEMP (°F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OUTLET EFF (%)	WATER EFF (%)	HEAD EFF (%)
0.00	133.90	3068.49	1508.00	2797.00	30.43	81.17	92.06	88.15
4.68	134.10	3066.55	1506.00	2792.00	30.13	80.78	91.64	87.74
8.33	133.40	3067.47	1509.00	2770.00	30.06	80.95	91.82	88.14
18.47	133.90	3064.66	1511.00	2814.00	30.50	80.83	91.71	88.13
24.67	133.50	3064.61	1512.20	2831.00	30.67	84.42	95.85	88.25
32.60	133.30	3068.76	1512.60	2829.00	30.65	80.85	91.71	88.15
38.93	133.00	3068.74	1509.00	2806.00	30.50	81.02	91.97	88.07
45.38	132.00	3064.73	1515.40	2796.00	30.50	81.12	92.30	88.22
56.30	133.40	3068.69	1513.60	2831.00	31.77	83.44	94.96	88.58
69.83	133.60	3068.67	1509.20	2820.00	30.21	79.83	90.65	88.00
81.28	133.50	3068.68	1501.60	2813.00	30.26	80.68	91.32	88.17
87.35	133.20	3064.75	1502.40	2828.00	29.99	79.28	89.73	88.14
92.05	132.70	3068.77	1497.80	2836.00	30.50	80.55	91.00	88.50
97.13	132.30	3046.77	1494.80	2837.00	29.84	78.83	89.00	88.15
102.00	132.10	3038.70	1495.60	2821.00	29.69	78.67	89.05	88.22
106.87	132.00	3040.85	1496.00	2804.00	29.40	78.53	89.40	88.22
114.97	132.70	3064.69	1507.60	2815.00	29.54	78.18	89.20	88.22
121.55	132.90	3068.79	1499.80	2820.00	29.54	78.17	89.20	88.22
125.93	133.20	3064.74	1506.40	2837.00	29.40	78.47	89.87	88.22
122.67	133.10	3037.74	1500.00	2820.00	29.72	78.71	89.81	88.22
139.63	132.60	3038.72	1499.80	2837.00	29.00	78.77	89.81	88.22
150.57	133.20	3032.76	1494.20	2824.00	29.12	77.42	89.11	88.22
157.32	133.70	3038.65	1491.00	2837.00	29.10	78.22	89.11	88.22
164.55	133.00	3032.65	1494.00	2837.00	29.11	78.22	89.11	88.22
171.13	133.50	3032.77	1494.40	2813.00	29.17	78.22	89.11	88.22
175.02	133.20	3024.65	1492.80	2804.00	29.00	78.22	89.11	88.22
178.90	133.50	3040.59	1493.00	2811.00	29.22	78.22	89.11	88.22

THE AVERAGE FLOW IS: 29.8495 GPM  
 THE AVERAGE SPEED IS: 2817.67 RPM  
 THE AVERAGE TORQUE IS: 1502.66 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2357

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3049.65 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 2.07746 GPM  
MEASURED SPEED IS: 39.7035 RPM  
MEASURED TORQUE IS: 17.2338 IN-LB  
DIFFERENTIAL PRESSURE IS: 28.4585 PSID

THE MAX. OVER ALL EFFICIENCY IS: 84.4165  
THE MIN. OVER ALL EFFICIENCY IS: 75.2718  
THE AVERAGE OVER ALL EFFICIENCY IS: 79.0743

THE MAX. VOLUMETRIC EFFICIENCY IS: 95.0536  
THE MIN. VOLUMETRIC EFFICIENCY IS 85.097  
THE AVERAGE VOLUMETRIC EFFICIENCY IS 89.6602

THE MAX. MECHANICAL EFFICIENCY IS 88.5602  
THE MIN. MECHANICAL EFFICIENCY IS 87.7298  
THE AVERAGE MECHANICAL EFFICIENCY IS 88.1808

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2358 RUN AT RATLD PRESSURE AND SPEED

M23583H

TIME MIN	OMT TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERSHOOT EFF (%)	LOC EFF (%)	MECH EFF (%)
0.00	126.00	3004.79	1447.40	2809.00	30.59	83.41	92.14	90.51
5.00	126.00	2997.17	1441.00	2811.00	30.60	83.25	92.10	90.55
9.98	125.30	3001.77	1441.20	2808.00	30.66	83.62	92.40	91.19
14.98	129.90	2994.04	1439.60	2828.00	30.62	82.82	91.61	90.29
19.98	127.70	3001.00	1437.40	2800.00	30.21	82.83	91.29	90.29
24.98	126.50	3011.60	1440.80	2810.00	30.31	82.92	91.28	90.62
30.00	126.40	3006.86	1439.80	2808.00	30.27	82.77	91.20	90.24
35.00	126.60	3005.07	1436.20	2806.00	29.85	81.94	90.01	90.91
40.00	127.10	3003.49	1435.60	2799.00	29.79	81.87	90.05	90.28
45.00	127.70	3004.31	1433.60	2810.00	30.02	82.45	90.53	91.05
50.00	127.80	3005.77	1444.40	2824.00	30.50	82.64	91.39	90.41
54.98	128.20	2999.91	1441.20	2803.00	30.33	82.82	91.56	90.44
59.98	126.00	3002.85	1441.00	2811.00	30.37	82.77	91.41	90.24
64.98	128.00	2999.75	1441.00	2803.00	30.20	82.40	91.15	90.41
69.98	127.80	3001.75	1443.20	2802.00	30.20	82.42	91.18	90.37
75.00	128.00	3007.75	1445.80	2824.00	30.46	82.50	91.25	90.39
80.00	128.40	3005.46	1451.80	2836.00	30.54	81.96	91.13	90.25
85.00	128.30	3000.04	1447.80	2822.00	30.40	82.09	91.10	90.00
90.00	128.60	3003.68	1445.40	2830.00	30.50	82.34	91.18	90.29
94.98	128.30	2999.08	1444.20	2827.00	30.46	82.27	91.17	90.23
99.98	128.30	2999.68	1445.80	2816.00	30.36	82.24	91.22	90.23
104.98	128.10	2998.61	1448.40	2803.00	30.17	81.94	91.07	89.90
109.98	128.10	2997.21	1447.20	2806.00	30.25	82.10	91.22	89.96
114.98	128.60	3003.12	1451.00	2818.00	30.37	82.02	91.19	89.83
119.98	128.50	3000.03	1454.20	2820.00	30.46	81.69	91.12	89.64
125.00	128.40	2994.21	1451.20	2797.00	30.11	81.66	91.07	89.25
130.00	128.10	2998.81	1446.20	2789.00	30.02	82.02	91.00	89.19
135.00	127.70	2994.10	1448.00	2778.00	29.80	81.57	90.78	89.04
140.00	127.60	2994.52	1446.60	2774.00	29.83	81.65	90.99	89.94
145.02	128.50	2999.94	1450.40	2824.00	30.45	82.00	91.23	89.07
149.98	129.00	3004.81	1455.80	2834.00	30.50	81.69	91.00	89.68
154.98	129.20	3000.28	1451.80	2838.00	30.54	81.77	91.05	89.29
159.98	129.00	2999.44	1454.20	2831.00	30.45	81.58	91.01	89.02
165.00	129.00	3001.43	1454.40	2817.00	30.27	81.54	90.92	89.02
170.00	129.50	2995.98	1451.20	2807.00	30.16	81.52	90.92	89.26
175.00	129.60	3001.62	1451.00	2808.00	30.30	81.73	90.91	89.88
180.00	129.90	2998.49	1453.40	2830.00	30.40	81.50	90.90	89.64

THE AVERAGE FLOW IS: 30.3064 GPM  
 THE AVERAGE SPEED IS: 2813 RPM  
 THE AVERAGE TORQUE IS: 1445.79 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2358

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3001.05 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .627171 GPM  
MEASURED SPEED IS: 40.6842 RPM  
MEASURED TORQUE IS: 15.7876 IN-LB  
DIFFERENTIAL PRESSURE IS: 10.7302 PSID

THE MAX. OVERALL EFFICIENCY IS: 83.6181  
THE MIN. OVERALL EFFICIENCY IS: 81.4985  
THE AVERAGE OVERALL EFFICIENCY IS: 82.2321

THE MAX. VOLUMETRIC EFFICIENCY IS: 92.3989  
THE MIN. VOLUMETRIC EFFICIENCY IS: 90.0101  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 91.1617

THE MAX. MECHANICAL EFFICIENCY IS: 91.0539  
THE MIN. MECHANICAL EFFICIENCY IS: 89.6185  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.1899



THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2359 RUN AT RATED PRESSURE AND SPEED

M2359CH

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERHILL EFF (%)	WGT LIFT (%)	WGT LIFT (%)
0.00	127.70	3182.54	1518.00	2804.00	29.50	81.06	89.00	91.04
5.00	131.70	3148.38	1501.60	2806.00	29.50	81.05	88.96	91.16
10.00	121.10	3081.56	1470.00	2794.00	29.80	82.51	90.57	91.06
15.00	131.10	3067.52	1473.00	2794.00	29.60	81.65	89.64	91.07
20.00	124.00	3122.60	1497.00	2801.00	29.80	81.60	90.00	90.87
25.00	124.60	3158.47	1505.20	2797.00	29.80	82.21	90.15	91.17
30.00	123.50	2914.70	1398.40	2799.00	30.10	82.42	90.99	90.50
35.00	127.70	3067.66	1435.20	2795.00	29.90	82.43	90.50	91.06
40.00	128.00	3167.58	1495.40	2808.00	29.99	81.61	90.37	90.50
45.00	127.50	3063.65	1469.40	2817.00	29.99	81.62	90.00	90.50
50.00	127.40	3093.46	1490.00	2800.00	29.80	81.21	90.05	90.16
55.00	125.40	2979.72	1442.00	2789.00	29.80	81.14	90.41	89.75
60.00	130.60	3077.35	1417.00	2796.00	29.80	85.06	90.18	90.31
65.00	126.20	3109.54	1475.20	2782.00	29.50	82.19	89.73	91.00
70.00	127.10	3109.43	1473.60	2782.00	29.50	82.28	89.73	91.00
75.00	126.00	3106.50	1480.00	2786.00	29.60	82.00	89.90	91.20
80.00	126.10	3125.59	1471.40	2792.00	29.60	84.20	90.31	90.77
85.00	126.60	3113.48	1489.60	2796.00	29.60	81.66	89.90	90.80
90.00	126.00	3004.65	1472.00	2793.00	29.80	80.00	89.28	90.66
95.00	129.90	2968.50	1434.20	2789.00	29.60	80.77	89.00	89.95
100.00	126.00	3010.61	1445.00	2802.00	29.80	81.43	89.99	90.47
105.00	133.50	3006.42	1547.60	2800.00	29.50	75.26	89.15	89.41
110.00	130.60	3006.49	1474.40	2797.00	29.80	79.94	90.15	89.66
115.00	129.90	3024.51	1460.00	2812.00	29.80	80.72	89.67	90.01
120.00	130.60	3024.41	1454.00	2810.00	29.80	81.11	89.73	90.30
125.00	131.00	3018.35	1431.00	2801.00	29.70	82.19	89.72	91.10
130.00	131.20	2948.67	1412.60	2815.00	29.90	81.53	89.89	90.70
135.00	129.90	2990.44	1422.20	2796.00	29.80	82.41	90.18	91.30
140.00	129.90	2994.52	1424.60	2806.00	30.10	82.61	90.72	91.05
145.00	131.40	2964.60	1452.00	2818.00	29.90	79.61	89.78	89.66
150.00	132.20	3004.40	1480.00	2800.00	29.60	78.88	89.45	90.17
155.00	132.10	3004.49	1472.60	2812.00	30.40	81.10	91.48	89.65
160.00	129.90	3024.42	1470.00	2810.00	29.80	80.19	89.73	89.34
165.00	129.20	3028.52	1484.60	2792.00	29.60	79.52	89.71	89.63
170.00	129.10	3024.38	1476.00	2778.00	29.50	79.97	89.85	89.90
175.00	129.00	3014.45	1475.00	2788.00	29.60	79.28	89.84	89.80
180.00	129.20	3018.65	1477.40	2812.00	29.80	79.62	89.67	89.78

THE AVERAGE FLOW IS: 29.7616 GPM  
 THE AVERAGE SPEED IS: 2798.62 RPM  
 THE AVERAGE TORQUE IS: 1468.89 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2359

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3046.3 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .532485 GPM  
MEASURED SPEED IS: 28.3292 RPM  
MEASURED TORQUE IS: 83.1016 IN-LB  
DIFFERENTIAL PRESSURE IS: 177.298 PSID

THE MAX. OVERALL EFFICIENCY IS: 85.0635  
THE MIN. OVERALL EFFICIENCY IS: 75.2587  
THE AVERAGE OVERALL EFFICIENCY IS: 81.2206

THE MAX. VOLUMETRIC EFFICIENCY IS: 91.4761  
THE MIN. VOLUMETRIC EFFICIENCY IS: 88.9577  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 89.9833

THE MAX. MECHANICAL EFFICIENCY IS: 94.3069  
THE MIN. MECHANICAL EFFICIENCY IS: 84.4059  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.2454

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2360 RUN AT RATED PRESSURE AND SPEED

M23603H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF(%)	WGT EFF (%)	MECH EFF (%)
0.00	136.70	3042.44	1486.70	2771.00	28.20	76.61	86.11	88.96
5.00	134.00	3044.40	1484.00	2758.00	27.91	76.79	85.62	89.09
10.00	134.90	3038.44	1484.60	2759.00	28.77	76.00	85.46	88.97
15.00	135.00	3044.38	1494.60	2759.00	28.88	77.79	87.31	88.50
20.00	136.40	3046.44	1497.60	2678.00	29.19	77.70	87.33	88.70
25.00	137.30	3044.48	1496.00	2644.00	29.31	77.13	87.21	88.47
30.00	137.00	3052.48	1497.40	2654.00	29.43	77.79	87.25	88.57
35.00	137.70	3054.46	1497.00	2654.00	29.41	77.32	87.21	88.65
40.00	138.20	3052.50	1494.40	2611.00	29.25	77.31	87.10	88.75
45.00	138.90	3044.50	1493.00	2625.00	29.05	77.06	87.01	88.55
50.00	131.20	3054.65	1497.00	2816.00	29.19	77.78	87.21	88.66
55.00	133.00	3058.59	1495.00	2633.00	29.31	77.83	87.54	88.89
60.00	137.60	3048.52	1493.60	2786.00	28.77	77.36	87.27	88.68
65.00	135.70	3058.50	1497.00	2794.00	28.88	77.65	87.46	88.77
70.00	133.00	3052.50	1488.20	2797.00	28.91	77.95	87.45	88.17
75.00	132.10	3058.54	1491.40	2782.00	28.82	78.11	87.65	88.10
80.00	131.00	3048.39	1491.00	2766.00	28.68	77.90	87.23	88.29
85.00	131.60	3054.47	1483.60	2756.00	28.52	78.34	87.57	88.45
90.00	132.20	3048.48	1493.20	2771.00	28.66	77.65	87.52	88.20
95.00	134.40	3050.58	1488.20	2784.00	28.77	77.90	87.45	88.06
100.00	136.60	3048.46	1489.00	2794.00	28.84	77.70	87.33	88.96
105.00	137.10	3062.37	1482.00	2793.00	28.78	78.30	87.19	88.28
110.00	134.00	3056.49	1493.00	2779.00	28.70	77.73	87.37	88.96
115.00	133.20	3056.38	1492.40	2766.00	28.56	77.26	87.37	88.98
120.00	131.20	3056.38	1486.40	2763.00	28.58	78.20	87.52	88.34
125.00	130.90	3062.77	1498.00	2796.00	28.96	77.86	87.63	88.83
130.00	132.10	3058.52	1493.60	2806.00	29.02	77.87	87.51	88.97
135.00	134.20	3046.53	1491.60	2813.00	29.05	77.55	87.37	88.74
140.00	136.60	3056.44	1487.00	2809.00	28.95	77.65	87.20	88.26
145.00	136.60	3056.59	1490.00	2796.00	28.78	77.59	87.09	88.08
150.00	134.40	3056.48	1491.40	2788.00	28.68	77.74	87.28	88.04
155.00	132.60	3058.56	1490.00	2784.00	28.77	77.99	87.43	88.19
160.00	130.90	3060.58	1490.60	2793.00	28.93	78.21	87.66	88.21
165.00	131.60	3056.69	1495.60	2804.00	28.99	77.71	87.49	88.08
170.00	133.00	3058.66	1492.00	2811.00	29.03	77.64	87.38	88.04
175.00	137.10	3054.56	1491.00	2808.00	28.92	77.65	87.16	88.20
180.00	136.30	3054.59	1486.00	2794.00	28.76	77.80	87.10	88.31

THE AVERAGE FLOW IS: 28.8551 GPM  
 THE AVERAGE SPEED IS: 2798.59 RPM  
 THE AVERAGE TORQUE IS: 1491.53 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2360

THE AVERAGE DIFFERENTIAL PRESSURE IS: 3052.99 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .066014 GPM  
MEASURED SPEED IS: 69.1157 RPM  
MEASURED TORQUE IS: 11.5566 IN-LB  
DIFFERENTIAL PRESSURE IS: 16.8392 PSID

THE MAX. OVERALL EFFICIENCY IS: 78.3429  
THE MIN. OVERALL EFFICIENCY IS: 76.0038  
THE AVERAGE OVERALL EFFICIENCY IS: 77.6032

THE MAX. VOLUMETRIC EFFICIENCY IS: 87.7265  
THE MIN. VOLUMETRIC EFFICIENCY IS: 85.4558  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 87.243

THE MAX. MECHANICAL EFFICIENCY IS: 89.7824  
THE MIN. MECHANICAL EFFICIENCY IS: 88.385  
THE AVERAGE MECHANICAL EFFICIENCY IS: 88.9362

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M2361 RUN AT RATED PRESSURE AND SPEED

M23613H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WQ EFF (%)	MECH EFF (%)
0.00	135.40	2950.27	1441.40	2811.00	29.43	78.79	88.58	88.93
4.00	132.20	2948.86	1449.20	2832.00	29.66	78.90	88.73	88.47
10.00	131.90	2944.91	1447.80	2846.00	30.11	79.12	89.51	88.73
14.00	131.00	2940.65	1444.80	2800.00	29.61	79.14	89.47	88.43
20.00	130.40	2922.50	1429.40	2793.00	29.58	79.61	89.61	88.83
24.00	130.10	2922.36	1430.00	2779.00	29.44	79.60	89.63	88.79
30.00	130.20	2924.67	1431.60	2763.00	29.25	79.51	89.56	88.71
34.00	131.00	2922.82	1427.20	2770.00	29.31	79.68	89.53	88.73
40.00	131.60	2934	1433.40	2789.00	29.57	79.82	89.71	88.96
44.00	132.10	2775.24	1431.60	2800.00	29.69	74.77	89.72	89.71
50.00	132.20	2930.76	1432.40	2800.00	29.86	80.00	89.98	88.96
52.77	131.90	2932.67	1439.20	2802.00	29.25	79.56	89.65	88.54
55.00	131.90	2939.32	1434.20	2795.00	29.77	80.12	89.96	88.66
59.00	131.90	2934.40	1433.40	2780.00	29.49	79.86	89.77	88.95
65.00	132.40	2947.31	1430.40	2818.00	30.01	80.69	89.12	89.53
70.00	132.00	2944.77	1430.00	2836.00	30.20	80.19	90.11	88.96
74.00	133.50	2947.69	1439.00	2849.00	30.43	80.39	90.36	88.96
80.00	133.20	2955.29	1439.00	2860.00	30.52	80.54	90.29	89.10
85.00	133.60	2953.15	1437.20	2861.00	30.59	80.79	90.48	89.28
89.00	133.40	2958.32	1442.60	2847.00	30.42	80.58	90.42	89.10
95.00	132.00	2949.73	1435.00	2831.00	30.25	80.72	90.42	89.10
99.00	132.00	2955.34	1438.20	2831.00	30.29	80.84	90.53	89.10
105.00	132.10	2947.81	1433.00	2800.00	29.97	80.73	90.30	89.10
109.00	132.00	2941.21	1429.60	2822.00	30.12	80.74	90.30	89.10
115.00	132.40	2959.48	1437.00	2825.00	30.15	80.78	90.31	89.43
120.00	131.90	2956.25	1438.60	2812.00	29.92	80.41	90.04	88.29
124.00	131.00	2947.64	1432.00	2797.00	29.66	80.25	89.71	89.44
130.00	132.00	2921.30	1420.00	2788.00	29.60	80.30	89.82	89.29
134.00	132.20	2912.81	1418.60	2805.00	29.73	80.03	89.69	89.21
140.00	132.00	2882.23	1410.00	2821.00	29.91	79.28	89.71	88.71
144.00	129.20	2894.84	1269.00	2849.00	30.23	81.06	91.28	88.25
150.00	128.00	2692.49	1319.40	2838.00	30.46	80.53	90.81	88.62
154.00	127.20	2673.89	1301.40	2826.00	29.91	79.97	89.56	88.22
160.00	132.90	2731.24	1335.20	2805.00	29.81	79.96	89.93	88.89
164.00	129.90	2771.01	1347.00	2811.00	29.29	80.15	89.66	89.28
170.00	129.30	2953.22	1434.00	2813.00	29.59	79.67	88.99	89.51
175.00	133.20	2948.22	1432.40	2822.00	29.59	79.00	88.73	89.12

THE AVERAGE FLOW IS: 29.8998 GPM  
 THE AVERAGE SPEED IS: 2814.68 RPM  
 THE AVERAGE TORQUE IS: 1418.18 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M2361

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2900.74 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: 1.01312 GPM  
MEASURED SPEED IS: 65.4127 RPM  
MEASURED TORQUE IS: 116.375 IN-LB  
DIFFERENTIAL PRESSURE IS: 252.965 PSID

THE MAX. OVERALL EFFICIENCY IS: 81.0595  
THE MIN. OVERALL EFFICIENCY IS: 74.2203  
THE AVERAGE OVERALL EFFICIENCY IS: 79.8946

THE MAX. VOLUMETRIC EFFICIENCY IS: 91.2801  
THE MIN. VOLUMETRIC EFFICIENCY IS: 88.5828  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 89.8832

THE MAX. MECHANICAL EFFICIENCY IS: 89.5262  
THE MIN. MECHANICAL EFFICIENCY IS: 82.7113  
THE AVERAGE MECHANICAL EFFICIENCY IS: 88.8721

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3362 RUN AT RATED PRESSURE AND SPEED

M33623H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WQ EFF (%)	MFCB EFF (%)
0.00	127.60	2520.25	1319.20	1815.00	20.52	79.43	85.64	92.74
5.00	127.60	2523.81	1333.20	1807.00	20.39	78.56	85.47	91.89
9.98	127.10	2499.43	1322.00	1803.00	20.40	78.61	85.69	91.77
14.98	127.10	2492.29	1307.60	1805.00	20.41	79.25	85.64	92.52
19.98	127.00	2485.39	1321.60	1798.00	20.26	77.92	85.34	91.29
25.00	126.80	2484.58	1299.00	1807.00	20.44	79.51	85.68	92.29
30.00	127.10	2482.65	1317.00	1806.00	20.42	78.35	85.61	91.51
35.00	127.00	2519.38	1315.40	1819.00	20.53	79.49	85.48	92.97
40.02	128.10	2486.45	1303.00	1811.00	20.47	79.77	85.61	92.52
44.98	127.70	2485.67	1314.40	1806.00	20.39	78.52	85.52	91.80
49.98	127.20	2478.33	1305.60	1800.00	20.32	78.79	85.49	92.14
54.98	126.90	2468.20	1299.40	1805.00	20.39	78.91	85.57	92.21
60.00	127.10	2483.31	1311.20	1804.00	20.36	78.61	85.49	91.94
65.00	127.60	2517.77	1318.00	1816.00	20.53	79.39	85.61	92.73
70.00	128.10	2533.94	1329.00	1826.00	20.63	79.20	85.56	92.53
74.98	127.90	2481.85	1304.00	1813.00	20.49	79.08	85.58	92.39
79.98	127.00	2469.48	1288.00	1809.00	20.47	79.71	85.69	93.01
84.98	127.20	2488.25	1300.20	1802.00	20.31	79.33	85.38	92.98
90.00	126.80	2477.25	1291.60	1795.00	20.26	79.61	85.49	92.11
95.00	126.90	2488.04	1302.20	1800.00	20.31	79.29	85.47	92.21
100.00	127.20	2525.61	1332.00	1812.00	20.44	78.65	85.44	92.04
104.98	127.50	2527.30	1335.40	1814.00	20.47	78.54	85.48	91.82
109.98	127.20	2512.40	1310.40	1810.00	20.43	79.58	85.49	93.02
114.98	127.10	2480.39	1295.40	1806.00	20.38	79.46	85.47	92.95
120.00	126.20	2474.93	1305.00	1802.00	20.35	78.71	85.54	92.00
125.00	126.60	2483.38	1293.60	1804.00	20.41	79.85	85.68	93.10
130.00	126.60	2490.45	1303.40	1808.00	20.46	79.49	85.69	92.25
134.98	126.90	2506.55	1313.40	1815.00	20.54	79.42	85.72	92.64
139.98	126.60	2491.94	1310.00	1812.00	20.47	79.01	85.55	92.24
144.98	126.50	2481.02	1302.20	1807.00	20.41	79.12	85.57	92.40
150.00	126.50	2465.74	1284.40	1800.00	20.36	79.84	85.66	92.10
155.00	126.20	2456.93	1296.20	1794.00	20.26	78.71	85.53	92.01
160.00	126.40	2493.98	1302.00	1808.00	20.45	79.67	85.67	92.98
164.98	127.10	2492.11	1313.00	1812.00	20.50	78.91	85.69	92.00
169.98	127.20	2510.41	1323.60	1820.00	20.58	78.82	85.65	92.02
174.98	127.20	2504.90	1305.40	1815.00	20.49	79.64	85.49	93.15
180.00	127.40	2492.42	1294.20	1811.00	20.47	80.06	85.62	93.48

THE AVERAGE FLOW IS: 20.4263 GPM  
 THE AVERAGE SPEED IS: 1808.03 RPM  
 THE AVERAGE TORQUE IS: 1308.82 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3362

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2493.44 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .233792 GPM  
MEASURED SPEED IS: 18.7135 RPM  
MEASURED TORQUE IS: 33.9763 IN-LB  
DIFFERENTIAL PRESSURE IS: 50.8823 PSID

THE MAX. OVERALL EFFICIENCY IS: 80.0583  
THE MIN. OVERALL EFFICIENCY IS: 77.9157  
THE AVERAGE OVERALL EFFICIENCY IS: 79.1449

THE MAX. VOLUMETRIC EFFICIENCY IS: 85.7151  
THE MIN. VOLUMETRIC EFFICIENCY IS: 85.3376  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 85.5652

THE MAX. MECHANICAL EFFICIENCY IS: 93.4843  
THE MIN. MECHANICAL EFFICIENCY IS: 91.2879  
THE AVERAGE MECHANICAL EFFICIENCY IS: 92.4814



THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3363 RUN AT RATED PRESSURE AND SPEED

M33633H

TIME MIN	CHL FT TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	DIFFERENTIAL EFF (%)	WGT EFF (%)	MECH EFF (%)
0.00	174.40	2489.99	1313.40	1801.00	21.29	82.42	89.54	92.00
5.00	176.40	2497.88	1321.60	1799.00	21.18	81.81	89.15	91.75
10.00	173.90	2489.13	1315.60	1804.00	21.28	82.06	89.33	91.64
15.00	175.10	2489.67	1318.40	1810.00	21.43	82.73	89.69	92.25
20.00	176.60	2489.56	1317.60	1809.00	21.44	82.35	89.77	91.72
25.00	177.10	2483.54	1306.80	1815.00	21.52	82.84	89.78	92.25
30.00	177.10	2483.52	1311.40	1810.00	21.45	82.54	89.77	91.93
35.00	177.30	2480.35	1314.60	1804.00	21.36	82.16	89.69	91.58
40.00	178.20	2493.51	1312.60	1796.00	21.28	82.76	89.73	92.21
45.00	131.20	2492.27	1316.80	1793.00	21.18	81.91	89.14	91.65
50.00	171.00	2503.47	1324.80	1814.00	21.44	82.17	89.51	91.79
55.00	170.40	2506.38	1321.00	1821.00	21.49	82.32	89.36	92.16
60.00	131.00	2495.25	1311.80	1816.00	21.34	82.18	89.99	92.33
65.00	179.30	2497.96	1312.20	1808.00	21.18	82.00	88.73	92.41
70.00	178.80	2499.10	1315.40	1801.00	21.04	81.61	88.48	92.22
75.00	178.40	2505.96	1322.40	1802.00	20.95	81.83	88.87	91.99
80.00	178.20	2499.00	1321.40	1802.00	20.95	80.61	87.80	91.86
85.00	178.80	2504.51	1322.20	1819.00	21.01	80.16	87.50	91.60
90.00	179.00	2503.91	1325.40	1825.00	21.05	80.11	87.35	91.70
95.00	178.80	2503.63	1313.40	1812.00	20.82	80.73	87.23	92.53
100.00	178.10	2509.41	1329.60	1802.00	20.78	79.80	87.09	91.62
105.00	178.20	2500.58	1317.60	1798.00	20.66	80.19	87.83	92.12
110.00	178.20	2498.22	1322.40	1802.00	20.72	79.86	87.87	91.76
115.00	178.80	2492.29	1323.00	1816.00	20.88	79.64	87.88	91.44
120.00	179.20	2499.92	1326.20	1829.00	20.92	79.47	86.83	91.50
125.00	178.80	2501.33	1326.00	1804.00	20.63	79.31	86.60	91.52
130.00	178.60	2498.98	1335.40	1792.00	20.59	78.84	86.78	90.84
135.00	178.30	2497.67	1318.20	1795.00	20.52	79.63	86.56	91.90
140.00	178.20	2503.68	1322.00	1805.00	20.63	79.58	86.55	91.93
145.00	178.50	2503.55	1323.00	1815.00	20.71	79.38	86.40	91.88
150.00	129.00	2505.44	1323.00	1826.00	20.82	79.39	86.34	91.93
155.00	129.10	2502.52	1330.20	1830.00	20.91	79.04	86.54	91.32
160.00	128.80	2503.01	1325.60	1826.00	20.76	78.93	86.09	91.66
165.00	128.80	2505.25	1340.20	1816.00	20.78	78.64	86.65	90.74
170.00	128.40	2497.88	1316.40	1802.00	20.58	79.47	86.27	92.11
175.00	128.30	2502.52	1333.60	1809.00	20.62	78.83	86.53	91.89
180.00	128.80	2501.14	1338.20	1825.00	20.78	78.26	86.25	90.73

THE AVERAGE FLOW IS: 21.0003 GPM  
 THE AVERAGE SPEED IS: 1810.08 RPM  
 THE AVERAGE TORQUE IS: 1321.23 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3363

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2498.16 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .822398 GPM  
MEASURED SPEED IS: 27.2131 RPM  
MEASURED TORQUE IS: 21.3082 IN-LB  
DIFFERENTIAL PRESSURE IS: 18.8692 PSID

THE MAX. OVERALL EFFICIENCY IS: 82.8417  
THE MIN. OVERALL EFFICIENCY IS: 78.2644  
THE AVERAGE OVERALL EFFICIENCY IS: 80.669

THE MAX. VOLUMETRIC EFFICIENCY IS: 89.7836  
THE MIN. VOLUMETRIC EFFICIENCY IS: 86.0946  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 87.872

THE MAX. MECHANICAL EFFICIENCY IS: 92.532  
THE MIN. MECHANICAL EFFICIENCY IS: 90.7269  
THE AVERAGE MECHANICAL EFFICIENCY IS: 91.7848

THREE HOUR PERFORMANCE TEST

PUMP NUMBER: M3364 RUN AT RATED PRESSURE AND SPEED

M33643H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OUTSIDE FEET (2)	WELL FEET (2)	HEAD FEET (2)
0.00	134.10	2470.63	1329.40	1799.00	21.26	81.02	89.50	90.51
4.00	134.20	2495.94	1346.60	1789.00	20.87	79.49	88.75	89.82
10.00	133.80	2500.22	1349.20	1797.00	20.89	79.20	88.83	89.75
14.00	128.80	2490.80	1348.80	1796.00	20.81	79.13	88.26	89.64
20.00	131.80	2490.66	1360.80	1774.00	20.63	78.53	88.09	89.13
24.00	131.40	2490.77	1346.00	1768.00	20.56	79.40	88.09	89.12
30.00	129.80	2500.81	1350.20	1800.00	21.01	79.73	88.39	89.20
34.00	132.90	2500.68	1353.80	1811.00	21.00	79.30	88.15	89.55
40.00	127.90	2527.14	1362.80	1815.00	21.19	79.63	88.43	89.63
44.00	131.90	2517.86	1350.20	1820.00	21.14	79.66	87.99	89.72
50.00	129.30	2527.48	1375.80	1820.00	21.14	78.47	87.97	89.19
55.00	129.40	2533.33	1367.40	1824.00	21.14	78.95	87.78	89.85
59.00	133.20	2536.07	1360.20	1820.00	20.94	78.89	87.15	89.51
65.00	129.30	2531.00	1372.20	1814.00	20.78	77.70	86.77	89.54
69.00	129.40	2529.02	1379.80	1804.00	20.63	77.87	86.60	89.29
75.00	133.20	2518.34	1364.40	1798.00	20.44	77.16	86.10	89.66
79.00	128.90	2526.90	1373.00	1795.00	20.45	77.11	86.29	89.24
85.00	130.30	2526.58	1365.00	1807.00	20.58	77.51	86.25	89.85
89.00	133.20	2530.27	1373.20	1813.00	20.64	77.14	86.23	89.44
95.00	128.50	2535.95	1382.40	1815.00	20.74	77.06	86.52	89.65
99.00	129.80	2518.36	1369.80	1821.00	20.71	76.89	86.13	89.28
105.00	133.20	2509.80	1356.80	1824.00	20.82	77.66	86.47	89.80
110.00	128.30	2513.54	1360.20	1827.00	20.71	77.01	85.83	89.20
114.00	129.50	2505.17	1365.20	1824.00	20.78	76.86	86.27	89.00
120.00	133.20	2507.56	1356.80	1818.00	20.74	77.52	86.40	89.21
124.00	127.80	2516.14	1366.20	1810.00	20.59	77.04	86.16	89.40
130.00	129.90	2509.97	1348.00	1801.00	20.42	77.64	85.88	89.39
134.00	131.80	2515.09	1356.00	1796.00	20.44	77.61	86.18	89.64
140.00	127.20	2516.34	1359.00	1800.00	20.61	77.59	86.32	89.86
145.00	130.90	2516.82	1359.40	1815.00	20.69	77.62	86.35	89.82
149.00	131.10	2509.87	1344.80	1820.00	20.67	77.93	86.01	89.60
155.00	127.20	2507.05	1357.40	1821.00	20.70	77.19	86.09	89.65
159.00	131.40	2500.21	1353.40	1825.00	20.75	77.49	86.13	89.90
165.00	129.90	2514.78	1365.80	1827.00	20.67	76.59	85.68	89.38
169.00	128.10	2519.94	1369.00	1820.00	20.71	76.66	85.78	89.25
175.00	132.00	2509.59	1355.40	1822.00	20.71	77.39	86.10	89.86

THE AVERAGE FLOW IS: 20.7674 GPM  
 THE AVERAGE SPEED IS: 1809.89 RPM  
 THE AVERAGE TORQUE IS: 1359.82 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3364

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2514.4 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .587062 GPM  
MEASURED SPEED IS: 39.5665 RPM  
MEASURED TORQUE IS: 29.2206 IN-LB  
DIFFERENTIAL PRESSURE IS: 34.6535 PSID

THE MAX. OVERALL EFFICIENCY IS: 81.0158  
THE MIN. OVERALL EFFICIENCY IS: 76.5905  
THE AVERAGE OVERALL EFFICIENCY IS: 78.0241

THE MAX. VOLUMETRIC EFFICIENCY IS: 89.5002  
THE MIN. VOLUMETRIC EFFICIENCY IS: 85.6786  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 86.9087

THE MAX. MECHANICAL EFFICIENCY IS: 90.5967  
THE MIN. MECHANICAL EFFICIENCY IS: 88.9852  
THE AVERAGE MECHANICAL EFFICIENCY IS: 89.7608

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3365 RUN AT RATED PRESSURE AND SPEED

M33653H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OUTLET FIT (%)	WGT EFF (%)	HEAT EFF (%)
0.00	132.10	2496.74	1431.20	1752.00	21.03	75.29	88.85	84.68
5.00	130.90	2507.28	1445.60	1793.00	20.93	74.87	88.39	84.70
10.00	131.00	2506.25	1461.20	1803.00	21.06	74.26	88.47	85.90
15.00	131.10	2531.81	1470.20	1800.00	21.52	74.86	88.13	83.50
20.00	132.20	2518.49	1459.00	1829.00	21.22	73.63	87.86	83.29
25.00	133.00	2507.28	1452.20	1805.00	21.11	74.05	87.62	84.50
30.00	134.90	2509.77	1454.40	1818.00	20.89	73.48	87.02	84.43
35.00	133.50	2536.14	1458.00	1809.00	20.62	73.56	87.15	84.29
40.00	134.30	2523.57	1437.20	1800.00	20.78	74.55	87.45	85.20
45.00	134.30	2530.02	1442.00	1799.00	20.70	74.23	87.14	85.17
50.00	131.70	2536.13	1459.00	1814.00	20.72	73.15	86.73	84.30
55.00	129.20	2531.39	1459.20	1824.00	20.88	73.01	86.68	84.21
60.00	129.00	2527.69	1452.20	1830.00	20.94	73.25	86.68	84.49
65.00	131.00	2525.74	1456.40	1824.00	20.81	72.74	86.39	84.18
70.00	131.70	2518.19	1447.40	1815.00	20.65	72.77	86.15	84.45
75.00	132.20	2507.48	1441.60	1807.00	20.48	72.50	85.85	84.43
80.00	132.20	2506.29	1439.60	1801.00	20.38	72.44	85.71	84.51
85.00	132.20	2520.42	1451.40	1814.00	20.50	72.15	85.58	84.30
90.00	133.50	2512.04	1435.60	1825.00	20.20	72.96	85.90	84.90
95.00	134.50	2514.60	1435.60	1834.00	20.25	72.06	85.67	85.00
100.00	133.20	2525.64	1440.20	1827.00	20.24	73.20	85.97	85.17
105.00	130.90	2515.60	1428.60	1820.00	20.62	73.37	85.82	85.40
110.00	129.00	2509.38	1429.00	1812.00	20.51	73.06	85.72	85.24
115.00	129.90	2506.95	1432.60	1804.00	20.39	72.74	85.62	84.90
120.00	131.00	2513.46	1450.60	1812.00	20.56	72.28	85.92	84.11
125.00	130.20	2511.29	1429.40	1823.00	20.22	73.41	86.07	85.20
130.00	129.30	2516.74	1441.00	1832.00	20.04	73.04	86.14	84.20
135.00	129.20	2500.96	1422.40	1829.00	20.28	73.68	86.03	85.62
140.00	129.00	2507.34	1440.60	1822.00	20.65	72.52	85.82	84.49
145.00	128.90	2502.26	1424.20	1812.00	20.58	73.32	86.00	85.30
150.00	130.00	2507.18	1442.20	1804.00	20.56	72.65	86.32	84.39
155.00	132.30	2499.02	1412.40	1812.00	20.55	73.51	85.82	85.59
160.00	133.60	2496.94	1423.00	1824.00	20.66	73.02	85.72	85.18
165.00	130.40	2502.21	1432.00	1831.00	20.62	73.20	86.34	84.22
170.00	130.50	2500.59	1420.40	1834.00	20.65	73.61	86.12	85.46
175.00	132.10	2501.20	1412.20	1826.00	20.21	73.86	85.90	85.90

THE AVERAGE FLOW IS: 20.7628 GPM  
 THE AVERAGE SPEED IS: 1816.67 RPM  
 THE AVERAGE TORQUE IS: 1441.04 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3365

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2515.78 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .618401 GPM  
MEASURED SPEED IS: 31.2346 RPM  
MEASURED TORQUE IS: 37.474 IN-LB  
DIFFERENTIAL PRESSURE IS: 30.8529 PSID

THE MAX. OVERALL EFFICIENCY IS: 75.2866  
THE MIN. OVERALL EFFICIENCY IS: 72.1508  
THE AVERAGE OVERALL EFFICIENCY IS: 73.372

THE MAX. VOLUMETRIC EFFICIENCY IS: 89.5328  
THE MIN. VOLUMETRIC EFFICIENCY IS: 85.5786  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 86.5633

THE MAX. MECHANICAL EFFICIENCY IS: 85.9782  
THE MIN. MECHANICAL EFFICIENCY IS: 83.5937  
THE AVERAGE MECHANICAL EFFICIENCY IS: 84.7504

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3366 RUN AT RATED PRESSURE AND SPEED

M33663H

TIME MIN	OUT FT TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	WFS#1 FFF(%)	OUT FTT (%)	WFS#2 FFF(%)
0.00	132.10	2489.67	1355.60	1795.00	21.54	81.05	90.89	89.15
4.00	132.30	2487.74	1350.00	1789.00	21.30	80.97	90.57	89.38
10.00	131.20	2492.74	1356.40	1801.00	21.56	80.88	90.65	89.21
15.00	131.10	2481.76	1338.00	1812.00	21.71	81.71	90.74	90.04
19.00	131.00	2478.17	1346.40	1816.00	21.78	81.17	90.84	89.35
25.00	131.10	2492.47	1346.40	1822.00	21.91	81.85	91.06	89.86
29.00	131.50	2499.08	1337.20	1825.00	21.93	82.59	90.99	90.25
35.00	131.60	2495.69	1336.60	1827.00	21.94	82.46	90.97	90.64
40.00	131.00	2492.92	1334.00	1820.00	21.84	82.47	90.90	90.66
44.00	131.60	2497.94	1345.00	1810.00	21.77	82.13	91.05	90.15
50.00	131.50	2492.63	1350.00	1802.00	21.61	81.35	90.81	89.57
54.00	131.20	2489.55	1333.20	1794.00	21.54	82.43	90.93	90.65
60.00	131.50	2491.87	1342.60	1804.00	21.65	81.90	90.89	90.09
64.00	131.50	2502.28	1340.40	1814.00	21.73	82.24	90.73	90.62
70.00	131.60	2494.46	1351.00	1821.00	21.81	81.30	90.69	89.63
74.00	131.90	2494.00	1334.40	1821.00	21.86	82.40	90.90	90.25
80.00	131.90	2495.28	1355.60	1824.00	21.93	81.36	91.04	89.35
84.00	132.10	2501.73	1340.40	1829.00	21.93	82.30	90.87	90.60
90.00	132.10	2500.87	1353.00	1821.00	21.84	81.53	90.85	89.72
94.00	132.20	2499.61	1351.60	1813.00	21.79	81.73	91.03	89.77
99.00	131.60	2506.57	1343.40	1807.00	21.65	82.19	90.73	90.57
105.00	131.40	2501.43	1351.20	1798.00	21.55	81.60	90.79	89.68
109.00	131.00	2505.07	1348.20	1809.00	21.66	81.81	90.69	90.20
115.00	131.10	2495.81	1353.60	1816.00	21.78	81.31	90.84	89.50
119.00	131.00	2504.47	1345.60	1820.00	21.84	82.14	90.90	90.35
125.00	130.60	2534.05	1365.00	1821.00	21.83	81.83	90.79	90.12
130.00	131.00	2550.87	1375.60	1823.00	21.83	81.64	90.69	90.02
134.00	131.50	2528.84	1358.60	1825.00	21.87	82.02	90.76	90.25
140.00	131.50	2549.33	1355.60	1820.00	21.79	82.78	90.67	91.29
144.00	131.20	2535.43	1371.20	1814.00	21.67	81.23	90.48	89.76
149.00	131.20	2539.59	1361.20	1803.00	21.58	82.12	90.66	90.57
155.00	131.00	2538.22	1356.20	1799.00	21.51	82.29	90.57	90.85
159.00	130.40	2538.21	1360.60	1800.00	21.57	81.84	90.37	90.56
165.00	130.50	2544.16	1356.20	1814.00	21.73	82.64	90.73	91.06
170.00	130.30	2535.00	1369.20	1810.00	21.77	81.50	90.67	89.87
174.00	130.20	2547.00	1374.60	1824.00	21.81	81.46	90.54	89.95

THE AVERAGE FLOW IS: 21.7354 GPM  
 THE AVERAGE SPEED IS: 1813.31 RPM  
 THE AVERAGE TORQUE IS: 1351.28 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3366

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2509.03 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .373766 GPM  
MEASURED SPEED IS: 27.6537 RPM  
MEASURED TORQUE IS: 29.6527 IN-LB  
DIFFERENTIAL PRESSURE IS: 58.1555 PSID

THE MAX. OVERALL EFFICIENCY IS: 82.7833  
THE MIN. OVERALL EFFICIENCY IS: 80.8846  
THE AVERAGE OVERALL EFFICIENCY IS: 81.8394

THE MAX. VOLUMETRIC EFFICIENCY IS: 91.0903  
THE MIN. VOLUMETRIC EFFICIENCY IS: 90.3658  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 90.7836

THE MAX. MECHANICAL EFFICIENCY IS: 91.288  
THE MIN. MECHANICAL EFFICIENCY IS: 89.1516  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.1331



THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3367 RUN AT RATED PRESSURE AND SPEED

M33673H

TIME MIN	OUTLET TEMP (F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERALL EFF (%)	WQ EFF (%)	MCH EFF (%)
0.00	132.00	2499.27	1344.40	1867.00	21.27	88.25	88.97	90.24
5.00	137.20	2491.41	1340.40	1864.00	21.10	79.92	88.57	90.25
10.00	137.60	2499.55	1341.60	1814.00	21.20	88.05	88.50	90.44
15.00	135.30	2483.55	1339.00	1826.00	21.37	79.77	88.64	89.98
20.00	133.70	2509.21	1343.60	1833.00	21.48	88.48	88.77	90.65
25.00	133.30	2507.02	1348.00	1838.00	21.51	79.98	88.63	90.25
30.00	132.50	2480.67	1343.00	1842.00	21.59	79.61	88.77	89.66
35.00	131.00	2519.61	1340.40	1834.00	21.54	81.19	88.96	91.25
40.00	131.50	2515.61	1346.40	1827.00	21.42	88.54	88.79	90.20
45.00	132.30	2514.00	1348.40	1819.00	21.32	88.37	88.78	90.51
50.00	132.50	2507.27	1343.00	1812.00	21.19	88.29	88.58	90.62
55.00	131.90	2510.24	1340.20	1816.00	21.28	88.20	88.74	90.92
60.00	131.20	2523.42	1350.00	1826.00	21.39	88.52	88.73	90.73
65.00	131.40	2508.15	1356.60	1832.00	21.50	79.77	88.87	89.25
70.00	132.70	2521.57	1351.20	1836.00	21.55	88.53	88.88	90.59
75.00	132.90	2520.61	1347.00	1840.00	21.55	88.60	88.72	90.64
80.00	132.10	2518.00	1353.00	1841.00	21.60	88.31	88.65	90.37
85.00	131.50	2511.09	1345.60	1832.00	21.48	88.47	88.81	90.59
90.00	131.20	2518.54	1344.20	1824.00	21.38	88.26	88.78	90.95
95.00	132.50	2513.97	1343.20	1816.00	21.26	88.57	88.66	90.65
100.00	132.20	2522.69	1351.60	1814.00	21.22	88.28	88.59	90.60
105.00	131.20	2523.34	1352.40	1825.00	21.37	88.33	88.67	90.57
110.00	131.00	2525.97	1354.40	1831.00	21.44	88.31	88.69	90.53
115.00	131.00	2522.20	1366.40	1837.00	21.48	79.68	88.54	89.98
120.00	132.20	2528.73	1359.40	1839.00	21.55	88.15	88.25	90.30
125.00	132.20	2522.21	1358.20	1842.00	21.61	88.11	88.85	90.14
130.00	132.10	2538.57	1357.00	1838.00	21.50	88.45	88.58	90.81
135.00	131.30	2525.45	1360.00	1830.00	21.39	79.82	88.54	90.14
140.00	130.20	2534.02	1366.00	1819.00	21.29	79.81	88.64	90.62
145.00	131.20	2527.50	1363.20	1814.00	21.19	79.62	88.45	90.00
150.00	132.30	2529.21	1351.20	1818.00	21.28	88.56	88.64	90.68
155.00	132.10	2524.41	1356.00	1828.00	21.37	79.98	88.54	90.32
160.00	131.00	2535.10	1367.40	1833.00	21.44	79.25	88.60	90.00
165.00	131.60	2529.03	1364.00	1838.00	21.48	79.69	88.52	90.00
170.00	131.40	2527.00	1374.00	1839.00	21.53	79.14	88.66	89.25
175.00	131.30	2525.00	1377.00	1842.00	21.56	78.96	88.66	89.04
180.00	131.10	2533.69	1364.20	1836.00	21.42	79.67	88.36	90.16

THE AVERAGE FLOW IS: 21.4063 GPM  
 THE AVERAGE SPEED IS: 1828.16 RPM  
 THE AVERAGE TORQUE IS: 1352.85 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3367

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2517.86 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .366288 GPM  
MEASURED SPEED IS: 29.0759 RPM  
MEASURED TORQUE IS: 27.0294 IN-LB  
DIFFERENTIAL PRESSURE IS: 37.1092 PSID

THE MAX. OVERALL EFFICIENCY IS: 81.1872  
THE MIN. OVERALL EFFICIENCY IS: 78.9624  
THE AVERAGE OVERALL EFFICIENCY IS: 80.1346

THE MAX. VOLUMETRIC EFFICIENCY IS: 88.9608  
THE MIN. VOLUMETRIC EFFICIENCY IS: 88.3565  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 88.6826

THE MAX. MECHANICAL EFFICIENCY IS: 91.2468  
THE MIN. MECHANICAL EFFICIENCY IS: 89.0426  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.3463

THREE HOUR PERFORMANCE TEST

PUMP NUMBER M3368 RUN AT RATED PRESSURE AND SPEED

M33683H

TIME MIN	OUTLET TEMP(F)	DIFF PRESS PSID	TORQUE IN-LB	SPEED RPM	FLOW GPM	OVERSII EFF(%)	UCI EFF (%)	MECH EFF (%)
0.00	128.20	2477.44	1337.00	1801.00	20.61	77.95	86.65	89.95
4.98	127.50	2500.78	1343.20	1806.00	20.59	78.06	86.36	90.38
9.98	127.50	2500.45	1326.00	1805.00	20.61	79.15	86.46	91.54
14.98	127.70	2500.41	1349.80	1803.00	20.57	77.71	86.41	89.99
20.00	128.00	2499.58	1346.00	1800.00	20.73	77.77	86.25	90.14
25.00	127.70	2495.09	1331.60	1821.00	20.78	78.62	86.42	90.90
30.00	127.40	2498.91	1329.80	1822.00	20.75	78.68	86.24	91.22
35.02	127.10	2495.72	1328.40	1809.00	20.55	78.49	86.65	91.20
39.98	127.00	2496.64	1331.00	1802.00	20.47	78.35	86.04	91.05
44.98	126.90	2496.42	1328.00	1793.00	20.35	78.44	85.95	91.25
49.98	126.00	2494.62	1346.60	1795.00	20.36	77.26	85.96	89.93
55.00	127.10	2501.15	1353.20	1811.00	20.56	77.14	85.97	89.72
60.00	127.20	2498.56	1354.60	1818.00	20.62	76.92	85.90	89.54
65.00	127.10	2499.86	1335.00	1811.00	20.55	76.93	85.94	89.50
69.98	127.10	2498.80	1357.60	1806.00	20.45	76.63	85.75	89.35
74.98	127.10	2495.68	1335.00	1798.00	20.35	77.76	85.73	90.69
79.98	127.40	2502.34	1344.40	1802.00	20.37	77.38	85.63	90.35
84.98	127.00	2498.41	1341.20	1812.00	20.51	77.33	85.50	90.43
90.00	128.20	2495.37	1335.40	1828.00	20.62	76.37	85.45	89.37
95.00	128.30	2496.11	1349.00	1826.00	20.55	76.55	85.22	89.02
100.00	127.90	2497.52	1351.40	1819.00	20.41	76.24	84.92	89.21
104.98	127.50	2501.73	1351.00	1814.00	20.30	76.18	84.24	89.69
109.98	127.00	2496.67	1354.20	1804.00	20.18	75.84	84.23	89.49
114.98	127.10	2500.33	1338.20	1816.00	20.34	75.82	84.83	89.36
120.00	127.40	2501.56	1344.40	1830.00	20.51	76.69	84.89	90.22
125.00	127.90	2494.19	1336.00	1813.00	20.30	75.74	84.82	89.29
130.00	128.10	2495.64	1348.00	1808.00	20.22	76.13	84.69	89.82
139.98	127.10	2497.51	1344.80	1811.00	20.36	76.78	85.16	90.15
145.00	127.50	2501.22	1338.40	1815.00	20.43	77.33	85.24	90.22
150.00	127.00	2497.11	1340.40	1828.00	20.62	77.26	85.42	89.43
155.00	127.90	2494.51	1331.00	1818.00	20.49	76.49	85.32	89.56
159.98	127.60	2494.46	1341.00	1811.00	20.32	76.88	85.18	90.24
164.98	127.10	2497.41	1342.80	1804.00	20.31	76.20	85.26	89.95
169.98	127.10	2497.13	1332.60	1799.00	20.26	77.30	85.29	90.62
175.00	127.10	2497.82	1340.00	1792.00	20.23	77.14	85.24	90.48
180.00	127.20	2499.31	1354.60	1810.00	20.39	76.44	85.33	89.56

THE AVERAGE FLOW IS: 20.4623 GPM  
 THE AVERAGE SPEED IS: 1810.86 RPM  
 THE AVERAGE TORQUE IS: 1344.58 IN-LB

THREE HOUR PERFORMANCE TEST  
CONTINUATION FOR PUMP M3368

THE AVERAGE DIFFERENTIAL PRESSURE IS: 2497.4 PSID

THE STANDARD DEVIATION OF THE:

MEASURED FLOW IS: .408016 GPM  
MEASURED SPEED IS: 25.8082 RPM  
MEASURED TORQUE IS: 24.6787 IN-LB  
DIFFERENTIAL PRESSURE IS: 10.9957 PSID

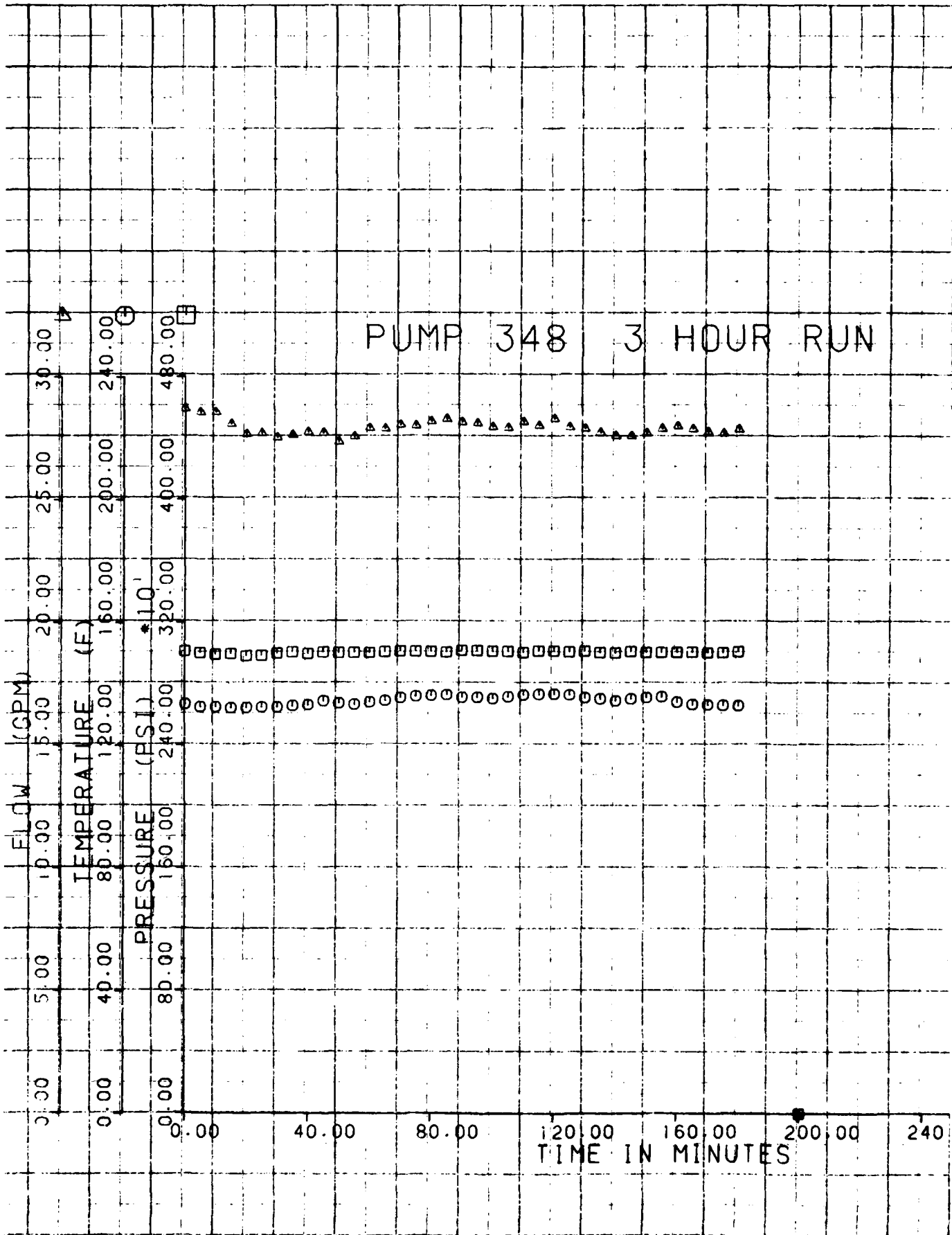
THE MAX. OVERALL EFFICIENCY IS: 79.1539  
THE MIN. OVERALL EFFICIENCY IS: 75.7416  
THE AVERAGE OVERALL EFFICIENCY IS: 77.1799

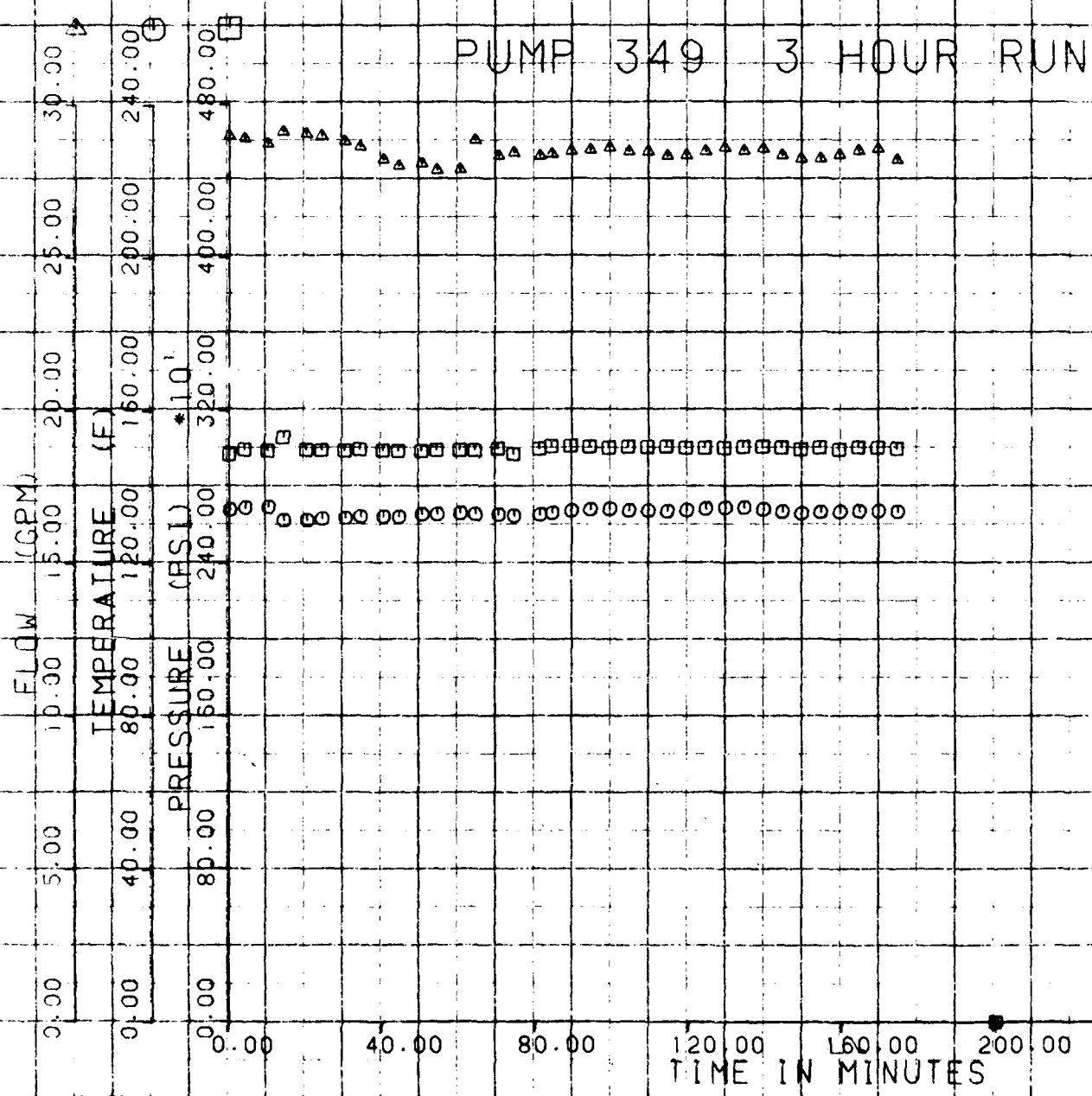
THE MAX. VOLUMETRIC EFFICIENCY IS: 86.6505  
THE MIN. VOLUMETRIC EFFICIENCY IS: 84.6939  
THE AVERAGE VOLUMETRIC EFFICIENCY IS: 85.5823

THE MAX. MECHANICAL EFFICIENCY IS: 91.5364  
THE MIN. MECHANICAL EFFICIENCY IS: 89.2871  
THE AVERAGE MECHANICAL EFFICIENCY IS: 90.1656

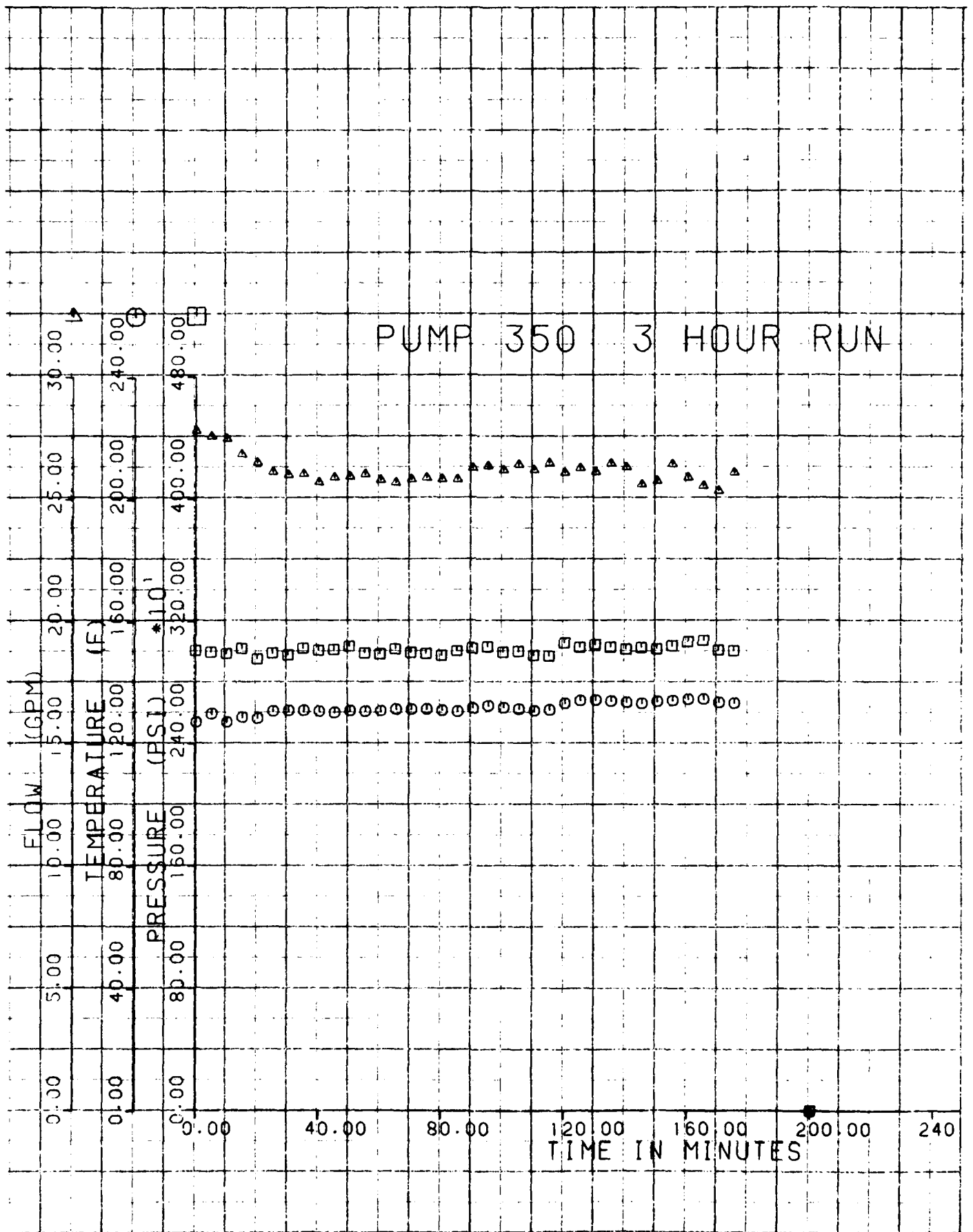
APPENDIX H  
THREE HOUR RUN GRAPHICAL DATA

# PUMP 348 3 HOUR RUN



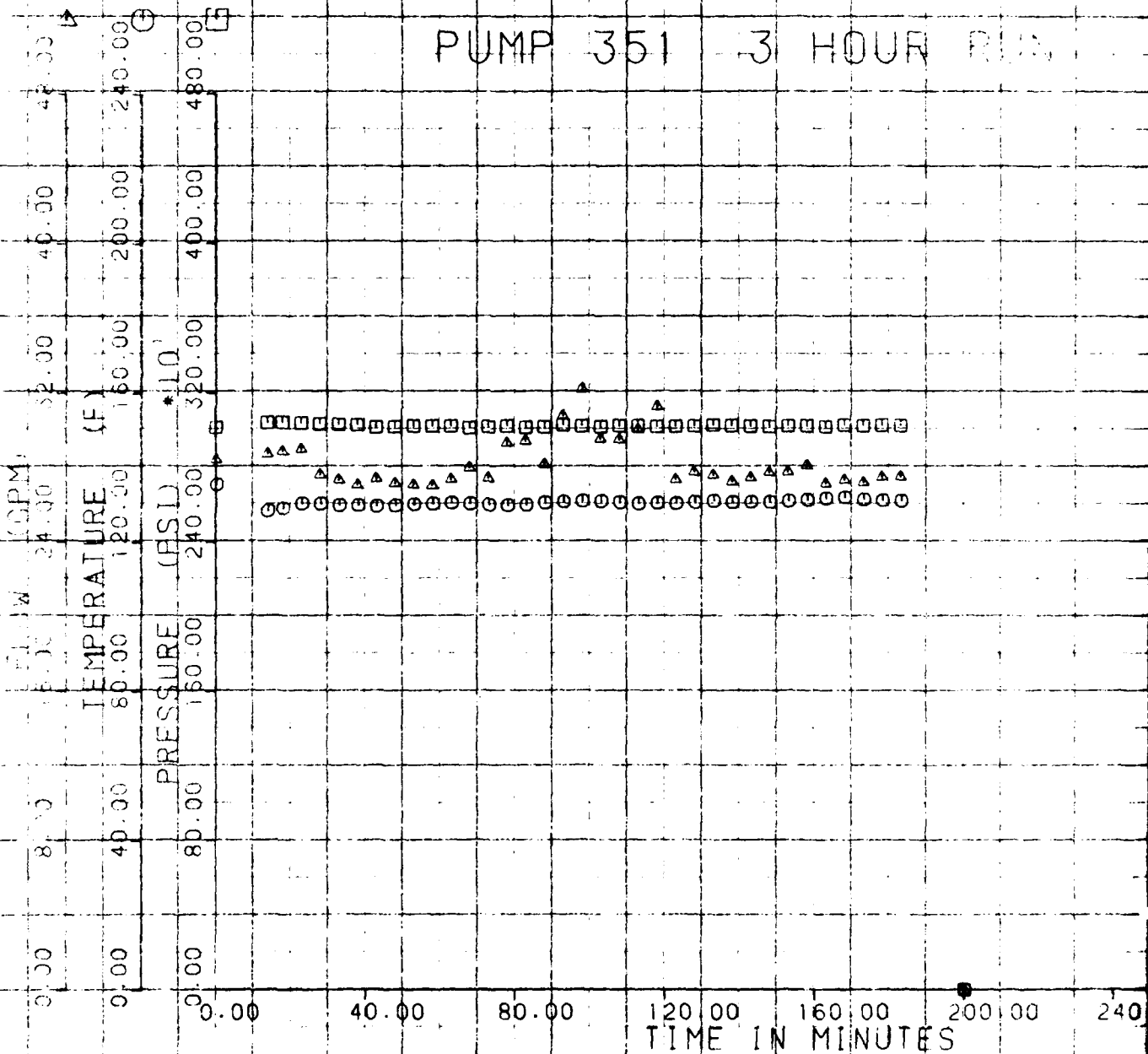


# PUMP 350 3 HOUR RUN

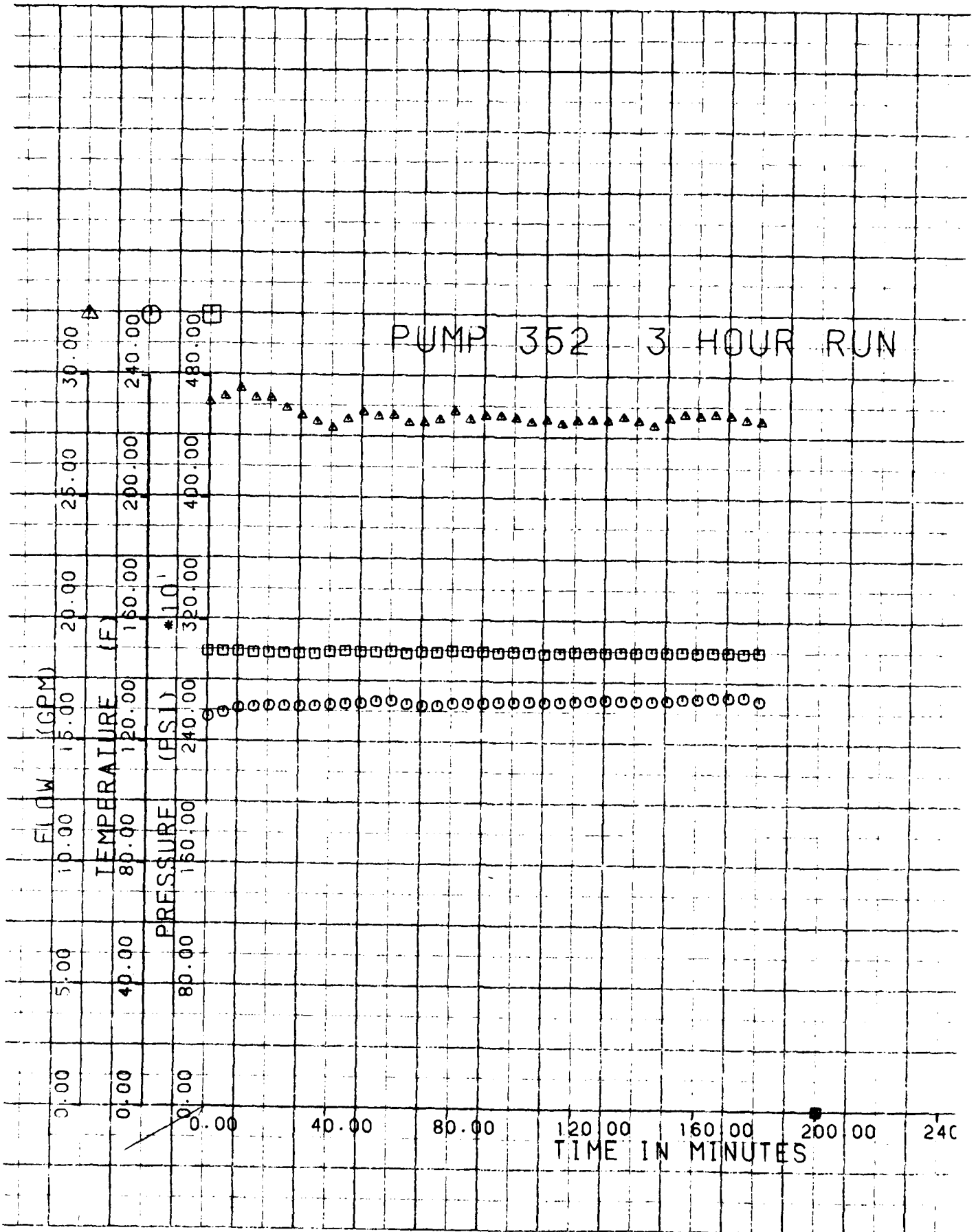




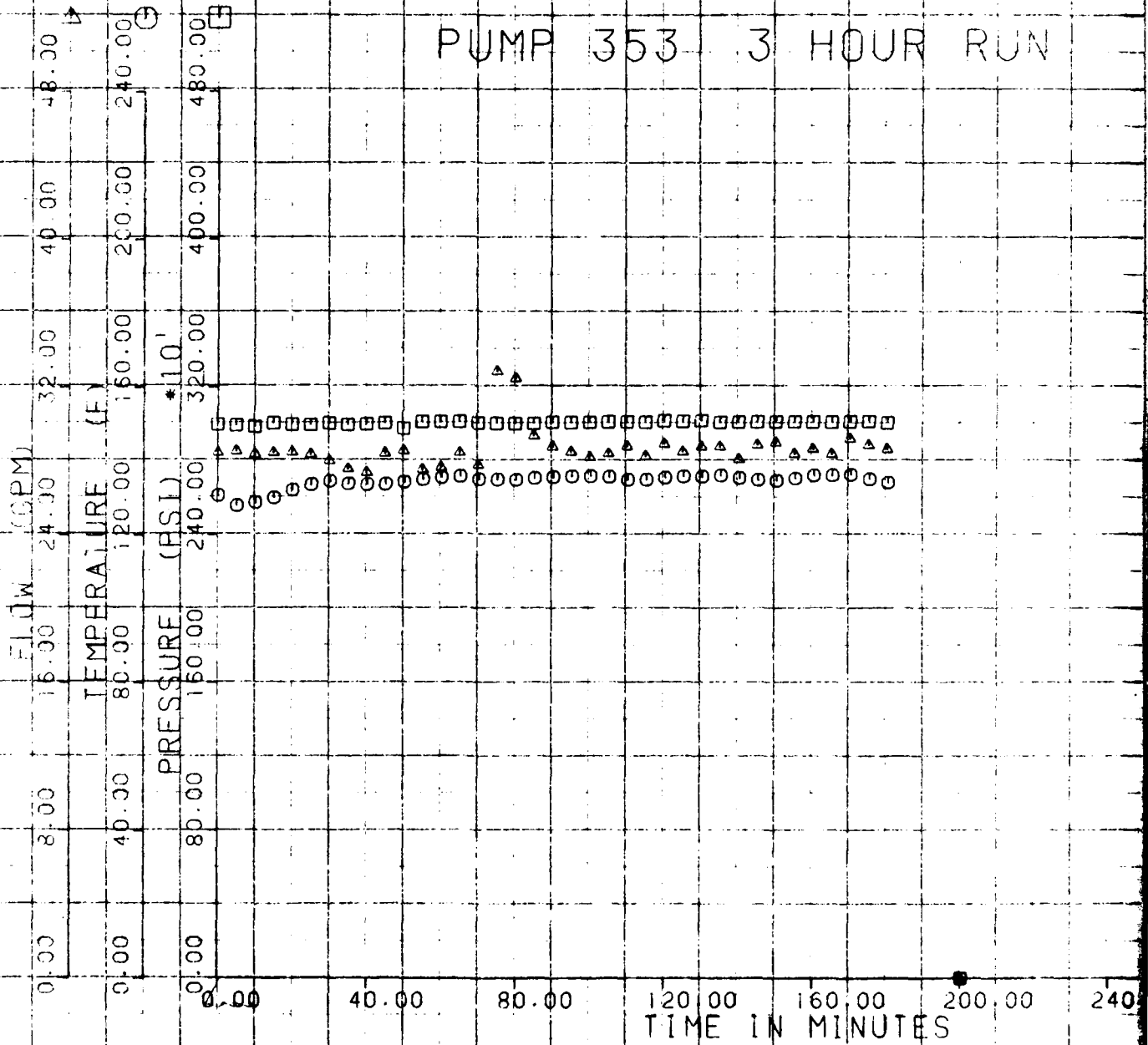
# PUMP 351 3 HOUR RUN



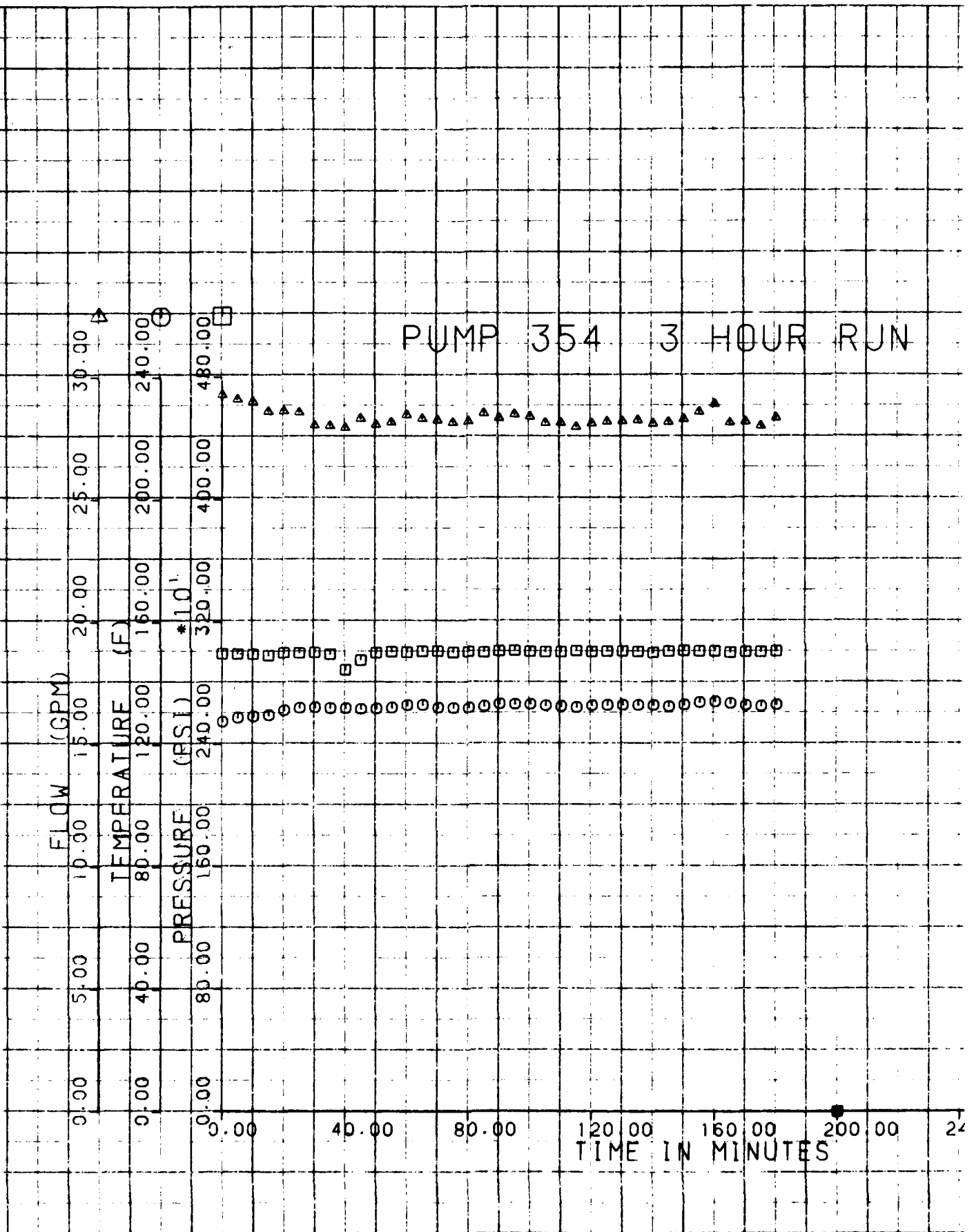
# PUMP 352 3 HOUR RUN



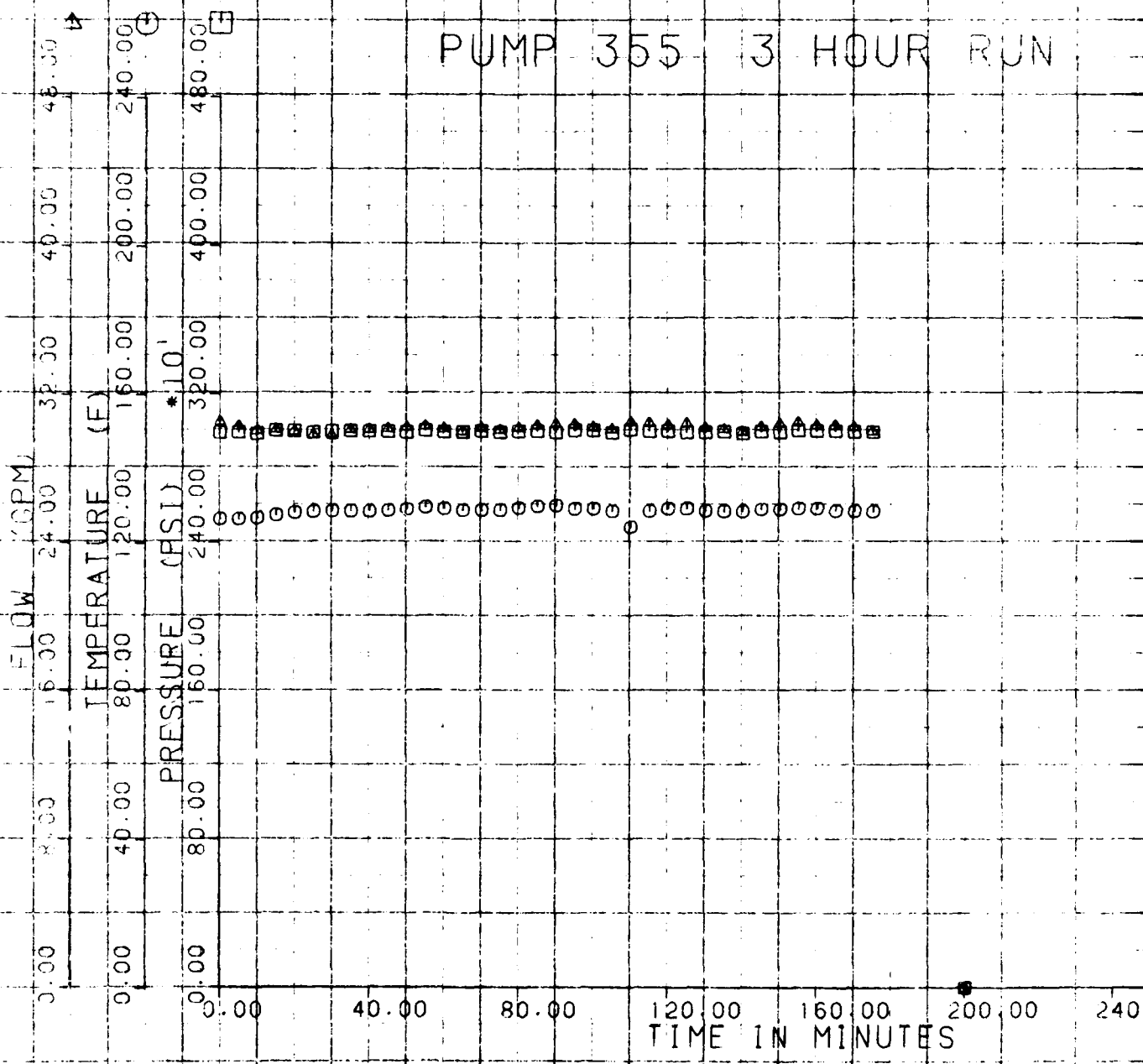
# PUMP 353 3 HOUR RUN



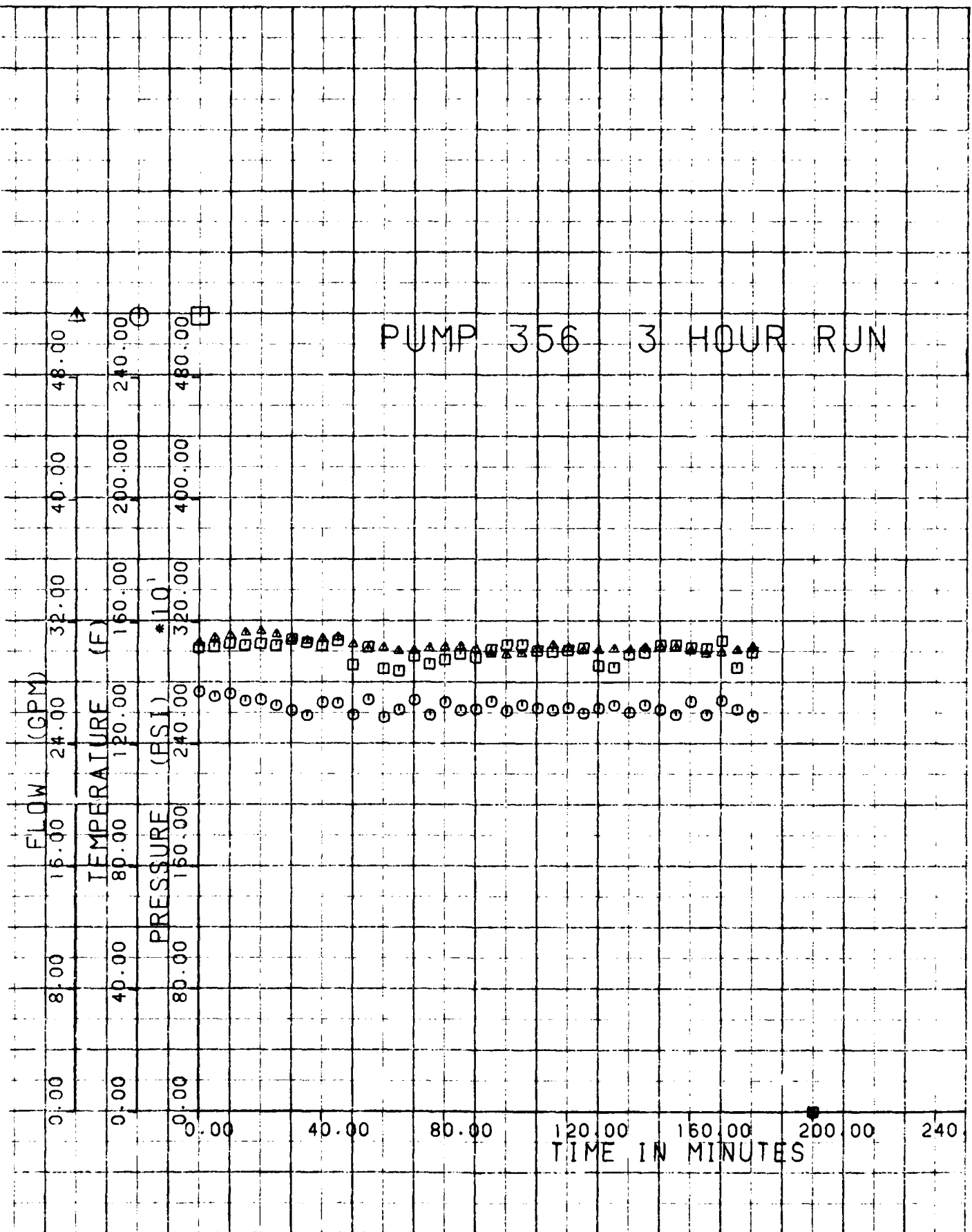
# PUMP 354 3 HOUR RUN



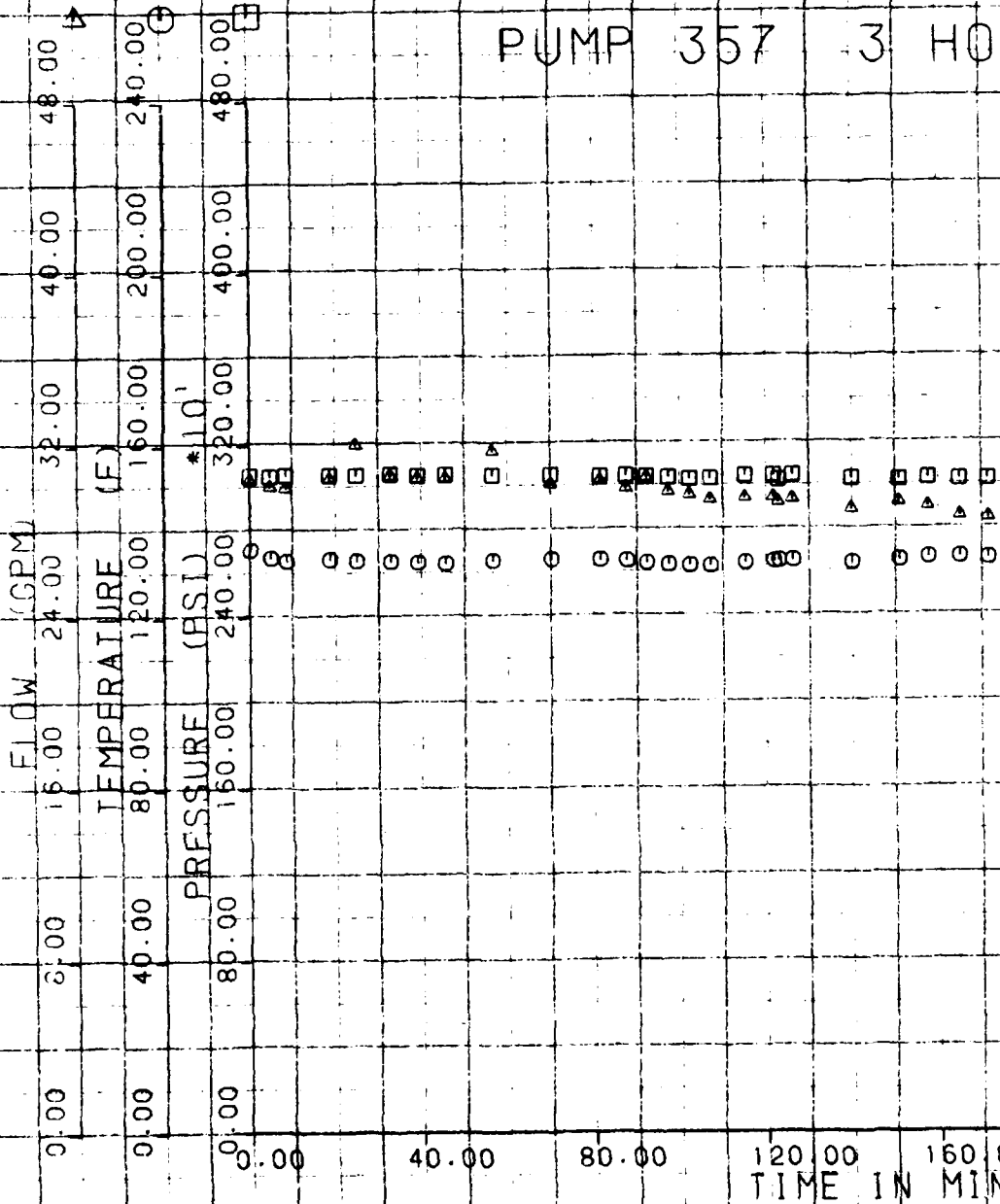
# PUMP 355 3 HOUR RUN



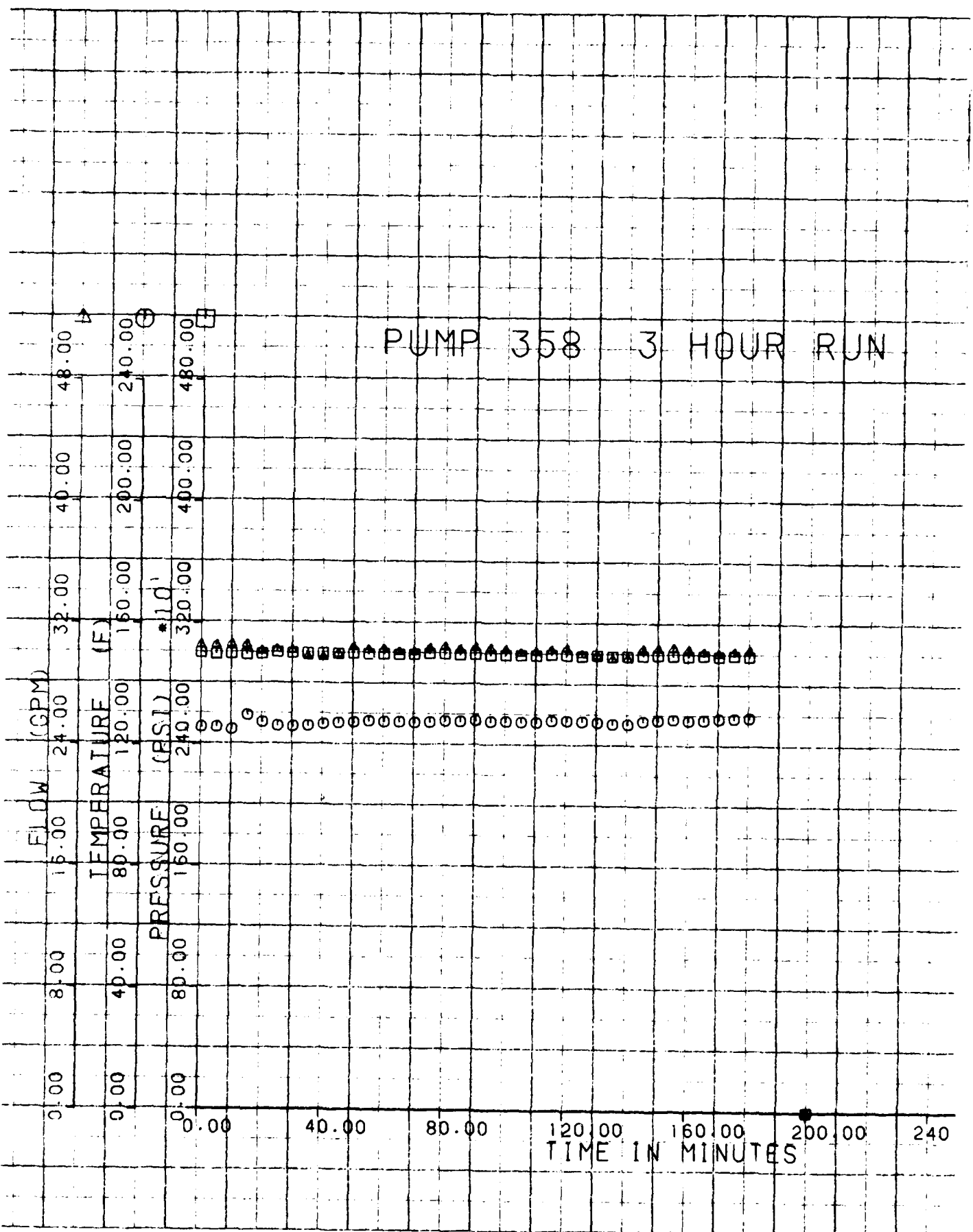
# PUMP 356 3 HOUR RUN



# PUMP 357 3 HOUR RUN

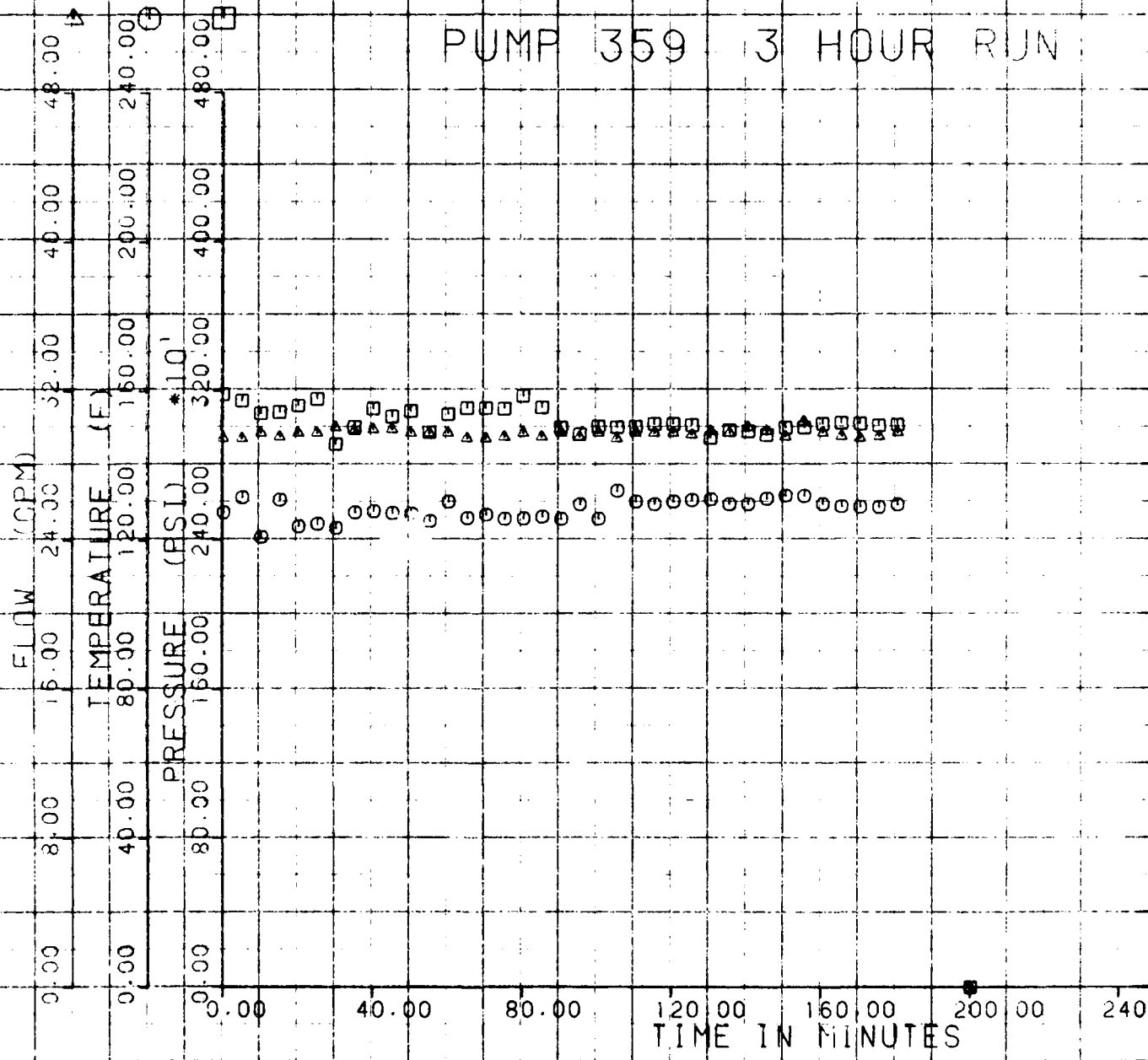


# PUMP 358 3 HOUR RUN

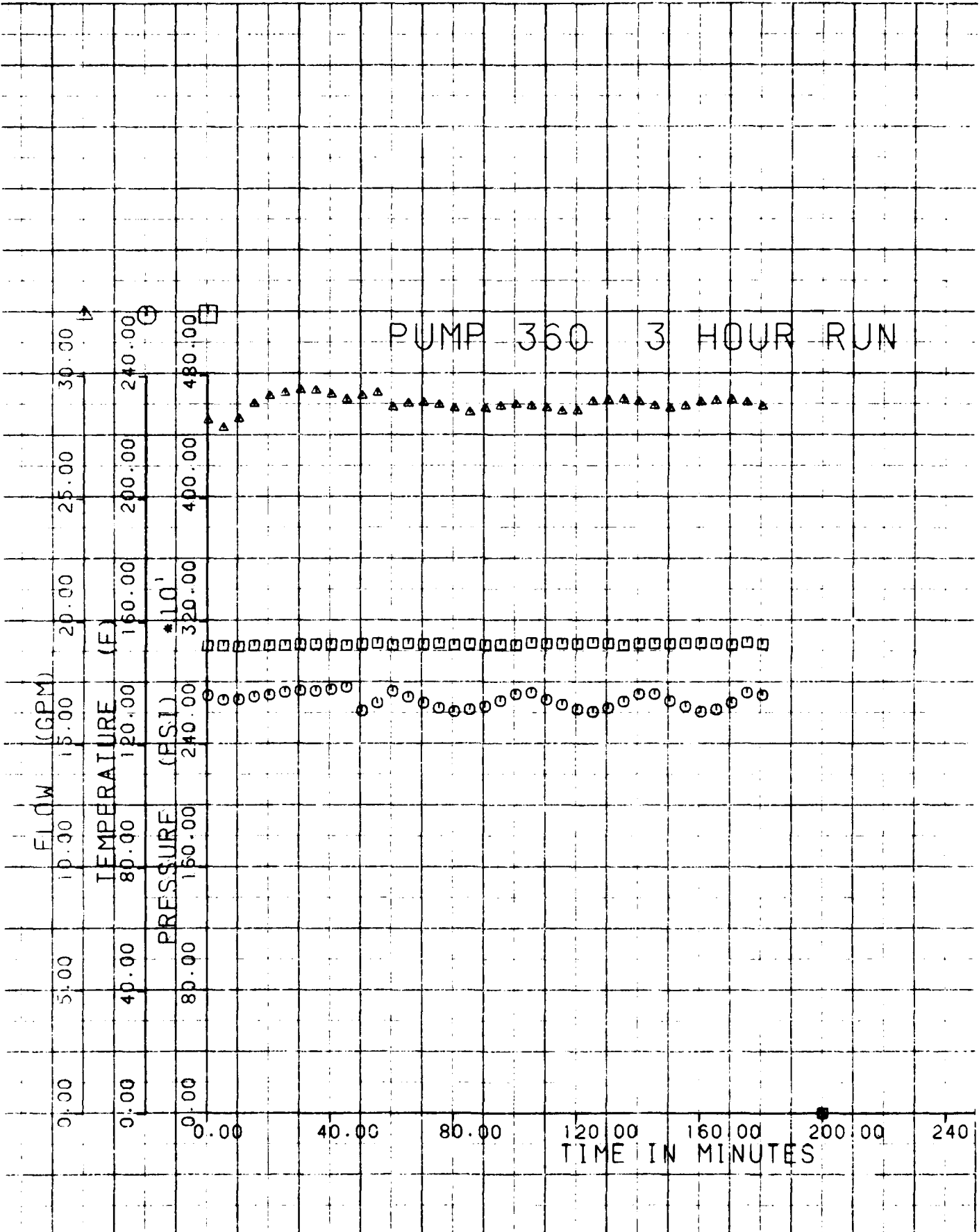




PUMP 359 3 HOUR RUN



# PUMP 360 3 HOUR RUN



AD-A117 962

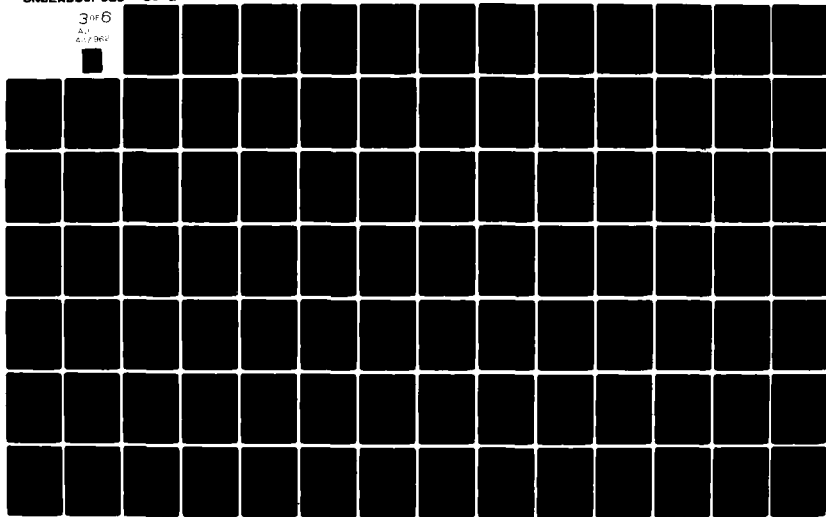
MILWAUKEE SCHOOL OF ENGINEERING WI FLUID POWER INST F/0 13/11  
BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
JUL 82 DAAK70-81-C-0002

UNCLASSIFIED 50423

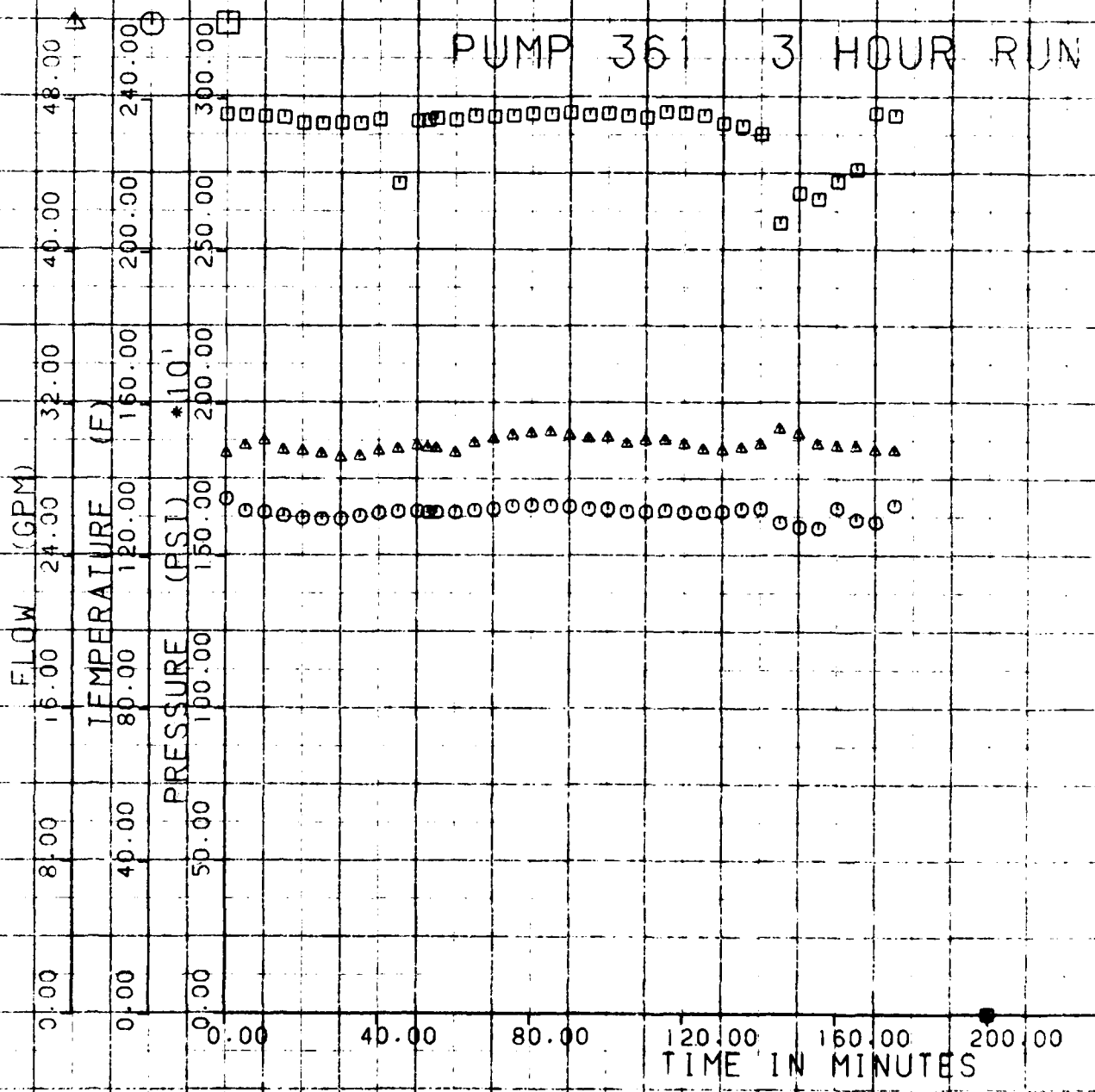
NL

3 of 6

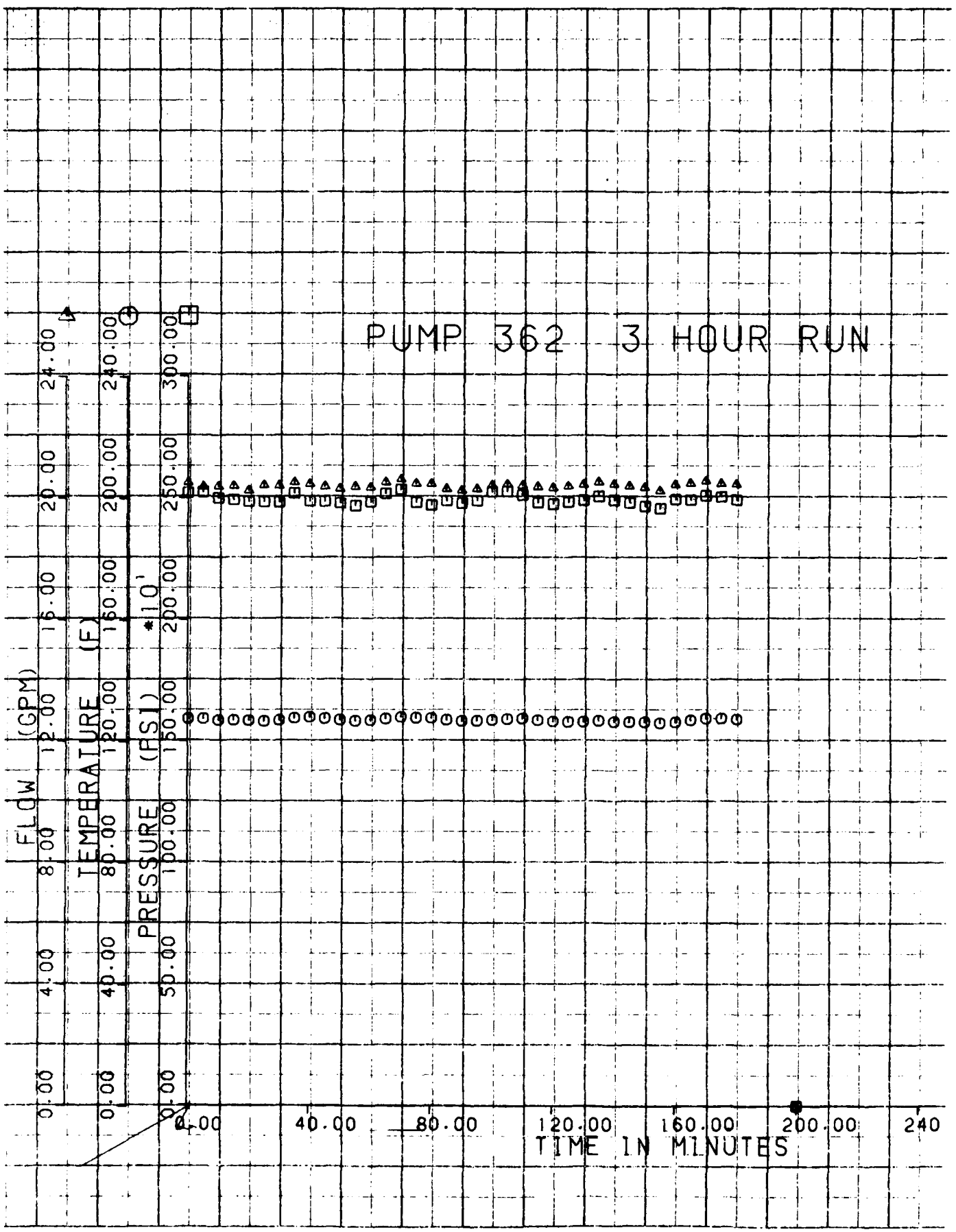
AD  
4/7/80



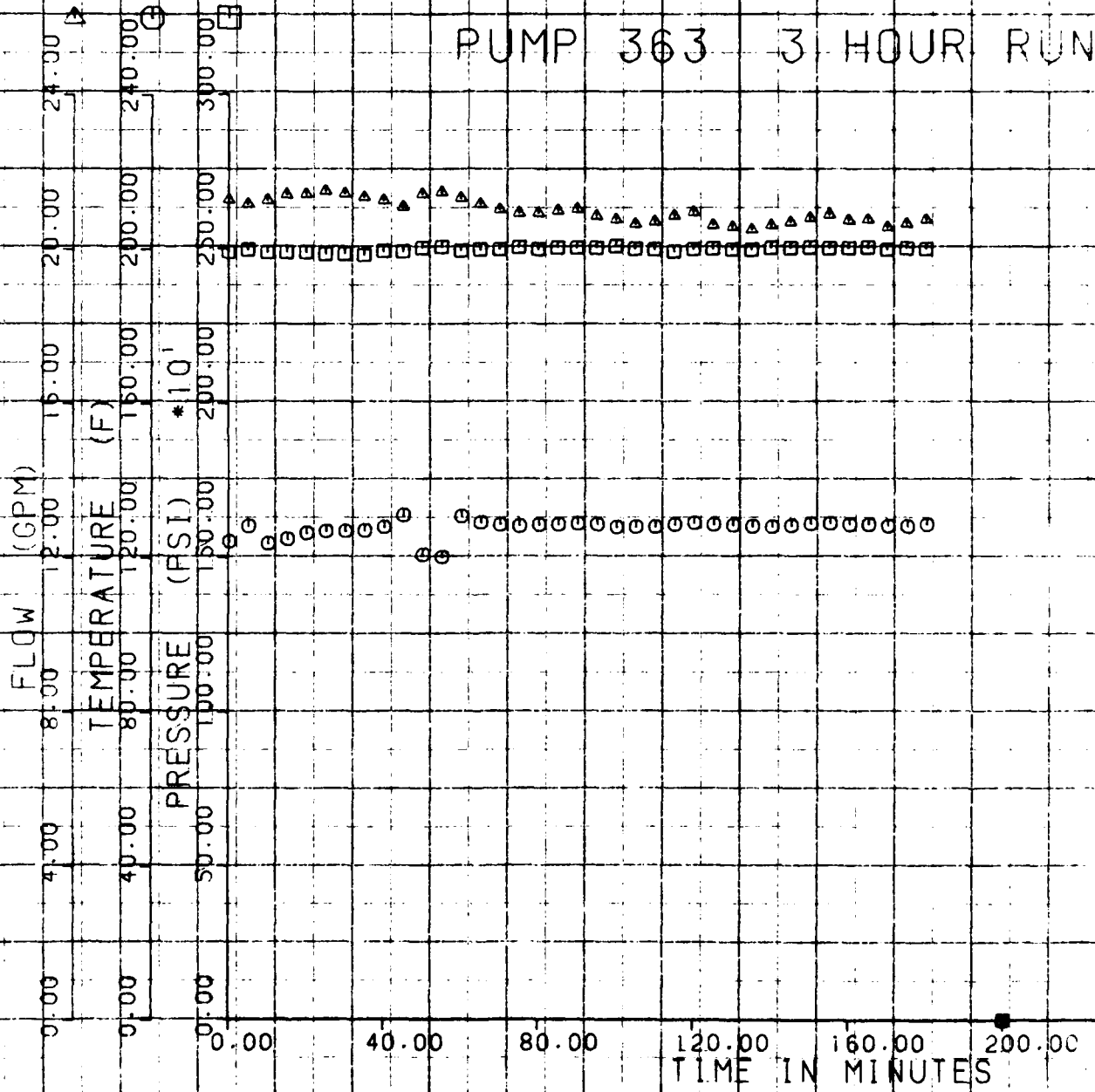
# PUMP 361 3 HOUR RUN



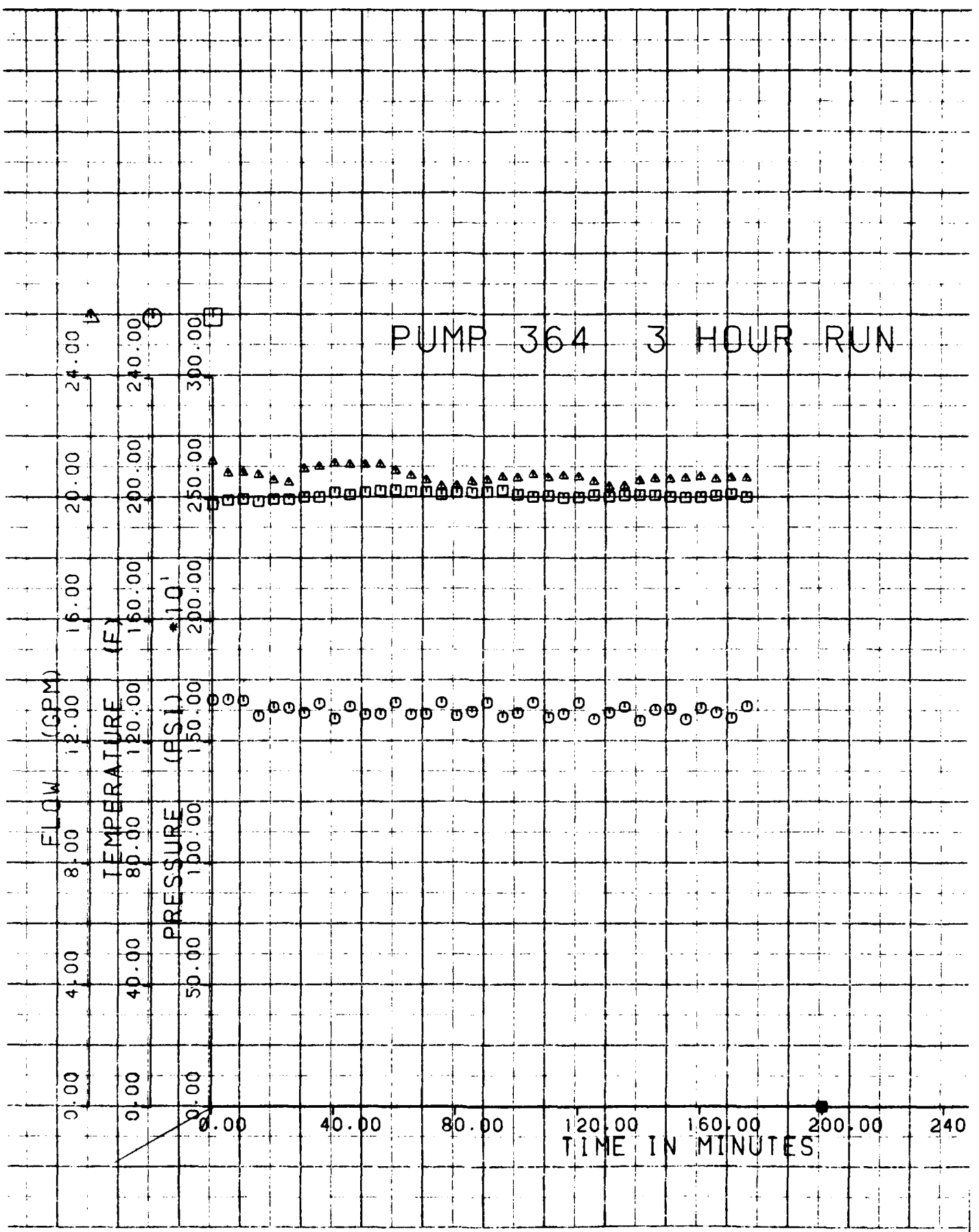
# PUMP 362 3 HOUR RUN



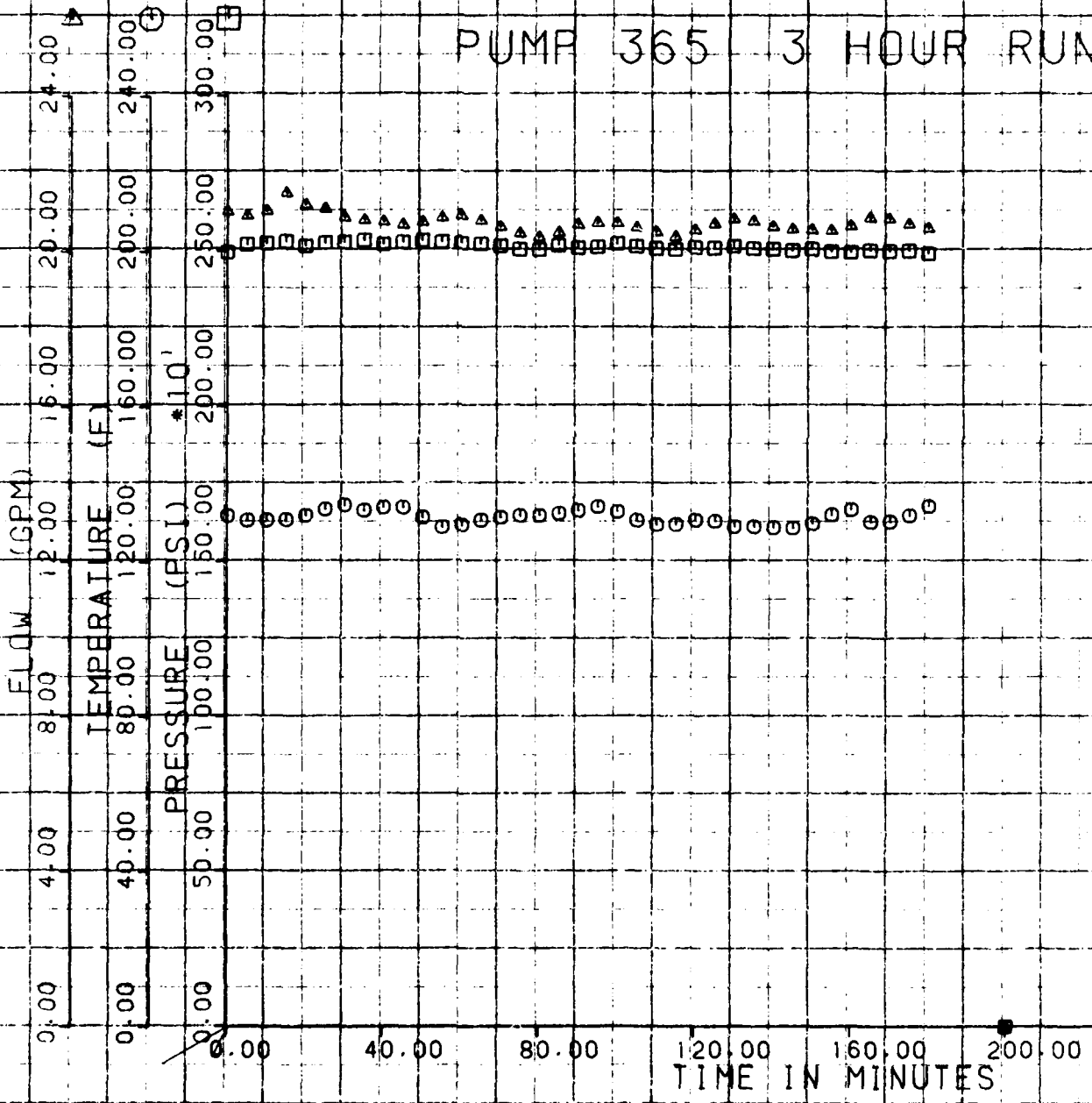
# PUMP 363 3 HOUR RUN



# PUMP 364 3 HOUR RUN

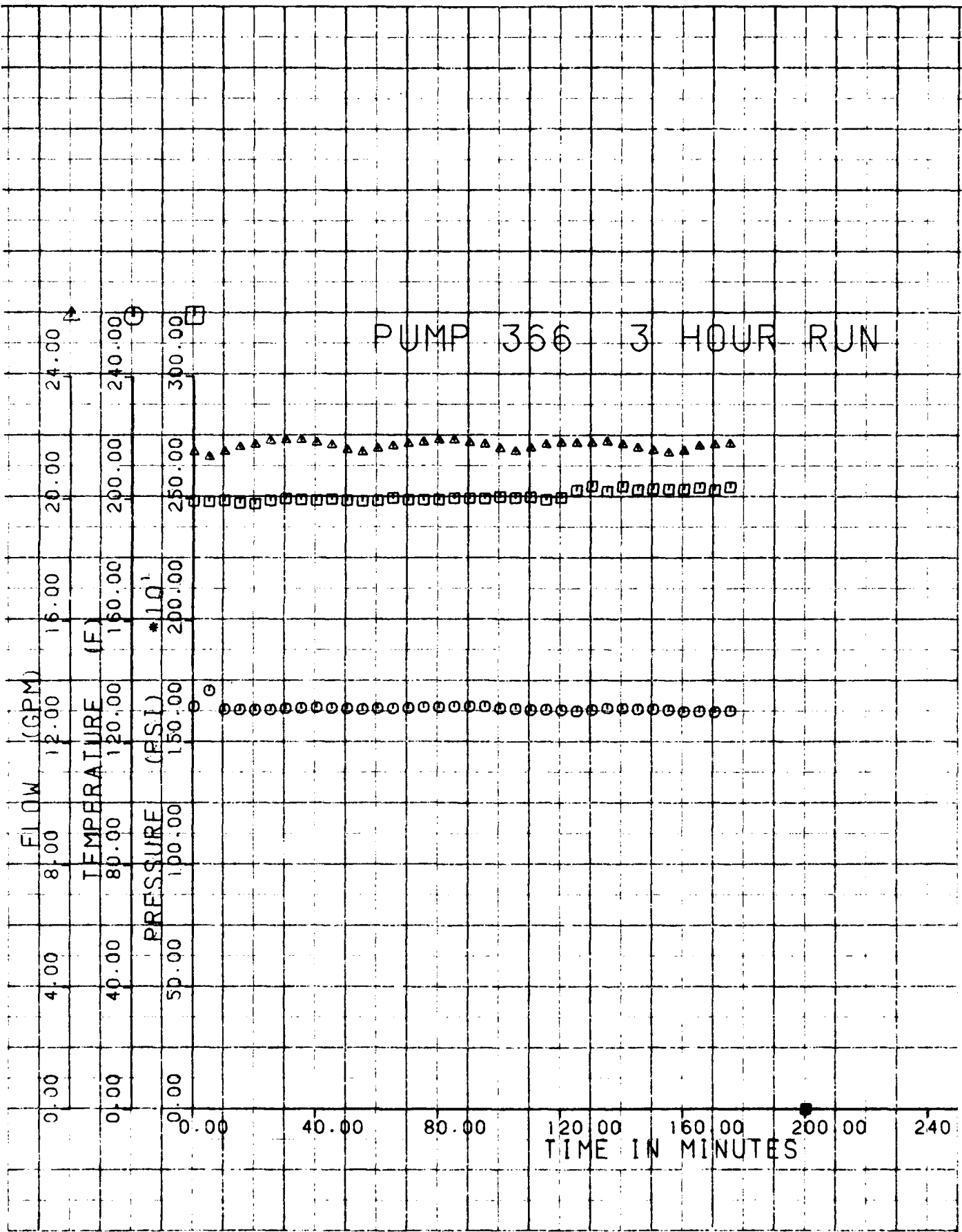


# PUMP 365 3 HOUR RUN

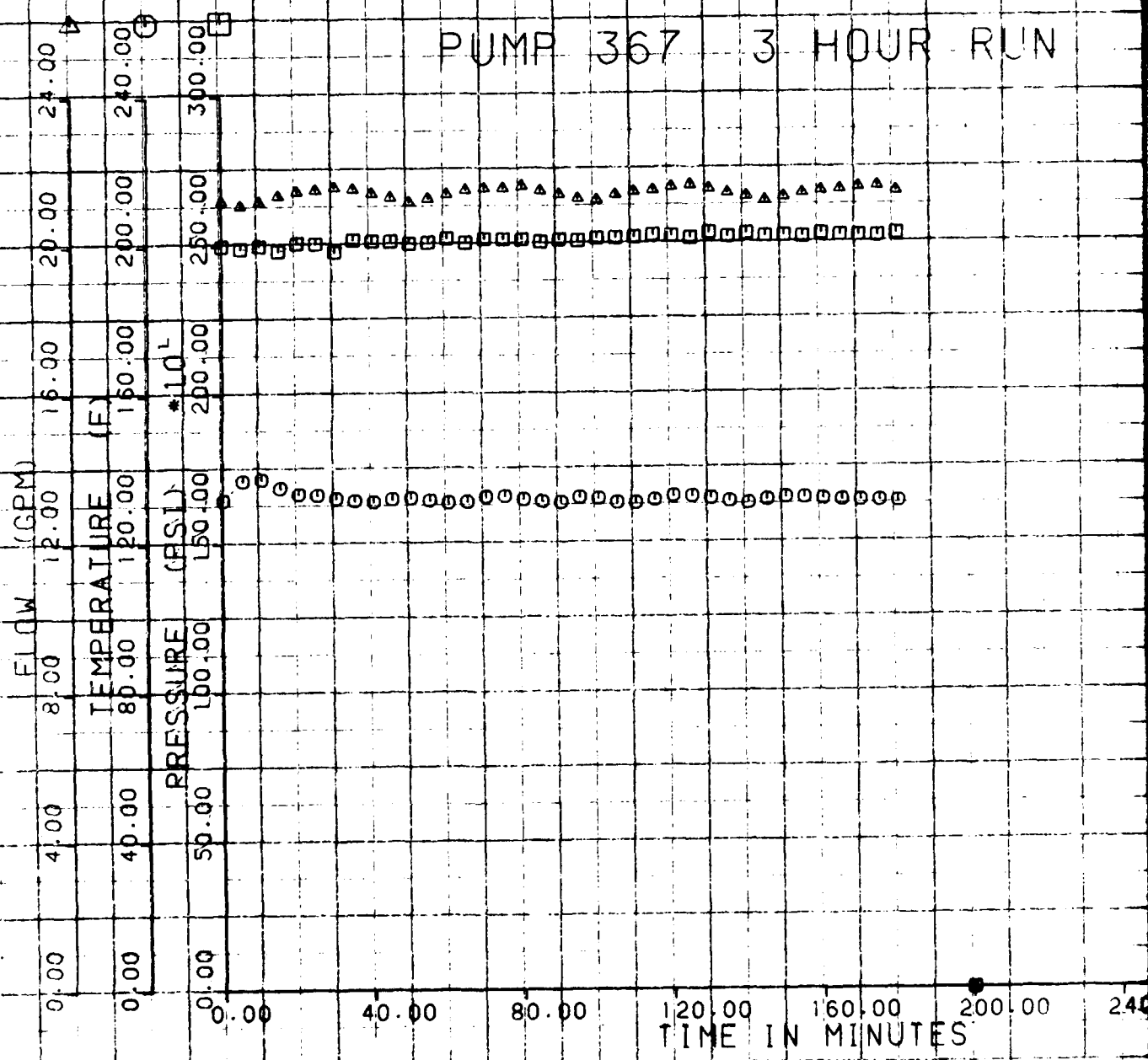




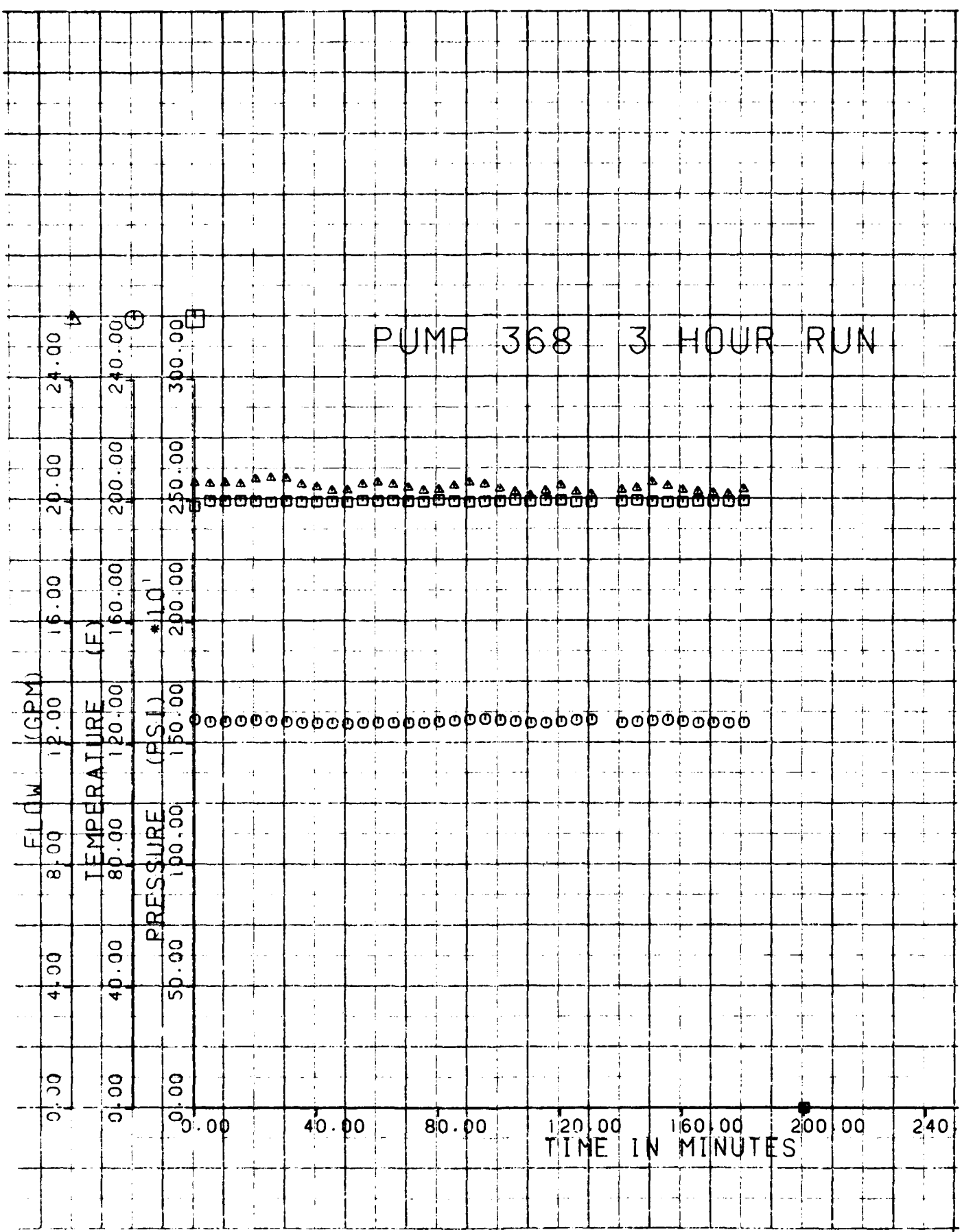
# PUMP 366 3 HOUR RUN



# PUMP 367 3 HOUR RUN



# PUMP 368 3 HOUR RUN



APPENDIX I  
POWER CONVERSION TEST DATA

POWER CONVERSION TEST  
PUMP NUMBER M13482 RUN AT 120 DEGREES (F) INLET TEMP.

M13482

OUTLET TEMP (F)	TRK. SPEED RPM	ADJ FLOW GPM	TRK PRESS. PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS ind3/rev
175.30	2700.00	28.90	3000.00	1456.75	58.33	62.41	80.65	90.83	89.77	2.47
172.00	2700.00	29.43	2400.00	1175.48	48.97	50.36	81.36	97.49	88.45	2.50
172.10	2700.00	29.93	1800.00	898.76	31.53	38.58	81.88	94.08	86.77	2.56
176.50	2700.00	30.75	1200.00	633.94	21.49	27.16	79.17	96.64	82.01	2.63
173.40	2700.00	31.29	600.00	358.38	10.90	15.01	72.60	98.35	74.19	2.68
171.00	2700.00	31.82	200.00	141.16	5.33	6.85	88.12	100.00	61.38	2.72
178.60	2160.00	22.38	3000.00	1449.83	39.04	49.66	78.61	87.92	89.69	2.39
170.70	2160.00	22.84	2400.00	1164.12	31.89	39.90	79.93	89.75	89.32	2.44
176.50	2160.00	23.33	1800.00	898.98	24.38	30.54	79.58	91.67	87.52	2.50
172.90	2160.00	24.83	1200.00	611.10	16.62	20.94	79.33	94.48	85.87	2.57
175.90	2160.00	24.46	600.00	333.85	8.42	11.44	73.62	96.18	77.86	2.62
172.10	2160.00	25.85	200.00	132.11	3.34	4.70	71.13	98.41	63.19	2.68
178.70	1620.00	15.94	3000.00	1448.84	27.77	32.24	74.56	83.48	89.21	2.27
171.10	1620.00	16.31	2400.00	1156.41	22.69	29.22	76.33	85.45	89.91	2.33
179.90	1620.00	16.67	1800.00	882.92	12.33	22.20	76.38	82.33	88.32	2.38
174.40	1620.00	17.39	1200.00	602.96	12.19	15.50	78.68	91.11	86.22	2.48
174.50	1620.00	17.86	600.00	321.66	6.13	8.27	74.16	93.57	80.81	2.55
175.40	1620.00	18.38	200.00	134.82	1.98	3.47	57.11	96.29	64.22	2.62
172.80	1080.00	9.72	3000.00	1441.30	16.96	24.20	68.68	76.41	90.18	2.08
170.20	1080.00	9.90	2400.00	1164.25	13.94	19.95	69.88	78.41	89.31	2.13
178.30	1080.00	10.38	1800.00	879.32	10.83	15.82	71.84	81.58	88.68	2.22
175.90	1080.00	10.85	1200.00	608.82	7.49	10.38	72.20	85.23	86.53	2.32
172.40	1080.00	11.15	600.00	311.43	3.88	5.34	72.68	82.58	83.42	2.38
117.60	1080.00	11.75	200.00	121.40	1.35	2.08	64.82	92.33	71.32	2.51
141.30	750.00	5.72	3000.00	1457.91	10.83	17.35	57.81	64.69	89.15	1.76
170.90	750.00	6.51	2400.00	1158.30	9.10	13.88	65.95	73.65	89.69	2.00
179.30	750.00	6.53	1800.00	882.83	6.88	10.51	64.22	73.93	88.33	2.01
178.90	750.00	6.92	1200.00	585.11	4.29	7.88	62.65	78.82	82.36	2.15
175.20	750.00	7.52	600.00	299.30	2.61	3.56	73.22	85.86	86.85	2.32
150.20	750.00	8.86	200.00	116.53	0.92	1.39	66.82	91.23	74.35	2.48

THE MAX. OVER ALL EFFICIENCY IS: 88.117  
THE MIN. OVER ALL EFFICIENCY IS: 57.1096  
THE MAX. SIMPLE DISPLACEMENT IS: 2.72208

POWER CONVERSION TEST  
PUMP NUMBER M13481 RUN AT 120 DEGREES (F) INLET TEMP.

M13481

OUTLET TEMP (F)	TOR. SPEED RPM	ADJ FLOW GPM	TOR PRESS. PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS IN/3700
195.30	2700.00	27.17	3000.00	1442.40	47.22	61.79	76.41	77.24	99.63	2.32
195.90	2700.00	27.77	2400.00	1161.04	38.81	49.74	78.02	78.95	99.02	2.38
186.60	2700.00	28.56	1800.00	887.75	29.88	38.03	78.58	81.28	97.12	2.44
183.00	2700.00	29.92	1200.00	617.40	20.73	26.45	78.36	85.04	93.10	2.56
180.60	2700.00	30.78	600.00	332.66	10.63	14.25	74.58	87.49	86.39	2.63
181.20	2700.00	31.71	200.00	135.12	4.70	5.79	81.27	90.13	70.90	2.71
195.60	2160.00	20.47	3000.00	1430.12	35.60	49.81	72.64	72.74	100.48	2.19
193.10	2160.00	20.90	2400.00	1157.60	28.99	39.67	73.07	74.25	99.31	2.23
181.90	2160.00	21.78	1800.00	880.64	22.91	30.18	75.91	77.09	97.91	2.32
182.00	2160.00	22.96	1200.00	604.30	15.94	20.71	76.97	81.60	95.12	2.46
187.90	2160.00	23.79	600.00	322.97	8.18	11.07	73.92	84.52	99	2.54
183.00	2160.00	24.86	200.00	129.02	2.95	4.42	66.71	88.34	75	2.66
193.80	1620.00	14.23	3000.00	1444.02	24.77	32.12	66.74	67.43	71	2.03
186.00	1620.00	14.78	2400.00	1155.33	20.69	29.20	69.68	70.00	70	2.11
188.00	1620.00	15.30	1800.00	881.35	15.82	22.65	70.05	72.48	77	2.18
186.20	1620.00	16.19	1200.00	594.19	11.29	15.22	73.09	76.21	77	2.31
183.20	1620.00	17.11	600.00	307.22	5.91	7.91	74.69	81.05	77	2.44
177.10	1620.00	18.12	200.00	122.39	1.92	3.15	62.47	85.83	78.22	2.50
201.60	1080.00	7.65	3000.00	1460.20	13.63	25.03	54.46	55.25	90.30	1.68
192.20	1080.00	8.43	2400.00	1150.88	11.28	19.88	59.22	59.88	99.11	1.80
191.20	1080.00	8.95	1800.00	878.55	9.38	15.06	62.28	63.64	90.14	1.92
188.00	1080.00	9.69	1200.00	599.20	6.22	10.22	65.42	68.85	95.93	2.02
182.90	1080.00	10.20	600.00	302.20	3.24	5.10	72.12	76.06	95.00	2.29
180.90	1080.00	11.60	200.00	114.54	1.25	1.96	63.93	82.44	83.64	2.40
213.60	675.00	3.94	3000.00	1463.93	6.90	15.68	44.02	44.29	90.16	1.35
199.00	675.00	4.52	2400.00	1174.18	6.31	12.58	50.14	51.39	92.91	1.55
193.60	675.00	4.91	1800.00	886.95	5.11	9.50	53.28	55.04	92.21	1.68
188.50	675.00	7.51	1200.00	602.22	5.24	6.50	80.58	85.44	94.65	2.52
180.60	675.00	7.99	600.00	303.94	2.28	3.26	85.22	90.80	94.56	2.23
194.10	675.00	8.29	200.00	100.21	0.95	1.16	81.88	100.00	88.12	3.01

THE MAX. OVER ALL EFFICIENCY IS: 85.2728  
THE MIN. OVER ALL EFFICIENCY IS: 44.0153  
THE MAX. SIMPLE DISPLACEMENT IS: 3.00966

POWER CONVERSION TEST  
PUMP NUMBER M13492 RUN AT 120 DEGREES (F) INLET TEMP.

M13492

INLET TEMP (F)	THR. SPEED RPM	ADJ FLOW GPM	THR PRESS PSID	ADJ TORR TH-1 RS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	WQ EFF (%)	MFCX EFF (%)	SIM DIS in3/rev
174.00	2700.00	29.23	3000.00	1448.37	50.97	62.05	82.15	91.01	90.60	2.50
178.00	2700.00	29.25	2400.00	1174.13	41.47	50.30	82.45	92.61	89.41	2.55
182.00	2700.00	30.37	1800.00	888.85	31.69	38.08	83.27	94.54	88.58	2.60
183.90	2700.00	31.05	1200.00	545.45	21.57	23.37	92.29	96.65	96.23	2.66
181.00	2700.00	31.65	600.00	321.62	11.05	13.28	88.16	98.54	81.60	2.71
178.90	2700.00	32.12	200.00	135.58	5.47	5.81	94.14	100.00	64.52	2.75
128.00	2100.00	22.01	3000.00	1459.05	39.75	50.01	79.49	88.77	89.93	2.44
130.00	2100.00	23.24	2400.00	1162.20	32.41	38.85	81.34	90.43	90.29	2.49
130.50	2100.00	23.73	1800.00	891.97	24.00	30.57	81.13	92.33	88.27	2.54
121.20	2100.00	24.38	1200.00	611.82	16.87	20.97	80.47	94.87	85.29	2.61
117.00	2100.00	24.95	600.00	334.33	8.46	11.46	73.81	97.08	78.58	2.67
117.40	2100.00	25.22	200.00	138.08	3.47	4.73	73.34	98.54	63.36	2.71
126.00	1600.00	16.26	3000.00	1435.95	28.28	36.91	76.62	84.37	91.38	2.32
128.20	1600.00	16.60	2400.00	1158.86	23.11	29.29	77.59	86.11	90.58	2.37
128.60	1600.00	17.00	1800.00	881.45	17.61	22.66	77.27	88.19	89.32	2.42
124.00	1600.00	17.61	1200.00	601.74	12.26	15.47	79.27	91.35	82.23	2.51
120.50	1600.00	18.14	600.00	317.05	6.30	8.15	77.31	94.11	82.27	2.59
117.20	1600.00	18.54	200.00	130.74	2.09	3.36	62.33	96.19	66.91	2.64
120.20	1000.00	9.87	3000.00	1438.28	17.18	24.65	69.28	76.85	91.23	2.11
129.50	1000.00	10.15	2400.00	1152.77	14.06	19.25	71.17	79.03	91.06	2.17
129.00	1000.00	10.60	1800.00	820.27	11.00	14.92	74.25	82.50	90.42	2.22
128.40	1000.00	11.13	1200.00	591.29	7.22	10.13	76.16	86.59	88.27	2.28
125.10	1000.00	11.58	600.00	303.74	3.92	5.20	76.28	90.15	86.40	2.48
127.00	1000.00	12.02	200.00	119.41	1.18	2.05	52.53	93.52	73.26	2.52
132.60	500.00	4.99	3000.00	1442.18	8.21	13.22	65.59	72.36	90.99	1.99
133.60	500.00	5.05	2400.00	1160.44	7.03	10.68	65.81	73.21	90.46	2.01
132.10	500.00	5.50	1800.00	822.86	5.24	8.08	71.11	79.28	89.69	2.19
126.60	500.00	6.66	1200.00	589.99	4.53	5.43	83.41	96.46	88.96	2.65
0.00	500.00	0.00	600.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	500.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

THE MAX. OVER ALL EFFICIENCY IS: 94.1443  
THE MIN. OVER ALL EFFICIENCY IS: 57.525  
THE MAX. SIMPLE DISPLACEMENT IS: 2.74825

POWER CONVERSION TEST  
PUMP NUMBER M13491 RUN AT 180 DEGREES (F) INLET TEMP.

M13491

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MCH EFF (%)	SIM DIS IN/REV
196.60	2700.00	27.57	3000.00	1446.50	47.97	61.97	77.33	85.75	90.65	2.25
188.70	2700.00	28.14	2400.00	1167.23	39.43	50.00	78.86	87.66	89.87	2.41
185.50	2700.00	28.99	1800.00	898.70	30.16	38.50	78.34	90.37	87.54	2.48
183.70	2700.00	30.27	1200.00	620.47	20.84	26.50	78.39	94.16	84.53	2.59
184.70	2700.00	31.17	600.00	334.65	10.90	14.34	76.05	97.11	78.36	2.67
176.50	2700.00	32.10	200.00	141.95	4.89	6.00	80.44	100.00	61.56	2.75
189.60	2160.00	21.03	3000.00	1446.01	36.64	49.56	73.93	81.89	90.68	2.25
192.40	2160.00	21.49	2400.00	1177.94	29.96	40.20	74.55	83.69	89.44	2.30
185.00	2160.00	22.30	1800.00	885.53	23.23	30.35	76.53	86.84	88.85	2.38
182.50	2160.00	23.40	1200.00	601.05	16.20	20.60	79.05	91.13	87.26	2.50
185.70	2160.00	24.33	600.00	320.61	8.41	10.99	76.50	94.76	81.80	2.60
183.00	2160.00	25.37	200.00	129.73	3.07	4.45	69.03	90.59	67.30	2.71
191.10	1620.00	14.48	3000.00	1443.40	25.21	37.10	67.95	75.20	90.84	2.07
188.00	1620.00	14.96	2400.00	1160.55	20.91	29.83	70.00	77.65	90.39	2.13
185.70	1620.00	15.61	1800.00	882.30	16.25	22.68	71.66	81.07	89.16	2.23
184.00	1620.00	16.55	1200.00	603.54	11.46	15.51	73.05	85.93	86.90	2.36
184.20	1620.00	17.50	600.00	312.10	6.05	8.07	75.43	90.87	84.01	2.50
183.90	1620.00	18.44	200.00	120.64	2.01	3.10	64.66	95.76	72.46	2.63
195.50	1080.00	8.37	3000.00	1449.69	14.40	24.84	58.77	64.83	90.45	1.70
189.10	1080.00	8.80	2400.00	1158.40	12.20	19.85	61.40	68.57	90.53	1.80
187.00	1080.00	9.35	1800.00	877.05	9.74	15.03	64.84	72.81	89.70	2.00
181.50	1080.00	10.21	1200.00	590.57	7.14	10.17	70.54	79.53	88.87	2.10
180.40	1080.00	11.09	600.00	302.30	3.00	5.10	73.35	86.40	86.75	2.37
176.20	1080.00	11.90	200.00	110.24	1.37	1.89	69.67	92.71	79.29	2.55
200.60	600.00	3.37	3000.00	1454.30	5.05	13.85	42.25	47.19	90.16	1.30
194.90	600.00	4.07	2400.00	1168.44	5.61	11.17	50.40	56.36	89.70	1.55
188.50	600.00	6.44	1800.00	879.14	6.75	8.37	80.69	90.34	89.49	2.40
183.60	600.00	5.00	1200.00	592.81	3.77	5.64	65.93	71.26	88.40	1.90
0.00	600.00	0.00	600.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	600.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

THE MAX. OVER ALL EFFICIENCY IS: 80.6932  
THE MIN. OVER ALL EFFICIENCY IS: 42.2505  
THE MAX. SIMPLE DISPLACEMENT IS: 2.74626



POWER CONVERSION TEST  
PUMP NUMBER M13502 RUN AT 120 DEGREES (F) INLET TEMP.

M13502

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ. FLOW GPM	TAR. PRESS. PSID	ADJ. TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	METH EFF (%)	SIM DIS in <sup>3</sup> /rev
130.50	2700.00	26.86	3000.00	1448.78	46.99	61.72	76.13	87.10	87.43	2.30
127.90	2700.00	27.74	2400.00	1167.57	38.63	50.02	77.22	89.97	86.31	2.37
124.90	2700.00	28.57	1800.00	894.88	29.79	38.34	77.70	92.66	84.45	2.44
123.30	2700.00	29.37	1200.00	618.62	20.39	26.50	76.92	95.24	81.45	2.51
119.20	2700.00	30.18	600.00	347.05	10.38	14.87	69.81	97.86	77.59	2.58
118.90	2700.00	30.84	200.00	162.54	5.14	6.96	73.75	100.00	51.66	2.64
126.50	2160.00	20.62	3000.00	1443.30	36.05	49.47	72.82	83.61	82.27	2.21
123.50	2160.00	21.43	2400.00	1159.89	29.81	39.72	75.83	86.89	86.94	2.29
123.50	2160.00	22.11	1800.00	888.48	23.06	30.18	76.41	89.62	85.84	2.36
125.80	2160.00	22.79	1200.00	603.23	15.83	20.67	76.59	92.32	83.52	2.44
122.80	2160.00	23.59	600.00	329.21	8.14	11.28	72.12	95.63	76.52	2.52
119.40	2160.00	24.22	200.00	157.51	3.21	5.40	59.43	98.18	53.31	2.59
127.10	1620.00	14.77	3000.00	1426.83	24.88	36.68	67.82	77.13	88.28	2.83
129.40	1620.00	14.96	2400.00	1145.83	20.84	29.45	70.77	80.82	82.94	2.13
125.40	1620.00	15.64	1800.00	878.00	16.33	22.36	73.82	84.53	86.82	2.23
121.20	1620.00	16.36	1200.00	595.69	11.41	15.31	74.51	88.42	84.58	2.33
117.20	1620.00	17.12	600.00	318.31	5.89	8.18	72.02	92.53	79.14	2.44
117.20	1620.00	17.76	200.00	133.46	1.95	3.43	56.86	96.81	62.92	2.53
132.50	1080.00	8.21	3000.00	1432.84	14.30	24.64	58.84	66.56	82.60	1.76
131.20	1080.00	8.86	2400.00	1141.00	12.40	19.55	63.41	71.88	88.32	1.89
129.90	1080.00	9.51	1800.00	864.95	9.89	14.82	66.73	72.89	82.38	2.03
126.60	1080.00	10.16	1200.00	581.20	7.01	9.92	70.34	82.40	86.62	2.12
125.50	1080.00	10.86	600.00	302.90	3.73	5.19	71.80	88.89	83.12	2.32
121.90	1080.00	11.40	200.00	119.88	1.24	2.05	60.16	92.40	70.85	2.44
152.80	750.00	3.50	3000.00	1469.46	6.15	12.49	35.12	40.90	85.22	1.88
138.90	750.00	4.29	2400.00	1145.39	6.69	13.63	49.86	55.95	82.98	1.48
131.00	750.00	5.65	1800.00	858.91	5.91	10.22	52.82	65.94	82.99	1.74
124.90	750.00	6.26	1200.00	583.89	4.46	6.95	64.24	73.14	86.29	1.93
121.20	750.00	6.59	600.00	298.66	2.29	3.55	64.45	76.92	84.35	2.03
124.40	750.00	7.35	200.00	113.76	0.78	1.35	52.89	85.28	73.82	2.26

THE MAX. OVER ALL EFFICIENCY IS: 77.7002  
THE MIN. OVER ALL EFFICIENCY IS: 35.1657  
THE MAX. SIMPLE DISPLACEMENT IS: 2.63814

POWER CONVERSION TEST  
PUMP NUMBER M13501 RUN AT 180 DEGREES (F) INLET TEMP.

M13501

OUTLET TEMP (F)	TRK. SPEED RPM	ADJ FLOW GPM	TRK PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS in <sup>3</sup> /rev
191.20	2700.00	22.56	3000.00	1444.29	39.32	61.87	63.55	77.58	82.24	1.95
191.50	2700.00	23.15	2400.00	1165.39	32.33	49.93	64.76	79.62	81.54	1.96
184.40	2700.00	24.17	1800.00	880.34	25.28	37.71	66.83	83.12	80.95	2.02
182.10	2700.00	25.34	1200.00	596.28	17.66	25.55	69.15	82.16	79.68	2.12
182.10	2700.00	27.25	600.00	326.08	9.62	13.97	68.89	93.71	72.85	2.33
182.00	2700.00	29.08	200.00	152.87	4.87	6.55	62.22	100.00	51.80	2.49
196.30	2160.00	16.29	3000.00	1469.74	26.41	50.37	56.40	70.85	80.81	1.74
190.50	2160.00	17.52	2400.00	1164.88	24.37	39.92	61.04	75.32	81.52	1.82
182.60	2160.00	18.14	1800.00	824.49	18.93	29.97	63.16	77.98	81.50	1.94
182.90	2160.00	19.07	1200.00	582.35	13.22	20.47	64.56	81.97	79.54	2.04
184.90	2160.00	20.74	600.00	314.02	7.18	10.76	66.62	89.12	75.64	2.22
178.20	2160.00	22.28	200.00	138.74	2.71	4.75	56.96	92.91	52.00	2.44
208.00	1620.00	9.81	3000.00	1451.90	17.09	32.32	45.80	56.23	81.81	1.40
193.00	1620.00	11.00	2400.00	1156.63	15.35	29.23	51.64	63.85	82.15	1.52
188.40	1620.00	12.13	1800.00	869.22	12.62	22.34	56.68	69.52	81.90	1.73
188.00	1620.00	12.84	1200.00	585.89	8.98	15.06	59.63	73.62	81.09	1.83
184.00	1620.00	14.44	600.00	301.75	5.04	7.76	64.96	82.76	78.23	2.06
176.20	1620.00	16.51	200.00	112.83	1.82	3.03	60.24	94.64	62.20	2.35
244.50	1080.00	3.88	3000.00	1491.59	6.21	25.56	26.22	33.33	79.63	0.83
212.40	1080.00	4.49	2400.00	1128.22	6.26	20.06	31.20	38.64	81.12	0.96
192.40	1080.00	5.64	1800.00	869.20	5.92	14.89	40.00	48.40	81.99	1.21
188.30	1080.00	6.21	1200.00	522.90	4.65	9.82	42.36	52.22	82.93	1.44
181.50	1080.00	8.59	600.00	299.91	2.92	5.14	52.88	73.82	79.21	1.84
178.60	1080.00	10.54	200.00	110.22	1.88	1.89	56.95	90.63	71.84	2.25

THE MAX. OVER ALL EFFICIENCY IS: 69.1474  
THE MIN. OVER ALL EFFICIENCY IS: 26.2655  
THE MAX. SIMPLE DISPLACEMENT IS: 2.48766

POWER CONVERSION TEST  
PUMP NUMBER M13512 RUN AT 120 DEGREES (F) INLET TEMP.

M13512

OUTLET TEMP (F)	TRK. SPEED RPM	ADJ FLOW CFM	TRK PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS in <sup>3</sup> /rev
127.10	2700.00	28.58	3000.00	1437.73	50.24	61.59	81.57	90.56	90.60	2.47
124.90	2700.00	29.39	2400.00	1159.63	40.91	49.68	82.34	92.16	89.86	2.51
126.00	2700.00	29.92	1800.00	884.56	31.23	37.90	82.42	93.84	88.35	2.56
121.20	2700.00	30.73	1200.00	618.75	21.26	26.51	80.20	96.38	84.21	2.63
120.70	2700.00	31.40	600.00	338.15	10.91	14.49	75.30	98.47	77.04	2.69
118.40	2700.00	31.89	200.00	136.35	5.56	5.84	95.21	100.00	63.69	2.73
130.40	2160.00	22.14	3000.00	1410.18	30.55	40.33	79.77	86.77	92.37	2.37
131.00	2160.00	22.63	2400.00	1152.29	31.51	39.49	79.79	88.71	90.43	2.42
130.00	2160.00	23.21	1800.00	872.95	24.15	29.92	80.73	90.97	89.53	2.48
123.70	2160.00	23.91	1200.00	603.24	16.60	20.67	80.31	93.72	86.37	2.56
123.10	2160.00	24.55	600.00	326.68	8.50	11.20	75.90	96.24	79.75	2.63
120.50	2160.00	25.11	200.00	135.53	3.40	4.65	73.15	98.43	64.07	2.69
120.00	1620.00	15.57	3000.00	1416.89	27.12	36.42	74.47	81.36	91.93	2.22
131.40	1620.00	15.96	2400.00	1140.93	22.22	29.33	75.76	83.44	91.33	2.28
128.90	1620.00	16.36	1800.00	858.14	17.14	22.06	77.71	85.49	91.07	2.33
120.20	1620.00	17.10	1200.00	588.18	11.76	15.12	77.79	89.37	88.58	2.44
121.70	1620.00	17.82	600.00	312.21	6.13	8.03	76.37	93.13	83.44	2.54
122.10	1620.00	18.46	200.00	127.02	1.93	3.29	58.69	96.50	67.94	2.63
131.30	1080.00	9.43	3000.00	1413.13	16.46	24.22	67.98	73.93	92.18	2.02
131.00	1080.00	9.76	2400.00	1134.96	13.61	19.45	69.96	76.54	91.81	2.09
130.20	1080.00	10.08	1800.00	861.10	10.51	14.76	71.23	79.07	90.76	2.16
127.00	1080.00	10.66	1200.00	575.91	7.30	9.82	74.75	83.55	90.47	2.20
110.00	1080.00	11.02	600.00	303.30	3.02	5.20	73.46	86.29	85.82	2.32
120.20	1080.00	11.83	200.00	114.29	1.16	1.92	59.15	92.71	75.65	2.53
133.90	830.00	6.50	3000.00	1424.42	11.32	18.26	60.59	66.32	91.45	1.81
131.10	830.00	7.01	2400.00	1135.50	9.72	14.96	65.34	71.55	91.26	1.95
131.60	830.00	7.30	1800.00	861.92	7.66	11.35	67.45	74.52	90.68	2.03
126.60	830.00	7.72	1200.00	579.39	5.39	7.63	70.59	79.31	89.93	2.16
123.60	830.00	8.30	600.00	294.90	2.84	3.88	72.99	84.20	88.32	2.31
122.90	830.00	9.01	200.00	109.82	0.94	1.45	65.11	91.82	79.08	2.51

THE MAX. OVER ALL EFFICIENCY IS: 95.2092  
THE MIN. OVER ALL EFFICIENCY IS: 58.6851  
THE MAX. SIMPLE DISPLACEMENT IS: 2.72811

POWER CONVERSION TEST  
PUMP NUMBER M13511 RUN AT 180 DEGREES (F) INLET TEMP.

M13511

OUTLET TEMP (F)	THR. SPEED RPM	ADJ FLOW GPM	THR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS in3/rev
191.00	2700.00	25.93	3000.00	1414.60	45.35	60.60	74.83	83.16	90.06	2.77
189.00	2700.00	26.81	2400.00	1147.16	37.37	49.15	75.93	85.90	88.84	2.79
188.70	2700.00	27.47	1800.00	874.36	28.65	37.46	76.48	87.93	87.47	2.35
185.70	2700.00	28.67	1200.00	594.07	19.88	25.45	78.13	91.78	85.79	2.45
181.10	2700.00	30.23	600.00	328.57	10.31	14.00	73.26	96.93	77.55	2.59
183.00	2700.00	31.19	200.00	132.01	4.65	5.66	82.28	100.00	64.34	2.67
195.50	2160.00	19.16	3000.00	1405.29	33.44	48.16	69.43	76.80	90.65	2.05
187.50	2160.00	20.09	2400.00	1145.27	27.96	39.25	71.24	80.50	88.99	2.15
190.50	2160.00	20.87	1800.00	864.93	21.68	29.64	73.14	83.66	88.37	2.23
181.40	2160.00	22.00	1200.00	592.23	15.28	20.30	75.30	88.49	86.05	2.36
184.40	2160.00	23.28	600.00	312.46	8.07	10.71	74.91	93.30	81.54	2.49
181.70	2160.00	24.51	200.00	127.46	2.96	4.37	67.28	90.24	66.63	2.67
191.00	1620.00	13.24	3000.00	1418.87	23.05	36.47	63.19	70.26	89.29	1.89
193.50	1620.00	13.87	2400.00	1134.54	19.26	29.16	66.03	73.05	89.83	1.97
191.00	1620.00	14.47	1800.00	861.13	15.12	22.14	68.37	77.33	88.26	2.06
187.00	1620.00	15.27	1200.00	571.63	10.68	14.69	72.66	81.61	89.15	2.18
180.00	1620.00	16.58	600.00	302.93	5.21	7.29	73.28	88.61	84.11	2.36
176.40	1620.00	17.88	200.00	119.26	1.99	3.07	64.95	95.56	71.22	2.55
199.00	1080.00	7.16	3000.00	1432.48	12.49	24.55	50.86	57.36	88.93	1.53
197.20	1080.00	7.63	2400.00	1149.01	10.67	19.69	53.96	61.20	88.20	1.63
189.20	1080.00	8.37	1800.00	865.43	8.20	14.83	58.66	67.07	88.37	1.79
182.60	1080.00	9.42	1200.00	575.28	6.53	9.06	66.28	75.54	88.58	2.02
181.90	1080.00	10.43	600.00	299.41	3.50	5.13	69.20	83.63	85.10	2.23
170.50	1080.00	11.55	200.00	108.64	1.27	1.86	68.34	92.55	70.18	2.47
222.20	830.00	3.90	3000.00	1451.59	6.83	19.12	35.73	40.23	87.26	1.09
206.00	830.00	4.26	2400.00	1152.67	6.64	15.18	43.71	49.63	88.47	1.37
194.50	830.00	5.53	1800.00	864.31	5.26	11.38	50.63	57.63	88.44	1.54
186.40	830.00	6.23	1200.00	583.19	4.26	7.13	55.51	65.01	87.38	1.73
181.50	830.00	7.51	600.00	295.48	2.55	3.89	65.61	78.37	86.23	2.09
182.00	830.00	8.67	200.00	109.23	0.88	1.45	60.27	90.41	77.40	2.41

THE MAX. OVER ALL EFFICIENCY IS: 82.2802  
THE MIN. OVER ALL EFFICIENCY IS: 35.7263  
THE MAX. SIMPLE DISPLACEMENT IS: 2.66819

POWER CONVERSION TEST  
 PUMP NUMBER M13522 RUN AT 120 DEGREES (F) INLET TEMP.

M13522

OUTLET TEMP (F)	TOR. SPEED RPM	ADJ FLOW (GPM)	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	UOL EFF (%)	MCH EFF (%)	SIM DIS. in3/rev
130.20	2700.00	29.44	3000.00	1452.03	51.14	62.21	82.27	91.50	90.53	2.52
131.10	2700.00	29.89	2400.00	1170.66	41.65	50.15	83.06	92.90	89.83	2.56
129.10	2700.00	30.46	1800.00	893.50	31.88	38.28	83.28	94.67	88.77	2.61
127.10	2700.00	31.17	1200.00	628.96	21.79	26.95	80.88	96.85	83.60	2.67
127.30	2700.00	31.71	600.00	345.86	10.96	14.82	73.94	98.53	76.81	2.71
124.40	2700.00	32.18	200.00	139.59	5.50	5.98	92.82	100.00	62.78	2.75
131.60	2160.00	22.72	3000.00	1435.48	39.64	49.20	80.58	88.26	91.57	2.43
129.90	2160.00	23.17	2400.00	1160.71	32.36	39.28	81.34	89.99	90.60	2.48
127.20	2160.00	23.74	1800.00	885.96	24.77	30.36	81.58	92.21	89.82	2.54
120.20	2160.00	24.41	1200.00	665.97	16.92	20.77	81.45	94.83	86.77	2.61
121.80	2160.00	24.87	600.00	333.00	8.57	11.41	75.00	96.60	78.95	2.66
122.10	2160.00	25.34	200.00	137.66	3.41	4.72	72.30	98.45	63.66	2.71
131.00	1620.00	16.11	3000.00	1431.40	28.13	36.29	76.44	83.47	91.83	2.30
128.20	1620.00	16.47	2400.00	1155.61	22.94	29.20	77.23	85.31	91.00	2.35
126.00	1620.00	16.89	1800.00	878.41	17.63	22.58	78.00	87.47	89.28	2.41
121.00	1620.00	17.52	1200.00	595.26	12.14	15.31	79.28	90.26	88.25	2.50
120.80	1620.00	18.11	600.00	320.24	6.27	8.24	76.05	93.81	81.96	2.58
121.30	1620.00	18.57	200.00	134.57	2.82	3.46	80.26	96.16	65.12	2.65
126.60	1080.00	9.82	3000.00	1447.21	17.86	24.81	68.28	76.32	90.80	2.10
124.90	1080.00	10.10	2400.00	1152.09	14.89	19.24	71.39	78.50	91.28	2.16
122.20	1080.00	10.47	1800.00	872.34	10.98	14.95	73.47	81.35	90.41	2.24
122.10	1080.00	11.03	1200.00	585.52	7.66	10.83	76.35	85.66	89.29	2.36
120.50	1080.00	11.36	600.00	300.50	3.90	5.29	73.68	88.26	85.22	2.43
119.00	1080.00	11.93	200.00	121.63	1.72	2.80	60.92	92.22	72.85	2.55
135.00	830.00	6.25	3000.00	1442.40	11.21	19.00	61.62	68.25	91.13	1.88
131.00	830.00	7.19	2400.00	1151.66	10.06	15.12	66.35	72.69	91.31	2.00
120.00	830.00	7.53	1800.00	871.34	7.83	11.48	68.26	76.14	90.51	2.10
124.20	830.00	8.85	1200.00	592.09	5.49	7.80	70.46	81.35	88.80	2.24
123.20	830.00	8.53	600.00	305.59	3.02	4.82	75.16	86.28	86.83	2.30
123.00	830.00	9.06	200.00	119.15	0.85	1.52	54.04	91.56	73.55	2.52

THE MAX. OVER ALL EFFICIENCY IS: 92.0246  
 THE MIN. OVER ALL EFFICIENCY IS: 54.0397  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.753

POWER CONVERSION TEST  
PUMP NUMBER M13521 RUN AT 180 DEGREES (F) INLET TEMP.

M13521

(IN) FT TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MCH EFF (%)	SIM DIS inches
187.50	2700.00	26.98	3000.00	1447.28	47.12	62.00	76.00	86.03	88.53	2.31
186.00	2700.00	27.65	2400.00	1168.45	38.60	50.06	77.10	88.17	87.72	2.37
190.00	2700.00	28.28	1800.00	889.31	29.49	38.10	77.40	90.18	86.44	2.42
184.50	2700.00	29.39	1200.00	612.49	20.46	26.24	77.99	93.70	83.67	2.51
185.30	2700.00	30.47	600.00	331.49	10.50	14.20	73.95	97.14	77.30	2.61
185.20	2700.00	31.36	200.00	134.19	4.66	5.75	81.13	100.00	63.65	2.68
189.10	2160.00	20.49	3000.00	1452.09	35.72	49.77	71.77	81.66	88.23	2.19
188.50	2160.00	20.89	2400.00	1169.48	29.20	40.08	72.85	83.25	87.64	2.23
186.00	2160.00	21.72	1800.00	878.97	22.74	30.12	75.49	86.56	87.46	2.32
183.50	2160.00	22.64	1200.00	600.02	15.74	20.56	76.55	90.24	85.41	2.42
180.90	2160.00	23.87	600.00	319.46	8.18	10.95	74.72	95.12	80.21	2.55
182.50	2160.00	24.88	200.00	131.74	2.92	4.52	65.88	98.84	64.84	2.65
193.10	1620.00	14.06	3000.00	1449.04	24.48	32.25	65.73	74.73	88.42	2.01
194.20	1620.00	14.54	2400.00	1166.48	20.16	28.98	67.25	77.26	87.82	2.07
187.90	1620.00	15.22	1800.00	879.50	15.86	22.61	70.15	88.88	87.40	2.12
179.20	1620.00	16.34	1200.00	595.24	11.31	15.30	73.95	96.81	86.10	2.33
181.00	1620.00	17.21	600.00	312.35	5.96	8.03	74.25	91.48	82.04	2.45
183.30	1620.00	18.15	200.00	125.10	1.89	3.22	58.24	96.43	68.28	2.59
196.00	1080.00	7.26	3000.00	1468.42	13.52	25.03	54.01	61.83	87.73	1.66
193.90	1080.00	8.48	2400.00	1168.96	11.82	20.03	59.24	62.52	82.68	1.81
191.50	1080.00	8.96	1800.00	873.54	9.33	14.92	62.32	71.44	88.00	1.92
186.90	1080.00	9.73	1200.00	592.62	6.75	10.16	66.51	77.53	86.48	2.00
185.00	1080.00	10.71	600.00	299.62	3.71	5.13	72.26	85.34	85.52	2.29
181.40	1080.00	11.61	200.00	110.35	1.29	1.89	68.04	92.55	77.40	2.48
212.90	830.00	4.62	3000.00	1473.84	8.10	19.41	41.22	42.89	86.93	1.29
198.20	830.00	5.45	2400.00	1173.11	7.63	15.45	49.40	56.54	82.32	1.52
191.20	830.00	6.22	1800.00	872.26	6.56	11.55	56.80	65.04	82.63	1.75
185.00	830.00	6.98	1200.00	603.06	4.82	7.94	60.21	72.42	84.90	1.94
182.50	830.00	7.88	600.00	296.61	2.84	3.91	72.25	81.22	86.39	2.19
182.10	830.00	8.73	200.00	102.82	0.98	1.42	69.24	90.59	79.22	2.43

THE MAX. OVER ALL EFFICIENCY IS: 81.1282  
THE MIN. OVER ALL EFFICIENCY IS: 41.721  
THE MAX. SIMPLE DISPLACEMENT IS: 2.68335

POWER CONVERSION TEST  
PUMP NUMBER M13532 RUN AT 120 DEGREES (F) INLET TEMP.

M13532

(OUTLET TEMP(F))	TOR. SPEED RPM	ADJ FLOW (GPM)	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	UNI EFF (%)	MECH EFF (%)	SIM DIS inches
134.90	2700.00	28.35	3000.00	1446.96	49.52	61.99	79.89	88.43	98.51	2.43
131.60	2700.00	29.09	2400.00	1168.52	40.62	50.06	81.15	90.75	89.66	2.49
128.00	2700.00	29.68	1800.00	900.85	31.24	38.59	80.94	93.20	87.23	2.56
121.50	2700.00	30.80	1200.00	629.74	21.39	26.98	79.29	96.00	83.19	2.64
124.90	2700.00	31.52	600.00	348.74	10.81	14.94	72.33	98.31	75.11	2.70
123.20	2700.00	32.06	200.00	141.13	5.45	6.05	90.14	100.00	61.82	2.74
128.70	2160.00	21.96	3000.00	1434.96	38.17	49.18	77.61	85.63	91.27	2.35
130.10	2160.00	22.52	2400.00	1167.50	31.38	40.02	78.43	87.29	89.73	2.41
125.50	2160.00	23.22	1800.00	885.56	24.32	30.35	80.30	90.55	88.73	2.48
120.20	2160.00	24.10	1200.00	614.04	16.22	21.02	79.35	94.29	85.20	2.50
122.30	2160.00	24.83	600.00	334.35	8.40	11.46	74.00	96.00	78.34	2.66
122.50	2160.00	25.35	200.00	143.09	3.32	4.90	68.81	98.85	61.02	2.71
128.00	1620.00	15.14	3000.00	1433.24	26.41	36.04	71.20	78.22	91.30	2.16
125.90	1620.00	15.75	2400.00	1155.69	21.95	29.71	73.89	81.86	90.66	2.25
124.90	1620.00	16.30	1800.00	877.06	12.06	22.56	75.50	84.76	89.51	2.32
123.00	1620.00	17.24	1200.00	604.03	11.96	15.53	77.00	89.61	86.73	2.46
121.30	1620.00	17.93	600.00	324.12	6.19	8.33	74.35	93.23	80.81	2.56
118.00	1620.00	18.54	200.00	142.92	1.92	3.62	53.53	96.30	61.02	2.64
134.60	1080.00	8.20	3000.00	1448.64	15.09	24.02	60.72	62.82	90.40	1.86
131.00	1080.00	9.24	2400.00	1150.29	12.02	19.05	64.05	72.09	90.45	1.90
129.00	1080.00	9.78	1800.00	825.50	10.22	15.00	68.10	76.22	89.74	2.09
125.20	1080.00	10.52	1200.00	592.12	7.20	10.15	71.23	82.05	88.47	2.25
123.90	1080.00	11.25	600.00	311.34	3.85	5.34	72.24	82.20	84.13	2.41
122.40	1080.00	11.73	200.00	126.22	1.22	2.16	58.52	91.49	69.12	2.51
144.40	830.00	5.61	3000.00	1452.02	9.71	19.19	50.60	56.94	89.80	1.56
136.40	830.00	6.39	2400.00	1163.10	8.05	15.32	52.72	64.82	90.02	1.70
131.60	830.00	6.89	1800.00	823.35	7.32	11.50	64.05	69.86	89.92	1.92
125.00	830.00	7.65	1200.00	594.81	5.29	7.83	62.59	72.63	88.02	2.13
112.90	830.00	8.29	600.00	305.50	2.85	4.02	70.06	84.16	85.24	2.31
110.60	830.00	8.72	200.00	120.02	1.06	1.50	62.16	88.40	72.25	2.43

THE MAX. OVER ALL EFFICIENCY IS: 90.1422  
THE MIN. OVER ALL EFFICIENCY IS: 50.6036  
THE MAX. SIMPLE DISPLACEMENT IS: 2.74289

POWER CONVERSION TEST  
 PUMP NUMBER M13531 RUN AT 180 DEGREES (F) INLET TEMP.

M13531

DISC TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LES	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS in3/rev
192.00	2700.00	24.00	3000.00	1434.10	42.04	61.44	68.42	78.55	87.31	2.00
191.60	2700.00	24.91	2400.00	1157.51	34.65	49.59	69.88	81.25	86.54	2.13
190.50	2700.00	25.74	1800.00	885.00	26.86	37.92	78.85	83.97	84.89	2.20
186.20	2700.00	26.88	1200.00	609.91	18.20	26.13	71.55	87.20	82.12	2.30
180.00	2700.00	28.92	600.00	335.77	10.06	14.38	69.94	94.36	74.50	2.47
179.20	2700.00	30.65	200.00	136.18	4.28	5.83	73.38	100.00	61.30	2.62
194.90	2160.00	17.07	3000.00	1424.54	29.00	48.82	61.03	69.59	87.90	1.83
194.20	2160.00	17.82	2400.00	1161.61	24.93	39.81	62.62	77.67	86.24	1.91
185.60	2160.00	19.29	1800.00	883.63	20.18	30.28	66.65	78.68	85.03	2.06
183.60	2160.00	20.36	1200.00	601.03	14.22	20.60	69.02	83.04	83.34	2.18
186.50	2160.00	22.26	600.00	322.26	7.62	11.04	69.01	90.28	77.21	2.38
184.50	2160.00	24.17	200.00	130.82	2.82	4.49	62.86	98.50	63.29	2.59
201.50	1620.00	10.64	3000.00	1444.82	18.59	32.14	50.05	52.04	86.62	1.52
199.00	1620.00	11.41	2400.00	1166.23	15.83	29.99	52.28	62.01	85.86	1.63
194.20	1620.00	12.19	1800.00	870.54	12.04	22.38	57.36	66.25	86.30	1.74
183.20	1620.00	13.62	1200.00	605.95	9.31	15.52	59.77	74.35	82.66	1.95
180.30	1620.00	15.64	600.00	309.41	5.36	7.95	62.43	85.06	80.94	2.23
179.30	1620.00	17.45	200.00	120.13	1.94	3.09	62.93	94.90	69.49	2.49
233.10	1000.00	3.82	3000.00	1422.46	6.29	25.23	26.91	31.59	85.04	0.83
219.30	1000.00	4.43	2400.00	1155.23	5.21	19.00	31.39	36.13	86.21	0.95
201.00	1000.00	5.52	1800.00	862.48	5.83	14.28	39.42	44.99	82.11	1.10
188.00	1000.00	6.96	1200.00	591.22	4.85	10.13	42.86	56.28	84.22	1.49
186.20	1000.00	9.24	600.00	302.28	3.20	5.19	61.24	75.32	82.21	1.90
181.40	1000.00	11.83	200.00	111.92	1.25	1.92	64.92	90.00	74.56	2.36
0.00	830.00	0.00	3000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
243.30	830.00	2.84	2400.00	1209.42	3.92	15.93	24.64	30.11	82.03	0.29
209.10	830.00	3.49	1800.00	882.82	3.68	11.69	31.43	32.05	84.62	0.92
195.50	830.00	4.85	1200.00	584.35	2.89	7.20	32.51	42.92	85.22	1.13
180.40	830.00	6.45	600.00	302.85	2.22	3.99	52.66	68.49	82.69	1.80
181.00	830.00	8.10	200.00	112.00	0.93	1.49	62.48	85.94	74.00	2.25

THE MAX. OVER ALL EFFICIENCY IS: 73.3846  
 THE MIN. OVER ALL EFFICIENCY IS: 24.639  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.62257



POWER CONVERSION TEST  
PUMP NUMBER M13542 RUN AT 120 DEGREES (F) INLET TEMP.

M13542

OUT FT TEMP (F)	TOR. SPEED RPM	ADJ FLOW (GPM)	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MCH EFF (%)	SIM DIS in3/rev
134.00	2700.00	29.19	3000.00	1450.10	50.90	62.12	82.06	90.94	90.42	2.50
132.20	2700.00	29.63	2400.00	1178.36	41.28	50.48	81.78	92.32	89.02	2.54
128.00	2700.00	30.27	1800.00	904.31	31.68	38.74	81.76	94.31	87.00	2.59
124.90	2700.00	30.97	1200.00	640.12	21.45	27.42	78.20	96.47	81.94	2.65
123.30	2700.00	31.60	600.00	352.14	11.06	15.09	73.29	98.44	74.47	2.70
131.60	2700.00	32.10	200.00	143.32	5.49	6.14	89.38	100.00	60.99	2.75
131.30	2160.00	22.46	3000.00	1446.10	39.15	49.56	78.98	87.45	90.67	2.40
129.40	2160.00	22.99	2400.00	1171.71	32.16	40.16	80.09	89.51	89.53	2.46
126.50	2160.00	23.54	1800.00	894.56	24.52	30.66	79.97	91.67	87.95	2.52
122.00	2160.00	24.12	1200.00	617.99	16.64	21.18	78.56	93.91	84.82	2.58
118.00	2160.00	24.78	600.00	332.52	8.56	11.52	73.95	96.48	77.69	2.65
123.40	2160.00	25.36	200.00	141.61	3.44	4.85	70.28	98.25	61.23	2.71
130.00	1620.00	15.72	3000.00	1439.96	22.45	32.01	74.15	81.62	91.06	2.24
127.20	1620.00	16.18	2400.00	1162.65	22.52	29.89	75.52	84.00	90.22	2.31
125.20	1620.00	16.65	1800.00	890.16	12.32	22.62	76.28	86.46	89.39	2.32
121.00	1620.00	17.22	1200.00	602.42	11.94	15.48	77.11	89.39	82.06	2.45
122.20	1620.00	17.82	600.00	321.34	6.16	8.26	74.63	92.81	81.61	2.55
122.60	1620.00	18.56	200.00	139.00	1.98	3.58	55.48	96.36	62.05	2.65
128.50	1080.00	9.60	3000.00	1451.10	16.72	24.82	62.23	74.29	90.36	2.05
128.20	1080.00	9.88	2400.00	1165.95	13.23	19.98	68.20	76.96	89.92	2.11
126.60	1080.00	10.20	1800.00	822.94	10.62	14.96	71.02	79.43	90.13	2.18
123.00	1080.00	10.66	1200.00	600.32	7.38	10.29	71.72	83.05	82.36	2.28
122.20	1080.00	11.20	600.00	310.45	3.95	5.32	74.24	82.21	84.42	2.40
120.00	1080.00	11.62	200.00	126.28	1.30	2.12	59.68	90.53	60.95	2.49
132.90	800.00	6.34	3000.00	1452.42	11.02	18.50	59.58	66.66	89.92	1.83
133.30	800.00	6.59	2400.00	1158.82	9.20	14.21	62.52	69.29	90.52	1.90
122.20	800.00	6.98	1800.00	890.92	7.26	11.18	64.95	73.36	89.31	2.01
123.30	800.00	7.44	1200.00	592.25	5.18	7.52	68.89	78.18	88.56	2.15
118.90	800.00	7.92	600.00	310.92	2.22	3.95	68.88	83.31	84.33	2.29
119.90	800.00	8.39	200.00	118.45	0.98	1.50	65.01	88.22	73.00	2.42

THE MAX. OVER ALL EFFICIENCY IS: 89.3834  
THE MIN. OVER ALL EFFICIENCY IS: 55.485  
THE MAX. SIMPLE DISPLACEMENT IS: 2.74625

POWER CONVERSION TEST  
PUMP NUMBER M13541 RUN AT 180 DEGREES (F) INLET TEMP.

M13541

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MICH EFF (%)	SIM DIS. in <sup>3</sup> /rev
194.10	2700.00	26.40	3000.00	1436.12	46.05	61.52	74.85	83.99	89.42	2.26
185.60	2700.00	27.21	2400.00	1166.25	37.08	49.96	75.02	86.54	86.66	2.33
183.50	2700.00	27.95	1800.00	890.66	29.20	38.16	76.53	88.92	86.51	2.39
187.50	2700.00	28.97	1200.00	602.89	20.12	25.83	77.89	92.16	85.28	2.48
180.60	2700.00	30.23	600.00	335.50	10.50	14.37	73.07	96.16	76.55	2.59
177.50	2700.00	31.44	200.00	134.43	4.67	5.76	81.01	100.00	63.68	2.69
190.20	2160.00	19.99	3000.00	1420.49	34.90	48.68	71.68	79.51	90.40	2.14
186.20	2160.00	20.51	2400.00	1148.62	28.57	39.37	72.57	81.54	89.44	2.19
184.00	2160.00	21.36	1800.00	884.36	22.35	30.31	73.74	84.93	87.12	2.20
183.10	2160.00	22.16	1200.00	606.24	15.24	20.78	73.37	88.13	84.73	2.32
179.20	2160.00	23.57	600.00	320.14	8.07	10.97	73.57	93.73	80.22	2.52
181.00	2160.00	24.57	200.00	134.86	2.91	4.62	62.92	97.71	63.48	2.63
192.00	1620.00	13.59	3000.00	1440.43	23.64	32.03	63.86	72.05	89.15	1.94
194.90	1620.00	13.98	2400.00	1154.91	19.66	29.69	66.23	74.11	88.95	1.99
187.00	1620.00	14.58	1800.00	826.25	15.20	22.54	67.44	77.29	87.88	2.00
181.20	1620.00	15.82	1200.00	594.06	11.01	15.27	72.10	83.86	86.46	2.26
181.00	1620.00	16.67	600.00	311.00	5.74	8.01	71.58	88.36	82.32	2.38
181.60	1620.00	17.81	200.00	122.74	1.90	3.28	52.96	94.42	62.02	2.54
198.60	1080.00	7.13	3000.00	1450.90	12.42	24.86	49.92	56.62	88.50	1.52
191.20	1080.00	8.02	2400.00	1166.55	11.13	19.99	55.68	63.29	88.06	1.72
191.00	1080.00	8.43	1800.00	822.13	8.04	15.03	58.83	62.02	82.04	1.80
182.00	1080.00	9.11	1200.00	590.72	6.32	10.12	62.42	72.49	86.94	1.95
182.20	1080.00	10.01	600.00	302.09	3.41	5.18	65.90	79.64	85.02	2.14
179.30	1080.00	11.32	200.00	116.91	1.19	2.00	59.58	90.41	73.23	2.43
214.20	800.00	4.30	3000.00	1469.49	7.50	18.65	40.19	46.21	82.38	1.24
194.30	800.00	5.02	2400.00	1122.23	6.90	14.94	46.20	53.88	82.26	1.45
190.60	800.00	5.50	1800.00	828.81	5.74	11.16	51.46	59.01	82.62	1.59
186.00	800.00	6.21	1200.00	592.52	4.22	7.52	56.21	66.62	86.68	1.79
186.40	800.00	6.90	600.00	303.40	2.35	3.85	61.13	74.11	84.65	1.99
181.20	800.00	8.10	200.00	112.55	0.89	1.43	62.43	86.92	76.06	2.34

THE MAX. OVER ALL EFFICIENCY IS: 81.0127  
THE MIN. OVER ALL EFFICIENCY IS: 40.1907  
THE MAX. SIMPLE DISPLACEMENT IS: 2.68944

POWER CONVERSION TEST  
PUMP NUMBER M23552 RUN AT 120 DEGREES (F) INLET TEMP.

M23552

DISP. FT TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SJM DIS int3rev
173.90	2000.00	30.76	3000.00	1442.79	53.77	64.00	83.92	91.67	91.64	2.54
172.70	2000.00	31.29	2400.00	1169.19	43.60	51.94	84.10	93.25	90.43	2.50
175.20	2000.00	31.05	1800.00	895.02	33.73	39.00	83.49	94.92	88.52	2.63
171.70	2000.00	32.50	1700.00	614.99	27.69	27.32	83.04	96.87	85.96	2.60
118.60	2000.00	33.12	600.00	344.12	11.53	15.29	75.40	98.70	76.81	2.73
116.00	2000.00	33.55	200.00	145.25	6.18	6.48	95.49	100.00	60.45	2.77
177.40	2740.00	23.77	3000.00	1436.66	41.33	51.06	80.94	88.37	91.99	2.45
176.90	2740.00	24.25	2400.00	1150.00	33.81	41.16	82.15	90.35	91.31	2.50
175.20	2740.00	24.87	1800.00	881.86	26.00	31.34	82.94	92.65	89.92	2.56
173.30	2740.00	25.50	1700.00	601.49	17.78	21.38	83.18	94.98	87.89	2.63
119.10	2740.00	26.05	600.00	328.21	9.03	11.67	77.41	97.06	80.54	2.69
116.10	2740.00	26.61	200.00	144.52	3.06	5.14	79.55	99.12	60.97	2.74
132.40	1600.00	16.53	3000.00	1431.94	28.78	38.17	75.40	82.11	92.30	2.77
129.30	1600.00	17.14	2400.00	1144.50	23.90	30.51	78.33	85.14	92.30	2.36
126.10	1600.00	17.89	1800.00	870.74	18.70	23.21	80.57	88.87	91.87	2.46
122.00	1600.00	18.56	1700.00	582.44	12.88	15.93	80.86	92.20	88.49	2.55
120.00	1600.00	19.00	600.00	317.36	6.53	8.46	77.17	94.40	83.29	2.61
119.50	1600.00	19.50	200.00	131.29	2.15	3.50	61.32	96.89	62.11	2.60
132.40	1120.00	9.95	3000.00	1432.24	17.32	25.45	68.26	74.13	92.20	2.05
128.20	1120.00	10.52	2400.00	1141.12	14.00	20.20	72.96	78.74	92.66	2.18
123.00	1120.00	11.14	1800.00	870.45	11.66	15.47	75.40	82.99	91.10	2.30
121.00	1120.00	11.76	1700.00	586.62	8.20	10.42	78.60	87.63	90.12	2.43
119.20	1120.00	12.03	600.00	302.70	4.16	5.47	76.15	89.65	85.90	2.40
117.90	1120.00	12.47	200.00	124.43	1.30	2.21	58.92	92.94	70.81	2.52
130.70	800.00	6.32	3000.00	1423.99	11.00	18.00	60.83	65.88	92.81	1.82
132.90	800.00	6.90	2400.00	1146.46	9.61	14.55	66.83	71.93	92.22	1.99
128.20	800.00	7.47	1800.00	865.60	7.04	10.99	71.32	77.95	91.61	2.16
123.70	800.00	8.04	1700.00	580.19	5.50	7.36	75.71	83.92	91.12	2.32
120.30	800.00	8.42	600.00	294.55	2.06	3.74	76.40	87.29	89.74	2.43
116.30	800.00	8.65	200.00	109.25	0.96	1.39	69.30	90.19	80.52	2.50

THE MAX. OVER ALL EFFICIENCY IS: 95.4916  
THE MIN. OVER ALL EFFICIENCY IS: 58.9213  
THE MAX. SIMPLE DISPLACEMENT IS: 2.76805

POWER CONVERSION TEST  
 PUMP NUMBER M23551 RUN AT 180 DEGREES (F) INLET TEMP.

M23551

OUTLET TEMP (F)	TRK. SPEED RPM	ADJ FLOW GPM	TRK PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS IN/34 IN
153.60	2800.00	27.94	3000.00	1436.68	48.70	63.83	76.30	84.57	90.58	2.30
156.00	2800.00	28.90	2400.00	1163.98	40.13	51.71	77.61	87.48	89.44	2.38
158.40	2800.00	29.99	1800.00	884.67	31.25	39.30	79.52	90.77	88.26	2.47
155.40	2800.00	31.14	1200.00	683.45	21.55	26.81	80.36	94.25	86.26	2.57
182.00	2800.00	32.27	600.00	322.99	11.13	14.35	77.58	97.53	88.58	2.66
181.50	2800.00	33.04	200.00	125.43	5.38	5.57	96.62	100.00	89.16	2.73
158.50	2240.00	28.70	3000.00	1435.64	36.11	51.83	70.76	78.31	90.65	2.13
155.20	2240.00	21.89	2400.00	1155.66	30.51	41.87	74.77	82.81	90.08	2.26
156.00	2240.00	22.96	1800.00	880.40	23.99	31.29	76.66	86.88	88.69	2.37
156.00	2240.00	24.02	1200.00	590.30	16.85	20.98	80.29	90.87	88.18	2.48
152.60	2240.00	25.36	600.00	311.23	8.74	11.06	78.99	95.94	83.62	2.61
177.50	2240.00	26.05	200.00	122.58	3.33	4.36	76.50	98.56	78.28	2.69
159.50	1680.00	14.02	3000.00	1443.13	24.44	38.47	63.52	78.23	90.18	1.93
159.50	1680.00	14.91	2400.00	1154.73	20.71	30.78	67.29	75.21	90.16	2.05
150.50	1680.00	15.88	1800.00	870.78	16.45	23.21	70.88	88.13	89.67	2.16
156.90	1680.00	17.04	1200.00	582.17	11.80	15.52	76.04	85.97	89.41	2.34
156.10	1680.00	18.18	600.00	301.26	6.33	8.04	78.69	91.20	88.25	2.50
181.20	1680.00	19.02	200.00	113.81	2.14	3.83	70.28	95.95	76.23	2.62
153.50	1120.00	7.59	3000.00	1432.80	13.21	25.46	51.88	52.45	90.83	1.57
153.50	1120.00	8.38	2400.00	1157.45	11.20	20.52	56.90	63.39	89.95	1.73
153.50	1120.00	9.48	1800.00	865.96	9.86	15.39	64.82	71.21	90.12	1.95
179.00	1120.00	10.60	1200.00	588.80	7.27	10.46	69.46	80.25	88.41	2.19
178.00	1120.00	11.60	600.00	293.35	4.03	5.21	72.22	82.28	88.22	2.39
178.50	1120.00	12.26	200.00	104.29	1.31	1.86	70.35	92.24	88.29	2.53

THE MAX. OVER ALL EFFICIENCY IS: 96.6197  
 THE MIN. OVER ALL EFFICIENCY IS: 51.8728  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.72552

POWER CONVERSION TEST  
 PUMP NUMBER M23562 RUN AT 120 DEGREES (F) INLET TEMP.

M23562

OUTLET TEMP (F)	TOR. SPEED RPM	ADJ FLOW GPM	TOR. PRESS PSID	ADJ TORQ WH-IPS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOU EFF (%)	MCH EFF (%)	SIM DIS in3/rev
134.30	2000.00	31.18	3000.00	1458.20	56.44	64.78	87.12	89.45	94.15	2.57
131.20	2000.00	31.94	2400.00	1177.32	45.05	52.31	86.13	91.64	93.29	2.63
126.00	2000.00	32.56	1800.00	900.26	34.60	40.00	86.51	93.43	91.50	2.69
120.50	2000.00	33.32	1200.00	620.74	24.13	27.50	87.50	95.61	88.47	2.75
116.00	2000.00	34.01	600.00	340.93	11.76	15.15	77.66	97.59	80.54	2.81
112.20	2000.00	34.65	200.00	170.37	3.23	7.57	42.64	100.00	53.27	2.88
131.00	2240.00	24.32	3000.00	1467.01	42.33	52.14	81.19	87.23	93.50	2.51
129.10	2240.00	24.50	2400.00	1175.57	35.01	41.78	83.29	88.96	93.43	2.56
127.00	2240.00	25.45	1800.00	888.55	27.16	31.50	86.02	91.26	92.71	2.62
120.60	2240.00	26.12	1200.00	613.35	18.66	21.00	85.60	93.69	89.53	2.69
117.20	2240.00	26.61	600.00	328.33	9.53	11.67	81.63	95.43	83.63	2.74
117.30	2240.00	27.29	200.00	170.10	2.17	6.33	34.23	97.86	51.39	2.81
131.40	1600.00	17.47	3000.00	1439.68	30.43	38.30	79.29	83.55	95.36	2.40
132.20	1600.00	17.90	2400.00	1170.51	24.62	31.42	78.36	86.00	93.20	2.47
127.20	1600.00	18.50	1800.00	886.68	18.92	23.64	80.04	88.46	92.90	2.54
117.40	1600.00	19.05	1200.00	602.67	13.67	16.02	85.10	91.09	91.12	2.62
119.30	1600.00	19.40	600.00	325.31	6.39	8.67	73.64	93.17	84.41	2.68
117.00	1600.00	19.99	200.00	133.95	1.95	3.52	54.71	95.50	60.33	2.75
134.30	1120.00	10.90	3000.00	1451.92	18.22	25.00	72.53	78.16	94.56	2.25
133.40	1120.00	11.36	2400.00	1161.25	15.04	20.64	76.72	81.48	94.50	2.34
131.00	1120.00	11.80	1800.00	875.00	12.16	15.55	78.21	85.20	94.13	2.45
127.50	1120.00	12.30	1200.00	591.04	8.52	10.52	81.01	88.00	92.29	2.55
122.10	1120.00	12.71	600.00	300.15	4.42	5.48	80.25	91.18	89.11	2.62
126.20	1120.00	13.02	200.00	111.02	1.22	1.99	66.51	93.43	81.01	2.69
145.00	875.00	7.61	3000.00	1461.02	13.09	20.30	64.50	69.03	93.92	2.01
137.60	875.00	8.40	2400.00	1166.10	11.61	16.19	71.69	77.10	94.19	2.22
132.00	875.00	9.00	1800.00	880.32	9.19	12.22	75.22	82.62	93.52	2.30
120.50	875.00	9.62	1200.00	588.10	6.50	8.12	80.54	88.29	93.32	2.54
126.10	875.00	9.94	600.00	290.35	3.26	4.14	78.64	90.39	92.03	2.60
125.90	875.00	10.19	200.00	102.01	1.32	1.50	88.31	93.60	84.90	2.69

THE MAX. OVER ALL EFFICIENCY IS: 88.3141  
 THE MIN. OVER ALL EFFICIENCY IS: 34.2293  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.87538

POWER CONVERSION TEST  
PUMP NUMBER M23561 RUN AT 100 DEGREES (F) INLET TEMP.

M23561

(INLET TEMP (F))	TOR. SPEED RPM	ADJ. FLOW GPM	TOR. PRESS. PSIG	ADJ. TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	METH EFF (%)	SIM DIS int3 rev
187.10	2900.00	29.05	3000.00	1451.22	51.96	64.47	80.59	85.47	92.28	2.48
194.00	2900.00	29.02	2400.00	1176.00	41.37	52.27	79.13	87.78	91.65	2.46
175.00	2900.00	31.12	1900.00	993.48	32.14	39.25	81.89	91.54	98.94	2.57
185.00	2900.00	32.17	1200.00	611.50	22.40	27.17	82.44	94.64	87.60	2.65
188.00	2900.00	33.17	600.00	323.57	11.96	14.38	83.17	97.56	82.77	2.74
170.60	2900.00	34.00	200.00	122.54	5.19	5.67	91.55	100.00	78.00	2.80
185.00	2240.00	22.39	3000.00	1450.15	39.21	51.54	76.07	82.31	92.34	2.31
191.40	2240.00	22.99	2400.00	1166.64	31.99	41.46	77.14	84.52	91.83	2.37
187.90	2240.00	23.76	1800.00	884.12	24.56	31.42	78.15	87.37	90.88	2.45
170.00	2240.00	25.07	1200.00	596.97	17.48	21.22	82.40	92.19	89.73	2.59
180.30	2240.00	25.96	600.00	312.50	9.17	11.11	82.58	95.45	85.70	2.68
183.00	2240.00	26.78	200.00	124.59	3.82	4.43	88.21	98.48	71.66	2.76
197.70	1680.00	15.89	3000.00	1438.66	26.21	38.35	68.35	73.97	93.88	2.82
194.30	1680.00	15.95	2400.00	1163.61	22.11	31.82	71.29	78.17	92.82	2.19
192.00	1680.00	16.96	1800.00	884.31	17.41	23.57	73.85	82.64	90.86	2.32
189.00	1680.00	17.87	1200.00	584.62	12.51	15.58	80.29	87.58	91.62	2.46
186.70	1680.00	18.91	600.00	302.64	6.82	8.82	85.19	92.71	88.50	2.60
186.90	1680.00	19.54	200.00	108.48	2.63	2.89	90.99	95.78	82.30	2.69
205.60	1120.00	9.39	3000.00	1456.68	14.56	25.89	56.26	61.63	91.93	1.73
195.50	1120.00	9.44	2400.00	1174.10	12.98	20.82	62.28	69.41	91.24	1.95
192.50	1120.00	10.32	1800.00	829.69	10.63	15.63	67.99	75.90	91.34	2.13
182.30	1120.00	11.20	1200.00	586.30	7.83	10.42	75.14	82.93	91.36	2.33
186.70	1120.00	12.12	600.00	296.04	4.25	5.26	88.71	89.15	90.42	2.50
186.60	1120.00	12.21	200.00	109.00	1.41	1.94	72.72	93.42	81.90	2.62
205.00	875.00	5.40	3000.00	1461.52	9.44	20.29	46.52	50.83	91.62	1.43
200.40	875.00	6.48	2400.00	1172.33	8.91	16.35	54.51	61.00	90.99	1.71
196.50	875.00	7.51	1800.00	881.95	7.29	12.24	63.68	70.66	91.18	1.90
190.70	875.00	8.26	1200.00	583.22	5.62	8.10	69.92	72.21	91.26	2.18
190.40	875.00	9.22	600.00	296.28	3.19	4.12	72.46	86.81	90.24	2.43
182.30	875.00	9.83	200.00	98.61	1.85	1.32	76.28	92.51	90.53	2.59

THE MAX. OVER ALL EFFICIENCY IS: 91.5541  
THE MIN. OVER ALL EFFICIENCY IS: 46.5211  
THE MAX. SIMPLE DISPLACEMENT IS: 2.80485

POWER CONVERSION TEST  
PUMP NUMBER M235720 RUN AT 120 DEGREES (F) INLET TEMP.

M235720

OUTLET TEMP(F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	WOL EFF (%)	MECH EFF (%)	SIM DIS in3/rev
134.40	2000.00	29.68	3000.00	1459.65	52.21	64.85	80.51	89.49	89.52	2.45
136.00	2000.00	30.33	2400.00	1191.26	42.52	52.92	80.34	91.44	87.25	2.50
138.00	2000.00	30.90	1800.00	932.74	32.61	41.44	78.70	93.16	84.05	2.55
133.20	2000.00	31.79	1200.00	526.51	21.98	24.22	88.90	95.83	93.92	2.62
125.50	2000.00	32.58	600.00	365.28	11.09	16.25	68.23	98.22	71.44	2.69
121.90	2000.00	33.17	200.00	189.85	3.39	8.43	40.22	100.00	45.88	2.74
131.10	2240.00	23.29	3000.00	1430.12	40.19	50.83	79.06	87.26	91.36	2.40
131.30	2240.00	23.88	2400.00	1125.65	32.52	41.28	72.95	89.69	88.91	2.45
128.00	2240.00	24.32	1800.00	932.83	24.26	33.13	74.25	91.82	84.12	2.51
126.30	2240.00	24.91	1200.00	522.28	12.53	18.24	93.55	93.82	99.12	2.52
120.20	2240.00	25.40	600.00	335.61	8.86	11.93	74.32	95.22	72.82	2.62
121.90	2240.00	25.93	200.00	120.26	2.28	6.82	44.50	92.23	51.81	2.62
130.10	1600.00	16.91	3000.00	1462.49	29.42	38.98	75.59	84.96	89.34	2.33
128.20	1600.00	17.26	2400.00	1184.00	24.52	31.56	72.68	86.22	88.28	2.32
125.50	1600.00	17.22	1800.00	902.45	18.53	24.19	76.59	89.28	86.39	2.44
119.00	1600.00	18.30	1200.00	529.99	12.80	15.46	82.82	91.95	90.12	2.52
121.60	1600.00	18.22	600.00	312.28	6.44	8.34	72.20	94.82	83.55	2.52
123.60	1600.00	19.08	200.00	124.85	1.86	3.59	51.81	95.86	64.60	2.62
139.00	1120.00	10.45	3000.00	1321.80	18.89	23.49	72.82	78.28	98.85	2.16
134.30	1120.00	10.86	2400.00	1022.65	15.33	19.15	80.83	81.86	92.00	2.24
126.30	1120.00	11.52	1800.00	811.04	12.81	14.41	83.30	86.81	96.66	2.38
119.00	1120.00	11.90	1200.00	562.19	8.40	10.80	83.39	89.69	92.15	2.45
120.90	1120.00	12.30	600.00	316.86	4.21	5.63	74.26	92.20	82.48	2.54
121.60	1120.00	12.51	200.00	142.19	1.29	2.62	49.29	94.29	50.18	2.58
129.20	560.00	4.63	3000.00	1489.82	8.12	12.53	64.28	69.84	92.68	1.91
134.10	560.00	5.82	2400.00	1146.82	2.13	10.19	69.95	76.42	91.14	2.09
132.60	560.00	5.56	1800.00	821.83	5.82	2.24	25.83	83.86	90.81	2.29
128.40	560.00	5.24	1200.00	596.82	4.81	5.30	25.23	86.42	82.69	2.32
126.00	560.00	6.86	600.00	329.62	2.83	2.93	69.36	91.39	29.22	2.50
124.30	560.00	6.19	200.00	140.69	0.58	1.25	46.34	93.33	61.91	2.55

THE MAX. OVER ALL EFFICIENCY IS: 93.5453  
THE MIN. OVER ALL EFFICIENCY IS: 40.2233  
THE MAX. SIMPLE DISPLACEMENT IS: 2.73661

POWER CONVERSION TEST  
PUMP NUMBER M235710 RUN AT 180 DEGREES (F) INLET TEMP.

M235710

OUTLET TEMP (F)	TOR. SPEED RPM	IND. FLOW (GPM)	TOR. PRESS. PSID	IND. TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MFOH EFF (%)	SIM DIS. in3/rev
195.00	2000.00	27.36	3000.00	1451.47	48.41	64.49	75.07	83.14	89.37	2.26
195.00	2000.00	28.78	2400.00	1179.77	41.11	52.39	78.46	87.44	87.95	2.37
189.00	2000.00	29.81	1800.00	981.00	31.84	48.83	79.54	90.59	86.37	2.46
188.70	2000.00	30.81	1200.00	619.43	22.09	27.52	88.28	95.62	83.77	2.54
186.60	2000.00	32.07	600.00	349.24	11.35	15.52	73.16	97.43	74.24	2.65
187.40	2000.00	32.91	200.00	166.05	3.71	7.38	58.29	100.00	52.05	2.77
195.90	2240.00	28.76	3000.00	1458.13	36.41	51.82	78.26	78.87	88.91	2.14
193.20	2240.00	21.79	2400.00	1190.77	38.87	42.32	71.85	82.25	87.18	2.25
189.90	2240.00	22.83	1800.00	989.85	23.58	32.34	72.66	86.71	85.49	2.35
190.50	2240.00	23.71	1200.00	629.36	16.68	22.37	74.57	90.85	82.48	2.45
183.80	2240.00	24.78	600.00	345.65	8.79	12.29	71.53	94.11	75.81	2.56
183.20	2240.00	25.45	200.00	148.89	3.21	5.29	68.68	96.64	58.85	2.62
196.40	1680.00	14.63	3000.00	1481.62	24.87	39.49	62.97	74.11	87.58	2.81
193.20	1680.00	15.56	2400.00	1187.55	21.88	31.66	68.87	78.82	87.33	2.14
184.50	1680.00	16.48	1800.00	983.21	16.97	24.88	78.48	83.46	86.17	2.77
181.00	1680.00	17.46	1200.00	622.23	12.15	16.59	73.26	88.41	83.34	2.48
185.00	1680.00	18.16	600.00	332.36	6.56	8.86	74.84	91.95	78.81	2.58
177.00	1680.00	18.87	200.00	155.28	1.88	4.14	43.47	95.54	55.69	2.59
201.60	1120.00	8.29	3000.00	1463.74	14.48	26.81	55.35	62.94	88.57	1.71
187.00	1120.00	9.37	2400.00	1191.67	12.99	21.18	61.33	71.15	87.83	1.93
189.90	1120.00	10.89	1800.00	984.89	18.62	16.88	66.85	76.65	85.96	2.08
186.00	1120.00	10.91	1200.00	615.39	7.81	18.94	71.48	82.89	84.27	2.25
186.30	1120.00	11.63	600.00	338.94	4.28	5.88	71.38	88.35	78.35	2.48
186.10	1120.00	12.38	200.00	133.88	1.51	2.36	63.93	93.43	64.94	2.54
209.20	560.00	3.28	3000.00	1453.89	5.47	12.91	42.36	48.68	89.22	1.37
198.40	560.00	4.87	2400.00	1191.59	5.62	18.59	55.85	61.28	87.84	1.68
192.10	560.00	4.66	1800.00	888.17	5.81	7.89	63.47	78.82	87.58	1.92
190.50	560.00	5.84	1200.00	1612.28	3.55	14.33	24.28	76.52	32.15	2.88
185.00	560.00	6.29	600.00	326.35	2.21	2.98	76.25	95.59	79.45	2.68
183.60	560.00	6.88	200.00	134.96	8.66	1.28	55.87	91.23	64.84	2.48

THE MAX. OVER ALL EFFICIENCY IS: 88.2791  
THE MIN. OVER ALL EFFICIENCY IS: 24.7769  
THE MAX. SIMPLE DISPLACEMENT IS: 2.71522



POWER CONVERSION TEST  
 PUMP NUMBER M23582 RUN AT 120 DEGREES (F) INLET TEMP.

M23582

INLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS (PSID)	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS inf/rev
130.10	2000.00	30.41	3000.00	1432.61	53.09	63.65	83.41	90.53	92.35	2.51
130.80	2000.00	30.01	2400.00	1159.32	41.83	51.51	81.21	89.35	91.30	2.48
127.10	2000.00	31.76	1800.00	881.38	33.22	39.16	84.84	94.55	90.02	2.62
120.30	2000.00	32.72	1200.00	606.84	22.87	26.96	84.02	92.41	87.21	2.70
124.80	2000.00	33.20	600.00	331.32	11.65	14.72	79.14	90.84	79.85	2.74
119.90	2000.00	33.59	200.00	147.92	6.36	6.52	96.78	100.00	59.61	2.72
126.90	2240.00	23.62	3000.00	1424.01	41.24	50.61	81.48	87.91	92.91	2.44
126.60	2240.00	24.21	2400.00	1144.29	33.89	40.69	83.30	90.09	92.46	2.50
124.20	2240.00	24.86	1800.00	862.96	26.03	30.85	84.32	92.51	91.46	2.56
118.80	2240.00	25.23	1200.00	594.85	12.82	21.14	84.51	95.26	88.92	2.65
119.40	2240.00	26.12	600.00	312.28	9.02	11.29	79.88	92.19	83.22	2.69
118.30	2240.00	26.52	200.00	125.62	3.93	4.42	82.89	90.21	70.19	2.74
125.90	1600.00	16.41	3000.00	1426.00	28.52	38.01	75.12	81.45	92.28	2.26
126.00	1600.00	17.13	2400.00	1136.64	23.99	30.30	79.19	84.90	93.12	2.35
122.10	1600.00	17.82	1800.00	859.89	18.68	22.92	81.48	88.62	92.32	2.46
126.60	1600.00	18.50	1200.00	581.53	12.95	15.50	83.52	91.82	91.01	2.54
122.20	1600.00	18.95	600.00	306.46	6.62	8.12	81.09	94.04	86.34	2.61
112.60	1600.00	19.32	200.00	123.80	2.21	3.30	66.94	96.12	71.24	2.66
126.30	1120.00	10.01	3000.00	1415.21	12.50	25.16	69.55	74.51	93.46	2.06
122.80	1120.00	10.55	2400.00	1134.08	14.68	20.15	72.82	78.50	93.33	2.18
125.80	1120.00	11.00	1800.00	859.85	11.51	15.28	75.35	81.82	92.32	2.22
123.30	1120.00	11.62	1200.00	582.22	8.12	10.36	78.86	86.88	90.81	2.41
119.00	1120.00	12.15	600.00	300.62	4.30	5.34	80.40	90.40	88.01	2.50
121.00	1120.00	12.49	200.00	112.24	1.35	1.99	62.45	92.92	78.59	2.58
133.40	800.00	5.29	3000.00	1415.01	10.10	12.96	56.23	60.36	93.50	1.62
129.40	800.00	6.65	2400.00	1135.19	9.26	14.41	64.24	69.30	93.24	1.92
128.50	800.00	7.36	1800.00	858.33	7.21	10.90	70.22	76.24	92.49	2.13
123.80	800.00	7.92	1200.00	526.82	5.49	7.32	74.91	82.50	91.25	2.29
120.50	800.00	8.41	600.00	292.42	2.89	3.21	72.89	82.65	90.48	2.43
118.40	800.00	8.65	200.00	109.00	0.96	1.30	69.52	90.89	80.92	2.50

THE MAX. OVER ALL EFFICIENCY IS: 96.7839  
 THE MIN. OVER ALL EFFICIENCY IS: 56.2322  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.77101

POWER CONVERSION TEST  
 PUMP NUMBER M23581 RUN AT 180 DEGREES (F) INLET TEMP.

M23581

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ INH RS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS. in3/rev
195.58	2800.00	27.11	3000.00	1433.16	47.49	63.67	74.58	82.16	98.78	2.74
196.00	2800.00	28.39	2400.00	1152.96	39.65	51.77	77.40	86.83	98.19	2.34
194.78	2800.00	29.77	1800.00	888.16	31.00	39.18	79.78	98.87	88.61	2.45
178.38	2800.00	31.20	1200.00	682.58	21.88	26.77	81.45	94.55	86.38	2.57
188.32	2800.00	32.48	600.00	321.47	11.38	14.28	79.14	98.42	88.87	2.68
182.38	2800.00	33.88	200.00	145.71	5.33	6.47	82.38	100.00	59.47	2.77
196.48	2740.00	28.23	3000.00	1432.99	35.29	58.93	69.38	76.64	96.71	2.89
186.68	2740.00	21.54	2400.00	1156.59	38.86	41.11	73.13	81.61	89.91	2.77
184.00	2740.00	22.69	1800.00	876.87	23.66	31.14	75.98	85.97	89.82	2.34
179.28	2740.00	24.18	1200.00	593.58	16.83	21.89	79.77	91.38	87.68	2.49
182.00	2740.00	25.37	600.00	313.12	8.83	11.13	79.36	96.18	83.82	2.62
183.18	2740.00	26.86	200.00	119.88	3.38	4.26	77.51	98.71	77.29	2.69
189.58	1680.00	13.69	3000.00	1423.55	24.82	32.95	63.38	69.15	91.31	1.88
198.78	1680.00	14.66	2400.00	1148.53	28.47	38.62	66.86	74.82	98.54	2.82
187.88	1680.00	15.64	1800.00	862.85	16.29	23.13	78.42	79.81	89.82	2.15
188.00	1680.00	17.12	1200.00	582.86	11.92	15.67	76.88	86.46	88.45	2.35
179.58	1680.00	18.29	600.00	383.88	6.29	8.18	77.66	92.38	85.52	2.51
183.98	1680.00	19.88	200.00	116.58	2.89	3.11	67.18	95.94	74.33	2.61
189.88	1120.00	7.11	3000.00	1429.17	12.41	25.48	48.88	53.86	98.95	1.42
193.28	1120.00	8.86	2400.00	1148.81	11.23	28.77	55.41	61.85	91.15	1.66
188.38	1120.00	9.18	1800.00	883.98	9.62	15.35	62.64	69.52	98.27	1.89
185.28	1120.00	10.26	1200.00	588.73	7.15	18.32	69.38	72.73	89.53	2.12
185.28	1120.00	11.41	600.00	298.26	3.91	5.38	73.81	86.42	82.16	2.35
182.00	1120.00	12.38	200.00	189.64	1.36	1.95	69.62	93.28	79.84	2.54
223.58	800.00	3.88	3000.00	1429.18	5.26	18.14	29.81	31.82	98.95	8.82
198.88	800.00	4.32	2400.00	1143.93	6.18	14.52	42.83	46.38	98.98	1.26
189.28	800.00	5.63	1800.00	873.88	5.89	11.88	53.13	58.62	89.33	1.62
182.68	800.00	6.83	1200.00	581.96	4.73	7.39	64.86	72.41	89.34	1.92
178.58	800.00	7.89	600.00	295.25	2.72	3.25	72.53	83.68	88.85	2.28
179.48	800.00	8.61	200.00	184.85	8.95	1.32	72.89	91.33	82.28	2.49

THE MAX. OVER ALL EFFICIENCY IS: 82.2978  
 THE MIN. OVER ALL EFFICIENCY IS: 29.814  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.72235

POWER CONVERSION TEST  
PUMP NUMBER M23592 RUN AT 120 DEGREES (F) INLET TEMP.

M23592

OUTLET TEMP (F)	THR. SPEED RPM	ADJ FLOW GPM	THR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS inf3/rev
127.70	2000.00	30.77	3000.00	1438.20	53.79	63.90	84.18	91.36	92.26	2.54
127.70	2000.00	31.43	2400.00	1161.69	43.80	51.61	84.87	93.29	91.37	2.58
122.10	2000.00	32.12	1800.00	891.23	33.65	39.60	84.98	95.36	89.33	2.65
123.00	2000.00	32.29	1200.00	614.41	22.81	27.30	83.57	97.33	86.30	2.70
123.40	2000.00	33.37	600.00	336.28	11.49	14.94	76.91	99.06	78.91	2.75
122.70	2000.00	33.68	200.00	144.32	6.11	6.41	95.22	100.00	61.29	2.78
126.20	2740.00	23.93	3000.00	1473.87	41.76	50.61	82.51	88.80	93.19	2.47
124.50	2740.00	24.49	2400.00	1153.26	34.10	40.99	83.18	90.89	92.04	2.53
122.40	2740.00	25.17	1800.00	877.33	26.20	31.18	84.03	93.41	90.74	2.60
119.10	2740.00	25.78	1200.00	592.52	18.05	21.06	85.70	95.65	89.57	2.66
117.00	2740.00	26.31	600.00	326.86	9.06	11.62	77.97	97.65	81.19	2.71
118.90	2740.00	26.66	200.00	149.25	3.72	5.30	70.17	98.93	59.27	2.75
120.20	1600.00	16.73	3000.00	1473.00	29.14	37.93	76.82	82.78	93.24	2.30
122.60	1600.00	17.47	2400.00	1148.87	24.30	30.62	79.61	86.43	92.39	2.40
125.10	1600.00	18.07	1800.00	869.83	18.79	23.19	81.05	89.41	91.52	2.48
122.60	1600.00	18.65	1200.00	591.10	13.03	15.76	82.70	92.27	89.29	2.56
120.50	1600.00	19.17	600.00	311.96	6.56	8.32	78.88	94.83	85.82	2.64
118.40	1600.00	19.55	200.00	131.36	2.13	3.50	60.70	96.22	62.34	2.69
127.00	1120.00	10.14	3000.00	1419.35	17.71	25.22	70.22	75.28	93.48	2.09
124.10	1120.00	10.71	2400.00	1142.88	14.90	20.31	73.35	79.50	92.88	2.21
121.00	1120.00	11.30	1800.00	861.35	11.77	15.31	76.90	83.84	92.43	2.33
119.20	1120.00	11.80	1200.00	585.91	8.20	10.41	78.76	82.54	90.58	2.43
117.00	1120.00	12.21	600.00	301.90	4.16	5.32	77.55	90.64	82.88	2.52
117.20	1120.00	12.49	200.00	118.24	1.33	2.10	63.24	92.71	74.81	2.58
130.20	720.00	4.95	3000.00	1452.73	8.59	16.60	51.76	52.15	91.33	1.59
133.00	720.00	5.69	2400.00	1158.12	8.22	13.23	62.15	67.99	91.65	1.89
129.00	720.00	6.45	1800.00	866.53	6.72	9.90	68.32	74.52	91.82	2.02
125.30	720.00	6.95	1200.00	578.20	4.83	6.61	73.14	80.20	91.29	2.23
121.60	720.00	7.26	600.00	301.00	2.50	3.45	72.50	83.82	82.93	2.33
118.00	720.00	7.28	200.00	111.25	0.80	1.22	63.15	89.28	79.51	2.49

THE MAX. OVER ALL EFFICIENCY IS: 95.2245  
THE MIN. OVER ALL EFFICIENCY IS: 51.7594  
THE MAX. SIMPLE DISPLACEMENT IS: 2.77892

POWER CONVERSION TEST  
PUMP NUMBER M23591 RUN AT 180 DEGREES (F) INLET TEMP.

M23591

OUTLET TEMP (F)	TORR. SPEED RPM	ADJ FLOW CFM	TORR PRESS. PSID	ADJ TORR IN-LES	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SM DIS. int3rev
187.00	2000.00	27.90	3000.00	1448.79	48.62	64.81	75.96	83.81	91.83	2.30
191.40	2000.00	28.82	2400.00	1162.25	48.19	51.64	77.84	86.56	90.28	2.38
183.50	2000.00	30.01	1800.00	879.64	31.55	39.88	80.74	90.14	89.46	2.48
185.20	2000.00	31.24	1200.00	601.16	21.60	26.71	80.89	93.82	87.77	2.50
176.90	2000.00	32.46	600.00	323.45	11.32	14.32	78.77	92.50	81.10	2.68
176.00	2000.00	33.30	200.00	151.64	4.31	6.74	64.04	100.00	52.66	2.75
189.10	2240.00	20.80	3000.00	1420.33	36.46	50.77	71.82	78.89	91.82	2.15
191.00	2240.00	21.75	2400.00	1150.91	30.26	40.91	73.98	81.65	91.17	2.24
187.20	2240.00	22.98	1800.00	874.72	24.02	31.89	72.26	86.22	89.96	2.32
190.30	2240.00	24.34	1200.00	578.28	17.22	20.55	84.04	91.32	90.22	2.51
188.30	2240.00	25.43	600.00	311.48	8.81	11.82	79.55	95.45	84.21	2.62
180.20	2240.00	26.13	200.00	143.82	3.31	5.11	64.72	98.88	60.29	2.69
190.00	1600.00	13.62	3000.00	1434.30	23.88	30.23	62.46	68.43	91.44	1.88
182.60	1600.00	14.80	2400.00	1148.50	20.82	30.62	68.18	74.06	91.36	2.03
182.10	1600.00	16.11	1800.00	864.82	16.96	23.85	73.56	80.63	90.19	2.21
184.40	1600.00	17.09	1200.00	589.19	11.89	15.21	75.69	85.52	89.04	2.33
184.90	1600.00	18.25	600.00	303.40	6.34	8.89	78.41	91.34	86.46	2.51
183.60	1600.00	19.30	200.00	117.21	2.13	3.12	68.14	96.61	74.60	2.65
206.10	1120.00	7.86	3000.00	1448.39	12.41	25.24	48.20	53.83	90.55	1.46
195.00	1120.00	8.83	2400.00	1123.95	11.18	20.86	53.61	60.29	89.38	1.66
182.00	1120.00	9.45	1800.00	821.28	9.94	15.48	64.21	70.93	90.32	1.95
186.20	1120.00	10.45	1200.00	585.00	7.33	10.40	70.51	78.48	89.68	2.16
172.90	1120.00	11.61	600.00	296.24	3.98	5.22	75.52	82.16	88.40	2.39
179.40	1120.00	12.35	200.00	100.62	1.31	1.93	62.66	92.26	80.50	2.53
222.50	720.00	2.60	3000.00	1495.10	4.50	12.00	26.33	30.33	82.22	0.83
202.10	720.00	3.23	2400.00	1191.34	5.21	13.61	38.31	43.61	88.82	1.20
198.40	720.00	4.92	1800.00	901.94	5.15	10.30	49.94	52.99	82.25	1.59
182.90	720.00	6.11	1200.00	590.59	4.18	6.84	61.13	71.33	82.64	1.90
183.40	720.00	7.12	600.00	298.99	2.45	3.42	71.82	83.25	82.23	2.30
180.00	720.00	7.26	200.00	104.14	0.85	1.19	71.22	90.68	82.96	2.49

THE MAX. OVER ALL EFFICIENCY IS: 84.0361  
THE MIN. OVER ALL EFFICIENCY IS: 26.3326  
THE MAX. SIMPLE DISPLACEMENT IS: 2.74692

POWER CONVERSION TEST  
PUMP NUMBER N23602 RUN AT 120 DEGREES (F) INLET TEMP.

N23602

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS in <sup>3</sup> /rev
134.20	2000.00	29.49	3000.00	1462.00	52.39	64.99	80.61	86.85	91.44	2.43
129.60	2000.00	30.55	2400.00	1194.13	42.40	53.05	79.92	89.96	89.62	2.52
125.00	2000.00	31.44	1800.00	983.98	33.14	40.16	82.53	92.59	88.79	2.59
126.90	2000.00	32.32	1200.00	624.52	23.21	27.75	83.65	95.17	85.68	2.67
119.50	2000.00	33.20	600.00	339.34	12.07	15.00	80.07	97.70	78.04	2.74
119.20	2000.00	33.96	200.00	142.07	4.46	6.31	70.70	100.00	62.77	2.80
132.20	2240.00	22.45	3000.00	1462.05	39.93	51.99	76.00	82.62	91.44	2.31
126.20	2240.00	23.51	2400.00	1181.72	32.00	42.00	76.10	86.54	90.56	2.42
124.50	2240.00	24.22	1800.00	894.50	25.45	31.29	80.06	89.13	89.72	2.50
122.00	2240.00	25.01	1200.00	612.61	17.89	21.77	82.16	92.07	87.34	2.58
126.30	2240.00	25.00	600.00	325.35	9.33	11.56	80.69	94.95	82.23	2.66
122.10	2240.00	26.71	200.00	142.17	2.56	5.05	50.59	90.32	62.73	2.75
134.90	1600.00	15.74	3000.00	1443.70	27.46	30.40	71.34	77.23	92.66	2.16
134.50	1600.00	16.46	2400.00	1169.15	22.00	31.17	73.41	80.77	91.53	2.26
130.50	1600.00	17.35	1800.00	885.25	17.04	23.61	75.57	85.15	90.61	2.39
126.90	1600.00	18.13	1200.00	602.19	13.23	16.05	82.43	88.90	88.85	2.49
124.60	1600.00	18.95	600.00	318.56	6.67	8.49	78.52	93.00	83.90	2.61
121.90	1600.00	19.67	200.00	126.11	2.42	3.36	72.12	96.54	70.72	2.70
142.20	1120.00	8.20	3000.00	1459.52	15.62	25.94	60.21	64.65	91.65	1.81
135.00	1120.00	9.21	2400.00	1120.62	13.52	20.00	65.25	71.40	91.42	2.00
131.20	1120.00	10.62	1800.00	885.89	11.10	15.74	71.04	78.22	90.60	2.19
125.30	1120.00	11.52	1200.00	593.25	8.30	10.54	79.45	84.29	90.19	2.30
125.50	1120.00	12.23	600.00	305.47	4.23	5.43	77.04	90.01	82.50	2.52
119.00	1120.00	12.26	200.00	116.01	1.51	2.00	72.60	93.96	76.34	2.63
142.30	875.00	5.45	3000.00	1462.76	9.66	20.30	47.39	51.34	91.14	1.44
132.60	875.00	6.20	2400.00	1181.14	9.22	16.40	59.25	63.09	90.60	1.79
134.10	875.00	7.25	1800.00	872.61	8.23	12.10	67.53	73.02	91.45	2.05
125.00	875.00	8.52	1200.00	589.01	6.22	8.10	76.62	80.24	90.04	2.26
122.40	875.00	9.33	600.00	306.52	3.16	4.20	73.20	82.09	86.20	2.46
116.30	875.00	9.90	200.00	120.01	1.09	1.62	65.25	93.24	74.31	2.61

THE MAX. OVER ALL EFFICIENCY IS: 83.6523  
THE MIN. OVER ALL EFFICIENCY IS: 47.39  
THE MAX. SIMPLE DISPLACEMENT IS: 2.80161

POWER CONVERSION TEST  
 PUMP NUMBER M23601 RUN AT 180 DEGREES (F) INLET TEMP.

M23601

OUTLET TEMP (F)	TRG. SPEED RPM	ADJ FLOW GPM	TRG PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	WOL EFF (%)	MECH EFF (%)	SIM DIS INCHES
196.50	2000.00	25.94	3000.00	1478.43	46.21	65.33	70.74	77.40	89.77	2.14
194.70	2000.00	27.09	2400.00	1185.54	38.25	52.67	72.63	80.85	89.00	2.24
188.10	2000.00	28.82	1800.00	901.18	30.83	40.04	75.00	85.99	87.89	2.38
186.00	2000.00	30.84	1200.00	622.21	21.78	27.64	78.78	92.03	84.86	2.54
184.70	2000.00	32.06	600.00	335.94	11.46	14.97	76.78	95.67	78.59	2.64
186.60	2000.00	33.51	200.00	139.07	3.73	6.18	68.34	100.00	63.28	2.76
192.50	2240.00	19.21	3000.00	1482.18	33.32	52.68	63.26	71.66	89.06	1.98
191.20	2240.00	20.67	2400.00	1183.77	28.98	42.07	68.88	77.09	89.21	2.13
186.70	2240.00	21.94	1800.00	892.36	23.83	31.72	72.68	81.82	88.76	2.26
186.30	2240.00	23.38	1200.00	618.98	16.52	21.72	76.09	87.20	86.42	2.41
179.70	2240.00	24.85	600.00	317.92	9.13	11.30	80.78	92.69	83.04	2.56
179.40	2240.00	26.18	200.00	122.36	3.30	4.35	75.79	92.66	71.92	2.70
180.30	1600.00	12.44	3000.00	1477.52	22.83	39.39	55.93	61.88	89.34	1.71
185.70	1600.00	13.78	2400.00	1181.78	19.29	31.50	61.25	68.52	89.36	1.89
183.10	1600.00	15.36	1800.00	891.64	16.06	23.72	62.52	76.32	88.83	2.11
182.10	1600.00	16.58	1200.00	606.76	12.04	16.12	74.46	82.48	82.02	2.28
182.50	1600.00	18.00	600.00	302.85	6.39	8.21	72.98	89.51	85.76	2.42
182.10	1600.00	19.22	200.00	113.73	2.21	3.83	72.83	95.52	72.38	2.64
215.80	1120.00	5.46	3000.00	1462.11	9.42	25.98	36.46	40.20	90.26	1.13
202.50	1120.00	6.81	2400.00	1179.85	9.60	20.92	45.81	50.83	89.51	1.41
192.00	1120.00	8.32	1800.00	884.49	8.82	15.22	56.43	62.03	89.55	1.72
184.70	1120.00	9.92	1200.00	594.23	7.00	10.56	66.32	73.98	89.81	2.05
178.60	1120.00	11.21	600.00	299.01	3.98	5.31	74.89	83.63	88.29	2.31
178.00	1120.00	12.31	200.00	102.19	1.42	1.90	72.08	91.80	82.10	2.54
209.20	875.00	3.83	3000.00	1426.85	5.42	20.50	26.65	36.59	89.28	1.01
211.00	875.00	3.78	2400.00	1184.16	5.39	16.44	32.72	36.02	89.18	1.00
195.00	875.00	5.20	1800.00	893.76	5.99	12.41	40.24	54.40	89.62	1.50
184.70	875.00	7.28	1200.00	598.96	5.02	8.20	61.19	69.35	89.35	1.92
182.30	875.00	8.50	600.00	301.92	2.84	4.19	62.68	81.13	82.44	2.24
181.30	875.00	9.35	200.00	105.92	1.14	1.42	72.26	89.20	83.05	2.42

THE MAX. OVER ALL EFFICIENCY IS: 80.7797  
 THE MIN. OVER ALL EFFICIENCY IS: 26.6546  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.7647

POWER CONVERSION TEST  
PUMP NUMBER M23612 RUN AT 120 DEGREES (F) INLET TEMP.

M23612

INLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS (PSID)	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VM EFF (%)	MCH EFF (%)	SM DIS int3rev
131.00	2000.00	29.64	2000.00	1447.37	51.99	64.38	80.86	86.04	93.75	2.45
129.40	2000.00	30.71	2400.00	1177.78	42.97	52.37	82.13	89.15	92.17	2.53
125.70	2000.00	31.87	1800.00	889.37	33.86	39.51	83.66	92.38	91.54	2.63
115.30	2000.00	32.85	1200.00	619.35	23.76	27.57	86.36	95.35	87.63	2.71
0.00	2000.00	0.00	600.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
124.20	2000.00	34.45	200.00	134.89	5.25	5.99	87.61	100.00	67.06	2.84
134.30	2240.00	27.68	2000.00	1439.01	39.55	51.15	77.33	82.31	94.29	2.34
134.60	2240.00	23.67	2400.00	1161.87	32.47	41.30	78.63	85.71	93.47	2.44
130.00	2240.00	24.63	1800.00	883.70	25.11	31.41	79.93	89.39	92.12	2.54
124.60	2240.00	25.56	1200.00	600.61	18.34	21.35	85.91	92.75	90.36	2.64
124.90	2240.00	26.57	600.00	325.85	8.00	11.58	69.11	96.77	93.28	2.73
126.50	2240.00	27.87	200.00	134.81	2.74	4.79	57.21	98.77	67.10	2.79
133.00	1600.00	16.87	2000.00	1440.22	27.47	38.39	71.55	77.78	94.21	2.71
131.20	1600.00	16.94	2400.00	1151.15	23.08	30.69	75.73	81.96	94.29	2.33
128.40	1600.00	17.86	1800.00	868.99	18.13	23.16	78.26	86.42	93.68	2.46
124.70	1600.00	18.67	1200.00	591.90	12.97	15.78	82.19	90.34	91.69	2.57
126.00	1600.00	19.37	600.00	308.37	6.69	8.77	81.38	93.73	68.00	2.66
126.70	1600.00	19.98	200.00	124.06	1.93	3.31	58.41	96.65	72.91	2.75
136.60	1120.00	9.39	2000.00	1440.40	15.96	25.60	62.36	68.12	94.20	1.94
133.50	1120.00	10.20	2400.00	1155.57	13.85	20.54	67.45	74.06	93.93	2.10
130.00	1120.00	11.10	1800.00	870.38	11.28	15.47	72.91	80.55	93.53	2.29
129.50	1120.00	11.68	1200.00	586.71	8.35	10.43	80.00	86.77	92.50	2.45
124.20	1120.00	12.58	600.00	304.87	3.98	5.42	73.41	91.28	89.01	2.59
125.10	1120.00	13.87	200.00	107.96	1.30	1.92	67.60	94.87	83.78	2.70
143.20	875.00	6.14	2000.00	1443.84	10.60	20.05	52.89	57.05	93.97	1.62
133.00	875.00	7.26	2400.00	1159.58	10.00	16.10	62.69	67.44	93.61	1.92
129.20	875.00	8.15	1800.00	877.01	8.40	12.18	69.65	75.71	92.83	2.15
127.20	875.00	8.97	1200.00	585.76	6.19	8.13	76.12	83.36	92.66	2.32
123.20	875.00	9.75	600.00	306.64	3.01	4.26	70.61	90.54	88.50	2.52
122.00	875.00	10.19	200.00	105.82	0.91	1.47	61.62	94.63	85.48	2.69

THE MAX. OVER ALL EFFICIENCY IS: 87.6084  
THE MIN. OVER ALL EFFICIENCY IS: 52.8083  
THE MAX. SIMPLE DISPLACEMENT IS: 2.84175

POWER CONVERSION TEST  
PUMP NUMBER M23611 RUN AT 180 DEGREES (F) INLET TEMP.

M23611

INLET TEMP (F)	TRG. SPEED RPM	ADJ FLOW GPM	TRG PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	MECH EFF (%)	STP DISC ind3rev	
190.30	2000.00	26.84	3000.00	1459.87	46.63	64.86	71.89	79.10	91.56	2.21
184.80	2000.00	28.00	2400.00	1176.73	38.71	52.28	74.04	82.51	90.87	2.31
185.10	2000.00	29.46	1800.00	884.58	30.05	39.30	76.46	86.83	90.66	2.43
184.20	2000.00	30.94	1200.00	600.50	22.36	26.68	83.81	91.19	89.83	2.55
178.90	2000.00	32.82	600.00	323.78	11.00	14.38	77.82	96.73	82.57	2.71
175.80	2000.00	33.93	200.00	134.35	3.61	5.97	60.54	100.00	66.33	2.80
180.80	2240.00	19.93	3000.00	1457.97	34.24	51.64	66.31	73.43	91.99	2.06
190.80	2240.00	20.81	2400.00	1168.84	29.89	41.54	70.82	76.65	91.48	2.15
184.90	2240.00	22.50	1800.00	883.10	23.00	31.39	73.27	82.88	90.82	2.32
191.80	2240.00	23.96	1200.00	597.63	16.72	21.24	78.73	88.76	89.46	2.47
181.10	2240.00	25.59	600.00	317.51	8.58	11.28	76.06	94.28	84.20	2.64
175.60	2240.00	26.63	200.00	127.16	3.00	4.52	66.40	98.10	78.06	2.75
192.50	1600.00	13.77	3000.00	1456.06	23.73	38.81	61.15	67.65	91.80	1.89
187.40	1600.00	14.27	2400.00	1170.05	19.65	31.19	63.81	78.10	91.39	1.96
185.90	1600.00	15.25	1800.00	880.66	15.95	23.48	67.95	77.37	91.87	2.17
182.30	1600.00	17.10	1200.00	590.43	12.04	15.74	76.48	83.97	90.55	2.35
180.40	1600.00	18.61	600.00	304.23	6.21	8.11	76.56	91.39	82.87	2.56
173.80	1600.00	19.57	200.00	112.03	2.10	2.99	78.32	96.14	79.54	2.69
204.00	1120.00	6.32	3000.00	1461.36	11.04	25.97	42.53	46.57	91.47	1.30
192.50	1120.00	7.51	2400.00	1175.30	10.38	20.89	49.68	55.30	90.98	1.55
184.00	1120.00	9.11	1800.00	874.50	9.31	15.54	59.93	67.10	91.71	1.88
191.10	1120.00	10.40	1200.00	588.49	7.23	10.46	69.14	76.62	90.85	2.15
181.60	1120.00	11.81	600.00	301.11	3.84	5.35	71.28	82.00	88.28	2.44
180.20	1120.00	12.63	200.00	104.62	1.68	1.86	90.19	93.08	85.17	2.61
208.20	875.00	3.25	3000.00	1477.82	5.61	20.52	27.33	30.66	90.45	0.86
199.00	875.00	4.95	2400.00	1174.19	6.82	16.30	41.83	46.67	91.82	1.31
185.30	875.00	6.36	1800.00	887.21	6.45	12.32	52.35	58.99	90.39	1.68
172.60	875.00	7.27	1200.00	591.12	5.33	8.21	64.89	73.31	90.45	2.05
175.30	875.00	9.82	600.00	296.71	2.89	4.12	70.14	85.54	90.10	2.39
190.50	875.00	9.74	200.00	100.13	1.18	1.39	84.93	91.82	88.99	2.52

THE MAX. OVER ALL EFFICIENCY IS: 90.1909  
THE MIN. OVER ALL EFFICIENCY IS: 27.3265  
THE MAX. SIMPLE DISPLACEMENT IS: 2.79945



POWER CONVERSION TEST  
 PUMP NUMBER M33622 RUN AT 120 DEGREES (F) INLET TEMP.

M33622

(NM) FT TEMP (F)	TOR. SPEED RPM	ADJ FLOW GPM	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS in3/rev
128.00	1000.00	20.00	2500.00	1298.47	36.37	37.00	81.76	92.36	88.89	2.68
125.30	1000.00	21.00	2000.00	1067.34	24.40	30.34	80.40	93.30	86.91	2.71
122.00	1000.00	21.37	1500.00	887.87	18.54	27.93	80.84	94.57	86.25	2.74
120.90	1000.00	21.77	1000.00	588.87	12.47	15.96	78.13	96.00	87.61	2.79
119.70	1000.00	22.20	500.00	300.40	6.35	8.58	73.90	98.56	76.04	2.86
118.60	1000.00	22.60	200.00	144.49	2.91	4.13	70.50	100.00	63.90	2.90
126.70	1440.00	15.95	2500.00	1293.61	23.00	29.56	78.09	88.20	89.27	2.56
124.20	1440.00	16.20	2000.00	1041.11	18.79	23.79	79.00	89.61	88.68	2.60
120.60	1440.00	16.45	1500.00	797.26	14.26	18.10	78.75	90.99	87.40	2.64
119.90	1440.00	16.81	1000.00	549.73	9.69	12.55	77.27	92.95	84.05	2.70
119.70	1440.00	17.41	500.00	291.37	4.91	6.66	73.87	96.31	79.73	2.79
119.90	1440.00	17.80	200.00	139.05	1.94	3.18	61.27	98.90	66.40	2.87
120.00	1000.00	18.71	2500.00	1281.90	15.50	21.97	70.94	78.96	90.03	2.79
120.00	1000.00	18.87	2000.00	1020.66	12.63	17.49	72.20	80.13	90.46	2.37
126.00	1000.00	11.31	1500.00	763.24	9.83	13.00	75.15	83.30	90.73	2.47
119.70	1000.00	12.10	1000.00	574.46	6.97	8.99	77.54	89.21	88.07	2.50
123.60	1000.00	12.71	500.00	275.73	3.67	4.73	76.70	93.69	83.71	2.77
123.70	1000.00	13.16	200.00	127.07	1.36	2.18	62.64	97.07	77.69	2.81
136.00	720.00	5.57	2500.00	1255.93	8.07	14.35	56.27	61.65	91.89	1.79
129.00	720.00	6.43	2000.00	1018.20	7.51	11.63	64.57	71.13	90.68	2.06
122.70	720.00	6.71	1500.00	770.20	5.76	8.00	65.50	74.19	89.91	2.15
120.20	720.00	7.00	1000.00	519.30	4.10	5.93	70.47	78.47	88.88	2.77
116.90	720.00	8.01	500.00	276.56	2.20	3.16	72.14	88.50	83.46	2.57
121.60	720.00	8.40	200.00	123.67	0.90	1.41	63.53	92.88	74.69	2.69

THE MAX. OVER ALL EFFICIENCY IS: 81.7636  
 THE MIN. OVER ALL EFFICIENCY IS: 56.2171  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.90059

POWER CONVERSION TEST  
PUMP NUMBER M33621 RUN AT 180 DEGREES (F) INLET TEMP.

M33621

OUTLET TEMP(F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	VOI EFF (%)	MFOH EFF (%)	SIM DIS in <sup>3</sup> /rev
180.00	1800.00	19.97	2500.00	1381.55	28.97	37.17	77.93	88.00	89.00	2.56
183.30	1800.00	20.14	2000.00	1045.07	23.32	29.05	78.13	88.74	88.70	2.58
182.30	1800.00	20.45	1500.00	796.90	17.74	22.76	77.95	90.13	87.74	2.62
182.10	1800.00	21.01	1000.00	538.21	12.13	15.37	78.94	92.59	86.11	2.70
182.50	1800.00	21.75	500.00	287.44	6.19	8.21	75.35	95.87	80.62	2.79
183.20	1800.00	22.69	200.00	133.17	2.54	3.00	66.81	100.00	69.68	2.91
187.20	1440.00	13.86	2500.00	1273.67	20.20	29.10	69.41	76.33	90.91	2.22
190.00	1440.00	14.14	2000.00	1021.92	16.46	23.35	70.48	77.90	90.70	2.27
184.00	1440.00	15.28	1500.00	790.01	13.23	18.05	73.29	84.70	88.00	2.45
178.00	1440.00	15.97	1000.00	539.56	9.18	12.33	74.48	87.99	85.89	2.56
180.40	1440.00	16.63	500.00	278.34	4.78	6.36	75.14	91.60	83.25	2.67
181.50	1440.00	17.50	200.00	130.69	1.88	2.99	63.11	96.42	78.92	2.81
196.00	1800.00	8.72	2500.00	1290.89	12.75	22.12	57.65	64.04	89.75	1.86
191.00	1800.00	8.95	2000.00	1018.77	10.45	17.45	59.86	65.70	91.03	1.91
188.30	1800.00	9.70	1500.00	776.31	8.42	13.30	63.28	71.23	89.55	2.07
187.50	1800.00	10.59	1000.00	525.15	6.07	9.00	67.41	77.79	88.75	2.22
177.00	1800.00	11.94	500.00	275.89	3.45	4.73	72.94	87.69	83.99	2.53
181.20	1800.00	12.75	200.00	124.66	1.34	2.14	62.55	93.62	74.36	2.73
201.00	720.00	3.91	2500.00	1254.95	5.68	14.34	39.62	43.03	92.33	1.25
195.40	720.00	4.81	2000.00	1002.90	5.63	11.46	49.17	52.98	92.42	1.54
185.50	720.00	4.68	1500.00	787.60	4.05	9.00	45.04	51.57	88.22	1.50
187.10	720.00	5.75	1000.00	518.00	3.34	5.93	56.30	63.38	89.33	1.85
186.50	720.00	7.00	500.00	262.95	2.05	3.00	68.20	77.13	88.12	2.25
184.00	720.00	8.15	200.00	114.90	0.90	1.31	68.45	89.76	80.62	2.61

THE MAX. OVER ALL EFFICIENCY IS: 78.9374  
THE MIN. OVER ALL EFFICIENCY IS: 39.62  
THE MAX. SIMPLE DISPLACEMENT IS: 2.91196

POWER CONVERSION TEST  
 PUMP NUMBER N33632 RUN AT 120 DEGREES (F) INLET TEMP.

N33632

OUTLET TEMP (F)	TOR. SPEED RPM	OUT FLOW CFM	TOR. PRESS. PSID	ADJ TORQ JH-PS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	OVER EFF (%)	MCH EFF (%)	SIM DIS. in <sup>3</sup> /rev
122.90	1800.00	21.40	2500.00	1334.41	31.10	38.11	81.61	93.35	87.77	2.75
123.70	1800.00	21.61	2000.00	1063.11	25.17	30.36	82.90	94.77	88.00	2.77
122.90	1800.00	21.95	1500.00	827.77	19.06	23.50	81.12	95.77	85.36	2.82
119.50	1800.00	22.28	1000.00	570.64	12.80	16.30	78.54	97.19	82.05	2.86
121.70	1800.00	22.70	500.00	310.63	6.54	8.87	73.71	99.02	75.36	2.91
117.30	1800.00	22.92	200.00	150.87	2.99	4.31	69.29	100.00	62.07	2.94
126.90	1440.00	16.36	2500.00	1303.58	23.80	29.78	79.92	89.21	89.79	2.62
125.90	1440.00	16.62	2000.00	1056.66	19.32	24.14	80.82	90.63	88.62	2.57
122.70	1440.00	16.80	1500.00	811.83	14.49	18.55	78.13	91.64	86.51	2.70
121.30	1440.00	17.14	1000.00	553.96	9.92	12.66	78.79	93.48	84.52	2.75
122.10	1440.00	17.62	500.00	301.30	5.05	6.88	73.35	96.34	77.70	2.83
119.50	1440.00	18.01	200.00	147.05	2.01	3.36	59.82	98.23	63.68	2.89
124.00	1080.00	11.51	2500.00	1307.33	16.70	22.40	74.55	83.66	89.53	2.46
125.10	1080.00	11.69	2000.00	1056.79	13.53	18.11	74.71	85.01	88.61	2.50
122.60	1080.00	11.93	1500.00	793.51	10.41	13.60	76.58	86.74	88.50	2.55
120.40	1080.00	12.23	1000.00	551.91	7.03	9.46	74.34	88.93	84.83	2.62
125.90	1080.00	12.73	500.00	290.73	3.65	4.98	73.26	92.54	80.52	2.72
122.70	1080.00	13.02	200.00	130.66	1.43	2.24	63.92	94.66	71.67	2.78
120.50	720.00	6.68	2500.00	1209.65	9.73	14.73	66.01	72.85	90.26	2.14
126.00	720.00	6.59	2000.00	1005.77	7.70	11.71	65.74	71.89	91.33	2.11
122.10	720.00	6.94	1500.00	797.94	6.06	9.12	66.53	75.71	88.01	2.23
124.20	720.00	7.31	1000.00	537.29	4.22	6.14	69.56	79.20	87.14	2.34
124.40	720.00	7.93	500.00	285.28	2.28	3.26	70.05	86.46	82.06	2.54
120.10	720.00	8.31	200.00	125.31	0.93	1.43	64.25	90.61	74.73	2.62

THE MAX. OVER ALL EFFICIENCY IS: 82.8952  
 THE MIN. OVER ALL EFFICIENCY IS: 59.8174  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.94172

POWER CONVERSION TEST  
 PUMP NUMBER N33631 RUN AT 180 DEGREES (F) INLET TEMP.

N33631

OUTLET TEMP (F)	TRF. SPEED RPM	INJ. FLOW GPM	TRF. PRESS. PSID	INJ. TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOL EFF (%)	MECH EFF (%)	SIM DIS in <sup>3</sup> /rev
183.00	1800.00	20.26	2500.00	1306.91	29.37	37.33	78.69	89.44	88.51	2.60
184.30	1800.00	20.52	2000.00	1065.56	23.76	30.43	78.06	90.59	86.85	2.63
186.50	1800.00	20.85	1500.00	810.85	18.02	23.14	77.87	92.04	85.68	2.68
177.90	1800.00	21.42	1000.00	542.36	12.39	15.49	79.95	94.54	85.31	2.75
179.50	1800.00	22.02	500.00	294.68	6.31	8.42	75.02	97.22	78.51	2.83
180.00	1800.00	22.65	200.00	138.63	2.52	3.96	63.76	100.00	66.75	2.91
188.40	1440.00	15.35	2500.00	1308.64	22.29	29.90	74.53	84.69	88.39	2.46
183.50	1440.00	15.60	2000.00	1046.12	18.14	23.90	75.90	86.09	88.46	2.50
182.00	1440.00	15.90	1500.00	795.69	13.80	18.18	75.91	87.25	87.23	2.55
181.30	1440.00	16.37	1000.00	540.71	9.46	12.35	76.54	90.35	85.57	2.63
179.50	1440.00	16.99	500.00	284.97	4.93	6.51	75.70	93.25	81.18	2.73
179.70	1440.00	17.20	200.00	129.50	1.91	2.96	64.68	97.66	71.46	2.84
188.70	1800.00	9.90	2500.00	1773.89	14.53	21.83	66.56	72.84	90.00	2.12
188.00	1800.00	10.04	2000.00	1048.69	11.68	17.97	65.02	73.89	88.24	2.15
188.30	1800.00	11.01	1500.00	785.95	9.57	13.47	71.08	81.03	88.31	2.36
181.70	1800.00	11.47	1000.00	542.44	6.59	9.30	70.94	84.37	85.30	2.45
179.30	1800.00	12.21	500.00	283.58	3.49	4.86	71.91	89.83	81.58	2.61
178.70	1800.00	12.73	200.00	126.57	1.40	2.17	64.37	93.62	73.11	2.72
189.10	720.00	5.50	2500.00	1263.25	7.97	14.43	55.23	60.67	91.57	1.76
194.60	720.00	6.29	2000.00	1005.98	7.42	11.49	64.58	69.36	91.95	2.02
186.70	720.00	6.48	1500.00	777.01	5.56	8.88	62.68	71.47	89.32	2.08
185.50	720.00	7.22	1000.00	526.26	4.13	6.01	68.62	79.68	87.92	2.32
180.60	720.00	8.19	500.00	275.25	2.30	3.15	73.02	90.42	83.98	2.63
176.00	720.00	8.81	200.00	121.98	0.97	1.39	69.29	97.22	75.86	2.88

THE MAX. OVER ALL EFFICIENCY IS: 79.9547  
 THE MIN. OVER ALL EFFICIENCY IS: 55.229  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.90722

POWER CONVERSION TEST  
PUMP NUMBER M33642 RUN AT 120 DEGREES (F) INLET TEMP.

M33642

(OIL) FT TEMP (F)	TOR. SPEED RPM	ADJ FLOW GPM	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS in <sup>3</sup> /rev
133.70	1800.00	21.07	2500.00	1364.61	30.59	38.97	78.48	91.07	86.58	2.70
131.40	1800.00	21.36	2600.00	1050.30	24.59	31.37	78.39	92.29	86.06	2.74
129.50	1800.00	21.77	1500.00	838.78	19.00	23.96	79.32	94.09	84.51	2.79
121.90	1800.00	22.22	1000.00	565.65	13.40	16.16	82.97	96.04	83.55	2.85
119.90	1800.00	22.78	500.00	305.16	6.74	8.77	77.31	98.46	77.43	2.92
117.10	1800.00	23.14	200.00	142.51	3.45	4.07	84.81	100.00	66.33	2.97
126.90	1440.00	16.31	2500.00	1328.20	23.82	30.35	78.48	88.10	88.95	2.62
125.30	1440.00	16.62	2000.00	1077.20	19.38	24.61	78.74	89.81	87.74	2.67
124.30	1440.00	16.91	1500.00	814.85	15.04	18.62	80.80	91.34	87.00	2.71
119.50	1440.00	17.31	1000.00	557.78	10.49	12.74	82.31	93.54	84.73	2.78
116.30	1440.00	17.91	500.00	303.17	5.10	6.93	73.57	96.74	77.94	2.82
118.00	1440.00	18.31	200.00	137.58	2.46	3.14	78.77	98.94	68.70	2.94
123.30	1800.00	11.39	2500.00	1338.48	16.78	22.94	73.17	82.07	88.77	2.44
120.30	1800.00	11.70	2000.00	1064.00	13.80	18.23	75.67	84.77	88.83	2.50
130.10	1800.00	12.17	1500.00	814.39	10.49	13.96	75.20	82.67	82.05	2.60
127.70	1800.00	12.55	1000.00	551.04	7.43	9.44	78.66	90.37	85.76	2.68
124.60	1800.00	13.13	500.00	288.75	4.01	4.81	83.36	94.57	84.16	2.81
122.00	1800.00	13.54	200.00	127.94	1.65	2.19	75.38	97.56	73.88	2.90
136.10	800.00	7.45	2500.00	1319.26	10.89	16.75	65.05	72.47	89.56	2.15
133.50	800.00	7.88	2000.00	1050.34	9.10	13.33	68.06	76.61	89.99	2.27
129.40	800.00	8.37	1500.00	797.18	7.43	10.12	73.40	81.38	88.97	2.42
127.00	800.00	8.83	1000.00	547.00	5.40	6.94	77.71	82.84	86.40	2.61
125.00	800.00	9.36	500.00	272.83	2.82	3.46	81.47	90.99	86.61	2.70
116.10	800.00	9.93	200.00	122.23	1.16	1.55	74.76	96.53	72.33	2.82

THE MAX. OVER ALL EFFICIENCY IS: 84.8136  
THE MIN. OVER ALL EFFICIENCY IS: 65.0515  
THE MAX. SIMPLE DISPLACEMENT IS: 2.96938

POWER CONVERSION TEST  
PUMP NUMBER M33641 RUN AT 180 DEGREES (F) INLET TEMP.

M33641

DISP. FT TEMP(F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	VOI EFF (%)	MECH EFF (%)	SIM DIS DISPLACEMENT
188.20	1800.00	19.97	2500.00	1337.35	28.75	38.20	75.26	87.77	87.36	2.56
189.20	1800.00	20.32	2000.00	1076.09	23.89	30.73	77.74	88.88	86.86	2.61
180.00	1800.00	20.84	1500.00	813.70	18.76	23.24	80.70	91.18	86.15	2.68
177.00	1800.00	21.64	1000.00	539.53	12.49	15.41	81.07	94.59	86.62	2.78
181.20	1800.00	22.54	500.00	291.55	6.09	8.33	73.20	98.53	80.14	2.89
184.50	1800.00	22.88	200.00	128.34	3.08	3.67	83.99	100.00	77.82	2.94
193.40	1440.00	14.57	2500.00	1312.22	21.18	29.98	70.65	79.61	89.83	2.34
189.60	1440.00	15.17	2000.00	1072.15	17.77	24.50	72.55	82.87	87.18	2.43
187.10	1440.00	15.73	1500.00	795.59	13.98	18.18	76.93	85.96	88.11	2.52
185.60	1440.00	16.50	1000.00	540.51	9.50	12.35	76.94	90.12	86.46	2.65
185.50	1440.00	17.35	500.00	288.74	4.91	6.60	74.43	94.76	80.93	2.78
185.00	1440.00	18.06	200.00	121.52	2.24	2.78	80.70	98.67	76.91	2.90
194.90	1000.00	9.23	2500.00	1319.04	13.28	22.60	58.77	67.73	88.57	1.97
193.80	1000.00	9.97	2000.00	1069.16	11.46	18.32	62.57	72.63	87.42	2.13
187.20	1000.00	10.83	1500.00	792.20	9.55	13.58	70.32	78.92	88.49	2.32
187.50	1000.00	11.72	1000.00	527.32	6.86	9.04	75.86	85.38	88.62	2.51
186.70	1000.00	12.44	500.00	273.45	3.72	4.69	80.55	90.62	85.45	2.66
186.40	1000.00	13.28	200.00	115.59	1.55	1.98	78.36	96.72	80.86	2.84
198.20	800.00	6.15	2500.00	1293.63	9.09	16.42	55.33	60.44	90.31	1.72
197.20	800.00	6.80	2000.00	1059.76	7.26	13.45	52.69	66.88	88.20	1.96
189.20	800.00	7.33	1500.00	790.92	6.41	10.04	63.82	72.11	88.63	2.12
188.90	800.00	8.30	1000.00	524.51	4.29	6.66	71.91	81.61	89.10	2.40
178.50	800.00	9.01	500.00	273.85	2.69	3.48	72.33	88.52	85.33	2.60
177.20	800.00	9.39	200.00	108.69	1.11	1.38	80.48	92.30	85.99	2.71

THE MAX. OVER ALL EFFICIENCY IS: 83.9898  
THE MIN. OVER ALL EFFICIENCY IS: 55.3263  
THE MAX. SIMPLE DISPLACEMENT IS: 2.93632

POWER CONVERSION TEST  
 PUMP NUMBER M33652 RUN AT 120 DEGREES (F) INLET TEMP.

M33652

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR. PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MECH EFF (%)	SIM DIS in3/rev
126.28	1800.00	21.33	2500.00	1357.93	31.39	38.78	80.93	91.68	87.29	2.74
129.18	1800.00	21.57	2000.00	1105.83	25.18	31.58	79.48	92.91	85.25	2.77
126.19	1800.00	21.58	1500.00	832.14	18.92	23.77	79.61	94.26	85.47	2.81
121.20	1800.00	22.16	1000.00	587.68	12.87	16.78	76.71	95.48	88.69	2.84
125.58	1800.00	22.29	500.00	317.36	5.25	9.06	63.46	98.17	74.78	2.92
123.30	1800.00	23.21	200.00	162.11	2.25	4.63	48.58	100.00	58.58	2.98
127.58	1440.00	16.46	2500.00	1365.00	24.26	31.19	77.80	88.64	86.84	2.64
128.48	1440.00	16.72	2000.00	1095.42	19.26	25.83	76.94	98.81	86.57	2.68
126.18	1440.00	17.05	1500.00	827.36	14.67	18.98	77.68	91.79	85.96	2.73
119.68	1440.00	17.24	1000.00	567.23	10.56	12.96	81.47	92.84	83.59	2.77
116.88	1440.00	17.84	500.00	308.83	5.24	7.06	74.28	96.84	76.77	2.86
117.00	1440.00	18.18	200.00	148.47	2.69	3.21	83.93	97.88	67.51	2.92
124.58	1800.00	11.28	2500.00	1352.51	17.11	23.18	73.81	83.99	87.64	2.58
124.38	1800.00	11.92	2000.00	1065.11	14.16	18.59	76.16	85.92	82.39	2.56
125.58	1800.00	12.33	1500.00	818.26	10.98	14.82	78.33	88.53	86.92	2.64
125.98	1800.00	12.62	1000.00	588.63	7.29	9.52	76.16	98.68	84.88	2.78
125.28	1800.00	13.08	500.00	291.88	3.98	4.99	78.21	93.92	81.47	2.88
124.68	1800.00	13.25	200.00	138.51	2.82	2.24	98.29	95.16	72.66	2.83
124.88	800.00	7.94	2500.00	1352.95	11.66	12.12	62.89	76.98	82.61	2.29
125.48	800.00	8.24	2000.00	1063.25	9.58	13.26	69.65	79.84	82.58	2.38
125.88	800.00	8.59	1500.00	796.21	7.62	10.11	75.88	83.28	89.33	2.48
122.38	800.00	9.83	1000.00	588.59	5.49	6.99	78.55	87.55	86.12	2.61
126.48	800.00	9.46	500.00	285.22	3.85	3.63	84.81	91.21	82.92	2.23
121.68	800.00	9.21	200.00	138.92	1.16	1.66	69.62	94.89	72.43	2.88

THE MAX. OVER ALL EFFICIENCY IS: 90.2885  
 THE MIN. OVER ALL EFFICIENCY IS: 48.5832  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.92917

POWER CONVERSION TEST  
 PUMP NUMBER M33651 RUN AT 180 DEGREES (F) INLET TEMP.

M33651

(OIL FT TEMP (F)	TOR. SPEED RPM	ADJ FLOW GPM	TOR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	METH EFF (%)	SIM DIS DISPLACEMENT
183.10	1800.00	20.18	2500.00	1341.09	29.27	38.30	76.42	89.65	85.77	2.59
189.70	1800.00	20.57	2000.00	1095.66	23.76	31.29	75.91	91.37	83.93	2.64
186.50	1800.00	20.78	1500.00	826.39	17.95	23.60	76.07	92.31	83.46	2.67
177.70	1800.00	21.35	1000.00	564.35	12.71	16.17	78.06	94.85	81.48	2.74
180.50	1800.00	21.91	500.00	296.70	6.68	8.47	78.00	97.32	77.49	2.81
184.20	1800.00	22.51	200.00	131.22	3.50	3.75	93.48	100.00	78.00	2.89
195.00	1440.00	13.17	2500.00	1330.65	19.18	30.40	63.09	73.15	86.39	2.11
194.40	1440.00	14.04	2000.00	1044.00	16.39	23.85	68.71	77.98	90.09	2.25
188.20	1440.00	15.16	1500.00	829.20	13.05	18.95	68.87	84.16	83.18	2.43
177.00	1440.00	16.58	1000.00	555.25	9.84	12.69	77.54	92.07	82.81	2.66
179.20	1440.00	17.22	500.00	269.06	5.05	6.60	76.53	95.64	79.54	2.76
182.10	1440.00	17.81	200.00	124.85	2.43	2.85	85.29	98.87	73.66	2.86
187.50	1800.00	9.27	2500.00	1353.61	13.31	23.20	57.36	68.60	84.92	1.98
181.00	1800.00	9.58	2000.00	1066.22	11.21	18.27	61.38	70.89	86.25	2.05
181.80	1800.00	10.11	1500.00	805.22	8.85	13.77	64.25	74.85	85.82	2.16
190.00	1800.00	11.25	1000.00	561.48	6.56	9.62	68.21	83.30	81.89	2.41
185.00	1800.00	12.55	500.00	268.14	3.61	4.80	75.19	92.92	82.82	2.68
182.10	1800.00	13.08	200.00	118.10	1.90	2.02	93.77	96.82	77.82	2.80
194.70	800.00	6.10	2500.00	1326.21	8.93	16.84	53.04	61.00	86.65	1.76
196.10	800.00	6.32	2000.00	1052.30	7.32	13.42	54.92	63.12	86.90	1.82
193.00	800.00	6.89	1500.00	800.42	5.81	10.16	57.16	68.85	86.17	1.99
187.90	800.00	7.66	1000.00	530.43	4.56	6.73	67.68	76.52	86.69	2.21
183.80	800.00	9.06	500.00	273.24	2.61	3.47	75.06	90.53	83.99	2.62
182.30	800.00	9.47	200.00	112.48	1.32	1.43	95.64	94.64	81.26	2.73

THE MAX. OVER ALL EFFICIENCY IS: 95.6375  
 THE MIN. OVER ALL EFFICIENCY IS: 53.0445  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.8891



POWER CONVERSION TEST  
PUMP NUMBER M33662 RUN AT 120 DEGREES (F) INLET TEMP.

M33662

INLET TEMP(F)	TAB. SPEED RPM	ADJ FLOW (GPM)	TAB PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	VOI EFF (%)	MCH EFF (%)	SIM DIS in <sup>3</sup> /rev
136.98	1800.00	21.56	2500.00	1365.67	31.66	39.00	81.18	92.48	87.25	2.77
138.20	1800.00	21.65	2000.00	1092.34	25.67	31.20	82.30	93.65	87.26	2.80
126.98	1800.00	22.09	1500.00	835.65	19.66	23.87	82.39	94.64	85.55	2.83
120.50	1800.00	22.52	1000.00	566.46	13.43	16.18	82.99	96.49	84.14	2.89
119.40	1800.00	23.02	500.00	306.27	7.00	8.75	80.98	98.64	77.82	2.95
120.38	1800.00	23.34	200.00	145.20	3.89	4.15	74.62	100.00	65.65	2.99
133.20	1440.00	16.72	2500.00	1338.98	24.42	30.59	79.82	89.58	88.99	2.68
132.10	1440.00	16.95	2000.00	1026.41	19.80	24.59	80.52	90.80	88.56	2.72
130.10	1440.00	17.25	1500.00	822.38	15.08	18.79	80.25	92.39	86.93	2.77
123.50	1440.00	17.51	1000.00	562.68	10.12	12.97	77.99	93.79	83.96	2.81
121.20	1440.00	18.02	500.00	292.68	5.66	6.80	83.23	96.52	80.86	2.89
121.20	1440.00	18.36	200.00	134.55	2.73	3.87	88.65	98.33	78.84	2.94
124.98	1800.00	11.67	2500.00	1320.20	17.15	22.62	75.82	83.33	90.25	2.50
127.20	1800.00	11.94	2000.00	1068.28	13.89	18.31	75.86	85.28	89.23	2.55
128.60	1800.00	12.18	1500.00	800.61	11.01	13.72	80.24	86.96	89.30	2.60
129.40	1800.00	12.48	1000.00	542.98	7.32	9.30	79.23	89.16	87.78	2.62
129.10	1800.00	13.06	500.00	293.28	3.95	5.05	78.50	93.25	81.26	2.79
125.20	1800.00	13.48	200.00	123.11	1.86	2.11	88.20	96.30	77.43	2.88
129.20	800.00	7.74	2500.00	1389.26	11.23	16.62	67.58	74.59	91.01	2.23
122.10	800.00	8.19	2000.00	1048.49	9.63	13.31	72.34	78.97	90.92	2.32
121.90	800.00	8.28	1500.00	792.94	7.48	10.13	73.83	79.82	89.60	2.39
122.20	800.00	8.95	1000.00	543.48	5.12	6.90	74.22	86.25	87.20	2.58
116.10	800.00	9.32	500.00	282.46	2.76	3.65	75.60	89.89	82.90	2.69
117.90	800.00	9.65	200.00	123.65	1.32	1.52	84.35	94.99	77.09	2.84

THE MAX. OVER ALL EFFICIENCY IS: 88.6478  
THE MIN. OVER ALL EFFICIENCY IS: 67.5771  
THE MAX. SIMPLE DISPLACEMENT IS: 2.99467

POWER CONVERSION TEST  
 PUMP NUMBER M33661 RUN AT 180 DEGREES (F) INLET TEMP.

M33661

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	OVER EFF (%)	MECH EFF (%)	SIM DIS in3/rev
181.10	1800.00	20.62	2500.00	1335.31	25.76	38.14	78.02	90.47	87.16	2.65
182.88	1800.00	20.83	2000.00	1074.37	23.82	30.68	77.62	91.37	86.66	2.67
184.20	1800.00	21.00	1500.00	793.00	18.31	22.65	80.86	92.49	88.06	2.71
182.50	1800.00	21.47	1000.00	544.09	12.92	15.54	83.14	94.19	85.56	2.76
181.50	1800.00	22.15	500.00	283.56	6.39	8.10	78.88	97.16	82.09	2.84
179.90	1800.00	22.79	200.00	133.68	3.12	3.82	81.81	100.00	69.65	2.93
187.50	1440.00	15.15	2500.00	1326.03	22.25	30.30	73.45	83.09	87.77	2.43
183.50	1440.00	15.32	2000.00	1063.46	17.94	24.30	73.82	84.00	82.55	2.46
182.50	1440.00	15.75	1500.00	797.25	13.60	18.22	74.62	86.39	82.59	2.53
177.70	1440.00	16.52	1000.00	538.34	9.56	12.76	74.96	90.62	83.38	2.65
175.40	1440.00	17.12	500.00	285.24	4.90	6.52	75.12	93.90	81.60	2.75
175.20	1440.00	17.72	200.00	126.95	2.67	2.90	92.08	97.17	73.34	2.84
185.30	1080.00	10.29	2500.00	1339.73	14.74	22.96	64.21	75.24	86.82	2.20
181.80	1080.00	10.55	2000.00	1061.76	12.24	18.19	67.29	77.15	82.69	2.26
181.60	1080.00	10.99	1500.00	800.09	9.63	13.86	69.46	80.33	86.33	2.35
178.50	1080.00	11.41	1000.00	518.31	6.81	8.88	76.63	83.42	89.82	2.44
178.50	1080.00	12.38	500.00	279.46	3.66	4.79	76.53	90.52	83.29	2.65
179.60	1080.00	13.02	200.00	124.00	1.68	2.14	78.55	95.21	74.60	2.78
192.20	800.00	7.47	2500.00	1312.71	11.05	16.66	66.33	73.28	88.66	2.16
192.00	800.00	6.61	2000.00	1046.09	7.88	13.28	59.36	65.22	89.01	1.91
185.20	800.00	7.23	1500.00	764.76	6.44	9.71	66.31	71.39	91.31	2.09
177.80	800.00	7.94	1000.00	531.46	4.58	6.25	62.88	78.32	82.60	2.29
175.30	800.00	8.62	500.00	274.81	2.47	3.49	70.20	85.13	84.20	2.49
181.10	800.00	9.46	200.00	116.52	1.22	1.48	82.16	93.38	79.82	2.73

THE MAX. OVER ALL EFFICIENCY IS: 92.0752  
 THE MIN. OVER ALL EFFICIENCY IS: 59.3601  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.92506

POWER CONVERSION TEST  
 PUMP NUMBER M33672 RUN AT 120 DEGREES (F) INLET TEMP.

M33672

OUTLET TEMP (F)	ROD. SPEED RPM	QD. FLOW GPM	TAR PRESS. PSID	ROD TORQ IN-LES	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	WQ EFF (%)	MECH EFF (%)	SIM DIS in3/rev
171.30	1800.00	21.70	2500.00	1396.68	38.93	39.89	77.53	91.85	85.55	2.73
171.00	1800.00	21.63	2000.00	1149.92	25.12	32.84	76.50	92.43	83.12	2.78
170.60	1800.00	21.95	1500.00	877.44	19.43	25.06	77.55	93.94	81.78	2.82
170.00	1800.00	22.60	1000.00	609.76	13.45	17.41	77.25	96.60	78.38	2.90
170.30	1800.00	23.12	500.00	331.53	6.62	9.47	78.48	99.01	72.08	2.92
170.70	1800.00	23.40	200.00	168.91	2.88	4.60	62.77	100.00	59.40	3.00
170.90	1440.00	16.52	2500.00	1449.78	24.82	33.13	72.65	88.24	82.41	2.65
170.30	1440.00	16.65	2000.00	1161.28	19.25	26.53	72.54	88.95	82.31	2.62
170.60	1440.00	16.98	1500.00	891.23	14.88	20.36	73.06	90.69	80.44	2.72
170.30	1440.00	17.44	1000.00	654.25	9.96	14.95	66.68	93.19	73.85	2.80
119.30	1440.00	12.90	500.00	369.84	5.12	8.45	61.23	95.43	64.61	2.82
116.50	1440.00	10.34	200.00	156.29	1.85	3.58	51.60	92.98	60.92	2.94
120.70	1000.00	11.52	2500.00	1444.55	16.82	24.25	62.94	82.89	82.21	2.46
125.50	1000.00	11.25	2000.00	1125.35	13.21	20.14	68.08	83.62	81.32	2.51
125.60	1000.00	12.12	1500.00	888.95	10.44	15.23	68.52	86.35	80.64	2.59
122.30	1000.00	12.61	1000.00	582.62	7.49	10.82	74.33	89.80	81.33	2.70
120.60	1000.00	13.84	500.00	315.43	3.95	5.41	71.31	92.89	75.26	2.79
112.90	1000.00	13.40	200.00	141.55	1.59	2.43	65.50	95.46	62.53	2.82
142.30	250.00	4.66	2500.00	1446.98	6.61	12.22	38.38	42.29	82.52	1.44
133.60	250.00	5.65	2000.00	1159.06	6.52	13.29	42.60	52.93	82.42	1.24
136.30	250.00	2.19	1500.00	869.32	6.22	10.35	60.16	73.22	82.46	2.21
127.90	250.00	8.42	1000.00	614.86	4.82	2.32	65.91	86.85	72.23	2.61
124.50	250.00	8.59	500.00	314.24	2.32	3.25	62.84	88.82	75.92	2.64
125.20	250.00	9.89	200.00	131.61	0.98	1.52	62.40	93.28	2.53	2.80

THE MAX. OVER ALL EFFICIENCY IS: 77.546  
 THE MIN. OVER ALL EFFICIENCY IS: 38.3842  
 THE MAX. SIMPLE DISPLACEMENT IS: 3.00287

POWER CONVERSION TEST  
 PUMP NUMBER M33682 RUN AT 120 DEGREES (F) INLET TEMP.

M33682

OUTLET TEMP (F)	TAR. SPEED RPM	ADJ FLOW GPM	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF (%)	VOI EFF (%)	MFCF EFF (%)	SIM DIS INSTRUM
125.90	1800.00	20.58	2500.00	1330.17	29.88	37.99	78.65	92.26	85.63	2.64
126.40	1800.00	20.88	2000.00	1069.68	24.25	30.55	79.38	93.62	85.18	2.68
122.70	1800.00	21.25	1500.00	832.12	18.46	23.77	77.66	95.25	82.13	2.73
119.90	1800.00	21.53	1000.00	560.29	12.35	16.00	77.21	96.50	81.31	2.76
120.50	1800.00	21.97	500.00	309.76	6.32	8.85	71.48	98.50	73.54	2.82
117.90	1800.00	22.31	200.00	147.87	2.82	4.22	66.85	100.00	61.62	2.86
124.10	1440.00	15.65	2500.00	1333.89	22.69	30.48	74.43	87.69	85.39	2.51
126.00	1440.00	16.02	2000.00	1075.53	18.54	24.57	75.43	89.76	84.72	2.57
127.50	1440.00	16.28	1500.00	815.82	14.09	18.64	75.62	91.24	83.77	2.61
125.40	1440.00	16.64	1000.00	558.58	9.57	12.76	75.82	93.23	81.56	2.67
121.70	1440.00	17.05	500.00	298.51	4.84	6.82	71.00	95.55	76.31	2.74
120.00	1440.00	17.26	200.00	145.42	1.85	3.32	55.53	96.74	62.66	2.77
126.60	1000.00	10.51	2500.00	1304.24	15.30	22.35	68.47	78.54	87.33	2.75
124.20	1000.00	11.43	2000.00	1059.82	13.36	18.15	73.60	85.38	86.04	2.44
122.10	1000.00	11.70	1500.00	808.92	10.12	13.86	72.98	87.44	84.48	2.50
120.10	1000.00	11.96	1000.00	543.64	6.90	9.32	74.09	89.36	83.08	2.56
118.60	1000.00	12.47	500.00	292.04	3.52	5.00	71.33	93.17	78.00	2.62
116.20	1000.00	12.12	200.00	133.42	1.35	2.29	59.26	90.58	68.29	2.59
127.40	720.00	6.82	2500.00	1289.20	8.25	14.73	59.40	62.50	88.35	1.93
125.90	720.00	6.40	2000.00	1032.82	7.40	11.85	62.44	71.25	87.87	2.05
121.10	720.00	7.30	1500.00	809.33	6.34	9.25	68.54	81.78	84.44	2.34
117.70	720.00	7.50	1000.00	532.19	4.33	6.14	70.50	84.00	84.81	2.41
117.20	720.00	7.92	500.00	282.16	2.28	3.22	70.68	88.22	80.23	2.54
116.30	720.00	8.22	200.00	131.62	0.90	1.50	59.86	92.24	69.20	2.65

THE MAX. OVER ALL EFFICIENCY IS: 79.383  
 THE MIN. OVER ALL EFFICIENCY IS: 55.5288  
 THE MAX. SIMPLE DISPLACEMENT IS: 2.86261

POWER CONVERSION TEST  
PUMP NUMBER M33681 RUN AT 180 DEGREES (F) INLET TEMP.

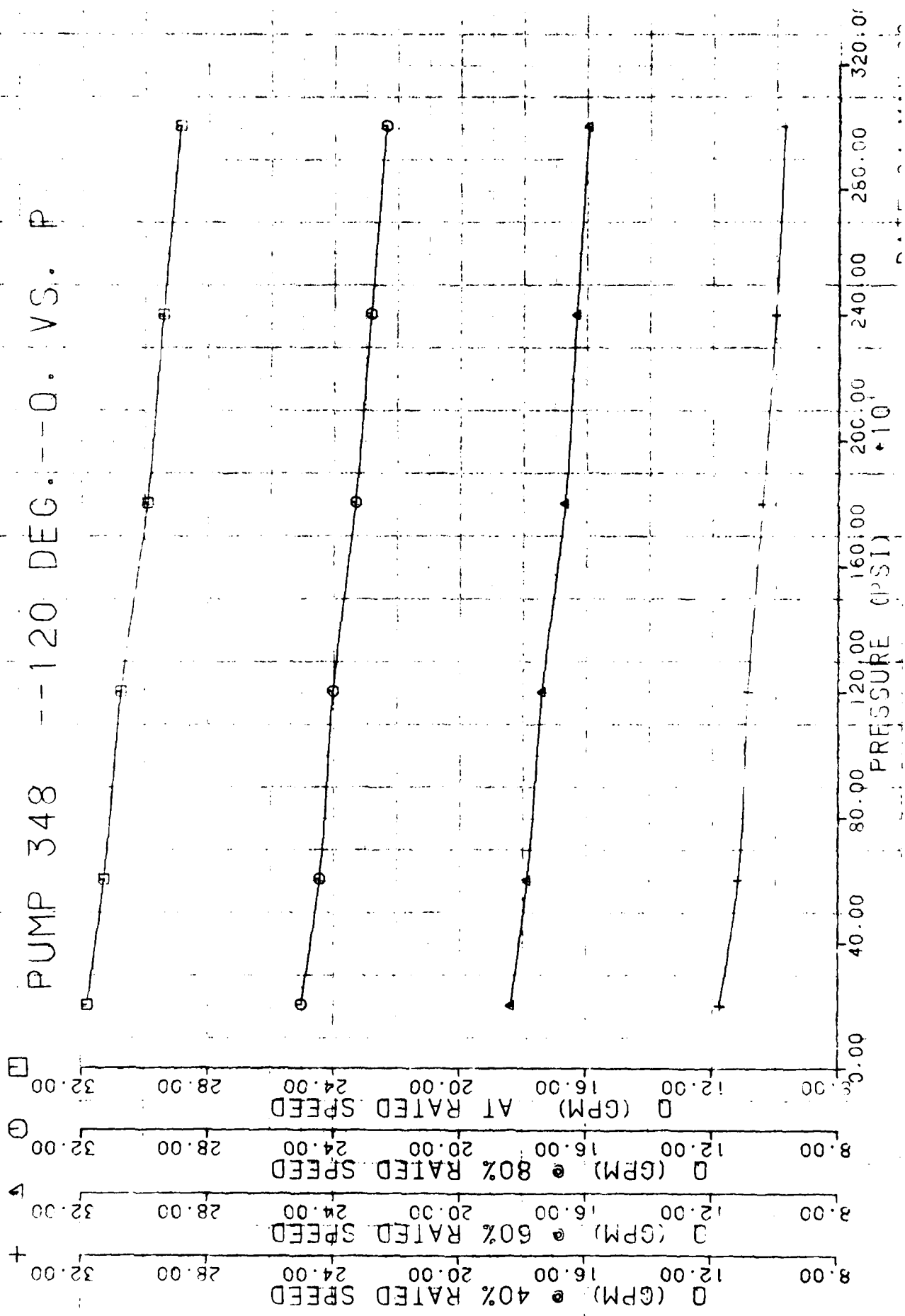
M33681

OUTLET TEMP(F)	TAR. SPEED RPM	ADJ FLOW (GPM)	TAR PRESS PSID	ADJ TORQ IN-LBS	OUTPUT HP	INPUT HP	OVER ALL EFF(%)	VOL. EFF (%)	MECH EFF (%)	SIM DIS inf3rev
183.68	1800.00	20.83	2500.00	1310.45	29.06	37.43	77.64	88.90	87.77	2.57
184.70	1800.00	20.39	2000.00	1045.27	23.65	29.85	79.22	90.50	88.83	2.62
179.50	1800.00	20.75	1500.00	808.60	17.97	23.09	77.88	92.10	85.35	2.66
178.10	1800.00	21.31	1000.00	539.98	12.32	15.42	79.98	94.60	85.20	2.73
182.70	1800.00	22.01	500.00	265.23	6.35	8.15	77.92	97.71	80.65	2.82
180.30	1800.00	22.53	200.00	133.83	2.52	3.82	65.97	100.00	68.75	2.89
185.70	1440.00	14.99	2500.00	1301.11	21.78	29.73	73.26	83.20	88.40	2.41
186.40	1440.00	15.29	2000.00	1037.56	17.72	23.71	74.74	84.85	88.68	2.45
186.70	1440.00	15.61	1500.00	793.44	13.61	18.13	75.08	86.64	86.98	2.50
182.70	1440.00	16.29	1000.00	538.29	9.42	12.30	76.61	90.38	85.47	2.61
183.20	1440.00	17.00	500.00	281.66	4.90	6.44	76.13	94.35	81.67	2.73
178.10	1440.00	15.53	200.00	128.48	1.66	2.94	56.49	86.17	71.62	2.49
191.90	1000.00	9.58	2500.00	1265.98	13.94	22.04	63.27	70.88	89.44	2.05
186.60	1000.00	10.55	2000.00	1043.29	12.25	17.88	68.51	78.83	88.20	2.26
187.70	1000.00	10.98	1500.00	793.60	9.46	13.60	69.58	81.77	86.96	2.35
185.50	1000.00	11.42	1000.00	531.62	6.61	9.11	72.56	84.47	86.54	2.44
180.70	1000.00	12.28	500.00	274.97	3.51	4.71	74.46	90.83	83.66	2.63
182.00	1000.00	12.87	200.00	119.16	1.38	2.04	67.38	95.20	77.22	2.75
206.00	720.00	4.79	2500.00	1263.70	7.00	14.44	48.46	53.13	91.02	1.54
196.00	720.00	5.16	2000.00	1016.52	6.04	11.61	51.97	57.31	90.52	1.66
185.10	720.00	5.34	1500.00	771.10	4.61	8.81	52.28	59.22	89.50	1.71
185.80	720.00	6.63	1000.00	522.31	3.86	5.97	64.67	73.59	88.09	2.13
184.10	720.00	7.66	500.00	274.12	2.23	3.13	71.36	85.06	83.92	2.46
180.70	720.00	8.39	200.00	115.52	0.92	1.32	69.97	93.82	79.66	2.69

THE MAX. OVER ALL EFFICIENCY IS: 79.9041  
THE MIN. OVER ALL EFFICIENCY IS: 48.4565  
THE MAX. SIMPLE DISPLACEMENT IS: 2.89077

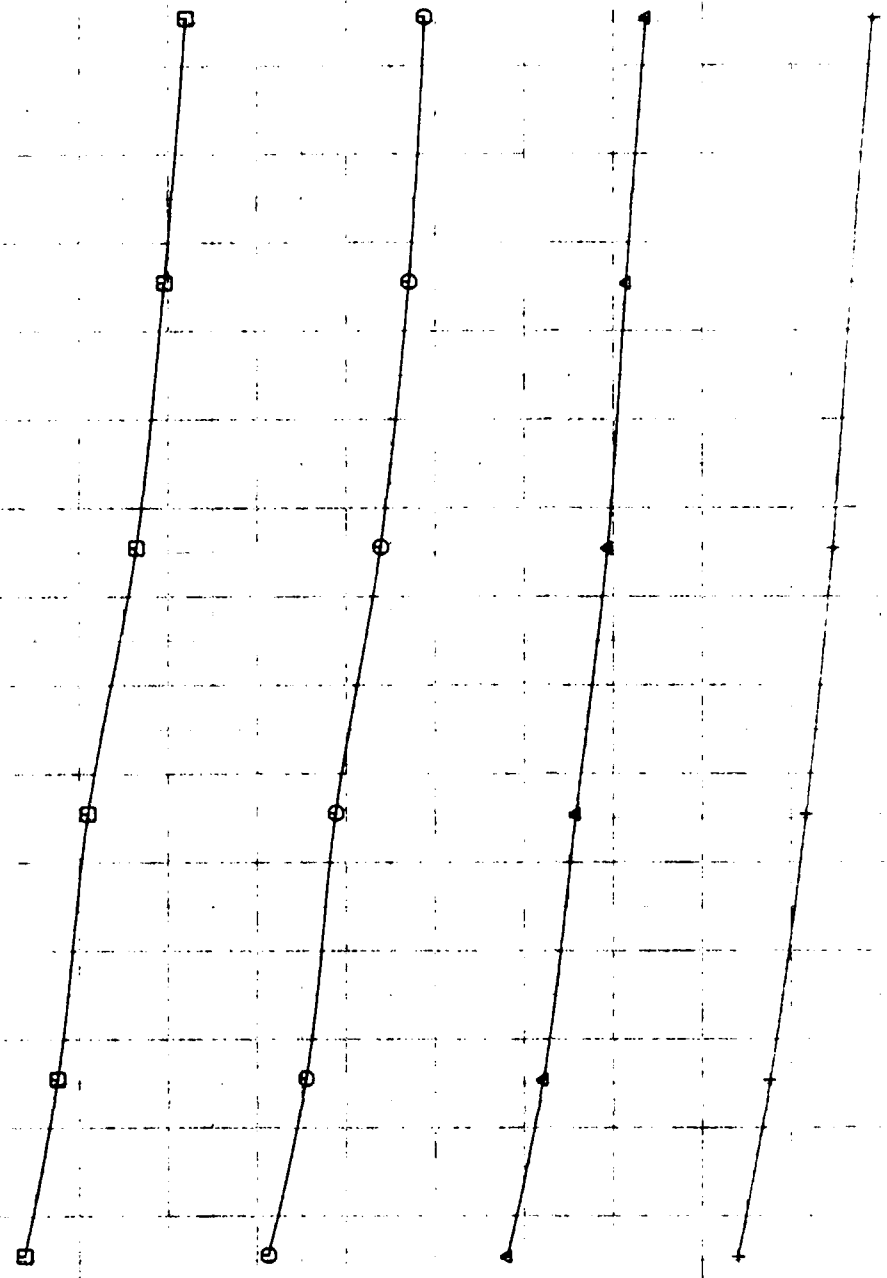
APPENDIX J  
POWER CONVERSION GRAPHICAL DATA

PUMP 348 -- 120 DEG. -- 0. VS. P



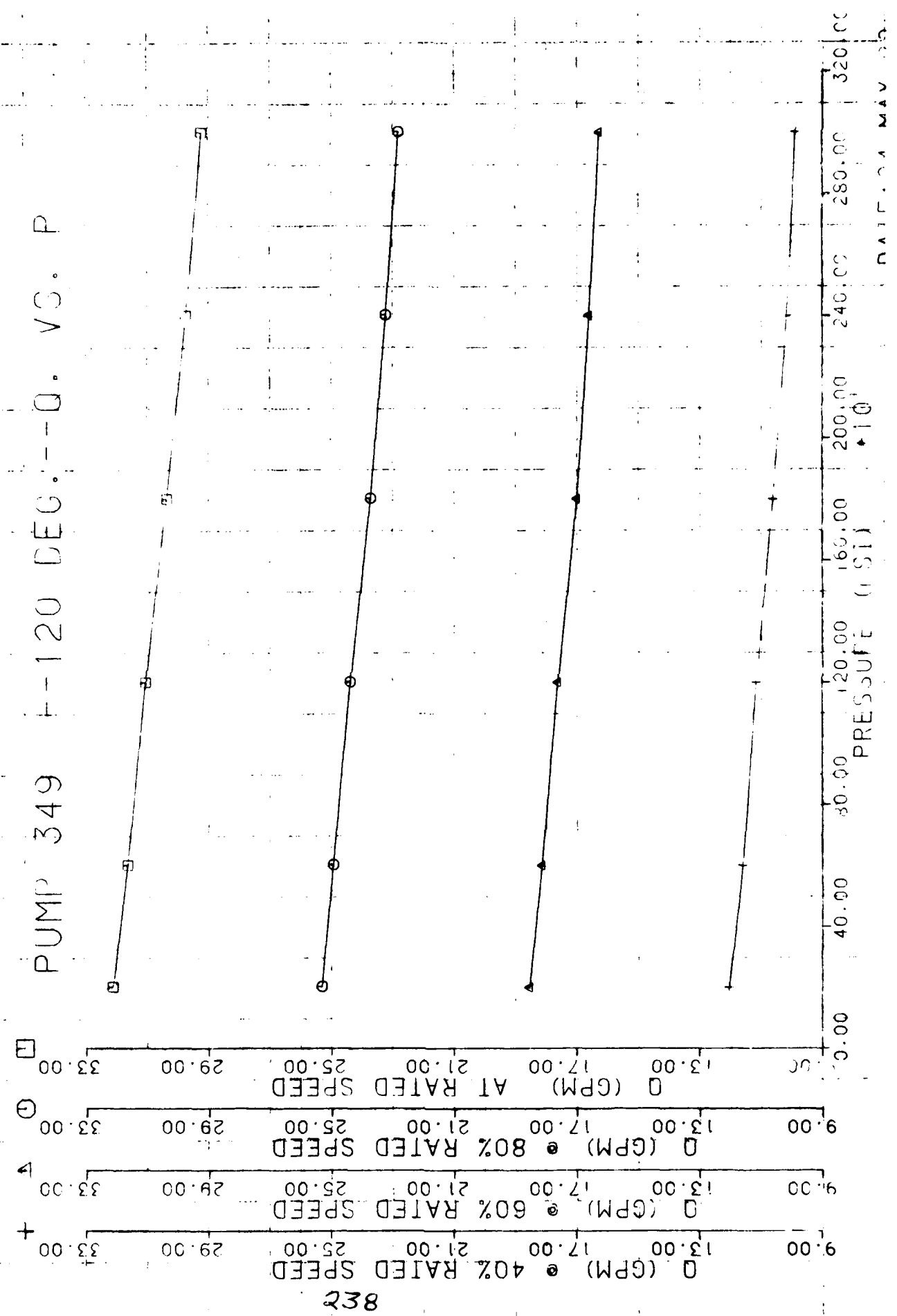
PUMP 348 -- 180 DEG. -- Q. VS. P

□ 0 (GPM) AT RATED SPEED  
 ○ 0 (GPM) 80% RATED SPEED  
 + 0 (GPM) 60% RATED SPEED  
 + 0 (GPM) 40% RATED SPEED





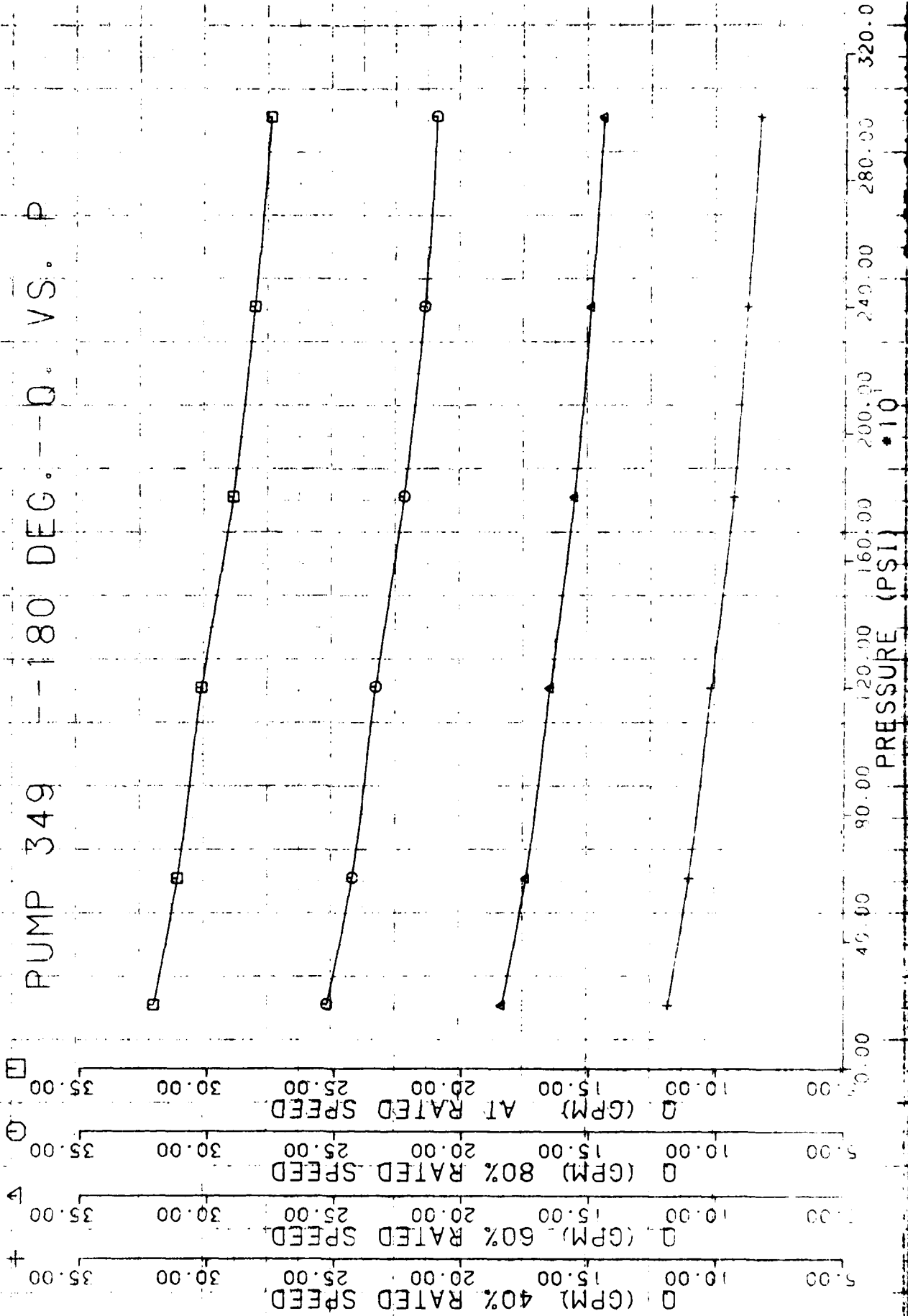
PUMP 349 F-120 DEG. -- 0. VS. P



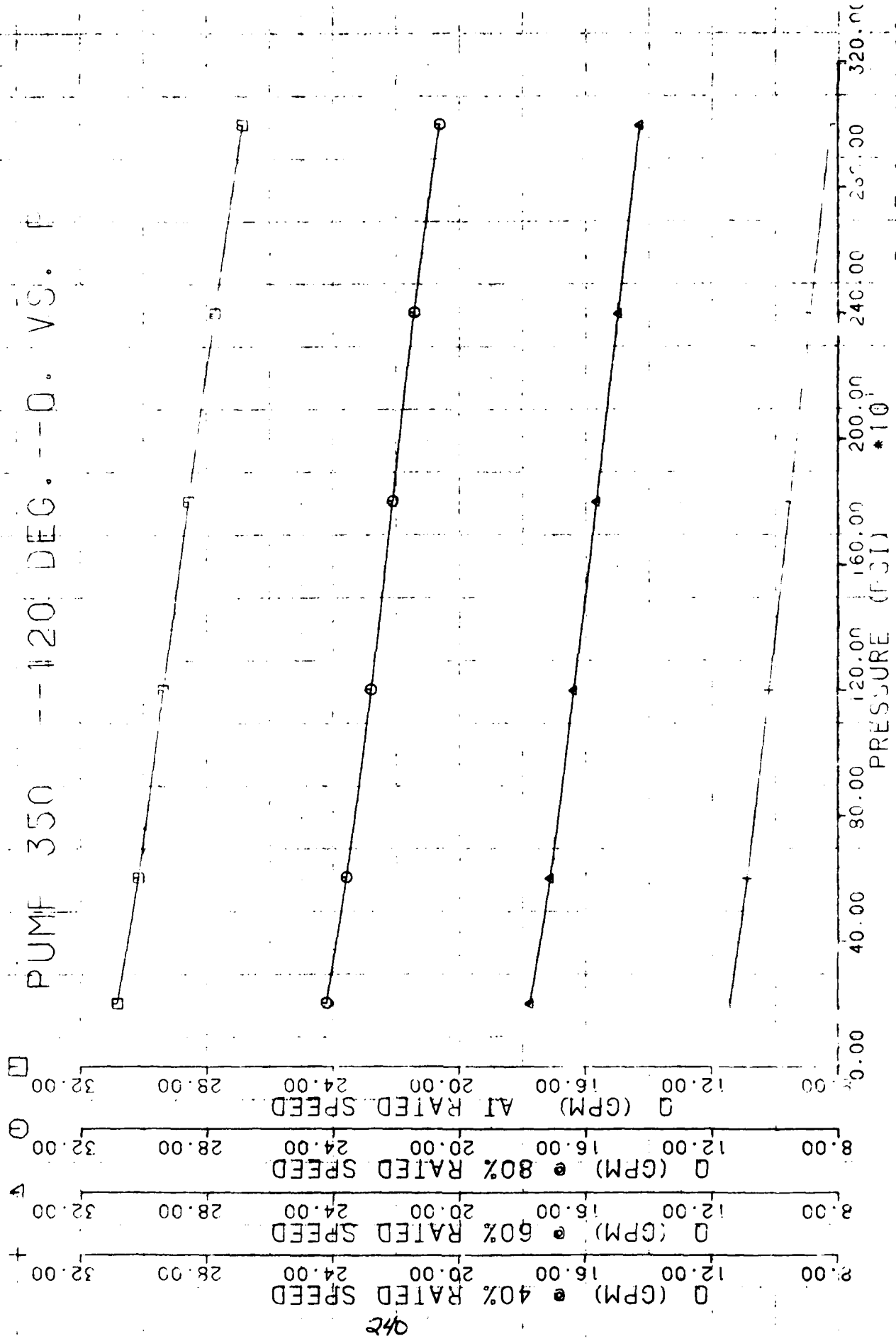
832

DATE: 04 MAY 68

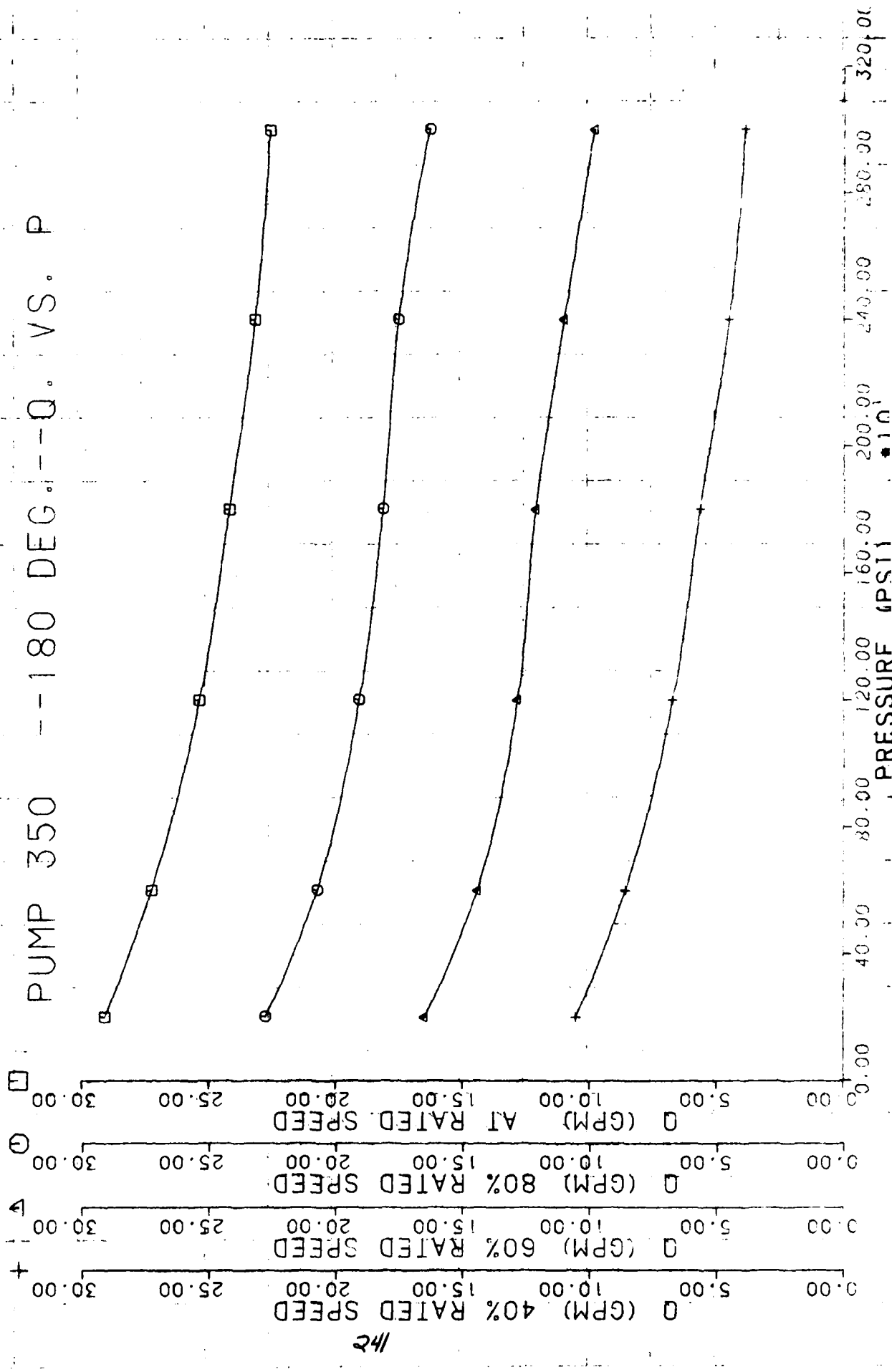
PUMP 349 -- 180 DEG. -- Q. VS. P



PUMF 350 -- 120 DEG. -- D. VS. P

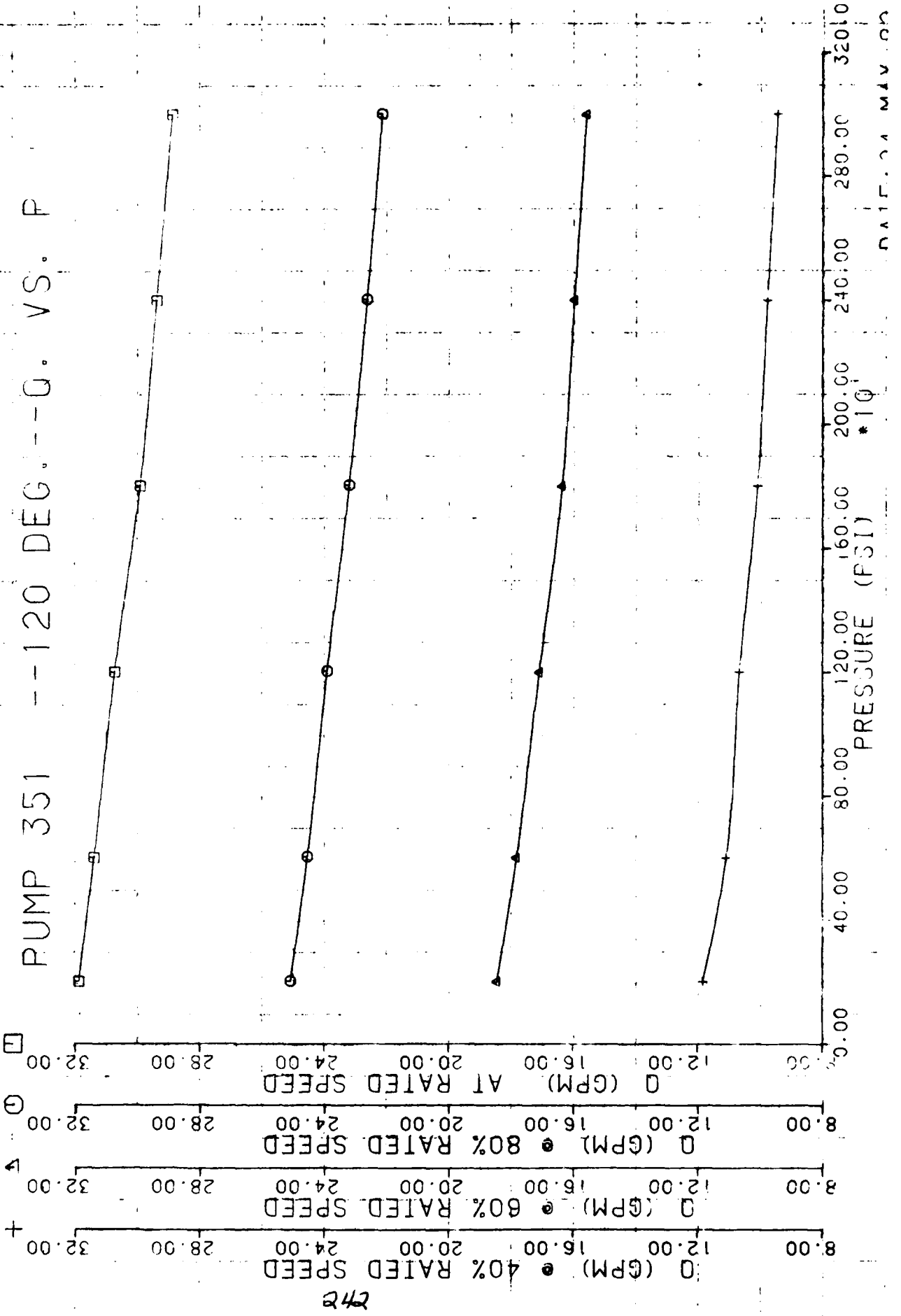


PUMP 350 --180 DEG.--Q. VS. P



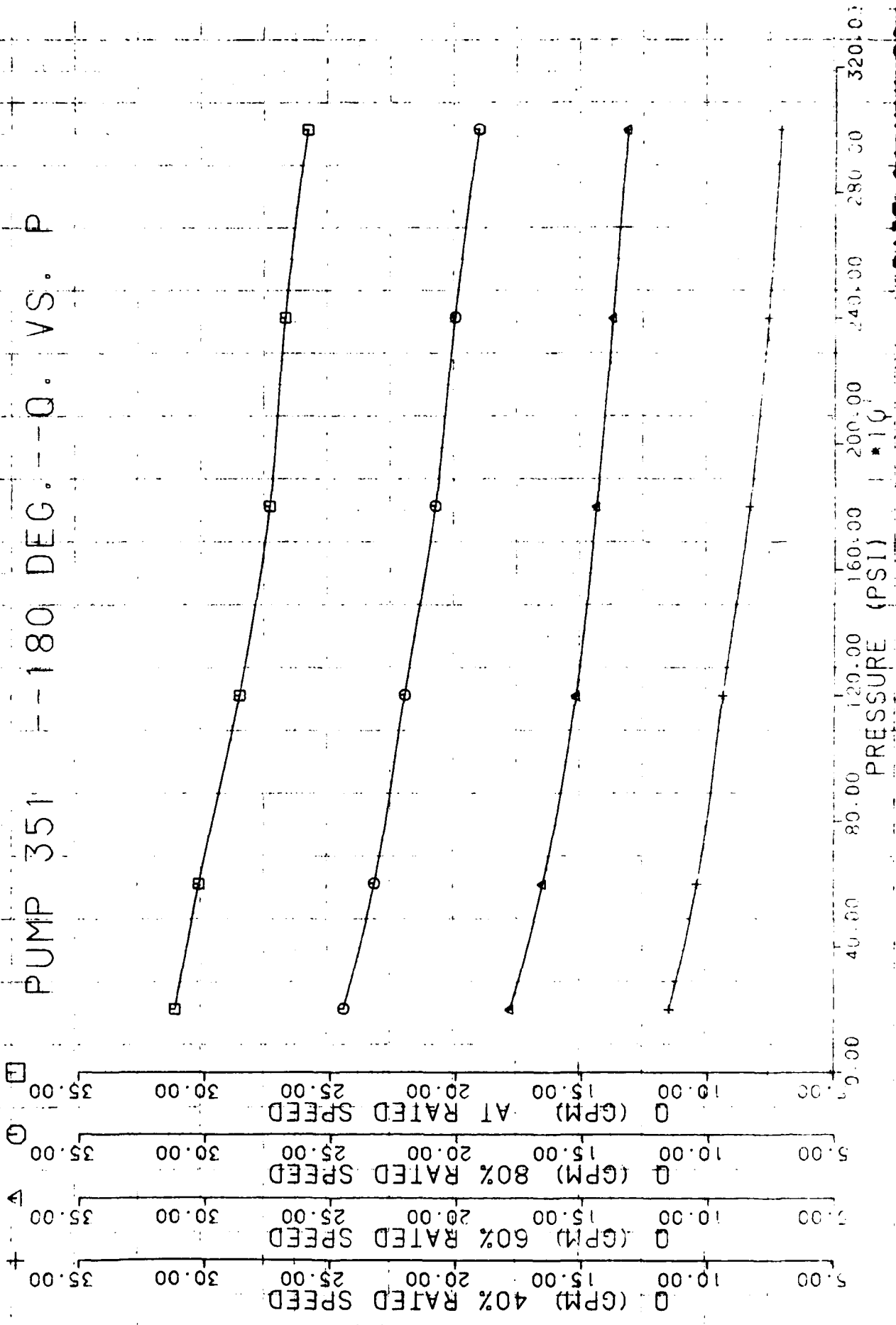
1/42

PUMP 351 --120 DEG.--Q. VS. P

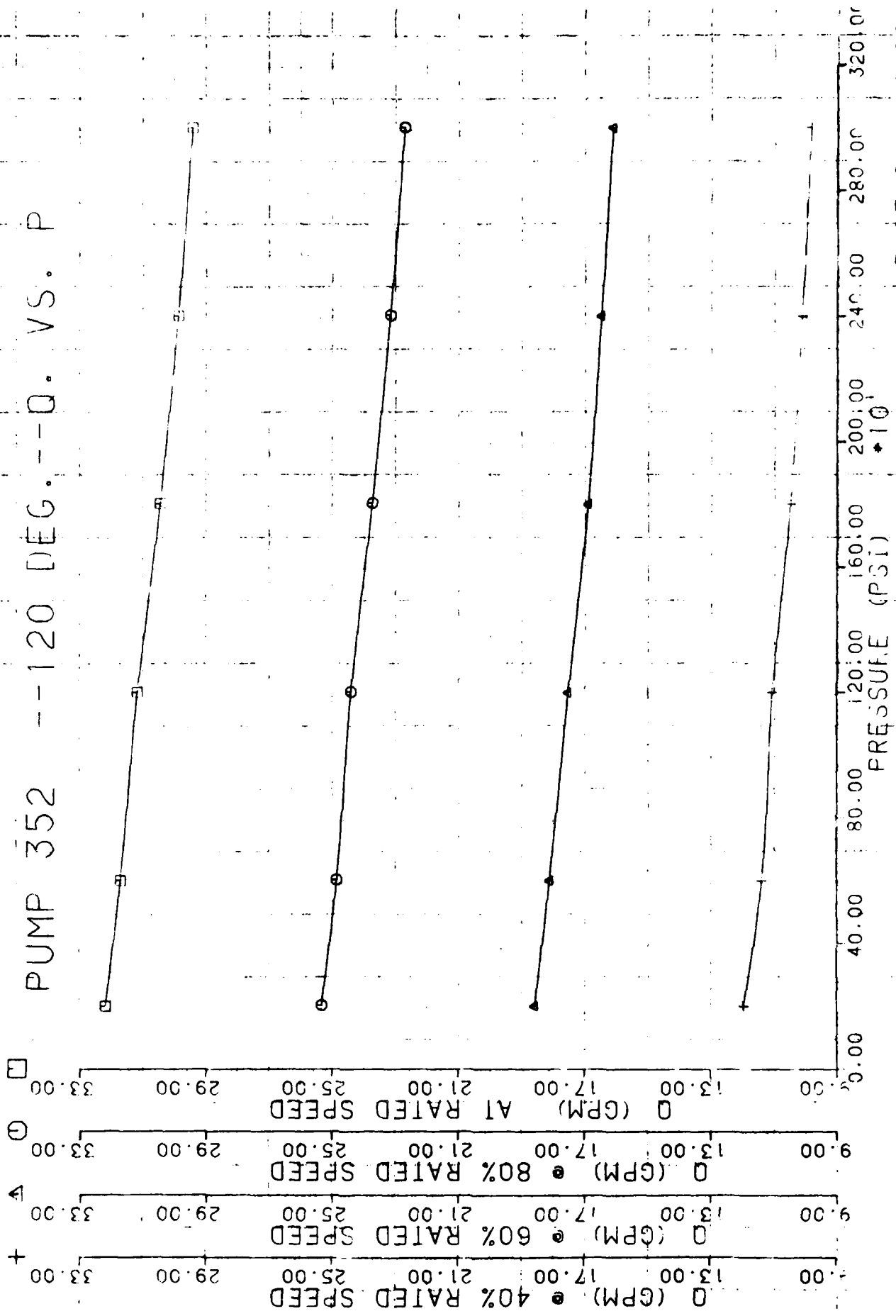


242

PUMP 351 -- 180 DEG. -- Q. VS. P

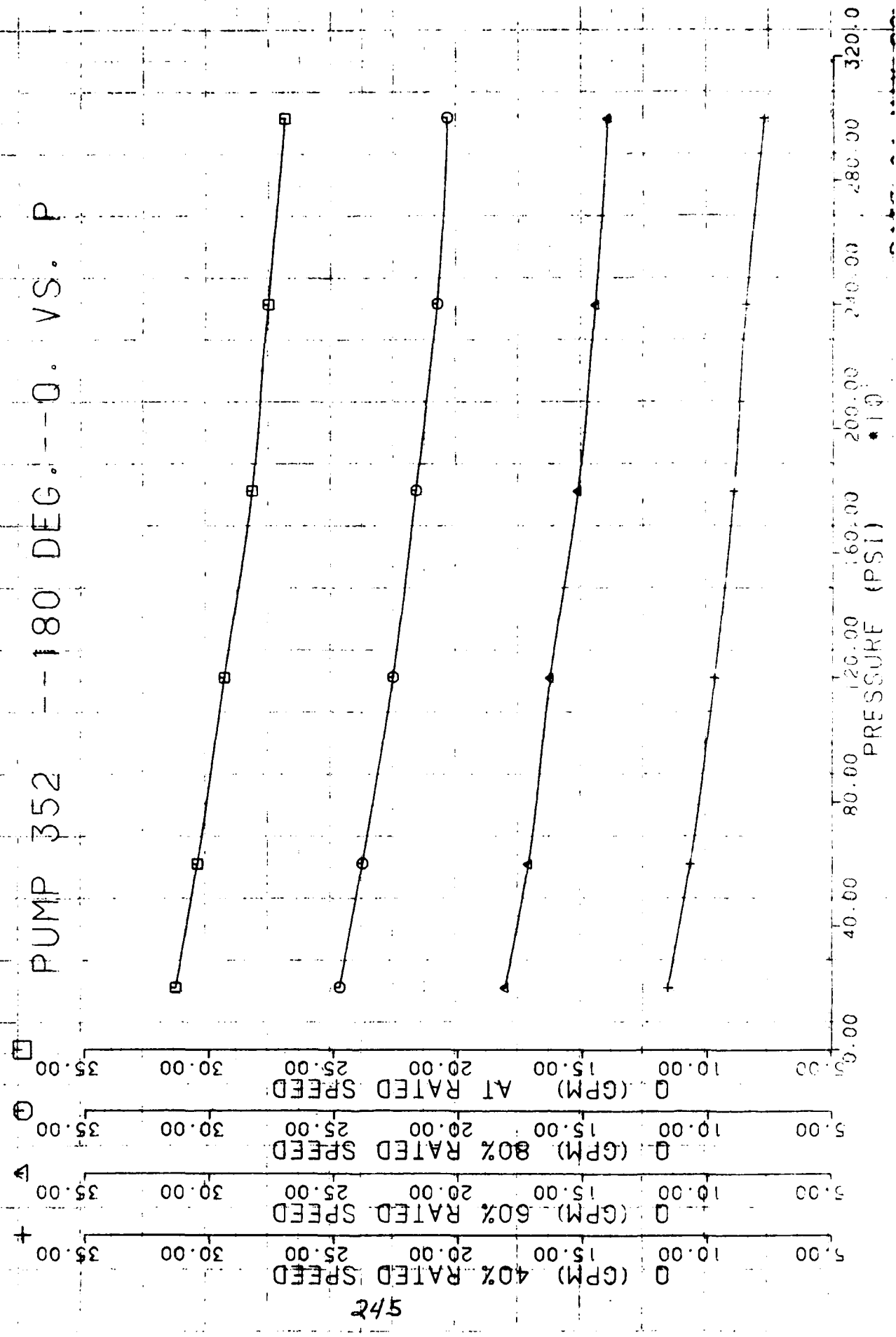


# PUMP 352 -- 120 DEG. -- Q. VS. P.



DATE: MAY 50

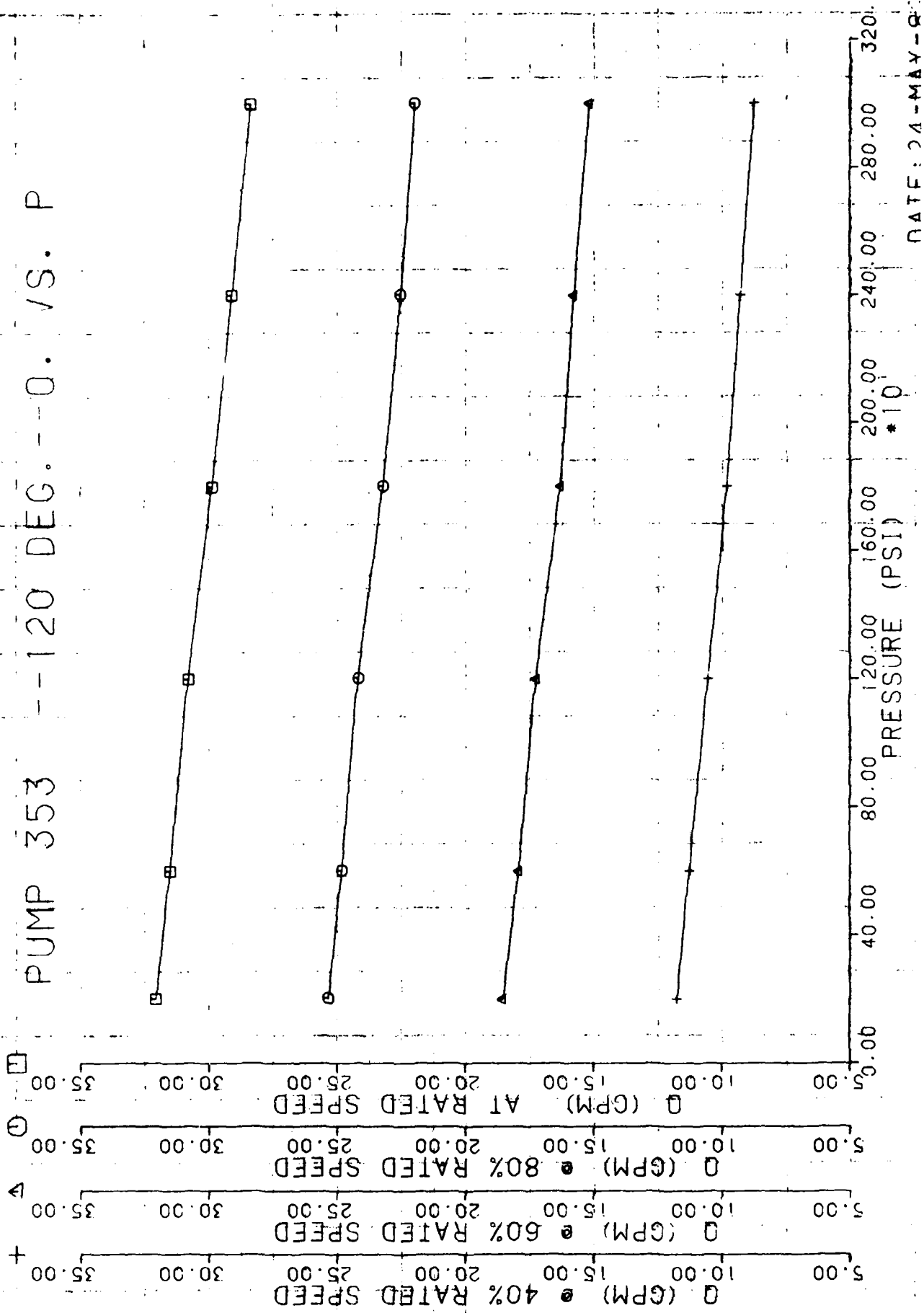
PUMP 352 -- 180 DEG. -- 0. VS. P



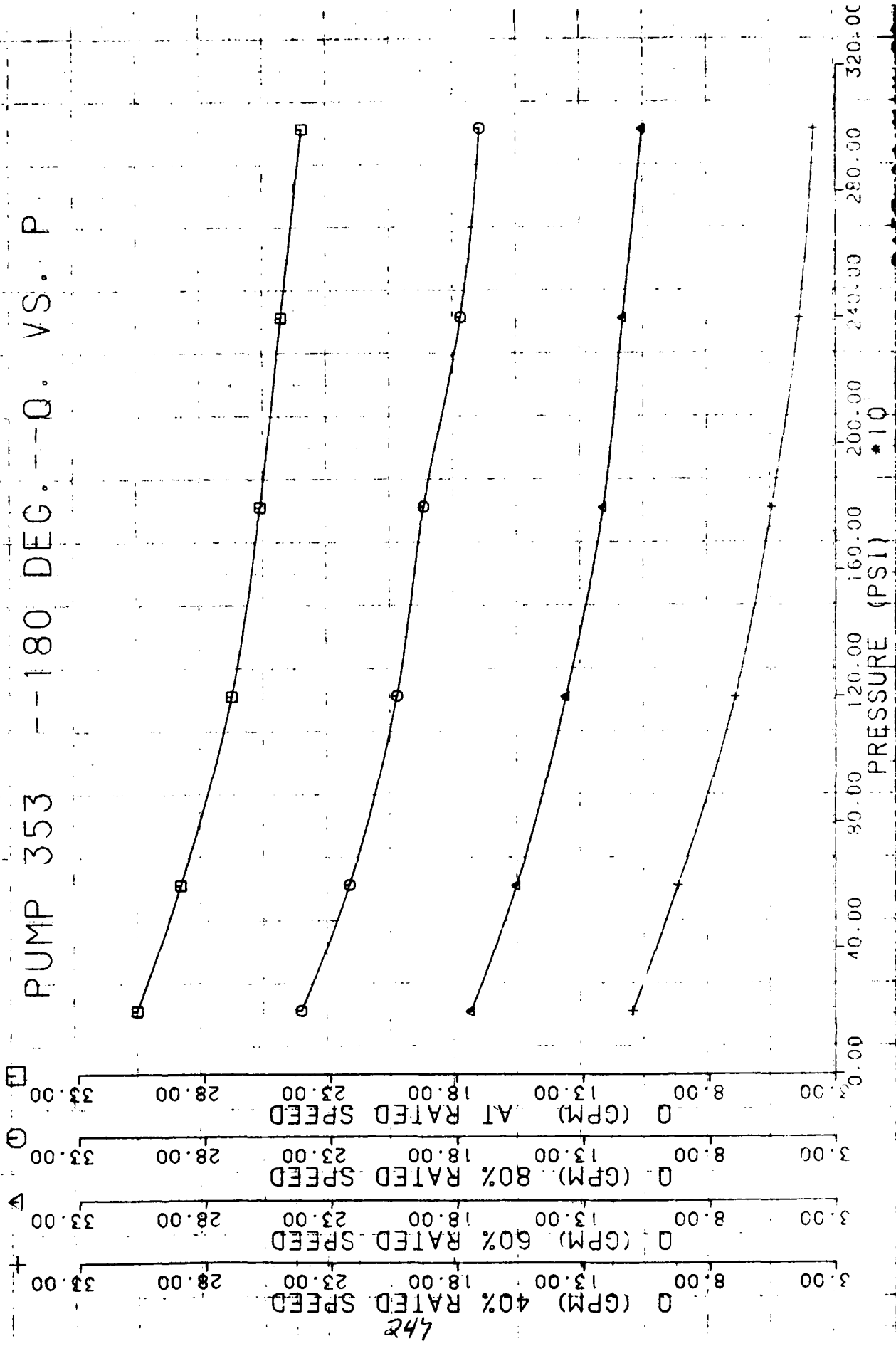
542



# PUMP 353 -- 120 DEG. -- 0. VS. P



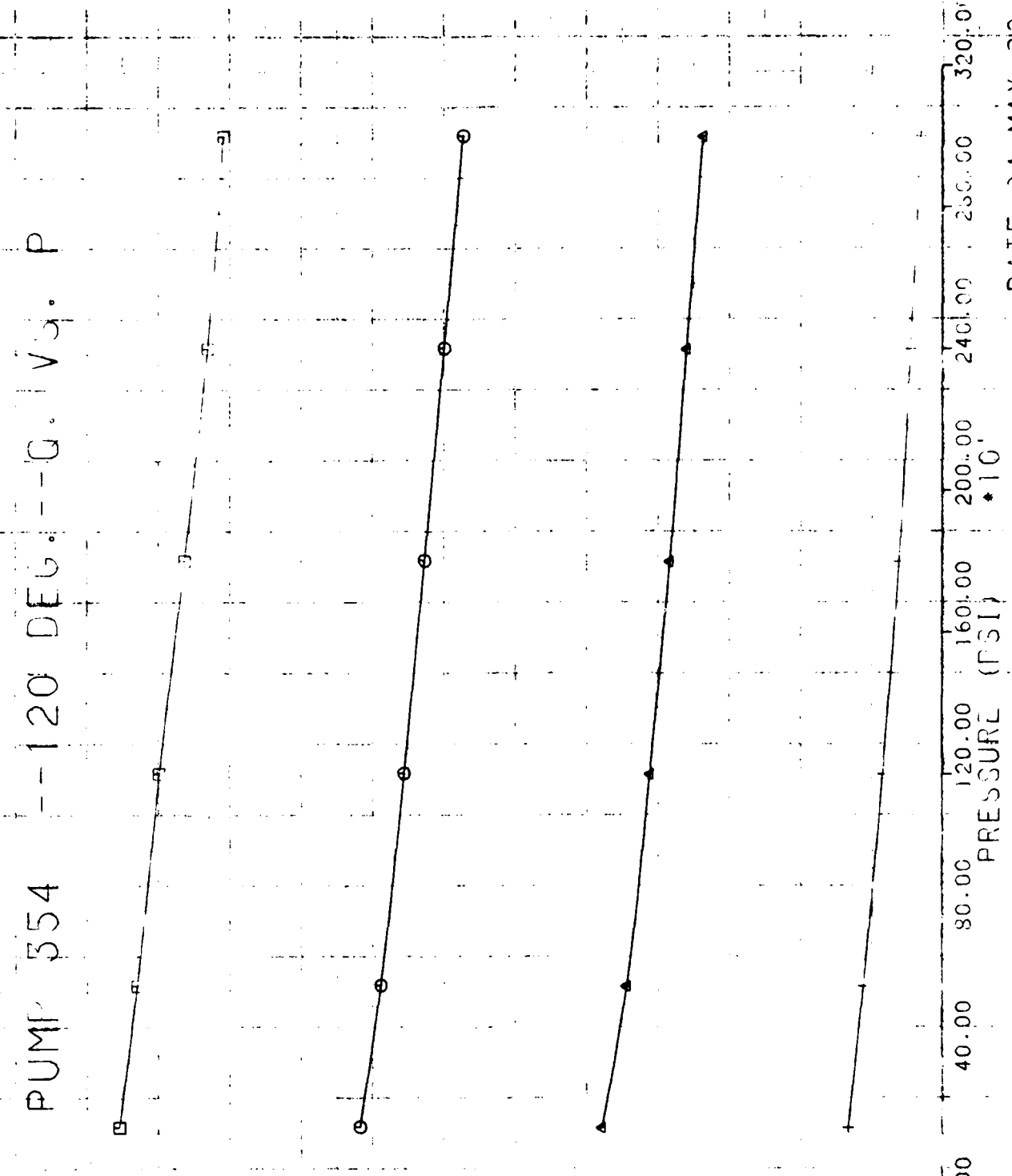
PUMP 353 --180 DEG.--Q. VS. P



472

PUMP 554 -- 120 DEG. -- G. VJ. P

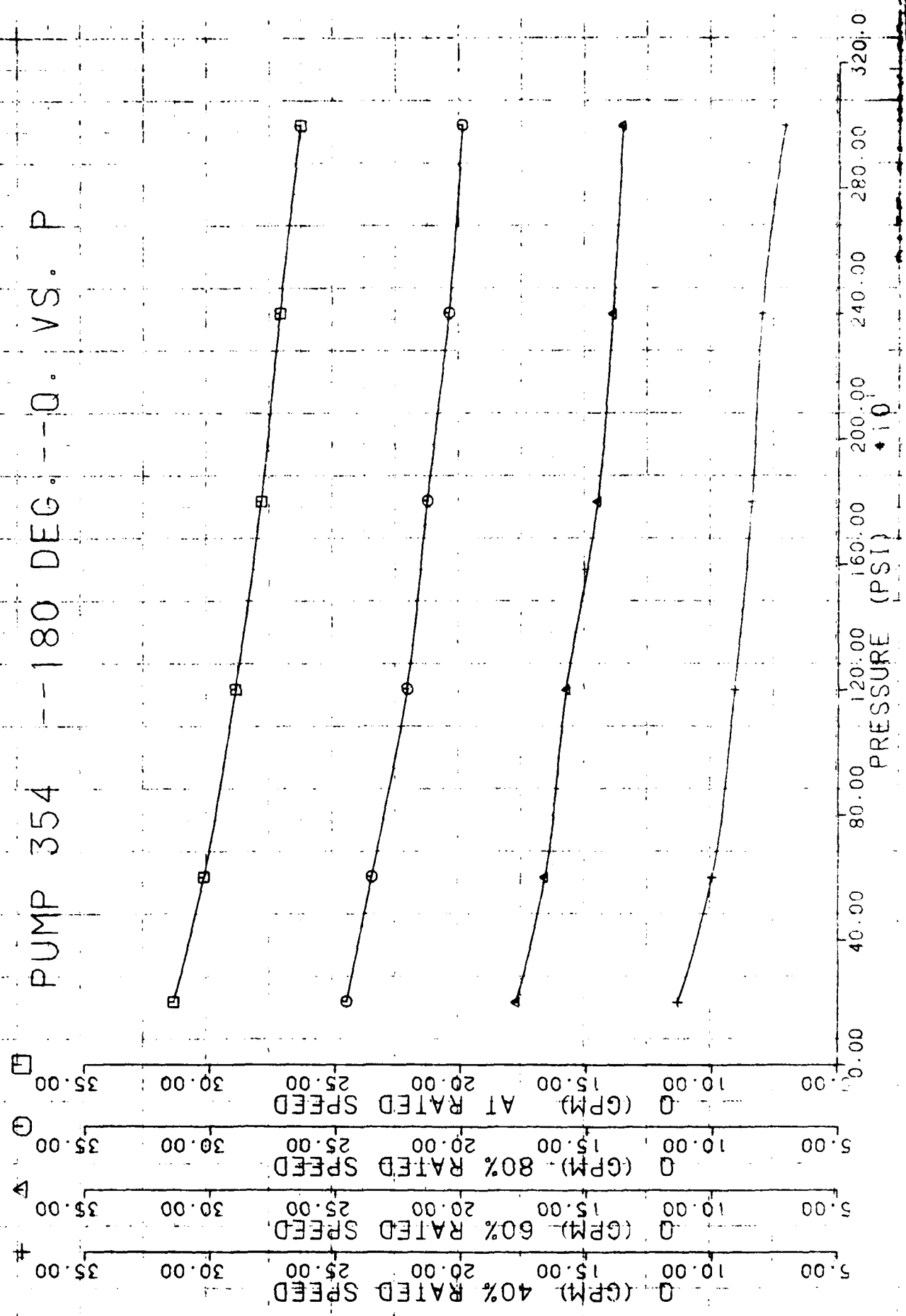
Q (GPM) @ 40% RATED SPEED  
 Q (GPM) @ 60% RATED SPEED  
 Q (GPM) @ 80% RATED SPEED  
 Q (GPM) AT RATED SPEED



DATE: MAY 20

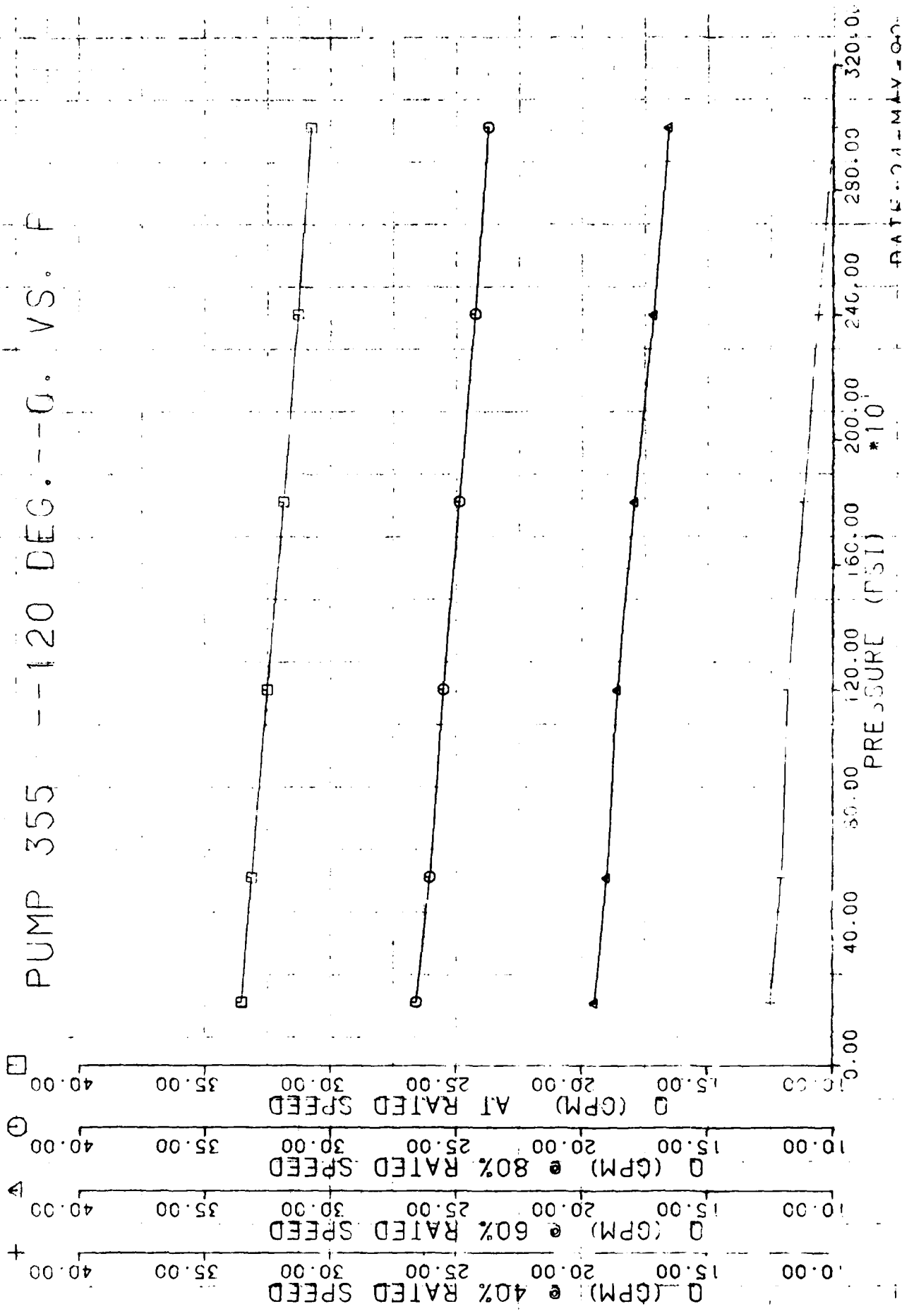
842

PUMP 354 --180 DEG. --0. VS. P



642

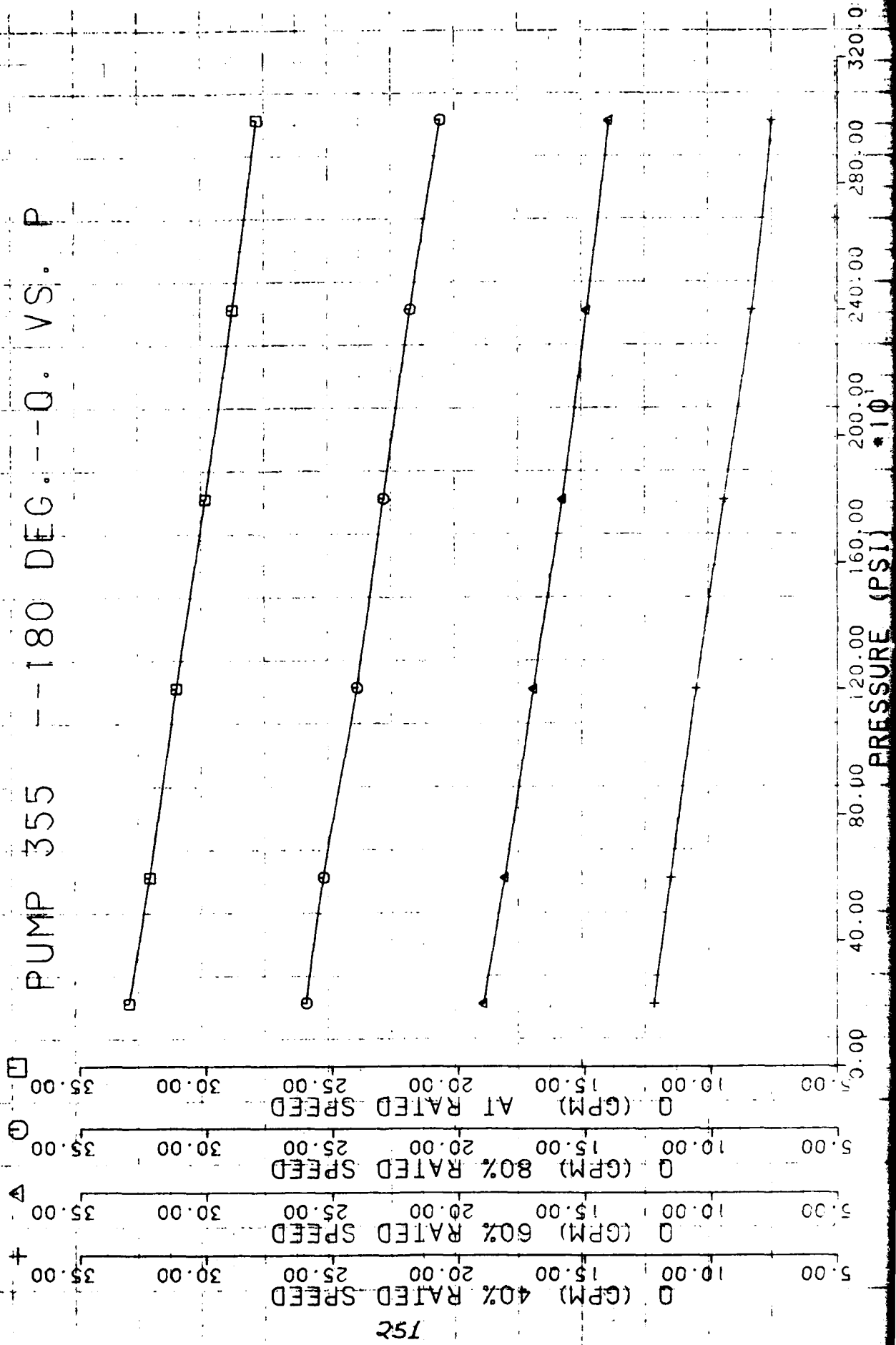
# PUMP 355 -- 120 DEG. -- G. VS. F.



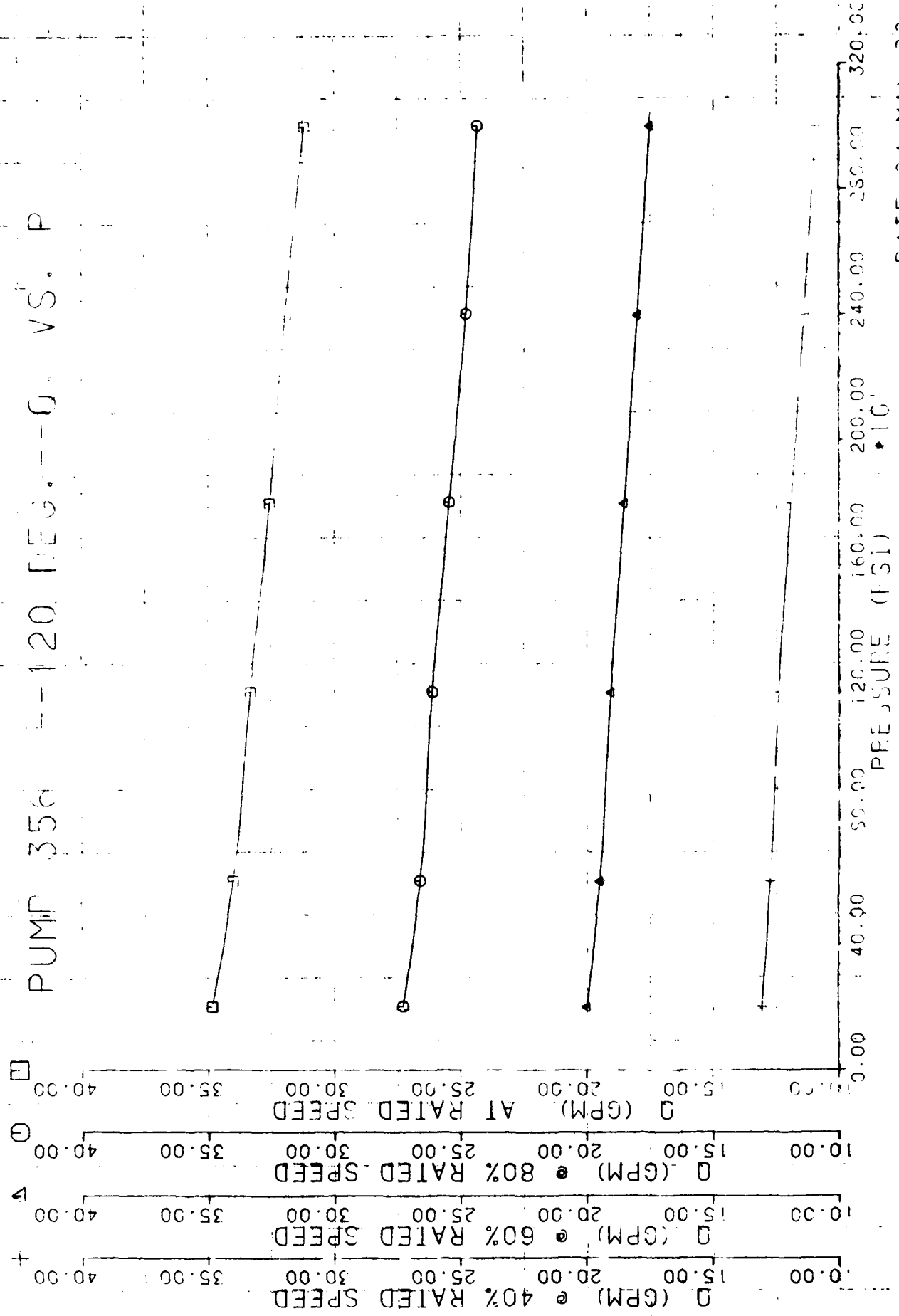
RATE 355-MAY-67

052

PUMP 355 -- 180 DEG. -- Q. VS. P

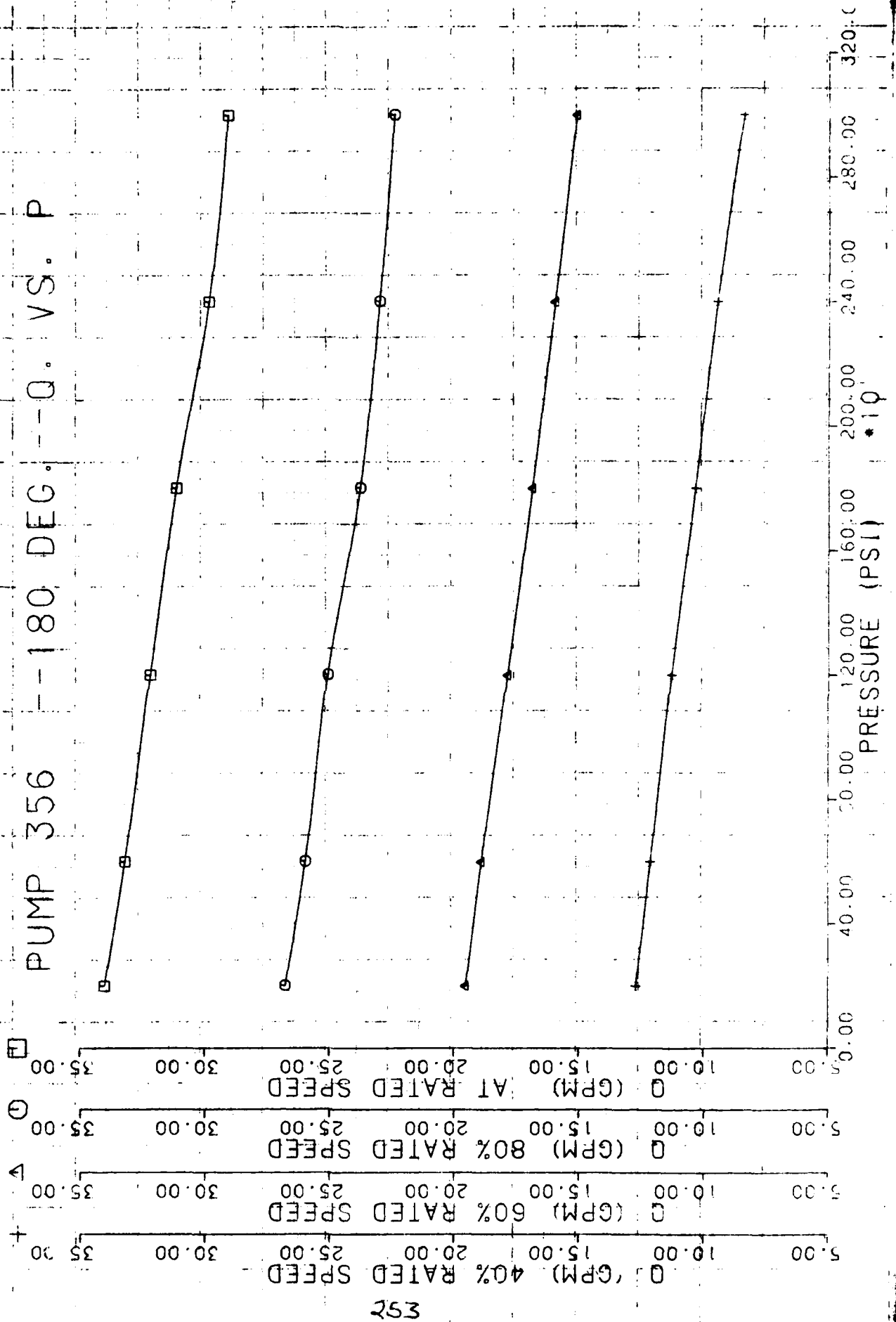


PUMP 356 -- 120 DEG. -- 0. VS. P



DATE: 04 MAY 50

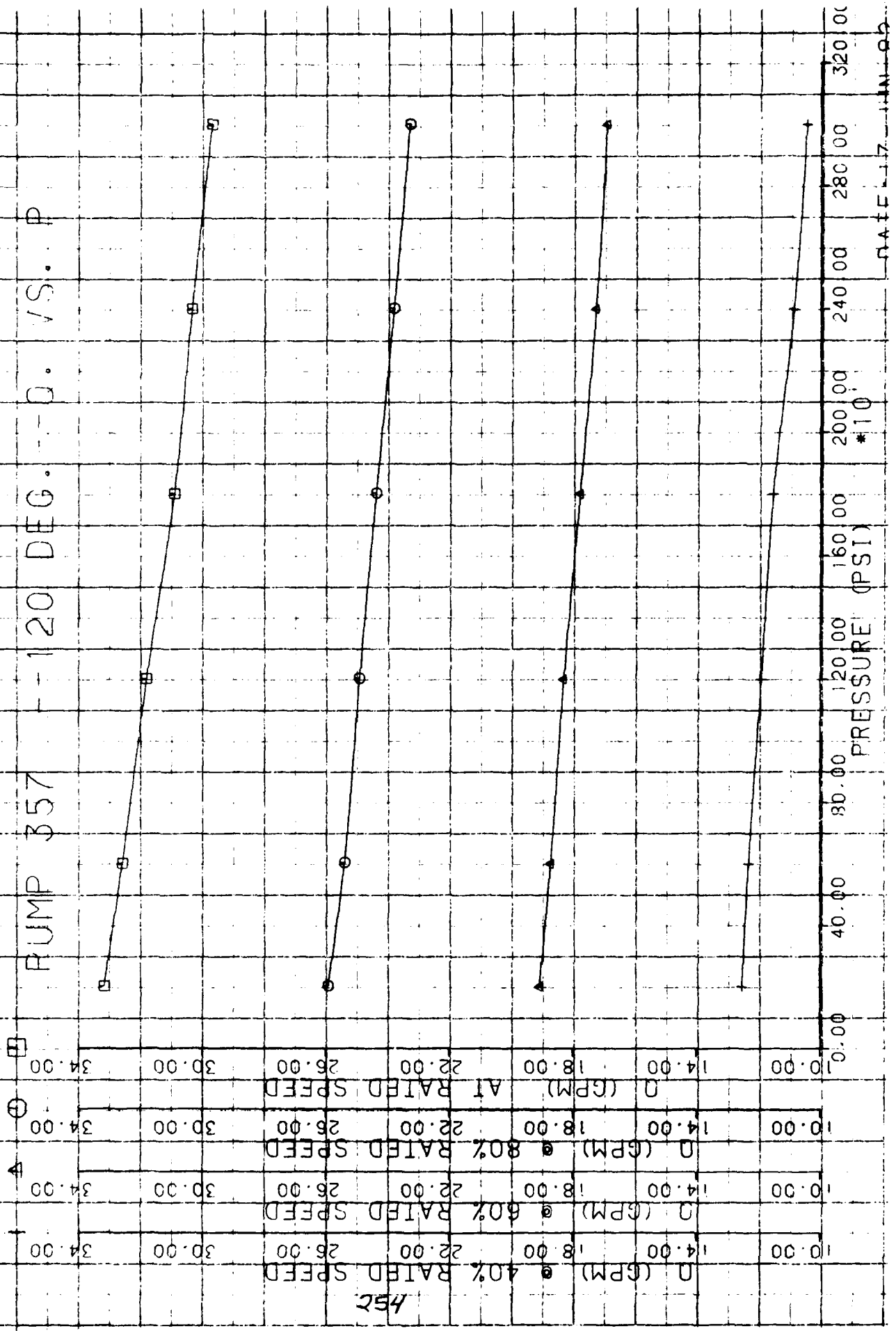
PUMP 356 -- 180 DEG. -- Q. VS. P



252



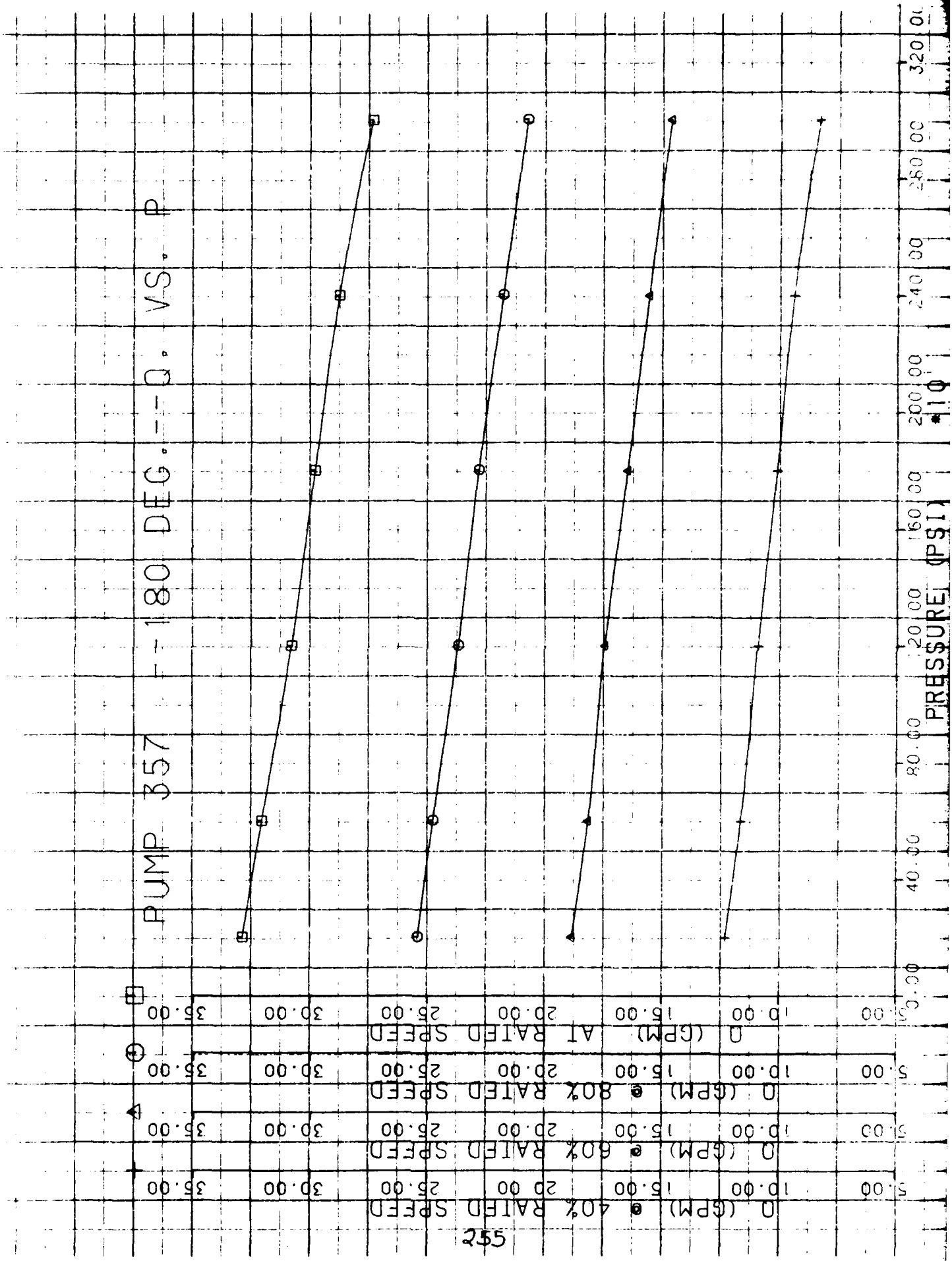
PUMP 357 -- 120 DEG. -- 0. VS. P



452

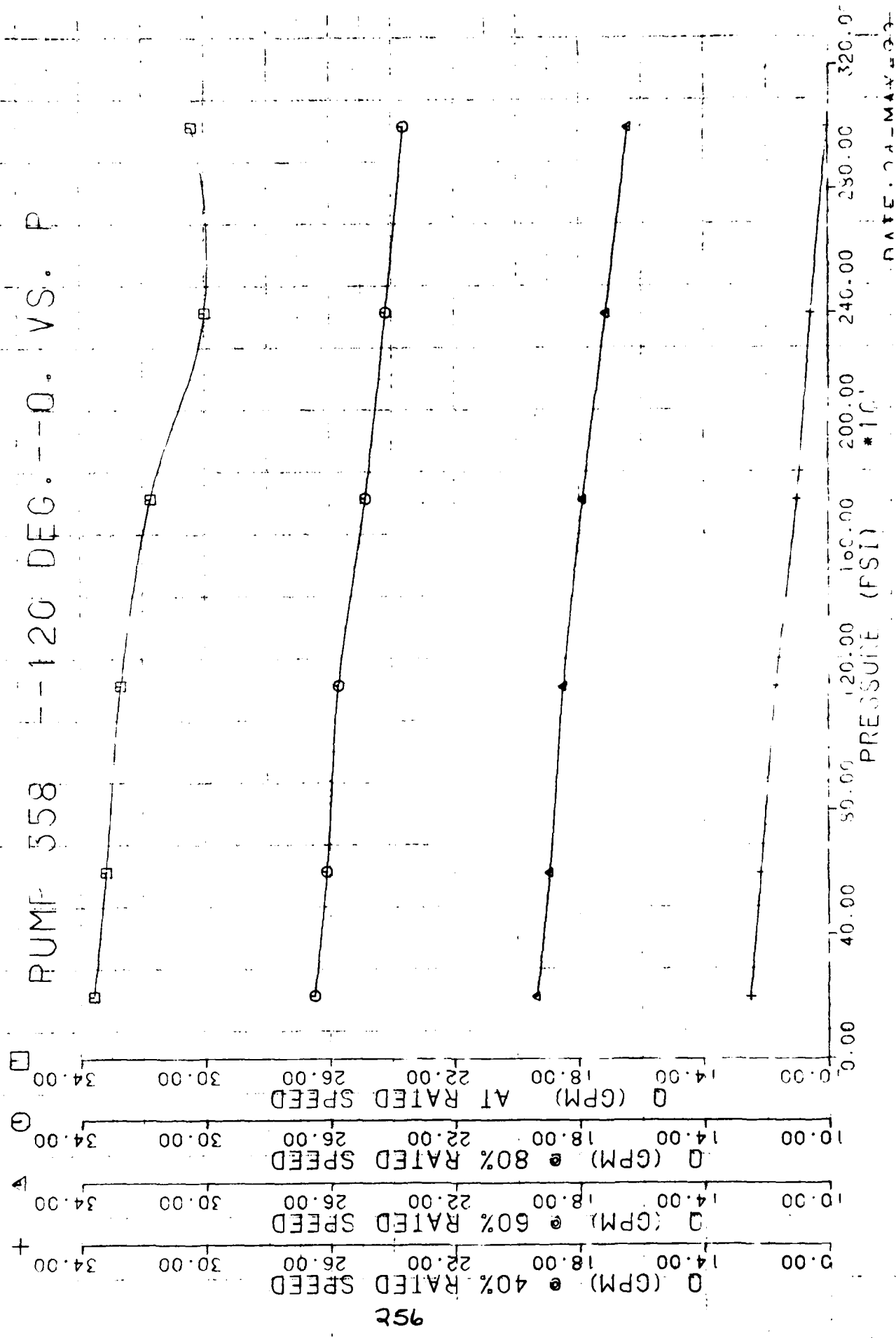
PUMP 357 -- 180 DEG. -- Q. VS. P

□ Q (GPM) AT RATED SPEED  
 ⊕ Q (GPM) @ 80% RATED SPEED  
 ▲ Q (GPM) @ 60% RATED SPEED  
 + Q (GPM) @ 40% RATED SPEED

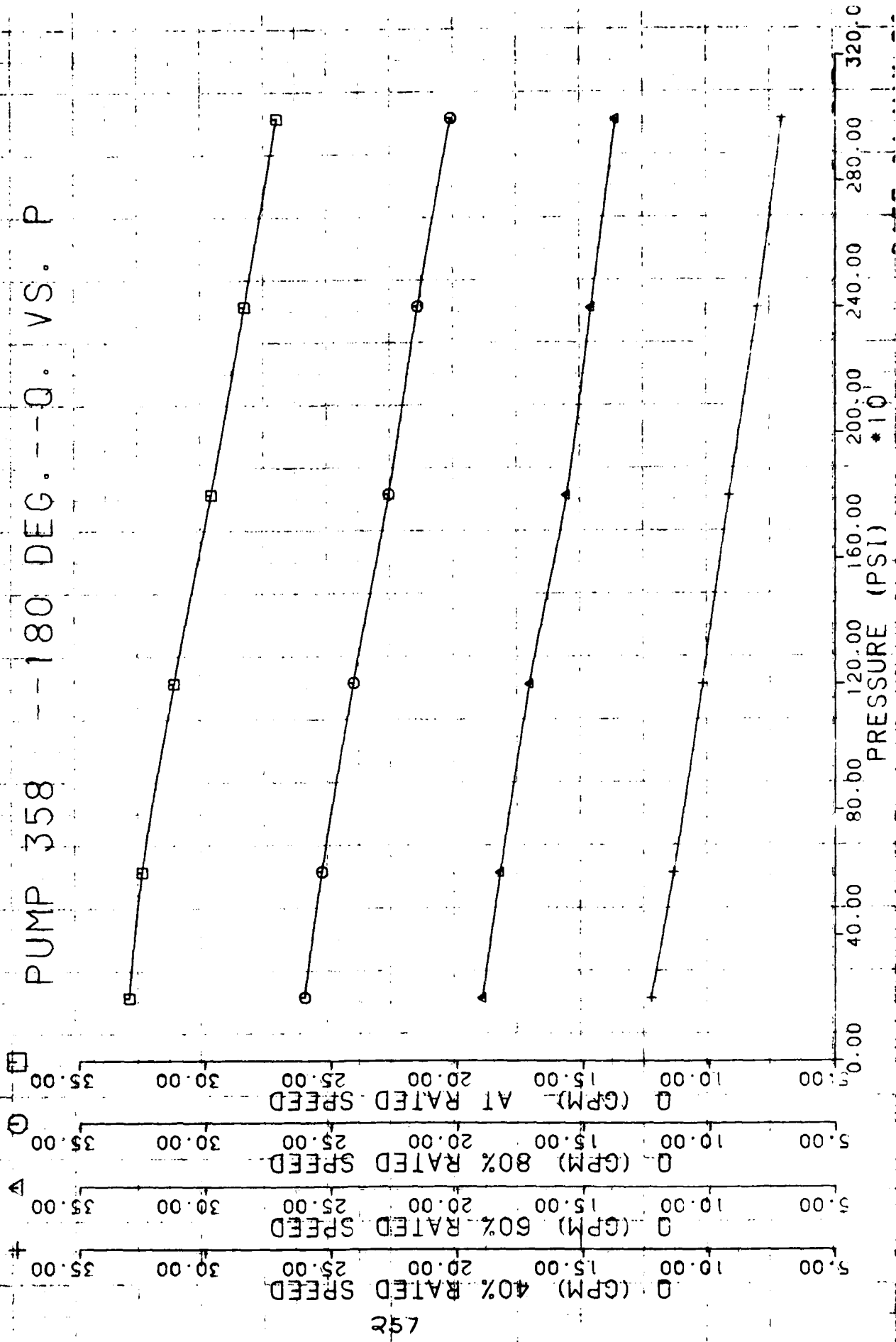


552

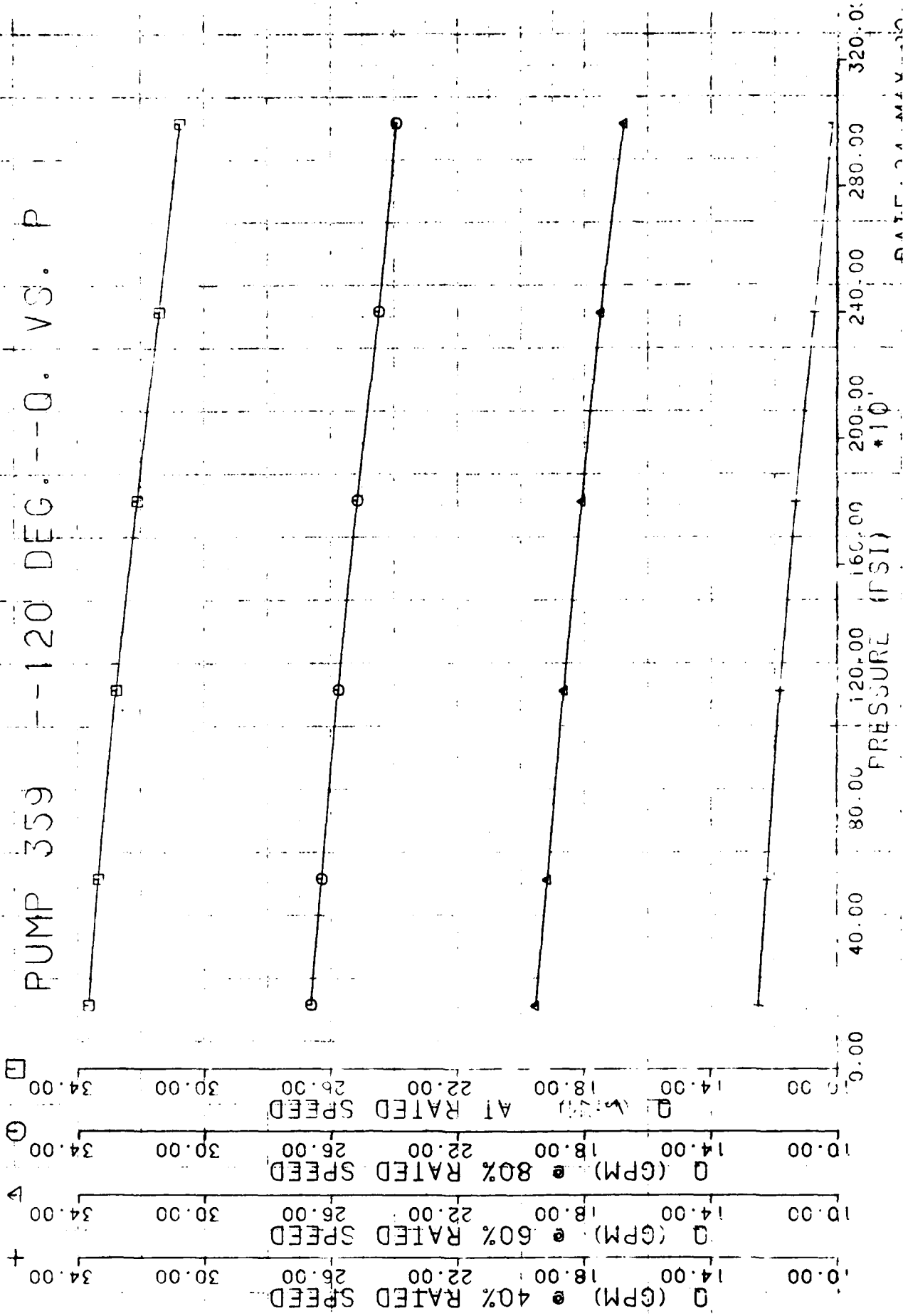
PUMP 558 -- 120 DEG. -- 0. VS. P



PUMP 358 -- 180 DEG. -- Q. VS. P



PUMP 359 --120 DEG.--0. VS. P

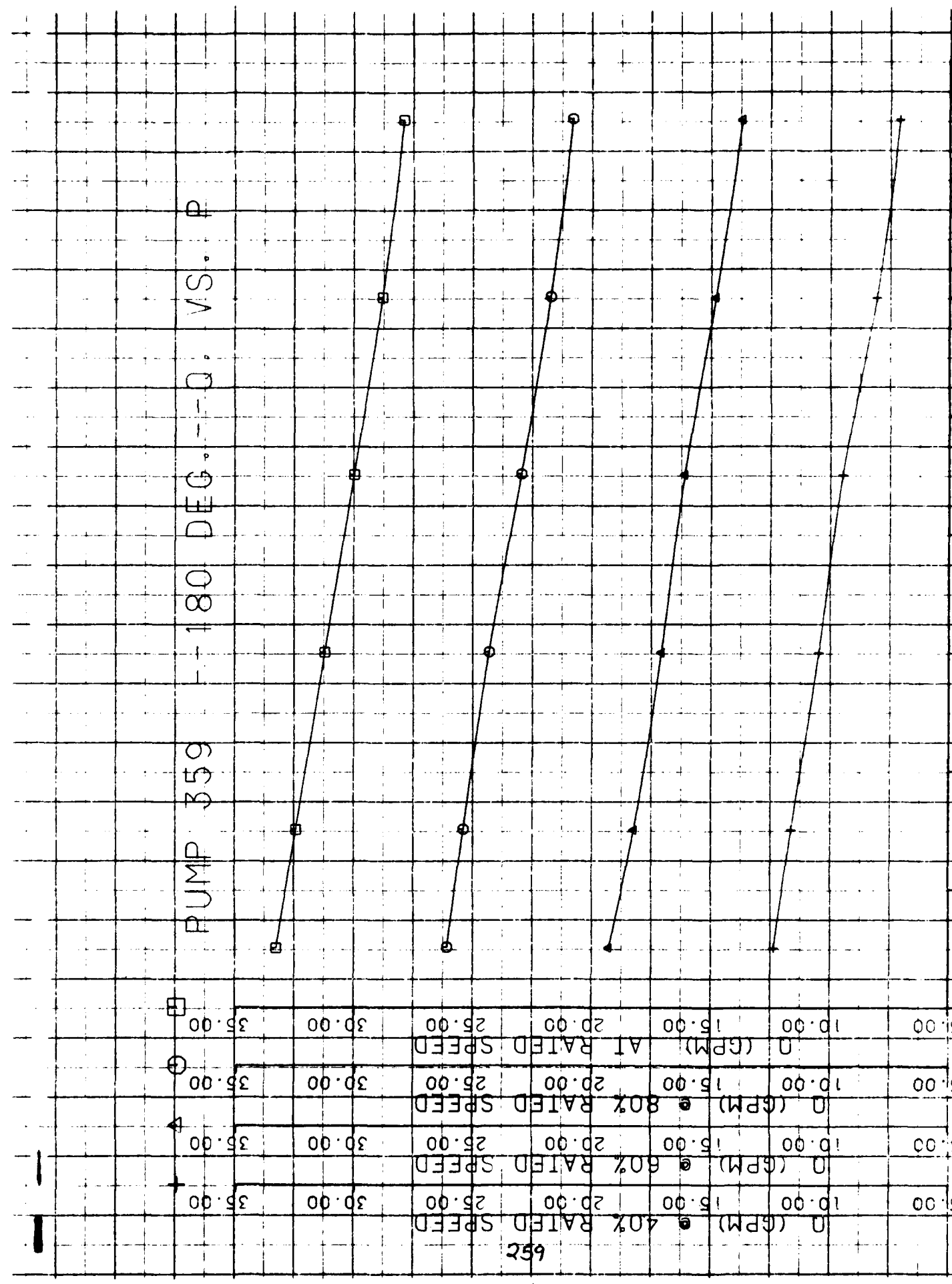


DATE: 01 MAY 1950

PUMP 359 -- 180 DEG. -- Q. VS. P

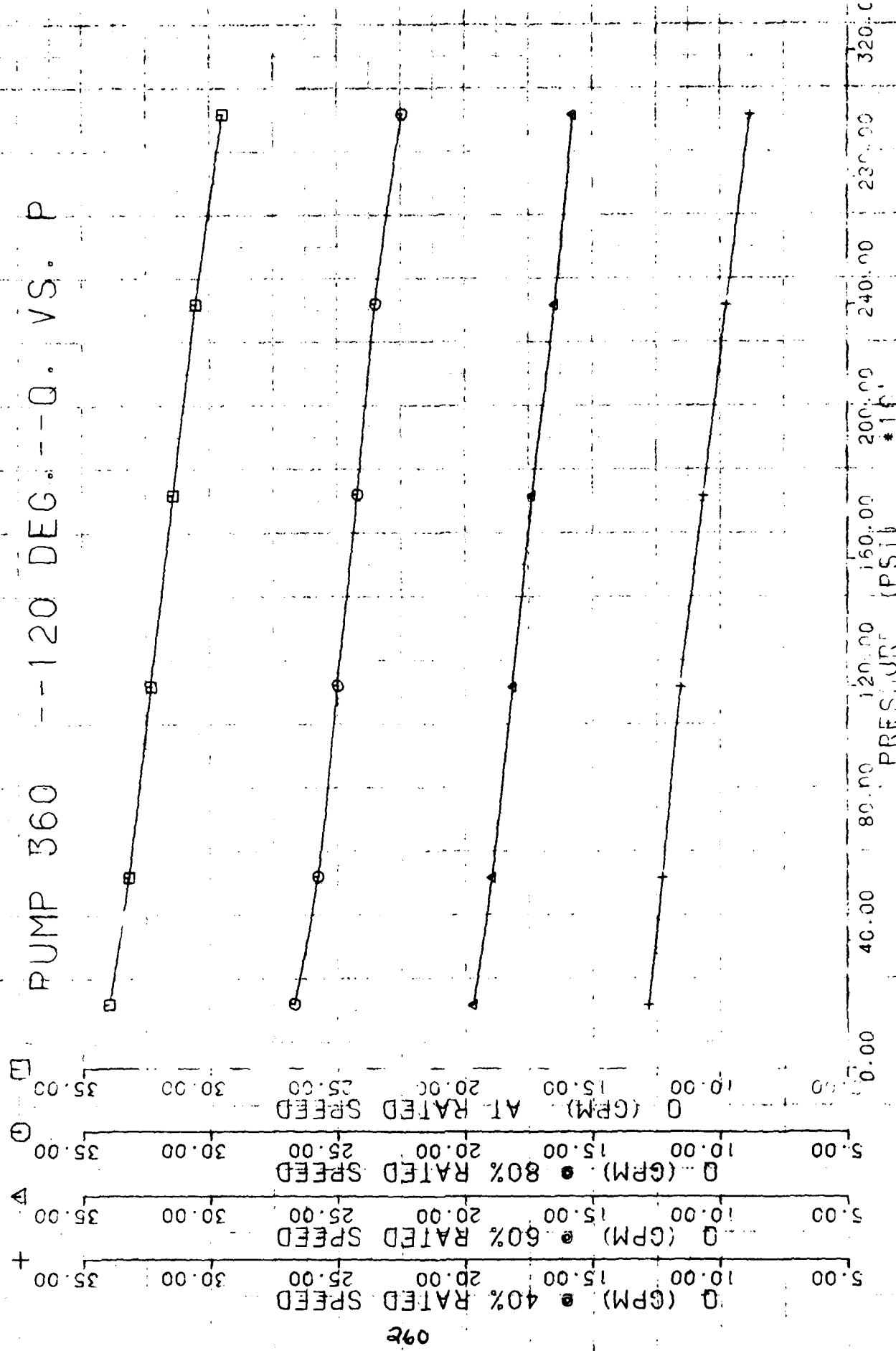
5.00 10.00 15.00 20.00 25.00 30.00 35.00  
 Q (GPM) @ 40% RATED SPEED  
 5.00 10.00 15.00 20.00 25.00 30.00 35.00  
 Q (GPM) @ 60% RATED SPEED  
 5.00 10.00 15.00 20.00 25.00 30.00 35.00  
 Q (GPM) @ 80% RATED SPEED  
 5.00 10.00 15.00 20.00 25.00 30.00 35.00  
 Q (GPM) AT RATED SPEED  
 5.00 10.00 15.00 20.00 25.00 30.00 35.00

40.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00  
 PRESSURE (PSI)



652

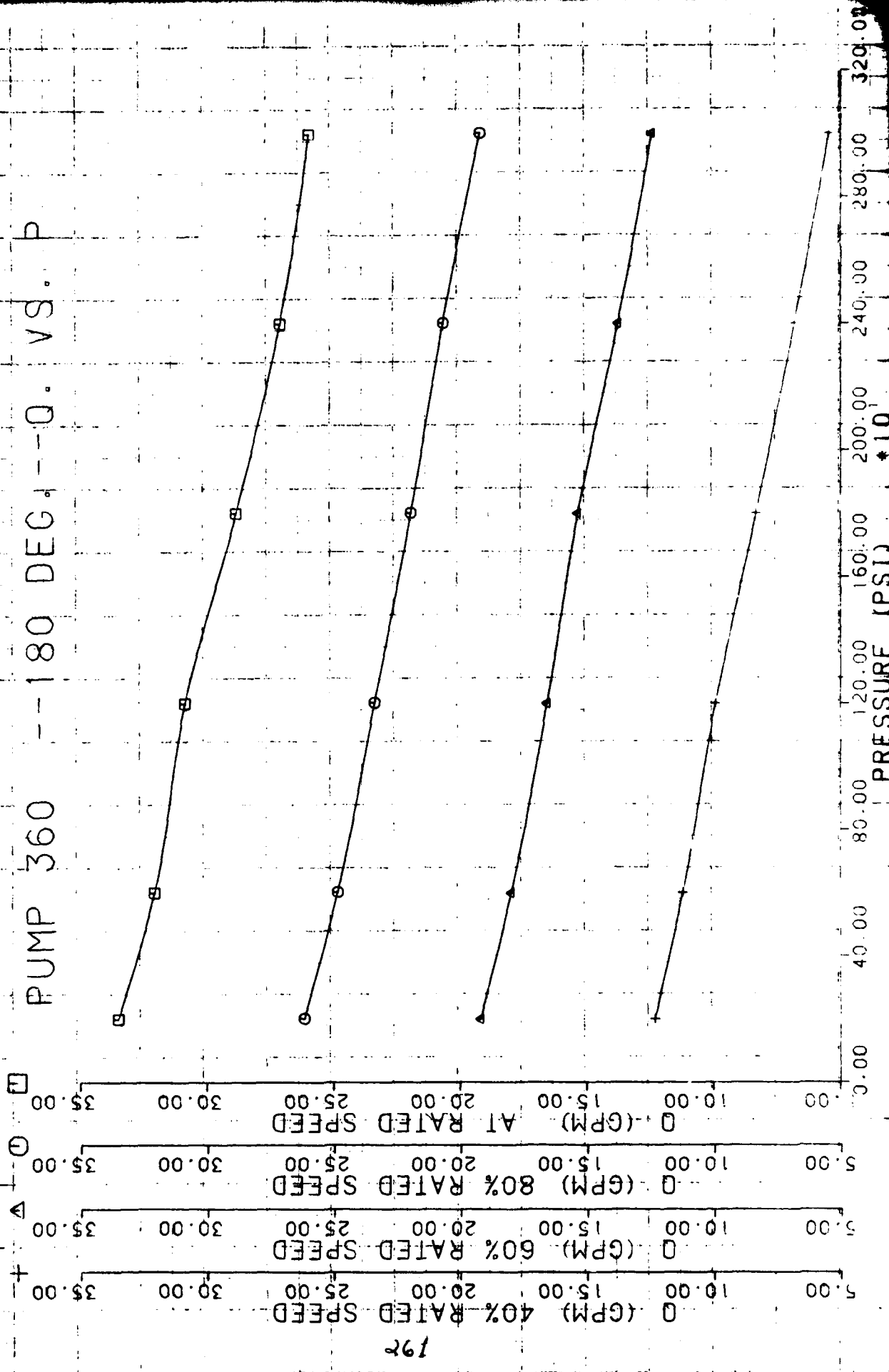
PUMP 360 --120 DEG.--0. VS. P



DATE - 31-MAY-69

092

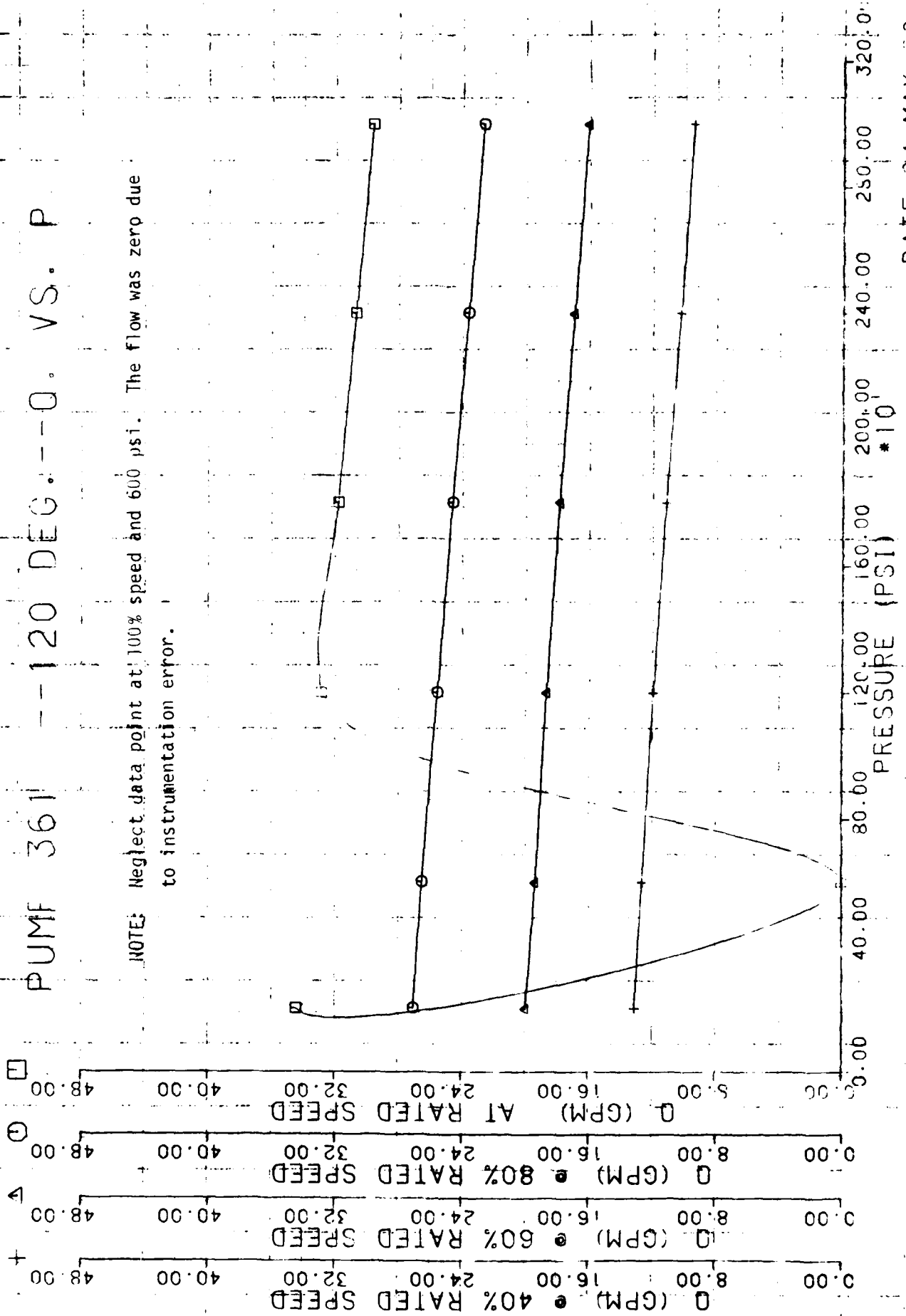
PUMP 360 -- 180 DEG. -- 0. VS. P





# PUMF 361 -- 120 DEG. -- 0. VS. P

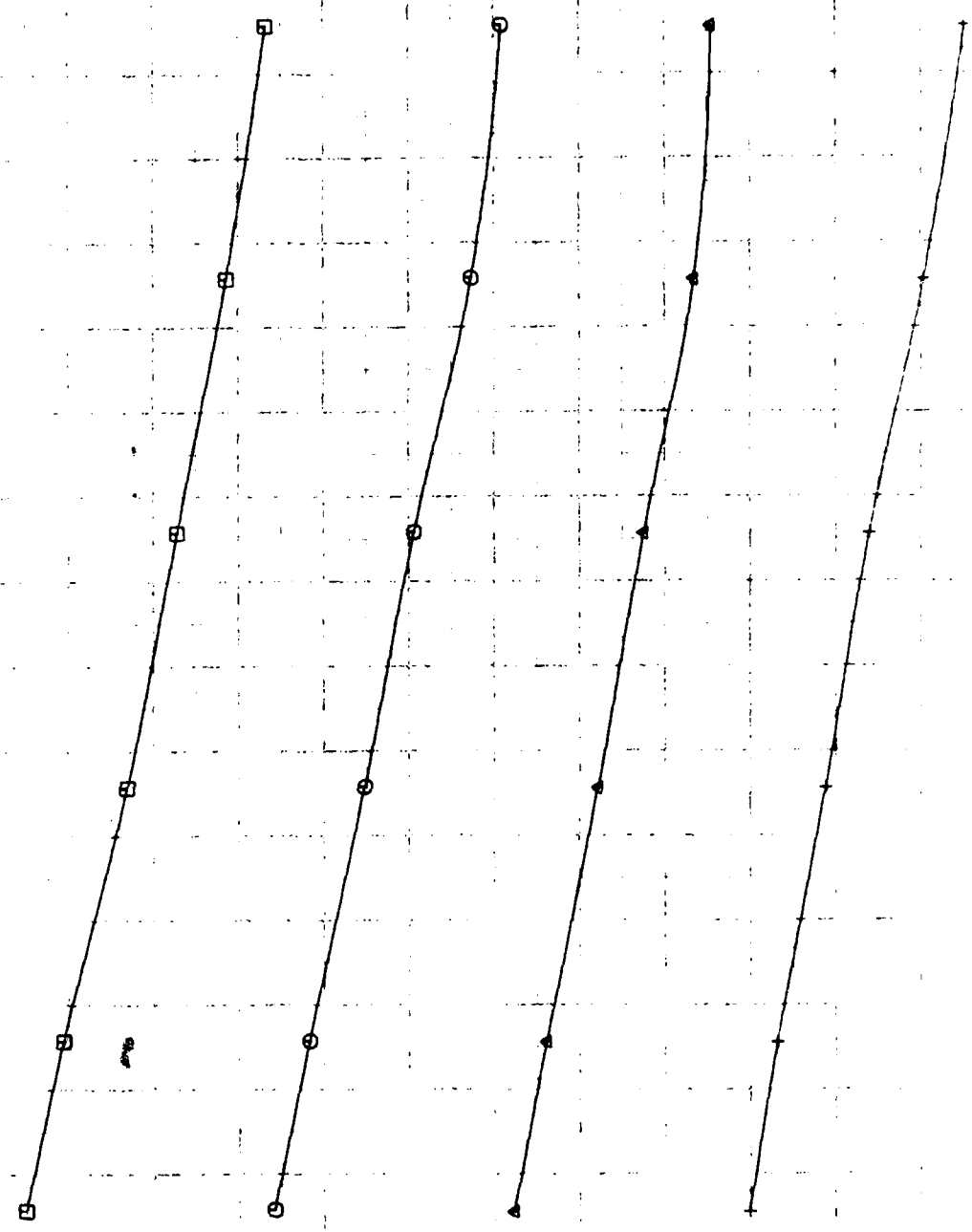
NOTE: Neglect data point at 100% speed and 600 psi. The flow was zero due to instrumentation error.



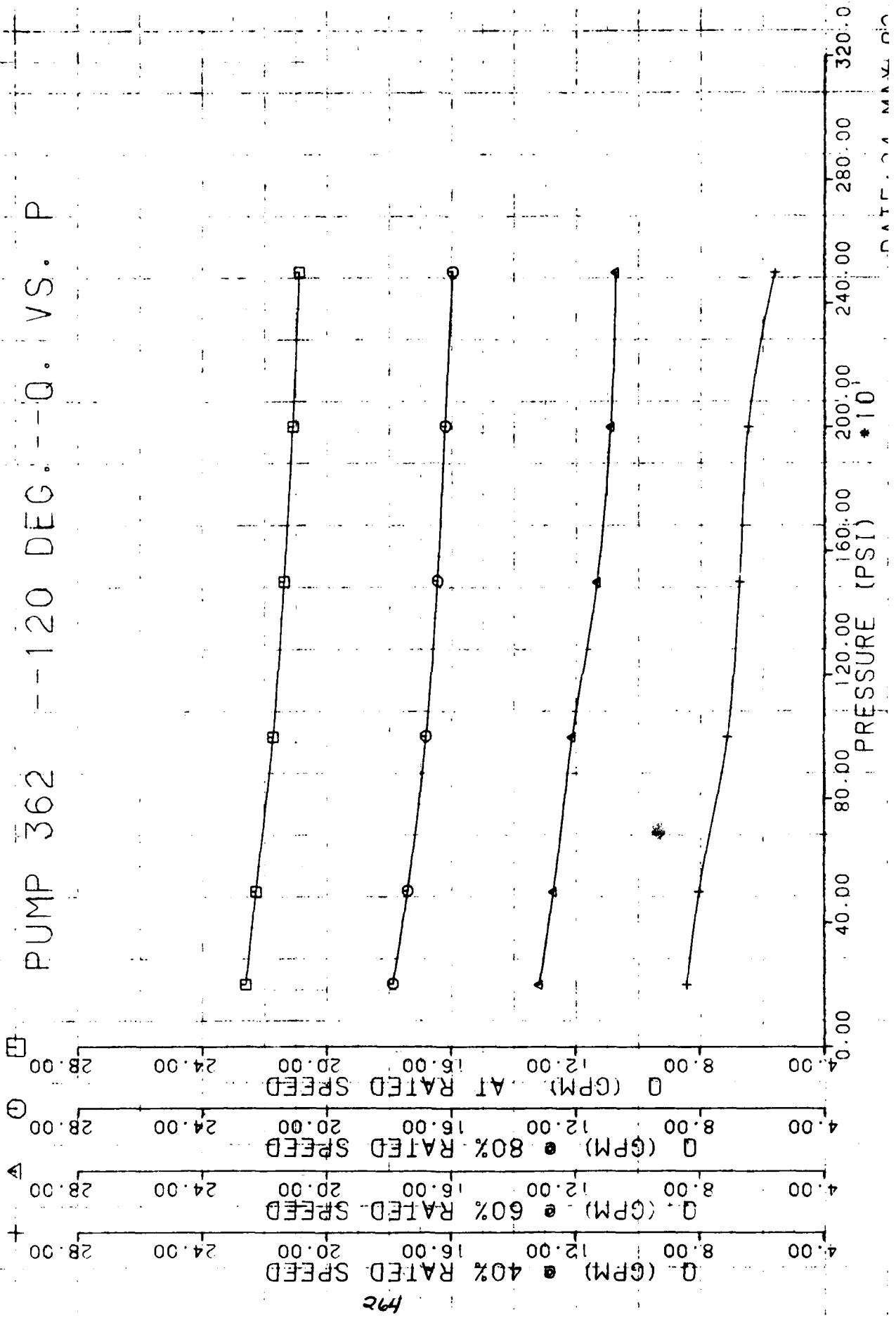
DATE: MAY 1950

# PUMP 361 F-180 DEG. - - 0. VS. P

+ 0 (GPM) 40% RATED SPEED
△ 0 (GPM) 60% RATED SPEED
○ 0 (GPM) 80% RATED SPEED
□ 0 (GPM) AT RATED SPEED



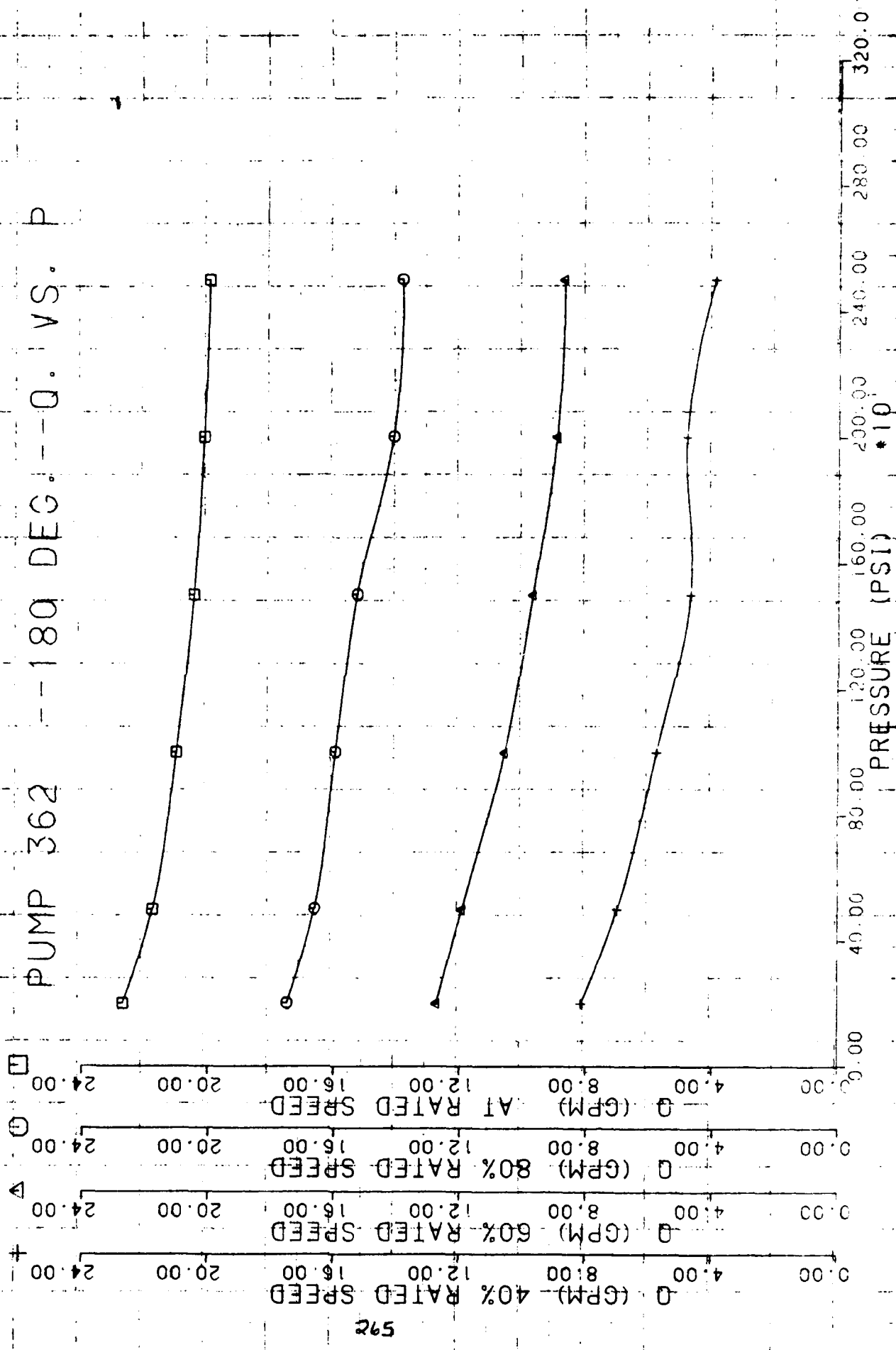
# PUMP 362 --120 DEG.--Q. VS. P



DATE: 04 MAR 60

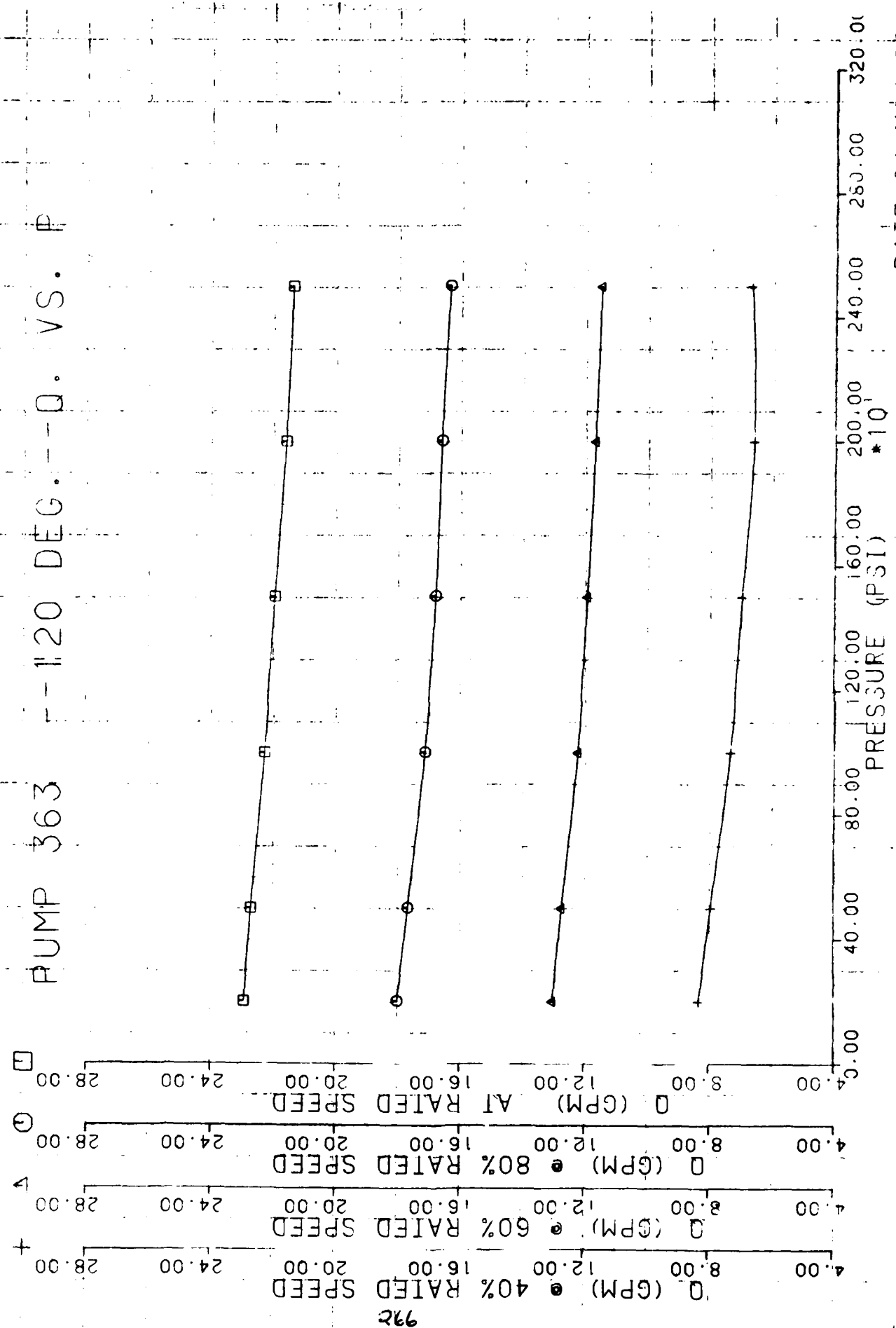
192

PUMP 362 --180 DEG. --0. VS. P



592

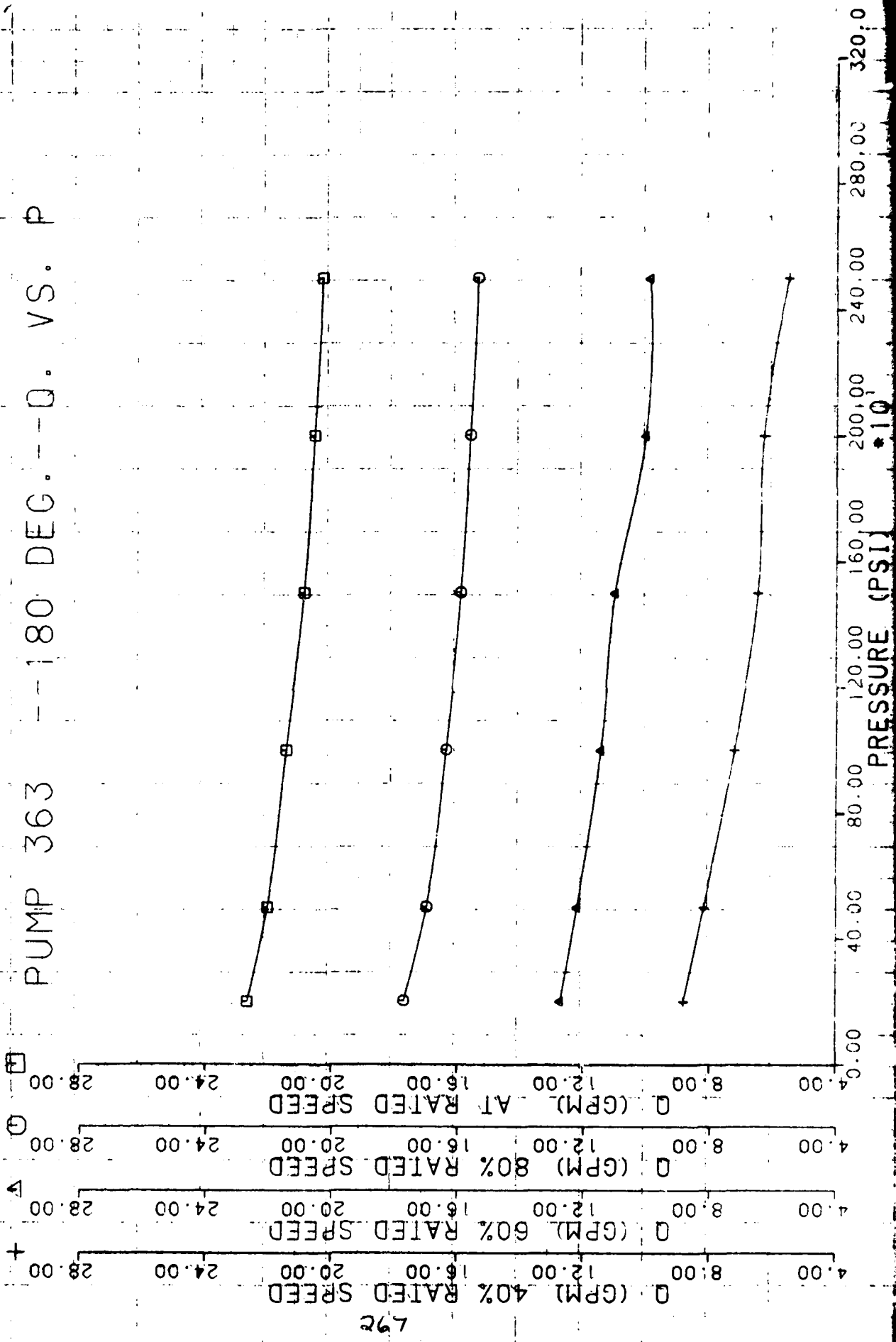
PUMP 363 -- 120 DEG. -- Q. VS. P



DATE: 04-MAY-68

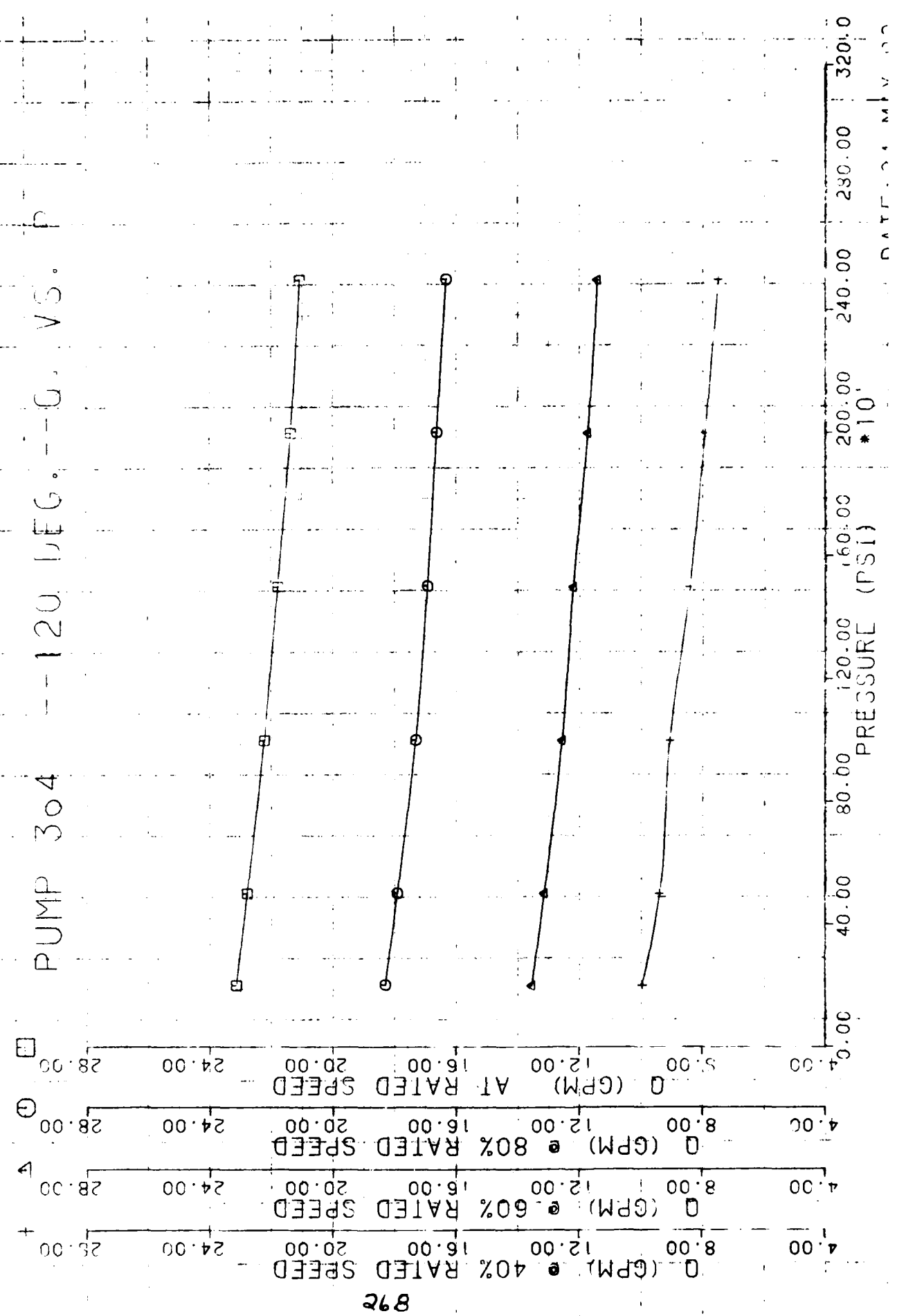
992

PUMP 363 -- 180 DEG. -- D. VS. P



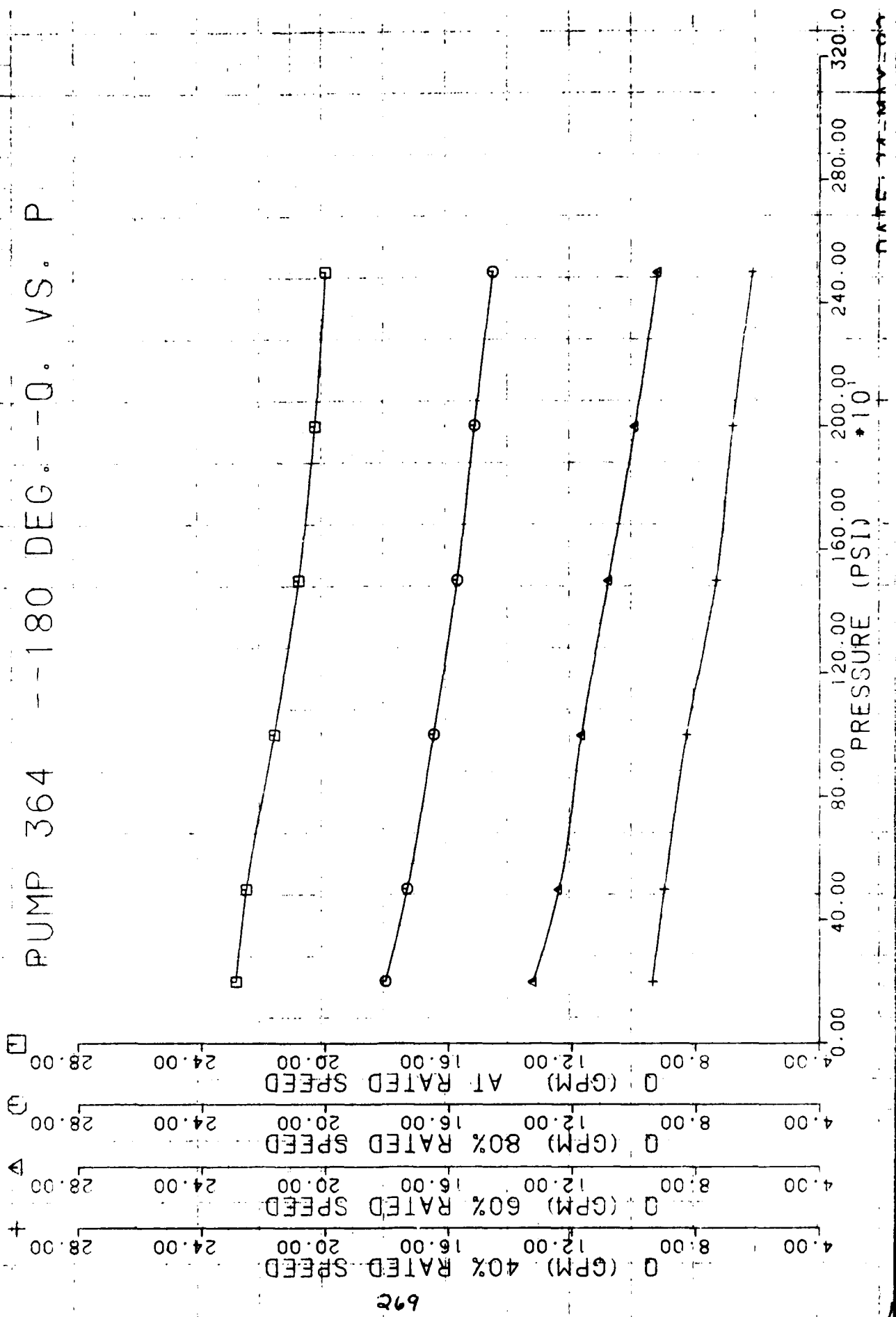
L72

PUMP 304 -- 120 DEG. -- G. VS. P



892

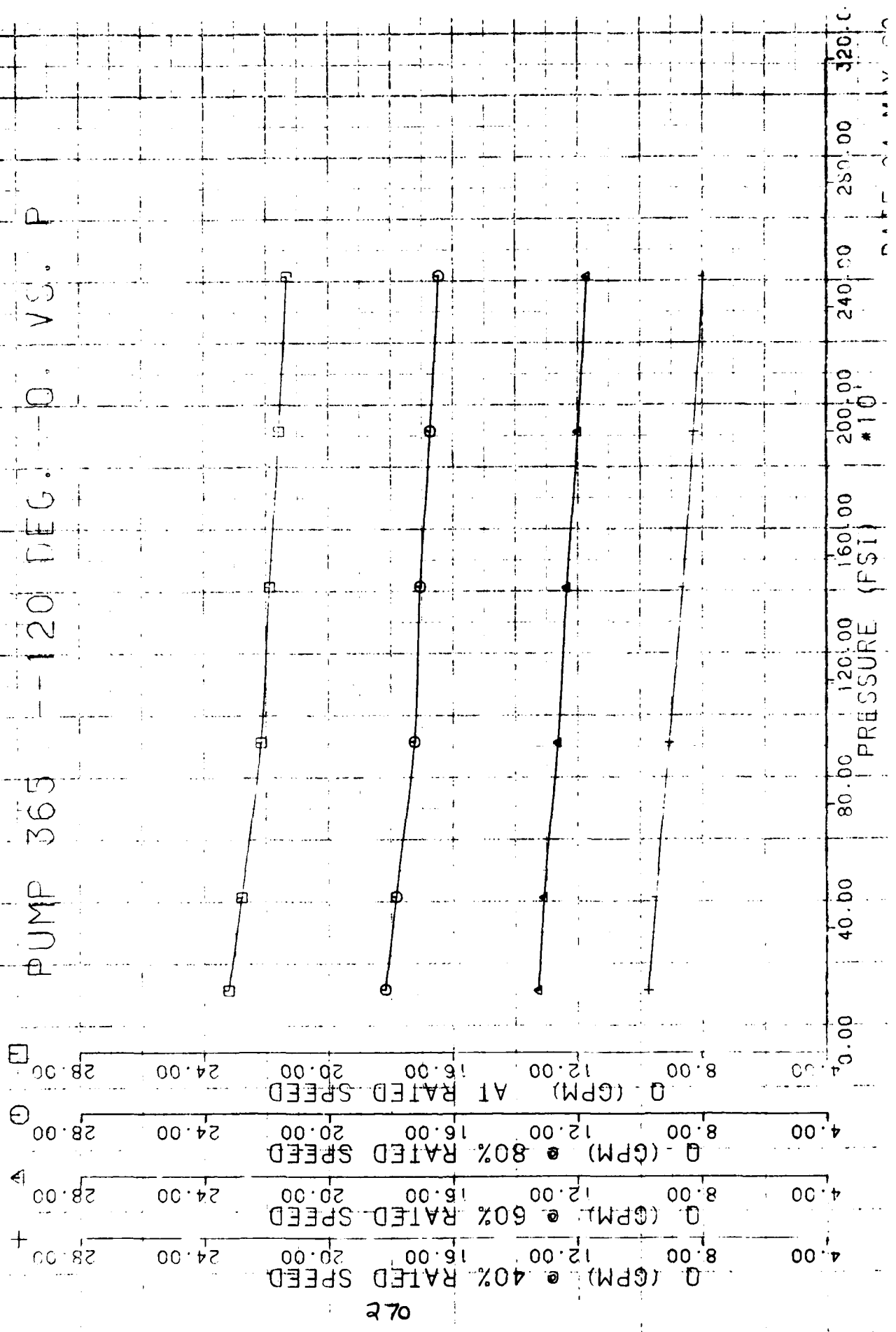
PUMP 364 --180 DEG.--0. VS. P



692

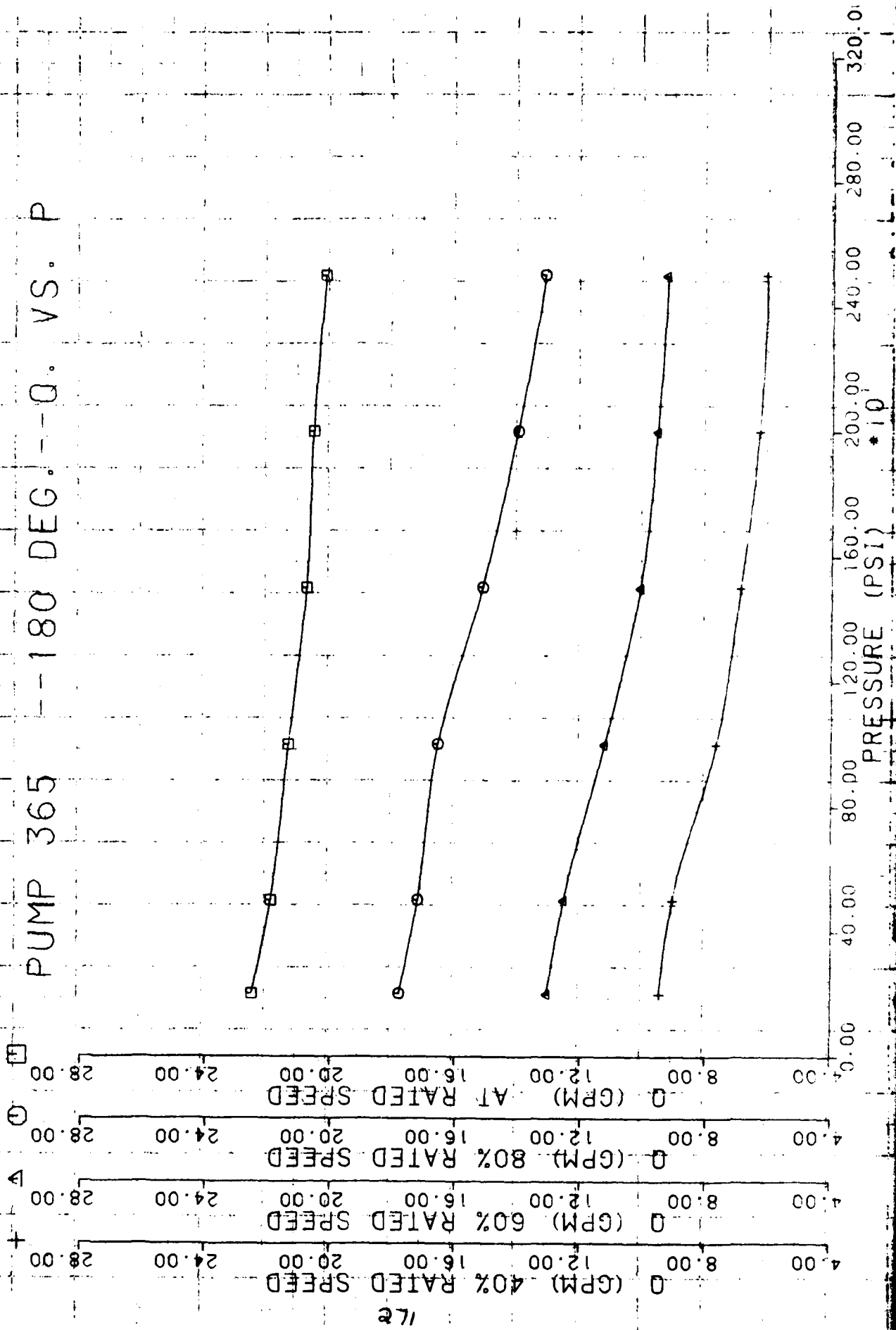


PUMP 365 -- 120 DEG. -- 0. VS. P



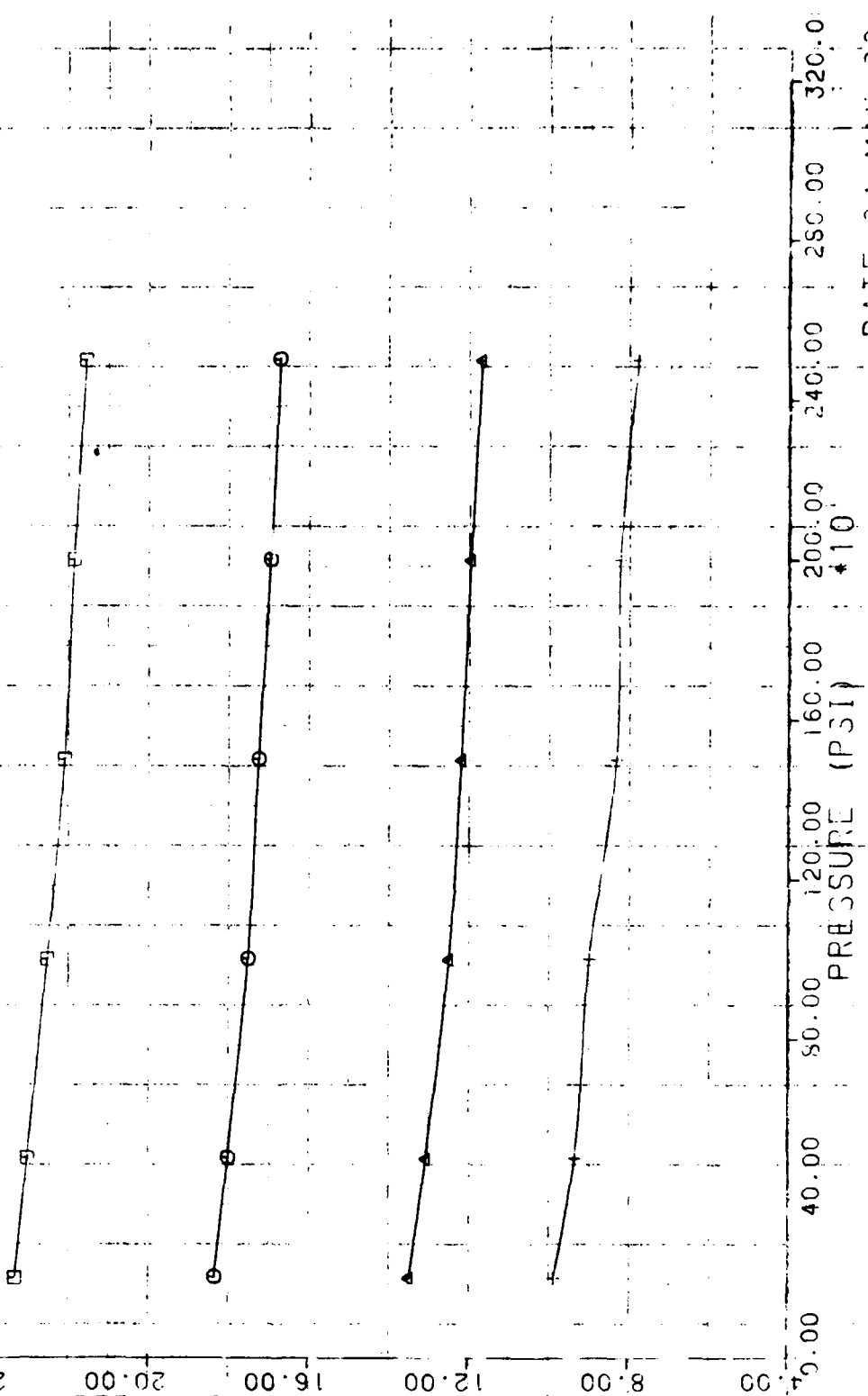
072

PUMP 365 --180 DEG.--0. VS. P

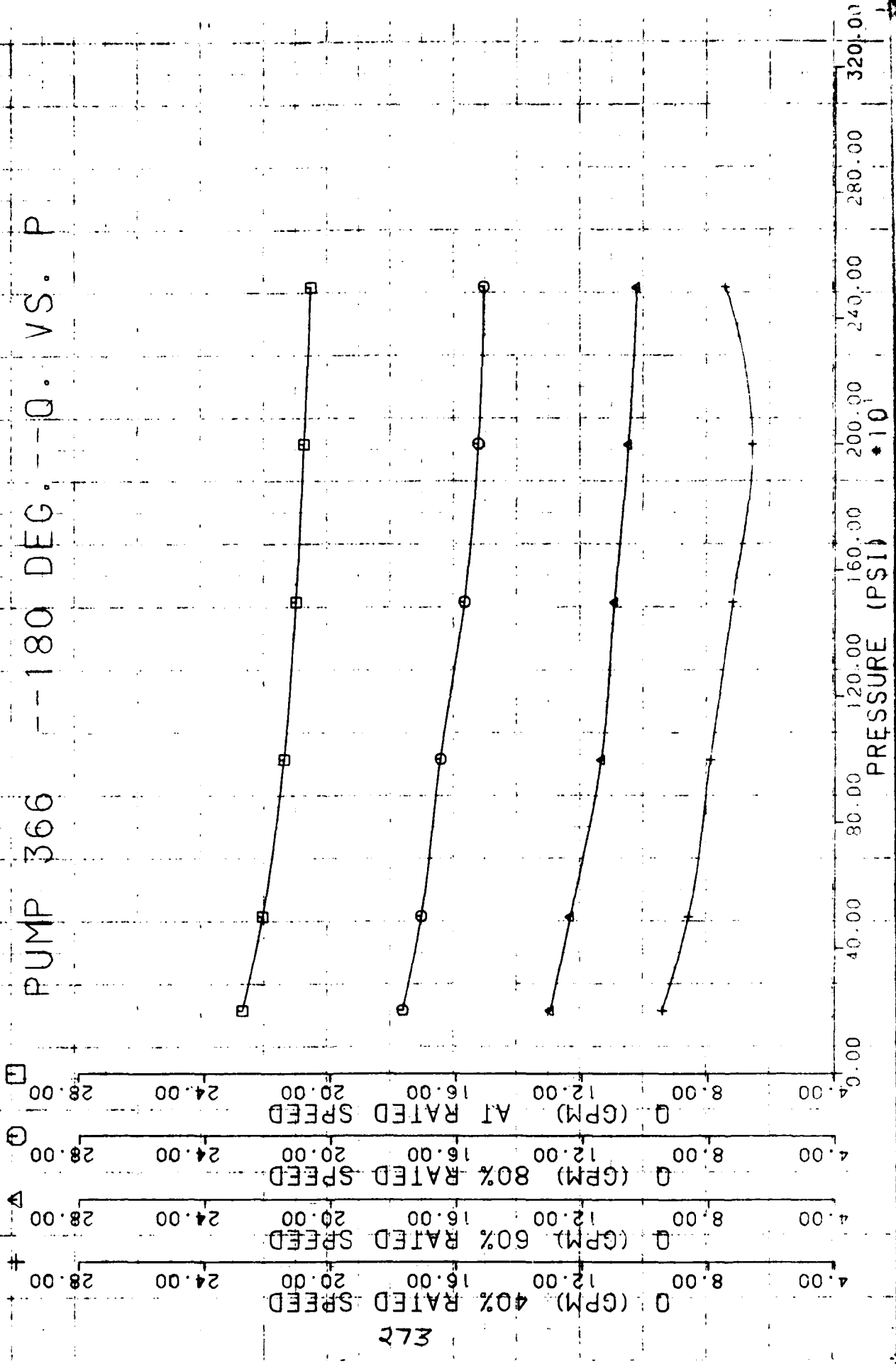


PUMP 360 --120 DEG.--0. VS. P

272  
 Q (GPM) @ 40% RATED SPEED 4.00 8.00 12.00 16.00 20.00 24.00 28.00  
 Q (GPM) @ 60% RATED SPEED 4.00 8.00 12.00 16.00 20.00 24.00 28.00  
 Q (GPM) @ 80% RATED SPEED 4.00 8.00 12.00 16.00 20.00 24.00 28.00  
 Q (GPM) AT RATED SPEED 4.00 8.00 12.00 16.00 20.00 24.00 28.00

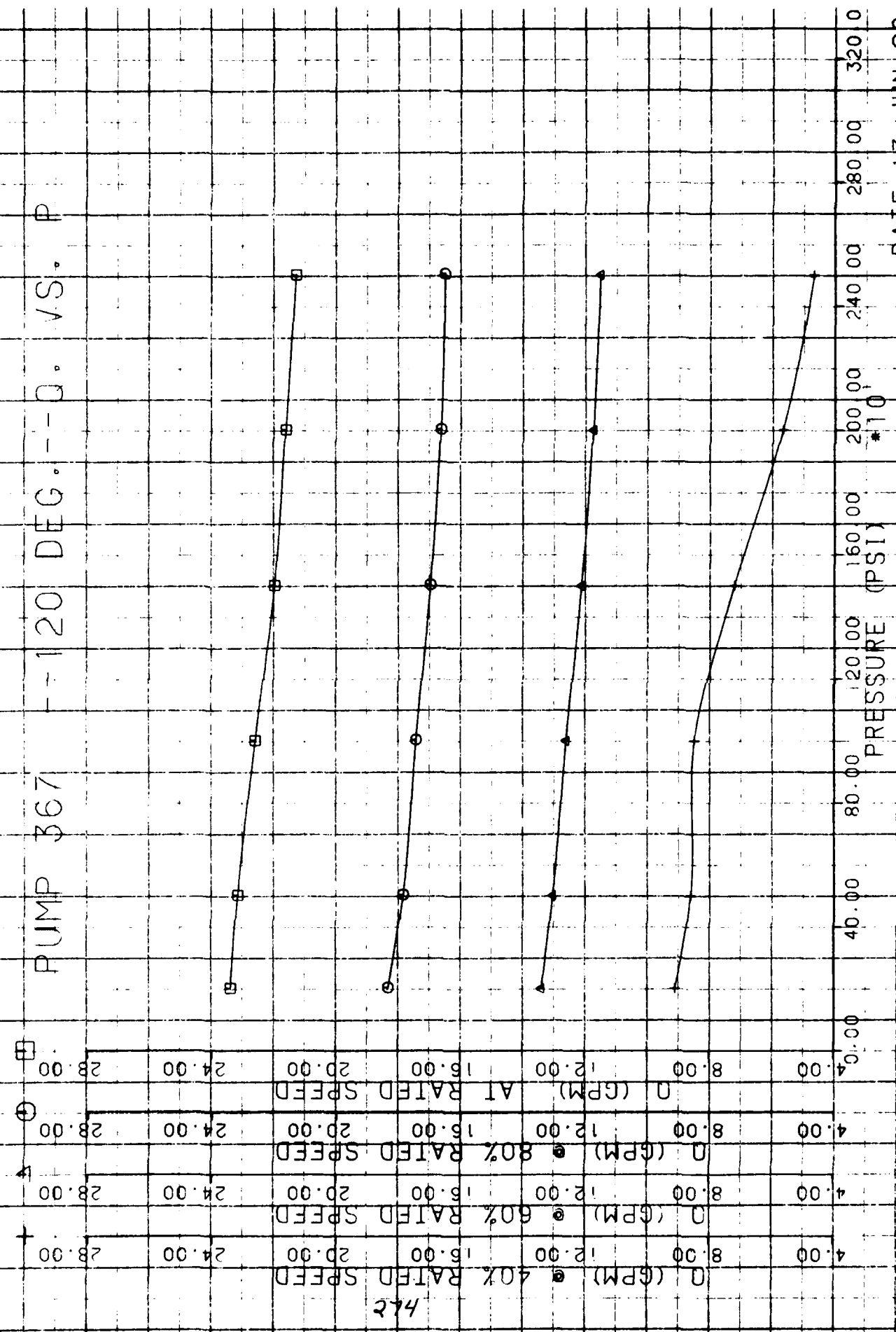


PUMP 366 --180 DEG. --0. VS. P



272

PUMP 367 -- 120 DEG. -- 0. VS. P



DATE 17 JUN 68

42

PUMP 367 - 180 DEG. - Q, VS. P

Q (GPM)	40% RATED SPEED	60% RATED SPEED	80% RATED SPEED	AT RATED SPEED
4.00	28.00	28.00	28.00	28.00
8.00	24.00	24.00	24.00	24.00
12.00	20.00	20.00	20.00	20.00
15.00	15.00	15.00	15.00	15.00
20.00	8.00	8.00	8.00	8.00
24.00	4.00	4.00	4.00	4.00
28.00	0.00	0.00	0.00	0.00

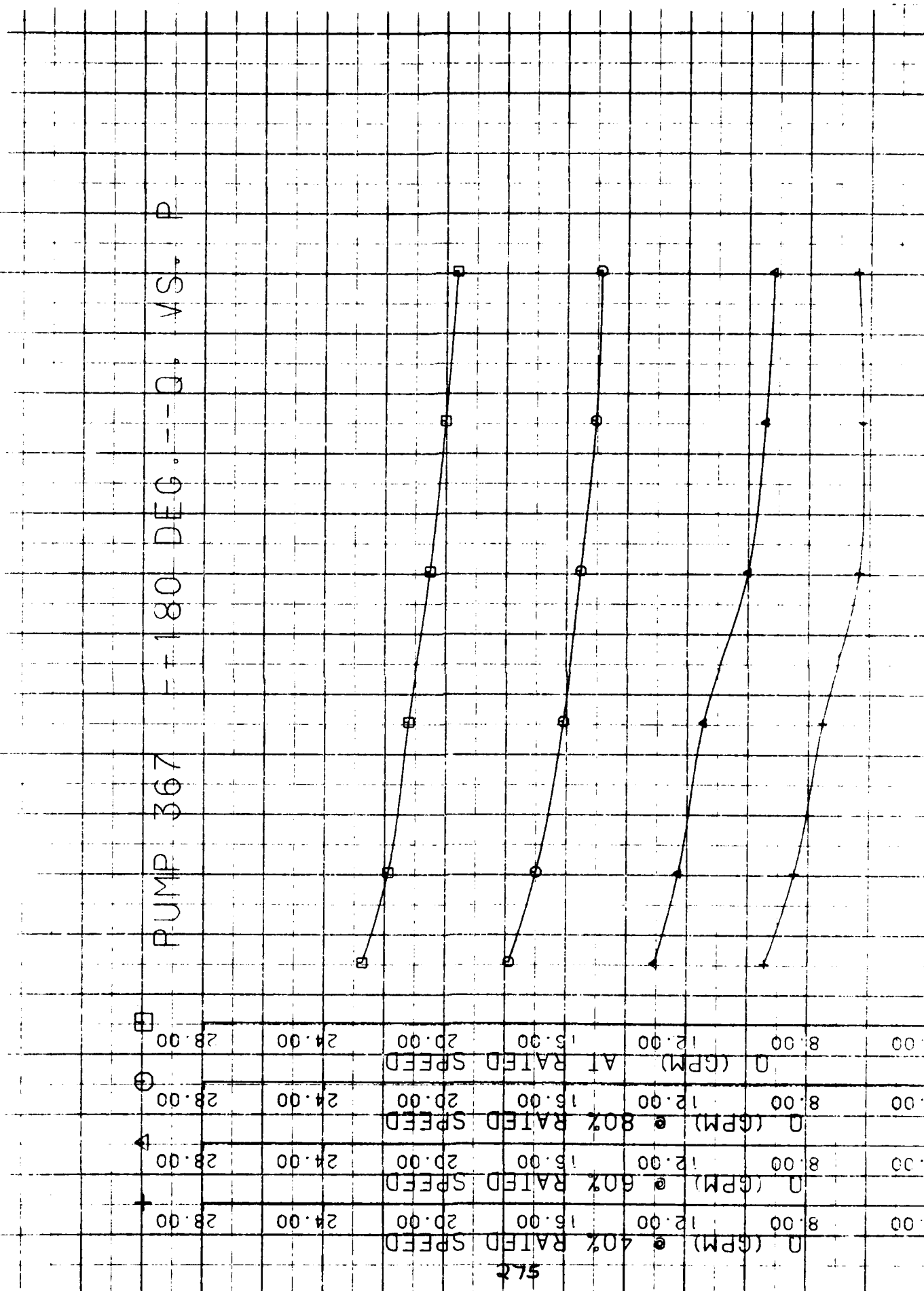
40.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00

PRESSURE (PSI)

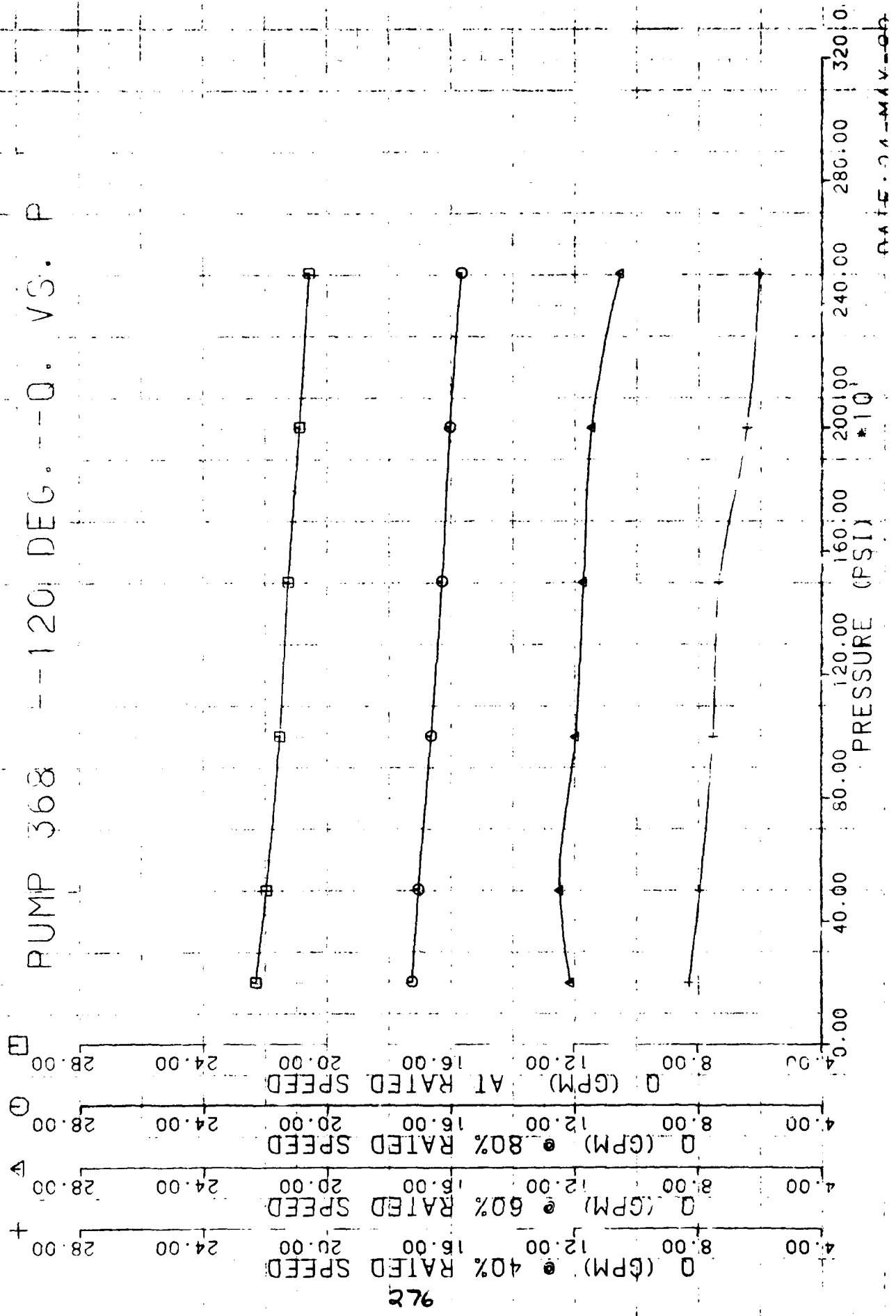
4.00 8.00 12.00 15.00 20.00 24.00 28.00

Q (GPM)

110



PUMP 368 --120 DEG. --0. VS. P

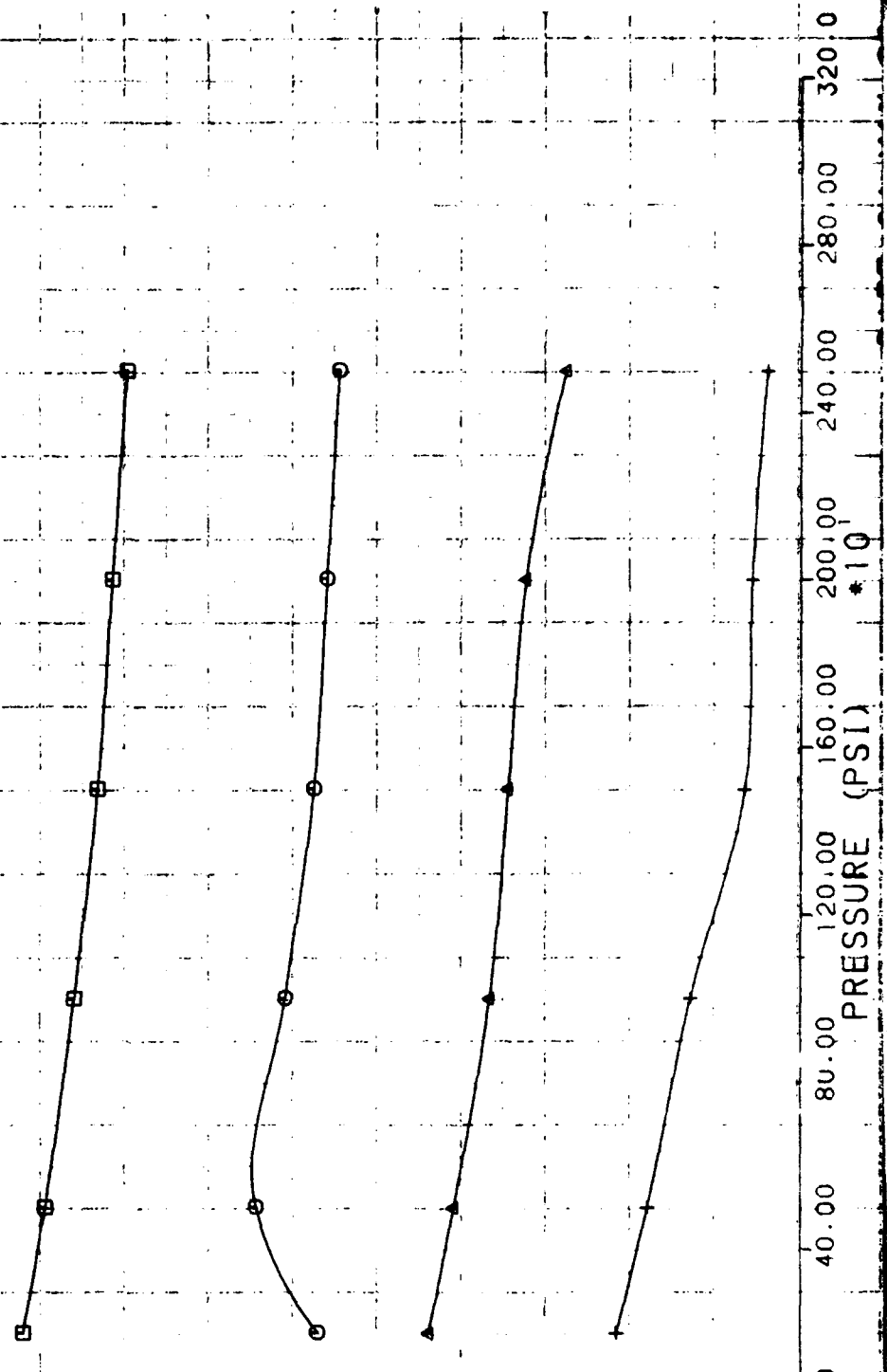


DATE: 01-MAY-60

92

PUMP 368 -- 180 DEG. -- Q. VS. P

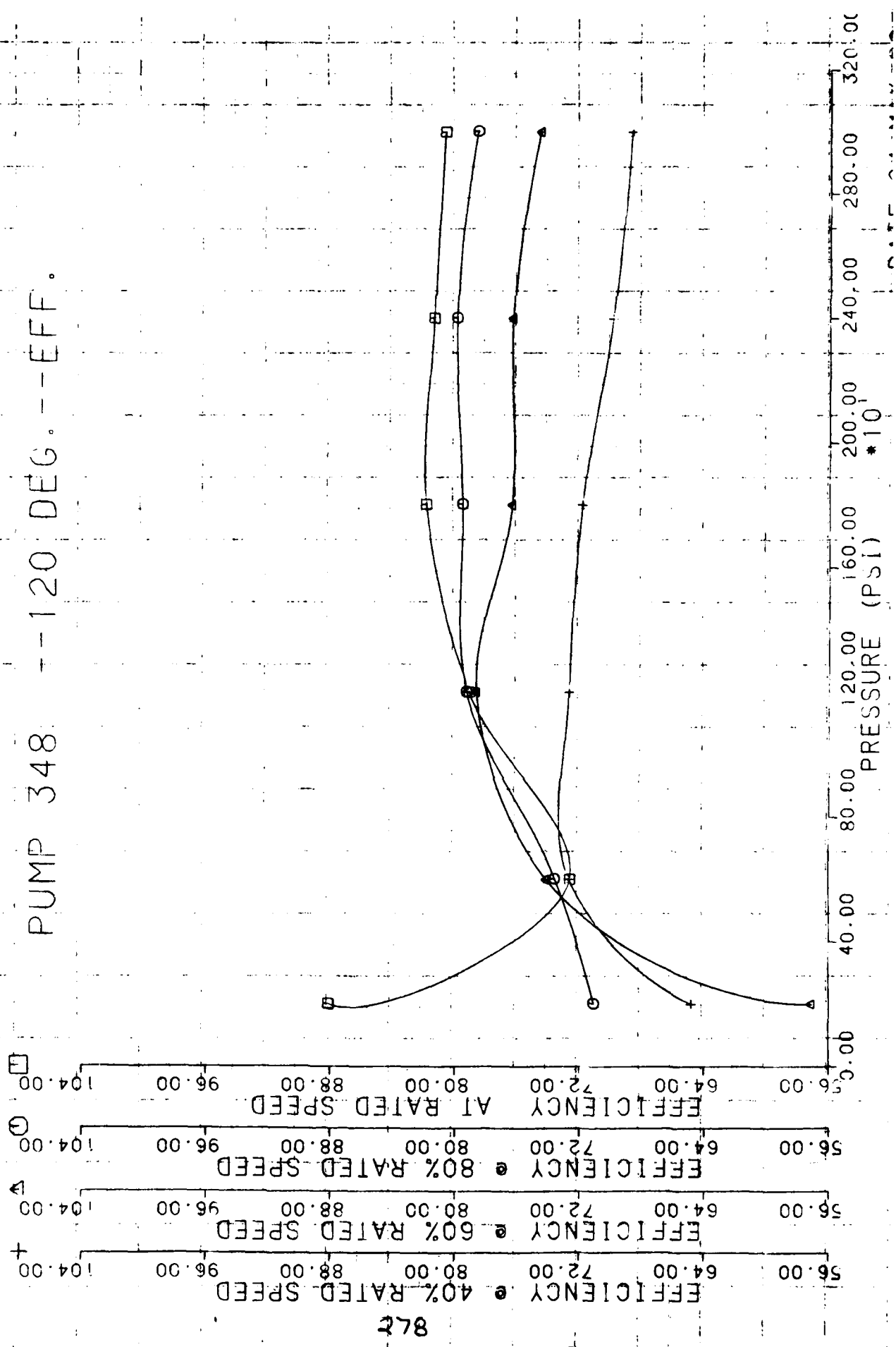
Q (GPM) 40% RATED SPEED  
 Q (GPM) 60% RATED SPEED  
 Q (GPM) 80% RATED SPEED  
 Q (GPM) AT RATED SPEED



L22

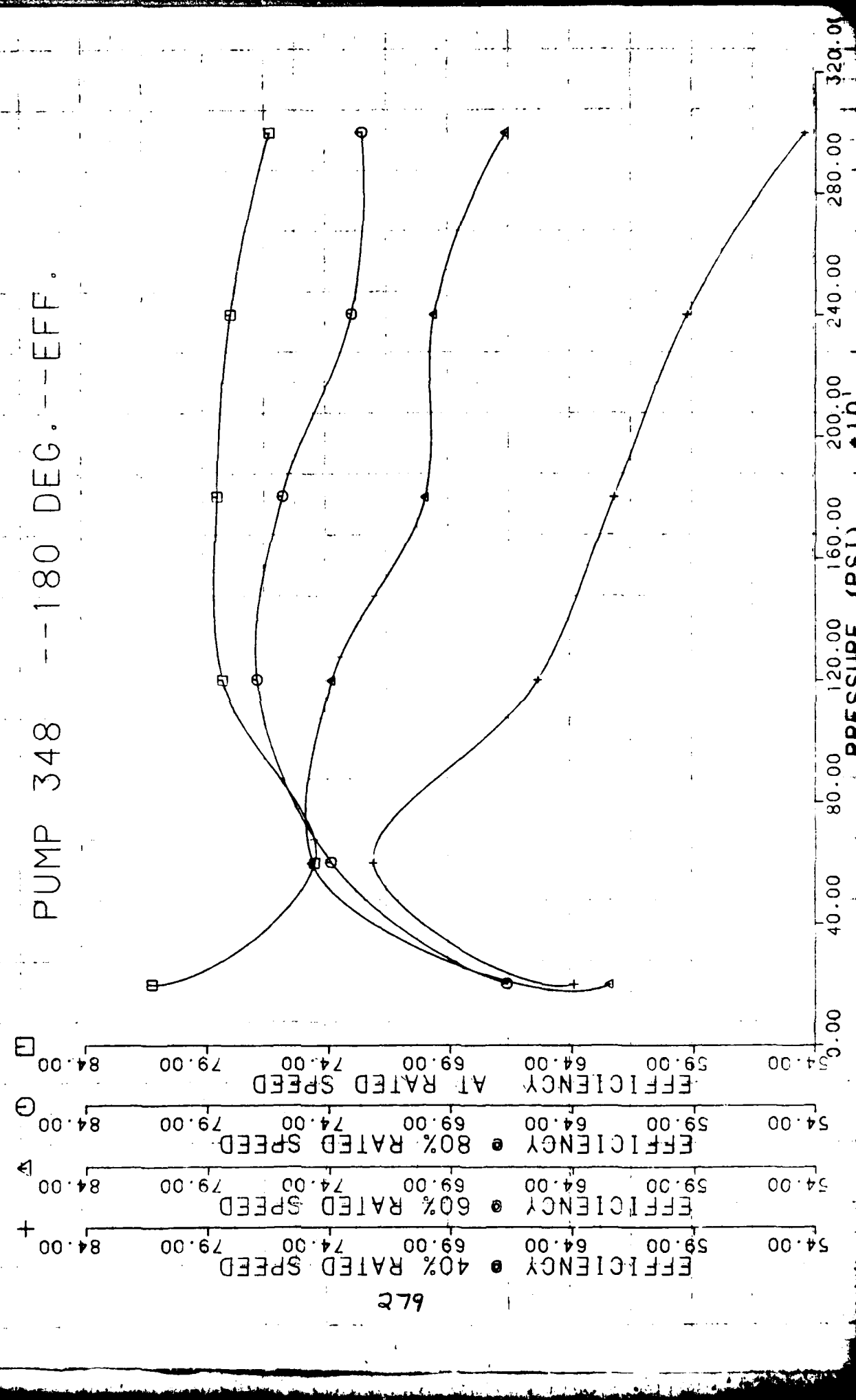


PUMP 348 --120 DEG.--EFF.



872

PUMP 348 --180 DEG.--EFF.

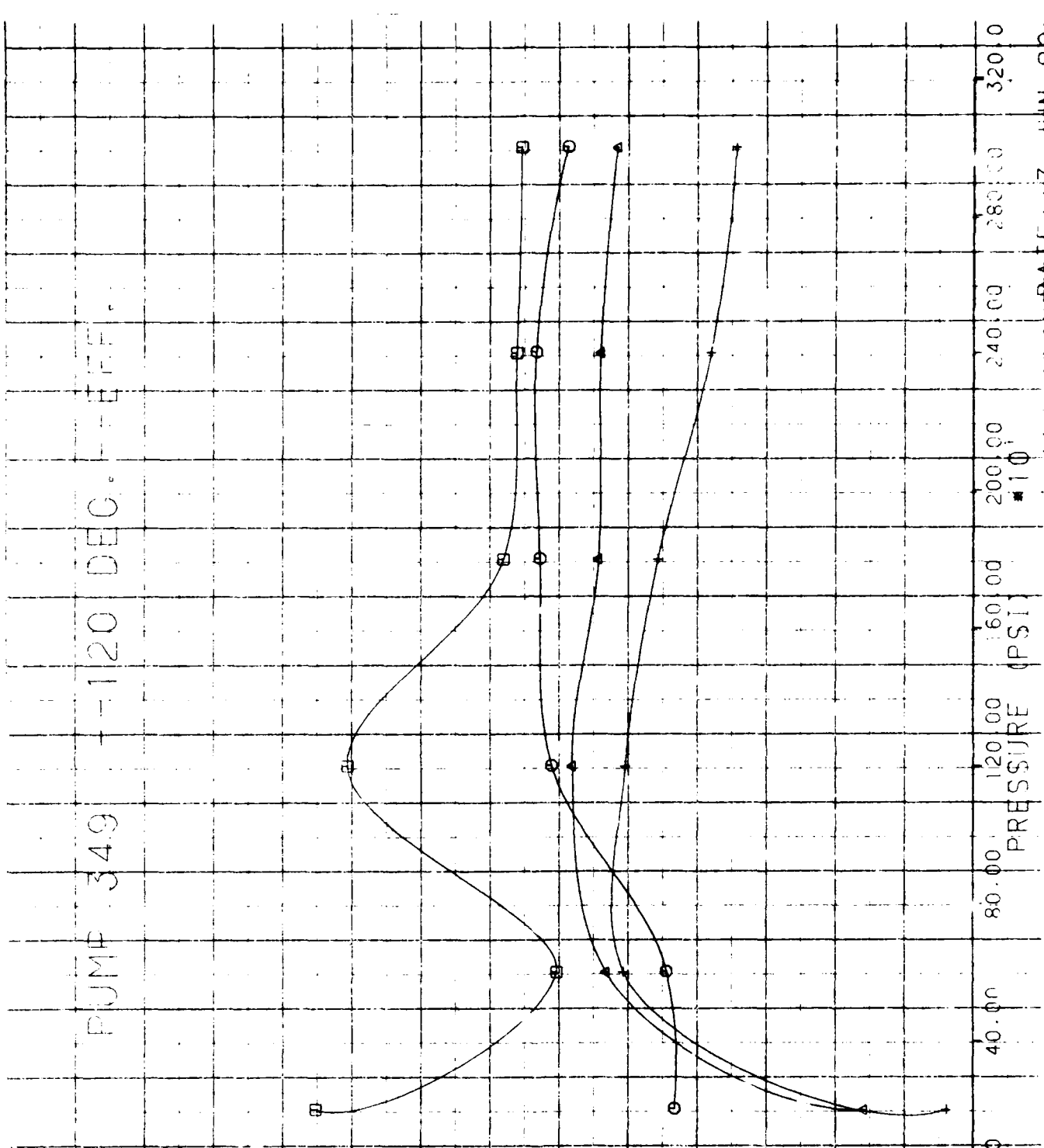


672

PUMP 349 - 120 DEC. - EFF.

EFFICIENCY @ 40% RATED SPEED	EFFICIENCY @ 60% RATED SPEED	EFFICIENCY @ 80% RATED SPEED	EFFICIENCY AT RATED SPEED
56.00	56.00	56.00	56.00
64.00	64.00	64.00	64.00
72.00	72.00	72.00	72.00
80.00	80.00	80.00	80.00
95.00	95.00	95.00	95.00
104.00	104.00	104.00	104.00

982



320.0  
280.00  
240.00  
200.00  
160.00  
120.00  
80.00  
40.00  
0.00

PRESSURE (PSI)

DATE: 11/17/57

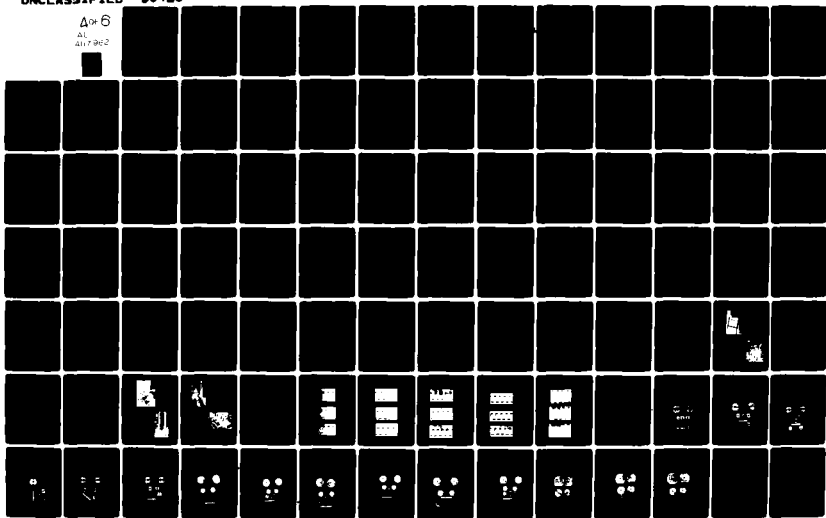
AD-A117 962

MILWAUKEE SCHOOL OF ENGINEERING WI FLUID POWER INST F/8 13/11  
BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
JUL 82  
50423 DAAK70-81-C-0002  
ML

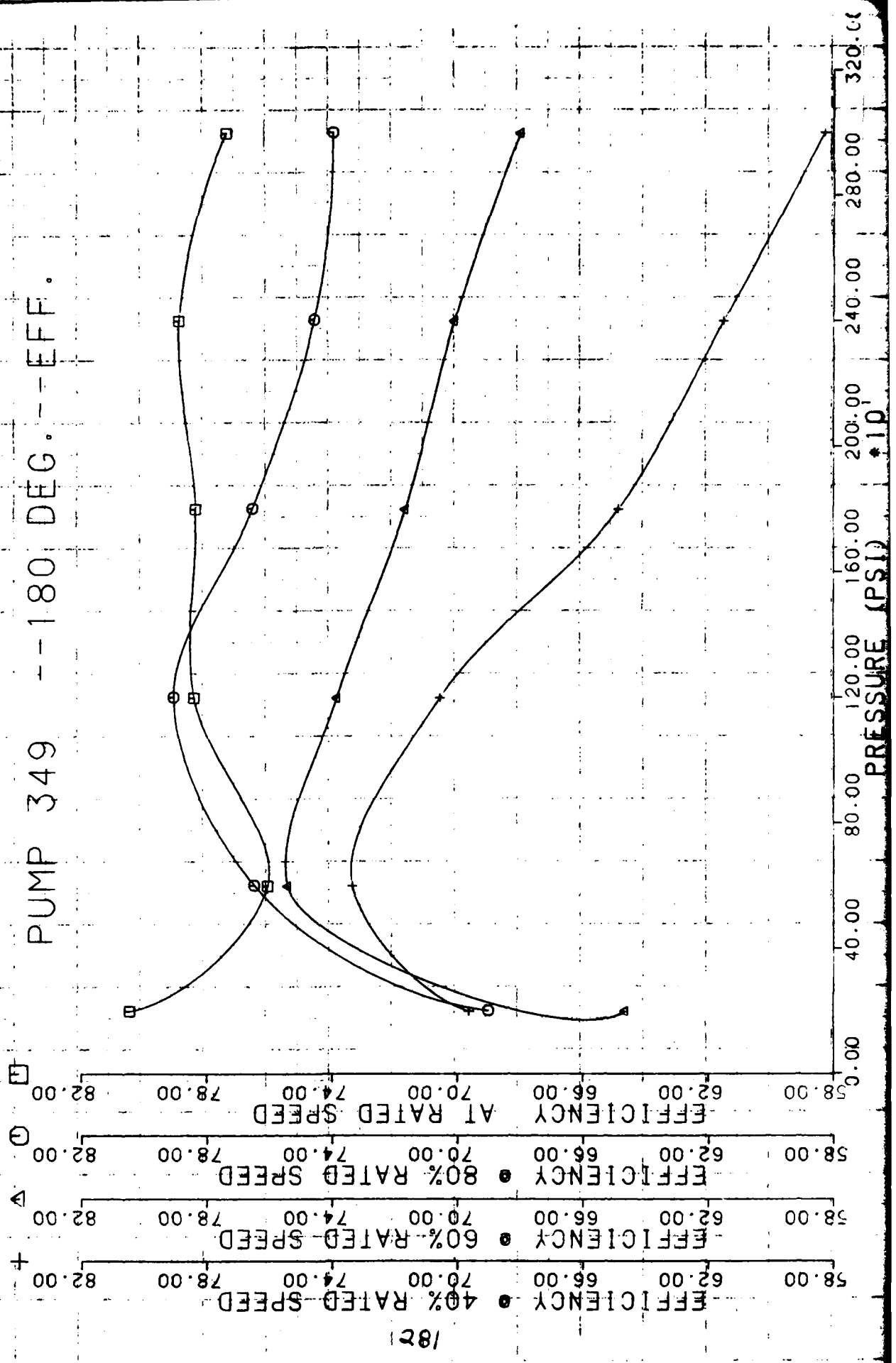
UNCLASSIFIED

APR 8

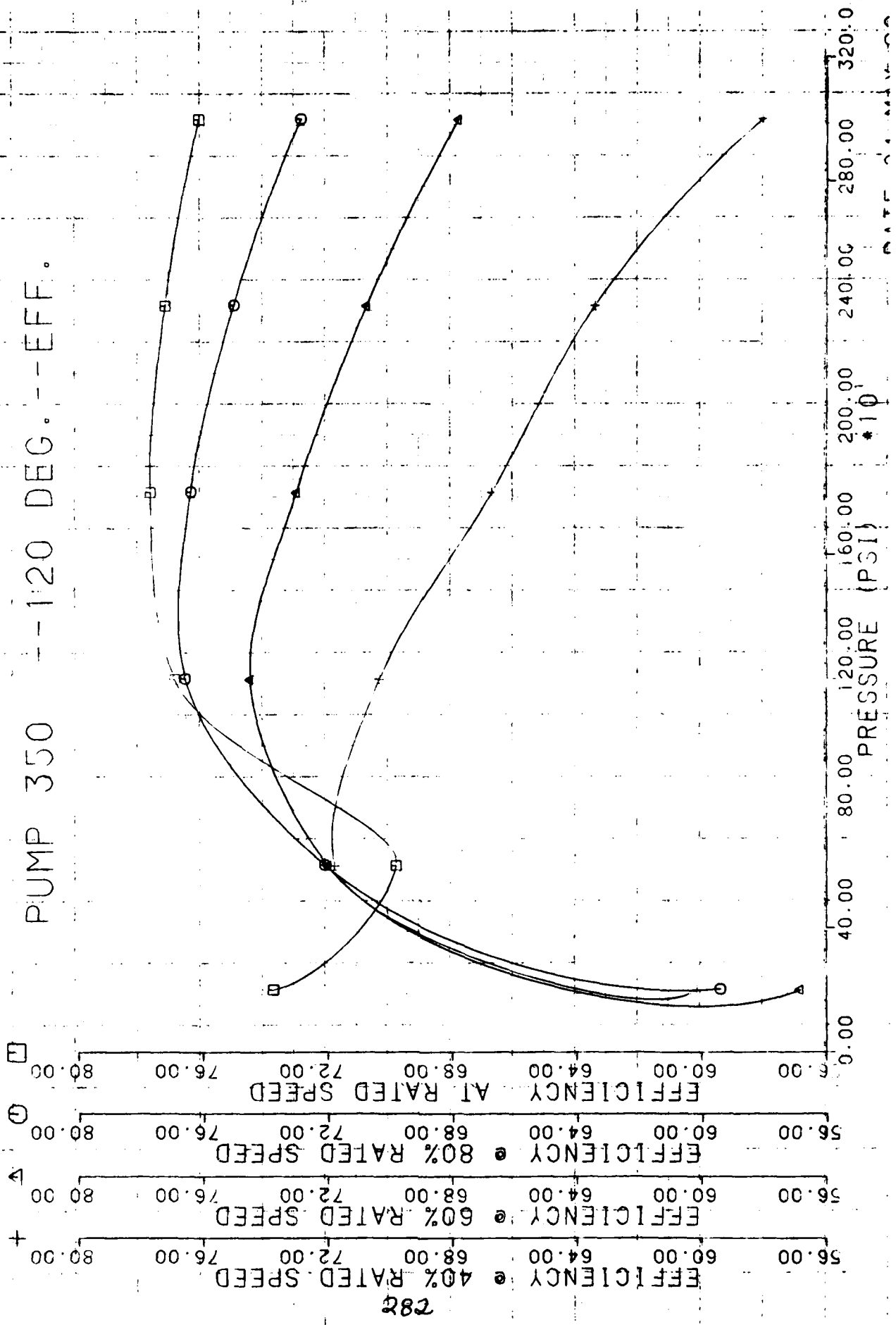
AD-A117 962



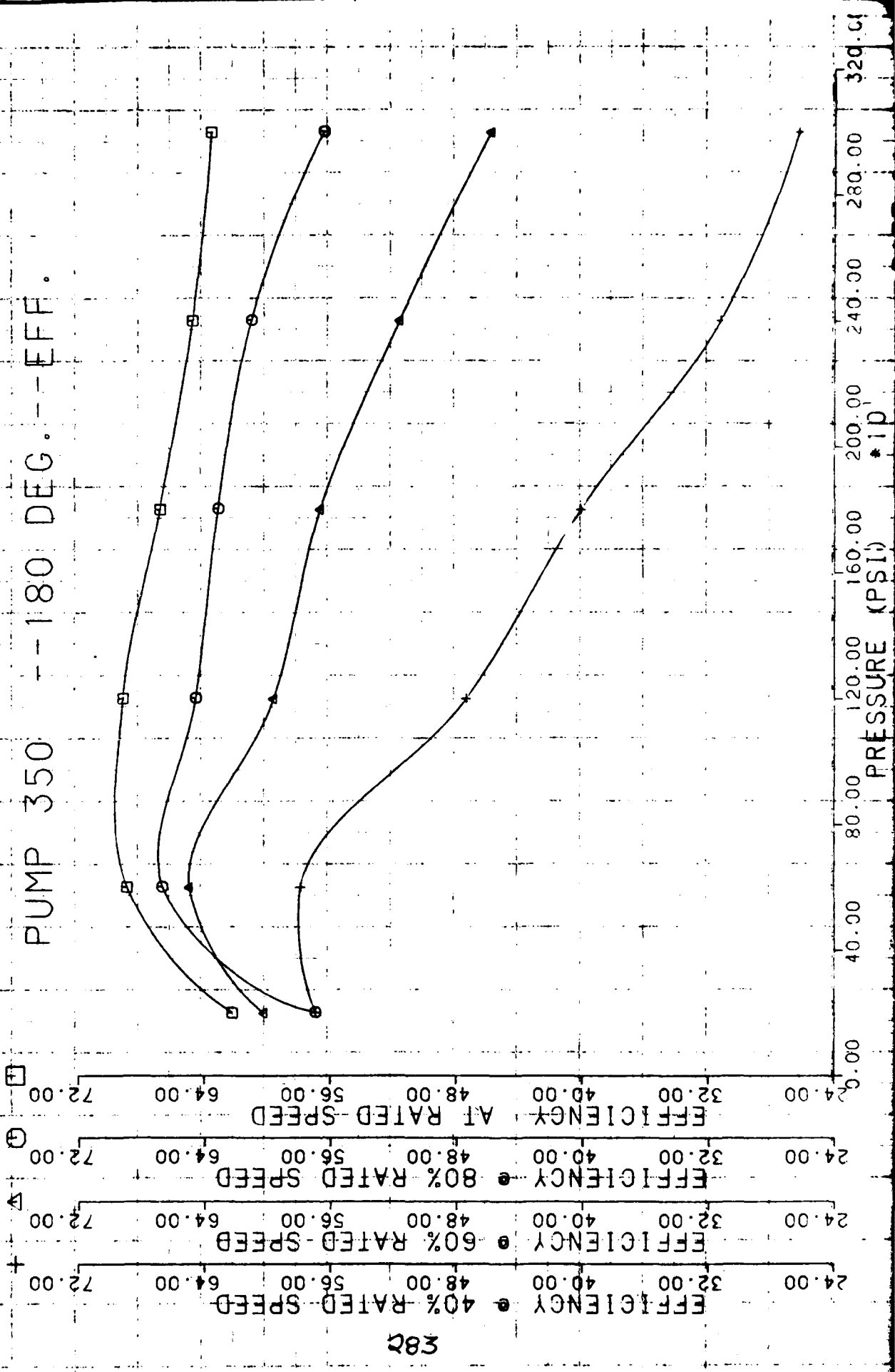
PUMP 349 --180 DEG.--EFF.



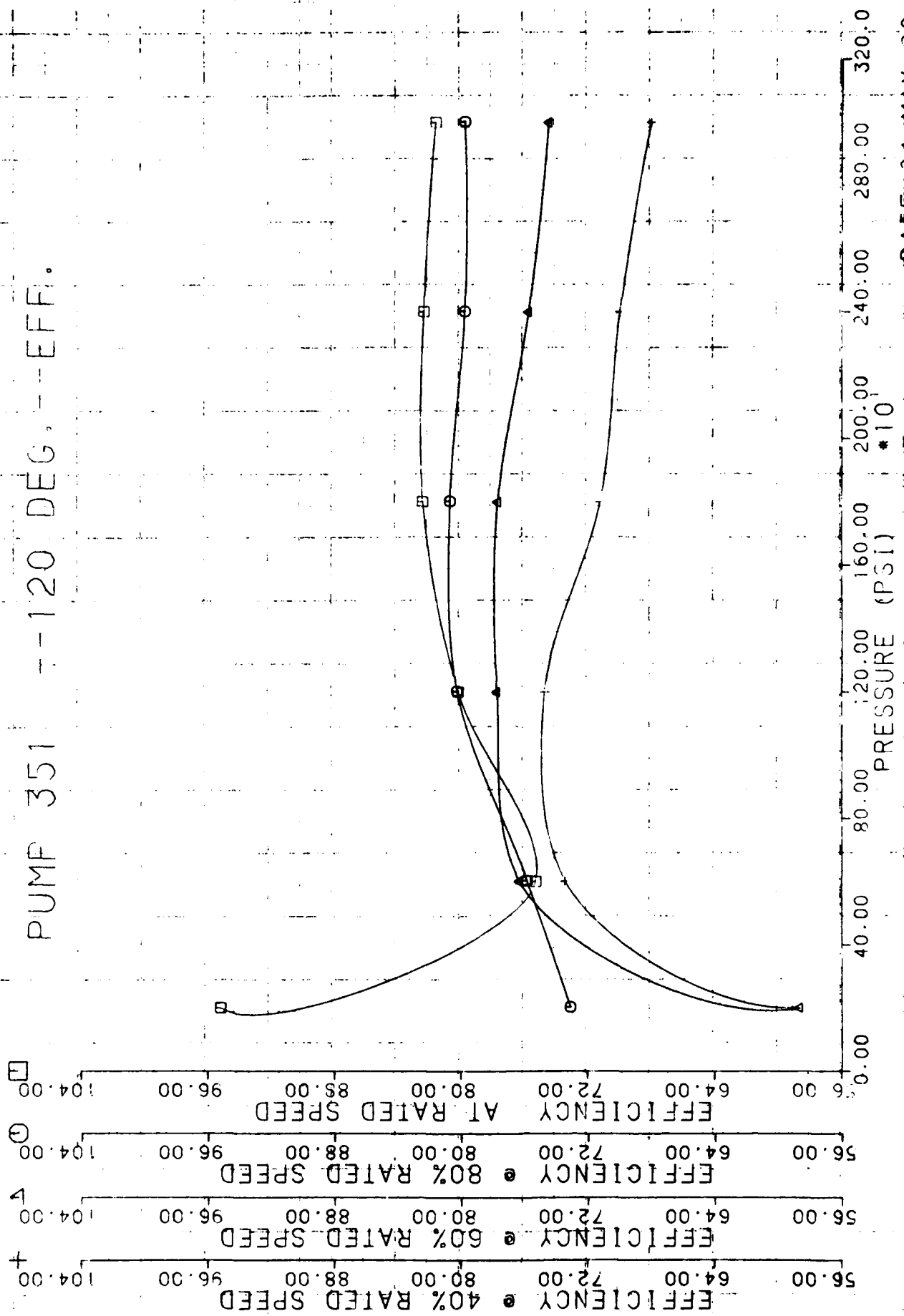
PUMP 350 --120 DEG.--EFF.



PUMP 350 --180 DEG.--EFF.

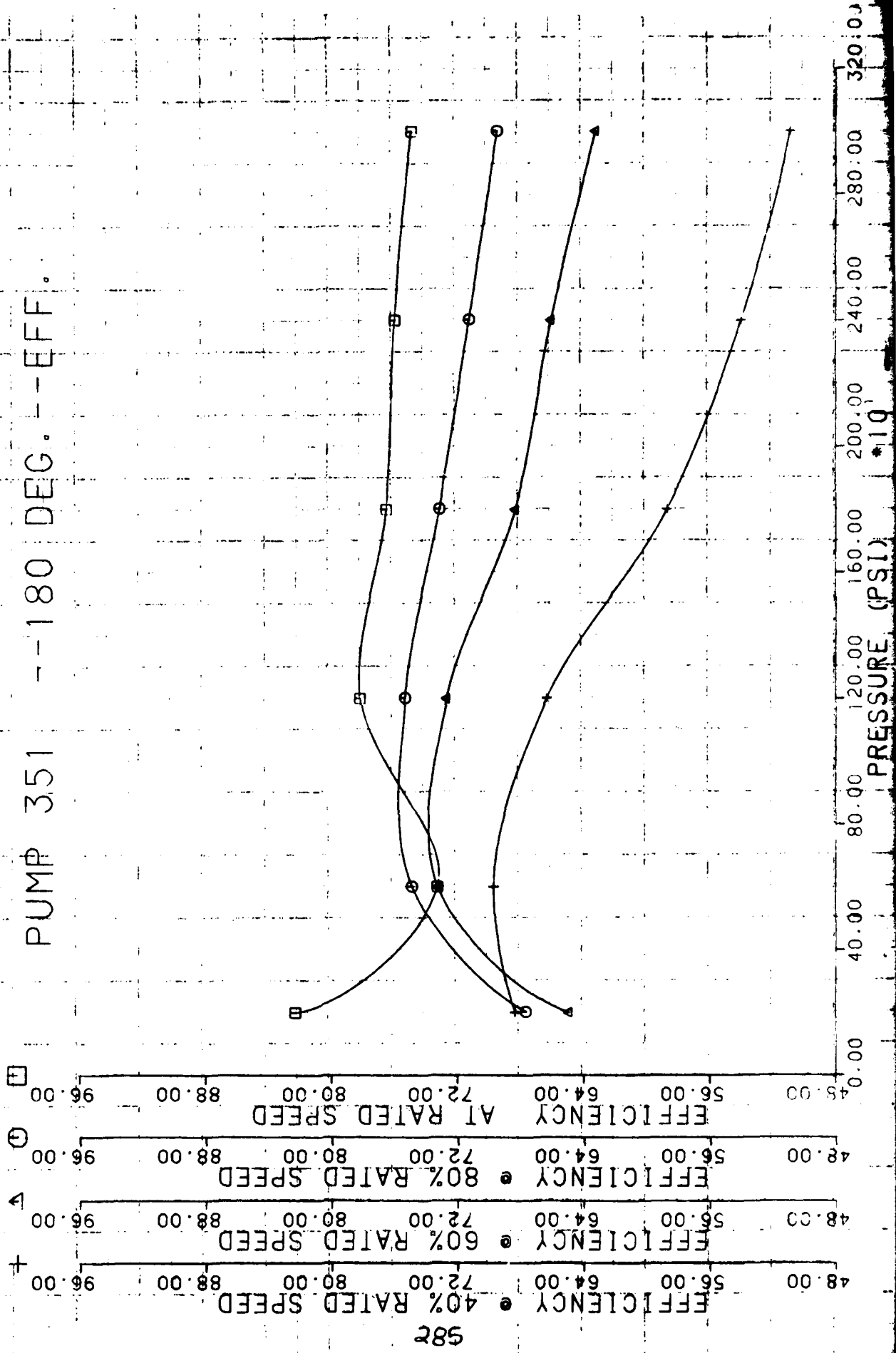


PUMP 351 -- 120 DEG. -- EFF.



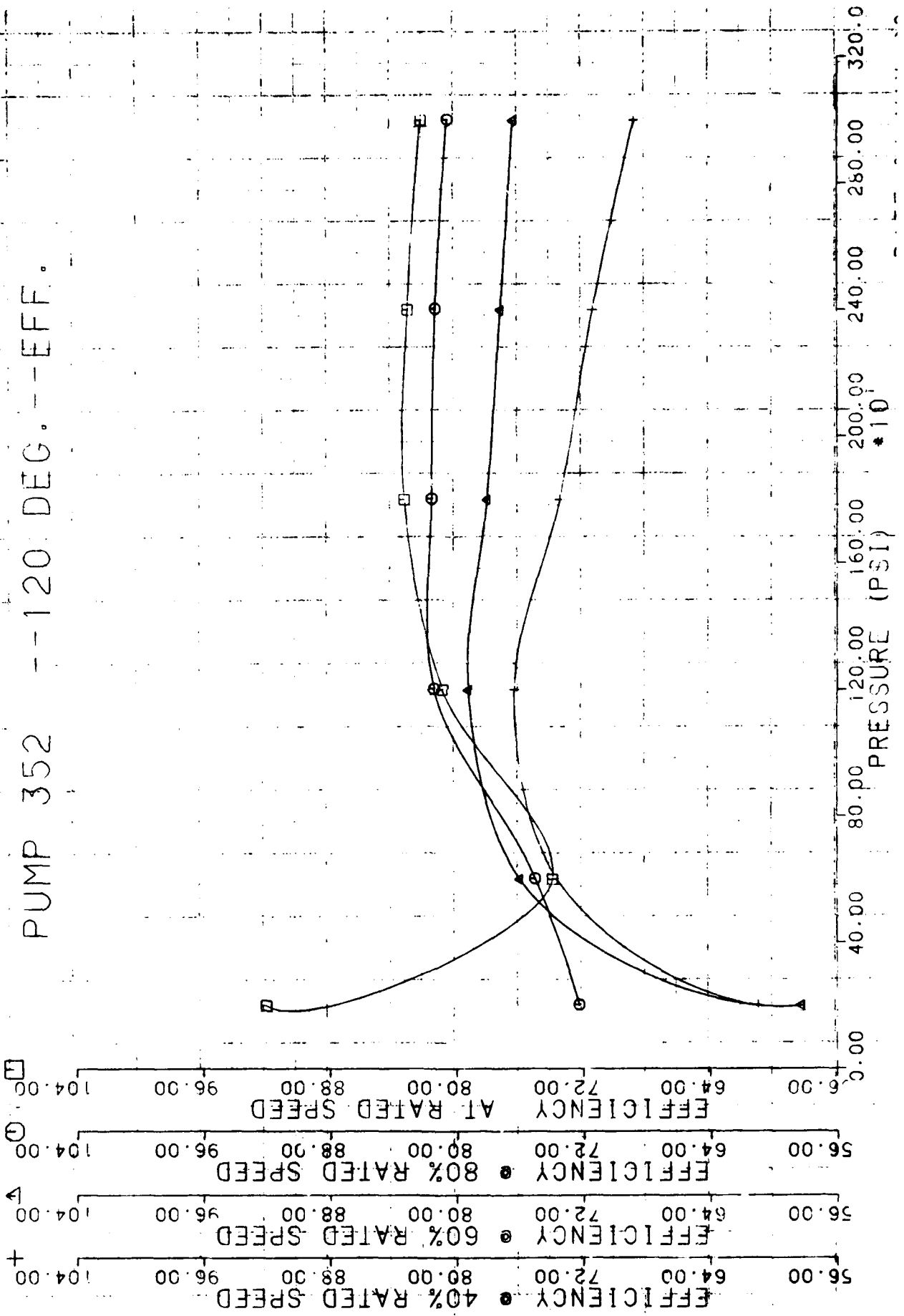


PUMP 351 --180 DEG.--EFF.

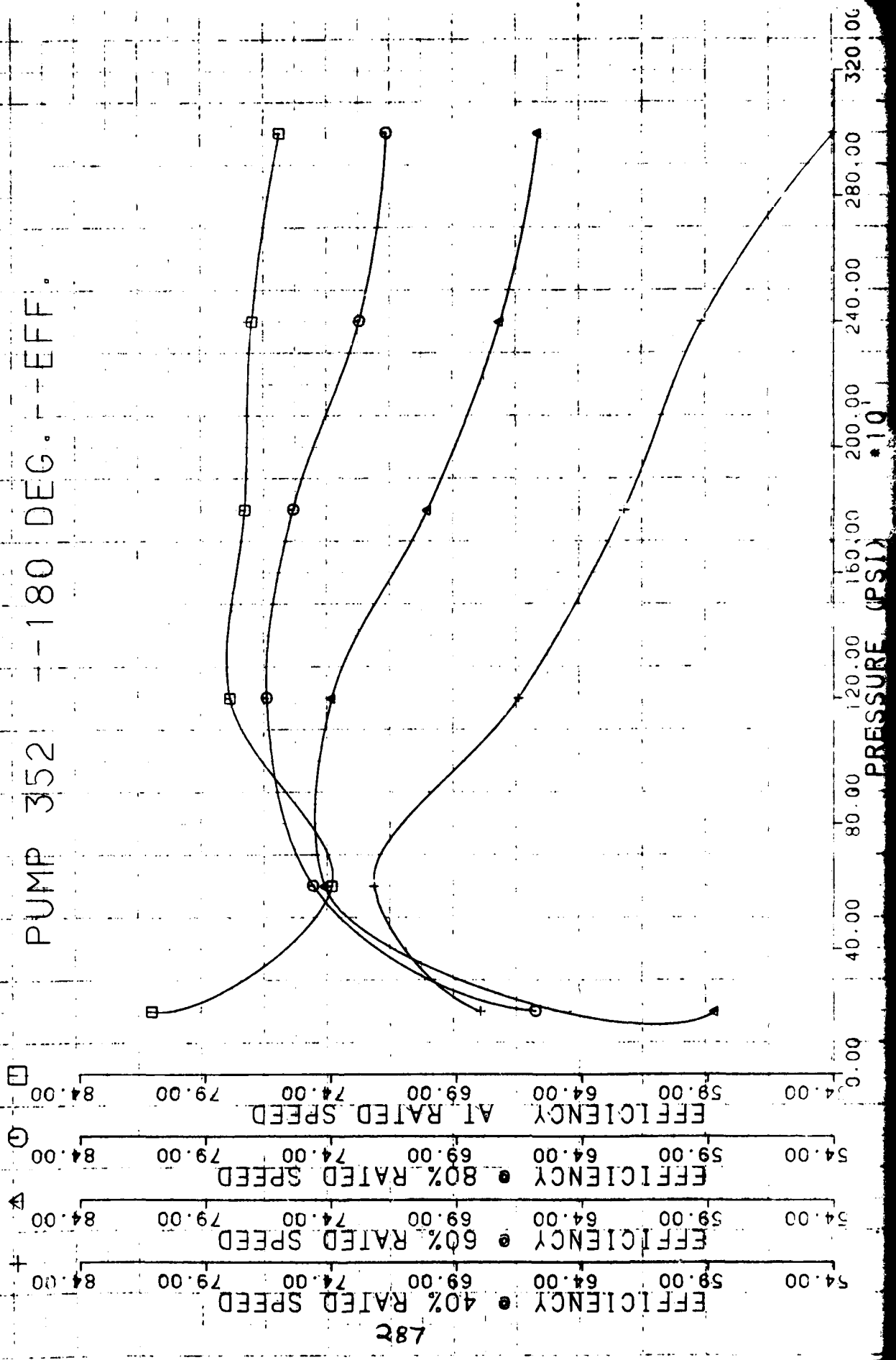


582

PUMP 352 --120 DEG.--EFF.

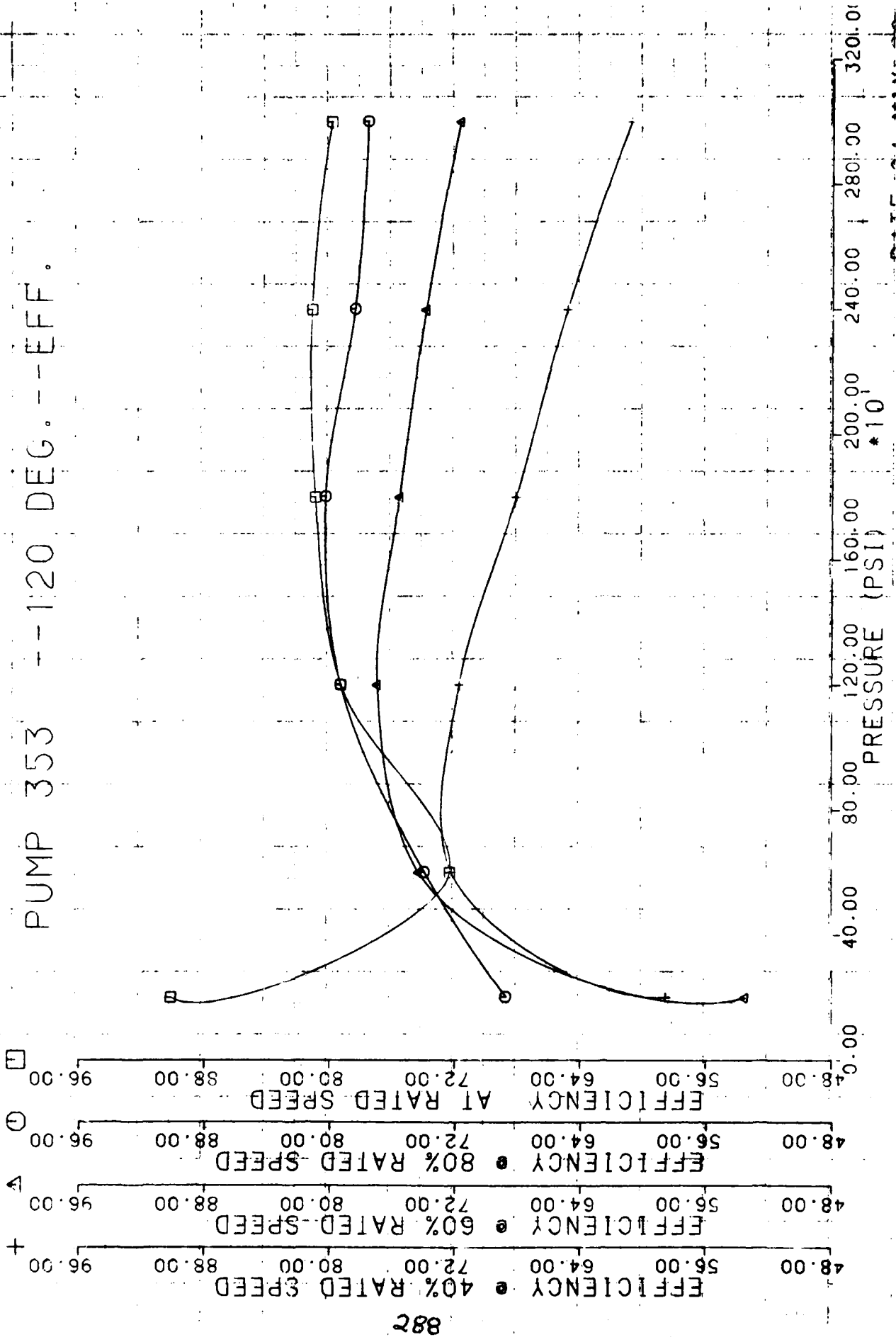


PUMP 352 --180 DEG. --EFF.

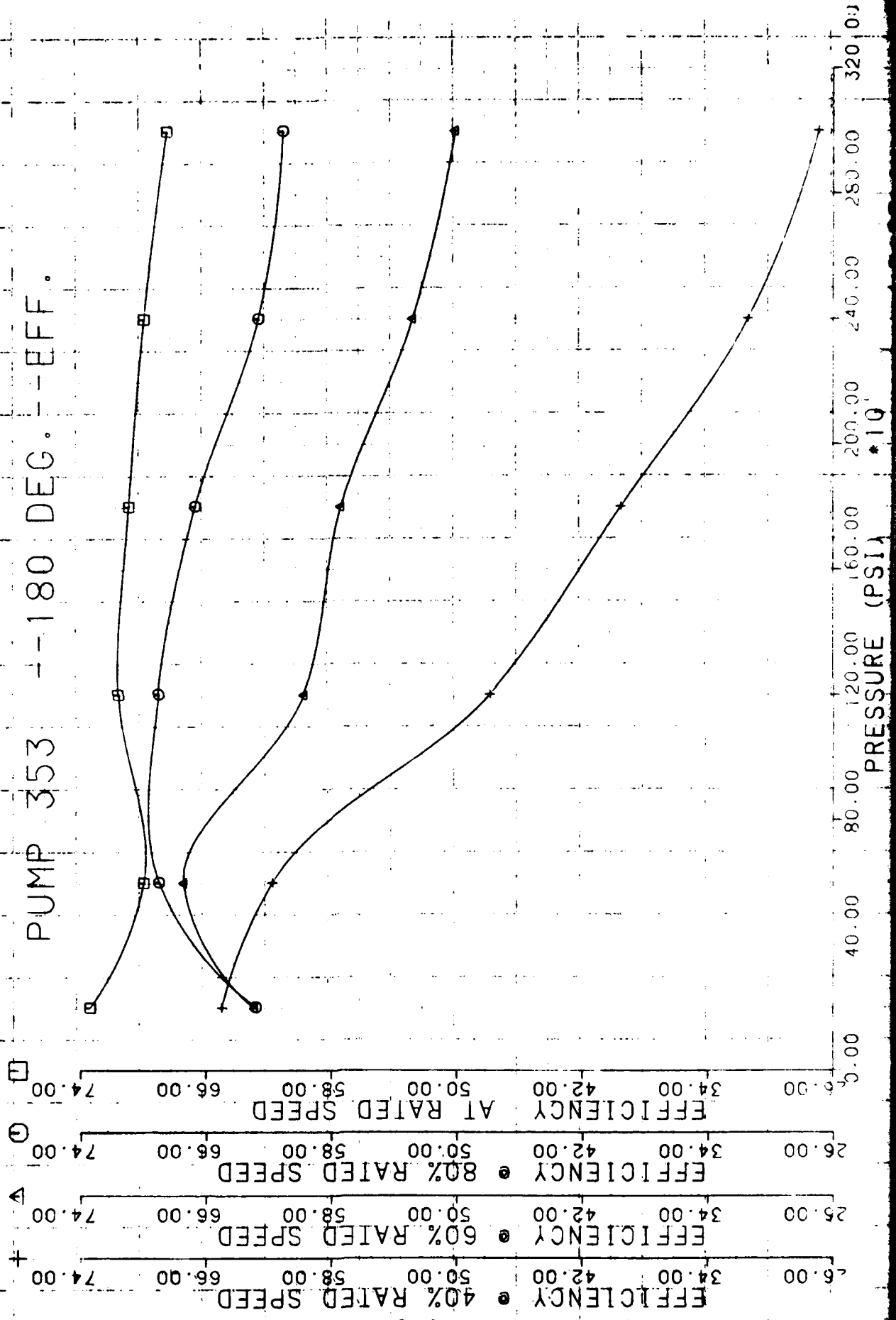


782

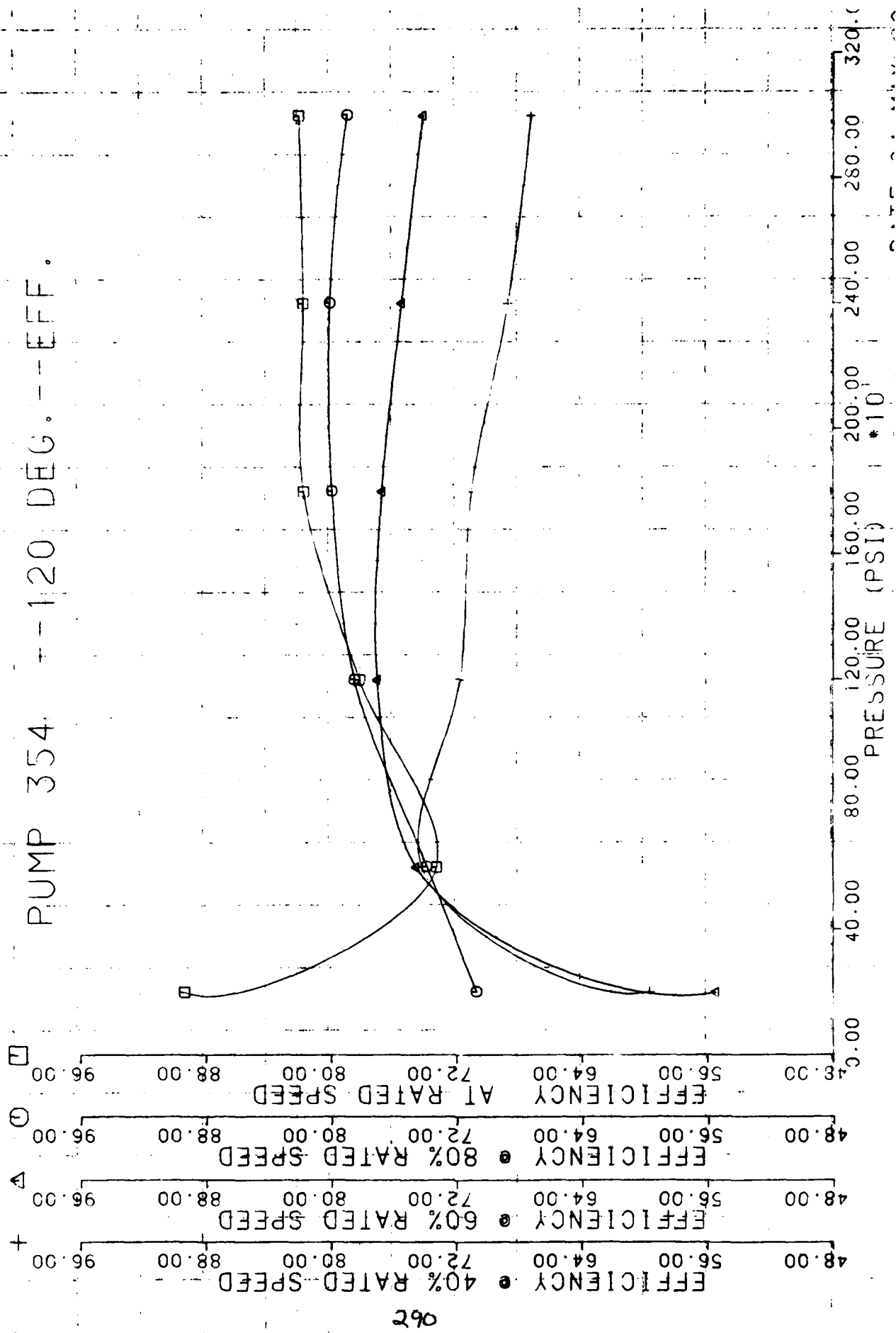
PUMP 353 --1:20 DEG.--EFF.



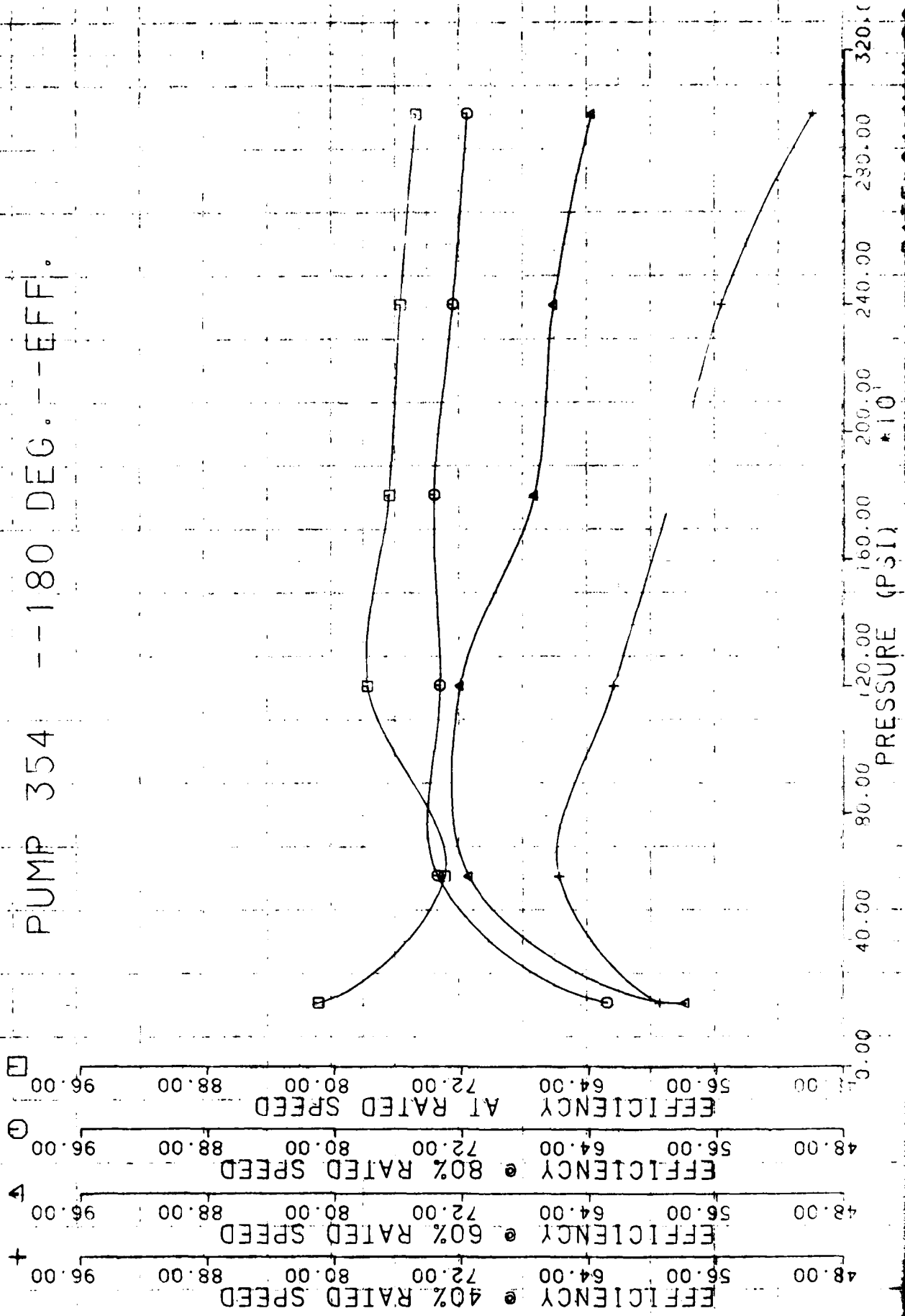
PUMP 353 --180 DEG. --EFF.



PUMP 354 --120 DEG.--EFF.



PUMP 354 --180 DEG.--EFF.



192

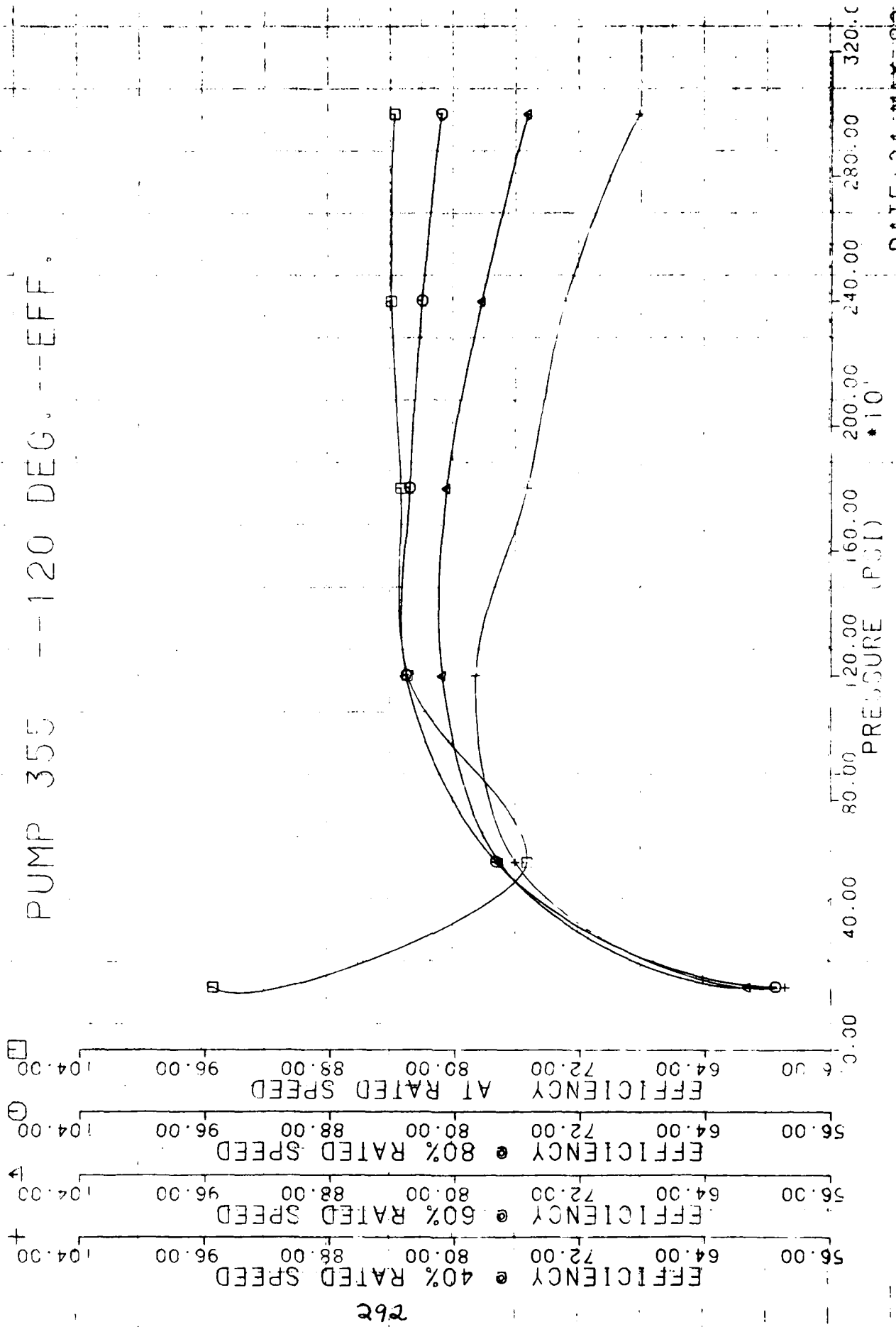
EFFICIENCY @ 40% RATED SPEED

EFFICIENCY @ 60% RATED SPEED

EFFICIENCY @ 80% RATED SPEED

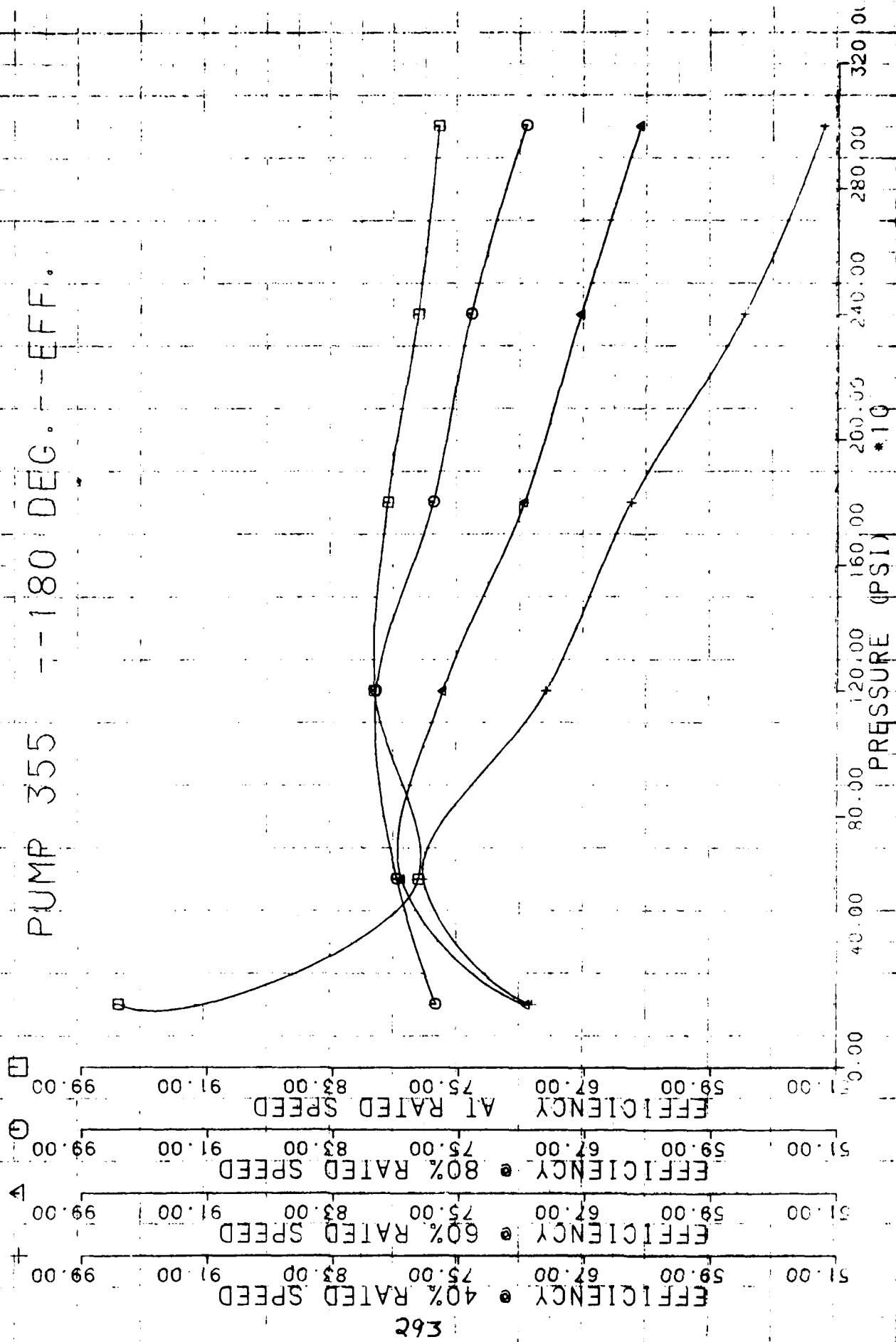
EFFICIENCY AT RATED SPEED

# PUMP 355 --120 DEG. --EFF.

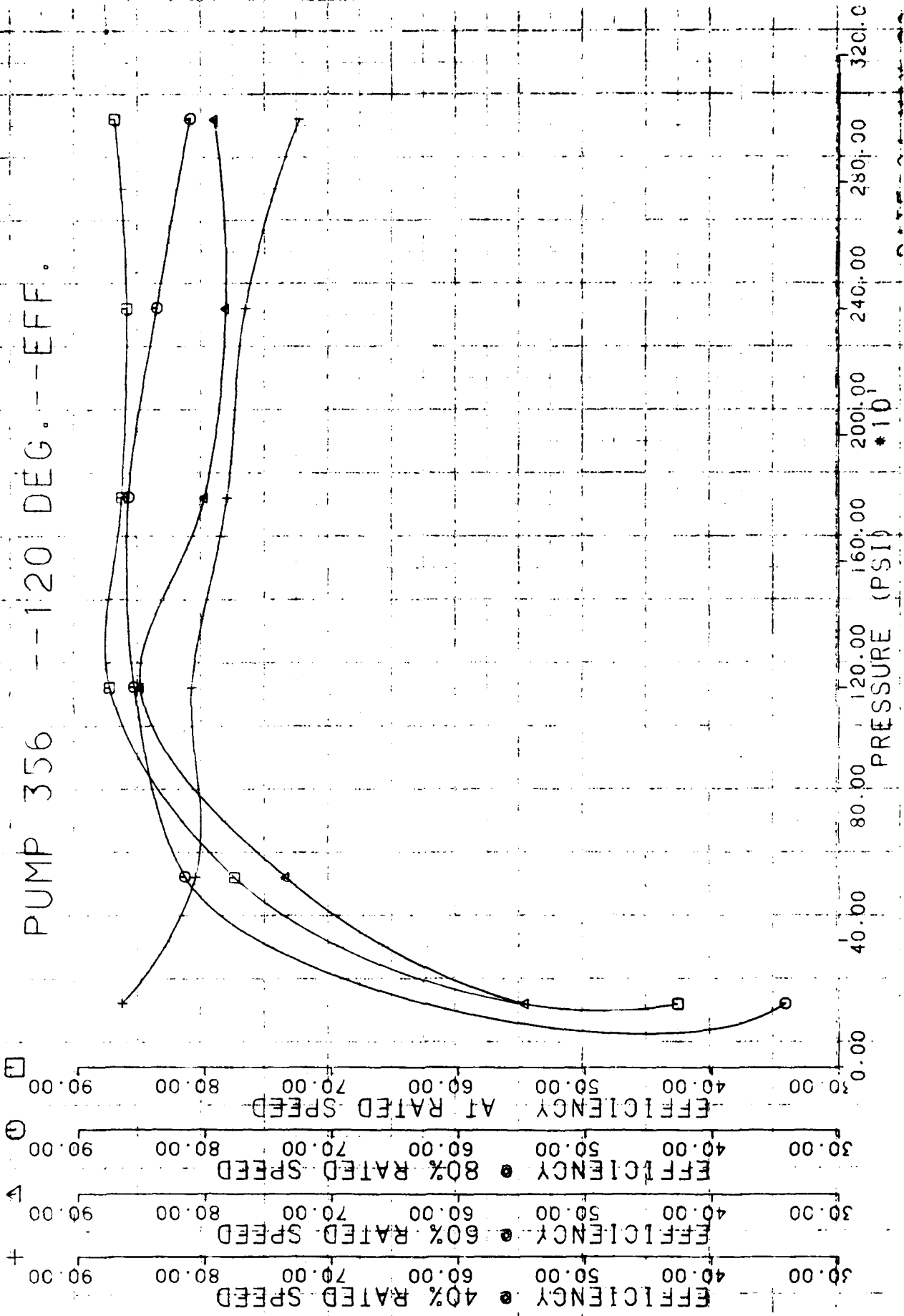




PUMP 355 --180 DEG.--EFF.

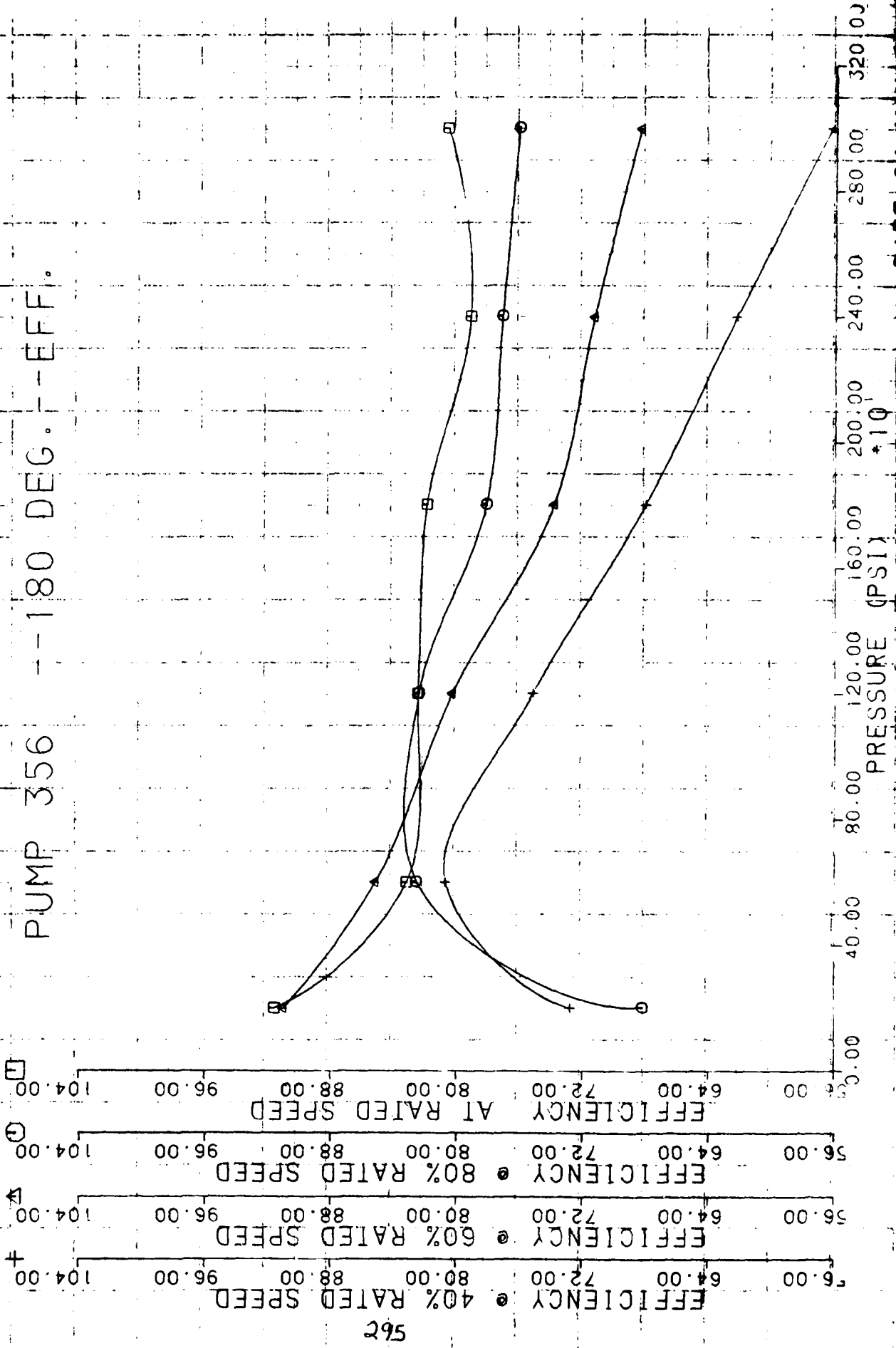


PUMP 356 --120 DEG.--EFF.



462

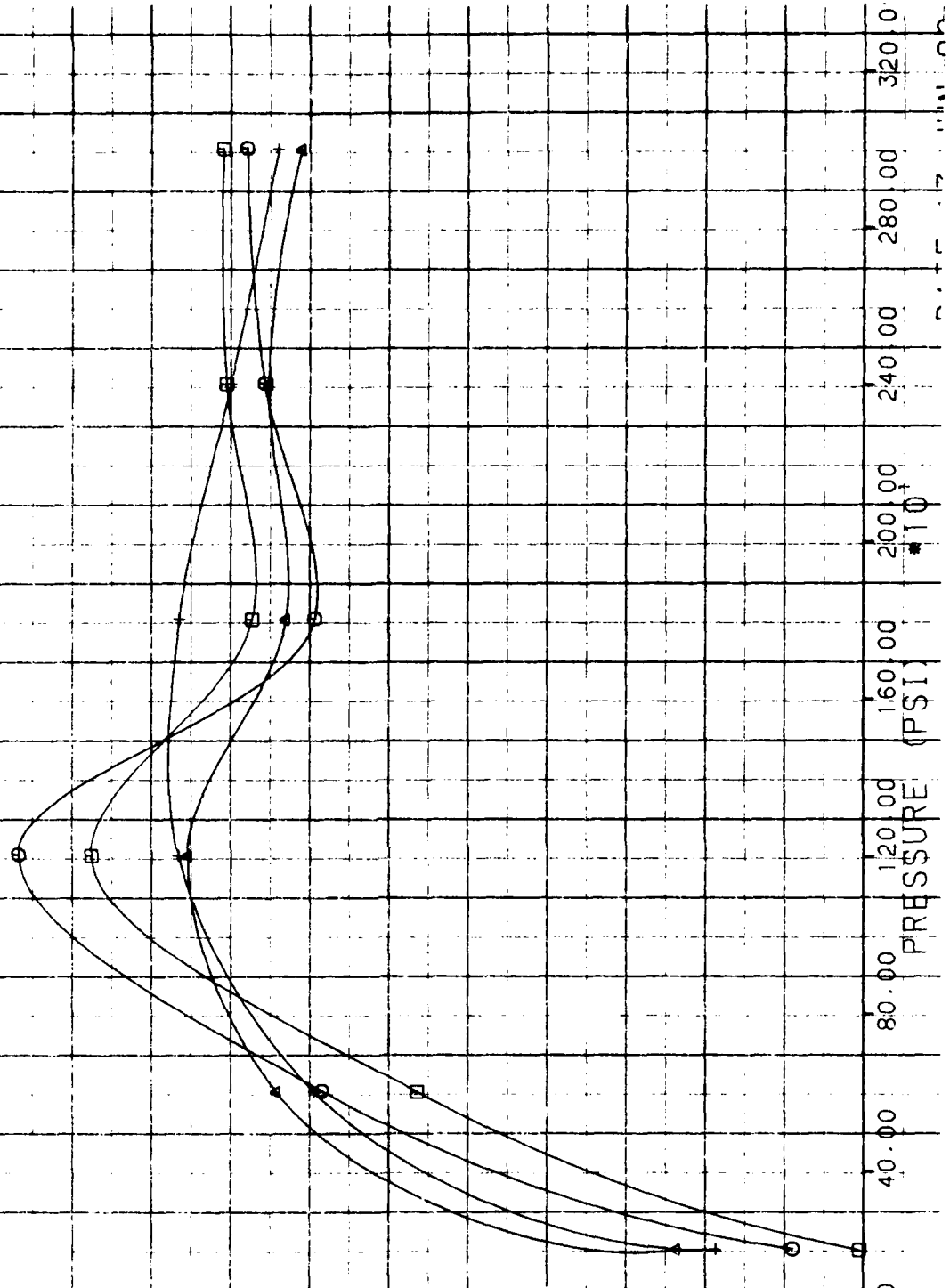
PUMP 356 --180 DEG. --EFF.



PUMP 357 - 120 DEG. - EFF.

40.00 50.00 60.00 70.00 80.00 90.00 100.00  
 EFFICIENCY @ 40% RATED SPEED  
 40.00 50.00 60.00 70.00 80.00 90.00 100.00  
 EFFICIENCY @ 60% RATED SPEED  
 40.00 50.00 60.00 70.00 80.00 90.00 100.00  
 EFFICIENCY @ 80% RATED SPEED  
 40.00 50.00 60.00 70.00 80.00 90.00 100.00  
 EFFICIENCY AT RATED SPEED

96C

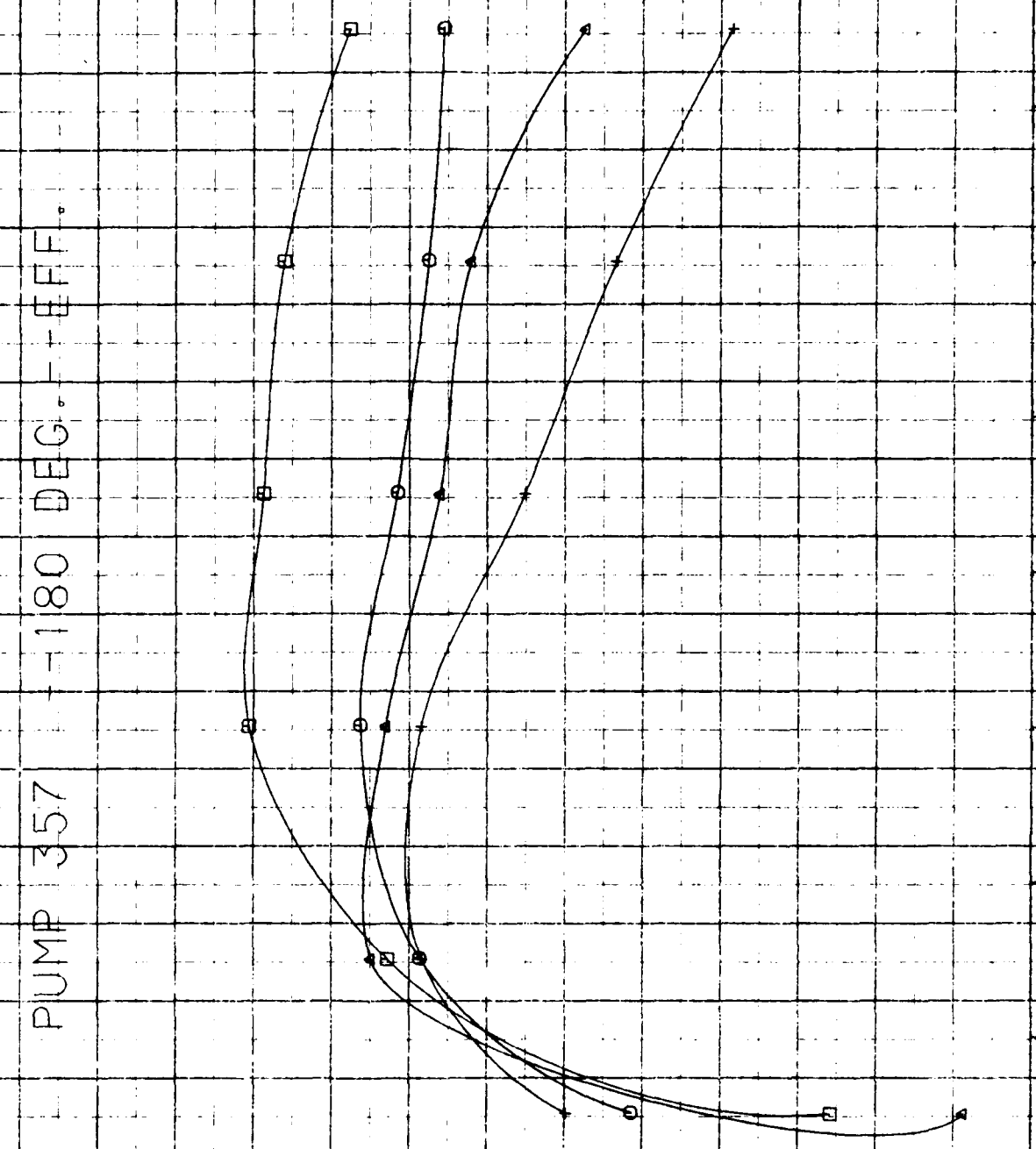


PUMP 357 -180 DEG. - EFF.

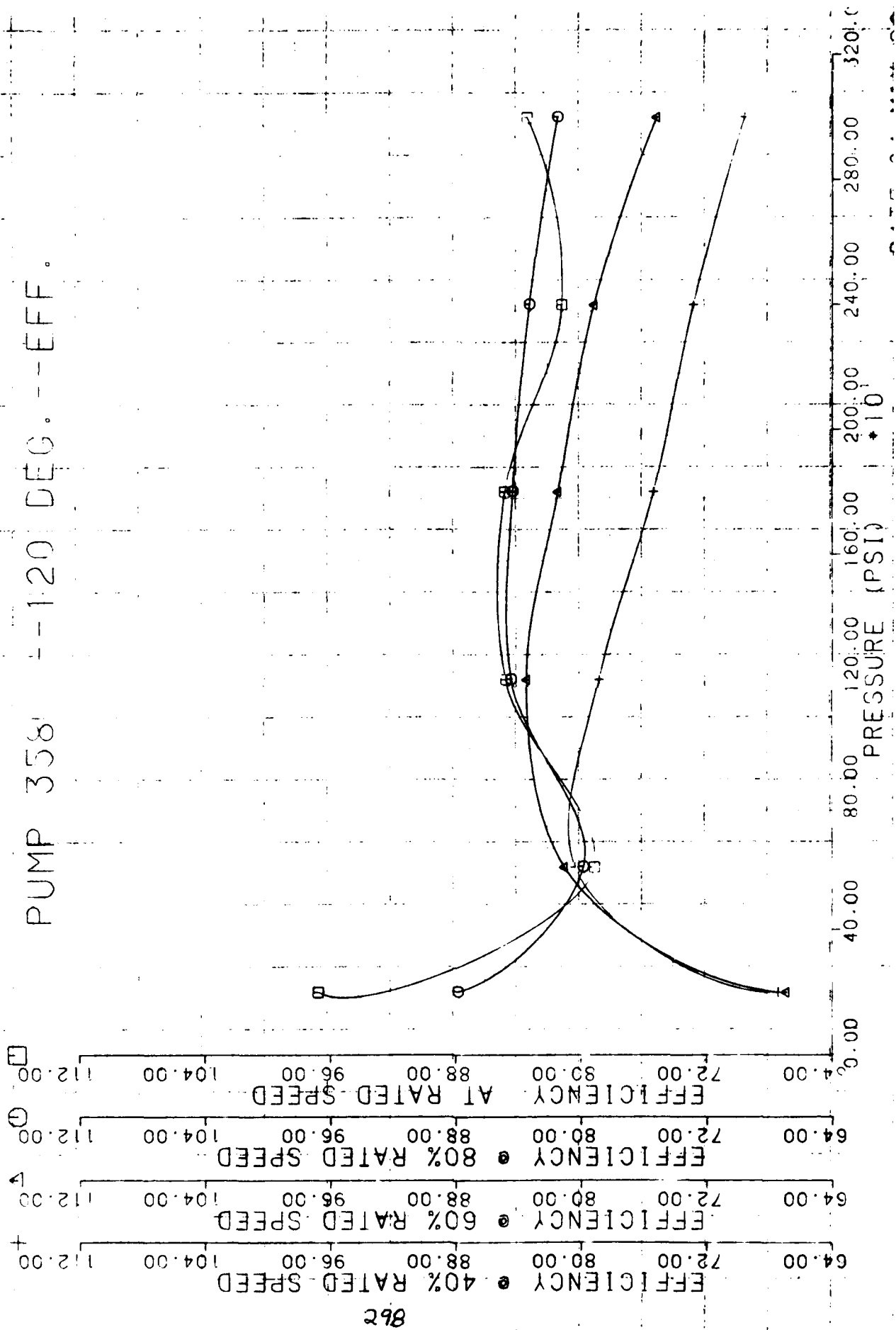
EFF. CIENCY	40.00	48.00	56.00	64.00	72.00	80.00	88.00
40.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
48.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
56.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
64.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
72.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
80.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00

466

PRESSURE (PSI) 0.00 40.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00

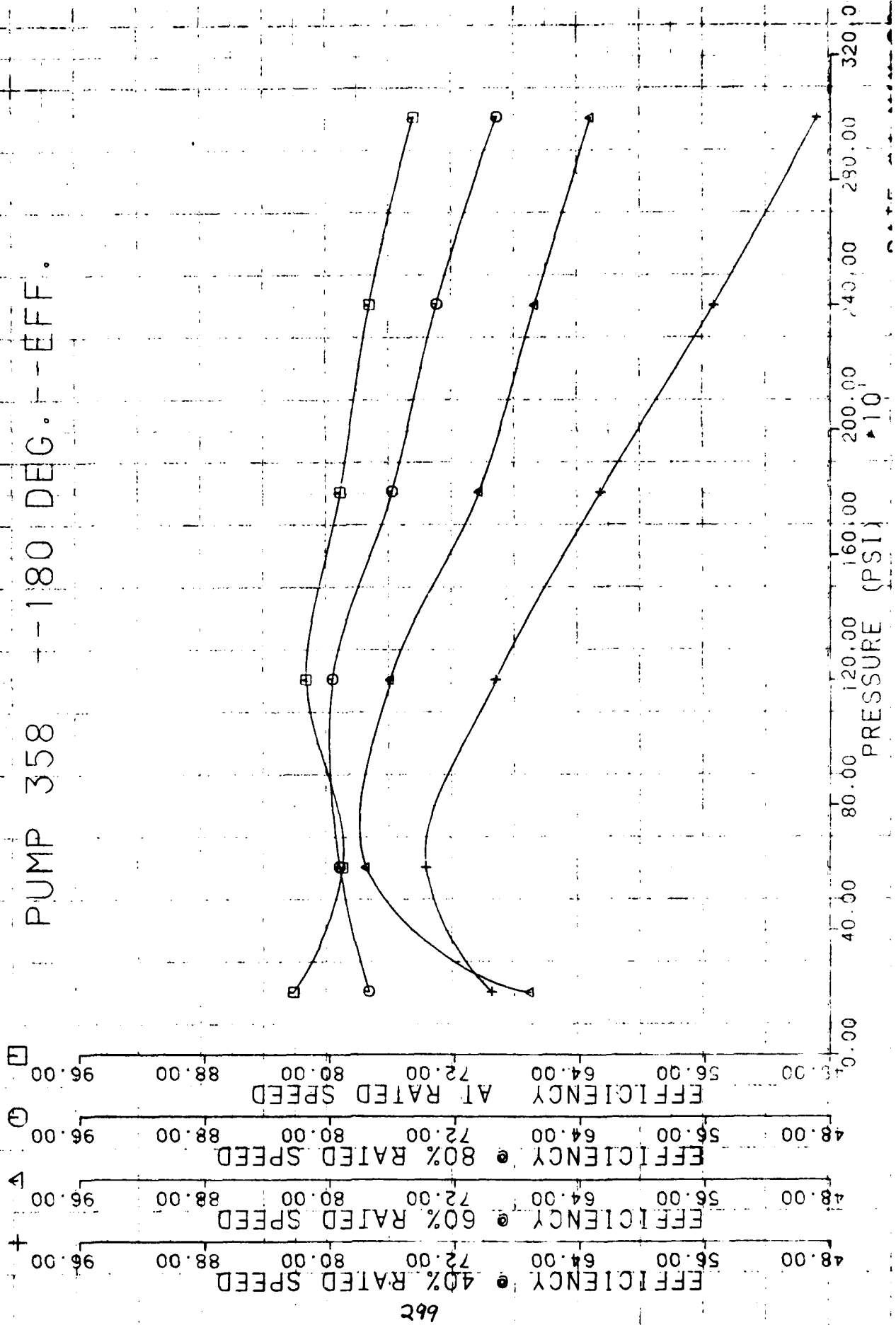


PUMP 358 -- 120 DEG. -- EFF.

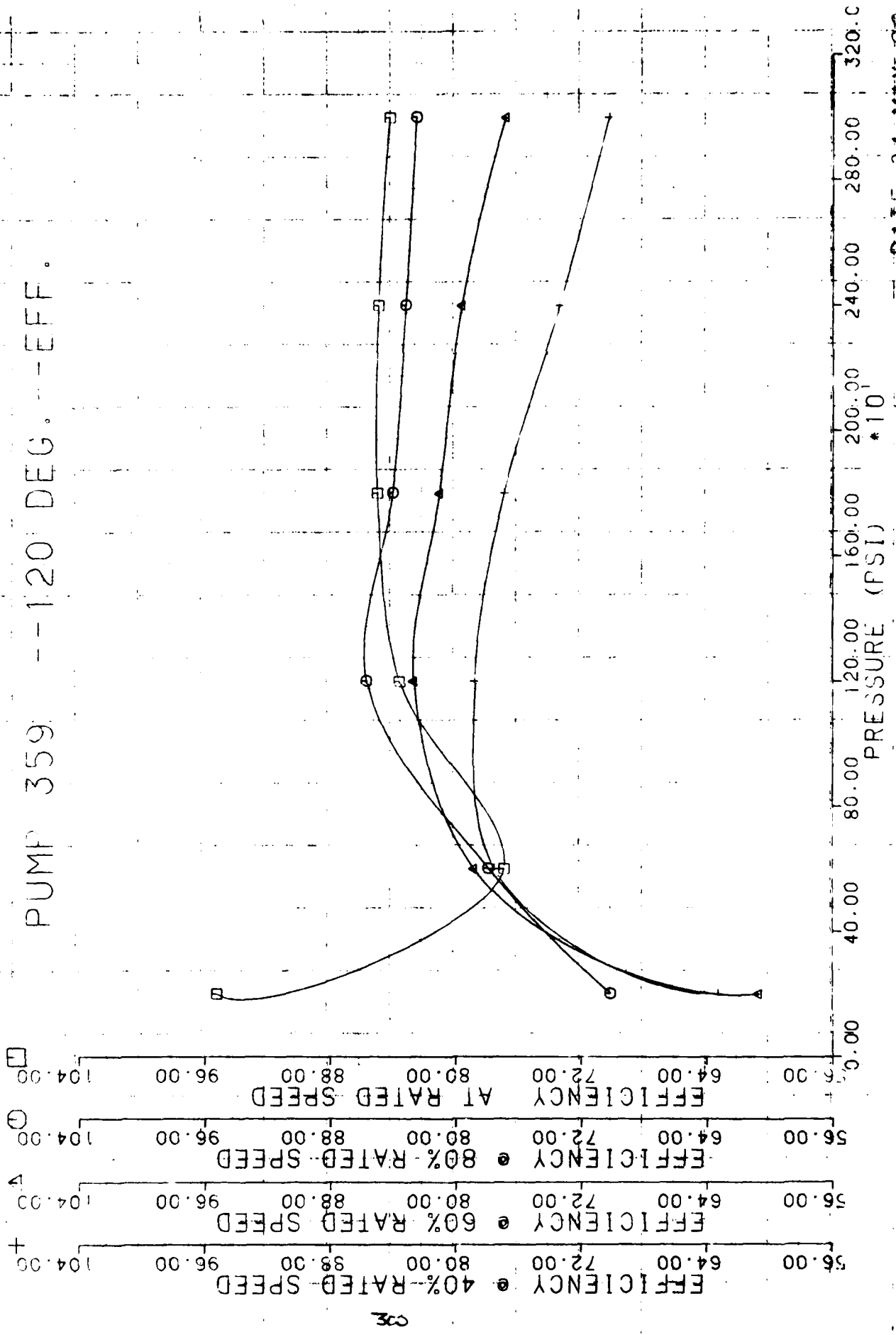


862

PUMP 358 --180 DEG. --EFF.

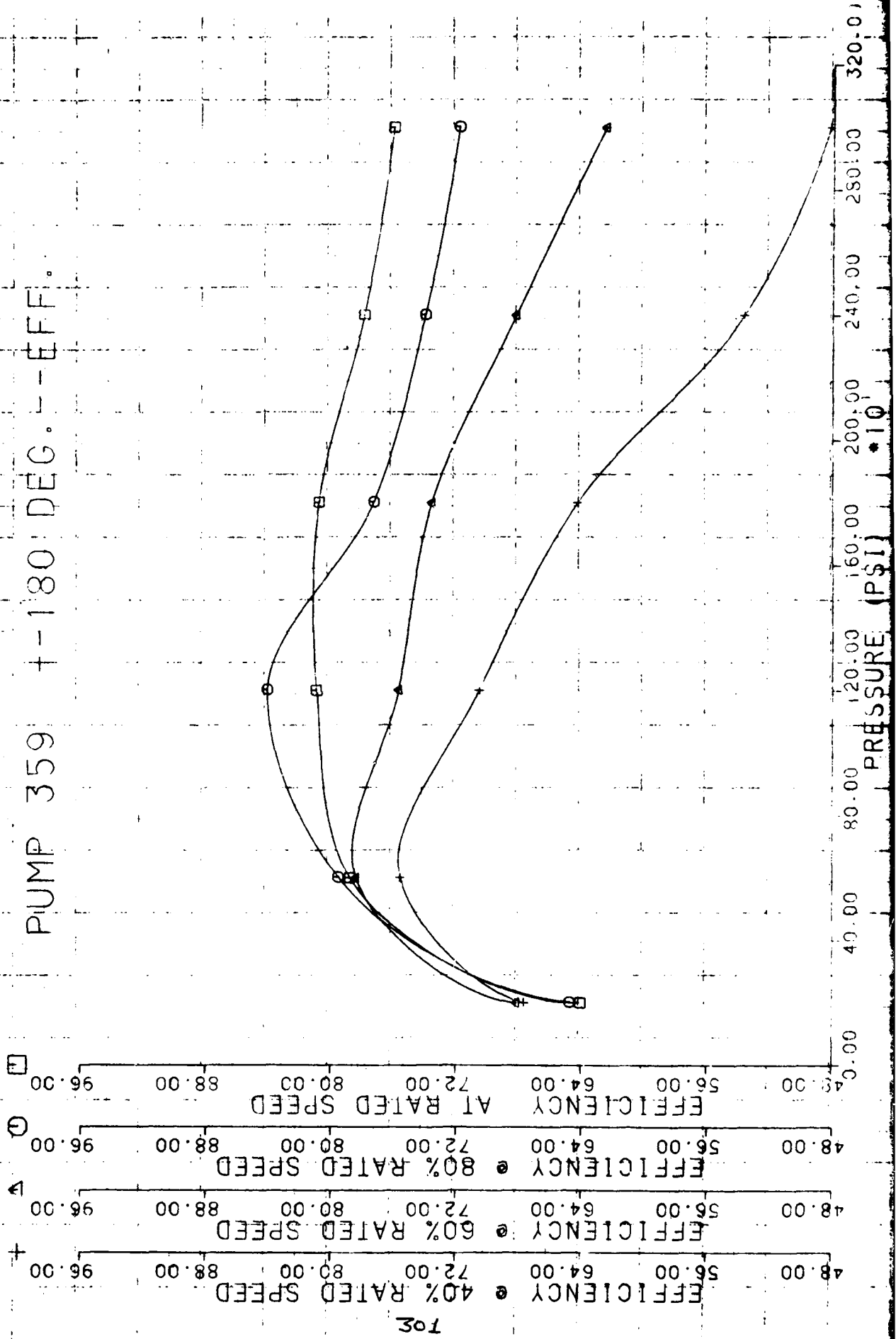


PUMP 359 --120 DEG. --EFF.

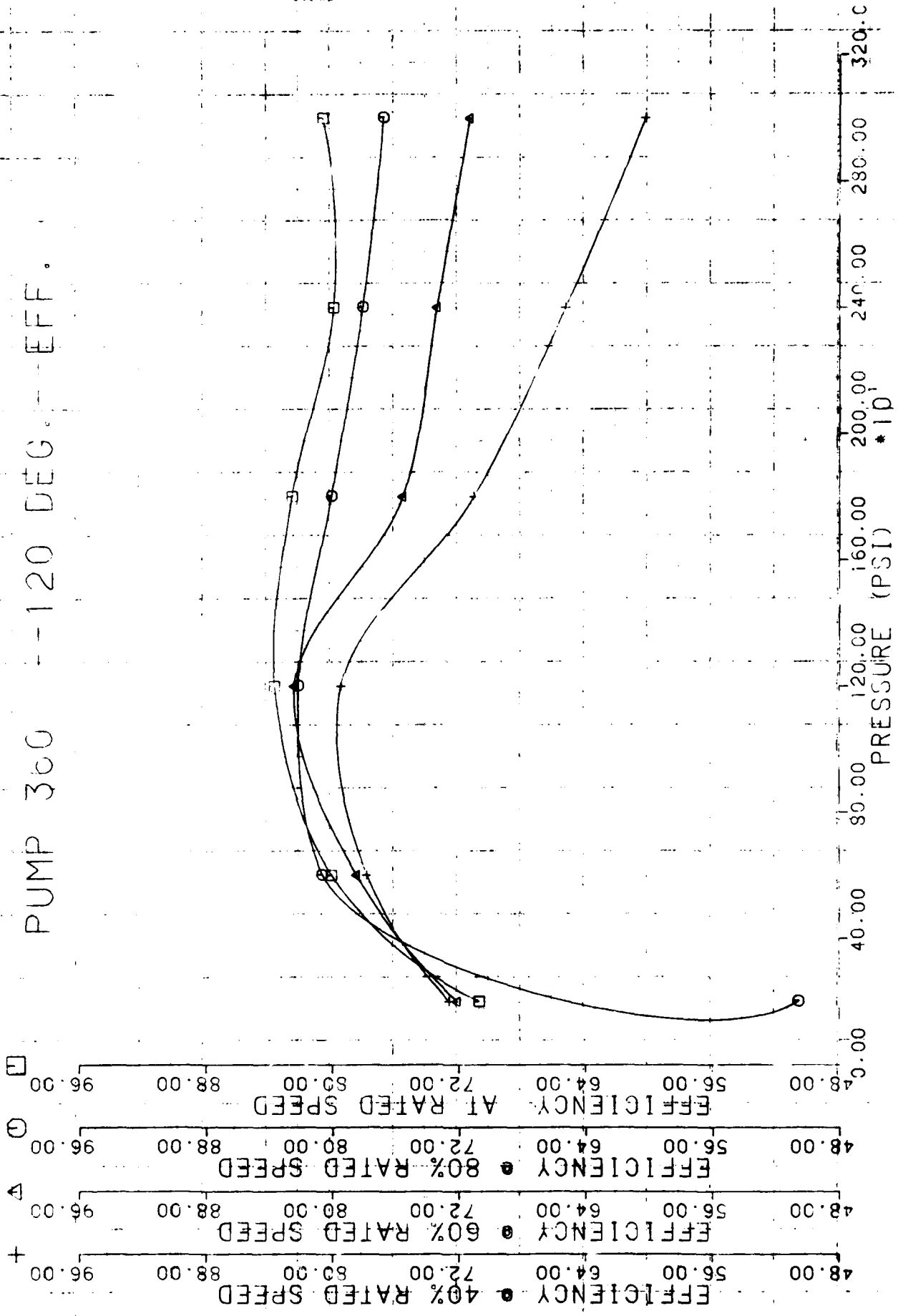




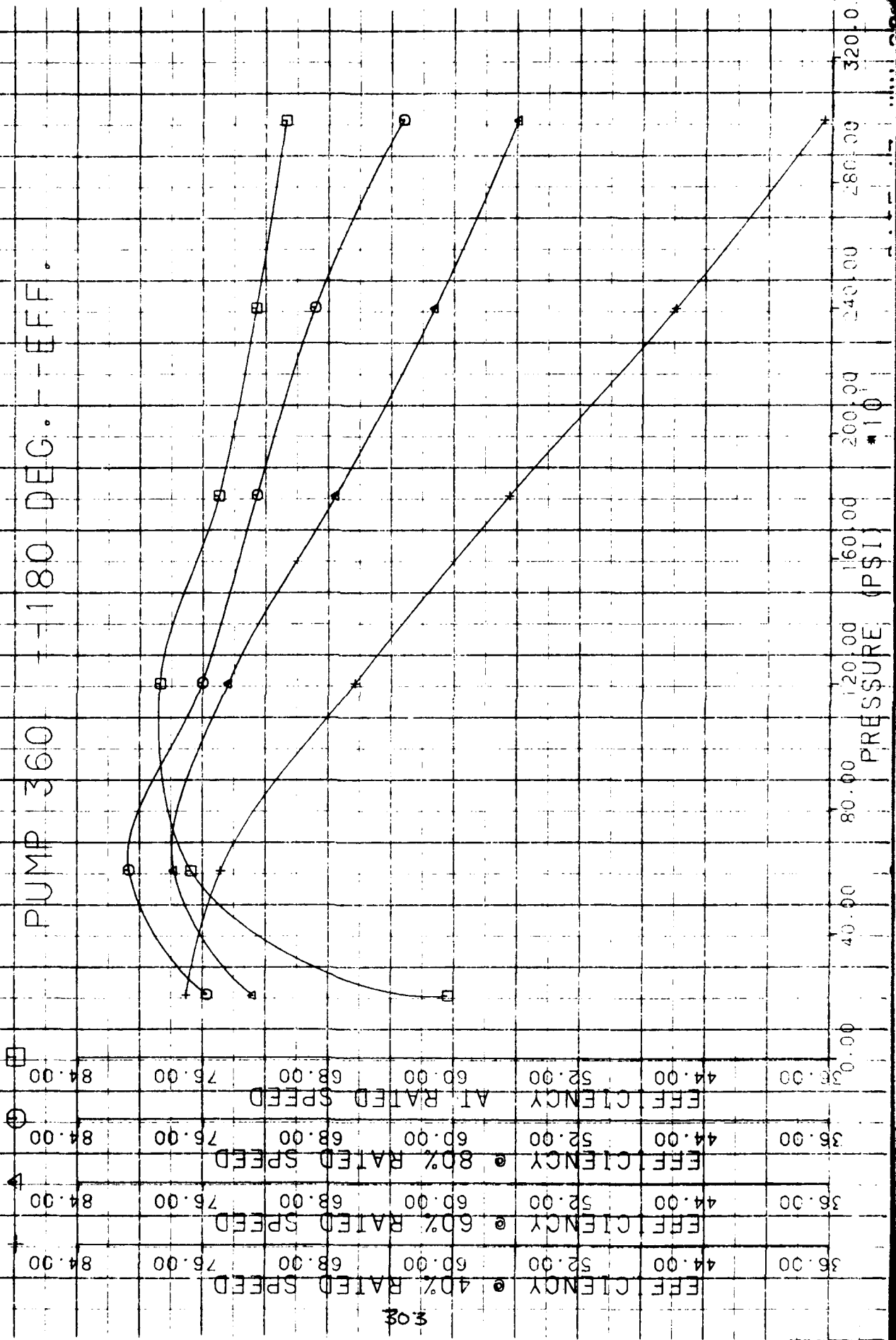
PUMP 359 +180 DEG. -- EFF.



PUMP 360 --120 DEG. -- EFF.

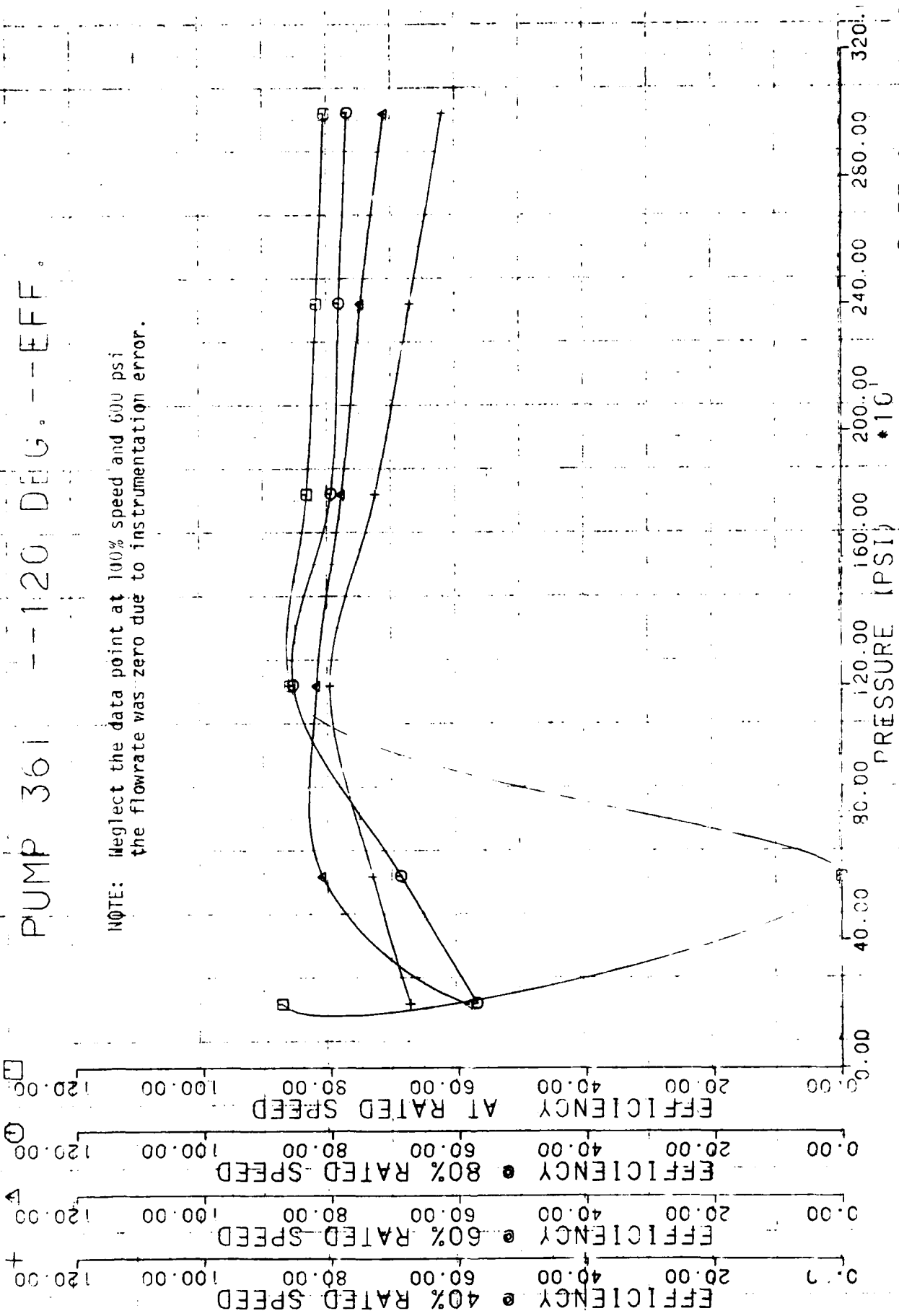


PUMP 360 -180 DEG. -EFF.



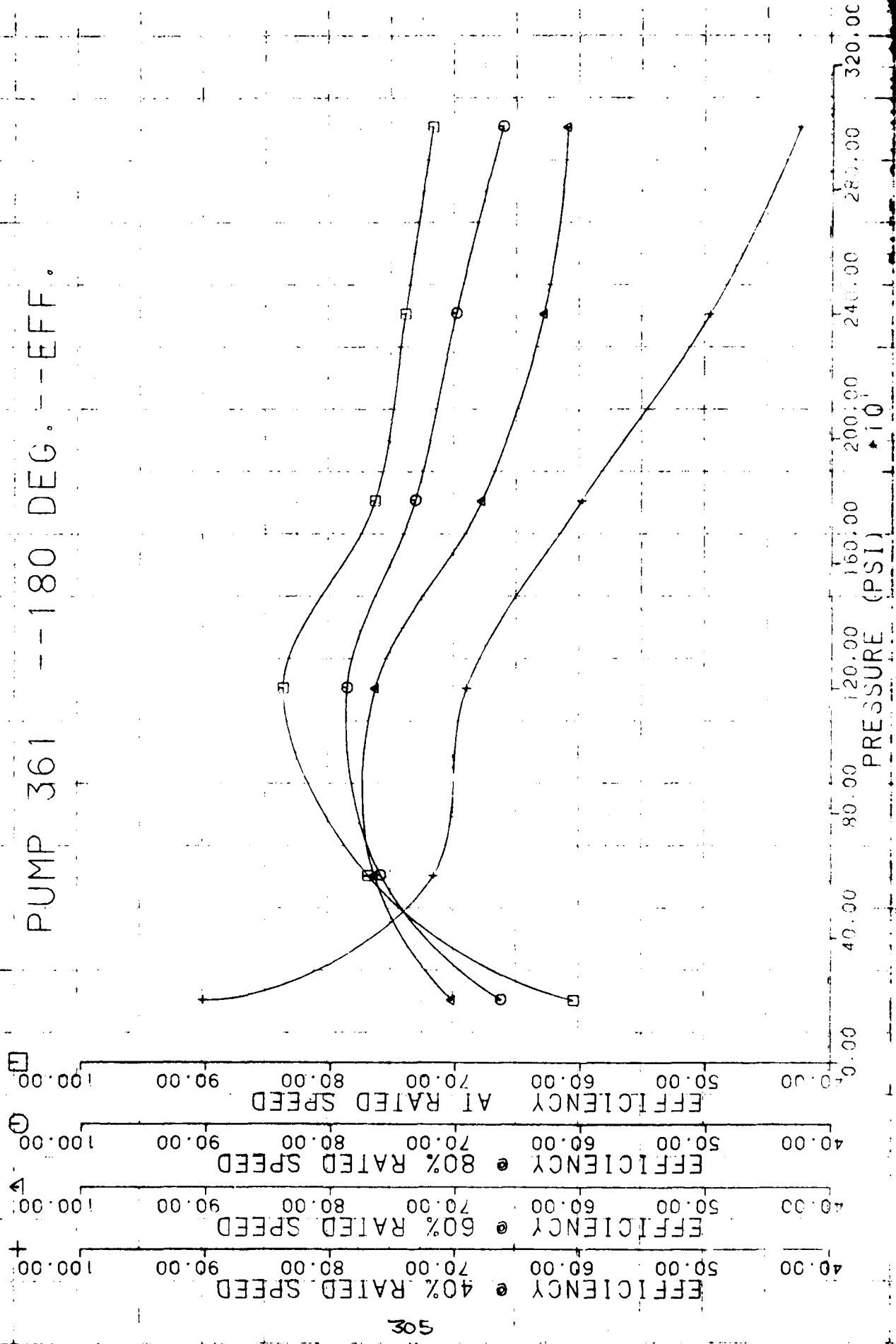
# PUMP 361 --120 DEG.--EFF.

NOTE: Neglect the data point at 100% speed and 600 psi  
the flowrate was zero due to instrumentation error.

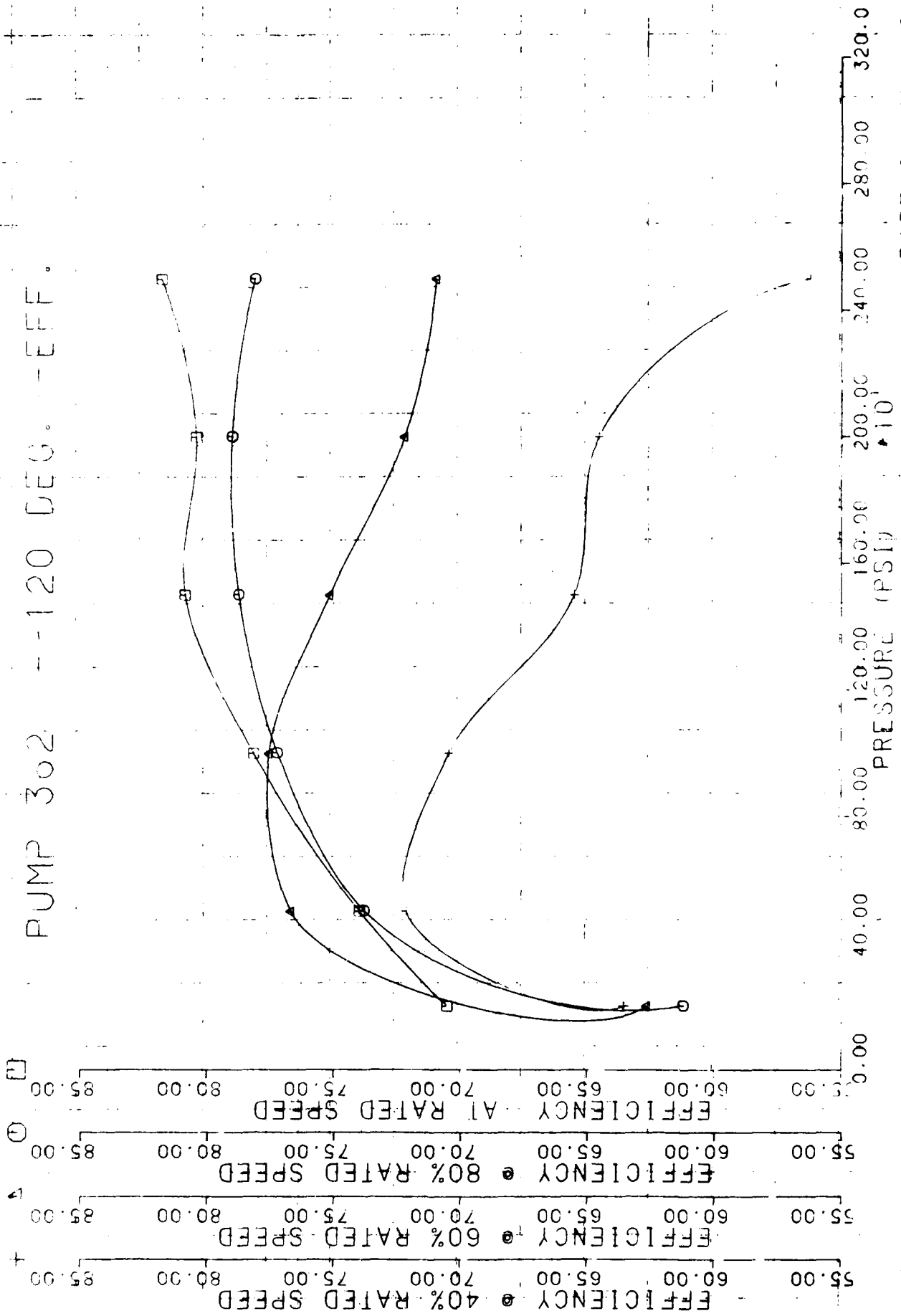


DATE: 04 MAY 64

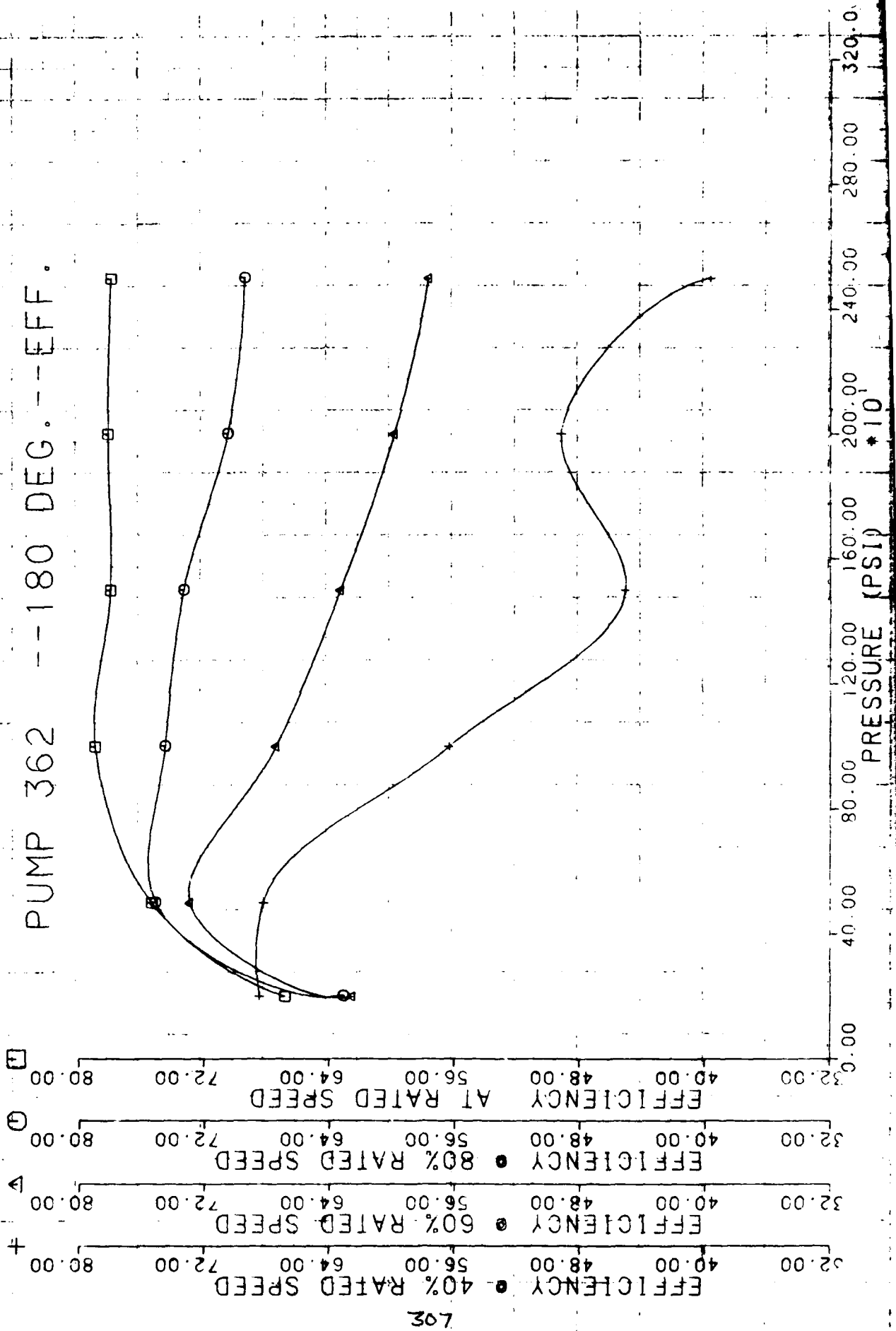
PUMP 361 --180 DEG. --EFF.



PUMP 302 -- 120 DEG. -- EFF.

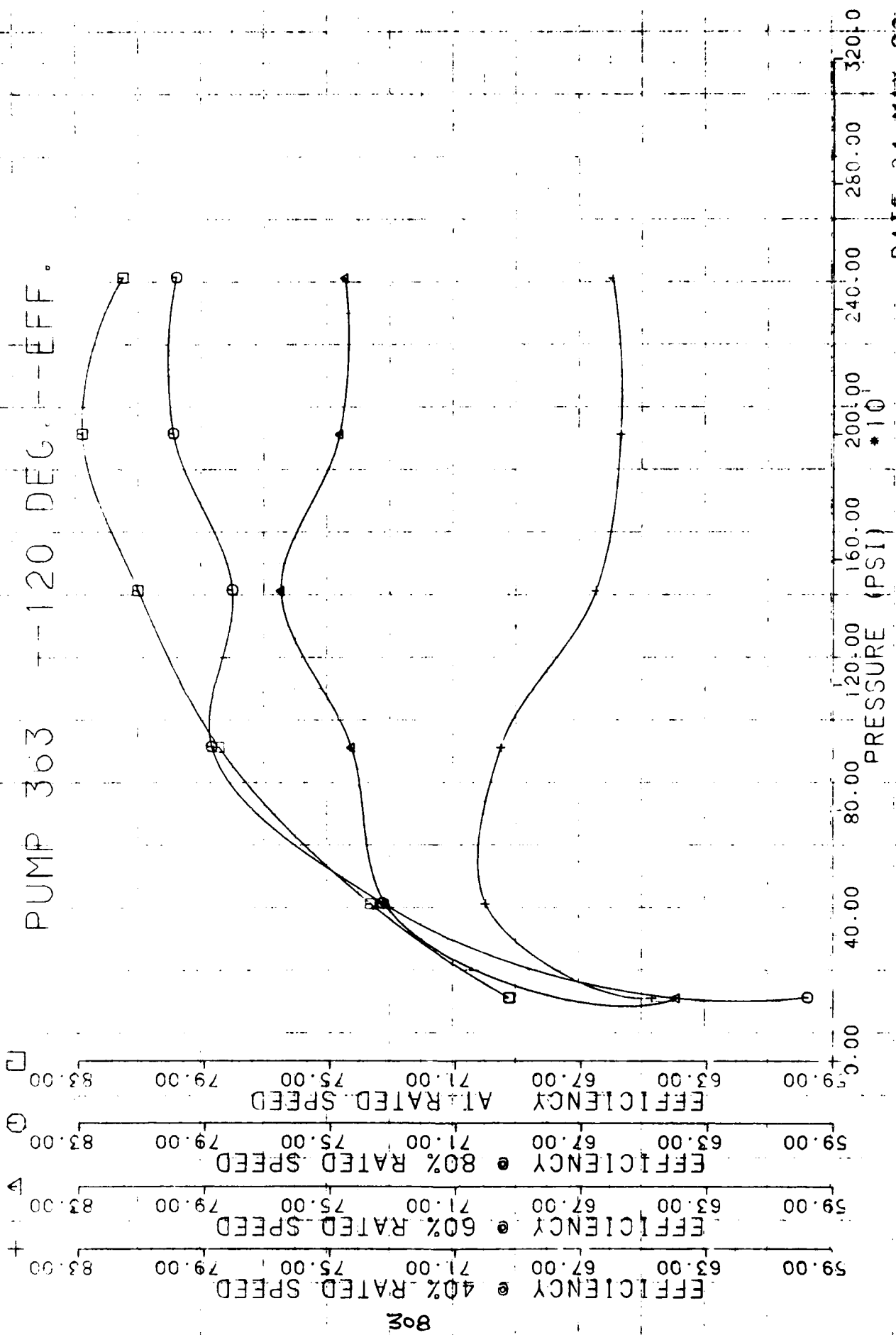


PUMP 362 --180 DEG. --EFF.



702

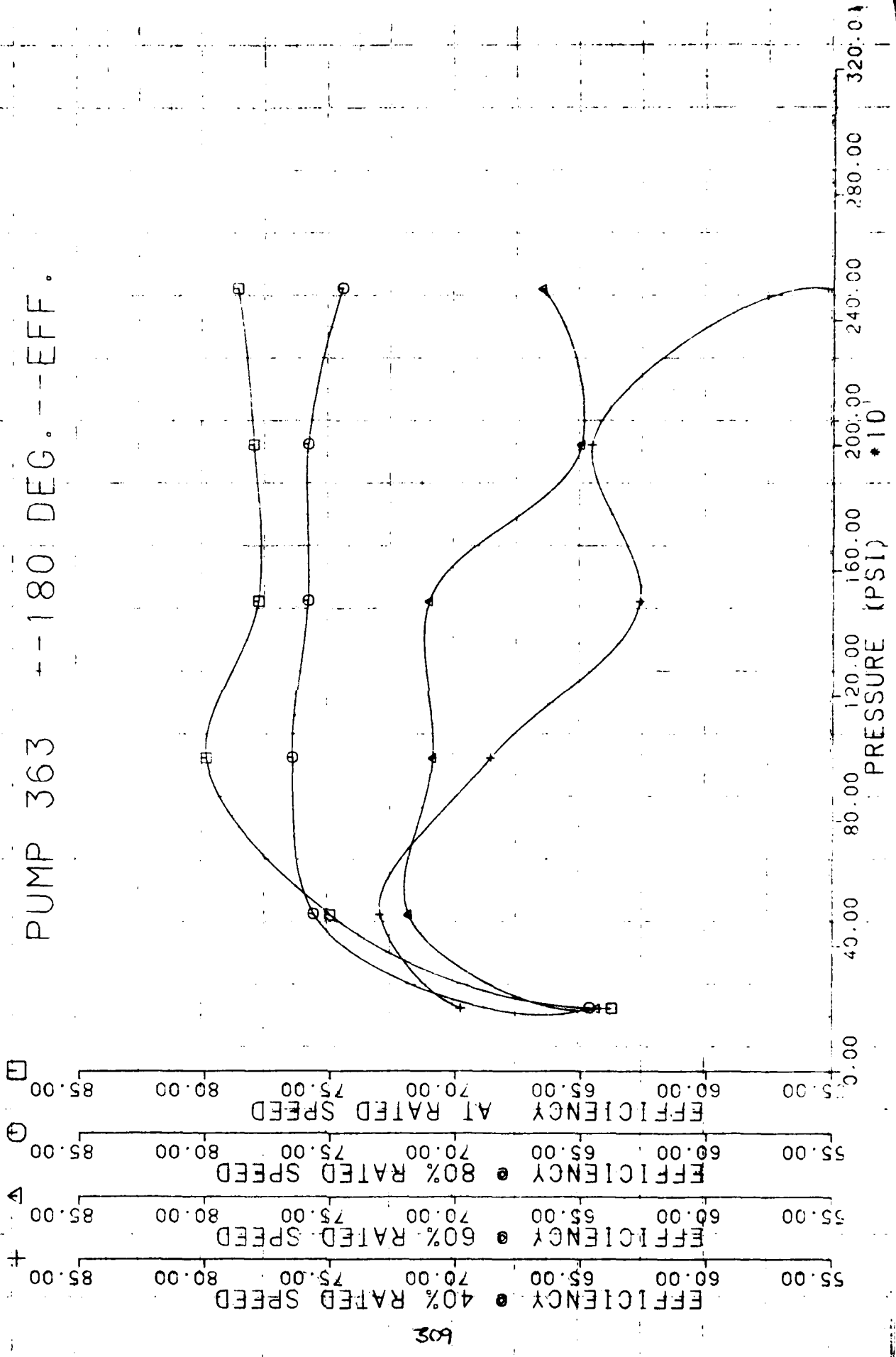
# PUMP 303 --120 DEG. --EFF.



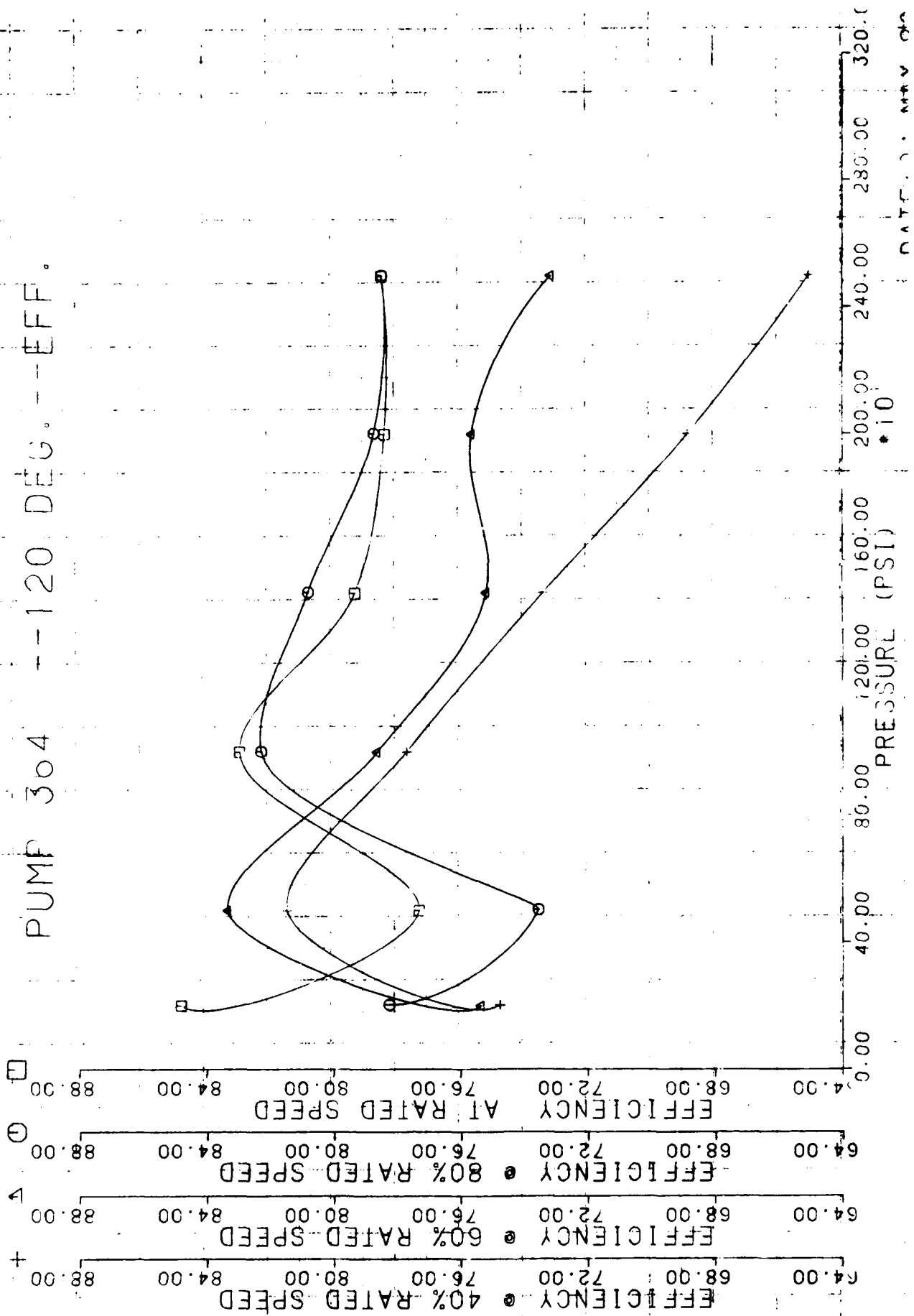
DATE: 04 MAY 67



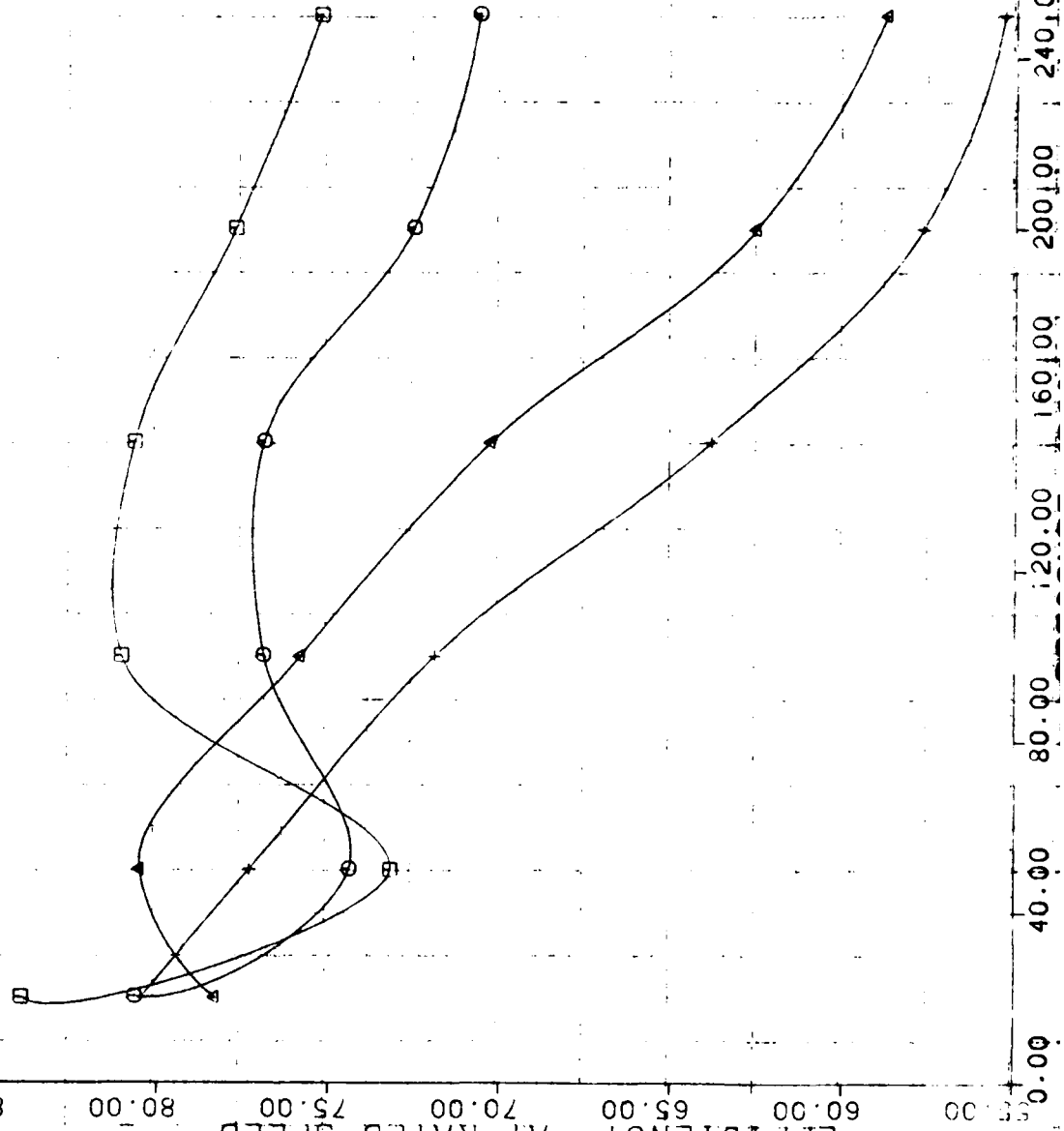
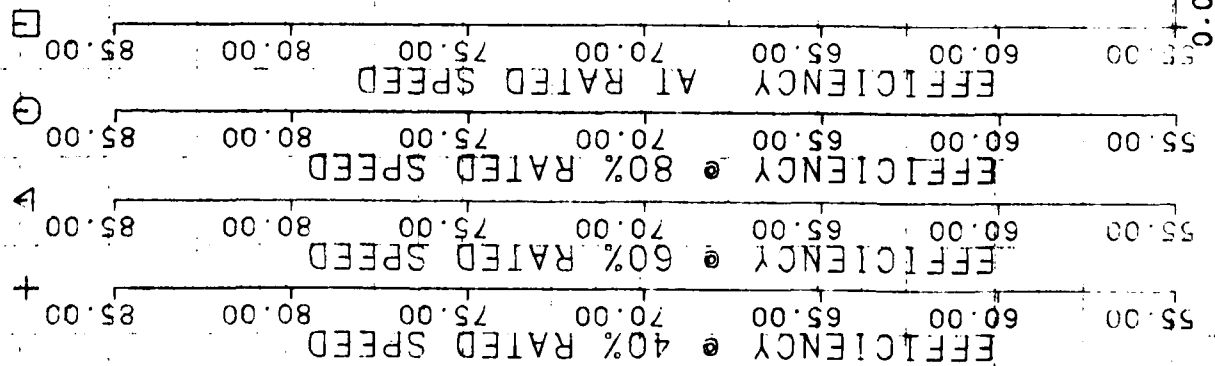
PUMP 363 --180 DEG.--EFF.



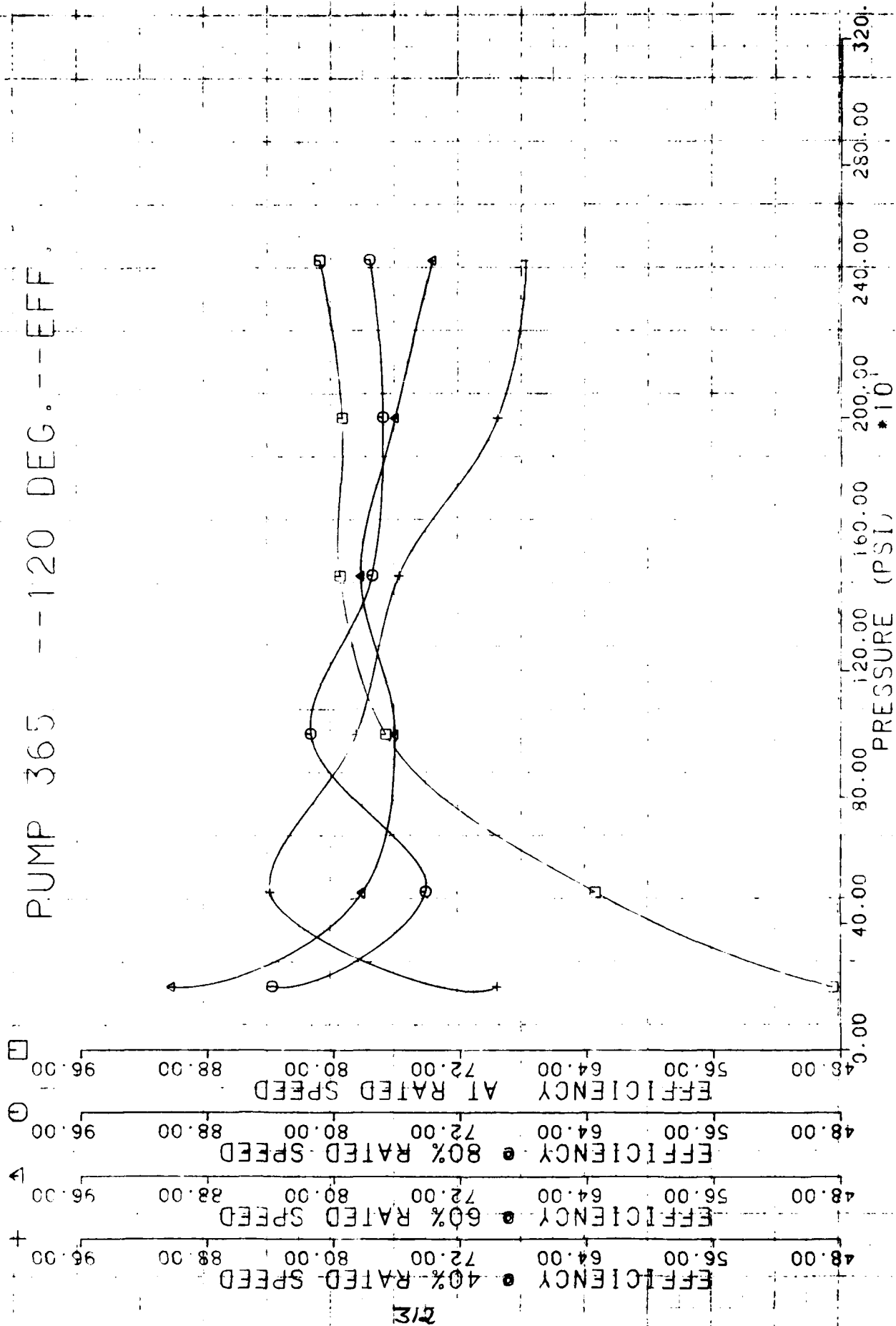
PUMP 304 --120 DEG.--EFF.



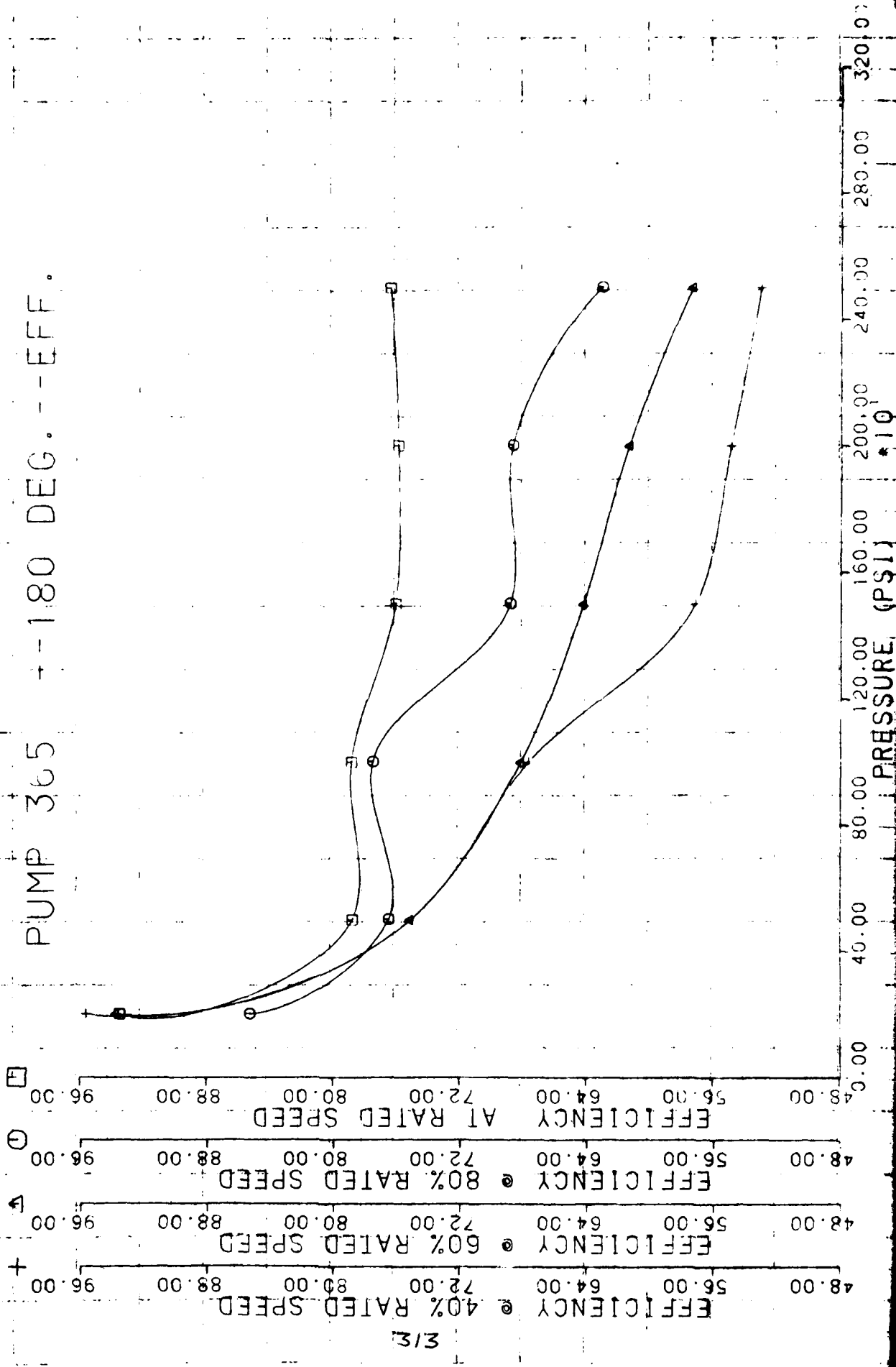
PUMP 364 --180 DEG. --EFF.



PUMP 365 --120 DEG.--EFF.

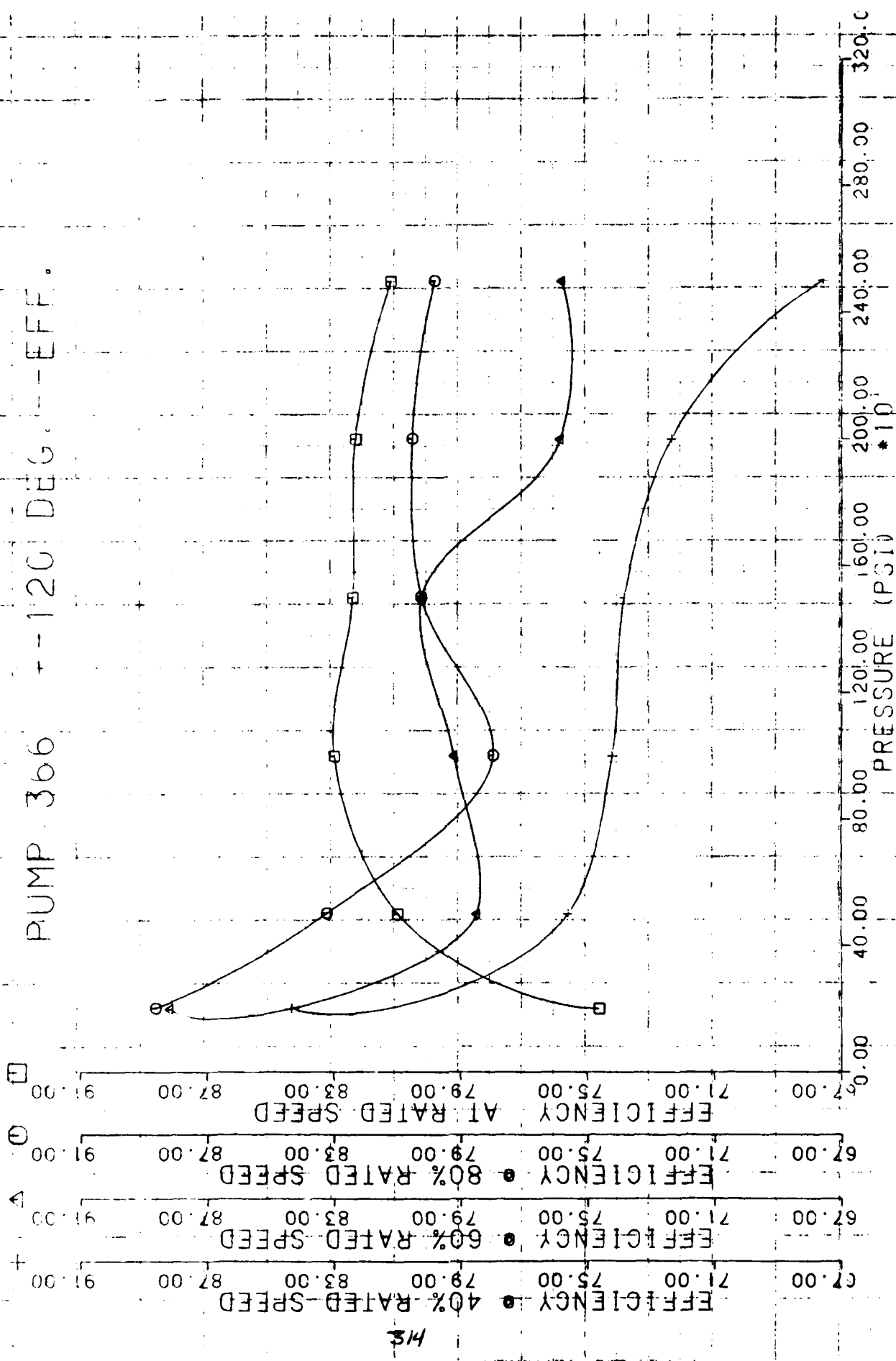


PUMP 365 --180 DEG. --EFF.

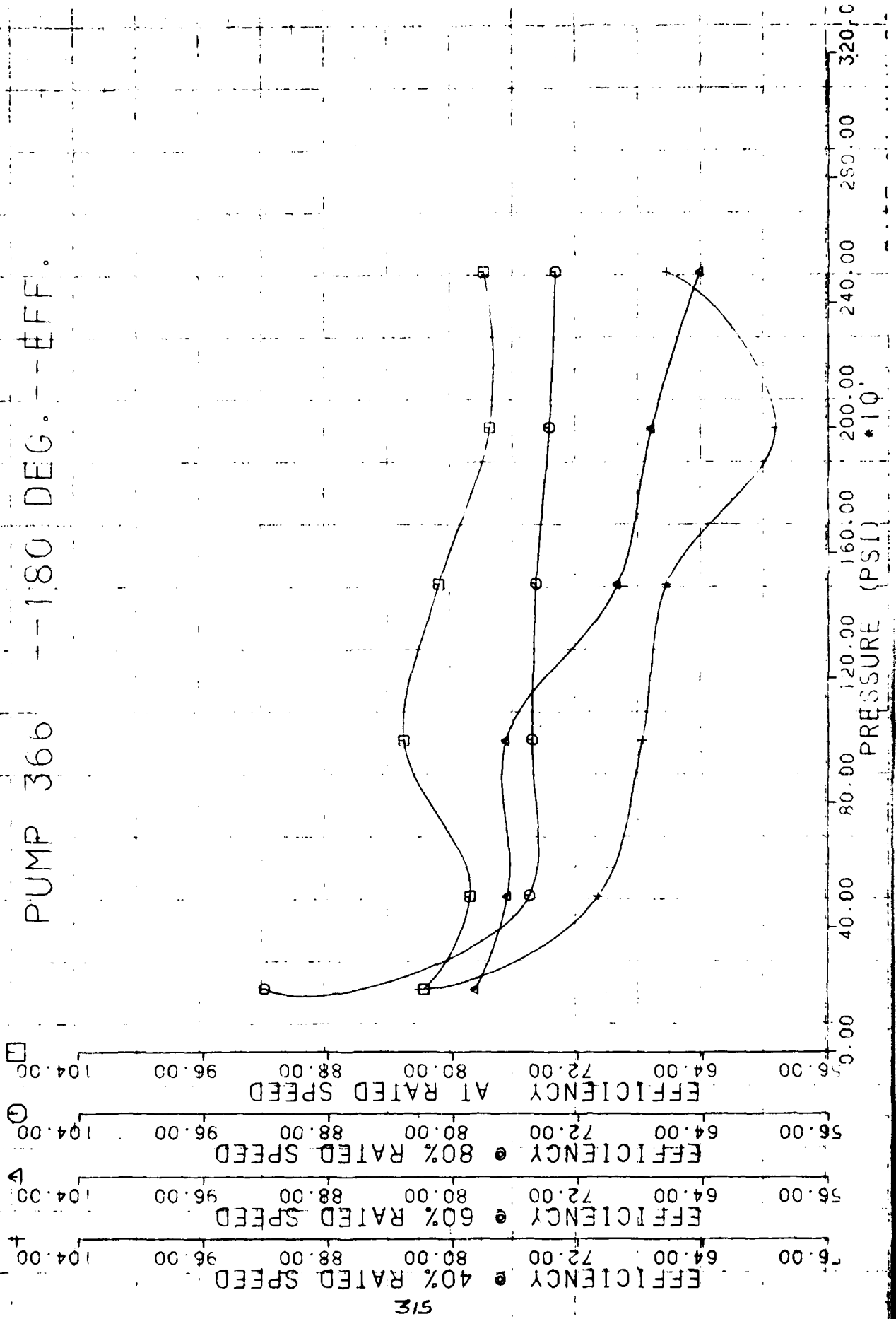


2/3

PUMP 366 -- 120 DEG. -- EFF.



PUMP 366 --180 DEG. --EFF.



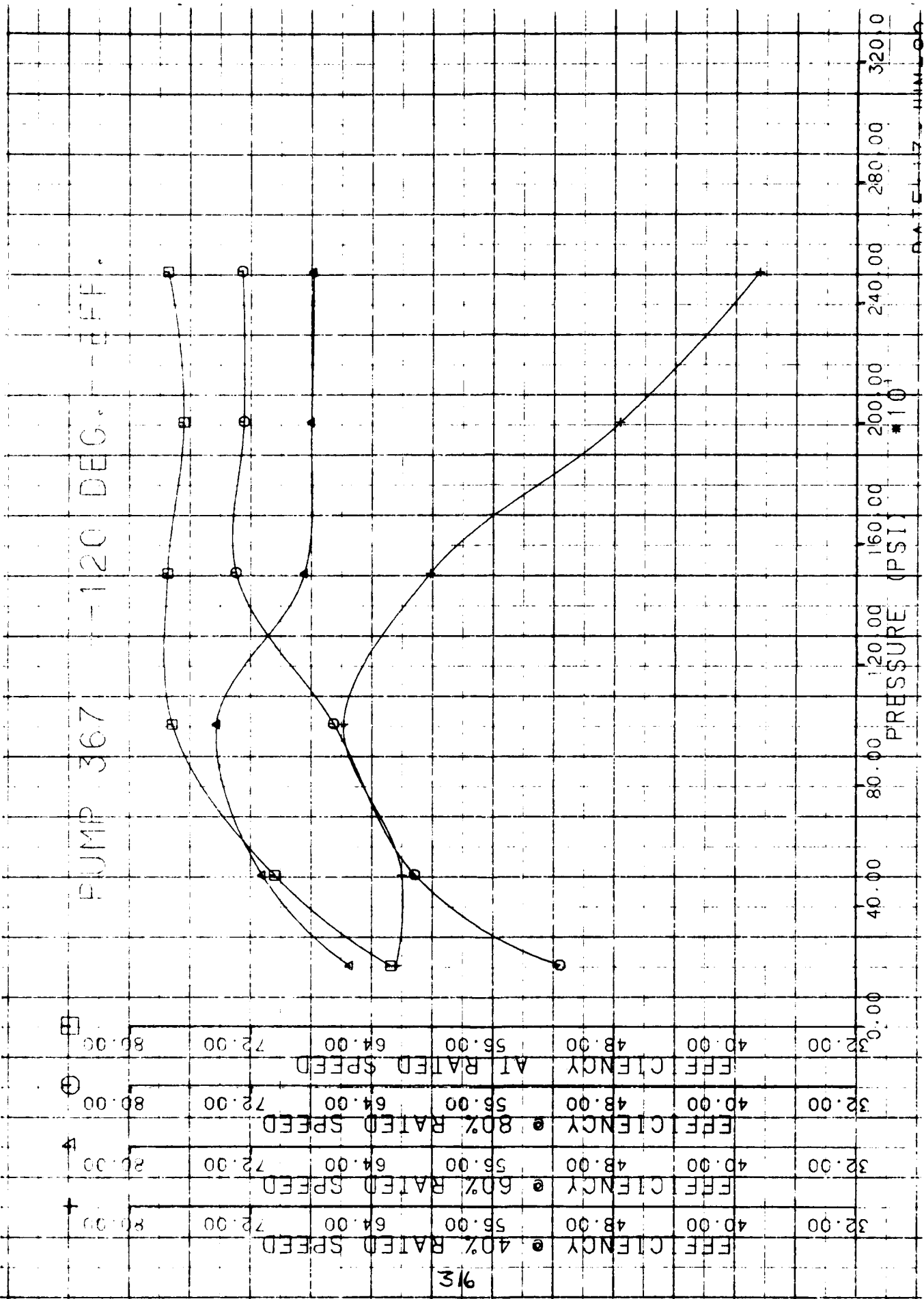
PUMP 367 -120 DEG. EFF.

32.00	40.00	48.00	55.00	64.00	72.00	80.00
EFFICIENCY @ 40% RATED SPEED	EFFICIENCY @ 60% RATED SPEED	EFFICIENCY @ 80% RATED SPEED	EFFICIENCY AT RATED SPEED			
32.00	40.00	48.00	55.00	64.00	72.00	80.00

913

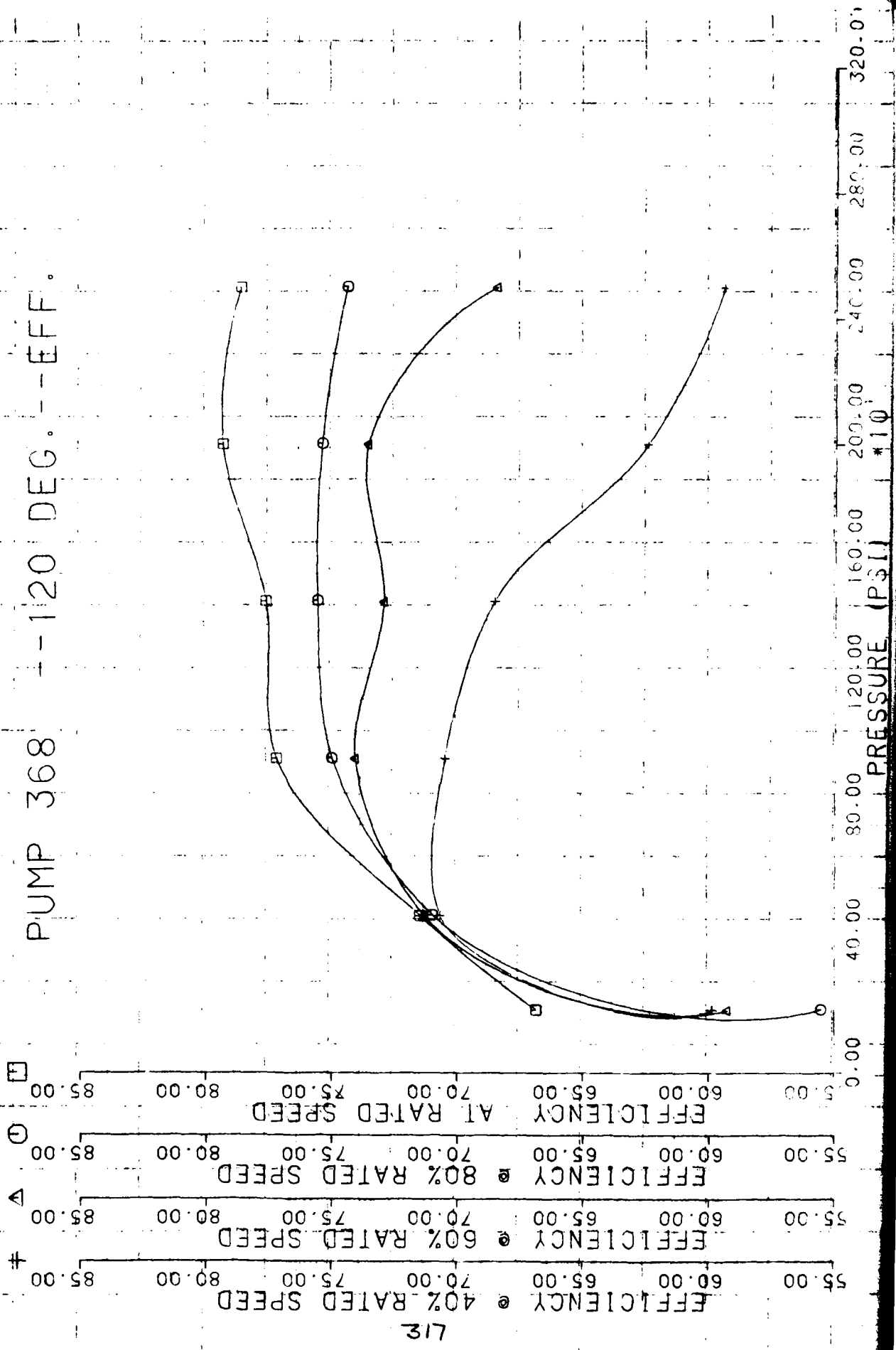
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PRESSURE (PSI) \*10

DATE 17 JUN 66

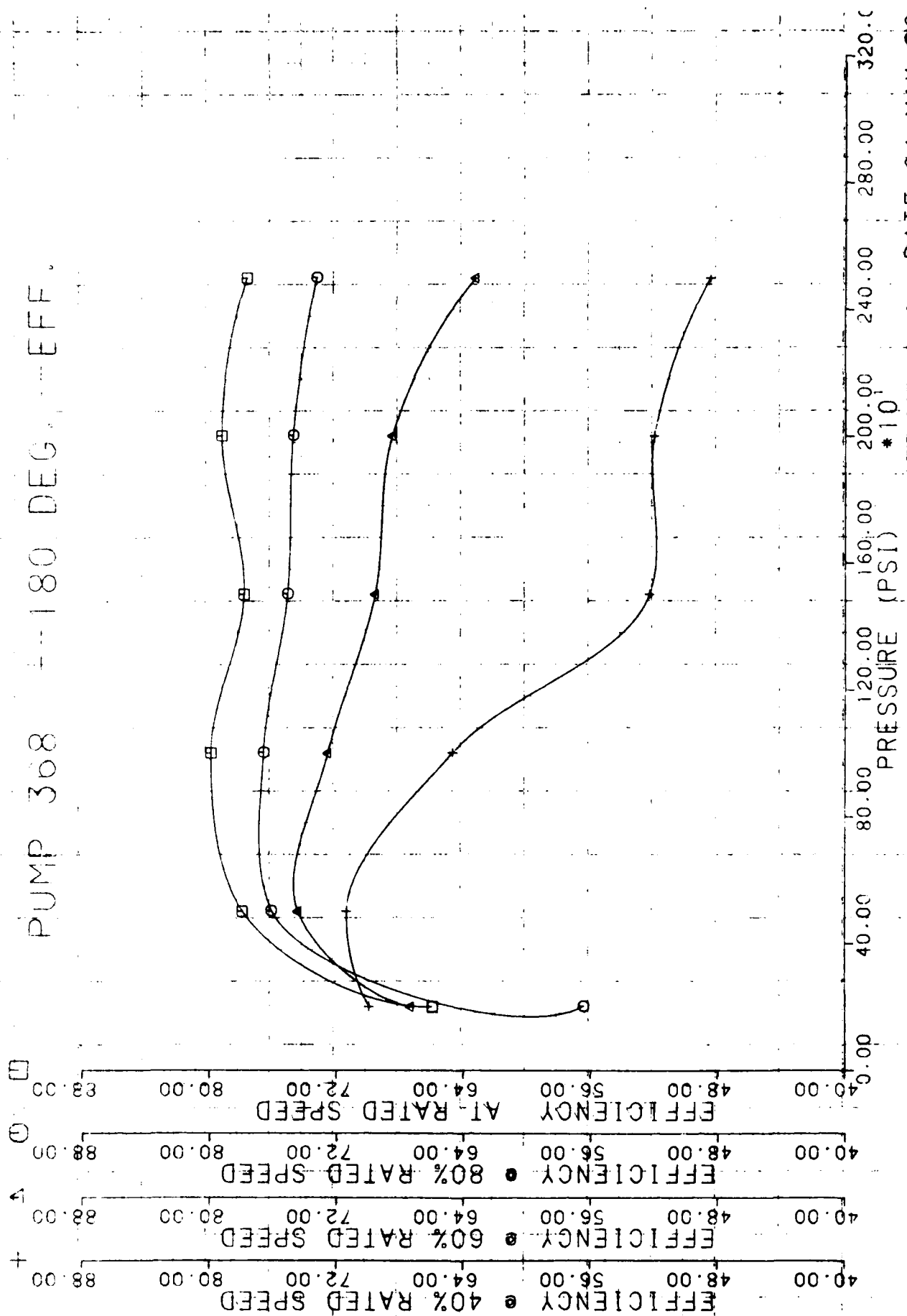




PUMP 368 --120 DEG. --EFF.



PUMP 368 -- 180 DEG. EFF.



APPENDIX K  
ENDURANCE AND DURABILITY TEST PROCEDURES

MIL-P-52675A(ME)  
22 August 1973  
SUPERSEDING  
MIL-P-52675  
15 January 1970

MILITARY SPECIFICATION

PUMPS, HYDRAULIC, OIL, FIXED DISPLACEMENT

2500 PSI (MAXIMUM WORKING PRESSURE)

1. SCOPE

1.1 Scope. This specification covers the 2500 pounds per square inch (psi), fixed displacement, gear or vane, hydraulic pumps for use on stationary and mobile equipment.

1.2 Classification. Hydraulic pumps shall be either gear or vane of the following types, as specified (see 6.2):

Type I - Single.

Type II - Double.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

FPP-B-601  
FPP-B-621  
FPP-B-636

- Boxes, Wood, Cleated-Plywood.  
- Boxes, Wood, Nailed and Lock-Corner.  
- Boxes, Shipping, Fibertboard.

FIG. 4-10

MIL-PRC-100A(MF)

MIL-B-640

- Boxes, Fiberboard, Corrugated, Triple-Wall.

MIL-T-60

- Tape: Packaging, Waterproof.

Military

MIL-P-110

- Preservation, Methods of.

MIL-B-1.1

- Barrier Material, Greaseproofed, Waterproofed, Flexible.

MIL-F-514

- Plates, Identification, Instruction and Marking, Blank.

MIL-T-100

- Treatment and Painting of Material.

MIL-L-2104

- Lubricating Oil, Internal Combustion Engine, Tactical Service.

MIL-G-5514

- Gland Design, Packings, Hydraulic, General Requirements for.

MIL-H-5600

- Hydraulic Fluid, Petroleum Base; Aircraft and Ordnance.

MIL-H-6083

- Hydraulic Fluid, Petroleum Base, for Preservation and Testing.

MIL-V-52687

- Valves, Relief, Hydraulic Pressure.

STANDARDS

Military

MIL-STD-105

- Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129

- Marking for Shipment and Storage.

MIL-STD-130

- Identification Marking of US Military Property.

MIL-STD-448

- Test Methods for Construction and Industrial Machinery.

MS39314

- Port, Mounting Face Dimensions Hydraulic, 4-Bolt Split-Flange Type Hose and Tube Connections, 0 to 2,000; 2,500; and 3,000 PSI.

(Copies of specifications and standards required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL BUREAU OF STANDARDS

Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

NATIONAL FLUID POWER ASSOCIATION

TF.9.1 - NFPA Recommended Standard Method for Extracting Fluid Sample.

(Application for copies should be addressed to the National Fluid Power Association, P.O. Box 49, Thiensville, WI 53092.)

SOCIETY OF AUTOMOTIVE ENGINEERS

SAE Handbook.

(Application for copies should be addressed to the Society of Automotive Engineers, Two Pennsylvania Plaza, New York, NY 10001.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, ATTN: Tariff Publishing Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, INC., ATTN: Tariff Order Section, 1616 P Street NW, Washington, DC 20036.)

### 3. REQUIREMENTS

3.1 Qualification. The pumps furnished under this specification shall be a product which has been tested, has passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable Qualified Products Lists (see 6.3).

3.2 Description. The pumps shall consist of the housing or body, the internal pumping elements, drive shaft and all other accessories necessary to form an operable pump to produce power for a hydraulic system when driven by an engine, an engine driven transmission or other type of drive. The pump shall deliver oil from its discharge port, into the hydraulic system.

3.3 Materials. Materials shall be new and as specified herein. Materials not specified shall be selected by the supplier and shall be subject to all provisions of this specification.

3.3.1 Metals. All metals shall be compatible with the oil, temperature, function, service, and storage conditions specified herein. Unless protected against electrolytic corrosion, dissimilar metals as defined in MIL-T-704 shall not be used in intimate contact with each other.

3.3.2 Material compatibility. All nonmetallic components of the pumps shall be compatible with lubricating oils conforming to MIL-L-2104, grade 10; CONOCO DN-600, type I; Emory 3906; and hydraulic fluids conforming to MIL-H-5606 and MIL-H-6063.

3.4 Environmental conditions. The pumps shall be constructed to operate throughout the environmental conditions specified herein.

3.4.1 Low temperature. After having been stored at a temperature of minus 65° F. plus or minus 5° F. for a period of not less than 12 hours, the pumps shall operate with an oil temperature of minus 50° F. plus or minus 5° F. The pumps shall also meet the operating and performance requirements specified herein when operated with an oil temperature down to minus 15° F. plus or minus 5° F. without malfunction or damage.

3.4.2 Contaminant tolerance level. When the pump is tested as specified in 4.5.2.2.6, the 1000 hours contaminant tolerance profile shall not drop below or cross the profile on figure 1.

3.5 Performance. The pumps shall be capable of developing a discharge pressure of 2,500 psi at rated flow and at all speeds from 600 rpm to 115 percent of rated speed without permanent deformation and damage, when operated with an inlet oil temperature of 150° F. plus or minus 5° F. and a minimum (numerically greater than) inlet pressure of 5 inches of mercury vacuum. The rated speed shall be the maximum at which the pump will operate continuously and meet the endurance requirements specified herein; and shall not exceed the manufacturer's maximum recommended continuous operating speed. When required, the operating speed may be less than the rated speed specified. The rated flow shall be the amount of oil expressed in gallons, delivered by the pump, per minute at rated speed. Rated flow and speed shall be as specified (see 6.2).

3.6 Efficiency. When operated at 2500 rpm and at an oil temperature of 150° F. plus or minus 5° F., the initial overall efficiency (combined hydraulic output/mechanical input) of the pump shall be not less than 75 percent for flow rates equal to or less than 15 gpm and shall be not less than 30 percent for flow rates greater than 16 gpm for a pressure range of 1000 psi to 2500 psi. A maximum drop in efficiency of 4 percent may be acceptable after endurance test. The efficiency of a dual-pump (when applicable) shall be determined by using the combined pump flow. The efficiency of flow-controlled pumps shall be determined with the flow-control element removed.

3.7 Proof pressure. The pumps shall withstand a minimum proof pressure of 3750 psi when tested as specified in 4.5.2.2.2 without damage or external leakage.

3.8 Endurance. The pumps shall meet the efficiency requirements and shall show no evidence of damage or external leakage after 1000 hours of continuous operation as specified in 4.5.2.2.4.

3.9 Oil. The pumps shall perform as specified herein with the following oils:

MIL-L-2104	- Grade 10 - For 0° F. to plus 220° F. temperature range.
CONOCO DN - 600, type I; - and Emory 3908.	- For 0° F. to minus 65° F. temperature range.

3.10 Leakage. The pumps shall show no evidence of external leakage when tested as specified herein, except that the shaft seal leakage shall not exceed 3 drops per hour upon completion of endurance test.



3.11 Mounting flange and drive shaft. The pumps shall have two-bolt mounting flange and involute spline drive shaft in accordance with SAE J744. A combination of a two-bolt and four-bolt configuration in one adapter may be acceptable for pump two-bolt mounting flange.

3.12 Ports. All ports of 3/4-inch and smaller nominal size shall conform to SAE J514 straight thread O-ring boss, and shall be limited to 1/4-inch, 3/8-inch, 1/2-inch and 3/4-inch sizes. Ports larger than 3/4-inch nominal size shall conform to MS39314. Outlet ports shall be large enough to limit the oil velocity to a maximum of 20 feet per second. Suction ports shall be of a size to permit entry of oil with a maximum inlet port velocity of 6 feet per second.

3.13 Threads. Straight threads conforming to Handbook H28 shall be used.

3.14 Lubrication. The pumps shall be self-lubricating by means of the oil circulating within the pump.

3.15 Direction of rotation. Rotation of the pumps shall be clockwise or counterclockwise as specified (see 6.2), when viewed from drive shaft end. The pumps shall be suitable for operation in both directions of rotation. Reverse rotation may be accomplished by dismantling and repositioning internal components as necessary. Change in direction of rotation should be accomplished without the addition, removal, or replacement of any component part. Direction of pump rotation shall be permanently marked on a reversible metal tag attached by screws to the mounting flange.

3.16 Interchangeability. All parts having the same manufacturer's part number shall without modification be directly and completely interchangeable with respect to installation and performance. Selective fitting shall be permitted when such fitted parts are identified as an assembly.

3.17 Seals. The construction of packing glands and characteristics of the static and dynamic seals shall conform in all respects to the performance requirements specified herein. All O-ring seals,askets and back-up ring and installation thereof shall conform to performance and dimensional requirements of MIL-G-9914.

3.18 Built-in relief valve. When the pump is furnished with a built-in relief valve, the relief valve shall conform to MIL-V-92637.

3.19 Identification marking. The pumps shall be identified in accordance with MIL-STD-130 on identification plates conforming to MIL-P-514, type III, composition A, class 1 with the following information:

Pump, hydraulic, oil, fixed displacement.

Flow \_\_\_\_\_ gpm at 2500 rpm, and 2500 psi.

Rated Pressure 2500 psi.

Rated Speed \_\_\_\_\_ rpm.

Manufacturer's Name.

Manufacturer's Part or Model Number \_\_\_\_\_.

Serial Number \_\_\_\_\_.

Pump type; Type I-Single, or Type II-Double \_\_\_\_\_.

Specification MIL-P-52675 \_\_\_\_\_.

Government Part No. \_\_\_\_\_ when specified by end item drawing (see 6.2).

3.20 Workmanship. All parts and components of the pumps including casting, forging, mold parts, stampings and machined surfaces shall be clean and free from sand, dirt, fins, pits, sprues, scale, and other harmful extraneous material. All edges shall be rounded or chamfered.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Component and material inspection. The supplier is responsible for insuring that components and materials used are manufactured, examined, and tested in accordance with referenced specifications and standards.

4.2 Classification of inspection. Inspection shall be classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).
- (c) Inspection of preparation for delivery (see 4.6).

4.3 Qualification (see 6.3).

4.3.1 Examination. The pumps shall be examined as specified in 4.5.1. Presence of one or more defects shall be cause for rejection.

4.3.2 Tests. The pumps shall be tested as specified in 4.5.2.2.1 through 4.5.2.2.6 in the following sequence. Failure of any test shall be cause for rejection.

- (a) Efficiency test (see 4.5.2.2.1).
- (b) Proof pressure test (see 4.5.2.2.2).
- (c) Performance test (see 4.5.2.2.3).
- (d) Endurance test (see 4.5.2.2.4).
- (e) Low temperature test (see 4.5.2.2.5).
- (f) Final efficiency test, run number 2 (see 4.5.2.2.1).
- (g) Contaminant tolerance test (see 4.5.2.2.6).

4.4 Quality conformance inspection.

4.4.1 Examination. Each pump shall be examined as specified in 4.5.1. Presence of one or more defects shall be cause for rejection of the pump.

4.4.2 Tests. Each pump shall be tested as specified in 4.5.2.2.7. Failure of the test shall be cause for rejection of the failed pump.

4.5 Inspection procedure.

4.5.1 Examination. The pumps shall be examined for the following defects:

101. Type not as specified.
  102. Material not as specified.
  103. Use of dissimilar metal not as specified.
  104. Threads not as specified.
  105. Mounting flange not as specified.
  106. Ports not as specified.
  107. Direction of rotation not as specified.
  108. Seals not as specified.
  109. Identification or special marking missing or illegible.
- 
110. Identification plate not as specified.
  111. Technical publications not as specified (see 6.4).
  112. Workmanship not as specified.

#### 4.5.2 Tests.

##### Test conditions.

4.5.2.1.1 Oil. Unless otherwise specified, all tests shall be conducted using oil conforming to MIL-L-2104, grade 10, at a temperature of 150° F. plus or minus 5° F.

4.5.2.1.2 Filtration. For all tests, the test oil shall be filtered through a filter element having a filtration ratio, at 10 micron, higher than 2.2.

4.5.2.1.3 Test apparatus. All test apparatus shall be accurate within the limits specified in MIL-STD-448, section 6.

4.5.2.1.4 Inlet pressure. Unless otherwise specified herein, the inlet pressure shall not exceed 14.7 psi.

##### 4.5.2.2 Test procedure.

4.5.2.2.1 Efficiency test. Install the pump in the test system shown in figure 2 or on a dynamometer test bench. Measure and record the overall efficiency (combined hydraulic output/mechanical input) at 2500 rpm speed at an oil temperature of 150° F. plus or minus 5° F. and at a minimum of 7 pressure points at equal increments starting with 1000 psi and continuing through 2500 psi. Efficiencies less than that specified in 3.6 shall constitute failure of this test.

4.5.2.2.2 Proof pressure test. Operate the pump at 3750 psi and maximum rated speed and hold for not less than 60 seconds. Check for external leaks at assembled surfaces and the shaft seal. Any evidence of mechanical malfunction, damage, or leakage shall constitute failure of this test.

4.5.2.2.3 Performance test. Each pump shall be operated at a discharge pressure of 2500 psi with a minimum inlet pressure of 5 inches mercury vacuum for:

- (a) 30 minutes at 600 rpm.
- (b) 30 minutes at rated speed.
- (c) 30 minutes at 115 percent of rated speed.

Inability of the pump to deliver 2500 psi at 600 rpm rated flow and 2500 psi at rated speed, and 2500 psi at 115 percent of rated speed or evidence of malfunction shall constitute failure of this test.

4.5.2.2.4 Endurance test. Install the pump in the test system for running the endurance test and cycle as follows: 5 seconds at minimum pressure and 5 seconds with pressure limited to not less than 2500 psi for a total of 1000 hours. Oil temperature shall be 220° F. plus or minus 5° F. during the first 50 hours of cycling. The oil temperature at the pump inlet shall be 200° F. plus or minus 5° F. for remaining 950 hours of the tests. Malfunction prior to completion of 1000 hours, failure to maintain 2500 psi, rated flow and rated speed or evidence of leakage greater than 3 drops per hour at shaft seal shall constitute failure of this test.

4.5.2.2.5 Low temperature test. Install the hydraulic system with the test pump in the climatic chamber. Fill the test system with CONOCO DN-600, type 1; or Emory 390<sup>6</sup> oil. The drive may be located externally to the climatic chamber. Lower the pump and test system temperature to minus 65° F. plus or minus 5° F. and maintain at this temperature for a minimum of 12 hours. At the conclusion of the soak period, raise the chamber temperature to minus 50° F. plus or minus 5° F. and stabilize to this temperature for a minimum of 1 hour. Operate the pump as shown in figure 3 as follows: Increase pump speed and pressure simultaneously to 1250 rpm and 250 psig respectively. When inlet oil temperature reaches minus 15° F. plus or minus 5° F., increase the pump speed and discharge pressure simultaneously to rated speed in a time interval of 0.2 minute and 2500 psig in a time interval of 0.1 minute respectively. Operate the pump until inlet oil temperature reaches plus 5° F.

Obtain the test data with recorder having a minimum response of 13 kHz with the provision for recording pump speed, discharge pressure, inlet temperature, and flow concurrently. Inability of the pump to rotate without damage at minus 50° F. plus or minus 5° F., inability of the pump to deliver 2500 psi over the entire speed range, inability of the pump to maintain rated flow at maximum rated speed at minus 15° F., plus or minus 5° F., or evidence of mechanical malfunction, damage, or shaft leakage in excess of 3 drops per hour shall constitute failure of this test.

4.5.2.2.6 Contaminant tolerance test. This test shall be conducted as follows and nonconformance to 3.4.2 shall constitute failure:

I. Equipment and Supplies.

- (a) Hydraulic test circuit as illustrated in figure 4.
- (b) Facility for measuring the gravimetric level of a fluid.
- (c) Supply of classified de-ionized (silica) contaminant (AC Fine Test Dust).
- (d) Supply of clean fluid sample bottles with a cleanliness level below 10 particles per milliliter.
- (e) Supply of clean slurry injection bottles.

II. Test Facility Requirements.

- (a) The test system illustrated in figure 4 shall consist of a reservoir, injection chamber, heat exchanger, flow meter, pressure gages, temperature indicator, control filter, test pump, and pump drive.
- (b) The reservoir shall be constructed with a conical bottom with a projected angle of not more than 90 degrees. The oil entering the reservoir shall be diffused below the surface of the oil. Provisions should be made to pressurize the reservoir.
- (c) The injection chamber shall be constructed as shown in figure 4. The volume of the chamber shall be approximately 500 ml., and the ratio L/D shall be 10. The included angle at the bottom of the chamber shall be not more than 90 degrees.
- (d) The heat exchanger shall be mounted vertically with the oil entering from the bottom.
- (e) The control filter shall be capable of providing a contaminant background of less than 500 particles larger than 10 micrometers per milliliter.

- (f) The flowmeter shall be insensitive to contaminant.
- (g) The lines connecting the hydraulic components shall be sized such that turbulent flow exists throughout the system.
- (h) The control filter shall be capable of providing a contaminant background of less than 10 mg/liter.

### III. System Verification.

- (a) Install a pump that is known to be relatively insensitive to contamination in the circuit.
- (b) Adjust system oil volume (exclusive of the filter system) so that it is numerically equal to one-fourth (plus or minus 10 percent) of the lowest volume flow rate to be used for testing.
- (c) Circulate through the filtering system until the contaminant background is less than 10 mg/liter.
- (d) By-pass the filter system.
- (e) Add a quantity of AC Fine Test Dust to the system to bring the contamination level to 300 mg/liter plus or minus 10 mg. per liter. The contaminant should be injected in the form of well-mixed slurry to prevent agglomeration of the particles.
- (f) Operate the system at the minimum flow rate to be used for testing.
- (g) Extract four oil samples at 15 minute intervals from the system in accordance with NFPA Standard T2.9.1. The system shall run continuously during this period.
- (h) Measure the gravimetric level of each sample in accordance with SAE ARP 765.
- (i) Compute the average of the four gravimetric levels obtained in (h) at each size. The system is qualified for testing if none of the levels differ from the average level by more than 10 percent.
- (j) Circulate through the filter until the contaminant background is less than 10 mg./liter.

### IV. Preliminary Preparation.

- (a) Install the test pump in the circuit.
- (b) Adjust the system volume (exclusive of the filter system) so that it is numerically equal to one-fourth (plus or minus 10 percent) of the volume flow rate of the pump to be tested.

- (c) Operate the pump at rated speed and 150° F plus or minus 5° F. temperature with the filter system in the circuit, using the following schedule for pump operating pressure.

15 minutes at 25 percent rated pressure.  
 15 minutes at 50 percent rated pressure.  
 15 minutes at 75 percent rated pressure.

Operate at rated pressure until flow rate has remained constant for at least 60 minutes.

- (d) Record the flow rate at the end of (c) as the rated flow of the pump ( $Q_r$ ).

#### V. Test Procedure.

- (a) Determine the quantity of contaminant ( $g_i$ ) required for each size injection according to the following expression:

$$g_i(\text{grams}) = 0.3 (\text{volume of system oil in Liters}).$$

- (b) Prepare a slurry containing  $g_i$  grams of contaminant of each of the following size ranges:

0-5 $\mu$ , 0-10 $\mu$ , 0-20 $\mu$ , 0-30 $\mu$ , 0-40 $\mu$ ,  
 0-50 $\mu$ , 0-60 $\mu$ , 0-70 $\mu$ , and 0-80 $\mu$

- (c) Operate the system at rated speed, pressure and temperature of 200°F. by-passing the filter system. Measure and record the initial flow rate. Inject the 0-5 $\mu$  slurry. Record the flow rate at 2-minute intervals. Continue operating until the flow rate remains constant for 10 minutes or for 30 minutes total, whichever occurs first.
- (d) Circulate through the filter system until contaminant background is less than 10 mg per liter.
- (e) Record the final flow rate with the pump operating at rated conditions specified in (c). If the flow rate has decreased to less than 60 percent of its original value ( $Q_r$ ), proceed directly to steps (g) and (h).
- (f) Repeat steps (c) through (e) using 0-10, 0-20, 0-30, 0-40, 0-50, 0-60, 0-70, and 0-80 micrometer contaminant in progressively increasing sizes.
- (g) Calculate the flow degradation ratio for each injection by dividing the final flow rate from (e) by the initial flow rate from (c).



- (h) Using the Computer Program, furnished by the procuring activity (see 6.5), calculate and present a 1000-hour Contaminant Tolerance Profile on the Particulate Contamination Chart Shown in figure 1.

4.5.2.2.7 Production test. Each pump shall be tested for proof pressure in accordance with 4.5.2.2.2. Each pump shall also be tested for rated flow at rated speed at an oil temperature not less than 80° F. and the flow reading shall be taken at 1000 psi, 1750 psi, and 2500 psi.

4.6 Inspection of preparation for delivery.

4.6.1 Quality conformance inspection of pack.

4.6.1.1 Inspection stages. Inspection shall be in two stages as follows:

- (a) The first stage shall include inspection of preservation, packaging and unit marking.
- (b) The second stage shall include inspection of materials and marking after closing and strapping of the container.

4.6.1.1.1 Units of product. For the purpose of inspection, a unit of product for the first stage of inspection shall be a complete pack with the box top not in place and the packages left unsealed. For the second stage of inspection a unit of product shall be a complete pack prepared for shipment.

4.6.1.2 Sampling. Sampling for examination shall be in accordance with MIL-STD-105.

4.6.1.3 Examination. Samples selected in accordance with 4.6.1.2 shall be examined for the following defects. AQL shall be 2.5 percent defective.

- 113. Materials, methods and containers not as specified for levels A, B, or C. Each incorrect material, method, or container shall constitute one defect.
- 114. Interior surfaces of the pumps not coated with preservative as specified for level A or B.
- 115. Pumps not wrapped with greaseproof paper for level A or B.
- 116. Greaseproof wrap not secured with tape as specified for level A or B.
- 117. Technical publications not preserved as specified for level A or B.
- 118. Cushioning not provided to prevent movement of pumps within the boxes as specified for level A or B.
- 119. Strapping not zinc coated for level A.
- 120. Fiberboard boxes not sealed and reinforced as specified for level B.

121. Marking illegible, incomplete, or incorrect.
122. Number of pumps to be packed together not as specified for level A or B.

## 5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A, B, or C as specified (see 6.2).

5.1.1 Level A. The interior surfaces of the pumps shall be coated with preservative lubricating oil conforming to MIL-H-6083. Each pump shall then be wrapped with greaseproof barrier-material conforming to MIL-B-121, type I, grade A, class 2. The wrap shall be secured with tape conforming to PPP-T-60, type III, class 1. The technical publications shall be preserved in accordance with MIL-P-116, method IC-1. Each pump with technical publications shall be packaged in a box conforming to PPP-B-636, W5c. Cushioning shall be provided to prevent movement within the box. After closure, the box shall be waterproof sealed, method V as specified in the appendix to the box specification.

5.1.2 Level B. Each pump and technical publications shall be preserved as specified in 5.1.1 for level A. The pump with technical publications shall be packaged in a box conforming to PPP-B-636, class domestic, variety SW, grade as applicable, style optional. Cushioning shall be provided to prevent movement within the box. The box shall be closed in accordance with the appendix to the box specification.

5.1.3 Level C. Each pump with technical publications shall be packaged in a fiberboard container that will afford protection against deterioration and damage. The supplier may use his commercial container providing it fulfills these requirements.

5.2 Packing. Packing shall be level A, B, or C as specified (see 6.2).

5.2.1 Level A. The pumps of like type, preserved and packaged as specified in 5.1, shall be packed in close-fitting boxes conforming to PPP-B-601, overseas type, grade B; or PPP-B-621, class 2, grade B; in quantities as specified (see 6.2), not to exceed the weight and dimensional limitations of the specification. The boxes shall be closed and strapped in accordance with the appendix to the box specification. Strapping shall be zinc coated.

5.2.2 Level B. The pumps of like type, preserved and packaged as specified in 5.1, shall be packed in close-fitting boxes conforming to

MIL-P-52675A(ME)

PPP-B-636, V3c, style RSC; boxes conforming to PPP-B-640, class 2, style optional; PPP-B-601, domestic type; or PPP-B-621, class 1; in quantities as specified (see 6.2), not to exceed the weight and dimensional limitations of the box specification. The box shall be waterproof sealed with tape and reinforced with bands of reinforced tape in accordance with the appendix to the applicable box specification.

5.2.3 Level C. The pumps of like type, preserved and packaged as specified in 5.1, shall be packed in fiberboard boxes complying with Uniform Freight Classification rules or with National Motor Freight Classification rules.

5.3 Marking. In addition to any special marking specified (see 6.2), packages and shipping containers shall be marked in accordance with MIL-STD-129.

## 6. NOTES

6.1 Intended use. The pumps covered by this specification are intended for production use, as spares, and as replacements in hydraulic systems on military stationary and mobile equipment.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type of pump required (see 1.2).
- (c) Flow and speed (see 3.5).
- (d) Direction of rotation (see 3.15).
- (e) Government part No. when specified by end item drawing (see 3.18).
- (f) Level of preservation and packaging and level of packing required (see 5.1 and 5.2). Level B preservation and packaging is intended to provide economical but limited protection and should be specified only when it has been determined the pumps will be held in covered storage for an indefinite period from date of initial preservation and packaging.
- (g) Number of pumps to be packed together (see 5.2.1 and 5.2.2).
- (h) Any special marking required (see 6.3).

### 6.3 Qualification.

6.3.1 When the pumps covered by this specification are procured as an end item by the Government, only bids or proposals offering pumps which are qualified under this specification (not necessarily listed on the QPL) at the time set for opening of the bids or award of a negotiated contract should be considered in making award.

6.3.2 When the pumps covered by this specification are components of an end item being procured by the Government, the requirements of ASPR 1-1107.2 ) shall apply.

6.3.3 It is intended that inclusion of pumps on the QPL may be accomplished by families or series. When a pump manufacturer produces a series of items that are identical in design and vary only in dimension, successful testing of the smallest and largest pump within the series will be considered as qualification of the entire series. Prior approval of the qualification of the series or families must be requested from the QPL authority. Approval will be based upon sufficient evidence submitted in the form of design drawings, literature or other documents, to indicate the design within the series are identical.

6.3.4 The attention of suppliers is called to the above conditions and manufacturers are urged to arrange to have the pumps that they propose to offer to the Government tested for qualification in order that they may be eligible to be awarded contracts or orders for pumps covered by this specification. The activity responsible for the Qualified Products List for this specification is: U. S. Army Mobility Equipment Research and Development Center, ATTN: STSFB-HM, Fort Belvoir, Virginia 22060.

6.4 Data requirements. The contracting officer should include requirements for such data as technical publications, instructional materials, illustrated parts list, and supplier's maintenance and operation manual to be furnished with each pump. Each pump should be accompanied by detailed instructions for changing direction of rotation, and when applicable include instructions for inlet and outlet port orientation.

6.5 The contracting officer should arrange to furnish the Computer Program for Contaminant Tolerance Profile required in 4.5.2.2.6 V(h).

Custodian:

Army - ME

User interest:

Army - AT

Preparing activity:

Army - ME

Project No. 4320-A103

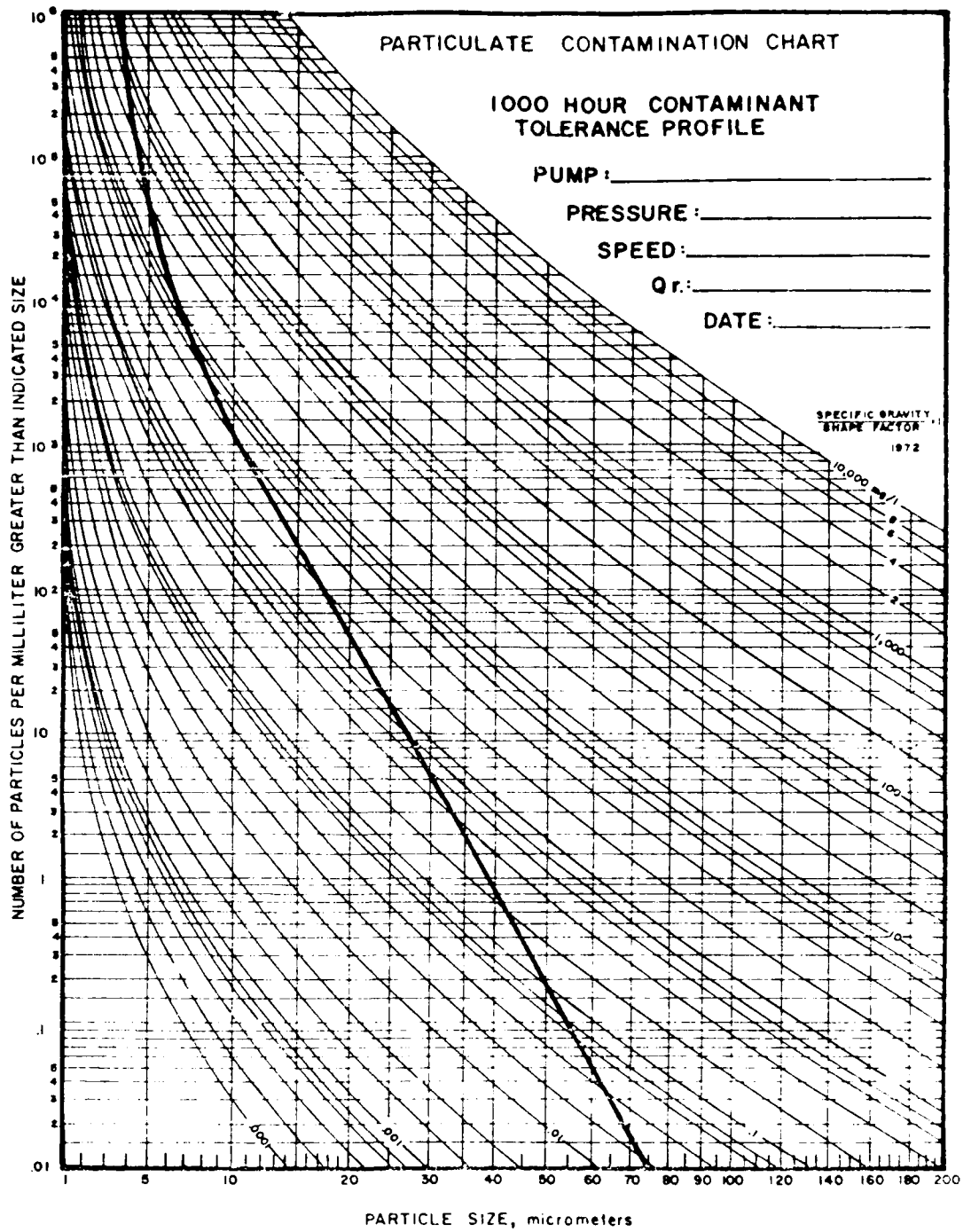
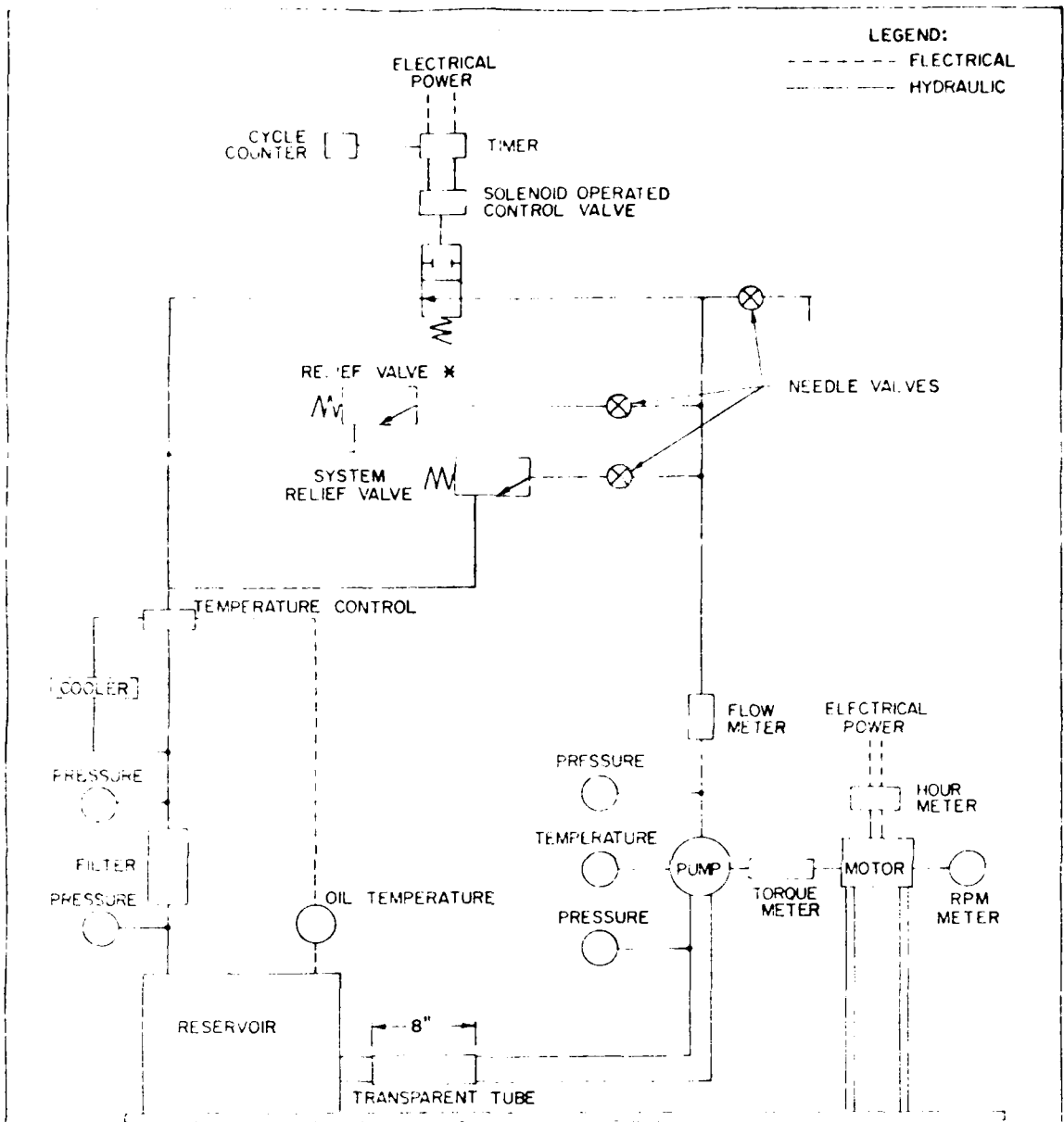


FIGURE I. CHART FOR CONTAMINANT TOLERANCE PROFILE.

X-2582



NOTES: RELIEF VALVE (\*) SETTING AT 150% OF MAX SYSTEM WORKING PRESSURE  
 ALL INSTRUMENTS SHALL HAVE AN ACCURACY OF  $\pm 2$  PERCENT.

Figure 2. TYPICAL TEST CIRCUIT DIAGRAM FOR PUMP, RESERVOIR, RELIEF VALVE AND FILTER TESTS.

[CX34]B

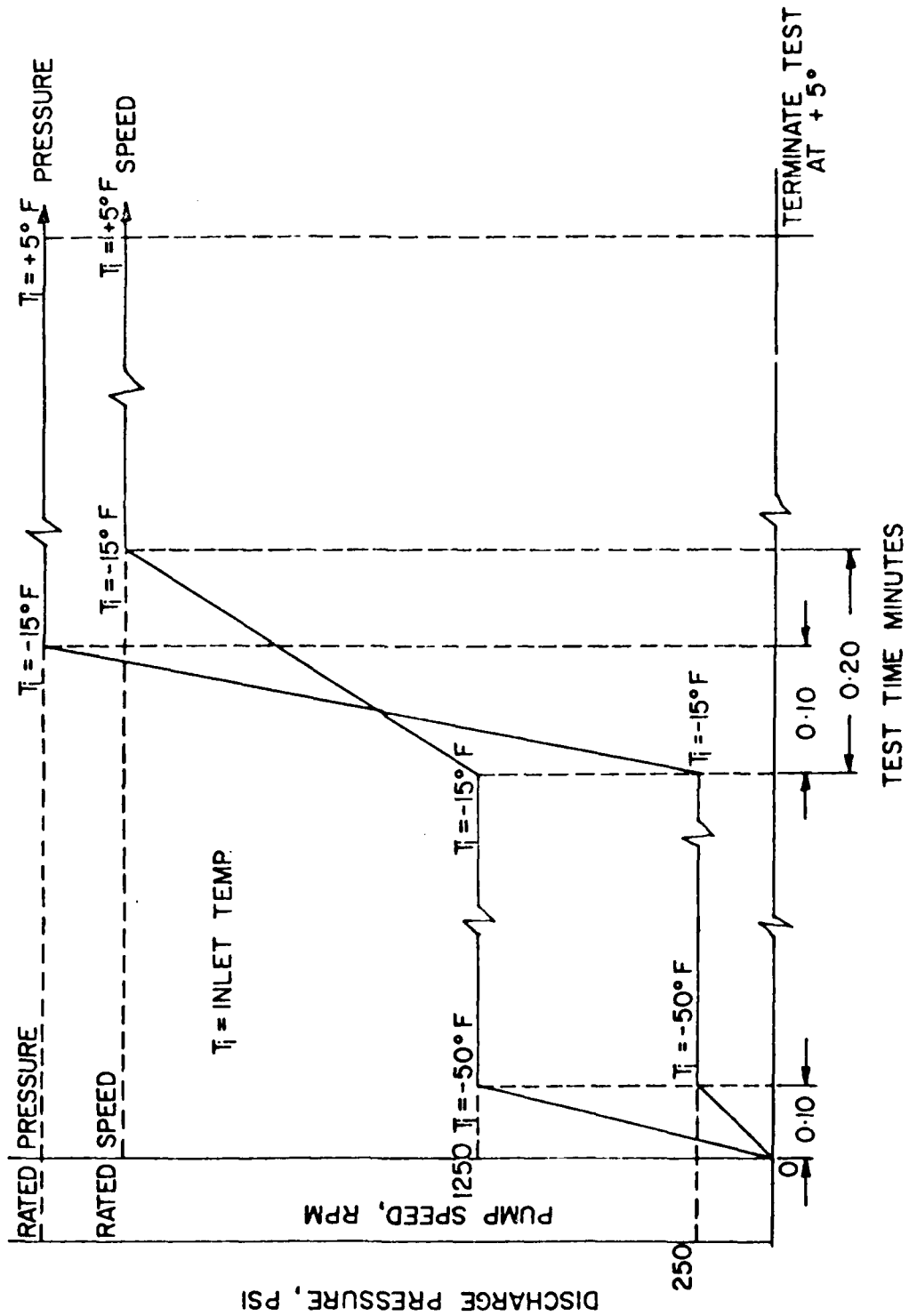


FIGURE 3. PUMP SPEED, PRESSURE AND TEMPERATURE SCHEDULE.

X-2236A

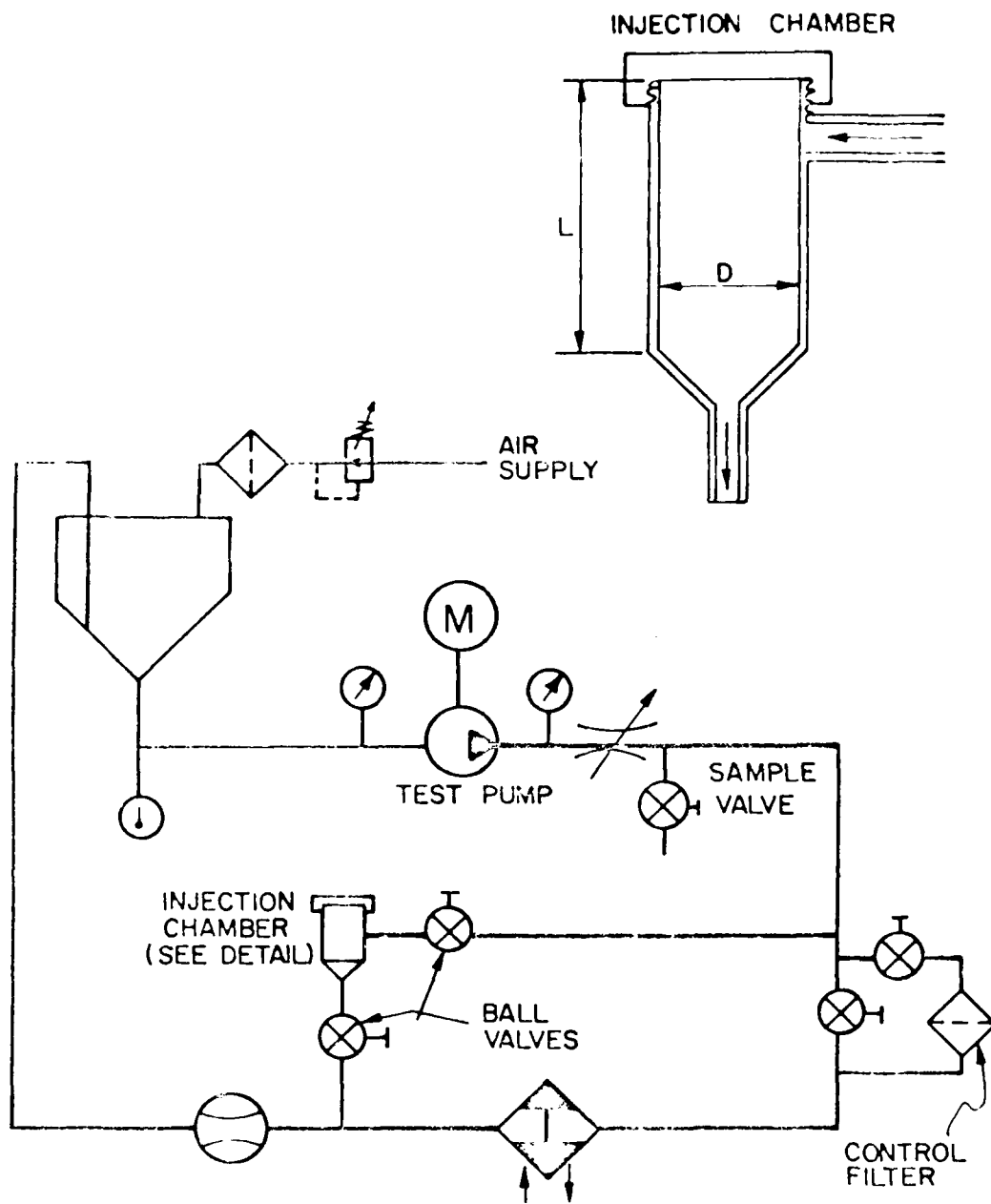


FIGURE 4. PUMP CONTAMINANT SENSITIVITY TEST CIRCUIT.

X-2533



MERADCOM TEST PROCEDURE

## METHOD FOR ESTABLISHING THE DURABILITY OF A FIXED DISPLACEMENT

## FLUID POWER PUMP, TESTED IN LOTS

- 1.0 SCOPE To provide a method for determining the durability of a fixed displacement, fluid power pump.
- 2.0 PURPOSE To verify the ability of a pump to perform satisfactorily during a specified period of time when subjected to cyclic discharge pressure at specified conditions of temperature, shaft speed, and system fluid.
- 3.0 DEFINITION
  - 3.1 Pump Durability The ability of a pump to endure specified operating conditions for an extended period of time.
- 4.0 PROCEDURE
  - 4.1 Install the pump in the test system as shown in Figure 1 and operate under the following conditions:
    - 4.1.1 Test Oil: All tests will be conducted using oil, lubricating, MIL-L-2104, grade 10 or fluids conforming to SAE J745.
    - 4.1.2 Filtration: The control filter will limit the total number of particles in the system fluid to no more than 1000 particles per milliliter greater than 10 microns and no less than 800 particles per milliliter greater than 10 microns.
    - 4.1.3 Instrumentation & Test Parameter Accuracy: Instrumentation and test parameter accuracy must be maintained within the limits set forth in ANSI B93.27.
    - 4.1.4 Inlet Pressure: The pump inlet oil pressure at the inlet fitting will be maintained within 1 in. Hg of atmospheric pressure.
    - 4.1.5 Aeration: The inlet oil must be visually free of entrained air throughout testing.
    - 4.1.6 Speed: Test speeds will be as close to pump manufacturers' rated values to the extent that standard gears are available from the gear box manufacturer.

EXHIBIT B

4.1.7 Pressure Range: From 0 to 115 percent of rated pressure.

4.1.8 Temperature: The inlet oil temperature for the durability test will be maintained at 180°F.

4.1.9 Endurance Cycle Conditions:  $60 \pm 6$  cycles/minute. The waveform is to be consistent with the impulse test waveform of SAE Standard J343. The outlet pressure waveform will conform to SAE J343 only to the extent the pump and other test system elements will allow conformity.

4.2.1 Measure and report the initial pump overall efficiency in accordance with NFPA/T3.9.17R1.

4.2.2 Volumetric efficiencies shall be measured and recorded at the beginning of each test and at one hour intervals thereafter.

4.3 Test Cycles: A total of 15 pumps shall be tested as follows:

Set Up #	# of pumps	test cycles
1	Three pumps of manufacturer #1	500,000 cycles per pump
2	Three pumps of manufacturer #2	500,000 cycles per pump
3	Three pumps of manufacturer #3	500,000 cycles per pump
4	One from each of the three manufacturers	500,000 cycles per pump
5	One from each of the three manufacturers	500,000 cycles per pump

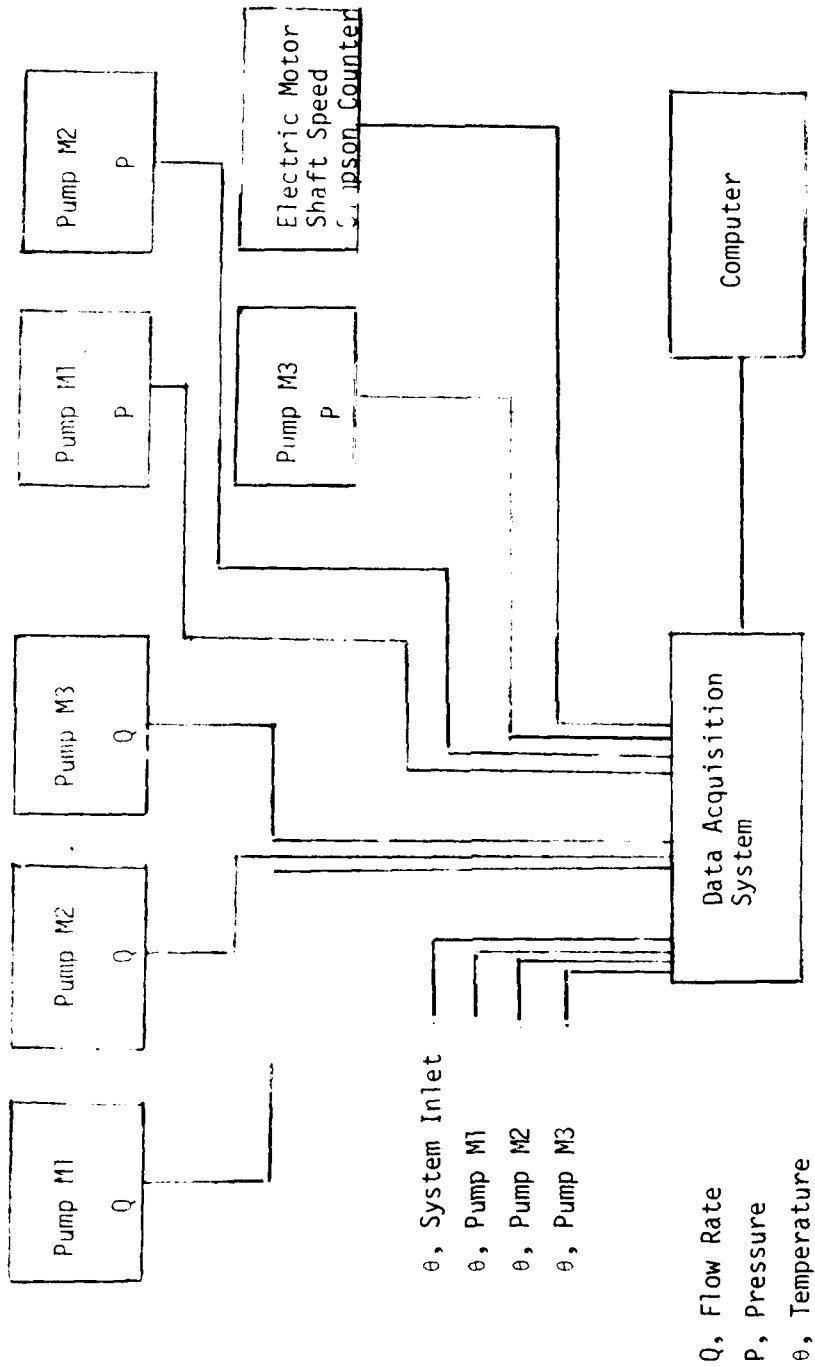
5. After completing the above tests, disassemble and examine the pump. Record any evidence of galling, scoring, pitting and structural damage.
6. Prepare test report with 8 x 10 B/W photos of each tested pump. Each report shall have an analysis of the test results of each tested pump.

APPENDIX L  
INSTRUMENTATION  
ENDURANCE AND DURABILITY TESTS

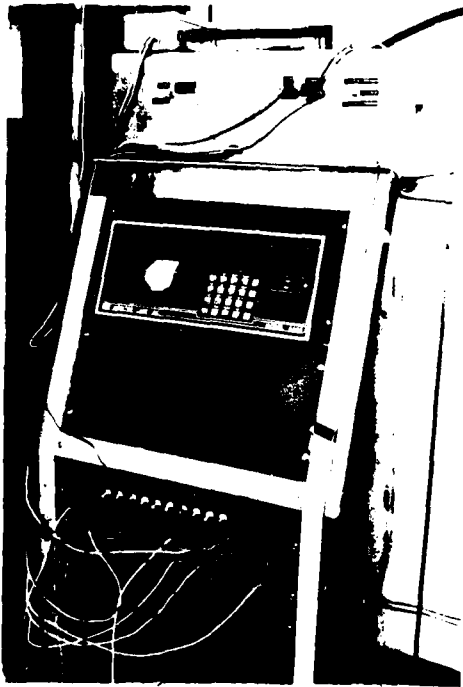
## INSTRUMENTATION

The instrumentation, calibration methods and procedures used in this contract, can be referenced to Part 2, of report number 50560, contract DAAK70-77-C-0214, dated November 12, 1979. The traceability statement for measurement of flow, pressure, and temperature are also found in Part 2 of the above mentioned report.

BLOCK DIAGRAM OF MEASUREMENT SYSTEM

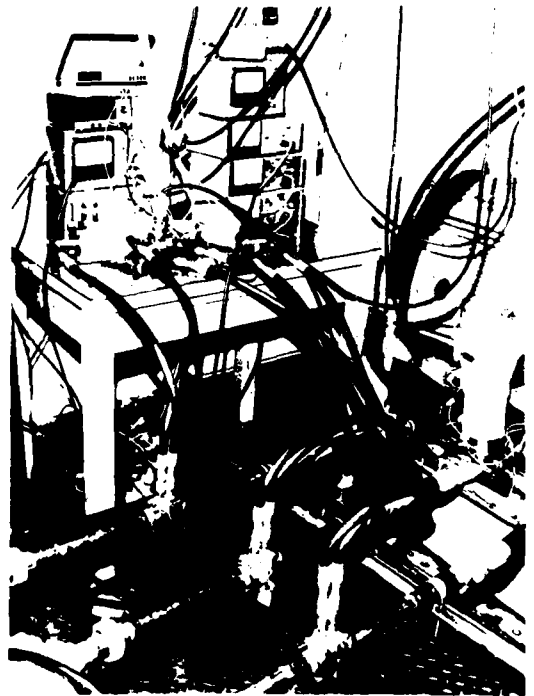


DURABILITY AND ENDURANCE TEST SETUP PICTURES



Data Acquisition System used to monitor and record test parameters. The timers used to trigger the DAS and cycle the outlet pressure are located on top of the DAS. The DAS was also used as a failsafe to shut down the test if parameters were not within specified values.

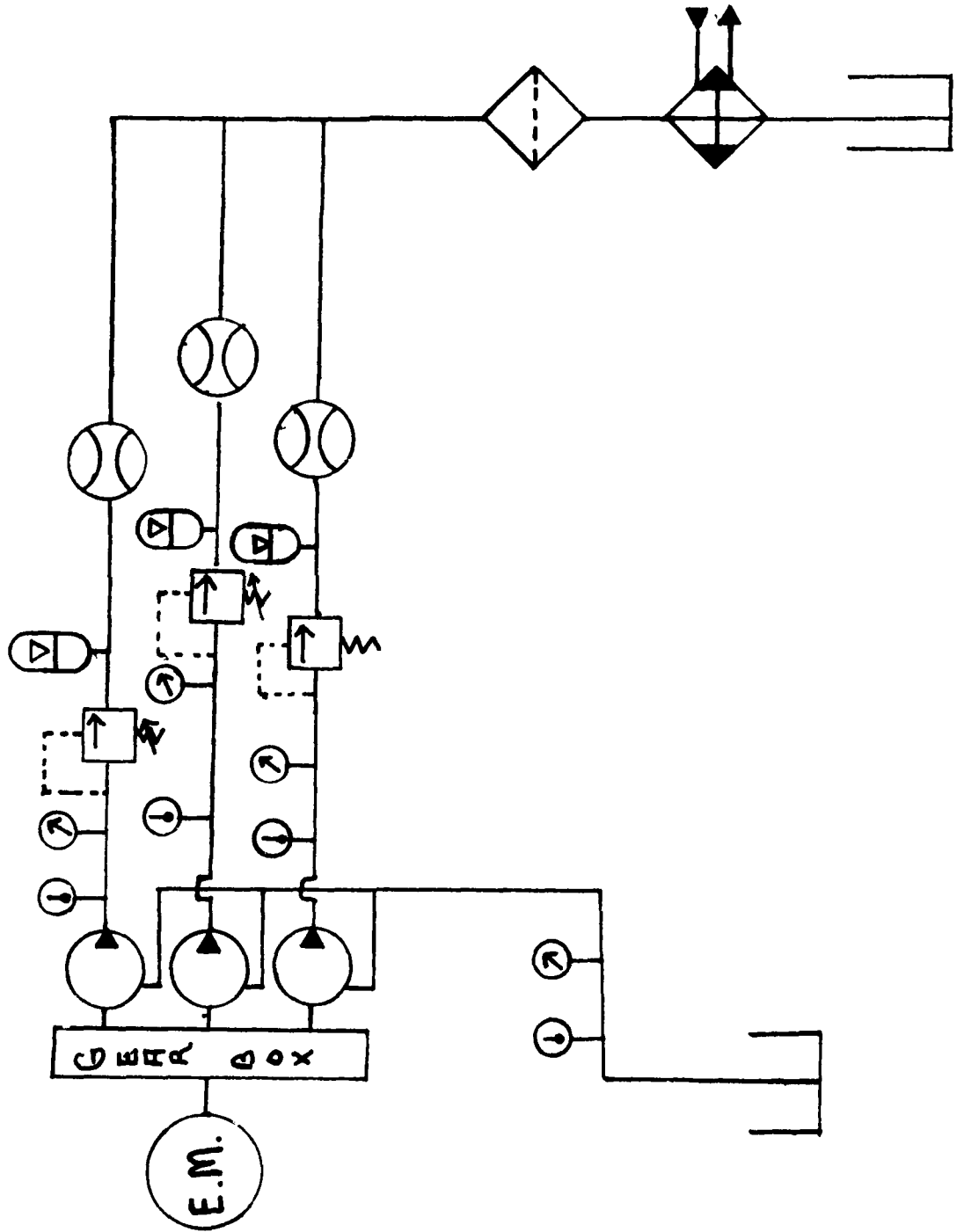
Amplifiers and readouts used for the pressure transducers and flowmeters. In the foreground are the orifice plate flowmeters which were connected via hoses to the transducers sitting on the table.



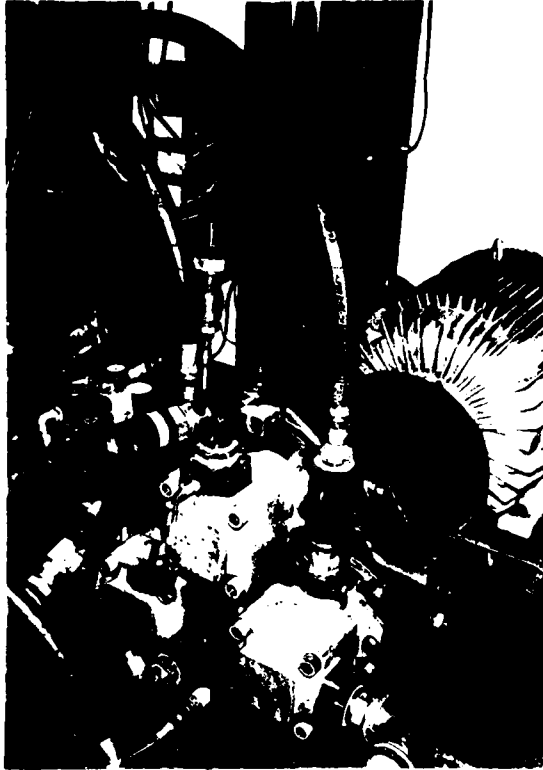
APPENDIX M  
CIRCUIT SCHEMATICS  
ENDURANCE AND DURABILITY TESTS



HYDRAULIC CIRCUIT SCHEMATIC FOR ENDURANCE AND DURABILITY TESTS

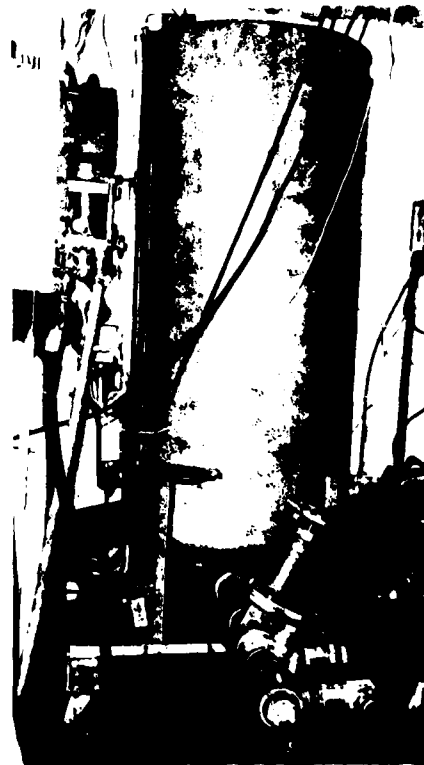


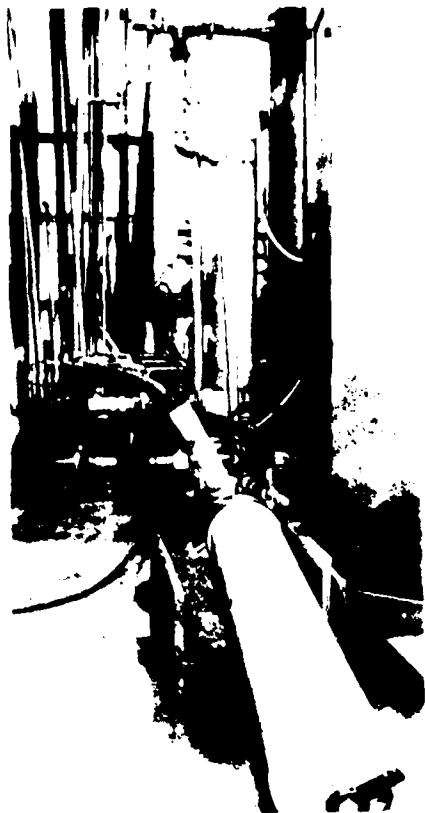
APPENDIX N  
TEST SETUP PHOTOGRAPHS  
ENDURANCE AND DURABILITY TESTS



Test pumps mounted on gearbox connected to a 200 HP electric motor with inlet and pressure lines plumbing. The inlet pressure transducer is mounted in the inlet flange on the center pump which was higher than the other two. This pump location had the lowest inlet pressure because of its height.

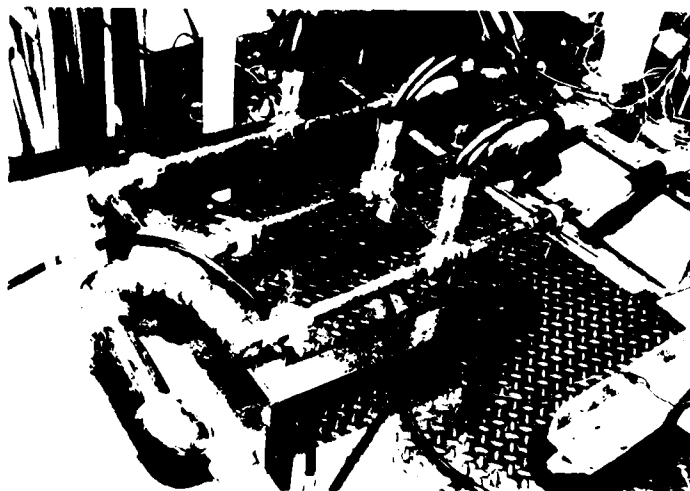
Reservoir and inlet plumbing for the three pumps. The inlet temperature probe is located in the tee at the bottom of the picture.





In the foreground is the filter used to maintain the contamination level in the circuit. The heat exchanger is mounted vertically on the left side of the reservoir.

Orifice plate flowmeters in the return lines. Sample tap is located in the elbow after the return lines were connected together. Relief valves are on the right side of the orifice plates. Pressure transducers were installed in the relief valve gage port. The outlet temperature probes were installed in a tee in the pressure line just ahead of the relief valves.



APPENDIX 0  
PRESSURE WAVESHAPES PHOTOGRAPHS

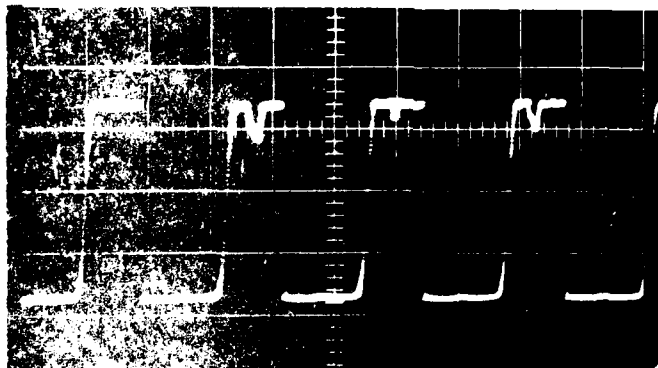
PHASES OF OUTLET PRESSURE

shot per test

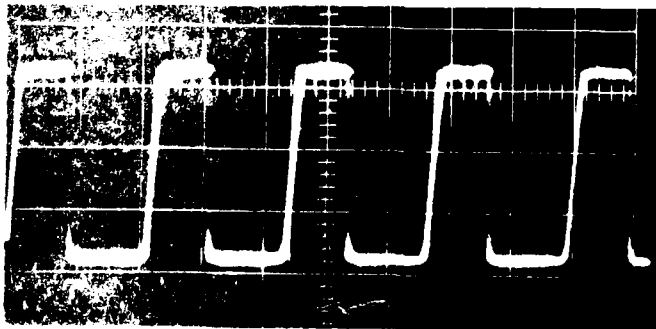
1,000 psi  
20 seconds per cm



Manufacturer Code M1  
Pump No. 348



Manufacturer Code M1  
Pump No. 349

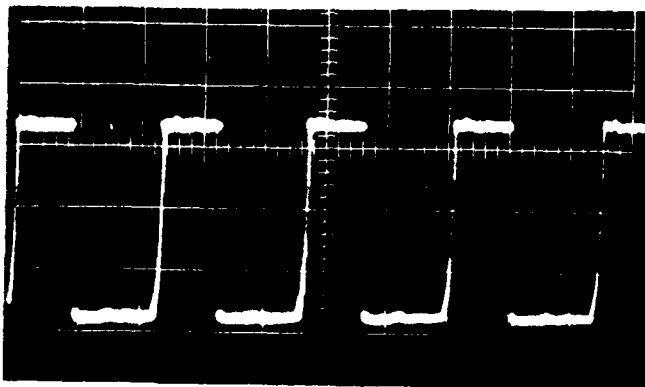


Manufacturer Code M1  
Pump No. 351

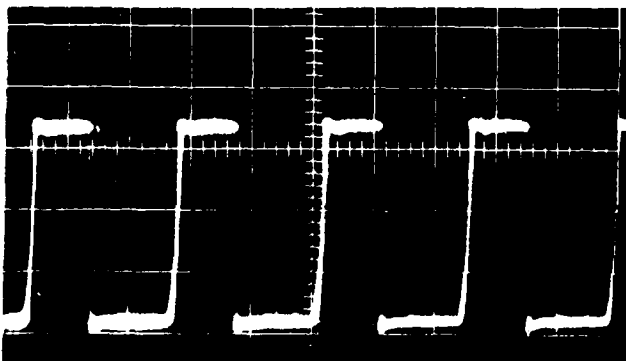
OSCILLOSCOPE TRACES OF OUTLET PRESSURE

Accelerated Life Test

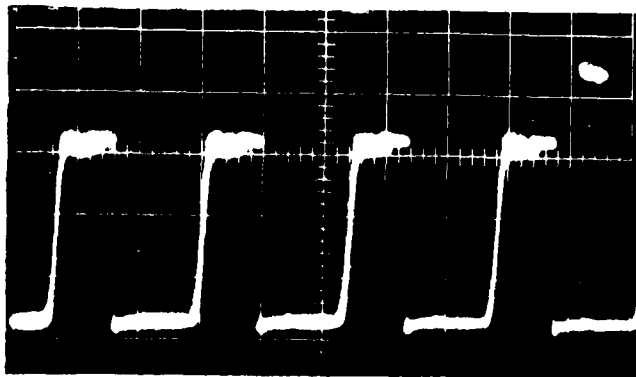
Vertical Axis 1 cm = 1,000 psi  
Horizontal Axis .5 seconds per cm



Manufacturer Code: 11  
Pump No. 355



Manufacturer Code: 11  
Pump No. 358



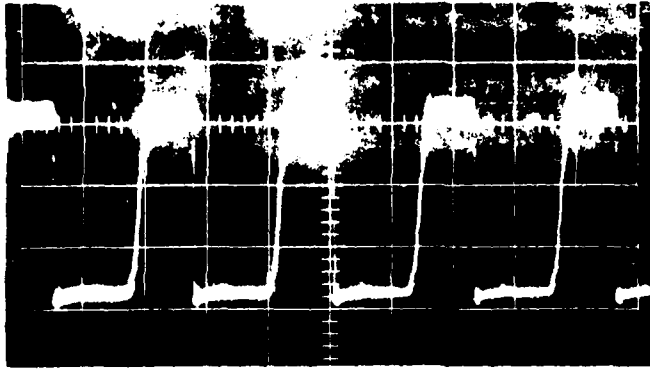
Manufacturer Code: 11  
Pump No. 361

OSCILLOSCOPE TRACES OF OUTLET PRESSURE

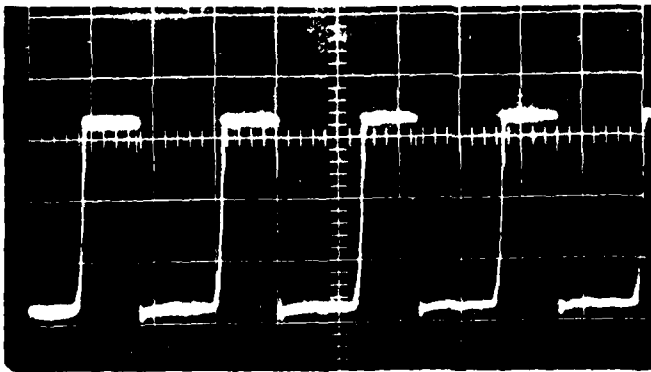
Accelerated Life Test

Vertical Axis 1cm = 1,000 psi

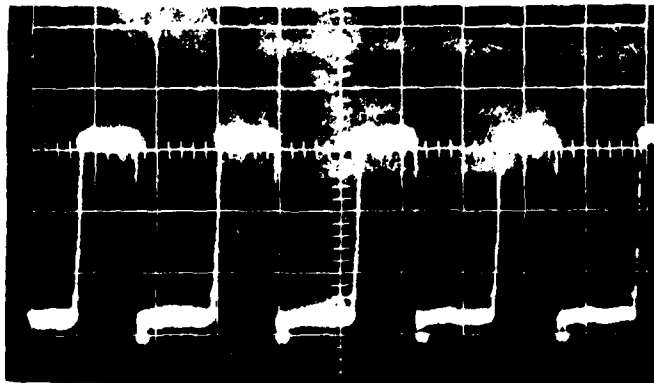
Horizontal Axis .5 seconds per cm



Manufacturer Code M1  
Pump No. 353



Manufacturer Code M1  
Pump No. 354



Manufacturer Code M2  
Pump No. 356



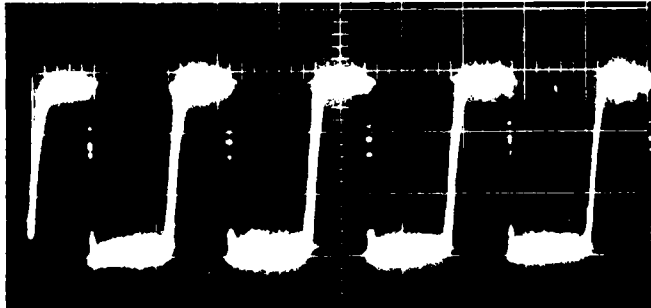
OSCILLOSCOPE TRACES OF OUTLET PRESSURE

Accelerated Life Test

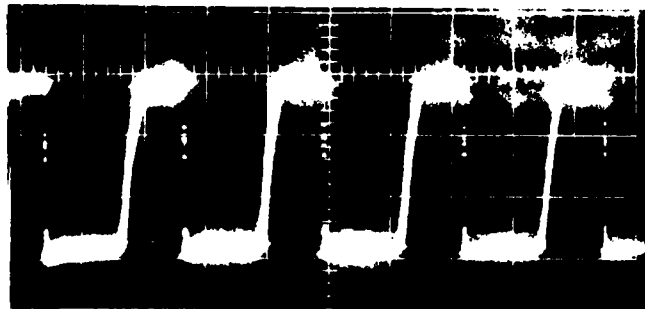
Vertical Axis 1cm - 1,000 psi  
Horizontal Axis .5 seconds per cm



Manufacturer Code M3  
Pump No. 364



Manufacturer Code M3  
Pump No. 366

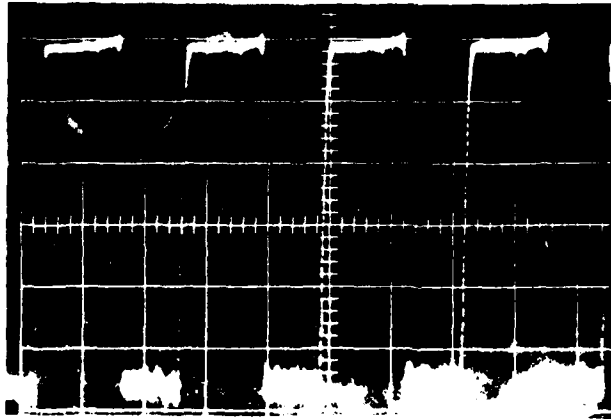


Manufacturer Code M3  
Pump No. 367

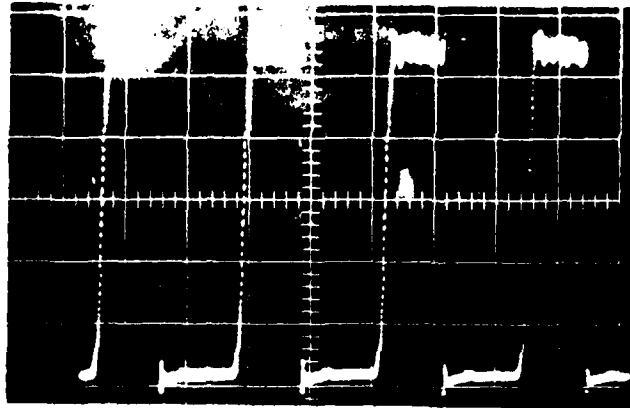
OSCILLOSCOPE TRACES OF OUTLET PRESSURE

Flow Rate: 1.0 liter per hour

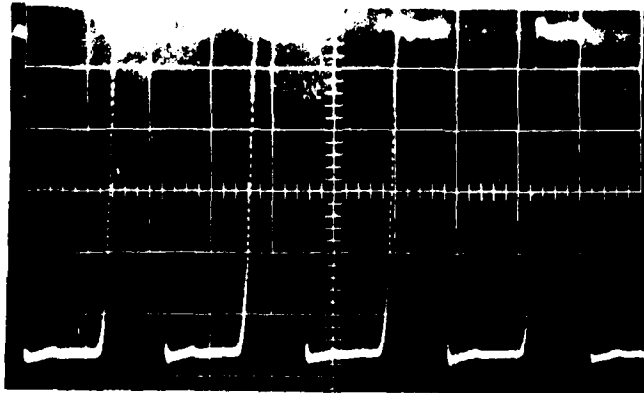
vertical Axis: 2.0 psi  
horizontal Axis: 20 seconds per cm



Manufacturer Code M1  
Pump #352



Manufacturer Code M2  
Pump #357



Manufacturer Code M2  
Pump #350

APPENDIX P  
PUMP FAILURE ANALYSIS

DURABILITY TEST

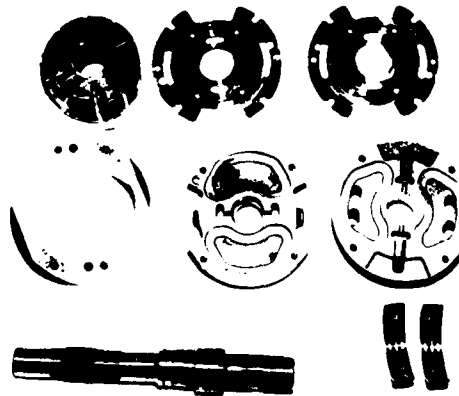
ANALYSIS OF MANUFACTURE M1'S PUMP #348

Manufacture M1's pump #348 completed the Accelerated Life Test without any failures. The pumping cartridge experienced excessive wear on the bronze side plates which would account for the 2.3% drop in flow rate. Some wear occurred in the cam ring and vane section of the pumping cartridge. Contamination generated from wear probably contributed to the pitting of the shaft end ball bearing and the bronze sleeve bearing.

*Inspected and found OK  
2000 hours, Pump No. #348*

*Completed Test*

*100 Hours*



DURABILITY TEST  
ANALYSIS OF MANUFACTURE M1'S PUMP #349

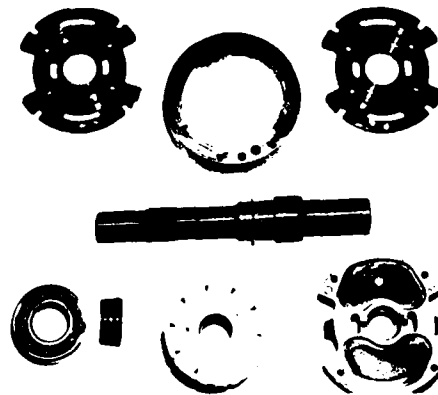
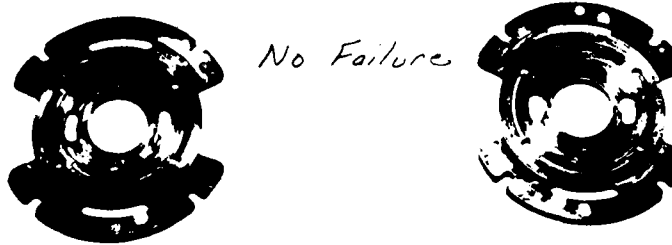
Manufacture M1's pump #349 completed the Accelerated Life Test without any catastrophic failures. The pumping cartridge experienced extensive wear on the side plates with some pitting; this would account for the 6.9% drop in flow rate. Some wear occurred in the cam ring and vane section of the pumping cartridge. Contamination generated from wear probably contributed to the pitting of the shaft end ball bearing and the bronze sleeve bearing.

*Accelerated Life Test (p.4)*

*Test Specimen: Pump # 349*

*Completed Test*

*No Failure*



DURABILITY TEST  
ANALYSIS OF MANUFACTURE M1'S PUMP #351

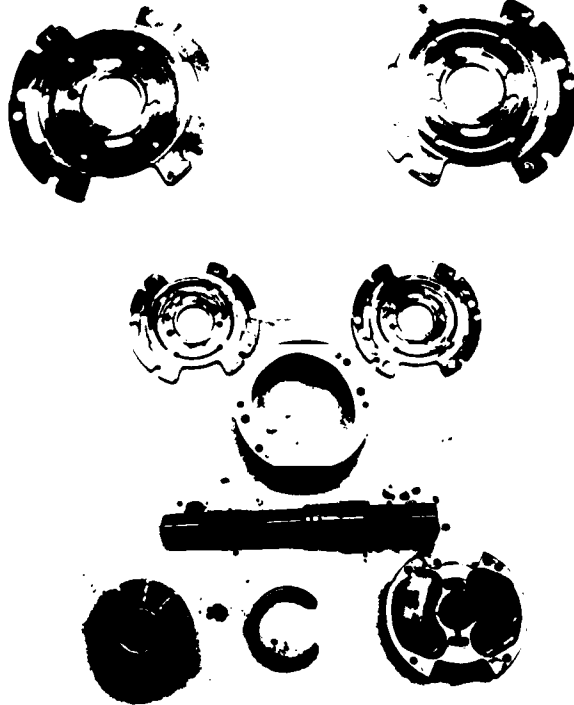
Manufacture M1's pump #351 failed to complete the Accelerated Life Test. Failure occurred at 217,000 cycles, at which time the flow decreased 24.5% from the original value. Severe wear and scoring of the pumping cartridge side plates caused flow degradation and eventual catastrophic failure of the side plates. Contamination generated from wear probably contributed to the pitting of the shaft end ball bearing and the bronze sleeve bearing. Wear also occurred in the cam ring and vane section which experienced some overheating.

*Accelerated Life Test (ML)*

*Test number Pump M1 # 351*

*Completed 217,000 cycles at test cycles*

*Pump failure due to Side Plate Fatigue*



ENDURANCE TEST

ANALYSIS OF MANUFACTURE M1'S PUMP #352

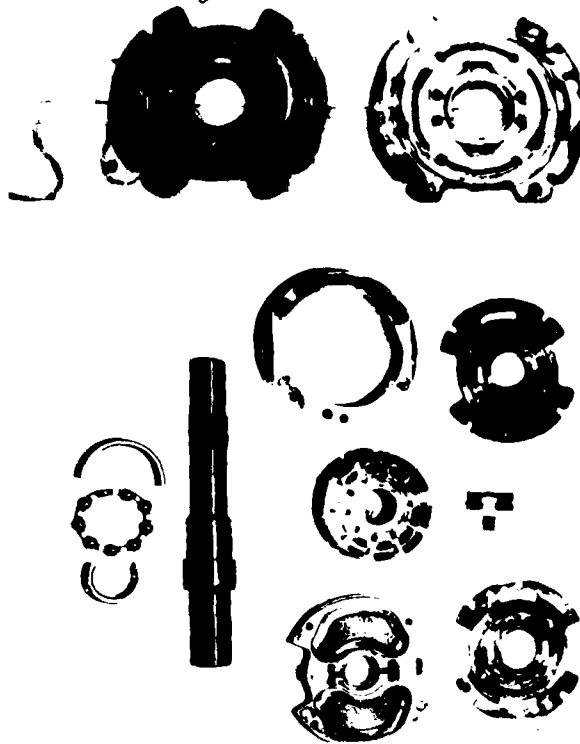
Manufacture M1's Pump #352 failed to complete the Endurance Test. Failure occurred at 283 hours into the test, at which time the flow decreased 26.7% from the original value. Severe wear and scoring of the pumping cartridge side plates caused flow degradation and eventually catastrophic failure. Contamination generated from wear probably contributed to excessive wear and pitting of both the shaft end ball bearing and the bronze sleeve bearing. Fatigue of the cam ring; along with excessive wear of the vanes were seen in the pumping cartridge.

*Endurance Test (1000 hour)*

*Test Specimen; Pump - M1 # 352*

*Pump completed 283 out of the 1000 hours*

*Pump Failure Due To Excessive wear  
and Fatigue of the Pumping  
Cartridge*

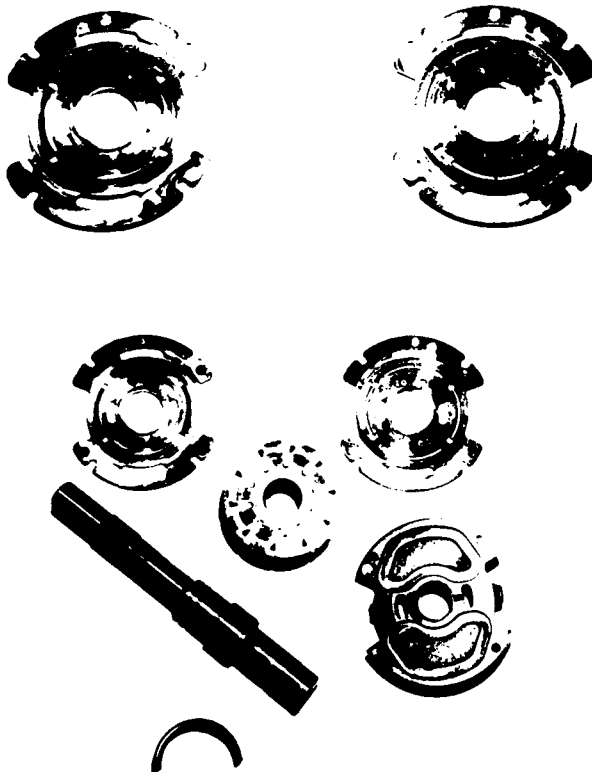


DURABILITY TEST  
ANALYSIS OF MANUFACTURE M1'S PUMP #353

Manufacture M1's pump #353 completed the Accelerated Life Test without any catastrophic failures. A 6.5% decrease in flowrate from the original value, was due mainly to the excessive wear and scoring of the pumping cartridge side plates. Contamination generated internally contributed to the wear of the bronze sleeve bearing and shaft end ball bearing. Some wear occurred within the cam ring and vane section which probably contributed along with the side plates, to the decrease in flowrate.

*Accelerated Life Test (P.4)  
Test Specimen, Pump - M1 #353*

*Completed Test  
No Failure*





DURABILITY TEST  
ANALYSIS OF MANUFACTURE MI'S PUMP #354

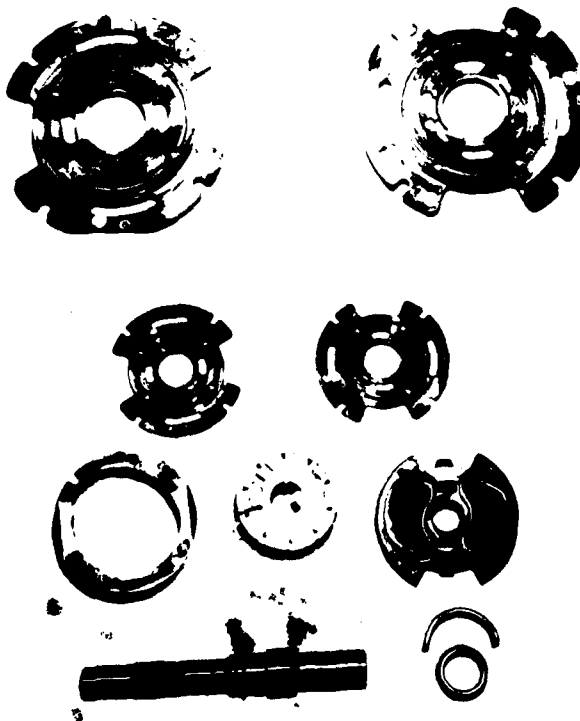
Manufacture MI's pump #354 completed the Accelerated Life Test without any failures. The pumping cartridge side plates experienced some wear, along with the vane and cam ring. Contamination generated internally likely contributed to the wear seen by the shaft end ball bearing and bronze sleeve bearing. A 2.74% increase in flowrate from the original value, may be accounted for by the cartridge's components wearing themselves in.

*Accelerated Life Test (P.4)*

*Test Specimen: Pump - MI #354*

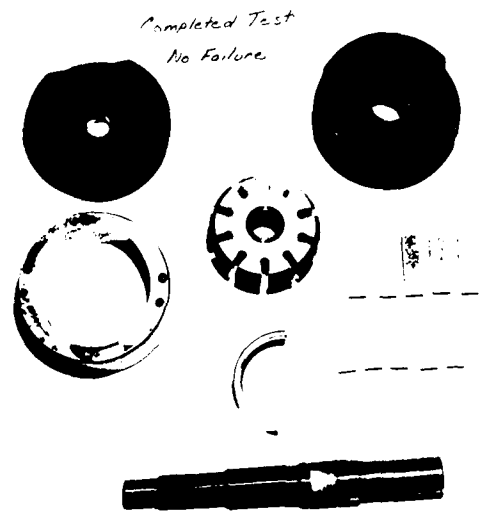
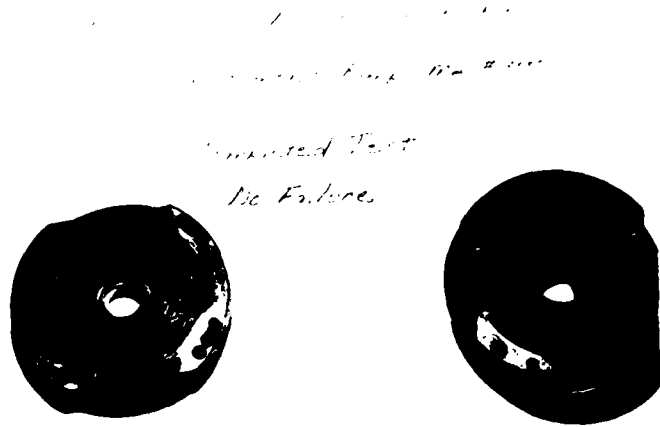
*Completed Test*

*No Failure*



DURABILITY TEST  
ANALYSIS OF MANUFACTURE M2'S PUMP #355

Manufacture M2's pump #355 completed the Accelerated Life Test without any failures. The side plates of the pumping cartridge experienced some wear; along with the vanes and cam ring. Contamination generated from wear probably contributed to the excessive wear of the shaft end ball bearing and the bronze sleeve bearing. The pump underwent a 5% increase in flowrate from the original value, which probably was due to the pumping cartridge's components lapping themselves in.



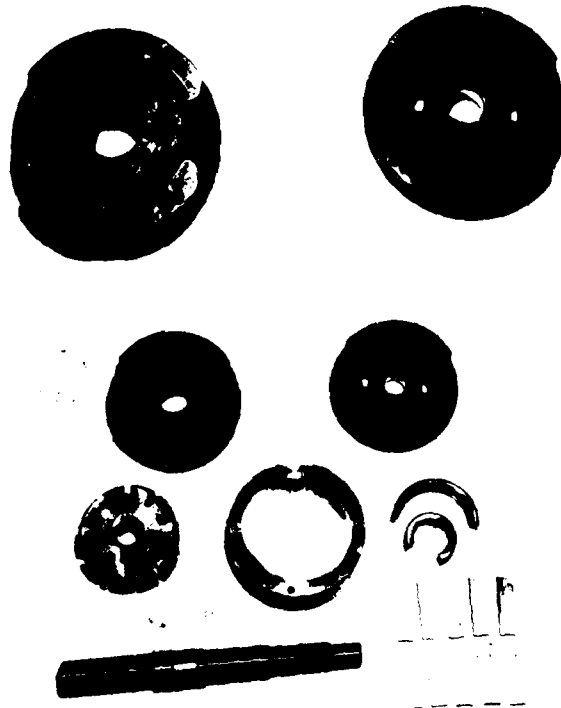
DURABILITY TEST

ANALYSIS OF MANUFACTURE M2'S PUMP #356

Manufacture M2's pump #356 completed the Accelerated Life Test without any failures. The pumping cartridge side plates underwent some wear, along with the vanes and cam ring. A 5.1% increase in flowrate from the original value was experienced, which probably could be accounted for by the pumping cartridge's components lapping themselves in. Contamination generated internally may have contributed to the wear seen by the shaft end ball bearing and the bronze sleeve bearing.

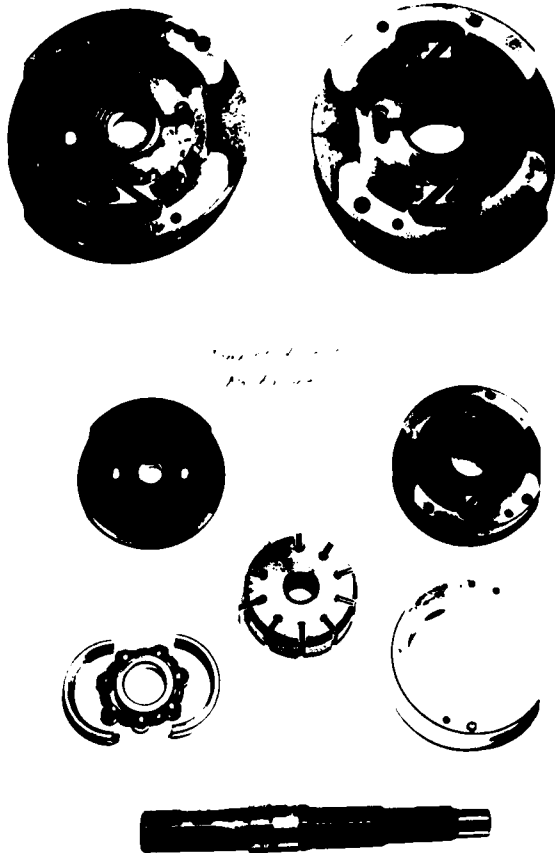
*Manufacture M2's Pump #356*  
*Completed Test*

*Completed Test*  
*No Failure*



ENDURANCE TEST  
ANALYSIS OF MANUFACTURE M2'S PUMP #357

Manufacture M2's pump #357 completed the Endurance Test without any catastrophic failures. The pumping cartridge side plates experienced some wear; along with the cam ring and vane section. Excessive wear occurred on the shaft end ball bearing and the bronze sleeve bearing which maybe contributed to the fact that they had exceeded their normal running life. The pump underwent an increase in flowrate of 21% of the original value, in the opinion of the writer this excessive increase was partially due to instrumentation error, but mainly to the pumping cartridge's components lapping themselves in.

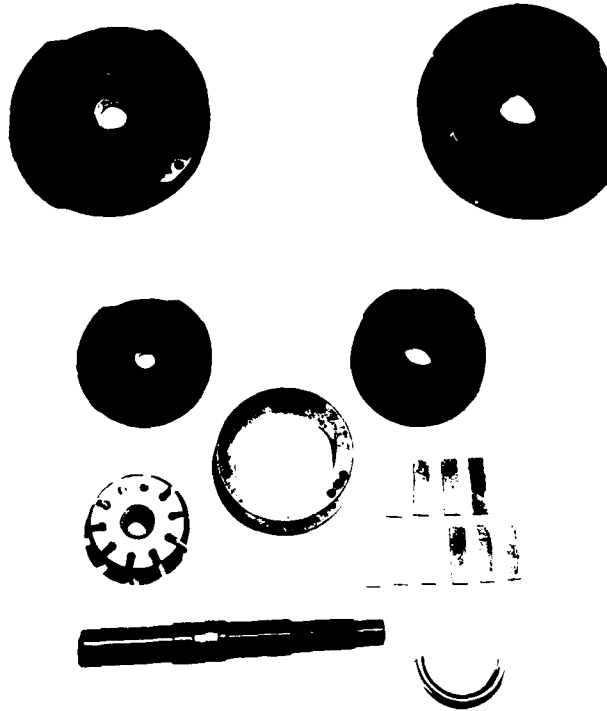


DURABILITY TEST  
ANALYSIS OF MANUFACTURE M2'S PUMP #358

Manufacture M2's pump #358 completed the Accelerated Life Test without any failures. The pumping cartridge side plates experienced some wear, along with the vanes and cam ring. The pump underwent a 7.5% increase in flowrate from the original value, which probably could be contributed to the pumping cartridge's components lapping themselves in. Contamination generated internally probably accounted for the wear seen by the shaft end ball bearing and the bronze sleeve bearing.

*Accelerated Life Test #41  
Test Specimen, Pump M2 # 358*

*Completed Test  
No Failure*

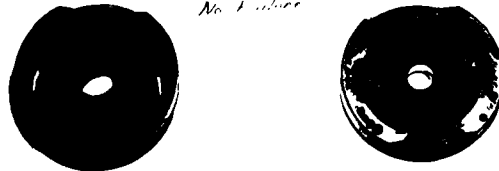


ENDURANCE TEST  
ANALYSIS OF MANUFACTURE M2'S PUMP #360

Manufacture M2's pump #360 completed the Endurance Test without any catastrophic failures. The pumping cartridge side plates experienced some wear; along with the cam ring and vane section. Excessive wear ran on the shaft end ball bearing and the bronze sleeve bearing maybe contributed to the fact that they had exceeded their normal running life. The pump underwnet an increase in flowrate of 12.6% of the original value; therefore the extended running of the pump probably contributed to the pumping cartridge's components lapping themselves in.



*Sample test results  
No failures*

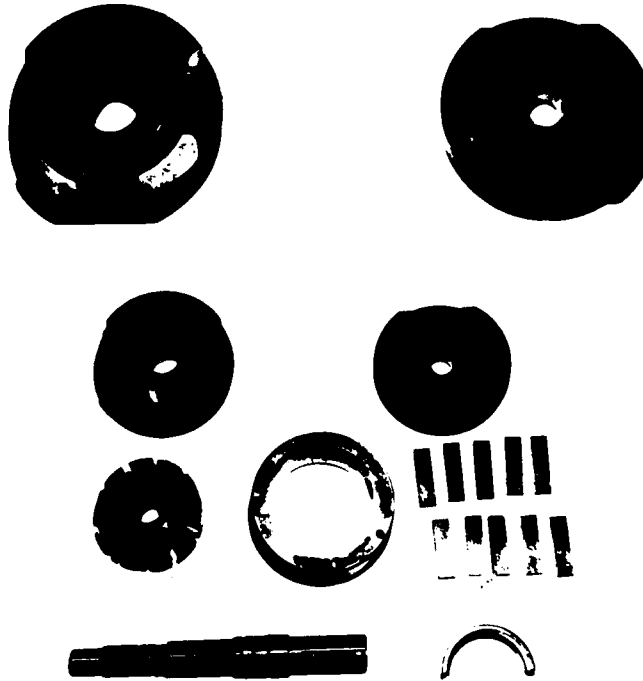


DURABILITY TEST  
ANALYSIS OF MANUFACTURE M2'S PUMP #361

Manufacture M2's pump #361 completed the Accelerated Life Test without any failures. The pumping cartridge side plates experienced some wear, along with the vanes and cam ring. Excessive wear of the shaft end ball bearing and the bronze sleeve bearing, was probably contributed by the internal contamination of the pump. An increase in flowrate of 9.5% of the original value may be contributed to the pumping cartridge's components lapping themselves in.

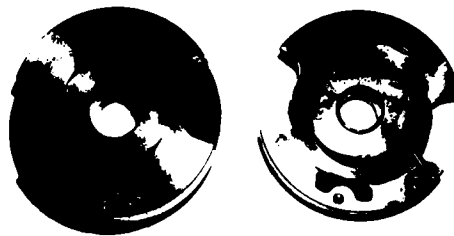
*Completed Life Test (9.5%)  
Test specimen Pump m2 #361*

*Completed Test  
No Failure*



DURABILITY TEST  
ANALYSIS OF MANUFACTURE M3'S PUMP #364

Manufacture M3's pump #364 completed the Accelerated Life Test without any failures. The pumping cartridge experienced minor wear throughout; both the shaft end ball bearing and the front sleeve bearing also underwent minor wear. The pump experienced a 3.4% increase in flowrate which was probably due to the cartridge's components lapping themselves in.





DURABILITY TEST  
ANALYSIS OF MANUFACTURE M3'A PUMP #366

Manufacture M3's pump #366 completed the Accelerated Life Test without any failures. The pumping cartridge side plates experienced minor wear which probably accounted for the 2% drop in flowrate. The cam ring and vane section of the pumping cartridge, along with the bearings in the pump experienced some wear.

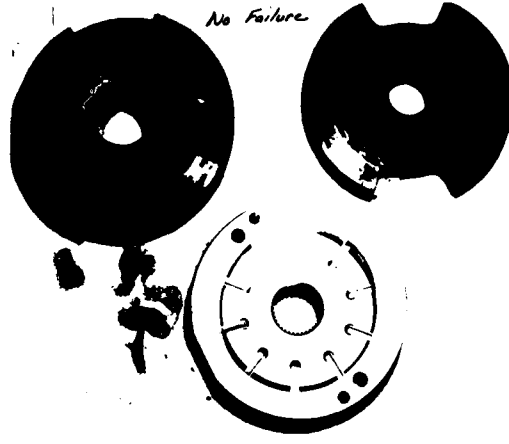
*Manufacture M3's Pump #366*

*Completed Test*

*No Failures*

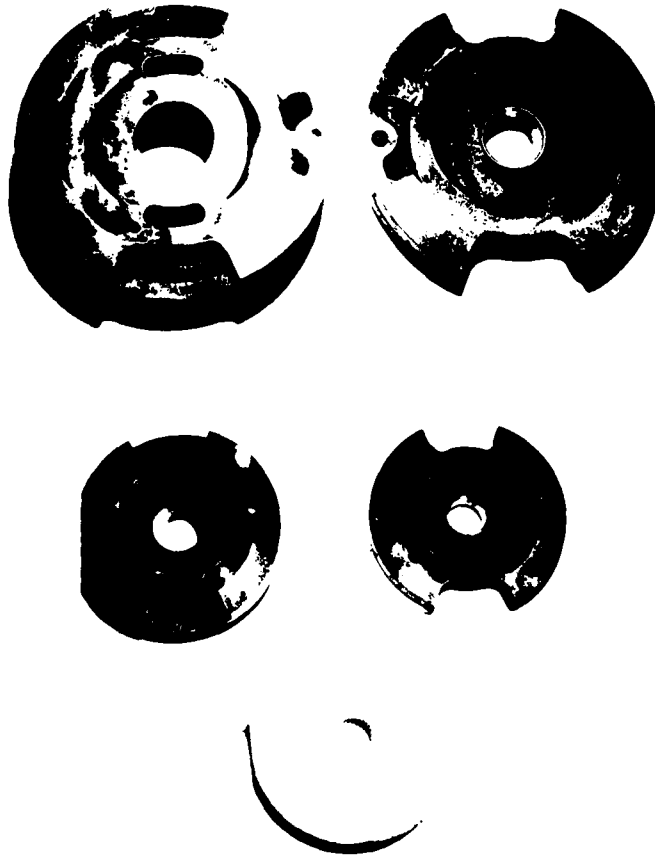


*No Failure*



DURABILITY TEST  
ANALYSIS OF MANUFACTURE M3'S PUMP #367

Manufacture M3's Pump #367 completed the Accelerated Life Test without any failures. Minor wear occurred on the pumping cartridge side plates which probably contributed to the 1.2% drop in flowrate. The cam ring and vane section of the cartridge; along with the bearings of the pump experienced some wear.



APPENDIX Q  
ENDURANCE AND DURABILITY TEST DATA

TABULATED DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M1

Test Specimens Consisted Of:

Pump #348, #349, and #351

- \* Data points were taken when outlet temperature thermocouple was malfunctioning; remaining data points were correct.
- \*\* Data points are automatically taken when the test is restarted after the DAS alarm system has shut it down.
- \*\*\* Pump was considered a failure due to excessive drop in flow; and removed from testing apparatus. (See Tabulated Durability Test Results)

AD-A117 962

MILWAUKEE SCHOOL OF ENGINEERING WI FLUID POWER INST F/G 13/11  
BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
JUL 82 DAAK70-81-C-0002

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PUMP #348

TIME HOURS	IN FT TEMP(°F)	OUT FT TEMP(°F)	IN PRES (PSI)	OUT PRES (PSI)	FLOW (GPM)	SPED (RPM)
1.00	169.70	186.50	1.31	3406.00	21.77	2750.00
2.00	177.10	189.00	1.36	3415.00	22.97	2750.00
3.00	169.00	186.60	1.35	3394.00	21.38	2750.00
4.00	173.50	188.00	1.37	3399.00	22.21	2750.00
5.00	171.00	188.10	1.29	3392.00	23.60	2750.00
6.00	172.50	187.00	1.35	3399.00	21.62	2750.00
7.00	169.40	185.60	1.29	3401.00	22.62	2750.00
8.00	169.70	186.20	1.26	3399.00	21.69	2750.00
9.00	170.10	186.70	1.25	3394.00	21.75	2750.00
10.00	171.60	188.30	1.24	3396.00	21.59	2750.00
11.00	173.00	188.50	1.28	3391.00	21.42	2750.00
*12.00	150.40	-1062.00	0.91	3425.00	23.24	2750.00
*13.00	172.30	-914.60	1.20	3404.00	22.26	2750.00
*14.00	171.00	395.20	1.13	3391.00	22.33	2750.00
*15.00	169.40	-1036.20	1.06	3395.00	22.65	2750.00
*16.00	168.40	-82.60	1.18	3393.00	22.47	2750.00
17.00	167.40	183.40	1.02	3394.00	22.62	2750.00
18.00	169.50	185.50	1.14	3403.00	24.66	2750.00
19.00	168.10	184.20	1.12	3413.00	25.05	2750.00
20.00	169.10	185.30	1.12	3405.00	26.16	2750.00
*21.00	170.50	-621.60	1.12	3391.00	26.62	2750.00
22.00	171.60	182.30	1.04	3414.00	21.74	2750.00
23.00	166.50	182.50	1.08	3393.00	22.73	2750.00
24.00	166.20	181.70	1.06	3392.00	22.47	2750.00
25.00	169.90	186.10	1.03	3392.00	22.21	2750.00
26.00	166.50	182.00	0.99	3393.00	22.38	2750.00
27.00	169.40	185.50	1.00	3379.00	22.68	2750.00
28.00	165.20	181.30	0.93	3395.00	22.65	2750.00
29.00	169.20	185.60	1.01	3396.00	22.97	2750.00
30.00	166.40	182.00	0.97	3391.00	26.00	2750.00
31.00	170.00	185.00	0.97	3403.00	26.77	2750.00
32.00	166.60	151.00	0.92	3405.00	22.86	2750.00
*33.00	106.20	83.00	-0.22	3481.00	23.96	2750.00
*34.00	166.20	96.00	1.31	3390.00	26.84	2750.00
35.00	168.00	107.00	1.24	3394.00	24.04	2750.00
36.00	166.20	121.00	1.19	3392.00	22.12	2750.00
*37.00	168.20	89.40	1.25	3393.00	26.98	2750.00
*38.00	166.20	110.20	1.23	3398.00	24.18	2750.00
*39.00	167.60	82.20	1.17	3393.00	23.05	2750.00
*40.00	164.20	110.20	1.12	3394.00	23.60	2750.00
*41.00	169.30	96.50	1.19	3395.00	24.81	2750.00
42.00	169.50	185.00	1.19	3396.00	24.10	2750.00
43.00	169.50	185.00	1.20	3403.00	26.96	2750.00
44.00	170.30	185.00	1.15	3404.00	22.09	2750.00
45.00	172.90	189.10	0.23	3374.00	21.32	2750.00
46.00	171.20	189.40	-0.13	3376.00	20.23	2750.00
47.00	174.20	191.40	-0.16	3372.00	21.35	2750.00
48.00	173.50	191.10	-0.23	3418.00	21.10	2750.00
49.00	173.50	191.20	-0.46	3415.00	20.28	2750.00
50.00	169.00	186.00	-0.55	3412.00	21.10	2750.00
**51.00	80.40	86.20	-1.52	231.00	48.33	2750.00
**52.00	119.40	121.60	-0.44	175.00	24.97	2750.00
**53.00	128.00	130.90	-0.54	169.00	32.53	2750.00

**54.00	175.00	192.30	0.00	0.00	21.56	7750.00
**55.00	144.90	151.70	-0.45	175.00	36.47	7750.00
56.00	170.30	187.50	0.16	3439.00	21.50	7750.00
57.00	170.90	188.10	-0.03	3442.00	21.02	7750.00
**58.00	173.00	175.10	-0.08	164.00	33.01	7750.00
59.00	169.90	189.00	0.00	3444.00	22.26	7750.00
60.00	172.40	189.60	0.25	3451.00	22.00	7750.00
**61.00	69.70	77.70	-1.61	201.00	47.00	7750.00
62.00	175.30	191.60	1.09	3449.00	22.73	7750.00
63.00	170.00	185.00	0.10	3450.00	25.09	7750.00
**64.00	67.70	78.00	-1.66	77.00	47.32	7750.00
65.00	167.00	184.10	0.74	3431.00	22.72	7750.00
66.00	168.10	185.50	0.62	3390.00	24.02	7750.00
67.00	168.20	185.30	0.14	3390.00	25.00	7750.00
**68.00	167.40	172.20	-0.79	143.00	31.51	7750.00
69.00	174.00	192.40	0.07	3386.00	25.50	7750.00
70.00	171.50	189.70	0.40	3376.00	25.52	7750.00
71.00	173.40	182.50	0.52	3370.00	26.39	7750.00
72.00	175.50	194.00	0.53	3370.00	25.23	7750.00
73.00	169.50	182.50	0.30	3369.00	25.31	7750.00
74.00	174.60	189.20	0.23	3393.00	25.32	7750.00
75.00	175.30	192.00	0.30	3400.00	22.19	7750.00
76.00	170.40	188.30	0.34	3396.00	26.14	7750.00
**77.00	70.00	85.00	-1.42	177.00	45.00	7750.00
78.00	172.00	190.20	0.44	3391.00	22.69	7750.00
79.00	169.10	182.00	0.22	3370.00	23.03	7750.00
80.00	167.10	184.00	-0.12	3370.00	25.39	7750.00
81.00	166.50	183.20	-0.35	3376.00	25.00	7750.00
82.00	165.00	176.00	-1.10	3390.00	24.39	7750.00
83.00	165.00	182.70	-0.54	3375.00	22.50	7750.00
**84.00	150.90	162.00	-1.29	103.00	32.50	7750.00
85.00	168.20	185.20	-0.50	3362.00	22.72	7750.00
86.00	162.50	185.00	-0.60	3360.00	22.05	7750.00
87.00	169.20	182.00	-0.52	3370.00	22.09	7750.00
88.00	167.20	184.00	-0.73	3390.00	23.31	7750.00
89.00	171.00	188.00	-0.69	3372.00	23.12	7750.00
90.00	162.00	184.90	-0.20	3360.00	23.26	7750.00
91.00	173.20	191.20	-0.02	3361.00	23.02	7750.00
92.00	172.20	192.00	0.14	3436.00	22.94	7750.00
93.00	168.50	186.50	0.01	3440.00	23.09	7750.00
94.00	172.10	190.20	0.01	3442.00	22.09	7750.00
95.00	165.50	183.10	-0.06	3444.00	23.20	7750.00
96.00	167.00	185.10	-0.00	3449.00	23.62	7750.00
97.00	169.60	188.00	-0.00	3439.00	23.29	7750.00
98.00	166.30	183.60	0.52	3432.00	23.51	7750.00
99.00	172.30	190.90	0.03	3452.00	23.20	7750.00
100.00	172.00	182.30	0.05	3430.00	23.72	7750.00
101.00	168.00	185.20	-0.02	3430.00	20.12	7750.00
102.00	168.50	186.10	-0.10	3439.00	23.20	7750.00
103.00	173.20	191.00	-0.02	3420.00	23.46	7750.00
104.00	168.10	185.30	-0.14	3436.00	23.31	7750.00
105.00	168.00	185.40	-0.16	3420.00	23.51	7750.00
106.00	162.50	185.10	-0.22	3420.00	23.32	7750.00
107.00	162.50	185.10	-0.20	3424.00	25.59	7750.00
108.00	162.50	185.20	-0.10	3432.00	23.10	7750.00

109.00	177.50	191.10	-0.16	3443.00	73.45	7750.00
110.00	169.00	185.00	-0.70	3438.00	73.14	7750.00
111.00	177.00	191.50	-0.70	3435.00	72.90	7750.00
112.00	174.00	189.60	-0.17	3436.00	72.97	7750.00
113.00	169.70	186.50	-0.70	3444.00	73.74	7750.00
114.00	169.10	186.70	-0.10	3434.00	73.17	7750.00
115.00	171.50	190.10	-0.16	3426.00	73.02	7750.00
116.00	173.40	191.00	-0.73	3430.00	72.97	7750.00
117.00	171.90	190.00	-0.73	3429.00	73.14	7750.00
118.00	166.00	183.10	-0.07	3425.00	70.79	7750.00
119.00	166.00	181.90	-0.63	3420.00	73.45	7750.00
120.00	167.30	184.50	-0.33	3418.00	73.30	7750.00
121.00	172.10	190.40	-0.77	3420.00	73.31	7750.00
122.00	170.40	180.70	0.70	3411.00	73.05	7750.00
123.00	164.70	184.00	-0.07	3420.00	75.67	7750.00
124.00	164.50	183.50	-0.77	3421.00	75.77	7750.00
125.00	169.50	180.30	0.37	3477.00	75.50	7750.00
126.00	172.90	194.00	0.39	3457.00	75.51	7750.00
127.00	169.60	189.40	0.39	3460.00	75.65	7750.00
128.00	160.90	180.50	0.37	3454.00	76.13	7750.00
129.00	171.10	180.90	0.37	3449.00	75.97	7750.00
130.00	172.60	193.70	0.30	3462.00	75.66	7750.00
131.00	169.30	189.10	0.30	3463.00	75.07	7750.00
132.00	169.90	190.30	0.70	3454.00	77.71	7750.00
133.00	170.00	190.20	0.70	3453.00	76.64	7750.00
134.00	171.90	192.30	0.73	3450.00	76.76	7750.00
135.00	171.60	192.00	0.35	3475.00	76.19	7750.00
136.00	169.30	180.90	0.20	3461.00	76.95	7750.00
137.00	170.70	189.00	0.23	3463.00	75.14	7750.00
138.00	169.30	189.70	0.19	3464.00	74.89	7750.00
139.00	174.30	193.30	0.77	3455.00	71.54	7750.00
140.00	169.70	189.50	0.17	3467.00	71.89	7750.00
141.00	174.00	194.10	0.75	3467.00	71.60	7750.00
142.00	169.40	189.00	0.16	3457.00	72.01	7750.00
143.00	174.00	192.50	0.77	3460.00	71.02	7750.00
144.00	160.70	180.70	0.17	3453.00	71.57	7750.00
145.00	171.00	191.90	0.73	3451.00	71.32	7750.00
146.00	169.90	190.00	0.37	3401.00	10.37	7750.00
147.00	172.50	197.00	0.45	3464.00	10.09	7750.00
148.00	172.70	191.00	0.36	3404.00	10.76	7750.00
149.00	135.70	153.70	0.49	3490.00	22.91	7750.00
150.00	167.00	185.00	0.55	3445.00	22.50	7750.00
151.00	170.00	189.50	-0.70	3461.00	22.74	7750.00
152.00	170.00	186.50	-0.33	3460.00	22.00	7750.00
153.00	167.50	184.30	-0.36	3440.00	22.42	7750.00
154.00	169.00	184.00	-0.57	3435.00	22.77	7750.00
155.00	165.10	183.50	-0.70	3446.00	22.45	7750.00



PUMP #349

TIME HOURS	IN FT TEMP(°F)	OUT FT TEMP(°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPED (RPM)
1.00	169.70	183.20	1.31	3381.00	25.76	7750.00
2.00	172.10	185.50	1.36	3346.00	25.97	7750.00
3.00	169.00	184.50	1.35	3369.00	25.61	7750.00
4.00	173.50	184.90	1.37	3356.00	25.78	7750.00
5.00	171.00	186.40	1.29	3353.00	25.83	7750.00
6.00	172.50	183.60	1.35	3422.00	25.69	7750.00
7.00	169.40	183.20	1.29	3404.00	25.61	7750.00
8.00	169.70	184.00	1.26	3361.00	25.85	7750.00
9.00	170.10	184.50	1.25	3398.00	25.93	7750.00
10.00	171.60	186.30	1.24	3372.00	25.73	7750.00
11.00	173.00	184.50	1.20	3410.00	25.73	7750.00
12.00	150.40	164.70	0.91	3354.00	26.41	7750.00
13.00	172.30	186.50	1.20	3379.00	25.75	7750.00
14.00	171.00	185.60	1.13	3415.00	25.50	7750.00
15.00	169.40	182.30	1.06	3399.00	25.85	7750.00
16.00	168.40	182.60	1.18	3424.00	25.87	7750.00
17.00	167.40	181.50	1.02	3400.00	25.83	7750.00
18.00	169.50	184.00	1.14	3434.00	25.77	7750.00
19.00	168.10	182.40	1.12	3412.00	25.55	7750.00
20.00	169.10	183.90	1.12	3412.00	25.61	7750.00
21.00	170.50	182.30	1.12	3434.00	25.93	7750.00
22.00	171.60	185.70	1.04	3447.00	25.93	7750.00
23.00	166.50	181.00	1.08	3413.00	25.77	7750.00
24.00	166.20	180.00	1.06	3430.00	25.85	7750.00
25.00	169.90	183.60	1.03	3454.00	25.92	7750.00
26.00	166.50	180.50	0.99	3403.00	25.98	7750.00
27.00	169.40	183.20	1.00	3407.00	25.79	7750.00
28.00	165.20	179.20	0.93	3440.00	25.92	7750.00
29.00	169.20	183.60	1.01	3441.00	25.84	7750.00
30.00	166.40	190.10	0.92	3519.00	20.40	7750.00
31.00	170.00	185.60	0.92	3444.00	22.36	7750.00
32.00	166.60	184.50	0.92	3481.00	22.41	7750.00
33.00	186.20	141.50	-0.22	3225.00	24.00	7750.00
34.00	166.20	185.00	1.31	3383.00	20.90	7750.00
35.00	168.00	180.30	1.24	3406.00	20.85	7750.00
36.00	166.20	185.00	1.19	3424.00	20.79	7750.00
37.00	168.20	186.10	1.25	3452.00	21.03	7750.00
38.00	166.20	186.00	1.23	3409.00	20.74	7750.00
39.00	162.60	186.20	1.12	3392.00	21.10	7750.00
40.00	164.20	184.30	1.12	3412.00	21.13	7750.00
41.00	169.30	180.50	1.19	3383.00	20.94	7750.00
42.00	169.50	180.00	1.19	3392.00	20.86	7750.00
43.00	169.50	180.60	1.20	3320.00	20.93	7750.00
44.00	170.30	189.50	1.15	3395.00	20.00	7750.00
45.00	172.90	190.10	0.23	3300.00	20.43	7750.00
46.00	171.20	191.60	-0.13	3309.00	20.39	7750.00
47.00	174.20	190.50	-0.16	3300.00	20.71	7750.00
48.00	173.50	192.60	-0.23	3309.00	20.20	7750.00
49.00	173.50	192.20	-0.46	3324.00	20.26	7750.00
50.00	169.00	182.50	-0.55	3332.00	20.52	7750.00
**51.00	00.40	00.00	-1.52	222.00	43.45	7750.00
**52.00	119.40	132.10	-0.44	3539.00	23.20	7750.00
**53.00	120.00	131.00	-0.54	100.00	31.35	7750.00

*54.00	175.00	195.00	0.00	0.00	20.07	7750.00
*55.00	144.90	150.30	-0.45	202.00	34.41	7750.00
56.00	170.30	190.00	0.16	3509.00	20.39	7750.00
57.00	170.90	190.50	-0.03	3449.00	20.11	7750.00
**58.00	173.00	173.00	-0.00	145.00	29.69	7750.00
59.00	169.90	191.30	0.00	3503.00	21.39	7750.00
60.00	172.40	190.60	0.25	3310.00	22.42	7750.00
**61.00	69.70	79.50	-1.61	275.00	44.09	7750.00
62.00	175.30	180.00	1.09	3294.00	23.22	7750.00
63.00	170.00	190.90	0.10	3291.00	20.54	7750.00
**64.00	67.70	76.40	-1.66	307.00	45.32	7750.00
65.00	167.00	186.00	0.74	3443.00	21.43	7750.00
66.00	168.10	187.60	0.62	3413.00	20.93	7750.00
67.00	168.20	185.70	0.14	3114.00	23.92	7750.00
*68.00	167.40	170.00	-0.79	167.00	30.23	7750.00
69.00	174.00	194.10	0.07	3309.00	21.37	7750.00
70.00	171.50	193.90	0.40	3635.00	20.49	7750.00
71.00	173.40	180.00	0.52	2993.00	21.41	7750.00
72.00	175.50	194.90	0.53	3160.00	21.12	7750.00
73.00	169.50	190.30	0.30	3521.00	20.96	7750.00
74.00	174.60	180.00	0.73	3122.00	21.53	7750.00
75.00	175.30	193.20	0.30	3150.00	21.27	7750.00
76.00	170.40	195.50	0.34	4020.00	20.26	7750.00
*77.00	70.00	80.00	-1.42	202.00	42.22	7750.00
78.00	172.00	197.20	0.44	4144.00	20.60	7750.00
79.00	169.10	186.20	0.22	2903.00	24.06	7750.00
80.00	167.10	184.20	-0.12	3305.00	22.16	7750.00
81.00	166.50	182.00	-0.35	2921.00	25.09	7750.00
82.00	165.00	181.50	-1.10	3005.00	23.05	7750.00
83.00	165.00	187.00	-0.54	3662.00	21.03	7750.00
*84.00	150.90	164.20	-1.29	192.00	31.20	7750.00
85.00	168.20	180.50	-0.50	3516.00	22.09	7750.00
86.00	167.50	180.00	-0.60	3502.00	24.32	7750.00
87.00	169.20	189.60	-0.52	3400.00	24.31	7750.00
88.00	167.20	186.00	-0.73	3402.00	24.22	7750.00
89.00	171.00	191.40	-0.69	3420.00	24.22	7750.00
90.00	167.00	186.90	-0.26	3490.00	21.95	7750.00
91.00	173.20	194.00	-0.02	3422.00	21.59	7750.00
92.00	172.20	193.00	0.14	3495.00	21.29	7750.00
93.00	168.50	180.40	0.01	3520.00	21.64	7750.00
94.00	172.10	192.30	0.01	3469.00	21.21	7750.00
95.00	165.50	184.50	-0.06	3520.00	21.22	7750.00
96.00	167.00	186.30	-0.00	3390.00	21.06	7750.00
97.00	169.60	189.10	-0.00	3401.00	21.90	7750.00
98.00	166.30	184.50	0.52	3426.00	22.05	7750.00
99.00	172.30	192.30	0.03	3412.00	21.03	7750.00
100.00	172.00	187.60	0.05	3414.00	21.03	7750.00
101.00	168.00	186.60	-0.02	3410.00	21.91	7750.00
102.00	168.50	187.40	-0.10	3416.00	21.91	7750.00
103.00	173.20	193.00	-0.02	3302.00	21.95	7750.00
104.00	168.10	186.50	-0.14	3423.00	21.90	7750.00
105.00	168.00	186.00	-0.16	3410.00	22.00	7750.00
106.00	167.50	186.20	-0.22	3440.00	22.01	7750.00
107.00	167.50	186.20	-0.20	3445.00	21.99	7750.00
108.00	167.50	186.40	-0.10	3455.00	22.02	7750.00

109.00	177.50	192.30	-0.16	3471.00	21.00	7750.00
110.00	169.00	186.70	-0.30	3469.00	22.04	7750.00
111.00	172.00	193.20	-0.20	3450.00	21.94	7750.00
112.00	174.00	189.00	-0.12	3453.00	21.90	7750.00
113.00	169.20	188.00	-0.20	3469.00	21.96	7750.00
114.00	169.10	188.00	-0.10	3479.00	22.05	7750.00
115.00	171.50	192.00	-0.16	3481.00	21.91	7750.00
116.00	173.40	193.40	-0.23	3455.00	22.00	7750.00
117.00	171.90	191.00	-0.23	3445.00	21.81	7750.00
118.00	166.00	184.70	-0.02	3507.00	22.16	7750.00
119.00	166.00	183.30	-0.63	3463.00	22.47	7750.00
120.00	167.30	186.30	-0.33	3482.00	22.01	7750.00
121.00	172.10	192.20	-0.22	3514.00	21.86	7750.00
122.00	170.40	190.60	0.20	3502.00	24.01	7750.00
123.00	164.20	183.30	-0.02	3491.00	21.91	7750.00
124.00	164.50	183.10	-0.22	3491.00	21.90	7750.00
125.00	169.50	187.40	0.32	3497.00	21.63	7750.00
126.00	172.90	193.00	0.39	3494.00	21.45	7750.00
127.00	169.60	189.00	0.39	3495.00	21.50	7750.00
128.00	168.90	188.00	0.32	3501.00	21.55	7750.00
129.00	171.10	188.50	0.32	3504.00	21.52	7750.00
130.00	172.60	193.20	0.30	3497.00	21.29	7750.00
131.00	169.30	188.90	0.30	3497.00	21.53	7750.00
132.00	169.90	190.40	0.20	3493.00	21.40	7750.00
133.00	170.00	190.40	0.20	3490.00	21.31	7750.00
134.00	171.90	192.20	0.23	3503.00	21.34	7750.00
135.00	171.60	192.00	0.35	3496.00	21.26	7750.00
136.00	169.30	188.20	0.20	3500.00	21.46	7750.00
137.00	170.20	188.00	0.23	3510.00	21.52	7750.00
138.00	169.30	189.20	0.19	3500.00	21.43	7750.00
139.00	174.30	189.00	0.22	3499.00	23.25	7750.00
140.00	169.20	189.60	0.12	3500.00	23.02	7750.00
141.00	174.00	192.60	0.25	3497.00	22.22	7750.00
142.00	169.40	189.20	0.16	3513.00	22.40	7750.00
143.00	174.00	189.00	0.22	3499.00	22.10	7750.00
144.00	168.20	188.20	0.12	3506.00	22.14	7750.00
145.00	171.00	192.50	0.23	3501.00	22.31	7750.00
146.00	169.90	189.00	0.32	3535.00	21.30	7750.00
147.00	177.50	197.50	0.45	3534.00	20.06	7750.00
148.00	172.20	191.60	0.36	3530.00	21.12	7750.00
149.00	135.20	156.20	0.49	3500.00	23.12	7750.00
150.00	167.00	186.00	0.55	3519.00	23.05	7750.00
151.00	170.00	189.90	-0.20	3489.00	23.24	7750.00
152.00	170.00	185.30	-0.33	3475.00	23.25	7750.00
153.00	167.50	184.20	-0.36	3471.00	23.23	7750.00
154.00	169.00	184.10	-0.52	3476.00	23.00	7750.00
155.00	165.10	183.60	-0.20	3476.00	23.99	7750.00

PUMP #351

TIME HOURS	INLET TEMP(°F)	OUTLET TEMP(°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPEED (RPM)
1.00	169.70	183.60	1.31	3132.00	24.71	7750.00
2.00	172.10	183.00	1.36	3333.00	20.41	7750.00
3.00	169.00	185.50	1.35	3415.00	24.35	7750.00
4.00	173.50	184.30	1.37	3339.00	25.15	7750.00
5.00	171.00	180.30	1.29	147.00	30.89	7750.00
*6.00	172.50	183.40	1.35	3477.00	24.06	7750.00
7.00	169.40	184.00	1.29	3477.00	23.91	7750.00
8.00	169.70	185.40	1.26	3490.00	23.96	7750.00
9.00	170.10	186.30	1.25	3486.00	24.01	7750.00
10.00	171.60	187.60	1.24	3481.00	23.91	7750.00
11.00	173.00	184.40	1.28	3461.00	23.84	7750.00
12.00	150.40	166.60	0.91	3661.00	25.36	7750.00
13.00	172.30	187.00	1.20	3470.00	24.11	7750.00
14.00	171.00	187.90	1.13	3470.00	24.00	7750.00
15.00	169.40	183.10	1.06	3485.00	24.30	7750.00
16.00	168.40	183.60	1.18	3473.00	24.20	7750.00
17.00	167.40	183.00	1.07	3491.00	24.18	7750.00
18.00	169.50	185.00	1.14	3482.00	24.20	7750.00
19.00	168.10	183.40	1.12	3466.00	24.19	7750.00
20.00	169.10	185.00	1.12	3476.00	24.15	7750.00
21.00	170.50	181.00	1.12	3485.00	24.16	7750.00
22.00	171.60	187.90	1.04	3574.00	21.60	7750.00
23.00	166.50	181.70	1.08	3488.00	23.06	7750.00
24.00	166.20	180.90	1.06	3483.00	24.18	7750.00
25.00	169.90	182.70	1.03	3483.00	23.62	7750.00
26.00	166.50	182.40	0.99	3490.00	23.85	7750.00
27.00	169.40	182.60	1.00	3476.00	23.68	7750.00
28.00	165.70	181.00	0.93	3471.00	24.73	7750.00
29.00	169.70	183.70	1.01	3479.00	23.85	7750.00
30.00	166.40	181.50	0.97	3495.00	24.31	7750.00
31.00	170.00	181.90	0.97	3464.00	24.20	7750.00
32.00	166.60	181.40	0.97	3465.00	24.21	7750.00
33.00	186.70	119.00	-0.27	3047.00	23.97	7750.00
34.00	166.70	180.30	1.31	3473.00	24.57	7750.00
35.00	168.00	184.20	1.24	3466.00	24.50	7750.00
36.00	166.20	181.50	1.19	3468.00	24.67	7750.00
37.00	168.20	180.00	1.25	3483.00	24.41	7750.00
38.00	166.70	181.10	1.23	3480.00	24.70	7750.00
39.00	167.60	182.30	1.17	3461.00	24.30	7750.00
40.00	164.70	180.20	1.12	3493.00	24.85	7750.00
41.00	169.30	184.00	1.19	3464.00	24.66	7750.00
42.00	169.50	184.10	1.19	3467.00	24.79	7750.00
43.00	169.50	184.50	1.20	3459.00	24.62	7750.00
44.00	170.30	185.10	1.15	3470.00	24.68	7750.00
45.00	172.90	180.00	0.23	3414.00	22.16	7750.00
46.00	171.70	180.70	-0.13	3396.00	21.78	7750.00
47.00	174.20	180.30	-0.16	3390.00	21.83	7750.00
48.00	173.50	189.10	-0.23	3382.00	21.37	7750.00
49.00	173.50	188.70	-0.46	3369.00	21.48	7750.00
50.00	169.00	185.00	-0.55	3390.00	21.65	7750.00
*51.00	00.40	90.00	-1.57	256.00	19.50	7750.00
52.00	119.40	133.10	-0.44	3770.00	24.76	7750.00
*53.00	128.00	131.00	-0.54	218.00	31.93	7750.00

54.00	175.00	195.00	0.00	0.00	21.89	7750.00
55.00	144.90	149.40	-0.45	182.00	30.69	7750.00
56.00	170.30	193.60	0.16	3431.00	18.68	7750.00
57.00	170.90	194.90	-0.03	3463.00	16.93	7750.00
58.00	173.00	172.00	-0.00	165.00	30.09	7750.00
*** 59.00	169.90	74.50	0.00	19.00	4.66	7750.00
*** 60.00	172.40	75.00	0.25	20.00	2.48	7750.00
61.00	69.70	62.50	-1.61	43.00	8.28	7750.00
62.00	175.30	65.90	1.09	28.00	2.27	7750.00
63.00	170.00	75.90	0.10	15.00	6.17	7750.00
64.00	67.70	63.40	-1.66	42.00	6.25	7750.00
65.00	167.00	68.00	0.74	26.00	2.71	7750.00
66.00	168.10	69.20	0.62	23.00	2.52	7750.00
67.00	168.20	76.00	0.14	17.00	7.05	7750.00
68.00	167.40	76.00	-0.79	17.00	8.25	7750.00
69.00	174.00	79.30	0.07	14.00	9.68	7750.00
70.00	171.50	77.00	0.40	19.00	8.29	7750.00
71.00	173.40	72.90	0.52	19.00	6.15	7750.00
72.00	175.50	72.20	0.53	20.00	3.69	7750.00
73.00	169.50	72.00	0.30	19.00	6.28	7750.00
74.00	174.60	72.00	0.23	20.00	6.56	7750.00
75.00	175.30	73.00	0.30	21.00	2.27	7750.00
76.00	170.40	73.00	0.34	21.00	9.44	7750.00
77.00	70.00	63.40	-1.42	29.00	3.93	7750.00
78.00	172.00	73.60	0.44	21.00	6.10	7750.00
79.00	169.10	73.90	0.22	0.00	8.26	7750.00
80.00	167.10	70.20	-0.12	0.00	7.13	7750.00
81.00	166.50	80.40	-0.35	0.00	8.03	7750.00
82.00	165.00	80.30	-1.10	0.00	8.99	7750.00
83.00	165.00	81.10	-0.54	0.00	8.35	7750.00
84.00	150.90	80.20	-1.29	0.00	2.97	7750.00
85.00	168.20	80.60	-0.50	0.00	7.69	7750.00
86.00	167.50	81.90	-0.60	0.00	3.40	7750.00
87.00	169.20	83.00	-0.52	0.00	0.00	7750.00
88.00	167.20	83.20	-0.23	0.00	5.01	7750.00
89.00	171.00	83.60	-0.69	0.00	1.62	7750.00
90.00	167.00	76.00	-0.26	0.00	5.40	7750.00
91.00	173.20	77.20	-0.02	0.00	0.89	7750.00
92.00	172.20	73.00	0.14	0.00	4.63	7750.00
93.00	168.50	73.50	0.01	0.00	6.15	7750.00
94.00	172.10	74.40	0.01	0.00	5.95	7750.00
95.00	165.50	74.00	-0.06	0.00	3.66	7750.00
96.00	167.00	74.00	-0.00	0.00	2.05	7750.00
97.00	169.60	74.50	-0.00	0.00	2.93	7750.00
98.00	166.30	70.20	0.52	0.00	8.04	7750.00
99.00	172.30	75.10	0.03	0.00	4.06	7750.00
100.00	172.00	73.40	0.05	0.00	4.10	7750.00
101.00	168.00	73.30	-0.02	0.00	3.89	7750.00
102.00	168.50	73.30	-0.10	0.00	2.11	7750.00
103.00	173.20	73.50	-0.02	0.00	4.24	7750.00
104.00	168.10	73.10	-0.14	0.00	4.12	7750.00
105.00	168.00	73.00	-0.16	0.00	3.44	7750.00
106.00	167.50	72.90	-0.22	0.00	1.24	7750.00
107.00	167.50	72.00	-0.20	0.00	3.23	7750.00
108.00	167.50	72.90	-0.18	0.00	3.26	7750.00

109.00	172.50	72.00	-0.16	0.00	3.83	2750.00
110.00	169.00	73.00	-0.30	0.00	5.30	2750.00
111.00	172.00	73.20	-0.20	0.00	3.69	2750.00
112.00	174.00	73.10	-0.12	0.00	3.66	2750.00
113.00	169.20	72.90	-0.28	0.00	3.62	2750.00
114.00	169.10	72.70	-0.18	0.00	3.79	2750.00
115.00	171.50	72.50	-0.16	0.00	4.51	2750.00
116.00	173.40	72.10	-0.23	0.00	3.41	2750.00
117.00	171.90	72.30	-0.23	0.00	5.30	2750.00
118.00	166.00	71.90	-0.02	0.00	0.09	2750.00
119.00	166.00	70.50	-0.63	0.00	3.66	2750.00
120.00	167.30	73.40	-0.33	0.00	4.12	2750.00
121.00	172.10	71.00	-0.22	0.00	4.34	2750.00
122.00	170.40	73.60	0.20	0.00	4.34	2750.00
123.00	164.70	70.50	-0.02	0.00	4.03	2750.00
124.00	164.50	00.30	-0.22	0.00	4.09	2750.00
125.00	169.50	74.50	0.32	0.00	1.53	2750.00
126.00	172.90	73.60	0.39	0.00	5.01	2750.00
127.00	169.60	73.60	0.39	0.00	3.21	2750.00
128.00	168.90	72.90	0.32	0.00	3.89	2750.00
129.00	171.10	72.60	0.32	0.00	3.29	2750.00
130.00	172.60	72.60	0.30	0.00	2.40	2750.00
131.00	169.30	72.50	0.30	0.00	5.64	2750.00
132.00	169.90	72.30	0.20	0.00	5.99	2750.00
133.00	170.00	72.50	0.20	0.00	1.81	2750.00
134.00	171.90	72.50	0.23	0.00	3.89	2750.00
135.00	171.60	72.60	0.35	0.00	3.26	2750.00
136.00	169.30	72.70	0.20	0.00	3.26	2750.00
137.00	170.20	72.40	0.23	0.00	4.06	2750.00
138.00	169.30	72.60	0.19	0.00	4.06	2750.00
139.00	174.30	72.60	0.22	0.00	4.10	2750.00
140.00	169.20	72.00	0.12	0.00	4.12	2750.00
141.00	174.00	72.20	0.25	0.00	0.00	2750.00
142.00	169.40	72.00	0.16	0.00	0.00	2750.00
143.00	174.00	72.10	0.22	0.00	0.00	2750.00
144.00	160.20	72.00	0.12	0.00	3.89	2750.00
145.00	171.00	72.10	0.23	0.00	3.99	2750.00
146.00	169.90	71.90	0.32	0.00	3.21	2750.00
147.00	172.50	71.40	0.45	0.00	3.41	2750.00
148.00	172.20	71.40	0.36	0.00	2.62	2750.00
149.00	135.20	75.00	0.49	0.00	3.44	2750.00
150.00	162.00	65.30	0.55	0.00	9.26	2750.00
151.00	170.00	82.00	-0.20	0.00	2.60	2750.00
152.00	170.00	74.20	-0.33	0.00	2.84	2750.00
153.00	162.50	94.10	-0.36	0.00	2.15	2750.00
154.00	169.00	81.30	-0.52	0.00	2.20	2750.00
155.00	165.10	75.00	-0.20	0.00	2.96	2750.00

TABULATED DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M2

Test Specimens Consisted Of:

Pump #355, #358, and #361

\*\* Data points are automatically taken when the test is restarted after the DAS alarm system has shut it down.

PUMP #355

TIME	INLET	OUTLET	DIFFERENCE	IN PRESS	OUT PRESS	FLOW	TEMP
(MM)	(FT)	(FT)	(FT)	(PSI)	(PSI)	(GPM)	(F)
1.00	170.70	164.00	-6.70	3501.00	3501.00	26.33	2750.00
2.00	165.00	177.00	12.00	3571.00	3571.00	26.65	2750.00
3.00	171.70	161.50	-10.20	3500.00	3500.00	26.65	2750.00
4.00	172.00	165.00	-7.00	3510.00	3510.00	26.16	2750.00
*5.00	171.40	169.10	-2.30	3500.00	3500.00	32.65	2750.00
6.00	171.20	164.00	-5.20	3500.00	3500.00	27.70	2750.00
7.00	167.00	160.50	-6.50	3512.00	3512.00	27.10	2750.00
8.00	170.50	164.50	-6.00	3533.00	3533.00	26.77	2750.00
9.00	169.30	162.00	-7.30	3546.00	3546.00	26.40	2750.00
10.00	173.10	167.00	-6.10	3483.00	3483.00	26.21	2750.00
11.00	170.00	163.30	-6.70	3503.00	3503.00	26.37	2750.00
12.00	172.20	165.10	-7.10	3500.00	3500.00	26.29	2750.00
13.00	171.20	164.00	-7.20	3570.00	3570.00	26.40	2750.00
14.00	169.20	162.00	-7.20	3571.00	3571.00	26.64	2750.00
15.00	169.20	162.00	-7.20	3572.00	3572.00	26.68	2750.00
16.00	169.50	162.20	-7.30	3569.00	3569.00	26.64	2750.00
17.00	172.30	165.00	-7.30	3560.00	3560.00	26.53	2750.00
18.00	169.10	160.20	-8.90	3550.00	3550.00	26.91	2750.00
19.00	176.30	164.00	-12.30	3547.00	3547.00	26.69	2750.00
20.00	174.00	167.50	-6.50	3501.00	3501.00	26.62	2750.00
21.00	169.20	161.00	-8.20	3507.00	3507.00	27.01	2750.00
22.00	165.20	177.00	11.80	3549.00	3549.00	27.23	2750.00
23.00	174.50	167.50	-7.00	3501.00	3501.00	26.59	2750.00
24.00	169.40	162.00	-7.40	3504.00	3504.00	27.16	2750.00
25.00	165.50	177.00	11.50	3500.00	3500.00	27.30	2750.00
26.00	175.50	168.30	-7.20	3545.00	3545.00	26.65	2750.00
27.00	130.00	150.00	20.00	3520.00	3520.00	26.24	2750.00
28.00	168.40	160.00	-8.40	3504.00	3504.00	27.07	2750.00
29.00	160.00	160.50	0.50	3510.00	3510.00	27.03	2750.00
30.00	171.20	165.00	-6.20	3512.00	3512.00	27.27	2750.00
31.00	168.00	161.50	-6.50	3517.00	3517.00	26.03	2750.00
32.00	172.00	161.30	-10.70	3517.00	3517.00	27.21	2750.00
33.00	171.30	165.50	-5.80	3515.00	3515.00	27.12	2750.00
34.00	168.50	162.30	-6.20	3500.00	3500.00	27.04	2750.00
35.00	167.20	161.10	-6.10	3505.00	3505.00	27.32	2750.00
36.00	167.10	160.20	-6.90	3517.00	3517.00	27.30	2750.00
37.00	167.30	160.00	-7.30	3520.00	3520.00	27.33	2750.00
38.00	168.00	163.00	-5.00	3513.00	3513.00	27.29	2750.00
39.00	170.00	164.40	-5.60	3571.00	3571.00	27.19	2750.00
40.00	168.00	162.40	-5.60	3573.00	3573.00	27.00	2750.00
41.00	166.00	160.20	-5.80	3549.00	3549.00	27.03	2750.00
42.00	166.20	179.20	13.00	3509.00	3509.00	27.16	2750.00
43.00	168.10	179.00	10.90	3505.00	3505.00	27.17	2750.00
44.00	170.40	164.50	-5.90	3490.00	3490.00	27.16	2750.00
45.00	167.00	160.00	-7.00	3499.00	3499.00	27.19	2750.00
46.00	167.50	161.20	-6.30	3512.00	3512.00	26.90	2750.00
47.00	166.00	160.10	-5.90	3507.00	3507.00	27.16	2750.00
48.00	169.20	163.30	-5.90	3500.00	3500.00	27.10	2750.00
49.00	167.40	179.30	11.90	3477.00	3477.00	27.21	2750.00
50.00	170.30	179.20	8.90	3501.00	3501.00	27.49	2750.00
51.00	166.10	160.50	-5.60	3490.00	3490.00	33.90	2750.00
52.00	167.20	160.30	-6.90	3499.00	3499.00	27.43	2750.00
53.00	166.50	179.00	12.50	3501.00	3501.00	27.32	2750.00



54.00	167.50	169.70	1.54	3390.00	77.70	7750.00
55.00	166.50	179.50	-1.50	3487.00	77.73	7750.00
56.00	166.50	179.50	-1.54	3493.00	77.40	7750.00
** 57.00	93.50	96.50	-1.01	348.00	76.56	7750.00
58.00	169.70	183.70	0.26	3500.00	77.13	7750.00
59.00	165.90	177.50	-1.15	3479.00	77.54	7750.00
60.00	165.90	177.50	-1.41	3472.00	77.79	7750.00
61.00	162.50	174.50	-1.70	3332.00	77.82	7750.00
62.00	167.00	168.00	-1.00	3473.00	77.71	7750.00
63.00	169.70	179.10	-0.79	3379.00	77.32	7750.00
64.00	167.40	161.00	-1.00	3405.00	76.75	7750.00
65.00	165.50	171.00	-1.29	3407.00	77.67	7750.00
66.00	162.50	175.20	-1.41	3411.00	76.69	7750.00
67.00	161.00	172.00	-1.00	3426.00	77.93	7750.00
68.00	162.50	172.90	-1.70	3462.00	77.98	7750.00
69.00	165.90	178.50	-1.00	3488.00	77.93	7750.00
70.00	165.20	173.40	-1.00	3486.00	76.00	7750.00
71.00	167.50	180.50	-1.66	3500.00	77.76	7750.00
72.00	169.70	178.00	-0.89	3500.00	77.42	7750.00
73.00	165.00	172.00	-1.00	3382.00	77.61	7750.00
74.00	162.40	174.50	-1.57	3391.00	76.63	7750.00
75.00	164.10	171.70	-1.02	3401.00	76.74	7750.00
76.00	163.00	176.00	-1.00	3380.00	76.50	7750.00
77.00	161.50	173.70	-1.65	3405.00	76.70	7750.00
78.00	162.00	174.10	-1.79	3382.00	76.63	7750.00
79.00	163.70	176.50	-1.61	3380.00	76.77	7750.00
80.00	164.50	177.00	-1.20	3493.00	76.64	7750.00
81.00	164.00	171.40	-1.27	3471.00	76.16	7750.00
82.00	167.50	177.50	-1.21	3471.00	77.25	7750.00
83.00	168.20	181.50	-1.10	3418.00	77.24	7750.00
84.00	164.50	172.00	-1.33	3439.00	77.42	7750.00
85.00	165.50	178.90	-1.20	3463.00	77.35	7750.00
86.00	157.20	168.70	-1.34	3510.00	77.64	7750.00
** 87.00	103.50	124.10	-1.85	241.00	76.20	7750.00
88.00	164.50	179.70	-1.23	3402.00	76.06	7750.00
89.00	167.20	180.50	-1.10	3332.00	77.68	7750.00
90.00	168.00	182.50	-1.15	3416.00	77.17	7750.00
91.00	167.00	180.40	-1.11	3503.00	77.23	7750.00
92.00	166.20	177.50	-1.20	3432.00	77.45	7750.00
93.00	167.50	180.00	-1.11	3393.00	77.40	7750.00
94.00	164.40	176.20	-1.13	3454.00	77.42	7750.00
95.00	164.00	176.40	-1.19	3494.00	77.38	7750.00
96.00	165.10	178.40	-1.22	3475.00	77.33	7750.00
97.00	166.40	180.00	-1.23	3474.00	77.28	7750.00
98.00	165.00	176.00	-1.11	3474.00	77.31	7750.00
99.00	164.00	172.00	-1.21	3471.00	77.42	7750.00
100.00	165.00	179.00	-1.11	3463.00	77.21	7750.00
101.00	166.50	172.20	-1.02	3482.00	77.26	7750.00
102.00	164.20	172.50	-1.21	3465.00	77.40	7750.00
103.00	167.50	180.50	-1.00	3415.00	77.45	7750.00
104.00	167.20	180.00	-1.02	3428.00	77.20	7750.00
105.00	165.00	178.00	-1.40	3460.00	77.20	7750.00
106.00	163.50	175.00	-1.21	3491.00	77.25	7750.00
107.00	163.90	175.50	-1.21	3476.00	77.77	7750.00
108.00	165.00	178.50	-1.70	3474.00	77.70	7750.00

109.00	154.10	166.00	-1.22	3538.00	78.13	7750.00
110.00	163.10	175.40	-1.70	3487.00	77.85	7750.00
111.00	163.90	175.70	-1.91	3466.00	77.83	7750.00
112.00	163.90	177.30	-1.80	3480.00	77.60	7750.00
113.00	162.40	175.20	-2.12	3473.00	78.00	7750.00
114.00	163.00	175.30	-1.74	3380.00	77.97	7750.00
115.00	164.90	177.90	-1.42	3467.00	77.71	7750.00
116.00	163.00	175.40	-1.42	3475.00	78.00	7750.00
117.00	161.40	173.20	-1.79	3483.00	77.98	7750.00
118.00	170.20	182.10	-1.00	3468.00	77.50	7750.00
119.00	165.60	179.00	-1.72	3485.00	77.64	7750.00
120.00	167.90	180.10	-1.17	3485.00	77.36	7750.00
121.00	169.00	182.30	-1.12	3481.00	77.04	7750.00
122.00	171.00	181.00	-0.99	3388.00	77.73	7750.00
123.00	164.20	176.50	-1.00	3520.00	77.38	7750.00
124.00	166.20	176.10	-1.38	3440.00	77.74	7750.00
125.00	165.20	176.40	-1.48	3458.00	77.63	7750.00
126.00	168.20	177.20	-1.10	3380.00	77.37	7750.00
127.00	169.00	178.20	-1.00	3475.00	77.14	7750.00
** 128.00	77.20	88.20	-2.14	265.00	33.57	7750.00
129.00	164.20	176.90	-1.16	3394.00	77.67	7750.00
130.00	168.30	178.30	-1.50	3391.00	77.59	7750.00
131.00	164.00	175.20	-1.66	3465.00	77.64	7750.00
132.00	167.60	176.80	-1.58	3379.00	77.97	7750.00
133.00	165.30	178.10	-1.57	3465.00	77.61	7750.00
134.00	164.20	176.40	-1.69	3394.00	77.79	7750.00
135.00	164.00	175.50	-1.81	3451.00	77.73	7750.00
136.00	166.00	178.00	-1.50	3400.00	77.79	7750.00
137.00	167.30	178.50	-1.61	3421.00	77.77	7750.00
138.00	169.00	182.00	-1.50	3451.00	77.11	7750.00
139.00	168.30	179.10	-1.45	3400.00	77.50	7750.00
140.00	168.10	179.50	-1.26	3427.00	77.36	7750.00
141.00	167.90	180.50	-1.35	3477.00	77.13	7750.00
142.00	169.60	182.10	-1.32	3425.00	77.71	7750.00
143.00	171.20	179.60	-1.30	3431.00	77.39	7750.00
144.00	167.90	180.40	-1.39	3480.00	77.26	7750.00
145.00	168.00	181.90	-1.44	3448.00	77.77	7750.00
146.00	170.60	179.50	-1.22	3408.00	77.50	7750.00
147.00	167.20	179.20	-1.50	3477.00	77.36	7750.00
148.00	171.00	179.20	-1.38	3492.00	77.75	7750.00
149.00	167.30	180.30	-1.50	3489.00	77.26	7750.00
150.00	167.50	178.50	-1.46	3412.00	77.42	7750.00
151.00	164.30	176.20	-0.88	3493.00	77.35	7750.00
152.00	168.20	181.20	-1.12	3394.00	77.29	7750.00
153.00	168.90	180.90	-1.36	3459.00	77.30	7750.00
154.00	163.10	175.10	-1.49	3380.00	77.64	7750.00

PUMP #358

TIME HOURS	IN FT TEMP(4F)	OUT FT TEMP(4F)	IN PRESS (PSI)	OUT PRESS (PSI)	PI (G) (GPM)	SPED (RPM)
1.00	170.70	191.70	0.14	4302.00	24.46	2750.00
2.00	165.00	177.30	-0.06	3363.00	27.27	2750.00
3.00	171.70	181.00	-0.48	3429.00	25.92	2750.00
4.00	172.00	185.70	-0.62	3211.00	26.12	2750.00
5.00	171.40	171.10	-1.56	2821.00	23.61	2750.00
6.00	171.20	186.30	-0.98	3506.00	25.45	2750.00
7.00	167.60	177.70	-1.01	2766.00	27.25	2750.00
8.00	170.50	181.90	-0.83	2897.00	26.89	2750.00
9.00	169.30	178.20	-0.59	2609.00	27.23	2750.00
10.00	173.10	184.00	-0.55	2855.00	26.89	2750.00
11.00	170.00	183.20	-0.42	3332.00	26.02	2750.00
12.00	172.20	183.00	-0.25	2980.00	26.05	2750.00
13.00	171.20	181.90	-0.12	2947.00	26.09	2750.00
14.00	169.20	179.00	-0.08	2931.00	26.30	2750.00
15.00	169.20	179.90	-0.02	2901.00	26.23	2750.00
16.00	169.50	180.10	-0.07	2900.00	26.29	2750.00
17.00	172.30	183.00	-0.22	2856.00	26.23	2750.00
18.00	168.10	178.60	-0.66	2915.00	26.40	2750.00
19.00	176.30	180.30	-0.50	2799.00	26.43	2750.00
20.00	174.60	185.30	-0.65	2917.00	26.21	2750.00
21.00	169.20	180.20	-0.65	2500.00	26.29	2750.00
22.00	165.20	175.90	-0.72	2882.00	26.68	2750.00
23.00	174.50	185.40	-0.52	2928.00	26.15	2750.00
24.00	169.40	180.30	-0.71	2926.00	26.26	2750.00
25.00	165.50	177.20	-0.74	3251.00	25.92	2750.00
26.00	175.50	182.20	-0.51	3142.00	25.64	2750.00
** 27.00	170.00	143.00	0.11	029.00	20.72	2750.00
28.00	168.40	181.10	-0.40	3430.00	25.22	2750.00
29.00	168.00	181.10	-0.74	3425.00	25.22	2750.00
30.00	171.20	186.60	-0.69	3433.00	25.64	2750.00
31.00	168.00	181.00	-0.95	3423.00	25.83	2750.00
32.00	172.60	181.60	-0.90	3431.00	25.28	2750.00
33.00	171.30	186.00	-0.90	3430.00	25.82	2750.00
34.00	168.50	183.00	-1.11	3435.00	25.94	2750.00
35.00	167.20	181.20	-1.14	3410.00	26.00	2750.00
36.00	167.10	181.00	-1.24	3414.00	26.04	2750.00
37.00	167.30	181.00	-1.12	3420.00	25.92	2750.00
38.00	168.00	183.20	-1.25	3422.00	25.90	2750.00
39.00	170.00	184.50	-1.23	3420.00	25.92	2750.00
40.00	168.00	182.50	-1.20	3423.00	26.01	2750.00
41.00	166.90	180.30	-1.30	3414.00	26.20	2750.00
42.00	166.20	179.90	-1.28	3415.00	26.23	2750.00
43.00	168.10	180.10	-1.33	3411.00	26.24	2750.00
44.00	170.40	185.00	-1.19	3412.00	26.16	2750.00
45.00	167.00	180.30	-1.30	3409.00	26.15	2750.00
46.00	167.50	181.30	-1.22	3402.00	26.20	2750.00
47.00	166.90	180.00	-1.26	3413.00	26.24	2750.00
48.00	169.20	184.20	-1.26	3410.00	26.20	2750.00
49.00	167.40	179.20	-1.43	3400.00	26.11	2750.00
** 50.00	170.30	179.60	-1.29	3420.00	26.10	2750.00
51.00	166.10	174.50	-2.16	3415.00	23.29	2750.00
52.00	167.20	181.00	-1.49	3403.00	26.18	2750.00
53.00	166.50	180.30	-1.51	3412.00	26.12	2750.00

54.00	167.50	181.50	-1.54	3402.00	26.72	2750.00
55.00	166.30	179.00	-1.50	3404.00	26.74	2750.00
56.00	166.30	179.90	-1.64	3395.00	26.87	2750.00
57.00	165.00	179.40	-1.56	3396.00	26.40	2750.00
58.00	168.00	179.00	-1.43	3396.00	26.21	2750.00
59.00	163.90	175.60	-1.57	3394.00	26.34	2750.00
60.00	166.70	175.60	-1.26	3396.00	26.14	2750.00
61.00	167.10	180.00	-1.18	3400.00	26.21	2750.00
** 62.00	75.00	91.70	-1.92	252.00	12.09	2750.00
** 63.00	84.10	91.00	-1.90	250.00	13.10	2750.00
64.00	163.60	176.70	-0.81	3399.00	26.55	2750.00
65.00	164.00	178.60	-1.20	3400.00	26.40	2750.00
66.00	162.30	177.00	-1.41	3394.00	26.53	2750.00
67.00	161.00	172.70	-1.60	3391.00	26.61	2750.00
68.00	162.50	173.50	-1.20	3382.00	26.51	2750.00
69.00	165.90	176.60	-1.66	3392.00	26.31	2750.00
70.00	165.20	173.40	-1.66	3387.00	26.51	2750.00
71.00	167.50	185.60	-1.66	3406.00	25.90	2750.00
72.00	169.20	173.20	-0.89	3400.00	26.16	2750.00
73.00	165.00	170.20	-1.00	3395.00	26.53	2750.00
74.00	162.40	173.20	-1.57	3391.00	26.44	2750.00
75.00	164.10	174.30	-1.62	3392.00	26.42	2750.00
76.00	163.60	177.90	-1.66	3392.00	26.40	2750.00
77.00	161.50	162.40	-1.65	3375.00	26.86	2750.00
78.00	162.00	181.30	-1.29	3382.00	26.40	2750.00
79.00	163.20	176.50	-1.61	3381.00	26.21	2750.00
80.00	164.50	179.40	-1.20	3395.00	26.06	2750.00
81.00	164.60	180.40	-1.22	3413.00	26.10	2750.00
82.00	167.50	192.20	-1.21	3412.00	25.95	2750.00
83.00	168.20	183.20	-1.10	3412.00	26.10	2750.00
84.00	164.30	171.60	-1.33	3419.00	26.18	2750.00
85.00	165.50	182.50	-1.20	3412.00	26.06	2750.00
86.00	152.20	170.30	-1.34	3432.00	25.92	2750.00
** 87.00	103.30	143.00	-1.85	210.00	12.60	2750.00
88.00	166.50	183.30	-1.23	3415.00	26.36	2750.00
89.00	162.20	186.50	-1.16	3400.00	26.19	2750.00
90.00	168.00	172.20	-1.15	3396.00	26.31	2750.00
91.00	162.00	190.10	-1.11	3403.00	26.23	2750.00
92.00	166.20	173.00	-1.20	3381.00	26.27	2750.00
93.00	162.30	190.00	-1.11	3412.00	26.53	2750.00
94.00	164.40	176.00	-1.13	3382.00	26.69	2750.00
95.00	164.00	168.10	-1.19	3400.00	26.51	2750.00
96.00	165.10	183.90	-1.22	3395.00	26.60	2750.00
97.00	166.40	179.20	-1.23	3411.00	26.50	2750.00
98.00	165.00	172.10	-1.11	3382.00	26.59	2750.00
99.00	164.00	176.00	-1.21	3410.00	26.63	2750.00
100.00	165.60	175.00	-1.11	3391.00	26.64	2750.00
101.00	166.90	182.20	-1.02	3404.00	26.61	2750.00
102.00	164.20	181.20	-1.21	3393.00	26.50	2750.00
103.00	162.30	191.00	-1.00	3410.00	26.50	2750.00
104.00	162.20	189.50	-1.02	3382.00	26.53	2750.00
105.00	165.00	170.10	-1.40	3392.00	26.04	2750.00
106.00	163.50	167.40	-1.26	3401.00	26.22	2750.00
107.00	163.90	174.20	-1.21	3396.00	22.01	2750.00
108.00	165.00	179.20	-1.20	3390.00	26.93	2750.00

109.00	154.10	166.40	-1.77	3437.00	27.01	7750.00
110.00	163.10	177.10	-1.70	3404.00	26.96	7750.00
111.00	163.90	175.30	-1.91	3377.00	26.54	7750.00
112.00	163.00	170.00	-1.80	3380.00	26.40	7750.00
113.00	162.40	176.30	-2.12	3395.00	26.46	7750.00
114.00	163.00	176.00	-1.74	3391.00	26.18	7750.00
115.00	164.90	178.50	-1.47	3402.00	26.16	7750.00
116.00	163.00	175.90	-1.47	3386.00	25.99	7750.00
117.00	161.40	173.40	-1.79	3377.00	26.11	7750.00
118.00	170.70	182.40	-1.00	3414.00	25.74	7750.00
119.00	165.60	179.70	-1.77	3394.00	25.87	7750.00
120.00	167.90	180.30	-1.17	3388.00	25.85	7750.00
121.00	169.00	182.00	-1.17	3410.00	25.76	7750.00
122.00	171.00	181.10	-0.99	3388.00	25.79	7750.00
123.00	164.70	177.00	-1.05	3434.00	25.76	7750.00
124.00	166.70	175.00	-1.30	3389.00	26.24	7750.00
125.00	165.70	175.00	-1.48	3403.00	26.07	7750.00
126.00	168.70	172.50	-1.10	3396.00	25.96	7750.00
127.00	169.00	190.10	-1.00	3374.00	26.02	7750.00
**128.00	77.70	89.30	-2.14	248.00	10.51	7750.00
129.00	164.70	179.50	-1.16	3411.00	26.21	7750.00
130.00	168.30	177.40	-1.50	3381.00	26.04	7750.00
131.00	164.00	178.20	-1.66	3377.00	26.15	7750.00
132.00	167.60	178.40	-1.50	3391.00	26.06	7750.00
133.00	165.30	178.00	-1.57	3383.00	26.20	7750.00
134.00	164.20	177.00	-1.69	3397.00	26.29	7750.00
135.00	164.00	175.90	-1.81	3383.00	26.19	7750.00
136.00	166.00	178.20	-1.50	3380.00	26.26	7750.00
137.00	167.30	179.60	-1.61	3402.00	26.10	7750.00
138.00	169.00	183.10	-1.52	3382.00	26.01	7750.00
139.00	168.30	182.20	-1.45	3383.00	26.24	7750.00
140.00	168.10	179.00	-1.76	3400.00	26.00	7750.00
141.00	167.90	180.20	-1.35	3378.00	26.21	7750.00
142.00	169.60	181.00	-1.37	3402.00	26.09	7750.00
143.00	171.20	181.40	-1.30	3391.00	26.51	7750.00
144.00	167.90	180.00	-1.39	3396.00	26.34	7750.00
145.00	168.00	183.50	-1.44	3412.00	26.26	7750.00
146.00	170.60	179.20	-1.77	3389.00	26.25	7750.00
147.00	167.20	180.50	-1.50	3402.00	26.01	7750.00
148.00	171.00	180.30	-1.30	3394.00	25.94	7750.00
149.00	167.30	180.00	-1.52	3383.00	26.09	7750.00
150.00	167.50	179.20	-1.46	3404.00	26.14	7750.00
151.00	164.30	177.20	-0.80	3382.00	26.23	7750.00
152.00	168.20	182.40	-1.17	3389.00	26.04	7750.00
153.00	168.90	180.00	-1.76	3395.00	25.93	7750.00
154.00	163.10	176.00	-1.49	3372.00	26.29	7750.00

PUMP #361

TIME HOURS	INLET TEMP (°F)	OUTLET TEMP (°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	STATUS
1.00	170.70	185.10	0.14	2930.00	24.24	2750.00
2.00	165.00	183.50	-0.06	3212.00	26.41	2750.00
3.00	171.70	183.00	-0.48	3452.00	31.54	2750.00
4.00	172.00	186.10	-0.02	3446.00	29.00	2750.00
** 5.00	171.40	171.50	-1.56	170.00	35.73	2750.00
6.00	168.40	181.10	-0.40	3452.00	26.33	2750.00
7.00	168.00	180.70	-0.74	3446.00	26.25	2750.00
8.00	171.70	185.00	-0.09	3444.00	26.03	2750.00
9.00	168.00	181.50	-0.95	3444.00	26.14	2750.00
10.00	172.00	184.00	-0.90	3430.00	26.19	2750.00
11.00	171.30	185.30	-0.90	3443.00	26.23	2750.00
12.00	168.50	181.90	-1.11	3435.00	26.30	2750.00
13.00	167.70	181.10	-1.14	3435.00	26.46	2750.00
14.00	167.10	180.00	-1.24	3444.00	26.45	2750.00
15.00	167.30	180.00	-1.17	3453.00	27.15	2750.00
16.00	168.00	182.50	-1.25	3421.00	30.00	2750.00
17.00	170.00	183.90	-1.23	3444.00	31.50	2750.00
18.00	168.00	181.50	-1.20	3453.00	31.20	2750.00
19.00	166.90	180.20	-1.30	3472.00	31.53	2750.00
20.00	166.70	179.00	-1.20	3432.00	32.00	2750.00
21.00	168.10	180.30	-1.33	3456.00	32.11	2750.00
22.00	170.40	184.10	-1.19	3454.00	32.30	2750.00
23.00	167.00	180.40	-1.30	3449.00	32.35	2750.00
24.00	167.50	181.00	-1.22	3418.00	31.63	2750.00
25.00	166.90	180.00	-1.20	3422.00	30.00	2750.00
26.00	169.20	182.00	-1.20	3424.00	29.05	2750.00
27.00	167.40	179.00	-1.43	3419.00	26.02	2750.00
28.00	170.30	181.20	-1.29	3421.00	31.20	2750.00
29.00	166.10	177.90	-2.16	3451.00	29.29	2750.00
30.00	167.20	180.40	-1.49	3400.00	31.40	2750.00
31.00	166.50	180.00	-1.51	3400.00	31.47	2750.00
32.00	167.50	181.00	-1.54	3440.00	32.15	2750.00
33.00	166.30	179.30	-1.50	3420.00	31.04	2750.00
34.00	166.30	179.00	-1.64	3425.00	31.30	2750.00
** 35.00	93.30	95.70	-1.61	240.00	30.00	2750.00
36.00	169.20	183.50	-0.20	3436.00	27.23	2750.00
37.00	165.90	178.30	-1.15	3425.00	29.02	2750.00
38.00	165.90	177.00	-1.41	3422.00	31.10	2750.00
39.00	162.50	175.20	-1.20	3320.00	31.04	2750.00
40.00	167.00	180.50	-1.00	3432.00	31.04	2750.00
41.00	169.20	181.00	-0.79	3313.00	30.74	2750.00
42.00	167.40	180.30	-1.00	3445.00	29.19	2750.00
43.00	165.30	177.00	-1.29	3410.00	31.40	2750.00
** 44.00	164.30	166.20	-1.19	166.00	33.42	2750.00
45.00	167.00	180.20	-1.12	3420.00	30.39	2750.00
46.00	168.30	182.00	-1.34	3435.00	31.05	2750.00
47.00	166.30	179.00	-1.20	3422.00	30.29	2750.00
48.00	165.50	178.20	-1.45	3418.00	26.37	2750.00
49.00	168.50	179.00	-1.40	3421.00	26.25	2750.00
50.00	164.40	177.00	-1.59	3414.00	26.61	2750.00
51.00	164.50	177.00	-1.74	3400.00	28.21	2750.00
52.00	165.90	179.40	-1.53	3415.00	29.45	2750.00
53.00	171.90	185.20	-1.20	3442.00	26.00	2750.00

**54.00	111.90	114.10	-1.57	270.00	23.17	7750.00
55.00	165.70	179.00	-0.94	3477.00	29.07	7750.00
56.00	163.00	176.40	-1.43	3419.00	26.42	7750.00
57.00	165.60	178.00	-1.56	3389.00	26.50	7750.00
58.00	168.00	181.20	-1.43	3402.00	26.30	7750.00
59.00	163.90	177.00	-1.57	3412.00	26.49	7750.00
60.00	166.70	180.10	-1.26	3419.00	26.39	7750.00
61.00	167.10	0.00	-1.18	3416.00	26.31	7750.00
**62.00	75.00	0.00	-1.92	261.00	37.45	7750.00
**63.00	94.10	90.60	-1.90	271.00	41.45	7750.00
64.00	163.60	176.70	-0.81	3443.00	26.96	7750.00
65.00	164.00	178.00	-1.20	3442.00	26.51	7750.00
66.00	162.30	175.30	-1.41	3449.00	26.64	7750.00
67.00	161.00	173.30	-1.60	3437.00	26.57	7750.00
68.00	162.50	173.60	-1.70	3385.00	26.78	7750.00
69.00	165.90	179.20	-1.66	3353.00	26.37	7750.00
70.00	165.20	175.40	-1.66	3429.00	26.78	7750.00
71.00	167.50	180.30	-1.66	3443.00	26.32	7750.00
72.00	169.20	180.10	-0.89	3451.00	26.35	7750.00
73.00	165.00	178.10	-1.00	3459.00	26.36	7750.00
74.00	162.40	175.00	-1.57	3452.00	26.73	7750.00
75.00	164.10	177.20	-1.62	3452.00	26.52	7750.00
76.00	163.60	177.00	-1.66	3437.00	26.59	7750.00
77.00	161.50	174.20	-1.65	3424.00	26.52	7750.00
78.00	162.00	175.10	-1.79	3395.00	26.52	7750.00
79.00	163.20	176.00	-1.61	3445.00	26.39	7750.00
80.00	164.50	177.00	-1.20	3434.00	26.19	7750.00
81.00	164.60	176.90	-1.27	3392.00	26.20	7750.00
82.00	167.50	178.50	-1.21	3406.00	26.33	7750.00
83.00	168.20	182.00	-1.10	3436.00	26.30	7750.00
84.00	164.30	177.60	-1.33	3440.00	26.29	7750.00
85.00	165.50	178.90	-1.28	3370.00	26.22	7750.00
86.00	157.20	169.20	-1.34	3400.00	26.00	7750.00
**87.00	103.30	120.40	-1.85	209.00	26.54	7750.00
88.00	166.50	179.00	-1.23	3407.00	26.26	7750.00
89.00	167.20	181.20	-1.16	3433.00	26.44	7750.00
90.00	168.00	182.00	-1.15	3432.00	26.02	7750.00
91.00	167.00	180.40	-1.11	3412.00	26.15	7750.00
92.00	166.20	178.00	-1.20	3431.00	26.39	7750.00
93.00	167.30	180.00	-1.11	3432.00	26.25	7750.00
94.00	164.40	177.10	-1.13	3419.00	26.22	7750.00
95.00	164.00	176.00	-1.19	3382.00	26.22	7750.00
96.00	165.10	178.40	-1.22	3423.00	26.28	7750.00
97.00	166.40	180.00	-1.23	3419.00	26.15	7750.00
98.00	165.00	176.90	-1.11	3426.00	26.32	7750.00
99.00	164.00	177.20	-1.21	3445.00	26.32	7750.00
100.00	165.60	178.00	-1.11	3453.00	26.17	7750.00
101.00	166.90	178.20	-1.02	3444.00	26.14	7750.00
102.00	164.20	177.50	-1.21	3450.00	26.10	7750.00
103.00	167.30	180.60	-1.00	3430.00	25.98	7750.00
104.00	167.20	180.50	-1.02	3402.00	26.21	7750.00
105.00	165.00	178.30	-1.40	3409.00	26.21	7750.00
106.00	163.50	176.10	-1.26	3423.00	26.32	7750.00
107.00	163.90	176.20	-1.21	3444.00	26.32	7750.00
108.00	165.00	177.90	-1.70	3427.00	26.52	7750.00

109.00	154.10	166.30	-1.22	3486.00	27.02	2750.00
110.00	163.10	175.00	-1.20	3441.00	26.62	2750.00
111.00	163.90	176.20	-1.91	3117.00	26.24	2750.00
112.00	163.00	177.00	-1.02	3433.00	26.63	2750.00
113.00	162.40	175.40	-2.12	3432.00	26.57	2750.00
114.00	163.00	176.30	-1.24	3399.00	26.66	2750.00
115.00	164.90	178.30	-1.42	3435.00	26.49	2750.00
116.00	163.00	175.20	-1.42	3435.00	26.52	2750.00
117.00	161.40	173.50	-1.29	3433.00	26.38	2750.00
118.00	170.20	183.00	-1.00	3377.00	26.23	2750.00
119.00	165.60	179.10	-1.22	3373.00	26.35	2750.00
120.00	167.90	180.00	-1.12	3359.00	26.36	2750.00
121.00	169.00	182.60	-1.12	3381.00	26.38	2750.00
122.00	171.00	184.40	-0.99	3361.00	26.10	2750.00
123.00	164.20	177.20	-1.05	3422.00	27.01	2750.00
124.00	166.20	177.60	-1.38	3447.00	26.59	2750.00
125.00	165.20	178.50	-1.48	3404.00	26.56	2750.00
126.00	168.20	179.00	-1.10	3407.00	26.44	2750.00
127.00	169.00	180.40	-1.00	3318.00	26.32	2750.00
** 128.00	77.20	86.90	-2.14	283.00	36.16	2750.00
129.00	164.20	177.00	-1.16	3440.00	26.29	2750.00
130.00	160.30	181.30	-1.50	3435.00	26.42	2750.00
131.00	164.00	176.60	-1.66	3430.00	26.27	2750.00
132.00	167.60	180.20	-1.50	3405.00	26.91	2750.00
133.00	165.30	178.40	-1.52	3412.00	26.40	2750.00
134.00	164.20	177.30	-1.69	3426.00	26.40	2750.00
135.00	164.00	176.50	-1.01	3430.00	26.52	2750.00
136.00	166.00	179.40	-1.50	3432.00	26.25	2750.00
137.00	167.30	179.20	-1.61	3395.00	26.49	2750.00
138.00	169.00	182.50	-1.52	3430.00	26.43	2750.00
139.00	168.30	180.00	-1.45	3362.00	26.32	2750.00
140.00	168.10	180.90	-1.26	3392.00	26.26	2750.00
141.00	167.90	181.20	-1.35	3382.00	26.44	2750.00
142.00	169.60	182.90	-1.32	3400.00	26.09	2750.00
143.00	171.20	182.30	-1.30	3352.00	26.49	2750.00
144.00	167.90	181.00	-1.39	3321.00	26.46	2750.00
145.00	168.00	182.50	-1.44	3326.00	26.50	2750.00
146.00	170.60	182.90	-1.22	3425.00	26.49	2750.00
147.00	167.20	180.50	-1.50	3442.00	26.40	2750.00
148.00	171.00	182.20	-1.30	3405.00	26.44	2750.00
149.00	167.30	180.00	-1.52	3411.00	26.52	2750.00
150.00	167.50	180.10	-1.46	3406.00	26.64	2750.00
151.00	164.30	177.00	-0.88	3460.00	26.54	2750.00
152.00	168.20	182.00	-1.12	3445.00	26.42	2750.00
153.00	168.90	182.20	-1.36	3431.00	26.18	2750.00
154.00	163.10	176.00	-1.49	3436.00	26.54	2750.00



TABULATED DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M1 AND M2

Test Specimens Consisted Of:

M1 - Pump #353 and 354  
M2 - Pump #356

- \* Data points were taken when outlet temperature thermocouple was malfunctioning; remaining data points were.
- \*\* Data points are automatically taken when the test is restarted after the DAS alarm system has shut it down.
- ? Suspect data point due to flowmeter transducer reading.

PUMP #353

TIME HOURS	IN FT TEMP(°F)	(10) FT TEMP(°F)	IN PRESS (PSI)	(10) PRESS (PSI)	FLOW (GPM)	DEPTH (FPM)
1.00	168.70	192.70	0.30	3393.00	21.60	2750.00
2.00	171.00	185.00	-0.20	3367.00	21.11	2750.00
3.00	173.00	193.10	-0.57	3371.00	21.18	2750.00
4.00	170.70	197.00	-0.65	3353.00	18.77	2750.00
5.00	174.60	196.60	-0.40	3377.00	18.20	2750.00
6.00	174.50	196.40	-0.57	3355.00	18.16	2750.00
7.00	174.30	195.20	-0.55	3350.00	17.47	2750.00
8.00	167.90	190.70	-0.83	3372.00	18.17	2750.00
9.00	172.60	196.50	-0.97	3375.00	18.29	2750.00
10.00	169.90	194.40	-1.00	3337.00	18.47	2750.00
11.00	170.90	194.90	-0.84	3337.00	18.77	2750.00
12.00	164.00	185.40	-1.65	3411.00	21.47	2750.00
13.00	172.00	195.20	-0.77	3377.00	18.56	2750.00
14.00	174.50	199.40	-0.77	3371.00	18.45	2750.00
15.00	131.40	134.00	-1.37	205.00	29.26	2750.00
**16.00	171.60	130.90	-1.70	209.00	23.73	2750.00
17.00	174.00	194.30	-0.75	3397.00	18.47	2750.00
18.00	170.00	194.40	-0.39	3369.00	18.44	2750.00
19.00	174.00	199.10	-0.50	3375.00	19.71	2750.00
20.00	171.50	196.00	-0.77	3373.00	19.84	2750.00
21.00	171.10	194.20	-0.75	3369.00	19.50	2750.00
**22.00	76.30	88.20	-2.07	50.00	18.14	2750.00
23.00	171.00	191.20	-0.23	3371.00	19.40	2750.00
24.00	171.90	196.20	-0.56	3367.00	19.37	2750.00
25.00	173.90	190.50	-0.67	3360.00	19.67	2750.00
**26.00	68.00	78.20	-2.07	317.00	9.29	2750.00
27.00	170.00	195.60	-0.13	3380.00	19.91	2750.00
28.00	170.60	194.90	-0.53	3366.00	19.91	2750.00
29.00	174.40	198.90	-0.54	3372.00	19.55	2750.00
30.00	175.50	196.30	-0.63	3376.00	19.67	2750.00
31.00	171.60	194.20	-0.63	3359.00	19.01	2750.00
32.00	172.40	196.10	-0.68	3360.00	19.47	2750.00
33.00	174.90	198.20	-0.77	3352.00	18.95	2750.00
34.00	171.20	194.10	-0.69	3354.00	19.68	2750.00
35.00	172.60	196.00	-0.29	3342.00	19.24	2750.00
36.00	175.50	195.00	0.04	3353.00	20.21	2750.00
37.00	171.00	193.50	-0.37	3370.00	19.20	2750.00
38.00	173.90	196.10	-0.47	3370.00	20.00	2750.00
39.00	170.00	192.40	-0.50	3343.00	19.62	2750.00
40.00	174.20	192.00	-0.20	3372.00	20.01	2750.00
41.00	173.10	196.00	-0.64	3371.00	19.74	2750.00
42.00	171.30	194.10	-0.67	3353.00	20.00	2750.00
43.00	171.10	193.40	-0.20	3352.00	19.77	2750.00
44.00	170.00	191.90	-0.73	3370.00	19.29	2750.00
**45.00	171.00	170.60	-1.67	174.00	20.33	2750.00
46.00	171.10	193.50	-0.85	3347.00	20.06	2750.00
47.00	172.40	192.50	-0.87	3347.00	19.93	2750.00
48.00	172.20	195.90	-0.86	3373.00	20.35	2750.00
49.00	173.50	197.30	-0.45	3350.00	19.80	2750.00
50.00	171.10	192.30	-0.61	3372.00	20.18	2750.00
51.00	169.00	188.00	-0.59	3347.00	18.91	2750.00
52.00	170.30	191.00	-0.60	3352.00	20.20	2750.00
53.00	170.50	193.10	-0.20	3374.00	20.36	2750.00

54.00	171.50	194.70	-0.50	3369.00	20.77	7750.00
55.00	174.70	194.50	-0.50	3333.00	20.17	7750.00
56.00	171.00	195.00	-0.50	3356.00	19.13	7750.00
57.00	172.20	192.70	-0.60	3315.00	20.59	7750.00
58.00	171.50	194.00	-0.60	3362.00	20.16	7750.00
59.00	173.50	196.60	-0.63	3342.00	20.56	7750.00
60.00	175.60	194.20	-0.50	3362.00	20.12	7750.00
61.00	171.70	194.00	-0.62	3341.00	20.11	7750.00
62.00	175.00	195.30	-0.60	3318.00	20.66	7750.00
**63.00	162.40	170.00	-1.12	184.00	30.12	7750.00
64.00	170.40	191.30	-0.39	3326.00	19.06	7750.00
65.00	170.70	192.50	-0.52	3343.00	19.04	7750.00
66.00	170.40	192.00	-0.64	3329.00	19.05	7750.00
67.00	170.30	191.50	-0.60	3321.00	19.06	7750.00
68.00	170.50	191.40	-0.62	3361.00	19.71	7750.00
69.00	172.00	191.10	-0.56	3352.00	19.81	7750.00
70.00	172.90	191.50	-0.53	3345.00	19.76	7750.00
71.00	174.50	192.50	-0.50	3314.00	19.68	7750.00
72.00	172.10	194.20	-0.64	3355.00	20.17	7750.00
73.00	170.40	191.50	-0.63	3323.00	20.12	7750.00
74.00	171.00	191.50	-0.50	3364.00	19.97	7750.00
75.00	172.00	191.50	-0.55	3366.00	19.30	7750.00
76.00	172.20	191.00	-0.60	3314.00	19.22	7750.00
77.00	170.50	191.50	-0.62	3320.00	19.09	7750.00
78.00	170.40	191.30	-0.79	3314.00	19.52	7750.00
79.00	170.60	192.20	-0.45	3322.00	20.12	7750.00
80.00	170.00	192.20	-0.00	3310.00	19.29	7750.00
81.00	173.00	194.70	-0.60	3310.00	19.47	7750.00
82.00	169.00	190.20	-0.00	3292.00	19.66	7750.00
83.00	171.30	193.20	-0.91	3360.00	19.60	7750.00
84.00	170.10	191.40	-0.09	3350.00	19.05	7750.00
85.00	172.40	194.50	-0.90	3304.00	19.02	7750.00
86.00	174.00	191.50	-0.74	3352.00	19.64	7750.00
87.00	170.20	191.10	-0.09	3312.00	19.71	7750.00
88.00	172.00	193.20	-0.90	3305.00	20.04	7750.00
89.00	174.00	191.50	-0.90	3366.00	19.72	7750.00
90.00	171.00	191.00	-0.90	3305.00	19.81	7750.00
91.00	171.50	192.00	-0.09	3349.00	19.69	7750.00
92.00	171.40	192.10	-0.00	3359.00	19.56	7750.00
93.00	172.00	192.00	-0.02	3364.00	19.09	7750.00
94.00	171.30	191.90	-0.02	3364.00	19.90	7750.00
95.00	171.50	192.30	-0.09	3366.00	19.29	7750.00
96.00	171.40	192.50	-0.00	3350.00	19.81	7750.00
97.00	171.90	194.00	-0.02	3365.00	19.47	7750.00
98.00	174.50	194.00	-0.90	3340.00	19.69	7750.00
99.00	170.20	191.60	-0.00	3300.00	19.71	7750.00
100.00	174.20	192.30	-0.09	3324.00	19.50	7750.00
101.00	171.50	191.40	-0.00	3361.00	19.40	7750.00
102.00	174.60	192.00	-0.02	3336.00	19.30	7750.00
103.00	171.50	193.00	-0.94	3323.00	19.33	7750.00
104.00	172.60	191.00	-0.92	3300.00	19.60	7750.00
105.00	174.00	193.50	-0.02	3319.00	19.45	7750.00
106.00	174.60	192.00	-0.99	3346.00	19.42	7750.00
107.00	174.00	195.60	-0.00	3342.00	19.31	7750.00
108.00	171.90	193.00	-0.20	3200.00	19.29	7750.00

109.00	171.00	191.40	-0.93	3358.00	19.70	7750.00
110.00	173.90	195.60	-0.70	3355.00	19.56	7750.00
111.00	167.70	189.70	-1.32	3349.00	19.50	7750.00
112.00	167.50	190.40	-1.46	3336.00	19.48	7750.00
* 113.00	166.50	0.00	-1.49	3337.00	19.79	7750.00
** 114.00	78.30	94.70	-1.77	289.00	16.85	7750.00
* 115.00	170.70	-136.70	-0.72	3361.00	19.87	7750.00
* 116.00	167.10	-642.30	-0.90	3339.00	19.85	7750.00
* 117.00	167.50	-910.30	-1.27	3348.00	19.92	7750.00
* 118.00	168.70	0.00	-1.32	3362.00	19.81	7750.00
119.00	173.10	143.30	-0.77	3354.00	20.14	7750.00
120.00	167.70	200.90	-1.11	3355.00	19.72	7750.00
121.00	167.10	194.50	-1.25	3358.00	19.71	7750.00
122.00	170.60	192.40	-1.15	3366.00	20.22	7750.00
123.00	169.60	191.10	-1.41	3341.00	20.23	7750.00
124.00	167.80	186.30	-1.84	3333.00	20.18	7750.00
** 125.00	98.60	100.00	-0.85	293.00	26.90	7750.00
126.00	177.10	190.50	0.15	3347.00	19.43	7750.00
127.00	167.10	181.10	-0.60	3360.00	19.07	7750.00
128.00	165.50	180.70	-1.26	3354.00	18.93	7750.00
129.00	169.80	185.50	-1.11	3354.00	18.78	7750.00
130.00	165.90	179.50	-1.27	3343.00	19.11	7750.00
131.00	167.90	180.00	-1.44	3347.00	18.90	7750.00
132.00	166.00	182.00	-1.40	3346.00	18.90	7750.00
133.00	168.60	180.50	-1.55	3331.00	18.85	7750.00
134.00	165.40	181.20	-1.20	3345.00	19.05	7750.00
** 135.00	81.90	90.20	-2.32	240.00	12.46	7750.00
136.00	170.10	180.10	-1.11	3330.00	20.29	7750.00
137.00	165.00	181.20	-1.00	3354.00	19.82	7750.00
138.00	162.00	177.00	-1.25	3334.00	20.00	7750.00
139.00	166.00	182.50	-1.36	3342.00	19.81	7750.00
140.00	162.00	175.00	-1.65	3321.00	20.23	7750.00
141.00	161.00	177.30	-1.66	3354.00	20.19	7750.00

PUMP #354

TIME HOURS	HEAT TEMP (°F)	CUMUL TEMP (°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SEFFD (PSI)
1.00	168.70	168.70	0.30	3473.00	24.11	2750.00
2.00	171.50	180.20	0.20	3466.00	24.13	2750.00
3.00	173.00	193.20	0.17	3444.00	23.98	2750.00
4.00	170.70	186.00	0.15	3450.00	24.24	2750.00
5.00	174.10	187.00	0.40	3397.00	24.37	2750.00
6.00	174.50	187.00	0.12	3377.00	24.47	2750.00
7.00	174.30	186.70	0.15	3463.00	24.37	2750.00
8.00	167.90	189.10	0.13	3440.00	24.64	2750.00
9.00	172.60	187.70	0.12	3374.00	24.64	2750.00
10.00	169.90	185.70	1.00	3377.00	24.75	2750.00
11.00	170.90	185.00	0.04	3412.00	24.41	2750.00
12.00	164.00	184.20	1.15	3451.00	23.31	2750.00
13.00	172.00	187.00	0.77	3341.00	24.26	2750.00
14.00	174.50	191.20	0.77	3443.00	24.06	2750.00
**15.00	131.40	133.00	1.37	272.00	30.85	2750.00
**16.00	121.00	130.70	1.70	275.00	30.84	2750.00
17.00	174.00	186.30	0.75	3392.00	24.27	2750.00
18.00	170.00	187.00	0.39	3460.00	22.85	2750.00
19.00	174.00	191.00	0.50	3427.00	23.22	2750.00
20.00	171.50	189.30	0.72	3462.00	23.43	2750.00
21.00	171.10	187.10	0.75	3445.00	23.31	2750.00
**22.00	76.30	68.30	2.07	267.00	31.11	2750.00
23.00	171.00	184.00	0.23	3397.00	23.46	2750.00
24.00	171.90	189.10	0.16	3452.00	23.25	2750.00
25.00	173.90	190.00	0.12	3390.00	23.31	2750.00
**26.00	60.00	77.70	2.02	250.00	31.22	2750.00
27.00	170.00	189.00	0.13	3331.00	22.29	2750.00
28.00	170.60	188.30	0.13	3449.00	23.01	2750.00
29.00	174.40	192.20	0.14	3333.00	22.84	2750.00
30.00	175.50	191.30	0.13	3361.00	22.84	2750.00
31.00	171.00	187.90	0.13	3350.00	23.39	2750.00
32.00	172.40	189.00	0.10	3330.00	23.31	2750.00
33.00	174.90	192.40	0.72	3330.00	23.04	2750.00
34.00	171.70	187.00	0.19	3343.00	23.35	2750.00
35.00	172.60	189.70	0.79	3332.00	23.32	2750.00
36.00	175.50	189.40	0.00	3322.00	23.29	2750.00
37.00	171.00	187.50	0.32	3342.00	23.24	2750.00
38.00	173.90	191.00	0.42	3326.00	23.04	2750.00
39.00	170.00	186.10	0.50	3344.00	23.29	2750.00
40.00	174.20	186.00	0.20	3343.00	23.24	2750.00
41.00	173.10	180.00	0.14	3356.00	23.19	2750.00
42.00	171.30	188.10	0.12	3333.00	23.24	2750.00
43.00	171.10	187.40	0.70	3340.00	23.37	2750.00
44.00	170.00	186.40	0.73	3330.00	23.34	2750.00
**45.00	171.00	171.00	1.12	260.00	30.00	2750.00
46.00	171.10	187.00	0.15	3331.00	23.46	2750.00
47.00	172.40	186.00	0.12	3331.00	23.62	2750.00
48.00	172.70	180.10	0.16	3330.00	23.36	2750.00
49.00	173.50	180.90	0.45	3310.00	23.25	2750.00
50.00	171.10	186.00	0.11	3340.00	23.33	2750.00
51.00	169.90	183.70	0.19	3332.00	23.46	2750.00
52.00	170.30	186.00	0.10	3320.00	23.39	2750.00
53.00	170.50	187.20	0.20	3331.00	23.32	2750.00

54.00	171.50	188.50	-0.50	3521.00	23.27	2750.00
55.00	174.20	189.50	-0.50	3522.00	23.44	2750.00
56.00	171.00	189.10	-0.50	3540.00	23.39	2750.00
57.00	172.20	187.40	-0.60	3534.00	23.43	2750.00
58.00	171.50	188.00	-0.60	3521.00	23.58	2750.00
59.00	173.50	191.00	-0.63	3552.00	23.31	2750.00
60.00	175.00	189.00	-0.50	3543.00	23.19	2750.00
61.00	171.20	188.20	-0.62	3516.00	23.39	2750.00
62.00	175.00	190.00	-0.60	3525.00	23.15	2750.00
**63.00	167.40	189.00	-1.12	3500.00	21.36	2750.00
64.00	170.40	188.00	-0.39	3529.00	23.56	2750.00
65.00	170.20	188.20	-0.52	3515.00	23.54	2750.00
66.00	170.40	188.20	-0.64	3540.00	23.39	2750.00
67.00	170.30	185.90	-0.60	3522.00	23.51	2750.00
68.00	170.50	185.00	-0.62	3498.00	23.28	2750.00
69.00	172.00	185.50	-0.56	3506.00	23.22	2750.00
70.00	172.90	186.10	-0.53	3490.00	23.42	2750.00
71.00	174.50	188.10	-0.58	3503.00	23.41	2750.00
72.00	172.10	188.40	-0.64	3496.00	23.56	2750.00
73.00	170.40	185.90	-0.63	3465.00	23.49	2750.00
74.00	171.00	186.00	-0.58	3468.00	23.65	2750.00
75.00	172.00	188.00	-0.55	3520.00	23.53	2750.00
76.00	172.20	186.00	-0.68	3489.00	23.53	2750.00
77.00	170.50	185.00	-0.62	3463.00	23.54	2750.00
78.00	170.40	185.90	-0.79	3469.00	23.52	2750.00
79.00	170.60	186.60	-0.45	3476.00	23.46	2750.00
80.00	170.00	187.10	-0.00	3495.00	23.34	2750.00
81.00	173.00	190.50	-0.68	3480.00	23.36	2750.00
82.00	169.00	185.40	-0.68	3490.00	23.28	2750.00
83.00	171.30	187.00	-0.91	3469.00	23.13	2750.00
84.00	170.10	185.00	-0.89	3485.00	23.51	2750.00
85.00	172.40	188.90	-0.90	3469.00	23.22	2750.00
86.00	174.00	186.30	-0.74	3480.00	23.29	2750.00
87.00	170.20	188.00	-0.89	3462.00	23.38	2750.00
88.00	172.00	188.20	-0.90	3504.00	23.10	2750.00
89.00	174.00	186.20	-0.90	3475.00	23.32	2750.00
90.00	171.90	186.40	-0.90	3474.00	23.38	2750.00
91.00	171.50	186.00	-0.89	3478.00	23.39	2750.00
92.00	171.40	186.60	-0.88	3460.00	23.29	2750.00
93.00	172.00	186.90	-0.82	3493.00	23.21	2750.00
94.00	171.30	186.60	-0.82	3469.00	23.59	2750.00
95.00	171.50	187.20	-0.89	3470.00	23.39	2750.00
96.00	171.40	187.10	-0.88	3499.00	23.44	2750.00
97.00	171.90	188.50	-0.82	3472.00	23.14	2750.00
98.00	174.50	190.10	-0.90	3482.00	23.13	2750.00
99.00	170.20	186.40	-0.80	3461.00	23.23	2750.00
100.00	174.20	188.10	-0.89	3483.00	23.24	2750.00
101.00	171.50	186.40	-0.88	3485.00	23.24	2750.00
102.00	174.60	191.60	-0.82	3470.00	22.82	2750.00
103.00	171.50	188.20	-0.94	3510.00	23.24	2750.00
104.00	172.60	187.00	-0.92	3462.00	23.38	2750.00
105.00	174.00	189.50	-0.82	3470.00	23.16	2750.00
106.00	174.60	187.00	-0.99	3480.00	23.15	2750.00
107.00	174.00	190.00	-0.88	3473.00	22.92	2750.00
108.00	171.90	188.20	-0.79	3489.00	23.22	2750.00

109.00	171.00	188.50	-0.93	3516.00	73.16	7750.00
110.00	173.90	190.50	-0.78	3512.00	72.97	7750.00
111.00	167.70	183.90	-1.32	3493.00	73.26	7750.00
112.00	167.50	184.50	-1.46	3491.00	73.26	7750.00
113.00	166.50	182.50	-1.49	3478.00	73.61	7750.00
** 114.00	78.30	93.80	-1.77	3400.00	19.87	7750.00
115.00	170.20	186.70	-0.77	3495.00	73.80	7750.00
116.00	167.10	182.00	-0.90	3479.00	74.40	7750.00
117.00	167.50	182.70	-1.27	3482.00	74.24	7750.00
118.00	168.70	182.50	-1.37	3489.00	74.18	7750.00
119.00	173.10	188.50	-0.77	3460.00	73.89	7750.00
120.00	167.20	183.40	-1.11	3473.00	74.14	7750.00
121.00	167.10	182.30	-1.25	3460.00	74.16	7750.00
122.00	170.60	186.40	-1.15	3489.00	74.89	7750.00
123.00	169.60	185.70	-1.41	3482.00	74.10	7750.00
124.00	167.80	180.90	-1.84	3473.00	74.26	7750.00
** 125.00	98.60	112.10	-0.05	240.00	28.53	7750.00
126.00	177.10	193.40	-0.15	3450.00	73.49	7750.00
127.00	167.10	187.60	-0.68	3450.00	75.47	7750.00
128.00	165.50	186.30	-1.26	3451.00	75.44	7750.00
129.00	169.80	191.40	-1.11	3440.00	74.98	7750.00
130.00	165.90	185.40	-1.27	3441.00	75.13	7750.00
131.00	167.90	186.40	-1.44	3405.00	75.31	7750.00
132.00	166.00	187.10	-1.48	3430.00	75.93	7750.00
133.00	168.60	187.40	-1.55	3448.00	75.47	7750.00
134.00	165.40	186.80	-1.20	3461.00	75.71	7750.00
** 135.00	81.90	91.20	-2.32	218.00	14.18	7750.00
136.00	170.10	188.00	-1.11	3406.00	74.85	7750.00
137.00	165.00	186.60	-1.00	3425.00	74.48	7750.00
138.00	162.00	183.30	-1.25	3434.00	74.45	7750.00
139.00	166.00	187.90	-1.36	3418.00	74.24	7750.00
140.00	162.80	181.50	-1.65	3416.00	74.81	7750.00
141.00	161.80	183.20	-1.66	3426.00	74.77	7750.00

PUMP #356

DATE	TIME	TEMP	DIFF	WIND	WIND DIR	WIND SP	WIND DIR
1.00	171.00	184.00	0.00	3420.00	23.00	270.00	
2.00	171.00	183.00	0.00	3300.00	23.00	270.00	
3.00	173.00	189.00	0.00	3250.00	23.00	270.00	
4.00	176.00	191.00	0.00	3290.00	23.00	270.00	
5.00	174.00	189.00	0.00	3400.00	23.00	270.00	
6.00	174.00	189.00	0.00	3410.00	23.00	270.00	
7.00	174.00	189.00	0.00	3400.00	23.00	270.00	
8.00	172.00	187.00	0.00	3400.00	23.00	270.00	
9.00	172.00	189.00	0.00	3400.00	23.00	270.00	
10.00	172.00	185.00	0.00	3410.00	23.00	270.00	
11.00	170.00	181.00	0.00	3400.00	23.00	270.00	
12.00	174.00	185.00	-0.05	3400.00	24.00	270.00	
13.00	172.00	187.00	0.00	3350.00	23.00	270.00	
14.00	174.00	189.00	0.00	3410.00	23.00	270.00	
**15.00	171.00	183.00	-0.00	3300.00	23.00	270.00	
**16.00	171.00	189.00	-0.00	3400.00	23.00	270.00	
17.00	171.00	189.00	0.00	3410.00	23.00	270.00	
18.00	170.00	185.00	0.00	3370.00	23.00	270.00	
19.00	174.00	189.00	0.00	3430.00	23.00	270.00	
20.00	171.00	189.00	0.00	3390.00	23.00	270.00	
21.00	171.00	181.00	0.00	3200.00	23.00	270.00	
**22.00	170.00	185.00	-0.00	3400.00	23.00	270.00	
23.00	171.00	184.00	0.00	3410.00	23.00	270.00	
24.00	171.00	187.00	0.00	3400.00	24.00	270.00	
25.00	173.00	189.00	0.00	3410.00	23.00	270.00	
**26.00	170.00	180.00	-0.00	3300.00	23.00	270.00	
27.00	170.00	184.00	0.00	3400.00	24.00	270.00	
28.00	170.00	186.00	0.00	3300.00	23.00	270.00	
29.00	174.00	189.00	0.00	3400.00	23.00	270.00	
30.00	175.00	190.00	0.00	3400.00	23.00	270.00	
31.00	171.00	184.00	0.00	3410.00	23.00	270.00	
32.00	170.00	187.00	0.00	3370.00	23.00	270.00	
33.00	170.00	186.00	0.00	3290.00	23.00	270.00	
34.00	171.00	186.00	0.00	3400.00	23.00	270.00	
35.00	170.00	187.00	0.00	3300.00	23.00	270.00	
36.00	175.00	189.00	0.00	3400.00	23.00	270.00	
37.00	171.00	185.00	0.00	3400.00	23.00	270.00	
38.00	170.00	189.00	0.00	3400.00	23.00	270.00	
39.00	170.00	184.00	0.00	3400.00	24.00	270.00	
40.00	174.00	187.00	0.00	3400.00	24.00	270.00	
41.00	173.00	189.00	0.00	3400.00	23.00	270.00	
42.00	171.00	181.00	0.00	3400.00	24.00	270.00	
43.00	171.00	186.00	0.00	3300.00	24.00	270.00	
44.00	170.00	185.00	0.00	3200.00	24.00	270.00	
**45.00	171.00	174.00	-0.00	100.00	23.00	270.00	
46.00	171.00	180.00	0.00	3300.00	24.00	270.00	
47.00	172.00	180.00	0.00	3410.00	24.00	270.00	
48.00	172.00	189.00	0.00	3400.00	24.00	270.00	
49.00	172.00	189.00	0.00	3400.00	24.00	270.00	
**50.00	171.00	185.00	0.00	0.00	24.00	270.00	
51.00	169.00	184.00	0.00	3400.00	24.00	270.00	
52.00	170.00	180.00	0.00	3400.00	24.00	270.00	
53.00	170.00	185.00	0.00	3400.00	24.00	270.00	



54.00	171.50	186.50	0.50	3461.00	24.64	775.00
55.00	174.70	189.70	0.50	3455.00	24.59	775.00
56.00	171.50	187.00	0.50	3438.00	24.54	775.00
57.00	172.50	186.10	0.60	3433.00	24.56	775.00
58.00	171.50	186.50	0.60	3421.00	24.54	775.00
59.00	173.50	189.20	0.63	3442.00	24.26	775.00
60.00	175.00	189.20	0.50	3426.00	24.39	775.00
61.00	171.20	186.50	0.62	3439.00	24.57	775.00
62.00	175.00	190.20	0.60	3436.00	24.26	775.00
**63.00	167.40	189.50	1.12	187.00	32.60	775.00
64.00	170.40	184.50	0.39	3453.00	24.57	775.00
65.00	170.20	185.00	0.50	3454.00	24.57	775.00
66.00	170.40	185.50	0.64	3454.00	24.37	775.00
67.00	170.50	184.90	0.60	3437.00	24.41	775.00
68.00	170.50	184.90	0.62	3436.00	24.52	775.00
69.00	172.00	185.20	0.56	3426.00	24.28	775.00
70.00	172.90	186.20	0.53	3442.00	24.39	775.00
71.00	174.50	189.20	0.58	3451.00	24.11	775.00
72.00	172.10	187.20	0.64	3446.00	24.58	775.00
73.00	170.40	185.50	0.63	3449.00	24.11	775.00
74.00	171.50	185.10	0.58	3426.00	24.55	775.00
75.00	172.50	185.50	0.55	3439.00	24.26	775.00
76.00	172.20	185.00	0.68	3441.00	24.40	775.00
77.00	170.50	185.50	0.62	3441.00	24.52	775.00
78.00	170.40	185.20	0.29	3436.00	24.54	775.00
79.00	170.00	185.20	0.45	3459.00	24.42	775.00
80.00	170.50	186.00	0.50	3452.00	24.28	775.00
81.00	173.50	189.50	0.68	3426.00	24.16	775.00
82.00	169.50	184.00	0.68	3449.00	24.52	775.00
83.00	171.50	186.50	0.81	3451.00	24.56	775.00
84.00	170.10	185.10	0.69	3462.00	24.65	775.00
85.00	172.40	187.00	0.50	3442.00	24.56	775.00
86.00	174.00	186.50	0.74	3448.00	24.49	775.00
87.00	170.20	185.20	0.69	3462.00	24.50	775.00
88.00	172.00	187.50	0.50	3465.00	24.68	775.00
89.00	174.00	186.50	0.50	3449.00	24.67	775.00
90.00	171.90	186.10	0.50	3446.00	26.37	775.00
91.00	171.50	186.10	0.69	3456.00	26.53	775.00
92.00	171.40	186.00	0.68	3444.00	27.73	775.00
93.00	172.00	186.50	0.62	3444.00	26.52	775.00
94.00	171.50	186.00	0.67	3459.00	27.09	775.00
95.00	171.50	186.50	0.69	3455.00	27.09	775.00
96.00	171.40	186.20	0.68	3450.00	26.58	775.00
97.00	171.50	187.50	0.62	3436.00	26.57	775.00
98.00	174.50	190.10	0.50	3463.00	26.96	775.00
99.00	170.20	185.50	0.66	3450.00	26.42	775.00
100.00	174.20	189.10	0.69	3454.00	26.32	775.00
101.00	171.50	185.50	0.66	3443.00	26.54	775.00
102.00	174.00	186.10	0.62	3446.00	26.53	775.00
103.00	171.50	186.50	0.64	3459.00	26.21	775.00
104.00	172.00	186.50	0.62	3442.00	26.39	775.00
105.00	174.00	189.00	0.67	3444.00	26.88	775.00
106.00	174.00	189.20	0.69	3445.00	26.56	775.00
107.00	174.00	189.20	0.68	3460.00	26.81	775.00
108.00	171.50	186.20	0.29	3453.00	41.01	775.00

109.00	171.00	165.50	0.50	3455.00	32.51	2750.00
110.00	173.50	169.00	-0.70	3460.00	43.11	2750.00
111.00	167.70	162.40	-1.70	3460.00	35.67	2750.00
? 112.00	167.50	162.00	-1.40	3460.00	54.44	2750.00
? 113.00	166.50	160.70	-1.49	3460.00	52.00	2750.00
** 114.00	70.30	90.70	-1.77	300.00	41.40	2750.00
115.00	170.20	165.10	-0.77	3450.00	24.41	2750.00
116.00	167.10	161.40	-0.90	3440.00	24.46	2750.00
117.00	167.50	161.90	-1.27	3450.00	24.31	2750.00
118.00	168.70	162.20	-1.37	3470.00	24.45	2750.00
119.00	173.10	168.00	-0.77	3460.00	24.13	2750.00
120.00	167.70	162.50	-1.11	3450.00	24.73	2750.00
121.00	167.10	161.50	-1.25	3470.00	24.51	2750.00
122.00	170.60	168.10	-1.15	3480.00	24.46	2750.00
123.00	169.60	164.50	-1.41	3460.00	24.32	2750.00
124.00	167.60	160.60	-1.64	3450.00	24.33	2750.00
125.00	90.60	100.20	-0.65	3500.00	27.69	2750.00
126.00	177.10	192.70	0.15	3400.00	25.97	2750.00
127.00	167.10	170.50	-0.60	3467.00	24.20	2750.00
128.00	165.50	173.20	-1.26	3464.00	24.25	2750.00
* 129.00	169.60	0.00	-1.11	3444.00	24.15	2750.00
130.00	165.90	179.90	-1.27	3452.00	24.40	2750.00
131.00	167.90	167.30	-1.44	3457.00	24.45	2750.00
132.00	166.00	206.20	-1.48	3449.00	26.67	2750.00
133.00	168.60	163.50	-1.55	3446.00	24.27	2750.00
134.00	165.40	175.20	-1.76	3457.00	24.45	2750.00
** 135.00	81.90	94.50	-2.37	180.00	30.67	2750.00
136.00	170.10	162.40	-1.11	3424.00	24.49	2750.00
137.00	165.00	179.60	-1.00	3402.00	24.61	2750.00
138.00	162.00	170.60	-1.25	3370.00	24.62	2750.00
139.00	166.00	161.00	-1.76	3427.00	24.50	2750.00
140.00	162.00	175.00	-1.65	3424.00	24.60	2750.00
141.00	161.00	176.50	-1.66	3444.00	24.69	2750.00

TABULATED DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M3

Test Specimens Consisted Of:

Pump #364, 366, and 367

- \* Data points were taken when outlet temperature thermocouple was malfunctioning; remaining data points were.
- \*\* Drive coupling in gearbox failed therefore pump shaft was not rotating.

PUMP #364

TIME HOURS	INLET TEMP.(#F)	OUTLET TEMP.(#F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPED (RPM)
1.00	167.90	177.40	1.60	2950.00	18.34	1800.00
2.00	141.50	150.50	1.42	2937.00	21.67	1800.00
3.00	165.00	174.40	1.51	2976.00	22.04	1800.00
4.00	144.90	153.90	1.40	2949.00	21.56	1800.00
5.00	146.70	155.70	1.38	2908.00	21.50	1800.00
6.00	153.20	162.50	1.27	2865.00	21.97	1800.00
7.00	165.30	174.00	1.31	2900.00	21.73	1800.00
8.00	161.10	170.40	1.23	2863.00	21.26	1800.00
9.00	162.00	169.50	1.26	2850.00	20.20	1800.00
10.00	172.30	182.00	1.35	2849.00	21.35	1800.00
11.00	163.00	172.60	1.28	2806.00	21.73	1800.00
12.00	166.40	175.00	1.32	2834.00	20.63	1800.00
13.00	169.30	179.00	1.31	2805.00	21.93	1800.00
14.00	162.20	171.90	1.33	2895.00	21.04	1800.00
15.00	170.00	179.50	1.31	2783.00	21.76	1800.00
16.00	159.40	169.00	1.24	2828.00	22.37	1800.00
17.00	163.30	172.70	1.34	2867.00	22.44	1800.00
18.00	170.30	179.00	1.36	2790.00	22.39	1800.00
19.00	163.40	173.10	1.40	2867.00	22.17	1800.00
20.00	169.40	178.70	1.30	2813.00	22.43	1800.00
21.00	165.10	175.50	1.28	2800.00	22.30	1800.00
22.00	174.60	184.30	1.36	2847.00	22.31	1800.00
23.00	167.30	175.00	1.30	2915.00	22.41	1800.00
24.00	163.40	173.00	1.20	2829.00	22.42	1800.00
25.00	173.60	183.00	1.31	2801.00	22.69	1800.00
26.00	155.00	165.90	1.17	2890.00	21.16	1800.00
27.00	166.00	176.50	1.24	2837.00	22.56	1800.00
28.00	161.40	171.00	1.24	2913.00	22.55	1800.00
29.00	153.60	163.00	1.10	2921.00	21.13	1800.00
* 30.00	145.30	144.60	1.33	3011.00	22.23	1800.00
31.00	168.60	176.50	1.52	2800.00	21.53	1800.00
* 32.00	149.20	128.70	1.06	3055.00	22.32	1800.00
* 33.00	151.00	141.00	1.22	3011.00	23.30	1800.00
34.00	154.20	163.20	1.46	2899.00	22.95	1800.00
35.00	160.00	172.50	1.57	2900.00	22.69	1800.00
36.00	174.00	183.50	1.54	2843.00	22.60	1800.00
37.00	160.70	169.60	1.52	2852.00	22.26	1800.00
38.00	150.90	166.40	1.44	2874.00	22.10	1800.00
39.00	157.20	166.00	1.45	2848.00	22.41	1800.00
40.00	150.20	166.70	1.46	2850.00	22.10	1800.00
41.00	155.20	165.70	1.34	2890.00	22.13	1800.00
42.00	155.30	164.60	1.32	2870.00	21.56	1800.00
43.00	150.20	160.30	1.24	2850.00	22.11	1800.00
44.00	153.10	162.30	1.28	2856.00	22.06	1800.00
45.00	157.10	166.30	1.31	2863.00	21.09	1800.00
46.00	153.00	162.50	1.32	2834.00	22.07	1800.00
47.00	153.20	162.40	1.28	2901.00	22.06	1800.00
48.00	156.00	166.50	1.32	2913.00	22.06	1800.00
49.00	152.00	162.30	1.27	2805.00	22.07	1800.00
50.00	152.50	162.00	1.29	2865.00	22.10	1800.00
51.00	152.30	161.90	1.25	2863.00	22.00	1800.00
52.00	150.90	161.00	1.20	2809.00	22.00	1800.00
53.00	152.30	161.90	1.24	2846.00	22.06	1800.00

54.00	152.10	161.30	1.24	2898.00	77.00	1800.00
55.00	156.60	165.70	1.24	2826.00	71.87	1800.00
56.00	158.30	159.90	1.21	2863.00	71.99	1800.00
57.00	154.20	163.70	1.21	2905.00	77.10	1800.00
58.00	152.20	161.30	1.22	2882.00	71.24	1800.00
59.00	153.00	163.30	1.33	2837.00	77.04	1800.00
60.00	161.40	169.40	1.32	2776.00	72.18	1800.00
61.00	153.30	163.00	1.38	2893.00	77.11	1800.00
62.00	153.70	163.20	1.19	2789.00	77.24	1800.00
63.00	159.50	168.20	1.39	2809.00	71.54	1800.00
64.00	165.20	166.00	1.26	2787.00	20.38	1800.00
65.00	165.00	166.30	1.29	2886.00	18.23	1800.00
66.00	159.00	168.40	1.35	2865.00	21.28	1800.00
67.00	162.50	171.80	1.28	2792.00	21.20	1800.00
68.00	155.90	165.00	1.40	2900.00	21.14	1800.00
69.00	158.50	160.40	1.32	2848.00	20.96	1800.00
70.00	155.90	165.50	1.28	2864.00	22.34	1800.00
71.00	157.00	167.60	1.26	2903.00	22.45	1800.00
72.00	156.00	165.50	1.18	2894.00	16.72	1800.00
73.00	161.10	170.60	1.27	2850.00	20.18	1800.00
74.00	155.20	165.00	1.16	2926.00	20.12	1800.00
75.00	155.70	165.20	1.25	2868.00	20.22	1800.00
76.00	154.20	164.40	1.28	2820.00	19.93	1800.00
* 77.00	162.20	171.00	0.83	3061.00	73.09	1800.00
78.00	159.20	169.00	1.32	2845.00	18.04	1800.00
79.00	159.00	169.50	1.28	2917.00	18.04	1800.00
80.00	155.20	165.30	1.26	2855.00	18.87	1800.00
81.00	161.30	170.20	1.23	2937.00	22.39	1800.00
82.00	158.30	167.50	1.26	2839.00	22.31	1800.00
83.00	155.20	165.50	1.28	2898.00	22.39	1800.00
84.00	161.60	170.90	1.15	2857.00	22.22	1800.00
85.00	155.00	165.30	1.18	2880.00	21.18	1800.00
86.00	155.00	164.20	1.17	2866.00	22.42	1800.00
87.00	156.50	166.20	1.20	2930.00	22.39	1800.00
88.00	157.20	166.00	1.14	2876.00	22.38	1800.00
89.00	154.00	164.40	1.07	2816.00	22.42	1800.00
90.00	152.20	162.50	1.17	2882.00	22.44	1800.00
91.00	161.00	171.40	1.14	2952.00	22.26	1800.00
92.00	154.00	164.00	1.12	2918.00	22.45	1800.00
93.00	162.00	172.10	1.07	2841.00	22.33	1800.00
94.00	162.50	171.10	1.13	2869.00	22.46	1800.00
95.00	154.20	164.00	1.07	2816.00	22.47	1800.00
96.00	152.60	162.00	1.12	2870.00	22.54	1800.00
97.00	152.60	162.40	1.11	2913.00	22.57	1800.00
98.00	159.00	168.40	1.06	2850.00	22.59	1800.00
99.00	153.20	163.40	1.13	2868.00	22.37	1800.00
100.00	160.00	170.10	1.00	2822.00	22.41	1800.00
101.00	156.60	166.10	1.11	2866.00	22.57	1800.00
102.00	160.00	169.50	1.09	2919.00	22.73	1800.00
103.00	152.20	162.50	1.13	2924.00	22.50	1800.00
104.00	153.20	163.50	1.04	2845.00	22.44	1800.00
105.00	151.00	161.50	1.42	2863.00	22.29	1800.00
106.00	154.20	164.40	1.39	2997.00	22.36	1800.00
107.00	152.10	162.00	1.43	2889.00	22.35	1800.00
108.00	148.90	158.20	1.32	2907.00	22.24	1800.00

109.00	143.10	152.20	1.32	2965.00	21.54	1800.00
110.00	152.30	161.40	1.32	2841.00	22.54	1800.00
111.00	137.00	146.70	1.30	2991.00	22.33	1800.00
112.00	141.00	146.30	1.56	2975.00	21.75	1800.00
113.00	143.20	153.10	1.77	2880.00	22.43	1800.00
114.00	147.70	157.10	1.29	2909.00	21.83	1800.00
*115.00	157.70	127.00	0.93	3026.00	21.80	1800.00
*116.00	155.00	145.10	1.22	2985.00	22.77	1800.00
117.00	152.60	161.60	1.37	2899.00	21.57	1800.00
118.00	155.50	160.40	1.44	2870.00	21.26	1800.00
119.00	136.50	146.30	1.17	2979.00	21.40	1800.00
120.00	156.00	165.70	1.37	2842.00	22.00	1800.00
121.00	146.50	155.50	1.19	2890.00	21.45	1800.00
122.00	159.30	168.50	1.30	2915.00	22.04	1800.00
123.00	161.50	166.40	1.28	2868.00	21.80	1800.00
124.00	152.20	161.30	1.38	2900.00	22.39	1800.00
*125.00	161.60	171.00	0.91	2853.00	21.90	1800.00
126.00	142.00	152.40	1.21	2965.00	22.68	1800.00
127.00	145.00	154.20	1.22	2968.00	21.69	1800.00
128.00	150.90	160.00	1.55	2848.00	21.30	1800.00
129.00	152.50	161.00	1.25	2812.00	22.64	1800.00
130.00	146.00	155.70	1.21	2823.00	22.26	1800.00
131.00	157.00	166.00	1.30	2947.00	21.59	1800.00
132.00	131.70	141.70	1.06	2970.00	21.21	1800.00
*133.00	165.10	114.70	0.73	3021.00	21.9	1800.00
134.00	144.20	154.40	1.30	2925.00	21.35	1800.00
135.00	153.50	162.90	1.28	2900.00	21.71	1800.00
136.00	142.90	153.40	1.14	2975.00	22.13	1800.00
137.00	148.20	158.30	1.39	2939.00	22.51	1800.00
138.00	149.70	159.40	1.19	2962.00	22.50	1800.00
139.00	150.50	160.20	1.19	2967.00	22.30	1800.00
140.00	161.00	170.90	1.29	2834.00	22.39	1800.00
*141.00	145.00	89.40	3.30	0.00	0.00	1800.00
*142.00	160.20	83.10	3.31	0.00	0.00	1800.00

PUMP #366

TIME HOURS	INLET TEMP(°F)	OUTLET TEMP(°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPEED (RPM)
1.00	167.90	177.60	1.60	2916.00	19.61	1800.00
2.00	141.50	150.70	1.42	2958.00	19.69	1800.00
3.00	165.00	174.50	1.51	2943.00	19.54	1800.00
4.00	144.90	154.30	1.40	2995.00	22.36	1800.00
5.00	146.70	156.10	1.38	2903.00	19.18	1800.00
6.00	153.20	163.30	1.27	2924.00	19.65	1800.00
7.00	165.30	175.00	1.31	2932.00	19.59	1800.00
8.00	161.10	170.60	1.23	2904.00	19.77	1800.00
9.00	162.00	169.90	1.26	2894.00	19.59	1800.00
10.00	177.30	182.00	1.35	2912.00	19.62	1800.00
11.00	163.00	173.10	1.28	2911.00	19.77	1800.00
12.00	169.30	179.00	1.31	2914.00	19.66	1800.00
13.00	162.20	172.30	1.33	2897.00	19.70	1800.00
14.00	170.00	179.70	1.31	2933.00	19.57	1800.00
15.00	159.40	169.50	1.24	2933.00	19.78	1800.00
16.00	163.30	173.30	1.34	2914.00	19.55	1800.00
17.00	170.30	180.10	1.36	2898.00	19.60	1800.00
18.00	163.40	170.70	1.40	2888.00	19.95	1800.00
19.00	169.40	179.00	1.30	2977.00	19.51	1800.00
20.00	165.10	175.60	1.28	2903.00	19.19	1800.00
21.00	174.60	184.10	1.36	2897.00	19.61	1800.00
22.00	167.30	176.90	1.30	2938.00	19.51	1800.00
23.00	163.40	173.00	1.20	2913.00	19.59	1800.00
24.00	173.60	183.10	1.31	2932.00	19.37	1800.00
25.00	155.00	166.00	1.17	2946.00	19.43	1800.00
26.00	166.00	176.60	1.24	2924.00	19.33	1800.00
27.00	161.40	170.50	1.24	2949.00	19.33	1800.00
28.00	153.60	161.50	1.10	2903.00	19.77	1800.00
* 29.00	145.30	143.90	1.33	3035.00	20.48	1800.00
30.00	160.60	176.90	1.52	2912.00	19.42	1800.00
* 31.00	149.20	127.20	1.06	3047.00	19.47	1800.00
* 32.00	151.00	140.50	1.22	3010.00	19.22	1800.00
33.00	154.20	163.50	1.46	2961.00	19.41	1800.00
34.00	160.00	177.50	1.57	2957.00	19.35	1800.00
35.00	174.00	183.00	1.54	2906.00	20.07	1800.00
36.00	160.70	170.10	1.52	2959.00	19.31	1800.00
37.00	150.90	166.20	1.44	2920.00	19.50	1800.00
38.00	157.20	166.40	1.45	2944.00	19.65	1800.00
39.00	150.20	167.00	1.46	2942.00	19.06	1800.00
40.00	155.20	164.20	1.34	2934.00	19.06	1800.00
41.00	155.30	164.00	1.32	2932.00	20.22	1800.00
42.00	150.20	160.20	1.24	2920.00	19.73	1800.00
43.00	153.10	163.00	1.20	2949.00	20.10	1800.00
44.00	157.10	167.00	1.31	2939.00	19.95	1800.00
45.00	153.00	163.00	1.32	2941.00	19.40	1800.00
46.00	153.20	162.90	1.20	2930.00	19.97	1800.00
47.00	156.00	166.40	1.32	2950.00	19.05	1800.00
48.00	152.00	162.60	1.27	2924.00	19.63	1800.00
49.00	152.50	162.10	1.29	2913.00	20.10	1800.00
50.00	152.30	162.00	1.25	2917.00	19.72	1800.00
51.00	150.90	160.40	1.20	2923.00	19.53	1800.00
52.00	152.30	162.20	1.24	2924.00	19.46	1800.00
53.00	152.10	161.40	1.24	2920.00	19.30	1800.00

54.00	156.60	166.40	1.74	2943.00	19.95	1800.00
55.00	158.30	168.30	1.71	2937.00	19.44	1800.00
56.00	154.20	163.00	1.21	2911.00	20.07	1800.00
57.00	152.20	162.10	1.22	2928.00	19.56	1800.00
58.00	153.00	163.50	1.33	2934.00	19.46	1800.00
59.00	161.40	169.40	1.32	2922.00	19.35	1800.00
60.00	153.30	163.20	1.38	2925.00	19.51	1800.00
61.00	153.70	163.70	1.19	2914.00	19.26	1800.00
62.00	159.50	166.60	1.39	2941.00	19.30	1800.00
63.00	165.20	165.00	1.26	2951.00	19.50	1800.00
64.00	165.00	167.00	1.29	2926.00	22.94	1800.00
65.00	159.00	167.50	1.35	2923.00	19.68	1800.00
66.00	162.50	172.00	1.28	2933.00	19.57	1800.00
67.00	155.90	166.40	1.40	2913.00	19.77	1800.00
68.00	150.50	161.50	1.32	2922.00	19.28	1800.00
69.00	155.90	164.50	1.28	2950.00	19.77	1800.00
70.00	157.00	168.00	1.26	2912.00	19.41	1800.00
71.00	156.00	166.10	1.18	2913.00	19.06	1800.00
72.00	161.10	171.00	1.27	2929.00	19.76	1800.00
73.00	155.20	163.12	1.16	2924.00	19.56	1800.00
74.00	155.70	165.50	1.25	2909.00	19.48	1800.00
75.00	154.70	164.00	1.28	2938.00	19.72	1800.00
* 76.00	162.20	121.00	0.83	3025.00	19.48	1800.00
77.00	159.20	169.20	1.32	2929.00	18.93	1800.00
78.00	159.00	167.60	1.28	2945.00	19.34	1800.00
79.00	155.20	165.20	1.26	2925.00	19.42	1800.00
80.00	161.30	170.20	1.23	2904.00	19.63	1800.00
81.00	158.30	166.30	1.26	2933.00	19.64	1800.00
82.00	155.20	165.50	1.28	2931.00	19.61	1800.00
83.00	161.60	171.20	1.15	2924.00	19.58	1800.00
84.00	155.00	165.90	1.18	2914.00	19.50	1800.00
85.00	155.00	165.30	1.17	2914.00	19.25	1800.00
86.00	156.50	166.00	1.20	2927.00	19.63	1800.00
87.00	157.20	167.20	1.14	2939.00	19.69	1800.00
88.00	154.00	164.60	1.07	2913.00	19.60	1800.00
89.00	152.20	163.00	1.17	2917.00	19.19	1800.00
90.00	161.00	171.00	1.14	2939.00	19.00	1800.00
91.00	154.00	164.20	1.12	2915.00	19.49	1800.00
92.00	162.00	172.20	1.07	2923.00	19.74	1800.00
93.00	162.50	171.00	1.13	2932.00	19.29	1800.00
94.00	154.20	164.50	1.07	2915.00	19.54	1800.00
95.00	157.60	167.20	1.12	2933.00	19.35	1800.00
96.00	157.60	167.20	1.11	2931.00	19.50	1800.00
97.00	159.00	168.40	1.06	2922.00	19.00	1800.00
98.00	153.20	163.00	1.13	2933.00	19.44	1800.00
99.00	160.00	170.00	1.00	2910.00	19.25	1800.00
100.00	156.60	166.60	1.11	2923.00	19.01	1800.00
101.00	160.00	173.60	1.09	2900.00	19.30	1800.00
102.00	157.20	167.30	1.13	2936.00	19.39	1800.00
103.00	153.20	164.00	1.04	2916.00	19.39	1800.00
104.00	151.00	161.50	1.42	2908.00	19.55	1800.00
105.00	154.30	164.00	1.39	2919.00	19.48	1800.00
106.00	152.10	159.90	1.43	2917.00	19.63	1800.00
107.00	148.90	159.00	1.32	2930.00	19.20	1800.00
108.00	143.10	151.00	1.32	2907.00	19.18	1800.00



109.00	152.30	161.90	1.32	2958.00	19.53	1800.00
110.00	137.00	146.00	1.38	2946.00	19.79	1800.00
111.00	141.00	145.90	1.56	2924.00	21.10	1800.00
112.00	143.20	152.70	1.27	2930.00	19.41	1800.00
113.00	147.70	157.10	1.29	2953.00	19.43	1800.00
* 114.00	157.70	125.90	0.93	3016.00	22.54	1800.00
* 115.00	155.00	145.20	1.22	2993.00	19.77	1800.00
116.00	152.60	161.90	1.37	2960.00	19.07	1800.00
117.00	155.50	160.20	1.44	2906.00	20.70	1800.00
118.00	136.50	146.00	1.17	2960.00	19.37	1800.00
119.00	156.00	165.70	1.37	2941.00	19.23	1800.00
120.00	146.50	156.00	1.19	2964.00	19.28	1800.00
121.00	159.30	168.60	1.30	2943.00	19.00	1800.00
122.00	161.50	165.50	1.28	2910.00	21.19	1800.00
123.00	152.20	161.40	1.38	2919.00	19.20	1800.00
* 124.00	161.60	120.10	0.91	3020.00	22.62	1800.00
125.00	142.00	152.50	1.21	2943.00	19.24	1800.00
126.00	145.00	154.40	1.22	2962.00	18.02	1800.00
127.00	150.90	161.30	1.55	2921.00	19.47	1800.00
128.00	152.50	162.10	1.25	2920.00	19.20	1800.00
129.00	146.00	156.10	1.21	2925.00	19.18	1800.00
130.00	157.00	166.30	1.30	2943.00	18.94	1800.00
131.00	131.70	142.10	1.06	2950.00	19.64	1800.00
* 132.00	165.10	115.40	0.73	3019.00	22.61	1800.00
133.00	144.20	154.20	1.30	2933.00	19.51	1800.00
134.00	153.50	162.00	1.28	2972.00	18.76	1800.00
135.00	142.90	151.60	1.14	2922.00	19.13	1800.00
136.00	140.20	150.90	1.39	2913.00	19.20	1800.00
137.00	149.70	159.00	1.19	2916.00	19.13	1800.00
138.00	150.50	160.50	1.19	2900.00	19.23	1800.00
139.00	161.00	171.50	1.29	2914.00	19.20	1800.00
140.00	145.00	154.30	3.30	2929.00	19.00	1800.00
141.00	160.20	169.20	3.31	2935.00	19.90	1800.00

PUMP #367

TIME	IN FT	OUTLET	IN PRESS	OUT PRESS	FLOW	SPEED
HOURS	TEMP(°F)	TEMP(°F)	(PSI)	(PSI)	(GPM)	(RPM)
1.00	167.90	176.10	1.60	3087.00	19.16	1800.00
2.00	141.50	150.40	1.42	3087.00	18.90	1800.00
3.00	165.00	173.40	1.51	3052.00	19.07	1800.00
4.00	144.90	153.00	1.40	3103.00	18.99	1800.00
5.00	146.70	155.70	1.38	3065.00	19.70	1800.00
6.00	153.70	162.30	1.77	3067.00	18.93	1800.00
7.00	165.30	173.50	1.31	3064.00	19.02	1800.00
8.00	161.10	169.30	1.73	3066.00	19.00	1800.00
9.00	162.00	165.50	1.26	3053.00	19.00	1800.00
10.00	177.30	180.50	1.35	3067.00	18.89	1800.00
11.00	163.00	171.90	1.28	2964.00	18.00	1800.00
12.00	169.30	177.90	1.31	3000.00	18.58	1800.00
13.00	162.70	170.00	1.33	3075.00	18.77	1800.00
14.00	170.00	178.60	1.31	3071.00	18.70	1800.00
15.00	159.40	167.90	1.24	3001.00	19.15	1800.00
16.00	163.30	171.90	1.34	3062.00	19.15	1800.00
17.00	170.30	178.90	1.36	3060.00	19.10	1800.00
18.00	163.40	170.10	1.40	2937.00	19.15	1800.00
19.00	169.40	177.00	1.30	3023.00	19.13	1800.00
20.00	165.10	173.00	1.28	2990.00	19.25	1800.00
21.00	174.60	182.90	1.36	3060.00	19.23	1800.00
22.00	167.30	175.50	1.30	3110.00	19.23	1800.00
23.00	163.40	171.90	1.20	3040.00	19.20	1800.00
24.00	173.60	181.40	1.31	3001.00	19.24	1800.00
25.00	156.00	162.50	1.17	3057.00	19.00	1800.00
26.00	166.00	175.00	1.24	3100.00	18.75	1800.00
27.00	161.40	169.60	1.24	2964.00	18.81	1800.00
28.00	153.60	159.90	1.10	2860.00	19.00	1800.00
29.00	145.30	143.70	1.33	3079.00	19.81	1800.00
30.00	168.60	174.30	1.52	3004.00	19.03	1800.00
* 31.00	149.70	170.10	1.06	3171.00	19.33	1800.00
* 32.00	151.60	140.20	1.22	3122.00	19.61	1800.00
33.00	154.20	162.10	1.46	3099.00	19.00	1800.00
34.00	160.00	176.00	1.57	3094.00	18.95	1800.00
35.00	174.00	181.90	1.54	3001.00	18.96	1800.00
36.00	160.70	165.90	1.52	3041.00	19.05	1800.00
37.00	150.90	162.00	1.44	2871.00	19.00	1800.00
38.00	157.70	166.00	1.45	3006.00	19.06	1800.00
39.00	150.70	166.10	1.46	3069.00	19.07	1800.00
40.00	155.70	164.70	1.34	2820.00	19.07	1800.00
41.00	155.30	164.30	1.32	2979.00	19.10	1800.00
42.00	150.70	159.00	1.24	3041.00	19.14	1800.00
43.00	153.10	162.00	1.28	3043.00	19.04	1800.00
44.00	157.10	166.00	1.31	3009.00	19.00	1800.00
45.00	153.00	161.00	1.32	3074.00	19.06	1800.00
46.00	153.70	161.50	1.28	3075.00	19.03	1800.00
47.00	156.00	165.00	1.32	3032.00	19.05	1800.00
48.00	152.00	161.30	1.77	3023.00	19.06	1800.00
49.00	152.50	160.00	1.29	3024.00	19.02	1800.00
50.00	152.30	160.70	1.25	3032.00	18.99	1800.00
51.00	150.90	159.90	1.20	2790.00	19.00	1800.00
52.00	152.30	160.90	1.24	3052.00	19.06	1800.00
53.00	152.10	160.40	1.24	2943.00	19.02	1800.00

54.00	156.60	165.10	1.24	3069.00	19.04	1000.00
55.00	150.30	158.70	1.21	3042.00	19.05	1000.00
56.00	154.20	163.00	1.21	2544.00	19.06	1000.00
57.00	152.20	159.90	1.22	3009.00	19.11	1000.00
58.00	153.00	162.50	1.33	3051.00	19.16	1000.00
59.00	161.40	164.60	1.32	3074.00	19.15	1000.00
60.00	153.30	162.30	1.38	2965.00	19.15	1000.00
61.00	153.70	162.50	1.19	3012.00	19.31	1000.00
62.00	159.50	164.40	1.39	2628.00	18.90	1000.00
63.00	165.20	165.30	1.26	2766.00	18.81	1000.00
64.00	165.00	165.50	1.29	3034.00	20.01	1000.00
65.00	159.00	167.70	1.35	2642.00	18.78	1000.00
66.00	162.50	170.00	1.28	3047.00	18.89	1000.00
67.00	155.90	164.90	1.40	3061.00	18.89	1000.00
68.00	150.50	159.50	1.32	3054.00	18.88	1000.00
69.00	155.90	164.50	1.28	2571.00	19.15	1000.00
70.00	157.00	166.90	1.26	3070.00	19.21	1000.00
71.00	156.00	164.40	1.18	3071.00	18.73	1000.00
72.00	161.10	169.50	1.27	3078.00	18.95	1000.00
73.00	155.20	163.00	1.16	2433.00	18.95	1000.00
74.00	155.70	164.20	1.25	2906.00	18.90	1000.00
75.00	154.70	163.20	1.28	3062.00	18.95	1000.00
* 76.00	162.20	121.60	0.83	3160.00	23.20	1000.00
77.00	159.70	168.60	1.32	2946.00	23.53	1000.00
78.00	159.00	168.50	1.28	2876.00	20.49	1000.00
79.00	155.70	164.30	1.26	2972.00	20.48	1000.00
80.00	161.30	169.30	1.23	3022.00	19.07	1000.00
81.00	150.30	166.00	1.26	2820.00	19.22	1000.00
82.00	155.70	164.50	1.28	3073.00	19.18	1000.00
83.00	161.60	169.90	1.15	3061.00	19.20	1000.00
84.00	155.00	164.50	1.18	3075.00	19.04	1000.00
85.00	155.00	163.50	1.17	3078.00	19.04	1000.00
86.00	156.50	165.00	1.20	2924.00	18.88	1000.00
87.00	157.20	166.30	1.14	3072.00	19.06	1000.00
88.00	154.00	163.00	1.07	2954.00	19.00	1000.00
89.00	152.20	162.00	1.17	3002.00	19.04	1000.00
90.00	161.00	170.10	1.14	3074.00	18.99	1000.00
91.00	154.00	163.40	1.12	3063.00	18.93	1000.00
92.00	162.00	171.20	1.07	3075.00	18.95	1000.00
93.00	162.50	165.40	1.13	3000.00	18.90	1000.00
94.00	154.20	163.50	1.07	3069.00	19.05	1000.00
95.00	157.60	166.30	1.12	2947.00	18.97	1000.00
96.00	157.60	166.60	1.11	3050.00	18.93	1000.00
97.00	159.00	167.50	1.06	3021.00	18.91	1000.00
98.00	153.70	162.50	1.13	3053.00	18.92	1000.00
99.00	160.00	169.20	1.00	3000.00	18.88	1000.00
100.00	156.60	165.20	1.11	3000.00	24.68	1000.00
101.00	160.00	160.50	1.09	3077.00	18.97	1000.00
102.00	157.20	166.50	1.13	2994.00	19.03	1000.00
103.00	153.20	163.20	1.04	3055.00	18.87	1000.00
104.00	151.00	159.20	1.42	2791.00	18.77	1000.00
105.00	154.30	163.10	1.39	2964.00	18.82	1000.00
106.00	152.10	160.60	1.43	2820.00	18.75	1000.00
107.00	148.90	157.20	1.32	3028.00	18.74	1000.00
108.00	143.10	151.00	1.32	2001.00	19.20	1000.00

109.00	152.30	160.90	1.32	3055.00	18.74	1800.00
110.00	137.00	146.30	1.30	3043.00	18.60	1800.00
111.00	141.00	146.40	1.56	2821.00	18.00	1800.00
112.00	143.20	152.40	1.27	2794.00	18.76	1800.00
113.00	147.70	156.60	1.29	2990.00	18.64	1800.00
* 114.00	157.70	126.90	0.93	3125.00	19.38	1800.00
* 115.00	155.00	144.70	1.22	3004.00	19.05	1800.00
116.00	152.60	161.20	1.37	3024.00	18.91	1800.00
117.00	155.50	159.00	1.44	2864.00	18.70	1800.00
118.00	136.50	146.00	1.17	3027.00	18.70	1800.00
119.00	156.00	165.20	1.37	2982.00	18.81	1800.00
120.00	146.50	155.40	1.19	3065.00	18.77	1800.00
121.00	159.30	167.50	1.30	3060.00	18.92	1800.00
122.00	161.50	165.70	1.28	2828.00	18.68	1800.00
123.00	152.20	158.00	1.38	2724.00	18.66	1800.00
* 124.00	161.60	121.00	0.91	3163.00	19.37	1800.00
125.00	142.00	151.00	1.21	3006.00	18.77	1800.00
126.00	145.00	153.20	1.22	3007.00	19.09	1800.00
127.00	150.90	159.00	1.55	2998.00	18.91	1800.00
128.00	152.50	161.20	1.25	3022.00	18.74	1800.00
129.00	146.00	154.90	1.21	3009.00	18.71	1800.00
130.00	157.00	165.30	1.30	3066.00	19.03	1800.00
131.00	131.20	140.40	1.06	2967.00	18.74	1800.00
* 132.00	165.10	113.60	0.73	3146.00	19.10	1800.00
133.00	144.20	153.20	1.30	2723.00	18.73	1800.00
134.00	153.50	162.10	1.28	3054.00	19.00	1800.00
135.00	142.90	151.50	1.14	2826.00	18.75	1800.00
136.00	148.20	157.20	1.39	3057.00	18.79	1800.00
137.00	149.20	158.40	1.19	3043.00	18.70	1800.00
138.00	150.50	159.30	1.19	3040.00	18.76	1800.00
139.00	161.00	169.20	1.29	3092.00	18.77	1800.00
140.00	145.00	151.50	3.30	3034.00	18.64	1800.00
141.00	160.20	168.40	3.31	3036.00	18.90	1800.00

TABULATED DATA OF 1,000 HR. TEST FOR MANUFACTURER M1 AND M2

Test Specimens Consisted Of:

- M1 - Pump #352
- M2 - Pump #357 and 360

Pump #352

TIME HOURS	INLET TEMP.(°F)	OUTLET TEMP.(°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPEED (RPM)
1.00	164.20	175.00	0.12	3150.00	25.21	7750.00
2.00	164.20	180.50	-0.83	3120.00	24.79	7750.00
3.00	165.70	179.00	-0.94	3086.00	24.78	7750.00
4.00	164.00	180.50	-1.04	3073.00	25.03	7750.00
5.00	164.50	174.30	-1.21	3056.00	25.11	7750.00
6.00	163.70	175.00	-1.29	3028.00	25.30	7750.00
7.00	164.40	179.00	-1.50	3000.00	25.26	7750.00
8.00	168.10	180.00	-1.41	2974.00	25.31	7750.00
9.00	167.00	177.00	-1.62	2941.00	25.45	7750.00
10.00	166.50	179.30	-1.04	2900.00	25.44	7750.00
11.00	162.00	179.90	-1.49	2902.00	25.72	7750.00
12.00	164.50	178.00	-1.50	2883.00	25.69	7750.00
13.00	163.70	178.00	-1.51	2860.00	26.16	7750.00
14.00	166.50	183.70	-0.41	3004.00	21.48	7750.00
15.00	165.10	181.70	-1.01	3104.00	21.70	7750.00
16.00	164.90	181.50	-1.03	2971.00	21.73	7750.00
17.00	164.00	182.00	-1.09	2970.00	21.82	7750.00
18.00	165.00	181.30	-0.76	3081.00	21.47	7750.00
19.00	164.30	180.00	-0.89	2912.00	21.59	7750.00
20.00	164.30	180.40	-1.01	2921.00	21.66	7750.00
21.00	166.40	181.20	-1.20	2722.00	21.84	7750.00
22.00	164.30	180.50	-0.82	3006.00	21.76	7750.00
23.00	168.00	185.40	-0.86	3047.00	21.63	7750.00
24.00	170.00	186.20	-0.89	3050.00	21.52	7750.00
25.00	168.00	185.00	-1.22	3031.00	21.79	7750.00
26.00	164.00	180.90	-1.62	2992.00	22.10	7750.00
27.00	167.50	181.00	-1.44	2131.00	21.90	7750.00
28.00	168.00	184.50	-1.59	1790.00	22.00	7750.00
29.00	165.00	182.00	-1.54	2232.00	21.89	7750.00
30.00	165.30	181.00	-1.81	2073.00	21.00	7750.00
31.00	166.00	179.00	-1.86	2095.00	21.95	7750.00
32.00	166.00	179.30	-1.92	2484.00	22.00	7750.00
33.00	168.00	184.30	-1.93	2061.00	21.66	7750.00
34.00	165.00	182.30	-0.00	3192.00	22.00	7750.00
35.00	167.50	184.00	-0.93	3118.00	21.94	7750.00
36.00	140.00	180.50	-1.04	3132.00	22.12	7750.00
37.00	165.50	183.50	-1.10	3129.00	22.10	7750.00
38.00	163.00	180.40	-1.52	3105.00	22.42	7750.00
39.00	168.40	184.00	-0.86	3144.00	22.06	7750.00
40.00	169.00	183.40	-0.85	3101.00	21.65	7750.00
41.00	165.50	180.00	-1.14	3009.00	22.25	7750.00
42.00	168.00	184.00	-1.29	3139.00	22.05	7750.00
43.00	167.00	182.50	-1.32	3059.00	22.32	7750.00
44.00	164.00	179.00	-1.40	3115.00	22.35	7750.00
45.00	169.30	184.20	-1.24	3091.00	22.42	7750.00
46.00	164.20	179.40	-1.45	3091.00	22.50	7750.00
47.00	164.50	179.50	-1.52	3112.00	22.55	7750.00
48.00	168.40	183.50	-1.59	3110.00	22.51	7750.00
49.00	165.50	180.50	-1.64	3116.00	22.50	7750.00
50.00	166.30	181.40	-1.56	3090.00	22.46	7750.00
51.00	167.00	182.40	-1.48	3092.00	22.25	7750.00

52.00	167.00	182.30	-1.49	3075.00	77.51	7750.00
53.00	165.70	181.00	-1.59	3101.00	77.65	7750.00
54.00	165.30	180.50	-1.48	3112.00	77.54	7750.00
55.00	167.50	182.00	-1.53	3123.00	77.30	7750.00
56.00	168.00	183.00	-1.40	3075.00	77.57	7750.00
57.00	166.40	181.30	-1.45	3068.00	77.39	7750.00
58.00	165.70	180.00	-1.49	3067.00	77.54	7750.00
59.00	165.50	180.50	-1.46	3077.00	77.47	7750.00
60.00	165.70	180.30	-1.51	3104.00	77.39	7750.00
61.00	166.90	181.60	-1.55	3105.00	77.73	7750.00
62.00	171.00	186.70	-0.17	3089.00	77.04	7750.00
63.00	167.60	182.50	-0.75	3084.00	77.56	7750.00
64.00	166.70	181.30	-1.01	3082.00	77.55	7750.00
65.00	166.50	181.10	-1.10	3076.00	77.15	7750.00
66.00	170.70	184.90	-1.32	3086.00	77.37	7750.00
67.00	169.00	183.50	-1.30	3094.00	77.77	7750.00
68.00	169.90	183.60	-1.50	3074.00	77.41	7750.00
69.00	165.90	183.20	-1.48	3084.00	77.39	7750.00
70.00	165.50	184.20	-1.54	3068.00	73.14	7750.00
71.00	169.60	181.40	-1.39	3071.00	77.74	7750.00
72.00	169.40	182.30	-1.51	3095.00	77.50	7750.00
73.00	173.50	184.20	-0.73	3100.00	77.36	7750.00
74.00	167.30	182.40	-1.10	3083.00	709.40	7750.00
75.00	170.70	185.20	-0.91	3099.00	77.55	7750.00
76.00	169.50	187.00	-1.09	3071.00	77.81	7750.00
77.00	170.00	186.40	1.44	3071.00	77.54	7750.00
78.00	170.70	186.60	1.41	3097.00	77.05	7750.00
79.00	171.10	184.70	1.26	3081.00	77.50	7750.00
80.00	171.10	184.70	1.26	3081.00	77.50	7750.00
81.00	150.90	173.10	1.37	3157.00	73.37	7750.00
82.00	172.70	182.20	1.49	2915.00	77.90	7750.00
83.00	173.00	182.50	1.35	2906.00	77.90	7750.00
84.00	168.90	183.10	1.23	2978.00	77.90	7750.00
85.00	168.00	182.20	1.20	2976.00	73.02	7750.00
86.00	167.50	181.90	1.20	2979.00	73.29	7750.00
87.00	172.30	186.40	1.57	2937.00	73.09	7750.00
88.00	167.00	179.00	1.43	2960.00	77.92	7750.00
89.00	167.00	181.70	1.40	2962.00	73.11	7750.00
90.00	167.40	181.30	1.30	2990.00	77.77	7750.00
91.00	167.40	181.00	1.10	2931.00	77.95	7750.00
92.00	167.00	181.10	1.30	2981.00	73.17	7750.00
93.00	167.20	181.40	1.32	2983.00	73.05	7750.00
94.00	166.90	179.30	1.35	2926.00	73.24	7750.00
95.00	168.00	181.00	1.34	2910.00	73.17	7750.00
96.00	168.20	182.50	1.25	2991.00	73.17	7750.00
97.00	169.30	183.50	1.24	2976.00	73.12	7750.00
98.00	171.70	186.20	1.16	2950.00	77.65	7750.00
99.00	170.50	184.60	1.50	2898.00	77.70	7750.00
100.00	170.70	184.20	1.55	3070.00	77.83	7750.00
101.00	166.40	181.10	1.39	3091.00	73.18	7750.00
102.00	172.00	184.90	1.44	3096.00	77.89	7750.00
103.00	171.50	187.00	1.40	3121.00	73.19	7750.00
104.00	167.00	182.10	1.44	3129.00	73.21	7750.00
105.00	168.20	183.10	1.42	3060.00	73.00	7750.00
106.00	168.30	183.40	1.36	3078.00	73.32	7750.00

107.00	171.20	186.40	1.46	3095.00	73.29	7750.00
108.00	172.00	184.90	1.46	3092.00	73.05	7750.00
109.00	166.40	181.20	1.42	3128.00	72.08	7750.00
110.00	167.20	182.20	1.41	3064.00	73.16	7750.00
111.00	167.90	183.00	1.44	3094.00	73.14	7750.00
112.00	168.30	183.50	1.40	3073.00	72.65	7750.00
113.00	167.10	182.00	1.40	3118.00	73.24	7750.00
114.00	167.50	182.30	1.39	3084.00	73.00	7750.00
115.00	167.30	181.90	1.34	3116.00	73.12	7750.00
116.00	166.50	181.10	1.36	3088.00	73.01	7750.00
117.00	166.50	180.30	1.38	3032.00	73.04	7750.00
118.00	167.00	182.60	1.34	3094.00	72.08	7750.00
119.00	168.40	183.50	1.25	3082.00	73.14	7750.00
120.00	169.20	185.00	1.31	3102.00	72.00	7750.00
121.00	171.20	187.00	1.34	3116.00	72.28	7750.00
122.00	169.50	184.50	1.28	3096.00	73.00	7750.00
123.00	168.00	183.50	1.28	3100.00	73.16	7750.00
124.00	166.60	181.00	1.41	3101.00	73.77	7750.00
125.00	166.40	181.00	1.31	3089.00	73.29	7750.00
126.00	172.50	187.50	1.34	3131.00	73.11	7750.00
127.00	166.90	182.10	1.28	3219.00	73.11	7750.00
128.00	171.40	186.90	1.15	3201.00	73.06	7750.00
129.00	168.20	183.00	1.28	3226.00	73.28	7750.00
130.00	166.10	181.00	1.69	3106.00	73.45	7750.00
131.00	167.90	183.00	1.06	3190.00	73.38	7750.00
132.00	167.00	182.00	1.13	3217.00	73.03	7750.00
133.00	167.10	182.30	1.14	3174.00	73.38	7750.00
134.00	173.20	186.00	1.24	3218.00	73.11	7750.00
135.00	171.20	182.60	1.18	3193.00	73.27	7750.00
136.00	168.00	184.20	1.16	3191.00	73.11	7750.00
137.00	167.40	182.50	1.14	1199.00	73.00	7750.00
138.00	168.20	181.20	1.15	3209.00	73.29	7750.00
139.00	169.20	184.00	1.47	3194.00	73.42	7750.00
140.00	172.00	187.00	1.47	3204.00	73.17	7750.00
141.00	169.50	184.30	1.43	3181.00	72.95	7750.00
142.00	174.30	182.40	1.41	3222.00	73.38	7750.00
143.00	174.50	189.20	1.42	3196.00	73.03	7750.00
144.00	169.30	184.30	1.37	3209.00	73.22	7750.00
145.00	167.40	182.40	1.36	3196.00	72.03	7750.00
146.00	168.00	182.00	1.40	3205.00	73.18	7750.00
147.00	170.20	185.50	1.41	3203.00	73.26	7750.00
148.00	167.50	182.50	1.36	3190.00	73.09	7750.00
149.00	166.90	181.20	1.35	3216.00	73.12	7750.00
150.00	169.00	184.00	1.50	3156.00	73.40	7750.00
151.00	169.00	184.20	1.43	3213.00	73.28	7750.00
152.00	172.00	191.50	1.51	3212.00	73.11	7750.00
153.00	173.20	188.00	1.30	3208.00	73.33	7750.00
154.00	170.50	185.50	1.22	3202.00	73.23	7750.00
155.00	171.10	186.20	1.23	3208.00	73.10	7750.00
156.00	168.20	183.50	1.17	3212.00	73.29	7750.00
157.00	173.50	186.00	1.28	3189.00	73.26	7750.00
158.00	173.10	188.10	1.19	3230.00	72.92	7750.00
159.00	167.40	182.00	1.08	3228.00	73.20	7750.00
160.00	167.20	182.00	1.09	3224.00	73.48	7750.00
161.00	167.90	182.30	1.13	3219.00	73.32	7750.00



162.00	168.60	182.30	1.14	3276.00	73.78	7750.00
163.00	167.50	181.50	1.16	3219.00	73.63	7750.00
164.00	172.40	187.00	1.21	3217.00	72.97	7750.00
165.00	172.10	186.00	1.24	3230.00	73.06	7750.00
166.00	168.20	182.00	1.20	3216.00	73.36	7750.00
167.00	167.50	182.00	1.22	3235.00	73.56	7750.00
168.00	167.70	182.40	1.23	3229.00	73.75	7750.00
169.00	167.70	182.30	1.17	3218.00	73.59	7750.00
170.00	170.30	183.00	1.23	3203.00	73.76	7750.00
171.00	168.00	182.50	1.21	3202.00	73.76	7750.00
172.00	170.20	183.50	1.23	3197.00	73.76	7750.00
173.00	171.00	186.00	1.19	3178.00	73.76	7750.00
174.00	172.90	187.70	1.20	3230.00	73.49	7750.00
175.00	172.60	187.50	1.20	3209.00	73.45	7750.00
176.00	171.00	185.30	1.21	3217.00	73.36	7750.00
177.00	171.40	186.40	1.19	3216.00	73.11	7750.00
178.00	172.50	187.30	1.20	3144.00	73.55	7750.00
179.00	171.10	186.00	1.21	3212.00	73.29	7750.00
180.00	169.00	183.60	1.19	3216.00	73.14	7750.00
181.00	167.90	182.20	1.31	3211.00	73.34	7750.00
182.00	169.00	184.40	1.34	3182.00	73.35	7750.00
183.00	169.90	184.50	1.31	3203.00	73.72	7750.00
184.00	168.00	182.50	1.31	3217.00	73.57	7750.00
185.00	168.10	182.50	1.28	3197.00	73.53	7750.00
186.00	171.30	185.90	1.34	3205.00	73.45	7750.00
187.00	171.40	186.10	1.52	3188.00	73.35	7750.00
188.00	173.20	187.70	1.34	3193.00	73.40	7750.00
189.00	168.90	183.30	1.28	3194.00	73.49	7750.00
190.00	168.90	182.00	1.25	3161.00	73.58	7750.00
191.00	176.20	189.60	1.58	3145.00	72.00	7750.00
192.00	172.60	186.20	1.51	3203.00	73.01	7750.00
193.00	175.20	190.20	1.52	3277.00	72.97	7750.00
194.00	175.30	190.50	1.54	3200.00	72.96	7750.00
195.00	172.40	187.00	1.54	3202.00	73.45	7750.00
196.00	170.00	186.60	1.42	3221.00	73.33	7750.00
197.00	167.30	183.30	1.40	3201.00	73.02	7750.00
198.00	167.10	183.00	1.35	3215.00	73.52	7750.00
199.00	170.00	184.00	1.35	3169.00	73.61	7750.00
200.00	169.20	181.50	1.35	3131.00	73.57	7750.00
201.00	169.20	180.90	1.26	3210.00	73.70	7750.00
202.00	175.30	189.50	1.00	3249.00	73.76	7750.00
203.00	176.00	189.20	0.72	3243.00	73.22	7750.00
204.00	178.00	192.50	1.06	3276.00	73.22	7750.00
205.00	178.40	192.40	0.82	3232.00	73.17	7750.00
206.00	179.90	192.90	0.84	3248.00	73.01	7750.00
207.00	173.60	188.10	0.92	3242.00	73.29	7750.00
208.00	180.00	194.50	0.77	3245.00	73.33	7750.00
209.00	179.00	193.50	0.85	3238.00	73.45	7750.00
210.00	171.00	186.20	1.65	3252.00	73.82	7750.00
211.00	169.50	184.00	1.59	3196.00	73.83	7750.00
212.00	171.10	185.00	1.59	3236.00	73.85	7750.00
213.00	170.00	184.50	1.59	3221.00	73.86	7750.00
214.00	169.00	176.40	1.22	3232.00	79.73	7750.00
215.00	170.00	184.40	1.54	3230.00	73.68	7750.00
216.00	172.00	186.50	1.52	3251.00	73.79	7750.00

217.00	175.00	190.50	1.55	3237.00	23.56	2750.00
218.00	170.90	185.10	1.50	3214.00	23.74	2750.00
219.00	173.90	188.30	1.52	3229.00	23.69	2750.00
220.00	171.50	207.30	1.47	3225.00	26.55	2750.00
221.00	167.00	181.60	1.65	3214.00	24.07	2750.00
222.00	167.00	180.60	1.64	3224.00	24.13	2750.00
223.00	163.70	177.10	1.46	3249.00	24.30	2750.00
224.00	163.00	176.50	1.39	3254.00	24.44	2750.00
225.00	162.00	176.30	1.26	3226.00	24.79	2750.00
226.00	163.40	176.50	1.24	3230.00	24.67	2750.00
227.00	164.10	177.60	1.18	3229.00	24.50	2750.00
228.00	176.50	190.00	1.40	3233.00	24.00	2750.00
229.00	175.40	188.60	1.38	3242.00	24.13	2750.00
230.00	171.00	185.00	1.34	3222.00	24.32	2750.00
231.00	172.10	186.10	1.37	3237.00	24.22	2750.00
232.00	171.30	185.10	1.35	3219.00	24.17	2750.00
233.00	173.50	187.00	1.34	3245.00	24.11	2750.00
234.00	174.90	189.10	1.35	3249.00	24.13	2750.00
235.00	173.50	186.70	1.32	3219.00	24.03	2750.00
236.00	176.00	191.10	1.38	3220.00	24.04	2750.00
237.00	179.90	185.00	1.35	3251.00	24.16	2750.00
238.00	170.60	184.50	1.31	3237.00	24.11	2750.00
239.00	172.90	191.40	1.35	3221.00	23.96	2750.00
240.00	172.00	187.00	1.30	3241.00	24.10	2750.00
241.00	176.00	189.00	1.31	3217.00	23.96	2750.00
242.00	176.00	191.00	1.35	3250.00	23.87	2750.00
243.00	170.70	184.60	1.30	3220.00	24.24	2750.00
244.00	176.10	190.40	1.49	3235.00	24.05	2750.00
245.00	174.00	188.00	1.47	3240.00	24.15	2750.00
246.00	171.70	185.70	1.46	3244.00	24.20	2750.00
247.00	174.10	188.20	1.47	3243.00	24.16	2750.00
248.00	174.00	188.00	1.46	3249.00	24.48	2750.00
249.00	172.00	191.90	1.51	3243.00	24.24	2750.00
250.00	176.00	189.90	1.43	3233.00	24.87	2750.00
251.00	171.00	186.00	1.41	3242.00	25.07	2750.00
252.00	175.90	190.30	1.43	3235.00	24.75	2750.00
253.00	172.00	186.30	1.43	3216.00	24.97	2750.00
254.00	172.70	186.60	1.36	3222.00	31.09	2750.00
255.00	172.50	186.70	1.41	3231.00	24.95	2750.00
256.00	174.01	188.50	1.39	3242.00	25.09	2750.00
257.00	172.00	191.50	1.44	3221.00	24.95	2750.00
258.00	176.90	190.90	1.43	3234.00	25.09	2750.00
259.00	166.70	180.30	1.30	3253.00	25.43	2750.00
260.00	174.00	188.20	1.42	3239.00	25.04	2750.00
261.00	178.40	192.50	1.44	3236.00	24.89	2750.00
262.00	166.00	179.50	1.30	3244.00	25.37	2750.00
263.00	175.00	189.00	1.42	3242.00	25.64	2750.00
264.00	178.50	192.00	1.44	3251.00	25.49	2750.00
265.00	174.50	185.20	1.40	3239.00	24.20	2750.00
266.00	173.90	187.20	1.39	3240.00	24.91	2750.00
267.00	172.00	192.00	1.43	3244.00	24.81	2750.00
268.00	180.00	194.20	1.41	3240.00	24.77	2750.00
269.00	166.20	180.10	1.28	3230.00	25.43	2750.00
270.00	175.30	189.20	1.36	3243.00	24.96	2750.00
271.00	178.30	192.40	1.38	3230.00	24.82	2750.00

777.00	179.30	193.50	1.56	3275.00	24.95	7750.00
773.00	178.10	192.40	1.83	3231.00	24.81	7750.00
774.00	179.50	193.90	1.70	3243.00	24.79	7750.00
775.00	173.90	187.60	1.60	3227.00	25.07	7750.00
776.00	179.20	203.00	1.95	3254.00	19.50	7750.00
777.00	174.70	202.50	2.73	3370.00	16.97	7750.00
778.00	174.50	257.40	3.00	1861.00	4.67	7750.00
779.00	174.60	85.30	2.84	0.00	0.00	7750.00

Pump #357

TIME HOURS	INLET TEMP (°F)	OUTLET TEMP (°F)	IN PRES (PSI)	OUT PRES (PSI)	FLOW (GPM)	SPEED (RPM)
1.00	164.70	173.00	0.12	2962.00	26.01	7750.00
2.00	164.70	175.50	-0.83	2966.00	26.21	7750.00
3.00	165.70	177.00	-0.94	2965.00	26.02	7750.00
4.00	164.00	176.00	-1.04	2961.00	25.70	7750.00
5.00	164.50	173.90	-1.21	2952.00	25.74	7750.00
6.00	163.70	174.60	-1.29	2944.00	25.74	7750.00
7.00	164.40	176.10	-1.50	2945.00	25.83	7750.00
8.00	168.10	174.70	-1.41	2936.00	25.75	7750.00
9.00	162.60	173.10	-1.62	2957.00	25.79	7750.00
10.00	166.50	178.10	-1.04	2914.00	25.69	7750.00
11.00	162.60	173.60	-1.49	2949.00	25.88	7750.00
12.00	164.50	174.70	-1.58	2955.00	25.90	7750.00
13.00	163.70	174.90	-1.51	2950.00	25.80	7750.00
14.00	166.50	177.90	-0.41	2962.00	26.51	7750.00
15.00	165.10	175.60	-1.01	2990.00	26.53	7750.00
16.00	164.90	176.00	-1.03	2995.00	26.56	7750.00
17.00	164.00	177.20	-1.09	2944.00	26.71	7750.00
18.00	165.60	175.50	-0.76	2979.00	26.66	7750.00
19.00	164.30	175.00	-0.89	2975.00	26.73	7750.00
20.00	164.30	175.00	-1.01	2957.00	26.76	7750.00
21.00	166.40	175.40	-1.20	2904.00	26.61	7750.00
22.00	164.30	175.00	-0.82	2936.00	26.85	7750.00
23.00	168.60	180.50	-0.86	2903.00	26.28	7750.00
24.00	170.00	176.30	-0.89	3005.00	26.46	7750.00
25.00	168.60	178.70	-1.27	2989.00	26.46	7750.00
26.00	167.50	174.30	-1.44	2959.00	26.79	7750.00
27.00	168.60	175.60	-1.59	2958.00	26.74	7750.00
28.00	165.60	177.30	-1.54	2900.00	26.74	7750.00
29.00	165.30	177.10	-1.81	3000.00	26.61	7750.00
30.00	166.00	173.30	-1.86	2951.00	27.00	7750.00
31.00	166.00	173.30	-1.92	2950.00	27.00	7750.00
32.00	168.00	176.70	-1.93	2994.00	26.74	7750.00
33.00	165.60	177.30	-0.80	2983.00	26.79	7750.00
34.00	167.50	179.20	-0.93	2985.00	26.45	7750.00
35.00	140.60	175.90	-1.04	2962.00	26.84	7750.00
36.00	165.50	179.50	-1.10	2983.00	26.41	7750.00
37.00	163.00	175.60	-1.52	2987.00	26.88	7750.00
38.00	168.40	179.00	-0.86	3007.00	26.46	7750.00
39.00	169.60	176.50	-0.85	2978.00	26.64	7750.00
40.00	165.50	176.00	-1.14	3007.00	26.66	7750.00
41.00	160.00	175.90	-1.29	2983.00	26.74	7750.00
42.00	167.00	178.50	-1.32	3006.00	26.53	7750.00
43.00	164.60	175.50	-1.40	3006.00	26.00	7750.00
44.00	169.30	177.00	-1.24	2968.00	26.72	7750.00
45.00	164.70	174.60	-1.45	2965.00	26.82	7750.00
46.00	164.50	174.30	-1.52	2967.00	26.90	7750.00
47.00	168.40	179.60	-1.59	2994.00	26.43	7750.00
48.00	165.50	176.20	-1.64	2993.00	26.73	7750.00
49.00	166.30	177.50	-1.56	2904.00	26.72	7750.00
50.00	167.00	178.40	-1.48	2979.00	26.60	7750.00
51.00	167.00	178.40	-1.49	2990.00	26.55	7750.00

52.00	165.70	176.90	-1.59	2900.00	26.75	7750.00
53.00	165.30	176.00	-1.40	2915.00	26.74	7750.00
54.00	167.50	178.40	-1.53	2907.00	26.66	7750.00
55.00	168.00	179.40	-1.40	2973.00	26.48	7750.00
56.00	166.40	177.70	-1.45	2988.00	26.68	7750.00
57.00	165.20	175.50	-1.49	2995.00	26.77	7750.00
58.00	165.50	176.30	-1.46	2810.00	26.66	7750.00
59.00	165.70	176.40	-1.51	2991.00	26.90	7750.00
60.00	166.90	178.00	-1.55	2906.00	26.68	7750.00
61.00	171.00	182.30	-0.17	2816.00	26.00	7750.00
62.00	167.60	178.00	-0.75	2967.00	26.68	7750.00
63.00	166.70	176.00	-1.01	2999.00	26.69	7750.00
64.00	166.50	177.20	-1.10	2809.00	26.58	7750.00
65.00	170.20	180.50	-1.37	2978.00	26.47	7750.00
66.00	169.00	180.40	-1.30	2909.00	26.54	7750.00
67.00	169.90	177.00	-1.50	2974.00	27.05	7750.00
68.00	165.90	175.40	-1.40	2988.00	26.00	7750.00
69.00	165.50	175.90	-1.54	2902.00	26.90	7750.00
70.00	169.60	175.40	-1.39	2969.00	26.93	7750.00
71.00	169.40	178.10	-1.51	2908.00	27.40	7750.00
72.00	173.50	180.00	-0.73	2979.00	26.77	7750.00
73.00	167.30	177.60	-1.10	2992.00	27.20	7750.00
74.00	170.20	181.40	-0.91	2819.00	26.49	7750.00
75.00	169.50	180.70	-1.09	2902.00	26.45	7750.00
76.00	170.00	181.30	1.44	2906.00	26.66	7750.00
77.00	170.70	178.00	1.41	2962.00	27.49	7750.00
78.00	171.10	177.90	1.76	2954.00	27.51	7750.00
79.00	158.90	169.20	1.37	2842.00	27.83	7750.00
80.00	172.70	183.40	1.49	2900.00	28.49	7750.00
81.00	173.00	184.00	1.35	2992.00	28.07	7750.00
82.00	168.90	179.50	1.73	2900.00	28.45	7750.00
83.00	168.00	178.20	1.70	2960.00	28.06	7750.00
84.00	167.50	177.70	1.70	2977.00	28.10	7750.00
85.00	172.30	182.59	1.57	2991.00	27.94	7750.00
86.00	167.00	177.90	1.43	2977.00	27.90	7750.00
87.00	167.00	177.50	1.40	2971.00	27.91	7750.00
88.00	167.40	176.70	1.30	2955.00	28.09	7750.00
89.00	167.40	176.50	1.10	2969.00	27.46	7750.00
90.00	167.00	177.20	1.30	2936.00	27.79	7750.00
91.00	167.20	177.30	1.32	2964.00	27.52	7750.00
92.00	166.90	177.00	1.35	2961.00	27.70	7750.00
93.00	168.00	178.50	1.34	2961.00	27.35	7750.00
94.00	168.20	178.00	1.25	2945.00	27.73	7750.00
95.00	169.30	180.00	1.24	2939.00	27.60	7750.00
96.00	171.20	182.20	1.16	2967.00	26.46	7750.00
97.00	170.50	180.90	1.50	2962.00	28.39	7750.00
98.00	170.70	181.70	1.55	2957.00	31.43	7750.00
99.00	166.40	176.50	1.39	2974.00	31.59	7750.00
100.00	172.00	177.00	1.44	2958.00	31.19	7750.00
101.00	171.50	182.70	1.48	2973.00	28.92	7750.00
102.00	167.00	178.00	1.44	2970.00	28.92	7750.00
103.00	168.20	179.30	1.42	2965.00	31.19	7750.00
104.00	168.30	179.50	1.36	2942.00	31.13	7750.00
105.00	171.20	182.50	1.46	2946.00	28.94	7750.00
106.00	172.00	177.50	1.46	2953.00	31.08	7750.00

107.00	166.40	176.70	1.47	2967.00	31.14	7750.00
108.00	167.20	178.50	1.41	2963.00	31.16	7750.00
109.00	167.90	179.00	1.44	2961.00	30.78	7750.00
110.00	168.30	179.60	1.40	2956.00	30.92	7750.00
111.00	167.10	177.60	1.40	2956.00	30.88	7750.00
112.00	167.50	178.40	1.39	2948.00	30.99	7750.00
113.00	167.30	177.10	1.34	2935.00	30.92	7750.00
114.00	166.50	176.00	1.36	2940.00	30.73	7750.00
115.00	166.50	176.90	1.38	2927.00	30.82	7750.00
116.00	167.00	178.20	1.34	2942.00	30.97	7750.00
117.00	168.40	179.70	1.25	2965.00	30.60	7750.00
118.00	169.70	180.90	1.31	2934.00	30.71	7750.00
119.00	171.70	180.50	1.34	2923.00	30.56	7750.00
120.00	169.50	180.70	1.28	2930.00	30.55	7750.00
121.00	168.00	179.90	1.28	2919.00	30.62	7750.00
122.00	166.60	176.60	1.41	2898.00	27.34	7750.00
123.00	166.40	176.60	1.31	3017.00	30.14	7750.00
124.00	172.50	183.50	1.34	3169.00	27.43	7750.00
125.00	166.90	178.10	1.20	3095.00	30.73	7750.00
126.00	171.40	186.90	1.15	3178.00	28.89	7750.00
127.00	168.70	180.00	1.20	3138.00	29.63	7750.00
128.00	166.10	177.40	1.69	3146.00	29.51	7750.00
129.00	167.90	179.90	1.06	3166.00	29.25	7750.00
130.00	167.00	178.30	1.13	3143.00	29.70	7750.00
131.00	167.10	178.00	1.14	3173.00	29.60	7750.00
132.00	173.20	179.00	1.24	3155.00	29.60	7750.00
133.00	171.70	184.10	1.18	3094.00	29.70	7750.00
134.00	168.00	181.10	1.16	3181.00	29.57	7750.00
135.00	167.40	178.60	1.14	3170.00	29.63	7750.00
136.00	168.20	177.20	1.15	3118.00	29.56	7750.00
137.00	169.20	180.90	1.47	3118.00	30.21	7750.00
138.00	172.00	184.00	1.47	3099.00	30.17	7750.00
139.00	169.50	180.70	1.43	3116.00	29.95	7750.00
140.00	174.30	184.40	1.41	3136.00	30.02	7750.00
141.00	174.50	186.60	1.42	3094.00	30.02	7750.00
142.00	169.30	180.60	1.37	3142.00	29.71	7750.00
143.00	167.40	178.40	1.36	3144.00	29.73	7750.00
144.00	168.00	178.30	1.40	3004.00	29.72	7750.00
145.00	170.20	182.30	1.41	3142.00	29.77	7750.00
146.00	167.50	178.60	1.36	3156.00	29.70	7750.00
147.00	166.90	178.30	1.35	3037.00	29.86	7750.00
148.00	169.00	180.40	1.50	3108.00	30.12	7750.00
149.00	169.00	182.20	1.43	3146.00	29.08	7750.00
150.00	177.00	182.40	1.51	3162.00	31.09	7750.00
151.00	173.20	186.00	1.30	3133.00	30.24	7750.00
152.00	170.50	182.00	1.22	3153.00	30.14	7750.00
153.00	171.10	182.90	1.23	3176.00	30.08	7750.00
154.00	168.20	180.70	1.17	3167.00	30.05	7750.00
155.00	173.50	179.00	1.20	3079.00	30.02	7750.00
156.00	173.10	181.30	1.19	3170.00	29.72	7750.00
157.00	167.40	178.20	1.00	3170.00	29.46	7750.00
158.00	167.20	178.30	1.09	3151.00	29.41	7750.00
159.00	167.90	178.60	1.13	3154.00	29.48	7750.00
160.00	168.60	178.50	1.14	3090.00	29.47	7750.00
161.00	167.50	178.30	1.16	3104.00	29.38	7750.00

162.00	172.40	179.60	1.21	3116.00	29.41	2750.00
163.00	172.10	184.00	1.24	3128.00	29.38	2750.00
164.00	168.20	180.00	1.20	3176.00	29.36	2750.00
165.00	167.50	178.60	1.22	3098.00	29.50	2750.00
166.00	167.70	178.00	1.23	3156.00	29.38	2750.00
167.00	167.70	179.00	1.17	3186.00	29.52	2750.00
168.00	170.30	178.40	1.23	3095.00	29.50	2750.00
169.00	168.00	178.60	1.21	3008.00	29.57	2750.00
170.00	170.20	179.10	1.23	3159.00	29.42	2750.00
171.00	171.00	183.00	1.19	3181.00	29.49	2750.00
172.00	172.90	182.50	1.20	3117.00	29.56	2750.00
173.00	172.60	184.50	1.20	3162.00	29.34	2750.00
174.00	171.00	182.50	1.21	3176.00	28.99	2750.00
175.00	171.40	183.50	1.19	3170.00	29.19	2750.00
176.00	172.50	182.30	1.20	3163.00	29.28	2750.00
177.00	171.10	183.50	1.21	3160.00	29.19	2750.00
178.00	169.00	181.20	1.19	3168.00	29.23	2750.00
179.00	167.90	179.00	1.31	3107.00	28.97	2750.00
180.00	169.00	182.10	1.34	3147.00	29.20	2750.00
181.00	169.90	181.50	1.31	3132.00	29.28	2750.00
182.00	168.00	179.40	1.31	3183.00	29.15	2750.00
183.00	168.10	179.10	1.28	3161.00	29.20	2750.00
184.00	171.30	183.50	1.34	3097.00	29.34	2750.00
185.00	171.40	183.50	1.52	3189.00	29.02	2750.00
186.00	173.20	181.50	1.34	3163.00	28.71	2750.00
187.00	168.90	179.00	1.28	3176.00	28.53	2750.00
188.00	168.90	178.70	1.25	3103.00	28.57	2750.00
189.00	176.20	187.50	1.58	3106.00	28.05	2750.00
190.00	172.60	180.00	1.51	3109.00	27.78	2750.00
191.00	175.20	186.50	1.52	3183.00	27.82	2750.00
192.00	175.30	187.10	1.54	3187.00	27.76	2750.00
193.00	172.40	183.00	1.54	3200.00	27.90	2750.00
194.00	170.00	182.40	1.47	3171.00	27.73	2750.00
195.00	167.30	178.20	1.40	3117.00	28.29	2750.00
196.00	167.10	177.00	1.35	3119.00	28.45	2750.00
197.00	170.00	177.30	1.35	3108.00	28.57	2750.00
198.00	169.70	175.50	1.35	3113.00	28.71	2750.00
199.00	169.20	174.60	1.26	3190.00	29.59	2750.00
200.00	175.30	186.20	1.00	3150.00	30.35	2750.00
201.00	176.00	184.30	0.72	3128.00	30.00	2750.00
202.00	178.00	188.00	1.06	3166.00	30.23	2750.00
203.00	178.40	189.10	0.82	3150.00	30.11	2750.00
204.00	179.90	186.20	0.84	3166.00	29.92	2750.00
205.00	173.60	184.20	0.92	3199.00	30.13	2750.00
206.00	180.00	187.50	0.77	3127.00	29.99	2750.00
207.00	179.00	189.00	0.85	3136.00	30.06	2750.00
208.00	171.00	182.50	1.65	3156.00	31.05	2750.00
209.00	169.50	180.00	1.59	3193.00	30.92	2750.00
210.00	171.10	182.30	1.59	3100.00	30.04	2750.00
211.00	178.00	180.50	1.59	3152.00	31.03	2750.00
212.00	169.00	173.60	1.22	3066.00	32.77	2750.00
213.00	178.00	180.40	1.54	3169.00	30.97	2750.00
214.00	172.00	183.00	1.52	3162.00	31.04	2750.00
215.00	175.00	186.90	1.55	3150.00	31.02	2750.00
216.00	170.90	181.20	1.50	3175.00	31.10	2750.00

217.00	173.90	184.90	1.52	3136.00	31.16	2750.00
218.00	171.50	203.30	1.47	3019.00	34.57	2750.00
219.00	167.00	177.60	1.65	3193.00	26.05	2750.00
220.00	167.00	176.70	1.64	3192.00	30.77	2750.00
221.00	163.70	173.00	1.46	3090.00	30.57	2750.00
222.00	163.00	173.60	1.39	3119.00	30.44	2750.00
223.00	162.00	173.40	1.26	3097.00	30.54	2750.00
224.00	163.40	173.20	1.24	3149.00	30.52	2750.00
225.00	164.10	174.00	1.18	3152.00	30.32	2750.00
226.00	176.50	182.50	1.40	3151.00	30.79	2750.00
227.00	175.40	182.30	1.38	3130.00	31.26	2750.00
228.00	171.00	181.40	1.34	3195.00	31.22	2750.00
229.00	172.10	182.00	1.37	3176.00	31.22	2750.00
230.00	171.30	181.30	1.35	3194.00	31.26	2750.00
231.00	173.50	182.00	1.34	3157.00	31.30	2750.00
232.00	174.90	185.50	1.35	3131.00	31.32	2750.00
233.00	173.50	181.00	1.32	3104.00	31.26	2750.00
234.00	176.00	187.40	1.38	3143.00	31.27	2750.00
235.00	170.90	181.00	1.35	3168.00	31.03	2750.00
236.00	170.60	181.00	1.31	3147.00	31.16	2750.00
237.00	177.90	184.50	1.35	3164.00	31.50	2750.00
238.00	172.00	183.00	1.30	3194.00	31.26	2750.00
239.00	176.00	183.50	1.31	3130.00	31.59	2750.00
240.00	176.00	187.50	1.35	3161.00	31.61	2750.00
241.00	170.70	181.00	1.30	3112.00	31.19	2750.00
242.00	176.10	186.60	1.49	3160.00	30.89	2750.00
243.00	174.00	185.70	1.47	3162.00	31.66	2750.00
244.00	171.70	182.60	1.46	3145.00	31.04	2750.00
245.00	174.10	185.00	1.47	3172.00	31.03	2750.00
246.00	174.00	184.00	1.46	3100.00	31.12	2750.00
247.00	177.00	185.50	1.51	3146.00	31.90	2750.00
248.00	176.00	186.60	1.43	3159.00	30.51	2750.00
249.00	171.00	182.60	1.41	3134.00	30.92	2750.00
250.00	175.90	187.00	1.43	3102.00	31.32	2750.00
251.00	172.00	182.30	1.42	3137.00	30.75	2750.00
252.00	177.70	182.90	1.36	3102.00	30.75	2750.00
253.00	177.50	182.90	1.41	3172.00	31.22	2750.00
254.00	174.00	185.00	1.39	3177.00	30.00	2750.00
255.00	177.00	188.20	1.44	3181.00	31.43	2750.00
256.00	176.90	187.60	1.43	3204.00	30.66	2750.00
257.00	166.70	177.00	1.30	3197.00	30.99	2750.00
258.00	174.00	185.50	1.42	3202.00	30.77	2750.00
259.00	178.40	189.00	1.44	3204.00	30.77	2750.00
260.00	166.00	176.20	1.30	3195.00	31.00	2750.00
261.00	175.00	185.50	1.42	3213.00	30.00	2750.00
262.00	178.50	189.00	1.44	3193.00	30.00	2750.00
263.00	174.50	179.00	1.40	3106.00	30.94	2750.00
264.00	173.90	184.00	1.38	3199.00	30.04	2750.00
265.00	177.00	188.40	1.43	3212.00	30.06	2750.00
266.00	180.00	190.60	1.41	3210.00	30.03	2750.00
267.00	166.70	177.10	1.28	3199.00	31.06	2750.00
268.00	175.30	185.90	1.36	3216.00	30.00	2750.00
269.00	178.30	188.90	1.38	3218.00	30.78	2750.00
270.00	179.30	190.20	1.36	3158.00	31.24	2750.00
271.00	178.10	190.30	1.03	3195.00	30.65	2750.00



277.00	179.50	197.00	1.78	3154.00	30.61	2750.00
273.00	173.90	184.00	1.68	3185.00	30.60	2750.00
274.00	179.70	183.60	1.95	3167.00	30.79	2750.00
275.00	174.70	184.00	2.73	3228.00	29.63	2750.00
276.00	174.50	184.50	3.00	3247.00	29.07	2750.00
277.00	174.60	181.30	2.84	3201.00	30.89	2750.00
278.00	167.00	177.00	2.00	3169.00	30.82	2750.00
279.00	167.50	177.30	2.75	3109.00	30.31	2750.00
280.00	167.00	177.10	2.74	3182.00	30.22	2750.00
281.00	169.00	180.00	2.72	3121.00	30.61	2750.00
282.00	168.40	176.90	2.69	3161.00	30.00	2750.00
283.00	166.50	176.70	2.70	3177.00	30.15	2750.00
284.00	167.50	178.40	2.72	3167.00	30.12	2750.00
285.00	171.50	178.50	2.72	3163.00	30.74	2750.00
286.00	166.50	176.60	2.72	3165.00	30.06	2750.00
287.00	166.70	176.60	2.71	3152.00	30.55	2750.00
288.00	168.20	179.20	2.69	3160.00	30.95	2750.00
289.00	169.60	180.50	2.70	3137.00	30.62	2750.00
290.00	170.10	180.90	2.67	3170.00	31.02	2750.00
291.00	170.00	180.40	2.68	3109.00	31.17	2750.00
292.00	168.30	179.20	2.63	3144.00	30.79	2750.00
293.00	167.00	178.40	2.63	3162.00	30.51	2750.00
294.00	165.50	175.70	2.62	3150.00	30.38	2750.00
295.00	165.30	175.50	2.60	3105.00	30.13	2750.00
296.00	171.50	179.40	2.63	3153.00	30.41	2750.00
297.00	175.90	176.00	2.62	3145.00	30.56	2750.00
298.00	169.60	180.00	2.59	3134.00	31.21	2750.00
299.00	171.50	178.10	2.58	3107.00	30.66	2750.00
300.00	165.20	175.50	2.59	3116.00	30.63	2750.00
301.00	169.70	180.60	2.58	3163.00	30.93	2750.00
302.00	168.90	179.70	2.58	3140.00	30.71	2750.00
303.00	168.10	176.70	2.57	3152.00	30.00	2750.00
304.00	165.70	176.50	2.56	3139.00	30.82	2750.00
305.00	168.70	179.30	2.57	3170.00	31.14	2750.00
306.00	165.60	175.90	2.55	3130.00	31.17	2750.00
307.00	165.00	175.50	2.58	3093.00	30.96	2750.00
308.00	169.00	180.60	2.58	3122.00	31.36	2750.00
309.00	169.50	180.50	2.57	3113.00	31.35	2750.00
310.00	171.50	181.70	2.57	3181.00	31.15	2750.00
311.00	165.50	175.90	2.57	3129.00	31.19	2750.00
312.00	168.00	178.70	2.57	3177.00	31.63	2750.00
313.00	170.60	181.00	2.57	3159.00	31.68	2750.00
314.00	170.50	180.00	2.58	3126.00	31.71	2750.00
315.00	168.60	179.50	2.59	3150.00	31.23	2750.00
316.00	170.50	180.90	2.57	3174.00	31.59	2750.00
317.00	169.40	175.50	2.53	3090.00	31.24	2750.00
318.00	165.30	176.00	2.53	3134.00	31.12	2750.00
319.00	167.20	178.00	2.49	3118.00	31.57	2750.00
320.00	168.00	179.00	2.49	3170.00	31.13	2750.00
321.00	165.70	175.60	2.50	3151.00	31.23	2750.00
322.00	165.50	175.50	2.48	3090.00	31.17	2750.00
323.00	165.60	176.60	2.49	3114.00	31.21	2750.00
324.00	169.60	180.30	2.54	3154.00	31.20	2750.00
325.00	166.50	175.20	2.50	3153.00	31.14	2750.00
326.00	165.10	175.30	2.53	3107.00	31.15	2750.00

327.00	178.90	178.60	2.51	3164.00	31.19	7750.00
328.00	166.30	177.50	2.50	3017.00	31.75	7750.00
329.00	167.10	174.70	2.47	3137.00	31.27	7750.00
330.00	165.50	176.60	2.48	3119.00	31.36	7750.00
331.00	166.10	174.90	2.48	3135.00	31.33	7750.00
332.00	165.10	169.90	2.45	1298.00	30.29	7750.00
333.00	170.00	181.50	2.49	3105.00	31.40	7750.00
334.00	164.00	175.00	2.48	3069.00	31.42	7750.00
335.00	166.00	175.30	2.47	3075.00	31.37	7750.00
336.00	167.00	178.70	2.46	3130.00	31.68	7750.00
337.00	165.20	174.50	2.48	3027.00	31.42	7750.00
338.00	169.00	179.60	2.46	3073.00	31.74	7750.00
339.00	166.00	176.00	2.46	3118.00	31.15	7750.00
340.00	169.50	176.50	2.46	3133.00	31.26	7750.00
341.00	168.00	179.70	2.46	3143.00	31.60	7750.00
342.00	178.30	182.50	2.79	2904.00	30.24	7750.00
343.00	174.00	185.10	2.82	3152.00	30.84	7750.00
344.00	177.90	183.70	2.85	3072.00	30.28	7750.00
345.00	172.50	182.20	2.82	2800.00	30.56	7750.00
346.00	178.70	189.00	3.81	3156.00	31.37	7750.00
347.00	173.60	183.30	3.82	3107.00	31.03	7750.00
348.00	173.00	183.00	2.80	3119.00	30.84	7750.00
349.00	174.50	183.50	2.81	3153.00	31.06	7750.00
350.00	176.30	186.90	2.83	3109.00	31.31	7750.00
351.00	174.50	184.20	2.81	3152.00	30.63	7750.00
352.00	176.20	187.00	2.83	3167.00	30.63	7750.00
353.00	179.60	190.00	2.81	3149.00	30.59	7750.00
354.00	172.00	183.00	2.83	3109.00	30.00	7750.00
355.00	179.10	186.00	2.80	3141.00	31.33	7750.00
356.00	175.50	185.70	2.78	3175.00	31.48	7750.00
357.00	173.30	183.70	2.78	3150.00	31.42	7750.00
358.00	173.30	183.10	2.78	3151.00	31.43	7750.00
359.00	179.50	189.00	2.77	3133.00	31.42	7750.00
360.00	173.30	183.20	2.79	3108.00	31.47	7750.00
361.00	177.20	185.00	2.78	3151.00	31.56	7750.00
362.00	175.00	186.60	2.79	3183.00	31.66	7750.00
363.00	180.20	190.40	2.77	3181.00	31.79	7750.00
364.00	174.00	181.00	2.81	3145.00	31.36	7750.00
365.00	171.60	181.00	2.74	3139.00	31.96	7750.00
366.00	170.10	180.10	2.76	3111.00	31.79	7750.00
367.00	172.50	182.60	2.75	3120.00	32.04	7750.00
368.00	173.10	183.20	2.77	3159.00	32.10	7750.00
369.00	172.70	182.90	2.73	3143.00	31.99	7750.00
370.00	170.00	177.60	2.75	3147.00	31.93	7750.00
371.00	167.20	177.00	2.77	3113.00	31.90	7750.00
372.00	173.50	183.00	2.74	3156.00	32.04	7750.00
373.00	174.00	179.40	2.73	3159.00	31.97	7750.00
374.00	167.00	177.00	2.75	3121.00	32.19	7750.00
375.00	167.90	178.00	2.74	3119.00	32.19	7750.00
376.00	168.10	178.40	2.77	3083.00	32.12	7750.00
377.00	170.60	181.00	2.75	3162.00	32.10	7750.00
378.00	171.00	181.40	2.73	3147.00	32.27	7750.00
379.00	171.30	181.70	2.74	3165.00	32.11	7750.00
380.00	168.50	179.00	2.74	3158.00	32.15	7750.00
381.00	170.10	180.20	2.74	3173.00	32.05	7750.00

382.00	172.90	183.20	2.74	3171.00	32.13	7750.00
383.00	174.10	181.40	2.70	3167.00	32.22	7750.00
384.00	167.60	177.50	2.70	3148.00	32.16	7750.00
385.00	167.10	177.00	2.70	3106.00	32.21	7750.00
386.00	169.20	180.00	2.70	3119.00	32.19	7750.00
387.00	169.00	180.50	2.71	3152.00	32.15	7750.00
388.00	172.50	172.70	2.71	3099.00	32.14	7750.00
389.00	174.20	183.20	2.72	3159.00	32.19	7750.00
390.00	168.40	177.70	2.71	3076.00	32.31	7750.00
391.00	167.70	172.20	2.72	3153.00	32.13	7750.00
392.00	169.00	179.50	2.72	3181.00	32.68	7750.00
393.00	168.50	179.50	2.72	3151.00	32.13	7750.00
394.00	170.10	181.00	2.72	3130.00	32.17	7750.00
395.00	168.00	179.00	2.74	3134.00	32.36	7750.00
396.00	171.20	181.00	2.75	3117.00	32.14	7750.00
397.00	168.70	179.50	2.73	3035.00	32.20	7750.00
398.00	167.30	177.30	2.76	3176.00	32.12	7750.00
399.00	169.50	180.40	2.76	3143.00	32.28	7750.00
400.00	171.20	181.70	2.75	3182.00	32.14	7750.00
401.00	166.00	176.70	2.76	3170.00	32.12	7750.00
402.00	167.20	177.50	2.76	3072.00	32.36	7750.00
403.00	168.50	179.10	2.77	3120.00	32.18	7750.00
404.00	169.00	179.00	2.80	3146.00	32.28	7750.00
405.00	168.10	179.30	2.79	3145.00	32.21	7750.00
406.00	167.10	177.00	2.77	3149.00	32.31	7750.00
407.00	166.50	177.10	2.78	3143.00	32.08	7750.00
408.00	168.20	179.00	2.76	3153.00	32.03	7750.00
409.00	166.40	176.00	2.77	3130.00	32.01	7750.00
410.00	166.60	177.00	2.78	3173.00	32.06	7750.00
411.00	166.10	176.60	2.77	3147.00	32.04	7750.00
412.00	166.20	176.20	3.00	3169.00	31.67	7750.00
413.00	171.30	181.90	2.97	3187.00	31.53	7750.00
414.00	174.00	184.30	2.97	3145.00	31.44	7750.00
415.00	170.00	176.90	2.94	3155.00	31.36	7750.00
416.00	170.30	180.50	2.91	3148.00	31.43	7750.00
417.00	167.00	177.20	2.90	3097.00	31.49	7750.00
418.00	170.10	180.50	2.87	3177.00	31.37	7750.00
419.00	166.70	176.00	2.91	3135.00	31.37	7750.00
420.00	171.00	181.30	2.90	3171.00	31.08	7750.00
421.00	165.00	175.60	2.88	3166.00	31.45	7750.00
422.00	172.40	182.50	2.89	3174.00	31.70	7750.00
423.00	166.70	176.40	2.91	3088.00	31.66	7750.00
424.00	172.50	182.70	2.91	3167.00	31.48	7750.00
425.00	171.00	176.90	2.96	3101.00	31.76	7750.00
426.00	167.00	177.20	2.95	3116.00	31.42	7750.00
427.00	173.30	179.70	2.95	3160.00	31.77	7750.00
428.00	167.00	176.70	2.87	3154.00	31.58	7750.00
429.00	170.50	181.10	2.84	3102.00	31.57	7750.00
430.00	172.00	182.50	2.94	3171.00	31.79	7750.00
431.00	172.20	182.30	2.94	3144.00	31.75	7750.00
432.00	171.60	181.90	2.91	3166.00	31.71	7750.00
433.00	172.10	182.40	2.89	3146.00	31.37	7750.00
434.00	170.30	180.90	2.89	3133.00	31.36	7750.00
435.00	172.00	182.50	2.89	3156.00	31.43	7750.00
436.00	169.50	175.50	2.89	3152.00	31.35	7750.00

437.00	166.50	176.00	2.89	3104.00	31.35	2750.00
438.00	169.50	180.10	2.84	3146.00	31.36	2750.00
439.00	171.90	182.40	2.89	3166.00	31.32	2750.00
440.00	173.10	183.40	2.88	3159.00	31.42	2750.00
441.00	173.70	183.40	2.89	3126.00	31.87	2750.00
442.00	172.00	182.30	2.91	3140.00	31.85	2750.00
443.00	173.00	183.10	2.90	3159.00	31.77	2750.00
444.00	171.00	175.70	2.93	3166.00	31.56	2750.00
445.00	166.30	176.00	2.90	3109.00	31.63	2750.00
446.00	173.00	183.10	2.91	3109.00	31.48	2750.00
447.00	166.00	175.70	2.92	3150.00	31.61	2750.00
448.00	172.10	182.20	2.92	3123.00	32.07	2750.00
449.00	168.00	176.70	2.92	3094.00	31.69	2750.00
450.00	170.50	180.90	2.94	3175.00	31.57	2750.00
451.00	173.00	176.60	2.92	3118.00	31.65	2750.00
452.00	166.50	176.00	2.91	3172.00	31.63	2750.00
453.00	170.10	181.00	2.90	3171.00	31.47	2750.00
454.00	172.60	182.90	2.90	3119.00	31.60	2750.00
455.00	173.00	177.10	2.91	3082.00	31.33	2750.00
456.00	165.10	175.40	2.91	3131.00	31.36	2750.00
457.00	172.20	182.30	2.92	3146.00	31.31	2750.00
458.00	168.00	178.60	2.91	3123.00	31.43	2750.00
459.00	168.50	179.50	2.93	3136.00	31.38	2750.00
460.00	173.00	183.20	2.91	3166.00	31.51	2750.00
461.00	166.20	176.00	2.93	3155.00	31.40	2750.00
462.00	173.50	177.70	2.92	3172.00	31.38	2750.00
463.00	172.10	182.50	2.92	3130.00	31.83	2750.00
464.00	168.30	178.50	2.93	3130.00	31.42	2750.00
465.00	172.50	182.70	2.92	3113.00	31.51	2750.00
466.00	170.20	178.50	2.93	3165.00	31.61	2750.00
467.00	170.00	181.50	2.93	3128.00	31.57	2750.00
468.00	173.00	178.10	2.94	3133.00	31.59	2750.00
469.00	168.90	180.90	2.94	3066.00	31.64	2750.00
470.00	172.70	178.00	2.93	3153.00	31.57	2750.00
471.00	173.40	183.50	2.94	3106.00	31.81	2750.00
472.00	170.00	181.00	2.95	3163.00	32.02	2750.00
473.00	165.90	175.00	2.94	3071.00	31.69	2750.00
474.00	169.00	179.00	2.96	3168.00	31.52	2750.00
475.00	173.30	182.20	2.96	3129.00	31.59	2750.00
476.00	170.30	181.20	2.93	3171.00	31.56	2750.00
477.00	169.20	179.10	2.96	3158.00	31.35	2750.00
478.00	172.60	182.60	2.95	3106.00	31.54	2750.00
479.00	164.50	174.60	2.94	3071.00	31.46	2750.00
480.00	172.00	179.20	2.94	3094.00	31.29	2750.00
481.00	170.10	180.00	3.18	3172.00	30.52	2750.00
482.00	166.30	176.70	3.17	3101.00	30.76	2750.00
483.00	170.90	175.90	3.16	3108.00	30.81	2750.00
484.00	169.50	180.60	3.14	3104.00	30.98	2750.00
485.00	167.90	178.70	3.12	3132.00	30.95	2750.00
486.00	166.00	176.00	3.15	3123.00	30.98	2750.00
487.00	166.30	176.20	3.12	3124.00	30.99	2750.00
488.00	167.00	177.20	3.11	3132.00	30.75	2750.00
489.00	166.50	176.70	3.13	3142.00	30.76	2750.00
490.00	166.60	176.50	3.11	3147.00	31.17	2750.00
491.00	166.60	176.50	3.10	3150.00	31.22	2750.00

492.00	165.90	175.90	3.12	3116.00	31.30	7750.00
493.00	166.70	176.70	3.08	3156.00	31.25	7750.00
494.00	168.00	177.40	3.09	3161.00	31.26	7750.00
495.00	170.70	181.30	3.08	3185.00	31.46	7750.00
496.00	165.70	176.10	3.07	3139.00	31.37	7750.00
497.00	172.20	182.60	3.08	3146.00	31.50	7750.00
498.00	166.70	176.00	3.09	3158.00	31.33	7750.00
499.00	167.10	178.00	3.05	3144.00	31.45	7750.00
500.00	168.60	177.00	3.05	3175.00	31.46	7750.00
501.00	170.30	181.30	3.07	3174.00	31.33	7750.00
502.00	168.90	179.50	3.05	3172.00	31.03	7750.00
503.00	171.00	177.50	3.11	3132.00	30.87	7750.00
504.00	176.90	189.30	3.09	3172.00	27.49	7750.00
505.00	166.50	176.60	3.09	3169.00	30.95	7750.00
506.00	173.10	183.70	3.08	3176.00	31.00	7750.00
507.00	166.40	176.50	3.09	3128.00	31.04	7750.00
508.00	171.10	182.30	3.11	3089.00	30.99	7750.00
509.00	173.00	179.30	3.09	3111.00	31.00	7750.00
510.00	169.20	180.50	3.07	3152.00	31.30	7750.00
511.00	166.50	176.30	3.05	3146.00	31.20	7750.00
512.00	168.00	177.60	3.05	3097.00	31.31	7750.00
513.00	167.60	177.00	3.05	3143.00	31.27	7750.00
514.00	167.20	177.10	3.04	3143.00	31.40	7750.00
515.00	166.20	176.00	3.05	3108.00	31.33	7750.00
516.00	166.40	176.00	3.04	3187.00	31.31	7750.00
517.00	166.90	176.70	3.05	3106.00	31.37	7750.00
518.00	166.50	176.00	3.04	3033.00	31.55	7750.00
519.00	166.60	176.50	3.03	3113.00	31.40	7750.00
520.00	166.60	176.40	3.05	3063.00	31.37	7750.00
521.00	168.00	177.40	3.04	3193.00	31.49	7750.00
522.00	168.00	176.00	3.03	3100.00	31.38	7750.00
523.00	168.00	177.20	3.01	3154.00	31.33	7750.00
524.00	174.00	182.00	3.01	3138.00	31.44	7750.00
525.00	167.70	178.00	3.01	3165.00	31.47	7750.00
526.00	168.30	179.50	3.01	3106.00	31.35	7750.00
527.00	173.60	184.00	3.02	3100.00	31.72	7750.00
528.00	167.00	176.50	2.99	3148.00	31.47	7750.00
529.00	174.30	179.40	3.01	3136.00	31.36	7750.00
530.00	166.70	177.00	3.00	3159.00	31.36	7750.00
531.00	167.50	177.10	3.01	3144.00	31.48	7750.00
532.00	173.30	179.40	2.99	3171.00	31.42	7750.00
533.00	167.60	179.20	2.99	3105.00	31.91	7750.00
534.00	170.10	176.00	3.00	3099.00	31.51	7750.00
535.00	171.10	181.70	2.99	3126.00	31.59	7750.00
536.00	167.90	178.10	2.98	3165.00	31.55	7750.00
537.00	171.10	181.90	2.99	3121.00	31.51	7750.00
538.00	167.90	177.50	2.98	3146.00	31.38	7750.00
539.00	172.00	182.50	2.99	3177.00	31.42	7750.00
540.00	169.00	178.70	2.98	3078.00	31.58	7750.00
541.00	171.60	181.90	2.95	3173.00	31.03	7750.00
542.00	173.60	203.90	2.97	3177.00	31.43	7750.00
543.00	165.90	175.50	2.98	3123.00	31.55	7750.00
544.00	172.30	182.50	2.97	3165.00	31.44	7750.00
545.00	173.20	183.30	2.97	3130.00	31.91	7750.00

546.00	177.50	182.00	3.23	3132.00	31.13	7750.00
547.00	167.10	176.40	3.20	3152.00	30.55	7750.00
548.00	172.00	178.50	3.17	3143.00	30.61	7750.00
549.00	170.70	181.30	3.16	3147.00	30.72	7750.00
550.00	166.90	176.00	3.16	3113.00	30.95	7750.00
551.00	172.40	182.70	3.15	3124.00	31.31	7750.00
552.00	173.40	178.00	3.14	3133.00	30.90	7750.00
553.00	167.10	177.50	3.13	3121.00	30.86	7750.00
554.00	167.10	176.50	3.12	3076.00	30.86	7750.00
555.00	170.70	180.60	3.14	3151.00	30.96	7750.00
556.00	167.00	177.10	3.12	3043.00	30.92	7750.00
557.00	171.00	177.00	3.12	3169.00	31.05	7750.00
558.00	172.10	182.50	3.10	3181.00	31.40	7750.00
559.00	167.00	177.20	3.09	3076.00	31.17	7750.00
560.00	173.60	183.90	3.11	3160.00	31.42	7750.00
561.00	167.00	176.60	3.11	3092.00	31.14	7750.00
562.00	168.90	177.50	3.11	3154.00	31.07	7750.00
563.00	173.70	181.70	3.07	3153.00	31.02	7750.00
564.00	167.00	178.10	3.09	3099.00	30.99	7750.00
565.00	174.00	181.70	3.06	3190.00	30.96	7750.00
566.00	167.50	177.40	3.04	3134.00	30.82	7750.00
567.00	170.40	181.00	3.06	3122.00	30.97	7750.00
568.00	172.60	183.00	3.09	3171.00	31.33	7750.00
569.00	173.10	185.00	3.18	3137.00	31.01	7750.00
570.00	174.10	179.00	3.23	3167.00	30.61	7750.00
571.00	171.50	183.20	3.27	3134.00	30.75	7750.00
572.00	171.50	180.40	3.23	3164.00	30.80	7750.00
573.00	172.00	182.40	3.25	3196.00	30.92	7750.00
574.00	175.90	186.00	3.28	3166.00	31.04	7750.00
575.00	168.60	178.10	3.25	3087.00	30.77	7750.00
576.00	169.50	179.00	3.24	3154.00	30.71	7750.00
577.00	174.30	184.50	3.23	3178.00	31.44	7750.00
578.00	168.00	177.50	3.23	3175.00	31.00	7750.00
579.00	168.10	177.60	3.22	3156.00	31.02	7750.00
580.00	174.00	183.40	3.21	3161.00	31.11	7750.00
581.00	170.20	180.30	3.28	3167.00	32.03	7750.00
582.00	168.60	177.70	3.23	3076.00	31.13	7750.00
583.00	167.90	178.00	3.21	3093.00	31.09	7750.00
584.00	167.90	177.90	3.19	3163.00	30.90	7750.00
585.00	167.50	177.00	3.16	3076.00	30.97	7750.00
586.00	168.00	178.40	3.14	3151.00	31.02	7750.00
587.00	170.70	181.50	3.13	3160.00	30.97	7750.00
588.00	168.20	179.00	3.15	3190.00	31.04	7750.00
589.00	168.30	178.50	3.15	3105.00	31.11	7750.00
590.00	167.50	177.70	3.15	3134.00	31.07	7750.00
591.00	175.10	180.20	3.14	3094.00	31.09	7750.00
592.00	175.50	185.90	3.14	3170.00	31.17	7750.00
593.00	170.10	179.60	3.13	3132.00	31.09	7750.00
594.00	169.00	179.20	3.13	3155.00	31.29	7750.00
595.00	174.60	184.00	3.15	3160.00	31.50	7750.00
596.00	168.20	178.00	3.13	3160.00	31.26	7750.00
597.00	167.50	177.00	3.12	3137.00	31.22	7750.00
598.00	174.50	184.60	3.14	3153.00	31.61	7750.00

599.00	168.00	177.70	3.03	3134.00	31.35	7750.00
600.00	168.50	177.90	3.05	3103.00	31.46	7750.00
601.00	168.40	177.70	3.04	3137.00	31.41	7750.00
602.00	176.20	185.70	3.11	3158.00	31.33	7750.00
603.00	169.90	179.50	3.10	3172.00	31.13	7750.00
604.00	171.00	179.00	3.13	3147.00	31.13	7750.00
605.00	169.90	180.60	3.10	3132.00	31.34	7750.00
606.00	174.50	181.00	3.09	3147.00	30.98	7750.00
607.00	173.50	183.60	3.09	3168.00	31.06	7750.00
608.00	176.90	182.90	3.08	3178.00	30.96	7750.00
609.00	169.30	179.90	3.06	3150.00	31.06	7750.00
610.00	173.70	184.00	3.06	3173.00	31.45	7750.00
611.00	169.00	177.60	3.06	3110.00	31.07	7750.00
612.00	167.00	177.50	3.06	3068.00	31.06	7750.00
613.00	168.70	179.50	3.06	3094.00	31.16	7750.00
614.00	166.50	176.90	3.14	3170.00	30.70	7750.00
615.00	171.30	182.00	3.14	3139.00	30.78	7750.00
616.00	172.00	182.40	3.13	3137.00	30.85	7750.00
617.00	171.30	181.00	3.11	3142.00	31.33	7750.00
618.00	167.50	178.30	3.13	3113.00	31.04	7750.00
619.00	169.00	179.50	3.13	3132.00	31.10	7750.00
620.00	167.10	177.00	3.11	3118.00	31.15	7750.00
621.00	169.40	180.10	3.15	3140.00	31.50	7750.00
622.00	171.20	181.00	3.12	3133.00	31.51	7750.00
623.00	168.30	179.00	3.04	3148.00	31.21	7750.00
624.00	168.90	179.70	3.05	3185.00	31.18	7750.00
625.00	174.60	184.70	3.02	3175.00	31.00	7750.00
626.00	168.20	178.10	3.12	3146.00	31.02	7750.00
627.00	168.50	178.00	3.10	3127.00	31.10	7750.00
628.00	167.50	177.50	3.10	3161.00	30.98	7750.00
629.00	166.50	176.40	3.08	3086.00	31.00	7750.00
630.00	168.30	179.00	3.07	3176.00	30.94	7750.00
631.00	170.20	181.00	3.08	3161.00	30.98	7750.00
632.00	167.50	178.00	3.06	3142.00	30.95	7750.00
633.00	167.70	177.70	3.06	3155.00	31.01	7750.00
634.00	167.40	177.70	3.04	3133.00	30.97	7750.00
635.00	166.30	176.10	3.02	3136.00	30.35	7750.00
636.00	166.50	176.00	3.05	3130.00	30.27	7750.00
637.00	173.50	183.30	3.05	3107.00	30.38	7750.00
638.00	166.70	176.00	3.05	3100.00	30.70	7750.00
639.00	166.70	176.00	3.05	3100.00	30.70	7750.00
640.00	167.50	177.40	3.05	3115.00	30.55	7750.00
641.00	166.30	176.90	3.04	3107.00	30.76	7750.00
642.00	165.00	175.50	3.02	3164.00	30.96	7750.00
643.00	166.20	176.40	3.04	3130.00	30.77	7750.00
644.00	165.90	176.00	3.03	3111.00	30.74	7750.00
645.00	169.50	180.30	3.03	3096.00	30.69	7750.00
646.00	158.10	167.70	3.04	3217.00	21.44	7750.00
647.00	173.40	182.90	3.03	3099.00	31.35	7750.00
648.00	171.90	182.10	3.01	3097.00	31.35	7750.00
649.00	166.10	176.00	2.98	3084.00	31.15	7750.00
650.00	166.10	176.50	3.99	3090.00	31.17	7750.00
651.00	167.50	178.00	3.28	3146.00	30.92	7750.00
652.00	166.00	177.00	3.24	3171.00	30.97	7750.00
653.00	170.60	181.00	3.20	3114.00	31.11	7750.00

654.00	172.00	182.30	3.20	3136.00	31.15	2750.00
655.00	168.00	179.50	3.16	3108.00	31.26	2750.00
656.00	167.50	177.60	3.18	3161.00	31.31	2750.00
657.00	169.00	177.70	3.19	3129.00	31.27	2750.00
658.00	168.00	178.00	3.17	3120.00	31.15	2750.00
659.00	167.90	178.00	3.17	3132.00	31.10	2750.00
660.00	167.60	177.50	3.17	3151.00	31.18	2750.00
661.00	167.70	177.70	3.15	3144.00	31.36	2750.00
662.00	168.50	178.30	3.14	3158.00	31.24	2750.00
663.00	174.20	184.60	3.13	3149.00	31.65	2750.00
664.00	168.70	178.70	3.14	3114.00	31.40	2750.00
665.00	170.00	181.00	3.18	3160.00	31.01	2750.00
666.00	164.90	174.60	3.12	3158.00	31.06	2750.00
667.00	169.00	179.20	3.08	3179.00	30.63	2750.00
668.00	165.10	175.50	3.07	3085.00	30.80	2750.00
669.00	168.60	179.00	3.06	3165.00	30.74	2750.00
670.00	170.10	180.50	3.06	3137.00	30.81	2750.00
671.00	170.50	180.50	3.05	3105.00	30.83	2750.00
672.00	166.90	177.50	3.04	3141.00	30.89	2750.00
673.00	165.90	175.70	3.04	3125.00	31.00	2750.00
674.00	165.70	175.50	3.06	3137.00	30.99	2750.00
675.00	165.90	176.00	3.05	3086.00	31.07	2750.00
676.00	168.70	179.70	3.04	3131.00	31.01	2750.00
677.00	170.10	180.50	3.05	3113.00	31.36	2750.00
678.00	172.40	182.60	3.05	3140.00	30.94	2750.00
679.00	171.00	182.10	3.05	3122.00	31.40	2750.00
680.00	173.00	183.30	3.06	3125.00	31.22	2750.00
681.00	166.50	176.50	3.03	3128.00	31.29	2750.00
682.00	166.00	176.90	3.03	3120.00	31.19	2750.00
683.00	174.00	178.50	3.04	3143.00	31.25	2750.00
684.00	173.60	182.60	3.03	3179.00	31.16	2750.00
685.00	173.50	178.00	3.02	3151.00	31.38	2750.00
686.00	167.10	176.50	3.01	3154.00	31.04	2750.00
687.00	165.00	175.10	3.00	3119.00	31.59	2750.00
688.00	169.00	180.30	2.99	3109.00	31.23	2750.00
689.00	168.20	179.00	2.97	3175.00	31.63	2750.00
690.00	171.20	179.60	2.97	3121.00	31.09	2750.00
691.00	164.70	174.50	2.95	3135.00	31.10	2750.00
692.00	170.00	180.40	2.94	3130.00	31.21	2750.00
693.00	170.90	181.10	2.97	3151.00	31.05	2750.00
694.00	170.70	181.30	2.96	3136.00	31.36	2750.00
695.00	172.50	182.00	2.95	3125.00	31.05	2750.00
696.00	173.00	180.90	2.98	3134.00	31.17	2750.00
697.00	166.50	176.40	2.96	3139.00	31.40	2750.00
698.00	170.50	181.10	2.97	3135.00	31.28	2750.00
699.00	169.50	180.20	2.99	3151.00	31.80	2750.00
700.00	170.50	181.00	2.97	3141.00	31.38	2750.00
701.00	171.90	182.40	2.97	3151.00	31.45	2750.00
702.00	171.00	181.50	2.95	3106.00	31.30	2750.00
703.00	171.50	181.90	2.89	3169.00	31.31	2750.00
704.00	168.00	179.60	2.89	3117.00	31.38	2750.00
705.00	170.00	180.60	2.92	3142.00	31.38	2750.00
706.00	168.00	179.50	2.88	3146.00	31.31	2750.00
707.00	166.00	176.70	2.97	3092.00	31.41	2750.00
708.00	170.00	181.00	2.95	3146.00	31.40	2750.00



709.00	167.10	177.50	2.90	3138.00	31.33	7750.00
710.00	167.00	177.70	2.96	3080.00	31.45	7750.00
711.00	166.30	175.90	2.96	3139.00	31.42	7750.00
712.00	169.70	179.90	3.19	3179.00	30.16	7750.00
713.00	171.10	178.50	3.18	3160.00	30.39	7750.00
714.00	170.60	181.30	3.15	3179.00	30.36	7750.00
715.00	169.90	180.10	3.14	3124.00	30.34	7750.00
716.00	173.40	183.70	3.14	3149.00	30.87	7750.00
717.00	168.90	179.00	3.14	3140.00	31.00	7750.00
718.00	169.40	180.10	3.14	3117.00	30.95	7750.00
719.00	171.00	181.90	3.11	3112.00	30.90	7750.00
720.00	167.90	178.00	3.14	3100.00	31.10	7750.00
721.00	171.00	181.40	3.13	3135.00	31.73	7750.00
722.00	170.00	180.10	3.18	3139.00	31.55	7750.00
723.00	169.10	178.90	3.17	3099.00	31.74	7750.00
724.00	173.00	183.50	3.12	3136.00	31.15	7750.00
725.00	167.30	177.00	3.13	3165.00	31.31	7750.00
726.00	169.60	178.10	3.12	3148.00	31.23	7750.00
727.00	168.60	179.00	3.10	3115.00	31.34	7750.00
728.00	175.00	178.70	3.00	3100.00	31.19	7750.00
729.00	167.50	177.00	3.10	3000.00	31.41	7750.00
730.00	174.30	184.40	3.10	3165.00	31.27	7750.00
731.00	167.40	177.00	3.09	3150.00	31.33	7750.00
732.00	174.70	184.50	3.00	3140.00	31.66	7750.00
733.00	168.10	177.90	3.07	3100.00	31.23	7750.00
734.00	173.90	183.70	3.09	3121.00	31.38	7750.00
735.00	174.60	184.40	3.00	3140.00	31.75	7750.00
736.00	168.50	177.90	3.00	3150.00	31.36	7750.00
737.00	169.00	179.70	3.06	3134.00	31.44	7750.00
738.00	174.20	179.00	3.07	3135.00	31.40	7750.00
739.00	168.50	178.40	3.00	3130.00	31.53	7750.00
740.00	168.00	177.50	2.99	3146.00	31.51	7750.00
741.00	169.90	180.00	3.00	3119.00	31.44	7750.00
742.00	175.00	184.90	3.03	3127.00	31.55	7750.00
743.00	173.10	180.10	3.06	3127.00	31.40	7750.00
744.00	167.60	177.10	3.01	3159.00	31.46	7750.00
745.00	160.40	169.60	3.00	3170.00	29.07	7750.00
746.00	167.70	176.60	2.96	3121.00	31.19	7750.00
747.00	177.50	182.50	2.90	3154.00	31.01	7750.00
748.00	166.90	176.70	2.94	3110.00	31.18	7750.00
749.00	167.30	176.00	2.91	3131.00	31.13	7750.00
750.00	168.90	177.00	2.92	3107.00	31.09	7750.00
751.00	167.00	176.50	2.94	3078.00	31.10	7750.00
752.00	166.30	176.10	2.95	3118.00	31.18	7750.00
753.00	168.40	177.60	2.93	3125.00	31.17	7750.00
754.00	168.70	177.00	2.91	3155.00	31.20	7750.00
755.00	168.70	177.60	2.95	3107.00	31.27	7750.00
756.00	167.60	177.20	2.97	3133.00	31.33	7750.00
757.00	160.90	170.50	3.14	3139.00	30.34	7750.00
758.00	157.90	167.50	3.02	3156.00	29.39	7750.00
759.00	169.00	179.20	3.00	3136.00	29.64	7750.00
760.00	170.00	178.70	3.12	3006.00	34.90	7750.00
761.00	172.00	182.60	3.11	3114.00	30.11	7750.00
762.00	165.30	175.40	3.00	3117.00	29.00	7750.00
763.00	165.00	174.60	3.09	3091.00	30.15	7750.00

764.00	165.40	174.80	3.10	3118.00	30.95	2750.00
765.00	168.90	175.10	3.09	3093.00	30.26	2750.00
766.00	170.20	180.50	3.11	3170.00	30.49	2750.00
767.00	166.60	176.00	3.10	3125.00	30.13	2750.00
768.00	166.50	176.20	3.10	3138.00	30.00	2750.00
769.00	170.40	180.50	3.09	3114.00	30.50	2750.00
770.00	166.80	175.90	3.07	3105.00	30.11	2750.00
771.00	169.50	179.50	3.08	3135.00	30.60	2750.00
772.00	173.20	178.60	3.08	3119.00	30.00	2750.00
773.00	168.00	179.00	3.04	3145.00	30.10	2750.00
774.00	173.80	180.20	3.10	3098.00	30.15	2750.00
775.00	166.10	175.60	3.09	3078.00	30.03	2750.00
776.00	173.50	180.50	3.05	3122.00	30.10	2750.00
777.00	166.10	176.00	3.03	3080.00	30.03	2750.00
778.00	172.80	182.60	3.06	3155.00	30.65	2750.00
779.00	173.50	178.20	3.05	3138.00	30.29	2750.00
780.00	165.80	175.40	3.04	3093.00	30.51	2750.00
781.00	172.00	181.80	3.06	3143.00	30.71	2750.00
782.00	172.80	177.10	3.05	3121.00	30.21	2750.00
783.00	165.50	175.10	3.05	3055.00	30.54	2750.00
784.00	156.00	165.40	3.16	3150.00	31.51	2750.00
785.00	166.30	175.60	3.10	3154.00	30.18	2750.00
786.00	166.60	176.20	3.06	3150.00	29.81	2750.00
787.00	166.50	175.90	3.05	3156.00	29.87	2750.00
788.00	166.10	175.50	3.06	3118.00	30.01	2750.00
789.00	166.20	176.00	3.03	3085.00	30.00	2750.00
790.00	173.90	183.20	3.04	3103.00	30.35	2750.00
791.00	166.90	176.20	3.01	3111.00	30.15	2750.00
792.00	177.10	186.50	3.03	3128.00	30.00	2750.00
793.00	175.80	185.10	3.01	3101.00	30.00	2750.00
794.00	179.60	189.00	3.01	3079.00	30.18	2750.00
795.00	182.90	192.10	2.99	3104.00	30.06	2750.00
796.00	163.20	173.00	3.27	3158.00	31.35	2750.00
797.00	167.00	176.90	3.22	3149.00	30.50	2750.00
798.00	165.50	174.60	3.20	3110.00	30.39	2750.00
799.00	165.30	174.50	3.18	3145.00	30.19	2750.00
800.00	165.30	174.50	3.17	3116.00	30.59	2750.00
801.00	165.20	174.20	3.19	3147.00	30.35	2750.00
802.00	165.40	174.80	3.17	3100.00	30.50	2750.00
803.00	165.20	175.50	3.16	3124.00	30.55	2750.00
804.00	165.20	174.50	3.14	3074.00	30.08	2750.00
805.00	165.20	175.00	3.14	3080.00	30.60	2750.00
806.00	167.00	177.10	3.14	3149.00	30.29	2750.00
807.00	168.00	178.10	3.15	3086.00	30.91	2750.00
808.00	169.30	179.10	3.13	3116.00	30.51	2750.00
809.00	167.00	177.00	3.15	3121.00	30.58	2750.00
810.00	166.80	176.90	3.14	3148.00	30.66	2750.00
811.00	166.00	175.90	3.12	3151.00	30.59	2750.00
812.00	167.40	177.40	3.12	3127.00	30.60	2750.00
813.00	167.20	177.00	3.09	3076.00	30.47	2750.00
814.00	167.20	176.60	3.12	3125.00	30.60	2750.00
815.00	166.30	175.20	3.12	3126.00	30.36	2750.00
816.00	165.90	175.10	3.13	3141.00	30.80	2750.00
817.00	166.50	175.00	3.13	3141.00	30.55	2750.00
818.00	166.10	175.50	3.09	3123.00	30.59	2750.00

819.00	166.50	175.90	3.09	3099.00	30.73	7750.00
820.00	167.00	176.10	3.11	3086.00	30.63	7750.00
821.00	166.80	176.20	3.10	3135.00	30.78	7750.00
822.00	166.70	176.00	3.07	3106.00	30.66	7750.00
823.00	166.50	175.60	3.06	3088.00	30.81	7750.00
824.00	166.50	175.90	3.05	3108.00	30.49	7750.00
825.00	165.40	175.90	3.05	3108.00	30.49	7750.00
826.00	165.40	175.70	3.06	3124.00	30.59	7750.00
827.00	173.50	183.00	3.08	3115.00	30.67	7750.00
828.00	170.00	180.00	3.07	3081.00	31.18	7750.00
829.00	166.00	175.70	3.09	3099.00	30.83	7750.00
830.00	166.90	177.00	3.06	3127.00	30.76	7750.00
831.00	177.00	181.60	3.20	3095.00	31.28	7750.00
832.00	170.20	180.50	3.20	3153.00	30.67	7750.00
833.00	166.30	176.20	3.16	3057.00	30.77	7750.00
834.00	168.00	179.00	3.12	3133.00	30.53	7750.00
835.00	169.00	179.30	3.05	3100.00	30.64	7750.00
836.00	169.50	179.00	3.06	3121.00	30.67	7750.00
837.00	167.90	177.90	3.07	3131.00	30.71	7750.00
838.00	170.10	180.10	3.08	3143.00	30.66	7750.00
839.00	168.00	178.30	3.05	3162.00	30.68	7750.00
840.00	166.90	176.90	3.06	3156.00	30.73	7750.00
841.00	166.40	175.70	3.05	3121.00	30.82	7750.00
842.00	169.40	179.40	3.02	3137.00	30.78	7750.00
843.00	171.40	181.30	3.04	3135.00	30.74	7750.00
844.00	172.00	181.60	3.01	3140.00	30.95	7750.00
845.00	172.00	181.00	3.00	3128.00	30.82	7750.00
846.00	177.30	182.00	3.01	3112.00	30.93	7750.00
847.00	172.10	181.70	2.97	3108.00	31.02	7750.00
848.00	171.30	181.00	2.96	3113.00	31.04	7750.00
849.00	171.00	180.90	2.98	3151.00	31.07	7750.00
850.00	167.90	178.00	3.01	3122.00	31.15	7750.00
851.00	167.50	177.90	3.00	3152.00	30.79	7750.00
852.00	168.70	178.00	3.02	3139.00	31.08	7750.00
853.00	167.40	177.40	2.97	3148.00	30.86	7750.00
854.00	167.60	177.50	3.02	3143.00	30.92	7750.00
855.00	167.70	177.40	2.99	3139.00	31.00	7750.00
856.00	167.70	176.90	2.96	3096.00	30.95	7750.00
857.00	167.70	177.50	2.98	3129.00	30.79	7750.00
858.00	168.10	178.10	3.15	3092.00	30.47	7750.00
859.00	171.50	181.90	3.16	3113.00	30.49	7750.00
860.00	169.00	180.00	3.15	3076.00	30.41	7750.00
861.00	168.60	178.10	3.10	3136.00	30.31	7750.00
862.00	169.90	180.00	3.15	3135.00	30.38	7750.00
863.00	168.90	178.30	3.16	3092.00	30.52	7750.00
864.00	172.00	182.20	3.13	3128.00	30.67	7750.00
865.00	171.50	181.50	3.08	3154.00	30.38	7750.00
866.00	170.50	180.70	3.09	3056.00	30.49	7750.00
867.00	175.10	182.00	3.09	3120.00	30.39	7750.00
868.00	169.10	178.40	3.08	3119.00	30.59	7750.00
869.00	171.90	182.00	3.12	3137.00	30.49	7750.00
870.00	169.40	179.10	3.08	3141.00	30.61	7750.00
871.00	175.00	184.60	3.07	3115.00	30.50	7750.00
872.00	173.70	183.60	3.06	3152.00	30.74	7750.00
873.00	174.30	184.10	3.03	3077.00	31.01	7750.00

874.00	173.10	183.00	3.07	3140.00	30.90	7750.00
875.00	169.60	179.00	3.06	3110.00	30.77	7750.00
876.00	169.00	179.60	3.06	3139.00	31.00	7750.00
877.00	169.60	179.50	3.05	3060.00	30.72	7750.00
878.00	167.50	176.00	3.07	3071.00	30.63	7750.00
879.00	167.00	177.60	3.06	3115.00	30.66	7750.00
880.00	166.60	176.30	3.05	3140.00	30.67	7750.00
881.00	167.70	177.00	3.01	3001.00	30.62	7750.00
882.00	169.10	179.50	3.01	3096.00	30.63	7750.00
883.00	172.50	181.70	3.02	3126.00	30.74	7750.00
884.00	171.40	181.40	3.00	3102.00	30.60	7750.00
885.00	167.70	176.50	2.98	3052.00	30.65	7750.00
886.00	167.30	176.30	2.98	3109.00	30.71	7750.00
887.00	167.50	177.00	2.98	3097.00	30.77	7750.00
888.00	170.20	177.30	2.98	3119.00	30.52	7750.00
889.00	173.00	183.00	3.02	3120.00	30.83	7750.00
890.00	175.00	178.30	3.02	3100.00	30.72	7750.00
891.00	173.50	183.10	3.01	3009.00	31.03	7750.00
892.00	168.70	177.00	3.00	3132.00	30.57	7750.00
893.00	175.50	180.60	3.04	3118.00	30.50	7750.00
894.00	173.30	183.10	3.04	3130.00	30.59	7750.00
895.00	169.00	177.90	3.01	3111.00	30.56	7750.00
896.00	171.50	181.60	3.01	3139.00	31.02	7750.00
897.00	174.70	184.30	3.02	3133.00	30.77	7750.00
898.00	170.50	179.90	3.02	3118.00	30.80	7750.00
899.00	173.00	183.60	2.97	3140.00	30.69	7750.00
900.00	173.50	182.60	2.96	3125.00	30.71	7750.00
901.00	175.20	184.50	2.95	3106.00	30.84	7750.00
902.00	166.70	175.40	3.00	3074.00	30.94	7750.00
903.00	166.70	176.00	2.93	3139.00	31.40	7750.00
904.00	167.30	177.20	3.15	3125.00	31.05	7750.00
905.00	166.10	175.90	3.71	3132.00	31.72	7750.00
906.00	177.40	182.30	3.55	3157.00	31.44	7750.00
907.00	171.00	181.00	3.63	3097.00	31.30	7750.00
908.00	171.50	181.60	3.68	3141.00	31.36	7750.00
909.00	166.50	176.00	3.65	3132.00	31.33	7750.00
910.00	171.50	181.50	3.64	3121.00	31.72	7750.00
911.00	172.00	178.50	3.65	3129.00	31.28	7750.00
912.00	166.50	176.00	3.67	3104.00	31.20	7750.00
913.00	171.00	181.30	3.63	3121.00	31.41	7750.00
914.00	165.50	175.10	3.65	3093.00	31.35	7750.00
915.00	171.00	181.90	3.69	3130.00	31.73	7750.00
916.00	170.60	180.90	3.71	3109.00	31.63	7750.00
917.00	170.50	180.70	3.65	3107.00	31.69	7750.00
918.00	170.00	181.00	3.71	3152.00	31.48	7750.00
919.00	165.70	175.40	3.72	3129.00	31.75	7750.00
920.00	165.00	174.00	3.65	3076.00	31.47	7750.00
921.00	166.10	175.90	3.50	3132.00	31.46	7750.00
922.00	169.60	179.50	3.48	3140.00	31.67	7750.00
923.00	168.10	178.10	3.60	3141.00	31.60	7750.00
924.00	167.00	176.00	3.63	3101.00	31.39	7750.00
925.00	167.70	177.60	3.59	3005.00	31.56	7750.00
926.00	167.00	176.40	3.57	3120.00	31.35	7750.00
927.00	177.00	186.50	3.44	3133.00	31.79	7750.00
928.00	178.90	188.40	3.37	3129.00	31.26	7750.00

929.00	177.50	186.94	3.31	3119.00	30.89	7750.00
930.00	176.50	185.90	3.46	3076.00	31.15	7750.00
931.00	179.10	188.50	3.43	3119.00	31.00	7750.00
932.00	181.40	190.70	3.33	3130.00	30.91	7750.00
933.00	165.00	175.00	3.58	3122.00	31.40	7750.00
934.00	165.00	175.00	3.54	3142.00	31.38	7750.00
935.00	170.50	180.00	3.50	3087.00	31.44	7750.00
936.00	171.50	181.20	3.44	3150.00	31.74	7750.00
937.00	172.40	182.00	3.40	3068.00	31.30	7750.00
938.00	172.60	182.40	3.44	3116.00	31.59	7750.00
939.00	172.30	182.00	3.35	3097.00	31.53	7750.00
940.00	170.30	180.30	3.44	3109.00	31.61	7750.00
941.00	172.00	181.60	3.41	3138.00	31.57	7750.00
942.00	174.90	179.90	4.00	3110.00	31.45	7750.00
943.00	167.00	176.20	4.00	3133.00	31.66	7750.00
944.00	174.00	183.60	3.33	3131.00	31.69	7750.00
945.00	169.30	176.00	3.36	3067.00	31.62	7750.00
946.00	166.90	176.10	3.44	3130.00	31.72	7750.00
947.00	166.50	176.00	2.44	3084.00	31.52	7750.00
948.00	164.50	174.20	2.52	3124.00	31.19	7750.00
949.00	171.10	180.30	2.49	3113.00	31.42	7750.00
950.00	176.40	186.20	2.46	3118.00	31.20	7750.00
951.00	183.40	193.10	2.41	3072.00	31.06	7750.00
952.00	185.40	195.20	2.40	3088.00	31.03	7750.00
953.00	184.50	194.40	2.39	3088.00	30.67	7750.00
954.00	184.00	193.50	2.44	3093.00	30.69	7750.00
955.00	171.00	180.20	2.46	3104.00	31.50	7750.00
956.00	169.20	179.30	2.47	3057.00	31.45	7750.00
957.00	173.50	182.20	2.45	3114.00	31.42	7750.00
958.00	166.50	175.20	2.49	3122.00	31.46	7750.00
959.00	172.00	182.20	2.48	3132.00	31.47	7750.00
960.00	166.40	175.20	2.49	3121.00	31.30	7750.00
961.00	170.00	179.10	2.51	3100.00	31.79	7750.00
962.00	172.00	176.40	2.45	2990.00	30.71	7750.00
963.00	164.00	174.20	2.51	3130.00	31.38	7750.00
964.00	165.50	175.00	2.53	3081.00	31.74	7750.00
965.00	172.50	182.00	2.65	3135.00	31.58	7750.00
966.00	168.50	178.20	2.67	3128.00	31.81	7750.00
967.00	165.20	175.00	2.67	3054.00	31.32	7750.00
968.00	168.00	178.20	2.51	3065.00	31.39	7750.00
969.00	165.50	174.50	2.53	3086.00	31.45	7750.00
970.00	170.30	180.20	2.52	3122.00	31.39	7750.00
971.00	166.30	175.50	2.52	3090.00	31.72	7750.00
972.00	167.50	176.60	2.53	3093.00	31.55	7750.00
973.00	174.00	182.20	2.63	3157.00	30.95	7750.00
974.00	167.00	176.40	2.65	3123.00	30.84	7750.00
975.00	166.50	176.10	2.61	3136.00	31.13	7750.00
976.00	164.30	173.90	2.64	3011.00	30.99	7750.00
977.00	171.00	177.00	2.65	3134.00	31.18	7750.00
978.00	163.00	173.60	2.61	3124.00	31.03	7750.00
979.00	164.00	168.00	2.39	3130.00	30.14	7750.00
980.00	165.00	175.20	2.29	3116.00	31.73	7750.00
981.00	164.00	173.00	2.67	3047.00	31.63	7750.00
982.00	171.50	180.50	2.66	3106.00	31.67	7750.00
983.00	167.10	177.00	2.68	3143.00	31.65	7750.00

984.00	166.70	176.00	2.68	3146.00	31.50	2750.00
985.00	169.00	178.00	2.70	3151.00	31.71	2750.00
986.00	167.10	176.60	2.68	3114.00	32.09	2750.00
987.00	169.00	179.20	2.67	3117.00	31.72	2750.00
988.00	167.20	176.70	2.65	3097.00	31.06	2750.00
989.00	168.10	178.10	2.65	3098.00	31.06	2750.00
990.00	169.00	178.70	2.64	3096.00	31.73	2750.00
991.00	172.70	182.50	2.63	3118.00	31.83	2750.00
992.00	168.60	178.60	2.65	3104.00	31.72	2750.00
993.00	167.00	176.50	2.66	3081.00	31.90	2750.00
994.00	172.00	175.90	2.65	3115.00	31.91	2750.00
995.00	166.50	176.20	2.67	3124.00	31.79	2750.00
996.00	165.90	175.10	2.64	3128.00	31.43	2750.00
997.00	168.90	173.00	3.11	3056.00	31.35	2750.00
998.00	173.00	178.90	3.00	3125.00	30.57	2750.00
999.00	166.70	176.90	3.06	3014.00	30.81	2750.00
1000.00	165.90	176.90	3.00	3102.00	30.01	2750.00

Pump # 360

TIME HOURS	INLET TEMP.(°F)	OUTLET TEMP.(°F)	IN PRESS (PSI)	OUT PRESS (PSI)	FLOW (GPM)	SPEED (RPM)
1.00	164.70	175.00	0.12	3001.00	28.35	2750.00
2.00	164.70	176.30	-0.83	2976.00	28.19	2750.00
3.00	165.70	178.70	-0.94	2974.00	28.07	2750.00
4.00	164.80	177.50	-1.04	3002.00	28.05	2750.00
5.00	164.50	175.30	-1.71	2973.00	28.16	2750.00
6.00	163.70	176.00	-1.79	2977.00	28.15	2750.00
7.00	164.40	177.00	-1.50	2971.00	28.24	2750.00
8.00	168.10	176.60	-1.41	2981.00	27.89	2750.00
9.00	162.60	174.70	-1.67	2984.00	28.02	2750.00
10.00	166.50	178.00	-1.04	2982.00	27.87	2750.00
11.00	162.60	174.60	-1.49	3009.00	27.88	2750.00
12.00	164.50	176.60	-1.58	2966.00	24.11	2750.00
13.00	163.70	175.00	-1.51	3001.00	23.80	2750.00
14.00	166.50	179.30	-0.41	2988.00	27.93	2750.00
15.00	165.10	177.40	-1.01	3010.00	27.87	2750.00
16.00	164.90	177.10	-1.03	2981.00	27.87	2750.00
17.00	164.00	177.00	-1.09	2979.00	27.85	2750.00
18.00	165.60	177.00	-0.76	2972.00	28.11	2750.00
19.00	164.30	176.50	-0.89	2989.00	28.07	2750.00
20.00	164.30	176.30	-1.01	2969.00	28.08	2750.00
21.00	166.40	177.00	-1.70	2967.00	28.02	2750.00
22.00	164.30	176.70	-0.82	2973.00	28.34	2750.00
23.00	168.60	181.60	-0.86	2976.00	27.71	2750.00
24.00	170.00	180.70	-0.89	2964.00	28.14	2750.00
25.00	168.60	181.40	-1.27	2964.00	27.96	2750.00
26.00	164.00	177.00	-1.67	2977.00	28.07	2750.00
27.00	167.50	176.40	-1.44	2952.00	27.90	2750.00
28.00	168.60	180.00	-1.59	2973.00	27.91	2750.00
29.00	165.60	178.10	-1.54	2977.00	28.07	2750.00
30.00	165.30	178.00	-1.81	2992.00	27.69	2750.00
31.00	166.00	174.30	-1.86	2947.00	27.55	2750.00
32.00	166.00	174.60	-1.92	2967.00	28.47	2750.00
33.00	168.00	179.00	-1.93	2963.00	28.12	2750.00
34.00	165.60	178.10	-0.80	2955.00	28.18	2750.00
35.00	167.50	180.30	-0.93	2954.00	28.04	2750.00
36.00	140.60	176.60	-1.04	2977.00	28.23	2750.00
37.00	165.50	179.00	-1.10	2992.00	27.94	2750.00
38.00	163.00	176.70	-1.52	2966.00	28.63	2750.00
39.00	168.40	180.50	-0.86	2965.00	28.55	2750.00
40.00	169.60	179.00	-0.85	2947.00	28.38	2750.00
41.00	165.50	177.30	-1.14	2958.00	28.53	2750.00
42.00	168.00	179.50	-1.79	2956.00	28.42	2750.00
43.00	167.00	179.40	-1.37	2949.00	28.72	2750.00
44.00	164.60	176.70	-1.40	2961.00	28.72	2750.00
45.00	169.30	180.60	-1.24	2952.00	28.59	2750.00
46.00	164.70	176.70	-1.45	2952.00	28.52	2750.00
47.00	164.50	175.90	-1.52	2948.00	28.61	2750.00
48.00	168.40	180.70	-1.59	2950.00	28.38	2750.00
49.00	165.50	177.70	-1.64	2940.00	28.55	2750.00
50.00	166.30	178.60	-1.56	2941.00	28.40	2750.00
51.00	167.00	179.50	-1.48	2947.00	28.87	2750.00

52.00	167.00	179.50	-1.49	2961.00	28.48	2750.00
53.00	165.70	178.00	-1.59	2942.00	28.25	2750.00
54.00	165.30	177.50	-1.48	2954.00	28.34	2750.00
55.00	167.50	179.70	-1.53	2910.00	28.47	2750.00
56.00	168.00	179.90	-1.40	2937.00	27.98	2750.00
57.00	166.40	178.30	-1.45	2953.00	28.24	2750.00
58.00	165.20	176.90	-1.49	2919.00	28.30	2750.00
59.00	165.50	177.50	-1.46	2948.00	28.38	2750.00
60.00	165.70	177.00	-1.51	2937.00	28.26	2750.00
61.00	166.90	178.50	-1.55	2945.00	28.26	2750.00
62.00	171.00	183.40	-0.17	2950.00	28.03	2750.00
63.00	167.60	178.50	-0.75	2923.00	27.17	2750.00
64.00	166.20	178.50	-1.01	2895.00	26.29	2750.00
65.00	166.50	178.20	-1.10	2907.00	25.51	2750.00
66.00	170.20	182.00	-1.32	2968.00	23.22	2750.00
67.00	169.00	181.00	-1.30	2907.00	22.40	2750.00
68.00	169.50	180.90	-1.50	2911.00	21.77	2750.00
69.00	165.90	176.60	-1.40	2966.00	21.24	2750.00
70.00	165.50	177.60	-1.54	2905.00	21.10	2750.00
71.00	169.60	177.90	-1.39	2914.00	20.96	2750.00
72.00	169.40	179.20	-1.51	2832.00	21.09	2750.00
73.00	173.00	184.20	-0.73	2911.00	19.94	2750.00
74.00	167.30	179.00	-1.10	2886.00	20.47	2750.00
75.00	170.20	182.50	-0.91	2931.00	19.30	2750.00
76.00	169.50	181.60	-1.09	2963.00	19.16	2750.00
77.00	170.00	182.00	1.44	2903.00	22.16	2750.00
78.00	170.20	180.50	1.41	2881.00	20.21	2750.00
79.00	171.10	180.00	1.26	2894.00	20.12	2750.00
80.00	171.10	180.00	1.26	2894.00	20.12	2750.00
81.00	158.90	170.20	1.37	2990.00	22.07	2750.00
82.00	172.20	184.90	1.49	2878.00	22.64	2750.00
83.00	173.00	185.20	1.35	2881.00	22.77	2750.00
84.00	168.90	180.00	1.23	2893.00	22.94	2750.00
85.00	168.00	179.60	1.20	2896.00	22.00	2750.00
86.00	167.50	179.30	1.20	2870.00	22.28	2750.00
87.00	172.30	184.30	1.57	2860.00	29.07	2750.00
88.00	167.00	179.60	1.43	2900.00	29.29	2750.00
89.00	167.00	179.10	1.40	2870.00	29.99	2750.00
90.00	167.40	178.20	1.30	2882.00	29.25	2750.00
91.00	167.40	178.00	1.10	2894.00	29.68	2750.00
92.00	167.00	178.50	1.30	2878.00	29.07	2750.00
93.00	167.20	178.90	1.32	2880.00	29.95	2750.00
94.00	166.90	178.30	1.35	2853.00	29.04	2750.00
95.00	168.00	179.60	1.34	2895.00	29.39	2750.00
96.00	168.20	180.00	1.25	2884.00	29.05	2750.00
97.00	169.30	181.20	1.24	2869.00	29.02	2750.00
98.00	171.20	183.60	1.16	2924.00	28.58	2750.00
99.00	170.50	182.10	1.58	2887.00	32.63	2750.00
100.00	170.20	183.10	1.55	2864.00	32.40	2750.00
101.00	166.40	178.10	1.39	2866.00	32.46	2750.00
102.00	172.00	180.10	1.44	2883.00	32.41	2750.00
103.00	171.50	184.00	1.48	2896.00	32.22	2750.00
104.00	167.00	179.40	1.44	2905.00	32.26	2750.00
105.00	168.20	180.40	1.42	2882.00	32.32	2750.00
106.00	168.30	180.50	1.36	2886.00	32.34	2750.00



107.00	171.20	183.50	1.46	2907.00	32.33	7750.00
108.00	172.00	180.00	1.46	2885.00	32.38	7750.00
109.00	166.40	178.00	1.42	2897.00	32.37	7750.00
110.00	167.20	179.40	1.41	2919.00	31.83	7750.00
111.00	167.90	180.00	1.44	2898.00	32.33	7750.00
112.00	168.30	180.50	1.40	2903.00	32.35	7750.00
113.00	167.10	179.00	1.40	2873.00	31.89	7750.00
114.00	167.50	179.50	1.39	2878.00	31.91	7750.00
115.00	167.30	178.60	1.34	2901.00	31.88	7750.00
116.00	166.50	178.00	1.36	2890.00	32.23	7750.00
117.00	166.50	178.30	1.38	2897.00	32.27	7750.00
118.00	167.00	179.60	1.34	2861.00	26.38	7750.00
119.00	168.40	180.50	1.25	2964.00	32.15	7750.00
120.00	169.70	181.00	1.31	2878.00	32.08	7750.00
121.00	171.70	183.50	1.34	2933.00	31.90	7750.00
122.00	169.50	181.60	1.28	2885.00	32.06	7750.00
123.00	168.00	180.60	1.28	2882.00	32.05	7750.00
124.00	166.60	177.70	1.41	2911.00	27.72	7750.00
125.00	166.40	178.50	1.31	2890.00	28.13	7750.00
126.00	172.50	185.70	1.34	2885.00	28.60	7750.00
127.00	166.90	177.00	1.20	3160.00	27.24	7750.00
128.00	171.40	184.50	1.15	3092.00	31.72	7750.00
129.00	168.70	181.50	1.20	3166.00	28.31	7750.00
130.00	166.10	178.50	1.69	3067.00	28.23	7750.00
131.00	167.90	180.50	1.06	3132.00	30.15	7750.00
132.00	167.00	179.60	1.13	3083.00	29.60	7750.00
133.00	167.10	179.70	1.14	3084.00	30.73	7750.00
134.00	173.20	182.40	1.24	3062.00	30.99	7750.00
135.00	171.70	183.30	1.18	3051.00	31.01	7750.00
136.00	168.00	184.40	1.16	3161.00	30.59	7750.00
137.00	167.40	179.00	1.14	3090.00	30.02	7750.00
138.00	168.70	179.00	1.15	3077.00	30.00	7750.00
139.00	169.70	182.00	1.47	3079.00	27.65	7750.00
140.00	172.00	185.50	1.47	3056.00	29.60	7750.00
141.00	169.50	182.00	1.43	3127.00	29.05	7750.00
142.00	174.30	186.00	1.41	3086.00	30.05	7750.00
143.00	174.50	188.30	1.42	3031.00	30.12	7750.00
144.00	169.30	182.50	1.37	3006.00	30.23	7750.00
145.00	167.40	180.40	1.36	3054.00	30.36	7750.00
146.00	168.00	179.30	1.40	3144.00	30.15	7750.00
147.00	170.20	183.90	1.41	3063.00	31.25	7750.00
148.00	167.50	180.70	1.36	3071.00	30.17	7750.00
149.00	166.90	179.60	1.35	3092.00	30.21	7750.00
150.00	169.00	182.00	1.50	3072.00	28.12	7750.00
151.00	169.00	183.30	1.43	3216.00	29.54	7750.00
152.00	172.00	188.10	1.51	3007.00	26.87	7750.00
153.00	173.70	187.50	1.30	3199.00	28.98	7750.00
154.00	170.50	184.40	1.22	3083.00	28.36	7750.00
155.00	171.10	184.90	1.23	3102.00	27.31	7750.00
156.00	168.70	182.00	1.17	3204.00	27.30	7750.00
157.00	173.50	182.10	1.20	3107.00	27.47	7750.00
158.00	173.10	186.30	1.19	3046.00	27.02	7750.00
159.00	167.40	180.10	1.08	3092.00	28.06	7750.00
160.00	167.70	180.00	1.09	3168.00	29.90	7750.00
161.00	167.90	180.60	1.13	3106.00	29.89	7750.00

162.00	168.60	180.00	1.14	3098.00	29.85	7750.00
163.00	167.50	179.50	1.16	3160.00	29.64	7750.00
164.00	172.40	183.60	1.21	3125.00	29.73	7750.00
165.00	172.10	185.40	1.24	3113.00	29.75	7750.00
166.00	168.20	181.50	1.20	3117.00	29.86	7750.00
167.00	167.50	180.10	1.22	3088.00	29.91	7750.00
168.00	167.70	180.70	1.23	3091.00	29.87	7750.00
169.00	167.70	181.00	1.17	3100.00	30.06	7750.00
170.00	170.30	180.00	1.23	3090.00	30.19	7750.00
171.00	168.00	180.60	1.21	3086.00	29.95	7750.00
172.00	170.20	181.30	1.23	3084.00	29.82	7750.00
173.00	171.00	184.00	1.19	3102.00	30.15	7750.00
174.00	172.90	185.90	1.20	3081.00	30.00	7750.00
175.00	172.00	186.40	1.20	3084.00	30.22	7750.00
176.00	171.00	184.40	1.21	3150.00	30.19	7750.00
177.00	171.40	185.40	1.19	3062.00	30.19	7750.00
178.00	172.50	185.70	1.20	3062.00	30.02	7750.00
179.00	171.10	185.00	1.21	3181.00	30.23	7750.00
180.00	169.00	182.50	1.19	3184.00	30.46	7750.00
181.00	167.90	180.10	1.31	3164.00	30.19	7750.00
182.00	169.80	183.30	1.34	3211.00	30.26	7750.00
183.00	169.90	183.00	1.31	3070.00	30.36	7750.00
184.00	168.00	181.10	1.31	3182.00	30.24	7750.00
185.00	168.10	181.00	1.28	3137.00	30.44	7750.00
186.00	171.30	184.20	1.34	3206.00	30.15	7750.00
187.00	171.40	185.00	1.52	3179.00	32.05	7750.00
188.00	173.20	185.50	1.34	3169.00	30.34	7750.00
189.00	168.90	182.00	1.28	3185.00	30.62	7750.00
190.00	168.90	179.00	1.25	3169.00	30.51	7750.00
191.00	176.20	190.10	1.58	3138.00	31.07	7750.00
192.00	172.60	183.70	1.51	3111.00	30.25	7750.00
193.00	175.20	189.20	1.52	3095.00	31.41	7750.00
194.00	175.30	189.50	1.54	3203.00	30.36	7750.00
195.00	172.40	185.70	1.54	3096.00	31.53	7750.00
196.00	170.00	184.50	1.42	3130.00	30.50	7750.00
197.00	167.30	180.30	1.40	3097.00	30.89	7750.00
198.00	167.10	179.70	1.35	3239.00	30.55	7750.00
199.00	170.00	180.50	1.35	3225.00	30.73	7750.00
200.00	169.20	179.60	1.35	3138.00	30.91	7750.00
201.00	169.20	178.50	1.26	3234.00	31.65	7750.00
202.00	175.30	188.40	1.00	3168.00	31.40	7750.00
203.00	176.00	187.30	0.72	3108.00	30.81	7750.00
204.00	178.00	191.10	1.06	3159.00	30.41	7750.00
205.00	178.40	191.60	0.82	3171.00	30.92	7750.00
206.00	179.90	190.10	0.84	3145.00	31.02	7750.00
207.00	173.60	186.70	0.92	3106.00	31.10	7750.00
208.00	180.00	192.30	0.77	3056.00	31.13	7750.00
209.00	179.00	192.10	0.85	3105.00	31.17	7750.00
210.00	171.80	184.50	1.65	3215.00	29.36	7750.00
211.00	169.50	182.50	1.59	3121.00	29.34	7750.00
212.00	171.10	184.50	1.59	3221.00	29.12	7750.00
213.00	170.00	182.60	1.59	3210.00	29.66	7750.00
214.00	169.00	175.50	1.22	3191.00	34.26	7750.00
215.00	170.00	182.70	1.54	3220.00	28.87	7750.00
216.00	172.00	184.30	1.52	3223.00	28.77	7750.00

217.00	175.00	189.00	1.55	3234.00	28.34	7750.00
218.00	178.90	183.30	1.50	3226.00	28.75	7750.00
219.00	173.90	186.00	1.52	3197.00	27.31	7750.00
220.00	171.50	205.00	1.47	3050.00	30.30	7750.00
221.00	167.00	179.60	1.65	3246.00	28.76	7750.00
222.00	167.00	179.10	1.64	3231.00	31.95	7750.00
223.00	163.70	175.50	1.46	3201.00	29.93	7750.00
224.00	163.00	175.00	1.39	3236.00	29.47	7750.00
225.00	162.00	174.90	1.26	3232.00	29.17	7750.00
226.00	163.40	175.30	1.24	3141.00	29.60	7750.00
227.00	164.10	176.60	1.18	3150.00	31.63	7750.00
228.00	176.50	187.40	1.40	3169.00	31.65	7750.00
229.00	175.40	186.20	1.38	3151.00	31.51	7750.00
230.00	171.00	183.90	1.34	3144.00	28.36	7750.00
231.00	172.10	185.10	1.37	3143.00	28.89	7750.00
232.00	171.30	184.10	1.35	3094.00	28.98	7750.00
233.00	173.50	185.20	1.34	3161.00	28.56	7750.00
234.00	174.90	187.60	1.35	3133.00	27.84	7750.00
235.00	173.50	185.00	1.32	3101.00	28.10	7750.00
236.00	176.00	189.70	1.38	3187.00	27.22	7750.00
237.00	170.90	183.50	1.35	3178.00	27.47	7750.00
238.00	170.60	183.00	1.31	3246.00	27.59	7750.00
239.00	177.90	188.60	1.35	3160.00	27.29	7750.00
240.00	172.00	185.70	1.30	3096.00	28.00	7750.00
241.00	176.00	187.30	1.31	3189.00	27.09	7750.00
242.00	176.00	189.50	1.35	3226.00	26.83	7750.00
243.00	170.70	182.00	1.30	3220.00	27.66	7750.00
244.00	176.10	188.00	1.49	3171.00	28.32	7750.00
245.00	174.00	187.70	1.47	3219.00	30.79	7750.00
246.00	171.70	184.50	1.46	3232.00	29.33	7750.00
247.00	174.10	187.40	1.47	3146.00	30.46	7750.00
248.00	174.00	187.00	1.46	3189.00	29.97	7750.00
249.00	177.00	190.00	1.51	3126.00	28.95	7750.00
250.00	176.00	188.00	1.43	3146.00	29.24	7750.00
251.00	171.00	184.50	1.41	3237.00	29.06	7750.00
252.00	175.90	189.20	1.43	3186.00	28.95	7750.00
253.00	172.00	184.00	1.43	3161.00	28.87	7750.00
254.00	172.70	185.30	1.36	3217.00	28.77	7750.00
255.00	172.50	185.50	1.41	3130.00	28.92	7750.00
256.00	174.00	187.70	1.39	3196.00	29.17	7750.00
257.00	177.00	190.70	1.44	3159.00	28.43	7750.00
258.00	176.90	190.10	1.43	3266.00	32.05	7750.00
259.00	166.70	179.30	1.30	3275.00	31.51	7750.00
260.00	174.00	187.70	1.42	3269.00	31.40	7750.00
261.00	178.40	191.50	1.44	3251.00	31.40	7750.00
262.00	166.00	178.30	1.30	3260.00	32.18	7750.00
263.00	175.00	188.00	1.42	3241.00	32.10	7750.00
264.00	178.50	191.50	1.44	3253.00	32.09	7750.00
265.00	174.50	183.00	1.40	3241.00	31.92	7750.00
266.00	173.90	186.70	1.38	3170.00	32.05	7750.00
267.00	177.00	191.00	1.43	3240.00	32.13	7750.00
268.00	180.00	183.30	1.41	3249.00	32.12	7750.00
269.00	166.70	179.00	1.28	3270.00	31.96	7750.00
270.00	175.30	188.40	1.36	3253.00	32.05	7750.00
271.00	178.30	191.50	1.38	3253.00	32.09	7750.00

272.00	179.30	192.50	1.56	3146.00	25.30	2750.00
273.00	178.10	192.00	1.83	3212.00	28.96	2750.00
274.00	179.50	193.40	1.78	3200.00	27.86	2750.00
275.00	173.90	187.00	1.68	3124.00	26.62	2750.00
276.00	179.20	190.60	1.95	3231.00	24.32	2750.00
277.00	174.20	186.30	2.23	3100.00	24.46	2750.00
278.00	174.50	187.30	3.00	3159.00	31.62	2750.00
279.00	174.60	185.00	2.84	3143.00	30.48	2750.00
280.00	167.00	179.00	2.00	3180.00	29.40	2750.00
281.00	167.50	179.00	2.75	3139.00	29.00	2750.00
282.00	167.00	178.00	2.74	3242.00	27.92	2750.00
283.00	169.00	182.00	2.72	3219.00	27.40	2750.00
284.00	168.40	178.90	2.69	3240.00	27.56	2750.00
285.00	166.50	178.00	2.70	3223.00	27.05	2750.00
286.00	167.50	179.60	2.72	3235.00	27.56	2750.00
287.00	171.50	180.00	2.72	3229.00	28.10	2750.00
288.00	166.50	178.20	2.72	3235.00	27.95	2750.00
289.00	166.20	178.20	2.71	3134.00	28.59	2750.00
290.00	168.20	180.30	2.69	3252.00	28.35	2750.00
291.00	169.60	181.20	2.70	3247.00	28.40	2750.00
292.00	170.10	182.30	2.67	3235.00	28.40	2750.00
293.00	170.00	182.00	2.68	3126.00	28.95	2750.00
294.00	168.30	180.50	2.63	3239.00	28.53	2750.00
295.00	167.00	179.50	2.63	3257.00	28.50	2750.00
296.00	165.50	177.30	2.62	3225.00	29.09	2750.00
297.00	165.30	176.90	2.60	3232.00	29.02	2750.00
298.00	171.50	183.50	2.63	3129.00	29.31	2750.00
299.00	175.50	177.50	2.62	3229.00	30.00	2750.00
300.00	169.60	181.20	2.59	3139.00	29.32	2750.00
301.00	171.50	180.20	2.58	3184.00	29.11	2750.00
302.00	165.20	176.90	2.59	3245.00	29.39	2750.00
303.00	169.20	182.00	2.58	3241.00	28.90	2750.00
304.00	165.40	176.60	2.58	3190.00	29.34	2750.00
305.00	168.90	181.10	2.58	3242.00	29.24	2750.00
306.00	168.10	178.20	2.57	3233.00	29.40	2750.00
307.00	165.20	177.00	2.56	3169.00	29.51	2750.00
308.00	168.20	181.10	2.57	3136.00	29.52	2750.00
309.00	165.60	177.10	2.55	3234.00	29.90	2750.00
310.00	165.00	176.50	2.58	3249.00	29.88	2750.00
311.00	169.00	181.90	2.58	3263.00	29.34	2750.00
312.00	169.50	181.60	2.57	3231.00	29.55	2750.00
313.00	171.50	184.00	2.57	3122.00	29.20	2750.00
314.00	165.50	177.00	2.57	3220.00	29.84	2750.00
315.00	168.00	180.00	2.57	3166.00	29.60	2750.00
316.00	170.60	182.20	2.57	3131.00	29.69	2750.00
317.00	170.50	182.50	2.58	3125.00	30.01	2750.00
318.00	168.60	180.00	2.59	3223.00	30.05	2750.00
319.00	170.50	182.20	2.57	3115.00	30.12	2750.00
320.00	169.40	177.50	2.53	3191.00	29.49	2750.00
321.00	165.30	177.00	2.53	3222.00	30.34	2750.00
322.00	167.20	179.30	2.49	3231.00	29.58	2750.00
323.00	168.00	180.30	2.49	3226.00	29.90	2750.00
324.00	165.20	177.50	2.50	3142.00	30.20	2750.00
325.00	165.50	177.00	2.48	3161.00	30.82	2750.00
326.00	165.60	177.60	2.49	3256.00	29.26	2750.00

327.00	169.60	181.70	2.54	3219.00	30.03	2750.00
328.00	166.50	176.70	2.50	3246.00	30.29	2750.00
329.00	165.10	176.50	2.53	3237.00	30.07	2750.00
330.00	170.90	183.00	2.51	3245.00	29.46	2750.00
331.00	166.30	177.70	2.50	3260.00	30.07	2750.00
332.00	167.10	177.50	2.47	3169.00	29.87	2750.00
333.00	165.50	177.50	2.48	3194.00	30.17	2750.00
334.00	166.10	177.20	2.48	3247.00	29.83	2750.00
335.00	165.10	171.00	2.45	3165.00	31.62	2750.00
336.00	170.00	182.60	2.49	3233.00	30.05	2750.00
337.00	164.00	175.90	2.48	3261.00	30.18	2750.00
338.00	166.00	177.00	2.47	3228.00	30.51	2750.00
339.00	167.00	180.00	2.46	3181.00	29.79	2750.00
340.00	165.20	175.50	2.48	3137.00	30.15	2750.00
341.00	169.00	180.50	2.46	3202.00	29.92	2750.00
342.00	166.00	177.60	2.46	3206.00	30.57	2750.00
343.00	169.50	178.50	2.46	3217.00	29.87	2750.00
344.00	168.00	181.00	2.46	3191.00	30.03	2750.00
345.00	178.30	184.70	2.79	3192.00	31.73	2750.00
346.00	174.00	186.50	2.82	3234.00	31.75	2750.00
347.00	177.90	184.30	2.85	3259.00	31.82	2750.00
348.00	172.50	183.60	2.82	3145.00	31.83	2750.00
349.00	178.70	191.10	3.81	3231.00	31.43	2750.00
350.00	173.60	185.20	3.82	3184.00	31.37	2750.00
351.00	173.00	185.60	2.80	3233.00	31.92	2750.00
352.00	174.50	186.40	2.81	3229.00	31.90	2750.00
353.00	176.30	188.40	2.83	3240.00	32.10	2750.00
354.00	174.50	186.40	2.81	3230.00	31.57	2750.00
355.00	176.20	188.90	2.83	3242.00	31.64	2750.00
356.00	179.60	192.00	2.81	3214.00	31.68	2750.00
357.00	172.00	184.40	2.83	3241.00	31.72	2750.00
358.00	179.10	191.40	2.80	3220.00	31.67	2750.00
359.00	175.50	187.90	2.78	3115.00	31.99	2750.00
360.00	173.30	185.40	2.78	3231.00	32.00	2750.00
361.00	173.30	185.50	2.78	3116.00	31.69	2750.00
362.00	179.50	191.70	2.77	3217.00	29.55	2750.00
363.00	173.30	184.90	2.79	3212.00	29.73	2750.00
364.00	177.20	187.50	2.78	3214.00	29.56	2750.00
365.00	175.00	188.30	2.79	3237.00	29.07	2750.00
366.00	180.20	192.50	2.77	3227.00	29.11	2750.00
367.00	174.00	183.60	2.81	3252.00	30.23	2750.00
368.00	171.60	183.40	2.74	3231.00	29.96	2750.00
369.00	170.10	181.90	2.76	3134.00	29.51	2750.00
370.00	172.50	184.30	2.75	3212.00	29.73	2750.00
371.00	173.10	185.10	2.77	3216.00	29.46	2750.00
372.00	172.70	184.50	2.73	3250.00	29.06	2750.00
373.00	170.00	181.20	2.75	3232.00	29.54	2750.00
374.00	167.20	178.50	2.72	3248.00	29.77	2750.00
375.00	173.50	185.30	2.74	3242.00	29.49	2750.00
376.00	174.00	183.00	2.73	3227.00	29.57	2750.00
377.00	167.00	178.50	2.75	3260.00	29.68	2750.00
378.00	167.90	179.50	2.74	3196.00	29.67	2750.00
379.00	168.10	179.50	2.72	3222.00	29.59	2750.00
380.00	170.60	182.50	2.75	3236.00	29.50	2750.00
381.00	171.00	183.00	2.73	3248.00	29.14	2750.00

382.00	171.30	183.40	2.74	3243.00	29.40	2750.00
383.00	168.50	180.60	2.74	3237.00	29.55	2750.00
384.00	170.10	182.30	2.74	3219.00	29.64	2750.00
385.00	172.90	185.00	2.74	3248.00	29.40	2750.00
386.00	174.10	186.10	2.70	3229.00	29.44	2750.00
387.00	167.60	179.40	2.70	3231.00	29.84	2750.00
388.00	167.10	178.50	2.70	3229.00	29.79	2750.00
389.00	169.20	181.10	2.70	3237.00	29.89	2750.00
390.00	169.80	181.30	2.71	3243.00	29.67	2750.00
391.00	172.50	184.00	2.71	3230.00	29.57	2750.00
392.00	174.20	186.20	2.72	3270.00	29.54	2750.00
393.00	168.40	178.50	2.71	3222.00	29.73	2750.00
394.00	167.20	178.90	2.72	3220.00	29.95	2750.00
395.00	169.00	181.00	2.72	3201.00	29.52	2750.00
396.00	168.50	180.80	2.72	3240.00	29.97	2750.00
397.00	170.10	182.30	2.72	3239.00	29.65	2750.00
398.00	168.80	180.20	2.74	3264.00	30.02	2750.00
399.00	171.20	183.00	2.75	3226.00	29.56	2750.00
400.00	168.20	180.40	2.73	3233.00	29.95	2750.00
401.00	167.30	179.00	2.76	3212.00	29.71	2750.00
402.00	169.50	181.20	2.76	3266.00	29.61	2750.00
403.00	171.20	183.30	2.75	3239.00	29.44	2750.00
404.00	166.80	178.50	2.76	3230.00	29.72	2750.00
405.00	167.20	178.50	2.76	3261.00	29.72	2750.00
406.00	168.50	180.40	2.77	3212.00	29.70	2750.00
407.00	169.00	181.00	2.80	3213.00	29.68	2750.00
408.00	168.10	180.50	2.79	3229.00	29.74	2750.00
409.00	167.10	178.50	2.77	3257.00	29.79	2750.00
410.00	166.50	178.50	2.78	3217.00	29.59	2750.00
411.00	168.20	180.30	2.76	3252.00	29.66	2750.00
412.00	166.40	177.60	2.77	3242.00	29.55	2750.00
413.00	166.60	178.50	2.78	3215.00	29.61	2750.00
414.00	166.10	177.90	2.77	3250.00	29.58	2750.00
415.00	166.20	177.50	3.00	3278.00	30.58	2750.00
416.00	171.30	183.40	2.97	3251.00	30.90	2750.00
417.00	174.00	185.00	2.97	3233.00	30.60	2750.00
418.00	170.00	178.10	2.94	3222.00	30.60	2750.00
419.00	170.30	182.10	2.91	3212.00	30.62	2750.00
420.00	167.00	177.00	2.90	3205.00	30.79	2750.00
421.00	170.10	182.00	2.87	3232.00	30.66	2750.00
422.00	166.20	177.00	2.91	3239.00	30.72	2750.00
423.00	171.00	183.00	2.90	3210.00	30.70	2750.00
424.00	165.00	177.20	2.88	3235.00	30.96	2750.00
425.00	172.40	184.50	2.89	3197.00	30.72	2750.00
426.00	166.20	177.60	2.91	3232.00	30.90	2750.00
427.00	172.50	184.40	2.91	3226.00	30.76	2750.00
428.00	171.00	178.90	2.96	3247.00	31.00	2750.00
429.00	167.00	178.20	2.95	3243.00	31.19	2750.00
430.00	173.30	184.00	2.95	3256.00	30.90	2750.00
431.00	167.00	178.20	2.87	3251.00	30.87	2750.00
432.00	170.50	182.10	2.84	3260.00	30.69	2750.00
433.00	172.00	184.00	2.94	3234.00	30.59	2750.00
434.00	172.20	184.00	2.94	3206.00	30.57	2750.00
435.00	171.60	183.50	2.91	3200.00	30.57	2750.00
436.00	172.10	184.00	2.89	3227.00	30.49	2750.00

437.00	170.30	182.30	2.89	3218.00	30.48	7750.00
438.00	172.00	184.00	2.89	3238.00	30.40	7750.00
439.00	169.50	178.00	2.89	3186.00	30.67	7750.00
440.00	166.50	177.60	2.89	3234.00	30.86	7750.00
441.00	169.50	181.60	2.84	3228.00	30.77	7750.00
442.00	171.90	184.00	2.89	3230.00	30.67	7750.00
443.00	173.10	185.00	2.88	3231.00	30.54	7750.00
444.00	173.20	184.90	2.89	3225.00	30.62	7750.00
445.00	172.00	183.70	2.91	2233.00	30.72	2750.00
446.00	173.00	184.90	2.90	3249.00	30.64	2750.00
447.00	171.00	178.50	2.93	3207.00	30.80	2750.00
448.00	166.30	177.80	2.90	3228.00	31.06	2750.00
449.00	173.00	185.00	2.91	3217.00	30.77	2750.00
450.00	166.00	177.50	2.92	3261.00	31.03	2750.00
451.00	172.10	183.60	2.92	3230.00	30.89	2750.00
452.00	168.00	178.10	2.92	3258.00	30.95	2750.00
453.00	170.50	182.40	2.94	3231.00	31.06	2750.00
454.00	173.00	180.60	2.92	3232.00	31.98	2750.00
455.00	166.50	177.90	2.91	3241.00	30.98	2750.00
456.00	170.10	182.30	2.90	3253.00	30.83	2750.00
457.00	172.60	184.30	2.90	3261.00	30.51	2750.00
458.00	173.00	180.30	2.91	3236.00	30.62	2750.00
459.00	165.10	176.50	2.91	3252.00	30.94	2750.00
460.00	177.20	184.00	2.92	3254.00	30.53	2750.00
461.00	168.00	179.50	2.91	3261.00	30.64	2750.00
462.00	168.50	180.70	2.93	3261.00	30.72	2750.00
463.00	173.00	184.90	2.91	3262.00	30.55	2750.00
464.00	166.20	177.50	2.93	3260.00	30.89	2750.00
465.00	173.50	182.50	2.92	3258.00	31.00	2750.00
466.00	172.10	183.70	2.92	3270.00	32.21	2750.00
467.00	168.30	180.20	2.93	3258.00	30.96	2750.00
468.00	172.50	184.00	2.92	3255.00	30.69	2750.00
469.00	170.20	180.60	2.93	3255.00	31.14	2750.00
470.00	170.00	182.70	2.93	3254.00	30.91	2750.00
471.00	173.00	185.10	2.94	3253.00	30.81	2750.00
472.00	168.90	181.90	2.94	3263.00	31.00	2750.00
473.00	172.20	182.00	2.93	3270.00	32.21	2750.00
474.00	173.40	184.00	2.94	3293.00	32.34	2750.00
475.00	170.00	182.10	2.95	3256.00	32.10	2750.00
476.00	165.90	177.00	2.94	3279.00	31.31	2750.00
477.00	169.00	180.70	2.96	3259.00	31.00	2750.00
478.00	173.30	184.00	2.96	3288.00	31.10	2750.00
479.00	170.30	182.30	2.93	3277.00	31.07	2750.00
480.00	169.20	181.40	2.96	3271.00	30.95	2750.00
481.00	172.60	184.00	2.95	3259.00	30.76	2750.00
482.00	164.50	175.60	2.94	3276.00	31.10	2750.00
483.00	172.00	184.00	2.94	3254.00	30.86	2750.00
484.00	170.10	182.10	3.18	3279.00	29.56	2750.00
485.00	166.30	177.30	3.17	3291.00	29.84	2750.00
486.00	170.90	177.20	3.16	3259.00	29.76	2750.00
487.00	169.50	181.30	3.14	3304.00	29.79	2750.00
488.00	167.90	179.70	3.12	3277.00	30.06	2750.00
489.00	166.00	177.30	3.15	3269.00	30.11	2750.00
490.00	166.30	177.50	3.12	3273.00	30.27	2750.00
491.00	167.00	178.40	3.11	3283.00	29.98	2750.00

492.00	166.50	178.00	3.13	3295.00	29.96	2750.00
493.00	166.60	177.90	3.11	3248.00	30.43	2750.00
494.00	166.60	177.90	3.10	3266.00	30.65	2750.00
495.00	165.90	177.10	3.12	3276.00	30.49	2750.00
496.00	166.20	177.50	3.08	3282.00	32.30	2750.00
497.00	168.00	179.00	3.09	3263.00	32.19	2750.00
498.00	178.70	182.60	3.08	3287.00	30.63	2750.00
499.00	165.70	177.40	3.07	3253.00	32.05	2750.00
500.00	172.20	184.00	3.08	3245.00	32.04	2750.00
501.00	166.70	178.00	3.09	3233.00	32.04	2750.00
502.00	167.10	179.00	3.05	3239.00	30.96	2750.00
503.00	168.60	180.50	3.05	3273.00	32.29	2750.00
504.00	178.30	182.40	3.07	3268.00	30.62	2750.00
505.00	168.90	180.70	3.05	3263.00	31.44	2750.00
506.00	171.00	179.00	3.11	3232.00	30.91	2750.00
507.00	176.90	190.00	3.09	3275.00	32.12	2750.00
508.00	166.50	177.90	3.09	3276.00	31.41	2750.00
509.00	173.10	185.00	3.08	3257.00	31.14	2750.00
510.00	166.40	177.50	3.09	3244.00	31.46	2750.00
511.00	171.10	183.30	3.11	3269.00	31.18	2750.00
512.00	173.00	183.00	3.09	3259.00	31.18	2750.00
513.00	169.20	181.50	3.07	3254.00	31.40	2750.00
514.00	166.50	178.00	3.05	3269.00	31.64	2750.00
515.00	168.00	179.10	3.05	3264.00	31.74	2750.00
516.00	167.60	178.90	3.05	3254.00	32.06	2750.00
517.00	167.20	178.50	3.04	3265.00	31.62	2750.00
518.00	166.20	177.40	3.05	3279.00	32.10	2750.00
519.00	166.40	177.90	3.04	3250.00	31.60	2750.00
520.00	166.90	178.00	3.05	3261.00	31.59	2750.00
521.00	166.50	177.10	3.04	3249.00	32.04	2750.00
522.00	166.60	177.80	3.03	3299.00	31.74	2750.00
523.00	166.60	177.50	3.05	3241.00	31.82	2750.00
524.00	168.00	179.60	3.04	3264.00	31.55	2750.00
525.00	168.00	179.40	3.03	3250.00	32.10	2750.00
526.00	168.00	179.30	3.01	3256.00	32.10	2750.00
527.00	174.00	186.00	3.01	3238.00	31.46	2750.00
528.00	167.70	180.00	3.01	3259.00	31.59	2750.00
529.00	168.30	180.90	3.01	3264.00	31.69	2750.00
530.00	173.60	185.70	3.02	3254.00	31.70	2750.00
531.00	167.00	178.20	2.99	3266.00	32.10	2750.00
532.00	174.30	184.10	3.01	3255.00	32.13	2750.00
533.00	166.70	178.90	3.00	3261.00	31.86	2750.00
534.00	167.50	178.60	3.01	3272.00	31.61	2750.00
535.00	173.30	184.50	2.99	3287.00	32.17	2750.00
536.00	167.60	180.00	2.99	3278.00	31.64	2750.00
537.00	178.10	179.70	3.00	3256.00	31.68	2750.00
538.00	171.10	183.20	2.99	3255.00	32.12	2750.00
539.00	167.90	180.00	2.98	3274.00	31.67	2750.00
540.00	171.10	183.10	2.99	3278.00	32.03	2750.00
541.00	167.90	179.00	2.98	3239.00	31.94	2750.00
542.00	172.00	184.00	2.99	3246.00	31.60	2750.00
543.00	169.00	180.30	2.98	3243.00	32.01	2750.00
544.00	171.60	183.70	2.95	3212.00	31.96	2750.00
545.00	173.60	185.90	2.97	3227.00	32.00	2750.00
546.00	165.90	177.00	2.90	3239.00	31.95	2750.00



547.00	172.50	184.20	3.23	3244.00	31.97	7750.00
548.00	167.10	177.90	3.20	3232.00	32.04	7750.00
549.00	172.00	180.90	3.17	3224.00	31.07	7750.00
550.00	170.70	182.50	3.16	3237.00	31.99	7750.00
551.00	166.90	178.20	3.16	3233.00	32.00	7750.00
552.00	172.40	184.10	3.15	3230.00	32.10	7750.00
553.00	173.40	181.50	3.14	3238.00	31.97	7750.00
554.00	167.10	178.50	3.13	3277.00	31.69	7750.00
555.00	167.10	178.20	3.12	3199.00	31.78	7750.00
556.00	170.20	182.10	3.14	3232.00	31.90	7750.00
557.00	167.00	178.40	3.12	3232.00	32.02	7750.00
558.00	171.00	179.10	3.12	3240.00	31.61	7750.00
559.00	172.10	184.00	3.10	3242.00	32.06	7750.00
560.00	167.00	178.30	3.09	3240.00	32.06	7750.00
561.00	173.60	185.50	3.11	3254.00	32.00	7750.00
562.00	167.00	178.00	3.11	3267.00	31.75	7750.00
563.00	168.90	179.00	3.11	3240.00	32.03	7750.00
564.00	173.70	185.10	3.07	3219.00	31.90	7750.00
565.00	167.00	179.20	3.09	3250.00	31.60	7750.00
566.00	174.00	186.50	3.06	3239.00	31.20	7750.00
567.00	167.50	178.90	3.04	3260.00	31.39	7750.00
568.00	170.40	182.20	3.06	3275.00	31.63	7750.00
569.00	172.60	184.40	3.09	3246.00	31.90	7750.00
570.00	173.10	186.00	3.10	3259.00	31.57	7750.00
571.00	174.10	181.70	3.23	3273.00	29.97	7750.00
572.00	171.50	184.00	3.27	3246.00	31.32	7750.00
573.00	171.50	182.10	3.23	3215.00	31.13	7750.00
574.00	172.00	183.90	3.25	3249.00	30.61	7750.00
575.00	175.90	187.50	3.20	3243.00	31.09	7750.00
576.00	168.60	180.20	3.25	3230.00	31.50	7750.00
577.00	169.50	180.90	3.24	3242.00	31.40	7750.00
578.00	174.30	186.10	3.23	3246.00	31.24	7750.00
579.00	168.00	179.20	3.23	3241.00	31.60	7750.00
580.00	168.10	179.30	3.22	3242.00	31.67	7750.00
581.00	174.00	185.00	3.21	3246.00	31.60	7750.00
582.00	170.20	181.70	3.20	3257.00	31.60	7750.00
583.00	168.60	179.40	3.23	3236.00	31.99	7750.00
584.00	167.90	179.10	3.21	3262.00	32.06	7750.00
585.00	167.90	179.40	3.19	3229.00	32.01	7750.00
586.00	167.50	178.00	3.16	3257.00	31.06	7750.00
587.00	168.00	179.50	3.14	3241.00	32.04	7750.00
588.00	170.20	182.20	3.13	3255.00	31.00	7750.00
589.00	168.20	180.10	3.15	3230.00	32.04	7750.00
590.00	168.30	179.20	3.15	3251.00	31.94	7750.00
591.00	167.50	179.10	3.15	3242.00	31.07	7750.00
592.00	175.10	183.90	3.14	3249.00	31.92	7750.00
593.00	175.50	182.40	3.14	3246.00	31.96	7750.00
594.00	170.10	181.30	3.13	3244.00	31.97	7750.00
595.00	169.00	180.20	3.13	3249.00	32.04	7750.00
596.00	174.60	186.30	3.15	3240.00	31.04	7750.00
597.00	168.20	179.50	3.13	3250.00	32.15	7750.00
598.00	167.50	179.10	3.12	3230.00	32.05	7750.00
599.00	174.50	186.00	3.14	3249.00	31.02	7750.00

600.00	168.00	179.30	3.03	3275.00	31.59	7750.00
601.00	168.50	179.20	3.05	3274.00	32.00	7750.00
602.00	168.40	179.40	3.04	3271.00	32.00	7750.00
603.00	176.20	180.00	3.11	3269.00	31.87	7750.00
604.00	169.90	181.10	3.10	3270.00	31.90	7750.00
605.00	171.00	181.50	3.13	3250.00	31.70	7750.00
606.00	169.90	181.70	3.10	3240.00	31.87	7750.00
607.00	174.50	183.10	3.09	3239.00	31.70	7750.00
608.00	173.50	185.30	3.09	3227.00	31.83	7750.00
609.00	176.90	186.60	3.00	3245.00	31.67	7750.00
610.00	169.30	181.00	3.06	3241.00	31.91	7750.00
611.00	173.20	185.20	3.06	3252.00	31.81	7750.00
612.00	169.00	179.20	3.06	3242.00	31.92	7750.00
613.00	167.00	178.20	3.06	3232.00	32.00	7750.00
614.00	168.20	180.20	3.06	3200.00	32.00	7750.00
615.00	166.50	178.20	3.14	3239.00	31.72	7750.00
616.00	171.30	183.00	3.14	3252.00	31.16	7750.00
617.00	172.00	183.50	3.13	3230.00	31.42	7750.00
618.00	171.30	183.20	3.11	3222.00	31.46	7750.00
619.00	167.50	179.10	3.13	3230.00	31.59	7750.00
620.00	169.00	180.20	3.13	3235.00	31.58	7750.00
621.00	167.10	178.60	3.11	3273.00	31.69	7750.00
622.00	169.40	181.00	3.15	3263.00	31.63	7750.00
623.00	171.20	182.90	3.12	3200.00	31.47	7750.00
624.00	168.30	180.00	3.04	3261.00	31.49	7750.00
625.00	168.90	181.00	3.05	3240.00	31.65	7750.00
626.00	174.60	186.50	3.02	3230.00	31.72	7750.00
627.00	169.20	179.60	3.12	3213.00	31.76	7750.00
628.00	168.50	180.00	3.10	3230.00	31.49	7750.00
629.00	167.50	179.00	3.10	3230.00	31.51	7750.00
630.00	166.50	177.50	3.00	3230.00	31.59	7750.00
631.00	168.30	180.20	3.02	3253.00	31.34	7750.00
632.00	176.20	182.20	3.00	3212.00	31.24	7750.00
633.00	167.50	179.00	3.06	3266.00	31.41	7750.00
634.00	167.20	179.10	3.06	3242.00	31.49	7750.00
635.00	167.40	178.00	3.04	3220.00	31.77	7750.00
636.00	166.30	177.40	3.02	3244.00	32.00	7750.00
637.00	166.50	178.10	3.05	3219.00	31.90	7750.00
638.00	173.50	185.10	3.05	3200.00	32.15	7750.00
639.00	166.20	177.90	3.05	3250.00	32.00	7750.00
640.00	166.20	177.90	3.05	3250.00	32.00	7750.00
641.00	167.50	178.00	3.05	3243.00	32.03	7750.00
642.00	166.30	177.20	3.04	3250.00	32.14	7750.00
643.00	165.00	177.00	3.02	3230.00	32.00	7750.00
644.00	166.20	177.50	3.04	3253.00	32.13	7750.00
645.00	165.90	176.00	3.03	3250.00	31.65	7750.00
646.00	169.50	181.10	3.03	3267.00	31.86	7750.00
647.00	158.10	168.50	3.04	3310.00	31.82	7750.00
648.00	173.40	184.20	3.03	3250.00	31.81	7750.00
649.00	171.90	183.30	3.01	3249.00	31.87	7750.00
650.00	166.10	177.00	2.90	3252.00	31.77	7750.00
651.00	166.10	177.40	3.09	3240.00	31.76	7750.00
652.00	167.50	179.30	3.20	3200.00	31.70	7750.00
653.00	166.00	178.50	3.24	3250.00	31.82	7750.00
654.00	170.60	182.10	3.20	3216.00	31.82	7750.00

655.00	172.00	183.60	3.20	3237.00	31.87	7750.00
656.00	168.00	180.60	3.16	3242.00	31.61	7750.00
657.00	167.50	179.00	3.18	3231.00	32.15	7750.00
658.00	169.00	178.00	3.19	3221.00	32.00	7750.00
659.00	168.00	179.30	3.17	3227.00	32.03	7750.00
660.00	167.00	179.30	3.17	3243.00	31.89	7750.00
661.00	167.60	179.00	3.17	3216.00	32.09	7750.00
662.00	167.70	179.00	3.15	3221.00	31.91	7750.00
663.00	168.50	180.00	3.14	3226.00	31.56	7750.00
664.00	174.20	186.00	3.13	3219.00	32.05	7750.00
665.00	168.70	180.00	3.14	3198.00	31.81	7750.00
666.00	170.00	182.60	3.18	3206.00	29.71	7750.00
667.00	164.00	176.00	3.12	3195.00	31.69	7750.00
668.00	169.00	180.60	3.00	3205.00	31.45	7750.00
669.00	165.10	176.30	3.07	3226.00	31.06	7750.00
670.00	168.60	180.40	3.06	3212.00	31.56	7750.00
671.00	170.10	181.70	3.06	3221.00	31.90	7750.00
672.00	170.50	181.70	3.05	3217.00	31.84	7750.00
673.00	166.00	178.50	3.04	3209.00	31.90	7750.00
674.00	165.00	177.00	3.04	3225.00	32.05	7750.00
675.00	165.70	176.00	3.06	3196.00	32.20	7750.00
676.00	165.00	177.00	3.05	3230.00	31.94	7750.00
677.00	168.70	180.40	3.04	3222.00	32.05	7750.00
678.00	170.10	181.60	3.05	3206.00	31.00	7750.00
679.00	172.40	184.00	3.05	3225.00	32.01	7750.00
680.00	171.00	183.30	3.05	3234.00	32.00	7750.00
681.00	173.00	184.70	3.06	3240.00	31.95	7750.00
682.00	166.50	177.70	3.03	3229.00	31.83	7750.00
683.00	166.00	178.00	3.03	3196.00	31.87	7750.00
684.00	174.00	183.20	3.04	3218.00	31.89	7750.00
685.00	173.60	185.50	3.03	3222.00	31.83	7750.00
686.00	173.50	181.70	3.02	3229.00	32.00	7750.00
687.00	167.10	178.40	3.01	3202.00	31.99	7750.00
688.00	165.00	176.10	3.00	3224.00	32.13	7750.00
689.00	169.00	181.40	2.99	3224.00	31.90	7750.00
690.00	168.20	180.30	2.97	3216.00	32.20	7750.00
691.00	171.20	183.00	2.97	3218.00	31.87	7750.00
692.00	164.70	176.00	2.95	3207.00	31.83	7750.00
693.00	170.00	181.60	2.94	3217.00	31.90	7750.00
694.00	170.00	182.50	2.97	3194.00	32.05	7750.00
695.00	170.70	182.40	2.96	3227.00	32.03	7750.00
696.00	172.50	184.40	2.95	3222.00	31.83	7750.00
697.00	173.00	184.60	2.90	3200.00	31.90	7750.00
698.00	166.50	177.70	2.96	3224.00	31.96	7750.00
699.00	170.50	182.40	2.97	3223.00	31.95	7750.00
700.00	169.50	181.50	2.99	3210.00	31.70	7750.00
701.00	170.50	182.40	2.97	3215.00	31.82	7750.00
702.00	171.00	183.20	2.97	3210.00	31.87	7750.00
703.00	171.00	183.00	2.95	3206.00	31.81	7750.00
704.00	171.50	183.50	2.89	3180.00	31.61	7750.00
705.00	168.00	180.60	2.89	3206.00	31.81	7750.00
706.00	170.00	181.00	2.92	3174.00	31.74	7750.00
707.00	168.00	180.70	2.88	3206.00	31.85	7750.00
708.00	166.00	177.00	2.97	3224.00	32.00	7750.00
709.00	170.00	182.10	2.95	3213.00	31.68	7750.00

710.00	167.10	178.70	2.98	3210.00	31.87	7750.00
711.00	167.00	178.70	2.96	3230.00	31.70	7750.00
712.00	166.30	177.50	2.96	3230.00	31.81	7750.00
713.00	169.70	181.50	3.19	3191.00	30.95	7750.00
714.00	171.10	179.00	3.18	3184.00	31.65	7750.00
715.00	170.60	182.50	3.15	3185.00	31.90	7750.00
716.00	169.90	181.30	3.14	3221.00	31.83	7750.00
717.00	173.40	184.90	3.14	3179.00	31.89	7750.00
718.00	168.90	180.50	3.14	3184.00	31.76	7750.00
719.00	169.40	181.00	3.14	3225.00	32.04	7750.00
720.00	171.80	183.30	3.11	3215.00	32.05	7750.00
721.00	167.90	179.10	3.14	3230.00	32.04	7750.00
722.00	171.00	182.60	3.13	3213.00	31.85	7750.00
723.00	170.00	181.30	3.18	3215.00	32.06	7750.00
724.00	169.10	180.20	3.17	3207.00	31.89	7750.00
725.00	173.80	185.10	3.12	3174.00	31.78	7750.00
726.00	167.30	178.50	3.13	3128.00	31.43	7750.00
727.00	169.60	179.20	3.12	3215.00	31.67	7750.00
728.00	168.60	180.00	3.10	3222.00	31.83	7750.00
729.00	175.00	182.60	3.08	3202.00	31.69	7750.00
730.00	167.50	178.30	3.10	3188.00	31.42	7750.00
731.00	174.30	185.90	3.10	3215.00	31.92	7750.00
732.00	167.40	178.50	3.09	3221.00	31.95	7750.00
733.00	174.20	186.10	3.08	3183.00	31.79	7750.00
734.00	168.10	179.20	3.07	3209.00	31.79	7750.00
735.00	173.90	185.40	3.09	3193.00	31.86	7750.00
736.00	174.60	186.00	3.08	3176.00	31.84	7750.00
737.00	168.50	179.20	3.08	3184.00	31.72	7750.00
738.00	169.80	181.10	3.06	3183.00	31.73	7750.00
739.00	174.20	181.20	3.07	3180.00	31.82	7750.00
740.00	168.50	179.60	3.08	3186.00	31.80	7750.00
741.00	168.00	179.00	2.99	3218.00	31.80	7750.00
742.00	169.90	181.00	3.00	3208.00	32.02	7750.00
743.00	175.00	188.40	3.03	3190.00	31.78	7750.00
744.00	173.10	180.80	3.06	3201.00	31.86	7750.00
745.00	167.60	178.90	3.01	3197.00	31.90	7750.00
746.00	160.40	171.00	3.00	3220.00	30.84	7750.00
747.00	167.20	178.60	2.96	3182.00	30.84	7750.00
748.00	172.50	184.20	2.98	3196.00	31.81	7750.00
749.00	166.90	178.00	2.94	3226.00	31.80	7750.00
750.00	167.30	178.60	2.91	3156.00	31.66	7750.00
751.00	168.90	178.00	2.92	3143.00	31.54	7750.00
752.00	167.00	178.00	2.94	3165.00	31.52	7750.00
753.00	166.30	177.90	2.95	3172.00	31.69	7750.00
754.00	168.40	179.60	2.93	3125.00	31.72	7750.00
755.00	168.20	179.20	2.91	3162.00	29.87	7750.00
756.00	168.20	179.20	2.95	3142.00	31.62	7750.00
757.00	167.60	178.90	2.97	3184.00	31.65	7750.00
758.00	160.90	172.00	3.14	3181.00	31.65	7750.00
759.00	157.90	168.60	3.02	3202.00	31.86	7750.00
760.00	169.00	180.20	3.08	3154.00	28.82	7750.00
761.00	170.00	180.50	3.12	3123.00	31.67	7750.00
762.00	172.00	183.90	3.11	3169.00	31.55	7750.00
763.00	165.30	176.60	3.08	3192.00	34.51	7750.00
764.00	165.00	176.00	3.09	3165.00	30.85	7750.00

765.00	165.40	176.50	3.10	3158.00	31.61	2750.00
766.00	168.90	176.00	3.09	3165.00	28.91	2750.00
767.00	170.20	182.00	3.11	3141.00	31.00	2750.00
768.00	166.60	177.20	3.10	3176.00	31.00	2750.00
769.00	166.50	177.00	3.10	3152.00	31.56	2750.00
770.00	170.40	181.00	3.09	3174.00	31.68	2750.00
771.00	166.00	177.20	3.07	3168.00	28.92	2750.00
772.00	169.50	181.00	3.08	3160.00	31.48	2750.00
773.00	173.20	182.00	3.08	3165.00	28.00	2750.00
774.00	168.00	180.60	3.04	3149.00	29.39	2750.00
775.00	173.00	184.50	3.10	3158.20	312.01	2750.00
776.00	173.00	184.50	3.10	3158.00	29.16	2750.00
777.00	166.10	177.10	3.09	3161.00	29.29	2750.00
778.00	173.50	183.10	3.05	3164.00	28.05	2750.00
779.00	166.10	177.20	3.03	3169.00	29.18	2750.00
780.00	172.00	184.50	3.06	3171.00	31.64	2750.00
781.00	173.50	182.20	3.05	3178.00	31.59	2750.00
782.00	165.00	176.00	3.04	3194.00	31.28	2750.00
783.00	172.00	183.60	3.06	3155.00	31.46	2750.00
784.00	172.00	180.20	3.05	3142.00	28.04	2750.00
785.00	165.50	176.50	3.05	3187.00	31.06	2750.00
786.00	156.00	166.40	3.16	3255.00	31.87	2750.00
787.00	166.30	177.40	3.10	3181.00	31.64	2750.00
788.00	166.60	177.90	3.06	3147.00	30.33	2750.00
789.00	166.50	177.20	3.05	3161.00	30.46	2750.00
790.00	166.10	177.10	3.06	3162.00	30.34	2750.00
791.00	166.20	177.50	3.03	3148.00	31.55	2750.00
792.00	173.90	185.20	3.04	3149.00	31.25	2750.00
793.00	166.90	178.20	3.01	3159.00	31.47	2750.00
794.00	177.10	188.60	3.03	3131.00	31.39	2750.00
795.00	175.00	182.30	3.01	3146.00	30.16	2750.00
796.00	179.60	191.00	3.01	3143.00	29.09	2750.00
797.00	182.90	194.30	2.99	3119.00	29.62	2750.00
798.00	163.20	174.50	3.22	3204.00	31.58	2750.00
799.00	162.00	178.40	3.22	3168.00	29.23	2750.00
800.00	165.50	176.30	3.20	3152.00	31.43	2750.00
801.00	165.30	176.30	3.18	3140.00	29.33	2750.00
802.00	165.30	176.00	3.17	3146.00	29.24	2750.00
803.00	165.20	173.20	3.19	3189.00	29.22	2750.00
804.00	165.40	175.20	3.17	3170.00	29.02	2750.00
805.00	165.20	173.90	3.16	3206.00	29.58	2750.00
806.00	165.20	170.20	3.14	3149.00	29.30	2750.00
807.00	165.20	171.40	3.14	3144.00	31.61	2750.00
808.00	162.00	182.50	3.14	3148.00	29.23	2750.00
809.00	168.00	177.20	3.15	3180.00	29.13	2750.00
810.00	169.30	181.20	3.13	3152.00	29.03	2750.00
811.00	162.00	177.40	3.15	3163.00	31.58	2750.00
812.00	166.00	173.00	3.14	3125.00	29.12	2750.00
813.00	166.00	172.60	3.12	3150.00	31.47	2750.00
814.00	162.40	172.30	3.12	3142.00	29.23	2750.00
815.00	162.20	182.00	3.09	3168.00	29.18	2750.00
816.00	162.20	177.20	3.12	3132.30	29.51	2750.00
817.00	166.30	170.30	3.12	3158.00	29.39	2750.00
818.00	165.90	175.50	3.13	3152.00	30.06	2750.00
819.00	166.50	181.10	3.13	3155.00	29.48	2750.00

820.00	166.10	176.70	3.09	3130.00	29.39	7750.00
821.00	166.50	174.70	3.09	3150.00	29.37	7750.00
822.00	167.00	191.00	3.11	3144.00	31.53	7750.00
823.00	166.00	185.70	3.10	3163.00	31.63	7750.00
824.00	166.70	187.00	3.07	3137.00	29.66	7750.00
825.00	166.50	176.00	3.06	3131.00	29.47	7750.00
826.00	166.50	180.40	3.05	3134.00	31.56	7750.00
827.00	165.40	180.40	3.05	3134.00	31.56	7750.00
828.00	165.40	176.00	3.06	3137.00	31.31	7750.00
829.00	173.50	180.70	3.08	3174.00	29.51	7750.00
830.00	170.00	183.00	3.07	3168.00	29.12	7750.00
831.00	166.00	176.70	3.09	3179.00	29.68	7750.00
832.00	166.90	176.30	3.06	3165.00	29.51	7750.00
833.00	172.00	182.50	3.20	3125.00	29.55	7750.00
834.00	170.70	181.50	3.20	3161.00	30.15	7750.00
835.00	166.30	176.00	3.16	3148.00	29.02	7750.00
836.00	160.00	180.00	3.12	3146.00	30.06	7750.00
837.00	169.00	180.00	3.05	3134.00	29.06	7750.00
838.00	169.50	180.50	3.06	3144.00	30.07	7750.00
839.00	167.90	178.50	3.07	3165.00	30.34	7750.00
840.00	170.10	180.90	3.08	3134.00	30.16	7750.00
841.00	168.00	179.00	3.05	3149.00	29.29	7750.00
842.00	166.90	177.70	3.06	3148.00	30.27	7750.00
843.00	166.40	176.90	3.05	3147.00	30.21	7750.00
844.00	169.40	180.00	3.07	3156.00	29.58	7750.00
845.00	171.40	182.10	3.04	3180.00	29.06	7750.00
846.00	172.00	182.00	3.01	3152.00	29.04	7750.00
847.00	172.00	182.70	3.00	3161.00	29.90	7750.00
848.00	172.30	183.00	3.01	3152.00	29.76	7750.00
849.00	172.10	182.70	2.97	3150.00	29.90	7750.00
850.00	171.30	182.10	2.96	3146.00	29.00	7750.00
851.00	171.00	181.90	2.98	3139.00	29.42	7750.00
852.00	167.90	178.50	3.01	3114.00	29.01	7750.00
853.00	167.50	178.50	3.00	3171.00	30.10	7750.00
854.00	168.70	179.50	3.02	3152.00	30.00	7750.00
855.00	167.40	178.10	2.97	3174.00	29.61	7750.00
856.00	167.60	178.60	3.02	3144.00	30.00	7750.00
857.00	167.70	178.70	2.99	3141.00	30.10	7750.00
858.00	167.20	178.00	2.96	3150.00	31.43	7750.00
859.00	167.70	178.40	2.98	3126.00	31.51	7750.00
860.00	168.10	178.90	3.15	3120.00	31.36	7750.00
861.00	171.50	182.50	3.16	3136.00	31.44	7750.00
862.00	169.00	180.60	3.15	3140.00	31.34	7750.00
863.00	168.00	179.50	3.10	3110.00	31.34	7750.00
864.00	169.90	180.70	3.15	3152.00	30.09	7750.00
865.00	168.90	179.30	3.16	3151.00	31.51	7750.00
866.00	172.00	182.70	3.13	3149.00	31.20	7750.00
867.00	171.50	182.40	3.00	3120.00	31.46	7750.00
868.00	170.50	181.20	3.09	3141.00	31.56	7750.00
869.00	175.10	185.00	3.09	3119.00	30.02	7750.00
870.00	169.10	179.50	3.08	3161.00	29.99	7750.00
871.00	171.90	182.70	3.12	3163.00	29.95	7750.00
872.00	169.40	180.00	3.08	3146.00	31.63	7750.00
873.00	175.00	185.70	3.07	3124.00	31.31	7750.00
874.00	173.70	184.60	3.06	3130.00	31.59	7750.00

875.00	174.30	184.00	3.03	3125.00	31.53	2750.00
876.00	173.10	184.00	3.07	3137.00	31.46	2750.00
877.00	169.60	180.00	3.06	3127.00	31.47	2750.00
878.00	169.00	180.50	3.06	3134.00	31.36	2750.00
879.00	169.60	180.00	3.05	3146.00	31.50	2750.00
880.00	167.50	177.70	3.07	3111.00	31.30	2750.00
881.00	167.00	178.50	3.06	3136.00	30.77	2750.00
882.00	166.60	177.30	3.05	3152.00	31.70	2750.00
883.00	167.70	178.00	3.01	3126.00	31.36	2750.00
884.00	169.10	179.00	3.01	3149.00	30.65	2750.00
885.00	177.50	183.10	3.07	3100.00	29.97	2750.00
886.00	171.40	182.00	3.00	3149.00	30.05	2750.00
887.00	167.20	177.50	2.98	3150.00	30.00	2750.00
888.00	167.30	177.50	2.98	3146.00	30.50	2750.00
889.00	167.50	178.00	2.98	3149.00	30.50	2750.00
890.00	170.20	179.70	2.98	3132.00	30.50	2750.00
891.00	173.00	183.70	3.07	3147.00	30.49	2750.00
892.00	175.00	183.00	3.07	3140.00	30.67	2750.00
893.00	173.50	184.00	3.01	3153.00	30.63	2750.00
894.00	168.70	179.40	3.00	3121.00	30.96	2750.00
895.00	175.50	185.70	3.04	3126.00	30.61	2750.00
896.00	173.30	184.20	3.04	3115.00	30.79	2750.00
897.00	169.00	179.30	3.01	3117.00	30.05	2750.00
898.00	171.50	182.30	3.01	3144.00	31.09	2750.00
899.00	174.70	185.50	3.07	3133.00	30.39	2750.00
900.00	170.50	181.40	3.07	3097.00	31.25	2750.00
901.00	173.00	184.60	2.97	3134.00	31.27	2750.00
902.00	173.50	184.00	2.96	3116.00	30.77	2750.00
903.00	175.20	185.00	2.95	3150.00	31.35	2750.00
904.00	166.70	176.60	3.00	3111.00	31.20	2750.00
905.00	166.70	177.20	2.93	3162.00	31.69	2750.00
906.00	167.30	177.00	3.15	3129.00	31.00	2750.00
907.00	166.10	176.50	3.21	3171.00	31.77	2750.00
908.00	172.40	183.40	3.25	3171.00	31.51	2750.00
909.00	171.00	181.60	3.63	3164.00	28.47	2750.00
910.00	171.50	182.30	3.68	3158.00	28.79	2750.00
911.00	166.50	177.50	3.65	3104.00	29.00	2750.00
912.00	171.50	182.30	3.64	3130.00	29.73	2750.00
913.00	172.00	181.00	3.65	3105.00	31.25	2750.00
914.00	166.50	177.10	3.67	3130.00	31.40	2750.00
915.00	171.00	181.70	3.63	3167.00	31.69	2750.00
916.00	165.50	176.00	3.65	3115.00	31.30	2750.00
917.00	171.00	182.60	3.69	3163.00	31.77	2750.00
918.00	170.60	181.40	3.71	3160.00	31.66	2750.00
919.00	170.50	181.20	3.65	3159.00	31.65	2750.00
920.00	170.00	180.00	3.71	3130.00	31.57	2750.00
921.00	165.20	176.50	3.77	3143.00	31.24	2750.00
922.00	165.00	175.40	3.65	3144.00	29.49	2750.00
923.00	166.10	176.00	3.50	3124.00	29.67	2750.00
924.00	169.00	180.40	3.47	3140.00	29.37	2750.00
925.00	160.10	175.00	3.60	3130.00	31.51	2750.00
926.00	167.00	177.40	3.63	3130.00	31.43	2750.00
927.00	167.20	178.20	3.50	3152.00	29.51	2750.00
928.00	167.00	177.60	3.57	3130.00	31.61	2750.00
929.00	177.00	187.90	3.44	3134.00	31.29	2750.00

938.00	179.90	190.00	7.37	7104.00	79.50	2750.00
939.00	177.50	189.70	7.31	7077.00	79.00	2750.00
940.00	177.50	187.10	7.40	7117.00	76.00	2750.00
941.00	179.10	188.00	7.37	7111.00	76.00	2750.00
942.00	181.00	186.00	7.37	7070.00	76.00	2750.00
943.00	185.00	174.70	7.50	7100.00	76.44	2750.00
944.00	185.00	178.00	7.54	7110.00	76.70	2750.00
945.00	179.50	183.00	7.50	7040.00	76.00	2750.00
946.00	171.50	180.70	7.44	7030.00	79.11	2750.00
947.00	170.00	182.00	7.40	7090.00	76.00	2750.00
948.00	170.00	187.00	7.40	7090.00	79.59	2750.00
949.00	170.00	180.00	7.35	7100.00	79.74	2750.00
950.00	170.00	180.00	7.40	7114.00	79.41	2750.00
951.00	170.00	180.00	7.41	7000.00	79.00	2750.00
952.00	171.00	180.00	7.60	7100.00	76.00	2750.00
953.00	170.00	178.00	7.30	7117.00	76.00	2750.00
954.00	170.00	180.00	7.30	7100.00	76.00	2750.00
955.00	170.00	180.00	7.30	7100.00	76.00	2750.00
956.00	170.00	180.00	7.30	7100.00	76.00	2750.00
957.00	170.00	180.00	7.30	7100.00	76.00	2750.00
958.00	170.00	180.00	7.30	7100.00	76.00	2750.00
959.00	170.00	180.00	7.30	7100.00	76.00	2750.00
960.00	170.00	180.00	7.30	7100.00	76.00	2750.00
961.00	170.00	180.00	7.30	7100.00	76.00	2750.00
962.00	170.00	180.00	7.30	7100.00	76.00	2750.00
963.00	170.00	180.00	7.30	7100.00	76.00	2750.00
964.00	170.00	180.00	7.30	7100.00	76.00	2750.00
965.00	170.00	180.00	7.30	7100.00	76.00	2750.00
966.00	170.00	180.00	7.30	7100.00	76.00	2750.00
967.00	170.00	180.00	7.30	7100.00	76.00	2750.00
968.00	170.00	180.00	7.30	7100.00	76.00	2750.00
969.00	170.00	180.00	7.30	7100.00	76.00	2750.00
970.00	170.00	180.00	7.30	7100.00	76.00	2750.00
971.00	170.00	180.00	7.30	7100.00	76.00	2750.00
972.00	170.00	180.00	7.30	7100.00	76.00	2750.00
973.00	170.00	180.00	7.30	7100.00	76.00	2750.00
974.00	170.00	180.00	7.30	7100.00	76.00	2750.00
975.00	170.00	180.00	7.30	7100.00	76.00	2750.00
976.00	170.00	180.00	7.30	7100.00	76.00	2750.00
977.00	170.00	180.00	7.30	7100.00	76.00	2750.00
978.00	170.00	180.00	7.30	7100.00	76.00	2750.00
979.00	170.00	180.00	7.30	7100.00	76.00	2750.00
980.00	170.00	180.00	7.30	7100.00	76.00	2750.00
981.00	170.00	180.00	7.30	7100.00	76.00	2750.00
982.00	170.00	180.00	7.30	7100.00	76.00	2750.00
983.00	170.00	180.00	7.30	7100.00	76.00	2750.00
984.00	170.00	180.00	7.30	7100.00	76.00	2750.00
985.00	170.00	180.00	7.30	7100.00	76.00	2750.00
986.00	170.00	180.00	7.30	7100.00	76.00	2750.00
987.00	170.00	180.00	7.30	7100.00	76.00	2750.00
988.00	170.00	180.00	7.30	7100.00	76.00	2750.00
989.00	170.00	180.00	7.30	7100.00	76.00	2750.00
990.00	170.00	180.00	7.30	7100.00	76.00	2750.00
991.00	170.00	180.00	7.30	7100.00	76.00	2750.00
992.00	170.00	180.00	7.30	7100.00	76.00	2750.00
993.00	170.00	180.00	7.30	7100.00	76.00	2750.00
994.00	170.00	180.00	7.30	7100.00	76.00	2750.00
995.00	170.00	180.00	7.30	7100.00	76.00	2750.00
996.00	170.00	180.00	7.30	7100.00	76.00	2750.00
997.00	170.00	180.00	7.30	7100.00	76.00	2750.00
998.00	170.00	180.00	7.30	7100.00	76.00	2750.00
999.00	170.00	180.00	7.30	7100.00	76.00	2750.00
1000.00	170.00	180.00	7.30	7100.00	76.00	2750.00



985.00	167.10	177.90	2.68	3210.00	31.37	7750.00
986.00	166.70	177.50	2.68	3191.00	31.87	7750.00
987.00	169.00	179.00	2.70	3210.00	31.90	7750.00
988.00	167.10	178.00	2.68	3210.00	31.87	7750.00
989.00	169.00	179.00	2.67	3205.00	31.77	7750.00
990.00	167.70	177.90	2.65	3145.00	31.48	7750.00
991.00	169.10	178.90	2.65	3199.00	31.64	7750.00
992.00	169.00	179.00	2.64	3139.00	31.69	7750.00
993.00	172.70	183.00	2.63	3173.00	31.69	7750.00
994.00	168.00	179.50	2.65	3201.00	31.87	7750.00
995.00	167.00	177.50	2.66	3190.00	31.94	7750.00
996.00	172.00	179.50	2.65	3179.00	34.74	7750.00
997.00	166.50	177.50	2.62	3200.00	29.41	7750.00
998.00	165.00	176.40	2.64	3205.00	29.71	7750.00
999.00	169.90	174.50	3.11	3204.00	31.58	7750.00
1000.00	173.00	179.00	3.00	3154.00	29.75	7750.00
1001.00	166.70	175.50	3.05	3174.00	30.75	7750.00
1002.00	165.00	175.10	3.00	3041.00	30.77	7750.00

APPENDIX R  
ENDURANCE AND DURABILITY TEST GRAPHICAL DATA

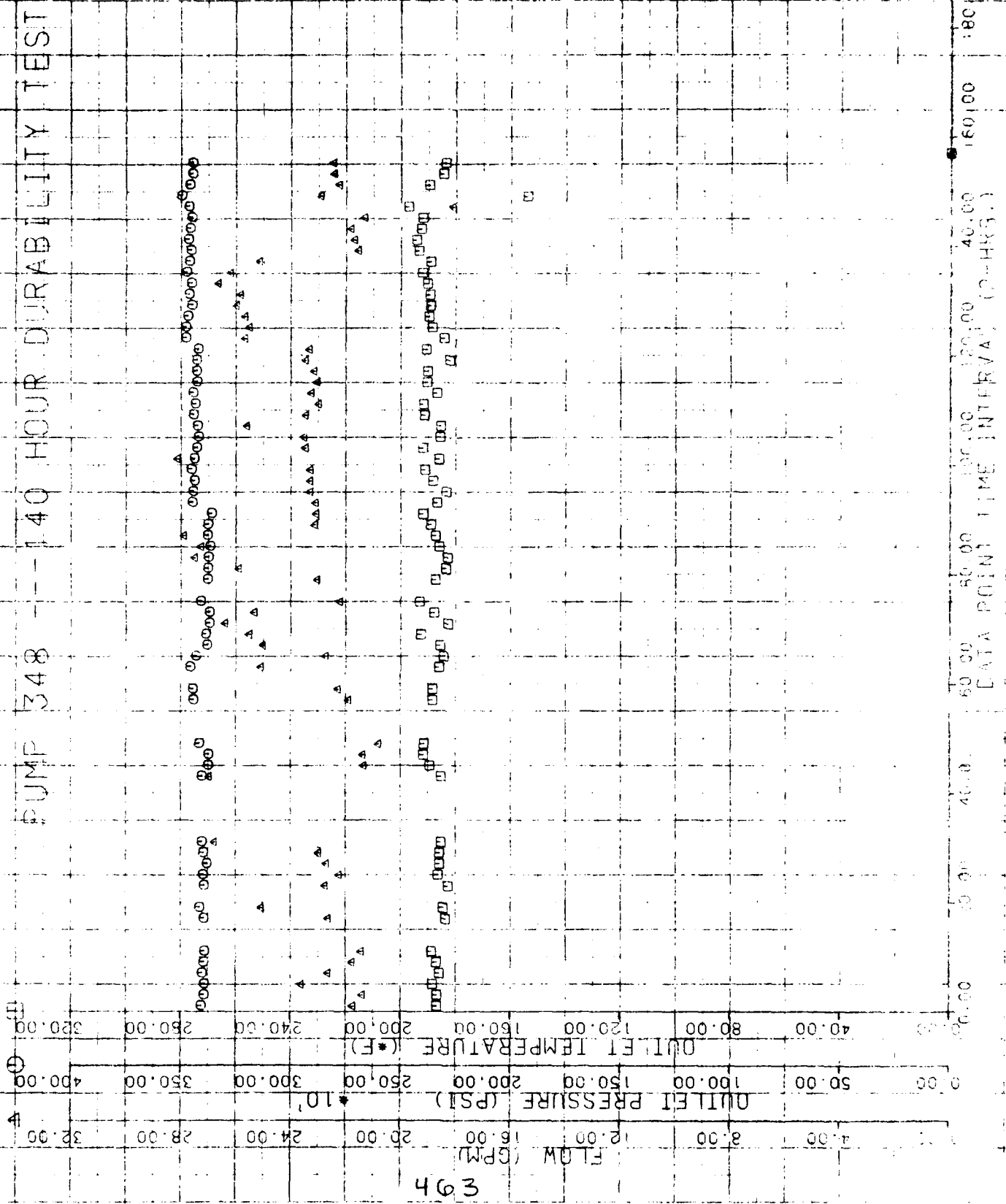
GRAPHICAL DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M1

Test Specimens Consisted Of:

Pump #348, #349, and #351

Every other data point was used to plot the graph in order to improve readability.

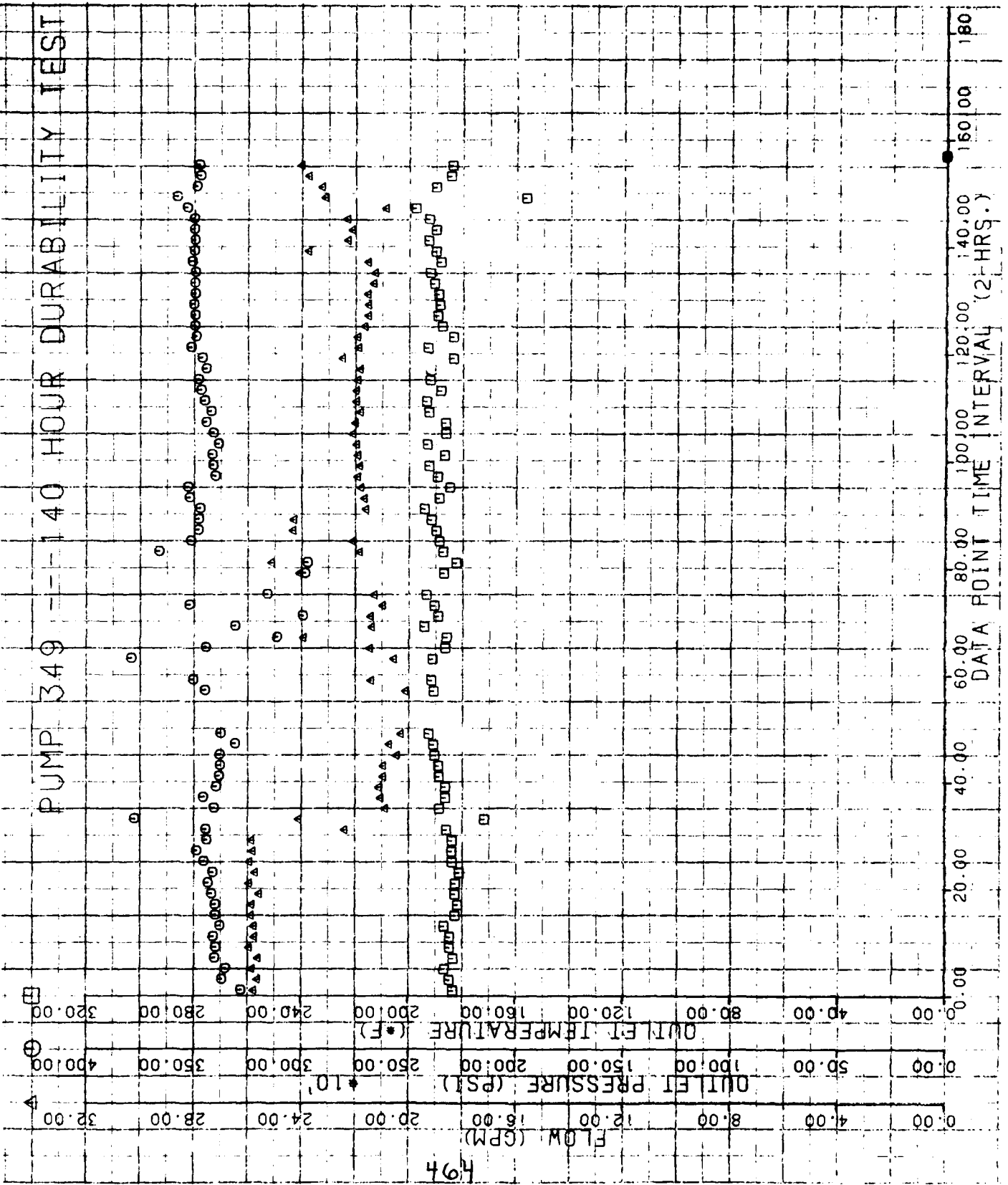
# PUMP 348 -- 140 HOUR DURABILITY TEST



394

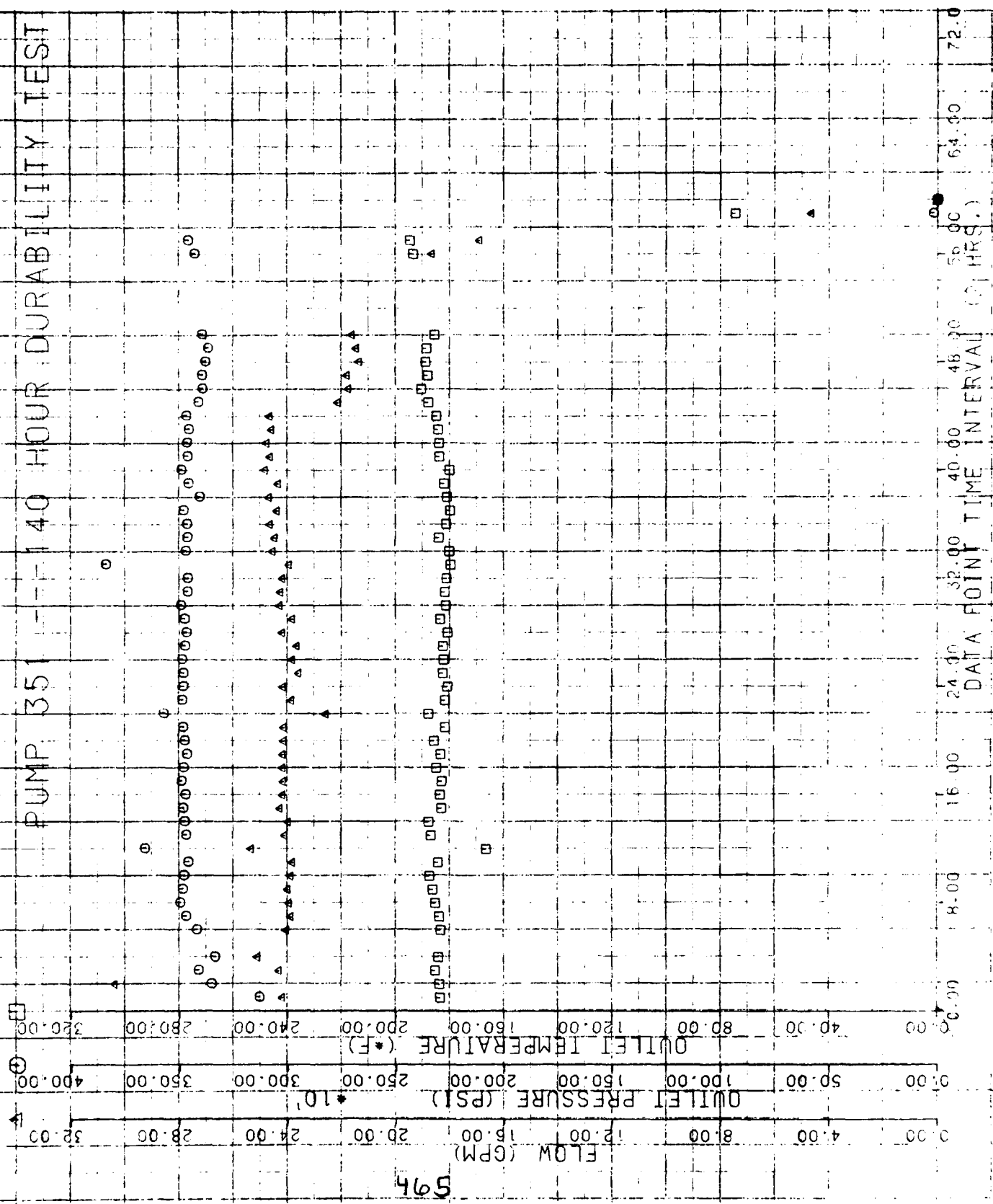
60.00 100.00 140.00 180.00 220.00 260.00 300.00 340.00 380.00 420.00 460.00 500.00 540.00 580.00 620.00 660.00 700.00 740.00 780.00 820.00 860.00 900.00 940.00 980.00 1020.00 1060.00 1100.00 1140.00 1180.00 1220.00 1260.00 1300.00 1340.00 1380.00 1420.00 1460.00 1500.00 1540.00 1580.00 1620.00 1660.00 1700.00 1740.00 1780.00 1820.00 1860.00 1900.00 1940.00 1980.00 2020.00 2060.00 2100.00 2140.00 2180.00 2220.00 2260.00 2300.00 2340.00 2380.00 2420.00 2460.00 2500.00 2540.00 2580.00 2620.00 2660.00 2700.00 2740.00 2780.00 2820.00 2860.00 2900.00 2940.00 2980.00 3020.00 3060.00 3100.00 3140.00 3180.00 3220.00 3260.00 3300.00 3340.00 3380.00 3420.00 3460.00 3500.00 3540.00 3580.00 3620.00 3660.00 3700.00 3740.00 3780.00 3820.00 3860.00 3900.00 3940.00 3980.00 4020.00 4060.00 4100.00 4140.00 4180.00 4220.00 4260.00 4300.00 4340.00 4380.00 4420.00 4460.00 4500.00 4540.00 4580.00 4620.00 4660.00 4700.00 4740.00 4780.00 4820.00 4860.00 4900.00 4940.00 4980.00 5020.00 5060.00 5100.00 5140.00 5180.00 5220.00 5260.00 5300.00 5340.00 5380.00 5420.00 5460.00 5500.00 5540.00 5580.00 5620.00 5660.00 5700.00 5740.00 5780.00 5820.00 5860.00 5900.00 5940.00 5980.00 6020.00 6060.00 6100.00 6140.00 6180.00 6220.00 6260.00 6300.00 6340.00 6380.00 6420.00 6460.00 6500.00 6540.00 6580.00 6620.00 6660.00 6700.00 6740.00 6780.00 6820.00 6860.00 6900.00 6940.00 6980.00 7020.00 7060.00 7100.00 7140.00 7180.00 7220.00 7260.00 7300.00 7340.00 7380.00 7420.00 7460.00 7500.00 7540.00 7580.00 7620.00 7660.00 7700.00 7740.00 7780.00 7820.00 7860.00 7900.00 7940.00 7980.00 8020.00 8060.00 8100.00 8140.00 8180.00 8220.00 8260.00 8300.00 8340.00 8380.00 8420.00 8460.00 8500.00 8540.00 8580.00 8620.00 8660.00 8700.00 8740.00 8780.00 8820.00 8860.00 8900.00 8940.00 8980.00 9020.00 9060.00 9100.00 9140.00 9180.00 9220.00 9260.00 9300.00 9340.00 9380.00 9420.00 9460.00 9500.00 9540.00 9580.00 9620.00 9660.00 9700.00 9740.00 9780.00 9820.00 9860.00 9900.00 9940.00 9980.00 10000.00

# PUMP 349 -- 140 HOUR DURABILITY TEST



494

# PUMP 35 -- 140 HOUR DURABILITY TEST



594

FLOW (GPM)

OUTLET PRESSURE (PSI)

OUTLET TEMPERATURE (\*F)

DATA POINT TIME INTERVAL (HRS.)

72.0

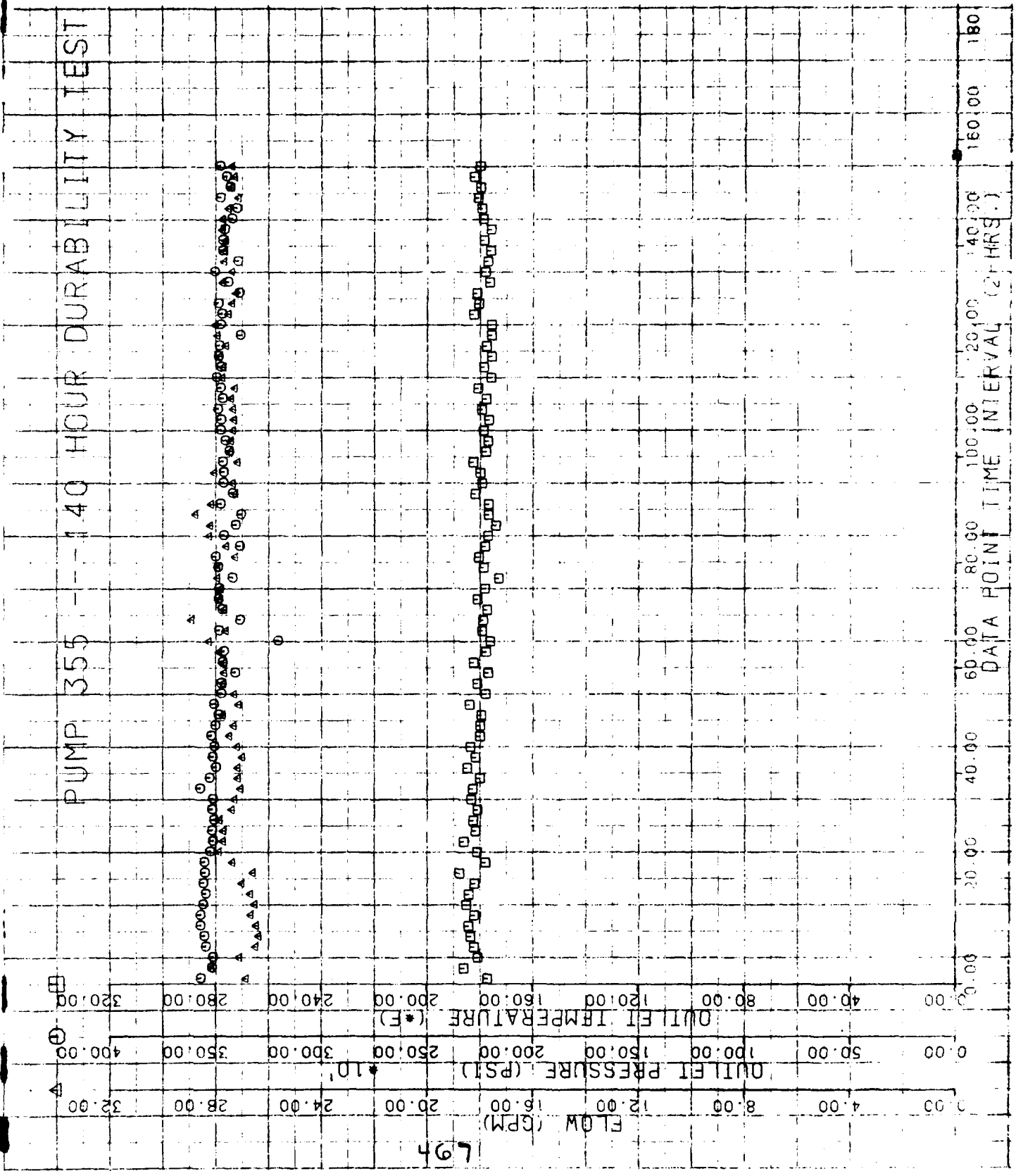
GRAPHICAL DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M2

Test Specimens Consisted Of:

Pump #355, #358, and #361

Every other data point was used to plot the graph in order to improve readability.

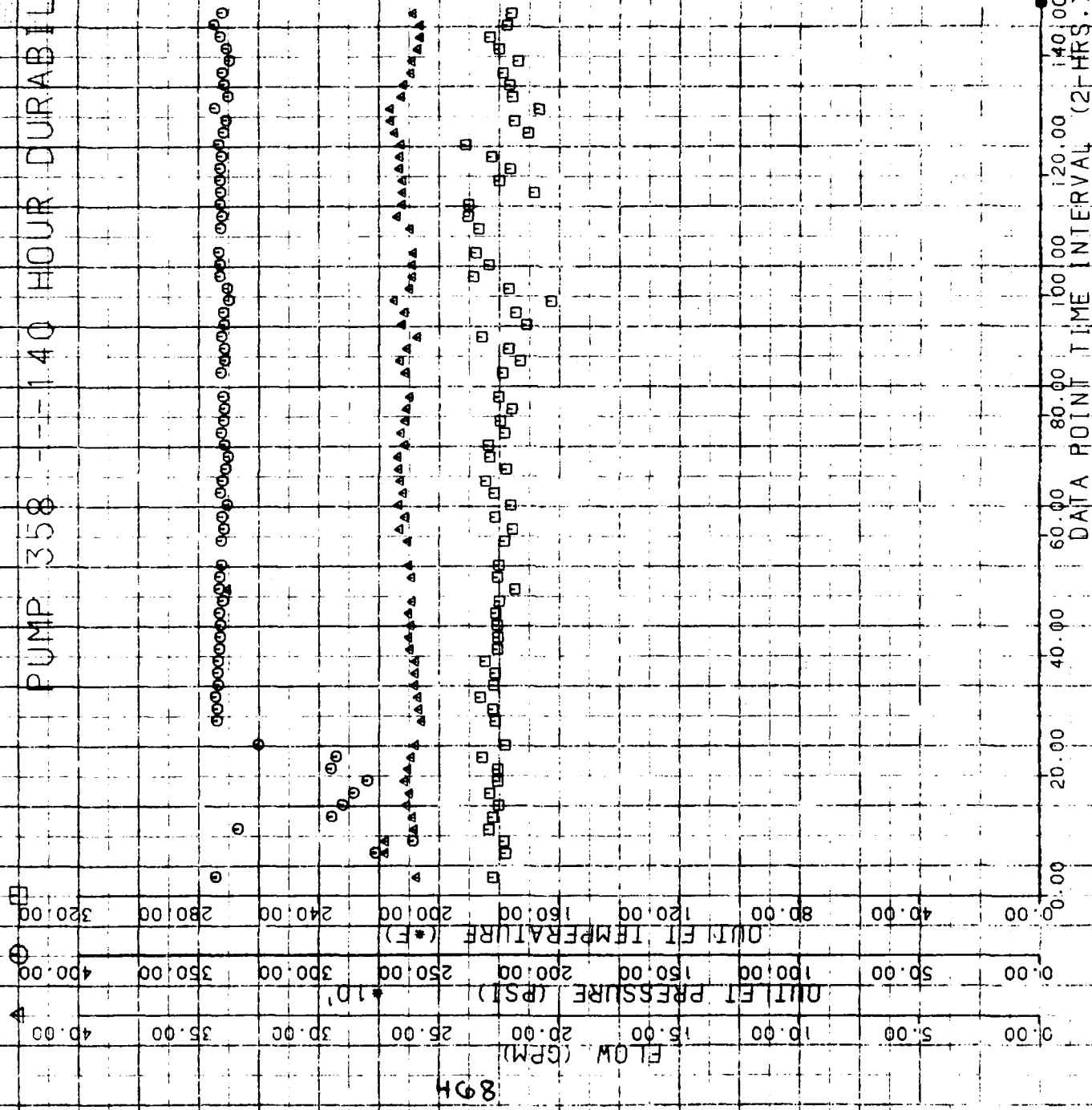
# PUMP 355 -- 140 HOUR DURABILITY TEST



L94



# PUMP 358 -- 140 HOUR DURABILITY TEST

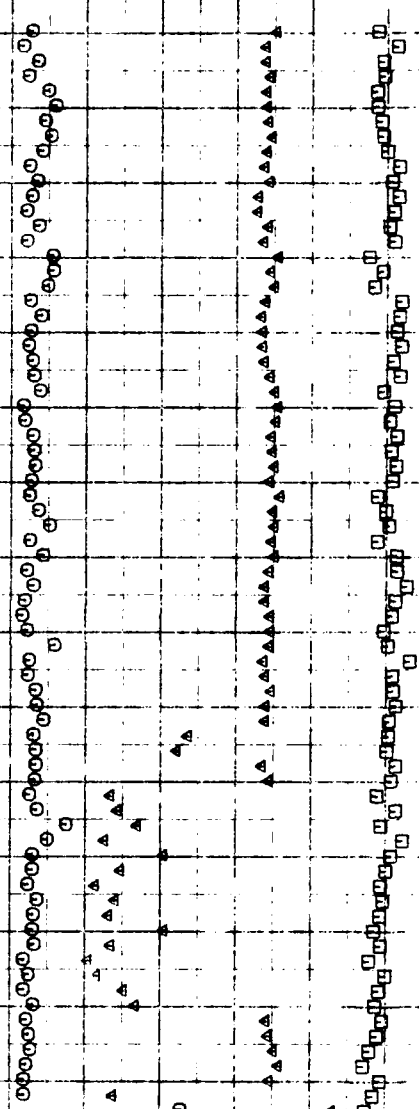


DATA POINT TIME INTERVAL (2-HRS.)

894

# PUMP 36 -- 140 HOUR DURABILITY TEST

FLOW (GPM) 0.00 5.00 10.00 15.00 20.00 25.00 30.00 35.00 40.00  
 OUTLET PRESSURE (PSI) 100.00 150.00 200.00 250.00 300.00 350.00 400.00  
 OUTLET TEMPERATURE (°F) 80.00 120.00 160.00 200.00 240.00 280.00 320.00



60.00 80.00 100.00 120.00 140.00 160.00 180.00  
 DATA POINT TIME INTERVAL (2-HRS)

694

GRAPHICAL DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M1 AND M2

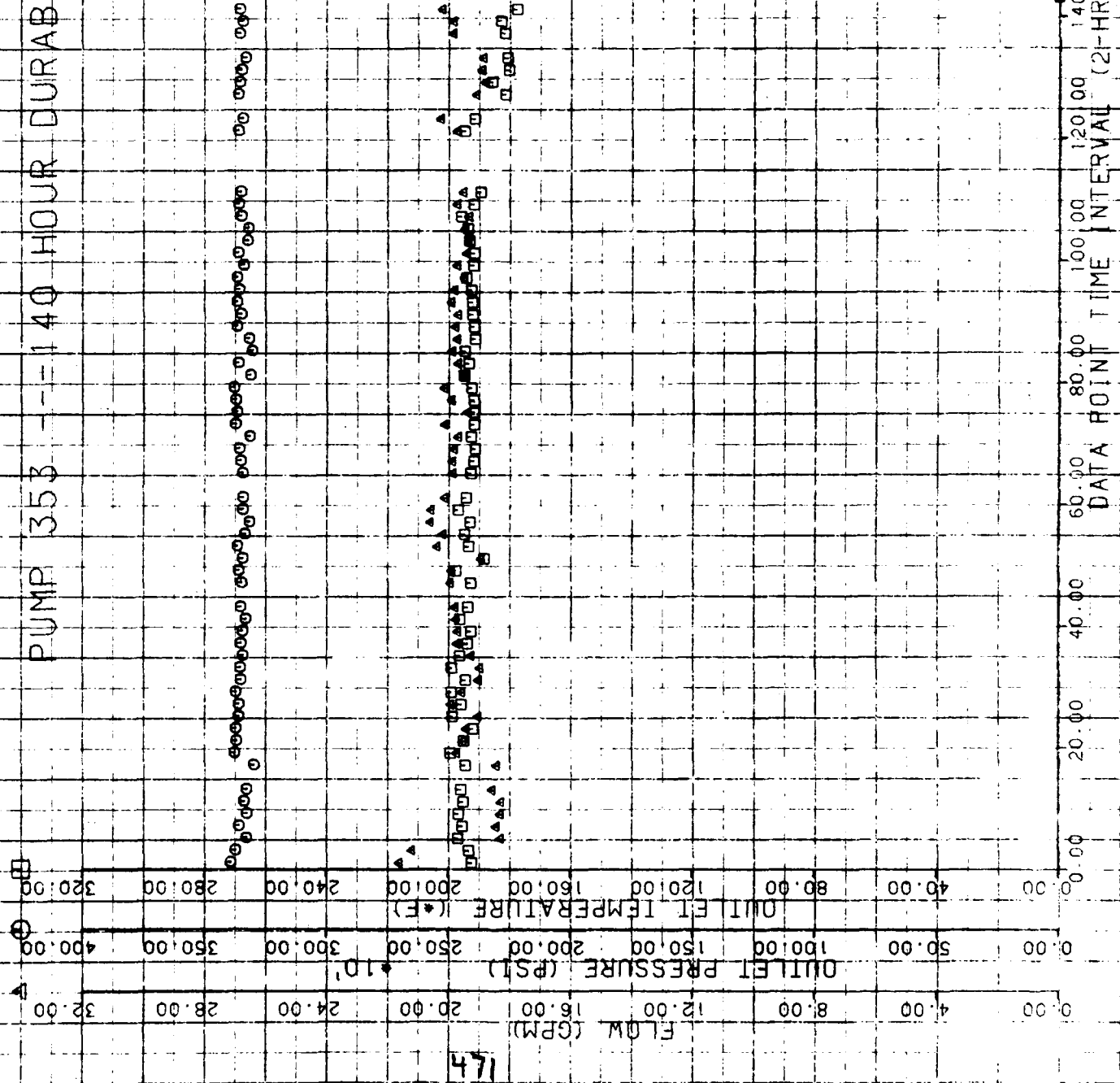
Test Specimens Consisted Of:

M1 - Pump #353 and 354

M2 - Pump #356

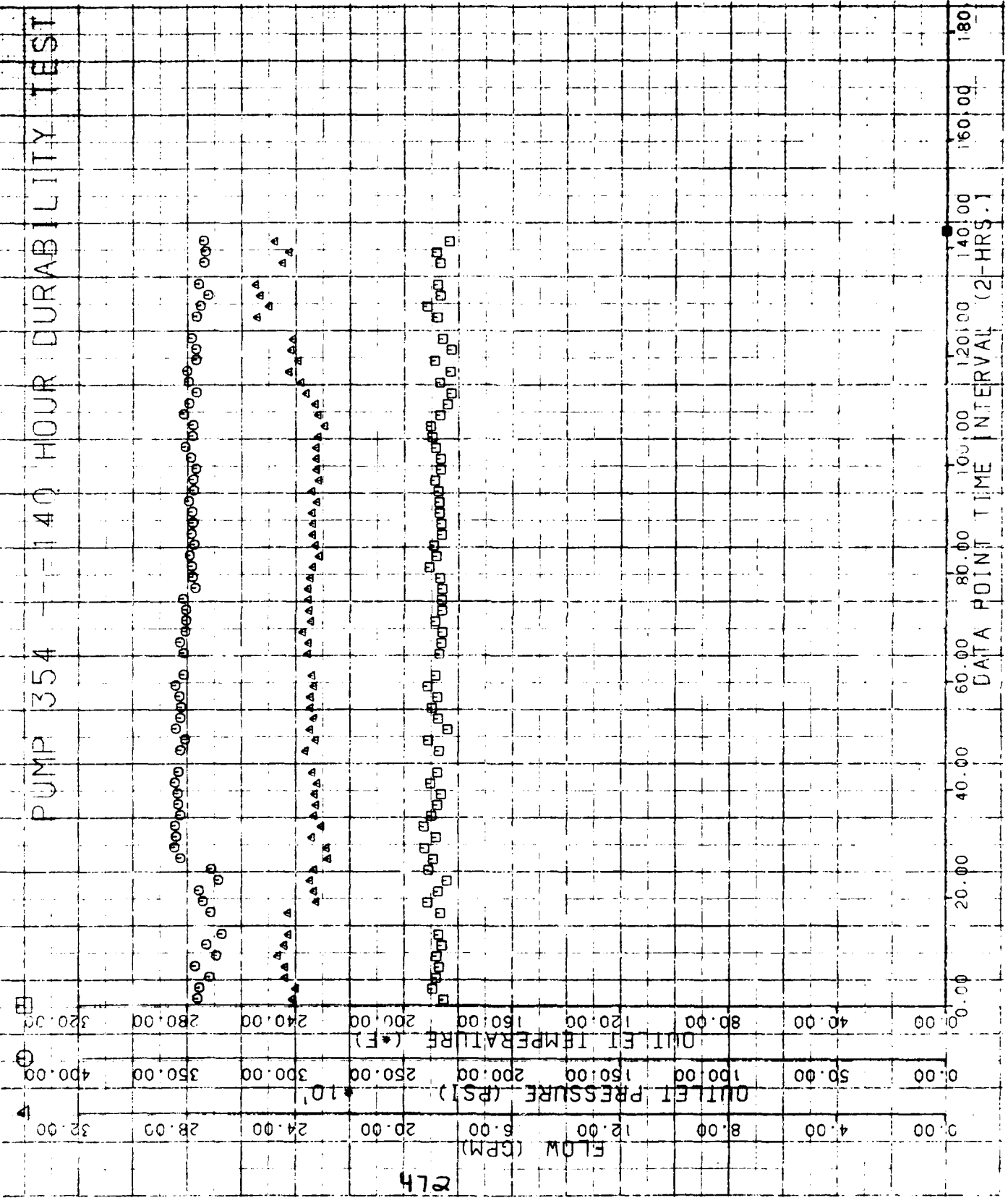
Every other data point was used to plot the graph in order to improve readability.

# PUMP 353 -- 140 HOUR DURABILITY TEST



DATA POINT TIME INTERVAL (2-HRS.)

# PUMP 354 -- 140 HOUR DURABILITY TEST



274

DATA POINT TIME INTERVAL (2-HRS.)

AD-A117 962

MILWAUKEE SCHOOL OF ENGINEERING WI FLUID POWER INST F/O 13/11  
BREAK-IN, PERFORMANCE, AND ENDURANCE TESTS RESULTS ON FIXED DIS--ETC(U)  
JUL 82 DAAK70-81-C-0002  
50423 ML

UNCLASSIFIED

6-8

6-7-96C



END

6-8

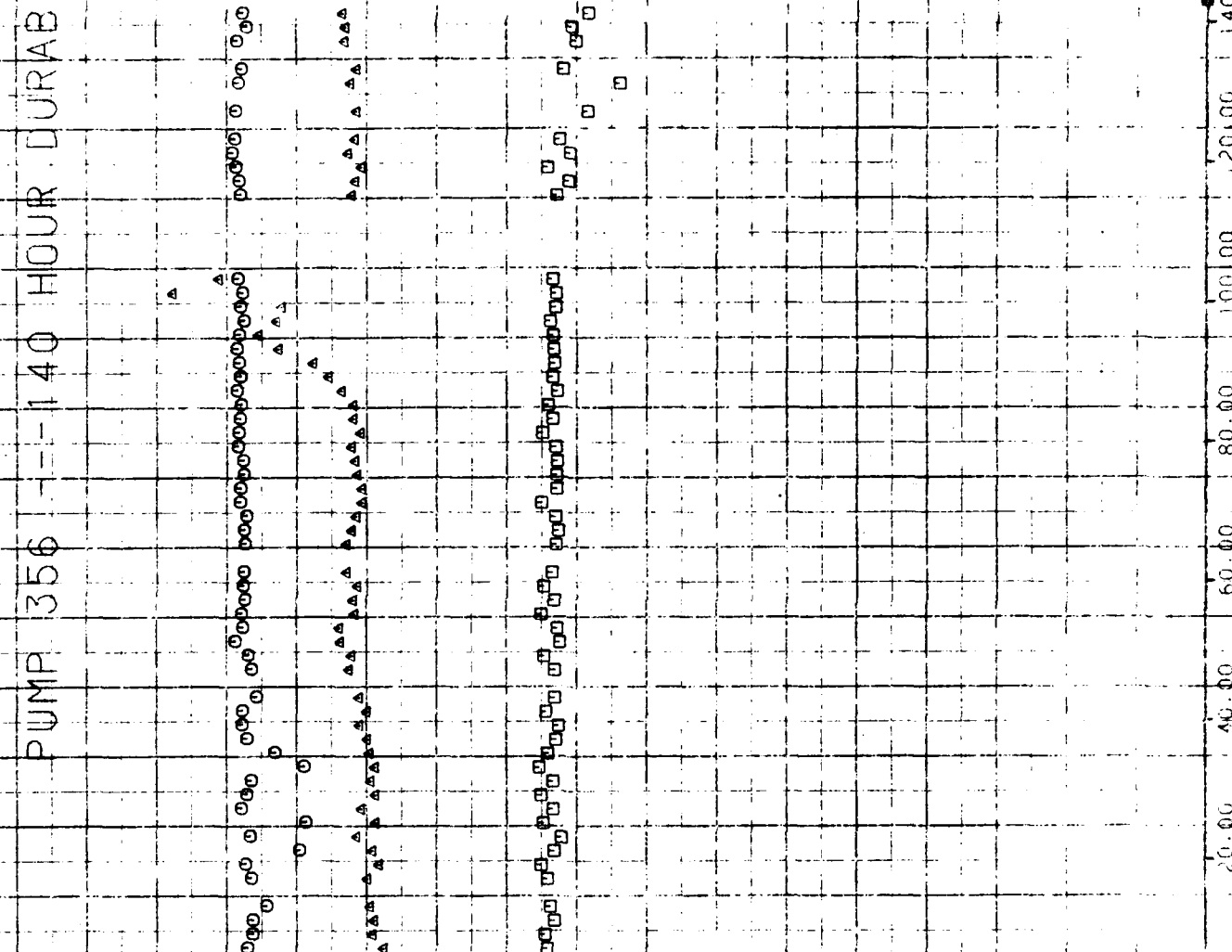
6-7-96C

DTIC

6-8

# PUMP 356 -- 140 HOUR DURABILITY TEST

FLOW (GPM) 0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00  
 OUTLET PRESSURE (PSI) 0.00 50.00 100.00 150.00 200.00 250.00 300.00 350.00 400.00  
 OUTLET TEMPERATURE (\*F) 0.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00



0.00 20.00 40.00 60.00 80.00 100.00 120.00 140.00 160.00 180.00  
 DATA POINT TIME INTERVAL (2-HRS)

864

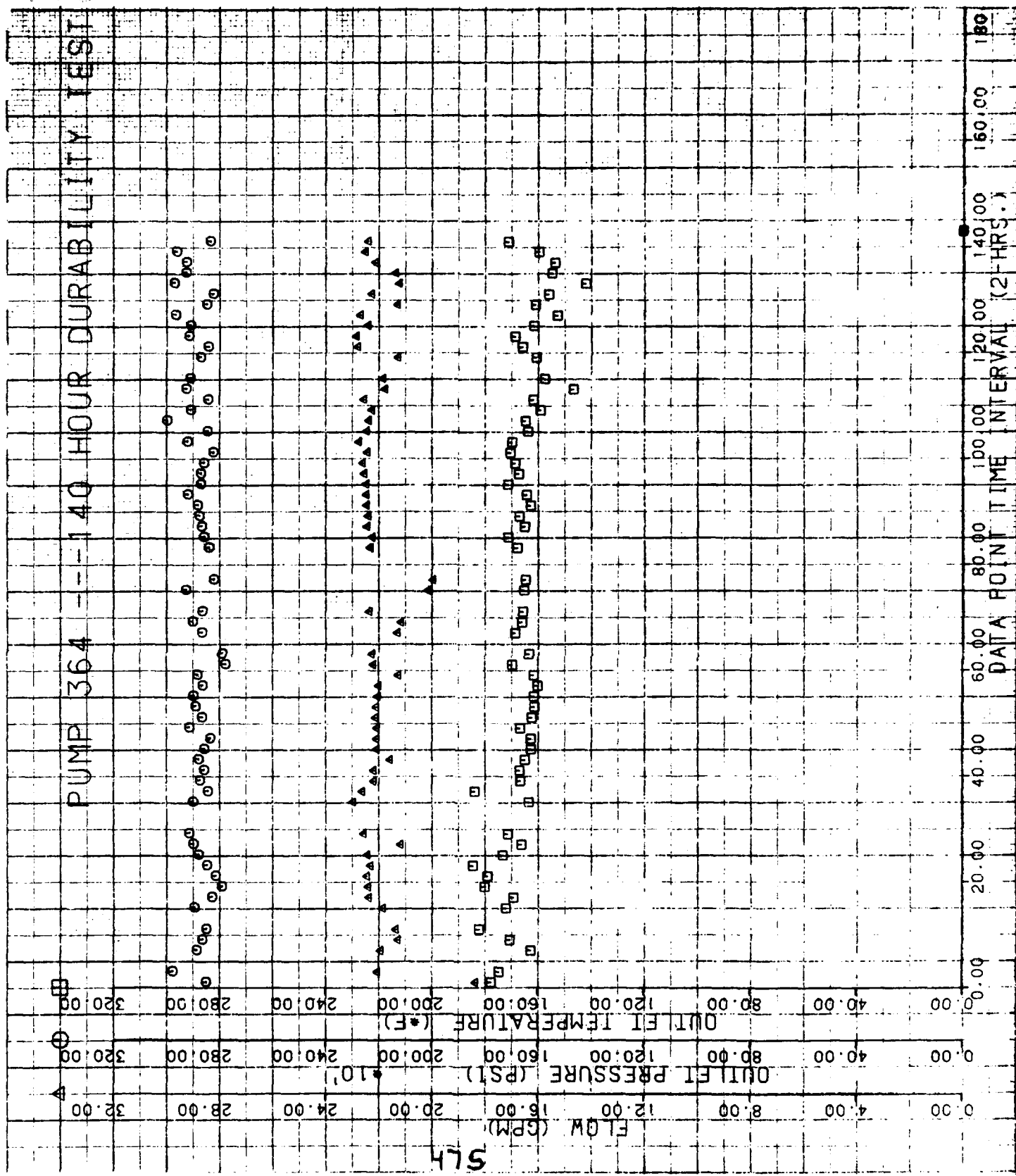
GRAPHICAL DATA OF ACCELERATED LIFE TEST FOR MANUFACTURE M3

Test Specimens Consisted Of:  
Pump #364, 366, and 367

Every other data point was used to plot the graph in order to improve readability.



# PUMP 364 -- 140 HOUR DURABILITY TEST

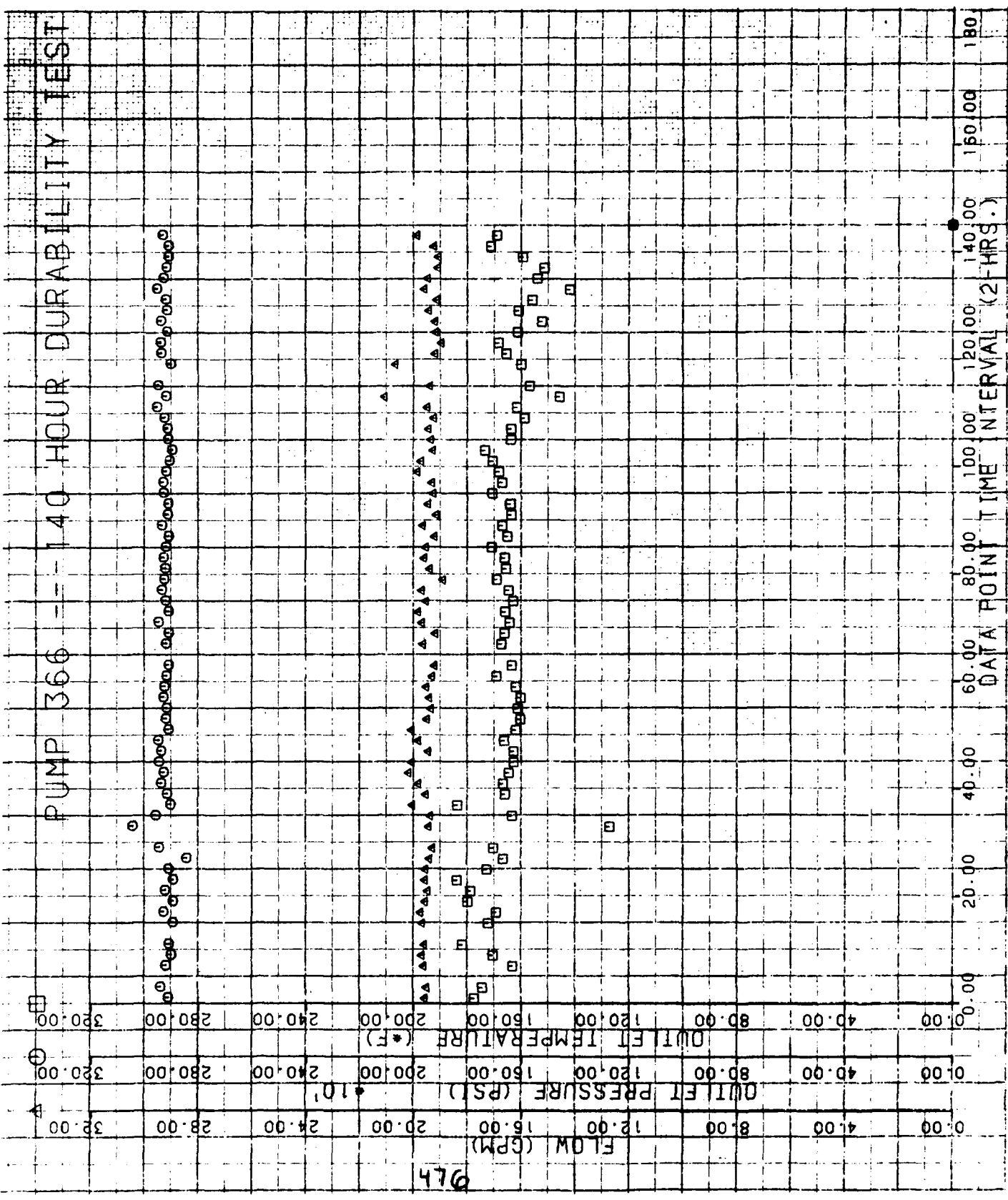


574

DATA POINT TIME INTERVAL (2-HRS.)

60.00 80.00 100.00 120.00 140.00 160.00 180

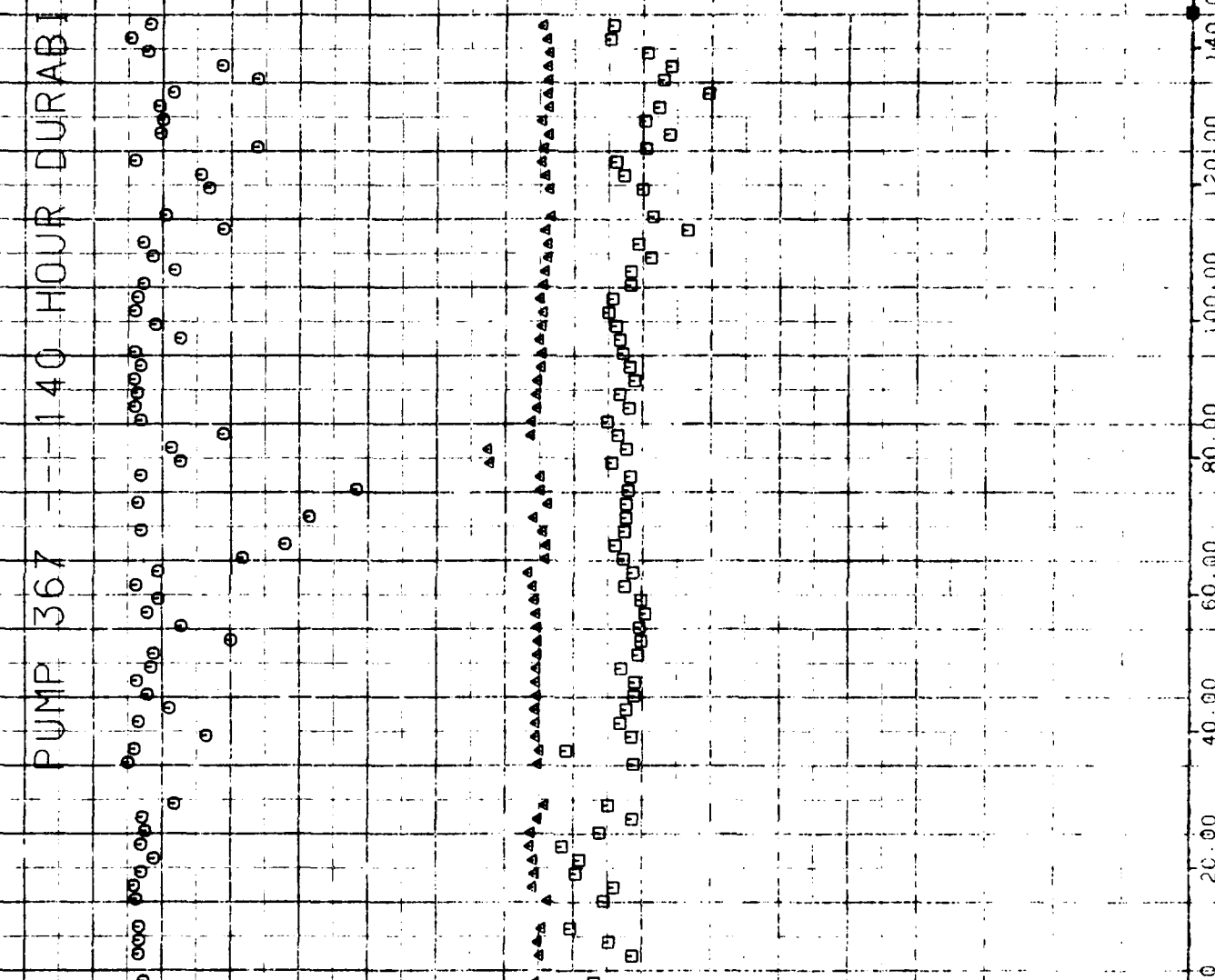
# PUMP 366 == 140 HOUR DURABILITY TEST



974

# PUMP 367 -- 140 HOUR DURABILITY TEST

FLOW (GPM) 0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00  
 OUTLET PRESSURE (PSI) 0.00 40.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00  
 OUTLET TEMPERATURE (\*F) 0.00 40.00 80.00 120.00 160.00 200.00 240.00 280.00 320.00



DATA POINT TIME INTERVAL (2-HRS.) 0.00 20.00 40.00 60.00 80.00 100.00 120.00 140.00 160.00 180.00

474

GRAPHICAL DATA OF 1,000 HR. TEST FOR MANUFACTURER M1 AND M2

Test Specimens Consisted Of:

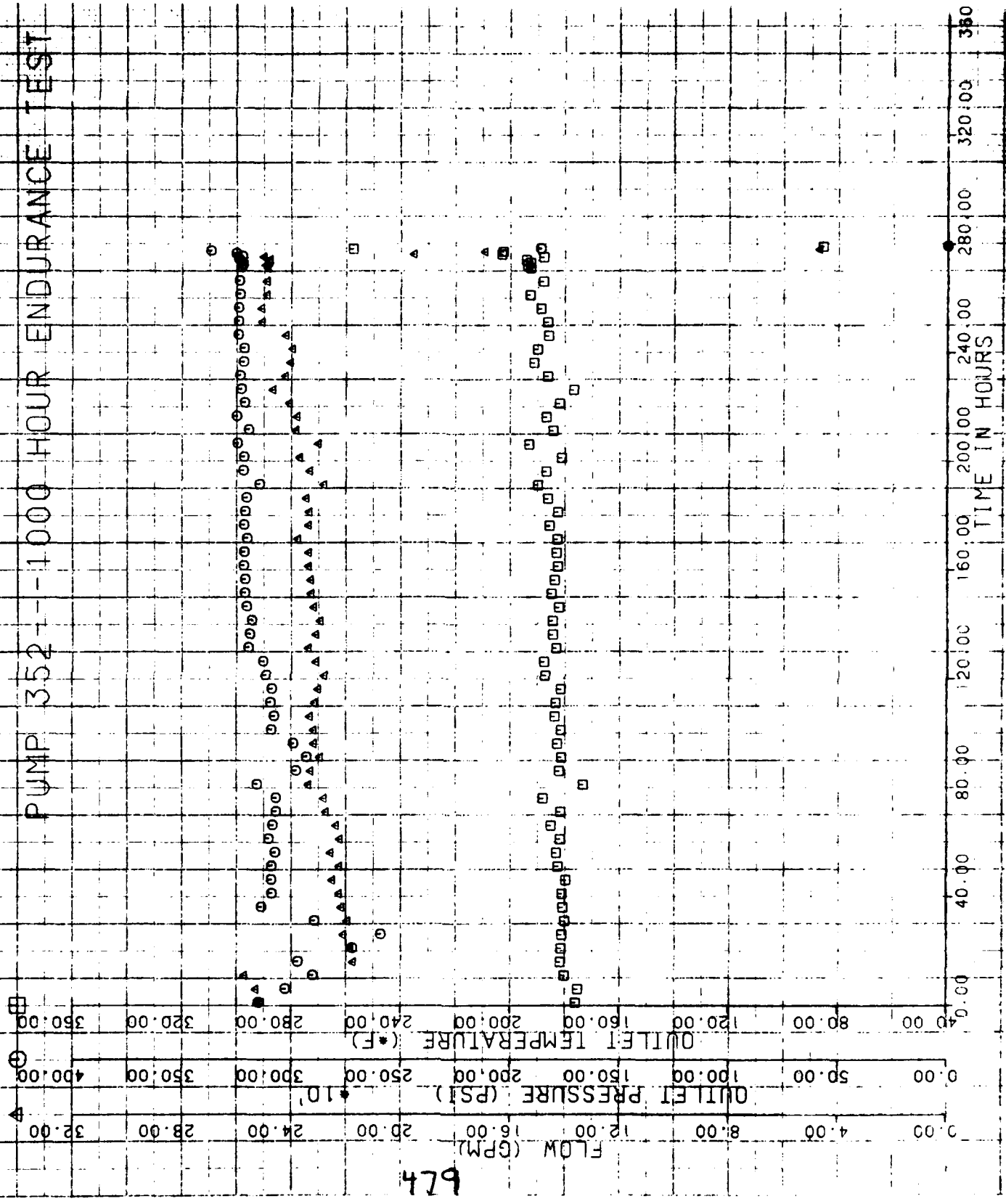
M1 - Pump #352

M2 - Pump #357 and 360

For pump #352 every data point was used to plot the graph.

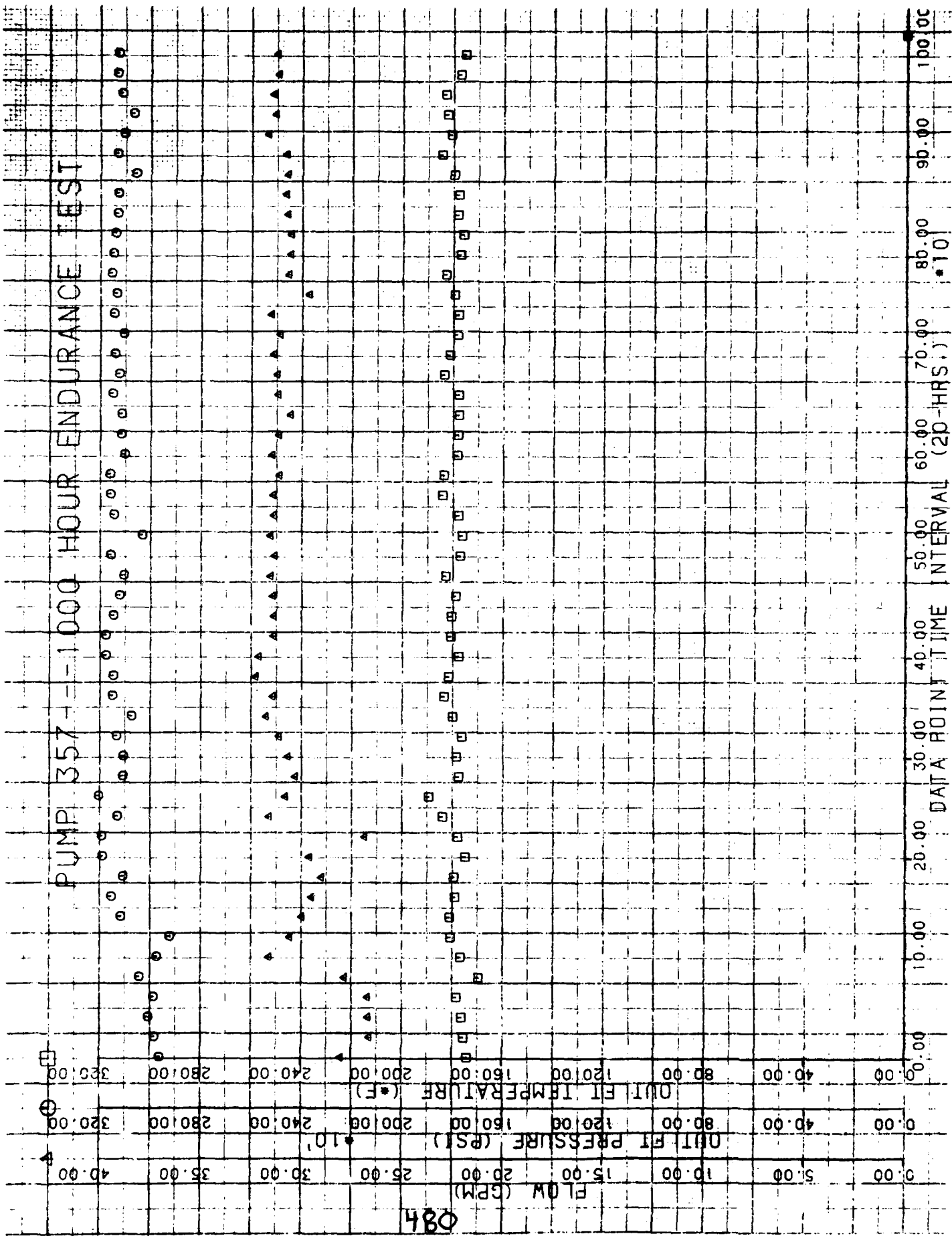
For pumps #357 and 360 data points at 20 hour intervals were used to plot the graph to improve readability.

# PUMP 352 - 1000 HOUR ENDURANCE TEST



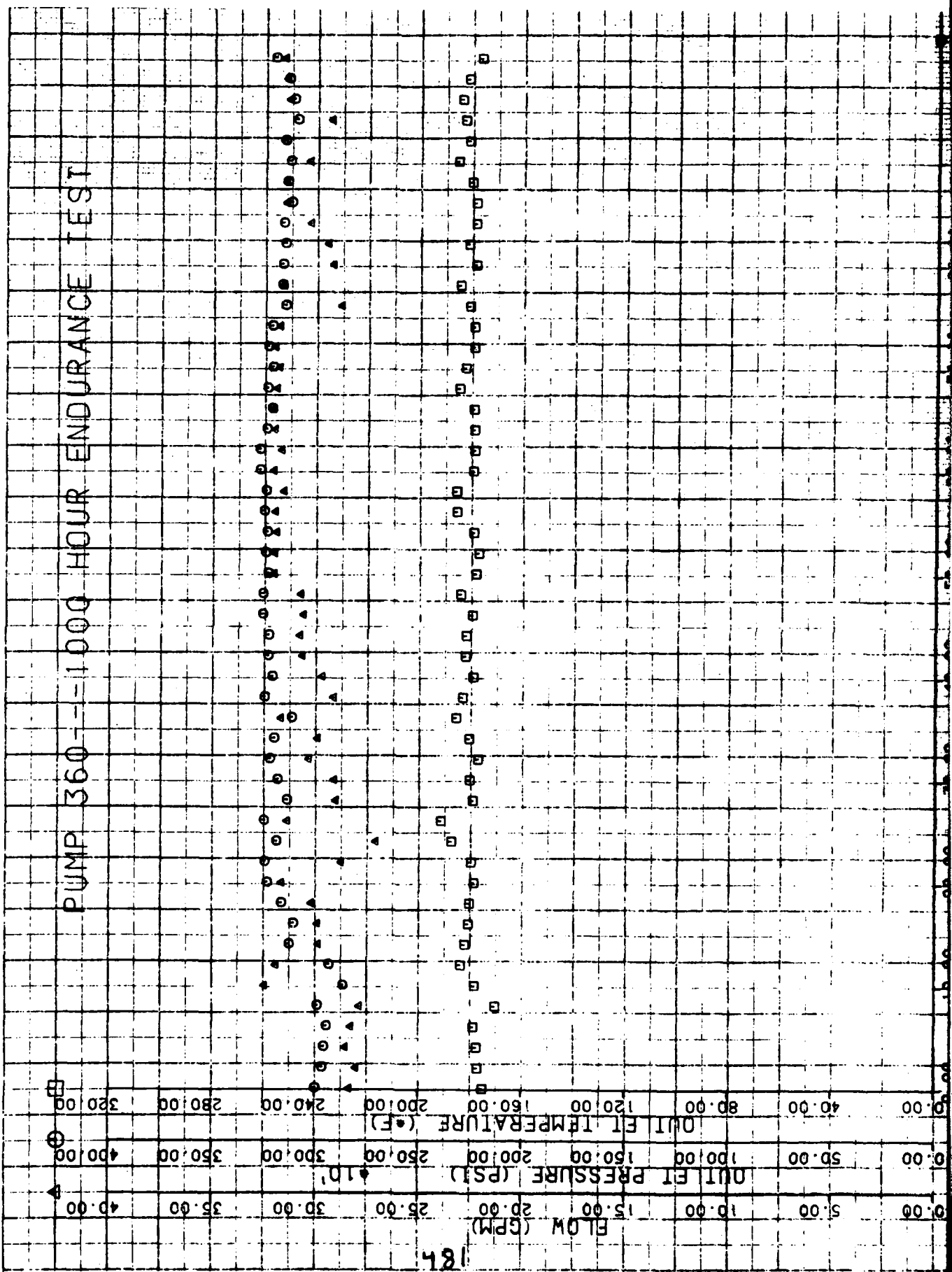
674

# PUMP 357 - 1000 HOUR ENDURANCE TEST



084

# PUMP 360 -- 1000 HOUR ENDURANCE TEST



APPENDIX S  
ORIGINAL THERMAL STABILITY SURVEY



THERMAL SURVEY

Revised 3/23/81

<p>ATO Hyd. Product Div. 527 W. Rich St. Columbus, OH 43215</p>	<p>Mike Merick</p>	<p>614/224/3394</p>
<p>Abex Denison Div. 1220 Dublin Rd. Columbus, OH 43216</p>	<p>R. Smilges Dir. Vane &amp; Valves</p>	<p>614/481/7341</p>
<p>Adan Hydraulics, Inc. 5630 Shattalon Dr., Box 11946 Winston-Salem, NC 27105</p>	<p>Terry Sulian Chief Engineer</p>	<p>919/767/1712</p>
<p>John S. Barnes Corp. 2222 15th St. Rockford, IL 61125</p>	<p>Floyd E. Carlson Director of Engineering</p>	<p>815, 100</p>
<p>Cessna Fluid Power Div. Box 1028 3401 E. 4th Hutchinson, KS 67501</p>	<p>Loren Alderson Mgr. New Product Eng.</p>	<p>316/663/5751</p>
<p>Commercial Shearing, Inc. Box 239 1775 Logan Ave. Youngstown, OH 44501</p>	<p>Edward J. Ratkay Mgr. of Quality Assurance</p>	<p>216/746/0811</p>
<p>Continental Hydraulics Div. 12520 Quentin Ave. S. Savage, MN 55378</p>	<p>A.D. Mills Chief Engineer</p>	<p>612/890/3300</p>
<p>Cross Manufacturing Co. 1300 Sierra Wichita, KS 67209</p>	<p>Dave Johnson</p>	<p>316-942-1295</p>
<p>Delavan Corp. 811 4th St. West Des Moines, IA 50265</p>	<p>Mgr. F.P. Eng.</p>	<p>515/274/1561</p>
<p>Double A Products 715E Duncan St. Manchester, MI</p>	<p>Jim Gill</p>	<p>313/428/8311</p>

Dowty Corp.  
P.O. Box 50000, Dept. S  
Sterling, VA 22170

Edward Rock  
Mgr. Hyd. Div.

800/336/3727

Dynapower  
Starbuck Ave.  
Watertown, NY 13601

John E.G. Young  
Mgr. of Engineering

315/788/8181

Dynex/Rivett Inc.  
770 Capitol Dr.  
Pewaukee, WI 53072

Allan E. Heinrich  
Mgr. of Engineering

414/691/0300

Eastern, Ind.  
LFE Flids. Ctrl. Div.  
110 Skiff St.  
Hamden, CT 06514

W.J. Walker  
Project Engineer

203/281/8132

Eaton Fid. Pwr. Operations  
Spencer Div.  
32nd Ave. West  
Spencer, IA 51301

Ken Knapp  
Engineering Mgr.

712/264/3216

Energy Mfg. Co., Inc.  
100 N. Main St.  
Monticello, IA 52310

R.R. Landis  
Engineer

319/465/3537

FMC Corp.  
Northern Ordnance Div.  
4800 E. River Rd.  
Minneapolis, MN 55421

Tom Gifford  
Sup. Pump Eng.

612/560/9201  
Ext. 2505

Federal Brase Mfg. Co.  
165 Cedar St.  
Corning, NY 14830

James Dugan  
Chief Engineer

607/732/6620

General Signal - Hydreco  
Box 2676  
9000 E. Michigan Ave.  
Kalamazoo, MI 49003

James L. Glidden  
VP - Engineering

616/349/1511

Gresen Mfg. Co.  
Box 313,  
600 Hoover St. N.E.  
Minneapolis, MN 55440

Bob Olen

612/623/1960

HPI-Nichols  
7900 Durand Ave.  
Sturtevant, WI 53177

Jack L. Johnson  
Engineering Mgr.

614/224/3394

Heil Co.  
3042 W. Montana St.  
Milwaukee, WI 53201

Norman Glomski  
Chief Engineer

414/647/3256

MTE Hydraulics Inc.  
4701 Kishwaukee St.  
Rockford, IL 61101

Robert Ernst  
Chief Engineer

815/397/4700

Monarch Road Machinery Co.  
P.O. Box 1764  
Grand Rapids, MI 49501

John Jackobowicz  
Chief Engineer

616/458/1300

W.H. Nichols Co.  
48 Woerd Ave.  
Waltham, MA 02154

Dr. Earl Maroney  
Engineering Mgr.

617/894/0650  
Ext. 259

Oilgear Co.  
2300 S. 51st St.  
Milwaukee, WI 53219

Kerry Karies  
Eng. Lab Sup.

414/327/1700  
Ext. 364

Owatonna Tool Co.  
Precision Hyd. Div.  
Eisenhower Dr.  
Owatonna, MN 55060

Jan Boers  
Mgr. of Engineering

507/451/5310

Parker Hannifin Corp.  
Ind. Hyd. Div.  
100 Parker Dr.  
Ostego, MI 49078

John Wright  
Chief Engineer

616/694/9411

Parker Mobile Hyd. Div.  
17325 Euclid Ave.  
Cleveland, OH 44112

Peter Willmer  
Chief Engineer

216/531/3000

Permco, Inc.  
Box 68  
1500 Frost Rd.  
Streetsboro, OH 44240

John Bates  
Director. of Eng.

216/626/2801

Rexnord Inc. Hyd. Components Div. Racine, WI 53401	Gary Smith Chief Engineer-Pumps	414/554/7100
Rexroth Corp 2315 City Line Rd. Box 2407 Bethlehem, PA 18018	Ted Lincoln	215/694/8300
Ross Gear Div. of TRW Box 60 800 Heath St. Lafayette, IN 47902	Dave Shropshire Engineering Mgr.	317/423/5377
Schnrader Bellows Div./Scovill, Inc. Box 631 200 W. Exchange St. Akron, OH 44309	James D. Bowman Sales & Engrg. Mgr.-Hydraulics	216/375/1349
Sperry Vickers 1401 Crooks Rd. Troy, MI 48084	Ashir Ahmed Sect. Head Vane Pumps	313/280/2244
Stone Hydraulic Industries, Inc. 2130 Harlem Rd. Rockford, IL 61111	Bruce Olson Chief Engineer	815/633/7215
Sundstrand Hydro-Transmission Div. 2800 E. 13th St. Ames, IA 50010	John Pinkerton Chief Eng. Hydrostatics	515/239/6000
Tyrone Hydraulics, Inc. Box 511 Corinth, MS 38834	Jim McBurnett VP-Engineering	601/287/1481
Webster Electric Co., Inc. 1900 Clark St. Racine, WI 53403	Walter Marietta Mgr. Engineering	414/633/3511

January 28, 1981

Mr. Tom Kendall  
Chief Enginee  
Abex Denison Div.  
1220 Dublin Rd.  
Columbus, OH 43216

Dear Mr. Kendall:

The Milwaukee School of Engineering has been contracted by the US Army MERADCOM to investigate thermal stability in hydraulic pumps in order to develop criteria for a universal test procedure. The findings of this survey and the resulting test procedure, if one can be developed will be given to independent standards writing bodies such as NFPA, SAE, and ISO for consideration as a national standard. Before proceeding with the development of a thermal stability test procedure, we are surveying pump manufacturers to determine the best course of action.

Realizing that some of the information maybe proprietary, I want to give you my personal assurances that the specific results of your response will be held in the strictest confidence. The Army has requested and will receive only a statistical summary of the individual returns.

If you would take a few minutes to complete the enclosed survey questionnaire regarding your thermal stability test procedures of hydraulic pumps, we will send you a copy of the summary and the proposed thermal stability test procedure. Please return your response before February 23, 1981.

Your help is greatly appreciated.

Sincerely,

Thomas S. Wanke  
Director, Fluid Power Institute

TSW:wp

HYDRAULIC PUMP THERMAL STABILITY  
TEST PROCEDURE SURVEY  
MSOE FLUID POWER INSTITUTE

\* Complete and return by 23 Feb., 1981 \*

Instructions:

Please circle the appropriate response to the following questions and/or fill in the required information.

1.0 Definition: Thermal stability is a point where the combination of high outlet pressure and slow rotational speed causes the outlet temperature to run away burning up the pump in a matter of minutes while the inlet temperature is held constant. In other words, what is the minimum rotational speed of the pump at a certain pressure that produces enough flow through the pump to prevent it from burning up?

2.0 Does your company currently use a test procedure to determine thermal stability as defined in section 1?

YES

NO

3.0 General

3.1 Is your procedure based on developmental

YES

NO

laboratory

YES

NO

or field studies?

YES

NO

3.2 Has your procedure evolved over time and experience with the product?

YES

NO

3.3 Was your procedure arbitrarily arrived at?

YES

NO

3.4 Is the procedure performed at one fluid temperature?

YES

NO

If not what other temperatures do you run at? \_\_\_\_\_



5.0 If a universal thermal stability procedure could be developed do you feel that it would benefit your company?

YES

NO

5.1 Would you use the procedure to qualify your companies pumps?

YES

NO

Thank you for your interest in our project and any recommendations or guidance your experts make regarding this inquiry. Additional comments may be attached if desired.

A statistical summary of the survey and the proposed thermal stability test procedure will be distributed to the respondents.

If any questions should arise, please contact us.

\_\_\_\_\_  
(Company)

\_\_\_\_\_  
(Name and Title of Respondent)

\_\_\_\_\_  
(Phone Number)

\_\_\_\_\_  
(Date)



FILMED  
1988