50-416

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 10, 1997

LICENSEE: ENTERGY OPERATIONS, INC. (EOI)

FACILITY: Grand Gulf Nuclear Station, Unit 1 (GGNS)

SUBJECT: MEETING ON MOV THRUST METHODOLOGY USED FOR GENERIC LETTER 95-07 FOR GRAND GULF NUCLEAR STATION, UNIT 1 (TAC NO. M93467)

A meeting was held on Tuesday, March 25, 1997, for the Nuclear Regulatory Commission (NRC) staff and the licensee to discuss the Entergy Operations, Inc. (EOI) motor-operated valve (MOV) thrust methodology used for Generic Letter (GL) 95-07 for Grand Gulf Nuclear Station, Unit 1 (GGNS). The meeting was held at the Energy Service Center at the GGNS site near Port Gibson in Claiborne County, Mississippi, at the request of the licensee. A notice of this meeting was issued on March 3, 1997.

Attachment 1 is the list of attendees, Attachment 2 is information provided by the NRC staff at the meeting, and Attachment 3 is the handout from the licensee at the meeting.

BACKGROUND:

GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," was issued by the NRC on August 17, 1995. In GL 95-07, the NRC requested licensees to perform (1) an evaluation of operational configurations of safety-related power-operated (i.e., motor-, air-, or hydraulic-operated) gate valves for susceptibility to pressure locking and thermal binding and (2) further analyses to ensure that the gate valves susceptible to pressure-locking or thermal binding are capable of performing their safety functions. NUREG-1275, Volume 9, "Pressure-Locking and Thermal Binding of Gate Valves," dated March 1993, gives the history of these events, describes the phenomena, discusses the consequences on valve functionality, summarizes preventive measures, and assesses the safety significance of the phenomena. Pressure-locking and thermal binding can cause a power-operated gate valve to fail to open and represent a common-mode failure mode that can render redundant trains of safety systems incapable of performing their safety function.

The licensee has submitted letters dated October 11, 1995, and February 13 and June 28, 1996. In the submittal of February 13, 1996, the licensee discussed

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tests at Wyle Laboratories on a 14"-900# flexible wedge gate valve (i.e., a 14-inch William Powell gate valve). The licensee also mentioned the valve thrust calculational methodology which was developed to evaluate valve operability under combination loading of pressure locking and design basis loss-of-coolant accident (LOCA) conditions. The licensee stated that this methodology was presented during an NRC public workshop on February 4, 1994, and summarized in NUREG/CP-0146. This meeting was to discuss the application of this methodology by the staff to valve test data.

MEETING SUMMARY:

The agenda for the meeting is the first page of Attachment 2.

The staff handed out two memoranda dated March 19 and June 25, 1996, from the Branch Chief of the Electrical, Materials and Mechanical Engineering Branch in the NRC office of Nuclear Regulatory Research. These memoranda provide preliminary pressure locking data from tests on flexible wedge gate valves that have been placed in the NRC public docket room. These two memoranda are in Attachment 2.

The staff discussed its application of the EOI valve thrust calculational methodology to the valve test data. The staff stated that, although both the EOI methodology and the "ComEd method" (another analytical method used to predict valve thrust) have been used to predict valve thrust, the intent was not to judge one method against another, but to compare each method's prediction against valve thrust required to open a valve and measured during a test.

The licensee stated that its valve thrust calculational methodology was not developed to estimate the thrust required to open a gate valve under a set of pressure-locking test conditions. The methodology was developed to evaluate valve operability under a combination loading of pressure locking and design basis loss-of-coolant accident (LOCA) conditions and is, therefore, integral to the overall process used by the licensee to evaluate valve performance under LOCA pressure-locking conditions. Because the licensee's expert on this methodology was not available onsite, the licensee stated that it would explain how to apply its methodology in the April 9, 1997, public meeting on two analytical methods to predict the thrust required to overcome pressure locking in flexible-wedge gate valves. Of the two analytical methods to be discussed at the April 9, 1997, meeting, one is the EOI methodology.

The licensee provided the staff with the report of the pressure-locking test of a 14-inch William Powell gate valve conducted at Wyle Laboratories

for the licensee. This is Attachment 3. This is the valve test that the licensee discussed in its letter of February 13, 1996.

After a discussion on the test report, the meeting ended.

4/10/97
Jack N. Donohew, Senior Project Manager
Project Directorate IV-1
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-416

Attachments: 1. List of Meeting Attendees
2. NRC staff's Handout
3. Licensee's Handout

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for the licensee. This is Attachment 3. This is the valve test that the licensee discussed in its letter dated February 13, 1996.

After a discussion on the test report, the meeting ended.

Jack N. Donohew, Senior Project Manager
Project Directorate IV-1
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-416

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cc w/atts: See next page

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ATTENDEES AT MEETING OF MARCH 25, 1997

GENERIC LETTER 95-07

NAME	AFFILIATION
R. Jackson	EOI - Grand Gulf
W. Hughey	EOI - Grand Gulf
R. Ingram	EOI - Grand Gulf
R. McCain	EOI - Grand Gulf
R. Fuller	EOI - Grand Gulf
J. Donohew	NRC/NRR/PDIV-1
S. Tingen	NRC/NRR/EMEB

where: EOI = Entergy Operations, Inc.
NRC = Nuclear Regulatory Commission
NRR = Office of Nuclear Reactor Regulation

ATTACHMENT 1

AGENDA

1. Walworth Test Data
2. Walworth Valve versus Grand Gulf Methodology
3. Trend Results Comparison of Commonwealth Edison and Grand Gulf Methodology
4. Validate Grand Gulf Computer Program
5. Clarify Any Ground Rules for Use of Grand Gulf Methodology
6. Obtain Better Understanding of How the Unwedging Thurst is Calculated
7. April 9, 1997, Meeting on GL 95-07
8. Test Methods Results

ATTACHMENT 2

Supplementary Pressure Locking Test Results, 6-inch Walworth Valve

The U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Regulatory Research, funded research at the Idaho National Engineering Laboratory (INEL) to provide technical information to support NRC's evaluations of industry responses to Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." Pressure locking and thermal binding are potential operational phenomena that may prevent a closed gate valve from opening. Pressure locking can occur when operating sequences or temperature changes cause the pressure of the fluid in the bonnet (and, in most valves, between the discs) to be higher than the pressure on the upstream and downstream sides of the disc assembly. This high fluid pressure forces the discs against both seats, making the disc assembly harder to unseat than anticipated by the typical design calculations, which generally consider frictional effects at only one of the two disc/seat interfaces.

The objectives of the INEL gate valve pressure locking research include the following:

1. Determine the relationship between the pressure in the bonnet and the opening thrust with the valve cold, and again with the valve hot

2. Evaluate the impact of temperature changes in the bonnet region on the rate of bonnet pressurization and on the associated thrust requirement to overcome thermally-induced pressure locking

3. Evaluate the effect of valve leakage for mitigating or eliminating pressure locking

4. Evaluate the effect of entrapped air for mitigating or eliminating pressure locking, and the extent to which air will remain entrapped in the valve bonnet during operation.

The test program consisted of testing two gate valves at various pressure locking conditions. The first valve tested was a 6-in., 600-lb-class Walworth flexible wedge gate valve equipped with a Limitorque SMB-0-25 motor actuator. Preliminary results from the Walworth valve tests were reported earlier (available in the NRC Public Document Room, Accession Number 9606270097). The second valve tested was a 6-inch, 900-lb-class Anchor/Darling double disc gate valve equipped with a Limitorque SMB-1-60 motor actuator. Preliminary results from the Anchor/Darling valve tests were reported earlier (available in the NRC Public Document Room, Accession Number 9701240039).

The results contained in the attached table were obtained from tests at the beginning of the program when the disc-to-seat friction factors were low. This data is being documented at this time to supplement the information identified in the previous paragraph for the Walworth valve.

TEST SETUP

The first valve tested was a Walworth 6-inch, 600-lb-class flexible-wedge gate valve with a Limitorque SMB-0-25 motor operator. The important valve specific information is listed below.

Disc thickness (one disc)	0.520 in.
Mean seat diameter	5.515 in.
Stem diameter	1.250 in.
Hub diameter	2.580 in.
Hub length	0.928 in.
Wedge angle	5°0' to 4°56'
Poison's ratio (disc material)	0.3
Modulus of Elasticity (disc material)	29,700 ksi (A217WC6)

Because the valve had been used in previous testing, the valve sealing surfaces were reconditioned in preparation for the pressure locking tests. Following this reconditioning, the valve seat leakage was well below accepted limits.

LOW TEMPERATURE PRESSURE LOCKING TESTS

The low temperature pressure locking tests evaluated the relationship between the fluid pressures in the valve and the valve opening thrust. The test matrix consisted of various upstream, downstream, and bonnet pressures distributed across a range of possible conditions. Periodic baseline valve strokes were also performed throughout the testing to evaluate the wedging versus unwedging relationship, obtain upstream and downstream seat friction values, and determine the load due to packing friction. The baseline strokes included a static valve closing and opening cycle and two differential pressure opening stokes: one with the downstream side and the bonnet pressurized, and one with the upstream side and the bonnet pressurized.

Two different methods were used to simulate pressure locking conditions. The first method began with the valve open and the test volume pressurized to 1200 psig. The valve was then closed and the pressures in the upstream leg, downstream leg, and bonnet were reduced to the desired test values. The valve was then opened and the stem force required to extract the valve disc was measured. The second method began with the valve open and depressurized. The valve was then closed and the pressures in the upstream leg, downstream leg, and bonnet were increased to the desired test values. The valve was then opened and the stem force required to extract the valve disc was measured. The results of the cold pressure locking tests are summarized in Table 1. Tests 201 through 218 used the first pressurization method and tests 219 through 225 used the second method.

Preliminary

Table 1. Summary of Supplementary Pressure Locking Test Results

Test		Pressure (psig)			Temp (°F)	Stem Thrust (lb_f)	Packing Drag (lb_f)	Valve	
Number	Type	Up	Bonnet	Down	Bonnet			Disc Factor	Friction Factor
201	HD	1092	1093	-2	72	1693		0.101	0.100
203	HU	0	1107	1103	72	1696		0.100	0.100
204	S	0	0	0	72	1988	408		
205	PL	-1	222	-1	72	3045			
206	PL	-1	497	-1	72	4217			
207	PL	-2	778	-2	73	5360			
208	PL	-1	[illegible]	0	73	6801			
209	PL	-1	1081	301	72	6293			
210	PL	-1	1077	587	72	5052			
211	PL	-1	1160	912	72	4764			
212	HU	-1	1130	1125	72	2423		0.127	0.123
213	PL	314	1116	-2	72	7268			
214	PL	621	1132	-1	73	6479			
215	PL	899	1122	-2	72	5535			
216	HD	1136	1137	-1	72	1948		0.108	0.108
217	PL	614	1126	297	72	5848			
218	PL	319	1082	316	73	6659			
219	HD	1092	1092	-1	73	2091		0.116	0.116
221	HU	-1	1092	1086	72	3151		0.158	0.157
222	PL	-1	255	-1	72	4083			
223	PL	-1	547	-1	73	5816			
224	PL	-2	829	-2	73	7258			
225	PL	-1	1126	-1	72	8888			

Test Types:

S = Static opening test
HU = Hydro opening test across upstream seat
HD = Hydro opening test across downstream seat
PL = Pressure lock opening test

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 25, 1996

MEMORANDUM TO: Richard H. Wessman, Chief
Mechanical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

FROM: Michael E. Mayfield, Chief
Electrical, Materials, and Mechanical
Engineering Branch
Division of Engineering Technology, RES

SUBJECT: TRANSMITTAL OF PRELIMINARY PRESSURE LOCKING DATA FROM FLEXIBLE WEDGE GATE VALVE TESTS

The subject data in the attachment is transmitted per your request. The attachment also includes information about the valve that was tested at the Idaho National Engineering Laboratory, the steps for performing the tests, and summaries of the test results. The data and the figures describing the test results are preliminary since the final report will not be completed until October 1996. However, the data can be utilized for detecting valve trends and behaviors under pressure locking conditions.

If you have any questions on the attachment, please call Gerald H. Weidenhamer (415-6015) of my staff.

Attachment: As stated

Pressure Locking Test Results, 6-inch Walworth Valve

The U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Regulatory Research, is funding the Idaho National Engineering Laboratory (INEL) to provide technical input for use in evaluating responses to Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." Pressure locking and thermal binding are common mode failure mechanisms that can cause gate valves to fail in the closed position and render redundant safety systems incapable of performing their safety functions. Pressure locking can occur when operating sequences or temperature changes cause the pressure of the fluid in the bonnet to be higher than the pressure on the upstream and downstream sides of the disc assembly. This high fluid pressure presses the discs against both seats, increasing the thrust requirement above that anticipated by the typical design calculations, which generally consider frictional effects at only one of the two disc/seat interfaces.

The INEL gate valve pressure locking research was designed to address the following objectives:

1. Study the relationship between bonnet pressure and opening thrust

2. Study the impact of temperature changes in the bonnet fluid on the rate of bonnet pressurization and on the associated thrust requirement to overcome thermally-induced pressure locking

3. Study the effect of valve leakage on bonnet pressure

4. Study the effect of entrapped air on thermally-induced pressure locking, and the extent to which air will remain entrapped in the valve bonnet during operation.

TEST SETUP

The first valve tested was a Walworth 6-inch, 600-lb-class, flexible-wedge gate valve with a Limitorque SMB-0-25 motor operator. The important valve specific information is listed below.

Disc thickness (one disc)	0.520 in.
Mean seat diameter	5.515 in.
Stem diameter	1.250 in.
Hub diameter	2.580 in.
Hub length	0.928 in.
Wedge angle	5°
Poison's ratio (disc material)	0.3
Modulus of Elasticity (disc material)	29,700 ksi (A217WC6)

Because the valve had been used in previous testing, the valve sealing surfaces were reconditioned in preparation for the pressure locking tests. Following this reconditioning, the valve seat leakage was well below accepted limits. Prior to any testing, the valve was subjected to a series of numerous open/close cycles to wear in (precondition) the sealing surfaces to provide a reasonable disc friction factor.

The valve was then subjected to two test sequences: low temperature (depressurization-induced) pressure locking tests, and thermally-induced pressure locking tests. Both sets of tests focused on the relationship between bonnet pressure and the opening thrust requirements. In addition, the thermally-induced pressure locking tests examined the relationship between bonnet temperature and bonnet pressure, the effects of valve leakage on the bonnet pressure, and the effects of air entrapped in the bonnet.

LOW TEMPERATURE PRESSURE LOCKING TESTS

The low temperature pressure locking tests studied the relationship between the fluid pressures in the valve and the valve opening thrust. The test matrix consisted of various upstream, downstream, and bonnet pressures distributed across a range of possible conditions. Periodic baseline valve strokes were also performed throughout the testing to evaluate the wedging versus unwedging relationship, obtain upstream and downstream seat friction values, and determine the load due to packing friction. The baseline strokes included a static valve closing and opening cycle and two differential pressure opening strokes: one with the downstream side and the bonnet pressurized, and one with the upstream side and the bonnet pressurized.

Two different methods were used to simulate pressure locking conditions. The first method began with the valve open and the test volume pressurized to 1200 psig. The valve was then closed and the pressures in the upstream leg, downstream leg, and bonnet were reduced to the desired test values. The valve was then opened and the stem force required to extract the valve disc was measured. The second method began with the valve open and depressurized. The valve was then closed and the pressures in the upstream leg, downstream leg, and bonnet were increased to the desired test values. The valve was then opened and the stem force required to extract the valve disc was measured. The stem thrust required to open the valve was not affected by the method used to pressurize the valve. The results of the low temperature pressure locking tests are summarized in Table 1. As can be seen in Table 1, the static unwedging thrust varied throughout the testing.

THERMALLY-INDUCED PRESSURE LOCKING TESTS

Pressure locking tests were also performed on the valve at elevated temperatures. In addition, tests were performed to study the impact of temperature changes on the rate of bonnet pressurization and on the associated thrust required to unseat the valve during opening. The effects of valve seat leakage on bonnet pressurization were also investigated, as were the effects of air entrapped in the bonnet.

Testing was performed with the valve heated both internally and externally. For the tests with internal heating, the heater in the upstream leg of the valve heated the fluid at 80°F per hour until the upstream fluid temperature reached 290°F; the upstream pressure was controlled at 50 psig. Discharge from the downstream side of the valve was measured as an indication of leakage from the bonnet to the downstream side. For external heating, heat tape wrapped around the valve body was used to heat the fluid in the valve. Once again, the fluid temperatures were limited to 290°F, and the upstream pressure was controlled at 50 psig.

The bonnet pressure was monitored during the heatup and compared to the measured leakage; these measurements helped to demonstrate a relationship between leakage and thermally induced bonnet pressurization. When the bonnet pressure reached 1200 psig, the valve was opened and the stem load required to extract the disc was measured.

The heatup tests produced bonnet pressures capable of causing pressure locking loads. The results from opening strokes during these tests showed that the required thrust is linear with pressure and that the results were consistent with the results from the earlier low temperature tests. The results of the high temperature pressure locking tests are included in Table 2. As with the low temperature pressure locking tests, the static unwedging thrust varied throughout the testing.

EFFECTS OF VALVE LEAKAGE

Leakage was measured during tests with both internal and external heating, as summarized in Table 3. Table 4 summarizes the leakage rates during low temperature pressurization of the bonnet.

When the unpressurized bonnet water was heated, the leakage was sufficient to prevent pressurization as the fluid expanded. In contrast, when the bonnet was pressurized to 700 psig prior to beginning the heating test, pressurization due to thermal expansion occurred. Most likely, the initial pressure (before heating) caused the disc surfaces to seal to the seat surfaces more effectively than in the tests without initial pressure.

Note that evidence of valve leakage during a differential pressure test does not necessarily mean that leakage will prevent pressure locking. The disc elastic response during a pressure locked condition and its match-up to the seat is different during pressure locking as compared to the differential pressure case. The effect of this difference was evident in the results observed, the leakage rates during the differential pressure tests showed no relationship to the leakage rates during the bonnet pressure tests. This demonstrates that the disc matches up to the seat surface differently during different tests.

EFFECTS OF ENTRAPPED AIR

Other tests were performed with heat applied from the outside of the valve to determine the effect of entrapped air on the bonnet pressure and on the associated opening stem load. The testing also investigated the extent to which the air will remain entrapped during operation, that is, whether the air pocket will remain intact, bleed off, or dissolve into the water.

Parametric tests were performed with air pockets representing 0.0, 0.5, 1.0 and 2.0% of the total valve volume. The air pockets were established by draining a known volume from the lower drain line while allowing air to enter through the high bonnet vent. Once the appropriate air volume was established the valve was heated to 290°F using the external heaters (heat tape). The pressure was monitored during the test and the valve was depressurized to 50 psig any time the pressure reached 1200 psi.

Figure 1 shows results from the heatup test with no entrapped air. The pressure increases rapidly after the bonnet pressure reaches 200 psig. Subsequent pressurization (following scheduled depressurizations) are very repeatable. Figures 2 through 4 show the same kind of data, but from tests with entrapped air volumes of 0.5, 1.0, and 2.0% air by volume. Here the behavior is similar, except that the initial pressurization begins at a higher temperature. As in the no-air test, subsequent repressurizations following depressurizations occur immediately. This indicates that once the air volume has collapsed as a result of the thermally-induced pressurization, the air volume does not reappear during the heatup cycle. Only after the valve was cooled and depressurized did the air volume reappear.

Additional tests were performed to study the effect of pressurizing the valve using a hydrostatic pump on the existence of an air volume. The first test was conducted at low temperature (approximately 70°F) and the second test was conducted at high temperature (approximately 250°F). In both tests, a 2% air volume was established and the valve bonnet pressurized to 1200 psig using only the hydrostatic pump. In both tests, the valve was pressurized for approximately two hours and about two-thirds of the air pocket remained in the valve following depressurization.

The final test series was performed with water flow through the bonnet, simulating the normal flow over the disc for a valve in service. As with the previous tests, a 2% air volume was established in the valve bonnet. A flowrate of approximately 8 gpm through the valve bonnet was created, and the amount of air remaining at various times was measured. Flow through the valve reduced the size of the air pocket over time, as shown in Figure 5.

In conclusion, the results described for all pressure locking testing are based on the testing of one flexible wedge gate valve. The results from pressure locking testing of other gate valves will be reported later. The applicability of these test results to the pressure locking phenomena requires further review.

Table 1. Summary of Low Temperature Pressure Locking Test Results

Test		Pressure (psig)			Temp (°F)	Stem Thrust (lb_f)	Packing Drag (lb_f)	Valve	
Number	Type	Up	Bonnet	Down	Bonnet			Valve Factor	Friction Factor
226	S	1	3	1	74	4353	1275		
227	HD	1072	1075	-4	72	14590		0.569	0.594
228	HU	-3	1039	1031	77	14612		0.591	0.618
229	PL	-3	495	-1	73	13652			
230	PL	-3	1065	-3	69	21132			
231	PL	-3	1127	363	72	18798			
232	PL	318	1056	-3	73	18634			
233	S	-1	1	-2	70	6065	1270		
234	HD	1009	1012	-2	71	14177		0.586	0.612
235	HU	-3	1041	1034	71	14778		0.596	0.624

Test Type:

S = Static opening test
HU = Hydro opening test across upstream seat
HD = Hydro opening test across downstream seat
PL = Pressure lock opening test

Table 2. Summary of High Temperature Pressure Locking Test Results

Test		Pressure (psig)			Temp (°F)	Stem Thrust (lb_f)	Packing Drag (lb_f)	Valve	
Number	Type	Up	Bonnet	Down	Bonnet			Valve Factor	Friction Factor
307	PL	34	1073	-2	203	18251			
308	S	14	16	12	217	6354	1130		
309	HD	1022	1024	-2	190	11895		0.489	0.507
310	HU	0	922	916	187	10429		0.474	0.491
312	S	200	207	196	71	5866	1383		
313	HD	1053	1056	5	69	11226		0.445	0.459
314	HU	6	1062	1055	67	12142		0.481	0.498
316	PL	-1	1141	-3	205	18096			
317	S	9	9	8	179	6404	1208		
318	HD	1059	1061	-4	181	12108		0.480	0.498
319	HU	-3	1019	1003	182	12703		0.530	0.551
322	S	41	44	57	69	5102	1384		
323	HD	1004	1007	44	67	11936		0.514	0.534
324	HU	39	1015	1009	76	12636		0.539	0.561
325	S	46	49	44	71	3944	1382		
326	HD	1097	1100	-4	66	14801		0.561	0.586
327	HU	-3	1073	1066	70	15256		0.595	0.622
329	PL	35	1105	-3	125	17010			
330	S	67	42	55	148	5022	1304		
331	HD	1080	1083	-4	136	14893		0.574	0.599
332	HU	-2	1047	1040	133	15242		0.611	0.641
341	HU	-1	1119	1114	66	15742		0.593	0.621
342	S	1	2	2	70	5924	1306		
343	PL	2	1050	3	65	19501			

Test Type:

S = Static opening test
HU = Hydro opening test across upstream seat
HD = Hydro opening test across downstream seat
PL = Pressure lock opening test

Table 3. Leak rate data during thermally-induced tests.

Initial bonnet pressure (psig)	Average heat-up rate (°F/hr)	Average leak rate from bonnet to downstream (cm^3/min)	Range of bonnet to downstream leak rates (cm^3/min)	Average leak rate from upstream to maintain 50 psig (cm^3/min)	Range of upstream leak rates to maintain 50 psig (cm^3/min)
50	45	16.2	12.5 - 22.2		
600	45	41.1	Not Measured		
1200	45	1.5	Not Measured		
50	66.6	1.6	1.45 - 1.83		
50	54.1	1.2	0.91 - 3.12	2.33	1.38 - 3.12
50	85.2	24.2	4.97 - 130	2.15	1.82 - 2.49
700	13.8	2.3		9.7	

Table 4. Cold leak rate data.

Bonnet pressure range (psig)	Leak rate from bonnet to downstream (cm^3/min)
1104 - 1326	0.216
504 - 640	1.233
1039 - 1294	0.114
572 - 670	0.078

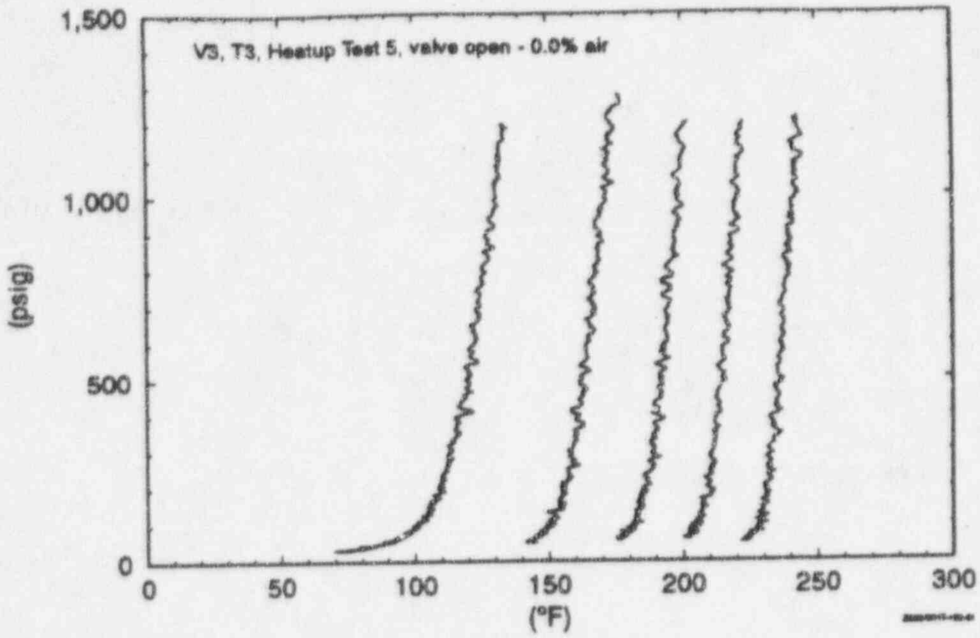


Figure 1. Pressure versus temperature with no entrapped air.

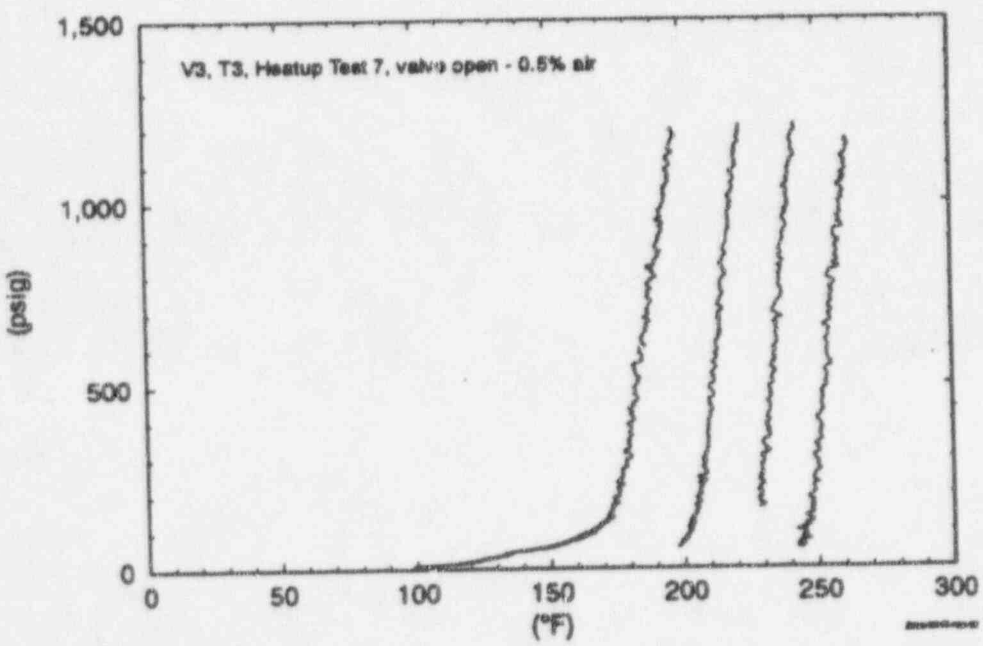


Figure 2. Pressure versus temperature with 0.5% entrapped air.

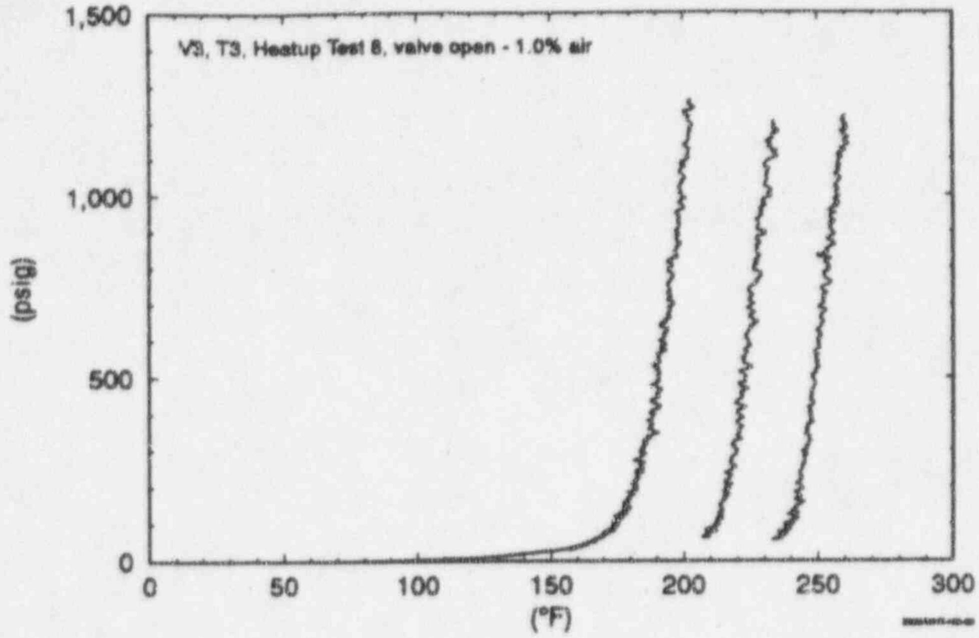


Figure 3. Pressure versus temperature with 1.0% entrapped air.

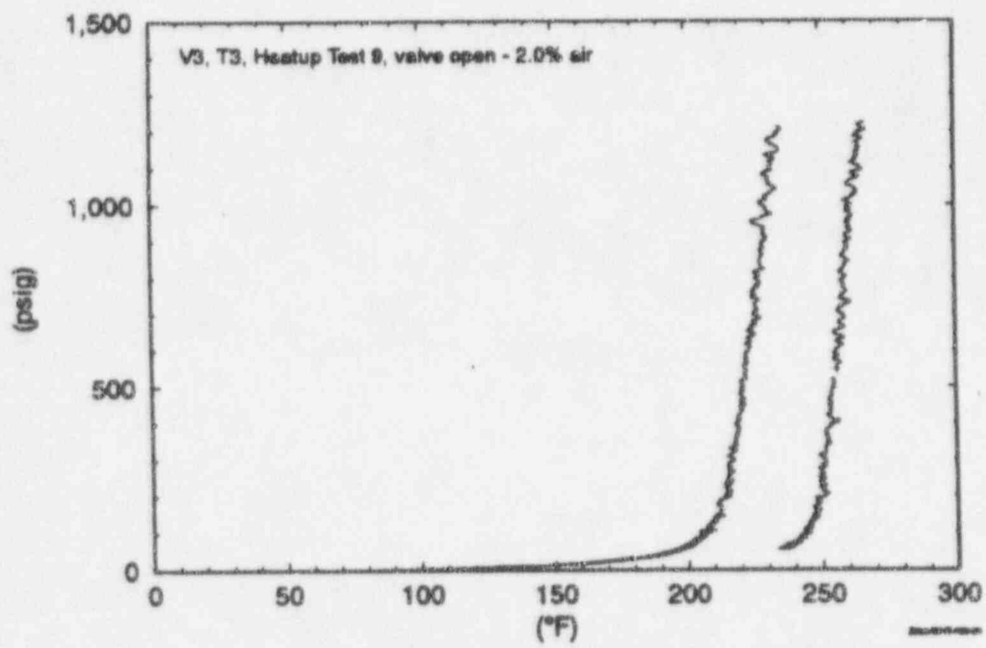


Figure 4. Pressure versus temperature with 2.0% entrapped air.

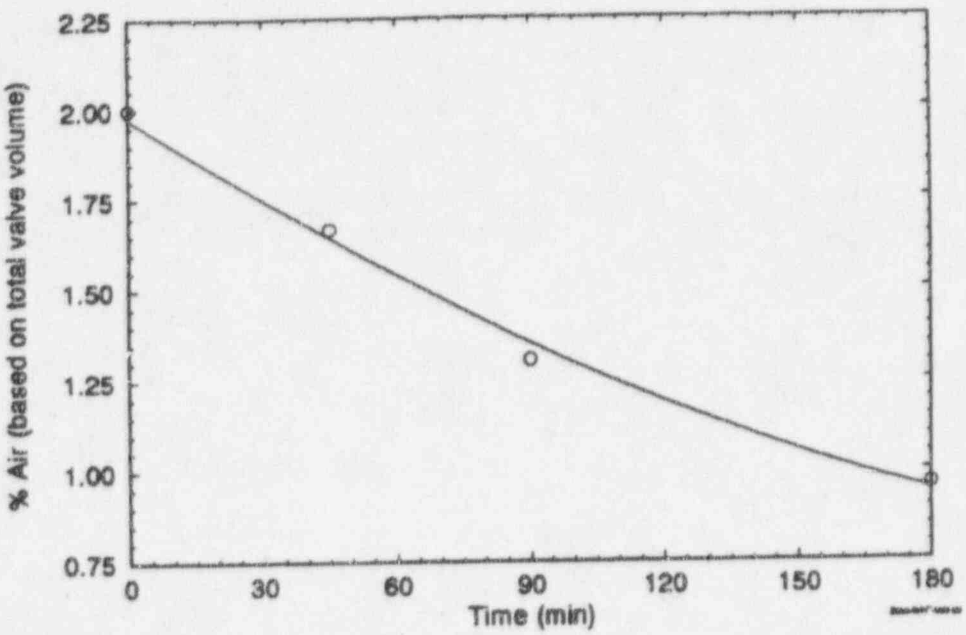


Figure 5. Percent entrapped air versus flow duration.

LICENSEE'S HANDOUT

ELBOW LOOP DIFFERENTIAL PRESSURE AND PRESSURE LOCK TESTS ON A 14-INCH WILLIAM POWELL GATE VALVE

FOR

ENTERGY OPERATIONS, INC.

GRAND GULF NUCLEAR STATION

J/N 43008

ATTACHMENT 3

LICENSEE'S HANDOUT

ELBOW LOOP DIFFERENTIAL PRESSURE AND PRESSURE LOCK TESTS ON A 14-INCH WILLIAM POWELL GATE VALVE

FOR

ENTERGY OPERATIONS, INC.

GRAND GULF NUCLEAR STATION

J/N 43008

ATTACHMENT 3

TEST REPORT

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

REPORT NO.	43008-01
OUR JOB NO.	43008
YOUR P. O. NO.	C-1015-28
CONTRACT	N/A
PAGE 1 of	128 PAGE REPORT
DATE	February 18, 1993

Entergy Operations, Inc.
P. O. Box 758
Port Gibson, MS 39150

FLOW LOOP DIFFERENTIAL PRESSURE AND PRESSURE LOCK TESTS ON A 14-INCH WILLIAM POWELL GATE VALVE FOR ENTERGY OPERATIONS, INC. GRAND GULF NUCLEAR STATION J/N 43008

For

Entergy Operations, Inc.
Port Gibson, MS

(pap)

STATE OF ALABAMA
COUNTY OF MADISON } ss

Ala Professional Eng.
Reg. No. 13475

Gerald R. Carbonneau, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted testing and is to the best of his knowledge true and correct in all respects.

SEAL

SUBSCRIBED and sworn to before me this 1st day of March, 19 93

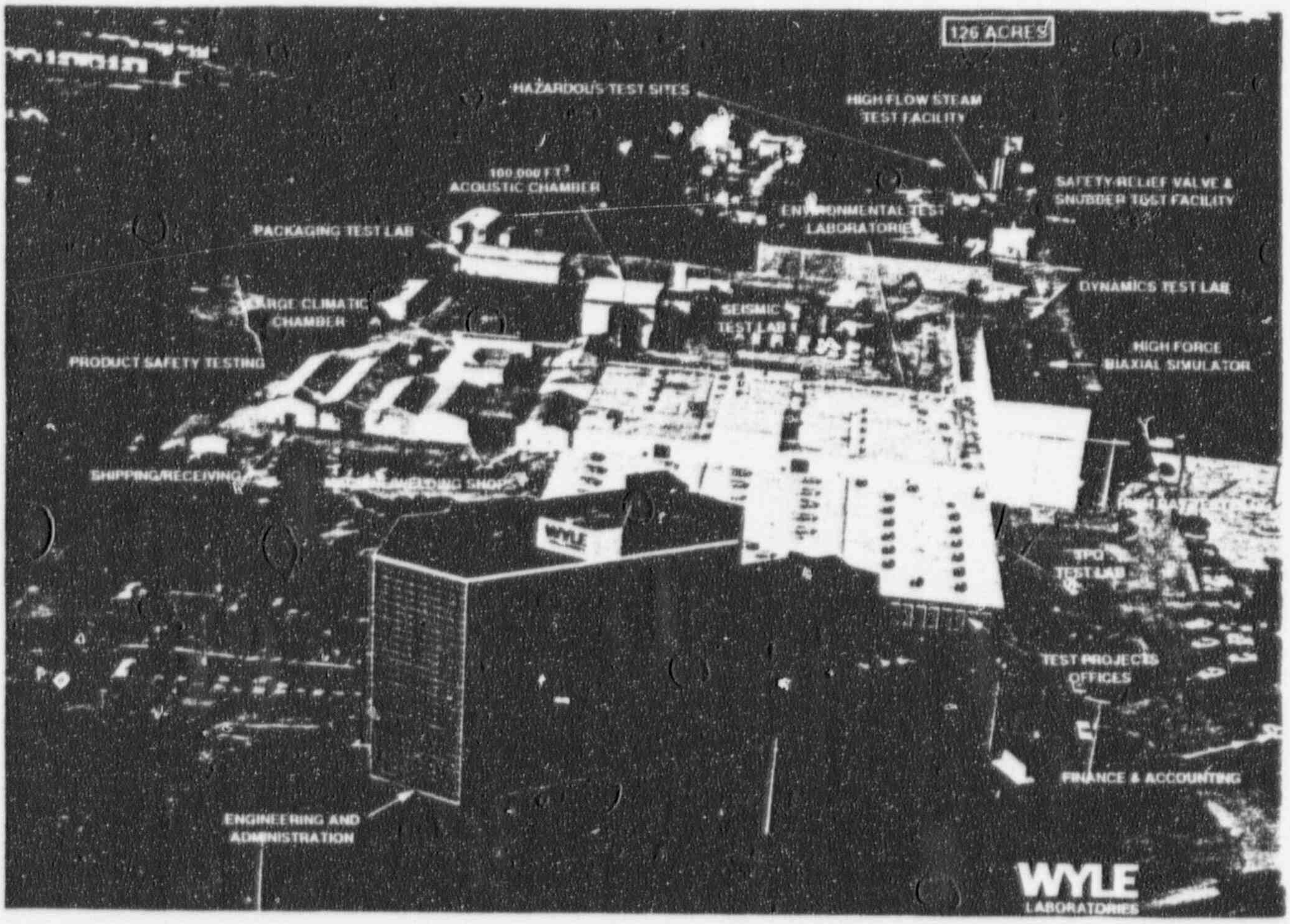
Notary Public in and for the State of Alabama at large
My commission expires September 7, 19 93

TEST BY: G. R. Carbonneau, Proj. Engineer

P. Turrentine 2/25/93
P. Turrentine, Dept. Manager

WYLE Q. A.: 3-1-93
R. G. Thomas, Q.A. Manager

WH-1404, 2/92



AERIAL VIEW OF WYLE/HUNTSVILLE

AERIAL VIEW OF WYLE/HUNTSVILLE

1.0 PURPOSE

The purpose of this report is to present the results of a test program conducted on a Motor-Operated Valve (MOV), 14-Inch, 600 Class, William Powell Gate Valve and Limitorque SB-3 Operator for Entergy Operations, Inc., Grand Gulf Nuclear Station. The valve was subjected to Bonnet Pressure Lock-up Tests and Full-Flow Differential Pressure Tests in the valve stem vertical and horizontal modes as required by Entergy Operations Contract No. C-1015-28, including Change Order No. 1, Entergy Letter GEXO:92-00743, and Wyle Laboratories' Test Procedure No. 43008 (Appendix VIII of this report).

2.0 REFERENCES

2.1 Contract No. C-1015-28, Entergy Operations, Inc.

2.2 Change Order No. 1 to Contract Order No. 28, dated November 16, 1992

2.3 Entergy Letter GEXO:92-00743

2.4 Wyle Laboratories' Test Procedure No. 43008

2.5 Wyle Laboratories' Quality Assurance Program

2.6 William Powell Company Instruction Manual, Pressure Seal Valves No. 69-1

3.0 QUALITY ASSURANCE

All work performed on this test program was conducted in accordance with Wyle Laboratories' Quality Assurance Program Manual dated June 30, 1988, approved by Entergy Operations and per the customer's Purchase Order. Wyle's Quality Assurance Program complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N45.2, and applicable regulatory guides.

4.0 TEST INSTRUMENTATION AND EQUIPMENT

4.1 Calibration of Test Equipment and System Calibration

Appendix V presents the Instrumentation Test Equipment listing all instrumentation used during this program, including calibration dates.

All instrumentation, measuring, and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

All test equipment used was calibrated on a periodic basis, with the calibration interval displayed on a decal (affixed to the equipment) indicating the last calibration date, the next calibration due date, accuracy, and by whom calibrated.

4.0 TEST INSTRUMENTATION AND EQUIPMENT (Continued)

4.2 Measurements and Tolerances

Unless specified otherwise, the tolerances on test condition measurements were as follows:

Measurement	Tolerance
Pressure	± 1% F.S.
Temperature	± 2°F
Flow Rate	± 5%
Current	± 2%
Voltage	± 1%
Time	± 0.25 sec
Stem Torque/Thrust (Teledyne)	± 1.0%
Displacement, Spring Pack	± 0.52%
Motor Power	± 3%

5.0 TEST SPECIMEN

The test specimen MOV supplied by Entergy Operations, Inc., Grand Gulf Nuclear Station, was inspected by Wyle on November 10, 1992, and found to be equipped with welded flanges (ANSI B16.5 14-inch, 600-pound class, raised face). The test specimen MOV upstream and downstream nozzles were Pipe Schedule 30 and Schedule 80, respectively. The flange bolt hole pattern had one bolt hole at top dead center of the valve.

The test specimen was a Motor-Operated Valve (MOV) Assembly consisting of one 14-inch diameter, 600-pound Class, carbon steel flex wedge gage valve with operator. The valve and operator nameplate data were recorded.

Valve:

William Powell Valve Company
1250 psi at 575°F (Design Pressure/Temperature)
Serial No. 67770-6, Year 1981
Class 1

Operator:

Limitorque   Rat. 43.87
Type SB   Size 3 150 ft-lb motor
Order 583616B Serial 258077
Valve 14 193-2-4100
229158 77°C

Figure 1 of this report presents a drawing of the test specimen MOV.

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TABLE OF CONTENTS (Continued)

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.1 Test Summary

Testing of the 14-inch, 600-pound Class William Powell Gate Valve is completed. This valve was subjected to a Pressure Lock-up Test and a Full-Flow Differential Pressure Test at Wyle Laboratories, Huntsville, Alabama, from December 28, 1992, through January 15, 1993. The valve performed normally throughout these tests. However, during the Pressure Lock-up Test, with 1080 psig applied to the bonnet and 0 psig applied to the inlet and outlet nozzles, the valve could not be stroked open.

The raw test data of the Full-Flow Differential Pressure Testing was subjected to analyses by Wyle's MOV Engineering Group. The results of the analyses are included within this report. The valve did not exhibit any unusual or anomalous behavior during these tests.

Table I presents a chronological history of the program.

6.2 Pre-Test Preparation

6.2.1 Receipt Inspection/Disassembly

On November 19, 1992, Wyle received the test specimen valve at Wyle's Steam Valve Facility. This shipment consisted of two packages, one for the valve body and flanges and one for the actuator and motor.

The shipment was inspected for radiation by Wyle's Radiation Safety Officer. It was found to be uncontaminated and was released. Next, Wyle's Quality Assurance personnel inspected the shipment. No damage was noted during this inspection. Nameplate data revealed that the valve and operator were as described in the Entergy Statement of Work. The nameplate data was recorded in the Project Logbook.

The valve was a William Powell valve (Serial No. 67770-6) and the operator was a Limitorque Type SB operator (Serial No. 258077).

On November 20, 1992, the valve body was disassembled, and the valve stem was removed in order to install the Teledyne Smart Stem. The valve was disassembled and reassembled following the instructions of the William Powell Company Instruction Manual, Pressure Seal Valves No. 69-1, provided by Entergy Operations, Inc.

In order to disassemble the valve, it was necessary to remove the bonnet packing leakage pipe. The stem was inspected for run-out using Wyle's Cordax Machine, packaged, and shipped to Teledyne Engineering Services, Waltham, Massachusetts, for Smart Stem installation. The bonnet was sent to Wyle's Machine Shop to have the bonnet package's leakage port drilled and tapped. Minor scratches were noted on the valve stem where the packing was located.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.2 Pre-Test Preparation (Continued)

6.2.1 Receipt Inspection/Disassembly (Continued)

On December 17, 1992, the valve stem was returned from Teledyne Engineering Services. The stem was checked for runout in the Cordax Machine and electrically checked. Teledyne stated that the Smart Stem hysteresis was 1% during calibration check. The Smart Stem calibration and inspection data are presented in Appendix IV.

On December 17, 1992, the Teledyne Smart Stem was installed in the test article MOV. The valve was reassembled using William Powell Instruction Manual 69-1. The stem was lubricated with Mobilux EP-1. A Certificate of Conformance is presented in Appendix II of this report. The actuator was mounted on the valve and the motor was mounted on the actuator. During assembly, some small amounts of grease were noted on the switch compartment. Inspection revealed a failed O-ring at the limit switch penetration. The O-ring was replaced.

6.2.2 Valve Installation and Orientation

On December 1, 1992, the valve body (valve disassembled) was installed in the Wyle flow loop. The valve was installed in the stem vertical orientation with the 14-inch, Schedule 30 nozzle facing the upstream direction. The test section piping was horizontal. A photograph of the installed test article is presented in Appendix III. The valve was installed using standard Wyle bolt-up procedures, and gaskets and bolting provided by Entergy. Entergy also provided the 14-inch, 300-pound Class weld neck flanges which were welded to the upstream and downstream piping test sections.

To protect the valve inlet, Schedule 30 pipe from over-pressurization, a 6-inch rupture disc rated 766 psig at 200°F, as determined by the calculations presented in Appendix I of Wyle Test Procedure 43008, was installed on top of the test loop 3,000-gallon vessel.

A Hydrostatic Test of the test article MOV and the test section was performed on December 19, 1992, following valve reassembly. With the test valve in the open position, piping was pressurized to 1200 ± 50 psig with ambient water and maintained for 10 minutes. The valve and test section piping were inspected for leakage. None was detected.

6.2.3 Actuator Installation and Wiring

The actuator was mounted on the test article valve on December 18, 1992. The motor was mounted on December 21, 1992. Bolting used was that supplied with the valve by Entergy. Torque was per Limitorque standard procedure for SB-3 actuators.

Power supply and control circuit wiring was established per procedure. Thermal overload protection was provided using 3 each Allen Bradley W61 21.7 amps.

Figure 2 presents the control wiring installation.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.2 Pre-Test Preparation (Continued)

6.2.4 Instrumentation

Spring pack displacement was measured using a LVD and mounting fixture, and by drilling a 1/4-inch hole in the spring pack cover plate. During plate removal, the declutch lever torsion spring was found to be out of position, rendering the handwheel inoperable. This was corrected prior to cover reinstallation.

The valve stem was equipped with a Teledyne Smart Stem. Appendix IV presents the stem calibration data.

Flow rate was measured using a 10-inch Venturi manufactured by Badger Corporation. Flow meter data are presented in Appendix VI.

Figures 3A, 3B, and 3C present schematics showing all instrumentation points during these tests.

All instrumentation used during these tests are listed on the Instrumentation Equipment Sheets in Appendix V.

6.2.5 Date Acquisition System (DAS)

The DAS consisted of the MEGADAC 5033A manufactured by Optim Corporation of Dayton, Ohio. Data acquired was placed on Panasonic optical disc cartridge LM-D702W of 1 GB capacity. The data were also transcribed to 8 mm FM tape as backup. Plots of each channel were produced, following each run, using the H-P Laser Jet Printer.

6.2.6 Actuator Switch Settings and Adjustment

Prior to testing, the Limitorque actuator switches were set using standard Wyle and Limitorque procedures.

- The open limit switch was set to 90% of travel.
- The open torque bypass switch was set to 20% of travel.
- The close torque bypass switch was set to 95%.
- The open torque switch was set to 63,800 pounds.
- The close torque switch was set to 80,000 pounds.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests

6.3.1 Pre-Test LLRT

On December 23, 1992, a pre-test LLRT was performed in order to baseline the valve seat leakage. This test was performed with the valve in the flow test loop with all instrumentation and equipment installed. With the valve open, the valve and test section were flooded with water at ambient temperature water. The valve bonnet was vented to remove an air pocket. The valve was then commanded closed electrically. Using a hydrostatic pump, the downstream side of the valve was pressurized to 1080 +100, -0 psig and allowed to stabilize for five minutes. The valve upstream test section was isolated. A fitting was removed on the air vent of the upstream test section. Any leakage across the valve seat would show up at this fitting.

Following stabilization, the valve was monitored for five minutes. During this period, no measurable leakage (i.e., greater than 1 milliliter) was observed.

6.3.2 Static Break-in Test/LLRT

A Static Break-in Test was performed after the pre-test LLRT. The valve was cycled open-to-closed-to-open 50 times. A rest period of three minutes minimum was allowed after each cycle. The first and every fifth subsequent stroke was recorded on the DAS. Each recorded stroke was reviewed on the monitor screen after stroking. A decrease in thrust was noted from stroke to stroke. The valve stem was relubricated with Nebule EP1 after 20 cycles.

A Post-Static Break-in Test LLRT was performed on the test article MOV on December 28, 1992. The procedure used is that specified in Section 6.3.1 of WLTP 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzles were solid with water. The valve was closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, were isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

6.3.3 Pressure Lock Test

On December 28, 1992, Pressure Lock Tests were initiated on the test MOV. The system was flooded with demineralized water. The bonnet air was vented at the packing drain tap until full of water. The valve upstream and downstream nozzles were solid with water as air was vented from the test section vent valves.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

The open torque bypass switch wire was disconnected during these tests; therefore, the torque switch was not bypassed. The open torque switch setting was at 63,800 pounds thrust which is less than the 78,000 pound criterion. All instrumentation channels and DAS remained in the same configuration as during the Static Break-in Test.

Test No. 1 was performed with zero pressure applied upstream, downstream, and at the bonnet. The valve was stroked closed, open, and closed while recording data. A review of the data channel plots revealed that during the opening stroke the valve, for reasons unknown, de-energized after less than a second. The start button was pushed again and the valve opened normally.

Test No. 2 was essentially a Leakage Test using pressure rate of increase. Initially, the inlet and outlet nozzles and bonnet were at zero pressure. The outlet nozzle was pressurized to 1080 psig. The bonnet pressure tracked the rise in downstream nozzle pressure as pressure was applied. The upstream pressure remained zero. Since the valve was not stroked, the DAS did not record data.

Test No. 3 was performed by pressurizing the bonnet to 1080 psig. Inlet and outlet nozzle pressures were zero psig. With DAS recording the data, the MOV was powered to open. The motor ran for approximately two seconds until the torque switch tripped at 63,800 pounds. Stem thrust rose to a maximum following TST to 119,334 pounds. Entergy Operations was notified of this anomaly (See also Notice of Anomaly No. 1, Appendix I) and Wyle was advised to wait on continuance of testing until the arrival of the Grand Gulf Engineer the following day.

Following the arrival of the Grand Gulf Engineer on December 29, 1992, testing continued. The bonnet pressure had been relieved and the valve stroked normally. Wyle was instructed to increase the torque switch setting to a value of 1.4. Wyle was also requested to perform Test No. 5 of WLTP 43008, Section 6.3.3, prior to Test No. 4. The upstream nozzle was pressurized to 320 psig. The bonnet and downstream nozzle were pressurized to 452 psig. The valve was stroked open. The torque switch trip occurred at approximately 50,000 pounds. The MOV was again given a command signal to open and did so normally.

Test No. 5 Repeat (R) was repeated after increasing the torque switch setting to 1.5. The valve was stroked open and operated normally.

Test No. 4A was modified to pressurize the bonnet to 700 psig, the upstream nozzle to 320, the downstream nozzle to 452. The open torque switch was reset to 1.65 per Grand Gulf instructions. The valve was stroked open. The valve performed normally.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

In Test No. 4B, the bonnet pressure was raised to 1080 psig. The open torque switch was increased to 1.75. The valve was stroked open and stopped after a couple of seconds. Approximately 15 seconds later, the v··ve start button was pushed and the valve opened normally.

6.3.4 Post-Test LLRT

On December 29, 1992, a Post-Pressure Leak Test LLRT was performed on the test article MOV. The procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, were isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation

On December 30, 1992, a Flow Loop Differential Pressure Test was initiated. Figure 3 presents a schematic of the flow loop test setup and loop schematic. Photographs of the test article MOV installation are presented in Appendix III.

Prior to testing, a trial run of the loop was performed to establish a control parameter (i.e. flow rate) and instrumentation checkout. This test was performed on December 30, 1992. The opening position, of the 10-inch loop blowdown valve, required to establish a flow rate of 9,000 gpm at 500 psig was determined.

On December 31, 1992, flow loop differential pressure testing of the test article MOV began, completing Strokes 1 and 2 as specified by the test procedure. Prior to test, the 3,000 gallon reservoir was filled with demineralized water (used throughout testing). The water was preheated by circulation through the test section up to the test article MOV using a pump and electric (225 Kw) heat exchanger until all the water was heated to the 150-200°F range. Heat-up was assisted by injection of steam and hot water into the recirculation flow. Following heat-up, the heat-up loop was isolated, and the 3,000 gallon vertical water vessel ullage was pressurized with GN_2 to 500 psig. This pressure was maintained during test runs using a 4-inch GN_2 regulator (C_v = 69.0).

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation (Continued)

During opening and closing strokes, the test article MOV was stroked between full close and 50-70% of full open to prevent running out of water during a run (i.e., at 9,000 gpm, a 3,000 gallon reservoir would be depleted in 20 seconds). The DAS was operational prior to, during, and immediately following stroking. Each test run consisted of one stroke followed by recharge of the system with demineralized water and retesting. During this period, X-Y plots were generated for each channel recorded during the test run. The following plots were generated:

Channel Designation	Units	Description
DP1	PSID	Venturi Delta Pressure
FL1	GPM	Flow Rate
TC2	°F	MOV Inlet Temperature
PS1	PSIG	Upstream Pressure
PS3	PSIG	Bonnet Pressure
DP2	PSID	Valve Delta Pressure
THR1	lb	Stem Thrust
TRQ1	inches/lb	Stem Torque
SPD	inches	Spring Pack Displacement
SG1	microinch/inch	Axial Valve Body Displacement (Strain)
SG2	microinch/inch	Radial Valve Body Displacement (Strain)
MC1	Amps	L1 Current (Motor)
MV1	VAC	L1 Neutral Voltage (Motor)
MP	Watts	True Power
S1	Amps	Open Limit Switch
S2	Amps	Open Torque Switch
S3	Amps	Close Torque Switch
S4	Amps	Close By-Pass Switch
S5	Amps	Open By-Pass Switch

After each stroke, plots were reviewed for accuracy and quality. Each plot was labeled with date and time, customer, stroke number, specimen orientation, channel designation, units, and channel description.

A listing of all strokes is presented in Table II. Logbook entries are presented in Appendix VII. Several strokes were repeated, at Entergy's request, because they did not meet acceptance criteria for either flow rate stability or pressure. Notice of Anomaly (NOA) No. 2, presented in Appendix I, documents a problem with peak pressure saturation of the valve inlet pressure (PS1) and valve delta pressure.

Test results in the form of plots for all strokes are presented in Attachment II to this report.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.6 Post-Test LLRT/Inspection

On January 9, 1993, a post-test LLRT and visual inspection were performed on the test article MOV. The LLRT procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, was isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

Also, a valve internal inspection was performed at this time. The inspection was witnessed by a Grand Gulf Engineer. This inspection was performed by removing the valve from the test section and looking into the inlet and outlet nozzles using a flashlight and inspection mirror. The valve disc and body seats were examined. Also, the guide rails were examined. The results were that only slight scratches were noted on the seats and guides.

6.3.7 Test Specimen Re-Orientation (Vertical to Horizontal)

On January 9, 1993, the test MOV was removed and reoriented from the vertical to the horizontal orientation. The actuator was not removed to perform this task. A crane was brought in to perform this reorientation. No other changes were made in test equipment or setup.

6.3.8 Flow Loop Differential Pressure Test (Horizontal Orientation)

On January 11, 1993, testing of the test specimen valve resumed. The valve stem orientation was horizontal. All conditions of test, instrumentation test equipment, and stroke sequence were the same as previously described in Section 6.3.5.

Photographs of the test setup are presented in Appendix III. Table III presents stroke information for this test sequence.

Data plots are presented in Attachment II to this report.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.9 Post-Test LLRT Inspection

On January 18, 1993, a post-test LLRT was performed on the test article MOV. The LLRT procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, was isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

On January 22, 1993, an additional Seat Leakage Test was performed at Entergy's request. The bonnet was pressurized to 1080 psig +100, -0 and leakage was observed across the downstream side. The results were leakage of 550 milliliters over a 5-minute period. These results were reported to Entergy Operations.

No obvious visual damage was noted during valve disassembly. A detailed internal inspection will be performed by Entergy Operations.

6.4 Data Analysis

Analysis of the William Powell 14-Inch, 600 Pound Gate Valve, Serial No. 67770-6, was performed by Wyle's MOV Engineering Group. The analysis consisted of viewing the test data using the data analysis computer program DADiSP 3.01b, distributed by DSP Development Corporation. The points of interest required by Test Procedure No. 43008, Revision C, were identified. The points found on the Stem Thrust (THR1) data channel were identified on DADiSP-generated plots. Data analysis sheets are attached for each stroke analyzed and are presented in Attachment I of this report.

An analysis of the static stroke that most immediately preceded the test sequences was evaluated to determine the thrust at Torque Switch Trip, which was -84,134 pounds. This value was used during subsequent analysis in determining the Rate-of-Loading Effect (if any) on closing strokes. This static stroke was labeled in the test log as Paragraph 6.3.3 Test #1: a,b,c." with the data contained in file B430081.002." A plot of Stem Thrust (THR1), identifying points of interest during the Static Test, is provided. The Rate of Loading Effect was determined by finding the value of stem thrust at Torque Switch Trip, and comparing it with the value obtained in the static stroke. Any value at Torque Switch Trip less than 97% of the static value was considered to have a Rate of Loading (ROL). The 97% was derived from assuming a switch error of 2.5% and a thrust error of 0.5%. As a result, the greatest ROL seen on a vertical test stroke was 3,456 pounds on stroke 12 (V). The greatest ROL seen on a horizontal test stroke was 1,545 pounds on stroke 14 (H).

6.0 REQUIREMENTS, PROCEDURES AND RESULTS (Continued)

6.4 Data Analysis (Continued)

Calculation of the Disk Factor was accomplished using both the Standard Industry and the Nuclear Maintenance Application Center (NMAC) equations. The Stem Factor (Coefficient of Friction - μ) was also calculated. A summary of Disk Factors and Stem Factors is provided. Plots are provided that show trends in the disk and stem factors for both closing and opening strokes. The summary also identifies anomalies found during the analysis. The individual stroke analysis data sheets and their supporting plots further describe the anomalies.

Minimum Available for Stem Thrust (THR1) was determined by finding the difference between the stem thrust at Torque Switch Trip and the stem thrust at Running. Inertia for Stem Thrust (THR1) was determined by finding the difference between the Final stem thrust and the stem thrust at Torque Switch Trip. They are summarized as follows:

Stem Vertical

	Average	Minimum	Maximum
Minimum Available Thrust (lbs)	80,360	77,901	84,294
Inertia on Thrust (lbs)	7,120	6,135	8,299

Stem Horizontal

	Average	Minimum	Maximum
Minimum Available Thrust (lbs)	81,143	77,901	84,294
Inertia on Thrust (lbs)	7,168	6,273	8,673

The results of the analysis of each stroke, including tabularized data and thrust traces, are presented in Attachment I.

7.0 DOCUMENTATION

7.1 Test Log Book

A Test Log Book was maintained; included were a daily description of activities and testing performed, the status of the test specimen, details of all test setups and calibration, specimen handling and setup, installation, and test data summaries. Each stroke was recorded in the log.

7.2 Test Data

All recordings were reviewed for accuracy and quality after each test. The test data were clearly identified with the valve serial number, Wyle job number, test date, customer, stroke number and orientation, remarks, and information required for analysis or retrieval.

All test data are currently recorded on an optical disk cartridge (Panasonic P/N LM-D702W). This disk cartridge holds one gigabyte of test data. Test data have also been transcribed from the optical disk cartridge to three 8-millimeter magnetic data cartridge tapes (3M P/N DC6150).

The disk cartridge and tapes have been labeled and placed in the raw data inventory file pending Entergy disposition instructions.

8.0 PERSONNEL CERTIFICATION

Wyle certifies that all personnel assigned to this test program were qualified for the tasks assigned. Certification is achieved through personnel education levels, vocational training, and practical experience as outlined in ANSI-N45.2.6 and NRC Regulatory Guide 1.58.

9.0 STORAGE AND HANDLING

The test specimen was stored in Wyle Laboratories' Valve Test Facility, a controlled storage area which complies with ANSI-N45.2.2, Level C. While the test specimen was installed in the test system, it was protected from inclement weather by an overhead roof.

On January 23, 1993, following completion of all testing, the test article MOV was removed from the test stand. After removing all instrumentation and power supplies, the actuator was removed from the valve and placed in the box in which it was received. The valve was disassembled, in-place, in the flow loop and the bonnet and stem were removed. The stem was cleaned and shipped to Teledyne Engineering Services on January 31, 1993, after being checked for runout. The valve body was returned to storage at the Valve Test Facility building. On February 17, 1993, following shipping instructions from Entergy, the valve was crated and prepared for shipment.

9.0 STORAGE AND HANDLING (Continued)

On February 19, 1993, the valve and actuator were shipped to Entergy Operations, Grand Gulf Nuclear Plant, without the Teledyne Smart Stem. The Smart Stem will be shipped upon return from Teledyne. This will allow Entergy to start their internal inspection of the valve.

TABLE I

CHRONOLOGICAL SUMMARY OF TEST PROGRAM

November 9, 1992	Test Valve Arrived at Wyle Laboratories
November 11, 1992	Test Valve Receipt Inspection Performed
November 20, 1992	Valve Disassembled
November 23, 1992	Valve Stem Shipped to Teledyne
December 1, 1992	Valve Body Installed in Flow Loop
December 17, 1992	Smart Stem Received from Teledyne
December 18, 1992	Compete Reassembly of Valve
December 21, 1992	Installation of Valve Operator
December 21, 1992	Complete Hydrostatic Test
December 23, 1992	Pre-Test LLRT, Start Pre-Conditioning
December 28, 1992	Completed Pre-Conditioning, Post-Test LLRT, Pressure Lock Check
December 29, 1992	Completed Pressure Lock Test, Post-Test LLRT
December 30, 1992	Trial Run
December 31, 1992	Performed Strokes 1 and 2, Vertical Mode
January 8, 1993	Completed Strokes - Vertical Mode
January 9, 1993	Post-Test LLRT, Reposition Valve - Horizontal Mode
January 11, 1993	Initiate Strckes
January 18, 1993	Post-Test LLRT
January 20, 1993	Completed Strokes - Horizontal Mode
January 22, 1993	Additional Seat Leakage Test
January 23, 1993	Valve Disassembled, Removed From Test Section
January 31, 1	Inspection of Smart Stem
February 19, 1993	Valve Body and Actuator Shipped to Grand Gulf

TABLE II

VERTICAL MODE SUMMARY

Date	Time	Stroke	Pressure	Remarks
12/31/92	12:55	Stroke 01	500	
	15:02	Stroke 02	500	PS1 Saturated (Sat)
1/04/93	11:40	Stroke 03	100	
	11:46	Stroke 04	100	
	14:43	Stroke 05	200	
	16:26	Stroke 06	200	NG -> 6RR
1/05/93	9:18	Stroke 07	300	
	10:40	Stroke 08	300	
	11:56	Stroke 09	400	
	13:47	Stroke 10	400	NG -> 10R
	15:38	Stroke 11	500	
	16:56	Stroke 12	500	NG -> 12R
1/06/93	9:30	Stroke 13	500	
	11:20	Stroke 14	500	
	13:22	Stroke 15	500	
	14:54	Stroke 16	500	PS1 Sat
	16:20	Stroke 17	500	
	17:52	Stroke 18	500	NG -> 18R
1/07/93	8:49	Stroke 19	500	
	10:54	Stroke 20	500	PS1 Sat
	13:23	Stroke 21	400	
	15:17	Stroke 22	400	
	17:06	Stroke 23	300	
	17:18	Stroke 24	800	
1/08/93	8:23	Stroke 25	700	
	8:30	Stroke 26	700	
	10:41	Stroke 27	100	
	10:46	Stroke 29	100	
	13:16	Stroke 06R	200	NG
	14:23	Stroke 10R	400	
	15:25	Stroke 12R	500	PS1 Sat
	19:49	Stroke 18R	500	PS1 Sat

NG = No Good
R = Repeat

TABLE III

HORIZONTAL MODE SUMMARY

Date	Time	Stroke	Pressure	Remarks
1/09/93	10:02	Stroke 01	500	
	11:40	Stroke 02	500	
	13:29	Stroke 03	100	NG
	13:40	Stroke 04	100	NG
	15:19	Stroke 05	200	NG
	15:30	Stroke 06	200	
	16:09	Stroke 07	300	
1/10/93	8:30	Stroke 08	300	(340)
	10:32	Stroke 09	400	
	12:49	Stroke 10	400	NG (300)
	13:35	Stroke 04R	100	(200)
	15:32	Stroke 11	500	
	16:56	Stroke 12	500	
1/11/93	8:48	Stroke 13	500	
	10:16	Stroke 14	500	PS1 Sat & DP2
	11:52	Stroke 15	500	
	14:09	Stroke 16	500	
	15:48	Stroke 17	500	NG
	18:27	Stroke 18	500	
1/12/93	8:09	Stroke 19	500	NG Venturi DP
	11:26	Stroke 19R	500	
	13:02	Stroke 20	500	
	14:46	Stroke 21	400	NG
	16:45	Stroke 22	400	NG
	17:57	Stroke 23	300	
1/23/93	9:18	Stroke 24	300	NG
	9:25	Stroke 25	200	
	11:10	Stroke 26	200	NG
	12:42	Stroke 27	100	
	12:48	Stroke 28	100	
	14:58	Stroke 17R	500	
	15:23	Stroke 26R	200	(100)
	17:19	Stroke 22R	400	NG
	17:35	Stroke 05R	200	
1/14/93	8:37	Stroke 10R	400	
	10:08	Stroke 14R	300	NG
	10:21	Stroke 03R	100	
	12:53	Stroke 24RR	300	NG (250) NG
	12:58	Stroke 23R	400	(370)
	15:22	Stroke 22RR	400	(370)
	15:28	Stroke 24RRR	300	(370)
1/20/93	10:22	Stroke 21R	400	NG
	11:54	Stroke 21R	400	NG
	13:41	Stroke 21R	400	NG
	15:72	Stroke 21R	400	NG
	15:43	Stroke 21R	400	

(XXX) - Achieved Test Pressure

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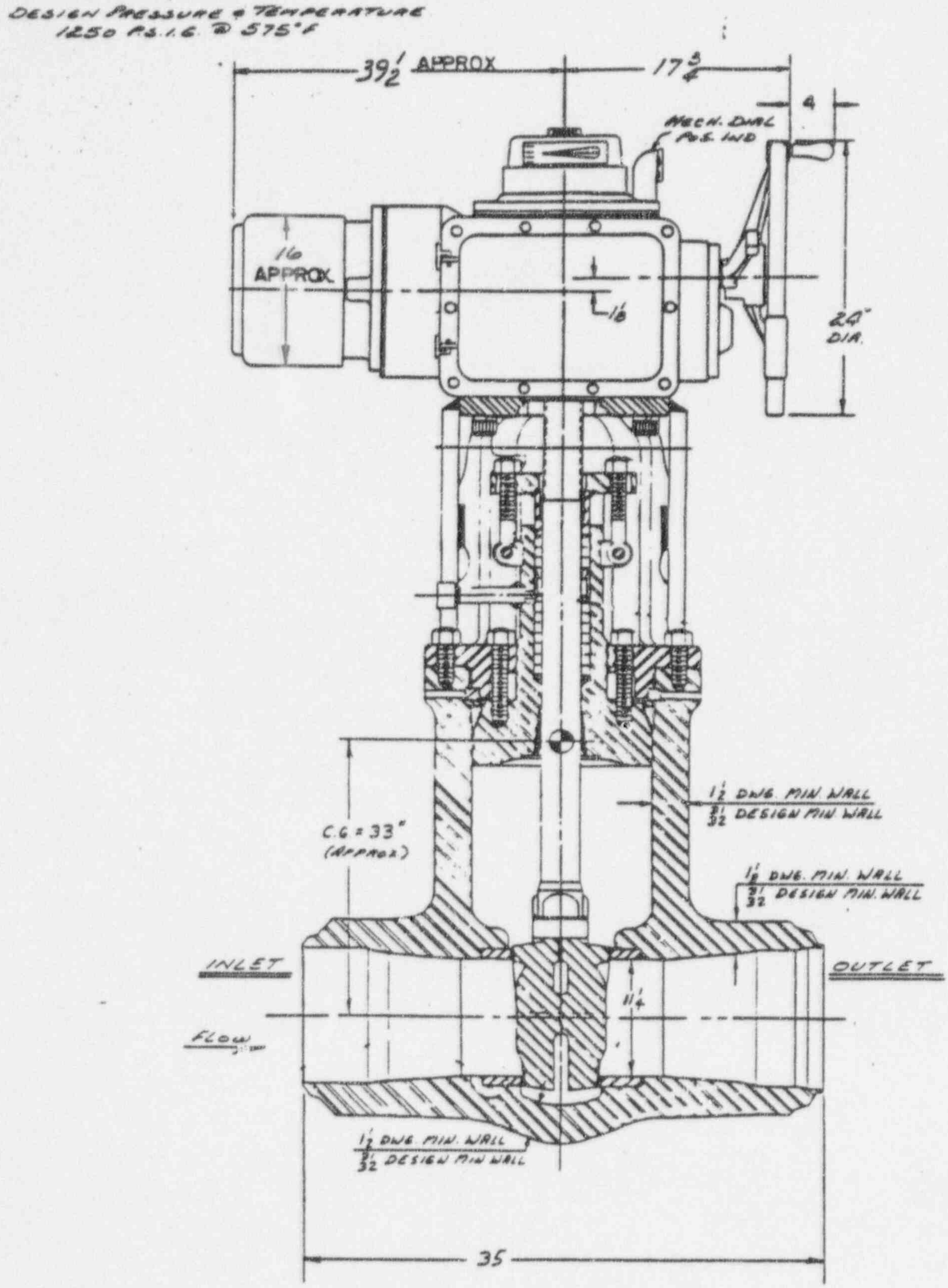

FIGURE 1. TEST SPECIMEN MOV

LIMIT SWITCH CONTACT FUNCTIONS

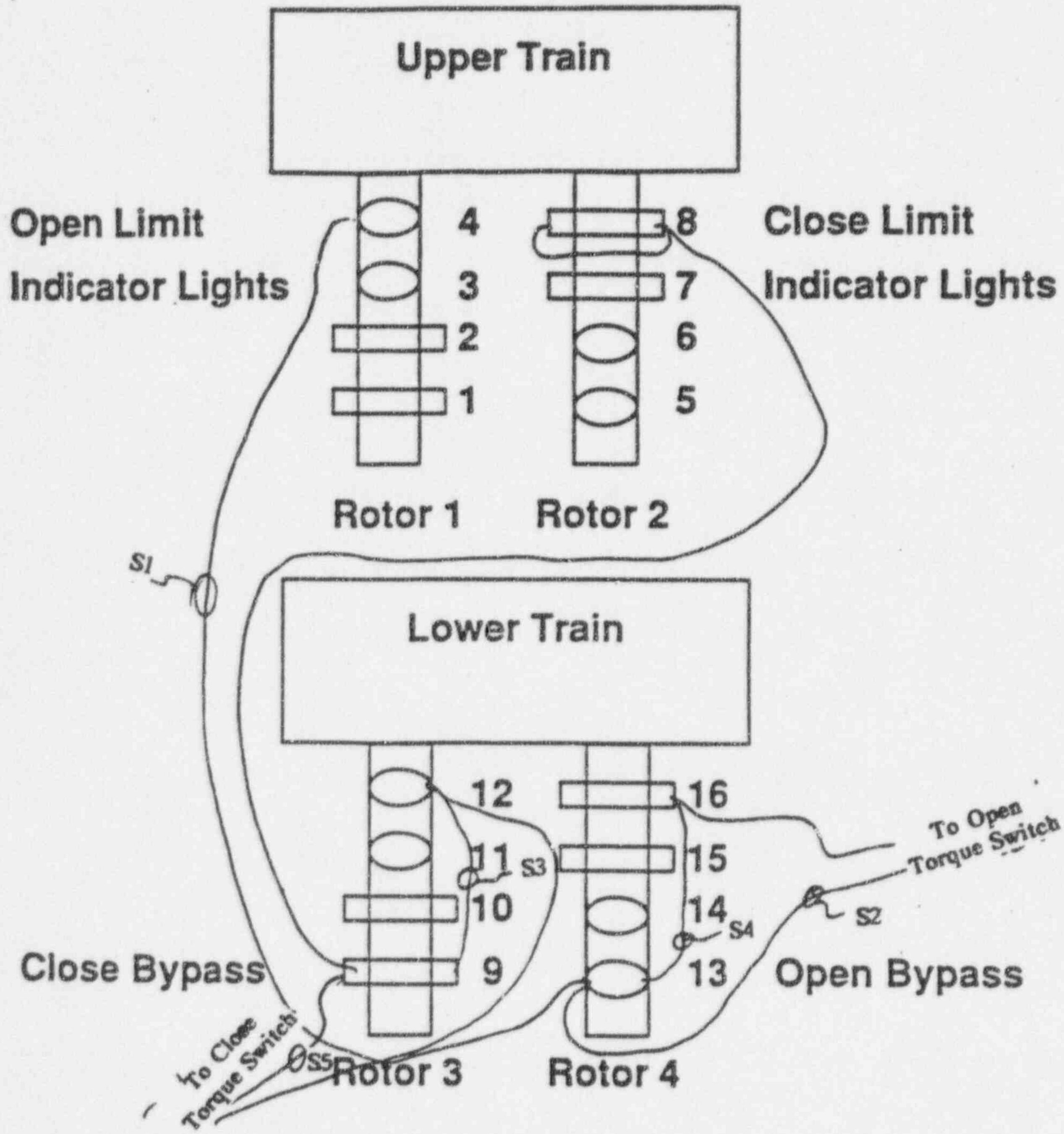

FIGURE 2. MOV CONTROL CIRCUIT WIRING INSTALLATION

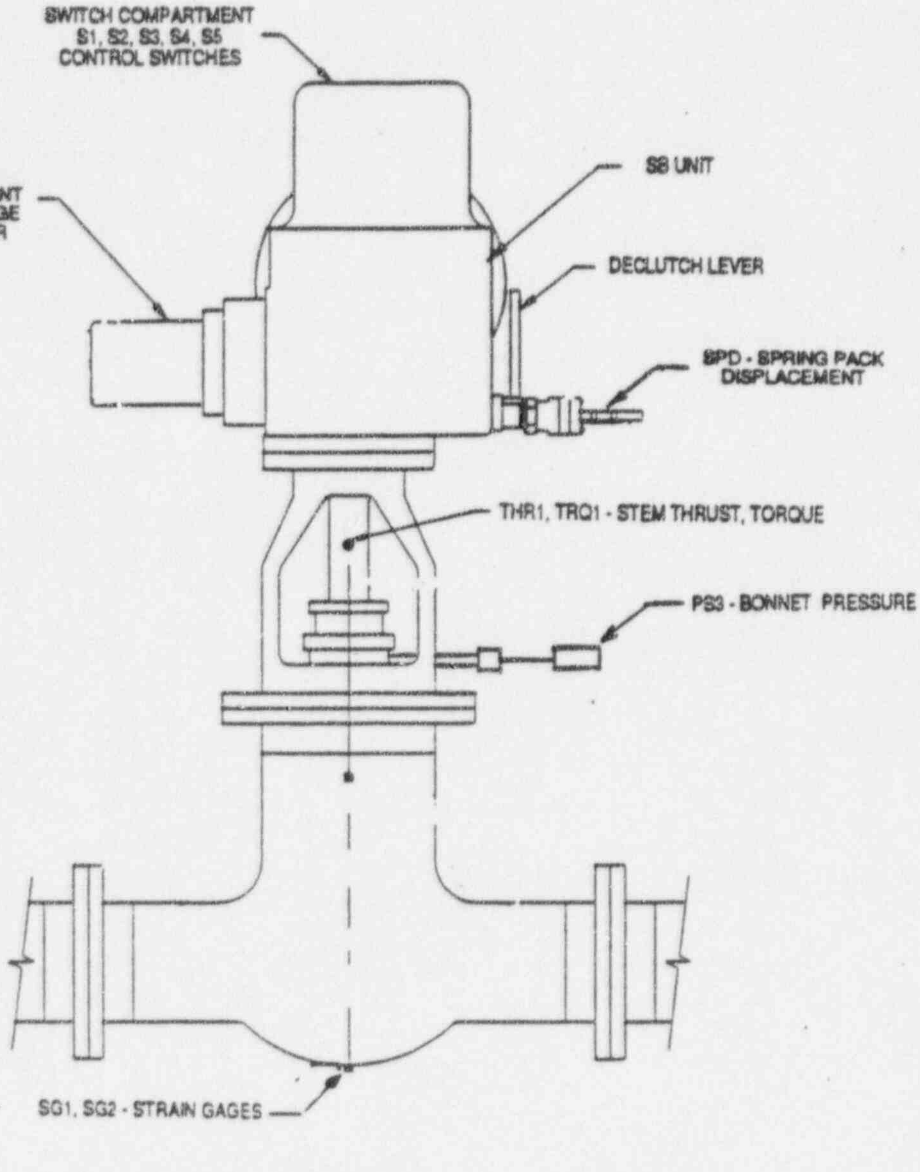

FIGURE 3A. TEST SPECIMEN, MOV INSTRUMENTATION FOR PRESSURE LOCK-UP AND FLOW LOOP DIFFERENTIAL PRESSURE TEST

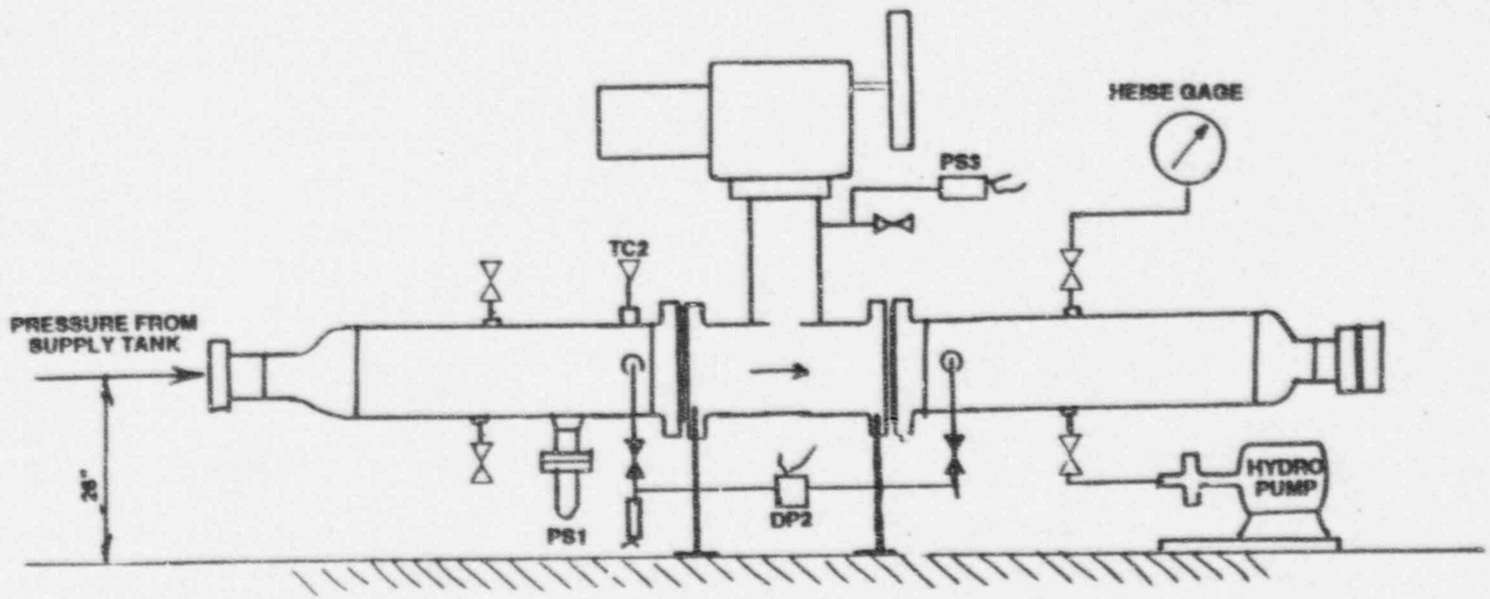

FIGURE 3B. INSTRUMENTATION AND TEST SCHEMATIC, PRESSURE TEST LOCKUP

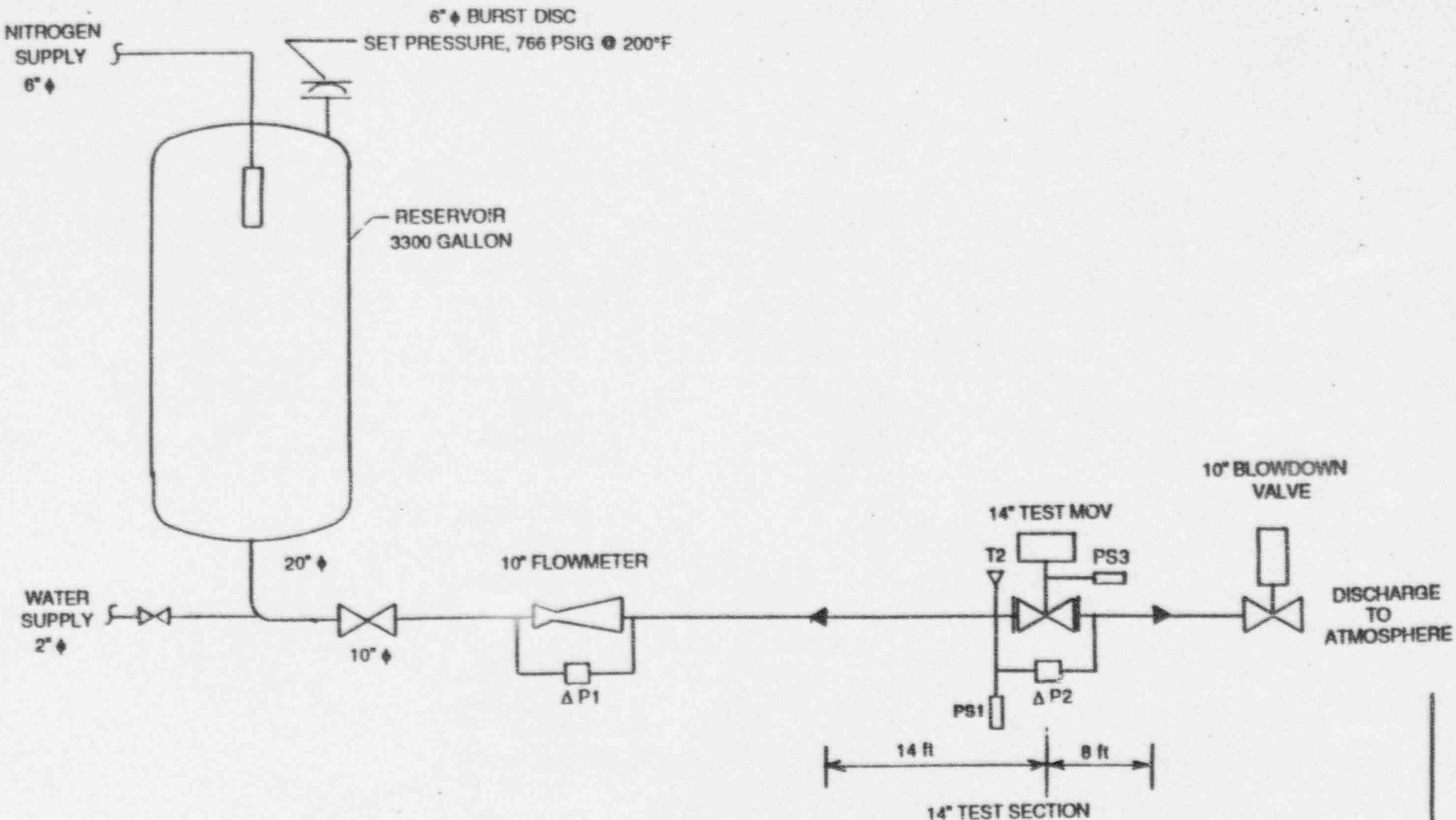

FIGURE 3C. FLOW LOOP INSTRUMENTATION

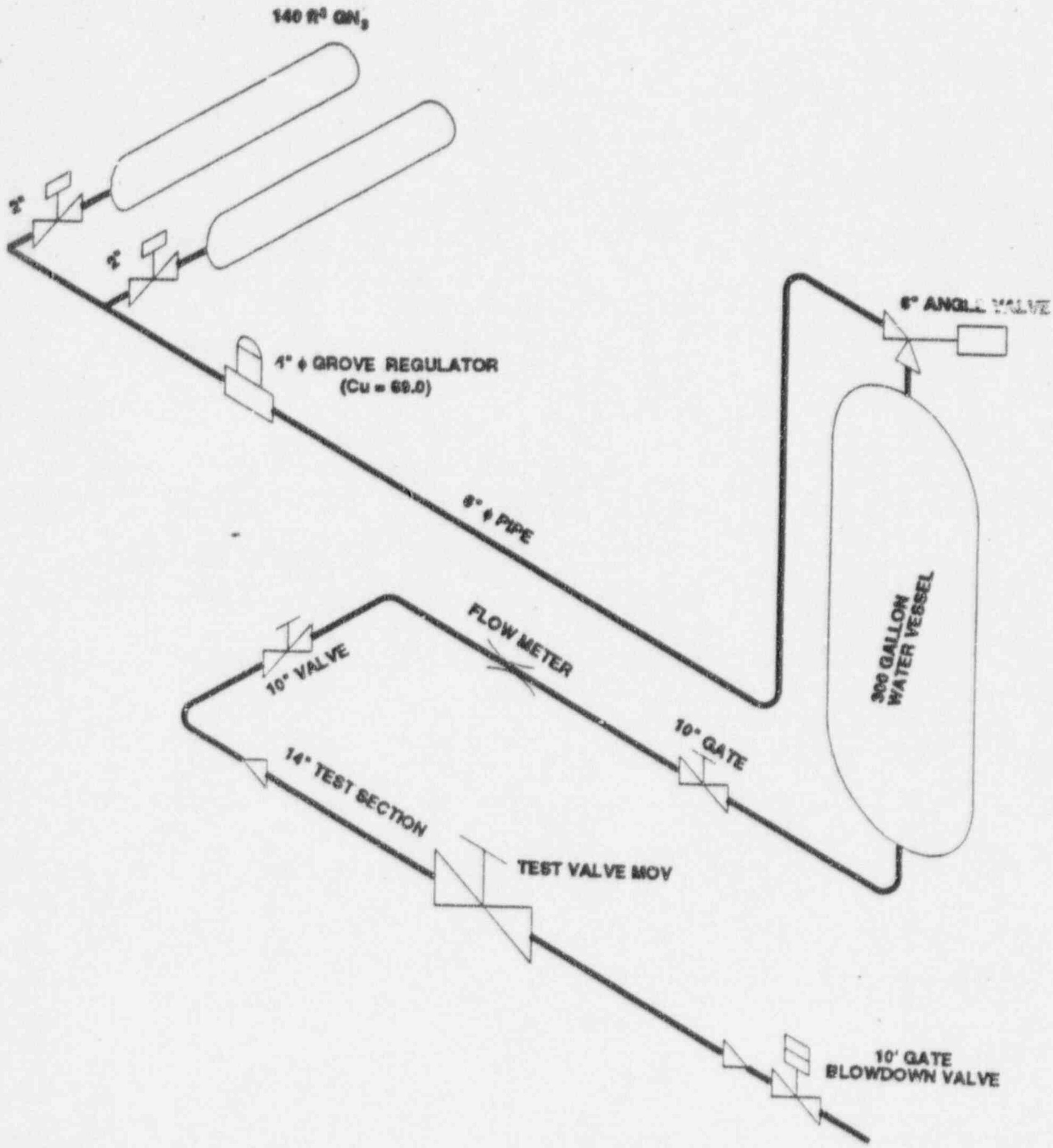

FIGURE 4. FLOW LOOP ISOMETRIC

APPENDIX I

NOTICES OF ANOMALY

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WYLE LABORATORIES

(Eastern Operations)

NOTICE OF ANOMALY

DATE: January 4, 1993

NOTICE NO: 1 P.O. NUMBER: C-1015-28 CONTRACT NO: N/A

CUSTOMER: Entergy Operations (Grand Gulf) WYLE JOB NO: 43008

NOTIFICATION MADE TO: Dave Wilson NOTIFICATION DATE: December 28, 1992

NOTIFICATION MADE BY: G. Carbonneau VIA: Verbal

CATEGORY: ☒ SPECIMEN ☐ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: December 28, 1992

PART NAME: 14-Inch W. Powell Gate Valve PART NO. N/A

TEST: Pressure Lock Test I.D. NO. 67770-6

SPECIFICATION: Wyle Test Procedure 43008 PARA. NO. 6.3.3

REQUIREMENTS:

Test No.		Description
3)	a)	Connect hydrostatic pump to bonnet leak-off line and pressurize bonnet to 1080 psig. With inlet and outlet nozzles at 0 psig, stroke valve open. There will be an immediate drop-off of bonnet pressure upon unseating.

DESCRIPTION OF ANOMALY:

With 1080 psig applied to the bonnet, the valve was energized to stroke open. Torque switch trip occurred almost immediately. The valve would not open and the bonnet pressure remained at 1080 psig.

DISPOSITION - COMMENTS - RECOMMENDATIONS:

It was not possible to open the valve in this condition. Per Grand Gulf instruction, Wyle proceeded with Test Nos. 4) and 5) during which the valve opened against pressure. These results are being reported to Grand Gulf for information.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

PROJECT ENGINEER: G. Carbonneau 1/4/93
G. Carbonneau

TEST WITNESS: Dave Wilson

PROJECT MANAGER: H. Jordan 1/4/93
H. Jordan

REPRESENTING: Entergy Operations

INTERDEPARTMENTAL COORDINATION:

QUALITY ASSURANCE: Duane [signature] 1/4/93

Wyle Form WH 1066, Rev. JAN '85

(pap)

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: February 15, 1993

NOTICE NO: 2 P.O. NUMBER: C-1015-28 CONTRACT NO: N/A

CUSTOMER: Entergy Operations/Grand Gulf WYLE JOB NO: 43008

NOTIFICATION MADE TO: Doug Jones NOTIFICATION DATE: February 11, 1993

NOTIFICATION MADE BY: G. Carbonneau VIA: Telephone

CATEGORY: ☐ SPECIMEN ☐ PROCEDURE ☒ TEST EQUIPMENT DATE OF ANOMALY: 12/31/92-1/11/93

PART NAME: Press. Transducer - PS1 and Diff. Press. Trans. DP2 PART NO. Wyle Nos. 061952 & 021577

TEST: Flow Loop Differential Pressure Test I.D. NO. 10555 & 039101

SPECIFICATION: WLTP 43008 PARA. NO. 7.2

REQUIREMENTS:

7.2 Test Data

All recordings shall be reviewed for accuracy and quality after each test.

DESCRIPTION OF ANOMALY:

Review of recordings resulted in several repeat strokes until desired level of accuracy was obtained. Criteria used was stability of pressure and flow rate during stroking.

During several runs which were accepted as valid runs by test, the valve inlet pressure (PS1) and in one case 14(H), the differential pressure (DP2) exceeded the saturation limit of the transducer/electronic. These runs included:

Vertical (V): Strokes 02, 16, 19, and 20
Horizontal (H): Stroke 11, 13, 15, and 19

DISPOSITION - COMMENTS - RECOMMENDATIONS:

These anomalies occurred during strokes requiring a differential pressure of 500 psig. During these tests, the valve inlet, valve differential, and bonnet pressures rose to values exceeding 590 psig, the electronic saturation of PS1.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: N/A

REPRESENTING: N/A

QUALITY ASSURANCE: R Hamilton 2/23/93

PROJECT ENGINEER: G. Carbonneau 2/22/93
G. Carbonneau, P.E.

PROJECT MANAGER: Herschel Jordan 2/23/93
H. Jordan

INTERDEPARTMENTAL COORDINATION:

APPENDIX II

McPHERSON OIL PRODUCTS' CERTIFICATE OF CONFORMANCE

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McPherson Oil Products

P.O. Box 1803 Decatur, Alabama 35602 (205) 353-3163

Date of Delivery: December 21, 1992

To Whom it may Concern:

The product delivered by McPherson Oil Company on Purchase order # 4-1977 and McPherson Oils Invoice # 92530 to Wyle Laboratories on the 21st day of December 1992 is Mobilux EP 1.

Ray Ward

Ray Ward
McPherson Oil Co.

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APPENDIX III

PHOTOGRAPHS

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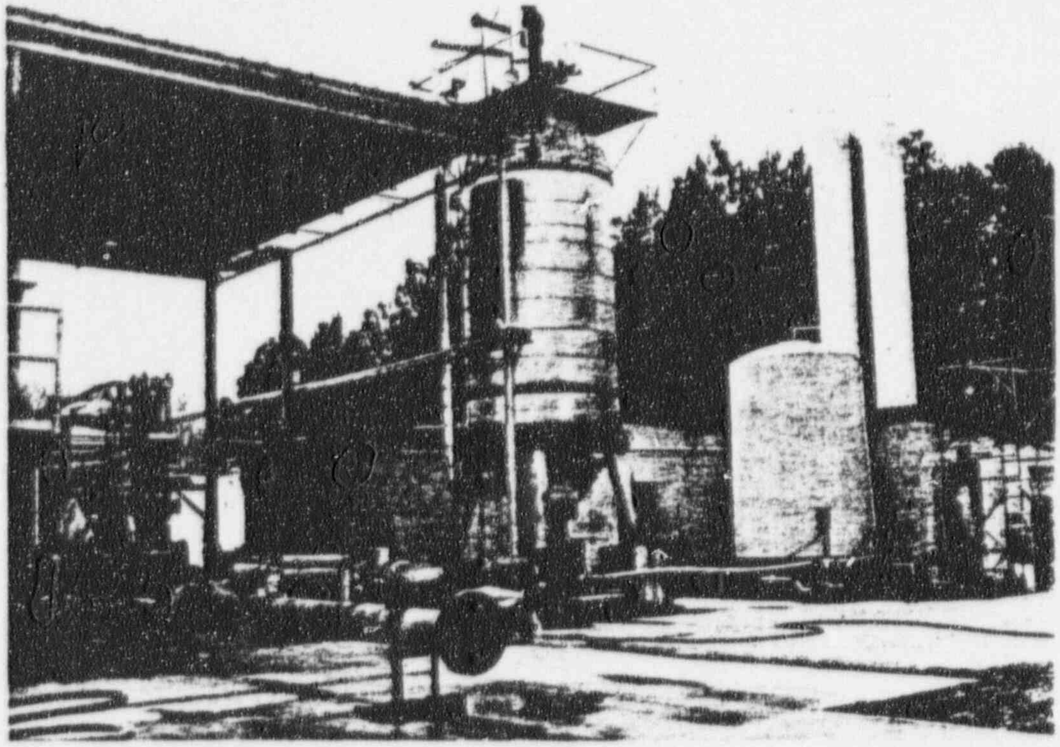
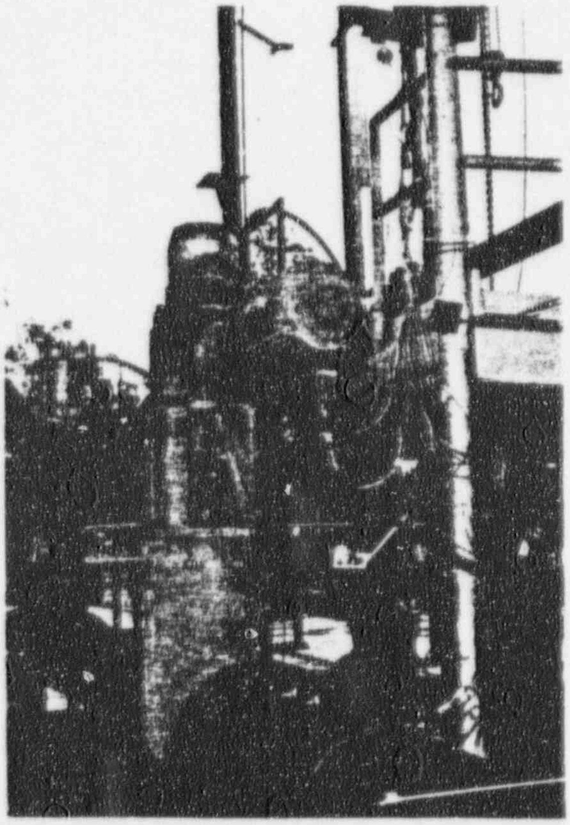


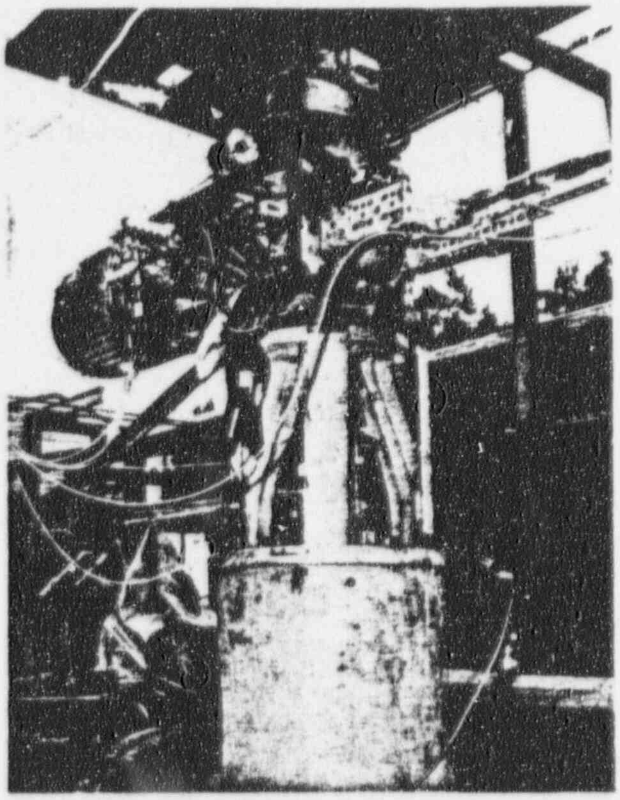
PHOTOGRAPH 1

VIEW OF FLOW LOOP FACILITY



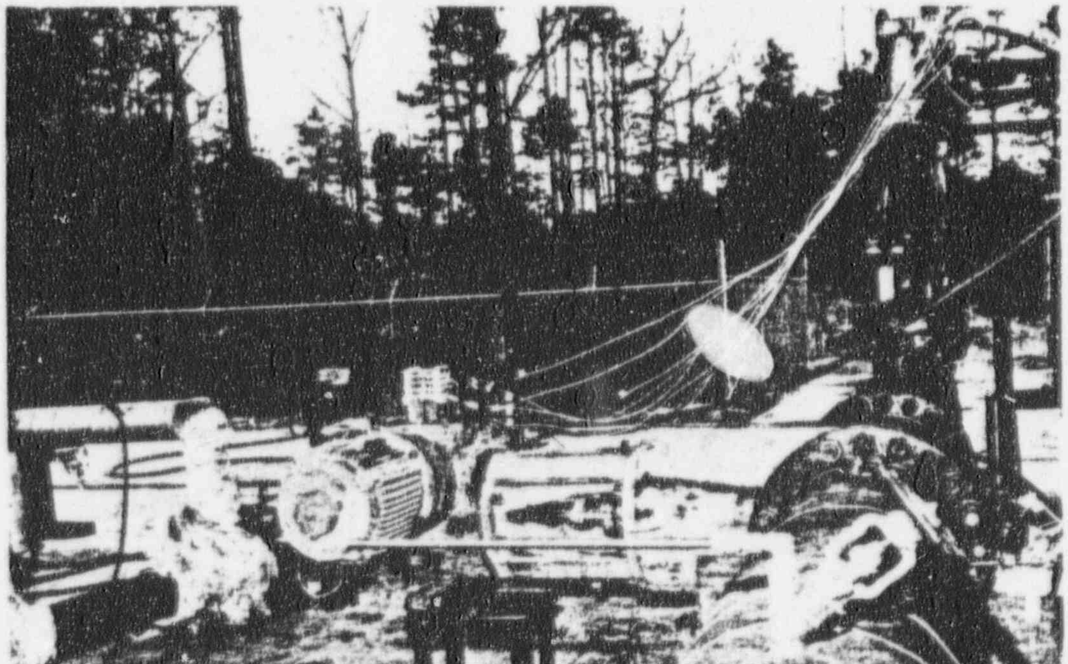
PHOTOGRAPH 2

VALVE INSTALLATION - VERTICAL MODE



PHOTOGRAPH 3

VALVE INSTALLATION - MOV INSTRUMENTATION



PHOTOGRAPH 4

VALVE INSTALLATION - HORIZONTAL MODE

APPENDIX IV

TELEDYNE SMART STEM DATA

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PACKING LIST

P.L. NO: 30829/001	DATE 12/15/92
SHIP TO: Wyle Laboratories 7800 Governors Drive Huntsville, AL 35806 Attn: Sherwyn Hyten	PROJECT NO. 30829 P.O. NO. 4-1727-P SHIP VIA UPS RED [x] PREPAID [ ] COLLECT

QUANTITY	DESCRIPTION	WEIGHT
1	SMARTSTEM^{tm}, S/N 67770-6 with Stem Nut	

REPORT OVERAGE, SHORTAGE, DAMAGE TO PURCHASING AGENT:
TELEDYNE ENGINEERING SERVICES · 10 FORBES ROAD · WOBURN, MA 01801-2103

SPECIAL INSTRUCTIONS, DOCUMENTATION TO BE INCLUDED	RELEASE FOR SHIPMENT	
Certificates of Calibration Certificate of Traceability Certificate of Conformance Bending Data Sheet	QAE [signature]	DATE 12/15/92
	TOTAL VALUE	
	DATE SHIPPED	SHIPPER
	SHIPPER B/L NO.	
	RECEIVED BY	DATE

cc: Project Manager
Purchasing Agent
PQAE

10/92

TELEDYNE
ENGINEERING SERVICES

A DIVISION OF TELEDYNE BROWN ENGINEERING
513 MILL STREET, POST OFFICE BOX 288
MARION, MASSACHUSETTS 02738-0288
(508) 748-0103 FAX (508) 748-2029

December 15, 1992
30829-1

CERTIFICATE OF CONFORMANCE

This will certify that the below identified product was calibrated under the rigid quality requirement of the referenced purchase order and applicable specifications. All direct and associated processing materials have been tested and approved.

All process and testing operations have been verified as acceptable by the Quality Assurance Department in conformance with the requirements of our Quality Program Manual and are certified to meet all general performance specifications of the referenced purchase order. Material has been controlled in accordance with the applicable requirements of 10CFR50, Appendix B and ANSI N45.2. The equipment listed is traceable to the National Institute of Standards and Technology (N.I.S.T.). Documentation in the form of test reports and Certificates of Conformance are on file and available for review upon request.

COMPANY NAME: Wyle Laboratories

PURCHASE ORDER NO.: 4-1727-P

Item No.	Quantity	Description	Serial No.
1	1	SMARTSTEM^{tm}	67770-6

CERTIFIED BY:

F/KMF
Kevin M. Fahey

TITLE: Quality Assurance Manager

DATE: 12/15/92

KMF/lac

TELEDYNE
ENGINEERING SERVICES
A DIVISION OF TELEDYNE BROWN ENGINEERING
513 MILL STREET, POST OFFICE BOX 288
MARION, MASSACHUSETTS 02738-0288
(508) 748-0103 FAX (508) 748-2029

VICES
GINEERING

December 15, 1992
30829-2

)07,
17667,

)07,
17667,

CERTIFICATE OF TRACEABILITY TO
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Client: Wyle Laboratories

Client Order No.: 4-1727-P

Date: December 15, 1992

THIS IS TO CERTIFY THAT:

The equipment listed is traceable to the National Institute of Standards and Technology (N.I.S.T.). Documentation in the form of test reports and Certificates of Conformance are on file and available for review upon request.

Equipment Under Test:

Manufacturer	Item	Serial No.
Teledyne Engineering Services	SMARTSTEM[tm]	67770-6

Test Equipment Used:

Manufacturer	Serial No.	Item	N.I.S.T. Traceability No.
Teledyne Eng. Serv.	0588	Calibration Arm	247931
Fluke	3960089	Digital Multimeter	243273, WWVBTRS, 246764, 243183
BLH	2169	Precision Calibrator	246764, 243273 WWVBTRS
Measurements Group	91105, 98408 89845	Strain Indicator	246764, 243273 WWVBTRS

TELEDYNE ENGINEERING SERVICES

December 15, 1992
30829-3

CERTIFICATE OF CALIBRATION

Project No.: 30829

Client: Wyle Laboratories   Purchase Order No.: 4-1727-P

Type: Torque   Part No.: SMARTSTEM™   Capacity: 30,000 in-lbs   Serial No. 67770-6

Input Resistance: 351 Ω   Output Resistance: 351 Ω at 77°F ± 3°F

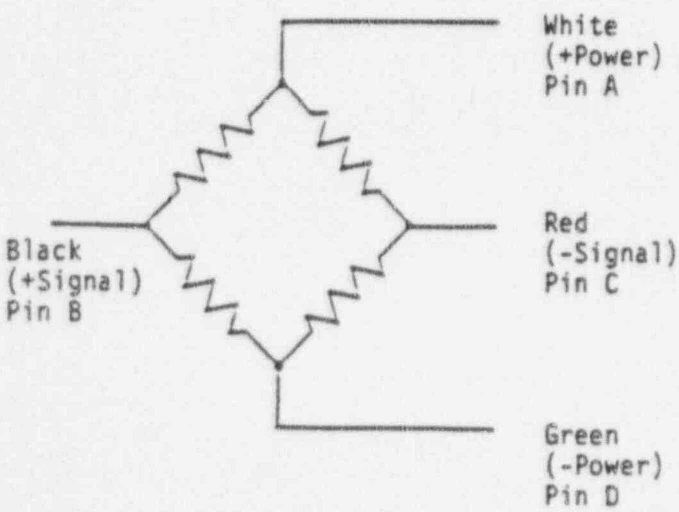
Bridge to Ground Resistance: >10 GΩ   Bridge to Shield Resistance: >10 GΩ

Zero Balance: +0.002 mv/v   Zero Return: <0.03 %   Linearity: <0.15 %

Hysteresis: <0.32 %   Repeatability: <0.06 %   Full Scale Output: +1.7470 mv/v CW, -1.7430 mv/v CCW

Temperature Compensation: <0.0025% F.S./°F

Excitation Voltage: 10 VDC



INPUT (in-lbs)	OUTPUT (mv/v)	
LOAD	CW	CCW
0	0.0000	0.0000
6,000	0.3475	-0.3460
12,000	0.6975	-0.6950
18,000	1.0480	-1.0450
24,000	1.3980	-1.3940
30,000	1.7470	-1.7430
24,000	1.3995	-1.3955
18,000	1.0515	-1.0490
12,000	0.7020	-0.7005
6,000	0.3530	-0.3510
0	0.0005	-0.0005

Certified By: Technician: Douglas S. Brightman [signature] Date: 12/15/92

Engineer: David L. Johnson [signature] Date: 12/15/92

TELEDYNE ENGINEERING SERVICES

December 15, 1992
30829-4

CERTIFICATE OF CALIBRATION

Project No.: 30829

Client: Wyle Laboratories

Purchase Order No.: 4-1727-P

Type: Thrust Part No.: SMARTSTEM[tm] Capacity: 100,000 lbs Serial No. 67770-6

Input Resistance: 351 Ω Output Resistance: 352 Ω at 77°F ± 3°F

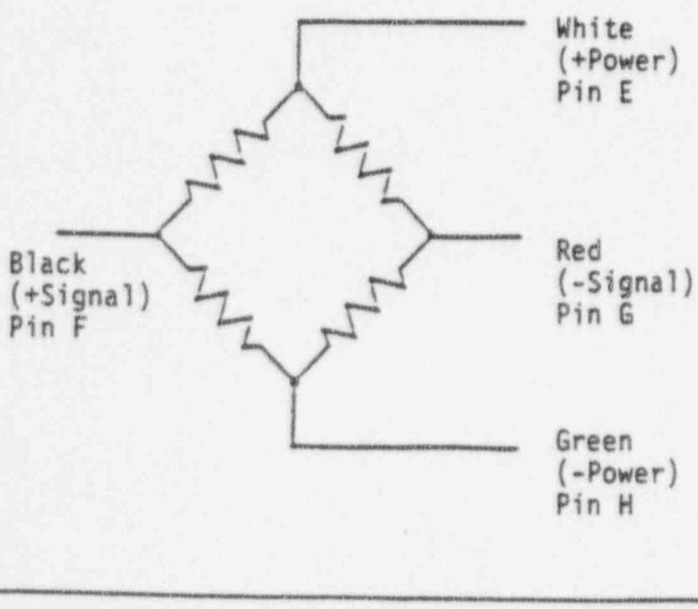
Bridge to Ground Resistance: >10 GΩ Bridge to Shield Resistance: >10 GΩ

Zero Balance: -0.0105 mv/v Zero Return: <0.01 % Linearity: <0.50 %

Hysteresis: <1.09 % Repeatability: <0.46 % Full Scale Output: +1.3870 mv/v Ten. -1.3355 mv/v Comp.

Temperature Compensation: <0.0025% F.S./°F

Excitation Voltage: 10 VDC



INPUT (lbs)	OUTPUT (mv/v)	
LOAD	TENSION	COMPRESSION
0	0.0000	0.0000
20,000	0.2725	-0.2710
40,000	0.5480	-0.5380
60,000	0.8275	-0.8045
80,000	1.1065	-1.0705
100,000	1.3870	-1.3355
80,000	1.1170	-1.0785
60,000	0.8400	-0.8175
40,000	0.5630	-0.5495
20,000	0.2840	-0.2775
0	0.0000	0.0000

Certified By: Technician: Douglas S. Brightman [signature] Date: 12/15/92

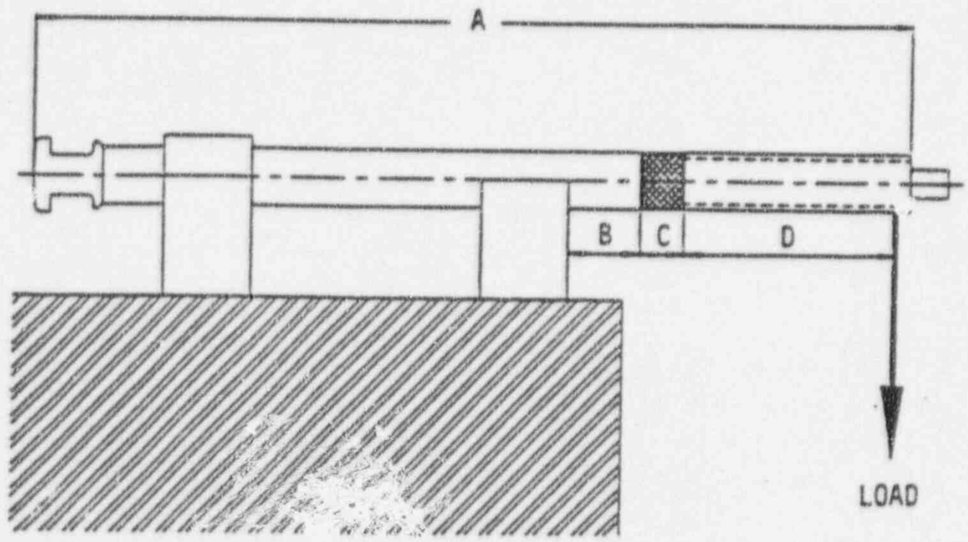
Engineer: David L. Johnson [signature] Date: 12/15/92

TELEDYNE ENGINEERING SERVICES

PROJECT NO.: 30829

DATE: 12-11-92 "as shipped" DJ

SMARTSTEM™ BENDING CHECK



STEM NO.: 67770-6 Load = 50 lbs.

A = 50.5" in. B = 2" in. C = 1" in. D = 21" in.

Full Scale Tension Output = 2774 μ in/in = 1.3870 mv/v @ 100,000 lbs.

Max. Output Due to Bending = 0 μ in/in = 0 mv/v

Corresponding Tension Load Due to Bending 0 lbs.

Percent of Full Scale 0 %

Performed By: [signature] Date: 12-11-92

DATA SHEET

Customer ~~EPRI~~ Entergy

Specimen / SMARTSTEM

WYLE LABORATORIES

Part No.

Spec.

Para.

S/N

GSI

Amb. Temp. N/A

Photo N/A

Test Med. N/A

Specimen Temp. N/A

Job No. ~~61921-00~~ 43008

Report No.

Start Date

Test Title / 67770-6 SMARTSTEM BRIDGE RESISTANCE CHECKOUT

WIRE COLORS	THRUST	TORQUE
BLACK TO WHITE	263.4	263.4
BLACK TO RED	351.6	350.6
BLACK TO GREEN	263.0	262.7
WHITE TO RED	263.3	262.7
WHITE TO GREEN	350.8	350.6
RED TO GREEN	263.4	262.7
ALL TO GROUND	$>2.0\times10^7\Omega$	$>2\times10^7\Omega$
THRUST TO TORQUE	$>2.0\times10^7\Omega$	
CALIBRATION DATA		
INPUT WHITE TO GREEN	351	351
OUTPUT BLACK TO RED	352	351

All readings are within spec

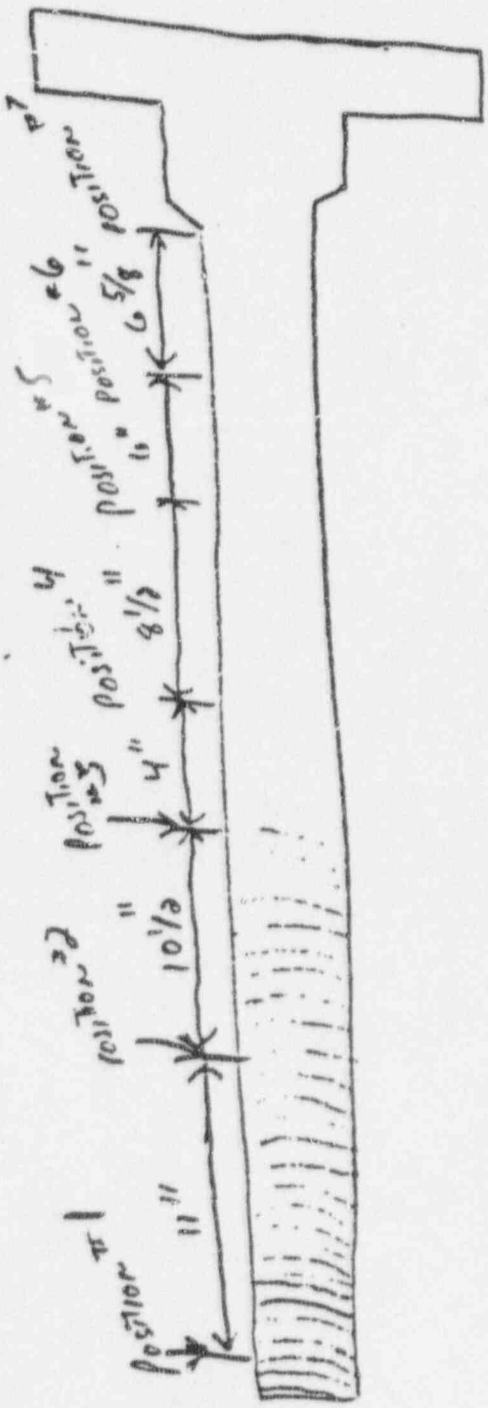
Tested By JH Morgan Date: 12/16/92

Witness Date:

Sheet No. of

Approved Tony Pate 12-16-92

Notice of Anomaly NA


POSITION #1
11"
POSITION #2
10 1/3"
POSITION #3
4"
POSITION #4
8 1/8"
POSITION #5
11"
POSITION #6
6 5/8"
POSITION #7

Name:

	ACTUAL	DEV
X	34.5001	-12.1249
Y	.0006	.0006
Z	-.0014	-.0014
DI	2.2442	2.2442
FM		.0002

ANSI CIRCULAR RUNOUT: To X axis, Radial
#14
Feature #36
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0021	.0021

RUN-OUT POSITION #6
#15
Feature #37
Type: O.D.
Name:

	ACTUAL	DEV
X	40.5000	-6.1250
Y	.0005	.0005
Z	-.0009	-.0009
DI	2.2443	2.2443
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#16
Feature #37
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0015	.0015

RUN-OUT POSITION #7
#17
Feature #38
Type: O.D.
Name:

	ACTUAL	DEV
X	46.6250	.0001
Y	0.0000	0.0000
Z	-.0003	-.0003
DI	2.2474	2.2474
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#18
Feature #38
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0004	.0004

RO			0.0000		.0154	.0154

RUN-OUT POSITION #2
#7
Feature #33
Type: O.D.
Name:

	ACTUAL	DEV
X	11.3210	-35.3039
Y	.0027	.0027
Z	.0043	.0043
DI	2.2481	2.2481
FM		.0004

ANSI CIRCULAR RUNOUT: To X axis, Radial
#8
Feature #33
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0077	.0077

RUN-OUT POSITION #3
#9
Feature #34
Type: O.D.
Name:

	ACTUAL	DEV
X	21.8208	-24.8041
Y	-.0005	-.0005
Z	.0002	.0002
DI	2.2399	2.2399
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#10
Feature #34
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0012	.0012

RUN-OUT POSITION #4
#11
Feature #35
Type: O.D.
Name:

	ACTUAL	DEV
X	25.6250	-20.9999
Y	.0003	.0003
Z	-.0011	-.0011
DI	2.2435	2.2435
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#12
Feature #35
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0015	.0015

RUN-OUT POSITION #5
#13
Feature #36

Part Program: Rev: 00.01

Date and Time: 11/21/92 09:44 Lot ID: 57770-6
Inspector: J B MCCARLEY Supplier/other: ENTERGY

ODA
#1

	ACTUAL	NOMINAL	DEV
X	22.5000	22.5000	0.0000
Y	0.0000	0.0000	0.0000
Z	0.0000	0.0000	0.0000
DI	2.2421	0.0000	2.2421
FM			.0002

ANSI CIRCULAR RUNOUT: To X axis, Radial
#2

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0002	.0002

ODB
#3

	ACTUAL	NOMINAL	DEV
X	46.6250	46.6250	0.0000
Y	0.0000	0.0000	0.0000
Z	0.0000	0.0000	0.0000
DI	2.2473	0.0000	2.2473
FM			.0001

ANSI CIRCULAR RUNOUT: To X axis, Radial
#4

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0001	.0001

RUN-OUT POSITION #1
#5
Feature #32
Type: O.D.
Name:

	ACTUAL	DEV
X	.8235	-45.8015
Y	.0053	.0053
Z	.0089	.0089
DI	2.2459	2.2459
FM		.0013

ANSI CIRCULAR RUNOUT: To X axis, Radial
#6
Feature #32
Type: O.D.

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APPENDIX V

INSTRUMENTATION EQUIPMENT SHEETS

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INSTRUMENTATION EQUIPMENT SHEET

Test Report No. 43008-01

DATE: 12/16/92
TECHNICIAN: J. MORGAN

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: EPRI ROOM
TYPE TEST: SMARTSTEM CHECKOUT

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	DIG MTR	VALHALLA	4150	82123	101040	.02-2KOHM	.02%RDG	10/20/92	04/16/93
2	DIG MTR	FLUKE	77	24869343	101824	DC	.3%	04/02/92	04/02/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION J. Morgan 12/16/92

CHECKED & RECEIVED BY [signature] 12-16-92

Q.A. [signature] 12-16-92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/22/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW GRD 12-23-92
TYPE TEST: HYDROSTAT + PRETEST LLRT

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	STOP WATCH	VWR	62379	N/A	103028	9HR/59MIN/59SEC	.5SEC	09/19/92	03/18/93
2	PRESS GAUGE	HEISE	CM	111137	109427	0-1,500 PSI	.1% FS	12/22/92	06/18/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 12/22/92 CHECKED & RECEIVED BY [signature]

Q.A. Brenda Bannister 12/23/92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/23/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: PRECONDITIONING

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	80i-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	887	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	502197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 12/23/92 CHECKED & RECEIVED BY [signature] 12/28/92

Q.A. [signature] 12-28-92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/28/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: PRESSURE LOCK-UP

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	801-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	B87	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
19	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
21	PRESS XDUCER	CEC	N/A	10555	061952			08/11/92	02/05/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 12/28/92 CHECKED & RECEIVED BY [signature] 12/28/92

Q.A. [signature] 12-28-92

Page No. 61

Test Report No. 43008-01

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/29/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	80i-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	887	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	502197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
19	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
21	PRESS XDUCER	CEC	N/A	10555	061952	0-500PSIA GMC 2/5/93		08/11/92	02/05/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	052564	0- 2,000 PSI	.03%	06/24/92	06/24/93
23	RESISTOR DEC	IET	RS-200	N/A	100955	1-10M OHM	1%	01/20/92	01/19/93
24	PRESS XDUCER	T HYDRONICS	TH-D	039101	021577	0-500 PSID	.5%	07/23/92	01/19/93
25	PRESS XDUCER	CEC	4-351	8562	109360	0-50 PSID	.75% FRO	07/23/92	01/19/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Corinne Duthie 12/29/92

CHECKED & RECEIVED BY G. L. Cole 12/31/92

Q.A. Brenda Baumiller 12/30/92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 01/04/93
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	801-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-C-75	B87	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
19	PRESS XDUCER	B&H ELECTRONICS	6000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
21	PRESS XDUCER	CEC	N/A	10555	061952			08/11/92	02/05/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93
23	RESISTOR DEC	IET	RS-200	N/A	100955	1-10M OHM	1%	01/20/92	01/19/93
24	PRESS XDUCER	T HYDRONICS	TH-D	039101	021577	0-500 PSID	.5%	07/23/92	01/19/93
25	PRESS XDUCER	T.HYDRONICS	TH-D	055403	109837	0-50 PSID	+-0.5%	12/01/92	05/28/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Graeme Duthie 1/4/93   CHECKED & RECEIVED BY [signature] 1/4/93

Q.A. Kevin M Turner 1-8-93

INSTRUMENTATION EQUIPMENT SHEET

DATE: 01/20/93 JOB NUMBER: 43008-00 TEST AREA: HI FLOW
TECHNICIAN: G. DUTHIE CUSTOMER: ENTERGY TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	551605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43886	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	PROBE CURRENT	FLUKE	80i-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
13	LINEAR XDUCER	WATERS	SLF-S-75	B87	108929	0-3 INCH	.1%	01/18/93	07/16/93
14	DATA ACQ SYS	OPTIM	5033A	502197	109469	MFG	MFG	12/01/92	12/01/93
15	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
16	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
17	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
18	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
19	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
20	PRESS XDUCER	CEC	N/A	10555	061952			08/11/92	02/05/93
21	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93
22	RESISTOR DEC	IET	RS-200	N/A	100955	1-10M OHM	1%	01/18/93	01/18/94
23	PRESS XDUCER	T.HYDRONICS	TH-D	055403	109837	0-50 PSID	+-0.5%	12/01/92	05/28/93
24	PRESS XDUCER	T-HYDRONICS	TH-D	048869	021580	0-500 PSID	.5% FRO	01/08/93	07/07/93
25	XFORMER CURRENT	FLUKE	Y8101	N/A	103600	1A-150A	2.5%	01/08/93	07/07/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 1-20-93

CHECKED & RECEIVED BY [signature] 1-20-93

Q.A. [signature] 1/21/93

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APPENDIX VI

BADGER FLOW METER DATA

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Badger Flow Meter

$Q_{gH} = 340.11\ (S)\ (FA)\ (D2)\ (FHM)\ (FGB)\ (FGF)$

where Q_{gH} = Flow (gallons per hour)
S = Orifice factor = 0.71365
FA = Orifice Area Correction Factor = 1.00111
D2 = Pipe I.D. Squared = 82.15609
FHM = Square Root of Differential Pressure (inches of water)
FGB = Base Specific Gravity = 1.01772 $\left(\frac{1}{G_b}\right)$
FGF = Flowing Specific Gravity = 0.99125 $\left(\sqrt{G_f}\right)$

$Q_{gpm} = Q_{gH} \div 60$

$$Q_{gpm} = \frac{340.11}{60}(0.71365)(1.00111)(82.15609)\left(\sqrt{\Delta P_{H_2O}}\right)(1.01772)(0.99125)$$

$Q_{gpm} = 335.6498769 * \sqrt{\Delta P_{H_2O}}$ $IN_{H_2O}^{68°F} = 27.728746 * PSI$

$psi = 0.036063657 * IN_{H_2O}^{68°F}$

$Q_{gpm} = 335.6498769 * \sqrt{\Delta P_{psi} * 27.728746}$

$Q_{gpm} = 335.6498769 * 5.26580915 * \sqrt{\Delta P_{psi}}$

$Q_{gpm} = 1767.468 * \sqrt{\Delta P_{psi}}$

ΔP_{H_2O} 68°F	Flow (gpm)		ΔP psi	Flow (gpm)
719	9000.	=>	25.92976938	9000.173607
704.7	8910.		25.41405909	8910.223079
690.5	8820.		24.90195516	8819.993864
676.5	8730.		24.39706396	8730.122587
7.182	900.0		0.259009185	899.5165163

Badger Meter, Inc.

P.O. BOX 581390
6116 EAST 15th STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 • FAX: (918) 832-9962

DIFFERENTIAL ELEMENT
PRIMARY DATA/CALCULATION SHEET
WATER CALCULATION - VOLUMETRIC FLOW

DATE	11-25-1992
BADGER S.O. NO.	954440
CUSTOMER	WYLE LABS
CUSTOMER P.O. NO.	4-5448-P
USER	
CONSULTING ENGR.	

LO-LOSS DATA

LO-LOSS STYLE	PMT-F	SERIAL NO.	954440-B
NOMINAL SIZE	10	TAG	
THROAT DIA (IN.)	7.695	BODY MATERIAL	CARBON STEEL
BETA RATIO	.849	THROAT MATERIAL	CARBON STEEL
TAP SIZE	1/2		
TAP LOCATION	INTEGRAL	PIPESHELL MATERIAL	CARBON STEEL

DIFFERENTIAL PRESSURE IS 718.95 INCHES OF WATER AT 9000 GPM.
PERMANENT PRESSURE LOSS IS 2.22 % OF DIFFERENTIAL.
PERMANENT PRESSURE LOSS IS 16.01 INCHES OF WATER AT 9000 GPM.

FLUID DATA

FLUID	WATER	OPER. SP. GR.	.98258
OPER. PRES. (PSIA)	514.7	BASE SP. GR.	.98258
OPER. TEMP. (F)	150	OPER. VISC. (CP)	.426
BASE TEMP. (F)	150		

FLOW DATA

MAX. FLOW (GPM)	9000	PIPE REYNOLDS NO.	7219794
NORM. FLOW (GPM)	6300	PIPE REYNOLDS NO.	5053856

CUSTOMER PIPELINE & FLANGE DATA

NOM. PIPE SIZE	10	PIPE MATERIAL	METAL
PIPE SCHED/CLASS	120	PIPE I.D. (IN.)	9.064

APPLICABLE DOCUMENTS

INSTALLATION/APPROVAL	PRODUCTION
______________	______________
______________	______________
______________	______________
______________	______________

REFERENCE FLOW METER ENGINEERING HANDBOOK, C.F. CUSICK, 3RD ED., 1961

CERTIFIED CORRECT BY . DATE

PREPARED BY JIM

Badger Meter, Inc.

P.O. BOX 581390
6116 EAST 15th STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 • FAX: (918) 832-9962

DIFFERENTIAL ELEMENT
SUPPLEMENTARY DATA SHEET
WATER CALCULATION - VOLUMETRIC FLOW

DATE	11-25-1992
BADGER S.O.NO.	954440
CUSTOMER	WYLE LABS
CUSTOMER P.O.NO.	4-5448-P
USER	
CONSULTING ENGR.	

LO-LOSS DATA

LO-LOSS STYLE	PMT-F	SERIAL NO.	954440-B
NOMINAL SIZE	10	TAG	

WORKING EQUATION FOR LIQUID FLOW
GAL/HR AT BASE TEMPERATURE

QGH=340.11(S)(FA)(D2)(FHM)(FGB)(FGF), (EQ 15, PG 95)

QGH = 540000	FHM = 26.8133
S = .71365	FGB = 1.01772
FA = 1.00111	FGF = .99125
D2 = 82.15609	

REYNOLDS NO. EQUATION FOR LIQUID FLOW
GAL/HR AT BASE TEMPERATURE

RD=52.654(QGHA)(GB)/(D)(U), (EQ 20, PG 97)

QGHA = 378000	D = 9.064
GB = .98258	U = .42692

DISCHARGE COEFFICIENT = .68639

Badger Meter, Inc.

P.O. BOX 581390
6116 EAST 15th STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 • FAX: (918) 832-9962

DIFFERENTIAL METER

FLOW VS DIFFERENTIAL CALCULATIONS
ENGLISH UNITS

BADGER S.O. 954440
DATE 11-25-1992
CUSTOMER WYLE LABS
ELEMENT 9.059999 X 7.695 PMT-F LO-LOSS
SERIAL NO(S) 954440-B
TAG INFO.

FLUID WATER
OPER.TEMP.(F) 150
OPER.PRES.(PSIA) 514.7

THROAT I.D.(IN) 7.695
PIPE I.D.(IN) 9.059999

RESOLUTION 1 PERCENT OF MAXIMUM
DIFF.UNITS INCHES OF 68F WATER

FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)
9000.	719.0	8910.	704.7	8820.	690.5	8730.	676.5
8640.	662.6	8550.	648.9	8460.	635.3	8370.	621.9
8280.	608.6	8190.	595.4	8100.	582.4	8010.	569.5
7920.	556.8	7830.	544.2	7740.	531.8	7650.	519.5
7560.	507.3	7470.	495.3	7380.	483.4	7290.	471.7
7200.	460.1	7110.	448.7	7020.	437.4	6930.	426.3
6840.	415.3	6750.	404.4	6660.	393.7	6570.	383.1
6480.	372.7	6390.	362.4	6300.	352.3	6210.	342.3
6120.	332.4	6030.	322.7	5940.	313.2	5850.	303.8
5760.	294.5	5670.	285.3	5580.	276.4	5490.	267.5
5400.	258.8	5310.	250.3	5220.	241.8	5130.	233.6
5040.	225.5	4950.	217.5	4860.	209.6	4770.	201.9
4680.	194.4	4590.	187.0	4500.	179.7	4410.	172.6
4320.	165.6	4230.	158.8	4140.	152.1	4050.	145.6
3960.	139.2	3870.	132.9	3780.	126.8	3690.	120.8
3600.	115.0	3510.	109.3	3420.	103.8	3330.	98.41
3240.	93.16	3150.	88.06	3060.	83.09	2970.	78.28
2880.	73.60	2790.	69.08	2700.	64.69	2610.	60.45
2520.	56.35	2430.	52.40	2340.	48.59	2250.	44.92
2160.	41.40	2070.	38.02	1980.	34.78	1890.	31.69
1800.	28.75	1710.	25.94	1620.	23.28	1530.	20.77
1440.	18.39	1350.	16.17	1260.	14.08	1170.	12.14
1080.	10.34	990.0	8.692	900.0	7.182		

PREDICTED DISCHARGE COEFFICIENT VS CALIBRATED DISCHARGE COEFFICIENT AND 2σ TOLERANCE COMPUTATION FOR LO-LOSS® FLOW TUBES.

SERIAL NO.	SIZE	RATIO	PRED. CD	CALIB. CD	% DEV.	LABORATORY*
32041	2	.704	.799	.7793	.038	ARL
28249	3	.743	.7635	.767	.458	UP
35687-9	4	.717	.76900	.76711	.2449	ARL
39706-1	4	.639	.80239	.80456	.2711	ARL
29088	6	.409	.873	.875	.229	UP
33565-1	6	.773	.74067	.74237	.230	ARL
35687-8	6	.573	.82532	.82433	.1193	ARL
33144	8	.472	.795	.7968	.226	ARL
35688-4	8	.710	.77105	.77034	.0910	ARL
42138-1	8	.459	.85738	.85799	.0707	ARL
42138-2	8	.459	.85738	.85753	.0170	ARL
42146-3	8	.459	.85738	.85407	.3865	ARL
42137-3	10	.612	.81122	.81401	.3445	ARL
42145-1	10	.612	.81122	.80891	.2845	ARL
42145-2	10	.612	.81122	.81260	.1707	ARL
32239B	12	.850	.689	.6886	.379	ARL
32282A	12	.73	.7595	.7598	.039	ARL
32282B	12	.73	.762	.7623	.039	ARL
32282C	12	.73	.768	.7672	.104	ARL
32282D	12	.73	.775	.7747	.038	ARL
32329A	12	.64	.7975	.796	.012	ARL
32329B	12	.64	.800	.8025	.312	ARL
32329C	12	.64	.805	.8061	.136	ARL
32329D	12	.64	.811	.8125	.184	ARL
32378A	12	.56	.8265	.8235	.362	ARL
32378B	12	.56	.828	.8298	.217	ARL
32378C	12	.56	.832	.8307	.156	ARL
32555A	12	.35	.885	.887	.225	ARL
32555B	12	.35	.887	.8886	.180	ARL
32555C	12	.35	.890	.8875	.280	ARL
32555D	12	.35	.893	.893	0	ARL
32557B	12	.47	.857	.8556	.163	ARL
32557C	12	.47	.8585	.8555	.349	ARL
30169	14	.754	.7505	.754	.466	ARL
35687-1	16	.645	.79887	.79944	.0708	ARL
37162-2	16	.584	.82047	.81838	.2543	ARL
29291	18	.768	.7385	.735	.473	UP
27385	20	.622	.8035	.800	.373	ARL
29213	20	.629	.801	.799	.249	ARL
32268	20	.790	.7435	.7427	.180	ARL
33294	20	.798	.73933	.7366	.369	ARL
H37395-1	20	.583	.81569	.81385	.2266	ARL
33751-2	24	.424	.86600	.86559	.0471	ARL
85044C	24	.614	.81004	.81330	.402	ARL
37162-1	30	.742	.75409	.75556	.1953	ARL
80715	30	.750	.74926	.74890	.048	ARL
906-7603	30	.749	.75184	.75112	.0959	ARL
80753	36	.662	.79150	.79260	.139	ARL

NO. OF CALIBRATIONS = 48 = n   2σ = COEFFICIENT TOLERANCE = ± .4915%

$$\sum_{i=1}^{n} (\%\ DEV_i)^2 = 2.89248$$

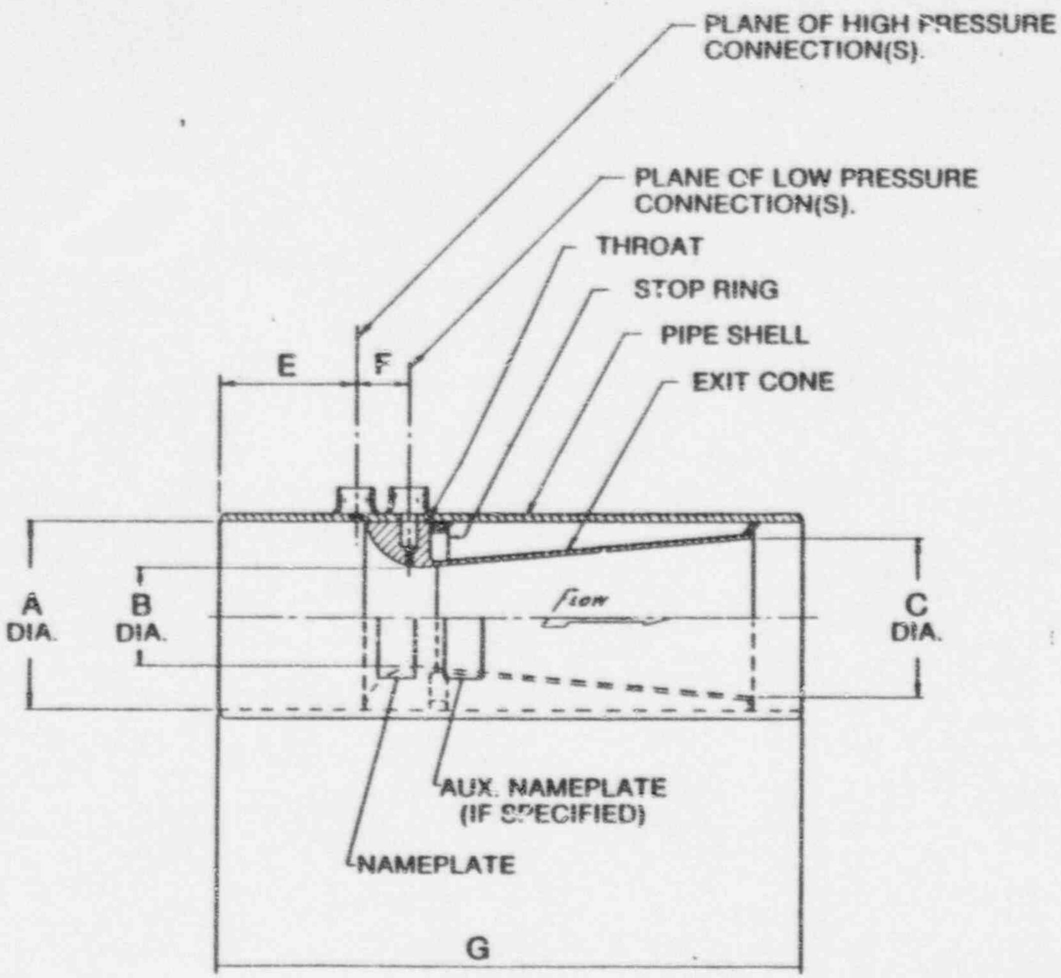
* ARL - ALDEN RESEARCH LABORATORIES, HOLDEN, MASS.

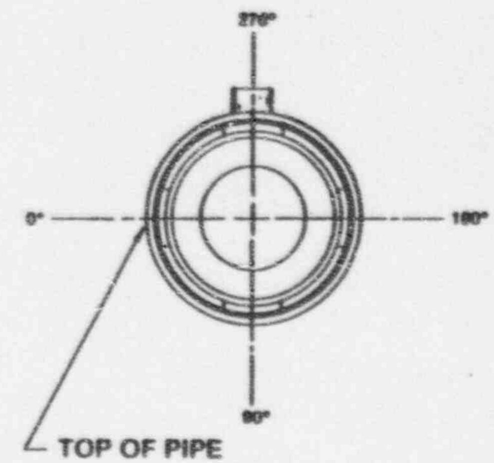
UP - UNIVERSITY OF PENNSYLVANIA

$$\sigma = \sqrt{\sum_{i=1}^{n} (\%\ DEV_i)^2 / n-1} = .24807$$

Badger Meter, Inc. Precision Products Division
6116 East 15th Street, Tulsa, Oklahoma 74112
(918) 836-8411

CD-950525 | 0.1





NOTE:
FOR DIMENSIONS, MATERIALS OF CONSTRUCTION AND ALL OTHER PERTINENT INFORMATION REFER TO DATA SHEET FURNISHED WITH THIS DWG.
IN HORIZONTAL PIPE RUNS INSTALL TUBE SO THAT THE WORD "TOP" ON THE NAMEPLATE IS AT THE TOP OF THE PIPE.

BADGER METER, INC.	
PNT-F 7" Butt Weld End Solid Throat	
Installation Dimensions	
01 — 9-6-79	CD-950525 01

Chapter II-V

Tolerances

II-V-1 Tolerances, Their Significance. Except by accident, no two meters, even of the same type, are likely to give *exactly* the same indication when the same quantity of fluid is flowing through each. The degree to which this applies is not the same for all types of meters, applying least to the displacement types and more to the differential-pressure types. For this reason, "tolerances" are assigned to the values of the factors entering into the metering of fluids. (The expressions, "limit of accuracy" or "per cent uncertainty," might well be substituted for "tolerance.") Tolerances have to do with those practically unavoidable differences between ostensibly duplicate primary elements. They do *not* refer to accidental errors of observation, concerning which no general predictions are possible.

In any one measurement, the probability is very small that the departures from 100 per cent accuracy in the individual items will all affect the final result in the same direction; hence, from mathematics, the overall tolerance will be the square root of the sum of the squares of the tolerances on (departures of) the individual factors. In other words, an overall tolerance determined in this way is the most probable amount of departure from the actual quantity, with there being as much chance that the departure will be smaller than larger than this amount.

II-V-2 There have been a number of procedures used for evaluating or assigning tolerances with the result that the per cent uncertainty assigned to an item by one worker has not been exactly comparable to that assigned by another to the same item. In order to provide a uniform basis for assigning numerical values to tolerances, the committee on Fluid Flow Measurement of the International Organization for Standardization (ISO/TC-30) has adopted the following procedure:

1. The numerical value of a tolerance shall be twice the standard deviation.
2. The standard deviation is to be computed as follows: Sum up the squares of the deviations with respect to *the most probable value;* divide by the number of observations minus one; take the square root of this quotient.

This procedure has been followed in evaluating the tolerances given in this edition of *Fluid Meters*. The *most probable values* of the discharge coefficients of square-edged orifices are, to date, the values computed by equations (II-III-1) through (II-III-6), or read from Tables II-III-2, II-III-3 and II-III-4. Similarly, for flow nozzles used with pipe-wall taps, the most probable values are those computed by equation (II-III-12) or read from Table II-III-5. For low-ratio nozzles with the downstream tap in the throat, the most probable values are those read from the curve of Fig. II-III-19. For Venturi tubes, the most probable values are given in Pars. I-5-35 and II-III-42.

The tolerance values given in Tables II-V-1 and II-V-2 are those recommended as applying to uncalibrated primary elements. When a primary element is calibrated, the tolerance to be used should be computed from the calibration data by the procedure described above.

II-V-3 Prior to the editing of the fifth edition of *Fluid Meters*, tolerance values given by this committee and also by the Gas Measurement Committee of the American Gas Association in their Report

No. 3 were not derived by an evaluation of the standard deviation. Instead, the arithmetic average of the departures of the test values from the correlation curves was computed, and this value, without being doubled, was reported as the tolerance for the particular item. It is of interest that those arithmetic average values are very close to the values of σ obtained in the recent correlation, which is the basis for some of the tolerances given here [1].

II-V-4 The application of the tolerances in the tables and the computation of the overall tolerance to which the measurement of the flow of a fluid may be subject are illustrated by two examples. In doing this the extent or power to which the separate factors affect the total tolerance is taken into account.

Item	*Tolerance (per cent)*	*Effect Factor*	*Square*
Tolerance for Example II-IV-2			
Orifice diameter, d	± 0.08	2	0.0256
Differential pressure, h_w	± 0.25	½	0.0156
Evaluation of density, ρ_1	± 0.50	½	0.0625
Coefficient, C	± 1.1	1	1.21
Expansion factor, Y_1	± 0.5	1	0.25
Area factor, F_a	± 0.02	1	0.0004
			1.5641
Overall tolerance	± 1.25		
Tolerance for Example II-IV-6			
Throat diameter, d	± 0.08	2	0.0256
Differential pressure, h_w	± 0.10	½	0.0025
Value of density, ρ	± 0.10	½	0.0025
Coefficient, C	± 0.70	1	0.49
			0.5206
Overall tolerance	± 0.72		

II-V-5 As may be seen from these examples, the overall tolerance will always be greater than that of the item having the largest tolerance. To say this another way, the final result of a flow-measurement computation cannot be more exact or have a smaller per cent uncertainty than the factor having the greatest uncertainty. Thus, where one factor, usually the coefficient, has a tolerance ranging from ± 0.4 to ± 4.0 per cent, the use of numbers with four to six significant digits does not imply a corresponding high degree of exactness. The use of so many digits improves the agreement between two or more computers and aids in the "rounding off" of the final result.

Reference

[1] "A Statistical Approach to the Prediction of Discharge Coefficients of Concentric Orifice Plates," R. B. Dowdell and Yu-Lin Chen; *Trans. ASME, Journal of Basic Engineering*, vol. 92, no. 3, Sept. 1970.

APPENDIX VII

LOGBOOK

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WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-28-92	127-Tae	[illegible] CO, [illegible]	B430081	003	Para. 6.3.3 Test # 3: a, b
	Failed	[illegible] Channel			Pressure in bonnet
					caused torque trip
12/29/92	—	—	B430081	004	PRE-BAL
12/29/92	—	—	B430081	005	BALANCE [illegible] piping
12/29/92	—	C-O	"	006	6.3.3 step 4 [illegible] 5 torque switch tripped [illegible] 3 [illegible]
12/29/92	—	C-O	"	007	Change of torque switch @ 1.5 repeat of above test
12/29/92	—	C-O	"	008	Changed torque switch [illegible] 1.6 repeat of above test
12/29/92	—	C-O	"	009	Changed torque switch [illegible] 7 repeat of above test
~~"~~			~~"~~	~~010~~	
12-29-92			C43008	001	PRE BAL No Flow NO PRESSURE
12-29-92			C43008	002	BALANCE
12-30-92			C43008	003	Pre Bal
12-30-92			C43008	004	Balance
12-30-92			C430081	001	PRE BAL Added PSI
12-30-92			C430081	002	Balance
12-30-92			C430081	003	Practice Flow Run
12-31-92			C430081	004	Pre Bal
12-31-92			C430081	005	Balance
12-31-92		C→O	C430081	006	Stroke #1 500 psid 9000 GPM

Establish Flow Rate

Position 2.38

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-31-92		O→C	C430081	007	Stroke #2 500 psid 9000 GPM
1-4-93			Replaced	DP1	
1-4-93			C430082	001	Prebal
1-4-93			C430082	002	Balance Valve at lost head pressure
1-4-93			C430082	003	Rebalance
1-4-93		C→O ~~O→C~~	C430082	004	Stroke #3 ~~Fail~~ 100 psid 4000 GPM
1-4-93		O→C	C430082	005	Stroke #4 100 psid 4000 GPM
1-4-93		C→O	C430082	006	Stroke #5 200 psid 5500 GPM
1-4-93			C430082	007	Prebal
1-4-93			C430082	008	Balance Zero ΔP1
1-4-93		O→C	C430082	009	Stroke #6 200 psid 5500 GPM
1-5-93		C→O	C430082	010	STROKE #7 300 PSID 7000 GPM
1-5-93		O→C	C430082	011	STROKE #8 300 PSID 7000 GPM
1-5-93		C→O	C430082	012	STROKE #9 400 PSID 8000 GPM
1-5-93		O→C	C430082	013	STROKE #10 400 PSID 8000 GPM
1-5-93		C→O	C430082	014	STROKE #11 500 PSID 9000 GPM
1-5-93		O→C	C430082	015	STROKE #12 500 PSID 9000 GPM
1-6-93		C→O	C430082	016	STROKE #13 500 PSID 9000 GPM
1-6-93		O→C	C430082	017	STROKE #14 500 PSID 9000 GPM
1-6-93		C→O	C430082	018	STROKE #15 500 PSID 9000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-6-93		O-C	C430082	019	STROKE #16 500 PSID 9000 GPM
1-6-93		C-O	C430082	020	STROKE #17 500 PSID 9000 GPM
1-6-93		O-C	C430082	021	STROKE #18 500 PSID 9000 GPM
1-7-93		C-O	C430082	022	STROKE #19 500 PSID 9000 GPM
1-7-93		O-C	C430082	023	STROKE #20 500 PSID 9000 GPM
1-7-93		C-O	C430082	024	STROKE #21 400 PSID 8000 GPM
1-7-93		O-C	C430082	025	STROKE #22 400 PSID 8000 GPM
1-7-93		C-O	C430082	026	STROKE #23 300 PSID 7000 GPM
1-7-93		O-C	C430082	027	STROKE #24 300 PSID 7000 GPM
[illegible]		C-O	C430082	028	STROKE #25 200 PSID 5500 GPM
1-8-93		O-C	C430082	029	STROKE #26 200 PSID 5500 GPM
1-8-93		C-O	C430082	030	STROKE #27 100 PSID 4000 GPM
1-8-93		O-C	C430082	031	STROKE #28 100 PSID 4000 GPM
1-8-93		O-C	C430082	032	STROKE #6R 200 PSID 5500 GPM REPEAT OF TEST #6
1-8-93		O-C	C430082	033	STROKE #10R 400 PSID 8000 GPM " #10
1-8-93		O-C	C430082	034	STROKE #6RR 200 PSID 5500 GPM REPEAT OF TEST #6R
1-8-93		O-C	C430082	035	STROKE #12R 500 PSID 9000 GPM REPEAT OF TEST #12
1-8-93		O-C	C430082	036	STROKE #18R 500 PSID 9000 GPM " #18
1-11-93			D43008	001	Pre Balance
1-11-93			D43008	002	Bal Check

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-11-93		C-O	D43008	003	STROKE #1 500 PSID 9000 GPM
1-11-93		O-C	D43008	004	STROKE #2 500 PSID 9000 GPM
1-11-93		C-O	D43008	005	STROKE #3 100 PSID 4000 GPM
1-11-93		O-C	D43008	006	STROKE #4 100 PSID 4000 GPM
1-11-93		C-O	D43008	007	STROKE #5 200 PSID 5500 GPM
1-11-93		O-C	D43008	008	STROKE #6 200 PSID 5500 GPM
1-11-93		C-O	D43008	009	STROKE #7 300 PSID 7000 PSID GPM
1-12-93		O-C	D43008	010	STROKE #8 300 PSID 7000 PSID GPM
1-12-93		C-O	D43008	011	STROKE #9 400 PSID 8000 GPM
1-12-93		O-C	D43008	012	STROKE #10 400 PSID 8000 GPM
1-12-93		O-C	D43008	013	STROKE #4R 100 PSID 4000 GPM (REPEAT OF STROKE #4)
1-12-93		C-O	D43008	014	STROKE #11 500 PSID 9000 GPM
1-12-93		O-C	D43008	015	STROKE #12 500 PSID 9000 GPM
1-13-93		C-O	D43008	016	STROKE #13 500 PSID 9000 GPM
1-13-93		O-C	D43008	017	STROKE #14 500 PSID 9000 GPM
1-13-93		C-O	D43008	018	STROKE #15 500 PSID 9000 GPM
1-13-93		O-C	D43008	019	STROKE #16 500 PSID 9000 GPM
1-13-93		C-O	D43008	020	STROKE #17 500 PSID 9000 GPM
1-13-93		O-C	D43008	021	STROKE #18 500 PSID 9000 GPM
1-14-93		C-O	D43008	022	STROKE #19 500 PSID 9000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
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DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-14-93		C-O	D43008	023	STROKE #19R 500 PSID 9000 GPM (REPEAT OF STROKE #17)
1-14-93		O-C	D43008	024	STROKE #20 500 PSID 9000 GPM
1-14-93		C-O	D43008	025	STROKE #21 400 PSID 8000 GPM
1-14-93		O-C	D43008	026	STROKE #22 400 PSID 8000 GPM
1-14-93		C-O	D43008	027	STROKE #23 300 PSID 7000 GPM
1-15-93		O-C	D43008	028	STROKE #24 300 PSID 7000 GPM
1-15-93		C-O	D43008	029	STROKE #25 200 PSID 5500 GPM
1-15-93		O-C	D43008	030	STROKE #26 200 PSID ~~4000~~ 5500 GPM
1-15-93		C-O	D43008	031	STROKE #27 100 PSID 4000 GPM
1-15-93		O-C	D43008	032	STROKE #29 100 PSID 4000 GPM
1-15-93		C-C	D43008	033	STROKE #17R 500 PSID 9000 GPM
1-15-93		O-C ~~C-O~~	D43008	034	STROKE # ~~23~~ 26R 200 PSID 4000 GPM
1-15-93		C-C	D43008	035	STROKE #22R 400 PSID 8000 GPM
1-15-93		C-O	D43008	036	STROKE #5R 200 PSID 5500 GPM
1-16-93		O-C	D43008	037	STROKE #10R 400 PSID 8000 GPM
1-16-93		O-C	D43008	038	STROKE #24R 300 PSID 7000 GPM
1-16-93		C-O	D43008	039	STROKE #3R 100 PSID 4000 GPM
1-16-93		O-C	D43008	040	STROKE #24RR 300 PSID 7000 GPM
1-16-93		C-O	D43008	041	STROKE #23R 300 PSID 7000 GPM
1-16-93		C-C	D43008	042	STROKE #22R 400 PSID 8000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-16-93		O-C	D43008	043	STROKE# 24RRR 300 PSID 7000 GPM
			changed valve Dp...		
1-20-93			D430081	001	Pre balance
1-20-93			D430081	002	Balance
1-20-93		C-O	D430081	003	STROKE #21R 400 PSID 8000 GPM
1-20-93		C-O	D430081	004	STROKE# 21R 400 PSID 8000 GPM
1-20-93		C-O	D430081	005	STROKE# 21R 400 PSID 8000 GPM
1-20-93		C-O	D430081	006	STROKE #21R 400 PSID 8000 GPM
1-20-93		C-O	D430081	007	STROKE #21R 400 PSID 8000 GPM

WYLE LABORATORIES

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DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
"	~~18/19~~ 36/37	O-C C-O	"	004	Cycle 10
"	[illegible]	OC - CO	"	005	Cycle 15
"	46/47	OC - CO	"	006	Cycle 20 → trip dropped to ≈ 73,000 lb
"	56/57	OC - CO	"	007	Cycle 25 → ≈ 72,000 lb trip → ≈ 71,000 lb trip
"	66/67	OC - CO	"	008	Cycle 30 → 70,500 lb trip
	76/87 (77) 86/87	OC - CO	"	009	Cycle 35 →
12-28-92			A430083	010	Pre bal
12-28-92			A430083	011	Balance
12-28-92	96/97	O→C & C→O	A430083	012	cycle 40
12-28-92	106/107 ~~96/97~~	O→C & C→O	A430083	013	cycle 45
12-28-92	116/117 ~~106/107~~	O→C & C→O	A430083	014	cycle 50
12-28-92			B43008	001	Pre-Bal
12-28-92			B43008	002	Balance
~~12-28-92~~			~~B43008~~	~~003~~	~~¶ 6.3.3 Test #1 a,b,c~~
	118 closed for LLRT				
12-28-92	119	Partial C→O	~~B430081~~		Zero Thrust & Torque
12-28-92	120-121-122	O→C & C→O	B430081	001	Torque Switch Settings
	123	C→O			adjust torque switch
12-28-92	124-125-126	OC, CO, OC	B430081	002	Para. 6.3.3 Test #1: a,b,c

A 430083 SETUP BUT NOT LOCKED

WYLE Laboratories

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

001 Prebalance
002 Balance

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-22-92	1	Partial O→C	A43008	003 ~~001~~ SDL	Torque switch Setting -56,000 lb ≈1 on close
12-22-92	2	Partial C→O	A43008	004 ~~002~~ SDL	2250 lb
12-22-92	3	Partial O→C	A43008	005 ~~003~~ SDL	≈1.5 -79900 lb
12-22-92	4	Partial C→O	A43008	006 ~~004~~ SDL	- 2422 lb
12-22-92	5	Partial O→C	A43008	007 ~~005~~ SDL	≈1.6 -79500 lb
12-22-92	6	Partial C→O	A43008	008 ~~006~~ SDL	2514 lb
12-22-92	7	Partial O→C	A43008	009 ~~007~~ SDL	≈1.7 -83400 lb
12-22-92	8	Partial C→O	A43008	010 ~~008~~ SDL	2560 lb
~~12-22-92~~	~~9~~	~~O→C~~	~~A43008~~	~~011~~	≈1.8 NEW TEST DEF DUE TO ≈1200 lb ZERO -OFFSET
12-22-92	—	—	A430081	001	PRE-BAL
11	—	—	11	002	BAL
11	9	O→C	11	003	≈1.8 AFTER BAL. -86,900 lbs TORQUE ≈82,000 lbs 1A ASSIGN
11	10	C→O	11	004	+1360 lbs
12.23.92	11	O→C	—	—	CLOSE VALVE FOR LEAK CHECK
12.23.92	12	~~[illegible]~~	A430082	001	Reset of MCI F.S. ~~PRE-BAL~~ BAL SAME PRE BAL AS BEFORE
11	~~13~~	C→O	—	—	OPEN TO OPEN LIMIT TO START PRE-COND
11	14/15	O-C C-O	A430082	002	PRE-COND cycle 1 CURRENT MCI OVER RANGE
11	16/18 22/23 11 ~~[illegible]~~ 20/21	—	A430083	001	PRE-BAL
11	—	—	11	002	BAL
11	~~[illegible]~~ 26/27	O-C C-O	11	003	PRE-COND cycle 5

APPENDIX VIII

WYLE LABORATORIES' TEST PROCEDURE NO. 43008

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
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TEST PROCEDURE NO. 43008

DATE: November 16, 1992

Revision A: 12/01/92
Revision B: 12/09/92
Revision C: 02/19/93

FLOW LOOP DIFFERENTIAL PRESSURE AND PRESSURE LOCK TESTS ON A 14-INCH WILLIAM POWELL GATE VALVE FOR ENTERGY OPERATIONS, INC. GRAND GULF NUCLEAR STATION

(pap)

APPROVED BY: Troy Parks 11-16-92
FOR: T. Parks

APPROVED BY:
FOR:

APPROVED BY:
FOR:

APPROVED BY PROJECT MANAGER: P. Turrentine 11/16/92
P. Turrentine

APPROVED BY QUALITY ENGINEER: R. G. Thomas 11-17-92
R. G. Thomas

PREPARED BY PROJECT ENGINEER: G. R. Carbonneau 11/16/92
G. R. Carbonneau

REVISIONS

FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	12/01/92	Page 7, Para. 6.2.4	GC	P.T. 12/2/92	Changed Quick Stem Sensor to "Smart"
				T.P. 12/2/92 RGT 12-3-92	Stem Sensor. Added Power Meter.
A	12/01/92	Page 8, Table	GC	P.T. 12/2/92	Revised Table to show Teledyne "Smart"
				T.P. 12/2/92	Stem, Ohio Semitronics, and Micro-
				RGT 12-3-92	Measurements.
A	12/01/92	Page 9	GC	P.T. 12/2/92	Added strain gage statement.
				T.P. 12/2/92 RGT 12-3-92	Dropped pressure transducer.
A	12/01/92	Page 21	GC	P.T. 12/2/92	Added Motor Power to Figure.
				RGT 12-3-92	
A	12/01/92	Page 22	GC	P.T. 12/2/92	Changed Figure to make consistent
				T.P. 12/2/92 RGT 12-3-92	with Table 1.

Test Report No. 43008-01

REVISIONS

Page 1a
Test Procedure No. 43008

REVISION. B

PROCEDURE NO. 43008

DATE: December 9, 1992

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

REV.NO.	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
B	12/9/92	All	GRC		Complete revision of procedure
					due to sequence of test being
					changed, and additional require-
					ments, per the direction of
					Entergy Operations.
C	2/19/93	Page 3	GRC		Added reference between 2.1 and
					2.2 and renumbered remaining
					references accordingly.
C	2/19/93	Page 5, Section 6.1	GRC		Deleted item 3), changed item 10),
					and renumbered items and
					references to items accordingly.
C	2/19/93	Page 6, Section 6.2.2	GRC		Changed 6.3.3 to 6.3.5.
C	2/19/93	Page 7, Section 6.2.2	GRC		Added "(HTP)" after hydrostatic
					test pressure.
C	2/19/93	Page 7, Section 6.2.4	GRC		Deleted the word variable and
					removed the "V" from "LVDT."
C	2/19/93	Page 10, Section 6.2.6	GRC		Changed 74,000 to 80,000; 84,000
					to 90,000; and 74,000 to 86,000.
C	2/19/93	Page 10, Section 6.3.1	GRC		Added "Static Break-In Test" and
					rearranged items in series.
C	2/19/93	Page 11, Section 6.3.2	GRC		Added "A post-static ... in
					Section 6.3.1."
C	2/19/93	Page 12, Section 6.3.4	GRC		Deleted "/Inspection" from
					heading.
C	2/19/93	Page 13, Section 6.3.8	GRC		Changed 6.3.3 to 6.3.5.
C	2/19/93	Page 16, Section 7.2	GRC		Changed "data" to "date."
C	2/19/93	Page 19, Figure 1	GRC		Replace with new figure.

REVISION B

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to present the test requirements, objectives, procedures, and equipment to be used to test a 14-Inch Flex Wedge Gate Valve and Actuator for Entergy Operations, Inc., Grand Gulf Nuclear Station.

The test objectives are:

- Observe and record the operational performance of this valve test specimen during opening and closing at various flow rates and differential pressures as specified in this procedure.
- Study the impact of pressure lockup on the test specimen.

2.0 REFERENCES

2.1 Entergy Operations' Contract No. C-1015-28, dated October 30, 1992.

2.2 Engergy Operations' Letter GEXO:92-00743, dated December 21, 1992. C

2.3 Wyle Laboratories' Quality Assurance Program Manual, dated June 1988.

2.4 Wyle Laboratories' Technical Proposal No. 544/1671/CP, dated October 14, 1992.

2.5 Nuclear Regulatory Commission Regulation 10 CFR 21.

2.6 American National Standard ANSI N45.2.2.

2.7 ASME/ANSI Code for Power Piping B31.1. C

3.0 QUALITY ASSURANCE

All work performed on this test program shall be controlled in accordance with Wyle Laboratories' Quality Assurance Program Manual dated June 30, 1988, approved by Entergy Operations and per the customer's Purchase Order. Wyle's QA program complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N45.2 and applicable regulatory guides.

4.0 TEST EQUIPMENT AND INSTRUMENTATION

4.1 Calibration of Test Equipment and System Calibration

All instrumentation, measuring, and test equipment used in the performance of this test program shall be calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

All test equipment shall be calibrated on a periodic basis, with the calibration interval displayed on a decal. This decal is affixed to the equipment and indicates the last calibration date, the next calibration due date, accuracy, and by whom calibrated.

4.0 TEST EQUIPMENT AND INSTRUMENTATION

4.2 Measurements and Tolerances

Unless specified otherwise, the tolerance on test condition measurements shall be as follows:

Measurement	Tolerance
Pressure	± 1% F.S.
Temperature	± 2°F
Flow Rate	± 5%
Current	± 2%
Voltage	± 1%
Time	± 0.25 sec
Stem Torque/Thrust (Teledyne)	± 1.0%
Displacement, Spring Pack	± 0.52%
Motor Power	± 3%

5.0 TEST SPECIMEN

The test specimen is a Motor-Operated Valve (MOV) Assembly consisting of one 14-inch diameter, 600 pound class, carbon steel flex wedge gate valve with operator as follows:

Valve:
William Powell Valve Company
1250 psi at 575°F (Design Pressure/Temperature)
Serial No. 67770-6, Year 1981
Purchase Order No. 9645M242.0
Item 8.02B, Job 9645
Tag SQ-14-EBA-GTF-MO-FO42B-ALPWY
Class 1
Valve Cv = 9240 gpm with a corresponding K = 0.235

The stroke time of the MOV is approximately 19 seconds.

Operator:
Limitorque Rat. 43.87
Type SB Size 3 150 ft-lb motor
Order 384616B Serial 258077
Valve 14 193-2-4100
2291158 772c
Purchase Order No. 9645-M-242.0
Item 8.02B, Job 9645
Tag SQ-14 EBA-GTF-MO-FO42B-ALPWY

5.0 TEST SPECIMEN (Continued)

The test specimen MOV will be supplied by Entergy Operations, Inc., Grand Gulf Nuclear Station, with welded flanges, ANSI B16.5 14-inch, 600 pound class, raised face. The test specimen MOV upstream and downstream nozzles are Pipe Schedule 30 and 80, respectively. The flange bolt hole pattern is with one bolt hole at top dead center of the valve.

6.0 REQUIREMENTS AND PROCEDURES

6.1 Test Sequence

The test specimen MOV shall be subjected to the following test sequence:

1) Receive and uncrate MOV.
2) Perform inspection for damage.
3) Install actuator on valve.
4) Install motor on actuator.
5) Assemble and connect protective control circuit.
6) Install instrumentation on valve and actuator.
7) Set up diagnostic equipment.
8) Adjust torque and limit switch settings such that measured thrust in both directions matches that measured in service.
9) Perform pre-test LLRT, static break-in testing, and post-static break-in testing LLRT.
10) Set up MOV and diagnostic equipment for pressure lock testing.
11) Perform pressure lock testing.
12) Perform flow loop testing in the vertical orientation.
13) Rotate MOV to the stem horizontal orientation.
14) Repeat flow loop testing of Step 12 for horizontal orientation.
15) Remove diagnostic equipment from MOV.
16) Remove valve, actuator and motor from the test stand and ship components back to Grand Gulf Nuclear Station.
17) Prepare written report.

6.2 Pre-Test Preparation

6.2.1 Receipt Inspection/Disassembly

Wyle will receive and uncrate the test specimen MOV valve, actuator, and motor at Wyle's Steam Valve Test Facility. Shipment will be initially surveyed prior to any other inspection for radioactive contamination by Wyle's radiation safety officer or his representative.

Wyle QA will perform a receiving inspection in accordance with Wyle's normal receiving procedures, checking all parts for damage, tagging parts, and signing documentation. Any and all damage will be immediately reported to Entergy Operations, Inc.

The Wyle project engineer will record all nameplate and other data into the Project Test Logbook. This data will be compared to that stated in Entergy Operations, Inc. Contract Order and Statement of Work.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.1 Receipt Inspection/Disassembly (Continued)

The test specimen shall be disassembled in accordance with the William Powell Company Valve Manual, supplied by Entergy Operations. The valve stem shall be removed and shipped to Teledyne for the Smart Stem installation. During reassembly, the stem threads shall be lubricated with Mobilux EP1. All subsequent relubrication shall be pre-approved by the Entergy Operations' Program Manager and shall be documented in the Log Book.

6.2.2 Valve Installation and Orientation

The test specimen MOV shall be installed and oriented in Wyle's Hot Water Blowdown System Flow Loop as follows:

- The valve stem will be vertical.
- The Schedule 30 nozzle will be facing upstream.
- The test section piping will be horizontal.

Installation and torque-up of bolts shall be performed using Wyle's standard procedures. Fourteen-inch flexitallic type gaskets and ASTM A193 B7 bolting shall be used.

The valve inlet Schedule 30 nozzle shall be protected from over-pressurization. Since there is a direct line of communication from the system 3000-gallon reservoir and the valve inlet, the reservoir 6-inch rupture disc will be utilized to provide protection. A Fike rupture disc rated at 766 psig, 200°F, shall be installed prior to flow loop differential pressure testing of Section 6.3.5 of this procedure being performed. The rating is based on the maximum allowable working or design pressure of 14-inch, Schedule 30, pipe flange joint per ASME/ANSI B31.1, Code for Power Piping. See Appendix I for calculations. C

Wyle will perform a pre-test hydrostatic test of the flanges welded by Entergy Operations, Inc. to the test specimen MOV. The basis for hydrostatic testing is ANSI/ASME B31.1, Code for Power Piping, Section 137.3.4.

137.3.4 Required Hydrostatic Test Pressure

Piping systems shall be subjected to a hydrostatic test pressure so that every point in the system is not less than 1.5 times the design pressure, but shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, pumps, or valves, in the system.

137.3.5 Hydrostatic Test Pressure Holding Time

The hydrostatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct the examinations for leakage.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.2 Valve Installation and Orientation (Continued)

The hydrostatic test pressure (HTP) shall be:

HTP = 1.5 x 766 psig = 1149 psi

which is less than the 1250 psi rating of the William Powell gate valve.

6.2.3 Actuator Installation and Wiring

The actuator shall be mounted on the valve using Limitorque mounting procedures regarding installation and torque-up of mounting bolts. Bolting is 8 each 7/8"-9 high strength socket head cap screws.

The MOV electric motor shall be mounted on the actuator using Limitorque mounting procedures. Bolting is 4 each 5/8"-11 high strength cap screws with lock washers.

Power supply and control circuit wiring shall be installed and wired as shown in Figure 1, Limitorque procedures, and Wyle standard procedures. Thermal overload settings will be as provided by Entergy Operations.

6.2.4 Instrumentation Installation

The required measurements and instruments are listed in Table I.

Spring pack displacement shall be measured using a Waters Longfellow linear displacement transducer (LDT). The LDT shall be mounted on a bracket attached to the spring pack cartridge cap. A hole will be drilled through the cap to connect the LDT rod to the spring pack lock nut.

Stem thrust and actuator output torque shall be measured using a Teledyne "Smart Stem Sensor" transducer assembly. This is essentially strain gages mounted to the valve stem. Teledyne will calibrate the Smart Stem Sensor and furnish a calibration certificate.

Motor power will be measured using an Ohio Semitronics Transformer Module. Current and voltage of this 3-phase, 480 volt AC motor will be measured using a Fluke ammeter and an Ohio Semitronics voltmeter.

The operator control circuitry and switch position shall be monitored by using clamp-on ammeter probes on the open and close torque switches, open limit, open and close by pass switches.

TABLE I

INSTRUMENTATION

Designation	Measurement	Range	Instrument	Accuracy
SPD	Spring Pack Displacement	0-1 inch	Waters SLF-W-75-D-1	0.1% FS
THR1	Stem Thrust	100 K lb	Teledyne Smart Stem	0.5%
TRQ1	Actuator Output Torque	2450 ft-lb	Teledyne Smart Stem	0.5%
S1	Switch Open Limit	150 amps	Fluke Y8101	2.5% F + 0.15a
S2	Switch Open Torque	150 amps	Fluke Y8101	2.5% F + 0.15a
S3	Switch Close Torque	150 amps	Fluke Y8101	2.5% F + 0.15a
S4	Switch Close Bypass	150 amps	Fluke Y8101	2.5% F + 0.15a
S5	Switch Open Bypass	150 amps	Fluke Y8101	2.5% F + 0.15a
MP	Motor Power	80,000 watts	Ohio Semitronics PC11063	0.5% FS
MC1	Motor Current	600 amps	Fluke VT801-600	2%
MV1	Motor Voltage	600 VAC	Ohio Semitronics	0.5% F50
TC2	Valve Inlet Temperature	1000°F	Medtherm, Type K	± 2°F
PS3	Valve Bonnet Pressure	1000 psi	CEC 5500	± 0.25% FRO
DP2	Valve Differential Pressure	1000 psid	T-Hydronics TH-D	± 0.25% FRO
DP1	Flowmeter Differential Pressure[1]	100 psid	T-Hydronics TH-D	± 0.25% FRO
FL1	Flowrate[1]	9000 gpm	Badger, Lo-Loss	± 0.75%
SG1	Valve Body Displacement	30,000 μ-in./inch	Micro-Measurements Model CEA-06-125	± 0.5%
SG2	Valve Body Displacement	30,000 μ-in./inch	Micro-Measurements Model CEA-06-125	± 0.5%

NOTE: 1) Flowrate shall be calculated using data and Badger Flowmeter equations.

WYLE LABORATORIES
Huntsville Facility

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.4 Instrumentation Installation (Continued)

Pressure and differential pressure measurement shall be by using CEC Model 5500 or Teledyne Taber Models 2217, 2104, or 206 pressure transducers. These are strain gage type pressure sensors of ± 0.25% accuracy full scale (F.S.). These instruments are conditioned by full bridge signal conditioning amplifiers.

The MOV test medium (water, 150-200°F) temperature shall be measured using a "K-type" thermocouple probe located upstream in close proximity to the test specimen inlet.

Valve body displacement shall be measured using Wyle installed strain gages at the locations shown in Figure 2. The strain gages shall be Micro-Measurements' (Model CEA-06-125) rosette biaxial foil strain gages, installed with M-Bond AE-10/15 adhesive using Wyle Procedure 85-12.

Flow rate shall be measured using a 10-inch diameter Venturi flowmeter manufactured by Badger Corporation. Signal output is provided by a differential pressure transducer mounted on the flowmeter used with Badger published equations to calculate the flow rate.

Figure 3 presents a schematic drawing of the test article instrumentation.

6.2.5 Data Acquisition System

The Data Acquisition System (DAS) will consist of a MEGADAC 5033A System driven by an IBM 486 host computer. This system will acquire test and diagnostic data and provide preliminary display and printout of selected data channels using a Hewlett-Packard Laser Jet Printer. The DAS will generate a tape cartridge data file for detailed data reduction and analysis.

6.2.6 Actuator Switch Settings and Adjustment

Prior to any testing or stroking of the valve, actuator switches shall be set as follows:

Torque switch and limit switch settings provided by Entergy Operations, Inc. are as follows:

- The open limit switch shall be set at 90% of open to prevent backseating the valve.
- The open torque bypass switch shall be set to bypass the open torque switch during the first 20% of travel in the opening direction.
- The close torque bypass switch shall be set to bypass the close torque switch during 95% of travel in the closing direction. The close torque switch shall be operational during the final 5% of opening.
- The open torque switch shall be set so as to limit opening thrust at the torque switch trip between 37,565 and 67,185 pounds.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.6 Actuator Switch Settings and Adjustment (Continued)

- The close torque switch shall be set so as to limit closing thrust at torque switch trip (TST) between 80,000 and 90,000 pounds. The current TST setting at Grand Gulf Nuclear Station, Unit 1, is approximately 86,000 pounds. Since thrust continues to increase following TST due to inertia, the torque switch shall be adjusted to assure that total thrust does not exceed 97,850 pounds. C

Torque switch settings shall be verified using Wyle diagnostic test equipment.

6.3 Tests

6.3.1 Pre-Test LLRT

An LLRT Leakage Rate Test shall quantify test specimen seat leakage prior to any testing and serve as a baseline for subsequent LLRTs. Test medium shall be water at ambient temperature. Test pressure shall be 1080 psig which will be applied to the downstream side of the test valve while monitoring the upstream side of the valve at atmospheric pressure for leakage.

The valve test specimen may be installed in either the flow loop test section or pressure lock test stand, as this LLRT test procedure will be repeated following the Static Break-In Test, Pressure Lock Test, and the vertical and horizontal orientation Flow Loop Differential Pressure Tests. C

With the valve test specimen open, it shall be filled with water such that all air pockets are vented. The valve test specimen shall be closed using normal motive power. The valve test specimen will be pressurized on the discharge nozzle side to 1080 psig and maintained for five minutes, allowing the valve to stabilize.

The leakage will then be measured over a five-minute period using a calibrated stopwatch and collecting the displaced liquid in a suitable container while maintaining 1080 psig downstream as determined by a Heise test gage. Valve packing will also be monitored for leakage.

The valve test specimen acceptable leakage is less than 3785 ml/min. If the leakage exceeds this limit, Entergy Operations will be notified immediately for corrective action.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.2 Static Break-in Test

Following the pre-test LLRT, a Static Break-in Test will be performed. With the test specimen installed in the flow loop test section and with the test section filled with water at ambient temperature, the valve will be stroked 50 strokes open and 50 strokes closed using normal motive power. These strokes shall be performed without flow or pressure in the test section. Initially, and every fifth open and closed stroke thereafter, data will be acquired and traces generated. To prevent motor overheating, a three-minute motor cool-down period will be required after each open/close cycle.

A post-static break-in LLRT shall be performed as specified in Section 6.3.1. C

6.3.3 Pressure Lock Test

During pre-test LLRT, an evaluation of the test specimen MOV seat leakage shall be made to determine if this leakage exceeds the test facility capability (1.5 gpm @ 1080 psig) of maintaining required bonnet pressure during pressure lock testing. Prior to test setup, Entergy Operations will be notified of the LLRT leakage and facility capability.

The test specimen MOV shall be configured for pressure lock testing. The test medium during pressure lock testing shall be water at ambient temperature. Care shall be taken to assure the test specimen MOV bonnet cavity and inlet and outlet nozzles are solid with water during these tests.

The open torque switch shall not be bypassed during pressure lock testing and shall be set not to exceed 78,000 pounds.

Instrumentation, including diagnostic test equipment, shall be the same as that used during flow loop differential pressure testing exclusive of facility instrumentation (flow rate, etc.). If it is necessary to remove the actuator to move the test specimen MOV, it will be necessary to re-establish control switch settings (open and close limits, bypass switches, etc).

With the DAS operational so that traces are generated for all strokes, the following Pressure Lock Tests shall be performed:

Test No.	Description
1)	a) With the bonnet and nozzles unpressurized, stroke test specimen MOV closed. b) With the bonnet and nozzles unpressurized, stroke test specimen MOV open. c) With the bonnet and nozzles unpressurized, stroke test specimen closed.
2)	With the valve in the closed position, pressurize the outlet nozzle to 1080 psig. Monitor pressures in the bonnet and inlet nozzle for 10 minutes or until stabilization. Depressurize prior to next step.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

Test No.	Description
3)	a) Connect hydrostatic pump to bonnet leak-off line and pressurize bonnet to 1080 psig. With inlet and outlet nozzles at 0 psig, stroke valve open. There will be an immediate drop off of bonnet pressure upon unseating.
	b) Stroke test specimen MOV closed.
4)	a) Pressurize the bonnet to 1080 psig. Pressurize the upstream Schedule 30 nozzle to 320 psig. Pressurize the downstream Schedule 80 nozzle to 452 psig. Stroke the test specimen MOV to the open position.
	b) Depressurize test specimen MOV to zero psig. Stroke test specimen MOV closed.
5)	a) Pressurize the bonnet to 452 psig. Pressurize the Schedule 30 nozzle to 320 psig. Pressurize the Schedule 80 nozzle to 452 psig. Stroke test specimen MOV open.
	b) Depressurize test specimen MOV and stroke closed.

6.3.4 Post-Test LLRT C

Perform a Post Pressure Lock Test LLRT as described in Section 6.3.1.

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation

The test specimen MOV shall be installed in the hot water blowdown flow loop with the valve stem vertical and the test section horizontal. Gaskets and bolting will be in accordance with Wyle standard procedures. Figure 4 presents a schematic drawing of the hot water blowdown flow loop.

The test section and 3000 gallon reservoir will be filled with water. The test specimen will be fully open. With the test section and reservoir ullage pressurized to approximately 500 psig, the facility 10-inch blowdown valve shall be opened until 9,000 gpm is achieved to determine facility blowdown valve's required open position. The test specimen will remain fully open during this trial run and not be stroked. With the test specimen valve closed, the test section and a reservoir will be filled with demineralized water which will be heated to 150-200°F by recirculation through the system 225 kW heater. Ullage pressure will be brought to 500 psig.

Close and open strokes will initiate and terminate at the 50% minimum/70% maximum open/close position respectively, since the total valve stroke time of 19 seconds would exhaust the 3000-gallon reservoir before stroke completion.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation (Continued)

With the test section at 500 psi and 150-200°F and the DAS operational, the test will be initiated by placing the 10-inch blowdown valve in its pre-determined open position (2 seconds) to achieve the required flow rate of 9,000 gpm. Next, the valve test specimen will be stroked open using normal motive power. As the valve strokes open, flow rate will increase to 9,000 gpm. Test termination will take place when the test specimen MOV reaches 70% of open, at which time the 10-inch blowdown valve will be commanded closed.

While test data is being reviewed, the reservoir shall be refilled and reheated prior to the next stroke. Stroke 2 (close) will be initiated by placing the 10-inch blowdown valve in its open position to achieve 9000 gpm, at which point the test MOV is commanded closed. Test termination occurs when the test MOV is fully closed. The test sequence of closing and opening strokes and test conditions is presented in Table II of this procedure.

6.3.6 Post-Test LLRT/Inspection

After Stroke No. 28 and prior to continuing, a post-test LLRT shall be performed. This test shall be a repeat of the pre-test LLRT of Section 6.3.1 of this procedure. Test results shall be reported to Entergy Operations.

Entergy Operations personnel shall inspect and photograph the downstream disk and seat, through the valve nozzle, prior to re-orientation.

6.3.7 Test Specimen Re-Orientation (Vertical to Horizontal)

Upon determination that the valve leakage rate is acceptable, the test specimen MOV shall be reoriented in the flow loop test section such that the valve stem is horizontal.

6.3.8 Flow Loop Differential Pressure Test (Horizontal Orientation)

The test requirements and procedures of Section 6.3.5 shall be repeated with the valve stem in the horizontal orientation. C

6.3.9 Post-Test LLRT/Inspection

A post-test LLRT shall be performed using the procedure of Section 6.3.1. Also, Entergy Operations personnel shall inspect and photograph the downstream disk and seats.

6.3.10 Post-Test Activities

Remove test equipment from the test specimen. Remove the test specimen MOV from the flow loop. The test specimen valve shall be disassembled and the stem shipped to Teledyne for a post-test calibration of the Smart Stem. The valve body and actuator shall be shipped to Entergy Operations, Grand Gulf Nuclear Station, without reassembly.

TABLE II

FLOW LOOP DIFFERENTIAL PRESSURE TEST SEQUENCE

Stroke	Direction	ΔP (psid)	Flow Rate (gpm)
1	Open	500	9000
2	Close	500	9000
3	Open	100	4000
4	Close	100	4000
5	Open	200	5500
6	Close	200	5500
7	Open	300	7000
8	Close	300	7000
9	Open	400	8000
10	Close	400	8000
11	Open	500	9000
12	Close	500	9000
13	Open	500	9000
14	Close	500	9000
15	Open	500	9000
16	Close	500	9000
17	Open	500	9000
18	Close	500	9000
19	Open	500	9000
20	Close	500	9000
21	Open	400	8000
22	Close	400	8000
23	Open	300	7000
24	Close	300	7000
25	Open	200	5500
26	Close	200	5500
27	Open	100	4000
28	Close	100	4000

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.4 Data Analysis

6.4.1 Data Channels

The following parameters shall be recorded during test specimen MOV stroking during break-in static strokes, flow loop differential pressure testing, and pressure lock testing:

1) Spring Pack Displacement
2) Stem Thrust
3) Actuator Output Torque
4) Motor Power (3-Phase)
5) Motor Current
6) Switches (open and close torque, open and close bypass, open limit)

Plots of the above parameters versus time will be generated for each valve stroke and included in the final report.

6.4.2 Data Analysis

The above plots will be analyzed and the following shall be calculated or determined:

		Open Stroke	Close Stroke
1) Stem Thrust	a) Running	X	X
	b) Maximum ΔP	X	X
	c) Unseating	X	
	d) Hammer Blow	X	
	e) Minimum Available		X
	f) Torque Switch Trip (TST)		X
	g) Total		X
	h) Inertia		X
2) Torque	a) Running	X	X
	b) Unseating	X	
	c) Minimum Available		X
	d) Torque Switch Trip (TST)		X
	e) Total		X
3) Stroke Time		X	X
4) Current	a) Running	X	X
	b) Unseating	X	
5) Power, Running		X	X

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.4 Data Analysis

6.4.1 Data Channels

The following parameters shall be recorded during test specimen MOV stroking during break-in static strokes, flow loop differential pressure testing, and pressure lock testing:

1) Spring Pack Displacement
2) Stem Thrust
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4) Motor Power (3-Phase)
5) Motor Current
6) Switches (open and close torque, open and close bypass, open limit)

Plots of the above parameters versus time will be generated for each valve stroke and included in the final report.

6.4.2 Data Analysis

The above plots will be analyzed and the following shall be calculated or determined:

		Open Stroke	Close Stroke
1) Stem Thrust	a) Running	X	X
	b) Maximum ΔP	X	X
	c) Unseating	X	
	d) Hammer Blow	X	
	e) Minimum Available		X
	f) Torque Switch Trip (TST)		X
	g) Total		X
	h) Inertia		X
2) Torque	a) Running	X	X
	b) Unseating	X	
	c) Minimum Available		X
	d) Torque Switch Trip (TST)		X
	e) Total		X
3) Stroke Time		X	X
4) Current	a) Running	X	X
	b) Unseating	X	
5) Power, Running		X	X

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.4 Data Analysis (Continued)

6.4.2 Data Analysis (Continued)

		Open Stroke	Close Stroke
6) Contactor Drop-out Time		X	X
7) Stem Factor*		X	X
8) Disc Factor*		X	X
9) Spring Pack Displacement	a) Unseating	X	
	b) Hammer Blow	X	
	c) At TST		X
	d) Total		X
	e) Inertia		X
10) Rate-of-Loading Effect*			X

*For flow loop differential pressure strokes only.

7.0 DOCUMENTATION

7.1 Test Log Book

A Test Log Book shall be maintained and shall include a daily description of activities and testing performed and any pertinent information regarding the status of the test specimen. The log shall be a complete chronological log including details of all test setups and calibration, specimen handling and setup, installation, and test data summaries. Each stroke shall be recorded in the log.

7.2 Test Data

All recordings shall be reviewed for accuracy and quality after each test. The test data shall be clearly identified with the valve serial number, Wyle job number, test date, customer, stroke number and orientation, remarks, and any pertinent information required for analysis or retrieval. C

7.3 Final Report

A final test report will be prepared and submitted to Entergy for approval. The report will include:

a) A copy of traces for each parameter monitored on every test stroke where traces are required. Each trace shall be clearly labeled with the stroke number and description.

7.0 DOCUMENTATION (Continued)

7.3 Final Report (Continued)

b) A description of test anomalies and resolution.

c) Certification records for test equipment.

d) A copy of the test log book documenting the chronology, time, and description for each stroke.

e) A schematic diagram of the flow test loop and pressure lock test setup showing all instrumentation points.

f) An isometric drawing of the flow test loop.

g) Photographs of the flow test loop and Pressure Lock Test, with close-ups of instrumentation and any damage noted at any point while the valve is at the test lab.

8.0 PERSONNEL CERTIFICATION

Wyle certifies that all personnel assigned to the steam valve test facility are qualified for the tasks assigned. Certification is achieved through personnel education levels, vocational training, and practical experience as outlined in ANSI-N45.2.6 and NRC Regulatory Guide 1.58.

9.0 STORAGE AND HANDLING

During any prolonged non-testing period, the test specimen shall be stored in a controlled storage area. The storage shall be maintained in accordance with good laboratory practices, i.e., being properly protected from grease, oil, solvents, and any surface dirt that could influence the results of the test program. The storage area shall be in compliance with ANSI-N45.2.2, Level C. While the test specimen is installed in the test system, it shall be adequately protected from inclement weather.

10.0 DISPOSITION

At the conclusion of the test program:

a) Remove diagnostic equipment from the MOV.

b) Remove valve, actuator, and motor from the test stand.

c) Items shall be cleaned to remove dirt, oil, manufacturing residue or other contamination. After cleaning, surfaces shall be free of the cleaning material, including lint, solvent, residue, etc. After cleaning, the item shall be protected from contamination until preservation and packaging are complete.

10.0 DISPOSITION (Continued)

d) Protect exposed machined surfaces from damage during shipping and handling. Sturdy boxes or strapping capable of withstanding impacts without damage to the item shall be used.

e) All openings shall be closed, vapor tight, and protected against damage, corrosion, and entrance of foreign matter. All exposed machined surfaces shall be protected.

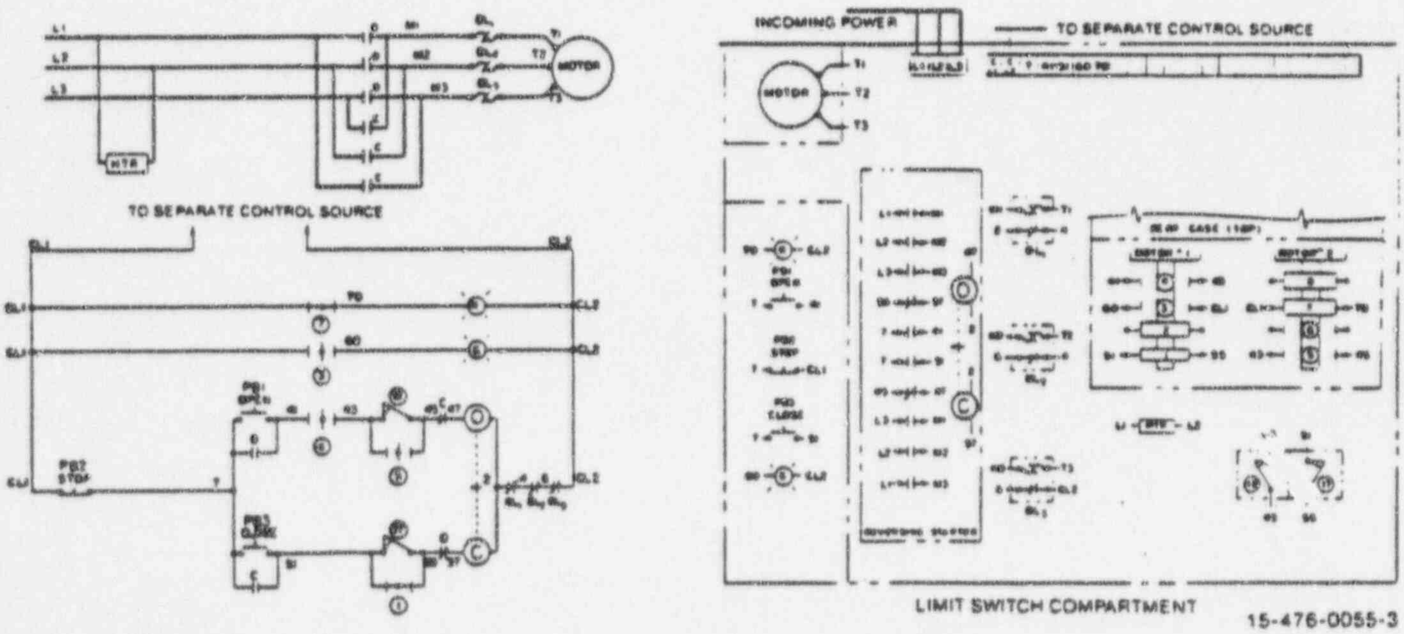
f) Package the components to ANSI N45.2.2, shipping level C criteria. Ship to GGNS for final post-test inspection of valve internals.

TYPICAL WIRING DIAGRAMS

The following drawings are typical Limitorque wiring diagrams showing built in motor controls for a 3 phase power supply for the electric motor. In the first drawing, the arrangement is a typical one for a wedge type gate valve or globe valve where the closing direction is limited by the torque switch, and the opening direction is limited by the geared limit switch.

The second drawing is one which could be used in controlling the opening and closing of butterfly valves, ball valves, plug valves or sluice gates, where the closing and opening directions are limited by the geared limit switch. The torque switches are wired in series with the geared limit switches to protect against mechanical overloads anywhere between full open and closed positions of the valve.

Both arrangements are shown with a three button (open, stop, close) pushbutton setup, and two lights to indicate full open or close positions of the valve. When the valve is at some intermediate position of travel, both lights will be on.



15-476-0055-3

VALVE SHOWN IN FULL OPEN POSITION

LIMIT SWITCH COMPARTMENT			
ROTOR	CONTACT	VALVE POSITION (FULL OPEN — FULL CLOSED)	FUNCTION
1	1	▬ - - - - - - - - - - - -	BY PASS CIR
	2	▬ - - - - - - - - - - - -	SPARE
	3	- ▬▬▬▬▬▬▬▬▬▬▬	IND LIGHT
	4	- ▬▬▬▬▬▬▬▬▬▬▬	OPEN LIMIT
2	5	- - - - - - - - - - - ▬	BY PASS CIR
	6	- - - - - - - - - - - ▬	SPARE
	7	▬▬▬▬▬▬▬▬▬▬▬ - -	IND LIGHT
	8	▬▬▬▬▬▬▬▬▬▬▬ - -	SPARE

NOTES
1 ▬ CLOSED CONTACT
2 - - - OPEN CONTACT

(17) CLOSING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING CLOSING CYCLE OF FULLY CLOSED VALVE

(18) OPENING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING OPENING CYCLE

FIGURE 1. WIRING DIAGRAM, PROTECTIVE CONTROL CIRCUIT

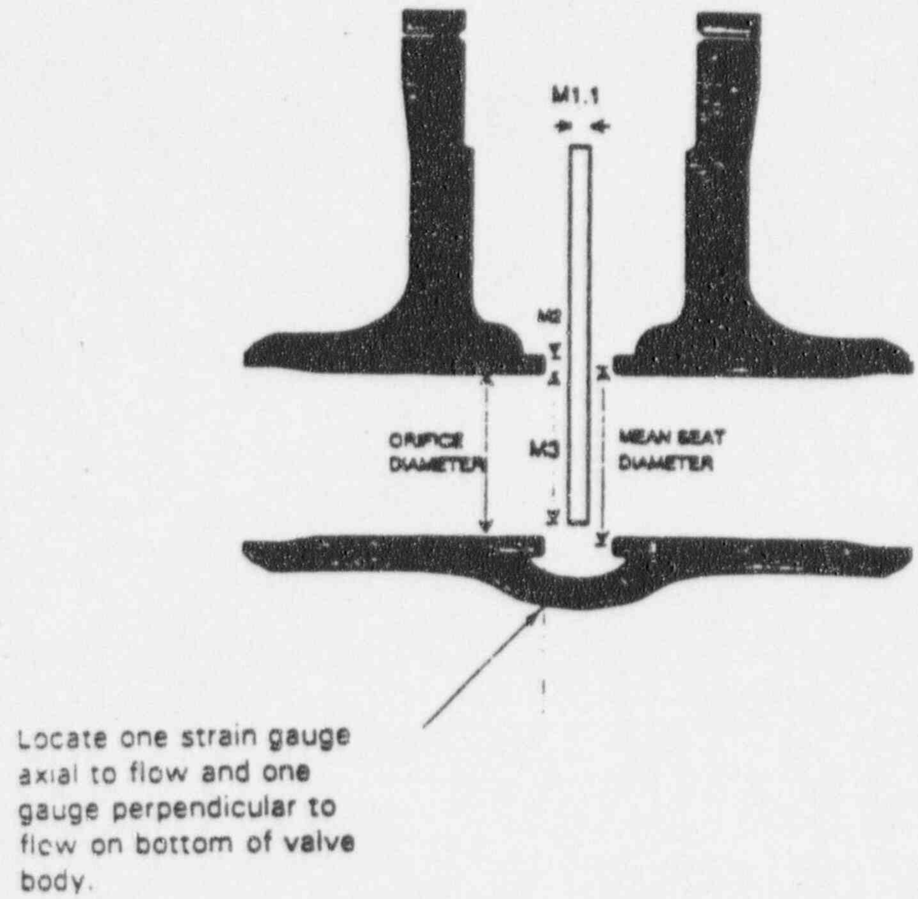


FIGURE 2. BODY DISPLACEMENT STRAIN GAGE LOCATION

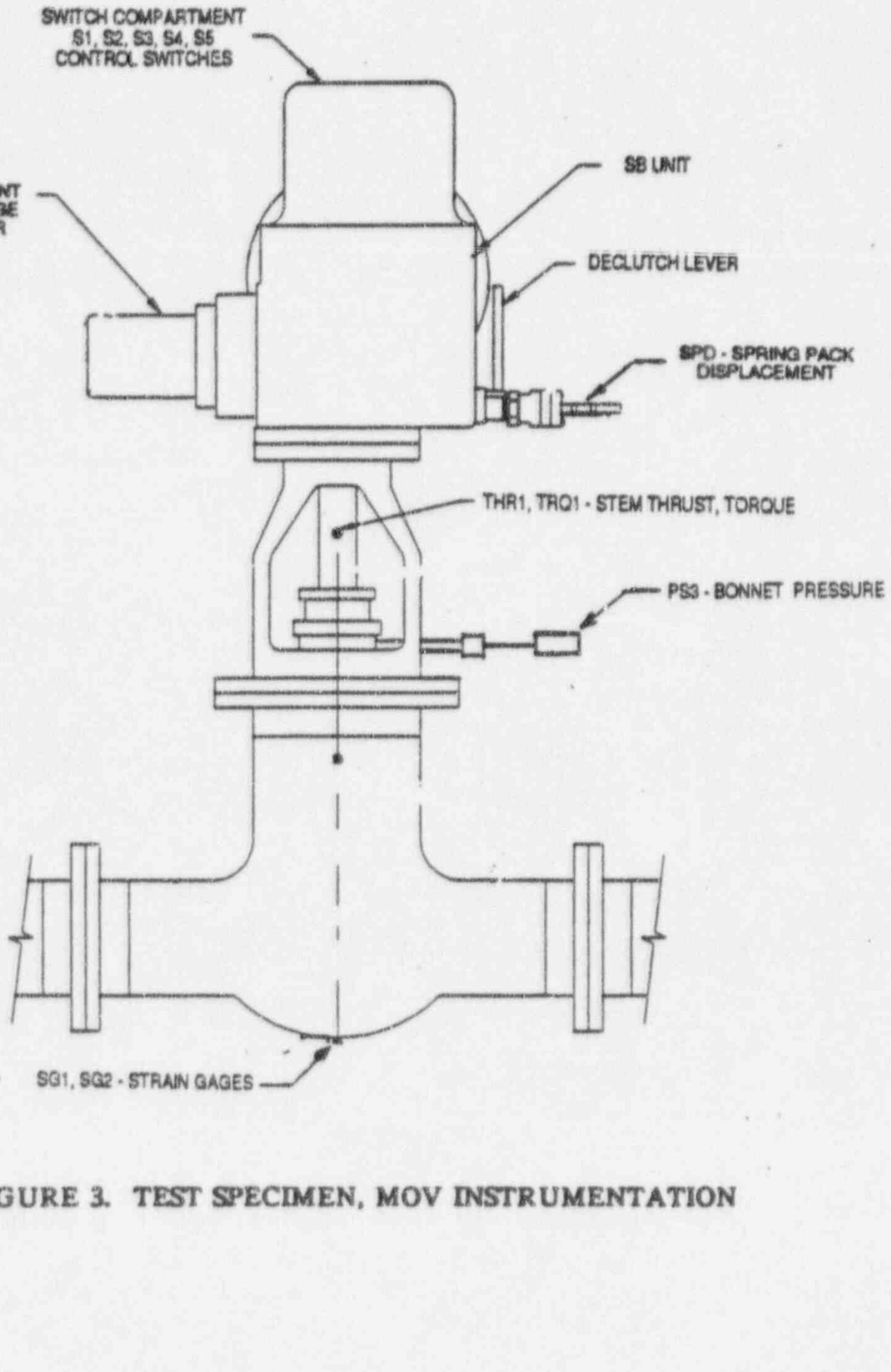


FIGURE 3. TEST SPECIMEN, MOV INSTRUMENTATION

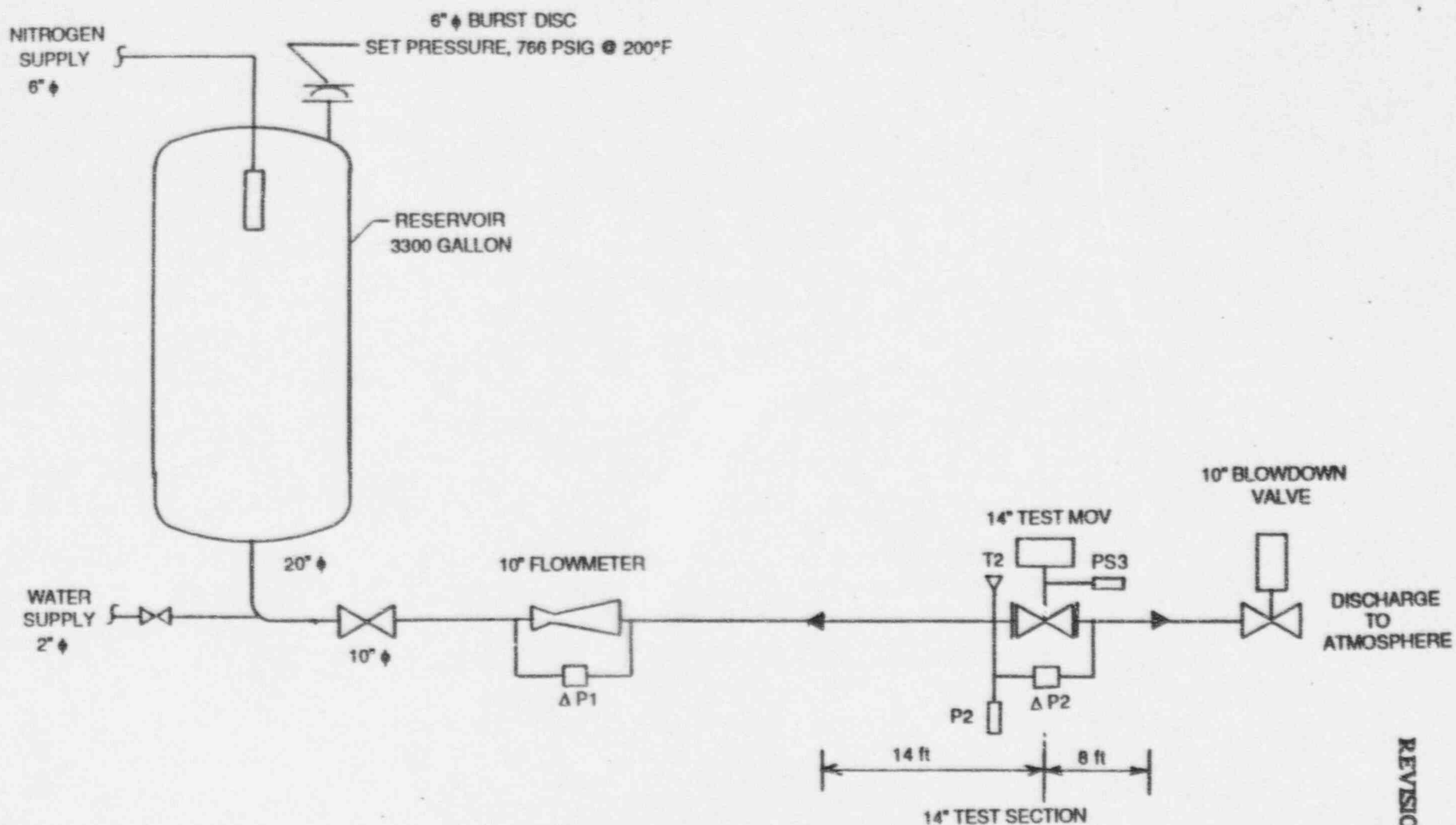


FIGURE 4. FLOW LOOP DIFFERENTIAL PRESSURE TEST

APPENDIX I

CALCULATION OF 14-INCH, SCHEDULE 30 PIPE DESIGN PRESSURE

CALCULATION OF 14-INCH, SCHEDULE 30 PIPE DESIGN PRESSURE

Calculate the pressure/temperature rating of the 14-inch, Schedule 30, carbon steel pipe with the circumferential butt joint.

From the ANSI/ASME Code for Pressure Piping B31.1, design pressure shall not exceed:

$$P = \frac{2SE(t_m - A)}{D_o - 2Y(t_m - A)} \quad \text{(4) Para. 104.1.2}$$

S = 17,500 psi, $T < 650°F$, ASTM A105, Table A

E = 0.8 joint efficiency

t_m = 0.375 inch wall thickness

A = corrosion allowance

D_o = 14.0 inches

Y = 0.4 Ferritic Steel from Table 104.1.2(A)

$$P = \frac{(2)(0.8)(17{,}500 \text{ psi})[(0.375) - 0]}{14.0 - (2)(0.4)[(0.375) - 0]}$$

P = 766 psig, $T < 650°F$

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APPENDIX IX

WYLE LABORATORIES' TEST PROCEDURE 85-12

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. Box 1008 • Huntsville, Alabama 35807
TWX(810) 726-2225 • TELEPHONE (205) 837-4411

TEST PROCEDURE NO. 85-12

DATE: January 28, 1985

FOIL STRAIN GAGES
INSTALLATION PROCEDURE
USING M-BOND AE-10/15
FOR
NUCLEAR POWER PLANTS

APPROVED BY PROJECT MANAGER: [signature] for H. JORDAN 1/30/85
H. Jordan

APPROVED BY QUALITY ENGINEER: G. W. Hight 1/30/85 [initials] 1-30-
G. Wayne Hight

PREPARED BY PROJECT ENGINEER: D. De Lucchi 1/30/85
D. De Lucchi

REVISIONS

(jmk)
FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	2/13/85	6, 9, 11, 12, 14 [initials] 5/23/85	DDL	[initials] 2/13/85 [initials] 3-25-85 GWH 3/25/85	Corrections and Update

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to provide the detailed requirements for a consistent and qualified method for installation of Foil Strain Gages and associated wiring, protective coating, and electrical checkout.

2.0 SCOPE

This procedure defines the requirements for qualifying and performing the installation of Foil Strain Gages for on reactor external components and for general use applications.

A detailed sequence covers quarter-bridge and rosette biaxial or triaxial and full-bridge Foil Strain Gages Micro-Measurements, Series EA and CEA Constant Foil Alloy in self-temperature-compensated form, open-face, polymide backing, installed with M-Bond AE-10/15 adhesive, and properly wired for data acquisition.

3.0 APPLICABLE DOCUMENTS, CODES AND STANDARDS

The following documents form a part of this procedure to the extent specified herein:

1. General and Detailed Installation Procedures per Appendices A, B, and C.
2. Foil Strain Gage - Micro-Measurements Brochure.
3. Adhesive and Protective Coating - Micro-Measurements Brochure.
4. Gage Installation Tester Manual - Vishay 1300.

4.0 DESCRIPTION

The Strain Gages will be installed using M-Bond AE-10/15 adhesive to ensure long life at elevated temperatures, high elongation, minimum zero shift, and hysteresis. Instrumentation procedure is presented in Appendix B. Foil Strain Gages and associated instrumentation wiring will be installed as shown in Appendix C, and wired in the quarter-bridge configuration, utilizing the three (3) wire system, or full-bridge configuration, utilizing the six (6) wire system with remote calibration. At the end of the wire, an electrical connection will be provided to mate the conditioning equipment receptacle.

4.0 DESCRIPTION (Continued)

The instrumentation wire attachment method used is a compromise between size and space availability of sufficient strength to survive high static and dynamic loads. The protective coating is selected and will be applied on top of the Strain Gage and wiring to insure protection, but not in excessive thickness to crack and damage the gage and wires.

An electrical check of the completely installed Strain Gage and wire is made to ensure there is proper electrical characteristics, no excessive deformation and sufficient insulation resistance. All those parts and functions are to be considered and performed with the highest possible degree of reliability.

5.0 SPECIAL CONSIDERATIONS

5.1 Operations shall be performed in the order presented unless otherwise specified by the responsible Wyle Project Engineer or Customer Representative.

5.2 All operations performed per this procedure shall be in accordance with the scope of applicable Wyle Safety and Quality Assurance Manuals and the Customer's Safety and Quality Program, if specifically required.

5.3 In the event of malfunction or failure, the Policies and Procedures sequence of operations associated with discrepant items shall cease until documentation and corrective action have been completed.

5.4 All operations and inspections shall be performed concurrently.

5.5 Changes to this procedure shall be accomplished by issuance of appropriate revisions in accordance with Wyle Laboratories' Quality Assurance Policies and Procedures Manual.

5.6 Operators shall read this procedure in its entirety before beginning any operations.

6.0 REQUIREMENTS

6.1 Prerequisites

Properly qualified personnel shall perform the installation work. Installations shall pass the required visual and electrical tests.

6.2 Equipment Required (Or Equivalent)

6.2.1 Strain Gage Checkout

	Name	P/N	Mfg
a.	Digital Multimeter**	Any with 5-1/2 digit resolution on Ohms (0.00001 KΩ)	
b.	Gage Installation Tester**	M/N 1300	Vishay

6.2.2 Gage Installation Tools

	Name	P/N	Mfg
a.	Scale, 6 inch, Steel	SSS-1	MM*
b.	Diagonal Cutters	DWC-1	MM
c.	Tweezers	BTW-1	MM
d.	Probe	DPR-1	MM
e.	Brush GT-11	MM	
f.	Ball Point Pen	Any	Any
g.	Soldering Iron 25-Watts	Any	Any
h.	Soldering Iron Holder	Any	Any
i.	Wire Stripper	Any	Any
j.	Shears	SSH-1	MM
k.	Magnifiers, 2-1/2 Power (Optional)	Any	Any
l.	Magnifying Glass (Optional)	Any	Any
m.	Heat Gun (Optional)	Any	Any

* Micro-Measurements, Inc.

** Periodic Calibration Required

6.0 **REQUIREMENTS (Continued)**

6.2 **Equipment Required (Or Equivalent) (Continued)**

6.2.3 **Gage Installation Materials**

a.	Wire, Ribbon or Cable (Three Conductors)	330-DFC or 3 Conductor Shielded 24A Cable	MM & SEA	
b.	Solder, Tin-Lead-Antimony (1/2 pound)	361A20R	MM	
c.	Conditioner	M-Prep-A	MM	
d.	Neutralizer 5	M-Prep-5	MM	
e.	Solvent Chlorothene NU	CNU-1	MM	
f.	Solvent-Freon TF	FTF-1	MM	
g.	Cellophane Tape, Clear, 3/4"	PCT-2	MM	
h.	Teflon Film (50') Optional	TFE-1	MM	
i.	Cotton Swabs (100 Pkg)	CSP-1	MM	A
	Gauze Sponges	CSP-1	MM	A
j.	Carbide Paper (400 Grit)	SCP-3	MM	
	Carbide Paper (320 Grit)	CCP-2	MM	
k.	Cement, Adhesive Kit	M-Bond AE-10/15	MM	
l.	Protective Coating	M-Coat A or AE-10	MM	
m.	Coating	RTV 3140, 3145,	MM	
		or 2216 A/B	3M	A
n.	Tape, Masking (100' Roll)	3/4"	Any	
o.	Pencil, Wooden with Eraser	Any	Any	
p.	Tissue (200 Count)	N/A	Kleenex	
q.	Spatula	SPT-1 or SPT2	MM	A
r.	Fiberglass Tape	TFT-1	MM	A
s.	Silicon Gum	SGP-1	MM	A
t.	Pressure Pads	GT-14	MM	A
u.	"C" Clamps	N/A	Any	A

6.3 **Procedure**

6.3.1 **Location**

a. Find and mark the locations on the specimen as specified by Customer requirements, using ball point pen and steel scale.

b. Label locations - S1 through S....n.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.2 Surface Preparation and Strain Gage Installation

CAUTION: DO NOT USE CHLORINATED SOLVENT ON SURFACES MADE OF STAINLESS STEEL AND SUBJECTED TO VERY HIGH TEMPERATURE.

a. See Appendix A, "Surface Preparation for Strain Gage Bonding", Pages 8 through 15.

b. See Appendix B, "Strain Gage Applications with M-Bond AE-10/15 Adhesive", Pages 16 through 20.

6.3.3 Gage Wiring and Routing

a. Attach the lead wires as specified in Appendix C, Pages 21 through 24, for the series of strain gages being installed.

— EA Series requires bondable terminals and a cable or wire strain relief loop of approximately 1/4-inch radius.

— EA Series - Option W - does not require additional bondable terminals since the terminals are an integral part of the strain gage itself. Cable or wire strain relief loop is required.

— CEA Series does not require additional bondable terminal since it features large integral copper-coated terminals. Cable or wire strain relief loop is required.

b. Tin gage tabs and terminal strip with solder.

CAUTION: The following operations must be accomplished by laying the fine Strain Gage Solder over the appropriate tab and momentarily applying the hot iron to the junction. Avoid excessive solder and overheating (excessive heat will degrade the Epoxy Bond and strain gage backing).

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.3 Gage Wiring and Routing (Continued)

c. Strip, position, and solder connecting leads to the Strain Gage terminal tabs. Make a cable strain relief loop by looping the cable up 1/4 inch. For a single quarter-bridge, the single wire is red, the two (2) wires to be coupled are black and white. For a full-bridge, the color code for interconnecting bridge wire is not applicable. Use any color available. Remove solder-flux residue first with rosin solvent, using a small camel-hair brush.

d. Route the lead wire neatly, using masking tape or fiberglass tape as needed to secure the wire to the surface. Welded shim stock may also be used.

e. Place a marker sleeve with the measurement number written for each gage or for each full bridge.

6.3.4 Installation Inspection

a. Inspect gage installation with a magnifying glass to verify freedom from voids under the gage, proper bonding, and integrity of the soldering joints.

b. After the last step of applying protective coating is completed and cured, repeat the same inspection. (See Paragraph 6.3.6.)

6.3.5 Checkout and Verification

a. Connect the gage installation tester, Vishay 1300, to each of the gages one by one.

b. Depress insulation resistance button marked "Meg Ω " and verify that insulation resistance is greater than 5,000 megohms.

c. Depress "Ω" and verify the gage resistance of 120 or 350 ohms.

d. Depress "1%". Deviation shall not be greater than 0.3% (3000 microstrain).

e. If the following checks are not met and problems are suspected, use the D.V.M. for troubleshooting.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.5 Checkout and Verification (Continued)

f. If problems can not be easily corrected, the strain gage shall be removed and a new one installed at that location.

g. Full-bridge checkout may be accomplished by connecting the bridge to the conditioning equipment and checking the zero balance and span.

NOTE: For final acceptance, repeat Steps a through e, after protective coating is applied. (See Paragraph 6.3.6.)

6.3.6 Protective Coating

a. Using rosin solvent and a brush, clean the gage, soldering tabs, and attachment wires.

b. Dry out rosin solvent with gauze sponge.

c. Apply a thin coat of M-Coat A polyurethane or M-Bond AE-10/15 over the gage, soldering tabs, part of the wire, and around the entire installation.

d. Let the first coat of M-Coat A dry, and apply a second thin coat. If M-Bond AE-10/15 is used, no additional application is necessary.

e. Coat wires only with M-Coat B. A

f. Let the second coat of M-Coat A dry, and apply a coat of TRV 3140, RTV 3145, or 3M 2216 A/B. Let dry and apply a third coat if desirable. A

g. Repeat installation inspection, Paragraph 6.3.4, and checkout verification, Paragraph 6.3.5.

6.3.7 Wiring

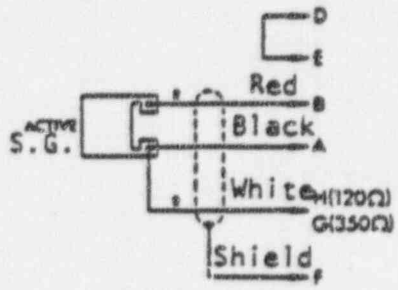
a. For quarter-bridge, connect the three (3) strain gage wires and shield to the building penetration, if applicable.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.7 Wiring (Continued)

b. Solder the electrical connector at the end of the cable as shown below:



c. The strain gage is now ready for connection to the conditioning equipment and system calibration as specified in Wyle Laboratories Procedure No. 361-9.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

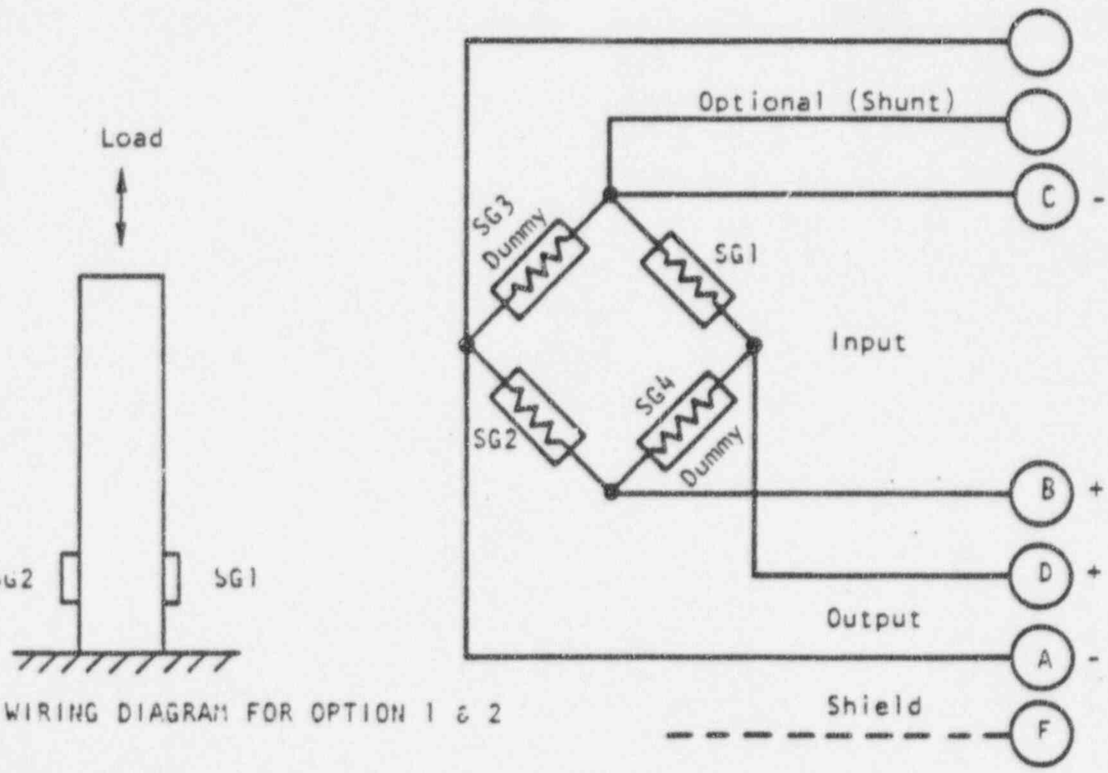
6.3.8 Wiring For Full-Bridge Arrangements

NOTE: Several full-bridge arrangements can be used depending on the type of measurement required. Consult your requirements and select one of the Options described below or contact the Project Engineer for detailed circuit to be used. A

6.3.8.1 Full-Bridge Strain Gage Arrangement to Measure Axial Load Only

Option #1

To measure axial load only, it requires a minimum of two (2) strain gages placed one on one side of the beam and the second on the opposite side of the beam. The arrangement will cancel the bending loads and will give double output sensitivity to the axial load.



WIRING DIAGRAM FOR OPTION 1 & 2

A

NOTE: This system will exhibit double sensitivity to thermoshift.

System calibration is accomplished by shunting one arm of the bridge, and the output voltage is multiplied by two (2) for the actual test data.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)

Option #2

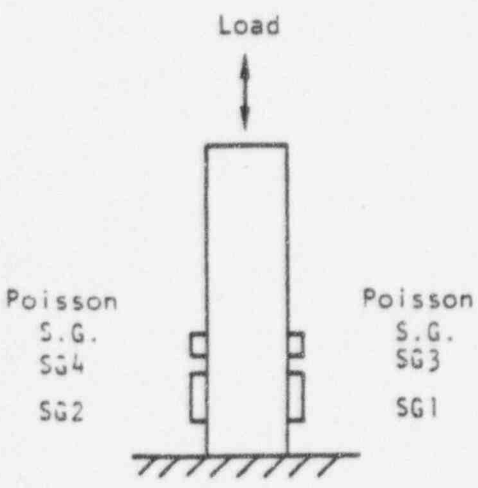
A second approach to measure axial load only, is the employment of a full strain gage bridge arrangement with two (2) opposite strain gages mounted in the line of axial load and two (2) strain gages mounted on a dummy piece of specimen not subjected to load, but subjected to the same temperature as the active strain gages. This arrangement will cancel the bending loads and give double output sensitivity to the axial load. Calibration may be performed by shunting one arm of the bridge and multiplying the output by the factor of two.

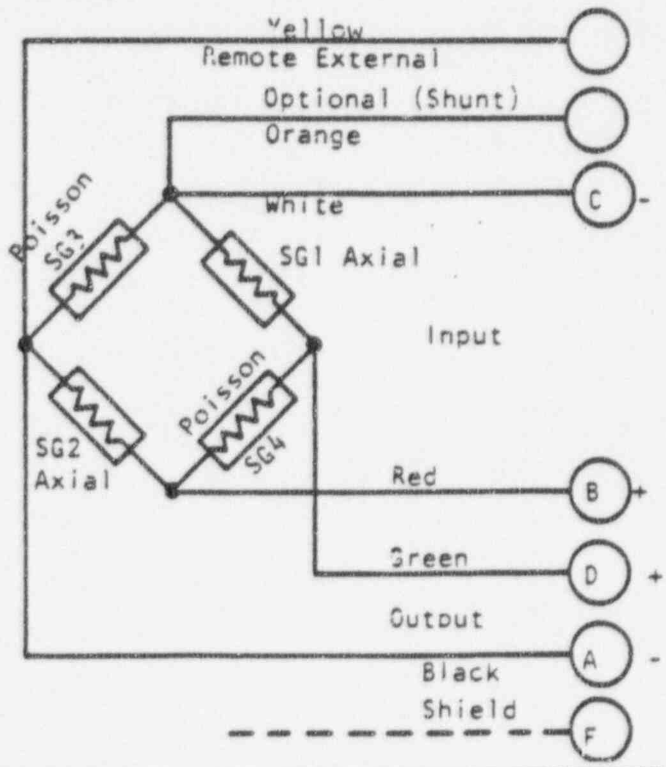
NOTE: This system will exhibit an ideal temperature compensation.

Option #3

The second set of strain gages may be installed on the specimen itself at 90° from the two (2) in line of force strain gages.

The two (2) additional gages mounted at 90° will be measuring the Poisson effect of the beam underload. Take into consideration that the Poisson effect is ordinarily 28 to 30% of the axial load readings.





WIRING DIAGRAM FOR OPTION 3

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)

NOTE: The output of the foregoing full-bridge arrangement will exhibit double sensitivity to axial load plus 60% additional output due to the Poisson effect.

This arrangement is ideal for the temperature compensation, but may present a problem when the Poisson effect is changed due to cross-loading.

System calibration is accomplished by shunting one (1) arm of the bridge, and the output voltage is multiplied by 2.6 for the actual test data.

6.3.8.2 Full-Bridge Strain Gage Arrangement to Measure Moment Load (Bending) Only

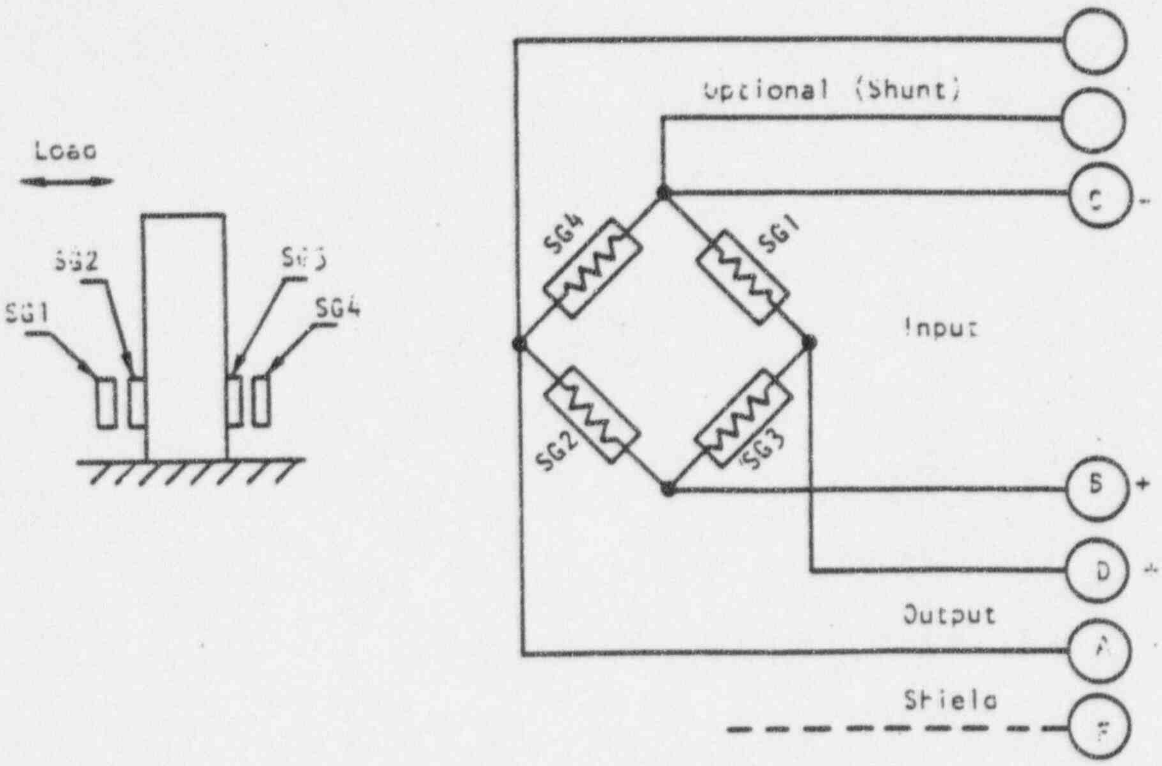
To measure moment load (bending), the most appropriate method is a full-bridge arrangement with two (2) strain gages on one side of the beam, and two (2) strain gages on the opposite side of the beam. All four (4) strain gages will be mounted in the line of force parallel to each other.

This arrangement, as depicted on the following page, will exhibit no output due to axial load and four (4) times the output sensitivity due to bending moment.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)



A

NOTE: This system will exhibit an ideal temperature compensation.

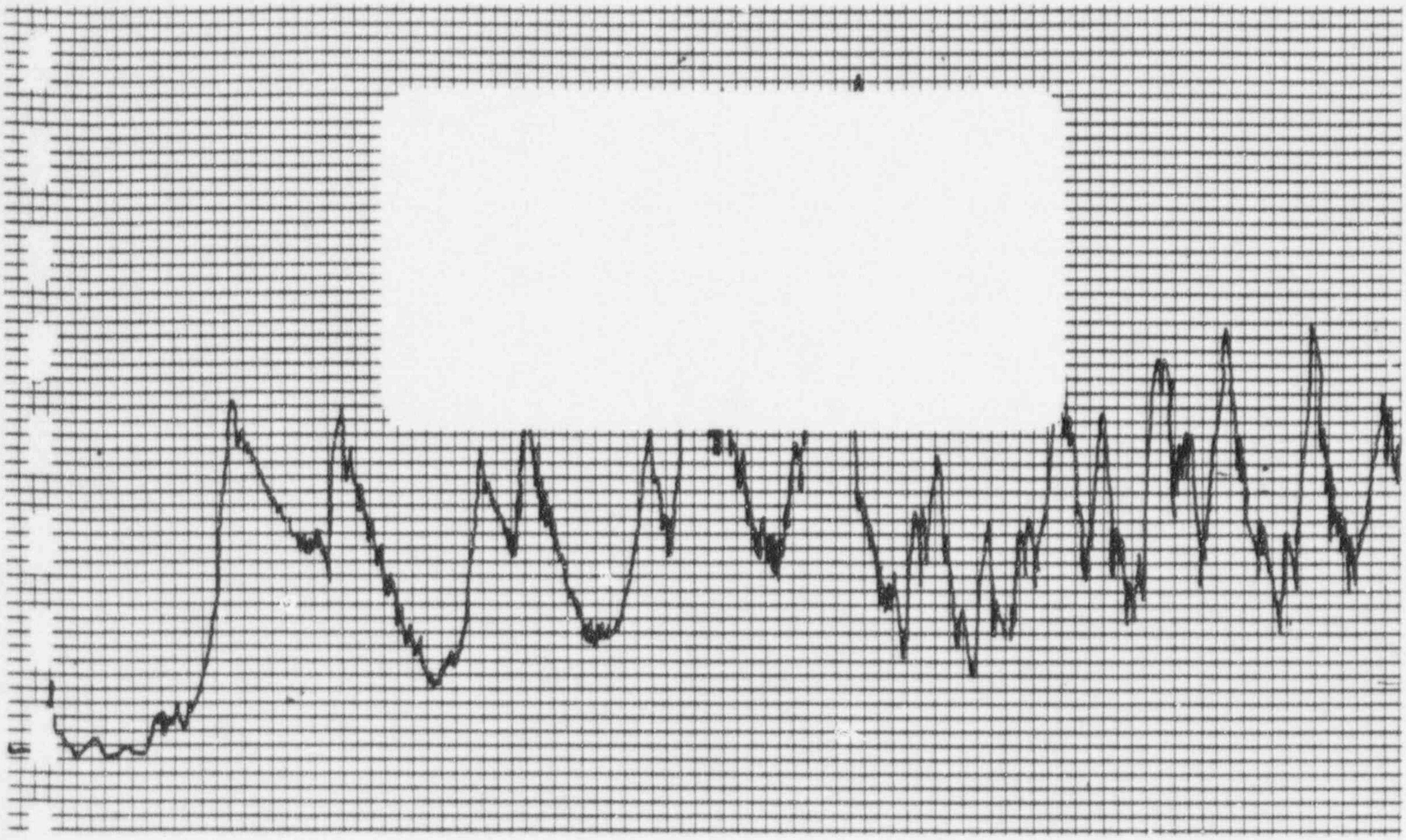
System calibration is accomplished by shunting one (1) arm of the bridge and multiplying the output voltage by four (4) for the actual test data.

6.3.8.3 Solder the electrical connector at the end of the cable as shown in the sketches.

6.3.8.4 The Strain Gage is now ready for connection to the conditioning equipment and for system calibration as specified in Wyle Procedure No. 361-9.

M-J5.08-Q1-43008-01-8.0-1-0

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
HUNTSVILLE, AL



NPE DOCUMENT REVIEW
APPROVED ENGINEERING REFERENCE DOCUMENT
RM [signature] FOR JLB Date 9-12-95

Q

test REPORT

Grand Gulf Nuclear Station — Nuclear Plant Engineering

SUPPLIER DOCUMENT REVIEW FORM

1. **Identification:**

Supplier: WYLE Laboratories

Document Title: Flow Loop Differential Pressure And Pressure Lock Tests On A 14 - Inch William Powell Gate Valve For Entergy Operations, Inc. Grand Gulf Nuclear Station J/N 43008

Document Type: Analysis

Supplier Document Number: 43008-01 Dated February 18, 1993

GGNS Supplier Dwg & Document ID Number: M-J5.08-Q1-43008-01-8.0-1-0

Applicable GGNS MPL Equipment Number(s): Q2E12F042B

Equipment Status: Installed ______ Not Installed X

If not installed, applicable Design Change Document to be used for installation:

N/A - The Unit 2 valve was used for prototype testing

Should reviewed document be returned to the supplier? YES ______ NO X

2. Basis for Review:

NPEAP 302, Section 7.4.2

3. Comments: (if none, so state)

None

4. Approval Status: (Per Supplier Approval Stamp)

APPROVED ENGINEERING REFERENCE DOCUMENT

Responsible Engineer: William T. White Date 9/11/95

Checked By: [signature] Date 9/11/95

Cognizant Group Supervisor: [signature] Date 9-12-95

FORM 302.1 REV. 3

TEST REPORT

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

Entergy Operations, Inc.
P. O. Box 758
Port Gibson, MS 39150

REPORT NO. 43008-01
OUR JOB NO. 43008
YOUR P. O. NO. C-1015-28
CONTRACT N/A
PAGE 1 of 128 PAGE REPORT
DATE February 18, 1993

ELOW LOOP DIFFERENTIAL PRESSURE
AND PRESSURE LOCK TESTS ON A
14-INCH WILLIAM POWELL GATE VALVE
FOR
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION
J/N 43008

For

Entergy Operations, Inc.
Port Gibson, MS

(pap)

STATE OF ALABAMA }
COUNTY OF MADISON } ss

Ala Professional Eng.
Reg. No. 13475

Gerald R. Carbonneau, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted testing and is to the best of his knowledge true and correct in all respects.

SEAL

SUBSCRIBED and sworn to before me this 1st day of March, 19 93

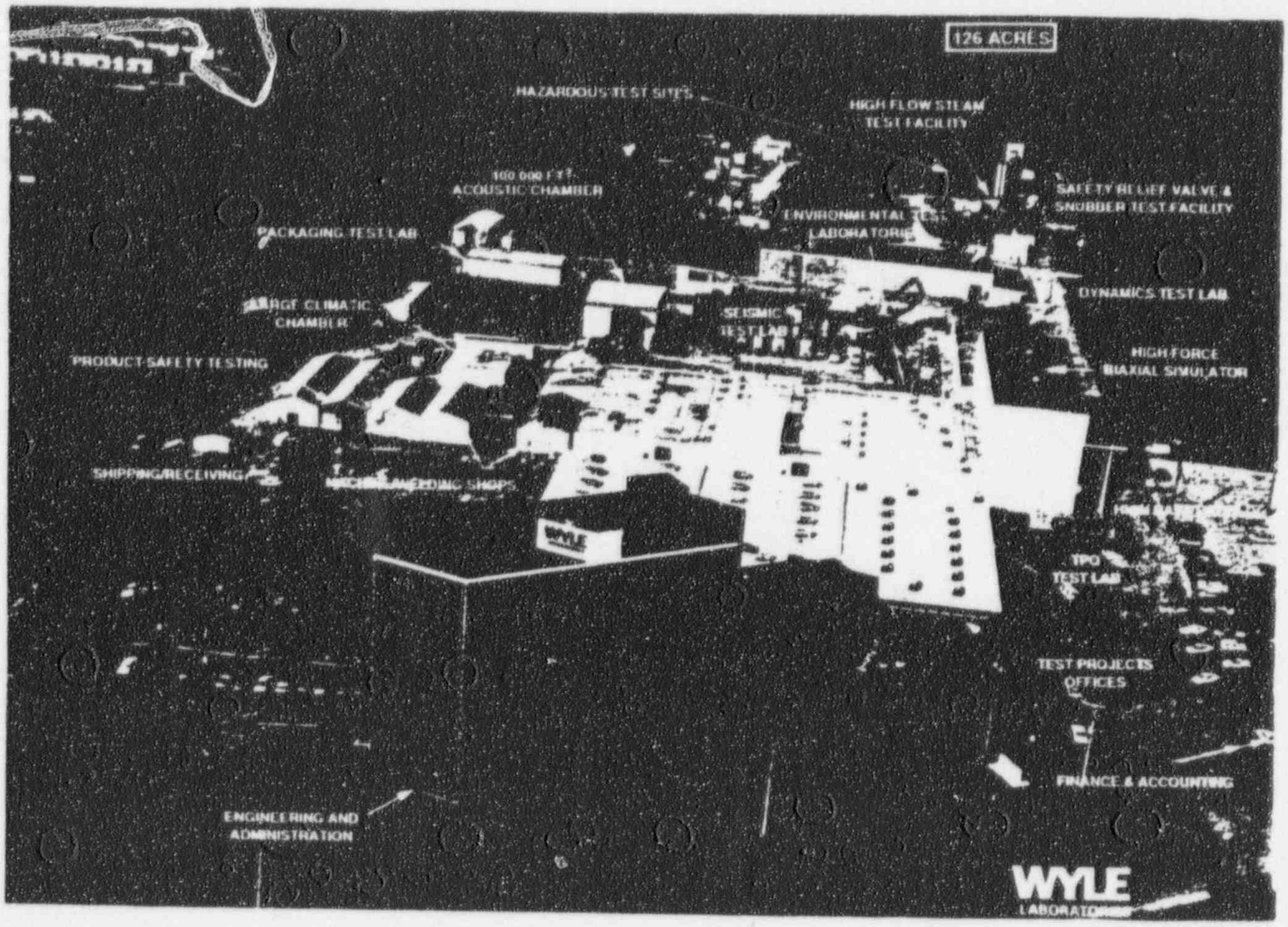
Notary Public in and for the State of Alabama at large.
My commission expires September 7, 19 93

TEST BY:
G. R. Carbonneau, Proj. Engineer

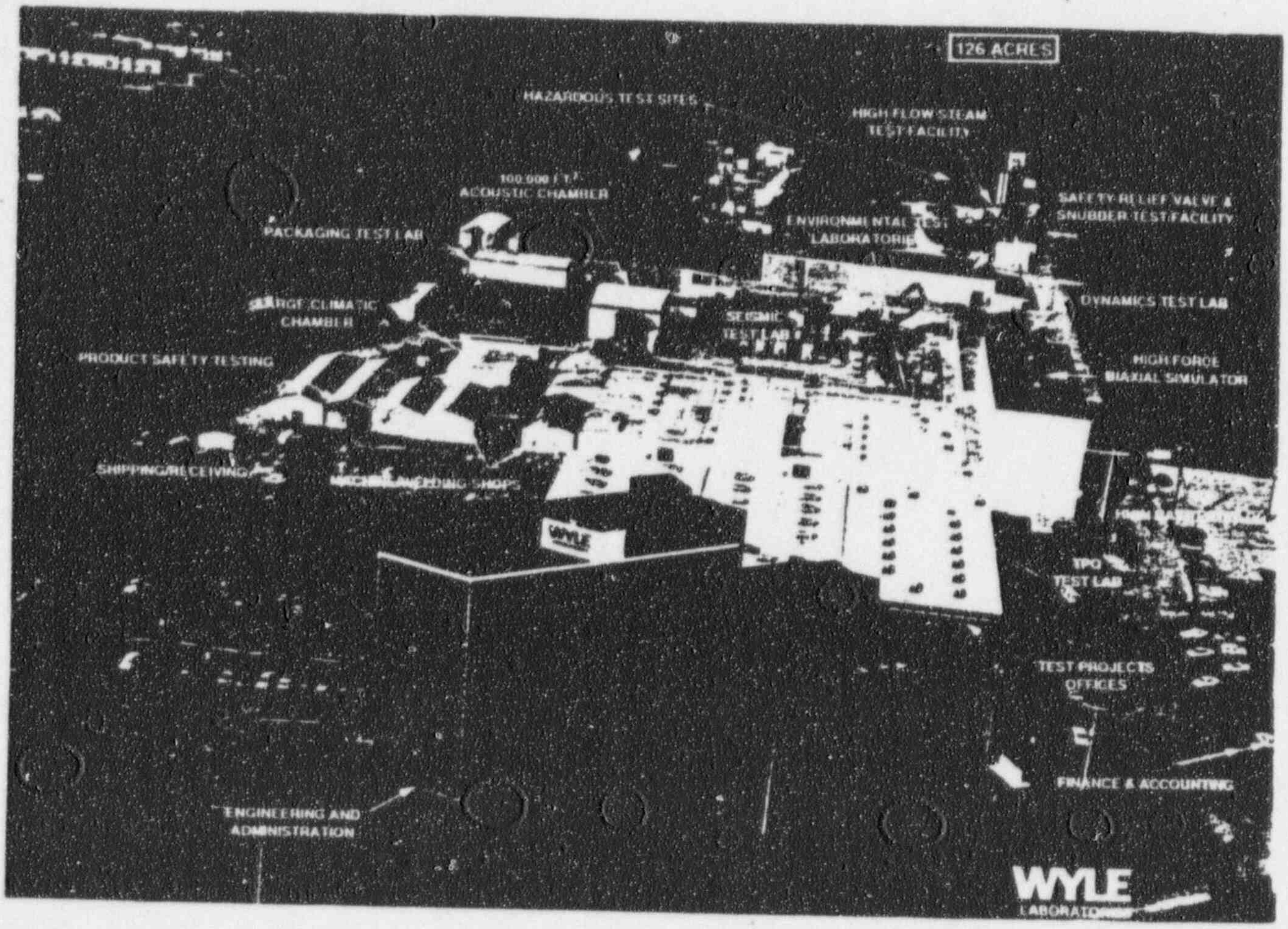
P. Turrentine 2/25/93
P. Turrentine, Dept. Manager

WYLE Q. A.: 3-1-93
R. G. Thomas, Q.A. Manager

WH-1404, 2/92



AERIAL VIEW OF WYLE/HUNTSVILLE



AERIAL VIEW OF WYLE/HUNTSVILLE

1.0 PURPOSE

The purpose of this report is to present the results of a test program conducted on a Motor-Operated Valve (MOV), 14-Inch, 600 Class, William Powell Gate Valve and Limitorque SB-3 Operator for Entergy Operations, Inc., Grand Gulf Nuclear Station. The valve was subjected to Bonnet Pressure Lock-up Tests and Full-Flow Differential Pressure Tests in the valve stem vertical and horizontal modes as required by Entergy Operations Contract No. C-1015-28, including Change Order No. 1, Entergy Letter GEXO:92-00743, and Wyle Laboratories' Test Procedure No. 43008 (Appendix VIII of this report).

2.0 REFERENCES

2.1 Contract No. C-1015-28, Entergy Operations, Inc.

2.2 Change Order No. 1 to Contract Order No. 28, dated November 16, 1992

2.3 Entergy Letter GEXO:92-00743

2.4 Wyle Laboratories' Test Procedure No. 43008

2.5 Wyle Laboratories' Quality Assurance Program

2.6 William Powell Company Instruction Manual, Pressure Seal Valves No. 69-1

3.0 QUALITY ASSURANCE

All work performed on this test program was conducted in accordance with Wyle Laboratories' Quality Assurance Program Manual dated June 30, 1988, approved by Entergy Operations and per the customer's Purchase Order. Wyle's Quality Assurance Program complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N45.2, and applicable regulatory guides.

4.0 TEST INSTRUMENTATION AND EQUIPMENT

4.1 Calibration of Test Equipment and System Calibration

Appendix V presents the Instrumentation Test Equipment listing all instrumentation used during this program, including calibration dates.

All instrumentation, measuring, and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

All test equipment used was calibrated on a periodic basis, with the calibration interval displayed on a decal (affixed to the equipment) indicating the last calibration date, the next calibration due date, accuracy, and by whom calibrated.

4.0 TEST INSTRUMENTATION AND EQUIPMENT (Continued)

4.2 Measurements and Tolerances

Unless specified otherwise, the tolerances on test condition measurements were as follows:

Measurement	Tolerance
Pressure	± 1% F.S.
Temperature	± 2°F
Flow Rate	± 5%
Current	± 2%
Voltage	± 1%
Time	± 0.25 sec
Stem Torque/Thrust (Teledyne)	± 1.0%
Displacement, Spring Pack	± 0.52%
Motor Power	± 3%

5.0 TEST SPECIMEN

The test specimen MOV supplied by Entergy Operations, Inc., Grand Gulf Nuclear Station, was inspected by Wyle on November 10, 1992, and found to be equipped with welded flanges (ANSI B16.5 14-inch, 600-pound class, raised face). The test specimen MOV upstream and downstream nozzles were Pipe Schedule 30 and Schedule 80, respectively. The flange bolt hole pattern had one bolt hole at top dead center of the valve.

The test specimen was a Motor-Operated Valve (MOV) Assembly consisting of one 14-inch diameter, 600-pound Class, carbon steel flex wedge gage valve with operator. The valve and operator nameplate data were recorded.

<u>Valve</u>:

William Powell Valve Company
1250 psi at 575°F (Design Pressure/Temperature)
Serial No. 67770-6, Year 1981
Class 1

<u>Operator</u>:

Limitorque Rat. 43.87
Type SB Size 3 150 ft-lb motor
Order 583616B Serial 258077
Valve 14 193-2-4100
229158 77°C

Figure 1 of this report presents a drawing of the test specimen MOV.

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6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.1 Test Summary

Testing of the 14-inch, 500-pound Class William Powell Gate Valve is completed. This valve was subjected to a Pressure Lock-up Test and a Full-Flow Differential Pressure Test at Wyle Laboratories, Huntsville, Alabama, from December 28, 1992, through January 15, 1993. The valve performed normally throughout these tests. However, during the Pressure Lock-up Test, with 1080 psig applied to the bonnet and 0 psig applied to the inlet and outlet nozzles, the valve could not be stroked open.

The raw test data of the Full-Flow Differential Pressure Testing was subjected to analyses by Wyle's MOV Engineering Group. The results of the analyses are included within this report. The valve did not exhibit any unusual or anomalous behavior during these tests.

Table I presents a chronological history of the program.

6.2 Pre-Test Preparation

6.2.1 Receipt Inspection/Disassembly

On November 19, 1992, Wyle received the test specimen valve at Wyle's Steam Valve Facility. This shipment consisted of two packages, one for the valve body and flanges and one for the actuator and motor.

The shipment was inspected for radiation by Wyle's Radiation Safety Officer. It was found to be uncontaminated and was released. Next, Wyle's Quality Assurance personnel inspected the shipment. No damage was noted during this inspection. Nameplate data revealed that the valve and operator were as described in the Entergy Statement of Work. The nameplate data was recorded in the Project Logbook.

The valve was a William Powell valve (Serial No. 67770-6) and the operator was a Limitorque Type SB operator (Serial No. 258077).

On November 20, 1992, the valve body was disassembled, and the valve stem was removed in order to install the Teledyne Smart Stem. The valve was disassembled and reassembled following the instructions of the William Powell Company Instruction Manual, Pressure Seal Valves No. 69-1, provided by Entergy Operations, Inc.

In order to disassemble the valve, it was necessary to remove the bonnet packing leakage pipe. The stem was inspected for run-out using Wyle's Cordax Machine, packaged, and shipped to Teledyne Engineering Services, Waltham, Massachusetts, for Smart Stem installation. The bonnet was sent to Wyle's Machine Shop to have the bonnet package's leakage port drilled and tapped. Minor scratches were noted on the valve stem where the packing was located.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.2 Pre-Test Preparation (Continued)

6.2.1 Receipt Inspection/Disassembly (Continued)

On December 17, 1992, the valve stem was returned from Teledyne Engineering Services. The stem was checked for runout in the Cordax Machine and electrically checked. Teledyne stated that the Smart Stem hysteresis was 1% during calibration check. The Smart Stem calibration and inspection data are presented in Appendix IV.

On December 17, 1992, the Teledyne Smart Stem was installed in the test article MOV. The valve was reassembled using William Powell Instruction Manual 69-1. The stem was lubricated with Mobilux EP-1. A Certificate of Conformance is presented in Appendix II of this report. The actuator was mounted on the valve and the motor was mounted on the actuator. During assembly, some small amounts of grease were noted on the switch compartment. Inspection revealed a failed O-ring at the limit switch penetration. The O-ring was replaced.

6.2.2 Valve Installation and Orientation

On December 1, 1992, the valve body (valve disassembled) was installed in the Wyle flow loop. The valve was installed in the stem vertical orientation with the 14-inch, Schedule 30 nozzle facing the upstream direction. The test section piping was horizontal. A photograph of the installed test article is presented in Appendix III. The valve was installed using standard Wyle bolt-up procedures, and gaskets and bolting provided by Entergy. Entergy also provided the 14-inch, 300-pound Class weld neck flanges which were welded to the upstream and downstream piping test sections.

To protect the valve inlet, Schedule 30 pipe from over-pressurization, a 6-inch rupture disc rated 766 psig at 200°F, as determined by the calculations presented in Appendix I of Wyle Test Procedure 43008, was installed on top of the test loop 3,000-gallon vessel.

A Hydrostatic Test of the test article MOV and the test section was performed on December 19, 1992, following valve reassembly. With the test valve in the open position, piping was pressurized to 1200 ± 50 psig with ambient water and maintained for 10 minutes. The valve and test section piping were inspected for leakage. None was detected.

6.2.3 Actuator Installation and Wiring

The actuator was mounted on the test article valve on December 18, 1992. The motor was mounted on December 21, 1992. Bolting used was that supplied with the valve by Entergy. Torque was per Limitorque standard procedure for SB-3 actuators.

Power supply and control circuit wiring was established per procedure. Thermal overload protection was provided using 3 each Allen Bradley W61 21.7 amps.

Figure 2 presents the control wiring installation.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS

6.2 Pre-Test Preparation (Continued)

6.2.4 Instrumentation

Spring pack displacement was measure' ısing a LVD and mounting fixture, and by drilling a 1/4-inch hole in the spring ,ack cover plate. During plate removal, the declutch lever torsion spring was found to be out of position, rendering the handwheel inoperable. This was corrected prior to cover reinstallation.

The valve stem was equipped with a Teledyne Smart Stem. Appendix IV presents the stem calibration data.

Flow rate was measured using a 10-inch Venturi manufactured by Badger Corporation. Flow meter data are presented in Appendix VI.

Figures 3A, 3B, and 3C present schematics showing all instrumentation points during these tests.

All instrumentation used during these tests are listed on the Instrumentation Equipment Sheets in Appendix V.

6.2.5 Date Acquisition System (DAS)

The DAS consisted of the MEGADAC 5033A manufactured by Optim Corporation of Dayton, Ohio. Data acquired was placed on Panasonic optical disc cartridge LM-D702W of 1 GB capacity. The data were also transcribed to 8 mm FM tape as backup. Plots of each channel were produced, following each run, using the H-P Laser Jet Printer.

6.2.6 Actuator Switch Settings and Adjustment

Prior to testing, the Limitorque actuator switches were set using standard Wyle and Limitorque procedures.

- The open limit switch was set to 90% of travel.
- The open torque bypass switch was set to 20% of travel.
- The close torque bypass switch was set to 95%.
- The open torque switch was set to 63,800 pounds.
- The close torque switch was set to 80,000 pounds.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests

6.3.1 Pre-Test LLRT

On December 23, 1992, a pre-test LLRT was performed in order to baseline the valve seat leakage. This test was performed with the valve in the flow test loop with all instrumentation and equipment installed. With the valve open, the valve and test section were flooded with water at ambient temperature water. The valve bonnet was vented to remove an air pocket. The valve was then commanded closed electrically. Using a hydrostatic pump, the downstream side of the valve was pressurized to 1080 +100, -0 psig and allowed to stabilize for five minutes. The valve upstream test section was isolated. A fitting was removed on the air vent of the upstream test section. Any leakage across the valve seat would show up at this fitting.

Following stabilization, the valve was monitored for five minutes. During this period, no measurable leakage (i.e., greater than 1 milliliter) was observed.

6.3.2 Static Break-in Test/LLRT

A Static Break-in Test was performed after the pre-test LLRT. The valve was cycled open-to-closed-to-open 50 times. A rest period of three minutes minimum was allowed after each cycle. The first and every fifth subsequent stroke was recorded on the DAS. Each recorded stroke was reviewed on the monitor screen after stroking. A decrease in thrust was noted from stroke to stroke. The valve stem was relubricated with Nebule EP1 after 20 cycles.

A Post-Static Break-in Test LLRT was performed on the test article MOV on December 28, 1992. The procedure used is that specified in Section 6.3.1 of WLTP 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzles were solid with water. The valve was closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, were isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

6.3.3 Pressure Lock Test

On December 28, 1992, Pressure Lock Tests were initiated on the test MOV. The system was flooded with demineralized water. The bonnet air was vented at the packing drain tap until full of water. The valve upstream and downstream nozzles were solid with water as air was vented from the test section vent valves.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

The open torque bypass switch wire was disconnected during these tests; therefore, the torque switch was not bypassed. The open torque switch setting was at 63,800 pounds thrust which is less than the 78,000 pound criterion. All instrumentation channels and DAS remained in the same configuration as during the Static Break-in Test.

Test No. 1 was performed with zero pressure applied upstream, downstream, and at the bonnet. The valve was stroked closed, open, and closed while recording data. A review of the data channel plots revealed that during the opening stroke the valve, for reasons unknown, de-energized after less than a second. The start button was pushed again and the valve opened normally.

Test No. 2 was essentially a Leakage Test using pressure rate of increase. Initially, the inlet and outlet nozzles and bonnet were at zero pressure. The outlet nozzle was pressurized to 1080 psig. The bonnet pressure tracked the rise in downstream nozzle pressure as pressure was applied. The upstream pressure remained zero. Since the valve was not stroked, the DAS did not record data.

Test No. 3 was performed by pressurizing the bonnet to 1080 psig. Inlet and outlet nozzle pressures were zero psig. With DAS recording the data, the MOV was powered to open. The motor ran for approximately two seconds until the torque switch tripped at 63,800 pounds. Stem thrust rose to a maximum following TST to 119,334 pounds. Entergy Operations was notified of this anomaly (See also Notice of Anomaly No. 1, Appendix I) and Wyle was advised to wait on continuance of testing until the arrival of the Grand Gulf Engineer the following day.

Following the arrival of the Grand Gulf Engineer on December 29, 1992, testing continued. The bonnet pressure had been relieved and the valve stroked normally. Wyle was instructed to increase the torque switch setting to a value of 1.4. Wyle was also requested to perform Test No. 5 of WLTP 43008, Section 6.3.3, prior to Test No. 4. The upstream nozzle was pressurized to 320 psig. The bonnet and downstream nozzle were pressurized to 452 psig. The valve was stroked open. The torque switch trip occurred at approximately 50,000 pounds. The MOV was again given a command signal to open and did so normally.

Test No. 5 Repeat (R) was repeated after increasing the torque switch setting to 1.5. The valve was stroked open and operated normally.

Test No. 4A was modified to pressurize the bonnet to 700 psig, the upstream nozzle to 320, the downstream nozzle to 452. The open torque switch was reset to 1.65 per Grand Gulf instructions. The valve was stroked open. The valve performed normally.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

In Test No. 4B, the bonnet pressure was raised to 1080 psig. The open torque switch was increased to 1.75. The valve was stroked open and stopped after a couple of seconds. Approximately 15 seconds later, the valve start button was pushed and the valve opened normally.

6.3.4 Post-Test LLRT

On December 29, 1992, a Post-Pressure Leak Test LLRT was performed on the test article MOV. The procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, were isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation

On December 30, 1992, a Flow Loop Differential Pressure Test was initiated. Figure 3 presents a schematic of the flow loop test setup and loop schematic. Photographs of the test article MOV installation are presented in Appendix III.

Prior to testing, a trial run of the loop was performed to establish a control parameter (i.e. flow rate) and instrumentation checkout. This test was performed on December 30, 1992. The opening position, of the 10-inch loop blowdown valve, required to establish a flow rate of 9,000 gpm at 500 psig was determined.

On December 31, 1992, flow loop differential pressure testing of the test article MOV began, completing Strokes 1 and 2 as specified by the test procedure. Prior to test, the 3,000 gallon reservoir was filled with demineralized water (used throughout testing). The water was preheated by circulation through the test section up to the test article MOV using a pump and electric (225 Kw) heat exchanger until all the water was heated to the 150-200°F range. Heat-up was assisted by injection of steam and hot water into the recirculation flow. Following heat-up, the heat-up loop was isolated, and the 3,000 gallon vertical water vessel ullage was pressurized with GN_2 to 500 psig. This pressure was maintained during test runs using a 4-inch GN_2 regulator (C_v = 69.0).

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation (Continued)

During opening and closing strokes, the test article MOV was stroked between full close and 50-70% of full open to prevent running out of water during a run (i.e., at 9,000 gpm, a 3,000 gallon reservoir would be depleted in 20 seconds). The DAS was operational prior to, during, and immediately following stroking. Each test run consisted of one stroke followed by recharge of the system with demineralized water and retesting. During this period, X-Y plots were generated for each channel recorded during the test run. The following plots were generated:

Channel Designation	Units	Description
DP1	PSID	Venturi Delta Pressure
FL1	GPM	Flow Rate
TC2	°F	MOV Inlet Temperature
PS1	PSIG	Upstream Pressure
PS3	PSIG	Bonnet Pressure
DP2	PSID	Valve Delta Pressure
THR1	lb	Stem Thrust
TRQ1	inches/lb	Stem Torque
SPD	inches	Spring Pack Displacement
SG1	microinch/inch	Axial Valve Body Displacement (Strain)
SG2	microinch/inch	Radial Valve Body Displacement (Strain)
MC1	Amps	L1 Current (Motor)
MV1	VAC	L1 Neutral Voltage (Motor)
MP	Watts	True Power
S1	Amps	Open Limit Switch
S2	Amps	Open Torque Switch
S3	Amps	Close Torque Switch
S4	Amps	Close By-Pass Switch
S5	Amps	Open By-Pass Switch

After each stroke, plots were reviewed for accuracy and quality. Each plot was labeled with date and time, customer, stroke number, specimen orientation, channel designation, units, and channel description.

A listing of all strokes is presented in Table II. Logbook entries are presented in Appendix VII. Several strokes were repeated, at Entergy's request, because they did not meet acceptance criteria for either flow rate stability or pressure. Notice of Anomaly (NOA) No. 2, presented in Appendix I, documents a problem with peak pressure saturation of the valve inlet pressure (PS1) and valve delta pressure.

Test results in the form of plots for all strokes are presented in Attachment II to this report.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.6 Post-Test LLRT/Inspection

On January 9, 1993, a post-test LLRT and visual inspection were performed on the test article MOV. The LLRT procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, was isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

Also, a valve internal inspection was performed at this time. The inspection was witnessed by a Grand Gulf Engineer. This inspection was performed by removing the valve from the test section and looking into the inlet and outlet nozzles using a flashlight and inspection mirror. The valve disc and body seats were examined. Also, the guide rails were examined. The results were that only slight scratches were noted on the seats and guides.

6.3.7 Test Specimen Re-Orientation (Vertical to Horizontal)

On January 9, 1993, the test MOV was removed and reoriented from the vertical to the horizontal orientation. The actuator was not removed to perform this task. A crane was brought in to perform this reorientation. No other changes were made in test equipment or setup.

6.3.8 Flow Loop Differential Pressure Test (Horizontal Orientation)

On January 11, 1993, testing of the test specimen valve resumed. The valve stem orientation was horizontal. All conditions of test, instrumentation test equipment, and stroke sequence were the same as previously described in Section 6.3.5.

Photographs of the test setup are presented in Appendix III. Table III presents stroke information for this test sequence.

Data plots are presented in Attachment II to this report.

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.3 Tests (Continued)

6.3.9 Post-Test LLRT Inspection

On January 18, 1993, a post-test LLRT was performed on the test article MOV. The LLRT procedure used was that specified in Section 6.3.1 of Wyle Laboratories' Test Procedure 43008. The valve and test section were filled with demineralized water at ambient temperature. With the valve open, all air pockets were bled until the valve bonnet and upstream and downstream nozzle were solid with water. The valve was powered closed. Using a hydrostatic pump, the valve was pressurized on the downstream side to 1080 +100, -0 psig. Pressure was monitored using a Heise test gage. The valve was allowed to stabilize for five minutes prior to monitoring leakage. The upstream nozzle and test section, filled with water, was isolated at 0 psig. The upstream section was monitored for leakage crossing the upstream disc from the pressurized downstream section and bonnet. A stopwatch was used to time the five-minute leakage observation period. No leakage greater than one milliliter was observed. No packing leakage was observed.

On January 22, 1993, an additional Seat Leakage Test was performed at Entergy's request. The bonnet was pressurized to 1080 psig +100, -0 and leakage was observed across the downstream side. The results were leakage of 550 milliliters over a 5-minute period. These results were reported to Entergy Operations.

No obvious visual damage was noted during valve disassembly. A detailed internal inspection will be performed by Entergy Operations.

6.4 Data Analysis

Analysis of the William Powell 14-Inch, 600 Pound Gate Valve, Serial No. 67770-6, was performed by Wyle's MOV Engineering Group. The analysis consisted of viewing the test data using the data analysis computer program DADiSP 3.01b, distributed by DSP Development Corporation. The points of interest required by Test Procedure No. 43008, Revision C, were identified. The points found on the Stem Thrust (THR1) data channel were identified on DADiSP-generated plots. Data analysis sheets are attached for each stroke analyzed and are presented in Attachment I of this report.

An analysis of the static stroke that most immediately preceded the test sequences was evaluated to determine the thrust at Torque Switch Trip, which was -84,134 pounds. This value was used during subsequent analysis in determining the Rate-of-Loading Effect (if any) on closing strokes. This static stroke was labeled in the test log as Paragraph 6.3.3 Test #1: a,b,c." with the data contained in file B430081.002." A plot of Stem Thrust (THR1), identifying points of interest during the Static Test, is provided. The Rate of Loading Effect was determined by finding the value of stem thrust at Torque Switch Trip, and comparing it with the value obtained in the static stroke. Any value at Torque Switch Trip less than 97% of the static value was considered to have a Rate of Loading (ROL). The 97% was derived from assuming a switch error of 2.5% and a thrust error of 0.5%. As a result, the greatest ROL seen on a vertical test stroke was 3,456 pounds on stroke 12 (V). The greatest ROL seen on a horizontal test stroke was 1,545 pounds on stroke 14 (H).

6.0 REQUIREMENTS, PROCEDURES, AND RESULTS (Continued)

6.4 Data Analysis (Continued)

Calculation of the Disk Factor was accomplished using both the Standard Industry and the Nuclear Maintenance Application Center (NMAC) equations. The Stem Factor (Coefficient of Friction - μ) was also calculated. A summary of Disk Factors and Stem Factors is provided. Plots are provided that show trends in the disk and stem factors for both closing and opening strokes. The summary also identifies anomalies found during the analysis. The individual stroke analysis data sheets and their supporting plots further describe the anomalies.

Minimum Available for Stem Thrust (THR1) was determined by finding the difference between the stem thrust at Torque Switch Trip and the stem thrust at Running. Inertia for Stem Thrust (THR1) was determined by finding the difference between the Final stem thrust and the stem thrust at Torque Switch Trip. They are summarized as follows:

Stem Vertical

	Average	Minimum	Maximum
Minimum Available Thrust (lbs)	80,360	77,901	84,294
Inertia on Thrust (lbs)	7,120	6,135	8,299

Stem Horizontal

	Average	Minimum	Maximum
Minimum Available Thrust (lbs)	81,143	77,901	84,294
Inertia on Thrust (lbs)	7,168	6,273	8,673

The results of the analysis of each stroke, including tabularized data and thrust traces, are presented in Attachment I.

7.0 DOCUMENTATION

7.1 Test Log Book

A Test Log Book was maintained; included were a daily description of activities and testing performed, the status of the test specimen, details of all test setups and calibration, specimen handling and setup, installation, and test data summaries. Each stroke was recorded in the log.

7.2 Test Data

All recordings were reviewed for accuracy and quality after each test. The test data were clearly identified with the valve serial number, Wyle job number, test date, customer, stroke number and orientation, remarks, and information required for analysis or retrieval.

All test data are currently recorded on an optical disk cartridge (Panasonic P/N LM-D702W). This disk cartridge holds one gigabyte of test data. Test data have also been transcribed from the optical disk cartridge to three 8-millimeter magnetic data cartridge tapes (3M P/N DC6150).

The disk cartridge and tapes have been labeled and placed in the raw data inventory file pending Entergy disposition instructions.

8.0 PERSONNEL CERTIFICATION

Wyle certifies that all personnel assigned to this test program were qualified for the tasks assigned. Certification is achieved through personnel education levels, vocational training, and practical experience as outlined in ANSI-N45.2.6 and NRC Regulatory Guide 1.5C.

9.0 STORAGE AND HANDLING

The test specimen was stored in Wyle Laboratories' Valve Test Facility, a controlled storage area which complies with ANSI-N45.2.2, Level C. While the test specimen was installed in the test system, it was protected from inclement weather by an overhead roof.

On January 23, 1993, following completion of all testing, the test article MOV was removed from the test stand. After removing all instrumentation and power supplies, the actuator was removed from the valve and placed in the box in which it was received. The valve was disassembled, in-place, in the flow loop and the bonnet and stem were removed. The stem was cleaned and shipped to Teledyne Engineering Services on January 31, 1993, after being checked for runout. The valve body was returned to storage at the Valve Test Facility building. On February 17, 1993, following shipping instructions from Entergy, the valve was crated and prepared for shipment.

9.0 STORAGE AND HANDLING (Continued)

On February 19, 1993, the valve and actuator were shipped to Entergy Operations, Grand Gulf Nuclear Plant, without the Teledyne Smart Stem. The Smart Stem will be shipped upon return from Teledyne. This will allow Entergy to start their internal inspection of the valve.

TABLE I

CHRONOLOGICAL SUMMARY OF TEST PROGRAM

November 9, 1992	Test Valve Arrived at Wyle Laboratories
November 11, 1992	Test Valve Receipt Inspection Performed
November 20, 1992	Valve Disassembled
November 23, 1992	Valve Stem Shipped to Teledyne
December 1, 1992	Valve Body Installed in Flow Loop
December 17, 1992	Smart Stem Received from Teledyne
December 18, 1992	Compete Reassembly of Valve
December 21, 1992	Installation of Valve Operator
December 21, 1992	Complete Hydrostatic Test
December 23, 1992	Pre-Test LLRT, Start Pre-Conditioning
December 28, 1992	Completed Pre-Conditioning, Post-Test LLRT, Pressure Lock Check
December 29, 1992	Completed Pressure Lock Test, Post-Test LLRT
December 30, 1992	Trial Run
December 31, 1992	Performed Strokes 1 and 2, Vertical Mode
January 8, 1993	Completed Strokes - Vertical Mode
January 9, 1993	Post-Test LLRT, Reposition Valve - Horizontal Mode
January 11, 1993	Initiate Strokes
January 18, 1993	Post-Test LLRT
January 20, 1993	Completed Strokes - Horizontal Mode
January 22, 1993	Additional Seat Leakage Test
January 23, 1993	Valve Disassembled, Removed From Test Section
January 31, 1993	Inspection of Smart Stem
February 19, 1993	Valve Body and Actuator Shipped to Grand Gulf

TABLE II

VERTICAL MODE SUMMARY

Date	Time	Stroke	Pressure	Remarks
12/31/92	12:55	Stroke 01	500	
	15:02	Stroke 02	500	PS1 Saturated (Sat)
1/04/93	11:40	Stroke 03	100	
	11:46	Stroke 04	100	
	14:43	Stroke 05	200	
	16:26	Stroke 06	200	-> 6RR
1/05/93	9:18	Stroke 07	300	
	10:40	Stroke 08	300	
	11:56	Stroke 09	400	
	13:47	Stroke 10	400	NG -> 10R
	15:38	Stroke 11	500	
	16:56	Stroke 12	500	NG -> 12R
1/06/93	9:30	Stroke 13	500	
	11:20	Stroke 14	500	
	13:22	Stroke 15	500	
	14:54	Stroke 16	500	PS1 Sat
	16:20	Stroke 17	500	
	17:52	Stroke 18	500	NG -> 18R
1/07/93	8:49	Stroke 19	500	
	10:54	Stroke 20	500	PS1 Sat
	13:23	Stroke 21	400	
	15:17	Stroke 22	400	
	17:06	Stroke 23	300	
	17:18	Stroke 24	800	
1/08/93	8:23	Stroke 25	700	
	8:30	Stroke 26	700	
	10:41	Stroke 27	100	
	10:46	Stroke 29	100	
	13:16	Stroke 06R	200	NG
	14:23	Stroke 10R	400	
	15:25	Stroke 12R	500	PS1 Sat
	19:49	Stroke 18R	500	PS1 Sat

NG = No Good
R = Repeat

TABLE III

HORIZONTAL MODE SUMMARY

Date	Time	Stroke	Pressure	Remarks
1/09/93	10:02	Stroke 01	500	
	11:40	Stroke 02	500	
	13:29	Stroke 03	100	NG
	13:40	Stroke 04	100	NG
	15:19	Stroke 05	200	NG
	15:30	Stroke 06	200	
	16:09	Stroke 07	300	
1/10/93	8:30	Stroke 08	300	(340)
	10:32	Stroke 09	400	
	12:49	Stroke 10	400	NG (300)
	13:35	Stroke 04R	100	(200)
	15:32	Stroke 11	500	
	16:56	Stroke 12	500	
1/11/93	8:48	Stroke 13	500	
	10:16	Stroke 14	500	PS1 Sat & DP2
	11:52	Stroke 15	500	
	14:09	Stroke 16	500	
	15:48	Stroke 17	500	NG
	18:27	Stroke 18	500	
1/12/93	8:09	Stroke 19	500	NG Venturi DP
	11:26	Stroke 19R	500	
	13:02	Stroke 20	500	
	14:46	Stroke 21	400	NG
	16:45	Stroke 22	400	NG
	17:57	Stroke 23	300	
1/23/93	9:18	Stroke 24	300	NG
	9:25	Stroke 25	200	
	11:10	Stroke 26	200	NG
	12:42	Stroke 27	100	
	12:48	Stroke 28	100	
	14:58	Stroke 17R	500	
	15:23	Stroke 26R	200	(100)
	17:19	Stroke 22R	400	NG
	17:35	Stroke 05R	200	
1/14/93	8:37	Stroke 10R	400	
	10:08	Stroke 14R	300	NG
	10:21	Stroke 03R	100	
	12:53	Stroke 24RR	300	NG (250) NG
	12:58	Stroke 23R	400	(370)
	15:22	Stroke 22RR	400	(370)
	15:28	Stroke 24RRR	300	(370)
1/20/93	10:22	Stroke 21R	400	NG
	11:54	Stroke 21R	400	NG
	13:41	Stroke 21R	400	NG
	15:72	Stroke 21R	400	NG
	15:43	Stroke 21R	400	

(XXX) - Achieved Test Pressure

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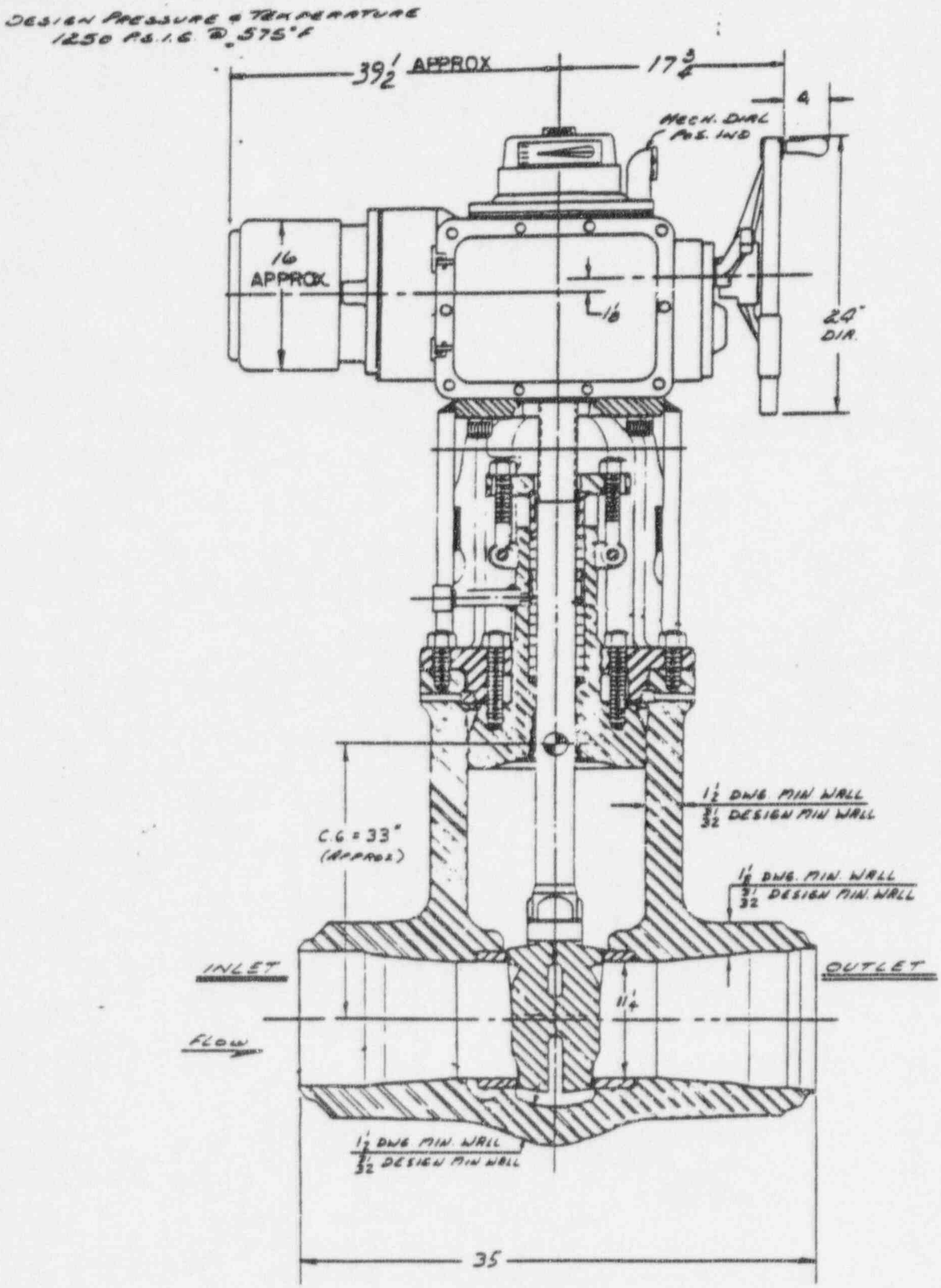

FIGURE 1. TEST SPECIMEN MOV

LIMIT SWITCH CONTACT FUNCTIONS

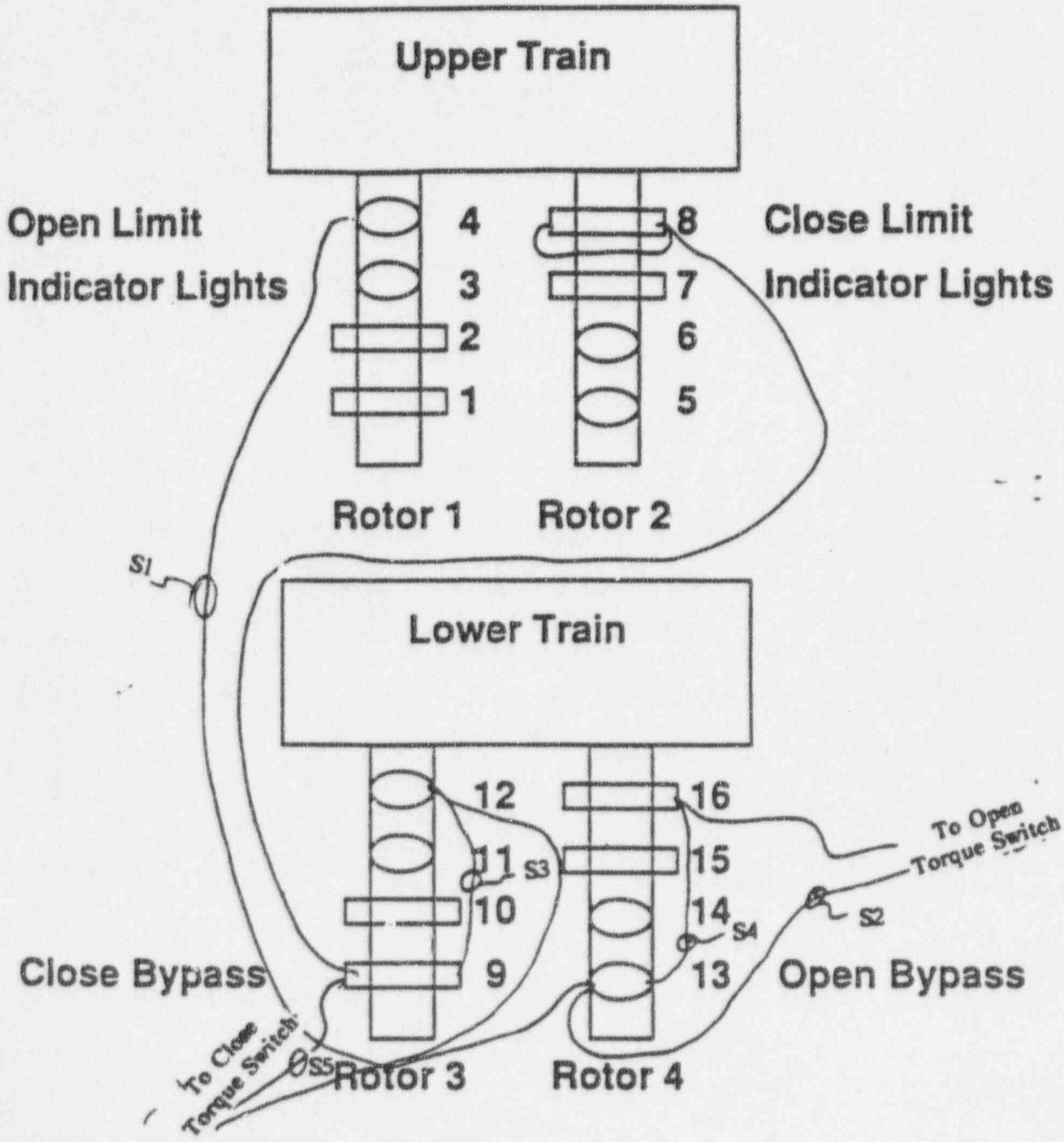

FIGURE 2. MOV CONTROL CIRCUIT WIRING INSTALLATION

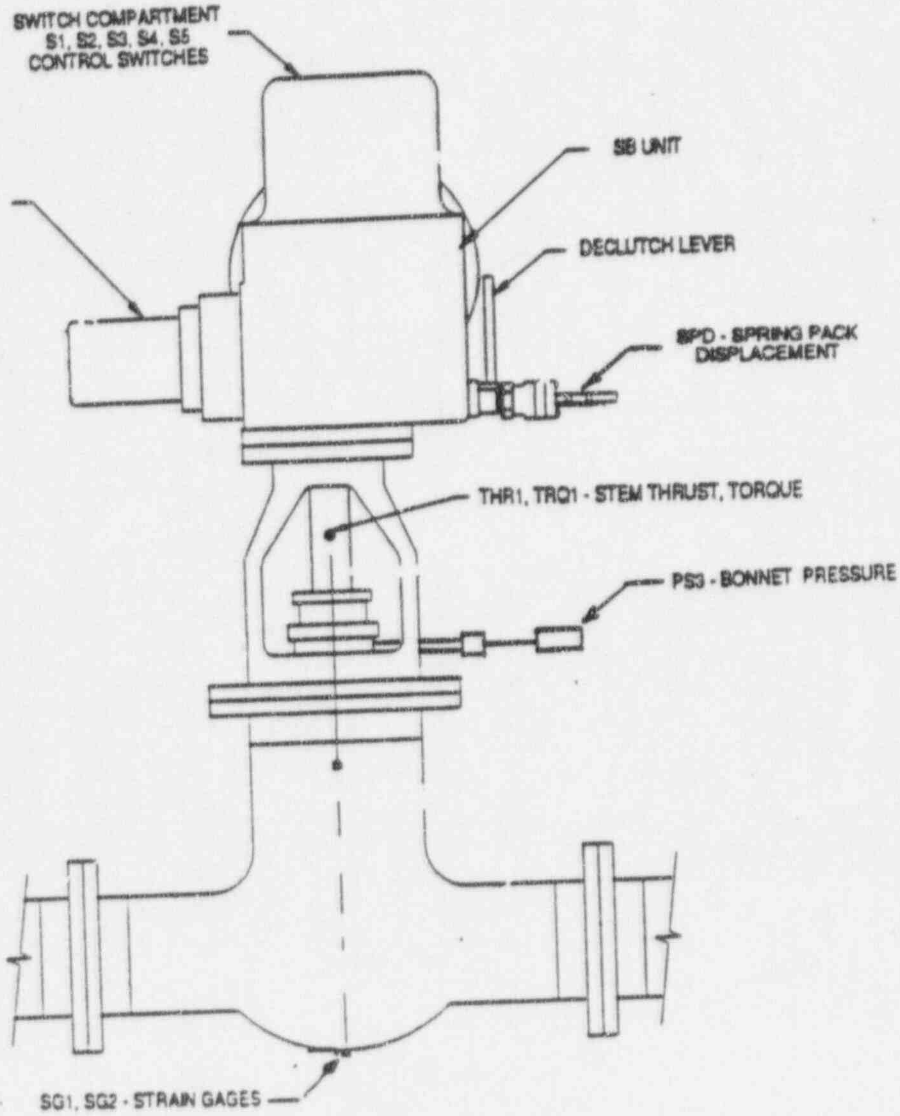

FIGURE 3A. TEST SPECIMEN, MOV INSTRUMENTATION FOR PRESSURE LOCK-UP AND FLOW LOOP DIFFERENTIAL PRESSURE TEST

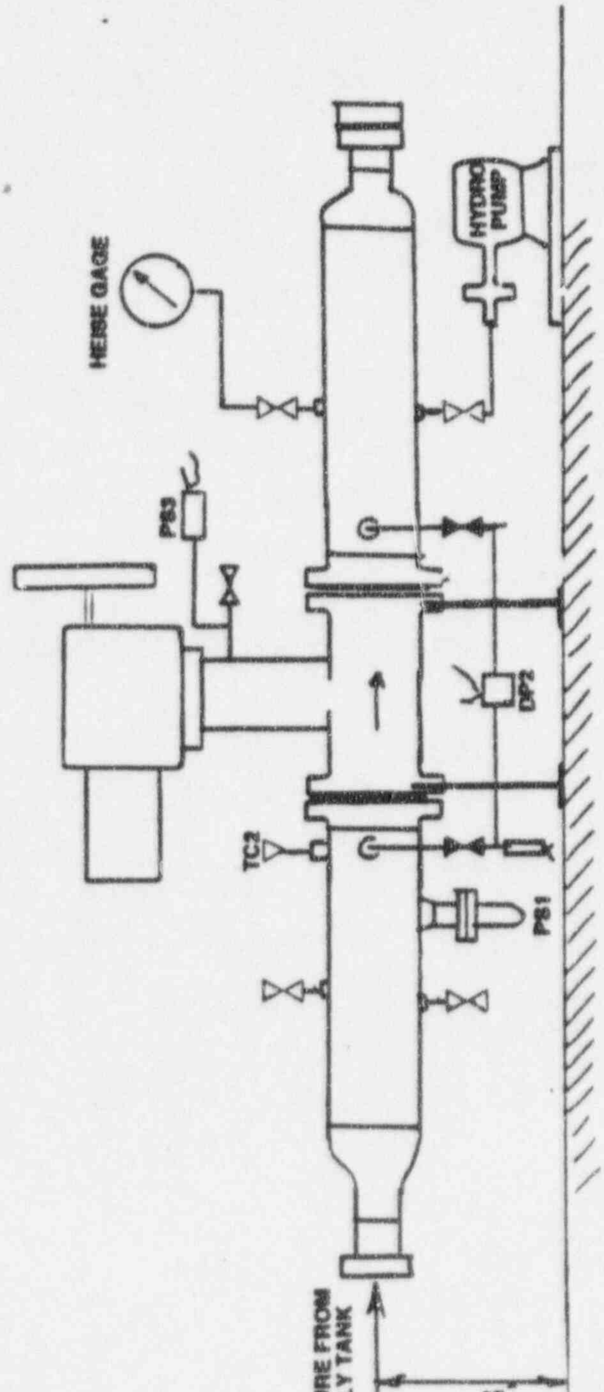

FIGURE 3B. INSTRUMENTATION AND TEST SCHEMATIC, PRESSURE TEST LOCK UP

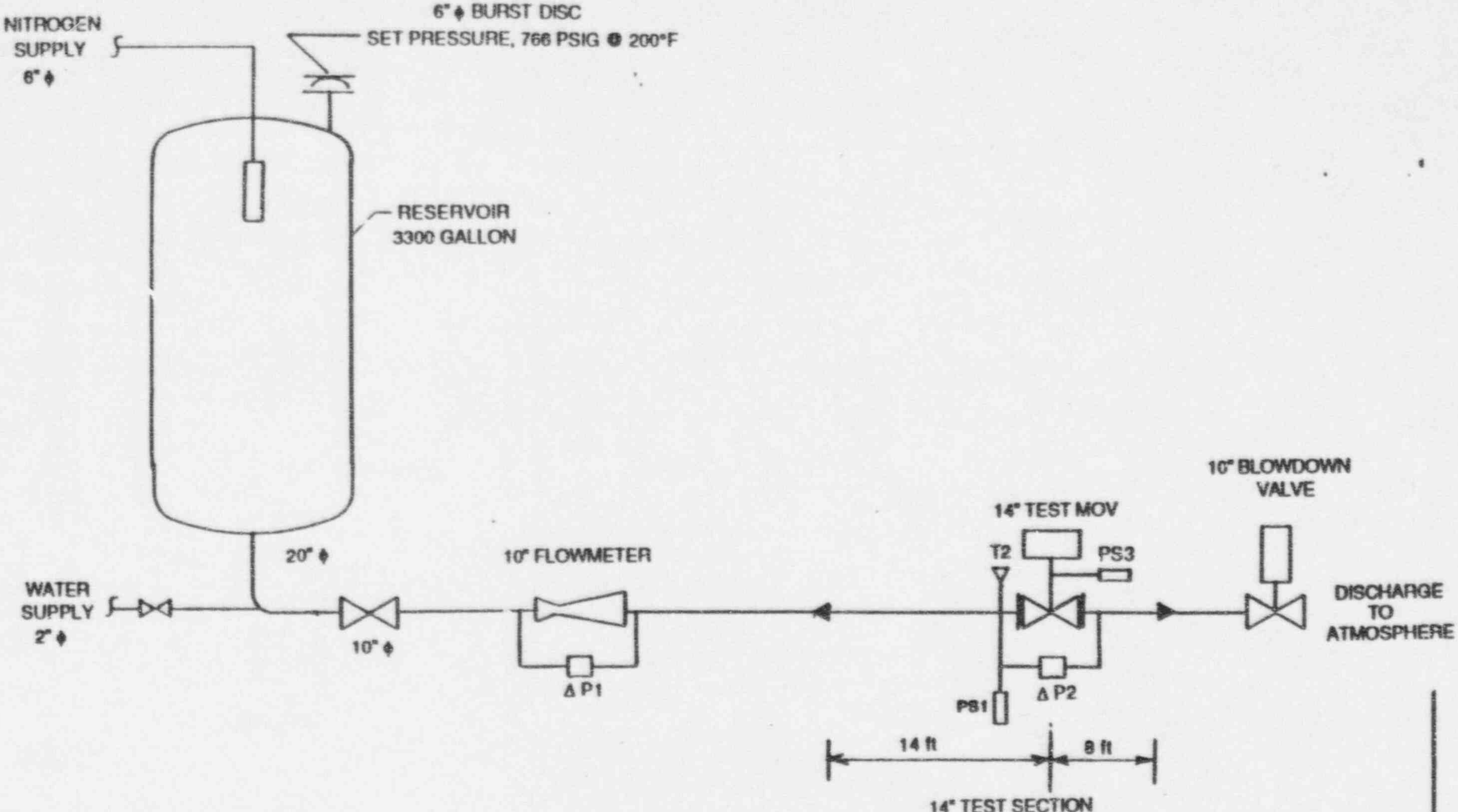

FIGURE 3C. FLOW LOOP INSTRUMENTATION

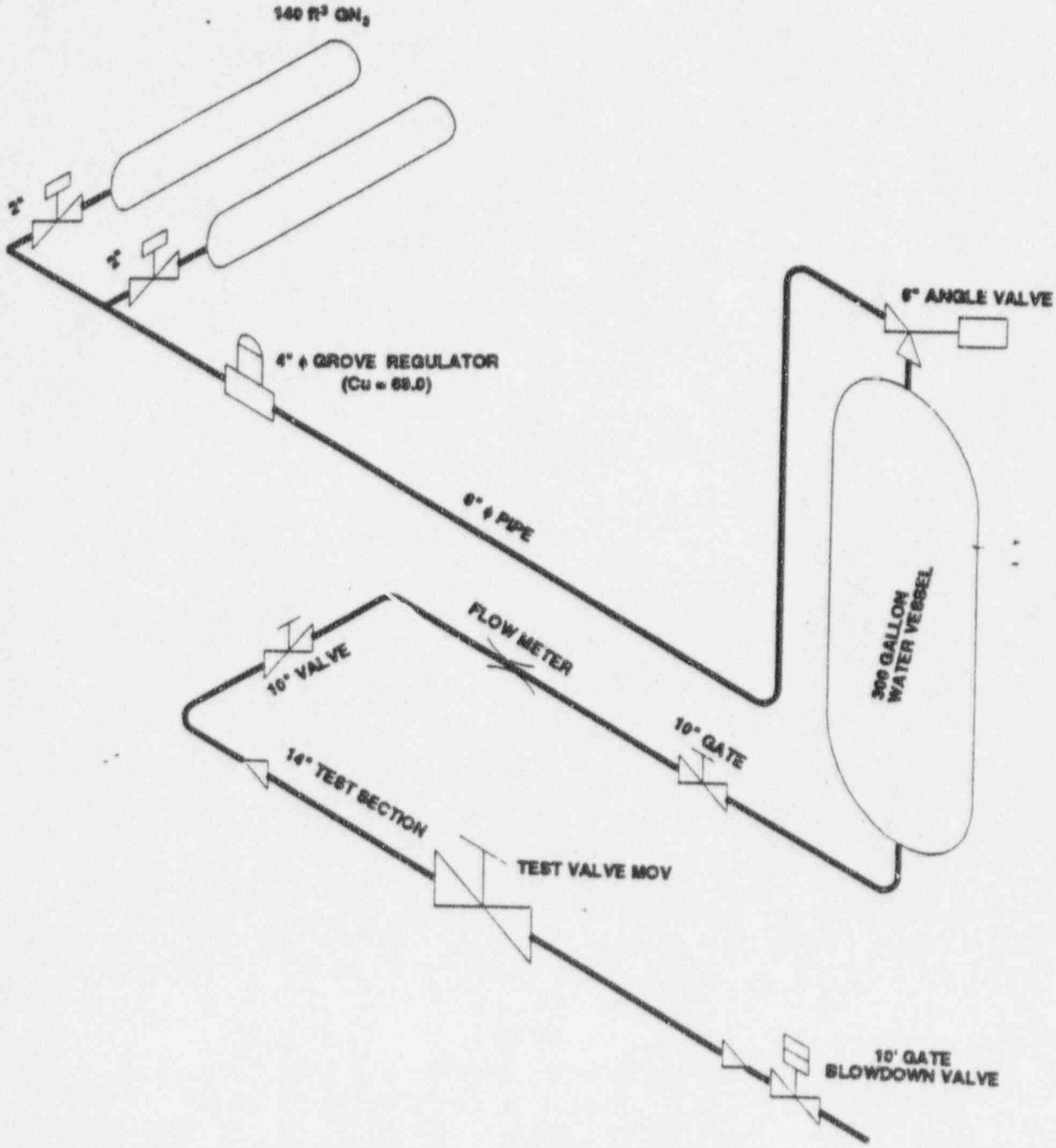

FIGURE 4. FLOW LOOP ISOMETRIC

APPENDIX I

NOTICES OF ANOMALY

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WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: January 4, 1993

NOTICE NO: 1 P.O. NUMBER: C-1015-28 CONTRACT NO: N/A

CUSTOMER: Entergy Operations (Grand Gulf) WYLE JOB NO: 43008

NOTIFICATION MADE TO: Dave Wilson NOTIFICATION DATE: December 28, 1992

NOTIFICATION MADE BY: G. Carbonneau VIA: Verbal

CATEGORY: ☒ SPECIMEN ☐ PROCEDURE ☐ TEST EQUIPMENT DATE OF ANOMALY: December 28, 1992

PART NAME: 14-Inch W. Powell Gate Valve PART NO. N/A

TEST: Pressure Lock Test I.D. NO. 67770-6

SPECIFICATION: Wyle Test Procedure 43008 PARA. NO. 6.3.3

REQUIREMENTS:

Test No.		Description
3)	a)	Connect hydrostatic pump to bonnet leak-off line and pressurize bonnet to 1080 psig. With inlet and outlet nozzles at 0 psig, stroke valve open. There will be an immediate drop-off of bonnet pressure upon unseating.

DESCRIPTION OF ANOMALY:

With 1080 psig applied to the bonnet, the valve was energized to stroke open. Torque switch trip occurred almost immediately. The valve would not open and the bonnet pressure remained at 1080 psig.

DISPOSITION - COMMENTS - RECOMMENDATIONS:

It was not possible to open the valve in this condition. Per Grand Gulf instruction, Wyle proceeded with Test Nos. 4) and 5) during which the valve opened against pressure. These results are being reported to Grand Gulf for information.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: Dave Wilson

REPRESENTING: Entergy Operations

QUALITY ASSURANCE: Duane [signature] 1/4/93

PROJECT ENGINEER: G. Carbonneau [signature] 1/4/93

PROJECT MANAGER: H. Jordan [signature] 1/4/93

INTERDEPARTMENTAL COORDINATION:

WYLE LABORATORIES (Eastern Operations)

NOTICE OF ANOMALY

DATE: February 15, 1993

NOTICE NO: 2 P.O. NUMBER: C-1015-28 CONTRACT NO: N/A

CUSTOMER: Entergy Operations/Grand Gulf WYLE JOB NO: 43008

NOTIFICATION MADE TO: Doug Jones NOTIFICATION DATE: February 11, 1993

NOTIFICATION MADE BY: G. Carbonneau VIA: Telephone

CATEGORY: ☐ SPECIMEN ☐ PROCEDURE ☒ TEST EQUIPMENT DATE OF ANOMALY: 12/31/92-1/11/93

PART NAME: Press. Transducer - PS1 and Diff. Press. Trans. DP2 PART NO. Wyle Nos. 061952 & 021577

TEST: Flow Loop Differential Pressure Test I.D. NO. 10555 & 039101

SPECIFICATION: WLTP 43008 PARA. NO. 7.2

REQUIREMENTS:

7.2 Test Data

All recordings shall be reviewed for accuracy and quality after each test.

DESCRIPTION OF ANOMALY:

Review of recordings resulted in several repeat strokes until desired level of accuracy was obtained. Criteria used was stability of pressure and flow rate during stroking.

During several runs which were accepted as valid runs by test, the valve inlet pressure (PS1) and in one case 14(H), the differential pressure (DP2) exceeded the saturation limit of the transducer/electronic. These runs included:

Vertical (V): Strokes 02, 16, 19, and 20
Horizontal (H): Stroke 11, 13, 15, and 19

DISPOSITION - COMMENTS - RECOMMENDATIONS:

These anomalies occurred during strokes requiring a differential pressure of 500 psig. During these tests, the valve inlet, valve differential, and bonnet pressures rose to values exceeding 590 psig, the electronic saturation of PS1.

NOTE: IT IS THE CUSTOMER'S RESPONSIBILITY TO ANALYZE ANOMALIES AND COMPLY WITH 10 CFR PART 21.

VERIFICATION:

TEST WITNESS: N/A

REPRESENTING: N/A

QUALITY ASSURANCE: R Hamilton 2/23/93

PROJECT ENGINEER: G. Carbonneau 2/22/93
G. Carbonneau, P.E.

PROJECT MANAGER: Herschel Jordan 2/23/93
H. Jordan

INTERDEPARTMENTAL COORDINATION:

APPENDIX II

McPHERSON OIL PRODUCTS' CERTIFICATE OF CONFORMANCE

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McPherson Oil Products

P.O. Box 1803 Decatur, Alabama 35602 (205) 353-3163

Date of Delivery: December 21, 1992

To Whom it may Concern:

The product delivered by McPherson Oil Company on Purchase order # 4-1977 and McPherson Oils Invoice # 92530 to Wyle Laboratories on the 21st day of December 1992 is Mobilux EP 1.

Ray Ward

Ray Ward
McPherson Oil Co.

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APPENDIX III

PHOTOGRAPHS

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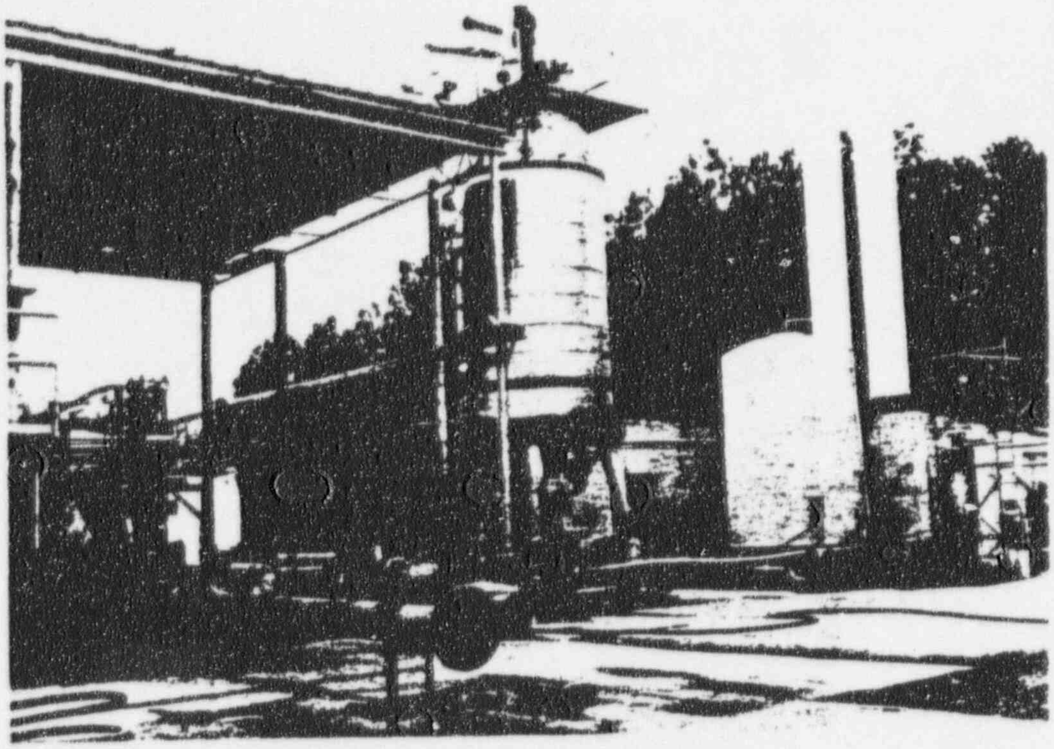
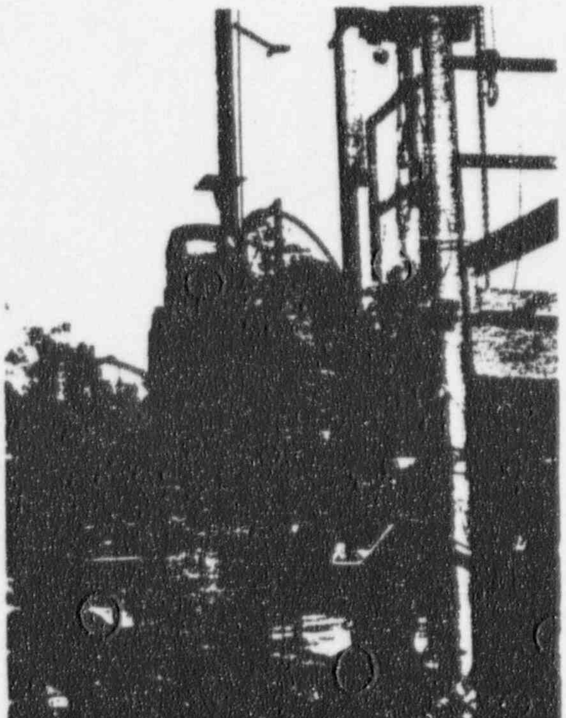


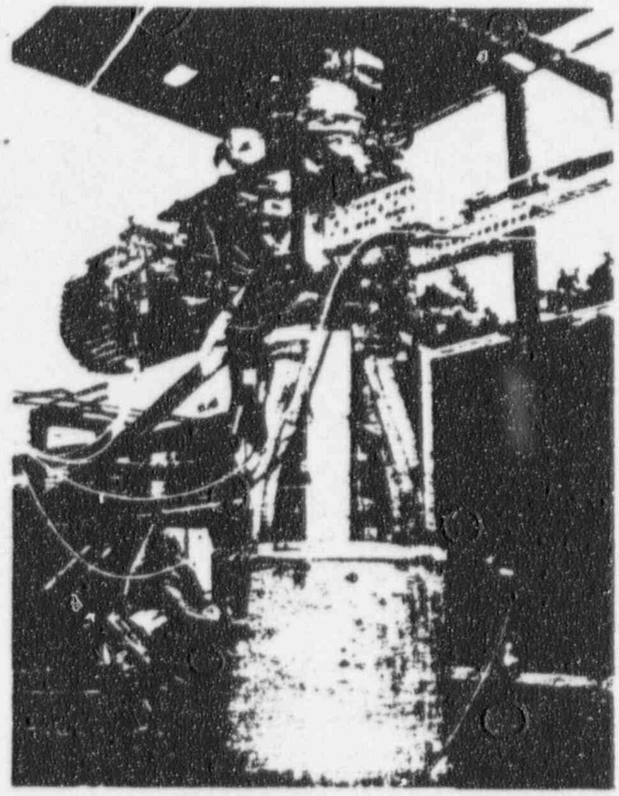
PHOTOGRAPH 1

VIEW OF FLOW LOOP FACILITY



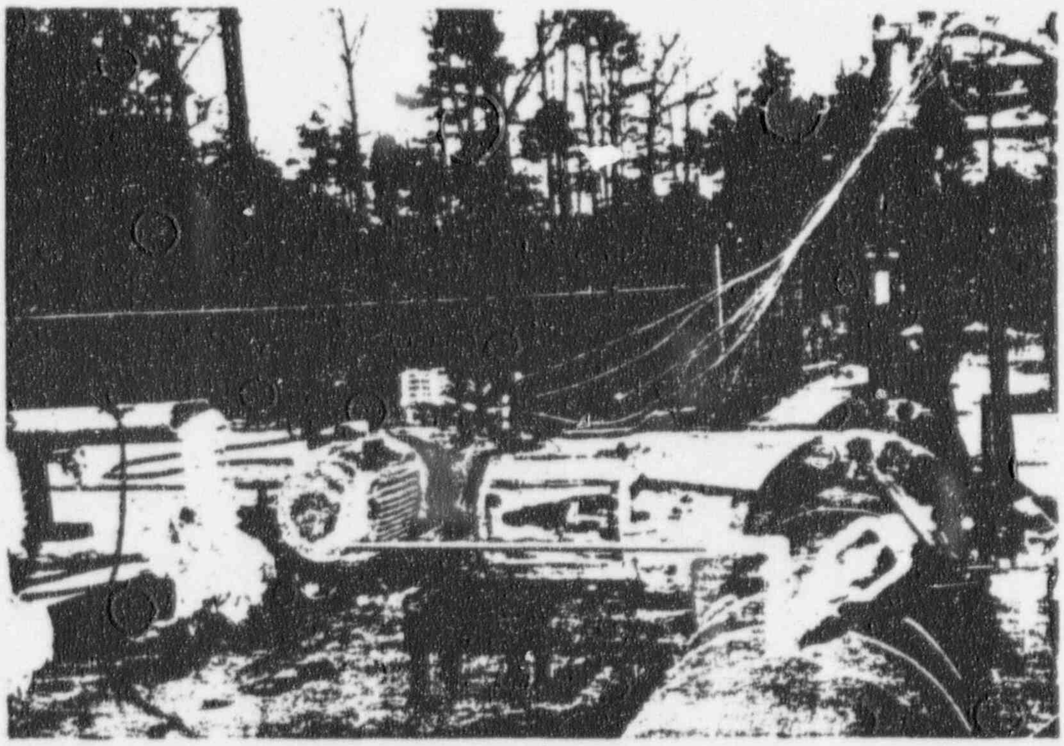
PHOTOGRAPH 2

VALVE INSTALLATION - VERTICAL MODE



PHOTOGRAPH 3

VALVE INSTALLATION - MOV INSTRUMENTATION



PHOTOGRAPH 4

VALVE INSTALLATION - HORIZONTAL MODE

APPENDIX IV

TELEDYNE SMART STEM DATA

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PACKING LIST

P.L. NO: 30829/001	DATE 12/15/92
SHIP TO: Wyle Laboratories 7800 Governors Drive Huntsville, AL 35806 Attn: Sherwyn Hyten	PROJECT NO. 30829 P.O. NO. 4-1727-P SHIP VIA UPS RED [X] PREPAID [ ] COLLECT

QUANTITY	DESCRIPTION	WEIGHT
1	SMARTSTEM^{tm}, S/N 67770-6 with Stem Nut	

REPORT OVERAGE, SHORTAGE, DAMAGE TO PURCHASING AGENT:
TELEDYNE ENGINEERING SERVICES · 10 FORBES ROAD · WOBURN, MA 01801-2103

SPECIAL INSTRUCTIONS, DOCUMENTATION TO BE INCLUDED	RELEASE FOR SHIPMENT	
Certificates of Calibration Certificate of Traceability Certificate of Conformance Bending Data Sheet	QAE [signature]	DATE 12/15/92
	TOTAL VALUE	
	DATE SHIPPED	SHIPPER
	SHIPPER B/L NO.	
	RECEIVED BY	DATE

cc: Project Manager
Purchasing Agent
PQAE

10/92

TELEDYNE
ENGINEERING SERVICES

A DIVISION OF TELEDYNE BROWN ENGINEERING
513 MILL STREET, POST OFFICE BOX 288
MARION, MASSACHUSETTS 02738-0288
(508) 748-0103 FAX (508) 748-2029

December 15, 1992
30829-1

CERTIFICATE OF CONFORMANCE

This will certify that the below identified product was calibrated under the rigid quality requirement of the referenced purchase order and applicable specifications. All direct and associated processing materials have been tested and approved.

All process and testing operations have been verified as acceptable by the Quality Assurance Department in conformance with the requirements of our Quality Program Manual and are certified to meet all general performance specifications of the referenced purchase order. Material has been controlled in accordance with the applicable requirements of 10CFR50, Appendix B and ANSI N45.2. The equipment listed is traceable to the National Institute of Standards and Technology (N.I.S.T.). Documentation in the form of test reports and Certificates of Conformance are on file and available for review upon request.

COMPANY NAME: Wyle Laboratories

PURCHASE ORDER NO.: 4-1727-P

Item No.	Quantity	Description	Serial No.
1	1	SMARTSTEM^{tm}	67770-6

CERTIFIED BY:

[signature] F/KMF
Kevin M. Fahey

TITLE: Quality Assurance Manager

DATE: 12/15/92

KMF/lac

TELEDYNE
ENGINEERING SERVICES

A DIVISION OF TELEDYNE BROWN ENGINEERING
513 MILL STREET, POST OFFICE BOX 288
MARION, MASSACHUSETTS 02738-0288
(508) 748-0103 FAX (508) 748-2029

December 15, 1992
30829-2

CERTIFICATE OF TRACEABILITY TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Client: Wyle Laboratories

Client Order No.: 4-1727-P

Date: December 15, 1992

THIS IS TO CERTIFY THAT:

The equipment listed is traceable to the National Institute of Standards and Technology (N.I.S.T.). Documentation in the form of test reports and Certificates of Conformance are on file and available for review upon request.

Equipment Under Test:

Manufacturer	Item	Serial No.
Teledyne Engineering Services	SMARTSTEM^{tm}	67770-6

Test Equipment Used:

Manufacturer	Serial No.	Item	N.I.S.T. Traceability No.
Teledyne Eng. Serv.	0588	Calibration Arm	247931
Fluke	3960089	Digital Multimeter	243273, WWVBTRS, 246764, 243183
BLH	2169	Precision Calibrator	246764, 243273 WWVBTRS
Measurements Group	91105, 98408 89845	Strain Indicator	246764, 243273 WWVBTRS

TELEDYNE ENGINEERING SERVICES

December 15, 1992
30829-3

CERTIFICATE OF CALIBRATION

Project No.: 30829

Client: Wyle Laboratories   Purchase Order No.: 4-1727-P

Type: Torque   Part No.: SMARTSTEM^tm   Capacity: 30,000 in-lbs   Serial No. 67770-6

Input Resistance: 351 Ω   Output Resistance: 351 Ω at 77°F ± 3°F

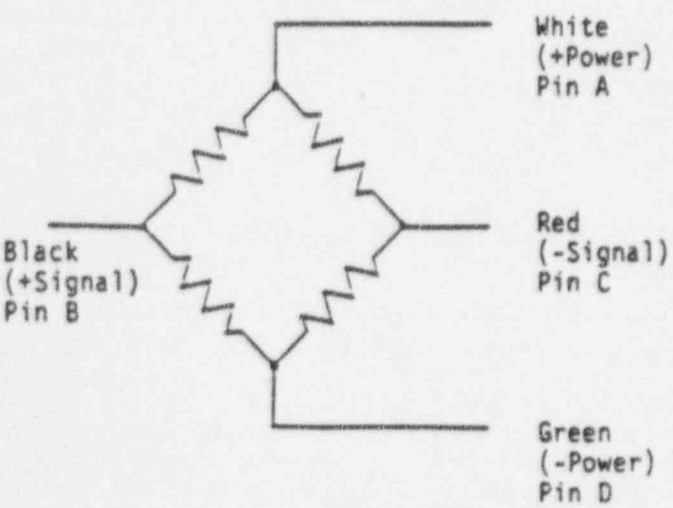
Bridge to Ground Resistance: >10 GΩ   Bridge to Shield Resistance: >10 GΩ

Zero Balance: +0.002 mv/v   Zero Return: <0.03 %   Linearity: <0.15 %

Hysteresis: <0.32 %   Repeatability: <0.06 %   Full Scale Output: +1.7470 mv/v CW; -1.7430 mv/v CCW

Temperature Compensation: <0.0025% F.S./°F

Excitation Voltage: 10 VDC



INPUT (in-lbs) LOAD	OUTPUT (mv/v) CW	OUTPUT (mv/v) CCW
0	0.0000	0.0000
6,000	0.3475	-0.3460
12,000	0.6975	-0.6950
18,000	1.0480	-1.0450
24,000	1.3980	-1.3940
30,000	1.7470	-1.7430
24,000	1.3995	-1.3955
18,000	1.0515	-1.0490
12,000	0.7020	-0.7005
6,000	0.3530	-0.3510
0	0.0005	-0.0005

Certified By: Technician: Douglas S. Brightman   Date: 12/15/92

Engineer: David L. Johnson   Date: 12/15/92

TELEDYNE ENGINEERING SERVICES

December 15, 1992
30829-4

CERTIFICATE OF CALIBRATION

Project No.: 30829

Client: Wyle Laboratories

Purchase Order No.: 4-1727-P

Type: Thrust Part No.: SMARTSTEMtm Capacity: 100,000 lbs Serial No. 67770-6

Input Resistance: 351 Ω Output Resistance: 352 Ω at 77°F ± 3°F

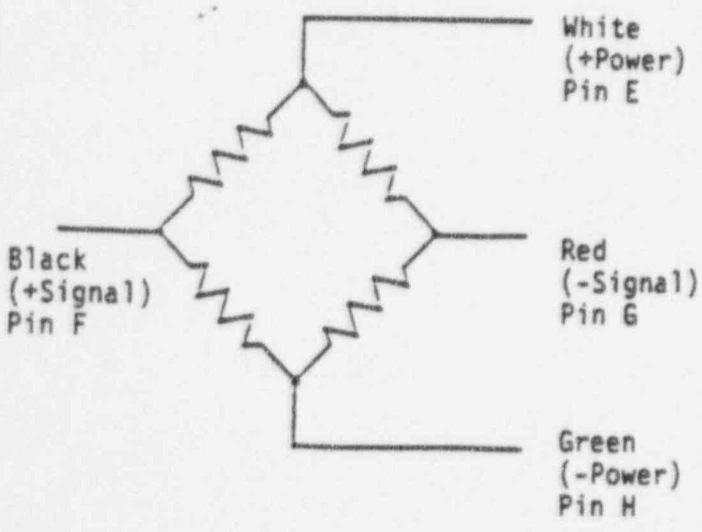
Bridge to Ground Resistance: >10 GΩ Bridge to Shield Resistance: >10 GΩ

Zero Balance: -0.0105 mv/v Zero Return: <0.01 % Linearity: <0.50 %

Hysteresis: <1.09 % Repeatability: <0.46 % Full Scale Output: +1.3870 mv/v Ten. -1.3355 mv/v Comp.

Temperature Compensation: <0.0025% F.S./°F

Excitation Voltage: 10 VDC



INPUT (lbs)	OUTPUT (mv/v)	
LOAD	TENSION	COMPRESSION
0	0.0000	0.0000
20,000	0.2725	-0.2710
40,000	0.5480	-0.5380
60,000	0.8275	-0.8045
80,000	1.1065	-1.0705
100,000	1.3870	-1.3355
80,000	1.1170	-1.0785
60,000	0.8400	-0.8175
40,000	0.5630	-0.5495
20,000	0.2840	-0.2775
0	0.0000	0.0000

Certified By: Technician: Douglas S. Brightman Date: 12/15/92

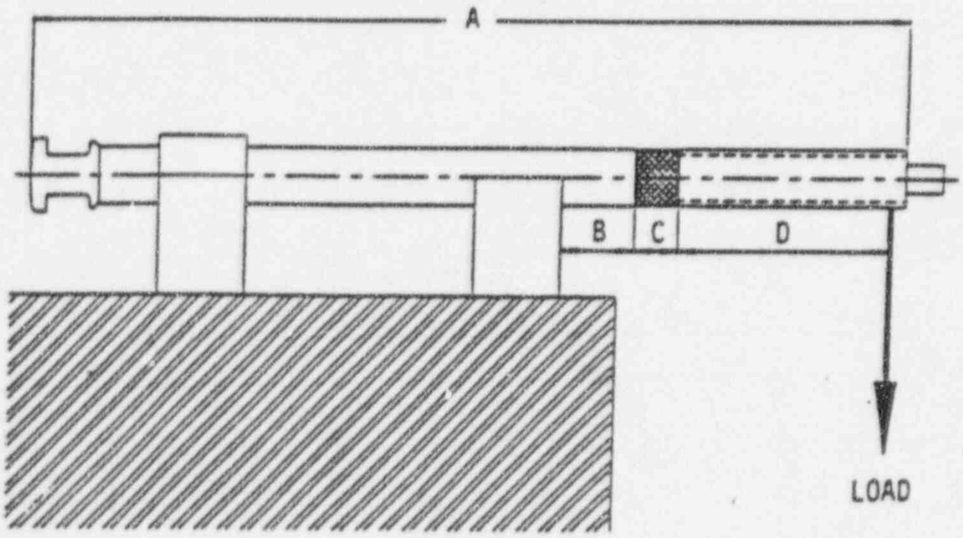
Engineer: David L. Johnson Date: 12/15/92

TELEDYNE ENGINEERING SERVICES

PROJECT NO.: 30829

DATE: 12-1-92 "as shipped" DJ

SMARTSTEM™ BENDING CHECK



STEM NO.: 67770-6 Load = 50 lbs.

A = 50.5" in. B = 2" in. C = 1" in. D = 21" in.

Full Scale Tension Output = 2774 μ in/in = 1.3870 mv/v @ 100,000 lbs.

Max. Output Due to Bending = 0 μ in/in = 0 mv/v

Corresponding Tension Load Due to Bending 0 lbs.

Percent of Full Scale 0 %

Performed By: [signature] Date: 12-1-92

DATA SHEET

Customer ~~EPRI~~ Entergy

Specimen 1 SMARTSTEM

Part No.

Spec.

Para.

S/N

GSI

Amb. Temp. N/A

Photo N/A

Test Med. N/A

Specimen Temp. N/A

WYLE LABORATORIES

Job No. ~~61921-00~~ 43008

Report No.

Start Date

Test Title 1 67770-6 SMARTSTEM BRIDGE RESISTANCE CHECKOUT

WIRE COLORS	THRUST	TORQUE
BLACK TO WHITE	263.4	263.4
BLACK TO RED	351.6	350.6
BLACK TO GREEN	263.0	262.7
WHITE TO RED	263.3	262.7
WHITE TO GREEN	350.8	350.6
RED TO GREEN	263.4	262.7
ALL TO GROUND	$>2.0 \times 10^7 \Omega$	$>2 \times 10^7 \Omega$
THRUST TO TORQUE	$>2.0 \times 10^7 \Omega$	
CALIBRATION DATA		
INPUT WHITE TO GREEN	351	351
OUTPUT BLACK TO RED	352	351

All readings are within spec

Tested By JHMorgan Date: 12/16/92

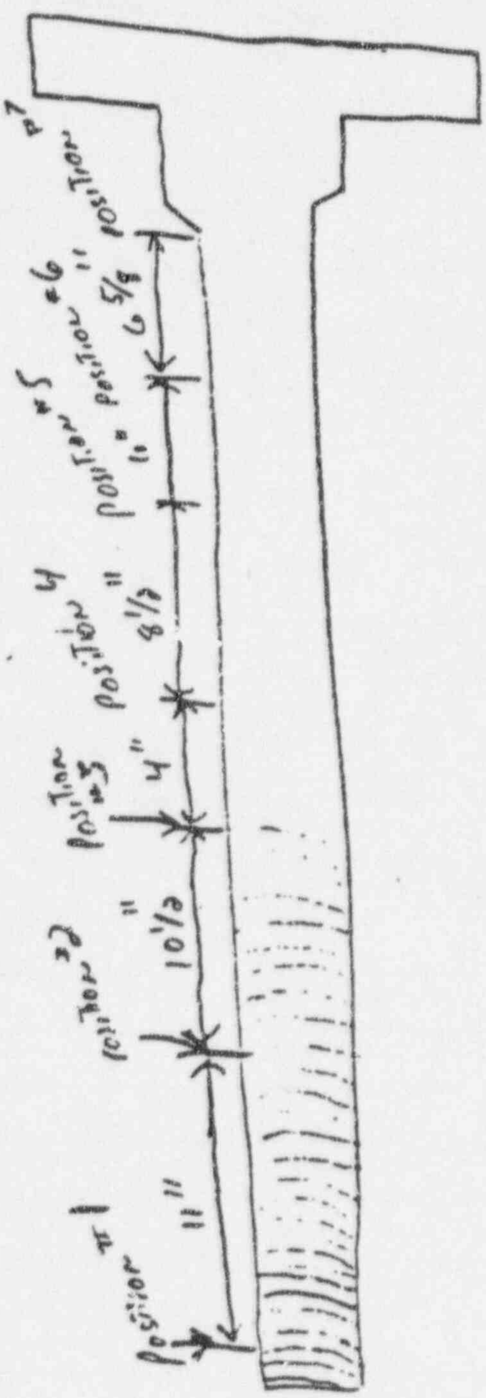
Witness Date:

Sheet No. of

Approved [signature] 12-16-92

Notice of Anomaly NA

Wyle Form WH 614A Rev. APR 84


Position #1
11"
Position #2
10 1/2"
Position #3
4"
Position 4
8 1/2"
Position #5
11"
Position #6
6 5/8"
Position 7

Type: O.D.
Name:

	ACTUAL	DEV
X	34.5001	-12.1249
Y	.0006	.0006
Z	-.0014	-.0014
DI	2.2442	2.2442
FM		.0002

ANSI CIRCULAR RUNOUT: To X axis, Radial
#14
Feature #36
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0021	.0021

RUN-OUT POSITION #6
#15
Feature #37
Type: O.D.
Name:

	ACTUAL	DEV
X	40.5000	-6.1250
Y	.0005	.0005
Z	-.0009	-.0009
DI	2.2443	2.2443
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#16
Feature #37
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0015	.0015

RUN-OUT POSITION #7
#17
Feature #38
Type: O.D.
Name:

	ACTUAL	DEV
X	46.5250	.0001
Y	0.0000	0.0000
Z	-.0003	-.0003
DI	2.2474	2.2474
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial
#18
Feature #38
Type: O.D.
Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0020		.0004	.0004

RO 0.0000 .0154 .0154

RUN-OUT POSITION #2

#7

Feature #33

Type: O.D.

Name:

	ACTUAL	DEV
X	11.3210	-35.3039
Y	.0027	.0027
Z	.0043	.0043
DI	2.2481	2.2481
FM		.0004

ANSI CIRCULAR RUNOUT: To X axis, Radial

#8

Feature #33

Type: O.D.

Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0077	.0077

RUN-OUT POSITION #3

#9

Feature #34

Type: O.D.

Name:

	ACTUAL	DEV
X	21.8209	-24.8041
Y	-.0005	-.0005
Z	.0002	.0002
DI	2.2399	2.2399
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial

#10

Feature #34

Type: O.D.

Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0012	.0012

RUN-OUT POSITION #4

#11

Feature #35

Type: O.D.

Name:

	ACTUAL	DEV
X	25.6250	-20.9999
Y	.0003	.0003
Z	-.0011	-.0011
DI	2.2435	2.2435
FM		.0003

ANSI CIRCULAR RUNOUT: To X axis, Radial

#12

Feature #35

Type: O.D.

Name:

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0015	.0015

RUN-OUT POSITION #5

#13

Feature #36

Rev: 00.01

Part Program:

Date and Time: 11/21/92 09:44
Inspector: J S MCCARLEY

Lot ID: 57770-5
Supplier/other: ENTERGY

ODA
#1

	ACTUAL	NOMINAL	DEV
X	22.5000	22.5000	0.0000
Y	0.0000	0.0000	0.0000
Z	0.0000	0.0000	0.0000
DI	2.2421	0.0000	2.2421
FM			.0002

ANSI CIRCULAR RUNOUT: To X axis, Radial
#2

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0002	.0002

ODB
#3

	ACTUAL	NOMINAL	DEV
X	46.6250	46.6250	0.0000
Y	0.0000	0.0000	0.0000
Z	0.0000	0.0000	0.0000
DI	2.2473	0.0000	2.2473
FM			.0001

ANSI CIRCULAR RUNOUT: To X axis, Radial
#4

	ACTUAL	NOMINAL	+ TOL	- TOL	DEV	OUT-TOL
RO			0.0000		.0001	.0001

RUN-OUT POSITION #1
#5
Feature #22
Type: O.D.
Name:

	ACTUAL	DEV
X	.8235	-45.8015
Y	.0053	.0053
Z	.0089	.0089
DI	2.2459	2.2459
FM		.0013

ANSI CIRCULAR RUNOUT: To X axis, Radial
#6
Feature #22
Type: O.D.

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APPENDIX V

INSTRUMENTATION EQUIPMENT SHEETS

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INSTRUMENTATION EQUIPMENT SHEET

Page No. 57
Test Report No. 43008-01

DATE: 12/16/92
TECHNICIAN: J. MORGAN

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: EPRI ROOM
TYPE TEST: SMARTSTEM CHECKOUT

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	DIG MTR	VALHALLA	4150	82123	101040	.02-2KOHM	.02%RDG	10/20/92	04/16/93
2	DIG MTR	FLUKE	77	24869343	101824	DC	.3%	04/02/92	04/02/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION J. Morgan 12/16/92

CHECKED & RECEIVED BY [signature] 12-16-92

Q.A. [signature] 12-16-92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/22/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW GRD 12-23-92
TYPE TEST: HYDROSTAT + PRETEST LLRT

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	STOP WATCH	VWR	62379	N/A	103028	9HR/59MIN/59SEC	.5SEC	09/19/92	03/18/93
2	PRESS GAUGE	HEISE	CM	111137	109427	0-1,500 PSI	.1% FS	12/22/92	06/18/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 12/22/92   CHECKED & RECEIVED BY [signature]

Q.A. Brenda Bannister 12/23/92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/23/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: PRECONDITIONING

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE :	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	265112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	80I-600	N/A	108474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	887	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Gene Duthie 12/23/92   CHECKED & RECEIVED BY [signature] 12/28/92

Q.A. Kevin M. Turner 12-28-92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/28/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: PRESSURE LOCK-UP

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	801-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	B87	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
19	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
21	PRESS XDUCER	CEC	N/A	10555	061952			08/11/92	02/05/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 12/28/92

CHECKED & RECEIVED BY [signature] 12/28/92

Q.A. [signature] 12-28-92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 12/29/92
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-053	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109513	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109514	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	07/22/92	01/18/93
13	PROBE CURRENT	FLUKE	801-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
14	LINEAR XDUCER	WATERS	SLF-S-75	B87	108929	0-3 INCH	.1%	07/22/92	01/18/93
15	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
18	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
19	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/05/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
21	PRESS XDUCER	CEC	N/A	10555	061952	0-500PSIA 9KC 2/4/93		08/11/92	02/05/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93
23	RESISTOR DEC	IET	RS-200	N/A	100955	1-10M OHM	1%	01/20/92	01/19/93
24	PRESS XDUCER	T HYDRONICS	TH-D	039101	021577	0-500 PSID	.5%	07/23/92	01/19/93
25	PRESS XDUCER	CEC	4-351	8562	109360	0-50 PSID	.75% FRO	07/23/92	01/19/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Connie Duthie 12/29/92 CHECKED & RECEIVED BY G.L. Calhoun 12/30/92

Q.A. Brenda Bosworth 12/30/92

INSTRUMENTATION EQUIPMENT SHEET

DATE: 01/04/93
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39616	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(60KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	XFORMER CURRENT	FLUKE	Y8101	N/A	103464	1A-150A	2.5%	12/01/92	05/28/93
13	PROBE CURRENT	FLUKE	80i-600	N/A	109474	1A TO 600A	2%	07/22/92	01/18/93
14	LINEAR XDUCER	WATERS	SLF-S-75	B67	108929	0-3 INCH	.1%	12/01/92	05/28/93
15	DATA ACQ SYS	OPTIM	6033A	S02197	109469	MFG	MFG	07/22/92	01/18/93
16	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	12/01/92	12/01/93
17	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	01/28/92	01/27/93
18	PROBE T/C	MEDTHERM	TC-K	1	105519	K	SEE CERT	12/03/92	12/03/93
19	PRESS XDUCER	B&H ELECTRONICS	6000-01	N/A	108375	0-2,500 PSIG	.15% FRO	12/15/92	06/11/93
20	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	11/06/92	05/05/93
21	PRESS XDUCER	CEC	N/A	10555	061952			12/08/92	06/04/93
22	DEADWGT TESTR	AMETEK	TQ-20	10710	092564	0- 2,000 PSI	.03%	08/11/92	02/05/93
23	RESISTOR DEC	IET	RS-200	N/A	100955	1-10K OHM	1%	06/24/92	06/24/93
24	PRESS XDUCER	T HYDRONICS	TH-D	039101	021577	0-500 PSID	.5%	01/20/92	01/19/93
25	PRESS XDUCER	T.HYDRONICS	TH-D	055403	109837	0-50 PSID	+-0.5%	07/23/92	01/19/93
								12/01/92	05/28/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION Graeme Duthie 1/4/93 CHECKED & RECEIVED BY [signature] 1/4/93

Q.A. Kevin M. Turner 1-8-93

- INSTRUMENTATION EQUIPMENT SHEET

DATE: 01/20/93
TECHNICIAN: G. DUTHIE

JOB NUMBER: 43008-00
CUSTOMER: ENTERGY

TEST AREA: HI FLOW
TYPE TEST: FLOW

NO.	INSTRUMENT	MANUFACTURER	MODEL #	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	CALIBR VOLT	TRANSMATION	1045	A39816	102233	99.99	.01%FS	11/11/92	05/10/93
2	DIG MTR	FLUKE	87	54140567	109698	DC VOLTS	.1%	06/04/92	06/04/93
3	CALIBR VOLT	DIGITEC	3110	651605	065112	0-100VDC	.01%	09/03/92	03/02/93
4	XDUCER POWER	OHIO SEMITRONIC	PC11-063	40725	021575	0-100A(80KW)	.5% FS	05/22/92	05/21/93
5	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43887	109612	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
6	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43888	109613	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
7	VOLT XDUCER	OHIO SEMITRONIC	VT7-010	43889	109614	0-600V 4-20MA	.5% FS	03/10/92	03/10/93
8	XFORMER CURRENT	FLUKE	Y8101	N/A	103603	1A-150A	2.5%	12/01/92	05/28/93
9	XFORMER CURRENT	FLUKE	Y8101	N/A	103609	1A-150A	2.5%	12/01/92	05/28/93
10	XFORMER CURRENT	FLUKE	Y8101	N/A	103610	1A-150A	2.5%	12/01/92	05/28/93
11	XFORMER CURRENT	FLUKE	Y8101	N/A	103459	1A-150A	2.5%	12/01/92	05/28/93
12	PROBE CURRENT	FLUKE	80i-600	N/A	109474	1A TO 600A	2%	12/01/92	05/28/93
13	LINEAR XDUCER	WATERS	SLF-S-75	887	108929	0-3 INCH	.1%	01/18/93	07/16/93
14	DATA ACQ SYS	OPTIM	5033A	S02197	109469	MFG	MFG	12/01/92	12/01/93
15	RES DECADE	IET	RS-201	N/A	109494	0-9,999,999OHMS	.1%	01/28/92	01/27/93
16	RESISTOR DEC	IET	RS-200	100276	100276	0-9,999,999 OHM	1%	12/03/92	12/03/93
17	PROBE T/C	MEDTHERM	TC-K	1	109519	K	SEE CERT	12/15/92	06/11/93
18	PRESS XDUCER	B&H ELECTRONICS	5000-01	N/A	108375	0-2,500 PSIG	.15% FRO	11/06/92	05/06/93
19	PRESS XDUCER	B&H ELECTRONICS	N/A	N/A	100411	0-1,000 PSIA	.25%FS	12/08/92	06/04/93
20	PRESS XDUCER	CEC	N/A	10555	061952			08/11/92	02/05/93
21	DEADWGT TESTR	AMETEK	TQ-20	1071C	092564	0- 2,000 PSI	.03%	06/24/92	06/24/93
22	RESISTOR DEC	IET	RS-200	N/A	100955	1-10M OHM	1%	01/18/93	01/18/94
23	PRESS XDUCER	T.HYDRONICS	TH-D	055403	109837	0-50 PSID	+-0.5%	12/01/92	05/28/93
24	PRESS XDUCER	T-HYDRONICS	TH-D	048869	021580	0-500 PSID	.5% FRO	01/08/93	07/07/93
25	XFORMER CURRENT	FLUKE	Y8101	N/A	103600	1A-150A	2.5%	01/08/93	07/07/93

This is to certify that the above instruments were calibrated using state-of-the-art techniques with standards whose calibration is traceable to the National Institute of Standards and Technology.

INSTRUMENTATION [signature] 1-20-93

CHECKED & RECEIVED BY [signature] 1-20-93

Q.A. [signature] 1/21/93

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APPENDIX VI

BADGER FLOW METER DATA

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Badger Flow Meter

$$Q_{gH} = 340.11\ (S)\ (FA)\ (D2)\ (FHM)\ (FGB)\ (FGF)$$

where Q_{gH} = Flow (gallons per hour)
- S = Orifice factor = 0.71365
- FA = Orifice Area Correction Factor = 1.00111
- D2 = Pipe I.D. Squared = 82.15609
- FHM = Square Root of Differential Pressure (inches of water)
- FGB = Base Specific Gravity = 1.01772 $\left(\frac{1}{G_b}\right)$
- FGF = Flowing Specific Gravity = 0.99125 $\left(\sqrt{G_f}\right)$

$$Q_{gpm} = Q_{gH} \div 60$$

$$Q_{gpm} = \frac{340.11}{60}(0.71365)(1.00111)(82.15609)\left(\sqrt{\Delta P_{H_2O}}\right)(1.01772)(0.99125)$$

$$Q_{gpm} = 335.6498769 * \sqrt{\Delta P_{H_2O}}$$

$IN_{H_2O}^{68°F} = 27.728746 * PSI$

$psi = 0.036063657 * IN_{H_2O}^{68°F}$

$$Q_{gpm} = 335.6498769 * \sqrt{\Delta P_{psi} * 27.728746}$$

$$Q_{gpm} = 335.6498769 * 5.26580915 * \sqrt{\Delta P_{psi}}$$

$$Q_{gpm} = 1767.468 * \sqrt{\Delta P_{psi}}$$

ΔP_{H_2O} 68°F	Flow (gpm)		ΔP psi	Flow (gpm)
719	9000.	⇒	25.92976938	9000.173607
704.7	8910.		25.41405909	8910.223079
690.5	8820.		24.90195516	8819.993864
676.5	8730.		24.39706396	8730.122587
7.182	900.0		0.259009185	899.5165163

Badger Meter, Inc.

P.O. BOX 5[illegible]
6116 EAST 15[illegible] STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 / FAX: (918) 832-9962

DIFFERENTIAL ELEMENT
PRIMARY DATA/CALCULATION SHEET
WATER CALCULATION - VOLUMETRIC FLOW

DATE	11-2[illegible]-1992
BADGER S.O.NO.	954440
CUSTOMER	WYLE LABS
CUSTOMER P.O.NO.	4-5448-P
USER	
CONSULTING ENGR.	

LO-LOSS DATA

LO-LOSS STYLE	PMT-F	SERIAL NO.	954440-B
NOMINAL SIZE	10	TAG	
THROAT DIA (IN.)	7.695	BODY MATERIAL	CARBON STEEL
BETA RATIO	.849	THROAT MATERIAL	CARBON STEEL
TAP SIZE	1/2		
TAP LOCATION	INTEGRAL	PIPESHELL MATERIAL	CARBON STEEL

DIFFERENTIAL PRESSURE IS 718.95 INCHES OF WATER AT 9000 GPM.
PERMANENT PRESSURE LOSS IS 2.22 % OF DIFFERENTIAL.
PERMANENT PRESSURE LOSS IS 16.01 INCHES OF WATER AT 9000 GPM.

FLUID DATA

FLUID	WATER	OPER.SP.GR.	.98258
OPER.PRES.(PSIA)	514.7	BASE SP.GR.	.98258
OPER.TEMP.(F)	150	OPER.VISC.(CP)	.426
BASE TEMP.(F)	150		

FLOW DATA

MAX.FLOW (GPM)	9000	PIPE REYNOLDS NO.	7219794
NORM.FLOW (GPM)	6300	PIPE REYNOLDS NO.	5053856

CUSTOMER PIPELINE & FLANGE DATA

NOM.PIPE SIZE	10	PIPE MATERIAL	METAL
PIPE SCHED/CLASS	120	PIPE I.D. (IN.)	9.064

APPLICABLE DOCUMENTS

INSTALLATION/APPROVAL	PRODUCTION

REFERENCE FLOW METER ENGINEERING HANDBOOK, C.F.CUSICK, 3RD ED., 1961

CERTIFIED CORRECT BY , DATE

PREPARED BY JIM

Badger Meter, Inc.

P.O. BOX 581390
6116 EAST 15th STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 • FAX: (918) 832-9962

DIFFERENTIAL ELEMENT
SUPPLEMENTARY DATA SHEET
WATER CALCULATION - VOLUMETRIC FLOW

DATE	11-25-1992
BADGER S.O.NO.	954440
CUSTOMER	WYLE LABS
CUSTOMER P.O.NO.	4-5448-P
USER	
CONSULTING ENGR.	

LO-LOSS DATA

LO-LOSS STYLE	PMT-F	SERIAL NO.	954440-B
NOMINAL SIZE	10	TAG	

WORKING EQUATION FOR LIQUID FLOW
GAL/HR AT BASE TEMPERATURE

QGH=340.11(S)(FA)(D2)(FHM)(FGB)(FGF). (EQ 15, PG 95)

QGH = 540000	FHM = 26.8133
S = .71365	FGB = 1.01772
FA = 1.00111	FGF = .99125
D2 = 82.15609	

REYNOLDS NO. EQUATION FOR LIQUID FLOW
GAL/HR AT BASE TEMPERATURE

RD=52.654(QGHA)(GB)/(D)(U). (EQ 20, PG 97)

QGHA = 378000	D = 9.064
GB = .98258	U = .42692

DISCHARGE COEFFICIENT = .68639

Badger Meter, Inc.

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6116 EAST 16th STREET
TULSA, OKLAHOMA 74158-1009
(918) 836-8411 • FAX: (918) 832-9962

DIFFERENTIAL METER

FLOW VS DIFFERENTIAL CALCULATIONS
ENGLISH UNITS

BADGER S.O.	954440
DATE	11-25-1992
CUSTOMER	WYLE LABS
ELEMENT	9.059999 X 7.695 PMT-F LO-LOSS
SERIAL NO(S)	954440-B
TAG INFO.	

FLUID	WATER	THROAT I.D.(IN)	7.695
OPER.TEMP.(F)	150	PIPE I.D.(IN)	9.059999
OPER.PRES.(PSIA)	514.7		

RESOLUTION	1 PERCENT OF MAXIMUM
DIFF.UNITS	INCHES OF 68F WATER

FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)	FLOW (GPM)	DIFF (IN)
9000.	719.0	8910.	704.7	8820.	690.5	8730.	676.5
8640.	662.6	8550.	648.9	8460.	635.3	8370.	621.9
8280.	608.6	8190.	595.4	8100.	582.4	8010.	569.5
7920.	556.8	7830.	544.2	7740.	531.8	7650.	519.5
7560.	507.3	7470.	495.3	7380.	483.4	7290.	471.7
7200.	460.1	7110.	448.7	7020.	437.4	6930.	426.3
6840.	415.3	6750.	404.4	6660.	393.7	6570.	383.1
6480.	372.7	6390.	362.4	6300.	352.3	6210.	342.3
6120.	332.4	6030.	322.7	5940.	313.2	5850.	303.8
5760.	294.5	5670.	285.3	5580.	276.4	5490.	267.5
5400.	258.8	5310.	250.3	5220.	241.8	5130.	233.6
5040.	225.5	4950.	217.5	4860.	209.6	4770.	201.9
4680.	194.4	4590.	187.0	4500.	179.7	4410.	172.6
4320.	165.6	4230.	158.8	4140.	152.1	4050.	145.6
3960.	139.2	3870.	132.9	3780.	126.8	3690.	120.8
3600.	115.0	3510.	109.3	3420.	103.8	3330.	98.41
3240.	93.16	3150.	88.06	3060.	83.09	2970.	78.28
2880.	73.60	2790.	69.08	2700.	64.69	2610.	60.45
2520.	56.35	2430.	52.40	2340.	48.59	2250.	44.92
2160.	41.40	2070.	38.02	1980.	34.78	1890.	31.69
1800.	28.75	1710.	25.94	1620.	23.28	1530.	20.77
1440.	18.39	1350.	16.17	1260.	14.08	1170.	12.14
1080.	10.34	990.0	8.692	900.0	7.182		

PREDICTED DISCHARGE COEFFICIENT VS CALIBRATED DISCHARGE COEFFICIENT AND 2σ TOLERANCE COMPUTATION FOR LO-LOSS® FLOW TUBES.

SERIAL NO.	SIZE	RATIO	PRED. CD	CALIB. CD	% DEV.	LABORATORY*
32041	2	.704	.799	.7793	.038	ARL
28249	3	.743	.7635	.767	.458	UP
35687-9	4	.717	.76900	.76711	.2449	ARL
39706-1	4	.639	.80239	.80456	.2711	ARL
29088	6	.409	.873	.875	.229	UP
33565-1	6	.773	.74067	.74237	.230	ARL
35687-8	6	.573	.82532	.82433	.1193	ARL
33144	8	.472	.795	.7968	.226	ARL
35688-4	8	.710	.77105	.77034	.0910	ARL
42138-1	8	.459	.85738	.85799	.0707	ARL
42138-2	8	.459	.85738	.85753	.0170	ARL
42146-3	8	.459	.85738	.85407	.3865	ARL
42137-3	10	.612	.81122	.81401	.3445	ARL
42145-1	10	.612	.81122	.80891	.2845	ARL
42145-2	10	.612	.81122	.81260	.1707	ARL
32239B	12	.850	.689	.6886	.379	ARL
32282A	12	.73	.7595	.7598	.039	ARL
32282B	12	.73	.762	.7623	.039	ARL
32282C	12	.73	.768	.7672	.104	ARL
32282D	12	.73	.775	.7747	.038	ARL
32329A	12	.64	.7975	.796	.012	ARL
32329B	12	.64	.800	.8025	.312	ARL
32329C	12	.64	.805	.8061	.136	ARL
32329D	12	.64	.811	.8125	.184	ARL
32378A	12	.56	.8265	.8235	.362	ARL
32378B	12	.56	.828	.8298	.217	ARL
32378C	12	.56	.832	.8307	.156	ARL
32555A	12	.35	.885	.887	.225	ARL
32555B	12	.35	.887	.8886	.180	ARL
32555C	12	.35	.890	.8875	.280	ARL
32555D	12	.35	.893	.893	0	ARL
32557B	12	.47	.857	.8556	.163	ARL
32557C	12	.47	.8585	.8555	.349	ARL
30169	14	.754	.7505	.754	.466	ARL
35687-1	16	.645	.79887	.79944	.0708	ARL
37162-2	16	.584	.82047	.81838	.2543	ARL
29291	18	.768	.7385	.735	.473	UP
27385	20	.622	.8035	.800	.373	ARL
29213	20	.629	.801	.799	.249	ARL
32268	20	.790	.7435	.7427	.180	ARL
33294	20	.798	.73933	.7366	.369	ARL
H37395-1	20	.583	.81569	.81385	.2266	ARL
33751-2	24	.424	.86600	.86559	.0471	ARL
85044C	24	.614	.81004	.81330	.402	ARL
37162-1	30	.742*	.75409	.75556	.1953	ARL
80715	30	.750	.74926	.74890	.048	ARL
906-7603	30	.749	.75184	.75112	.0959	ARL
80753	36	.662	.79150	.79260	.139	ARL

NO. OF CALIBRATIONS = 48 = n

2σ = COEFFICIENT TOLERANCE = ± .4915%

$$\sum_{i=1}^{n} (\%\ DEV_i)^2 = 2.89[illegible]48$$

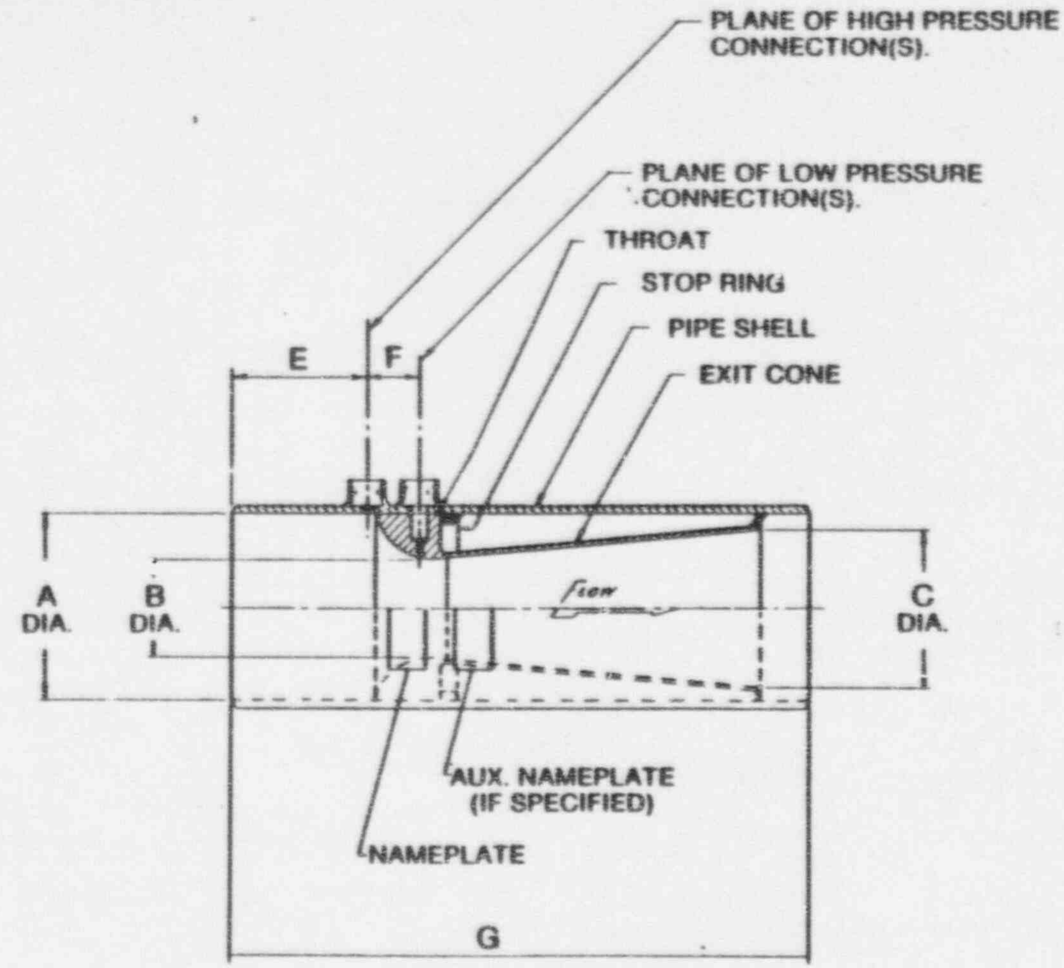
* ARL - ALDEN RESEARCH LABORATORIES, HOLDEN, MASS.

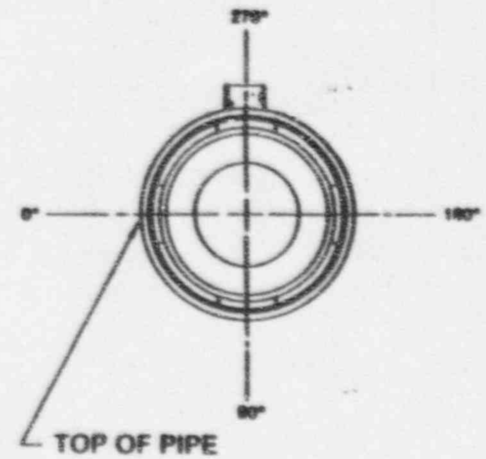
UP - UNIVERSITY OF PENNSYLVANIA

$$\sigma = \sqrt{\sum_{i=1}^{n} (\%\ DEV_i)^2/n-1} = .24807$$

Badger Meter, Inc. Precision Products Division
6116 East 15th Street, Tulsa, Oklahoma 74112
(918) 836-8411

CD-950525 | 01





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Test Report No. 43008-01

NOTE:
FOR DIMENSIONS, MATERIALS OF CONSTRUCTION AND ALL OTHER PERTINENT INFORMATION REFER TO DATA SHEET FURNISHED WITH THIS DWG.
IN HORIZONTAL PIPE RUNS INSTALL TUBE SO THAT THE WORD "TOP" ON THE NAMEPLATE IS AT THE TOP OF THE PIPE.

BADGER METER, INC.

PMT-F 7 Butt Weld End Solid Throat

INSTALLATION DIMENSIONS

01 | S | 3-6-79

Paxx 3-6-79

1 of 1

CD-950525 | 01

Chapter II-V

Tolerances

II-V-1 Tolerances. Their Significance. Except by accident, no two meters, even of the same type, are likely to give *exactly* the same indication when the same quantity of fluid is flowing through each. The degree to which this applies is not the same for all types of meters, applying least to the displacement types and more to the differential-pressure types. For this reason, "tolerances" are assigned to the values of the factors entering into the metering of fluids. (The expressions, "limit of accuracy" or "per cent uncertainty," might well be substituted for "tolerance.") Tolerances have to do with those practically unavoidable differences between ostensibly duplicate primary elements. They do *not* refer to accidental errors of observation, concerning which no general predictions are possible.

In any one measurement, the probability is very small that the departures from 100 per cent accuracy in the individual items will all affect the final result in the same direction; hence, from mathematics, the overall tolerance will be the square root of the sum of the squares of the tolerances on (departures of) the individual factors. In other words, an overall tolerance determined in this way is the most probable amount of departure from the actual quantity, with there being as much chance that the departure will be smaller than larger than this amount.

II-V-2 There have been a number of procedures used for evaluating or assigning tolerances with the result that the per cent uncertainty assigned to an item by one worker has not been exactly comparable to that assigned by another to the same item. In order to provide a uniform basis for assigning numerical values to tolerances, the committee on Fluid Flow Measurement of the International Organization for Standardization (ISO/TC-30) has adopted the following procedure:

1. The numerical value of a tolerance shall be twice the standard deviation.
2. The standard deviation is to be computed as follows: Sum up the squares of the deviations with respect to *the most probable value;* divide by the number of observations minus one; take the square root of this quotient.

This procedure has been followed in evaluating the tolerances given in this edition of *Fluid Meters.* The *most probable values* of the discharge coefficients of square-edged orifices are, to date, the values computed by equations (II-III-1) through (II-III-6), or read from Tables II-III-2, II-III-3 and II-III-4. Similarly, for flow nozzles used with pipe-wall taps, the most probable values are those computed by equation (II-III-12) or read from Table II-III-5. For low-ratio nozzles with the downstream tap in the throat, the most probable values are those read from the curve of Fig. II-III-19. For Venturi tubes, the most probable values are given in Pars. I-5-35 and II-III-42.

The tolerance values given in Tables II-V-1 and II-V-2 are those recommended as applying to uncalibrated primary elements. When a primary element is calibrated, the tolerance to be used should be computed from the calibration data by the procedure described above.

II-V-3 Prior to the editing of the fifth edition of *Fluid Meters*, tolerance values given by this committee and also by the Gas Measurement Committee of the American Gas Association in their Report

No. 3 were not derived by an evaluation of the standard deviation. Instead, the arithmetic average of the departures of the test values from the correlation curves was computed, and this value, without being doubled, was reported as the tolerance for the particular item. It is of interest that those arithmetic average values are very close to the values of σ obtained in the recent correlation, which is the basis for some of the tolerances given here [1].

II-V-4 The application of the tolerances in the tables and the computation of the overall tolerance to which the measurement of the flow of a fluid may be subject are illustrated by two examples. In doing this the extent or power to which the separate factors affect the total tolerance is taken into account.

Item	*Tolerance (per cent)*	*Effect Factor*	*Square*
Tolerance for Example II-IV-2			
Orifice diameter, d	± 0.08	2	0.0256
Differential pressure, h_w	± 0.25	½	0.0156
Evaluation of density, ρ_1	± 0.50	½	0.0625
Coefficient, C	± 1.1	1	1.21
Expansion factor, Y_1	± 0.5	1	0.25
Area factor, F_a	± 0.02	1	0.0004
			1.5641
Overall tolerance	± 1.25		
Tolerance for Example II-IV-6			
Throat diameter, d	± 0.08	2	0.0256
Differential pressure, h_w	± 0.10	½	0.0025
Value of density, ρ	± 0.10	½	0.0025
Coefficient, C	± 0.70	1	0.49
			0.5206
Overall tolerance	± 0.72		

II-V-5 As may be seen from these examples, the overall tolerance will always be greater than that of the item having the largest tolerance. To say this another way, the final result of a flow-measurement computation cannot be more exact or have a smaller per cent uncertainty than the factor having the greatest uncertainty. Thus, where one factor, usually the coefficient, has a tolerance ranging from ± 0.4 to ± 4.0 per cent, the use of numbers with four to six significant digits does not imply a corresponding high degree of exactness. The use of so many digits improves the agreement between two or more computers and aids in the "rounding off" of the final result.

Reference

[1] "A Statistical Approach to the Prediction of Discharge Coefficients of Concentric Orifice Plates," R. B. Dowdell and Yu-Lin Chen: *Trans. ASME, Journal of Basic Engineering*, vol. 92, no. 3, Sept. 1970.

APPENDIX VII

LOGBOOK

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WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-28-92	127-Tor Failed	Partial CO, DO Thrust Channel	B430081	003	Para 6.3.3 Test 3: a, b
					Pressure in thrust
					~~caused torque trip~~
12/29/92	——	——	B430081	004	PRE-BAL
12/29/92	——	——	B430081	005	BALANCE after [illegible] on piping
12/29/92	—	C-O	"	006	6.3.3 step 4 [illegible] torque switch tripped [illegible] 3 [illegible]
12/29/92	——	C-O	"	007	Changed torque switch @ 1.5 repeat of above test
12/29/92	—	C-O	"	008	Changed torque switch to 1.6 repeat of above test
12/29/92	—	C-O	"	009	Changed torque switch @ 7 repeat of above test
~~—~~	~~—~~	~~—~~	~~"~~	~~010~~	~~—~~
12-29-92			C43008	001	PRE BAL No Flow No PRESSURE
12-29-92			C43008	002	BALANCE
12-30-92			C43008	003	Pre Bal
12-30-92			C43008	004	Balance — Establish Flow Rate
12-30-92			C430081	001	PRE BAL Added PSI
12-30-92			C430081	002	Balance — Position 2.38
12-30-92			C430081	003	Practice Flow Run
12-31-92			C430081	004	Pre Bal
12-31-92			C430081	005	Balance
12-31-92		C→O	C430081	006	Stroke #1 500 psid 9000 GPM

WYLE

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-31-92		O→C	C430081	007	Stroke #2 500 psid 9000 GPM
1-4-93			Replaced	DP1	
1-4-93			C430082	001	Prebal
1-4-93			C430082	002	Balance [illegible]
1-4-93			C430082	003	Rebalance
1-4-93		C→O; O→C	C430082	004	Stroke #3 [illegible] 100 psid 4000 GPM
1-4-93		O→C	C430082	005	Stroke #4 100 psid 4000 GPM
1-4-93		C→O	C430082	006	Stroke #5 200 psid 5500 GPM
1-4-93			C430082	007	Prebal
1-4-93			C430082	008	Balance Zero off DP1
1-4-93		O→C	C430082	009	Stroke #6 200 psid 5500 GPM
1-5-93		C->O	C430082	010	STROKE #7 300 PSID 7000 GPM
1-5-93		O->C	C430082	011	STROKE #8 300 PSID 7000 GPM
1-5-93		C->O	C430082	012	STROKE #9 400 PSID 8000 GPM
1-5-93		O->C	C430082	013	STROKE #10 400 PSID 8000 GPM
1-5-93		C->O	C430082	014	STROKE #11 500 PSID 9000 GPM
1-5-93		O->C	C430082	015	STROKE #12 500 PSID 9000 GPM
1-6-93		C->O	C430082	016	STROKE #13 500 PSID 9000 GPM
1-6-93		O->C	C430082	017	STROKE #14 500 PSID 9000 GPM
1-6-93		C->O	C430082	018	STROKE #15 500 PSID 9000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-6-93		O-C	C430082	019	STROKE #16 500 PSID 9000 GPM
1-6-93		C-O	C430082	020	STROKE #17 500 PSID 9000 GPM
1-6-93		O-C	C430082	021	STROKE #18 500 PSID 9000 GPM
1-7-93		C-O	C430082	022	STROKE #19 500 PSID 9000 GPM
1-7-93		O-C	C430082	023	STROKE #20 500 PSID 9000 GPM
1-7-93		C-O	C430082	024	STROKE #21 400 PSID 8000 GPM
1-7-93		O-C	C430082	025	STROKE #22 400 PSID 8000 GPM
1-7-93		C-O	C430082	026	STROKE #23 300 PSID 7000 GPM
1-7-93		O-C	C430082	027	STROKE #24 300 PSID 7000 GPM
[illegible]		C-O	C430082	028	STROKE #25 200 PSID 5500 GPM
1-8-93		O-C	C430082	029	STROKE #26 200 PSID 5500 GPM
1-8-93		C-O	C430082	030	STROKE #27 100 PSID 4000 GPM
1-8-93		O-C	C430082	031	STROKE #28 100 PSID 4000 GPM
1-8-93		O-C	C430082	032	STROKE #6R 200 PSID 5500 GPM REPEAT OF TEST #6
1-8-93		O-C	C430082	033	STROKE #10R 400 PSID 8000 GPM " #10
1-8-93		O-C	C430082	034	STROKE #6RR 200 PSID 5500 GPM REPEAT OF TEST #6R
1-8-93		O-C	C430082	035	STROKE #12R 500 PSID 9000 GPM REPEAT OF TEST #12
1-8-93		O-C	C430082	036	STROKE #18R 500 PSID 9000 GPM " #18
1-11-93			D43008	001	Pre Balance
1-11-93			D43008	002	Bal Check

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-11-93		C-O	D43008	003	STROKE #1 500 PSID 9000 GPM
1-11-93		O-C	D43008	004	STROKE #2 500 PSID 9000 GPM
1-11-93		C-O	D43008	005	STROKE #3 100 PSID 4000 GPM
1-11-93		O-C	D43008	006	STROKE #4 100 PSID 4000 GPM
1-11-93		C-O	D43008	007	STROKE #5 200 PSID 5500 GPM
1-11-93		O-C	D43008	008	STROKE #6 200 PSID 5500 GPM
1-11-93		C-O	D43008	009	STROKE #7 300 PSID 7000 GPM
1-12-93		O-C	D43008	010	STROKE #8 300 PSID 7000 GPM
1-12-93		C-O	D43008	011	STROKE #9 400 PSID 8000 GPM
1-12-93		O-C	D43008	012	STROKE #10 400 PSID 8000 GPM
1-12-93		O-C	D43008	013	STROKE #4R 100 PSID 4000 GPM (RERUN OF STROKE #4)
1-12-93		C-O	D43008	014	STROKE #11 500 PSID 9000 GPM
1-12-93		O-C	D43008	015	STROKE #12 500 PSID 9000 GPM
1-13-93		C-O	D43008	016	STROKE #13 500 PSID 9000 GPM
1-13-93		O-C	D43008	017	STROKE #14 500 PSID 9000 GPM
1-13-93		C-O	D43008	018	STROKE #15 500 PSID 9000 GPM
1-13-93		O-C	D43008	019	STROKE #16 500 PSID 9000 GPM
1-13-93		C-O	D43008	020	STROKE #17 500 PSID 9000 GPM
1-13-93		O-C	D43008	021	STROKE #18 500 PSID 9000 GPM
1-14-93		C-O	D43008	022	STROKE #19 500 PSID 9000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-14-93		C-O	D43008	023	STROKE #19R 500 PSID 9000 GPM
1-14-93		O-C	D43008	024	STROKE #20 500 PSID 9000 GPM
1-14-93		C-O	D43008	025	STROKE #21 400 PSID 8000 GPM
1-14-93		O-C	D43008	026	STROKE #22 400 PSID 8000 GPM
1-14-93		C-O	D43008	027	STROKE #23 300 PSID 7000 GPM
1-15-93		O-C	D43008	028	STROKE #24 300 PSID 7000 GPM
1-15-93		C-O	D43008	029	STROKE #25 200 PSID 5500 GPM
1-15-93		O-C	D43008	030	STROKE #26 200 PSID ~~4000~~ 5500 GPM
1-15-93		C-O	D43008	031	STROKE #27 100 PSID 4000 GPM
1-15-93		O-C	D43008	032	STROKE #29 100 PSID 4000 GPM
1-15-93		C-C	D43008	033	STROKE #17R 500 PSID 9000 GPM
1-15-93		~~C-O~~ O-C	D43008	034	STROKE # ~~28~~ 26R 200 PSID 4000 GPM
1-15-93		O-C	D43008	035	STROKE #22R 400 PSID 8000 GPM
1-15-93		C-O	D43008	036	STROKE #5R 200 PSID 5500 GPM
1-16-93		O-C	D43008	037	STROKE #10R 400 PSID 9000 GPM
1-16-93		O-C	D43008	038	STROKE #24R 300 PSID 7000 GPM
1-16-93		C-O	D43008	039	STROKE #3R 100 PSID 4000 GPM
1-16-93		O-C	D43008	040	STROKE #24RR 300 PSID 7000 GPM
1-16-93		C-O	D43008	041	STROKE #23R 300 PSID 7000 GPM
1-16-93		C-C	D43008	042	STROKE #22R 400 PSID 8000 GPM

REPEAT OF STROKE #17

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
1-16-93		O-C	D93008	043	STROKE # 24RRR 300 PSID 7000 GPM
			changed valve D..		
1-20-93			D430081	001	Pre balance
1-20-93			D430081	002	Balance
1-20-93		C-O	D430081	003	STROKE #21R 400 PSID 8000 GPM
1-20-93		C-C	D430081	004	STROKE # 21R 400 PSID 8000 GPM
1-20-93		C-C	D430081	005	STROKE # 21R 400 PSID 8000 GPM
1-20-93		C-C	D430081	006	STROKE #21R 400 PSID 8000 GPM
1-20-93		C-C	D430081	007	STROKE #21R 400 PSID 8000 GPM

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
"	~~14/14~~ 36/37	O-C C-O	"	004	Cycle 10
"	[illegible]	OC - CO	"	005	cycle 15
"	46/47	OC - CO	"	006	cycle 20 – trip dropped to ≈ 73,000 lb
"	56/57	OC - CO	"	007	cycle 25 → ≈ 72,000 lb trip → ≈ 71,000 lb trip
"	66/67	OC - CO	"	008	Cycle 30 → 70,500 lb trip
	76/87 (77)	OC - CO	"	009	Cycle 35 →
12-28-92			A430083	010	Pre bal
12-28-92			A430083	011	Balance
12-28-92	96/97	O→C & C→O	A430083	012	cycle 40
12-28-92	106/107 ~~96/97~~	O→C & C→O	A430083	013	cycle 45
12-28-92	116/117 ~~106/107~~	O→C & C→O	A430083	014	cycle 50
12-28-92			B43008	001	Pre-Bal
12-28-92			B43008	002	Balance
~~12-28-92~~			~~B43008~~	~~003~~	~~6.3.3 Test a, b, c~~
	118 closed for LLRT				
12-28-92	119	Partial C→O	~~B430081~~		Zero Thrust & Torque
12-28-92	120-121-122	O→C & C→O	B430081	001	Torque Switch Settings
	123	C→O			adjust torque switch
12-28-92	124-125-126	OC, CO, OC	B430081	002	Para. 6.3.3 Test 01; a, b, c

A 430083 SETUP BUT NOT LOCKED

WYLE LABORATORIES

MOV FLOW TEST PROJECT PROCEDURE	No. 43008-00
Subject: Data Acquisition Setup and Validation	Revision: 0

DATA FILE INVENTORY

001 Prebalance
002 Balance

DATE	STROKE	DIRECTION O-C C-O	DATA FILE	DATA SET	REMARKS
12-22-92	1	Partial O→C	A43008	~~001~~ 003	Torque switch Setting -56900 lb, ≈1
12-22-92	2	Partial C→O	A43008	~~002~~ 004	2250 lb
12-22-92	3	Partial O→C	A43008	~~003~~ 005	≈1.5 -79900 lb
12-22-92	4	Partial C→O	A43008	~~004~~ 006	2422 lb
12-22-92	5	Partial O→C	A43008	~~005~~ 007	≈1.6 -79500 lb
12-22-92	6	Partial C→O	A43008	~~006~~ 008	2514 lb
12-22-92	7	Partial O→C	A43008	~~007~~ 009	≈1.7 -83400 lb
12-22-92	8	Partial C→O	A43008	~~008~~ 010	2560 lb
~~12-22-92~~	~~9~~	~~O→C~~	~~A43008~~	~~011~~	≈1.8 NEW TEST DUE TO ≈12000 lb OFFSET
12-22-92	—	—	A430081	001	PRE-BAL
"	—	—	"	002	BAL
"	9	O→C	"	003	≈1.8 AFTER BAL. -86,900 lbs TORQUE ≈ 82,000 lbs
"	10	C→O	"	004	+1360 lbs
12-23-92	11	O→C	—	—	CLOSE VALVE FOR LEAK CHECK
12-23-92	12	~~[illegible]~~	A430082	001	Reset of MCI F.S. ~~PRE-BAL~~ BAL. SAME PRE BAL AS BEFORE
"	~~13~~	C→O	—	—	OPEN TO OPEN LIMIT TO START PRE-COND
"	14/15	O-C C-O	A430082	002	PRE-COND Cycle 1 CURRENT MCI OVER RANGE
"	~~16/17 18/19~~ 20/21	—	A430083	001	PRE-BAL
"	—	—	"	002	BAL
"	~~[illegible]~~ 2&1.2=	O-C C-O	"	003	PRE-COND cycle 5

APPENDIX VIII

WYLE LABORATORIES' TEST PROCEDURE NO. 43008

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TEST PROCEDURE

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
P.O. Box 077777, Huntsville, AL 35807-7777
TWX (910) 997-0886, Phone (205) 837-4411

TEST PROCEDURE NO. 43008

DATE: November 16, 1992

Revision A: 12/01/92

Revision B: 12/09/92

Revision C: 02/19/93

FLOW LOOP DIFFERENTIAL PRESSURE

AND PRESSURE LOCK TESTS

ON A

14-INCH WILLIAM POWELL GATE VALVE

FOR

ENTERGY OPERATIONS, INC.

GRAND GULF NUCLEAR STATION

APPROVED BY: Troy Parks 11-16-92
FOR: ______

APPROVED BY: ______
FOR: ______

APPROVED BY: ______
FOR: ______

APPROVED BY PROJECT MANAGER: P. Turrentine 11/16/92 (pap)
P. Turrentine

APPROVED BY QUALITY ENGINEER: R. G. Thomas 11-17-92
R. G. Thomas

PREPARED BY PROJECT ENGINEER: G. R. Carbonneau 11/16/92
G. R. Carbonneau

REVISIONS

FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
A	12/01/92	Page 7, Para. 6.2.4	GC	P.T. 12/2/92	Changed Quick Stem Sensor to "Smart"
			GRC 12/1/92	T.P. 12/2/92 RGT 12-3-92	Stem Sensor. Added Power Meter.
A	12/01/92	Page 8, Table	GC	P.T. 12/2/92	Revised Table to show Teledyne "Smart"
			GRC 12/1/92	T.P. 12/2/92	Stem, Ohio Semitronics, and Micro-
				RGT 12-3-92	Measurements.
A	12/01/92	Page 9	GC	P.T. 12/2/92	Added strain gage statement.
			GRC 12/1/92	T.P. 12/2/92 RGT 12-3-92	Dropped pressure transducer.
A	12/01/92	Page 21	GC	P.T. 12/2/92	Added Motor Power to Figure.
			GRC 12/1/92	RGT 12-3-92	
A	12/01/92	Page 22	GC	P.T. 12/2/92	Changed Figure to make consistent
			GRC 12/1/92	T.P. 12/2/92 RGT 12-3-92	with Table 1.

Test Report No. 43008-01

REVISIONS

Page 1a
Test Procedure No. 43008

REVISION B

PROCEDURE NO. 43008

DATE: December 9, 1992

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

REV.NO.	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
B	12/9/92	All	GRC		Complete revision of procedure due to sequence of test being changed, and additional requirements, per the direction of Entergy Operations.
C	2/19/93	Page 3	GRC		Added reference between 2.1 and 2.2 and renumbered remaining references accordingly.
C	2/19/93	Page 5, Section 6.1	GRC		Deleted item 3), changed item 10), and renumbered items and references to items accordingly.
C	2/19/93	Page 6, Section 6.2.2	GRC		Changed 6.3.3 to 6.3.5.
C	2/19/93	Page 7, Section 6.2.2	GRC		Added "(HTP)" after hydrostatic test pressure.
C	2/19/93	Page 7, Section 6.2.4	GRC		Deleted the word variable and removed the "V" from "LVDT."
C	2/19/93	Page 10, Section 6.2.6	GRC		Changed 74,000 to 80,000; 84,000 to 90,000; and 74,000 to 86,000.
C	2/19/93	Page 10, Section 6.3.1	GRC		Added "Static Break-In Test" and rearranged items in series.
C	2/19/93	Page 11, Section 6.3.2	GRC		Added "A post-static ... in Section 6.3.1."
C	2/19/93	Page 12, Section 6.3.4	GRC		Deleted "/Inspection" from heading.
C	2/19/93	Page 13, Section 6.3.8	GRC		Changed 6.3.3 to 6.3.5.
C	2/19/93	Page 16, Section 7.2	GRC		Changed "data" to "date."
C	2/19/93	Page 19, Figure 1	GRC		Replace with new figure.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to present the test requirements, objectives, procedures, and equipment to be used to test a 14-Inch Flex Wedge Gate Valve and Actuator for Entergy Operations, Inc., Grand Gulf Nuclear Station.

The test objectives are:

- Observe and record the operational performance of this valve test specimen during opening and closing at various flow rates and differential pressures as specified in this procedure.
- Study the impact of pressure lockup on the test specimen.

2.0 REFERENCES

2.1 Entergy Operations' Contract No. C-1015-28, dated October 30, 1992.

2.2 Engergy Operations' Letter GEXO:92-00743, dated December 21, 1992. C

2.3 Wyle Laboratories' Quality Assurance Program Manual, dated June 1988.

2.4 Wyle Laboratories' Technical Proposal No. 544/1671/CP, dated October 14, 1992.

2.5 Nuclear Regulatory Commission Regulation 10 CFR 21.

2.6 American National Standard ANSI N45.2.2.

2.7 ASME/ANSI Code for Power Piping B31.1. C

3.0 QUALITY ASSURANCE

All work performed on this test program shall be controlled in accordance with Wyle Laboratories' Quality Assurance Program Manual dated June 30, 1988, approved by Entergy Operations and per the customer's Purchase Order. Wyle's QA program complies with the applicable requirements of 10 CFR 50 Appendix B, ANSI N45.2 and applicable regulatory guides.

4.0 TEST EQUIPMENT AND INSTRUMENTATION

4.1 Calibration of Test Equipment and System Calibration

All instrumentation, measuring, and test equipment used in the performance of this test program shall be calibrated in accordance with Wyle Laboratories' Quality Assurance Program which complies with the requirements of Military Specification MIL-STD-45662A. Standards used in performing calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

All test ec[illegible]ment shall be calibrated on a periodic basis, with the calibration interval displaye[illegible] decal. This decal is affixed to the equipment and indicates the last calibration [illegible], the next calibration due date, accuracy, and by whom calibrated.

4.0 TEST EQUIPMENT AND INSTRUMENTATION

4.2 Measurements and Tolerances

Unless specified otherwise, the tolerance on test condition measurements shall be as follows:

Measurement	Tolerance
Pressure	± 1% F.S.
Temperature	± 2°F
Flow Rate	± 5%
Current	± 2%
Voltage	± 1%
Time	± 0.25 sec
Stem Torque/Thrust (Teledyne)	± 1.0%
Displacement, Spring Pack	± 0.52%
Motor Power	± 3%

5.0 TEST SPECIMEN

The test specimen is a Motor-Operated Valve (MOV) Assembly consisting of one 14-inch diameter, 600 pound class, carbon steel flex wedge gate valve with operator as follows:

Valve:

William Powell Valve Company
1250 psi at 575°F (Design Pressure/Temperature)
Serial No. 67770-6, Year 1981
Purchase Order No. 9645M242.0
Item 8.02B, Job 9645
Tag SQ-14-EBA-GTF-MO-FO42B-ALPWY
Class 1
Valve Cv = 9240 gpm with a corresponding K = 0.235

The stroke time of the MOV is approximately 19 seconds.

Operator:

Limitorque Rat. 43.87
Type SB Size 3 150 ft-lb motor
Order 384616B Serial 258077
Valve 14 193-2-4100
2291158 772c
Purchase Order No. 9645-M-242.0
Item 8.02B, Job 9645
Tag SQ-14 EBA-GTF-MO-FO42B-ALPWY

5.0 TEST SPECIMEN (Continued)

The test specimen MOV will be supplied by Entergy Operations, Inc., Grand Gulf Nuclear Station, with welded flanges, ANSI B16.5 14-inch, 600 pound class, raised face. The test specimen MOV upstream and downstream nozzles are Pipe Schedule 30 and 80, respectively. The flange bolt hole pattern is with one bolt hole at top dead center of the valve.

6.0 REQUIREMENTS AND PROCEDURES

6.1 Test Sequence

The test specimen MOV shall be subjected to the following test sequence:

1) Receive and uncrate MOV.
2) Perform inspection for damage.
3) Install actuator on valve.
4) Install motor on actuator.
5) Assemble and connect protective control circuit.
6) Install instrumentation on valve and actuator.
7) Set up diagnostic equipment.
8) Adjust torque and limit switch settings such that measured thrust in both directions matches that measured in service.
9) Perform pre-test LLRT, static break-in testing, and post-static break-in testing LLRT.
10) Set up MOV and diagnostic equipment for pressure lock testing.
11) Perform pressure lock testing.
12) Perform flow loop testing in the vertical orientation.
13) Rotate MOV to the stem horizontal orientation.
14) Repeat flow loop testing of Step 12 for horizontal orientation.
15) Remove diagnostic equipment from MOV.
16) Remove valve, actuator and motor from the test stand and ship components back to Grand Gulf Nuclear Station.
17) Prepare written report.

6.2 Pre-Test Preparation

6.2.1 Receipt Inspection/Disassembly

Wyle will receive and uncrate the test specimen MOV valve, actuator, and motor at Wyle's Steam Valve Test Facility. Shipment will be initially surveyed prior to any other inspection for radioactive contamination by Wyle's radiation safety officer or his representative.

Wyle QA will perform a receiving inspection in accordance with Wyle's normal receiving procedures, checking all parts for damage, tagging parts, and signing documentation. Any and all damage will be immediately reported to Entergy Operations, Inc.

The Wyle project engineer will record all nameplate and other data into the Project Test Logbook. This data will be compared to that stated in Entergy Operations, Inc. Contract Order and Statement of Work.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.1 Receipt Inspection/Disassembly (Continued)

The test specimen shall be disassembled in accordance with the William Powell Company Valve Manual, supplied by Entergy Operations. The valve stem shall be removed and shipped to Teledyne for the Smart Stem installation. During reassembly, the stem threads shall be lubricated with Mobilux EP1. All subsequent relubrication shall be pre-approved by the Entergy Operations' Program Manager and shall be documented in the Log Book.

6.2.2 Valve Installation and Orientation

The test specimen MOV shall be installed and oriented in Wyle's Hot Water Blowdown System Flow Loop as follows:

- The valve stem will be vertical.
- The Schedule 30 nozzle will be facing upstream.
- The test section piping will be horizontal.

Installation and torque-up of bolts shall be performed using Wyle's standard procedures. Fourteen-inch flexitallic type gaskets and ASTM A193 B7 bolting shall be used.

The valve inlet Schedule 30 nozzle shall be protected from over-pressurization. Since there is a direct line of communication from the system 3000-gallon reservoir and the valve inlet, the reservoir 6-inch rupture disc will be utilized to provide protection. A Fike rupture disc rated at 766 psig, 200°F, shall be installed prior to flow loop differential pressure testing of Section 6.3.5 of this procedure being performed. The rating is based on the maximum allowable working or design pressure of 14-inch, Schedule 30, pipe flange joint per ASME/ANSI B31.1, Code for Power Piping. See Appendix I for calculations. C

Wyle will perform a pre-test hydrostatic test of the flanges welded by Entergy Operations, Inc. to the test specimen MOV. The basis for hydrostatic testing is ANSI/ASME B31.1, Code for Power Piping, Section 137.3.4.

137.3.4 Required Hydrostatic Test Pressure

Piping systems shall be subjected to a hydrostatic test pressure so that every point in the system is not less than 1.5 times the design pressure, but shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, pumps, or valves, in the system.

137.3.5 Hydrostatic Test Pressure Holding Time

The hydrostatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct the examinations for leakage.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.2 Valve Installation and Orientation (Continued)

The hydrostatic test pressure (HTP) shall be:

HTP = 1.5 x 766 psig = 1149 psi

which is less than the 1250 psi rating of the William Powell gate valve.

6.2.3 Actuator Installation and Wiring

The actuator shall be mounted on the valve using Limitorque mounting procedures regarding installation and torque-up of mounting bolts. Bolting is 8 each 7/8"-9 high strength socket head cap screws.

The MOV electric motor shall be mounted on the actuator using Limitorque mounting procedures. Bolting is 4 each 5/8"-11 high strength cap screws with lock washers.

Power supply and control circuit wiring shall be installed and wired as shown in Figure 1, Limitorque procedures, and Wyle standard procedures. Thermal overload settings will be as provided by Entergy Operations.

6.2.4 Instrumentation Installation

The required measurements and instruments are listed in Table I.

Spring pack displacement shall be measured using a Waters Longfellow linear displacement transducer (LDT). The LDT shall be mounted on a bracket attached to the spring pack cartridge cap. A hole will be drilled through the cap to connect the LDT rod to the spring pack lock nut.

Stem thrust and actuator output torque shall be measured using a Teledyne "Smart Stem Sensor" transducer assembly. This is essentially strain gages mounted to the valve stem. Teledyne will calibrate the Smart Stem Sensor and furnish a calibration certificate.

Motor power will be measured using an Ohio Semitronics Transformer Module. Current and voltage of this 3-phase, 480 volt AC motor will be measured using a Fluke ammeter and an Ohio Semitronics voltmeter.

The operator control circuitry and switch position shall be monitored by using clamp-on ammeter probes on the open and close torque switches, open limit, open and close by pass switches.

TABLE I

INSTRUMENTATION

Designation	Measurement	Range	Instrument	Accuracy
SPD	Spring Pack Displacement	0-1 inch	Waters SLF-W-75-D-1	0.1% FS
THR1	Stem Thrust	100 K lb	Teledyne Smart Stem	0.5%
TRQ1	Actuator Output Torque	2450 ft-lb	Teledyne Smart Stem	0.5%
S1	Switch Open Limit	150 amps	Fluke Y8101	2.5% F + 0.15a
S2	Switch Open Torque	150 amps	Fluke Y8101	2.5% F + 0.15a
S3	Switch Close Torque	150 amps	Fluke Y8101	2.5% F + 0.15a
S4	Switch Close Bypass	150 amps	Fluke Y8101	2.5% F + 0.15a
S5	Switch Open Bypass	150 amps	Fluke Y8101	2.5% F + 0.15a
MP	Motor Power	80,000 watts	Ohio Semitronics PC11063	0.5% FS
MC1	Motor Current	600 amps	Fluke VT801-600	2%
MV1	Motor Voltage	600 VAC	Ohio Semitronics	0.5% F50
TC2	Valve Inlet Temperature	1000°F	Medtherm, Type K	± 2°F
PS3	Valve Bonnet Pressure	1000 psi	CEC 5500	± 0.25% FRO
DP2	Valve Differential Pressure	1000 psid	T-Hydronics TH-D	± 0.25% FRO
DP1	Flowmeter Differential Pressure[1]	100 psid	T-Hydronics TH-D	± 0.25% FRO
FL1	Flowrate[1]	9000 gpm	Badger, Lo-Loss	± 0.75%
SG1	Valve Body Displacement	30,000 μ-in./inch	Micro-Measurements Model CEA-06-125	± 0.5%
SG2	Valve Body Displacement	30,000 μ-in./inch	Micro-Measurements Model CEA-06-125	± 0.5%

NOTE: 1) Flowrate shall be calculated using data and Badger Flowmeter equation.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.4 Instrumentation Installation (Continued)

Pressure and differential pressure measurement shall be by using CEC Model 5500 or Teledyne Taber Models 2217, 2104, or 206 pressure transducers. These are strain gage type pressure sensors of ± 0.25% accuracy full scale (F.S.). These instruments are conditioned by full bridge signal conditioning amplifiers.

The MOV test medium (water, 150-200°F) temperature shall be measured using a "K-type" thermocouple probe located upstream in close proximity to the test specimen inlet.

Valve body displacement shall be measured using Wyle installed strain gages at the locations shown in Figure 2. The strain gages shall be Micro-Measurements' (Model CEA-06-125) rosette biaxial foil strain gages, installed with M-Bond AE-10/15 adhesive using Wyle Procedure 85-12.

Flow rate shall be measured using a 10-inch diameter Venturi flowmeter manufactured by Badger Corporation. Signal output is provided by a differential pressure transducer mounted on the flowmeter used with Badger published equations to calculate the flow rate.

Figure 3 presents a schematic drawing of the test article instrumentation.

6.2.5 Data Acquisition System

The Data Acquisition System (DAS) will consist of a MEGADAC 5033A System driven by an IBM 486 host computer. This system will acquire test and diagnostic data and provide preliminary display and printout of selected data channels using a Hewlett-Packard Laser Jet Printer. The DAS will generate a tape cartridge data file for detailed data reduction and analysis.

6.2.6 Actuator Switch Settings and Adjustment

Prior to any testing or stroking of the valve, actuator switches shall be set as follows:

Torque switch and limit switch settings provided by Entergy Operations, Inc. are as follows:

- The open limit switch shall be set at 90% of open to prevent backseating the valve.
- The open torque bypass switch shall be set to bypass the open torque switch during the first 20% of travel in the opening direction.
- The close torque bypass switch shall be set to bypass the close torque switch during 95% of travel in the closing direction. The close torque switch shall be operational during the final 5% of opening.
- The open torque switch shall be set so as to limit opening thrust at the torque switch trip between 37,565 and 67,185 pounds.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.2 Pre-Test Preparation (Continued)

6.2.6 Actuator Switch Settings and Adjustment (Continued)

- The close torque switch shall be set so as to limit closing thrust at torque switch trip (TST) between 80,000 and 90,000 pounds. The current TST setting at Grand Gulf Nuclear Station, Unit 1, is approximately 86,000 pounds. Since thrust continues to increase following TST due to inertia, the torque switch shall be adjusted to assure that total thrust does not exceed 97,850 pounds. C

Torque switch settings shall be verified using Wyle diagnostic test equipment.

6.3 Tests

6.3.1 Pre-Test LLRT

An LLRT Leakage Rate Test shall quantify test specimen seat leakage prior to any testing and serve as a baseline for subsequent LLRTs. Test medium shall be water at ambient temperature. Test pressure shall be 1080 psig which will be applied to the downstream side of the test valve while monitoring the upstream side of the valve at atmospheric pressure for leakage.

The valve test specimen may be installed in either the flow loop test section or pressure lock test stand, as this LLRT test procedure will be repeated following the Static Break-In Test, Pressure Lock Test, and the vertical and horizontal orientation Flow Loop Differential Pressure Tests. C

With the valve test specimen open, it shall be filled with water such that all air pockets are vented. The valve test specimen shall be closed using normal motive power. The valve test specimen will be pressurized on the discharge nozzle side to 1080 psig and maintained for five minutes, allowing the valve to stabilize.

The leakage will then be measured over a five-minute period using a calibrated stopwatch and collecting the displaced liquid in a suitable container while maintaining 1080 psig downstream as determined by a Heise test gage. Valve packing will also be monitored for leakage.

The valve test specimen acceptable leakage is less than 3785 ml/min. If the leakage exceeds this limit, Entergy Operations will be notified immediately for corrective action.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.2 Static Break-in Test

Following the pre-test LLRT, a Static Break-in Test will be performed. With the test specimen installed in the flow loop test section and with the test section filled with water at ambient temperature, the valve will be stroked 50 strokes open and 50 strokes closed using normal motive power. These strokes shall be performed without flow or pressure in the test section. Initially, and every fifth open and closed stroke thereafter, data will be acquired and traces generated. To prevent motor overheating, a three-minute motor cool-down period will be required after each open/close cycle.

A post-static break-in LLRT shall be performed as specified in Section 6.3.1. C

6.3.3 Pressure Lock Test

During pre-test LLRT, an evaluation of the test specimen MOV seat leakage shall be made to determine if this leakage exceeds the test facility capability (1.5 gpm @ 1080 psig) of maintaining required bonnet pressure during pressure lock testing. Prior to test setup, Entergy Operations will be notified of the LLRT leakage and facility capability.

The test specimen MOV shall be configured for pressure lock testing. The test medium during pressure lock testing shall be water at ambient temperature. Care shall be taken to assure the test specimen MOV bonnet cavity and inlet and outlet nozzles are solid with water during these tests.

The open torque switch shall not be bypassed during pressure lock testing and shall be set not to exceed 78,000 pounds.

Instrumentation, including diagnostic test equipment, shall be the same as that used during flow loop differential pressure testing exclusive of facility instrumentation (flow rate, etc.). If it is necessary to remove the actuator to move the test specimen MOV, it will be necessary to re-establish control switch settings (open and close limits, bypass switches, etc).

With the DAS operational so that traces are generated for all strokes, the following Pressure Lock Tests shall be performed:

Test No.	Description
1)	a) With the bonnet and nozzles unpressurized, stroke test specimen MOV closed. b) With the bonnet and nozzles unpressurized, stroke test specimen MOV open. c) With the bonnet and nozzles unpressurized, stroke test specimen closed.
2)	With the valve in the closed position, pressurize the outlet nozzle to 1080 psig. Monitor pressures in the bonnet and inlet nozzle for 10 minutes or until stabilization. Depressurize prior to next step.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.3 Pressure Lock Test (Continued)

Test No.	Description
3)	a) Connect hydrostatic pump to bonnet leak-off line and pressurize bonnet to 1080 psig. With inlet and outlet nozzles at 0 psig, stroke valve open. There will be an immediate drop off of bonnet pressure upon unseating. b) Stroke test specimen MOV closed.
4)	a) Pressurize the bonnet to 1080 psig. Pressurize the upstream Schedule 30 nozzle to 320 psig. Pressurize the downstream Schedule 80 nozzle to 452 psig. Stroke the test specimen MOV to the open position. b) Depressurize test specimen MOV to zero psig. Stroke test specimen MOV closed.
5)	a) Pressurize the bonnet to 452 psig. Pressurize the Schedule 30 nozzle to 320 psig. Pressurize the Schedule 80 nozzle to 452 psig. Stroke test specimen MOV open. b) Depressurize test specimen MOV and stroke closed.

6.3.4 Post-Test LLRT C

Perform a Post Pressure Lock Test LLRT as described in Section 6.3.1.

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation

The test specimen MOV shall be installed in the hot water blowdown flow loop with the valve stem vertical and the test section horizontal. Gaskets and bolting will be in accordance with Wyle standard procedures. Figure 4 presents a schematic drawing of the hot water blowdown flow loop.

The test section and 3000 gallon reservoir will be filled with water. The test specimen will be fully open. With the test section and reservoir ullage pressurized to approximately 500 psig, the facility 10-inch blowdown valve shall be opened until 9,000 gpm is achieved to determine facility blowdown valve's required open position. The test specimen will remain fully open during this trial run and not be stroked. With the test specimen valve closed, the test section and a reservoir will be filled with demineralized water which will be heated to 150-200°F by recirculation through the system 225 kW heater. Ullage pressure will be brought to 500 psig.

Close and open strokes will initiate and terminate at the 50% minimum/70% maximum open/close position respectively, since the total valve stroke time of 19 seconds would exhaust the 3000-gallon reservoir before stroke completion.

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.3 Tests (Continued)

6.3.5 Flow Loop Differential Pressure Test - Vertical Orientation (Continued)

With the test section at 500 psi and 150-200°F and the DAS operational, the test will be initiated by placing the 10-inch blowdown valve in its pre-determined open position (2 seconds) to achieve the required flow rate of 9,000 gpm. Next, the valve test specimen will be stroked open using normal motive power. As the valve strokes open, flow rate will increase to 9,000 gpm. Test termination will take place when the test specimen MOV reaches 70% of open, at which time the 10-inch blowdown valve will be commanded closed.

While test data is being reviewed, the reservoir shall be refilled and reheated prior to the next stroke. Stroke 2 (close) will be initiated by placing the 10-inch blowdown valve in its open position to achieve 9000 gpm, at which point the test MOV is commanded closed. Test termination occurs when the test MOV is fully closed. The test sequence of closing and opening strokes and test conditions is presented in Table II of this procedure.

6.3.6 Post-Test LLRT/Inspection

After Stroke No. 28 and prior to continuing, a post-test LLRT shall be performed. This test shall be a repeat of the pre-test LLRT of Section 6.3.1 of this procedure. Test results shall be reported to Entergy Operations.

Entergy Operations personnel shall inspect and photograph the downstream disk and seat, through the valve nozzle, prior to re-orientation.

6.3.7 Test Specimen Re-Orientation (Vertical to Horizontal)

Upon determination that the valve leakage rate is acceptable, the test specimen MOV shall be reoriented in the flow loop test section such that the valve stem is horizontal.

6.3.8 Flow Loop Differential Pressure Test (Horizontal Orientation)

The test requirements and procedures of Section 6.3.5 shall be repeated with the valve stem in the horizontal orientation. C

6.3.9 Post-Test LLRT/Inspection

A post-test LLRT shall be performed using the procedure of Section 6.3.1. Also, Entergy Operations personnel shall inspect and photograph the downstream disk and seats.

6.3.10 Post-Test Activities

Remove test equipment from the test specimen. Remove the test specimen MOV from the flow loop. The test specimen valve shall be disassembled and the stem shipped to Teledyne for a post-test calibration of the Smart Stem. The valve body and actuator shall be shipped to Entergy Operations, Grand Gulf Nuclear Station, without reassembly.

TABLE II

FLOW LOOP DIFFERENTIAL PRESSURE TEST SEQUENCE

Stroke	Direction	ΔP (psid)	Flow Rate (gpm)
1	Open	500	9000
2	Close	500	9000
3	Open	100	4000
4	Close	100	4000
5	Open	200	5500
6	Close	200	5500
7	Open	300	7000
8	Close	300	7000
9	Open	400	8000
10	Close	400	8000
11	Open	500	9000
12	Close	500	9000
13	Open	500	9000
14	Close	500	9000
15	Open	500	9000
16	Close	500	9000
17	Open	500	9000
18	Close	500	9000
19	Open	500	9000
20	Close	500	9000
21	Open	400	8000
22	Close	400	8000
23	Open	300	7000
24	Close	300	7000
25	Open	200	5500
26	Close	200	5500
27	Open	100	4000
28	Close	100	4000

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.4 Data Analysis

6.4.1 Data Channels

The following parameters shall be recorded during test specimen MOV stroking during break-in static strokes, flow loop differential pressure testing, and pressure lock testing:

1) Spring Pack Displacement
2) Stem Thrust
3) Actuator Output Torque
4) Motor Power (3-Phase)
5) Motor Current
6) Switches (open and close torque, open and close bypass, open limit)

Plots of the above parameters versus time will be generated for each valve stroke and included in the final report.

6.4.2 Data Analysis

The above plots will be analyzed and the following shall be calculated or determined:

		Open Stroke	Close Stroke
1) Stem Thrust	a) Running	X	X
	b) Maximum ΔP	X	X
	c) Unseating	X	
	d) Hammer Blow	X	
	e) Minimum Available		X
	f) Torque Switch Trip (TST)		X
	g) Total		X
	h) Inertia		X
2) Torque	a) Running	X	X
	b) Unseating	X	
	c) Minimum Available		X
	d) Torque Switch Trip (TST)		X
	e) Total		X
3) Stroke Time		X	X
4) Current	a) Running	X	X
	b) Unseating	X	
5) Power, Running		X	X

6.0 REQUIREMENTS AND PROCEDURES (Continued)

6.4 Data Analysis (Continued)

6.4.2 Data Analysis (Continued)

		Open Stroke	Close Stroke
6) Contactor Drop-out Time		X	X
7) Stem Factor*		X	X
8) Disc Factor*		X	X
9) Spring Pack Displacement	a) Unseating	X	
	b) Hammer Blow	X	
	c) At TST		X
	d) Total		X
	e) Inertia		X
10) Rate-of-Loading Effect*			X

*For flow loop differential pressure strokes only.

7.0 DOCUMENTATION

7.1 Test Log Book

A Test Log Book shall be maintained and shall include a daily description of activities and testing performed and any pertinent information regarding the status of the test specimen. The log shall be a complete chronological log including details of all test setups and calibration, specimen handling and setup, installation, and test data summaries. Each stroke shall be recorded in the log.

7.2 Test Data

All recordings shall be reviewed for accuracy and quality after each test. The test data shall be clearly identified with the valve serial number, Wyle job number, test date, customer, stroke number and orientation, remarks, and any pertinent information required for analysis or retrieval. C

7.3 Final Report

A final test report will be prepared and submitted to Entergy for approval. The report will include:

a) A copy of traces for each parameter monitored on every test stroke where traces are required. Each trace shall be clearly labeled with the stroke number and description.

7.0 DOCUMENTATION (Continued)

7.3 Final Report (Continued)

b) A description of test anomalies and resolution.

c) Certification records for test equipment.

d) A copy of the test log book documenting the chronology, time, and description for each stroke.

e) A schematic diagram of the flow test loop and pressure lock test setup showing all instrumentation points.

f) An isometric drawing of the flow test loop.

g) Photographs of the flow test loop and Pressure Lock Test, with close-ups of instrumentation and any damage noted at any point while the valve is at the test lab.

8.0 PERSONNEL CERTIFICATION

Wyle certifies that all personnel assigned to the steam valve test facility are qualified for the tasks assigned. Certification is achieved through personnel education levels, vocational training, and practical experience as outlined in ANSI-N45.2.6 and NRC Regulatory Guide 1.58.

9.0 STORAGE AND HANDLING

During any prolonged non-testing period, the test specimen shall be stored in a controlled storage area. The storage shall be maintained in accordance with good laboratory practices, i.e., being properly protected from grease, oil, solvents, and any surface dirt that could influence the results of the test program. The storage area shall be in compliance with ANSI-N45.2.2, Level C. While the test specimen is installed in the test system, it shall be adequately protected from inclement weather.

10.0 DISPOSITION

At the conclusion of the test program:

a) Remove diagnostic equipment from the MOV.

b) Remove valve, actuator, and motor from the test stand.

c) Items shall be cleaned to remove dirt, oil, manufacturing residue or other contamination. After cleaning, surfaces shall be free of the cleaning material, including lint, solvent, residue, etc. After cleaning, the item shall be protected from contamination until preservation and packaging are complete.

10.0 DISPOSITION (Continued)

d) Protect exposed machined surfaces from damage during shipping and handling. Sturdy boxes or strapping capable of withstanding impacts without damage to the item shall be used.

e) All openings shall be closed, vapor tight, and protected against damage, corrosion, and entrance of foreign matter. All exposed machined surfaces shall be protected.

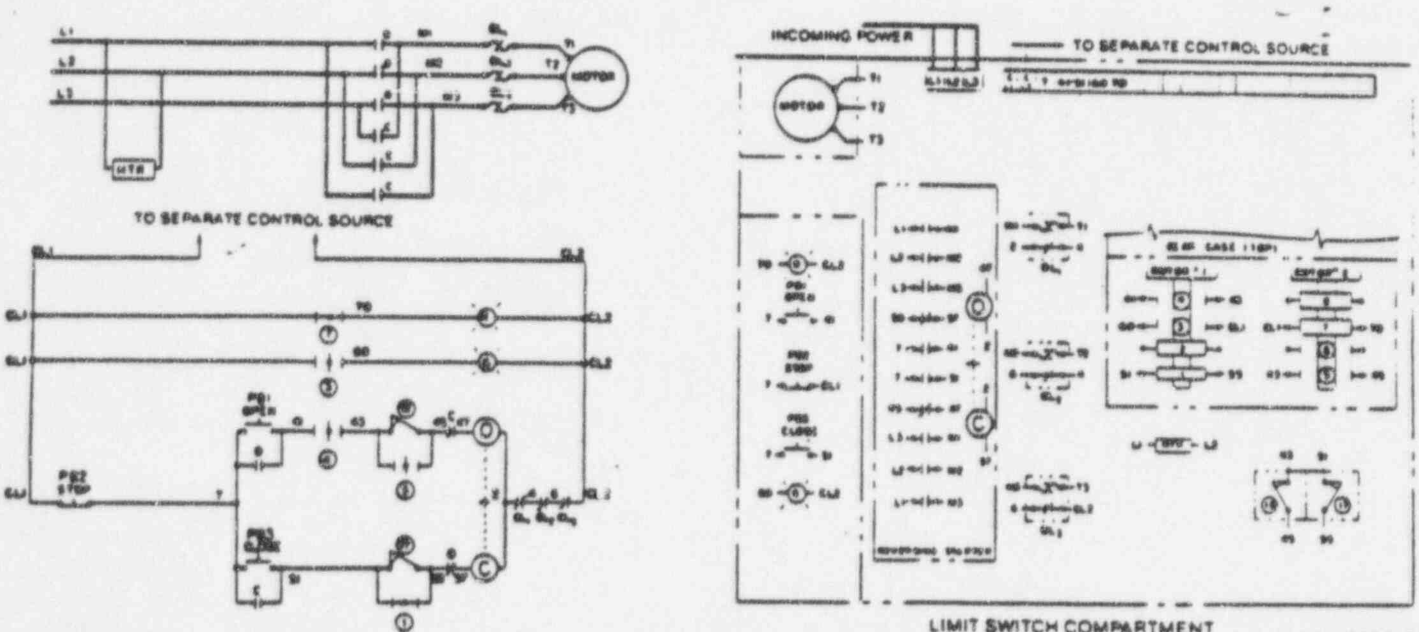
f) Package the components to ANSI N45.2.2, shipping level C criteria. Ship to GGNS for final post-test inspection of valve internals.

TYPICAL WIRING DIAGRAMS

The following drawings are typical Limitorque wiring diagrams showing built in motor controls for a 3 phase power supply for the electric motor. In the first drawing, the arrangement is a typical one for a wedge type gate valve or globe valve where the closing direction is limited by the torque switch, and the opening direction is limited by the geared limit switch.

The second drawing is one which could be used in controlling the opening and closing of butterfly valves, ball valves, plug valves or sluice gates, where the closing and opening directions are limited by the geared limit switch. The torque switches are wired in series with the geared limit switches to protect against mechanical overloads anywhere between full open and closed positions of the valve.

Both arrangements are shown with a three button (open, stop, close) pushbutton setup, and two lights to indicate full open or close positions of the valve. When the valve is at some intermediate position of travel, both lights will be on.



15-476-0055-3

VALVE SHOWN IN FULL OPEN POSITION

ROTOR	CONTACT	LIMIT SWITCH COMPARTMENT — VALVE POSITION: FULL OPEN … FULL CLOSED	FUNCTION
1	[illegible]	— - - - - - - -	BY PASS CL
	[illegible]	— - - - - - - -	SPARE
	[illegible]	- ————————	IND LIGHT
	[illegible]	- ————————	OPEN LIMIT
2	[illegible]	- - - - - - - - —	BY PASS CLIM
	[illegible]	- - - - - - - - —	SPARE
	[illegible]	———————— - -	IND LIGHT
	[illegible]	———————— - -	SPARE

NOTES
1 —— CLOSED CONTACT
2 - - - OPEN CONTACT

(17) CLOSING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING CLOSING CYCLE OF FULLY CLOSED VALVE

(18) OPENING TORQUE SWITCH INTERRUPTS CONTROL CIRCUIT IF MECHANICAL OVERLOAD OCCURS DURING OPENING CYCLE

FIGURE 1. WIRING DIAGRAM, PROTECTIVE CONTROL CIRCUIT

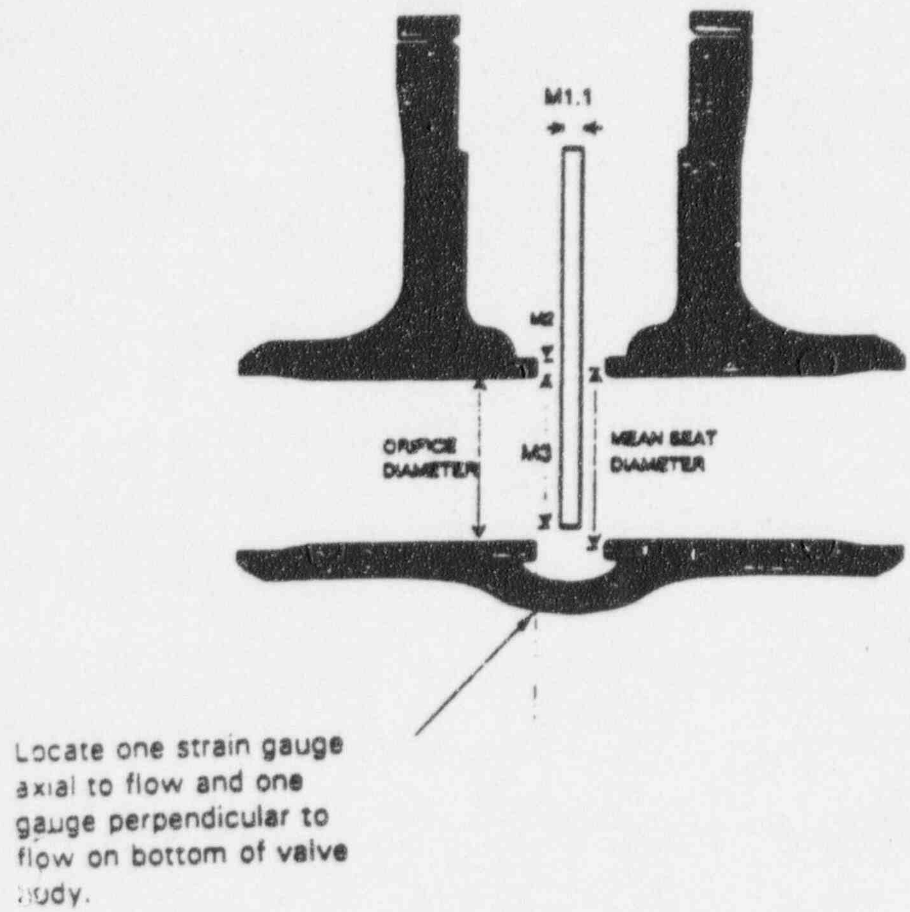


FIGURE 2. BODY DISPLACEMENT STRAIN GAGE LOCATION

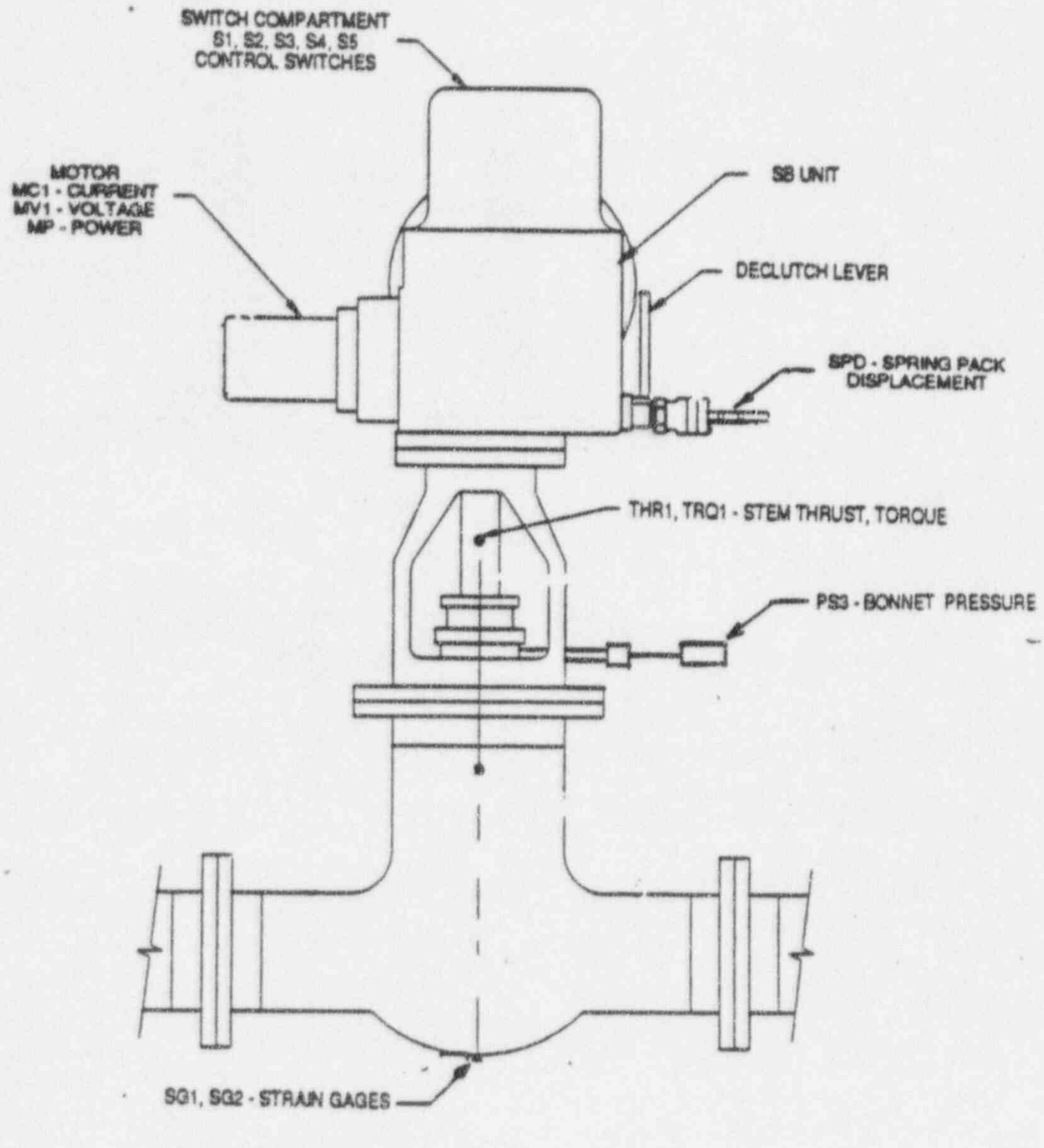


FIGURE 3. TEST SPECIMEN, MOV INSTRUMENTATION

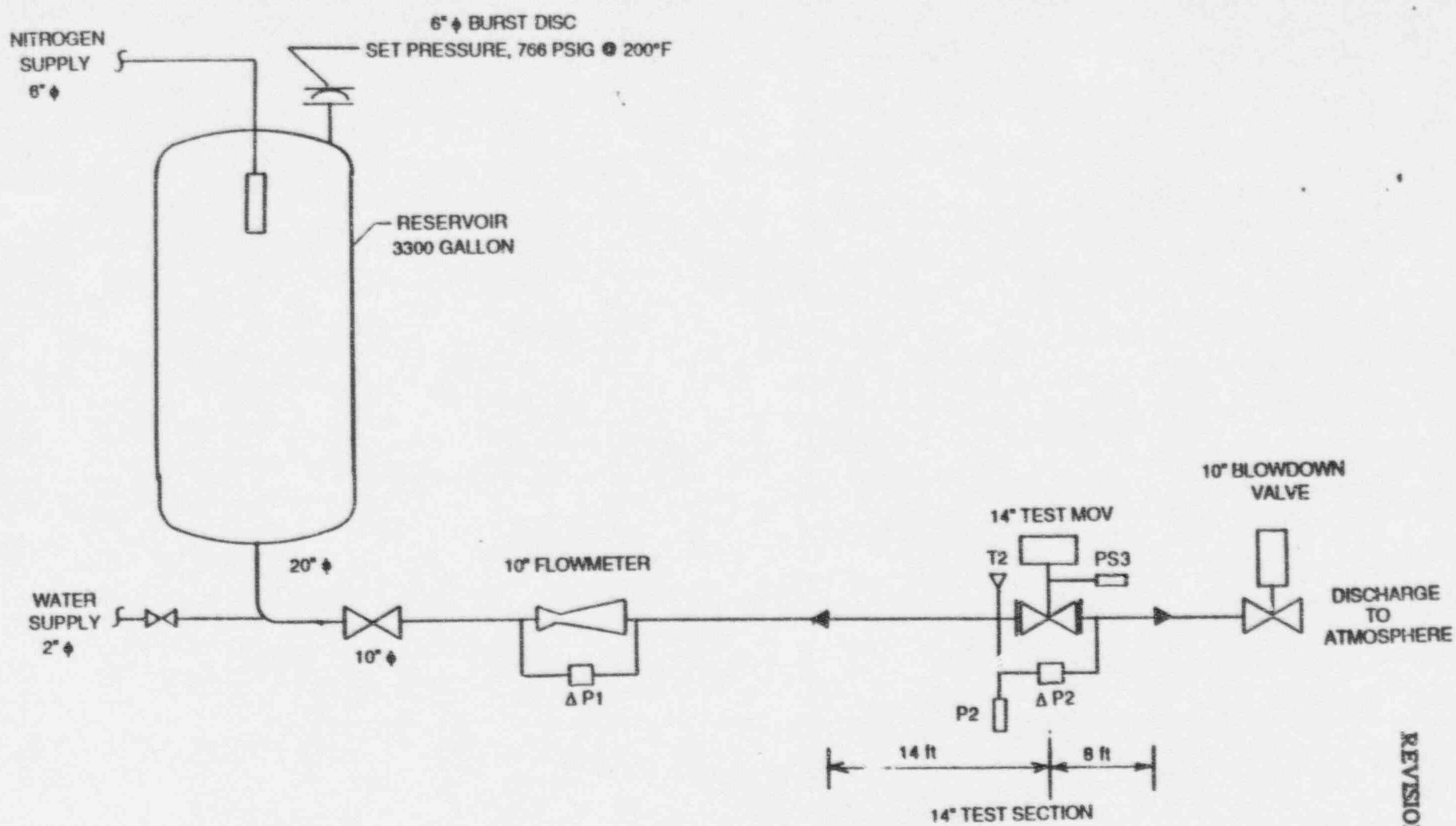


FIGURE 4. FLOW LOOP DIFFERENTIAL PRESSURE TEST

APPENDIX I

CALCULATION OF 14-INCH, SCHEDULE 30 PIPE DESIGN PRESSURE

CALCULATION OF 14-INCH, SCHEDULE 30 PIPE DESIGN PRESSURE

Calculate the pressure/temperature rating of the 14-inch, Schedule 30, carbon steel pipe with the circumferential butt joint.

From the ANSI/ASME Code for Pressure Piping B31.1, design pressure shall not exceed:

$$P = \frac{2SE(t_m - A)}{D_o - 2Y(t_m - A)}$$ (4) Para. 104.1.2

S = 17,500 psi, $T < 650°F$, ASTM A105, Table A

E = 0.8 joint efficiency

t_m = 0.375 inch wall thickness

A = corrosion allowance

D_o = 14.0 inches

Y = 0.4 Ferritic Steel from Table 104.1.2(A)

$$P = \frac{(2)(0.8)(17{,}500\ \text{psi})[(0.375) - 0]}{14.0 - (2)(0.4)[(0.375) - 0]}$$

P = 766 psig, $T < 650°F$

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APPENDIX IX

WYLE LABORATORIES' TEST PROCEDURE 85-12

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. Box 1008 • Huntsville, Alabama 35807
TWX(810) 726-2225 • TELEPHONE (205) 837-4411

TEST PROCEDURE NO. 85-12

DATE: January 28, 1985

FOIL STRAIN GAGES INSTALLATION PROCEDURE USING M-BOND AE-10/15 FOR NUCLEAR POWER PLANTS

APPROVED BY PROJECT MANAGER: [signature] for H. Jordan 1/30/85
H. Jordan

APPROVED BY QUALITY ENGINEER: G. W. Hight 1/30/85 [initials] 1-30-[illegible]
G. Wayne Hight

PREPARED BY PROJECT ENGINEER: D. De Lucchi 1/30/85
D. De Lucchi

REVISIONS

(jmk)
FORM 1054-1 Rev. 4/74

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES
A	2/13/85	6, 9, 11, 12, 14	DDL [initials] 3/25/85	[initials] 3/24/85 [initials] 3-25-85 GWH 3/25/85	Corrections and Update

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to provide the detailed requirements for a consistent and qualified method for installation of Foil Strain Gages and associated wiring, protective coating, and electrical checkout.

2.0 SCOPE

This procedure defines the requirements for qualifying and performing the installation of Foil Strain Gages for on reactor external components and for general use applications.

A detailed sequence covers quarter-bridge and rosette biaxial or triaxial and full-bridge Foil Strain Gages Micro-Measurements, Series EA and CEA Constant Foil Alloy in self-temperature-compensated form, open-face, polymide backing, installed with M-Bond AE-10/15 adhesive, and properly wired for data acquisition.

3.0 APPLICABLE DOCUMENTS, CODES AND STANDARDS

The following documents form a part of this procedure to the extent specified herein:

1. General and Detailed Installation Procedures per Appendices A, B, and C.
2. Foil Strain Gage - Micro-Measurements Brochure.
3. Adhesive and Protective Coating - Micro-Measurements Brochure.
4. Gage Installation Tester Manual - Vishay 1300.

4.0 DESCRIPTION

The Strain Gages will be installed using M-Bond AE-10/15 adhesive to ensure long life at elevated temperatures, high elongation, minimum zero shift, and hysteresis. Instrumentation procedure is presented in Appendix B. Foil Strain Gages and associated instrumentation wiring will be installed as shown in Appendix C, and wired in the quarter-bridge configuration, utilizing the three (3) wire system, or full-bridge configuration, utilizing the six (6) wire system with remote calibration. At the end of the wire, an electrical connection will be provided to mate the conditioning equipment receptacle.

4.0 **DESCRIPTION (Continued)**

The instrumentation wire attachment method used is a compromise between size and space availability of sufficient strength to survive high static and dynamic loads. The protective coating is selected and will be applied on top of the Strain Gage and wiring to insure protection, but not in excessive thickness to crack and damage the gage and wires.

An electrical check of the completely installed Strain Gage and wire is made to ensure there is proper electrical characteristics, no excessive deformation and sufficient insulation resistance. All those parts and functions are to be considered and performed with the highest possible degree of reliability.

5.0 **SPECIAL CONSIDERATIONS**

5.1 Operations shall be performed in the order presented unless otherwise specified by the responsible Wyle Project Engineer or Customer Representative.

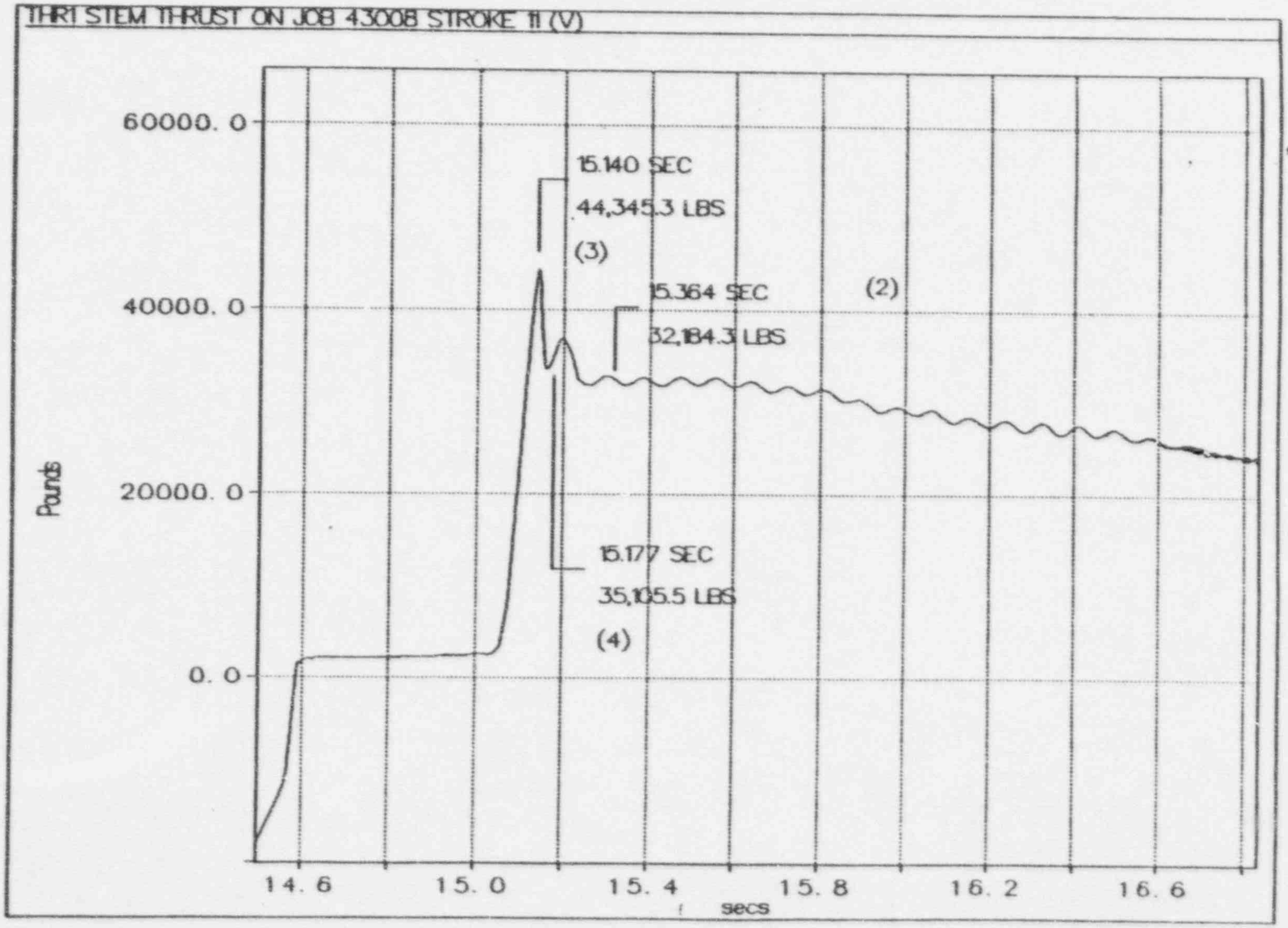
5.2 All operations performed per this procedure shall be in accordance with the scope of applicable Wyle Safety and Quality Assurance Manuals and the Customer's Safety and Quality Program, if specifically required.

5.3 In the event of malfunction or failure, the Policies and Procedures sequence of operations associated with discrepant items shall cease until documentation and corrective action have been completed.

5.4 All operations and inspections shall be performed concurrently.

5.5 Changes to this procedure shall be accomplished by issuance of appropriate revisions in accordance with Wyle Laboratories' Quality Assurance Policies and Procedures Manual.

5.6 Operators shall read this procedure in its entirety before beginning any operations.


THR1 STEM THRUST ON JOB 43008 STROKE 11 (V)
60000. 0
40000. 0
20000. 0
0. 0
Pounds
15.140 SEC
44,345.3 LBS
(3)
15.364 SEC
32,184.3 LBS
(2)
15.177 SEC
35,105.5 LBS
(4)
14. 6
15. 0
15. 4
15. 8
16. 2
16. 6
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-4-93	Test Time	11:40:59
Test Description	100 psid 4000 GPM C→O	Stroke #	3(v)
Data File	C4300B2	Data Set	4

OPEN STROKE

Running Current	16.3	amps RMS	Unseating Current	27.4	amps RMS
Running Power	7324.7	watts	Stroke Time	18.5	sec
Contactor Drop-out Time	0.013	sec			
Disk Factor (Standard) at Max dP	.3938		Disk Factor (NMAC) at Max dP	.5597	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.669	3225.3	-50.82	====	67.2	====	.0985
2. Max. dP	3.731	8447.8	-131.96	====	112.6	113.0	.0971
3. Unseating	3.157	48,465.9	-696.30	-0.0469	====	====	====
4. Just After Unseating	3.357	5968.6	-89.54	0.0007	92.52	92.63	====
5. Hammer Blow	1.928	-90,481.1	====	0.0191	====	====	====

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

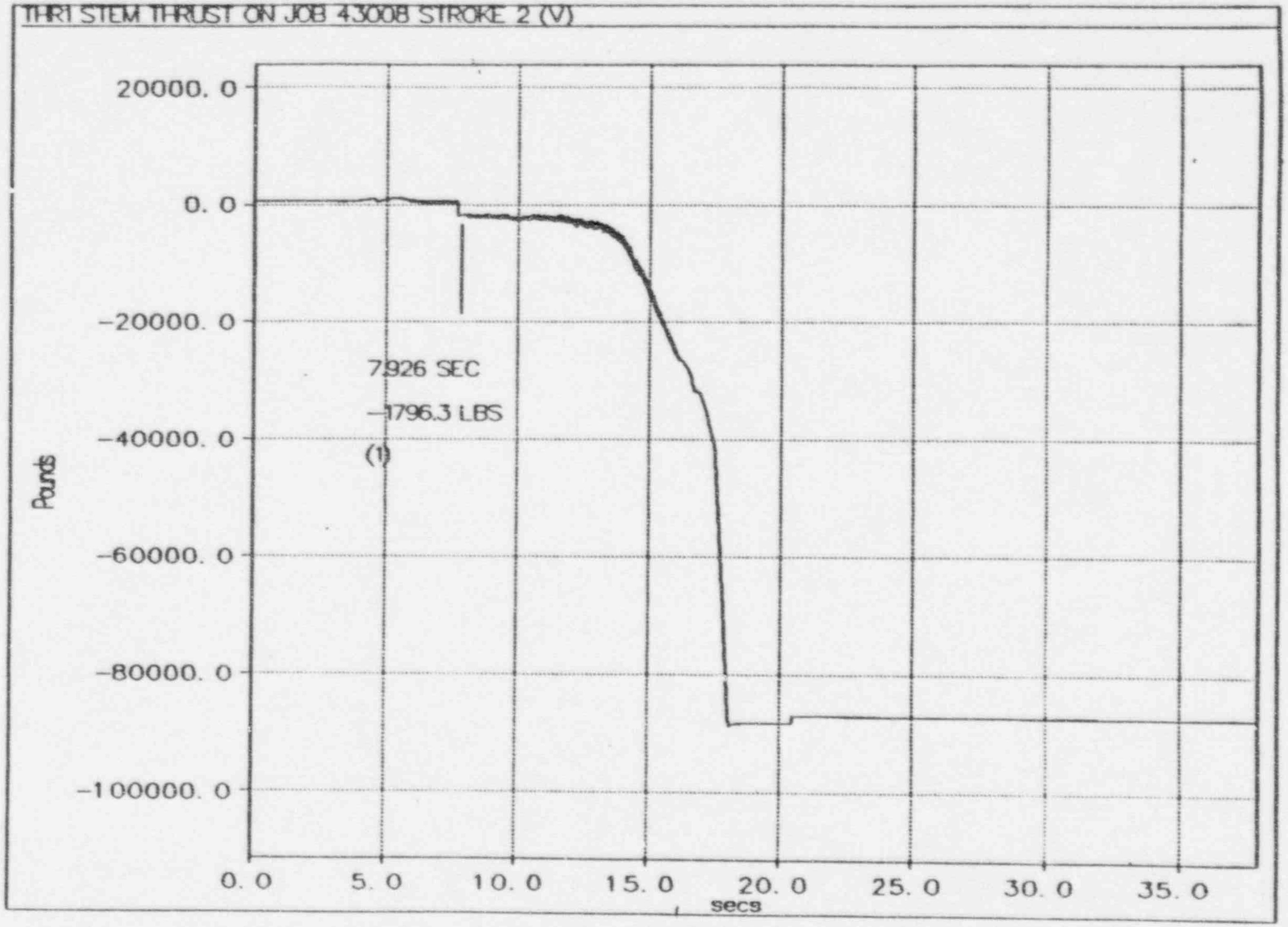
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

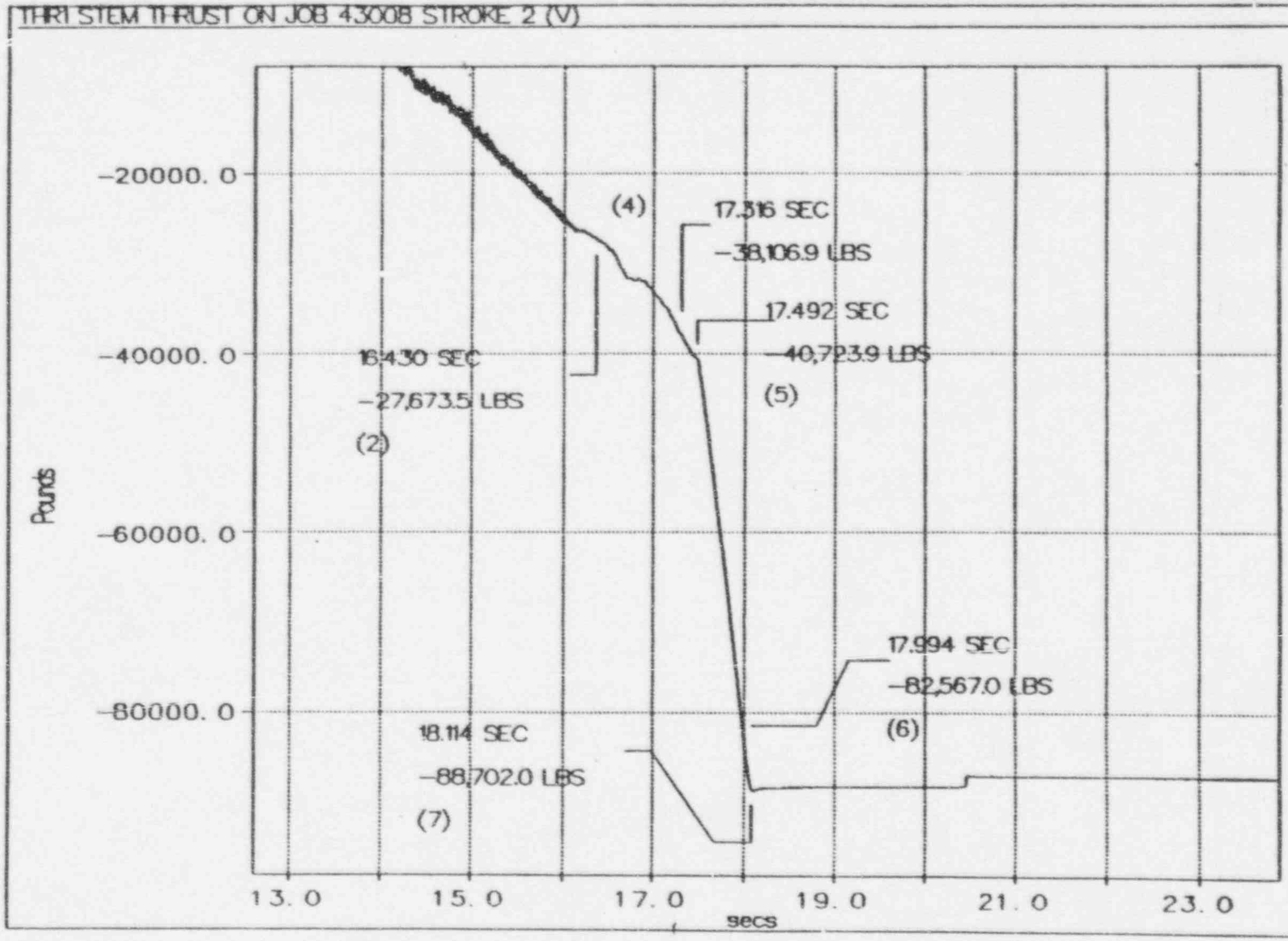
Remarks

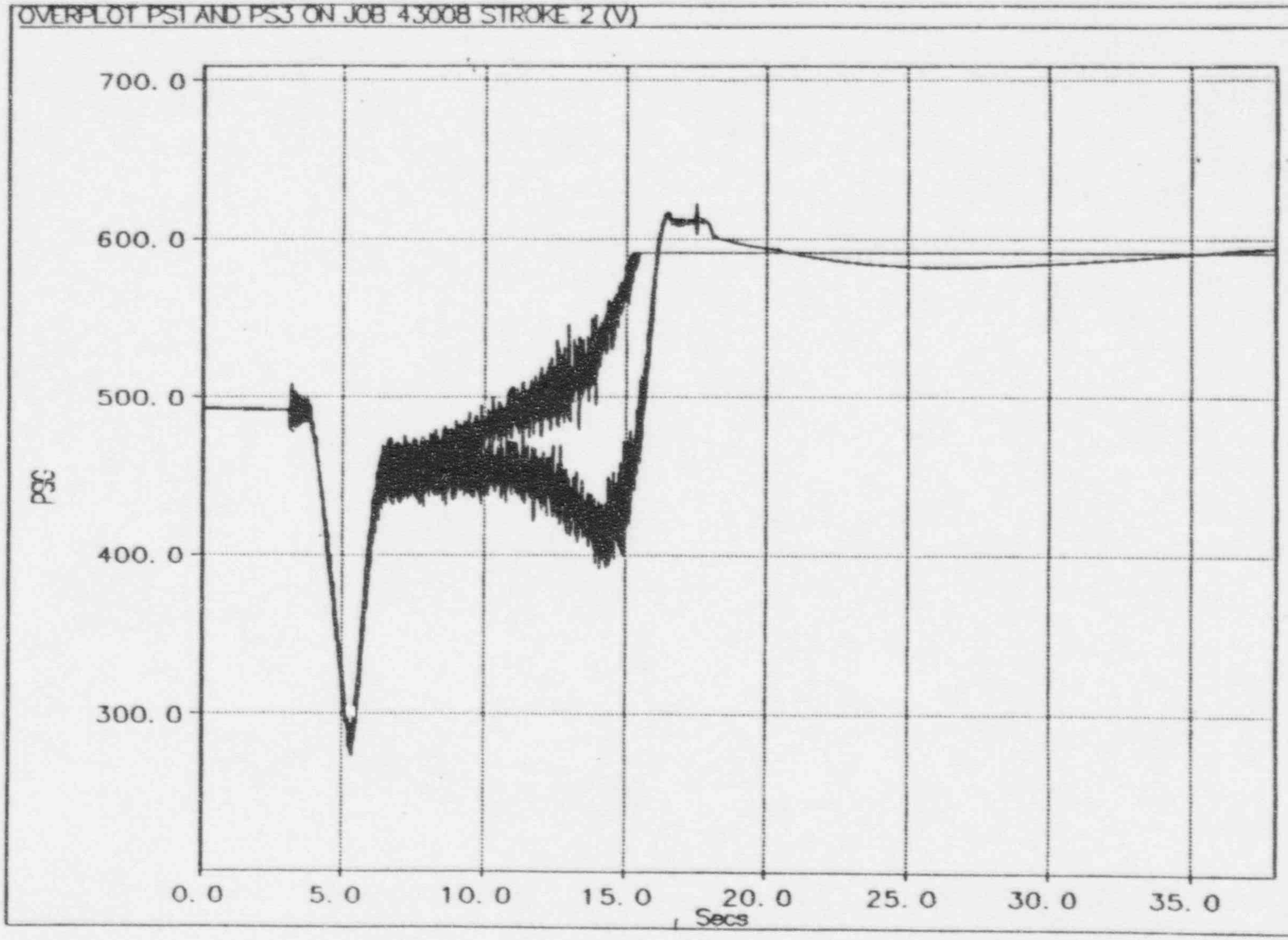
Analyzed by: [signature] 2/3/93

Verified by: [signature] 2/15/93



THR1 STEM THRUST ON JOB 43008 STROKE 2 (V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
7.926 SEC
-1796.3 LBS
(1)
0. 0
5. 0
10. 0
15. 0
20. 0
25. 0
30. 0
35. 0
secs


THRI STEM THRUST ON JOB 43008 STROKE 2 (V)
Pounds
-20000. 0
-40000. 0
-60000. 0
-80000. 0
13. 0
15. 0
17. 0
19. 0
21. 0
23. 0
secs
16.430 SEC
-27,673.5 LBS
(2)
(4)
17.316 SEC
-38,106.9 LBS
17.492 SEC
-40,723.9 LBS
(5)
17.994 SEC
-82,567.0 LBS
(6)
18.114 SEC
-88,702.0 LBS
(7)



OVERPLOT PS1 AND PS3 ON JOB 43008 STROKE 2 (V)
700. 0
600. 0
500. 0
400. 0
300. 0
PSIG
0. 0
5. 0
10. 0
15. 0
20. 0
25. 0
30. 0
35. 0
Secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 12-31-92 **Test Time** 15:02:51
Test Description 500 psid 9000 GPM O->C **Stroke #** 2 (v)
Data File C430081 **Data Set** 7

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 19.4 amps RMS
Running Power 10,814.1 watts
Contactor Drop-out Time 0.009 sec
** Disk Factor (Standard) at Max dP .3539
Stroke Time 10.6 sec
Rate of Loading N/O
** Disk Factor (NMAC) at Max dP .4179

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)**	Valve Differential Pressure (psid)	Stem Factor
1. Running	7.926	-1796.3	41.41	====	449.2	====	N/A
2. Max. dP	16.430	-27,673.5	467.41	====	613.9	617.3	.1107
3. Minimum Available	====	80,770.7	1287.39	====	====	====	====
4. Just Prior to Wedging	17.316	-38,106.9	628.58	0.0602	====	====	====
5. Wedging	17.492	-40,723.9	677.38	0.0718	611.0	610.8	====
6. Torque Switch Trip	17.994	-82,567.0	1328.80	0.2329	====	====	.1021
7. Total	18.114	-88,702.0	1460.20	0.2593	====	====	====
8. Inertia	====	6135.0	====	——	====	====	====

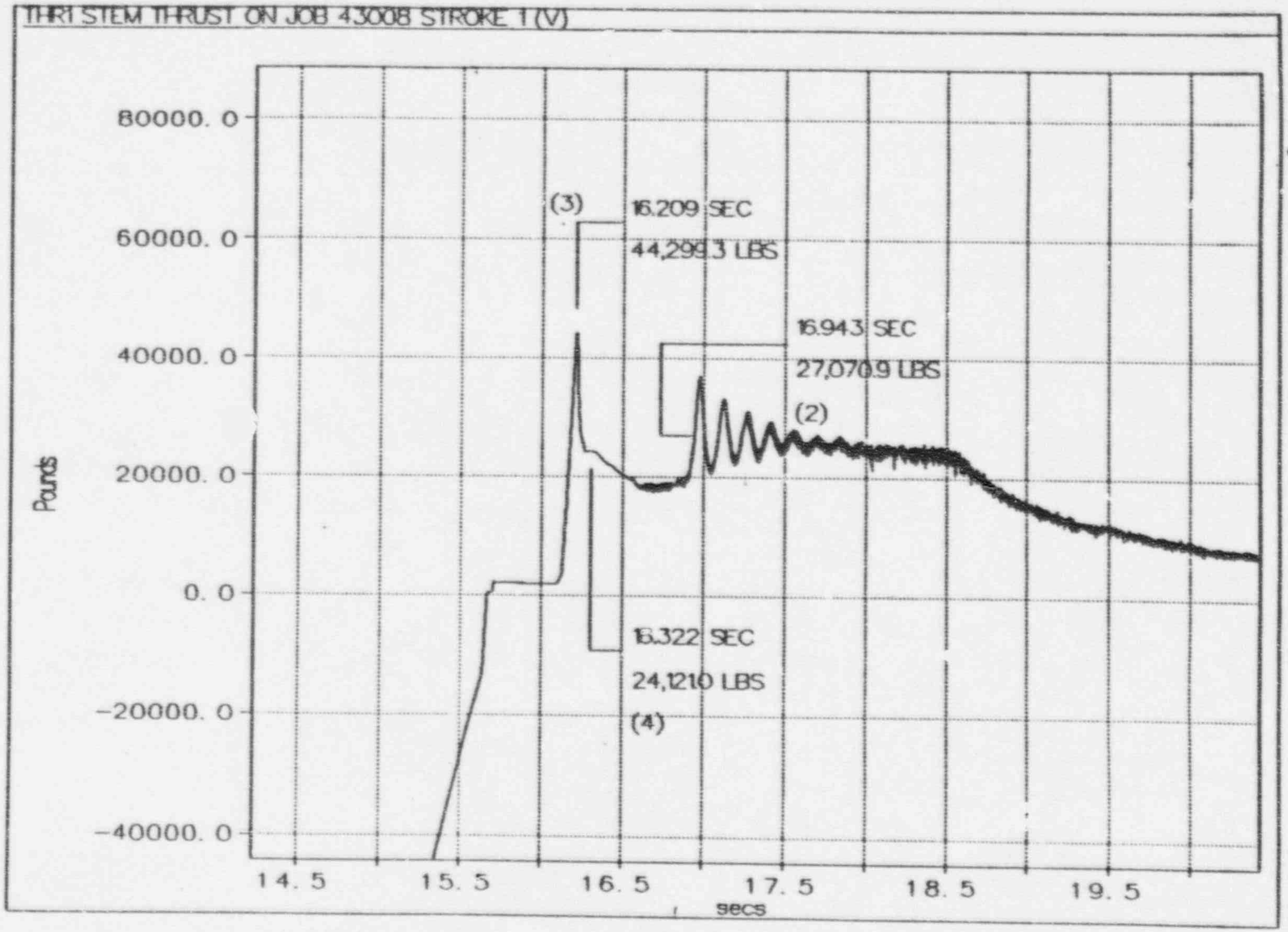
Note: All values annotated above are actual values, with no correction for static conditions.

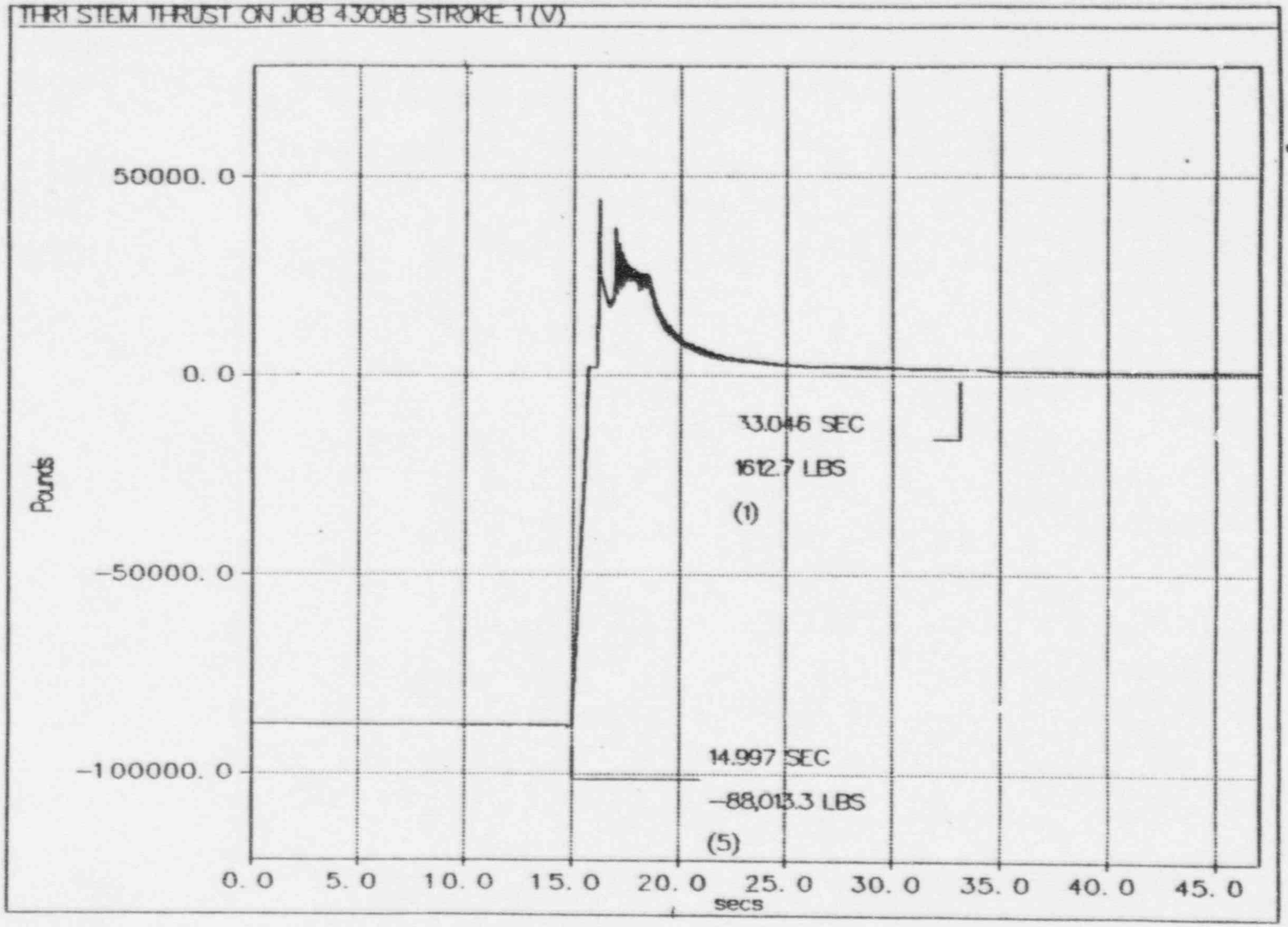
Remarks

** DISK FACTOR CALCULATED USING PS3. PS1 SATURATED DURING STROKE

Analyzed by: [signature] 2/4/93

Verified by: [signature] 2/15/93


THR1 STEM THRUST ON JOB 43008 STROKE 1 (V)
Pounds
80000. 0
60000. 0
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
(3)
16.209 SEC
44,299.3 LBS
16.943 SEC
27,070.9 LBS
(2)
16.322 SEC
24,121.0 LBS
(4)
14. 5
15. 5
16. 5
17. 5
18. 5
19. 5
secs



THR1 STEM THRUST ON JOB 43008 STROKE 1 (V)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
33.046 SEC
1612.7 LBS
(1)
14.997 SEC
-88,013.3 LBS
(5)
0. 0
5. 0
10. 0
15. 0
20. 0
25. 0
30. 0
35. 0
40. 0
45. 0
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 12-31-92
Test Description 500 psid 9000 GPM C->O
Data File C4300B1

Test Time 12:55:58
Stroke # 1 (v)
Data Set 6

OPEN STROKE

Running Current 15.9 amps RMS
Running Power 6593.2 watts
Contactor Drop-out Time 0.007 sec
Disk Factor (Standard) at Max dP .4187

Unseating Current 25.7 amps RMS
Stroke Time 18.5 sec
Disk Factor (NMAC) at Max dP .5068

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	33.046	1612.7	-25.86	====	380.8	====	N/A
2. Max. dP	16.943	27,070.9	-418.16	====	511.8	521.4	.0952
3. Unseating	16.209	44,299.3	-618.51	0.0218	====	====	====
4. Just After Unseating	16.322	24,121.0	-372.16	0.0314	496.4	495.9	====
5. Hammer Blow	14.997	-88013.3	====	0.0937	====	====	====

CLOSE STROKE

Running Current ____ amps RMS
Running Power ____ watts
Contactor Drop-out Time ____ sec
Disk Factor (Standard) at Max dP ____

Stroke Time ____ sec
Rate of Loading ____
Disk Factor (NMAC) at Max dP ____

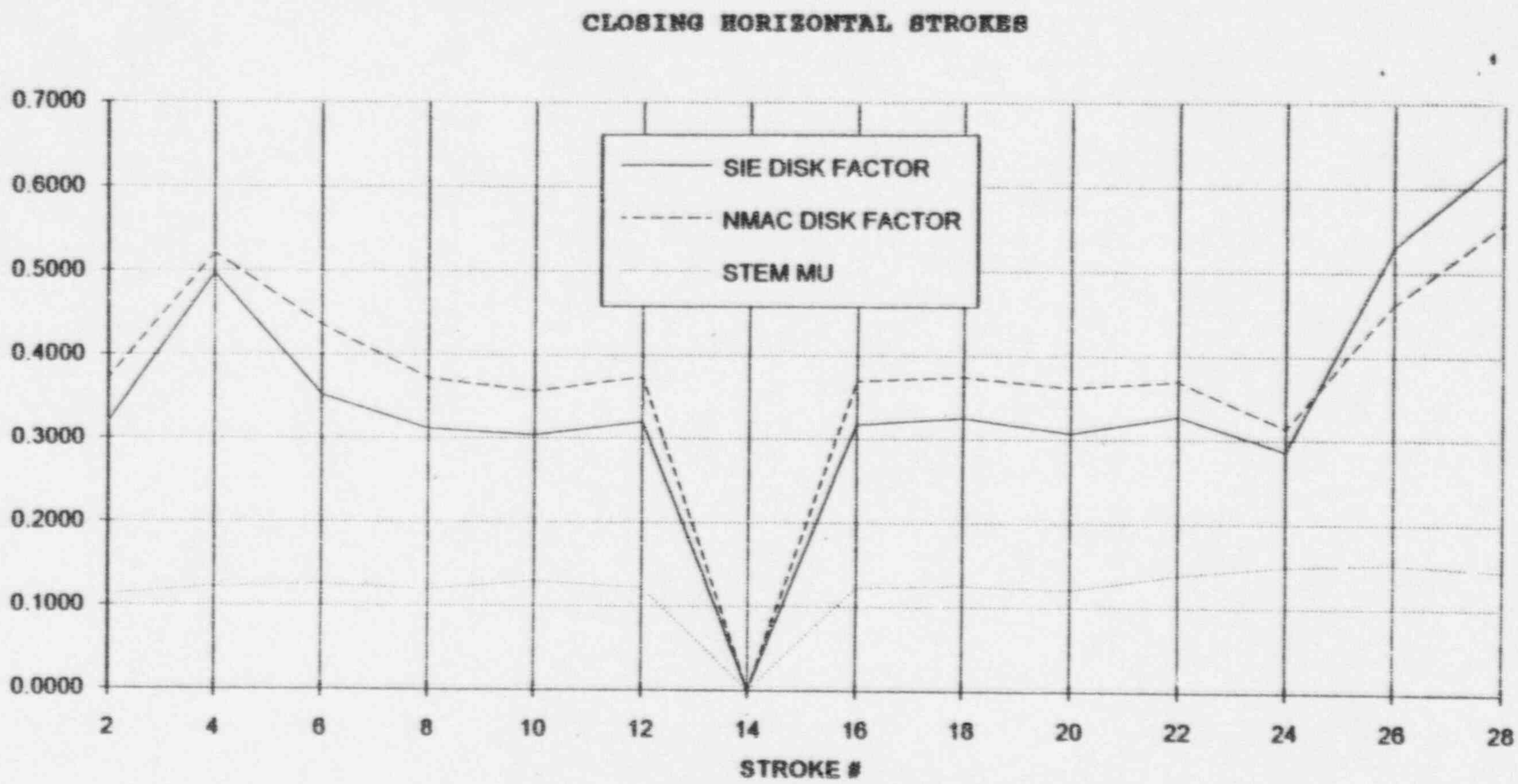
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

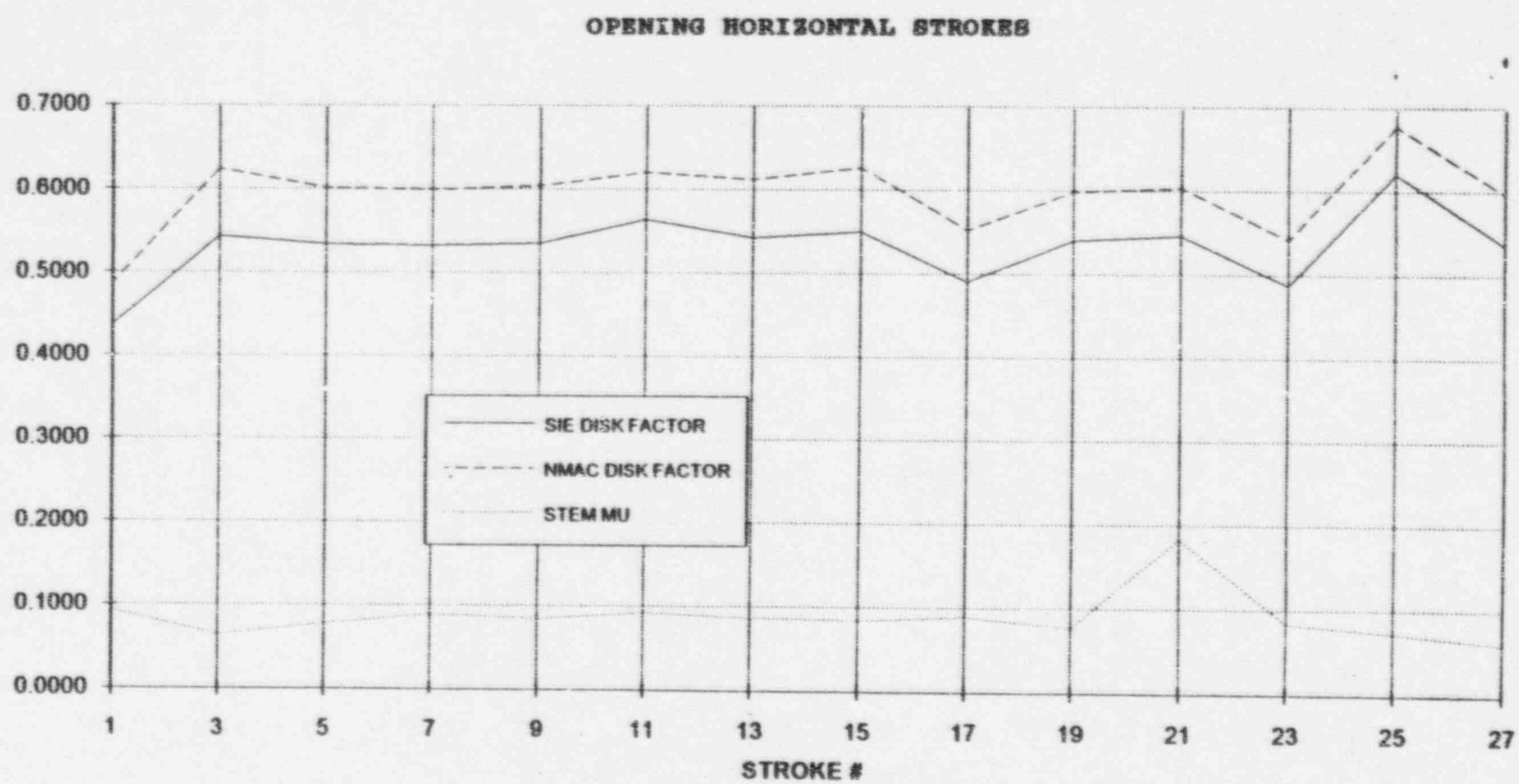
Remarks

Analyzed by: [signature] 2/4/93

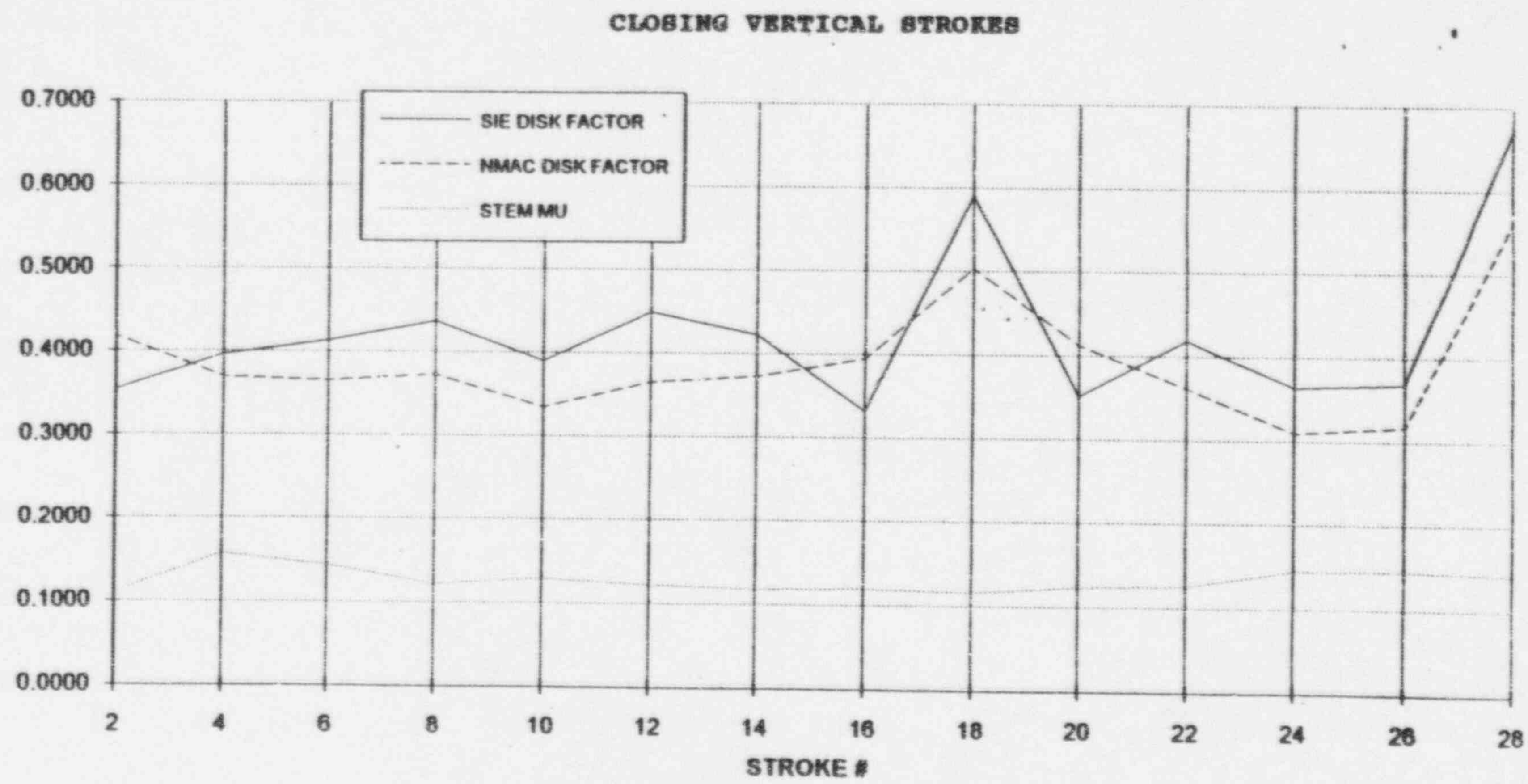
Verified by: [signature] 2/15/93



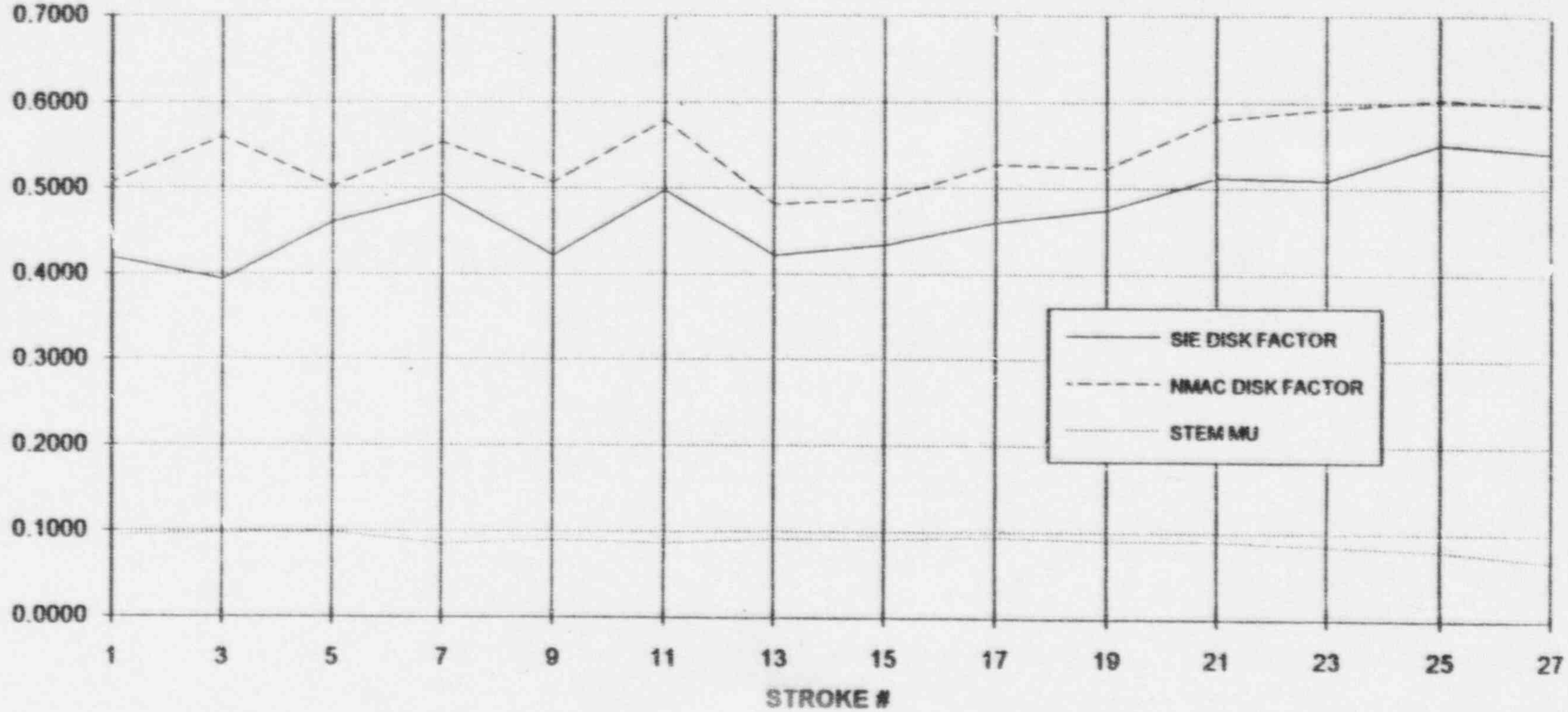
CLOSING HORIZONTAL STROKES
SIE DISK FACTOR
NMAC DISK FACTOR
STEM MU
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
2
4
6
8
10
12
14
16
18
20
22
24
26
28
STROKE #



OPENING HORIZONTAL STROKES
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
STROKE #
SIE DISK FACTOR
NMAC DISK FACTOR
STEM MU


CLOSING VERTICAL STROKES
SIE DISK FACTOR
NMAC DISK FACTOR
STEM MU
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
2
4
6
8
10
12
14
16
18
20
22
24
26
28
STROKE #

OPENING VERTICAL STROKES



NOTE 1. Upstream Pressure PS1 saturated during stroke. PS3 was found to follow PS1, therefore the Disk Factor was calculated using PS3 values.

NOTE 2. Both the Uostream Pressure PS1 and the Valve Differential Pressure DP2 saturated during the stroke. No Disk Factor or Stem Mu were calculated at the Max dP point.

NOTE 3. Wedge appeared to skip during unseating.

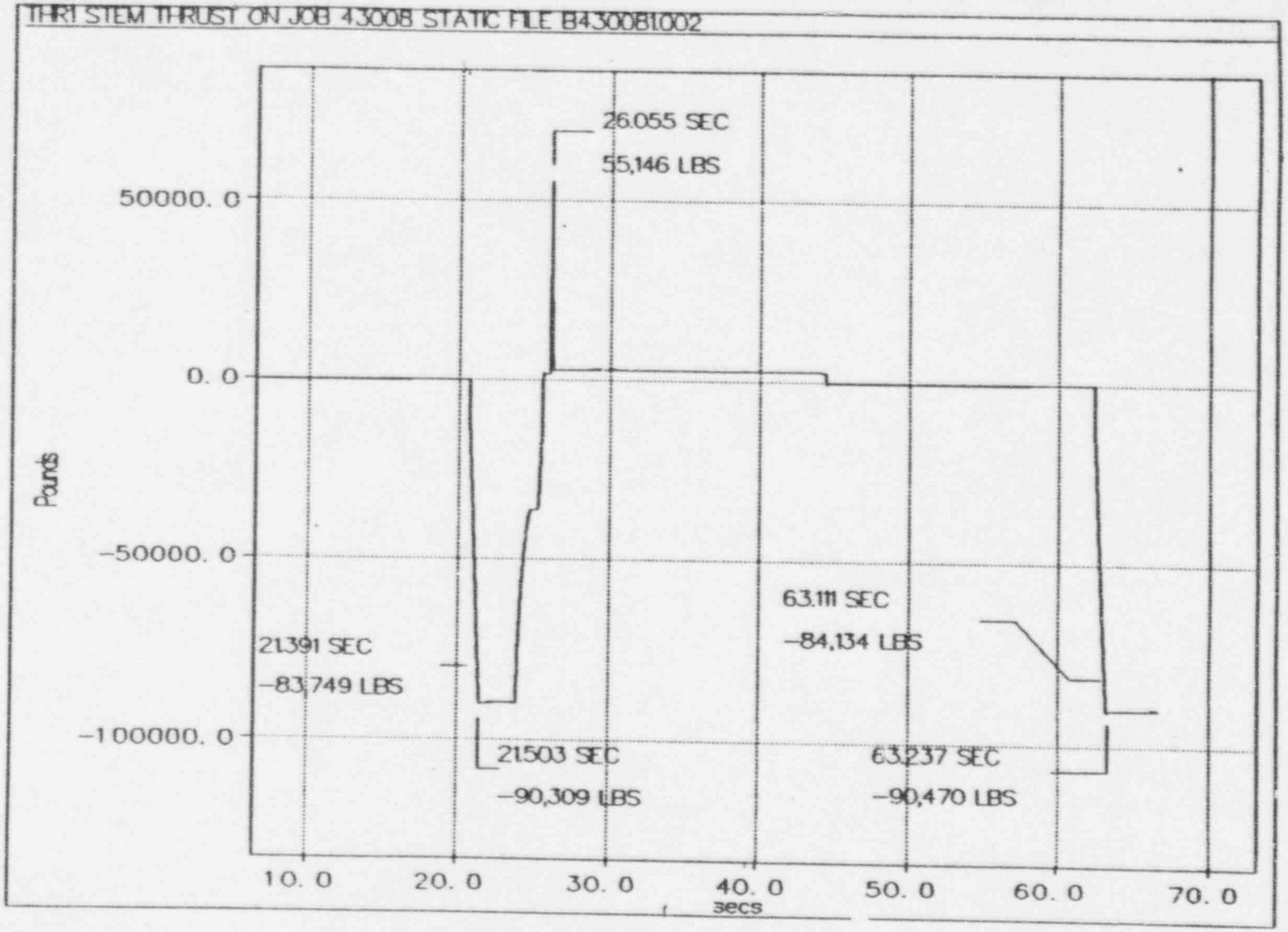
NOTE 4. The maximum differential pressure occurred after wedging.

GRAND GULF/ENTERGY JOB 43008

STROKE NUMBER	DATA FILE	DATA SET	STEM ORIENTATION	STROKE DIRECTION	PSID	GPM	DISK FACTOR (SIE)	DISK FACTOR (NMAC)	STEM FACTOR (μ)	RATE OF LOADING	NOTE
1	C430081	006	Vertical	Opening	500	9000	0.4187	0.5068	0.0952	-	
2	C430081	007	Vertical	Closing	500	9000	0.3539	0.4179	0.1107	No	(1)
3	C430082	004	Vertical	Opening	100	4000	0.3938	0.5597	0.0971	-	
4	C430082	005	Vertical	Closing	100	4000	0.3960	0.3691	0.1568	No	
5	C430082	006	Vertical	Opening	200	5500	0.4601	0.5024	0.0982	-	
6R	C430082	034	Vertical	Closing	200	5500	0.4129	0.3654	0.1432	No	
7	C430082	010	Vertical	Opening	300	7000	0.4931	0.5531	0.0854	-	
8	C430082	011	Vertical	Closing	300	7000	0.4368	0.3727	0.1221	No	
9	C430082	012	Vertical	Opening	400	8000	0.4219	0 5069	0.0898	-	
10R	C430082	033	Vertical	Closing	400	8000	0.3897	0.3346	0.1293	Yes	
11	C430082	014	Vertical	Opening	500	9000	0.4979	0.5794	0.0869	-	
12R	C430082	035	Vertical	Closing	500	9000	0.4486	0.3654	0.1220	Yes	
13	C430082	016	Vertical	Opening	500	9000	0.4214	0.4816	0.0909	-	
14	C430082	017	Vertical	Closing	500	9000	0.4222	0.3724	0.1181	Yes	
15	C430082	018	Vertical	Opening	500	9000	0.4336	0.4870	0.0907	-	(3)
16	C430082	019	Vertical	Closing	500	9000	0.3322	0.3947	0.1193	Yes	(1)
17	C430082	020	Vertical	Opening	500	9000	0.4596	0.5273	0.0935	-	(3)
18R	C430082	036	Vertical	Closing	500	9000	0.5899	0.5030	0.1157	Yes	(4)
19	C430082	022	Vertical	Opening	500	9000	0.4747	0.5234	0.0899	-	(1)(3)
20	C430082	023	Vertical	Closing	500	9000	0.3514	0.4123	0.1236	Yes	(1)
21	C430082	024	Vertical	Opening	400	8000	0.5128	0.5798	0.0902	-	
22	C430082	025	Vertical	Closing	400	8000	0.4180	0.3618	0.1256	Yes	
23	C430082	026	Vertical	Opening	300	7000	0.5098	0.5928	0.0846	-	
24	C430082	027	Vertical	Closing	300	7000	0.3638	0.3096	0.1453	Yes	
25	C430082	028	Vertical	Opening	200	5500	0.5511	0.6033	0.0797	-	
26	C430082	029	Vertical	Closing	200	5500	0.3682	0.3168	0.1456	Yes	
27	C430082	030	Vertical	Opening	100	4000	0.5420	0.5966	0.0680	-	(3)
28	C430082	031	Vertical	Closing	100	4000	0.6703	0.5606	0.1416	Yes	(4)

GRAND GULF/ENTERGY JOB 43008

STROKE NUMBER	DATA FILE	DATA SET	STEM ORIENTATION	STROKE DIRECTION	PSID	GPM	DISK FACTOR (SIE)	DISK FACTOR (NMAC)	STEM FACTOR (μ)	RATE OF LOADING	NOTE
1	D43008	003	Horizontal	Opening	500	9000	0.4364	0.4866	0.0930	-	
2	D43008	004	Horizontal	Closing	500	9000	0.3193	0.3712	0.1124	No	
3R	D43008	039	Horizontal	Opening	100	4000	0.5435	0.6240	0.0640	-	
4R	D43008	013	Horizontal	Closing	100	4000	0.4969	0.5204	0.1224	No	(4)
5R	D43008	036	Horizontal	Opening	200	5500	0.5335	0.6014	0.0772	-	
6	D43008	008	Horizontal	Closing	200	5500	0.3525	0.4360	0.1259	No	
7	D43008	009	Horizontal	Opening	300	7000	0.5320	0.5985	0.0889	-	
8	D43008	010	Horizontal	Closing	300	7000	0.3119	0.3717	0.1194	Yes	
9	D43008	011	Horizontal	Opening	400	8000	0.5348	0.6045	0.0840	-	
10R	D43008	037	Horizontal	Closing	400	8000	0.3042	0.3568	0.1296	Yes	
11	D43008	014	Horizontal	Opening	500	9000	0.5637	0.6206	0.0913	-	(1)
12	D43008	015	Horizontal	Closing	500	9000	0.3207	0.3743	0.1219	No	
13	D43008	016	Horizontal	Opening	500	9000	0.5425	0.6121	0.0862	-	(1)
14	D43008	017	Horizontal	Closing	500	9000	-	-	-	Yes	(2)
15	D43008	018	Horizontal	Opening	500	9000	0.5498	0.6266	0.0838	-	(1)(3)
16	D43008	019	Horizontal	Closing	500	9000	0.3174	0.3700	0.1229	Yes	
17R	D43008	033	Horizontal	Opening	500	9000	0.4909	0.5517	0.0887	-	(3)
18	D43008	021	Horizontal	Closing	500	9000	0.3258	0.3744	0.1248	No	
19	D43008	023	Horizontal	Opening	500	9000	0.5403	0.5979	0.0769	-	(1)(3)
20	D43008	024	Horizontal	Closing	500	9000	0.3075	0.3628	0.1206	Yes	
21R	D430081	007	Horizontal	Opening	400	8000	0.5465	0.6033	0.1833	-	(3)
22R	D43008	042	Horizontal	Closing	400	8000	0.3277	0.3702	0.1381	No	
23R	D43008	041	Horizontal	Opening	300	7000	0.4876	0.5416	0.0831	-	
24RR	D43008	040	Horizontal	Closing	300	7000	0.2855	0.3135	0.1492	No	
25	D43008	029	Horizontal	Opening	200	5500	0.6203	0.6774	0.0724	-	
26R	D43008	034	Horizontal	Closing	200	5500	0.5305	0.4624	0.1526	No	
27	D43008	031	Horizontal	Opening	100	4000	0.5354	0.5968	0.0604	-	
28	D43008	032	Horizontal	Closing	100	4000	0.6369	0.5581	0.1455	No	


THRI STEM THRUST ON JOB 43008 STATIC FILE B430081002
26.055 SEC
55,146 LBS
50000. 0
0. 0
Pounds
-50000. 0
-100000. 0
21.391 SEC
-83,749 LBS
21.503 SEC
-90,309 LBS
63.111 SEC
-84,134 LBS
63.237 SEC
-90,470 LBS
10. 0
20. 0
30. 0
40. 0
50. 0
60. 0
70. 0
secs

DATA ANALYSIS RESULTS

ATTACHMENT I

TO
TEST REPORT NO. 43008-1
FOR
ENTERGY OPERATIONS

M-J5.08-Q1-43008-01-8.0-1-0

DATA ANALYSIS RESULTS

ATTACHMENT I

TO
TEST REPORT NO. 43008-1
FOR
ENTERGY OPERATIONS

NPE DOCUMENT REVIEW
APPROVED ENGINEERING REFERENCE DOCUMENT
RM. RJWright FOR JLB Date 9-12-95

Q

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-5-93
Test Description 500 Psid 9000 GPM C→O
Data File C4300B2

Test Time 15:38:11
Stroke # 11 (v)
Data Set 14

OPEN STROKE

Running Current 16.3 amps RMS
Running Power 7224.5 watts
Contactor Drop-out Time 0.010 sec
Disk Factor (Standard) at Max dP .4979

Unseating Current 27.3 amps RMS
Stroke Time 18.5 sec
Disk Factor (NMAC) at Max dP .5794

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	31.121	3104.8	-26.30	====	324.4	====	N/A
2. Max. dP	15.364	32,184.3	-472.33	====	506.3	506.7	.0869
3. Unseating	15.140	44,345.3	-607.99	-0.0159	====	====	====
4. Just After Unseating	15.177	35,105.5	-497.18	-0.0099	500.85	501.4	====
5. Hammer Blow	13.931	-84,460.9	====	0.0795	====	====	====

CLOSE STROKE

Running Current amps RMS
Running Power watts
Contactor Drop-out Time sec
Disk Factor (Standard) at Max dP

Stroke Time sec
Rate of Loading
Disk Factor (NMAC) at Max dP

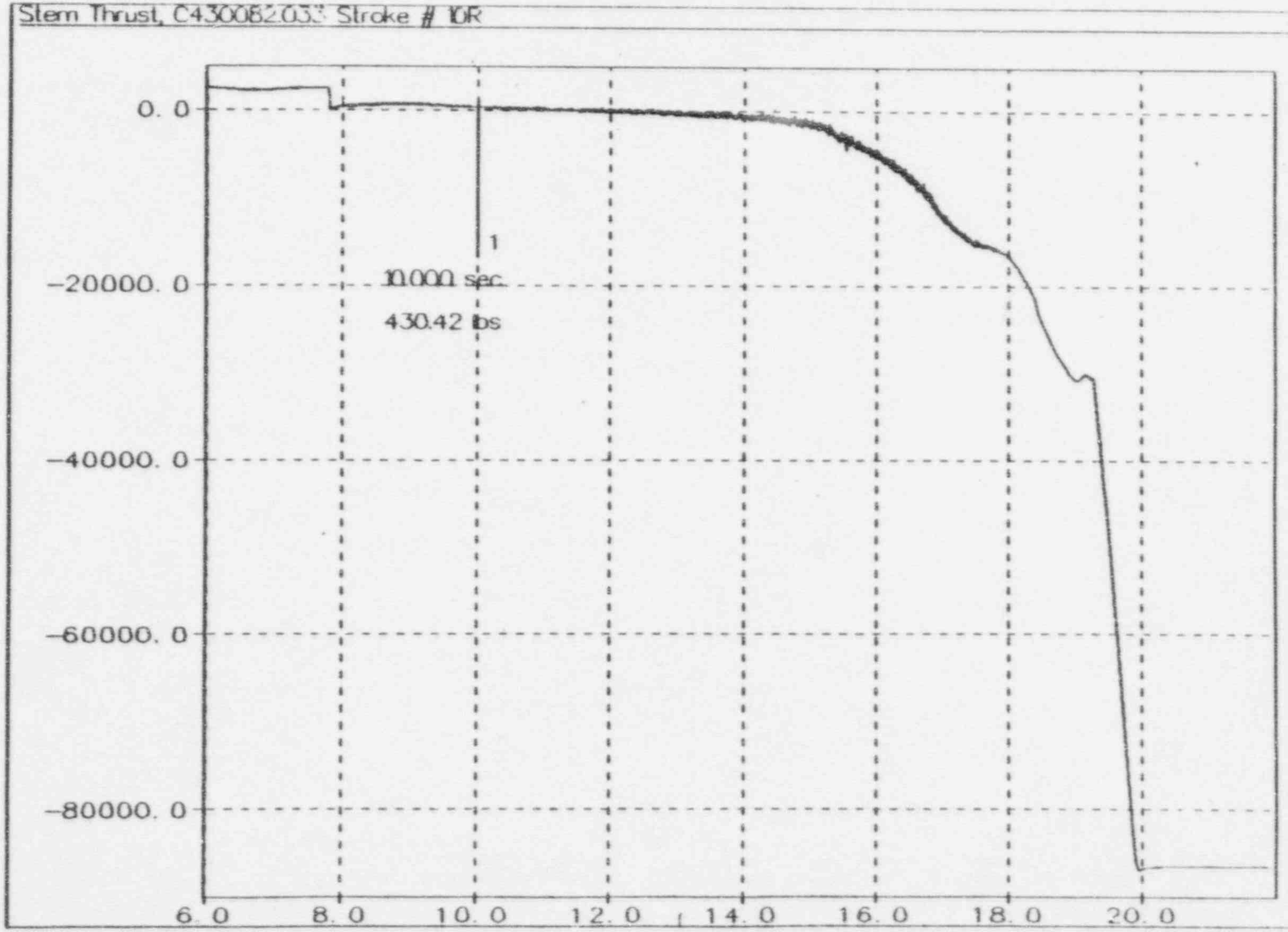
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

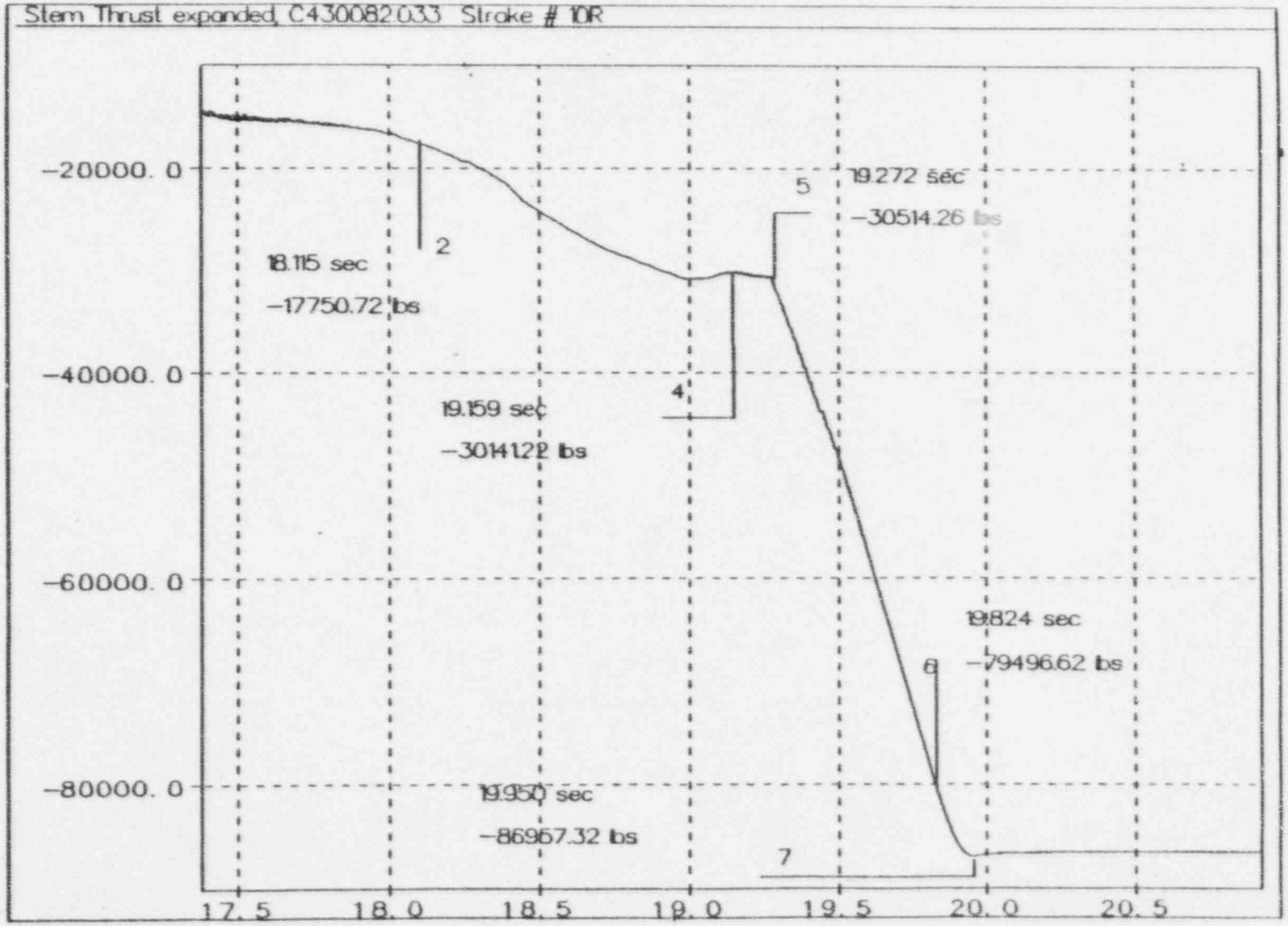
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/4/93

Verified by: [signature] 2/15/93


Stem Thrust, C430082033 Stroke # 10R
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
1
10.000 sec.
430.42 lbs



Stem Thrust expanded, C430082.033 Stroke # 10R
-20000. 0
-40000. 0
-60000. 0
-80000. 0
17. 5
18. 0
18. 5
19. 0
19. 5
20. 0
20. 5
2
18.115 sec
-17750.72 lbs
4
19.159 sec
-30141.22 lbs
5
19.272 sec
-30514.26 lbs
6
19.824 sec
-79496.62 lbs
7
19.950 sec
-86967.32 lbs

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/8/93	Test Time	14:22:39
Test Description	400 PSI 8000 GPM	Stroke #	10 R(V)
Data File	AC430082	Data Set	033

OPEN STROKE

Running Current ______ amps RMS

Running Power ______ watts

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS

Stroke Time ______ sec

Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Unseating					****	****	****
4. Just After Unseating							****
5. Hammer Blow			****		****	****	****

CLOSE STROKE

Running Current 16.39 amps RMS

Running Power 9233.50 watts

Contactor Drop-out Time 0.015 sec

Disk Factor (Standard) at Max dP -0.389673

Stroke Time 18.3 sec

Rate of Loading Yes about 2100 lbs

Disk Factor (NMAC) at Max dP -0.334609

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	430.42	29.437	****	311.75	****	N/A
2. Max. dP	18.115	-17750.72	330.75	****	479.48	480.46	0.139[illegible]
3. Minimum Available	****	79066.20	5[illegible].00	****	****	****	****
4. Just Prior to Wedging	19.158	-30141.22	528.18	0.054510	****	****	****
5. Wedging	19.272	-30514.26	529.53	0.053994	472.60	472.50	****
6. Torque Switch Trip	19.824	-79496.62	1303.28	0.235240	****	****	0.105245
7. Total	19.950	-86957.32	1528.47	0.268424	****	****	****
9. Inertia	****	7460.70	****	N/A	****	****	****

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

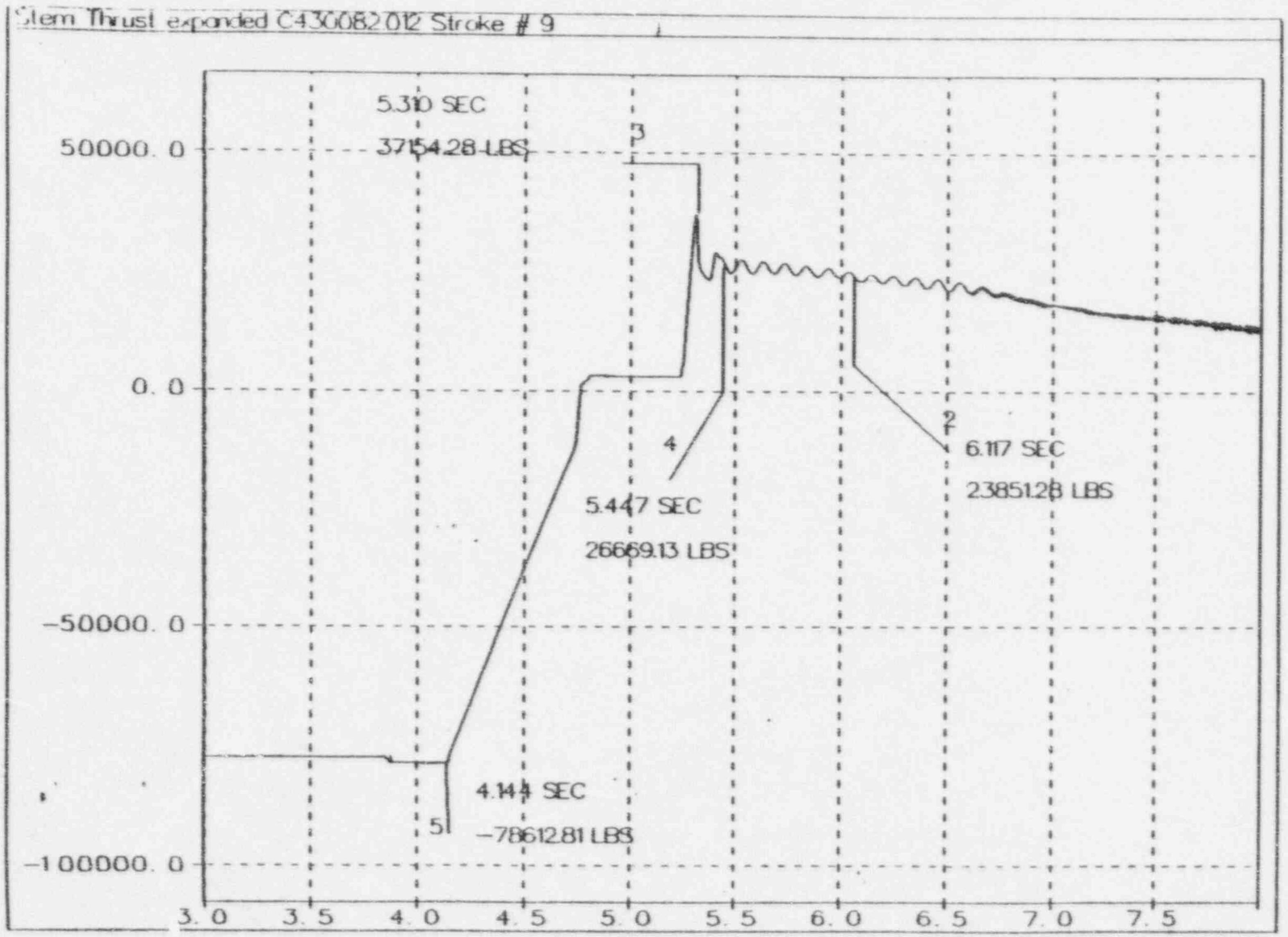
By Pass: 18.208 sec

Motor Starts: ..500 sec

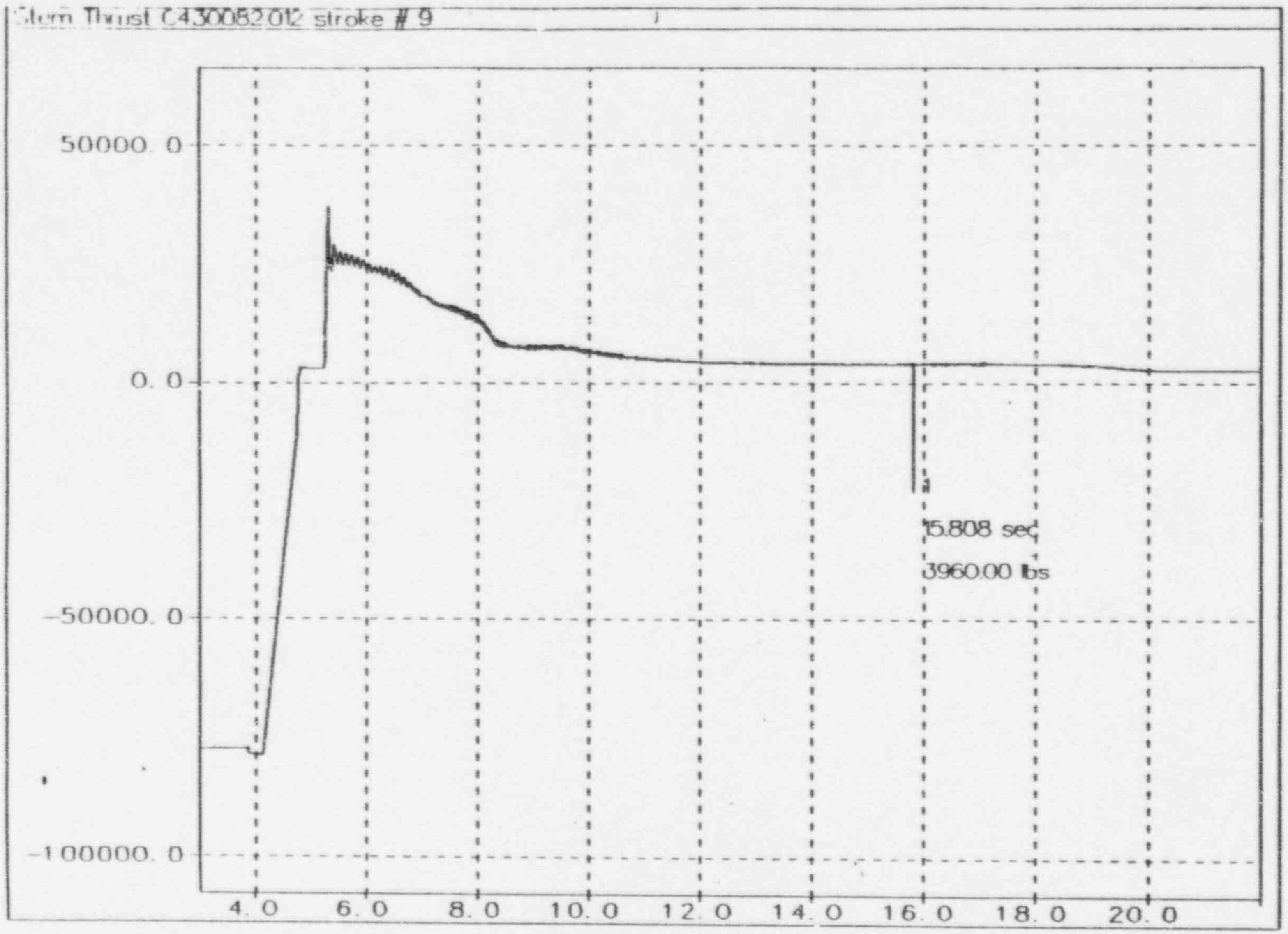
" Stop: 19.933 sec

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93



Stem Thrust expanded C430082.012 Stroke # 9
5.310 SEC
37154.28 LBS
3
50000. 0
0. 0
-50000. 0
-100000. 0
4
5.447 SEC
26669.13 LBS
2
6.117 SEC
23851.28 LBS
4.144 SEC
5
-78612.81 LBS
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5
7. 0
7. 5


Stem Thrust C430082012 stroke # 9
50000. 0
0. 0
-50000. 0
-100000. 0
4. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
15.808 sec
3960.00 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-05-1993	Test Time	11:56:15.00
Test Description	400 PSI 3000 GPM	Stroke #	9 (V)
Data File	CA430082	Data Set	012

OPEN STROKE

Iur 5.88 A ncc

Running Current	16.68 amps RMS		Unseating Current	25.6? amps RMS
Running Power	7860.72 watts		Stroke Time	8.5 sec
Contactor Drop-out Time	0.011 sec			
Disk Factor (Standard) at Max dP	0.4218533		Disk Factor (NMAC) at Max dP	0.5069109

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	15.808	3960.00	-44.88	■■■■	94.54	■■■■	0.050979
2. Max. dP	6.117	23851.92	-356.37	■■■■	404.14	403.97	0.089785
3. Unseating	5.310	37154.28	-516.54	0.000984	■■■■	■■■■	■■■■
4. Just After Unseating	5.447	26669.13	-392.41	0.003749	403.69	404.01	■■■■
5. Hammer Blow	4.144	-78612.81	■■■■	0.035836	■■■■	■■■■	■■■■

CLOSE STROKE

Running Current	amps RMS		Stroke Time	sec
Running Power	watts		Rate of Loading	
Contactor Drop-out Time	sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Minimum Available	■■■■			■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging					■■■■	■■■■	■■■■
5. Wedging							■■■■
6. Torque Switch Trip					■■■■	■■■■	
7. Total					■■■■	■■■■	■■■■
8. Inertia	■■■■		■■■■		■■■■	■■■■	■■■■

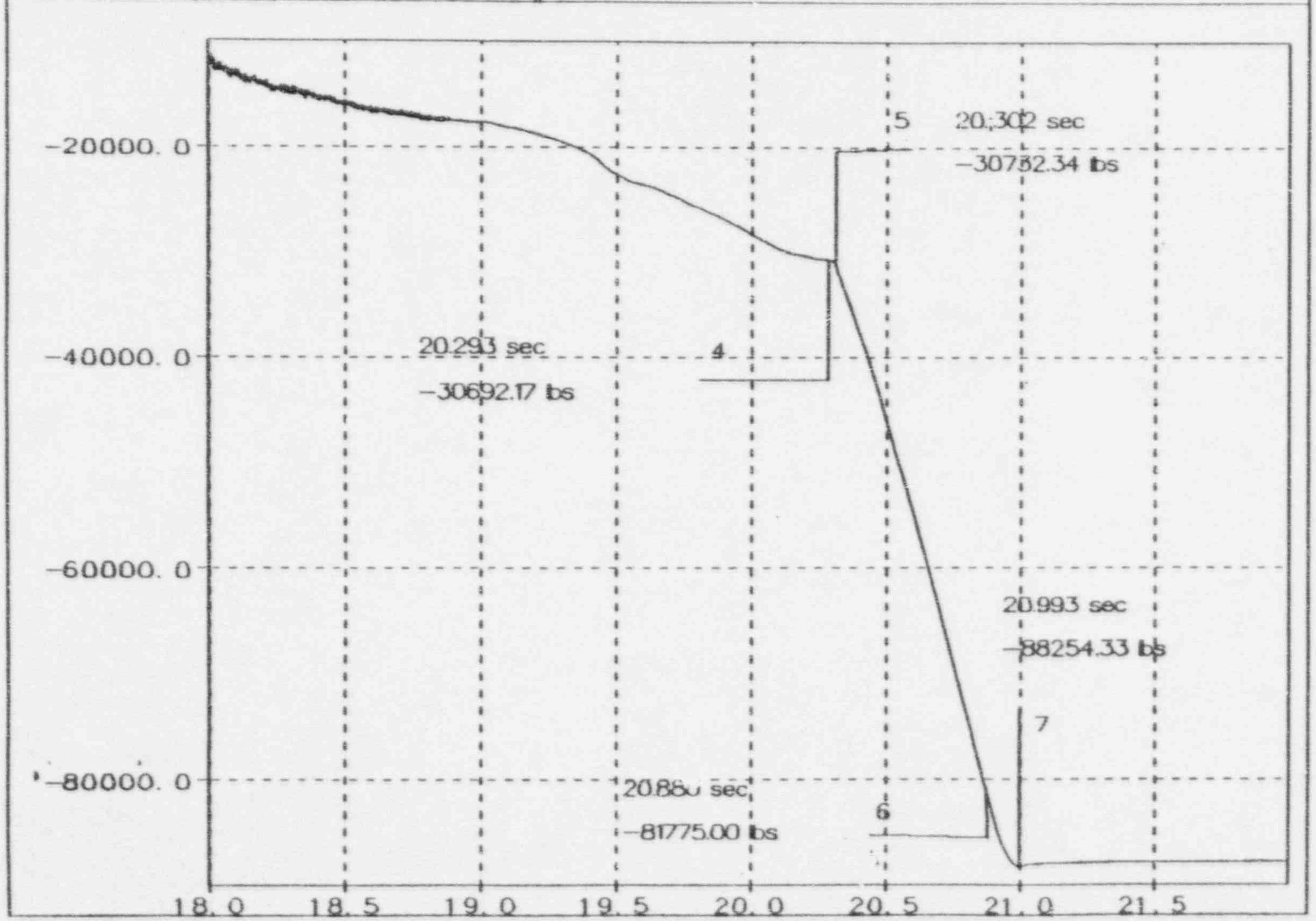
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

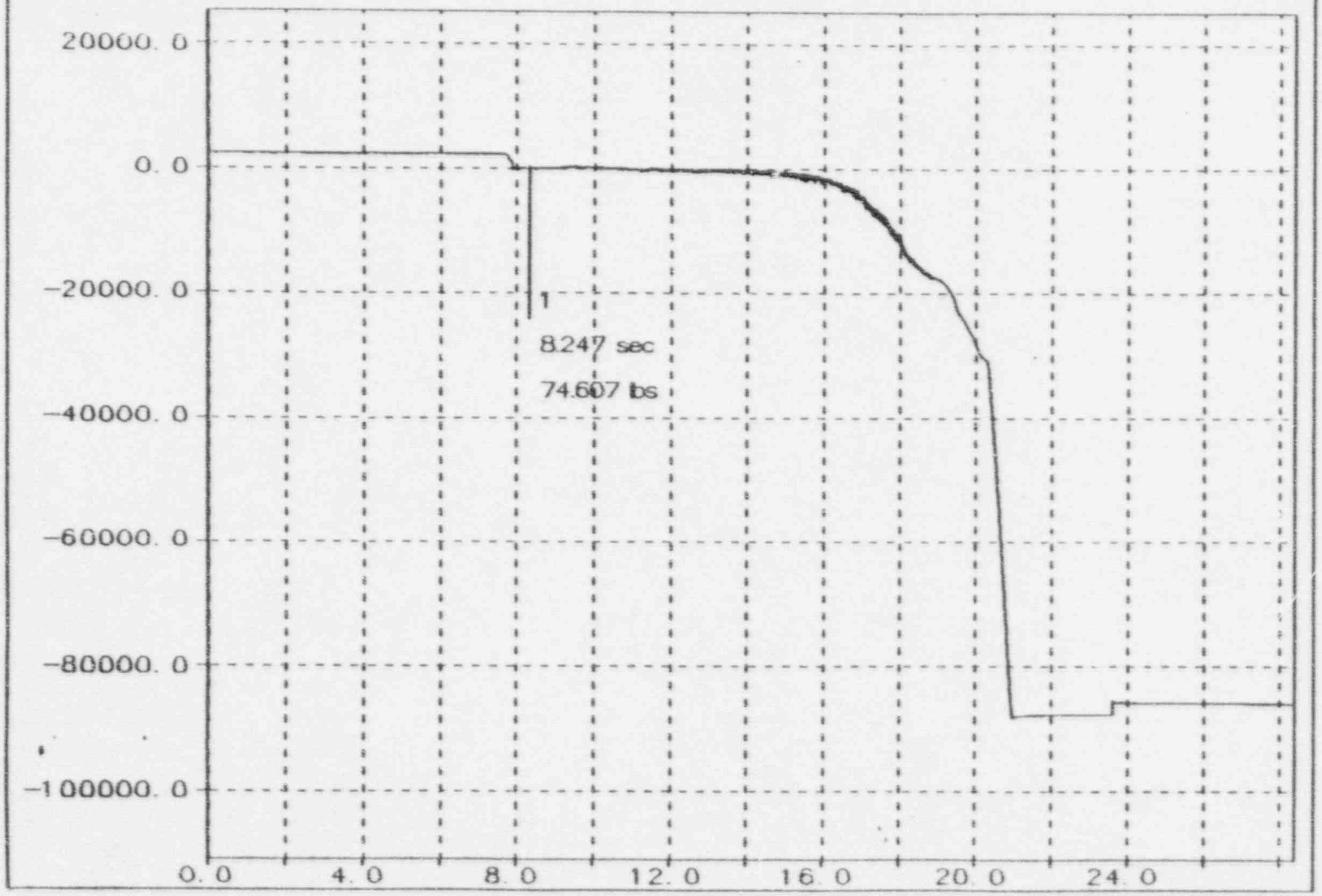
Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/16/93

Stem Thrust expanded, C430082011 Stroke # 8



Stem Thrust C4300820II stroke # 8



Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-05-1993
Test Description 300 PSI 7000 GPM
Data File GO430082

Test Time 10:40:01 am
Stroke # 8 (V)
Data Set 011

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 16.68 amps RMS
Running Power 9075.7 watts
Contactor Drop-out Time 0.015 sec
Disk Factor (Standard) at Max dP 0.436822

Stroke Time 13.4 sec
Rate of Loading No
Disk Factor (NMAC) at Max dP 0.3726522

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	8.247	74.607	26.41	====	289.23	====	N/A
2. Max. dP	19.361	-20172.58	360.18	====	472.60	472.10	0.1205578
3. Minimum Available	====	81700.39	1293.99	====	====	====	====
4. Just Prior to Wedging	20.293	-30692.17	524.15	0.04382	====	====	====
5. Wedging	20.302	-30732.34	523.93	0.04393	471.55	470.55	====
6. Torque Switch Trip	20.880	-81775.00	1320.40	0.23327	====	====	0.1026977
7. Total	20.993	-88254.33	1518.51	0.26116	====	====	====
8. Inertia	====	6479.33	====	---	====	====	====

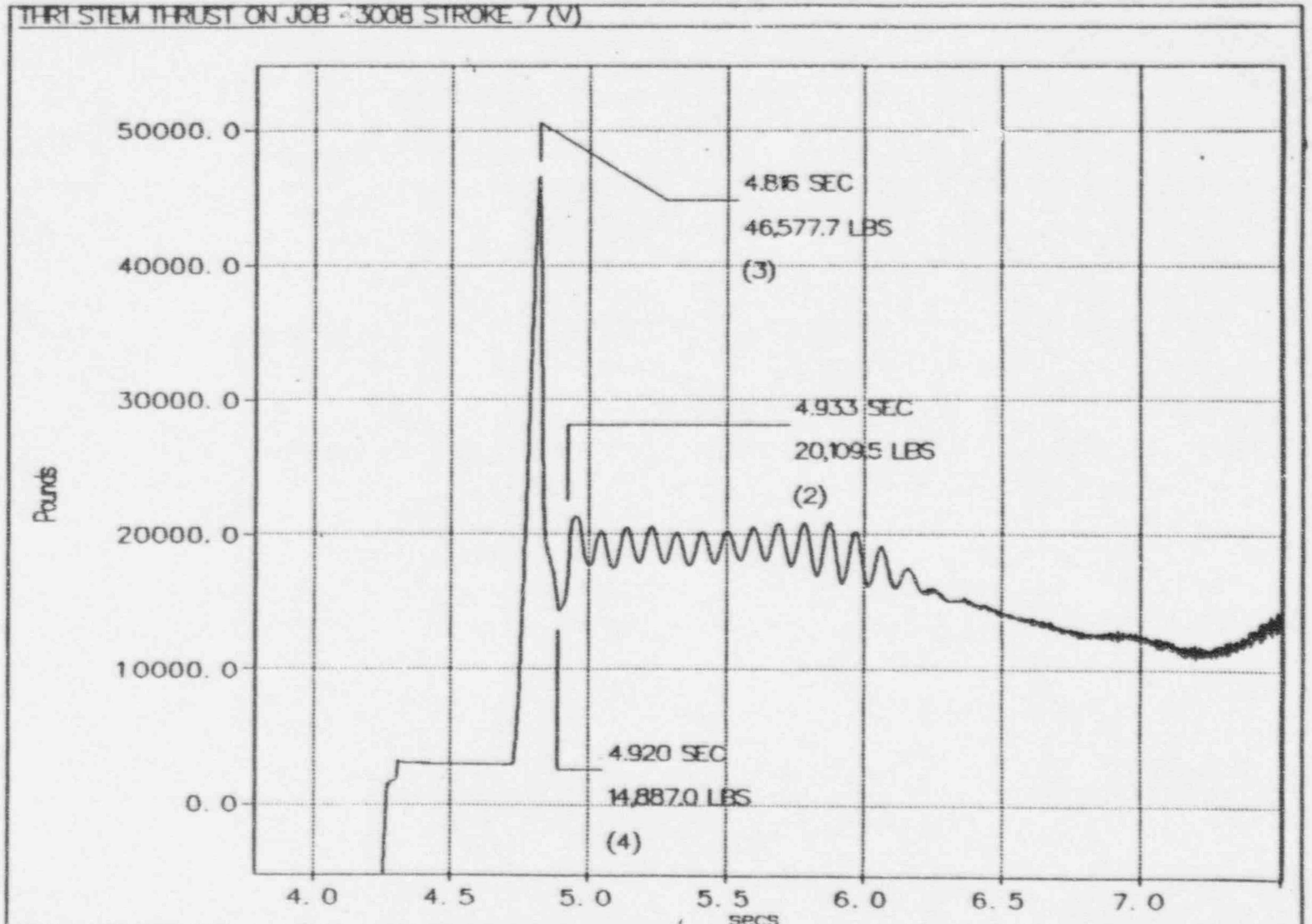
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

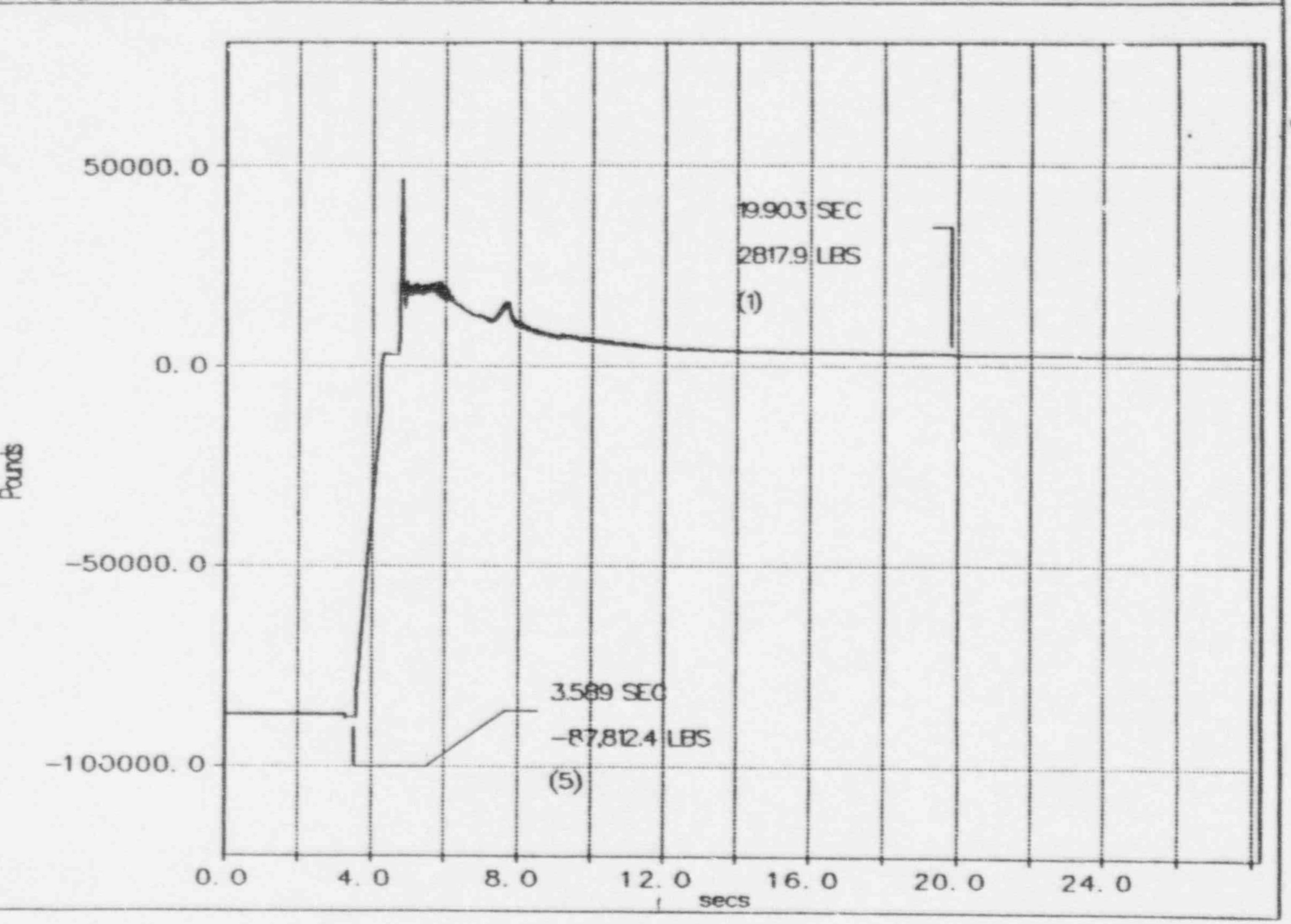
By Pass: 19.354 sec

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


THR1 STEM THRUST ON JOB -3008 STROKE 7 (V)
4.816 SEC
46,577.7 LBS
(3)
4.933 SEC
20,109.5 LBS
(2)
4.920 SEC
14,887.0 LBS
(4)
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
Pounds
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5
7. 0
secs

THRI STEM THRUST ON JOB 43008 STROKE 7 (V)



Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-5-93 **Test Time** 8:18:29
Test Description 300 psid 7000 GPM C→O **Stroke #** 7 (v)
Data File C430082 **Data Set** 10

OPEN STROKE

Running Current 16.3 amps RMS
Running Power 7384.8 watts
Contactor Drop-out Time 0.007 sec
Disk Factor (Standard) at Max dP .4931
Unseating Current 27.2 amps RMS
Stroke Time 18.5 sec
Disk Factor (NMAC) at Max dP .5531

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.903	2817.9	-25.74	====	350.4	====	N/A
2. Max. dP	4.933	20,109.5	-292.24	====	303.6	304.0	.0854
3. Unseating	4.816	46,577.7	-649.40	-0.0251	====	====	====
4. Just After Unseating	4.910	14,887.0	-215.57	-0.0001	304.5	301.1	====
5. Hammer Blow	3.589	-87,812.4	====	+0.0688	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

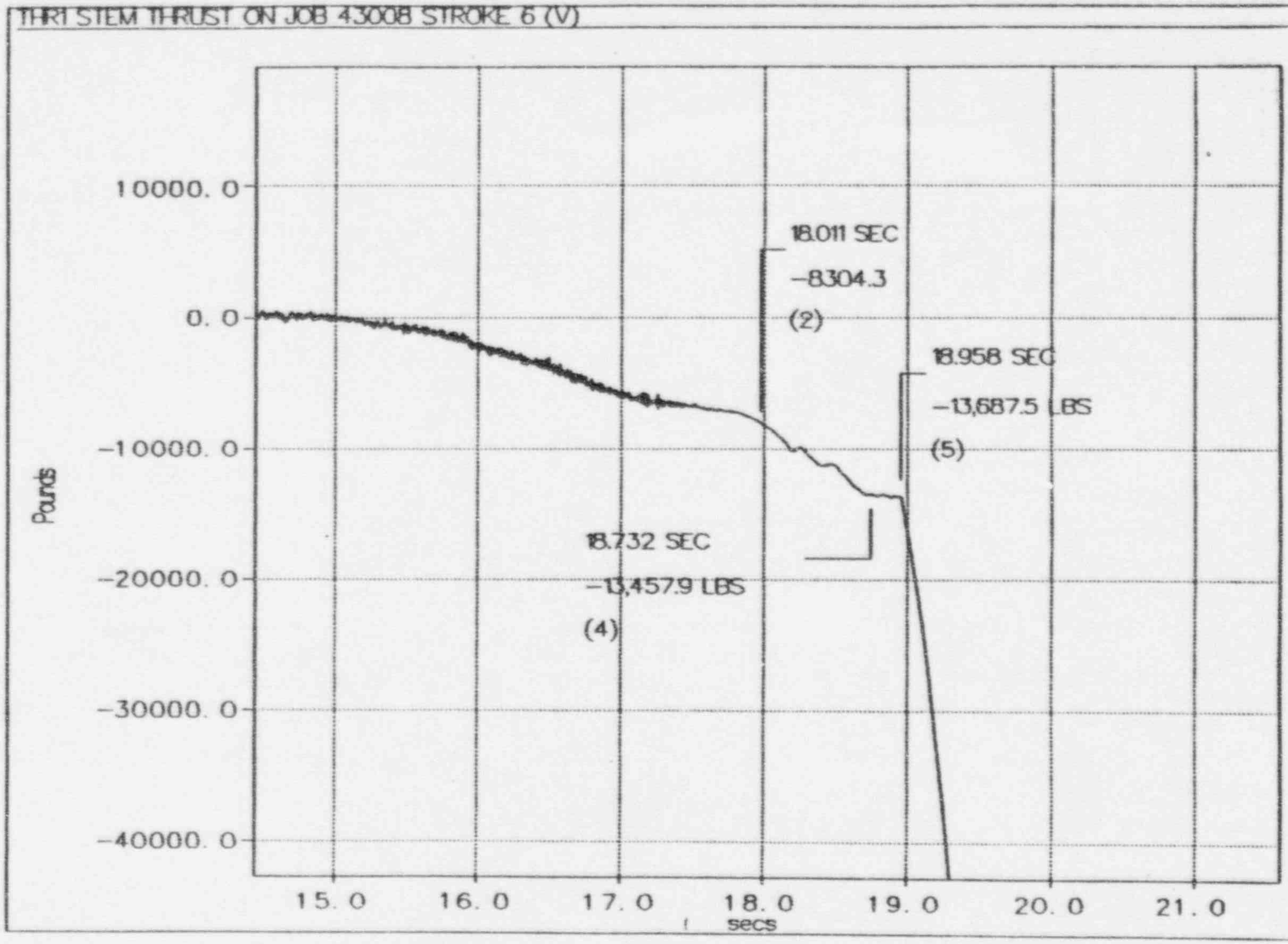
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

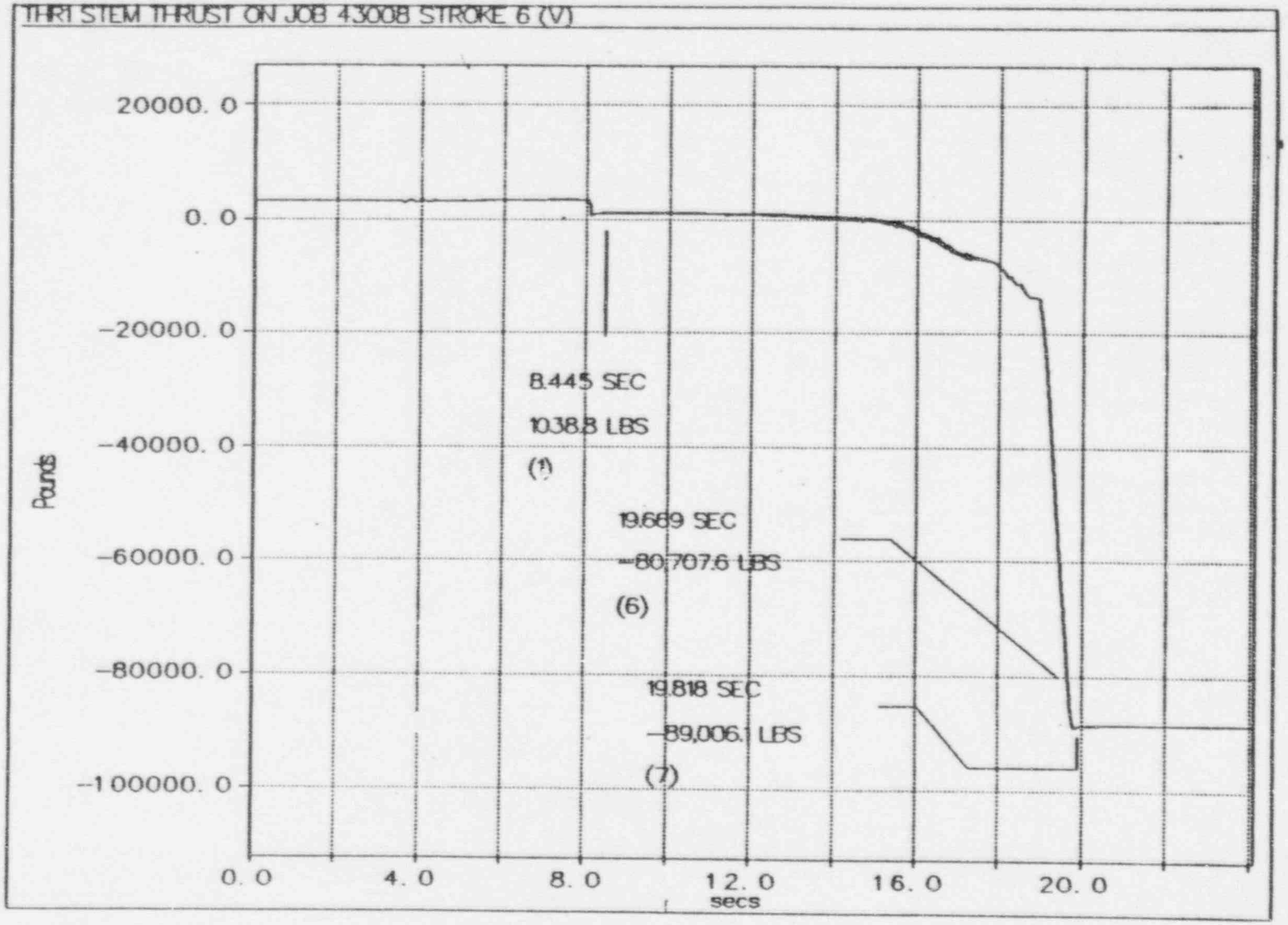
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/5/93

Verified by: [signature] 2/15/93


THR1 STEM THRUST ON JOB 43008 STROKE 6 (V)
10000. 0
0. 0
-10000. 0
-20000. 0
-30000. 0
-40000. 0
Pounds
15. 0
16. 0
17. 0
18. 0
19. 0
20. 0
21. 0
secs
18.011 SEC
-8304.3
(2)
18.958 SEC
-13,687.5 LBS
(5)
18.732 SEC
-13,457.9 LBS
(4)


THR1 STEM THRUST ON JOB 43008 STROKE 6 (V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
secs
8.445 SEC
1038.8 LBS
(1)
19.669 SEC
-80,707.6 LBS
(6)
19.818 SEC
-89,006.1 LBS
(7)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-8-93	Test Time	15:25:13
Test Description	200 psid 5500 GPM O->C	Stroke #	6(v) R
Data File	C4300B2	Data Set	34

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 17.6 amps RMS
Running Power 10,473.5 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP .4129
Stroke Time 11.9 sec
Rate of Loading 455 - ≈ 3400 LBS Difference from static [illegible]
Disk Factor (NMAC) at Max dP .3654

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	8.445	1038.8	17.9	====	149.2	====	—
2. Max. dP	18.011	-8304.3	165.65	====	225.1	231.1	.1432
3. Minimum Available	====	81,746.4	1284.02	====	====	====	====
4. Just Prior to Wedging	18.732	-13,457.9	246.35	0.0445	====	====	====
5. Wedging	18.958	-13,687.5	252.17	0.0445	220.0	222.9	====
6. Torque Switch Trip	19.669	-80,707.6	1301.93	0.2350	====	====	.1025
7. Total	19.818	-89,006.1	1501.28	0.2746	====	====	====
8. Inertia	====	8298.5	====	—	====	====	====

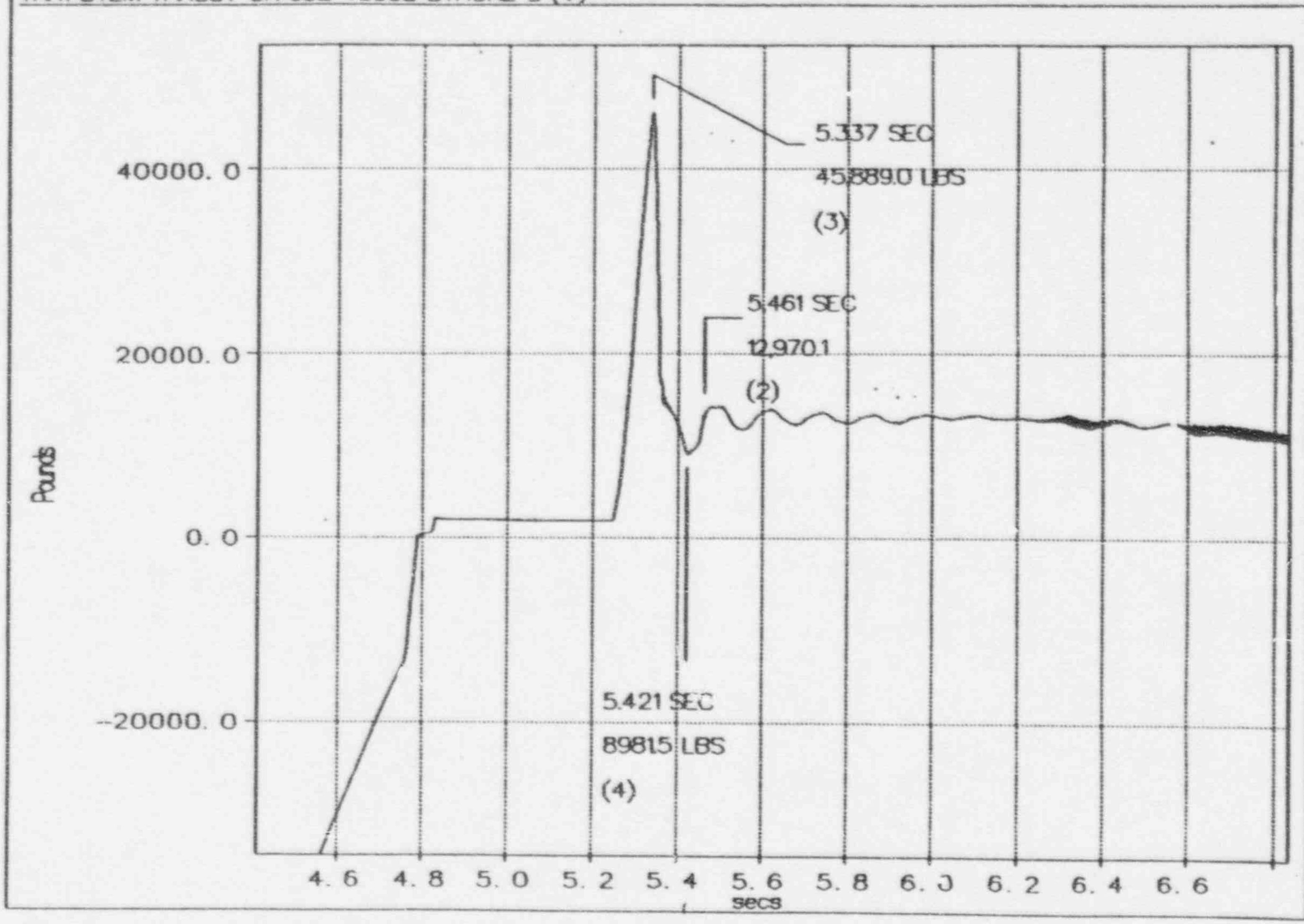
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

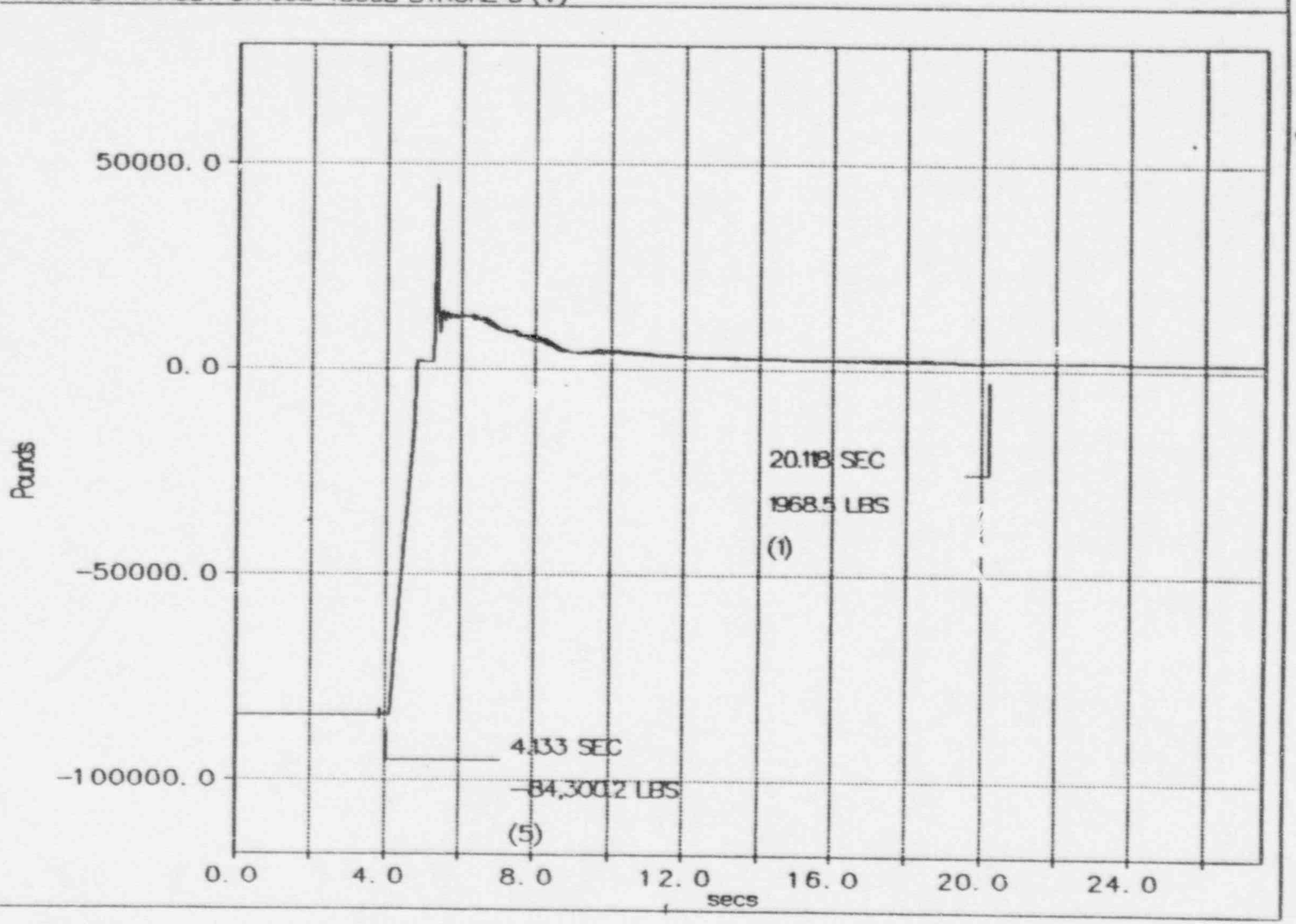
Analyzed by: [signature] 2/5/93

Verified by: [signature] 2/15/93

THR1 STEM THRUST ON JOB 43008 STROKE 5 (V)



THR1 STEM THRUST ON JOB 43008 STROKE 5 (V)



Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-4-93	**Test Time**	14:23:36
Test Description	200 PSid 5500 GPM C->O	**Stroke #**	5 (v)
Data File	C43008Z	**Data Set**	6

OPEN STROKE

Running Current	15.3	amps RMS	Unseating Current	26.1	amps RMS
Running Power	6938.9	watts	Stroke Time	18.4	sec
Contactor Drop-out Time	0.010	sec			
Disk Factor (Standard) at Max dP	.4601		Disk Factor (NMAC) at Max dP	.5024	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	20.118	1968.5	-32.01	====	230.1	====	N/A
2. Max. dP	5.461	12,970.1	-203.93	====	205.6	206.3	.0982
3. Unseating	5.337	45889.0	-667.20	-0.0088	====	====	====
4. Just After Unseating	5.421	8981.5	-145.73	+0.0086	210.0	210.7	====
5. Hammer Blow	4.133	-84300.2	====	+0.0810	====	====	====

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

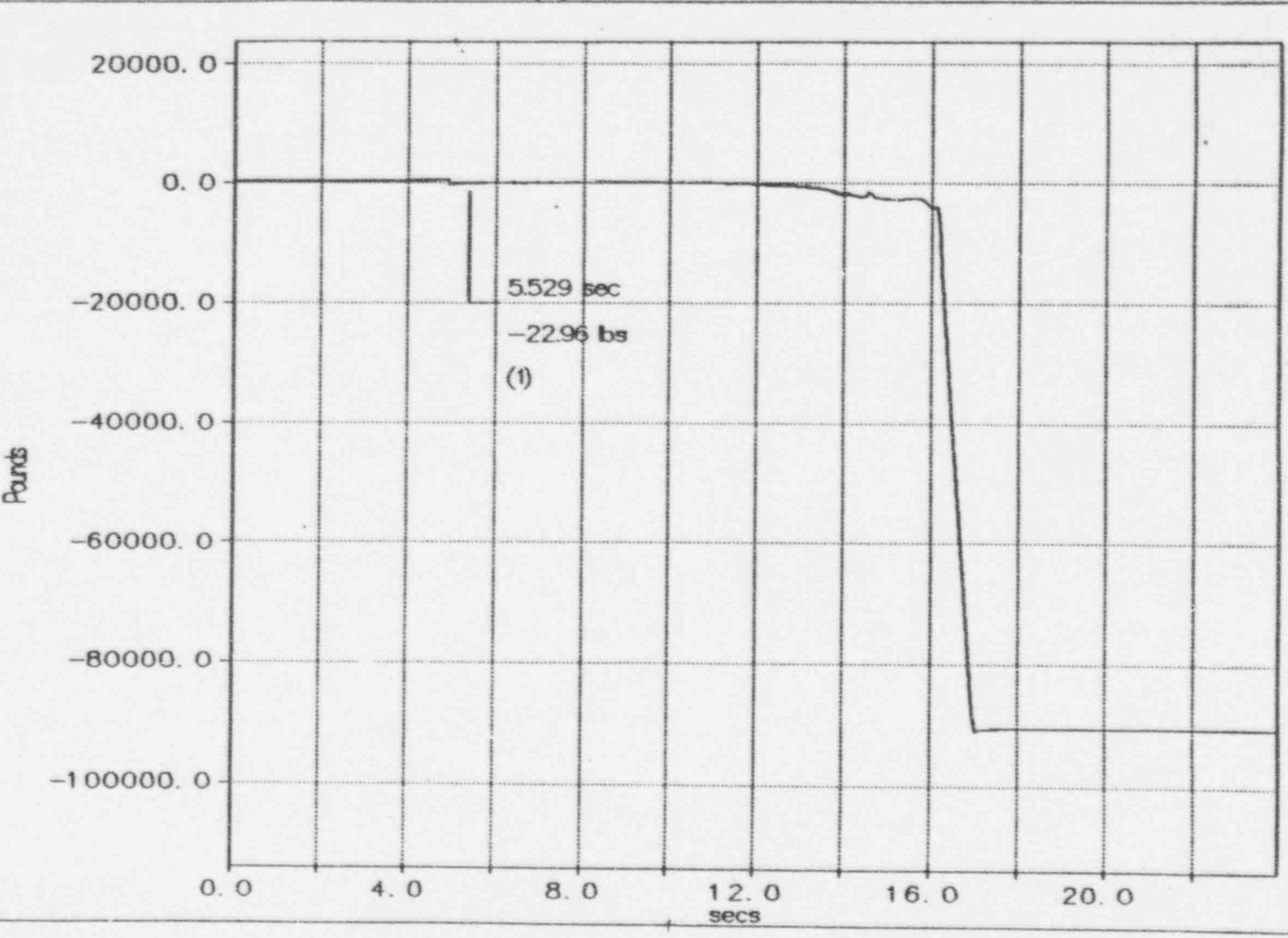
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

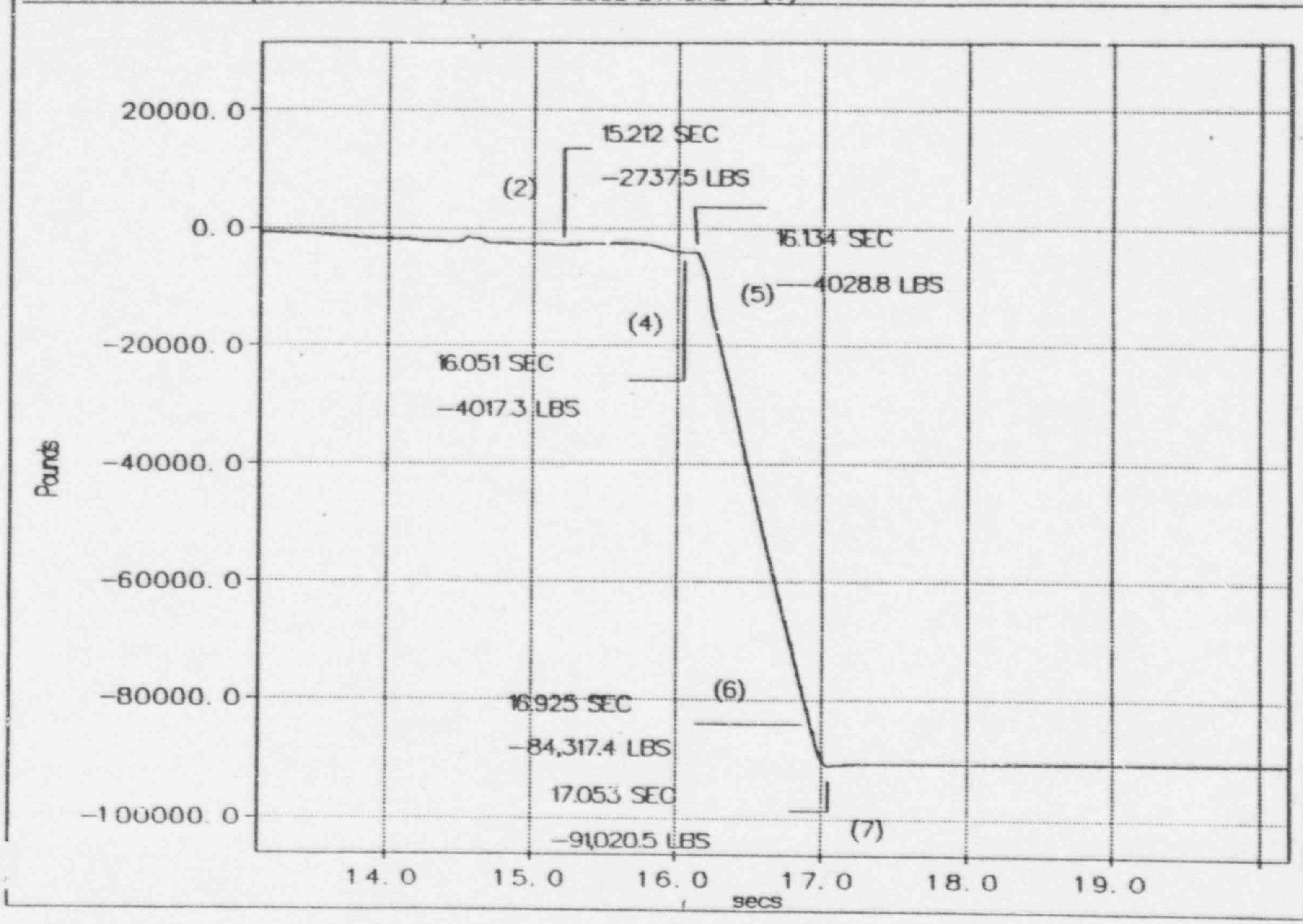
Analyzed by: [signature] 2/5/93

Verified by: [signature] 2/15/93

THRI STEM THRUST ON JOB 43008 STROKE 4 (V)



THR1 STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 4 (V)



Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-4-93	**Test Time**	11:46:09
Test Description	100 PSId 4000 GPM O→C	**Stroke #**	4 (v)
Data File	C4300B2	**Data Set**	5

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	17.17	amps RMS	Stroke Time	12.0	sec
Running Power	9381.3	watts	Rate of Loading	NONE	
Contactor Drop-out Time	0.010	sec			
Disk Factor (Standard) at Max dP	.3960		Disk Factor (NMAC) at Max dP	.3691	

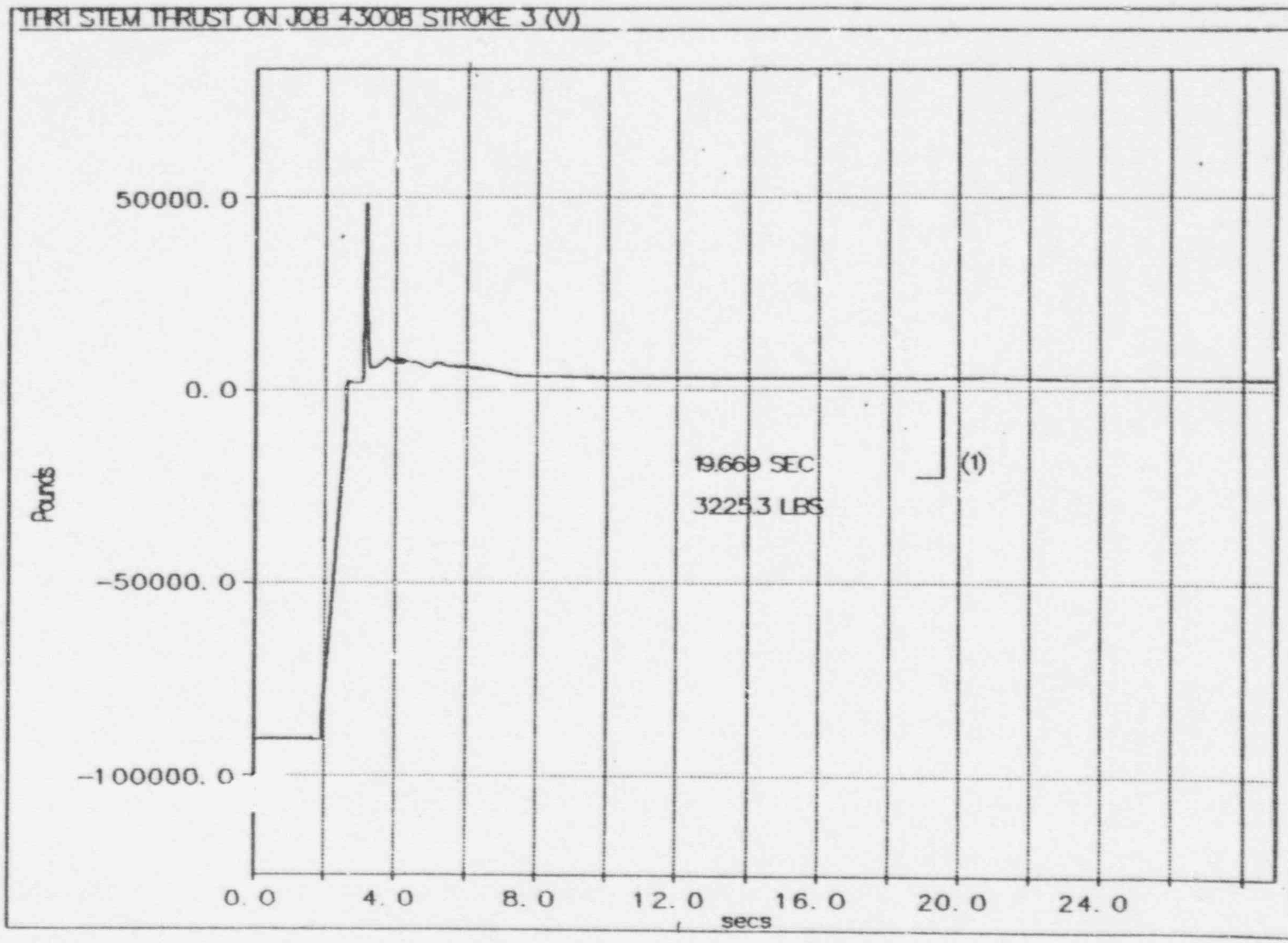
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	5.529	-22.96	10.75	====	76.2	====	N/A
2. Max. dP	15.212	-2737.5	58.09	====	66.4	70.1	.1568
3. Minimum Available	====	84,294.4	1305.96	====	====	====	====
4. Just Prior to Wedging	16.051	-4017.3	76.67	0.0140	====	====	====
5. Wedging	16.134	-4028.8	78.13	0.0140	65.2	67.14	====
6. Torque Switch Trip	16.925	-84,317.4	1316.71	0.2332	====	====	.0970
7. Total	17.053	-91,020.5	1482.58	0.2640	====	====	====
8. Inertia	====	6703.1	====	0.0308	====	====	====

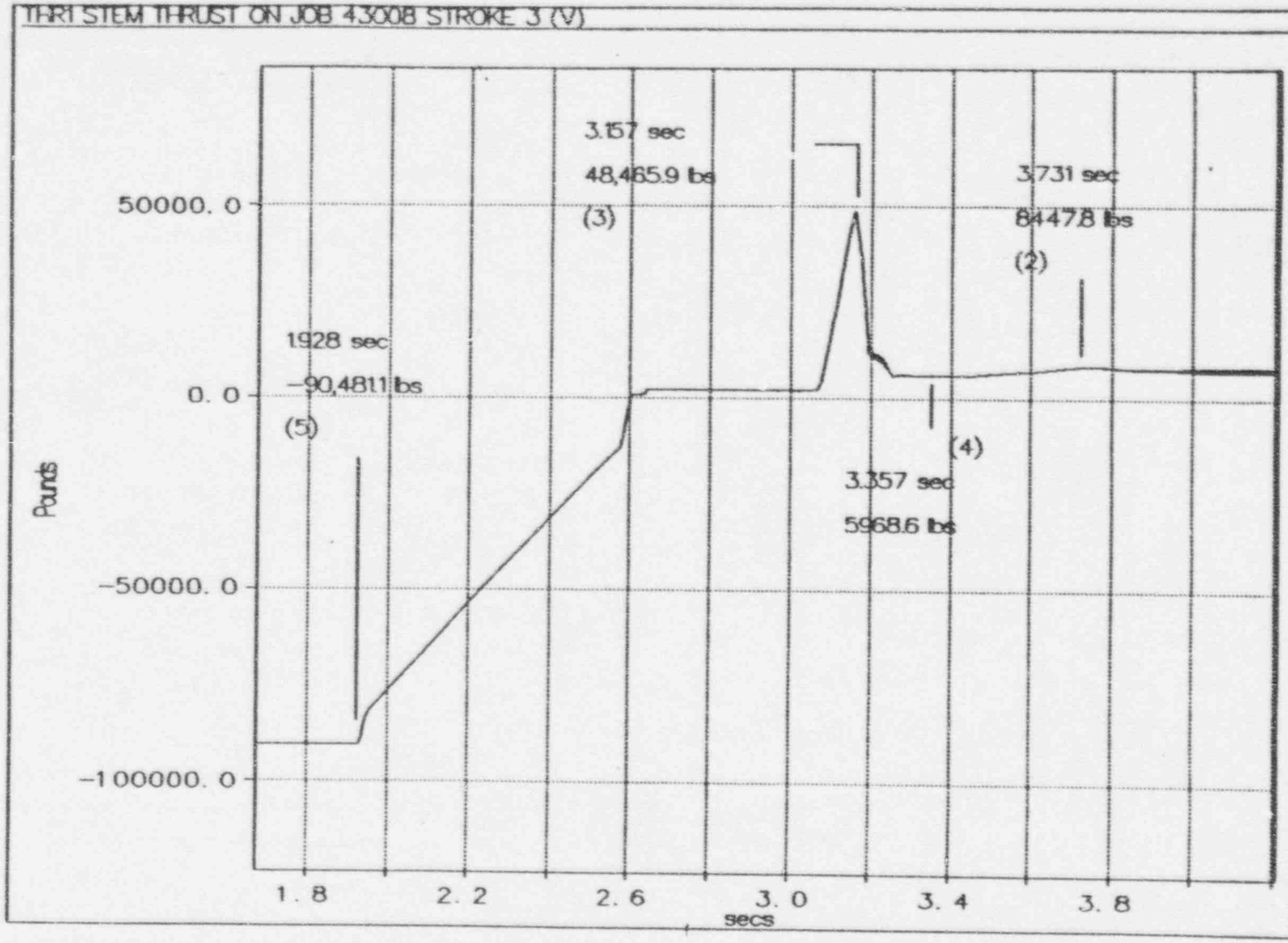
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

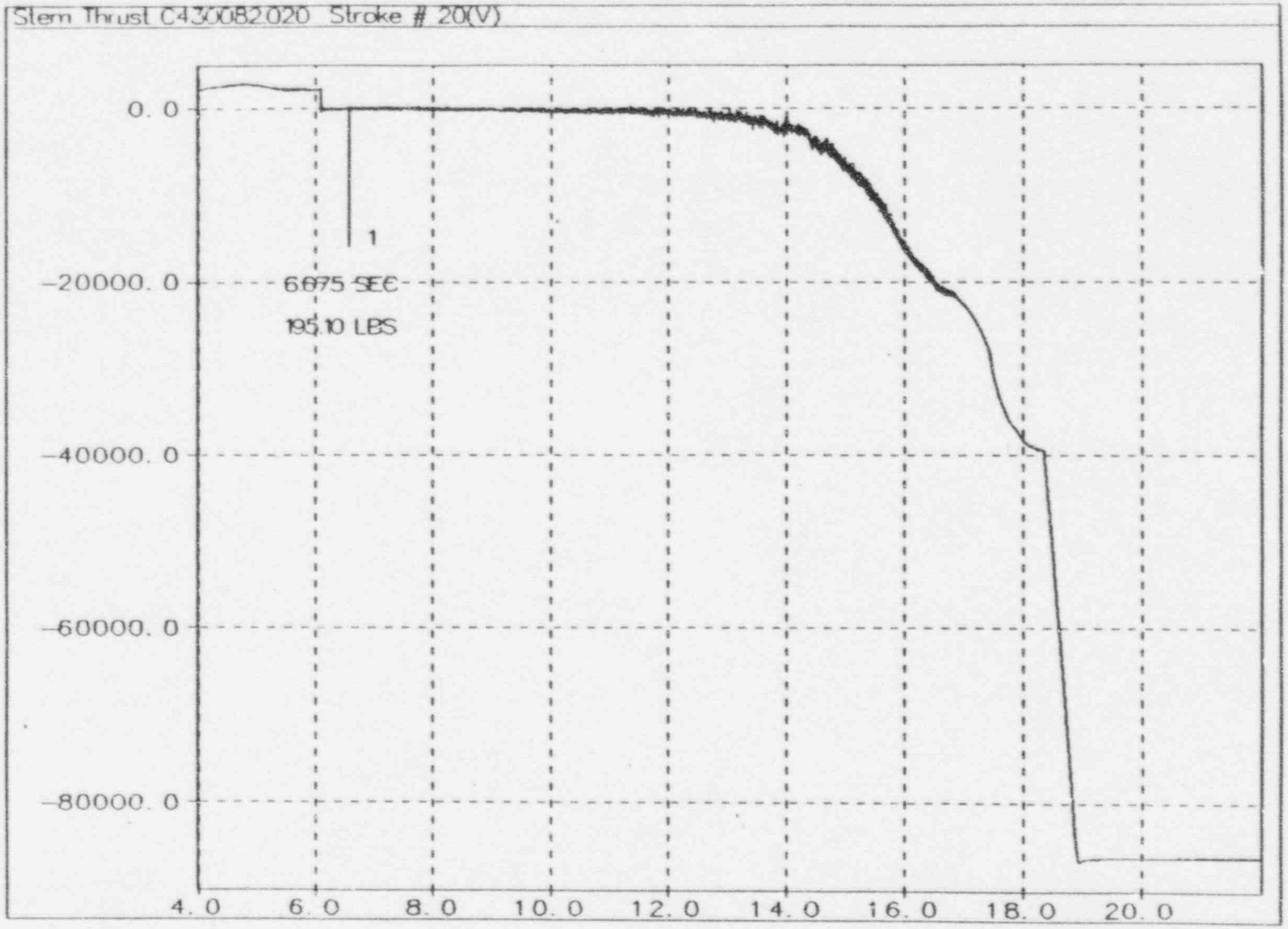
Analyzed by: [signature] 2/3/93

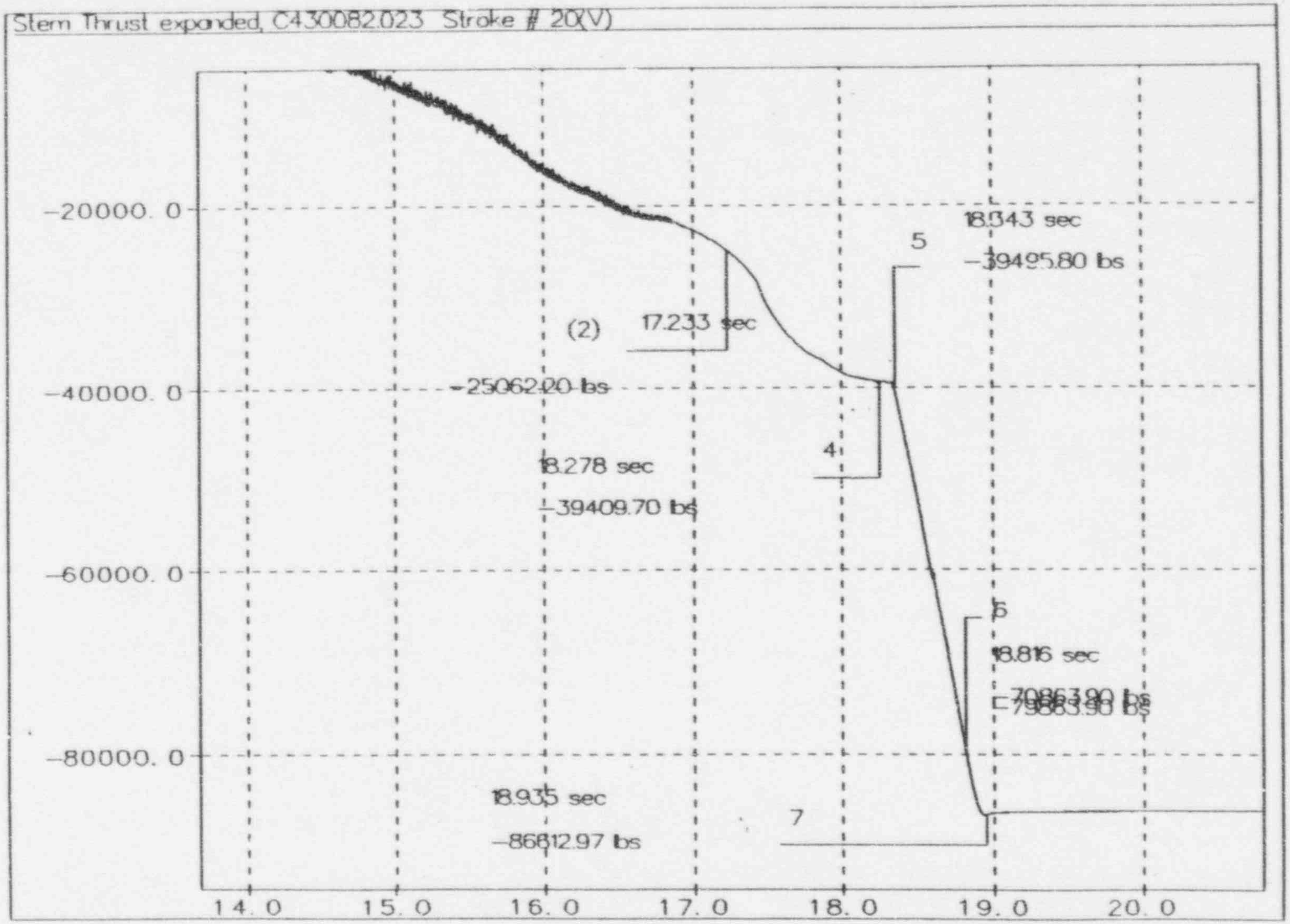
Verified by: [signature] 2/15/93


THRI STEM THRUST ON JOB 43008 STROKE 3 (V)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
19.669 SEC
3225.3 LBS
(1)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
secs

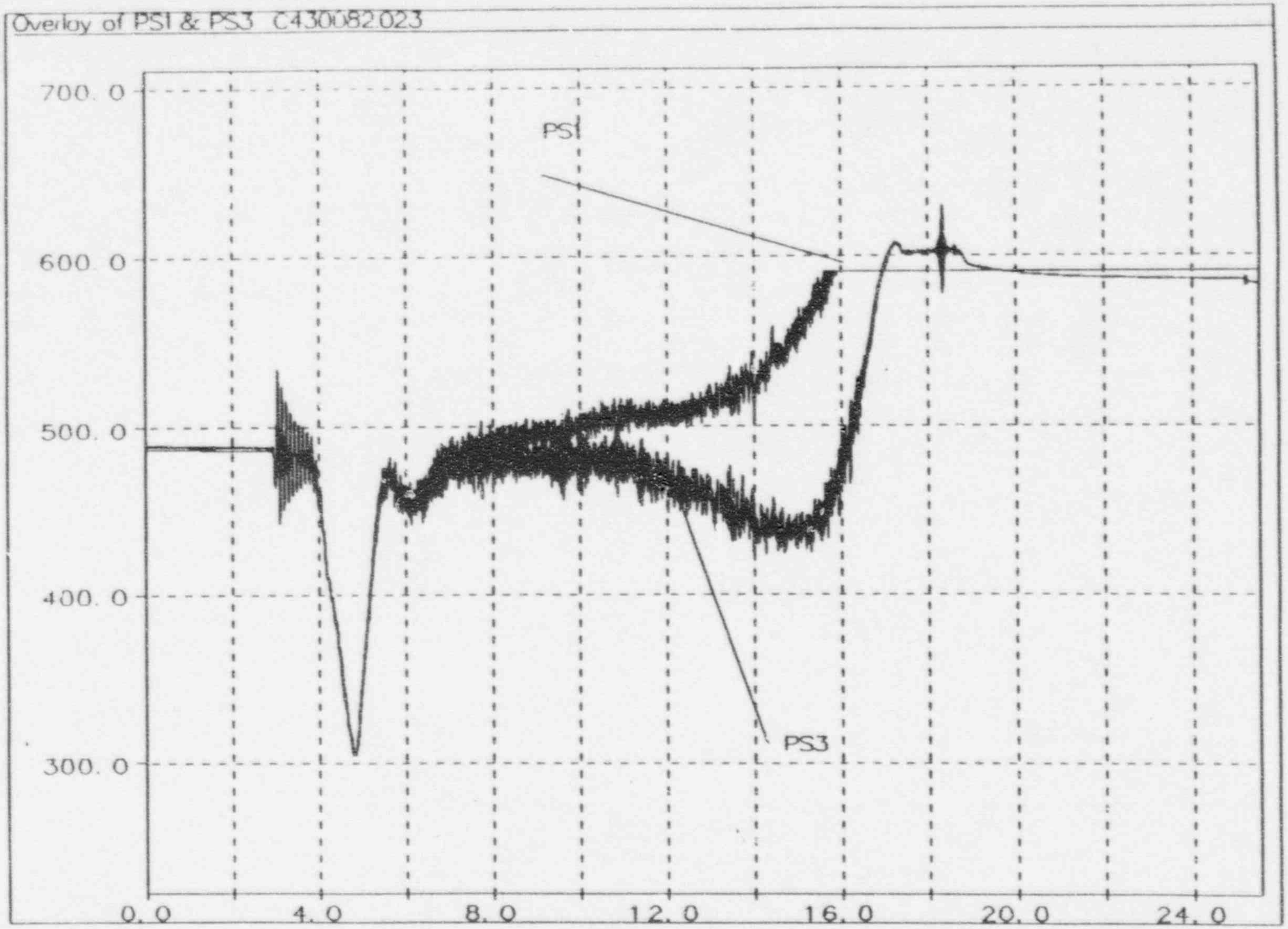


THRI STEM THRUST ON JOB 43008 STROKE 3 (V)
3.157 sec
48,465.9 lbs
(3)
3.731 sec
8447.8 lbs
(2)
1.928 sec
-90,481.1 lbs
(5)
(4)
3.357 sec
5968.6 lbs
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
1. 8
2. 2
2. 6
3. 0
3. 4
3. 8
secs


Stem Thrust C430082020 Stroke # 20(V)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
1
6.875 SEC
195.10 LBS



Stem Thrust expanded, C430082.023 Stroke # 20(V)
-20000. 0
-40000. 0
-60000. 0
-80000. 0
14. 0
15. 0
16. 0
17. 0
18. 0
19. 0
20. 0
(2)
17.233 sec
-25062.20 lbs
4
18.278 sec
-39409.70 lbs
5
18.343 sec
-39495.80 lbs
6
18.816 sec
7
18.935 sec
-86812.97 lbs



Overlay of PS1 & PS3 C430082023
700.0
600.0
500.0
400.0
300.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
PS1
PS3

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/7/93
Test Description 400PSI 800GPM
Data File QC430083.

Test Time 13:23:26
Stroke # 21(v)
Data Set .024

OPEN STROKE

Running Current 16.00 amps RMS
Running Power 7565.90 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.512751

Unseating Current 25.50 amps RMS
Stroke Time 18.40 sec
Disk Factor (NMAC) at Max dP 0.579819

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	3099.10	-29.90	====	348.00	====	N/A
2. Max. dP	5.765	25789.60	-401.30	====	400.20	401.70	0.090196
3. Unseating	5.055	40827.20	-574.75	0.028544	====	====	====
4. Just After Unseating	5.242	27202.90	-403.70	0.003749	400.65	402.13	====
5. Hammer Blow	3.887	-78136.50	====	0.036803	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

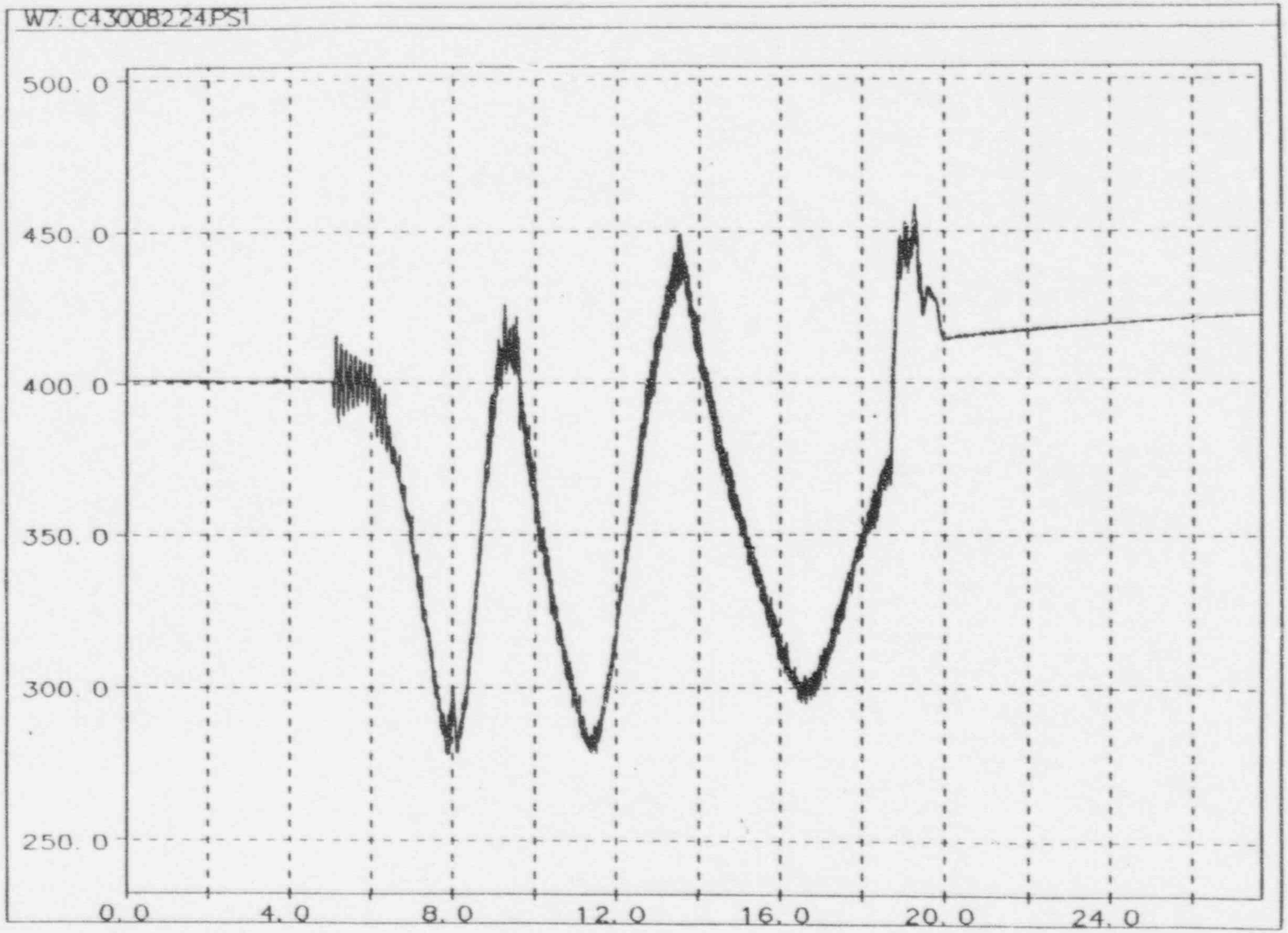
Note: All values annotated above are actual values, with no correction for static conditions.

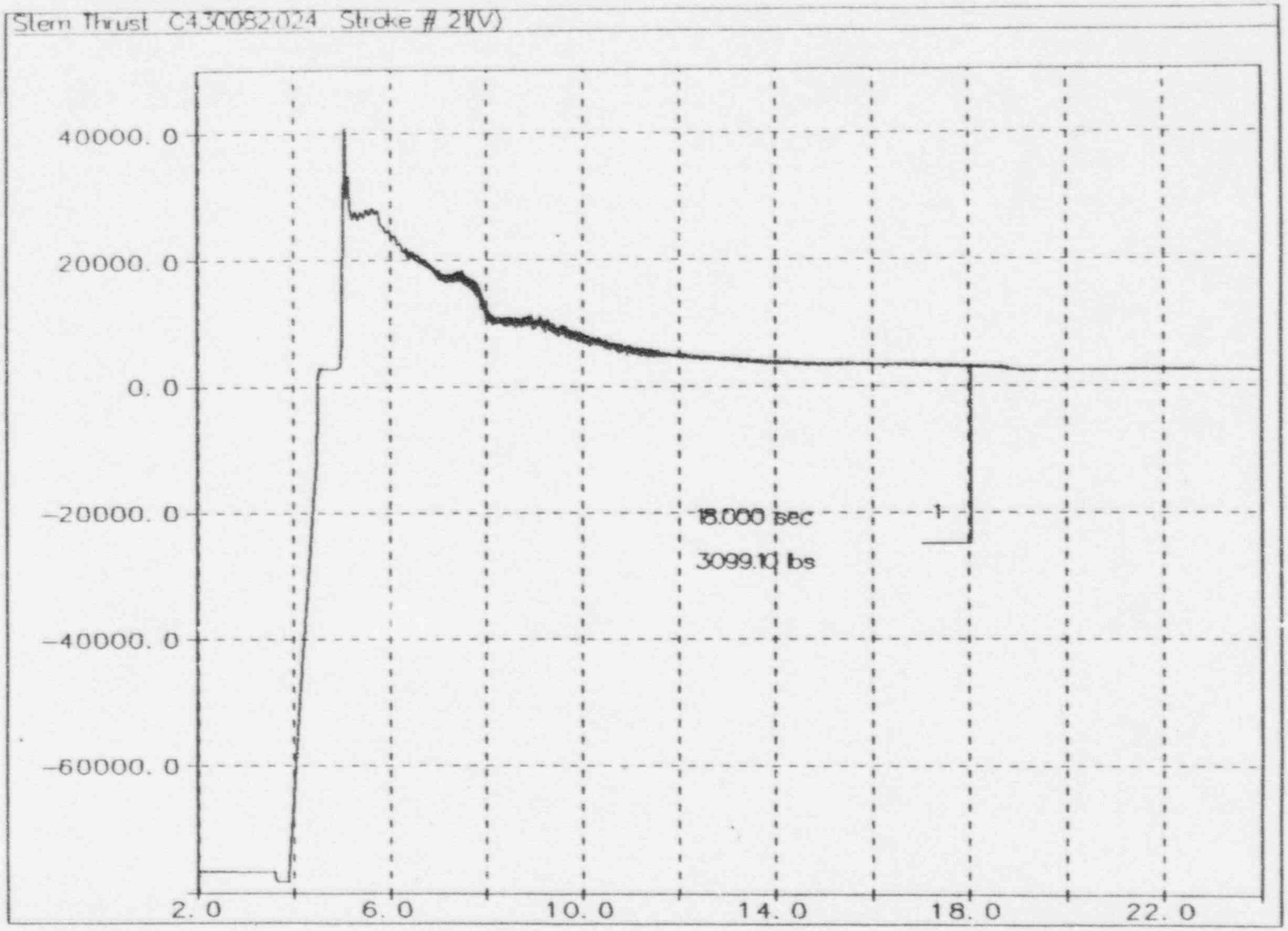
Remarks

Unseating in 2 steps: 2nd → 5.113 sec → 33383.75 lbs
Poor regulation of PSI (see plot)
S_1 = 22.011 sec
Motor Start: 3,568 sec.
" Stop: 22.022 sec

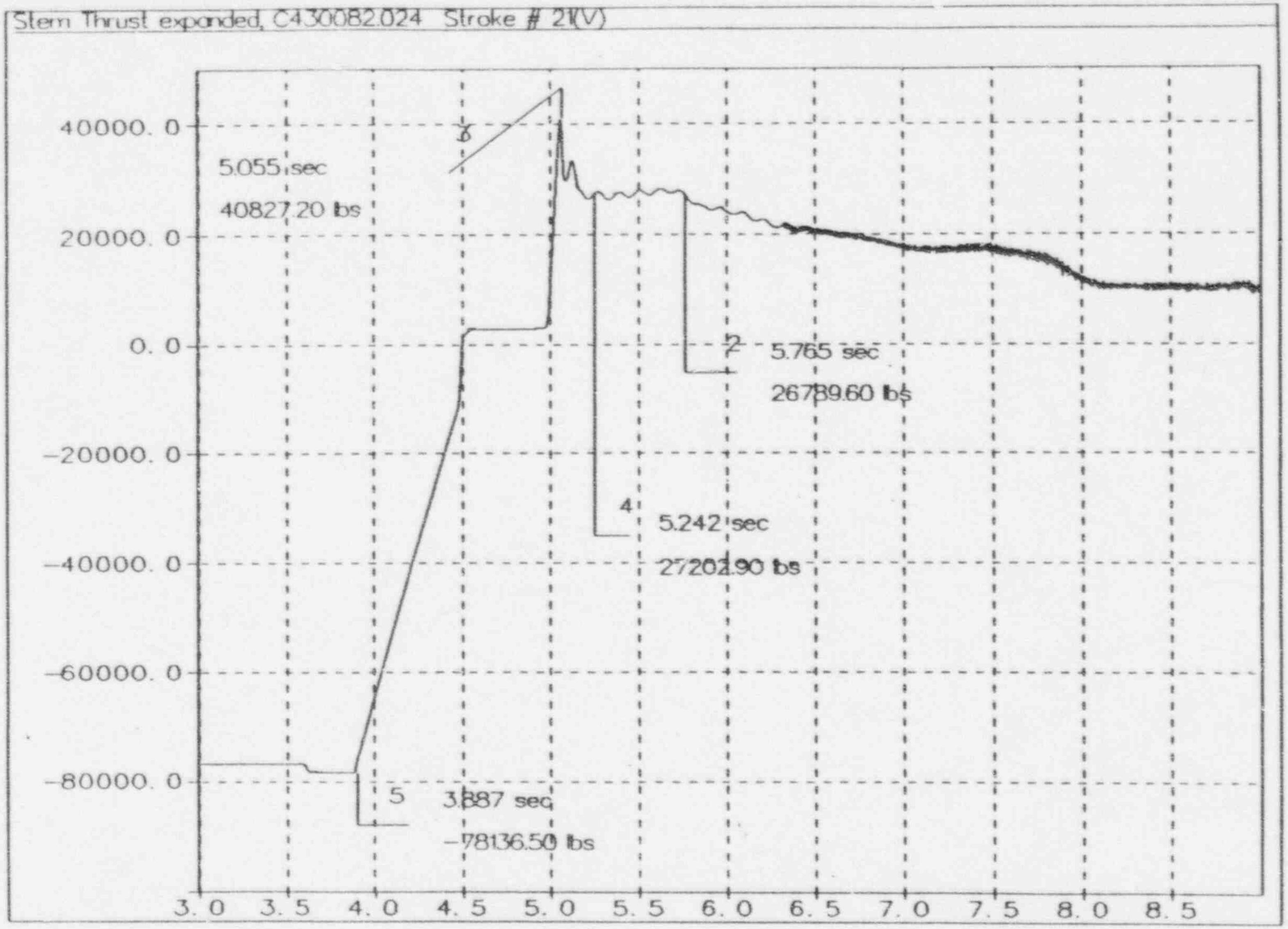
Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


W7: C43008224PSI
500.0
450.0
400.0
350.0
300.0
250.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0



Stem Thrust C430082024 Stroke # 21(V)
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
2. 0
6. 0
10. 0
14. 0
18. 0
22. 0
18.000 sec
3099.10 lbs
1



Stem Thrust expanded, C430082.024 Stroke # 21(V)
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5
7. 0
7. 5
8. 0
8. 5
5.055 sec
40827.20 lbs
2
5.765 sec
26789.60 lbs
4
5.242 sec
27202.90 lbs
5
3.887 sec
-78136.50 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-7-93	**Test Time**	15:17:56
Test Description	400 PSID, 8000 GPM	**Stroke #**	22 (V)
Data File	AC430082	**Data Set**	025

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	17.156	amps RMS	Stroke Time	13.239	sec
Running Power	8918	watts	Rate of Loading	yes ~1500 lbs.	
Contactor Drop-out Time	0.010	sec			
Disk Factor (Standard) at Max dP	0.4180		Disk Factor (NMAC) at Max dP	0.3618	

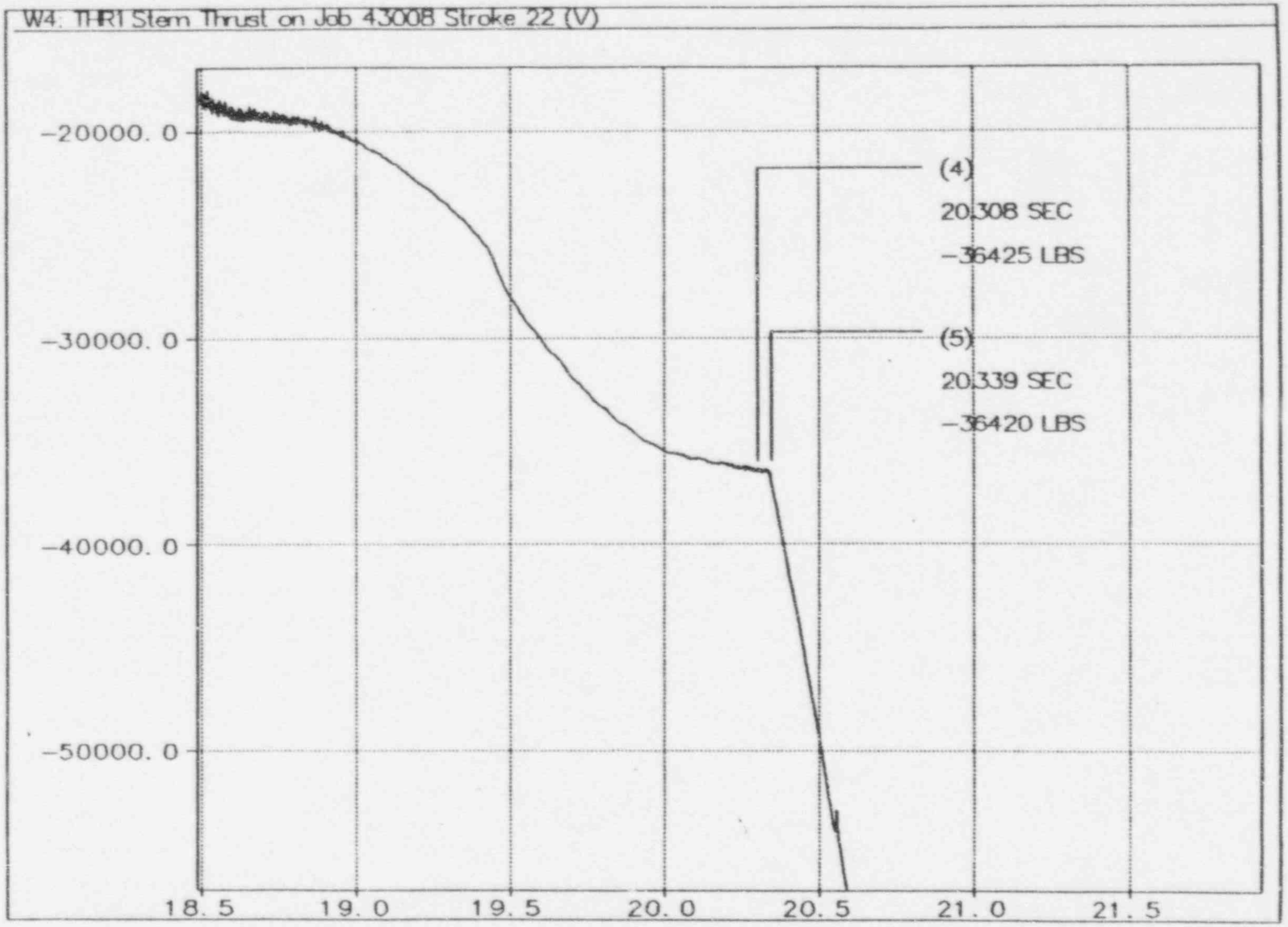
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.000	390.25	29.10	====	399.34	====	0.6988
2. Max. dP	19.209	-22508	411.67	====	560.50	560.27	0.1256
3. Minimum Available	====	79526	1294.4	====	====	====	====
4. Just Prior to Wedging	20.308	-36425	629.1	0.0687	====	====	====
5. Wedging	20.339	-36420	630.93	0.0689	554.15	553.81	====
6. Torque Switch Trip	20.839	-79916	1323.5	0.2360	====	====	0.1071
7. Total	20.958	-86630	1525.5	0.2673	====	====	====
8. Inertia	====	6714	====	0.0313	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

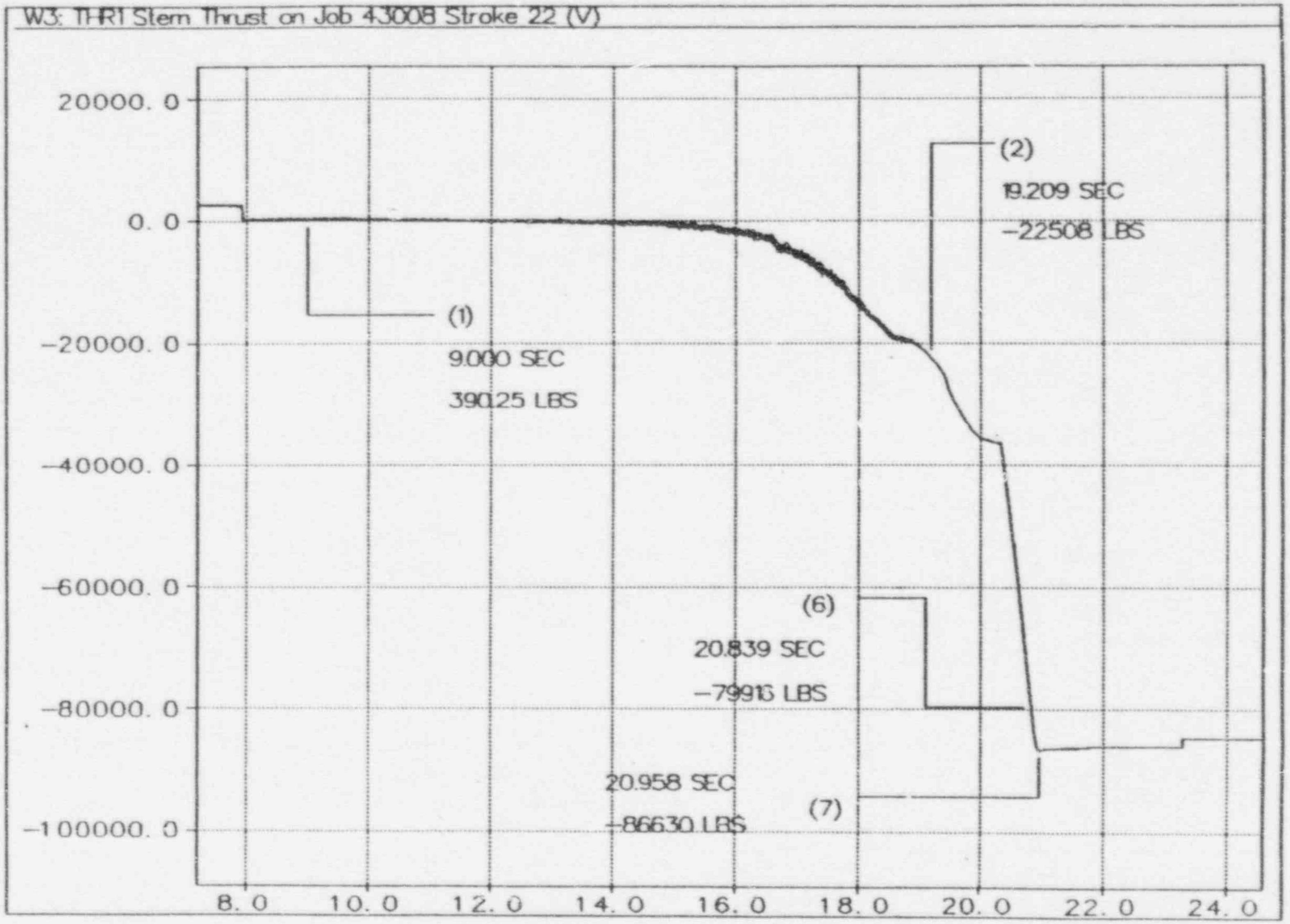
Remarks

Analyzed by: David Kessler 2/5/93

Verified by: [signature] 2/15/93



W4: THR1 Stem Thrust on Job 43008 Stroke 22 (V)
-20000. 0
-30000. 0
-40000. 0
-50000. 0
18. 5
19. 0
19. 5
20. 0
20. 5
21. 0
21. 5
(4)
20.308 SEC
-36425 LBS
(5)
20.339 SEC
-36420 LBS


W3: THR1 Stem Thrust on Job 43008 Stroke 22 (V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
24. 0
(1)
9.000 SEC
390.25 LBS
(2)
19.209 SEC
-22508 LBS
(6)
20.839 SEC
-79916 LBS
(7)
20.958 SEC
-86630 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-7-93
Test Description 300 PSID 7000 GPm
Data File C430082

Test Time 17:06:43
Stroke # 23 (V)
Data Set 026

OPEN STROKE

Running Current 16.175 amps RMS
Running Power 7004 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.5098

Unseating Current 26.552 amps RMS
Stroke Time 18.392 sec
Disk Factor (NMAC) at Max dP 0.5928

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	4292.8	-37.27	====	143.63	====	0.0223
2. Max. dP	4.458	21912	-316.9	====	298.63	300.41	0.0846
3. Unseating	4.334	44793	-635.0	-.0392	====	====	====
4. Just After Unseating	4.458	21912	-316.9	.00094	298.63	300.41	====
5. Hammer Blow	3.158	-78751	====	.0587	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

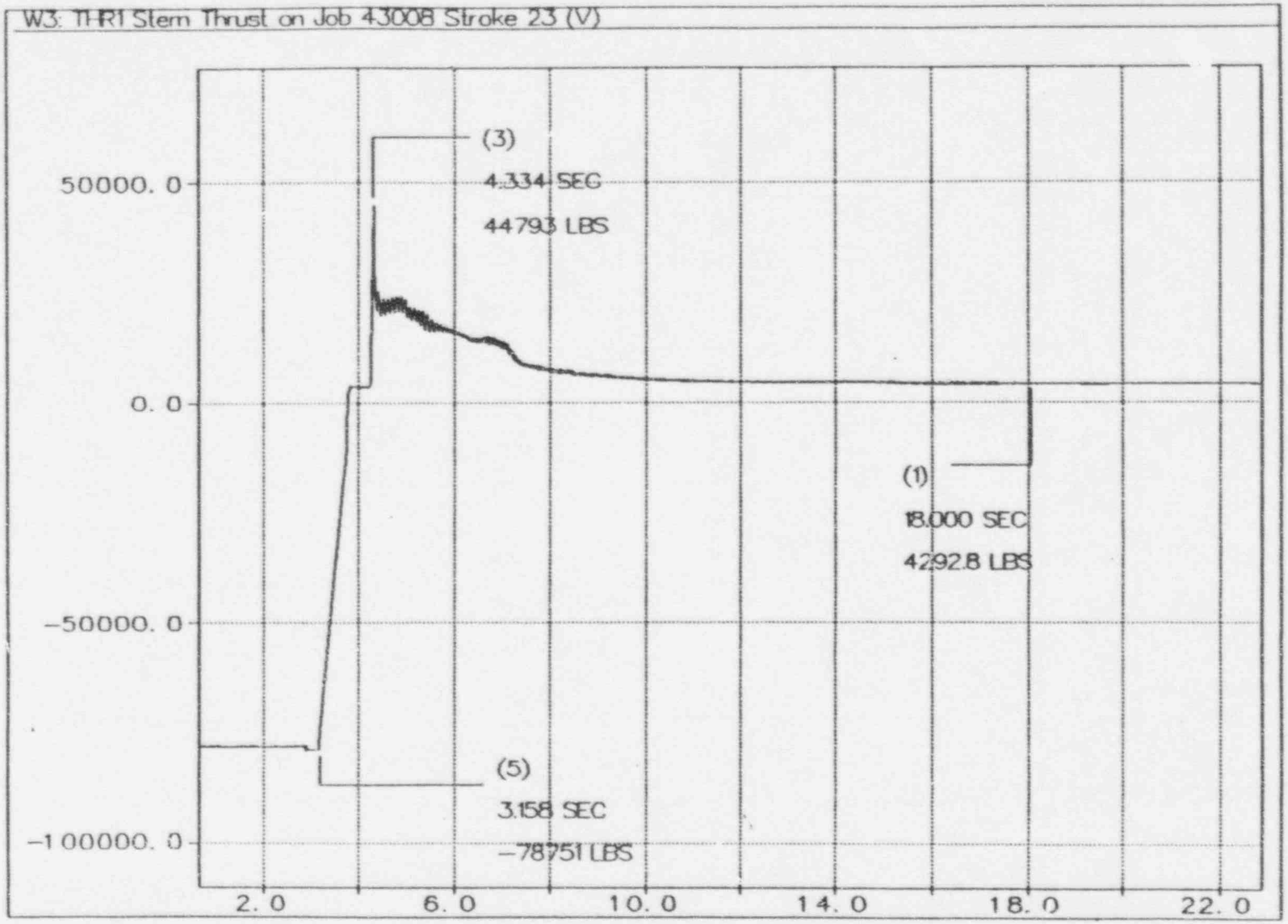
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

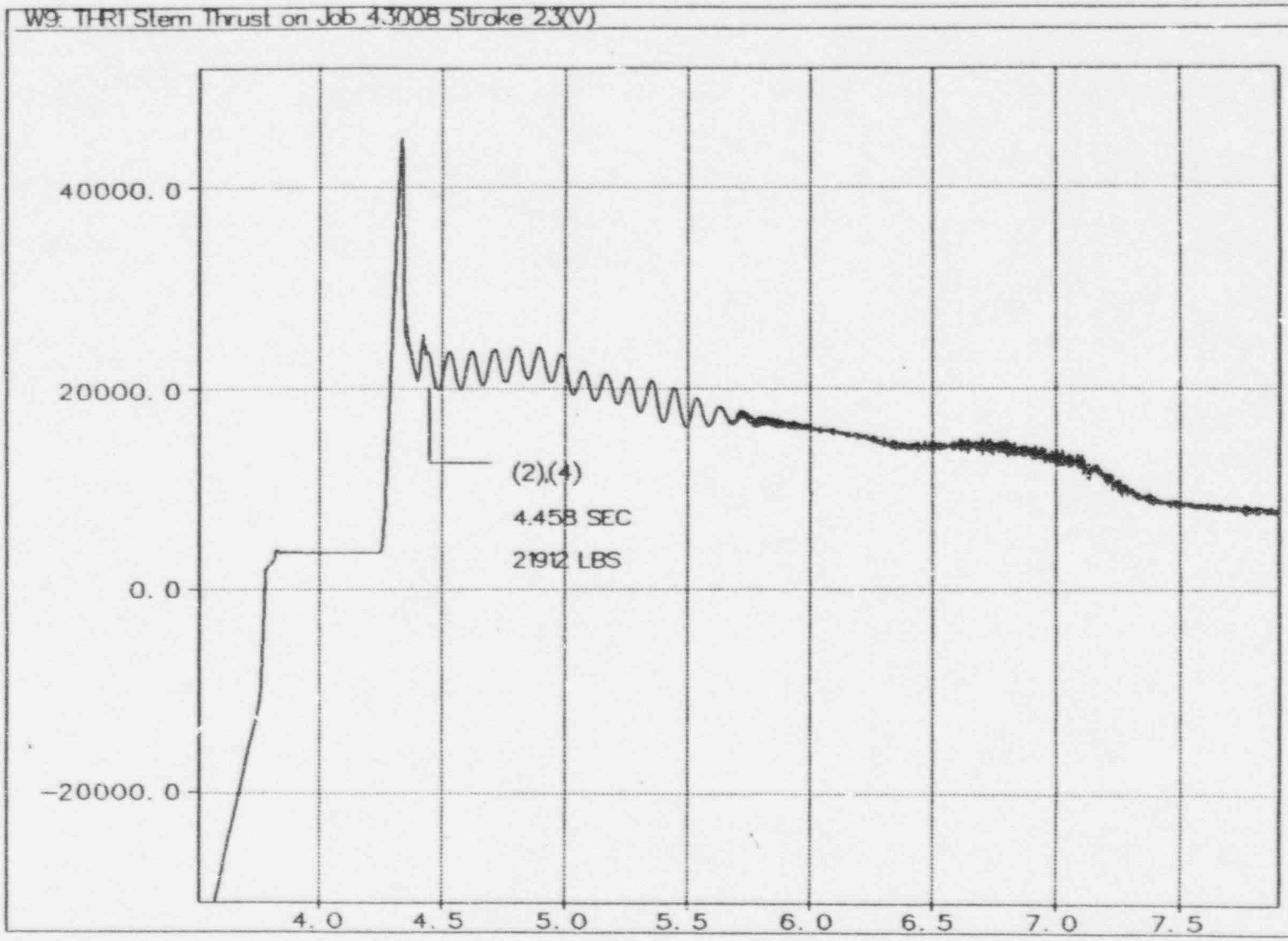
Remarks

Analyzed by: David Kessler 2/4/93

Verified by: [signature] 2/15/93



W3: THR1 Stem Thrust on Job 43008 Stroke 23 (V)
50000. 0
0. 0
-50000. 0
-100000. 0
2. 0
6. 0
10. 0
14. 0
18. 0
22. 0
(3)
4.334 SEC
44793 LBS
(1)
18.000 SEC
4292.8 LBS
(5)
3.158 SEC
-78751 LBS


W9: THR1 Stem Thrust on Job 43008 Stroke 23(V)
40000.0
20000.0
0.0
-20000.0
(2),(4)
4.458 SEC
21912 LBS
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/7/93	**Test Time**	10:54:02.00
Test Description	500 PSI 900 GPM	**Stroke #**	20(V)
Data File	0C430082	**Data Set**	073

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	17.86	amps RMS	Stroke Time	13.0 sec
Running Power	9505	watts	Rate of Loading	Yes ~1750 Lbs
Contactor Drop-out Time	0.014	sec		
Disk Factor (Standard) at Max dP	*0.351492		Disk Factor (NMAC) at Max dP	0.412319

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	6.675	195.10	34.92	====	473.20	====	N/A
2. Max. dP	17.233	-25062.20	453.64	====	591.02 *	607.5	0.123574
3. Minimum Available	====	73669		====	====	====	====
4. Just Prior to Wedging	18.278	-39409.70	674.92	0.078320	====	====	====
5. Wedging	18.343	-39495.80	678.95	0.079913	591.08	600.21	====
6. Torque Switch Trip	18.816	-79863.30	1319.06	0.234725	====	====	0.106652
7. Total	18.935	-85612.97	1518.75	0.262231	====	====	====
8. Inertia	====	6743	====	N/A	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

By Pass 17.285 sec
Motor start: 5.789 sec
" Stop 18.830 sec
Saturation on PS1 before valve closing
disk factor meaningless

Analyzed by: [signature] 2/15/93

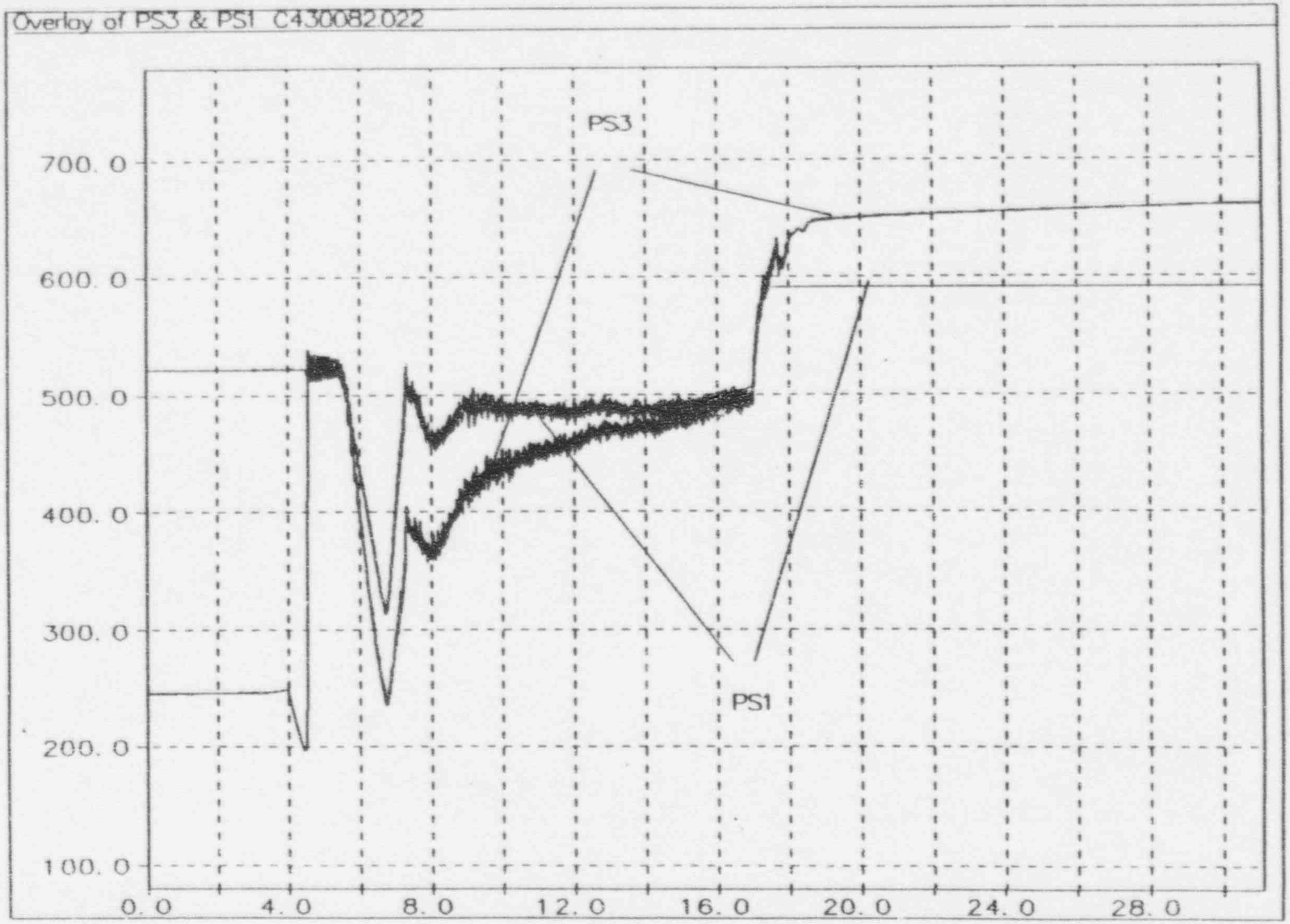
Verified by: [signature] 2/15/93

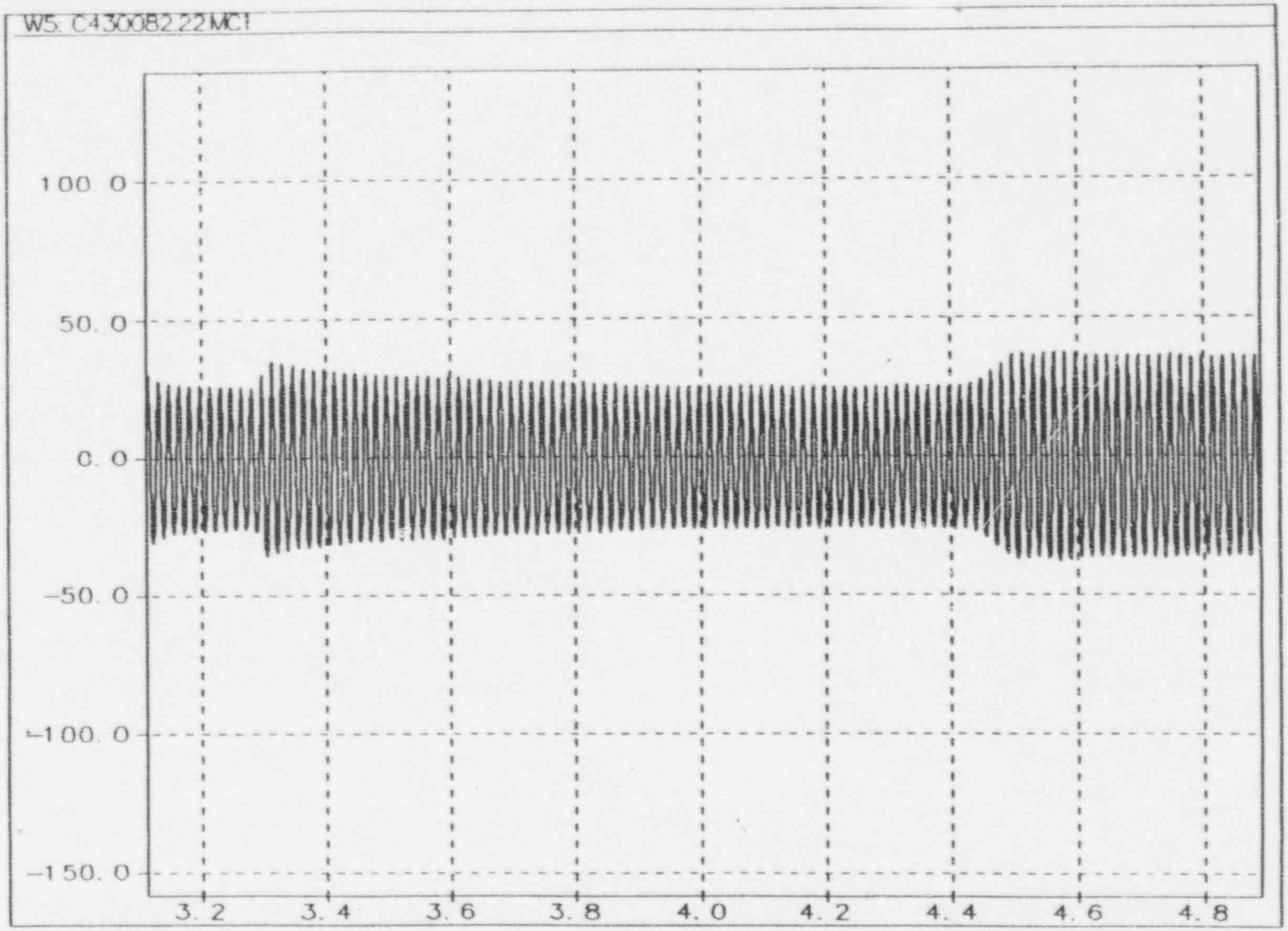
* at closure, PS3 does not follow PS1, consequently disk factor calculated can only be an approximation

Thrust at Maximum dP:	? 30502.80
Thrust at Running:	? 1968.5
Pressure at Running:	? 628.43
Pressure at Max dP:	? 519.50
Pressure at After Cracking:	? 521.35
Diff Pressure at Max dP:	? 519.70
Diff Pressure at After Cracking:	? 521.50

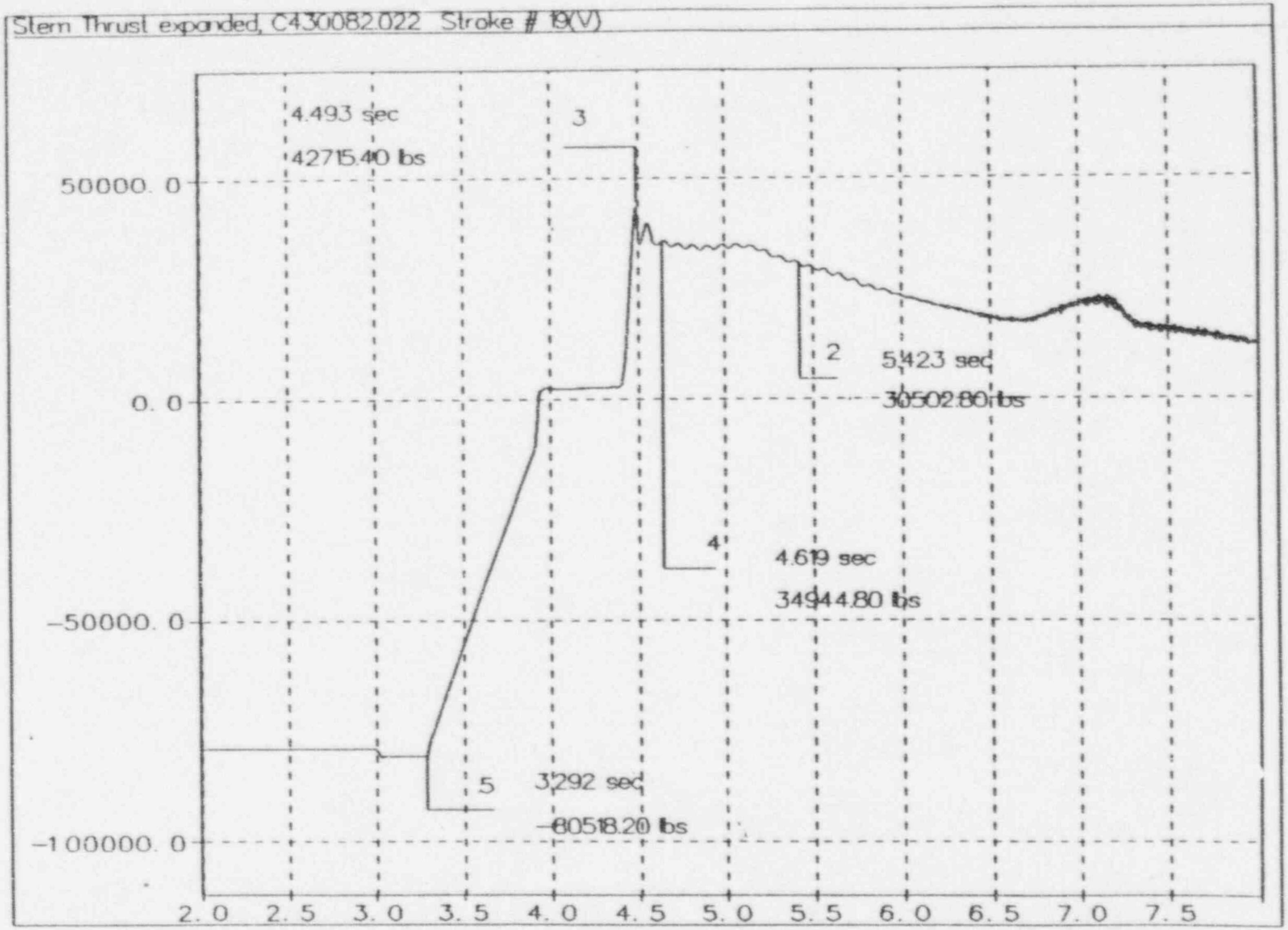
The NMAC Disc Factor (u) = : .5233618
The SIE Disc Factor (u) = : .4746904

Depress <Shift> <Print Scrn> for a Copy ?

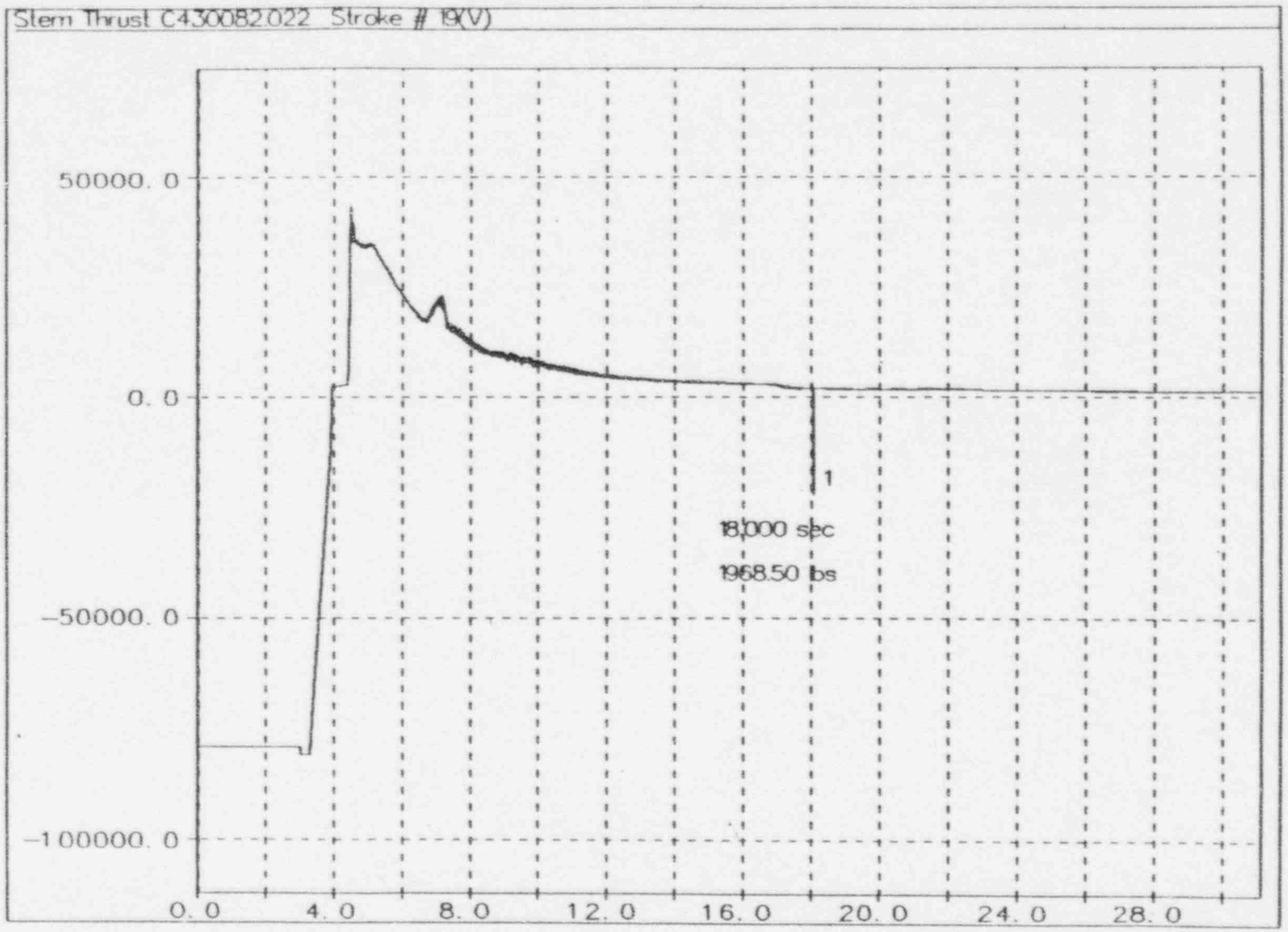

Overlay of PS3 & PS1 C430082.022
PS3
PS1
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0



W5: C430082.22MCI
100.0
50.0
0.0
-50.0
-100.0
-150.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8



Stem Thrust expanded, C430082.022 Stroke # 19(V)
4.493 sec
42715.40 lbs
3
2
5.423 sec
30502.80 lbs
4
4.619 sec
34944.80 lbs
5
3.292 sec
-80518.20 lbs
50000. 0
0. 0
-50000. 0
-100000. 0
2. 0
2. 5
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5
7. 0
7. 5


Stem Thrust C430082.022 Stroke # 19(V)
50000. 0
0. 0
-50000. 0
-100000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
28. 0
1
18.000 sec
1968.50 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/7/92
Test Description 500PSI 900-GPM
Data File 9C42.2081

Test Time 8:49:14...
Stroke # 19(1)
Data Set 022

OPEN STROKE

Running Current 15.80 amps RMS
Running Power 8292.30 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.474690*

Unseating Current 25.40 amps RMS or 26.20 amps
Stroke Time 18.53 sec
Disk Factor (NMAC) at Max dP 0.526253*

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	1968.50	-21.8	====	628.43*	====	N/A
2. Max. dP	5.423	30502.80	-456.00	====	519.50	519.70	0.089872
3. Unseating	4.493	42715.40	-576.40	0.019779	====	====	====
4. Just After Unseating	4.619	34944.80	-498.30	0.016779	521.35	521.50	====
5. Hammer Blow	3.292	-805[illegible]	====	0.008296	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

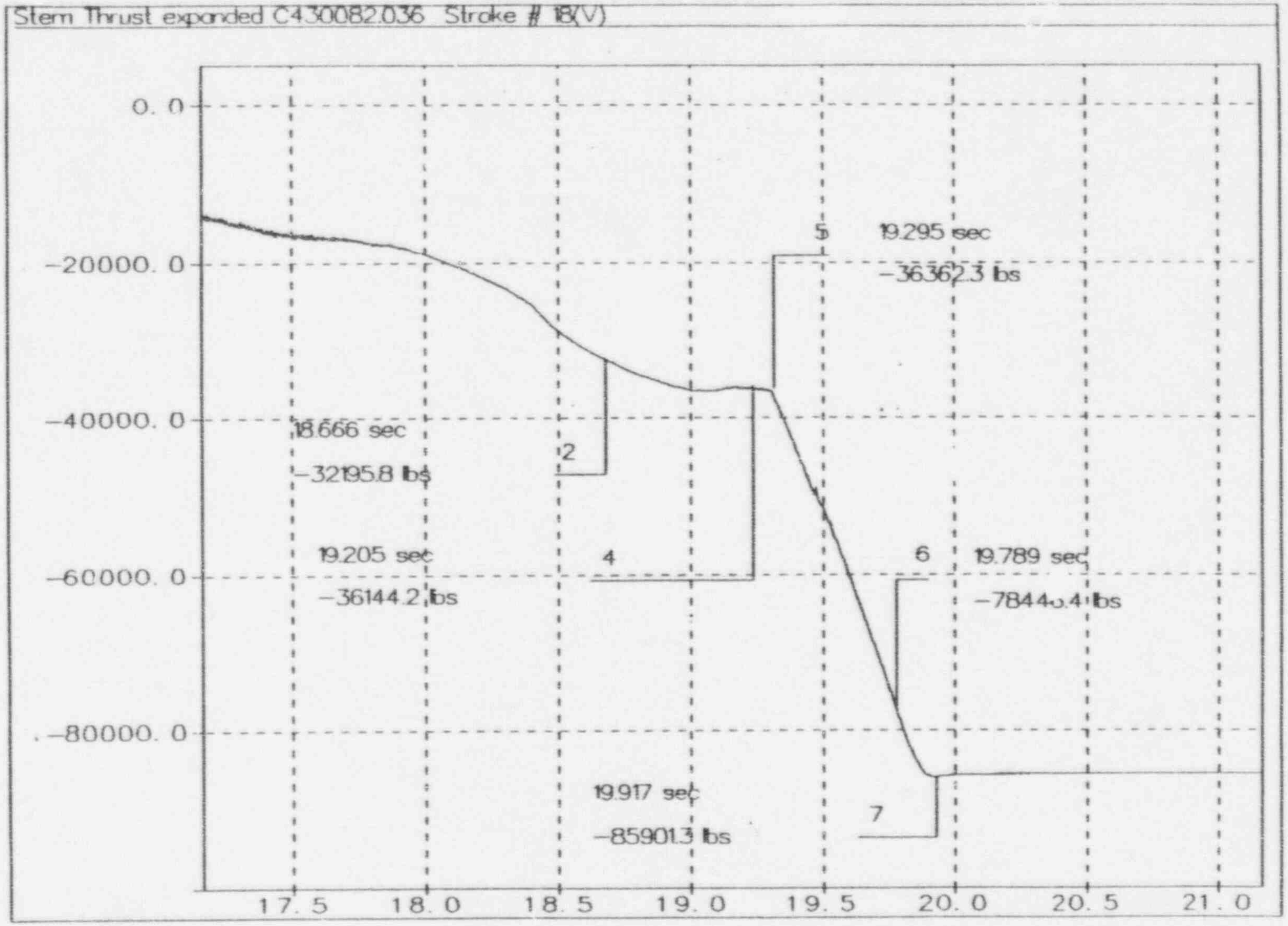
It can be observed that PS3 @ maxDP follows closely PS1. Consequently for calculation of Disk Factor we will take PS3 & not PS1
Disk Factor (NMAC) = 0.5233[illegible]
" (Std) = 0.4746[illegible]

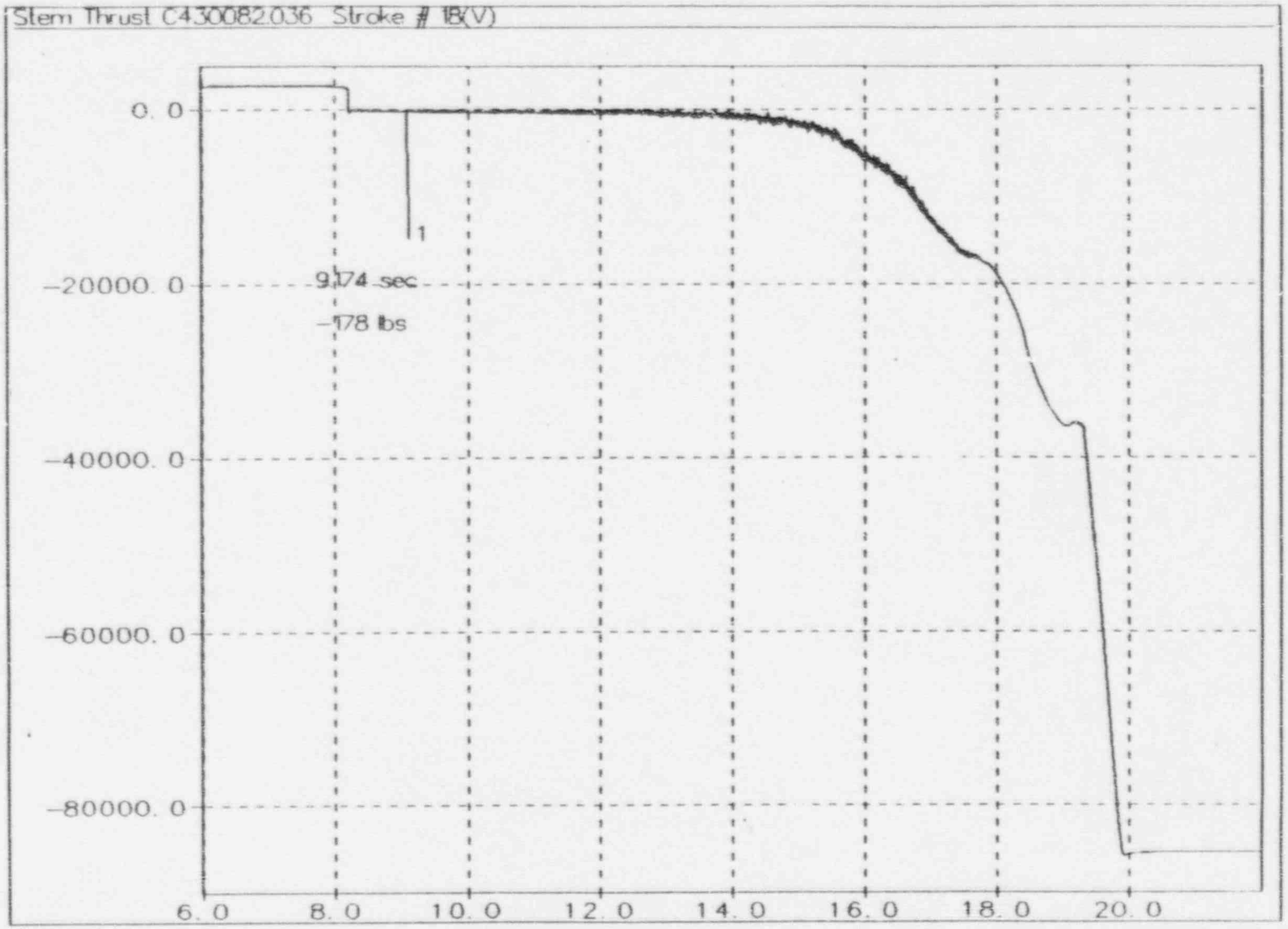
Remarks

S_1: 21.496
Motor Start: 2.968 sec
[illegible] - [illegible]: 21.507 sec
Unseating [illegible] 2nd → 4.554 sec: 39817.2 lbs (26.20 Amps)
Saturation of PS1 or electronics

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


Stem Thrust expanded C430082.036 Stroke # 18(V)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
17.5
18.0
18.5
19.0
19.5
20.0
20.5
21.0
2
18.666 sec
-32195.8 lbs
4
19.205 sec
-36144.2 lbs
5
19.295 sec
-36362.3 lbs
6
19.789 sec
7
19.917 sec
-85901.3 lbs



Stem Thrust C430082.036 Stroke # 18(V)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
1
9.174 sec
-178 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/8/93	**Test Time**	19:49:30.00
Test Description	500 PSI 9000 GPM	**Stroke #**	18B(V)
Data File	AC430082	**Data Set**	03[illegible]

OPEN STROKE

Running Current ______ amps RMS

Running Power ______ watts

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS

Stroke Time ______ sec

Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 17.10 amps RMS

Running Power 9075 watts

Contactor Drop-out Time 0.015 sec

Disk Factor (Standard) at Max dP 0.589870

Stroke Time 11.90 sec

Rate of Loading 780 ~3160 Lbs

Disk Factor (NMAC) at Max dP 0.503021

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.17A	-178	48.23	====	461.35	====	N/A
2. Max. dP	18.666	-32195.8	559.10	====	538.00	589.70	0.115728
3. Minimum Available	====	48268		====	====	====	====
4. Just Prior to Wedging	19.205	-36144.2	619.50	0.070680	====	====	====
5. Wedging	19.295	-36362.3	624.60	0.071107	558.00	558.20	====
6. Torque Switch Trip	19.789	-78446.4	1300.5	0.235334	====	====	0.107266
7. Total	19.917	-85901.3	1513.60	0.267018	====	====	====
8. Inertia	====	7455	====	N/A	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

ByPass: 18.280

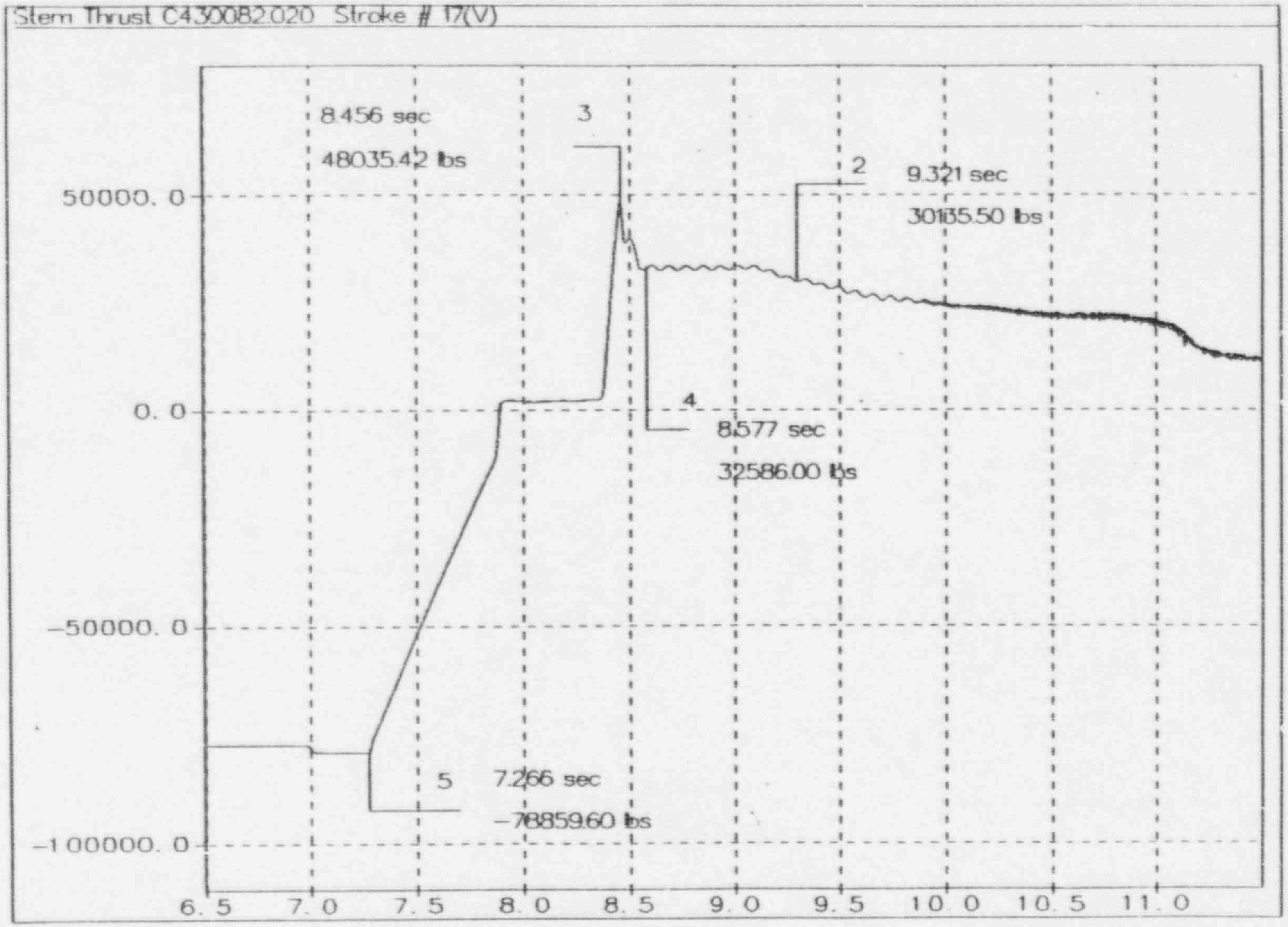
Motor Stop: 19.804

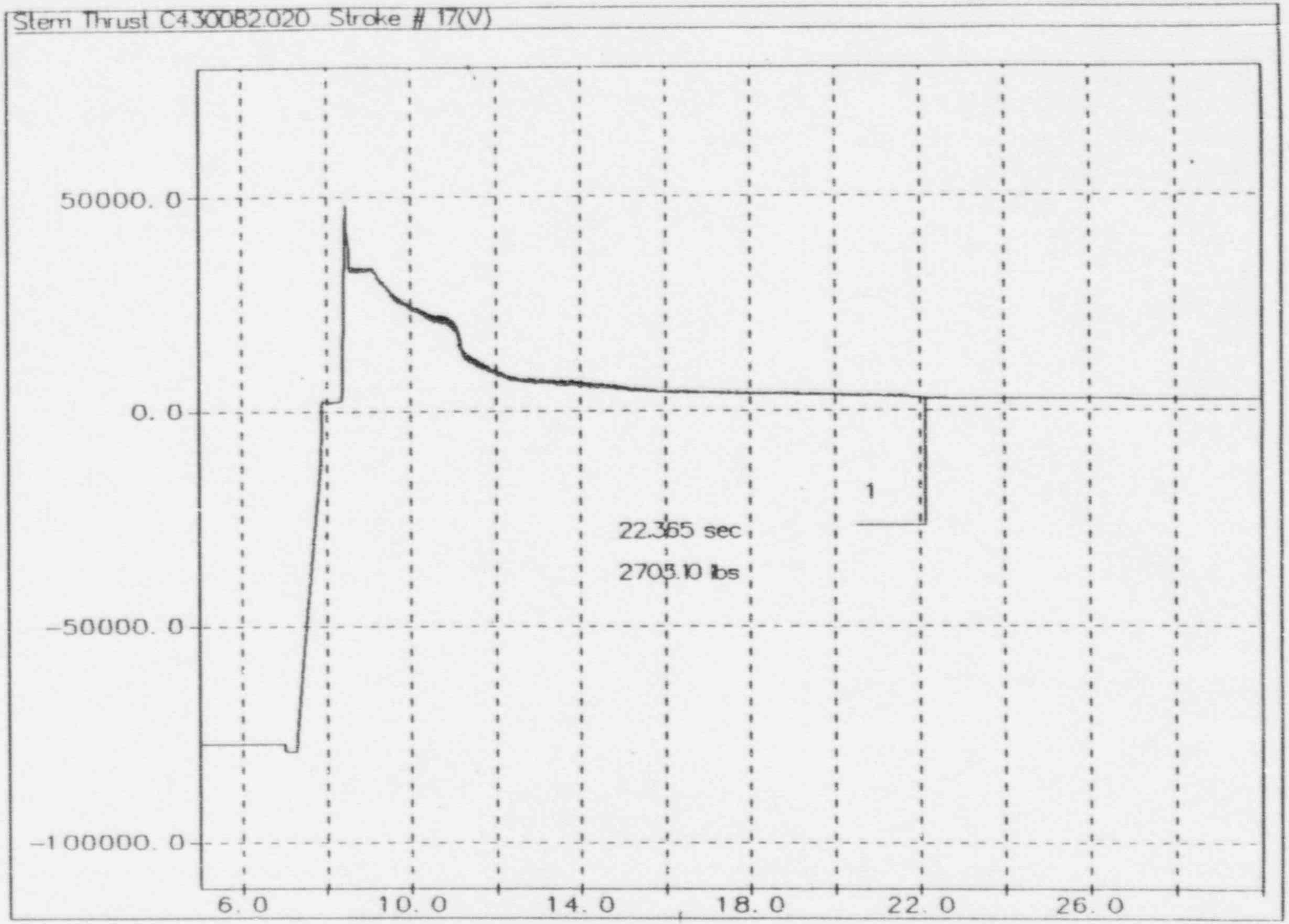
" Start: 7.905

MAX ΔP OCCURRES AFTER WEDGING.
POINT TAKEN PRIOR TO WEDGING. [initials]

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


Stem Thrust C430082.020 Stroke # 17(V)
8.456 sec
48035.42 lbs
3
2
9.321 sec
30135.50 lbs
4
8.577 sec
32586.00 lbs
5
7.266 sec
-78859.60 lbs
50000. 0
0. 0
-50000. 0
-100000. 0
6. 5
7. 0
7. 5
8. 0
8. 5
9. 0
9. 5
10. 0
10. 5
11. 0


Stem Thrust C430082.020 Stroke # 17(V)
50000. 0
0. 0
-50000. 0
-100000. 0
6. 0
10. 0
14. 0
18. 0
22. 0
26. 0
1
22.365 sec
2705.10 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/6/93
Test Description 500 PSI 9000 GPM
Data File AC430082

Test Time 16:20:19.00
Stroke # 17(V)
Data Set 020

OPEN STROKE

Running Current 16.16 amps RMS
Running Power 7235 watts
Contactor Drop-out Time 0.012 sec
Disk Factor (Standard) at Max dP 0.459563

Unseating Current 27.92 amps RMS
Stroke Time 18.44 sec
Disk Factor (NMAC) at Max dP 0.527251

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	22.365	2703.10	-14.50	====	432.20	====	N/A
2. Max. dP	9.321	30125.50	-460.70	====	510.94	515.15	0.093447
3. Unseating	8.456	48035.42	-669.80	0.018780	====	====	====
4. Just After Unseating	8.577	32586.00	-476.70	0.008718	510.63	511.11	====
5. Hammer Blow	7.266	-78859.60	====	0.085631	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

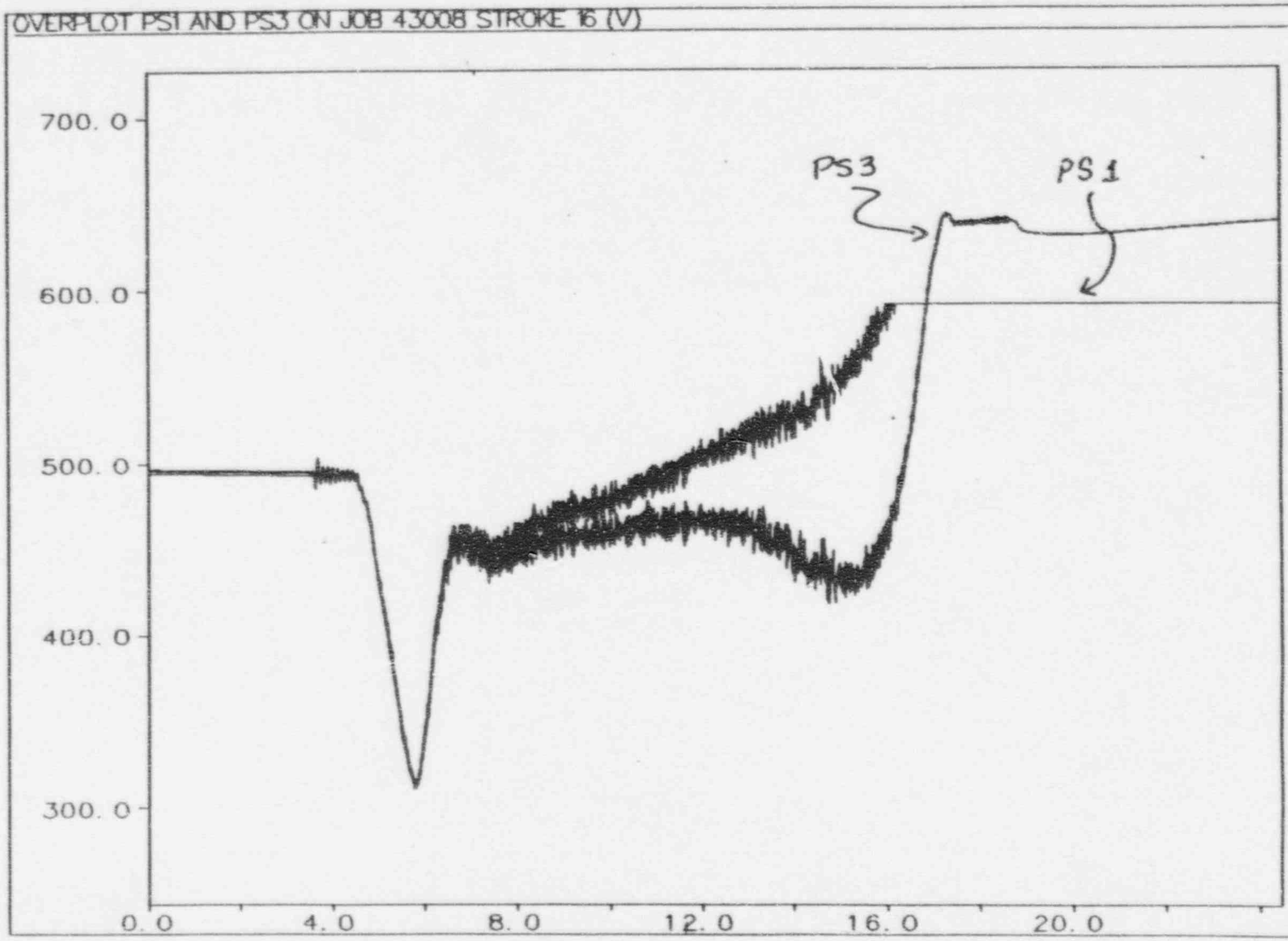
Note: All values annotated above are actual values, with no correction for static conditions.

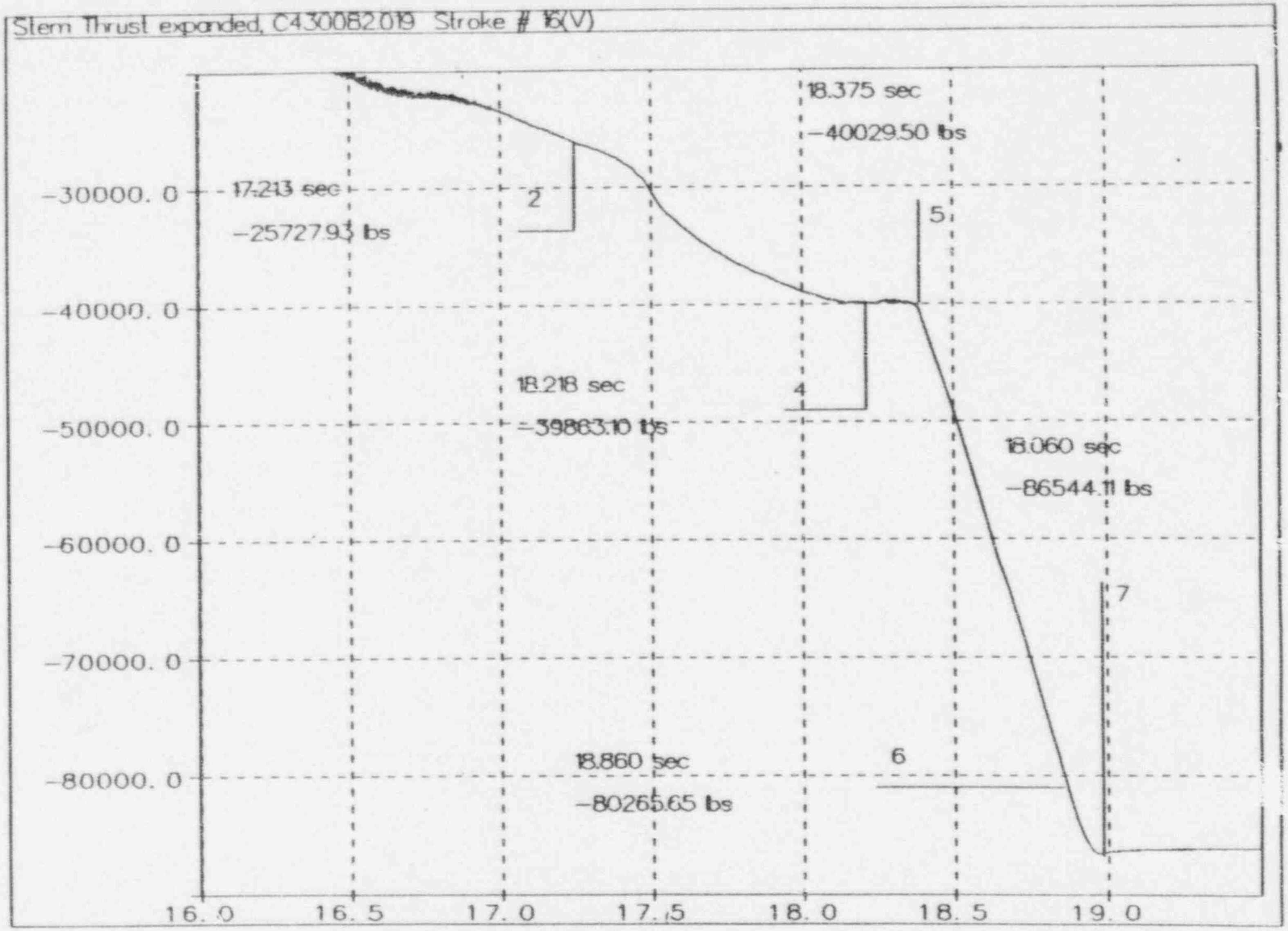
Remarks

unseating in 2 steps
S_i: 25.596 sec
motor stop: 25.408
" start: 6.855

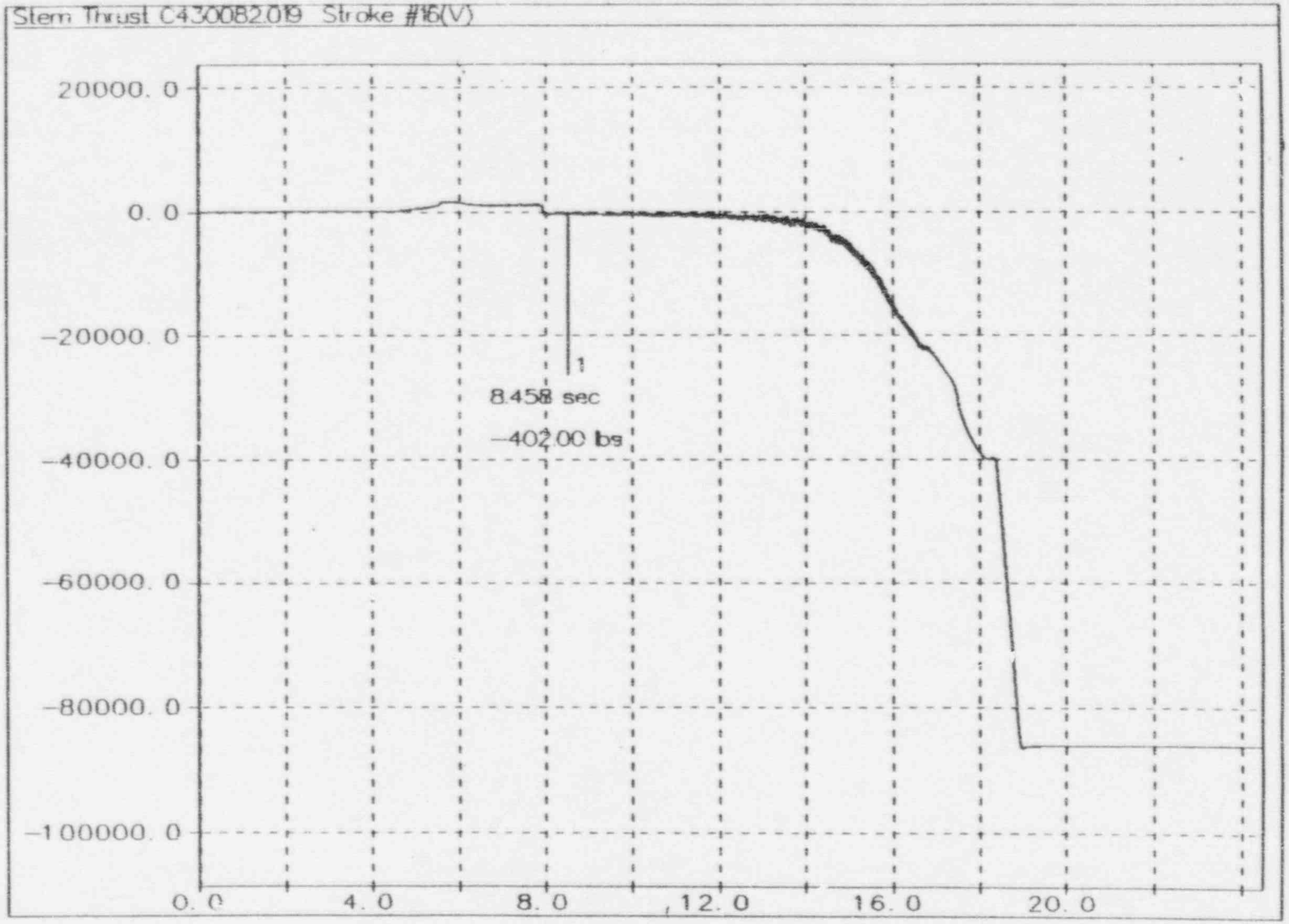
Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


OVERPLOT PS1 AND PS3 ON JOB 43008 STROKE 16 (V)
700.0
600.0
500.0
400.0
300.0
0.0
4.0
8.0
12.0
16.0
20.0
PS3
PS1



Stem Thrust expanded, C430082019 Stroke # 16(V)
-30000. 0
-40000. 0
-50000. 0
-60000. 0
-70000. 0
-80000. 0
16. 0
16. 5
17. 0
17. 5
18. 0
18. 5
19. 0
17.213 sec
-25727.93 lbs
2
18.375 sec
-40029.50 lbs
5
18.218 sec
-39863.10 lbs
4
18.060 sec
-86544.11 lbs
7
18.860 sec
-80265.65 lbs
6


Stem Thrust C430082.019 Stroke #16(V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
1
8.458 sec
-402.00 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/6/93	**Test Time**	14:54:51.00
Test Description	500PSI 9000GPM	**Stroke #**	16(X)
Data File	9C430082	**Data Set**	019

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	17.26	amps RMS	Stroke Time	10.39	sec
Running Power	9100.7	watts	Rate of Loading	Yes ~1350 lbs	
Contactor Drop-out Time	0.019	sec			
* Disk Factor (Standard) at Max dP	0.3322		* Disk Factor (NMAC) at Max dP	.3947	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	* Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	8.458	-402.0	39.73	====	451.7	====	N/A
2. Max. dP	17.213	-25727.93	455.32	====	637.3	639.53	0.119272
3. Minimum Available	====	79863.6	1281	====	====	====	====
4. Just Prior to Wedging	18.218	-39863.10	677.27	0.079066	====	====	====
5. Wedging	18.375	-40029.50	683.76	0.08089	638.7	634.39	====
6. Torque Switch Trip	18.860	-80265.65	1320.65	0.236459	====	====	0.105980
7. Total	18.969	-86544.11	1426.17	0.261535	====	====	====
8. Inertia	====	6278.5	====	N/A	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

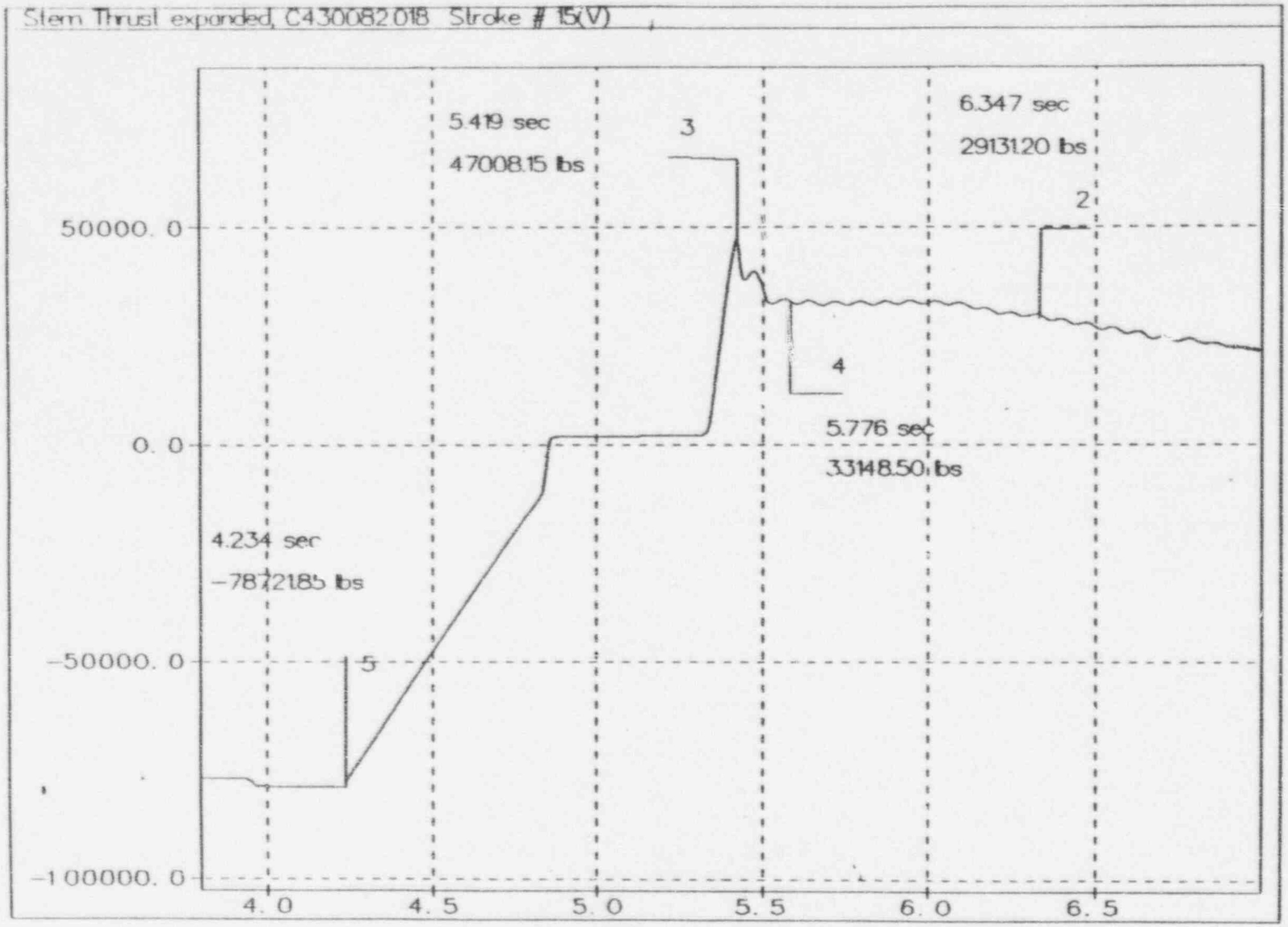
Remarks

S_3: 18.860
ByPass: 17.318
Motor Stop: 18.875
Motor Start: 7.912

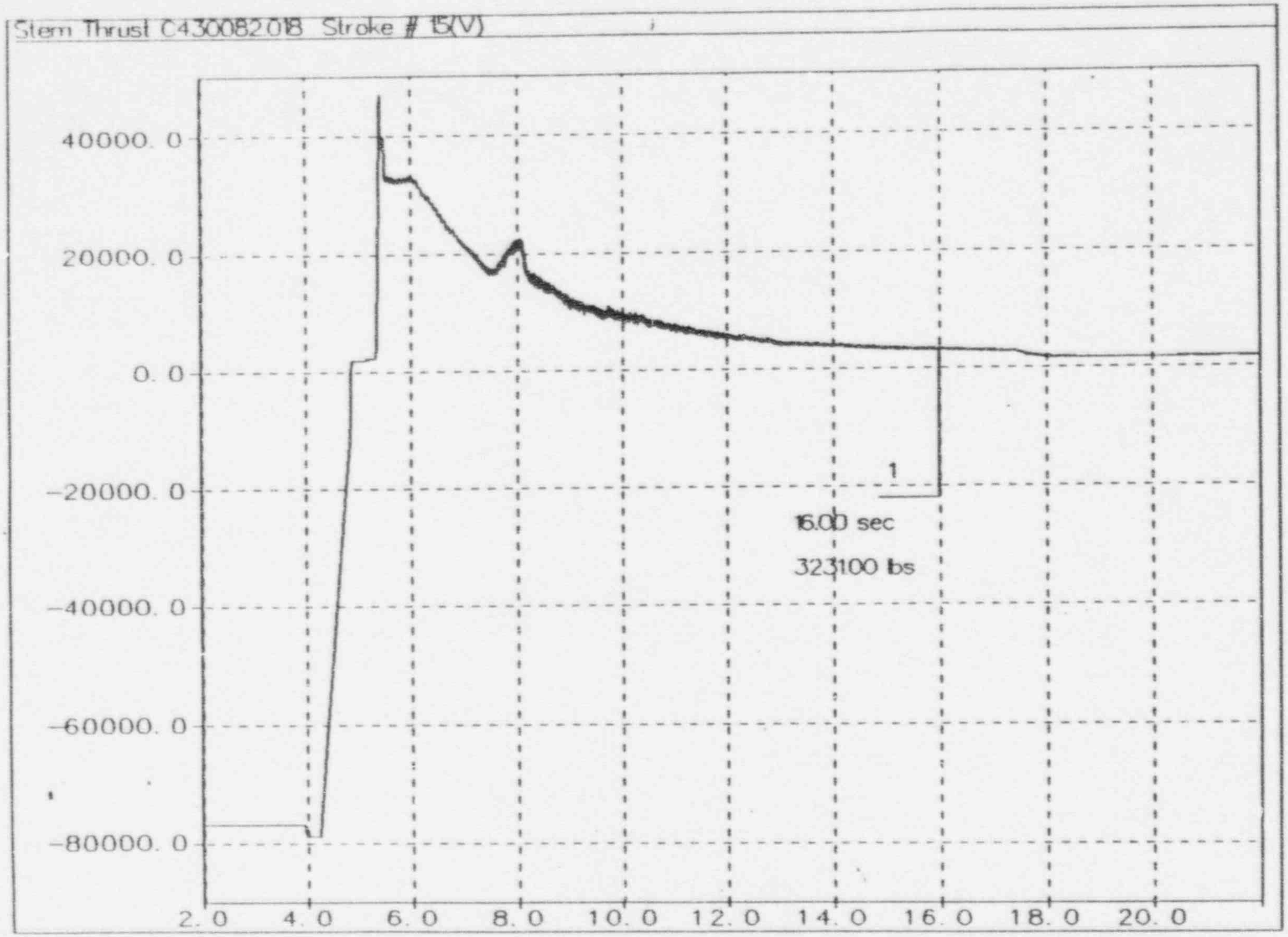
Saturation of Sensor or Electronic on PS1
PS3 DID NOT TRACK WITH PS1, DISK FACTORS ARE UNDEPENDABLE

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93



Stem Thrust expanded, C430082.018 Stroke # 15(V)
5.419 sec
47008.15 lbs
3
6.347 sec
29131.20 lbs
2
4
5.776 sec
33148.50 lbs
4.234 sec
-78721.85 lbs
5
50000. 0
0. 0
-50000. 0
-100000. 0
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5


Stem Thrust C430082018 Stroke # 15(V)
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
2. 0
4. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
1
16.00 sec
323100 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/6/93
Test Description 500PSI 9000GPM+
Data File 0CA30082

Test Time :22:50
Stroke # 15(V)
Data Set 018

OPEN STROKE

Running Current 16.0 amps RMS
Running Power 7746 watts
Contactor Drop-out Time 0.008 sec
Disk Factor (Standard) at Max dP 0.433560

Unseating Current 27.94 amps RMS
Stroke Time 18.5 sec
Disk Factor (NMAC) at Max dP 0.486991

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	16.800	3231.00	-26.50	====	437.50	====	N/A
2. Max. dP	6.347	29131.20	-437.75	====	512.55	512.97	0.090702
3. Unseating	5.419	47008.15	-641.00	-0.009327	====	====	====
after 2nd uns 4. Just After Unseating	5.776	33148.50	-483.97	-0.007593	515.90	516.30	====
5. Hammer Blow	4.134	-78781.85	====	0.087834	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

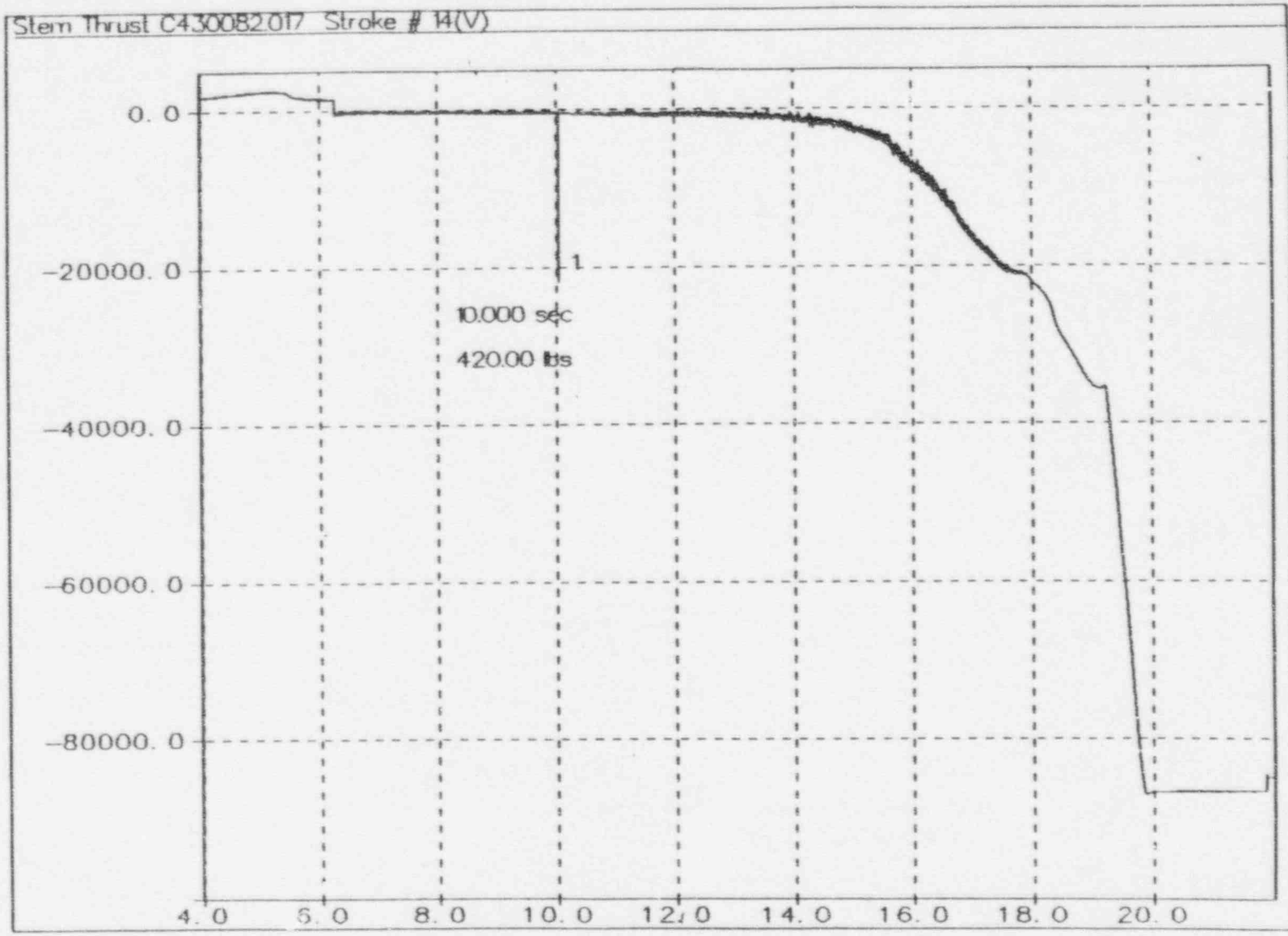
Remarks

The unseating occured in 2 steps.
2nd : 5.410 & 39719.6 Lbs

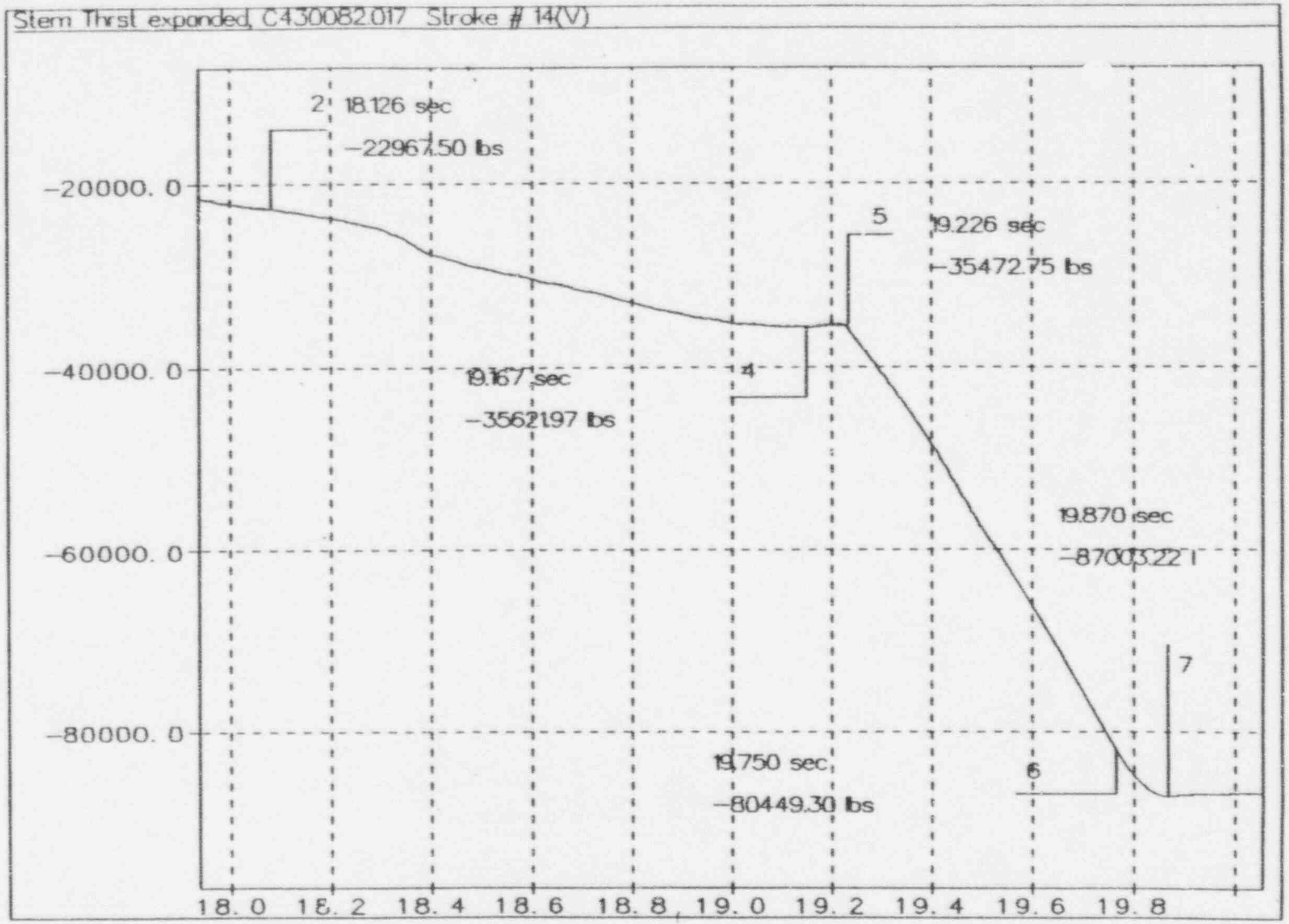
S: 22.386 sec
motor start : 3.912 sec
" stop : 22.394 sec

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93



Stem Thrust C430082.017 Stroke # 14(V)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
1
10.000 sec
420.00 lbs



Stem Thrst expanded, C430082.017 Stroke # 14(V)
2
18.126 sec
-22967.50 lbs
5
19.226 sec
-35472.75 lbs
4
19.167 sec
-35621.97 lbs
19.870 sec
-87003.22 l
7
6
19.750 sec
-80449.30 lbs
-20000. 0
-40000. 0
-60000. 0
-80000. 0
18. 0
18. 2
18. 4
18. 6
18. 8
19. 0
19. 2
19. 4
19. 6
19. 8

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/06/93	**Test Time**	11:10:4_ _m
Test Description	500PSI 9000GPM	**Stroke #**	14(V)
Data File	0C430082	**Data Set**	017

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	18.57	amps RMS	Stroke Time	13.8	sec
Running Power	10564.80	watts	Rate of Loading	yes 21161 Lbs	
Contactor Drop-out Time	0.015	sec			
Disk Factor (Standard) at Max dP	0.422178		Disk Factor (NMAC) at Max dP	0.372417	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	420.00	38.17	====	479.72	====	N/A
2. Max. dP	18.126	-22967.50	403.85	====	564.05	565.83	0.118055
3. Minimum Available	====	80029	1266	====	====	====	====
4. Just Prior to Wedging	19.167	-35621.97	599.70	0.066609	====	====	====
5. Wedging	19.226	-35472.75	599.26	0.067633	557.43	556.63	====
6. Torque Switch Trip	19.750	-80449.30	1801.04	0.239569	====	====	0.102970
7. Total	19.870	-87003.22	1496.24	0.258216	====	====	====
8. Inertia	====	6554	====	N/A	====	====	====

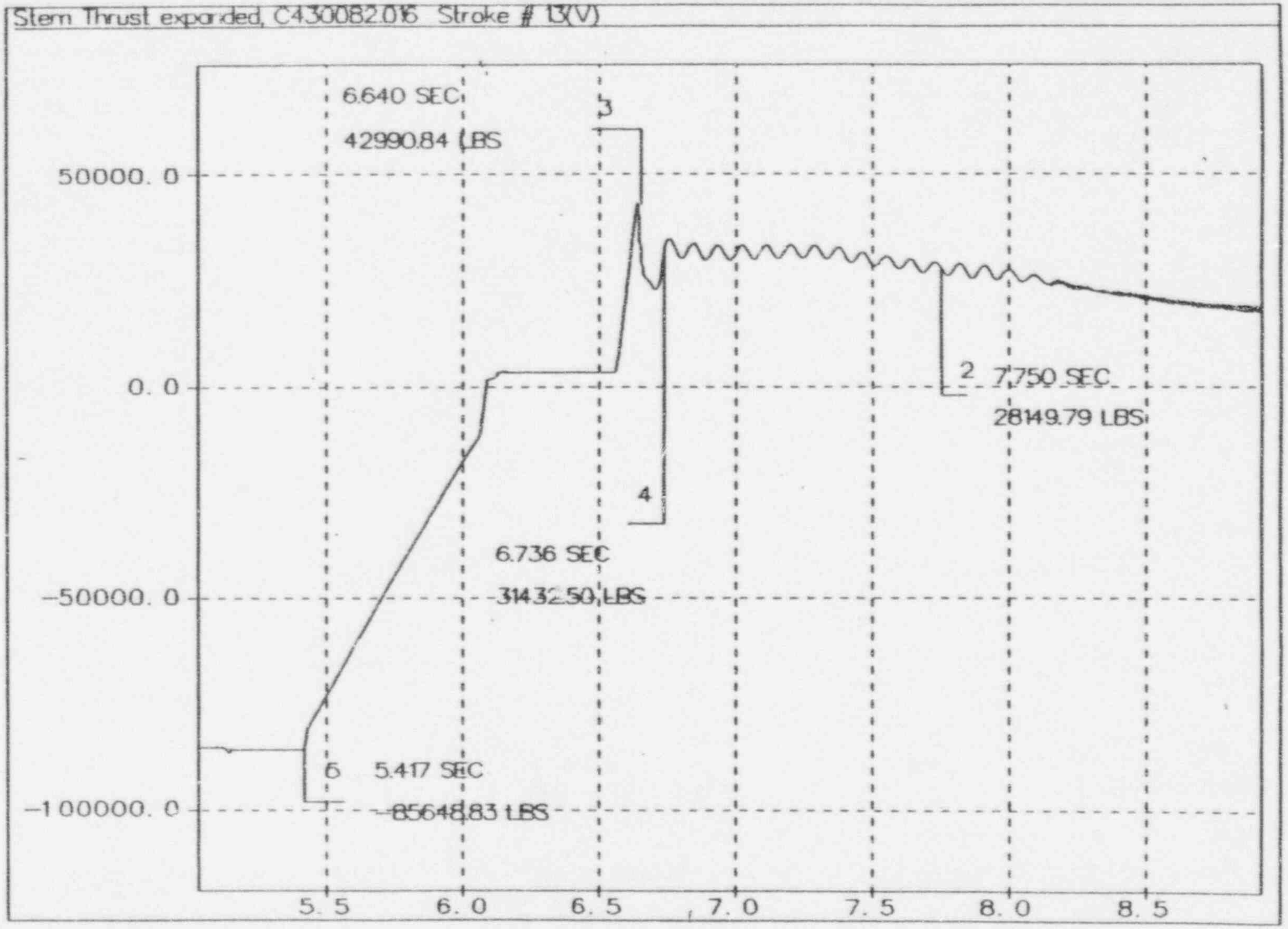
Note: All values annotated above ar[illegible] actual values, with no correction for static conditions.

Remarks

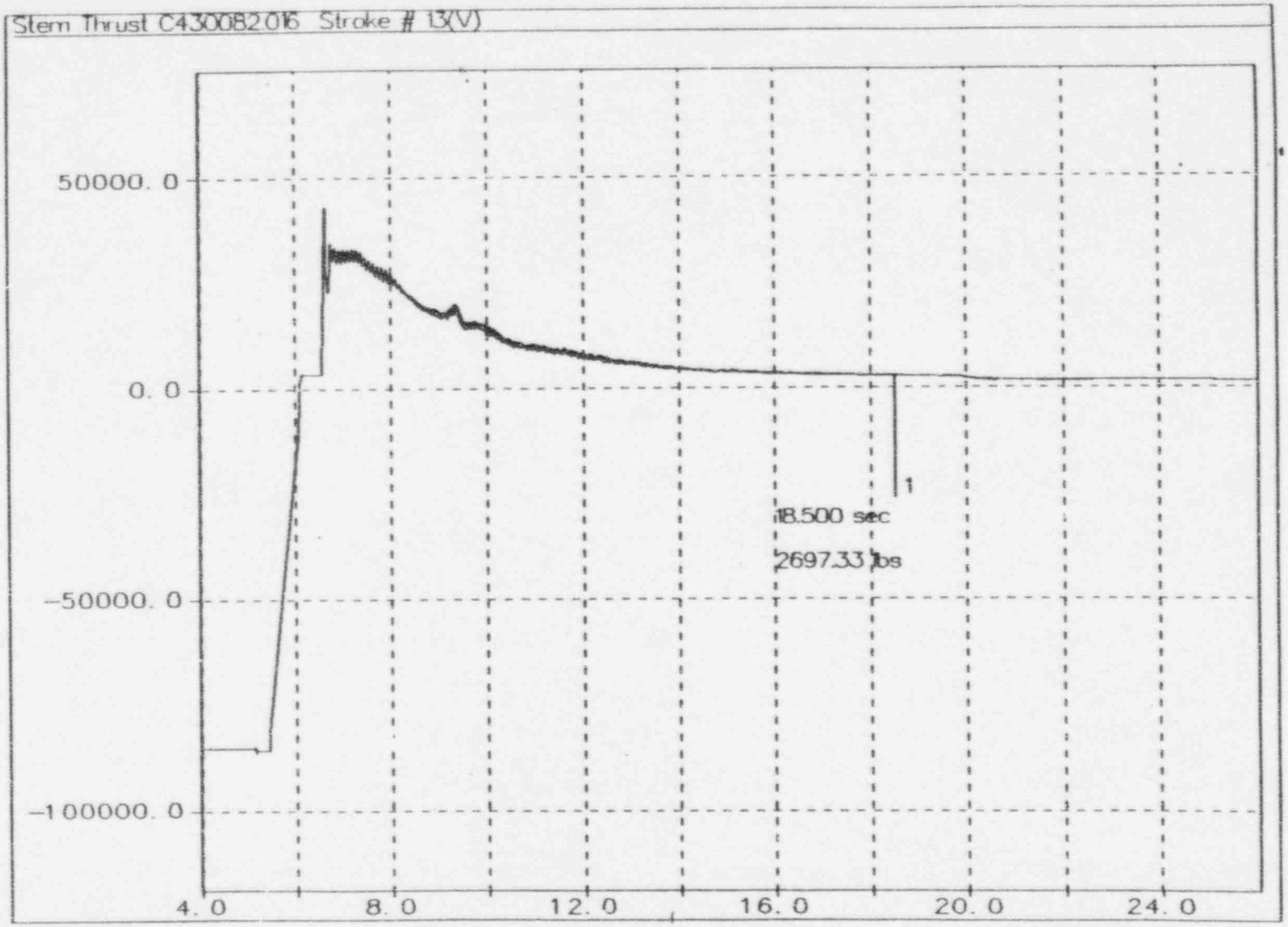
S_3: 19.750
Bypass: 18.[illegible]
motor Stop: 19.763
" Start: 5.353

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93



Stem Thrust expanded, C430082.016 Stroke # 13(V)
6.640 SEC
42990.84 LBS
3
50000. 0
0. 0
-50000. 0
-100000. 0
2 7.750 SEC
28149.79 LBS
4
6.736 SEC
31432.50 LBS
5 5.417 SEC
-85648.83 LBS
5. 5
6. 0
6. 5
7. 0
7. 5
8. 0
8. 5



Stem Thrust C430082016 Stroke # 13(V)
50000. 0
0. 0
-50000. 0
-100000. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
1
18.500 sec
2697.33 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-6-93
Test Description - 500 PSI 9000 GPM
Data File 9C430082

Test Time 9:30:12.00
Stroke # C→O #13(V)
Data Set .016

OPEN STROKE

Running Current 16.64 amps RMS
Running Power 8920 watts
Contactor Drop-out Time 0.012 sec
Disk Factor (Standard) at Max dP 0.421431

Unseating Current 27.86 amps RMS
Stroke Time 18.60 sec
Disk Factor (NMAC) at Max dP 0.481613

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.500	2697.33	-80.71	====	475.19	====	N/A
2. Max. dP	7.750	28149.79	-423.64	====	507.12	518.31	0.09094
3. Unseating	6.640	42990.84	-579.33	0.003514	====	====	====
4. Just After Unseating	6.736	31432.50	-440.77	0.003468	514.32	514.49	====
5. Hammer Blow	5.417(s)	-85648.83	====	0.033318	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

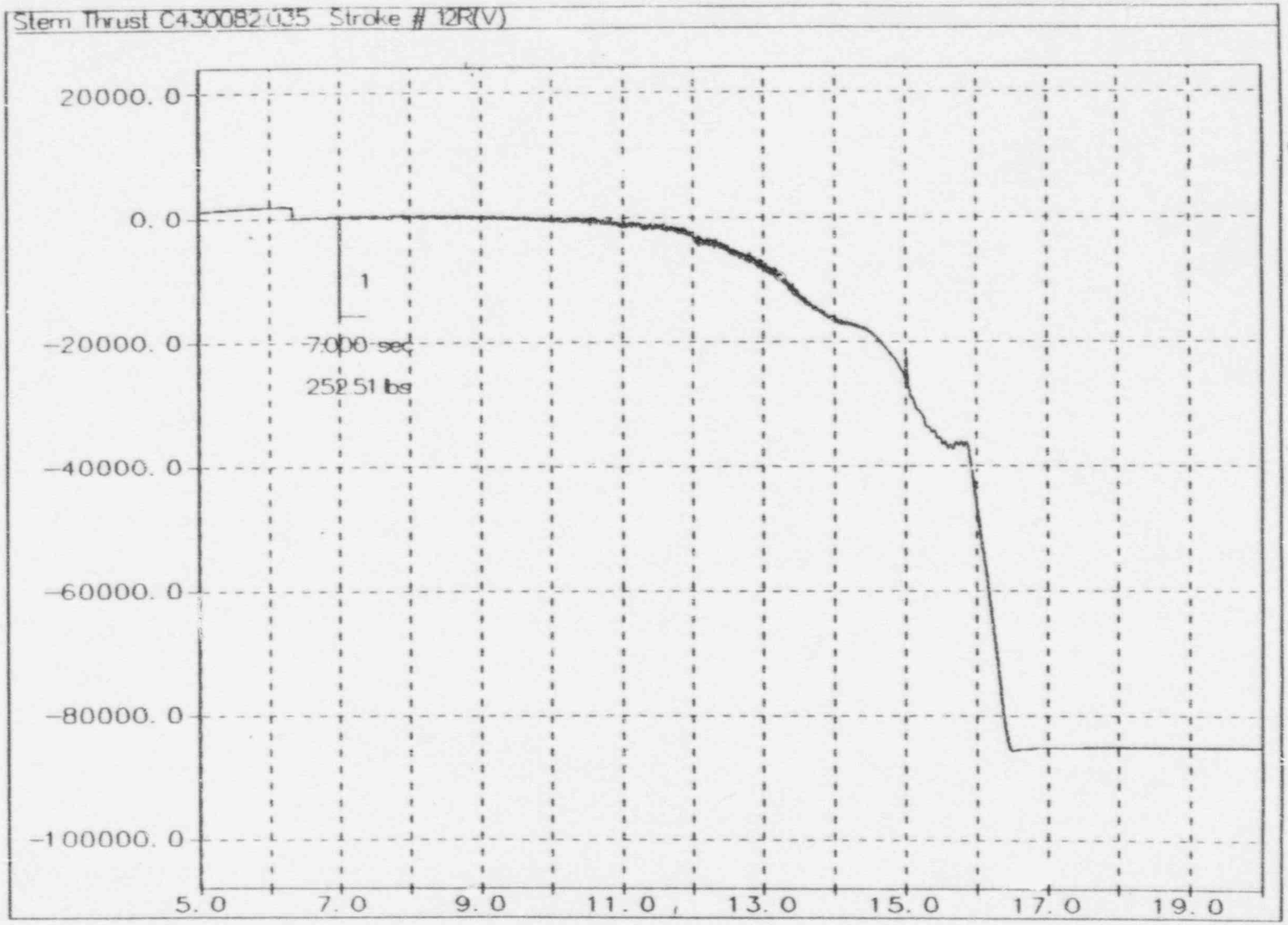
Note: All values annotated above are actual values, with no correction for static conditions.

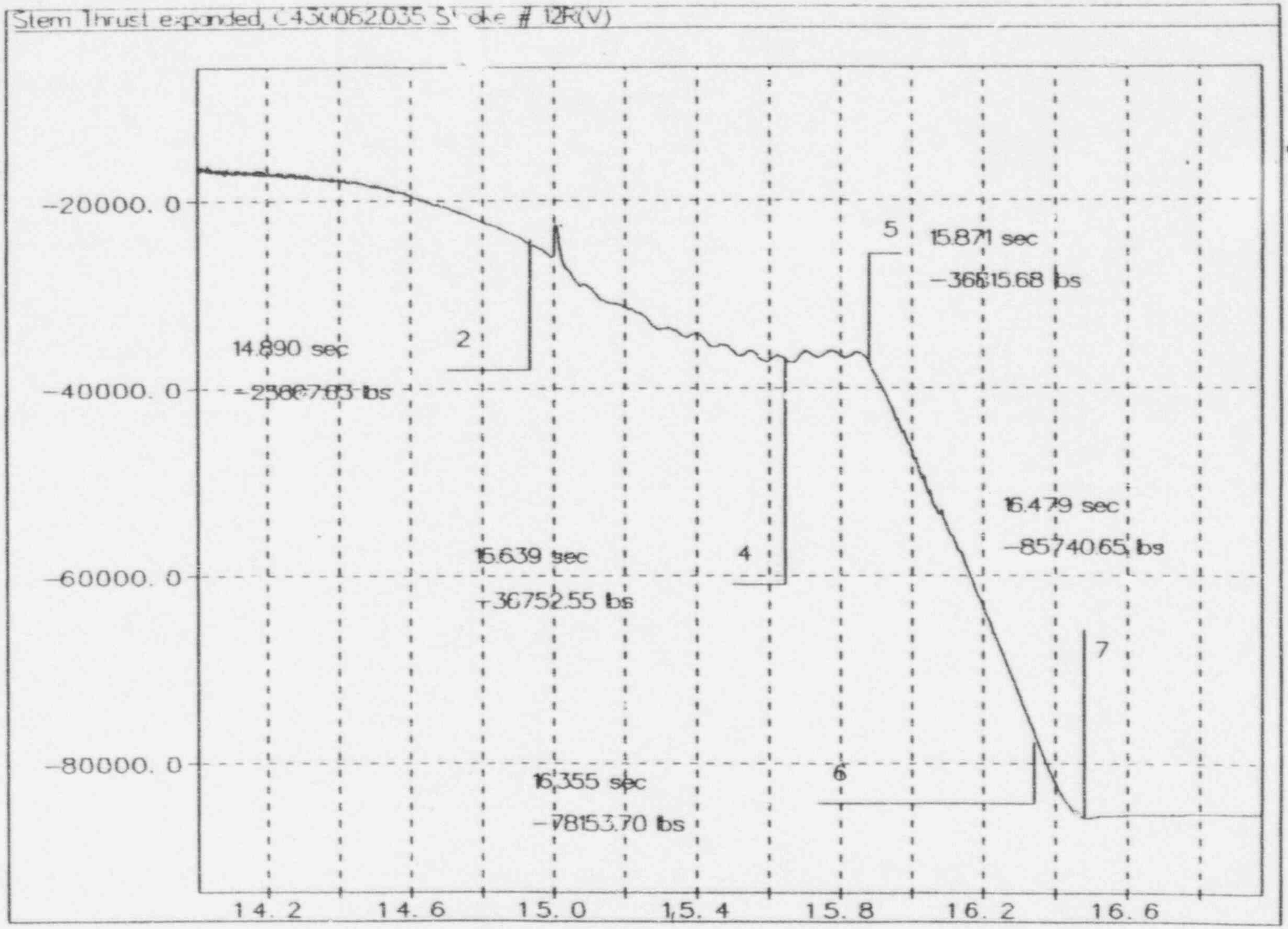
Remarks

S_1: 23.656
Motor Start: 5.034 sec.
" Stop: 23.708 sec

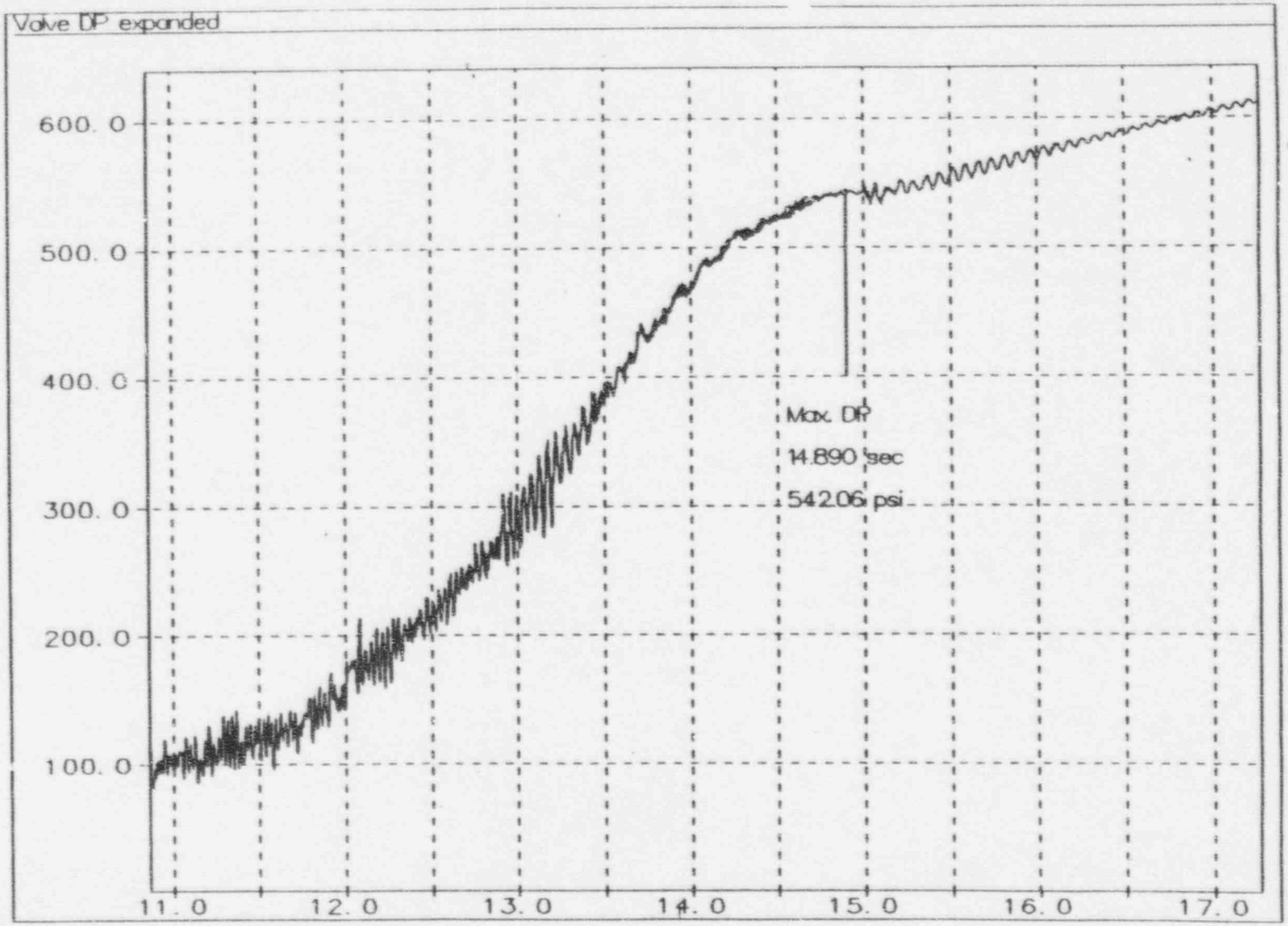
Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


Stem Thrust C430082.035 Stroke # 12R(V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
5. 0
7. 0
9. 0
11. 0
13. 0
15. 0
17. 0
19. 0
1
7.000 sec
252.51 lbs



Stem Thrust expanded, C430062035 Stroke # 12R(V)
-20000.0
-40000.0
-60000.0
-80000.0
14.2
14.6
15.0
15.4
15.8
16.2
16.6
2
14.890 sec
-25807.83 lbs
4
15.639 sec
-36752.55 lbs
5
15.871 sec
-36615.68 lbs
6
16.355 sec
-78153.70 lbs
7
16.479 sec
-85740.65 lbs


Valve DP expanded
600.0
500.0
400.0
300.0
200.0
100.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
Max. DP
14.890 sec
542.06 psi

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-8-93
Test Description 500PSI 9000GPM
Data File OC430086

Test Time 17:52:05.00
Stroke # 12R(V)
Data Set 035

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 17.16 amps RMS
Running Power 2300 watts
Contactor Drop-out Time 0.014 sec
Disk Factor (Standard) at Max dP 0.44855

Stroke Time 10.0 sec
Rate of Loading Yes ~3500 Lbs
Disk Factor (NMAC) at Max dP 0.36538

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	7.000	252.51	31.56	====	355.70	====	N/A
2. Max. dP	14.890	-23667.63	424.87	====	535.67	541.29	0.12198
3. Minimum Available	====	77931.10	1267	====	====	====	====
4. Just Prior to Wedging	15.639	-36752.55	637.42	0.069461	====	====	====
5. Wedging	15.871	-36815.68	637.53	0.071992	567.82	567.66	====
6. Torque Switch Trip	16.355	-78152.70	1298.57	0.224116	====	====	0.107713
7. Total	16.479	-85740.65	1509.11	0.26500	====	====	====
8. Inertia	====	7587	====	N/A	====	====	====

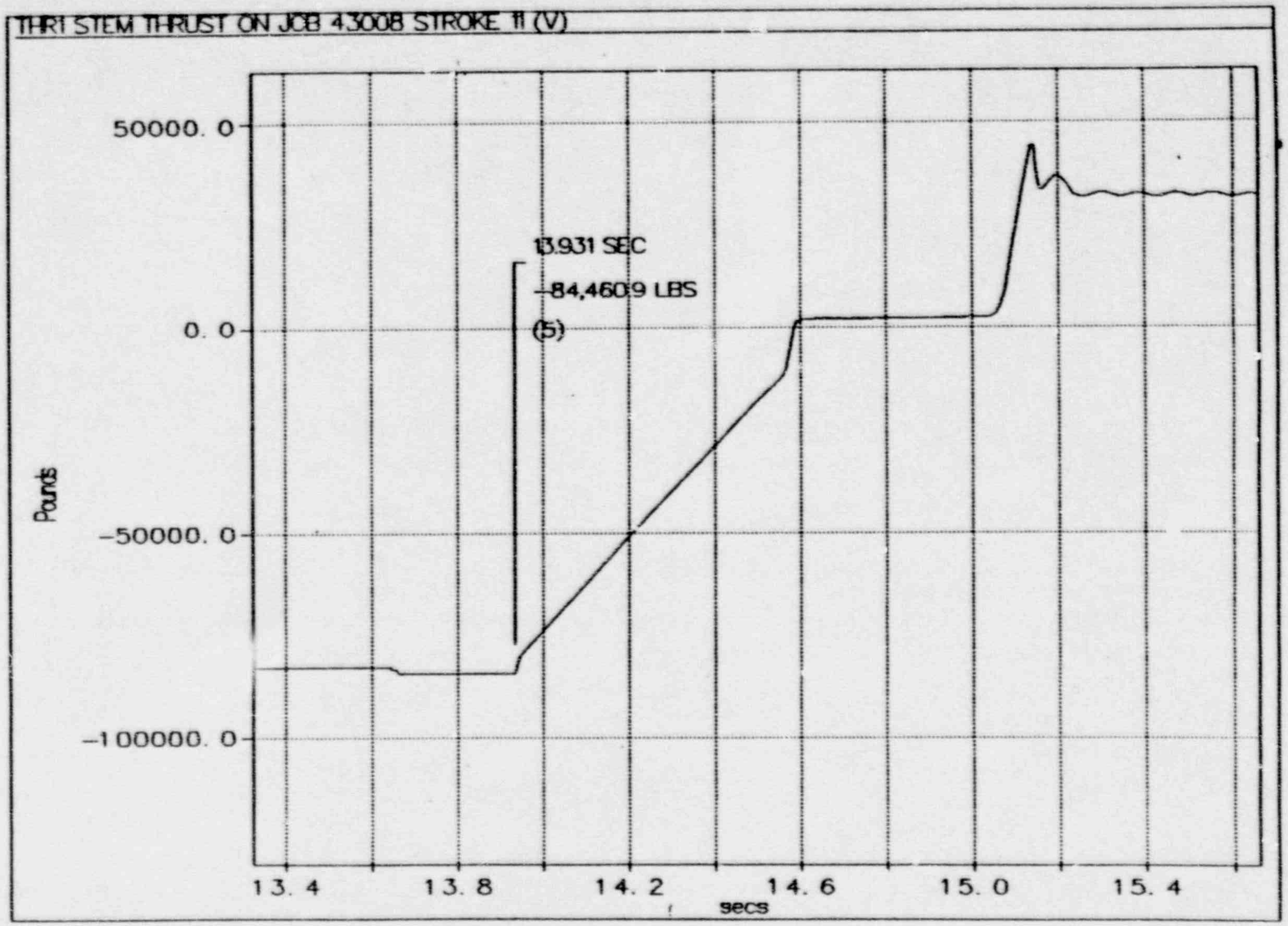
Note: All values annotated above are actual values, with no correction for static condition

Remarks

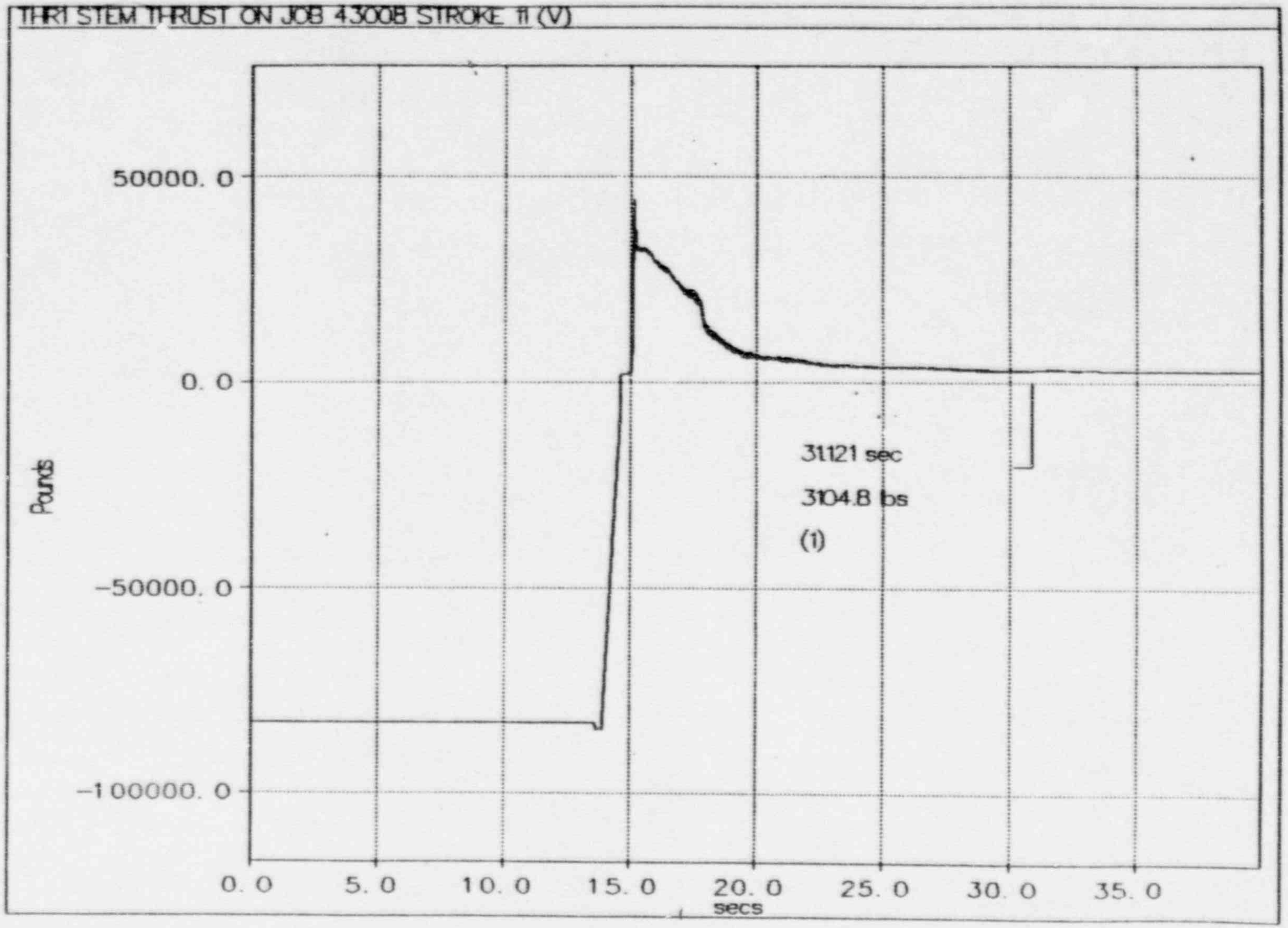
Motor Stop: 16.369
" Start: 6.310
Bypass: 14.851

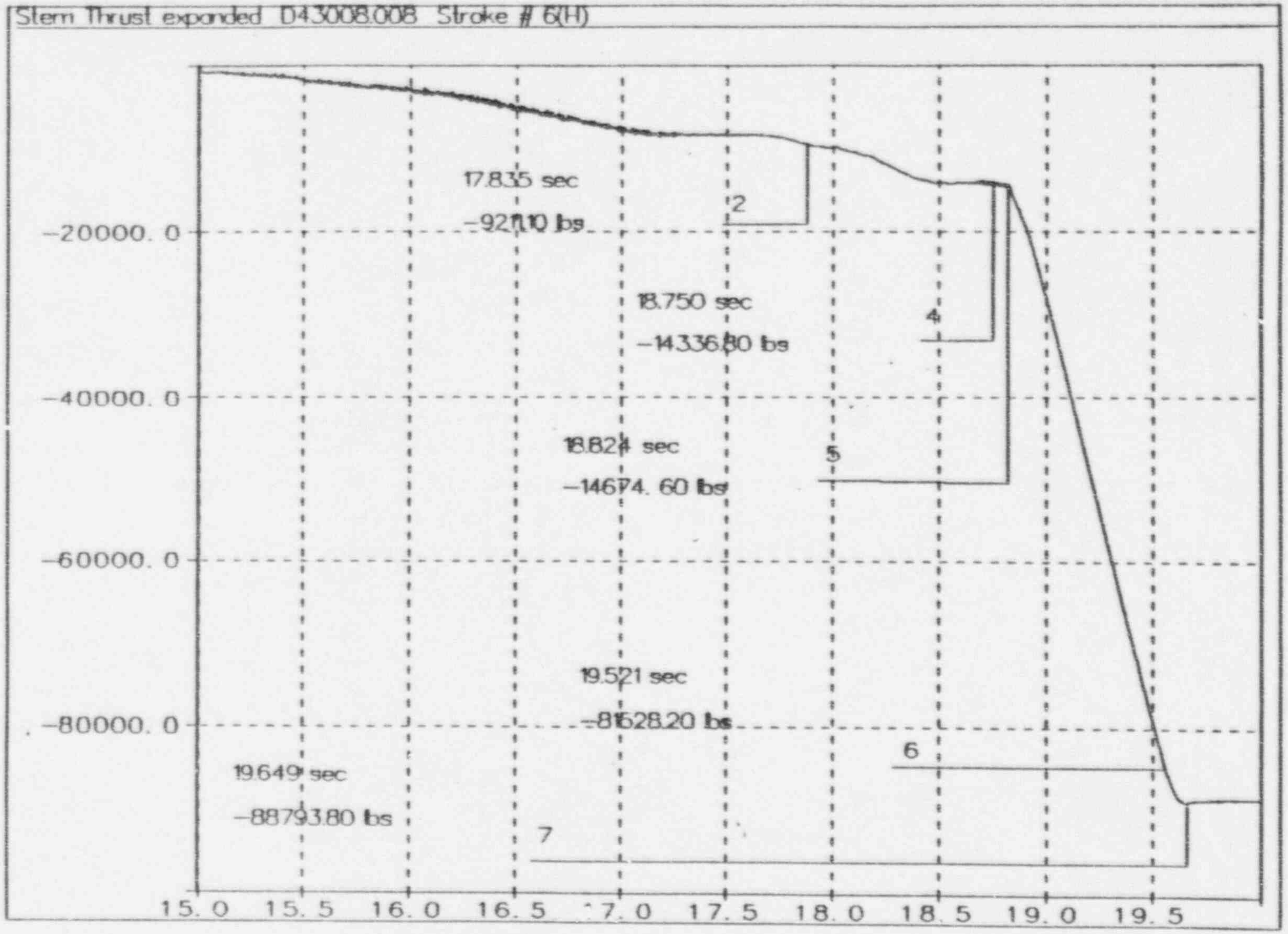
Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93

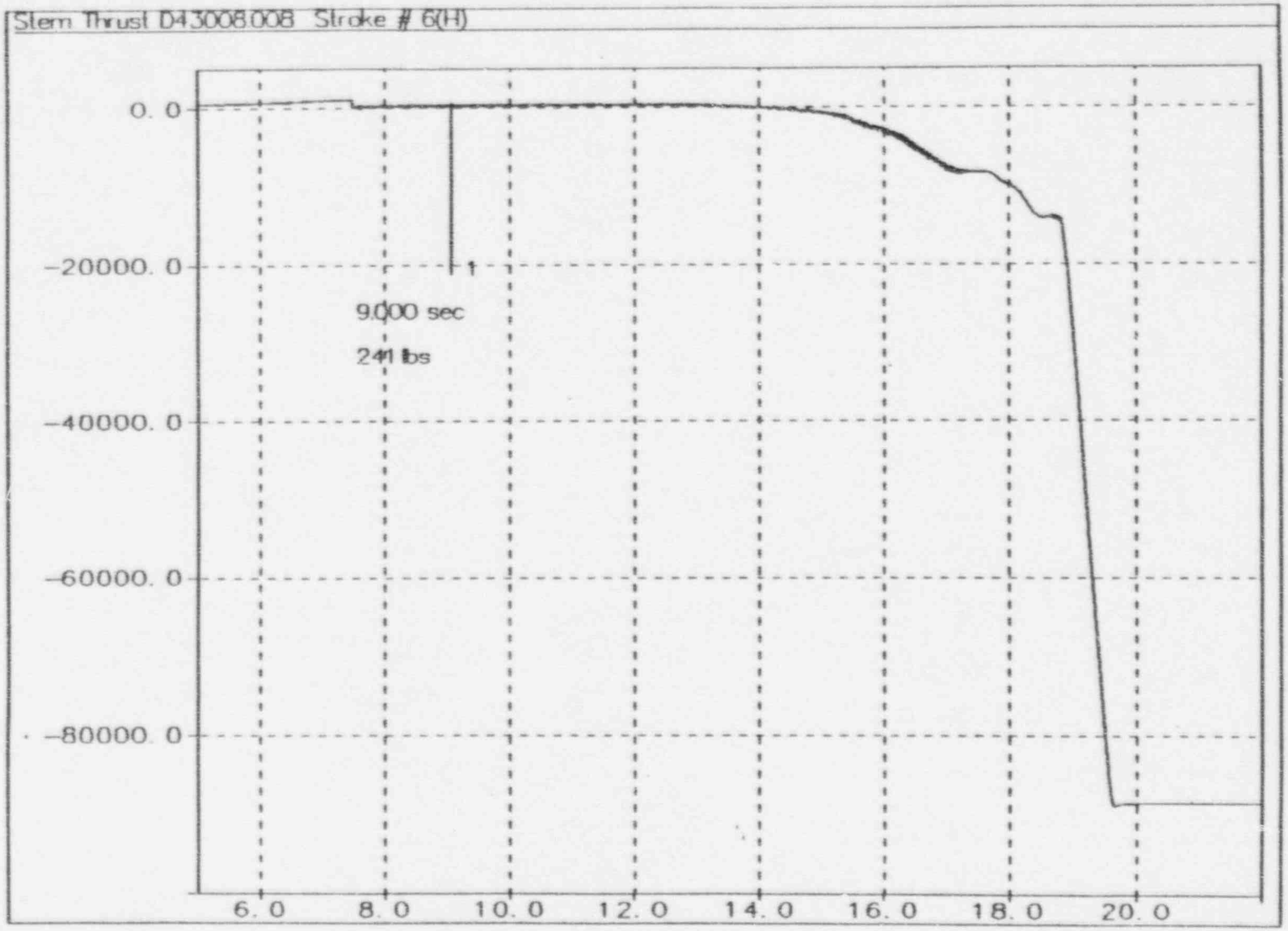


THR1 STEM THRUST ON JOB 43008 STROKE 11 (V)
13.931 SEC
-84,460.9 LBS
(5)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
13. 4
13. 8
14. 2
14. 6
15. 0
15. 4
secs


THR1 STEM THRUST ON JOB 4300B STROKE 11 (V)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
0. 0
5. 0
10. 0
15. 0
20. 0
25. 0
30. 0
35. 0
secs
31.121 sec
3104.8 lbs
(1)



Stem Thrust expanded D43008.008 Stroke # 6(H)
17.835 sec
-9211.10 lbs
2
18.750 sec
-14336.80 lbs
4
18.824 sec
-14674. 60 lbs
5
19.521 sec
-81628.20 lbs
6
19.649 sec
-88793.80 lbs
7
-20000. 0
-40000. 0
-60000. 0
-80000. 0
15. 0
15. 5
16. 0
16. 5
17. 0
17. 5
18. 0
18. 5
19. 0
19. 5


Stem Thrust D43008.008 Stroke # 6(H)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
1
9.000 sec
241 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/13/93 **Test Time** 15:30:04.01
Test Description 200PSI 5500 GPM **Stroke #** 6(H)
Data File D43008 **Data Set** 008

OPEN STROKE

Running Current ______ amps RMS Unseating Current ______ amps RMS
Running Power ______ watts Stroke Time ______ sec
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Unseating					■■■■	■■■■	■■■■
4. Just After Unseating							■■■■
5. Hammer Blow			■■■■		■■■■	■■■■	■■■■

CLOSE STROKE

Running Current 15.20 amps RMS Stroke Time 12.06 sec
Running Power 7252 watts Rate of Loading NO
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.352488 Disk Factor (NMAC) at Max dP 0.436020

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.880	+241.00?	19.5	■■■■	131.11	■■■■	N/A
2. Max. dP	17.835	-9211.10	168.70	■■■■	221.41	226.65	0.125858
3. Minimum Available	■■■■	81287	1277.20	■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging	18.750	-14336.80	242.88	0.000703	■■■■	■■■■	■■■■
5. Wedging	18.824	-14674.60	253.06	0.000703	215.80	216.40	■■■■
6. Torque Switch Trip	19.521	-81528.20	1296.70	0.221086	■■■■	■■■■	0.100109
7. Total	19.649	-88793.80	1519.85	0.254645	■■■■	■■■■	■■■■
8. Inertia	■■■■	7265	■■■■	N/A	■■■■	■■■■	■■■■

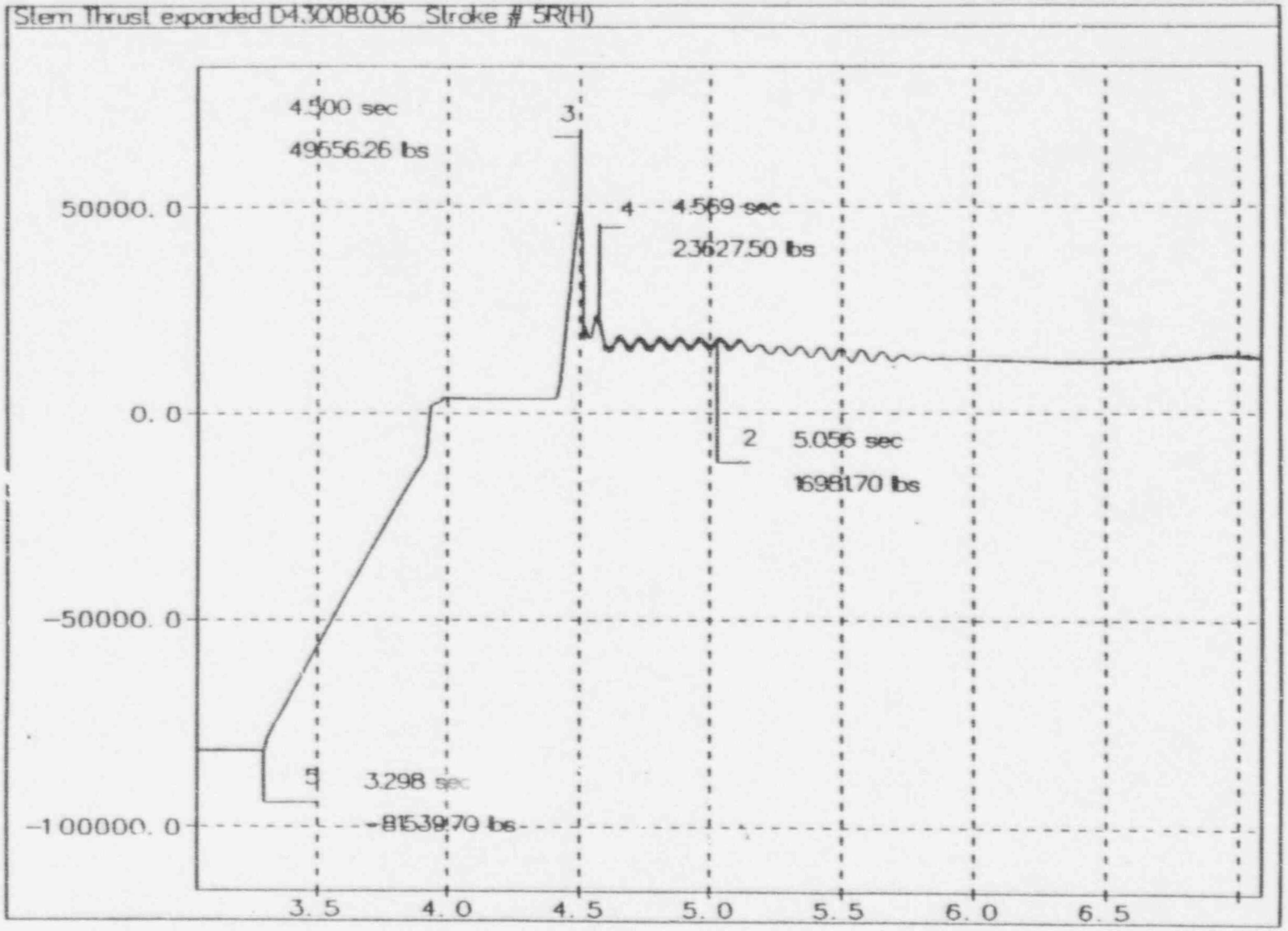
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

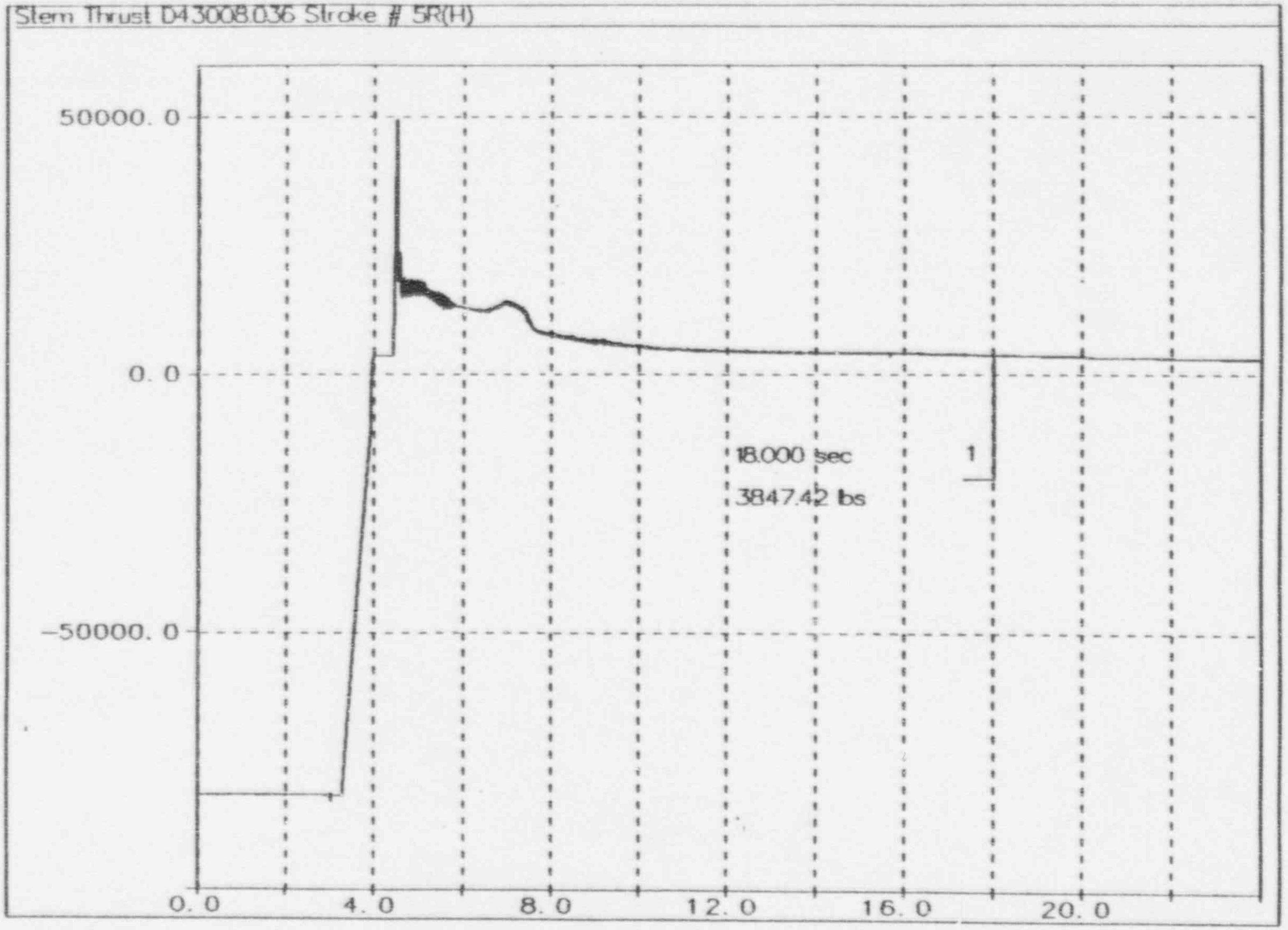
ByPass: 18.000
Motor Start: 7.459
" Stop: 19.533
There probably is a slight offset on Thrust (~600 lbs)

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



Stem Thrust expanded D43008.036 Stroke # 5R(H)
4.500 sec
49556.26 lbs
3
4
4.569 sec
23627.50 lbs
2
5.056 sec
16981.70 lbs
5
3.298 sec
-81539.70 lbs
50000. 0
0. 0
-50000. 0
-100000. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5



Stem Thrust D43008.036 Stroke # 5R(H)
50000. 0
0. 0
-50000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
18.000 sec
3847.42 lbs
1

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/13/93
Test Description 200PSI 5500GPM
Data File a.d43008

Test Time 17:35:51
Stroke # 3B(H)
Data Set 036

OPEN STROKE

Running Current 14.8 amps RMS
Running Power 6372 watts
Contactor Drop-out Time 0.012 sec
Disk Factor (Standard) at Max dP 0.533546

Unseating Current 25.8 amps RMS
Stroke Time 18.4 sec
Disk Factor (NMAC) at Max dP 0.601422

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	3847.42	-29.70	----	172.71	----	N/A
2. Max. dP	5.056	16881.70	-233.81	----	213.62	214.60	0.077195
3. Unseating	4.500	49556.26	-681.63	0.070443	----	----	----
4. Just After Unseating	4.569	23627.50	-337.46	0.017529	214.53	216.14	----
5. Hammer Blow	3.298	-81539.70	----	0.054182	----	----	----

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

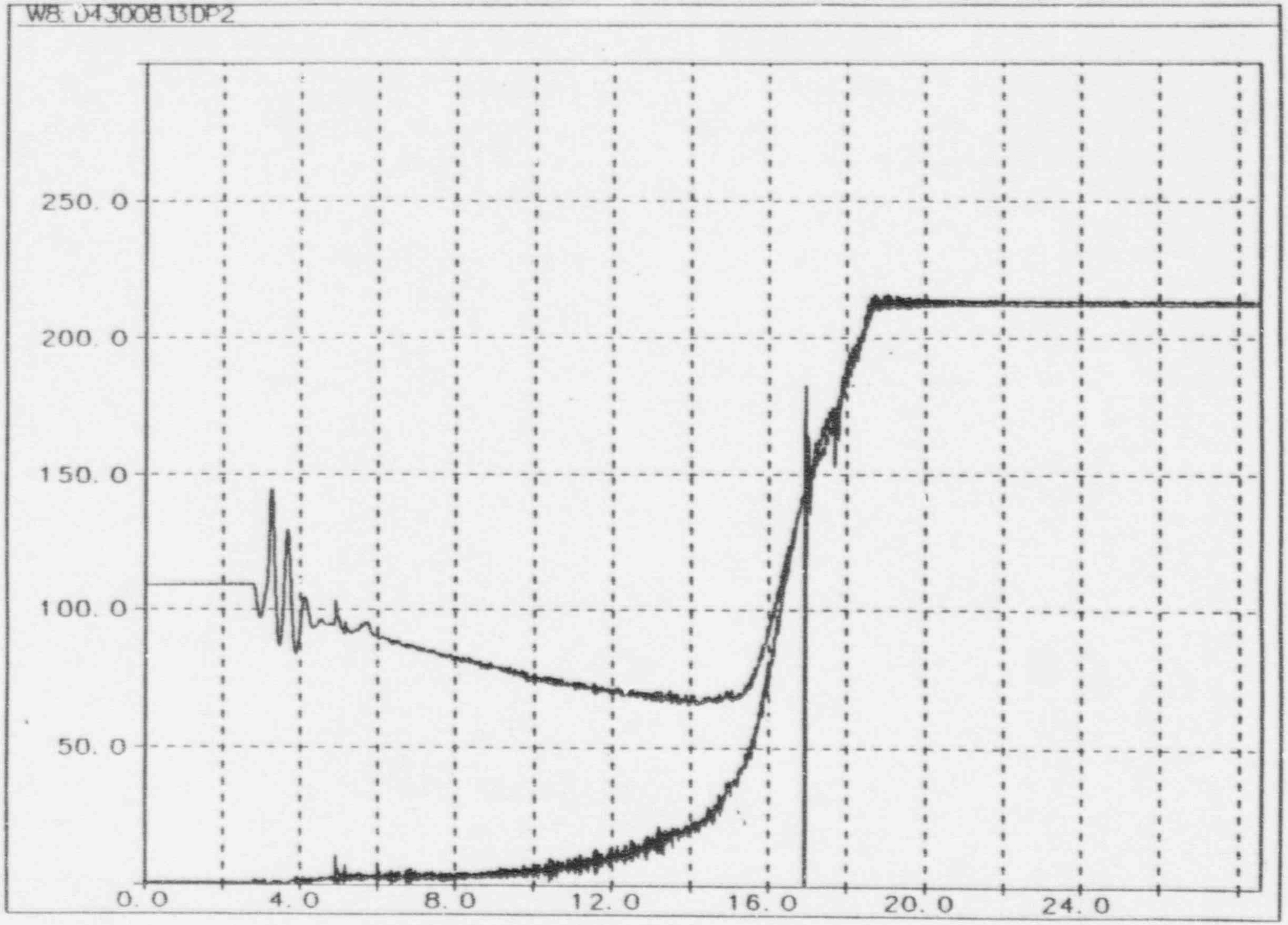
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				----		----	
2. Max. dP				----			
3. Minimum Available	----			----	----	----	----
4. Just Prior to Wedging					----	----	----
5. Wedging							----
6. Torque Switch Trip					----	----	
7. Total					----	----	----
8. Inertia	----		----		----	----	----

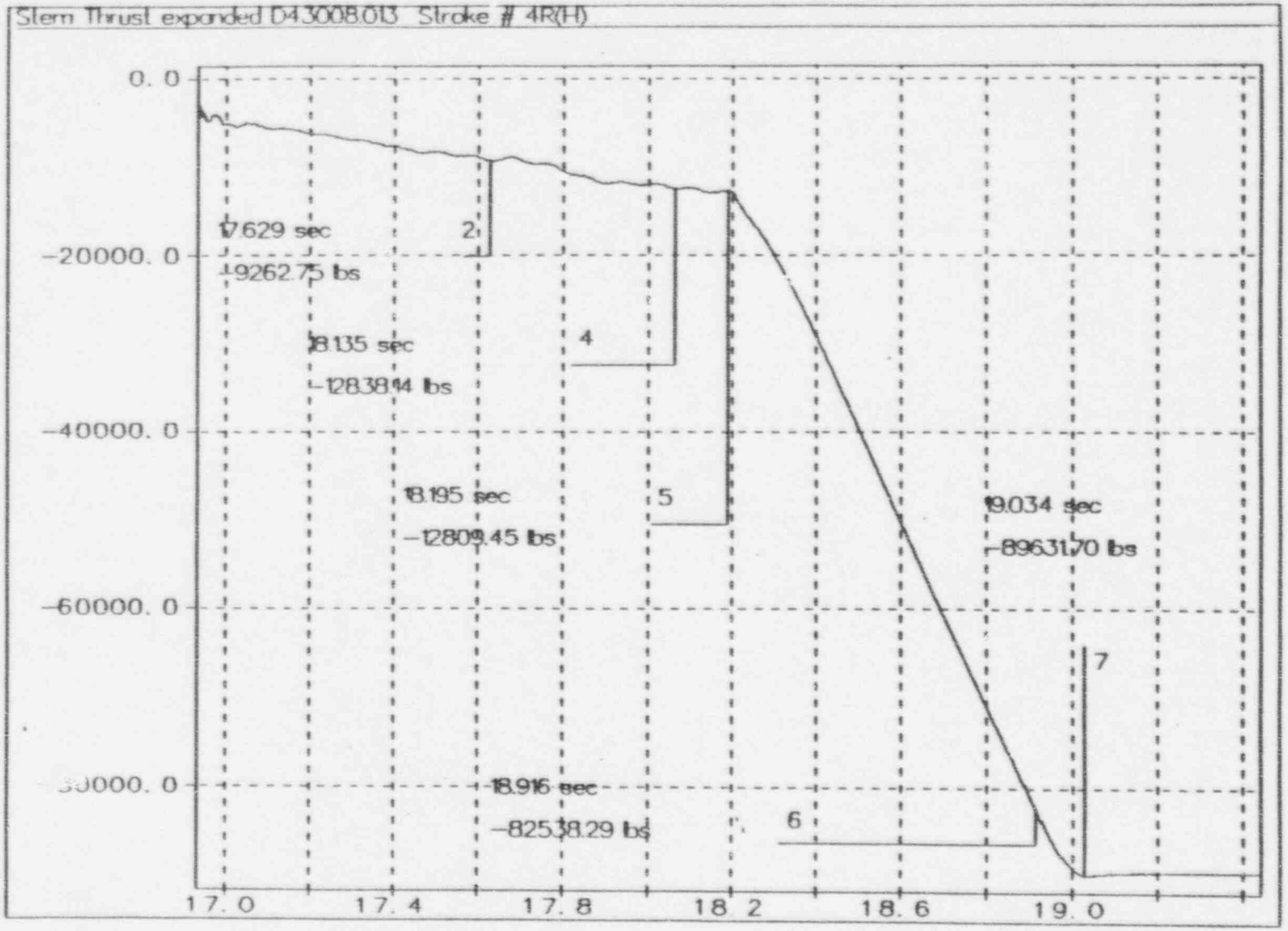
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks
S_1: 21.367 sec
Motor Start: 2.380 sec
Motor Stop: 21.373 sec
Upstream Pressure highly variable.

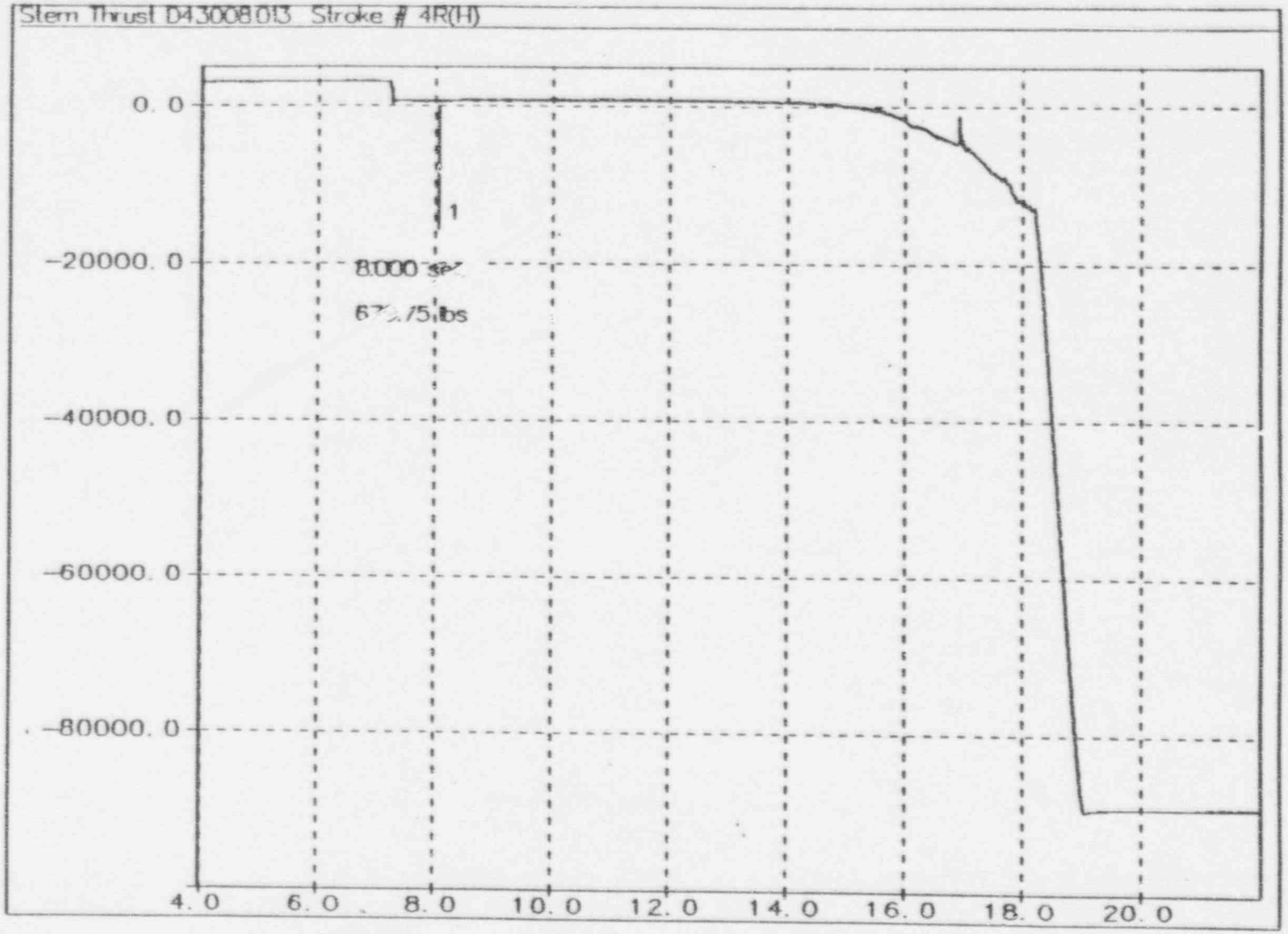
Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93


W8: D43008.13DP2
250.0
200.0
150.0
100.0
50.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0



Stem Thrust expanded D43008.013 Stroke # 4R(H)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
17.0
17.4
17.8
18.2
18.6
19.0
17.629 sec
-19262.75 lbs
2
18.135 sec
-12838.14 lbs
4
18.195 sec
-12809.45 lbs
5
19.034 sec
-89631.70 lbs
7
18.916 sec
-82538.29 lbs
6



Stem Thrust D43008013 Stroke # 4R(H)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
1
8.000

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/10/93	**Test Time**	13:35:40.0?
Test Description	100 PSI 4000 GPM	**Stroke #**	4B(H)
Data File	D43008	**Data Set**	013

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 14.3 amps RMS
Running Power 6507.6 watts
Contactor Drop-out Time 0.014 sec
Disk Factor (Standard) at Max dP 0.496995

Stroke Time 19.0 sec
Rate of Loading NO
Disk Factor (NMAC) at Max dP 0.520394

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	8.000	679.75	7.4	====	83.06	====	N/A
2. Max. dP	17.629	-9262.75	166.66	====	168.31	173.94	0.122419
3. Minimum Available	====	81858	1299	====	====	====	====
4. Just Prior to Wedging	18.135	-12838.14	214.23	0.000187	====	====	====
5. Wedging	18.195	-12802.95	217.92	0.000094	191.54	193.59	====
6. Torque Switch Trip	18.716	-82538.29	1306.41	0.222164	====	====	0.0992849
7. Total	19.039	-89631.70	1533.51	0.251739	====	====	====
8. Inertia	====	7093	====	N/A	====	====	====

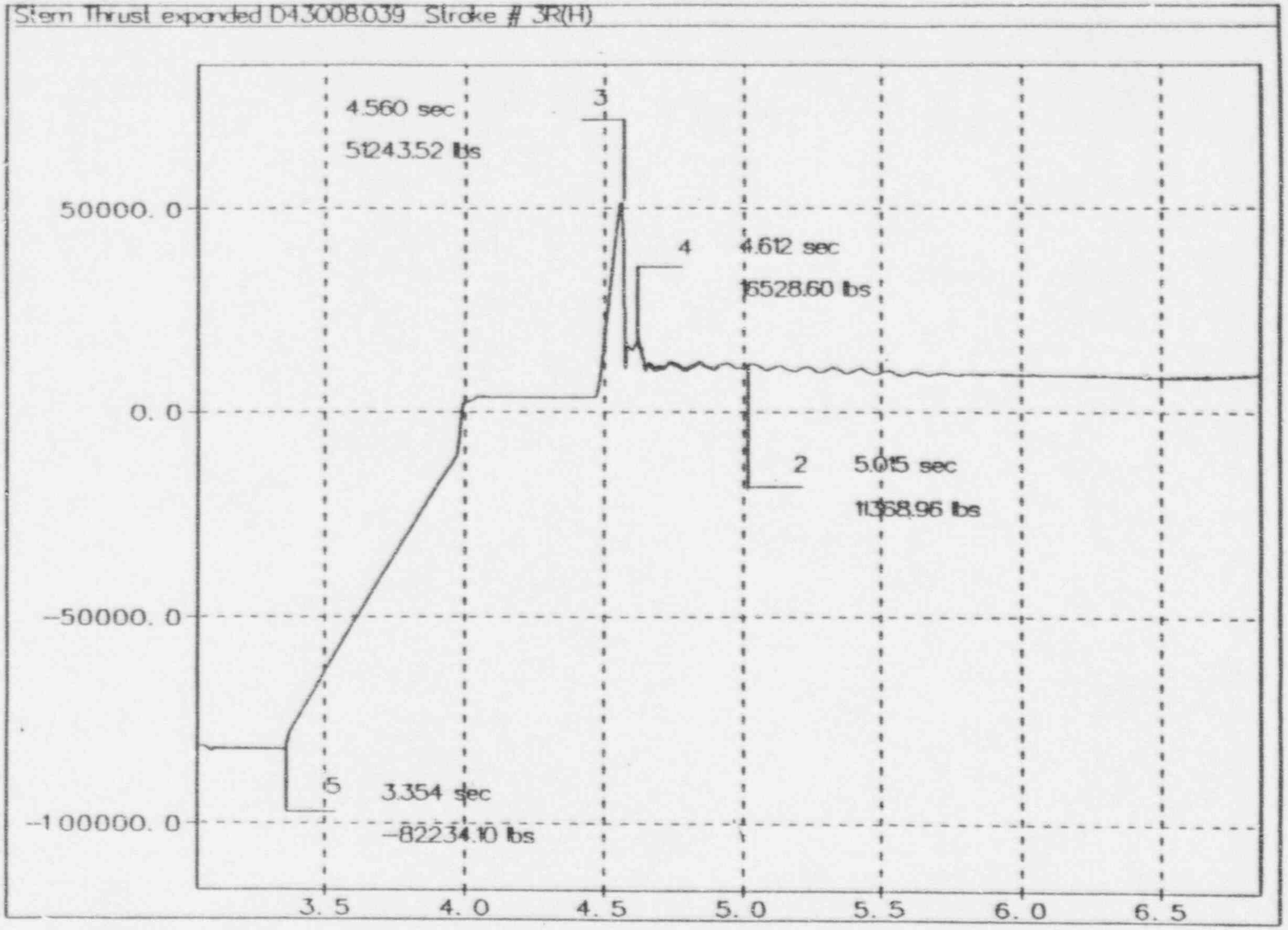
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

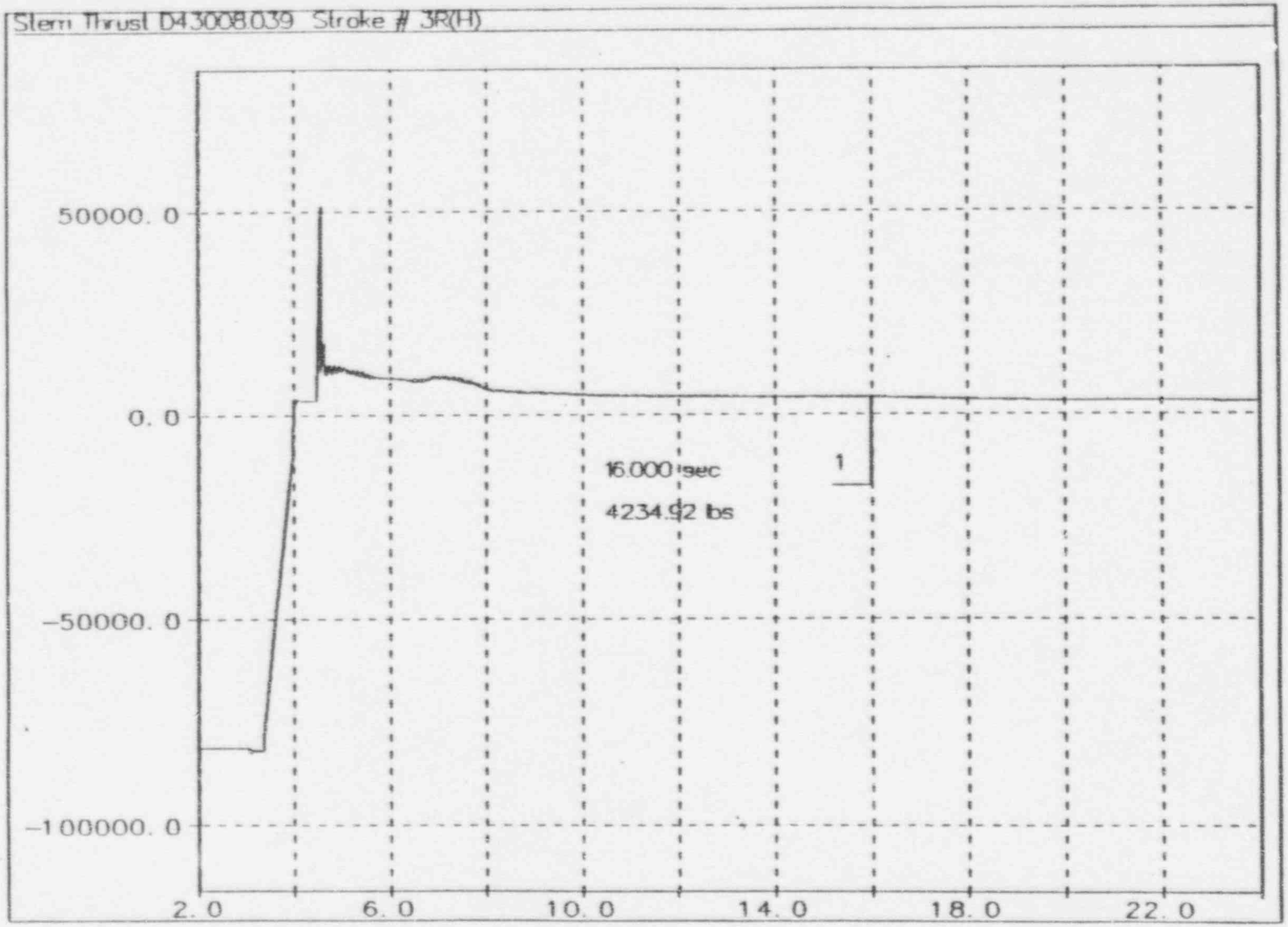
ByPass: 17.389 sec
Motor start: 6.915 sec.
" stop: 18.930 sec.
Disk probably fluttering & flow reinitiate a 2nd time - Max dP taken at 2nd flow interupt

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



Stem Thrust expanded D43008.039 Stroke # 3R(H)
4.560 sec
51243.52 lbs
3
4
4.612 sec
16528.60 lbs
2
5.015 sec
11,368.96 lbs
5
3.354 sec
-82234.10 lbs
50000. 0
0. 0
-50000. 0
-100000. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5


Stem Thrust D43008.039 Stroke # 3R(H)
50000. 0
0. 0
-50000. 0
-100000. 0
2. 0
6. 0
10. 0
14. 0
18. 0
22. 0
16.000 sec
4234.92 lbs
1

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/14/93	**Test Time**	10:21:05
Test Description	100PSI 4000GPM	**Stroke #**	35(+)
Data File	2d93008	**Data Set**	030

OPEN STROKE

Running Current	16.00	amps RMS	Unseating Current	27.0	amps RMS
Running Power	6860	watts	Stroke Time	18.4	sec
Contactor Drop-out Time	0.011	sec			
Disk Factor (Standard) at Max dP	0.548503		Disk Factor (NMAC) at Max dP	0.623975	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	16.000	4234.92	-37.4	■■■■	83.95	■■■■	N/A
2. Max. dP	5.015	11368.36	-142.59	■■■■	113.35	114.61	0.064005
3. Unseating	4.560	51243.52	-698.10	0.079913	■■■■	■■■■	■■■■
4. Just After Unseating	4.612	16528.60	-223.52	0.018185	112.47	113.73	■■■■
5. Hammer Blow	3.354	-82234.10	■■■■	N/A	■■■■	■■■■	■■■■

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Minimum Available	■■■■			■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging					■■■■	■■■■	■■■■
5. Wedging							■■■■
6. Torque Switch Trip					■■■■	■■■■	
7. Total					■■■■	■■■■	■■■■
8. Inertia	■■■■		■■■■		■■■■	■■■■	■■■■

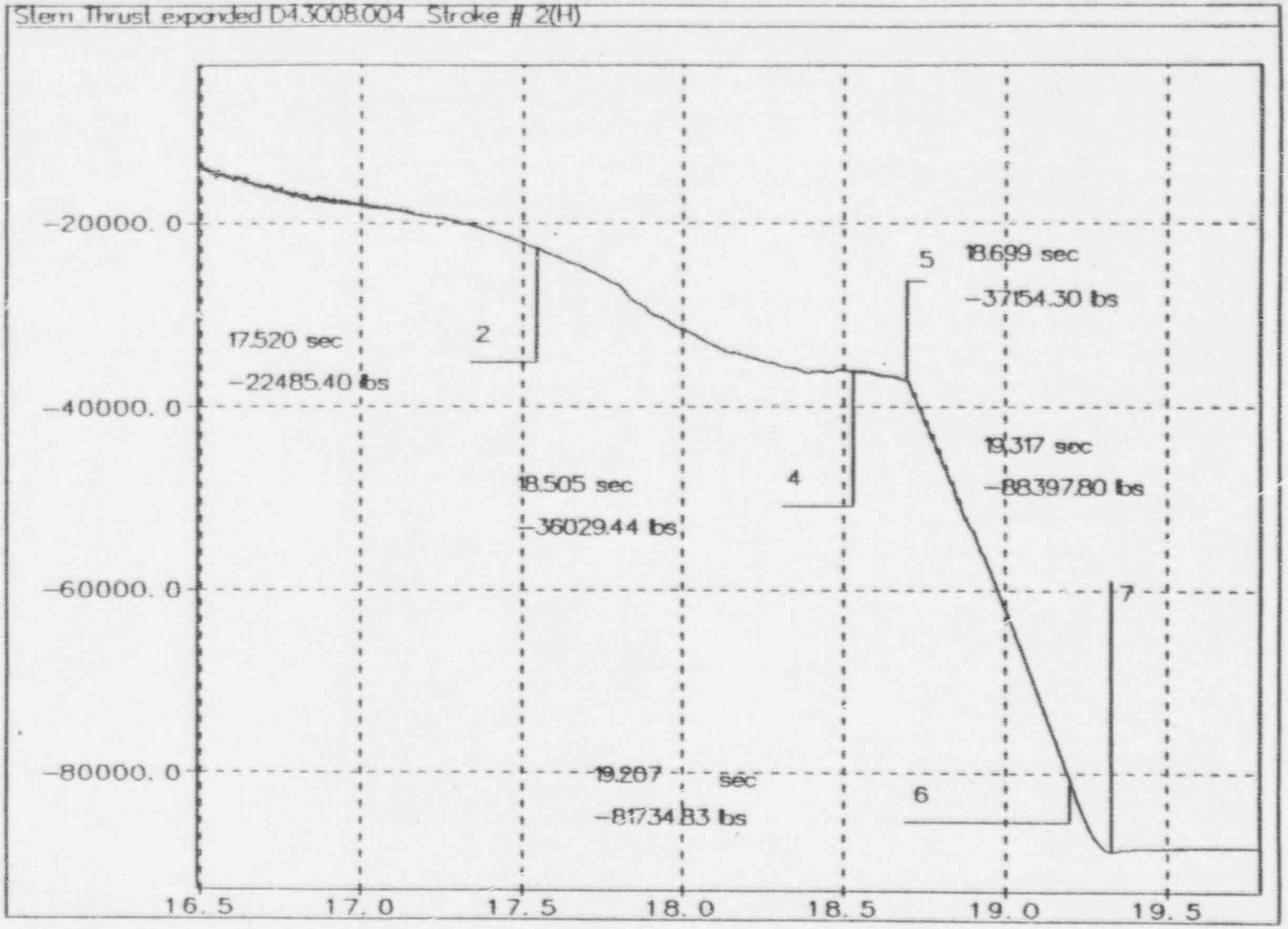
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

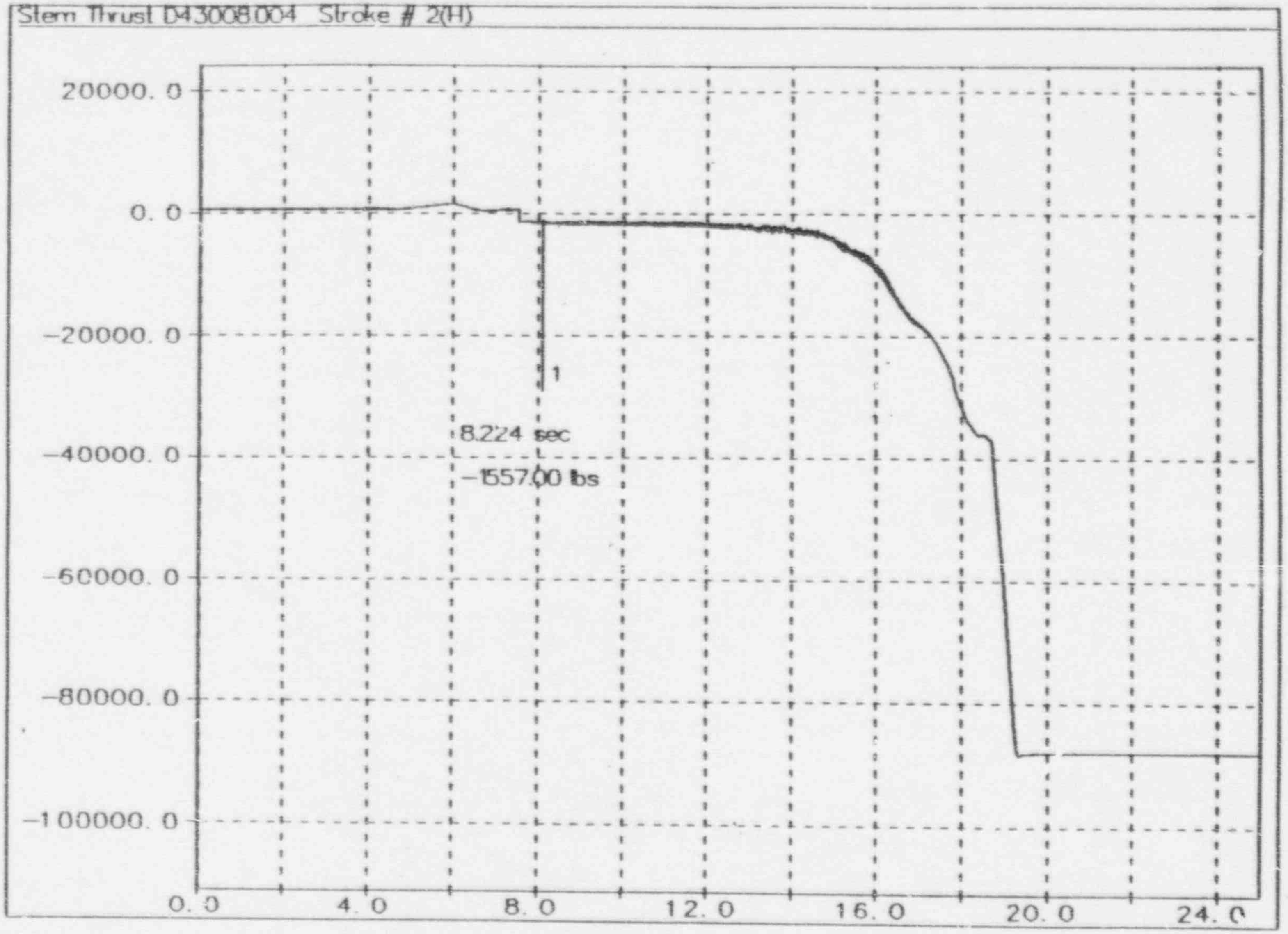
ST: 21.424 sec
Motor Start: 3.037 sec
" Stop: 21.435 sec
Upstream pressure highly variable

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



Stem Thrust expanded D43008.004 Stroke # 2(H)
-20000.0
-40000.0
-60000.0
-80000.0
16.5
17.0
17.5
18.0
18.5
19.0
19.5
2
17.520 sec
-22485.40 lbs
4
18.505 sec
-36029.44 lbs
5
18.699 sec
-37154.30 lbs
6
19.207 sec
-81734.83 lbs
7
19.317 sec
-88397.80 lbs


Stem Thrust D43008.004 Stroke # 2(H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
1
8.224 sec
-1557.00 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/09/93 **Test Time** 11:40:02.[illegible]

Test Description 500PSI 9000 GPM **Stroke #** 2(H)

Data File 9d 4300B **Data Set** 004

OPEN STROKE

Running Current ______ amps RMS Unseating Current ______ amps RMS

Running Power ______ watts Stroke Time ______ sec

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Unseating					■■■■	■■■■	■■■■
4. Just After Unseating							■■■■
5. Hammer Blow			■■■■		■■■■	■■■■	■■■■

CLOSE STROKE

Running Current 17.40 amps RMS Stroke Time 1[illegible].00 sec

Running Power 9010 watts Rate of Loading No

Contactor Drop-out Time 0.014 sec

Disk Factor (Standard) at Max dP 0.319345 Disk Factor (NMAC) at Max dP 0.371164

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.224	-[illegible].20	43.20	■■■■	510.20	■■■■	N/A
2. Max. dP	17.520	-22485.40	383.46	■■■■	544.70	547.60	0.112396
3. Minimum Available	■■■■	80178	1264.70	■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging	18.505	-36023.44	596.23	0.051369	■■■■	■■■■	■■■■
5. Wedging	18.699	-37154.37	629.54	0.054650	542.00	543.80	■■■■
6. Torque Switch Trip	19.207	-81734.93	1307.86	0.223570	■■■■	■■■■	0.101141
7. Total	19.317	-88297.80	151[illegible]	0.248973	■■■■	■■■■	■■■■
8. Inertia	■■■■	6663	■■■■	N/A	■■■■	■■■■	■■■■

Note: All values annotated above are actual values, with no correction for static conditions.

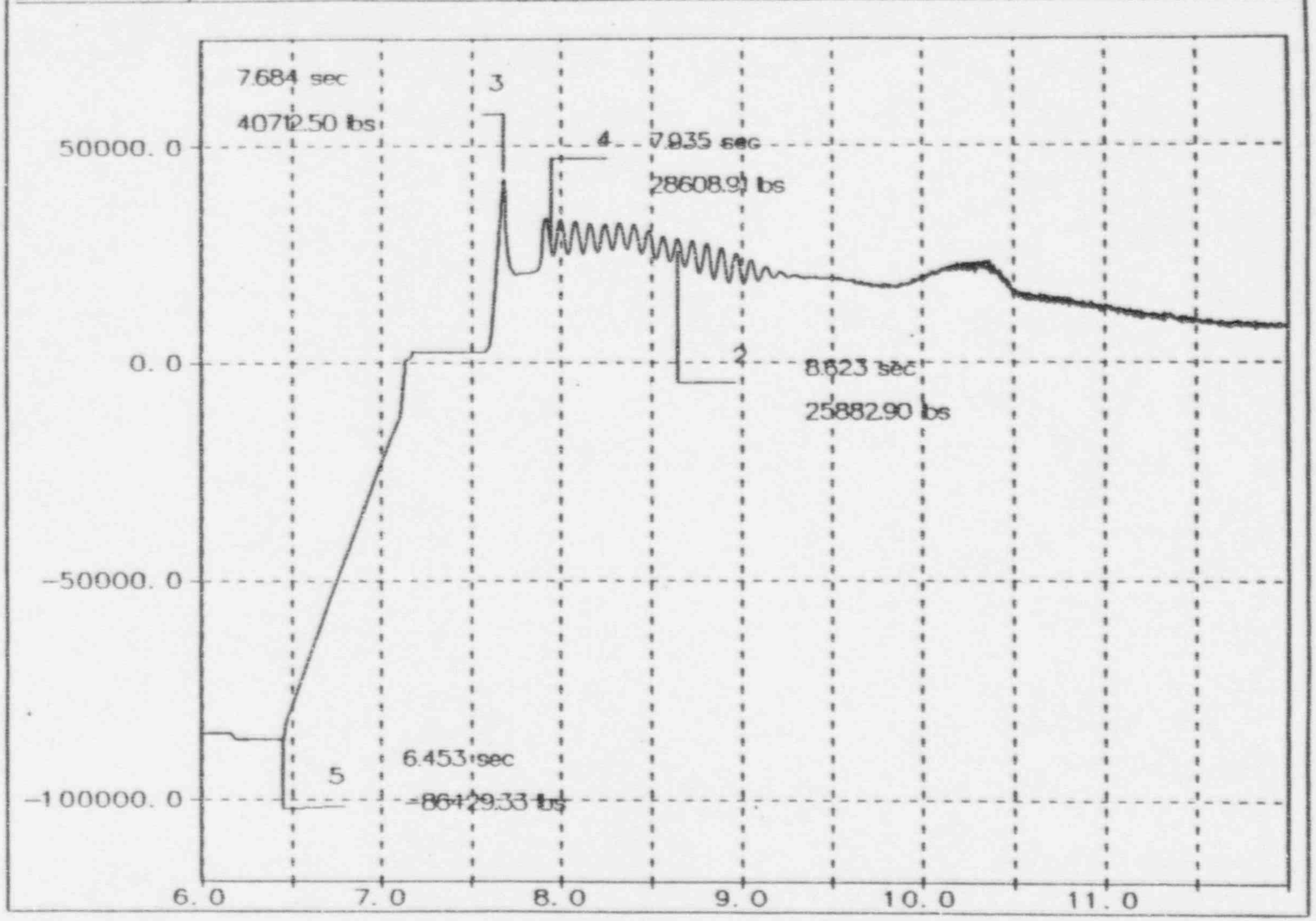
Remarks

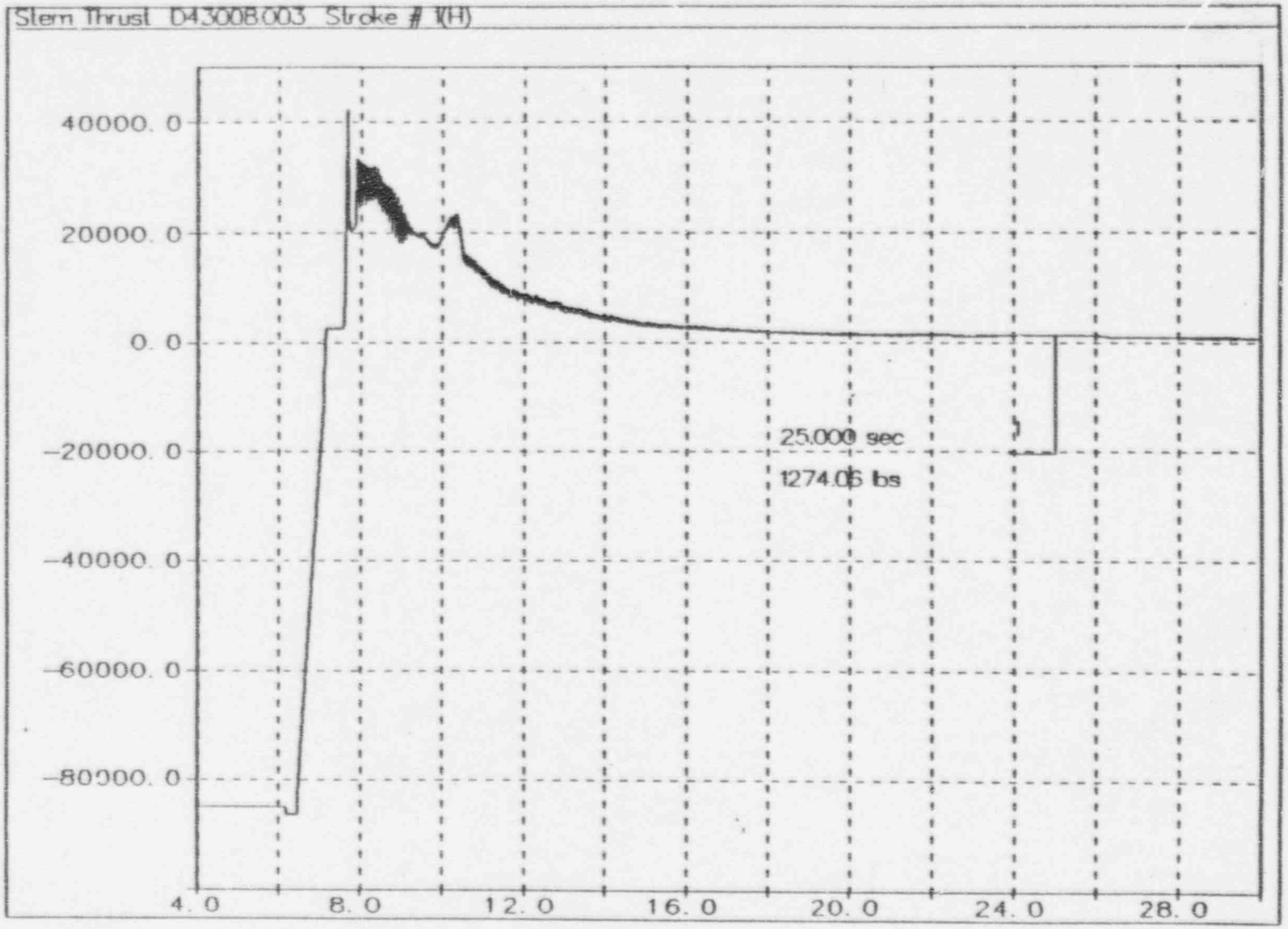
S_3: 19.207 sec
Motor Start: 9.216 sec
" Stop . 19.221 sec
ByPass: 17.672 sec

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93

Stem Thrust expanded D43008.003 Stroke # 1(H)





Stem Thrust D43008.003 Stroke # 1(H)
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
28. 0
25.000 sec
1274.06 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-08-93
Test Description 50-PSI 9000GPM
Data File AD43008

Test Time 10:02:19.00
Stroke # 1(H)
Data Set 003

OPEN STROKE

Running Current 16.7 amps RMS
Running Power 7887 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.435394

Unseating Current 26.80 amps RMS
Stroke Time 18.6 sec
Disk Factor (NMAC) at Max dP 0.486578

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	25.000	1274.06	-19.25	====	455.00	====	N/A
2. Max. dP	8.623	25882.90	-394.43	====	483.81	484.50	0.092076
3. Unseating	7.684	40712.50	-551.00	0.049354	====	====	====
4. Just After Unseating	7.935	28608.91	-420.20	0.035668	492.00	492.3	====
5. Hammer Blow	6.453	-86423.33	====	0.052968	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

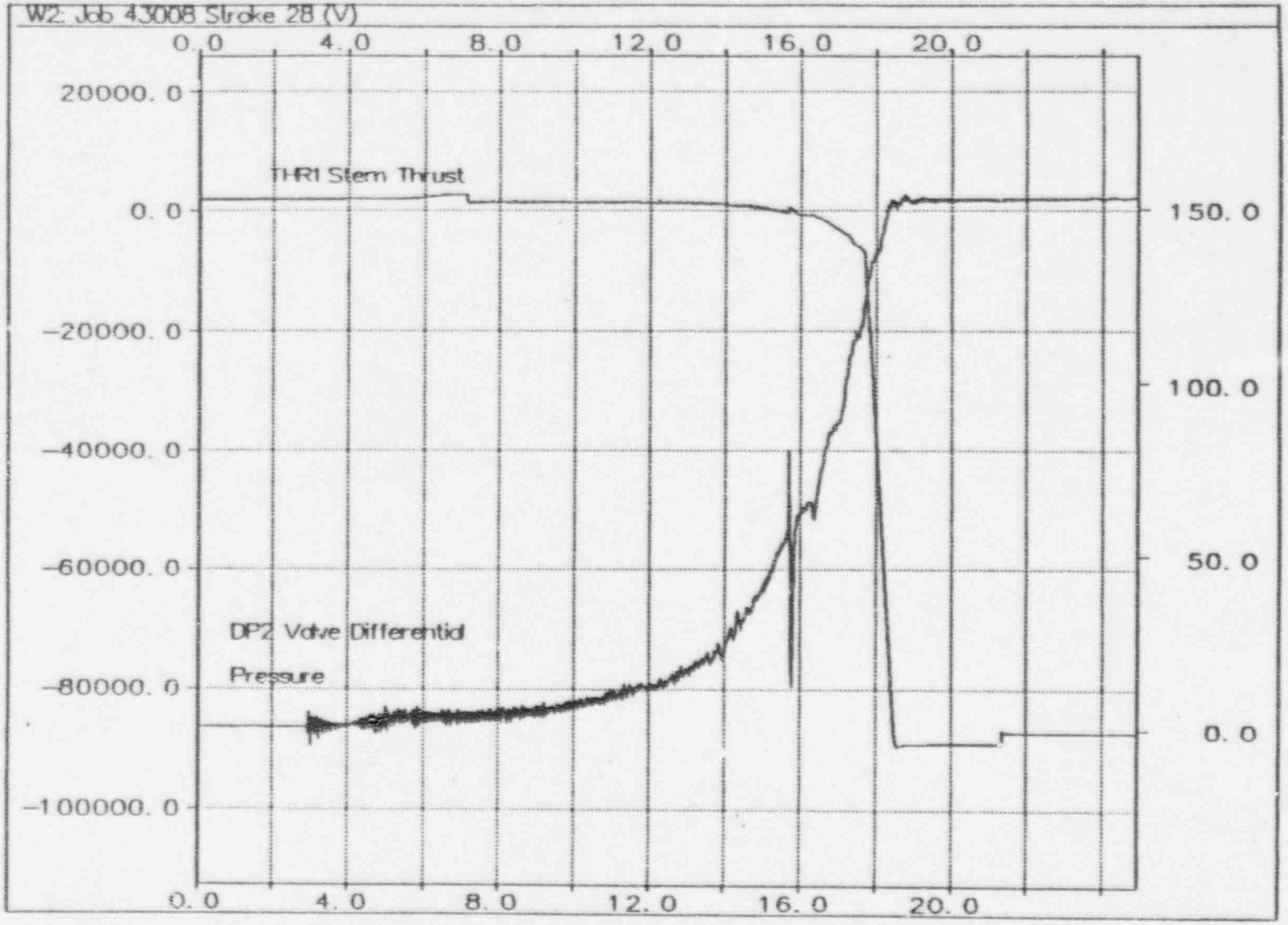
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

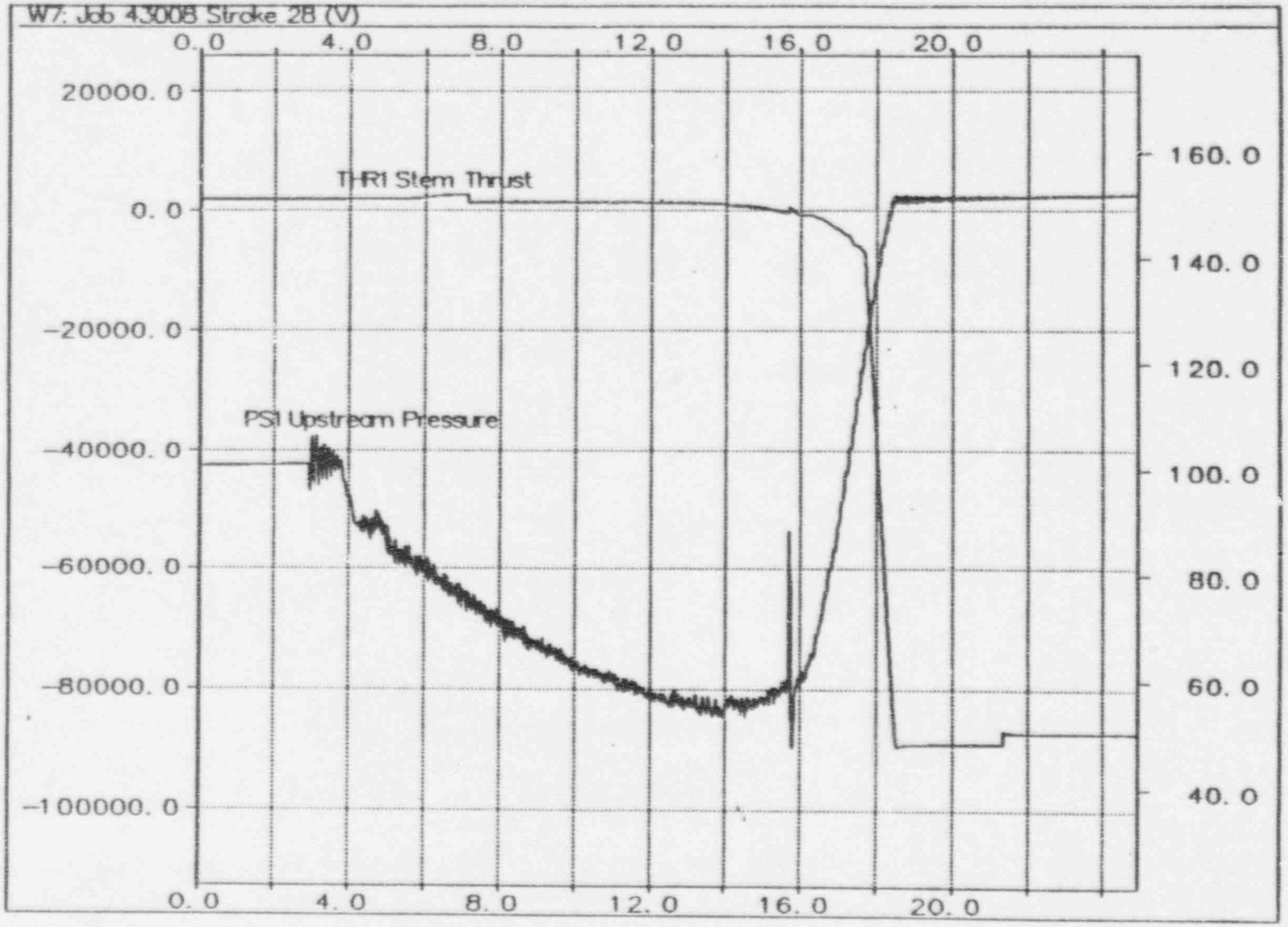
S_1 = 24.695
Motor Start: 6.132 sec
" Stop: 24.706

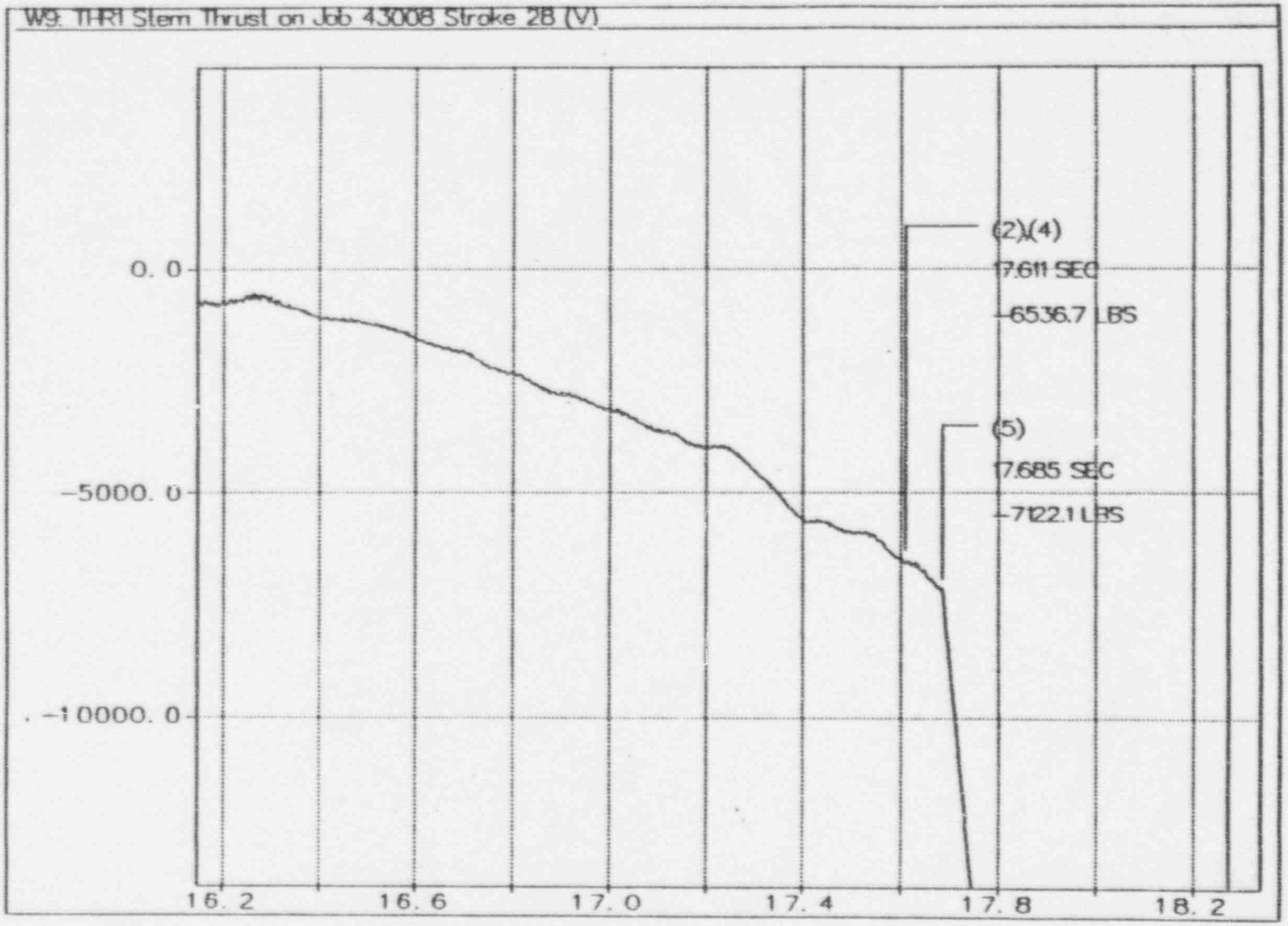
Analyzed by: [signature] 2/11/93

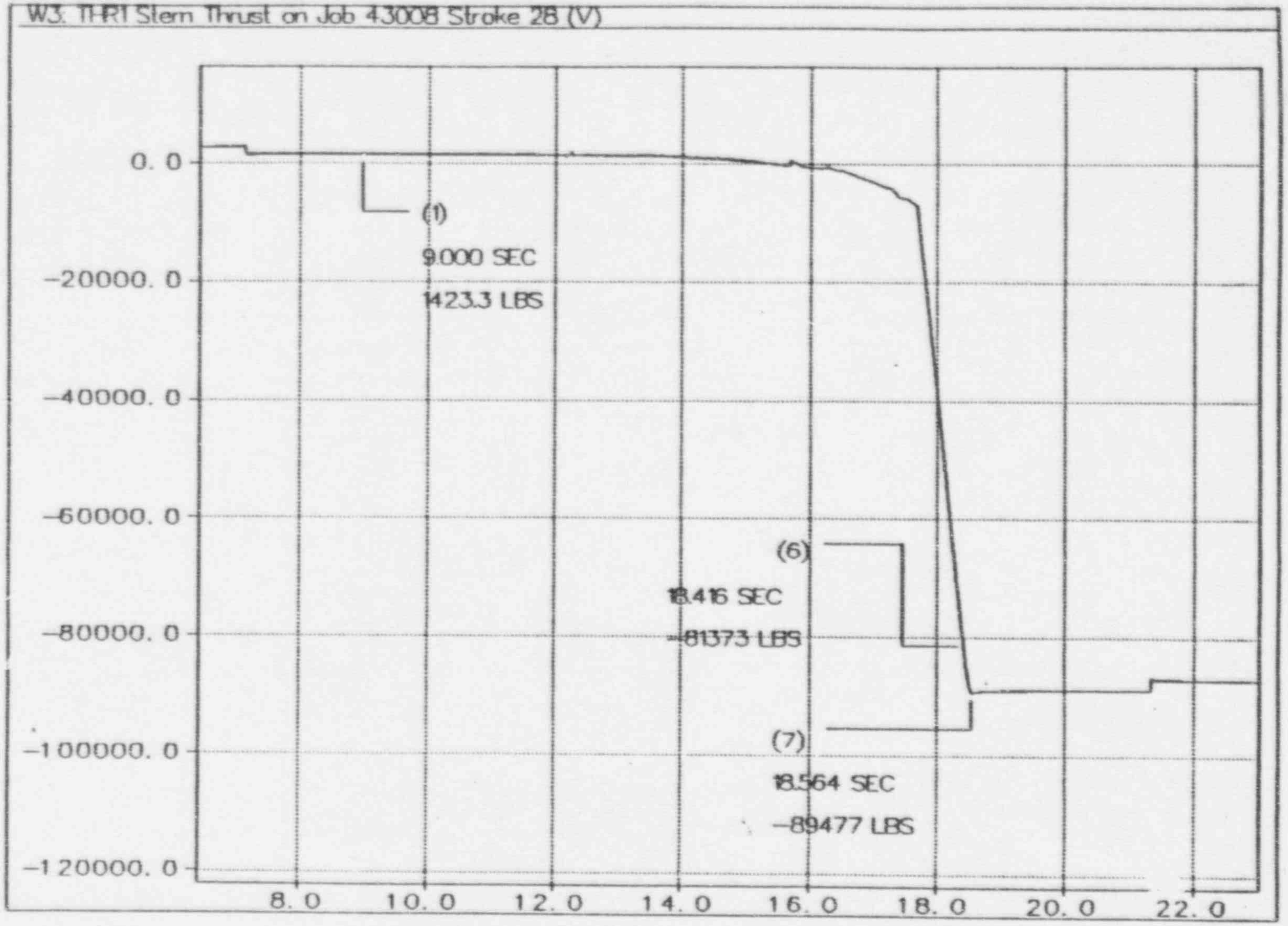
Verified by: [signature] 2/15/93



W2: Job 43008 Stroke 28 (V)
THR1 Stem Thrust
DP2 Valve Differential
Pressure
20000.0
0.0
-20000.0
-40000.0
-60000.0
-80000.0
-100000.0
150.0
100.0
50.0
0.0
0.0
4.0
8.0
12.0
16.0
20.0


W7: Job 43008 Stroke 28 (V)
THR1 Stem Thrust
PS1 Upstream Pressure
20000.0
0.0
-20000.0
-40000.0
-60000.0
-80000.0
-100000.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
0.0
4.0
8.0
12.0
16.0
20.0


W9: THR1 Stem Thrust on Job 43008 Stroke 28 (V)
0.0
-5000.0
-10000.0
16.2
16.6
17.0
17.4
17.8
18.2
(2),(4)
17.611 SEC
-6536.7 LBS
(5)
17.685 SEC
-7122.1 LBS



W3. THR1 Stem Thrust on Job 43008 Stroke 28 (V)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
-100000.0
-120000.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
(1)
9.000 SEC
1423.3 LBS
(6)
18.416 SEC
-81373 LBS
(7)
18.564 SEC
-89477 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-8-93
Test Description 100 PSID, 4000 GPM
Data File C430082

Test Time 10:46:46
Stroke # 28 (V)
Data Set 031

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Unseating					****	****	****
4. Just After Unseating							****
5. Hammer Blow			****		****	****	****

CLOSE STROKE

Running Current 17.890 amps RMS
Running Power 9724 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.6703

Stroke Time 11.307 sec
Rate of Loading Yes slight rate of loading noted
Disk Factor (NMAC) at Max dP 0.5606

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.000	1423.3	9.178	****	66.617	****	0.0019
2. Max. dP *	17.611	-6536.7	129.39	****	118.16	117.22	0.1416
3. Minimum Available	****	79950	130.50	****	****	****	****
4. Just Prior to Wedging	17.611	-6536.7	129.39	0.0141	****	****	****
5. Wedging	17.685	-7122.1	139.68	0.0142	121.77	121.92	****
6. Torque Switch Trip	18.416	-81373	1299.5	0.2340	****	****	0.1008
7. Total	18.564	-89477	1498.1	0.2725	****	****	****
8. Inertia	****	8104	****	0.0385	****	****	****

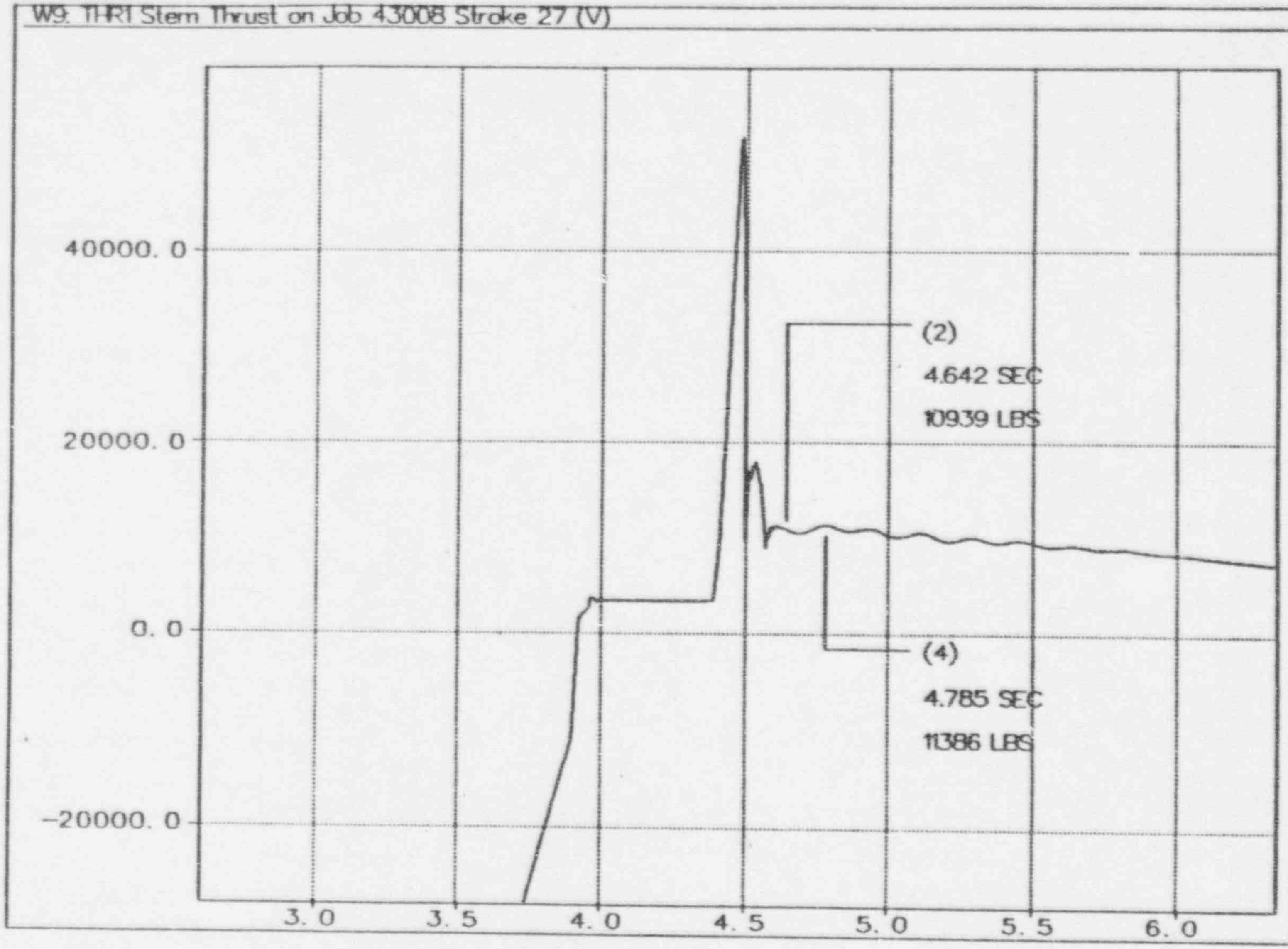
Note: All values annotated above are actual values, with no correction for static conditions.

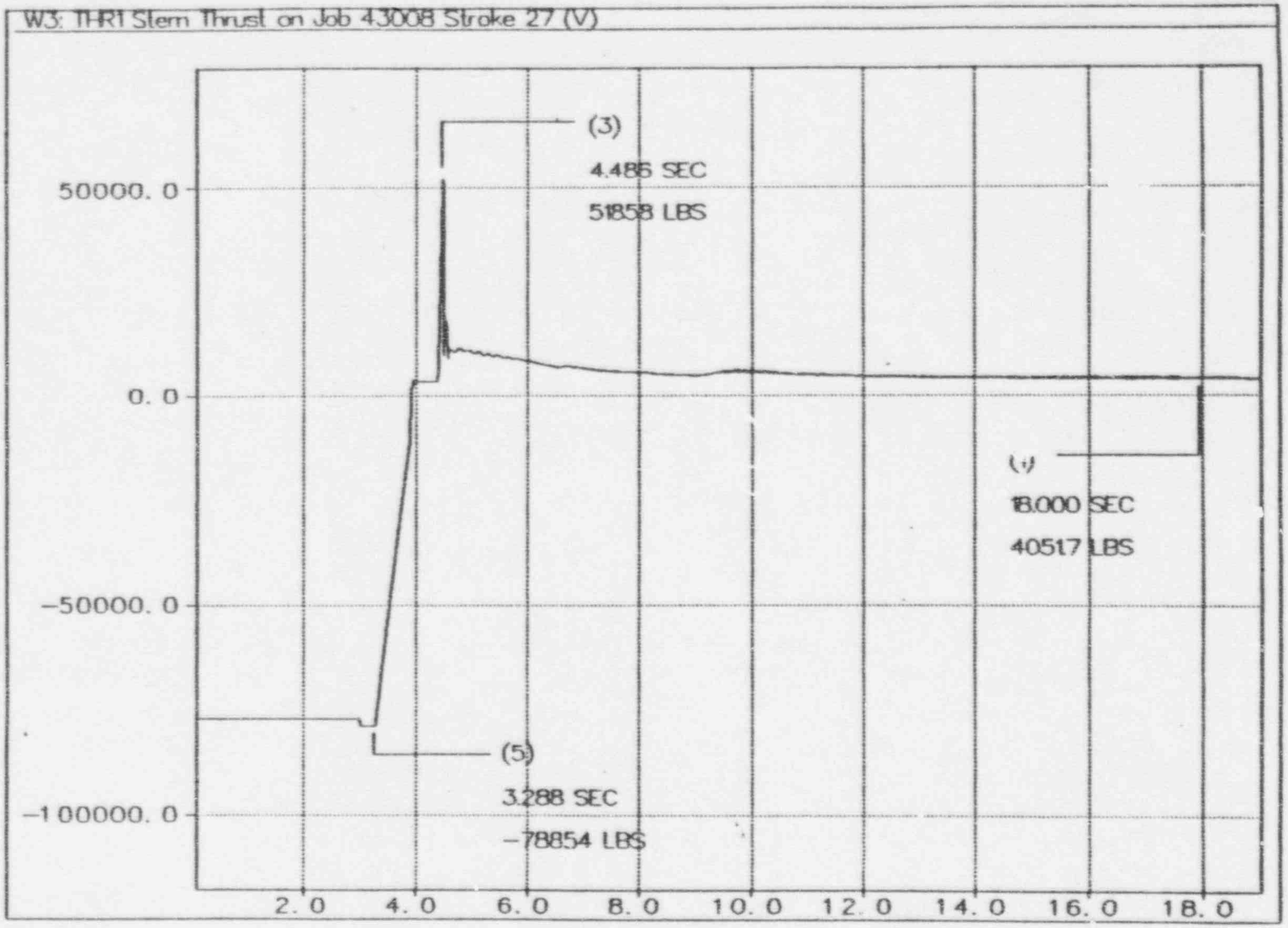
Remarks

* MAX. dP TAKEN AT JUST PRIOR TO WEDGING. POSSIBLE PRESSURE CONTROL PROBLEM CAUSED PRESSURE TO INCREASE AFTER VALVE WAS CLOSED. SEE ATTACHED PLOTS.

Analyzed by: David Kessler 2/5/93

Verified by: [signature] 2/15/93


W9: THR1 Stem Thrust on Job 43008 Stroke 27 (V)
40000. 0
20000. 0
0. 0
-20000. 0
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
(2)
4.642 SEC
10939 LBS
(4)
4.785 SEC
11386 LBS


W3: THR1 Stem Thrust on Job 43008 Stroke 27 (V)
50000. 0
0. 0
-50000. 0
-100000. 0
2. 0
4. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
(3)
4.486 SEC
51858 LBS
(5)
3.288 SEC
-78854 LBS
18.000 SEC
40517 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-8-93	**Test Time**	10:41:51
Test Description	100 PSID 4000 GPM	**Stroke #**	27 (V)
Data File	C430082	**Data Set**	030

OPEN STROKE

Running Current	17.236	amps RMS	Unseating Current	29.635	amps RMS
Running Power	8441	watts	Stroke Time	18.465	sec
Contactor Drop-out Time	0.010	sec			
Disk Factor (Standard) at Max dP	0.5420		Disk Factor (NMAC) at Max dP	0.5966	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	4051.7	-39.62	****	144.35	****	0.0342
2. Max. dP	4.642	10939	-141.3	****	109.56	110.94	0.0680
3. Unseating	4.486	51858	-716.2	-.0099	****	****	****
4. Just After Unseating	4.785	11386	-150.8	.0236	109.11	110.48	****
5. Hammer Blow	3.288	-78854	****	.0968	****	****	****

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Minimum Available	****			****	****	****	****
4. Just Prior to Wedging					****	****	****
5. Wedging							****
6. Torque Switch Trip					****	****	
7. Total					****	****	****
8. Inertia	****		****		****	****	****

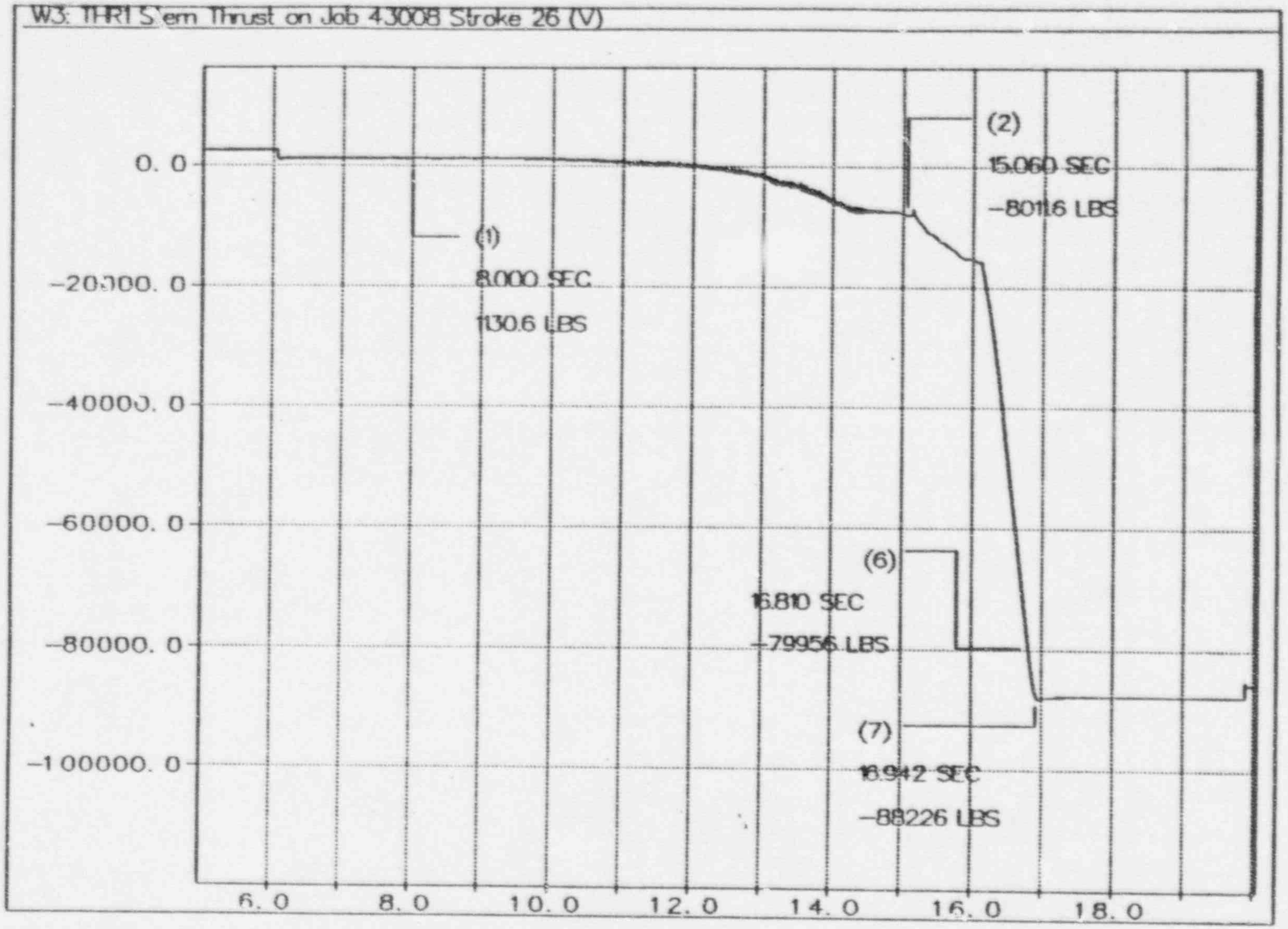
Note: All values annotated above are actual values, with no correction for static conditions.

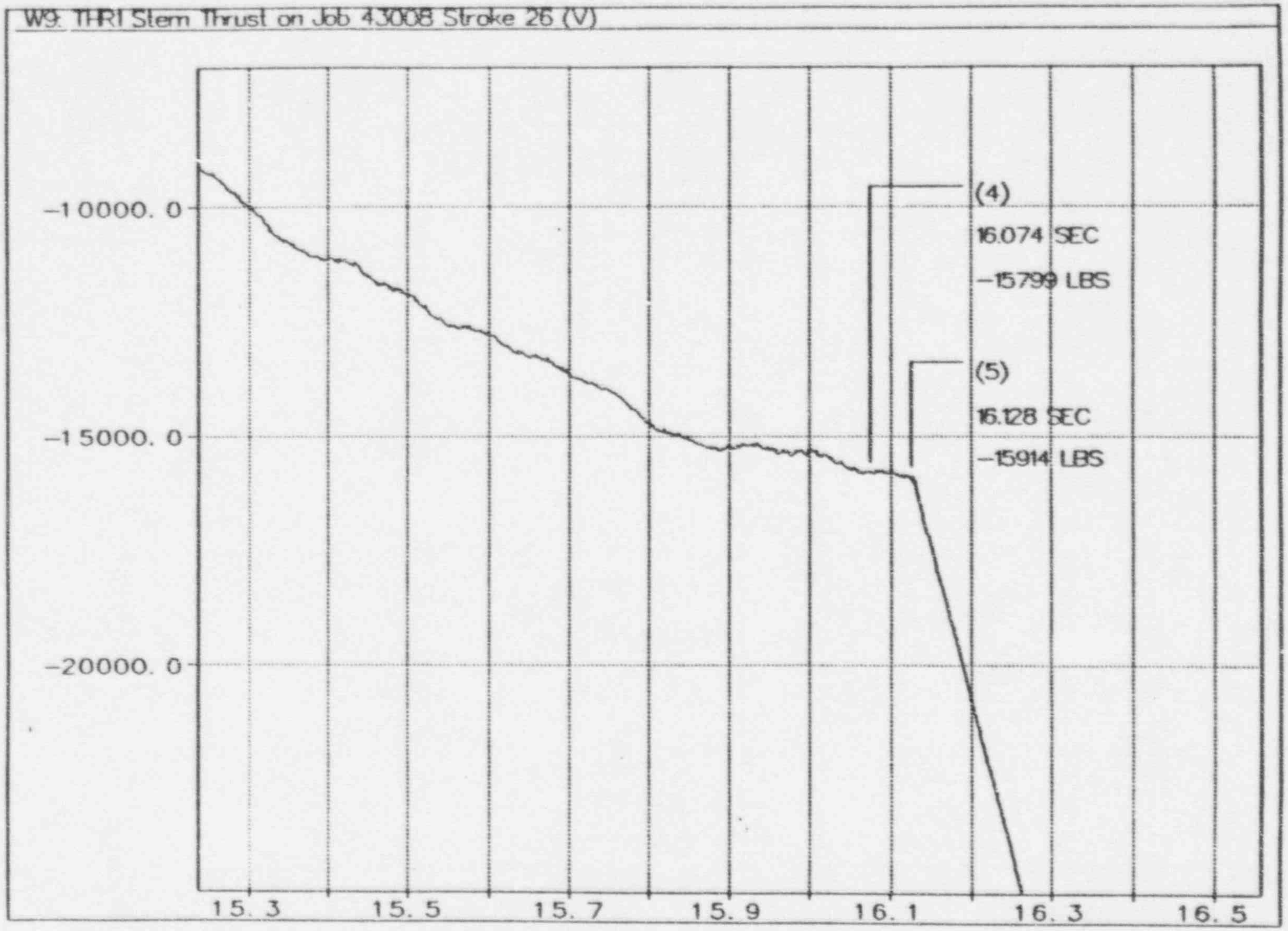
Remarks

UNSEATING IN 2 STEPS JMS

Analyzed by: David Kessler 2/5/93

Verified by: [signature] 2/15/93


W3: THR1 Stem Thrust on Job 43008 Stroke 26 (V)
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
(1)
8.000 SEC
1130.6 LBS
(2)
15.060 SEC
-8011.6 LBS
(6)
16.810 SEC
-79956 LBS
(7)
16.942 SEC
-88226 LBS


W9: THRI Stem Thrust on Job 43008 Stroke 26 (V)
-10000. 0
-15000. 0
-20000. 0
15. 3
15. 5
15. 7
15. 9
16. 1
16. 3
16. 5
(4)
16.074 SEC
-15799 LBS
(5)
16.128 SEC
-15914 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/8/93	**Test Time**	8:30:03
Test Description	200 PSID, 5500 GPM	**Stroke #**	26(V)
Data File	C430082	**Data Set**	029

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Unseating					****	****	****
4. Just After Unseating							****
5. Hammer Blow			****		****	****	****

CLOSE STROKE

Running Current	18.933	amps RMS	Stroke Time	10.757	sec
Running Power	4741	watts	Rate of Loading	Yes	
Contactor Drop-out Time	0.014	sec			
Disk Factor (Standard) at Max dP	0.3682		Disk Factor (NMAC) at Max dP	0.3168	

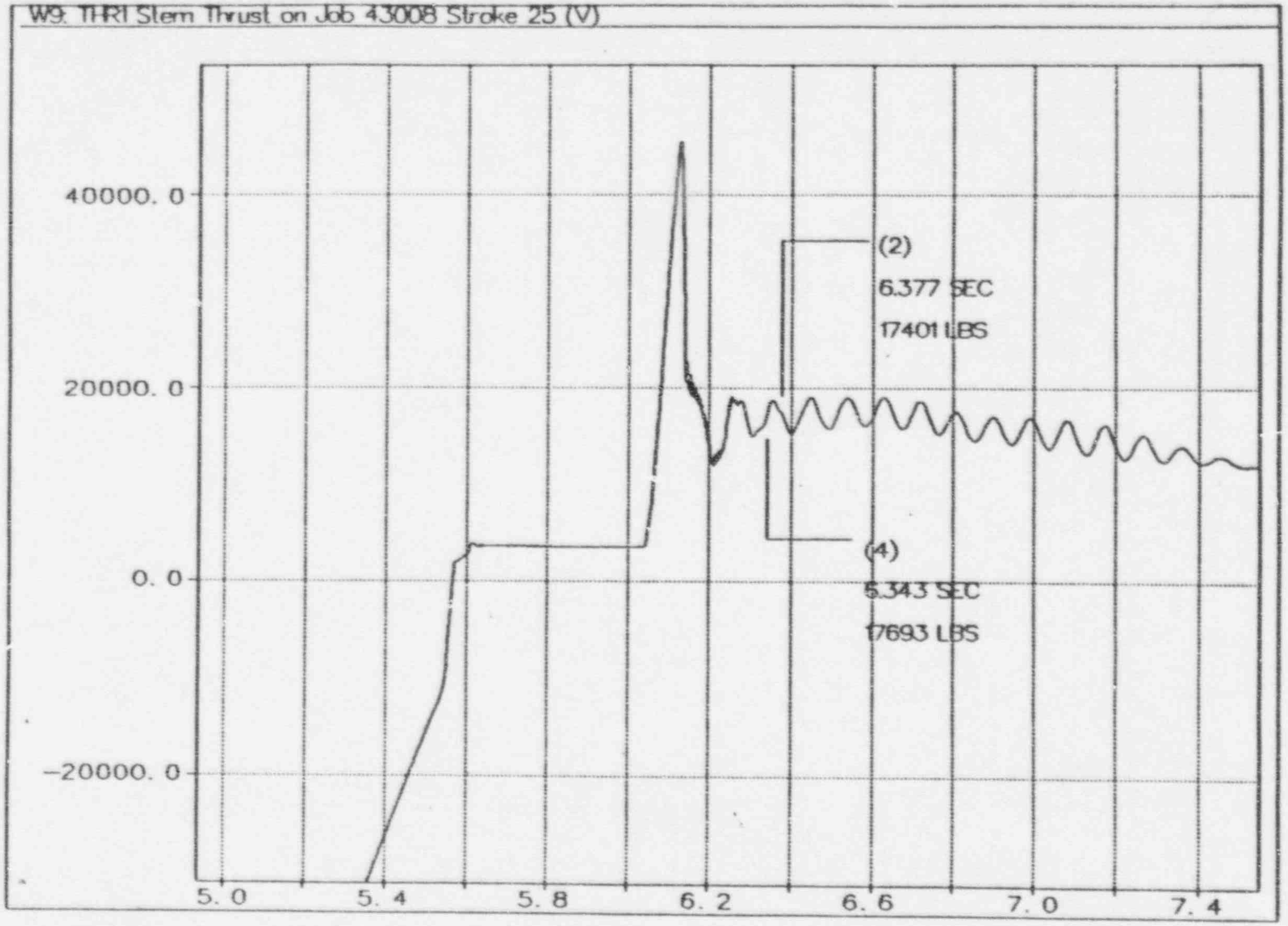
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	8.000	1130.6	16.01	****	141.78	****	0.0814
2. Max. dP	15.060	-8011.6	161.6	****	252.73	256.87	0.1456
3. Minimum Available	****	78825	1270.6	****	****	****	****
4. Just Prior to Wedging	16.074	-15799	281.2	.0149	****	****	****
5. Wedging	16.128	-15914	283.4	.0148	245.88	248.72	****
6. Torque Switch Trip	16.810	-79956	1286.6	.2335	****	****	0.1021
7. Total	16.942	-88226	1530.3	.2685	****	****	****
8. Inertia	****	8270	****	.0350	****	****	****

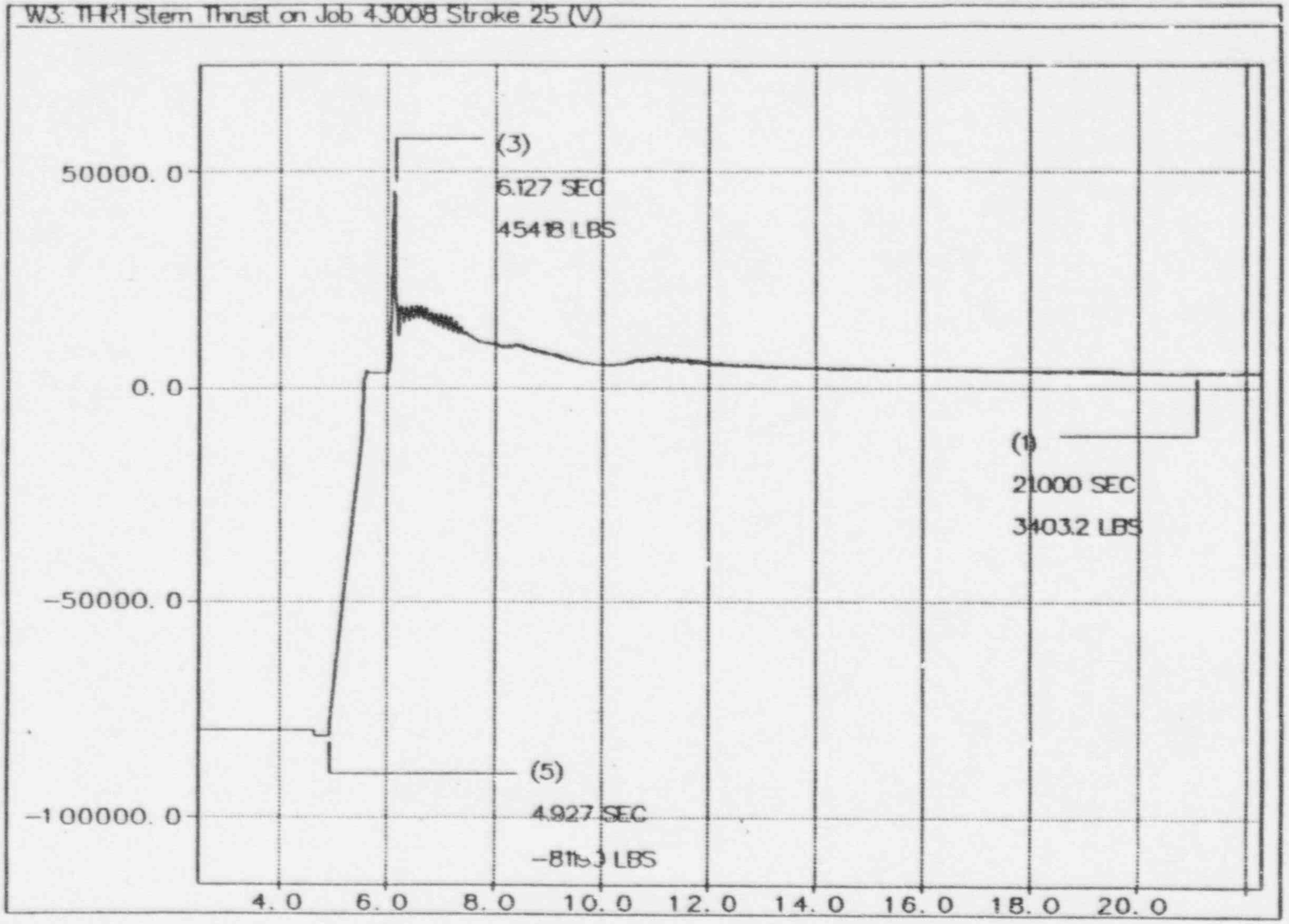
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: David Kessler 2/5/93

Verified by: [signature] 2/15/93


W9: THR1 Stem Thrust on Job 43008 Stroke 25 (V)
40000. 0
20000. 0
0. 0
-20000. 0
5. 0
5. 4
5. 8
6. 2
6. 6
7. 0
7. 4
(2)
6.377 SEC
17401 LBS
(4)
6.343 SEC
17693 LBS


W3: THRT Stem Thrust on Job 43008 Stroke 25 (V)
(3)
6.127 SEC
45418 LBS
(1)
21000 SEC
3403.2 LBS
(5)
4.927 SEC
50000. 0
0. 0
-50000. 0
-100000. 0
4. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-8-93	**Test Time**	8:23:20
Test Description	200 PSID, 5500 GPM	**Stroke #**	25 (v)
Data File	C430082	**Data Set**	028

OPEN STROKE

Running Current	16.104	amps RMS	Unseating Current	27.860	amps RMS
Running Power	8497	watts	Stroke Time	18.506	sec
Contactor Drop-out Time	0.009	sec			
Disk Factor (Standard) at Max dP	0.5511		Disk Factor (NMAC) at Max dP	0.6033	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	21.000	3403.2	-26.97	****	270.02	****	.0141
2. Max. dP	6.377	17401	-243.7	****	220.39	221.92	.0797
3. Unseating	6.127	45418	-618.5	-.0104	****	****	****
4. Just After Unseating	6.343	17693	-245.3	.0102	222.18	223.72	****
5. Hammer Blow	4.927	-81190	****	.0897	****	****	****

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Minimum Available	****			****	****	****	****
4. Just Prior to Wedging					****	****	****
5. Wedging							****
6. Torque Switch Trip					****	****	
7. Total					****	****	****
8. Inertia	****		****		****	****	****

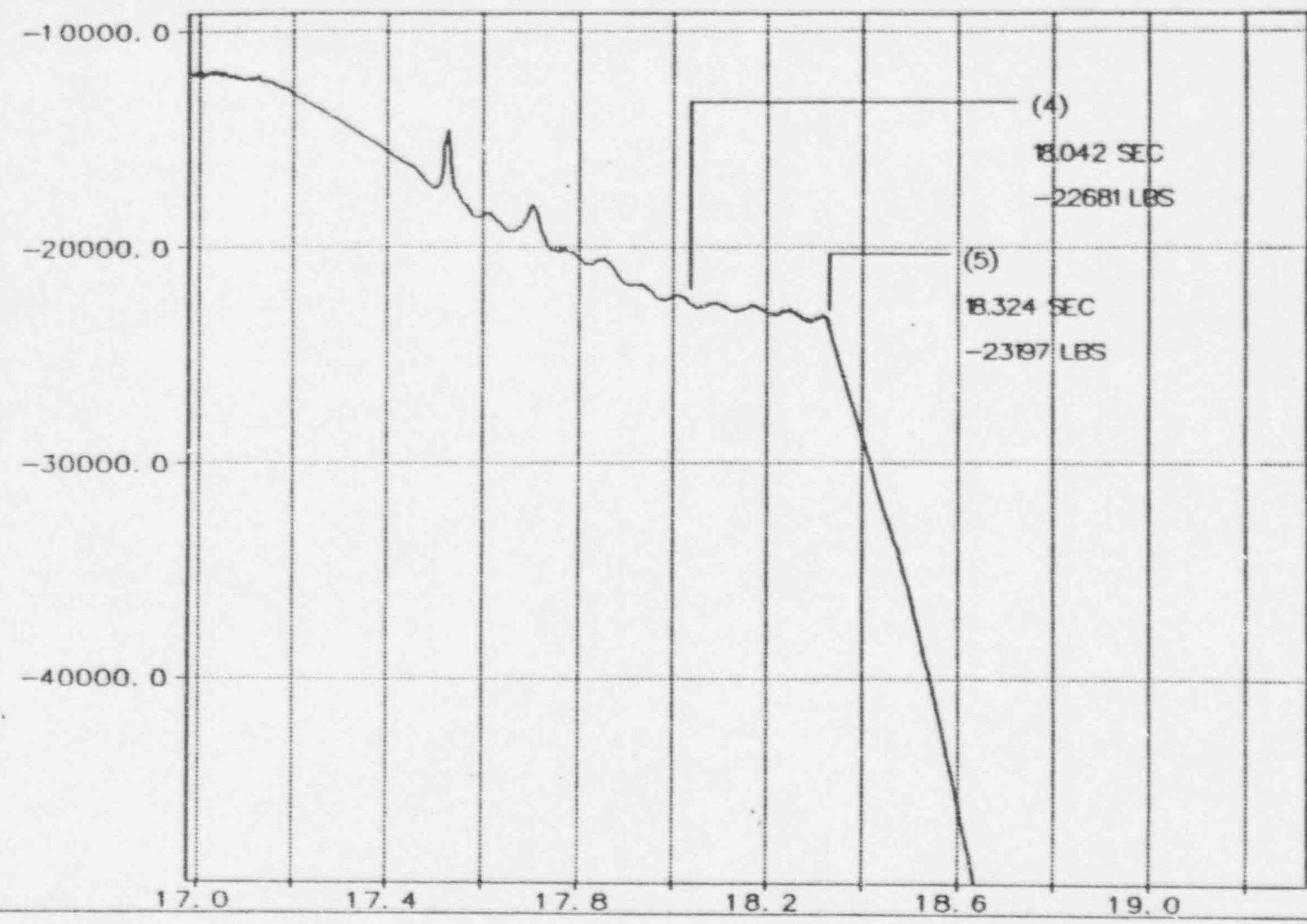
Note: All values annotated above are actual values, with no correction for static conditions.

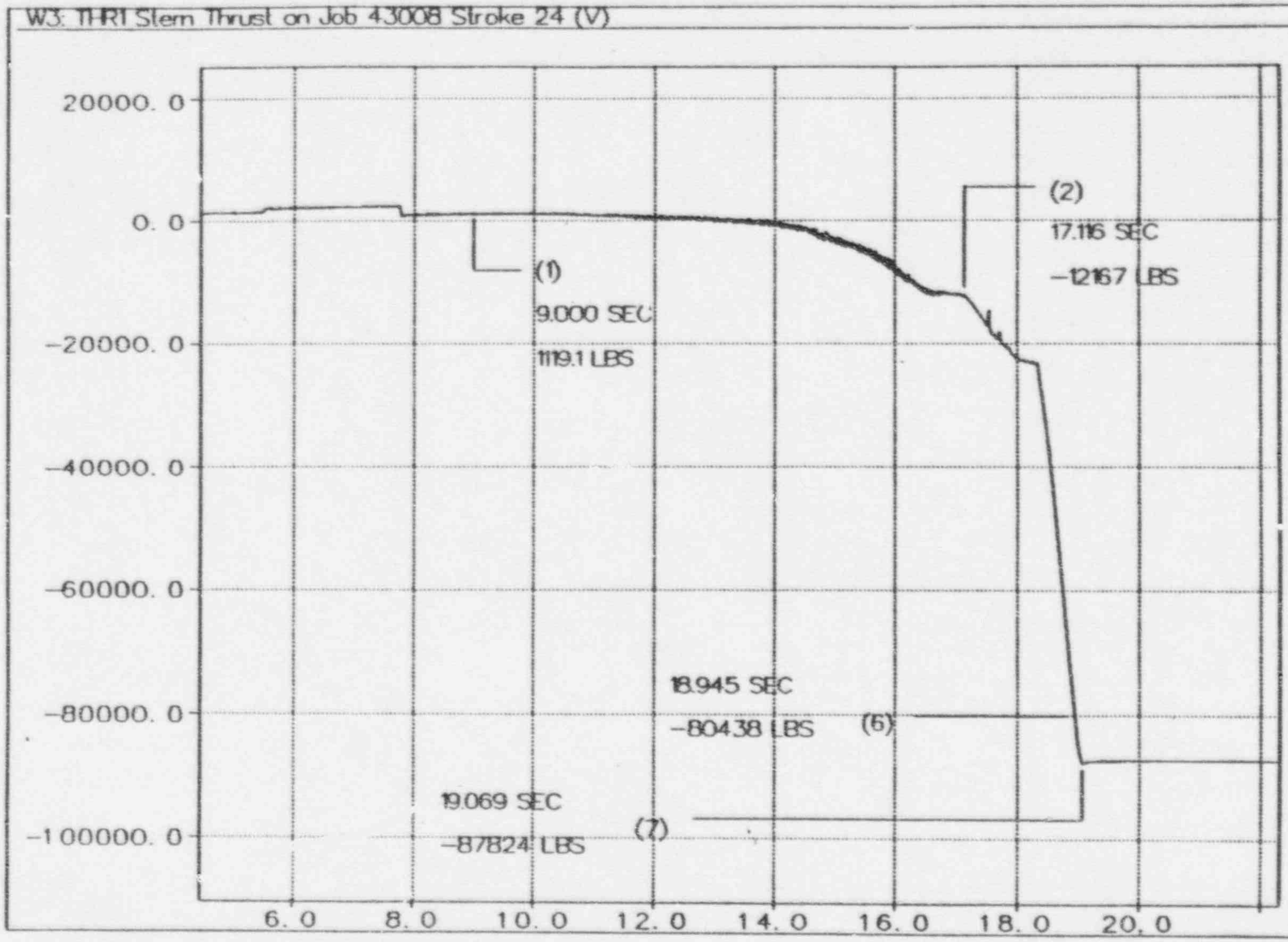
Remarks

Analyzed by: David Kessler 2/5/93

Verified by: [signature] 2/15/93

W4: THR1 Stem Thrust on Job 43008 Stroke 24 (V)





W3: THR1 Stem Thrust on Job 43008 Stroke 24 (V)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
(1)
9.000 SEC
1119.1 LBS
(2)
17.116 SEC
-12167 LBS
(6)
18.945 SEC
-80438 LBS
(7)
19.069 SEC
-87824 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-7-93 **Test Time** 17:18:16
Test Description 300 PSID, 7000 GPM **Stroke #** 24 (V)
Data File C430082 **Data Set** 027

OPEN STROKE

Running Current ______ amps RMS Unseating Current ______ amps RMS
Running Power ______ watts Stroke Time ______ sec
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 16.927 amps RMS Stroke Time 11.191 sec
Running Power 8958 watts Rate of Loading Yes ~1000 Lbs
Contactor Drop-out Time 0.014 sec
Disk Factor (Standard) at Max dP 0.3638 Disk Factor (NMAC) at Max dP 0.3096

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.000	1119.1	22.50	====	199.42	====	0.1449
2. Max. dP	17.116	-12167	245.01	====	376.47	378.73	0.1453
3. Minimum Available	====	79319	1296.4	====	====	====	====
4. Just Prior to Wedging	18.042	-22681	403.72	.0176	====	====	====
5. Wedging	18.324	-23197	419.73	.0195	367.61	368.17	====
6. Torque Switch Trip	18.945	-80438	1318.9	.2359	====	====	0.1054
7. Total	19.069	-87824	1547.2	.2712	====	====	====
8. Inertia	====	7386	====	.0353	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: David Kessler 2/5/93
Verified by: [signature] 2/15/93

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)

NOTE: The output of the foregoing full-bridge arrangement will exhibit double sensitivity to axial load plus 60% additional output due to the Poisson effect.

This arrangement is ideal for the temperature compensation, but may present a problem when the Poisson effect is changed due to cross-loading.

System calibration is accomplished by shunting one (1) arm of the bridge, and the output voltage is multiplied by 2.6 for the actual test data.

6.3.8.2 Full-Bridge Strain Gage Arrangement to Measure Moment Load (Bending) Only

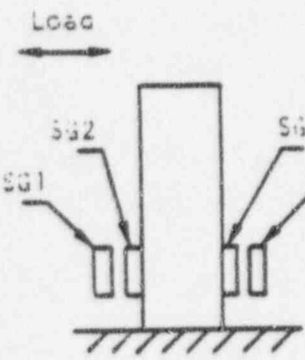
To measure moment load (bending), the most appropriate method is a full-bridge arrangement with two (2) strain gages on one side of the beam, and two (2) strain gages on the opposite side of the beam. All four (4) strain gages will be mounted in the line of force parallel to each other.

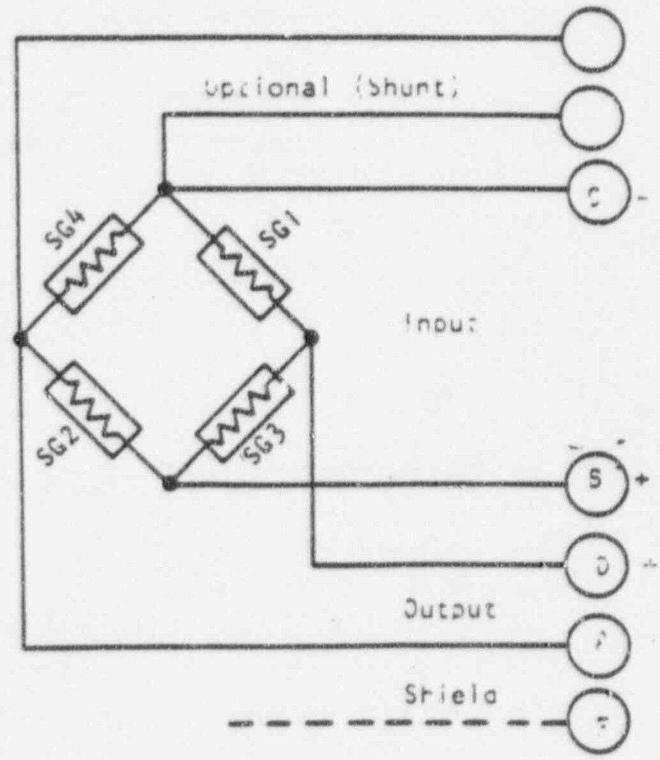
This arrangement, as depicted on the following page, will exhibit no output due to axial load and four (4) times the output sensitivity due to bending moment.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)





A

NOTE: This system will exhibit an ideal temperature compensation.

System calibration is accomplished by shunting one (1) arm of the bridge and multiplying the output voltage by four (4) for the actual test data.

6.3.8.3 Solder the electrical connector at the end of the cable as shown in the sketches.

6.3.8.4 The Strain Gage is now ready for connection to the conditioning equipment and for system calibration as specified in Wyle Procedure No. 361-9.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

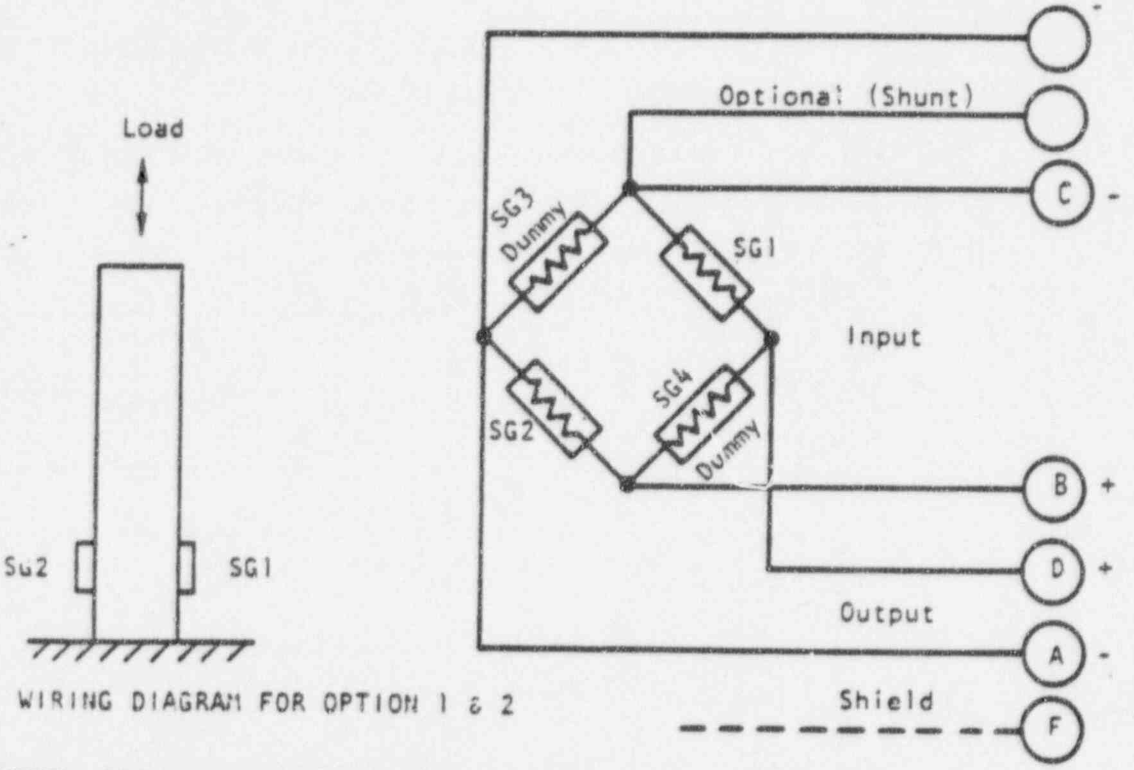
6.3.8 Wiring For Full-Bridge Arrangements

NOTE: Several full-bridge arrangements can be used depending on the type of measurement required. Consult your requirements and select one of the Options described below or contact the Project Engineer for detailed circuit to be used. A

6.3.8.1 Full-Bridge Strain Gage Arrangement to Measure Axial Load Only

Option #1

To measure axial load only, it requires a minimum of two (2) strain gages placed one on one side of the beam and the second on the opposite side of the beam. The arrangement will cancel the bending loads and will give double output sensitivity to the axial load.



A

NOTE: This system will exhibit double sensitivity to thermoshift.

System calibration is accomplished by shunting one arm of the bridge, and the output voltage is multiplied by two (2) for the actual test data.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.8 Wiring For Full-Bridge (Continued)

Option #2

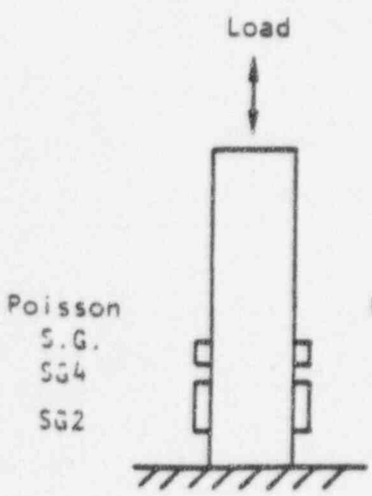
A second approach to measure axial load only, is the employment of a full strain gage bridge arrangement with two (2) opposite strain gages mounted in the line of axial load and two (2) strain gages mounted on a dummy piece of specimen not subjected to load, but subjected to the same temperature as the active strain gages. This arrangement will cancel the bending loads and give double output sensitivity to the axial load. Calibration may be performed by shunting one arm of the bridge and multiplying the output by the factor of two.

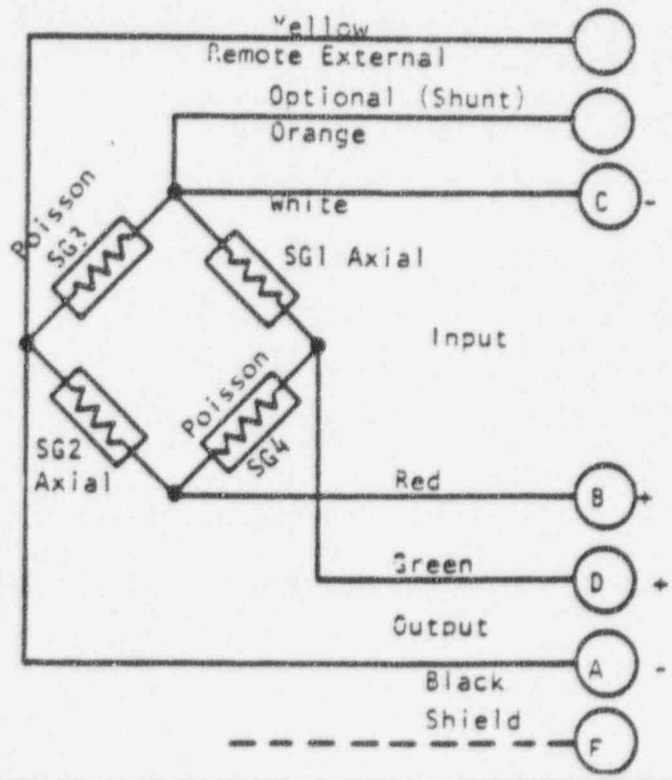
NOTE: This system will exhibit an ideal temperature compensation.

Option #3

The second set of strain gages may be installed on the specimen itself at 90° from the two (2) in line of force strain gages.

The two (2) additional gages mounted at 90° will be measuring the Poisson effect of the beam underload. Take into consideration that the Poisson effect is ordinarily 28 to 30% of the axial load readings.





A

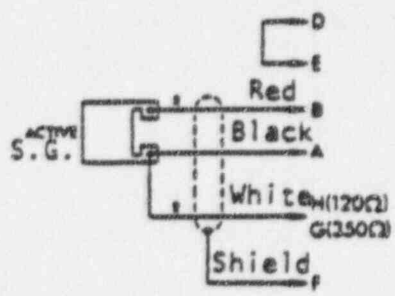
WIRING DIAGRAM FOR OPTION 3

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.7 Wiring (Continued)

b. Solder the electrical connector at the end of the cable as shown below:



c. The strain gage is now ready for connection to the conditioning equipment and system calibration as specified in Wyle Laboratories Procedure No. 361-9.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.5 Checkout and Verification (Continued)

f. If problems can not be easily corrected, the strain gage shall be removed and a new one installed at that location.

g. Full-bridge checkout may be accomplished by connecting the bridge to the conditioning equipment and checking the zero balance and span.

NOTE: For final acceptance, repeat Steps a through e, after protective coating is applied. (See Paragraph 6.3.6.)

6.3.6 Protective Coating

a. Using rosin solvent and a brush, clean the gage, soldering tabs, and attachment wires.

b. Dry out rosin solvent with gauze sponge.

c. Apply a thin coat of M-Coat A polyurethane or M-Bond AE-10/15 over the gage, soldering tabs, part of the wire, and around the entire installation.

d. Let the first coat of M-Coat A dry, and apply a second thin coat. If M-Bond AE-10/15 is used, no additional application is necessary.

e. Coat wires only with M-Coat B. A

f. Let the second coat of M-Coat A dry, and apply a coat of TRV 3140, RTV 3145, or 3M 2216 A/B. Let dry and apply a third coat if desirable. A

g. Repeat installation inspection, Paragraph 6.3.4, and checkout verification, Paragraph 6.3.5.

6.3.7 Wiring

a. For quarter-bridge, connect the three (3) strain gage wires and shield to the building penetration, if applicable.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.3 Gage Wiring and Routing (Continued)

c. Strip, position, and solder connecting leads to the Strain Gage terminal tabs. Make a cable strain relief loop by looping the cable up 1/4 inch. For a single quarter-bridge, the single wire is red, the two (2) wires to be coupled are black and white. For a full-bridge, the color code for interconnecting bridge wire is not applicable. Use any color available. Remove solder-flux residue first with rosin solvent, using a small camel-hair brush.

d. Route the lead wire neatly, using masking tape or fiberglass tape as needed to secure the wire to the surface. Welded shim stock may also be used.

e. Place a marker sleeve with the measurement number written for each gage or for each full bridge.

6.3.4 Installation Inspection

a. Inspect gage installation with a magnifying glass to verify freedom from voids under the gage, proper bonding, and integrity of the soldering joints.

b. After the last step of applying protective coating is completed and cured, repeat the same inspection. (See Paragraph 6.3.6.)

6.3.5 Checkout and Verification

a. Connect the gage installation tester, Vishay 1300, to each of the gages one by one.

b. Depress insulation resistance button marked "Meg Ω " and verify that insulation resistance is greater than 5,000 megohms.

c. Depress "Ω" and verify the gage resistance of 120 or 350 ohms.

d. Depress "1%". Deviation shall not be greater than 0.3% (3000 microstrain).

e. If the following checks are not met and problems are suspected, use the D.V.M. for troubleshooting.

6.0 REQUIREMENTS (Continued)

6.3 Procedure (Continued)

6.3.2 Surface Preparation and Strain Gage Installation

CAUTION: DO NOT USE CHLORINATED SOLVENT ON SURFACES MADE OF STAINLESS STEEL AND SUBJECTED TO VERY HIGH TEMPERATURE.

a. See Appendix A, "Surface Preparation for Strain Gage Bonding", Pages 8 through 15.

b. See Appendix B, "Strain Gage Applications with M-Bond AE-10/15 Adhesive", Pages 16 through 20.

6.3.3 Gage Wiring and Routing

a. Attach the lead wires as specified in Appendix C, Pages 21 through 24, for the series of strain gages being installed.

— EA Series requires bondable terminals and a cable or wire strain relief loop of approximately 1/4-inch radius.

— EA Series - Option W - does not require additional bondable terminals since the terminals are an integral part of the strain gage itself. Cable or wire strain relief loop is required.

— CEA Series does not require additional bondable terminal since it features large integral copper-coated terminals. Cable or wire strain relief loop is required.

b. Tin gage tabs and terminal strip with solder.

CAUTION: The following operations must be accomplished by laying the fine Strain Gage Solder over the appropriate tab and momentarily applying the hot iron to the junction. Avoid excessive solder and overheating (excessive heat will degrade the Epoxy Bond and strain gage backing).

6.0 REQUIREMENTS (Continued)

6.2 Equipment Required (Or Equivalent) (Continued)

6.2.3 Gage Installation Materials

a.	Wire, Ribbon or Cable (Three Conductors)	330-DFC or 3 Conductor Shielded 24A Cable	MM & SEA	
b.	Solder, Tin-Lead-Antimony (1/2 pound)	361A20R	MM	
c.	Conditioner	M-Prep-A	MM	
d.	Neutralizer 5	M-Prep-5	MM	
e.	Solvent Chlorothene NU	CNU-1	MM	
f.	Solvent-Freon TF	FTF-1	MM	
g.	Cellophane Tape, Clear, 3/4"	PCT-2	MM	
h.	Teflon Film (50') Optional	TFE-1	MM	
i.	Cotton Swabs (100 Pkg)	CSP-1	MM	A
	Gauze Sponges	CSP-1	MM	A
j.	Carbide Paper (400 Grit)	SCP-3	MM	
	Carbide Paper (320 Grit)	CCP-2	MM	
k.	Cement, Adhesive Kit	M-Bond AE-10/15	MM	
l.	Protective Coating	M-Coat A or AE-10	MM	
m.	Coating	RTV 3140, 3145, or 2216 A/B	MM 3M	A
n.	Tape, Masking (100' Roll)	3/4"	Any	
o.	Pencil, Wooden with Eraser	Any	Any	
p.	Tissue (200 Count)	N/A	Kleenex	
q.	Spatula	SPT-1 or SPT2	MM	A
r.	Fiberglass Tape	TF[illegible]-1	MM	A
s.	Silicon Gum	SGP-1	MM	A
t.	Pressure Pads	GT-14	MM	A
u.	"C" Clamps	N/A	Any	A

6.3 Procedure

6.3.1 Location

a. Find and mark the locations on the specimen as specified by Customer requirements, using ball point pen and steel scale.

b. Label locations - S1 through S....n.

6.0 REQUIREMENTS

6.1 Prerequisites

Properly qualified personnel shall perform the installation work. Installations shall pass the required visual and electrical tests.

6.2 Equipment Required (Or Equivalent)

6.2.1 Strain Gage Checkout

	Name	P/N	Mfg
a.	Digital Multimeter**	Any with 5-1/2 digit resolution on Ohms (0.00001 KΩ)	
b.	Gage Installation Tester**	M/N 1300	Vishay

6.2.2 Gage Installation Tools

	Name	P/N	Mfg
a.	Scale, 6 inch, Steel	SSS-1	MM*
b.	Diagonal Cutters	DWC-1	MM
c.	Tweezers	BTW-1	MM
d.	Probe	DPR-1	MM
e.	Brush GT-11	MM	
f.	Ball Point Pen	Any	Any
g.	Soldering Iron 25-Watts	Any	Any
h.	Soldering Iron Holder	Any	Any
i.	Wire Stripper	Any	Any
j.	Shears	SSH-1	MM
k.	Magnifiers, 2-1/2 Power (Optional)	Any	Any
l.	Magnifying Glass (Optional)	Any	Any
m.	Heat Gun (Optional)	Any	Any

* Micro-Measurements, Inc.

** Periodic Calibration Required

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-10-93
Test Description 400 PSID, 8000 GPM
Data File D43008

Test Time 10:32:58
Stroke # 9 (H)
Data Set 011

OPEN STROKE

Running Current 15.795 amps RMS
Running Power 6517 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.5348

Unseating Current 23.237 amps RMS
Stroke Time 18.392 sec
Disk Factor (NMAC) at Max dP 0.6045

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.000	2054.6	-18.58	====	390.36	====	0.0262
2. Max. dP	4.223	27381	-394.3	====	411.67	412.85	0.0840
3. Unseating	4.108	36930	-504.7	.02860	====	====	====
4. Just After Unseating	4.678	27398	-403.7	.01931	409.67	410.84	====
5. Hammer Blow	2.953	-77362	====	.08558	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

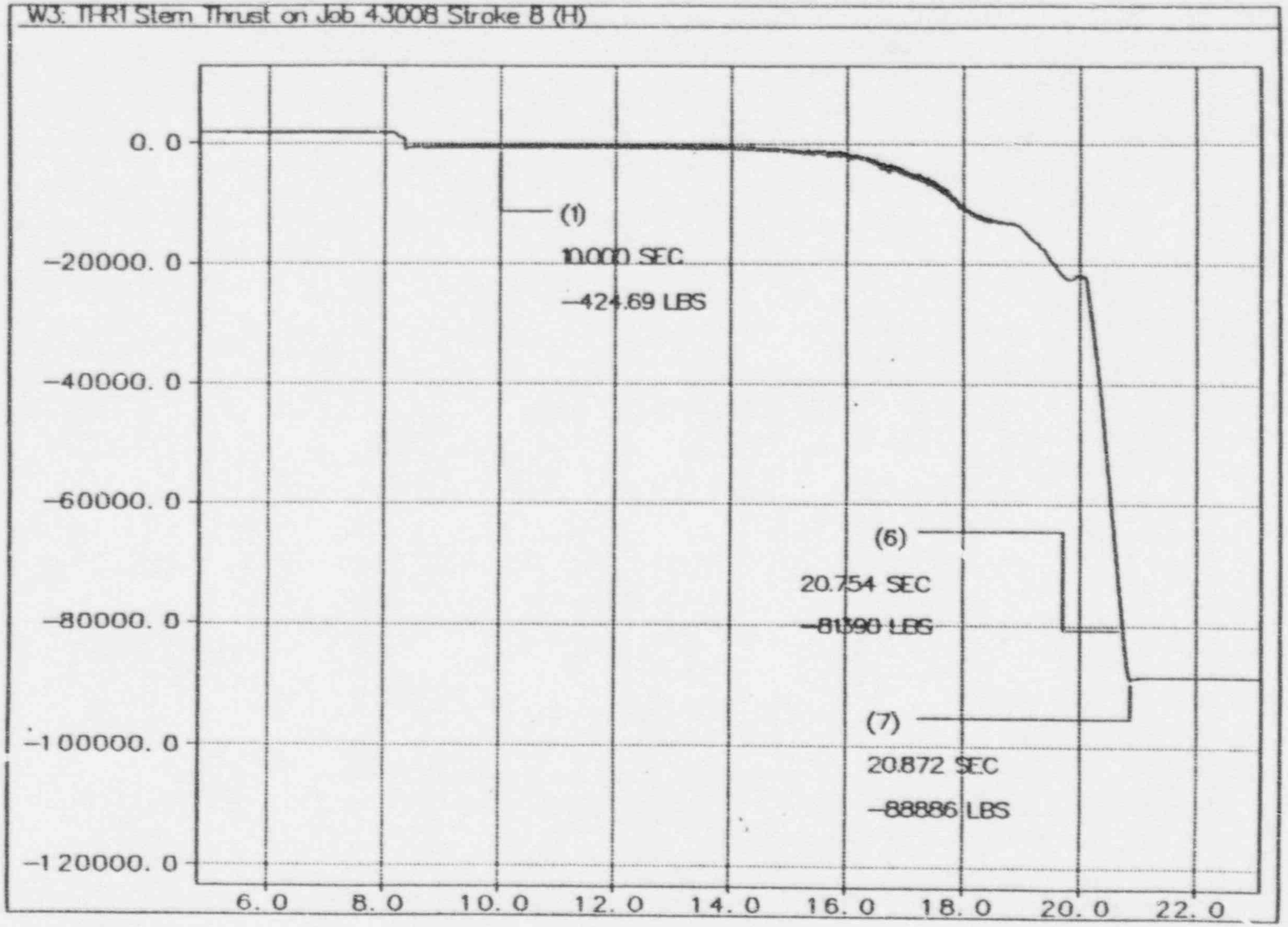
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

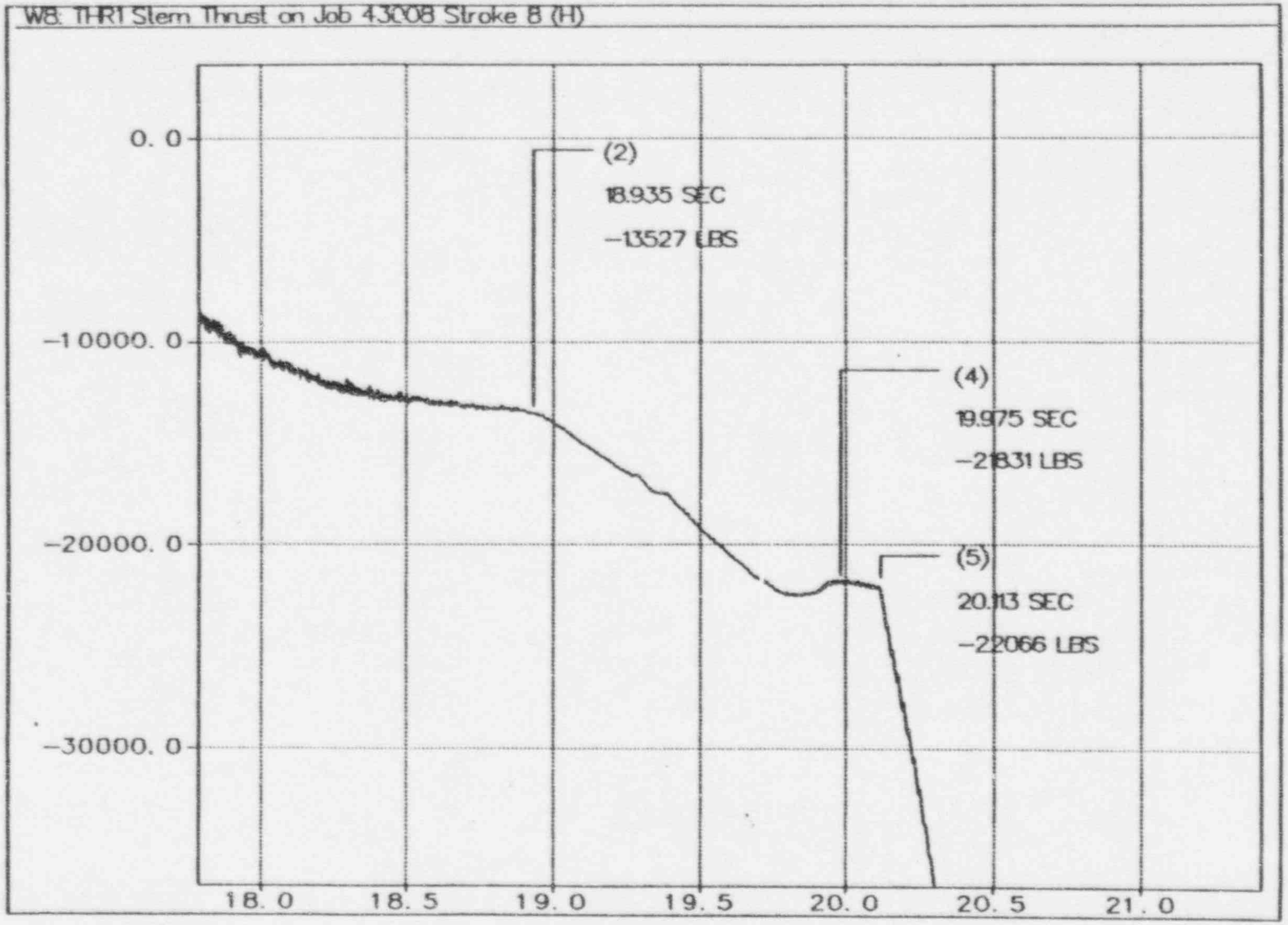
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: David Kessler 2/9/93

Verified by: [signature] 2/15/93


W3: THR1 Stem Thrust on Job 43008 Stroke 8 (H)
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
-120000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
(1)
10.000 SEC
-424.69 LBS
(6)
20.754 SEC
-81390 LBS
(7)
20.872 SEC
-88886 LBS



W8: THR1 Stem Thrust on Job 43008 Stroke 8 (H)
0. 0
-10000. 0
-20000. 0
-30000. 0
18. 0
18. 5
19. 0
19. 5
20. 0
20. 5
21. 0
(2)
18.935 SEC
-13527 LBS
(4)
19.975 SEC
-21831 LBS
(5)
20.113 SEC
-22066 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-10-93
Test Description 300 PSID, 7000 GPM
Data File D43008

Test Time 8:30:41
Stroke # 8 (H)
Data Set 010

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				----		----	
2. Max. dP				----			
3. Unseating					----	----	----
4. Just After Unseating							----
5. Hammer Blow			----		----	----	----

CLOSE STROKE

Running Current 17.032 amps RMS
Running Power 8508 watts
Contactor Drop-out Time 0.013 sec
Disk Factor (Standard) at Max dP 0.3119

Stroke Time 12.724 sec
Rate of Loading Yes
Disk Factor (NMAC) at Max dP 0.3717

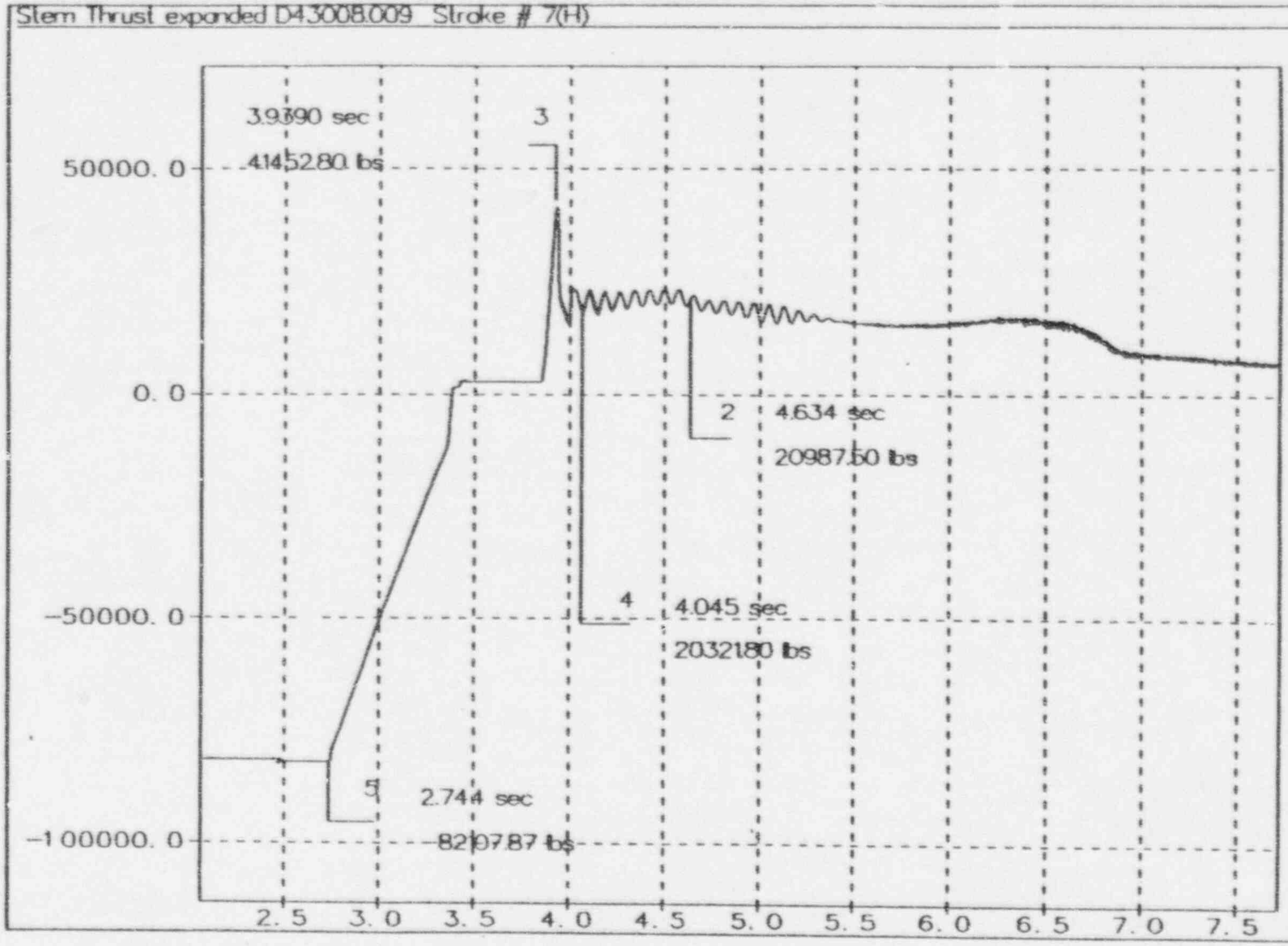
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	-424.69	22.05	----	299.87	----	0.4744
2. Max. dP	18.935	-13527	239.52	----	348.75	350.04	0.1194
3. Minimum Available	----	80965	1260.0	----	----	----	----
4. Just Prior to Wedging	19.975	-21831	352.68	.00459	----	----	----
5. Wedging	20.113	-22066	358.61	.00417	340.45	342.07	----
6. Torque Switch Trip	20.754	-81390	1282.0	.22080	----	----	0.0985
7. Total	20.872	-88886	1506.5	.24921	----	----	----
8. Inertia	----	7496	----	.02841	----	----	----

Note: All values annotated above are actual values, with no correction for static conditions.

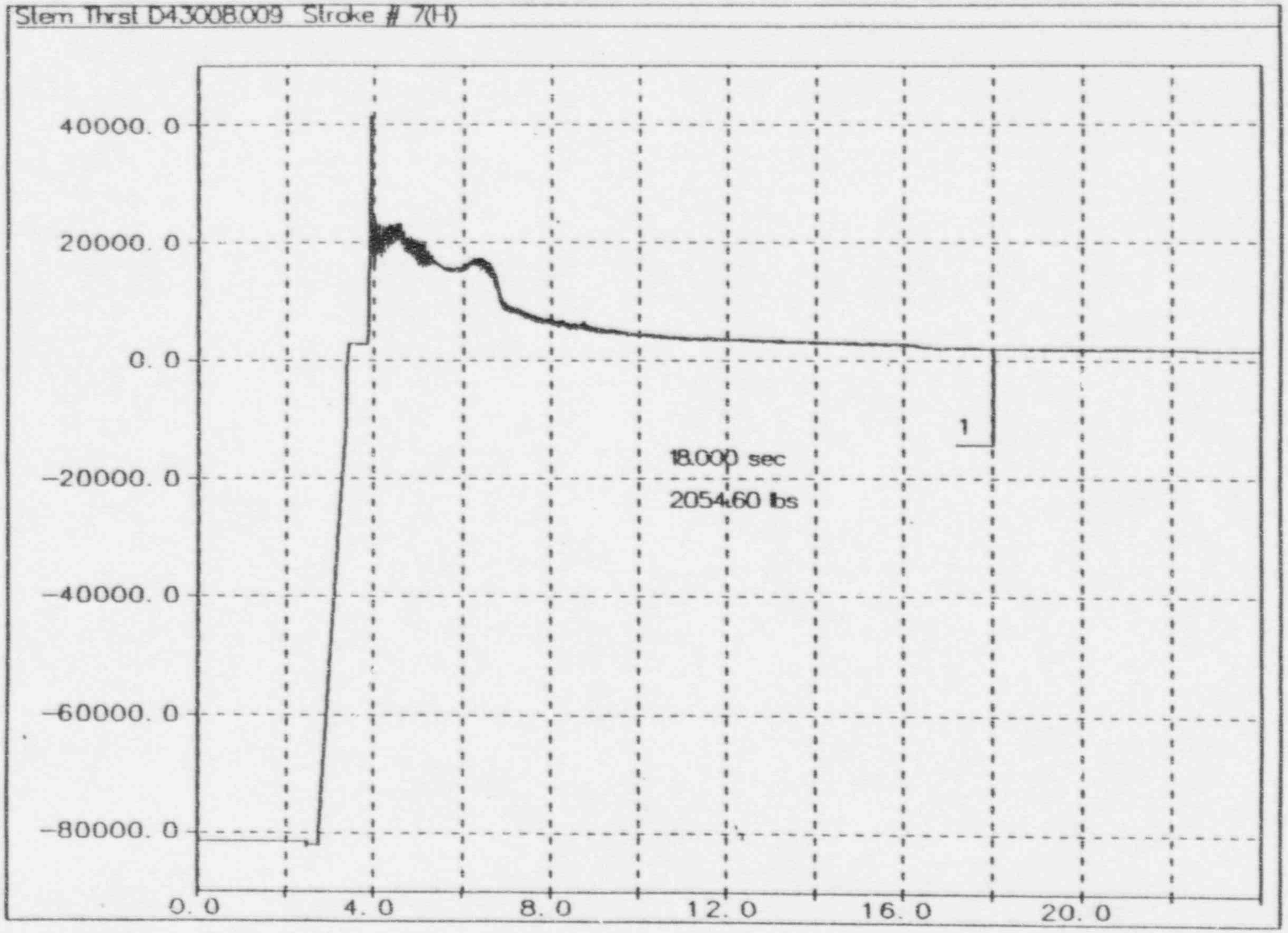
Remarks

Analyzed by: David Kessler 2/9/93

Verified by: [signature] 2/15/93



Stem Thrust expanded D43008.009 Stroke # 7(H)
3.9390 sec
41452.80 lbs
3
50000. 0
0. 0
-50000. 0
-100000. 0
2
4.634 sec
20987.50 lbs
4
4.045 sec
20321.80 lbs
5
2.744 sec
-82107.87 lbs
2. 5
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
6. 5
7. 0
7. 5


Stem Thrst D43008.009 Stroke # 7(H)
40000. 0
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
1
18.000 sec
2054.60 lbs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/8/93 **Test Time** 16:09:34...
Test Description 300PSI 7000GPM **Stroke #** 7(H)
Data File J43008 **Data Set** 009

OPEN STROKE

Running Current 16.10 amps RMS
Running Power 6658.50 watts
Contactor Drop-out Time 0.010 sec
Disk Factor (Standard) at Max dP 0.532010
Unseating Current 26.00 amps RMS
Stroke Time 18.4 sec
Disk Factor (NMAC) at Max dP 0.598511

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.00	2054.60	-14.77	■■■■	363.87	■■■■	U/A
2. Max. dP	4.634	20887.50	-311.83	■■■■	304.15	310.50	0.088890
3. Unseating	3.330	41452.80	-582.24	0.048047	■■■■	■■■■	■■■■
4. Just After Unseating	4.045	20321.80	-299.07	0.009796	303.79	305.19	■■■■
5. Hammer Blow	2.744	-82107.87	■■■■	0.075086	■■■■	■■■■	■■■■

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displace-ment (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Minimum Available	■■■■			■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging					■■■■	■■■■	■■■■
5. Wedging							■■■■
6. Torque Switch Trip					■■■■	■■■■	
7. Total					■■■■	■■■■	■■■■
8. Inertia	■■■■		■■■■		■■■■	■■■■	■■■■

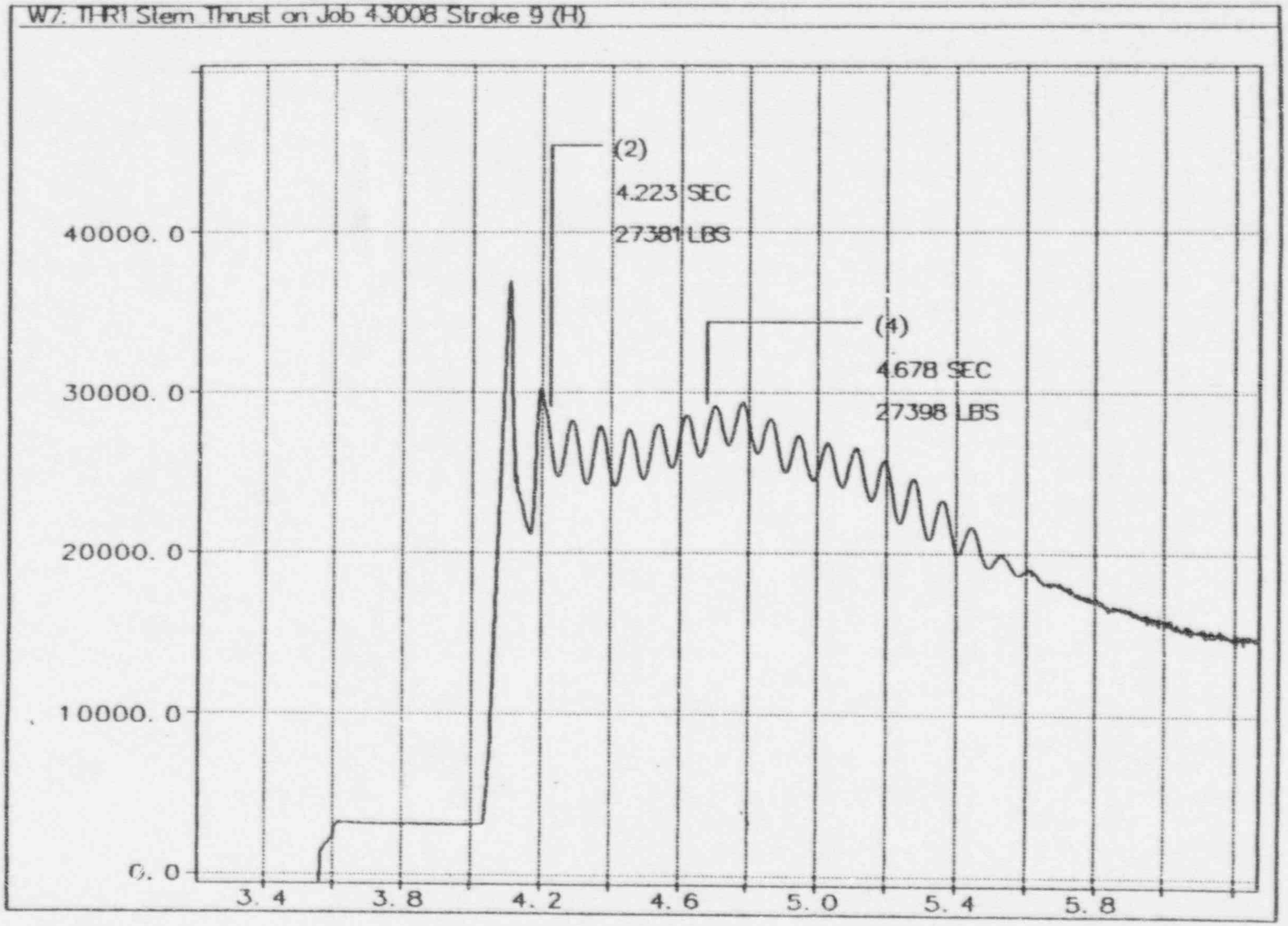
Note: All values annotated above are actual values, with no correction for static conditions.

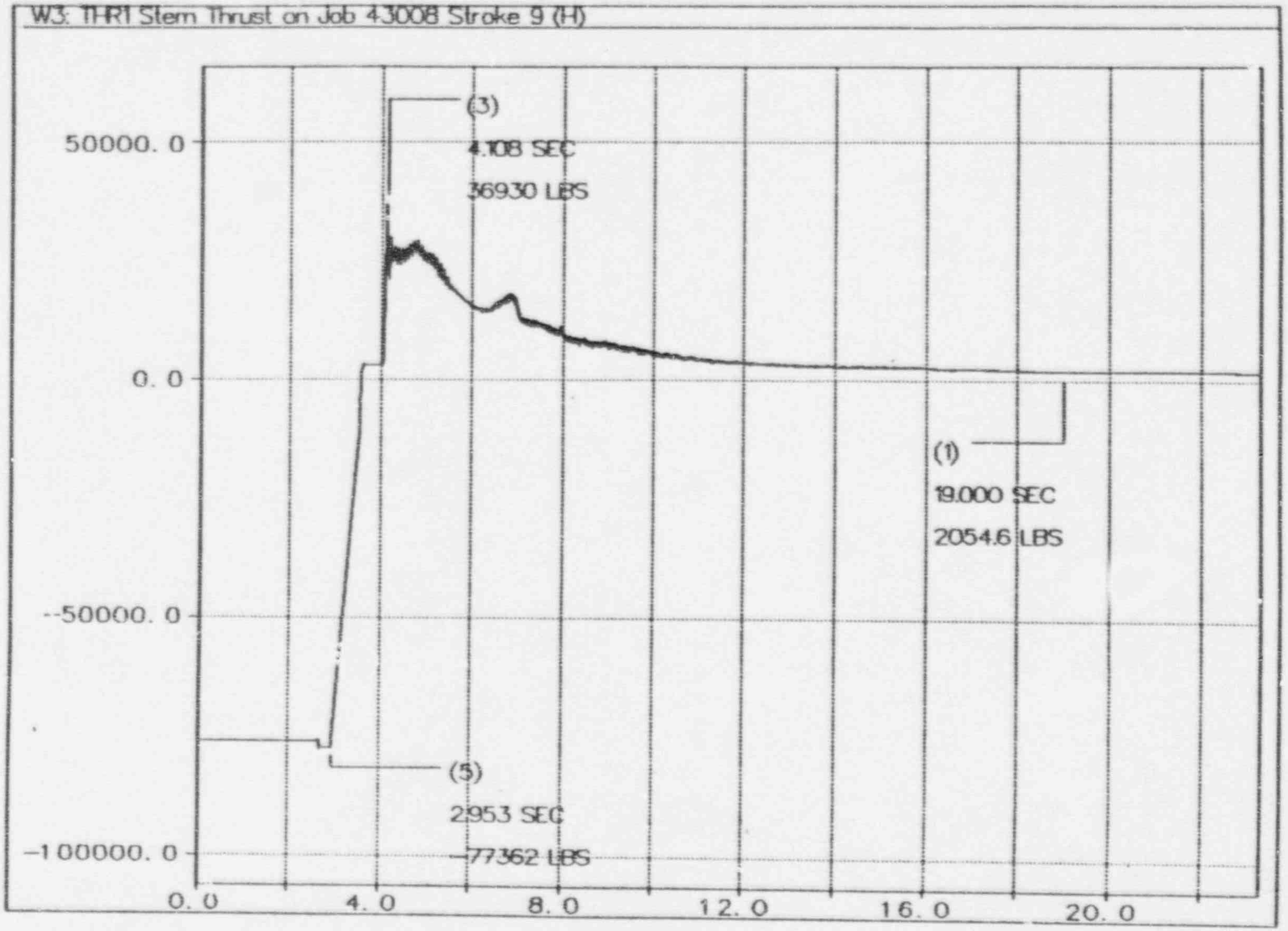
Remarks

S: 20.818 sec
Motor Start: 2.426 sec
Motor Stop: 20.828 sec

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93


W7: THR1 Stem Thrust on Job 43008 Stroke 9 (H)
(2)
4.223 SEC
27381 LBS
(4)
4.678 SEC
27398 LBS
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
3. 4
3. 8
4. 2
4. 6
5. 0
5. 4
5. 8



W3: THR1 Stem Thrust on Job 43008 Stroke 9 (H)
50000. 0
0. 0
-50000. 0
-100000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
(3)
4.108 SEC
36930 LBS
(1)
19.000 SEC
2054.6 LBS
(5)
2.953 SEC
-77362 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-14-93 **Test Time** 8:37:16
Test Description 400 PSID, 8000 GPM **Stroke #** 10R (H)
Data File D4300B **Data Set** 037

OPEN STROKE

Running Current ______ amps RMS Unseating Current ______ amps RMS
Running Power ______ watts Stroke Time ______ sec
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Unseating					■■■■	■■■■	■■■■
4. Just After Unseating							■■■■
5. Hammer Blow			■■■■		■■■■	■■■■	■■■■

CLOSE STROKE

Running Current 17.006 amps RMS Stroke Time 11.212 sec
Running Power 8853 watts Rate of Loading Yes
Contactor Drop-out Time 0.014 sec
Disk Factor (Standard) at Max dP 0.3042 Disk Factor (NMAC) at Max dP 0.3568

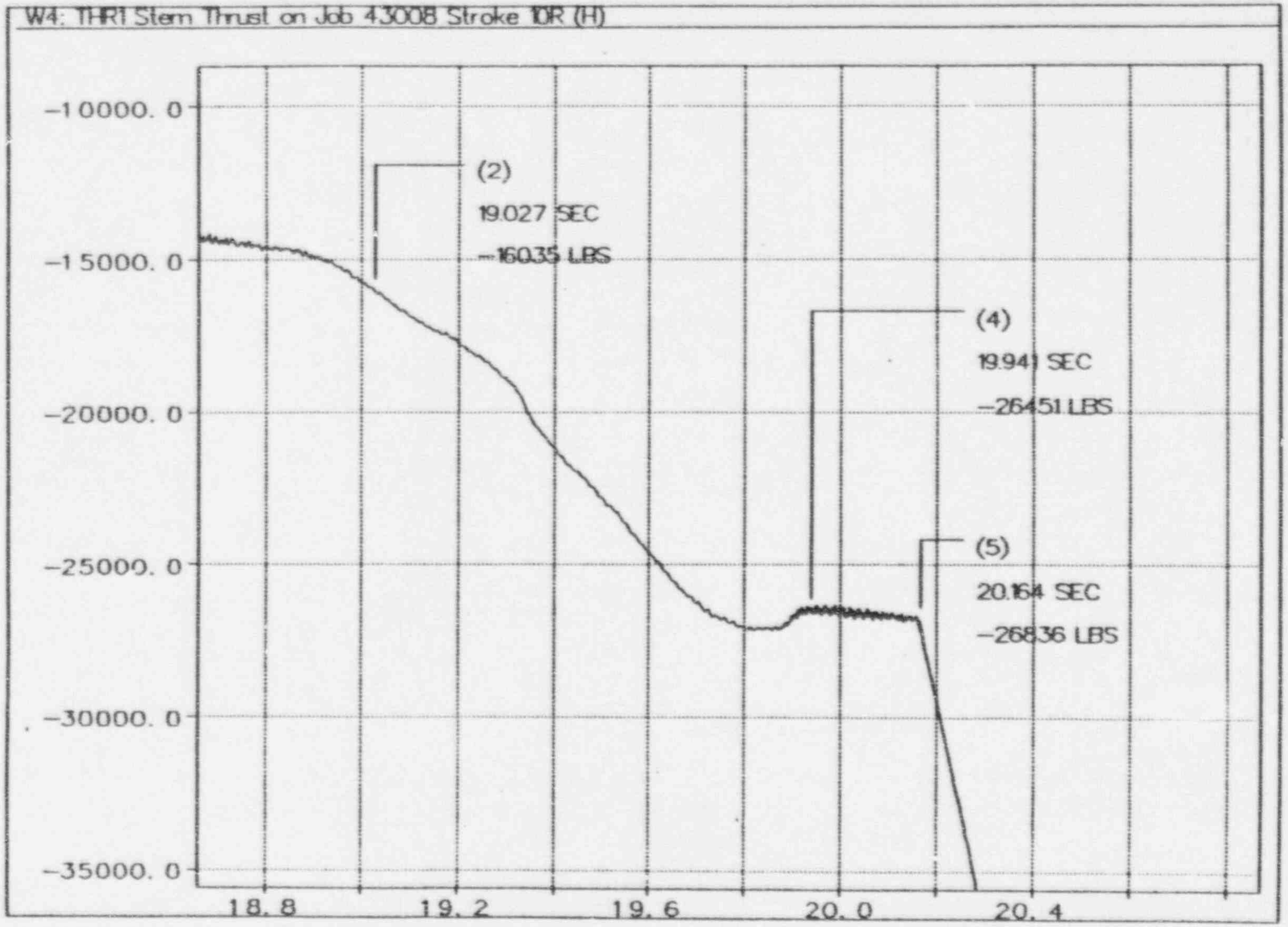
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	12.036	-51.651	38.06	■■■■	431.62	■■■■	N/A
2. Max. dP	19.027	-16035	299.29	■■■■	434.42	436.80	0.1296
3. Minimum Available	■■■■	80449	1259.96	■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging	19.941	-26451	446.70	.02714	■■■■	■■■■	■■■■
5. Wedging	20.164	-26836	459.80	.02718	428.13	428.52	■■■■
6. Torque Switch Trip	20.759	-80501	1298.02	.22085	■■■■	■■■■	0.1025
7. Total	20.893	-87663	1471.73	.24790	■■■■	■■■■	■■■■
8. Inertia	■■■■	7162	■■■■	.02705	■■■■	■■■■	■■■■

Note: All values annotated above are actual values, with no correction for static conditions.

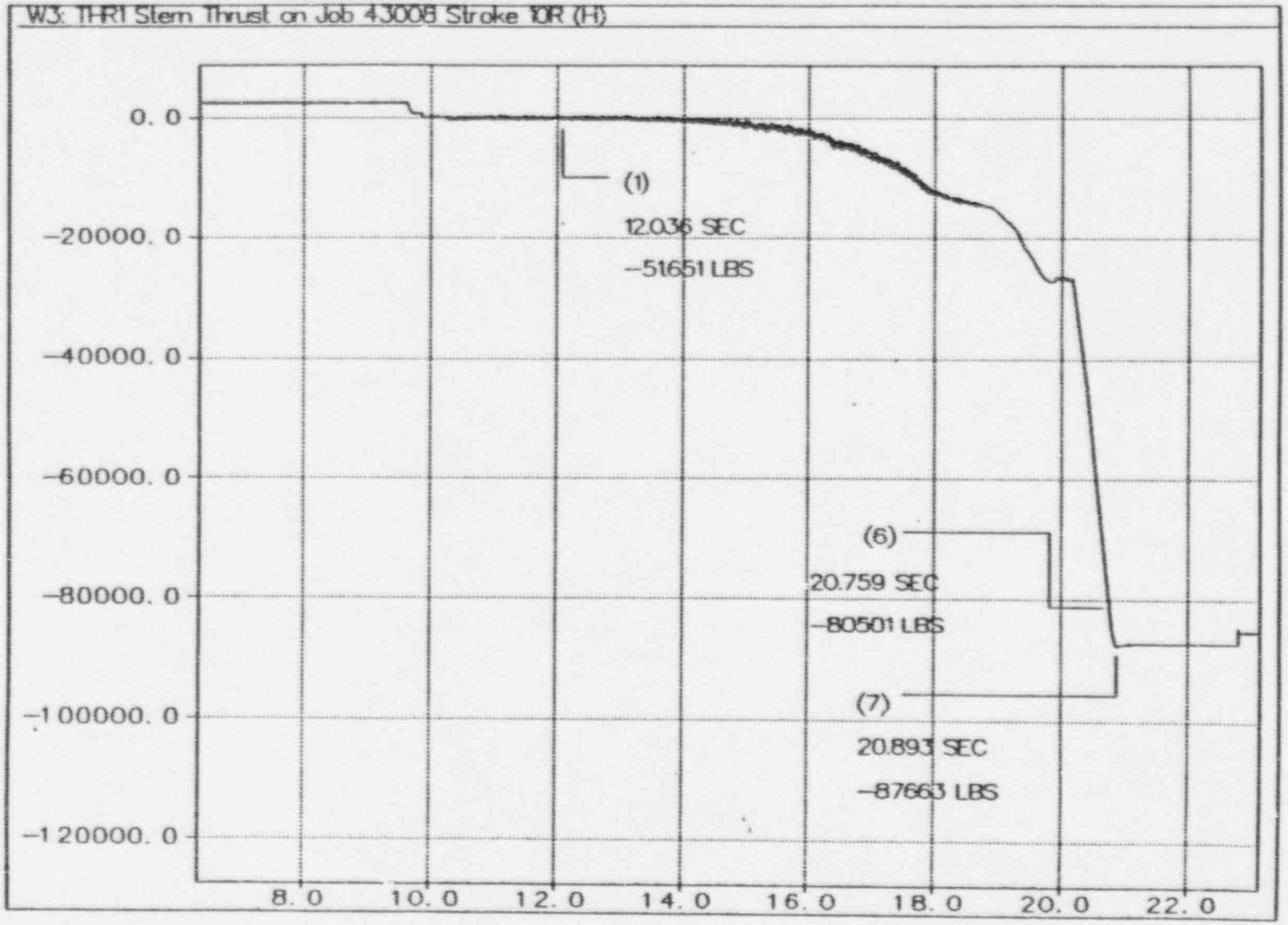
Remarks

Analyzed by: David Kessler 2/11/93

Verified by: [signature] 2/15/93



W4: THR1 Stem Thrust on Job 43008 Stroke 10R (H)
-10000.0
-15000.0
-20000.0
-25000.0
-30000.0
-35000.0
18.8
19.2
19.6
20.0
20.4
(2)
19.027 SEC
-16035 LBS
(4)
19.941 SEC
-26451 LBS
(5)
20.164 SEC
-26836 LBS



W3: THR1 Stem Thrust on Job 43008 Stroke 10R (H)
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
-120000. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
(1)
12.036 SEC
-51651 LBS
(6)
20.759 SEC
-80501 LBS
(7)
20.893 SEC
-87663 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-10-93	**Test Time**	15:32:17
Test Description	500 psid 9000 GPM C-O	**Stroke #**	11 (H)
Data File	D43008	**Data Set**	14

OPEN STROKE

Running Current	14.6	amps RMS	Unseating Current	22.7	amps RMS
Running Power	5822	watts	Stroke Time	18.4	sec
Contactor Drop-out Time	0.011	sec			
Disk Factor (Standard) at Max dP	.5637		Disk Factor (NMAC) at Max dP	.6206	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	2[illegible].000	946.93	-20.71	====	638.4 *	====	N/A
2. Max. dP	[illegible].870	53,423.9	-504.1	====	503.0	503.9	.0913
3. Unseating	6.087	40,793	-567.0	-0.0448	====	====	====
4. Just After Unseating	6.215	33,395.2	-493.7	-0.0320	503.2	503.8	====
5. Hammer Blow	4.896	-82,837	====	-0.0061	====	====	====

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

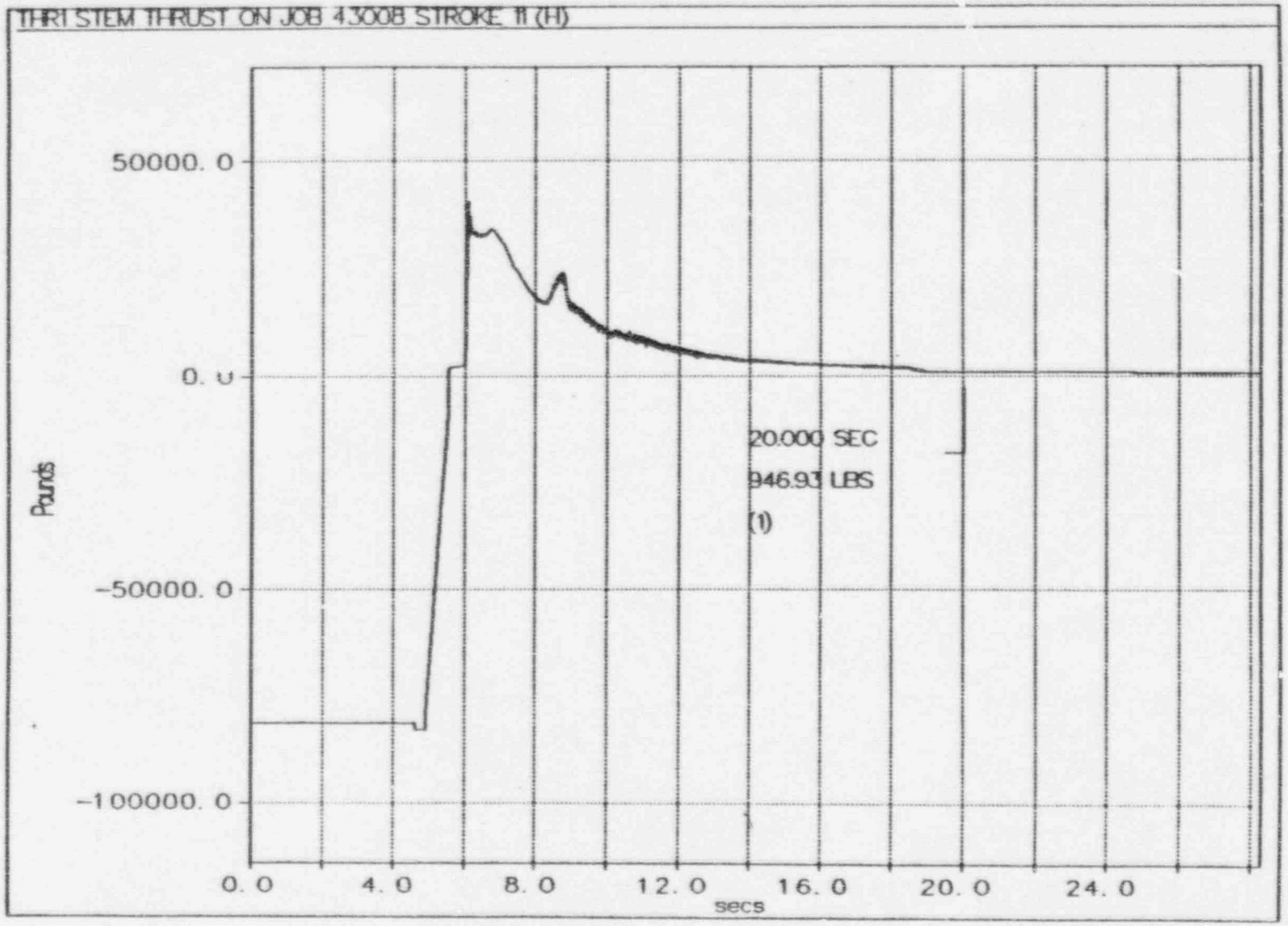
Remarks

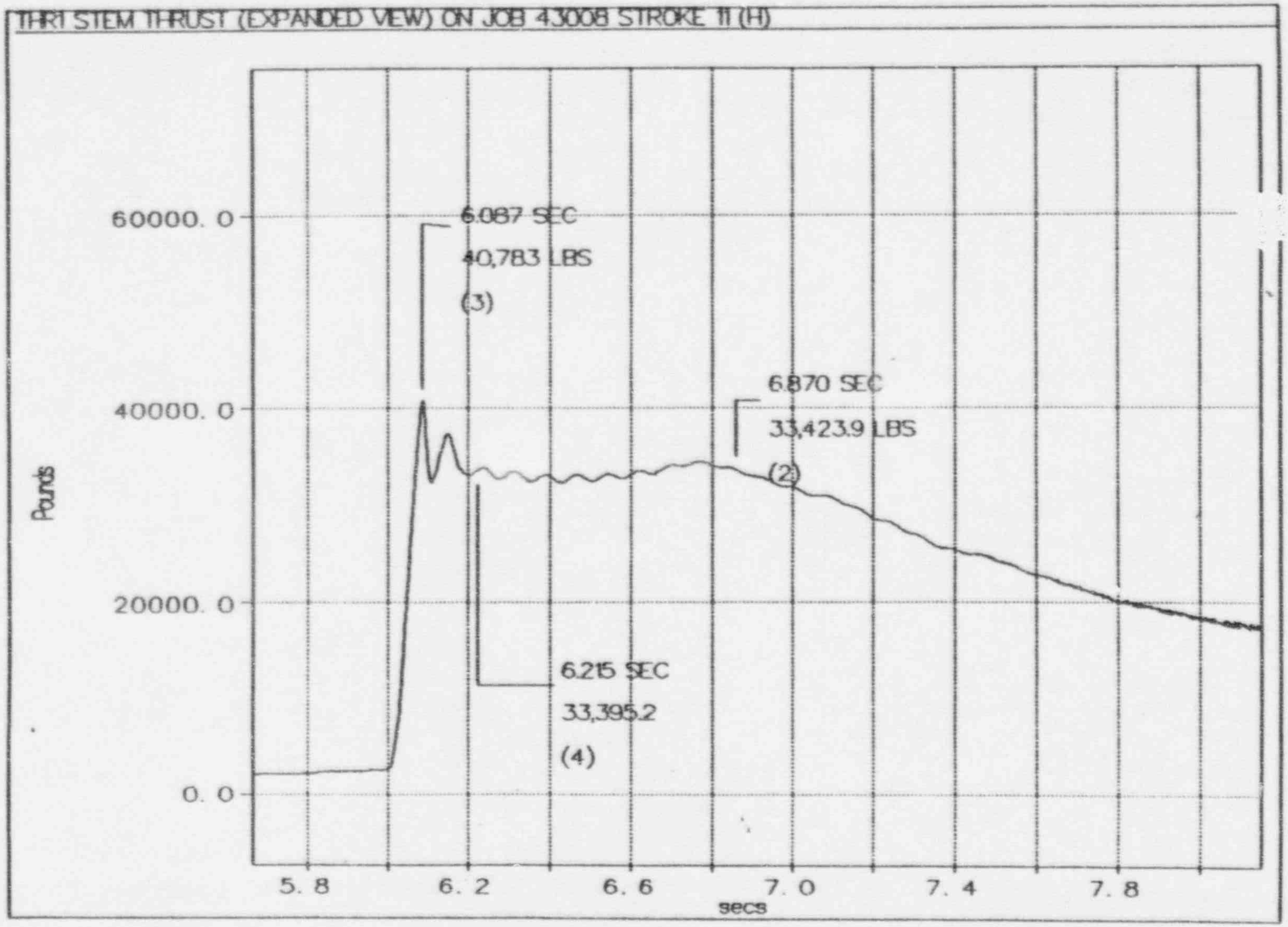
UNSEATING IN TWO STEPS

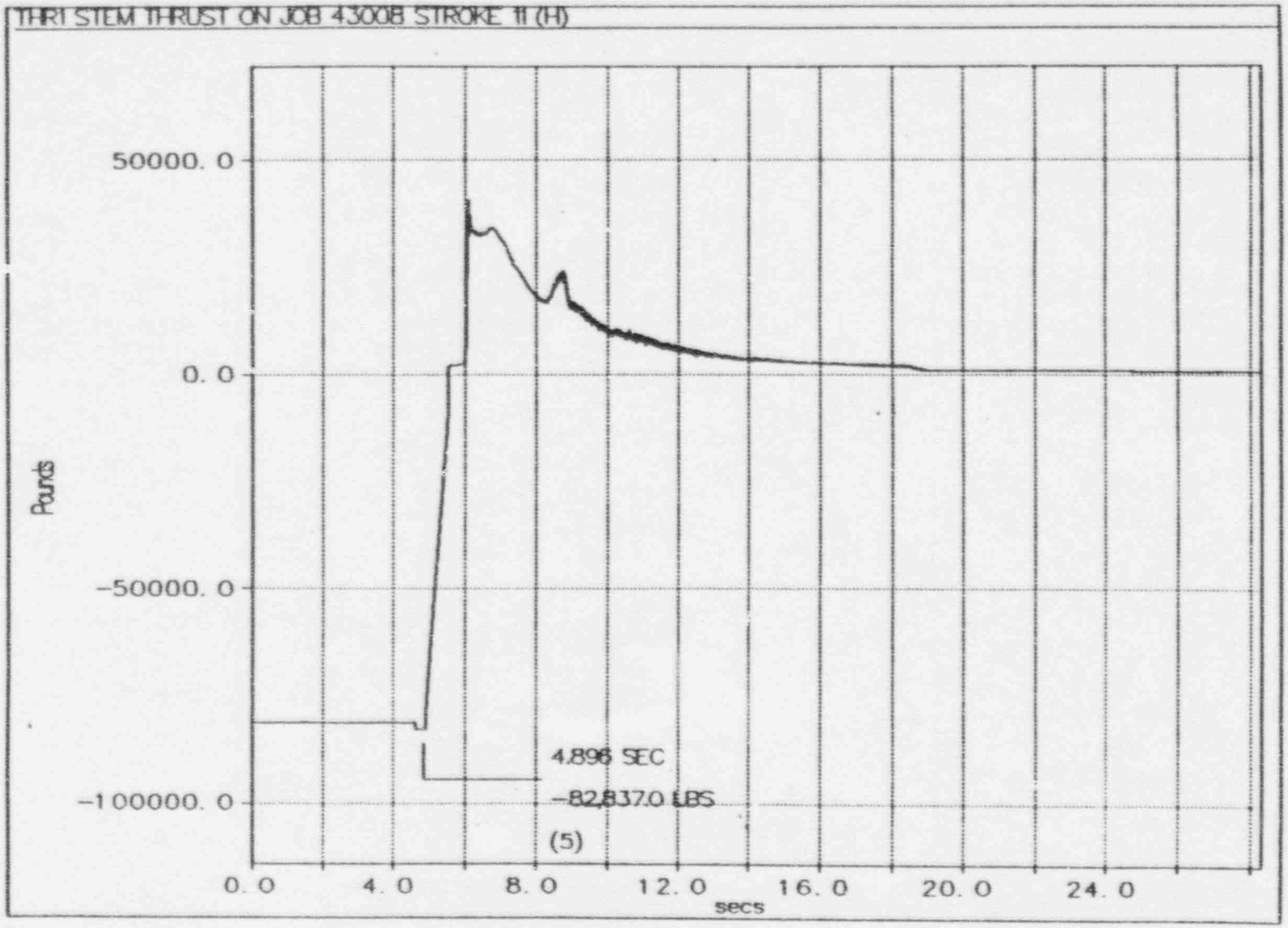
* PS1 SATURATED AT RUNNING. PS3 TRACKS PS1; DATA TAKEN FROM PS3.

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/16/93


THRI STEM THRUST ON JOB 43008 STROKE 11 (H)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
20.000 SEC
946.93 LBS
(1)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
secs


THR1 STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 11 (H)
Pounds
60000.0
40000.0
20000.0
0.0
6.087 SEC
40,783 LBS
(3)
6.870 SEC
33,423.9 LBS
(2)
6.215 SEC
33,395.2
(4)
5.8
6.2
6.6
7.0
7.4
7.8
secs


THRI STEM THRUST ON JOB 43008 STROKE 11 (H)
50000.0
0.0
-50000.0
-100000.0
Pounds
0.0
4.0
8.0
12.0
16.0
20.0
24.0
secs
4.896 SEC
-82,837.0 LBS
(5)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-10-93	Test Time	16:56:36
Test Description	500 PSID 9000 GPM	Stroke #	12 (H)
Data File	D43008	Data Set	015

OPEN STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS
Stroke Time ______ sec
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				----		----	
2. Max. dP				----			
3. Unseating					----	----	----
4. Just After Unseating							----
5. Hammer Blow			----		----	----	----

CLOSE STROKE

Running Current 15.486 amps RMS
Running Power 6756 watts
Contactor Drop-out Time 0.015 sec
Disk Factor (Standard) at Max dP 0.3207

Stroke Time 12.314 sec
Rate of Loading No
Disk Factor (NMAC) at Max dP 0.3743

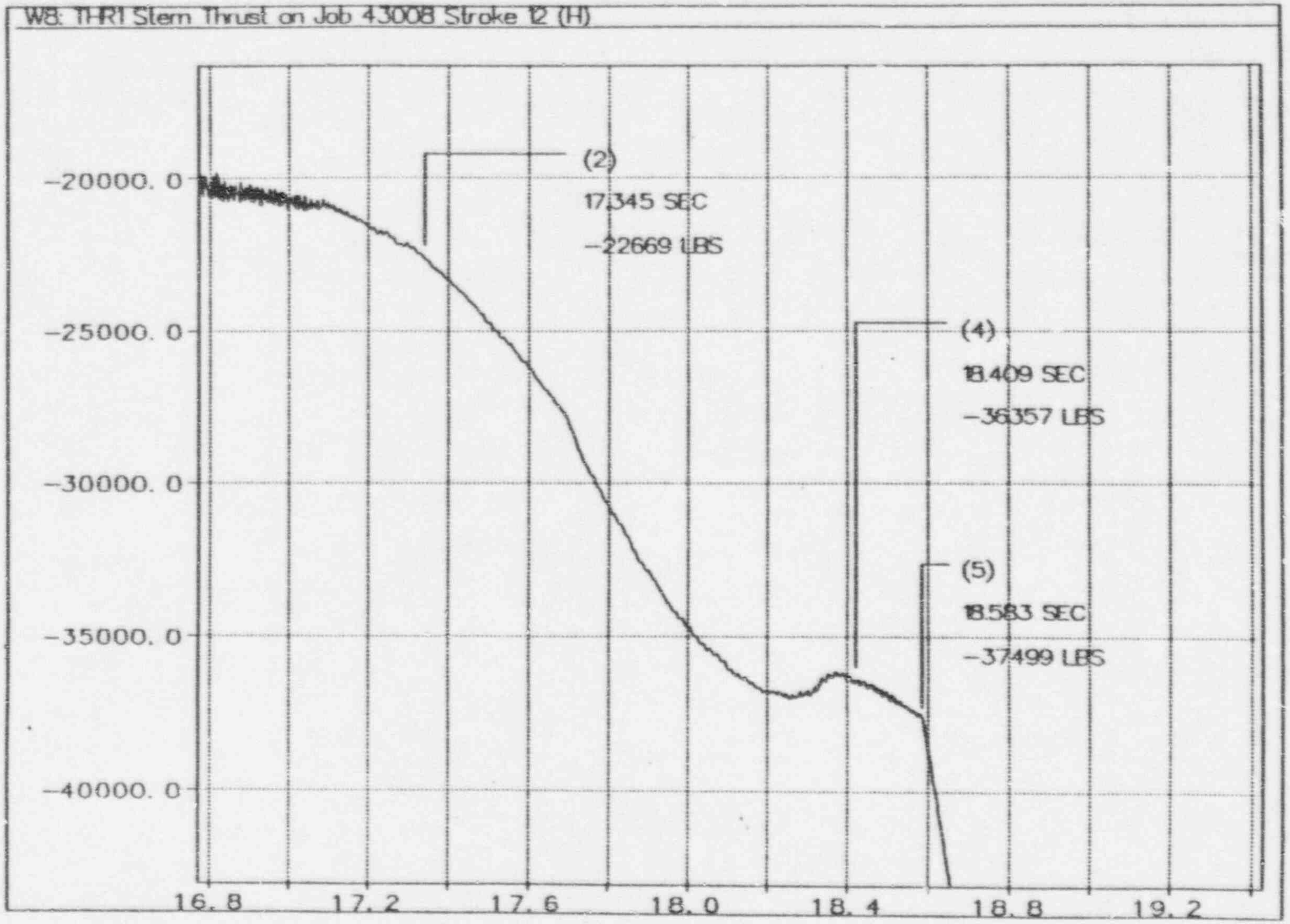
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	-1107.6	45.33	----	509.55	----	N/A
2. Max. dP	17.345	-22669	406.85	----	565.82	561.32	0.1219
3. Minimum Available	----	80701	1295.78	----	----	----	----
4. Just Prior to Wedging	18.409	-36357	619.85	.05315	----	----	----
5. Wedging	18.583	-37499	642.80	.05456	557.36	557.22	----
6. Torque Switch Trip	19.102	-81809	1341.11	.22188	----	----	0.1053
7. Total	19.212	-88082	1535.41	.24925	----	----	----
8. Inertia	----	6273	----	.02737	----	----	----

Note: All values annotated above are actual values, with no correction for static conditions.

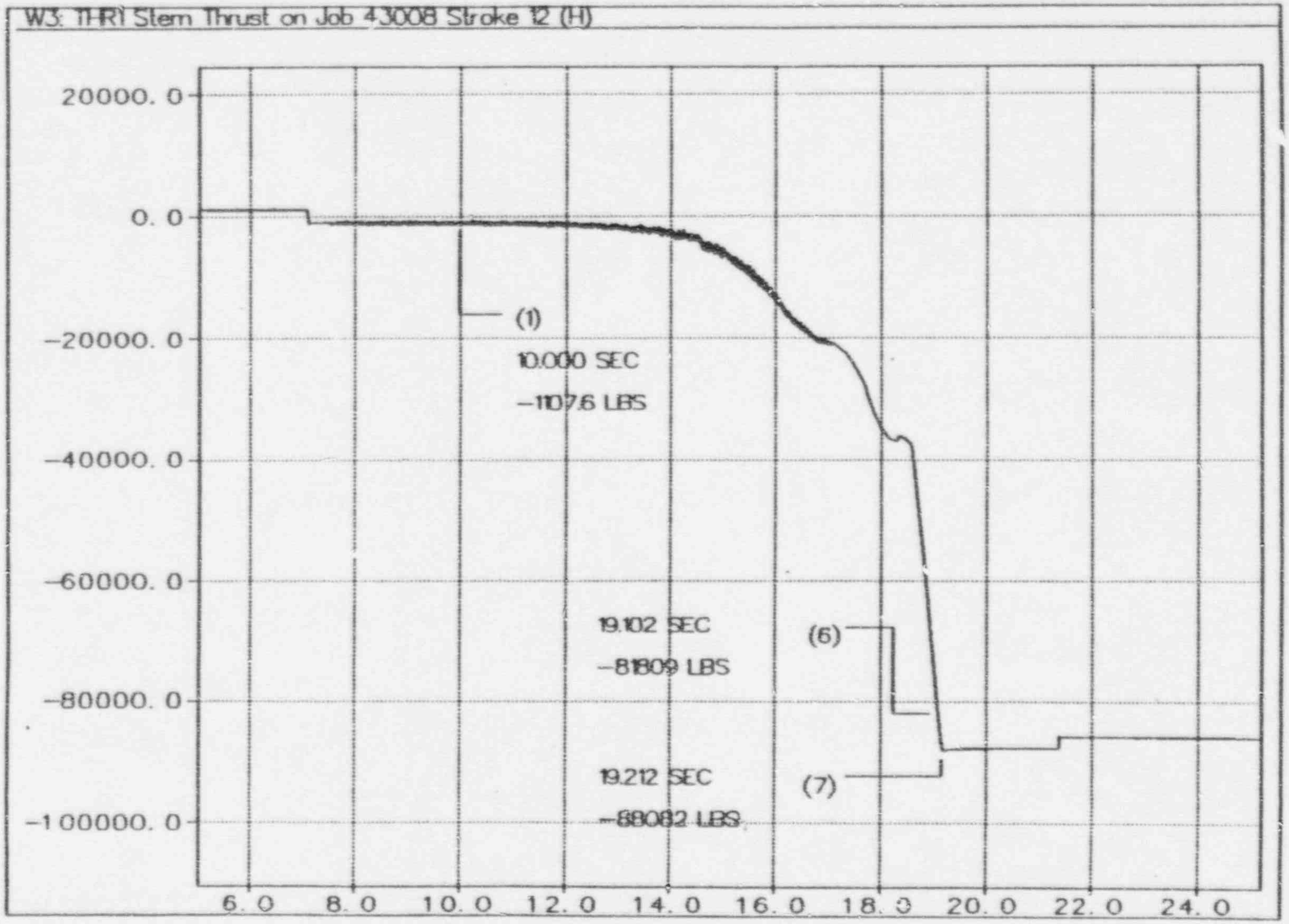
Remarks

Analyzed by: David Kessler 2/12/93

Verified by: [signature] 2/15/93



W8: THR1 Stem Thrust on Job 43008 Stroke 12 (H)
-20000. 0
-25000. 0
-30000. 0
-35000. 0
-40000. 0
16. 8
17. 2
17. 6
18. 0
18. 4
18. 8
19. 2
(2)
17.345 SEC
-22669 LBS
(4)
18.409 SEC
-36357 LBS
(5)
18.583 SEC
-37499 LBS


W3: THR1 Stem Thrust on Job 43008 Stroke 12 (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
24. 0
(1)
10.000 SEC
-1107.6 LBS
19.102 SEC
-81809 LBS
(6)
19.212 SEC
-88082 LBS
(7)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-11-93 **Test Time** 8:48:34

Test Description 500 PSId 8000 GPM C-70 **Stroke #** 13 (H)

Data File D43008 **Data Set** 16

OPEN STROKE

Running Current 14.9 amps RMS

Running Power 6612 watts

Contactor Drop-out Time 0.011 sec

Disk Factor (Standard) at Max dP .5425

Unseating Current 22.8 amps RMS

Stroke Time 18.4 sec

Disk Factor (NMAC) at Max dP .6121

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	20.000	1130.0	-25.74	▪▪▪▪	656.8*	▪▪▪▪	N/A
2. Max. dP	5.861	32,735.3	-478.3	▪▪▪▪	495.9	509.1	.0862
3. Unseating	5.033	37,923	-511.6	0.0546	▪▪▪▪	▪▪▪▪	▪▪▪▪
4. Just After Unseating	5.218	28,195.7	-401.7	0.0543	494.5	494.8	▪▪▪▪
5. Hammer Blow	3.871	-77,740	▪▪▪▪	0.0967	▪▪▪▪	▪▪▪▪	▪▪▪▪

CLOSE STROKE

Running Current ______ amps RMS

Running Power ______ watts

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______

Stroke Time ______ sec

Rate of Loading ______

Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				▪▪▪▪		▪▪▪▪	
2. Max. dP				▪▪▪▪			
3. Minimum Available	▪▪▪▪			▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
4. Just Prior to Wedging					▪▪▪▪	▪▪▪▪	▪▪▪▪
5. Wedging							▪▪▪▪
6. Torque Switch Trip					▪▪▪▪	▪▪▪▪	
7. Total					▪▪▪▪	▪▪▪▪	▪▪▪▪
8. Inertia	▪▪▪▪		▪▪▪▪		▪▪▪▪	▪▪▪▪	▪▪▪▪

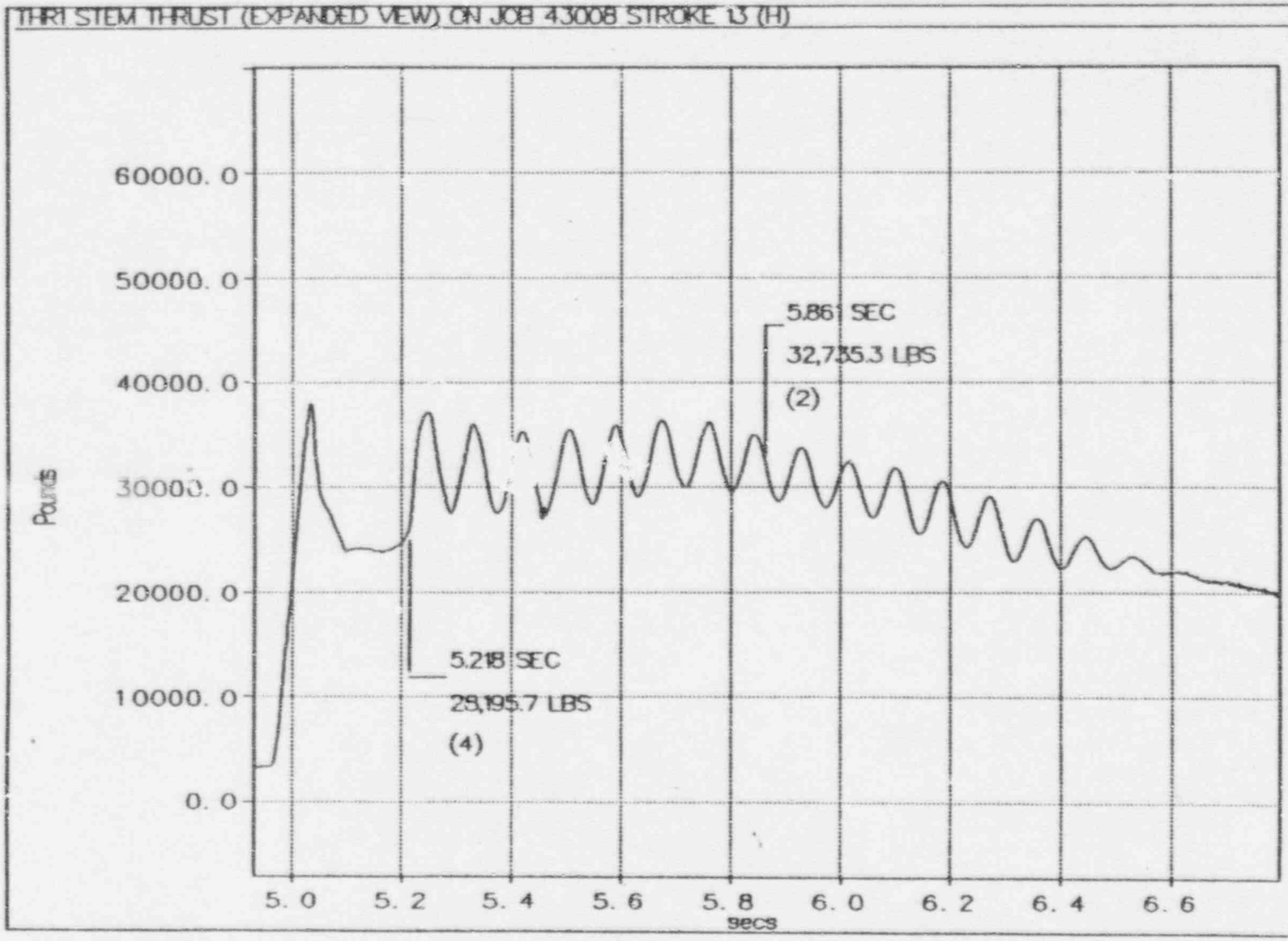
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

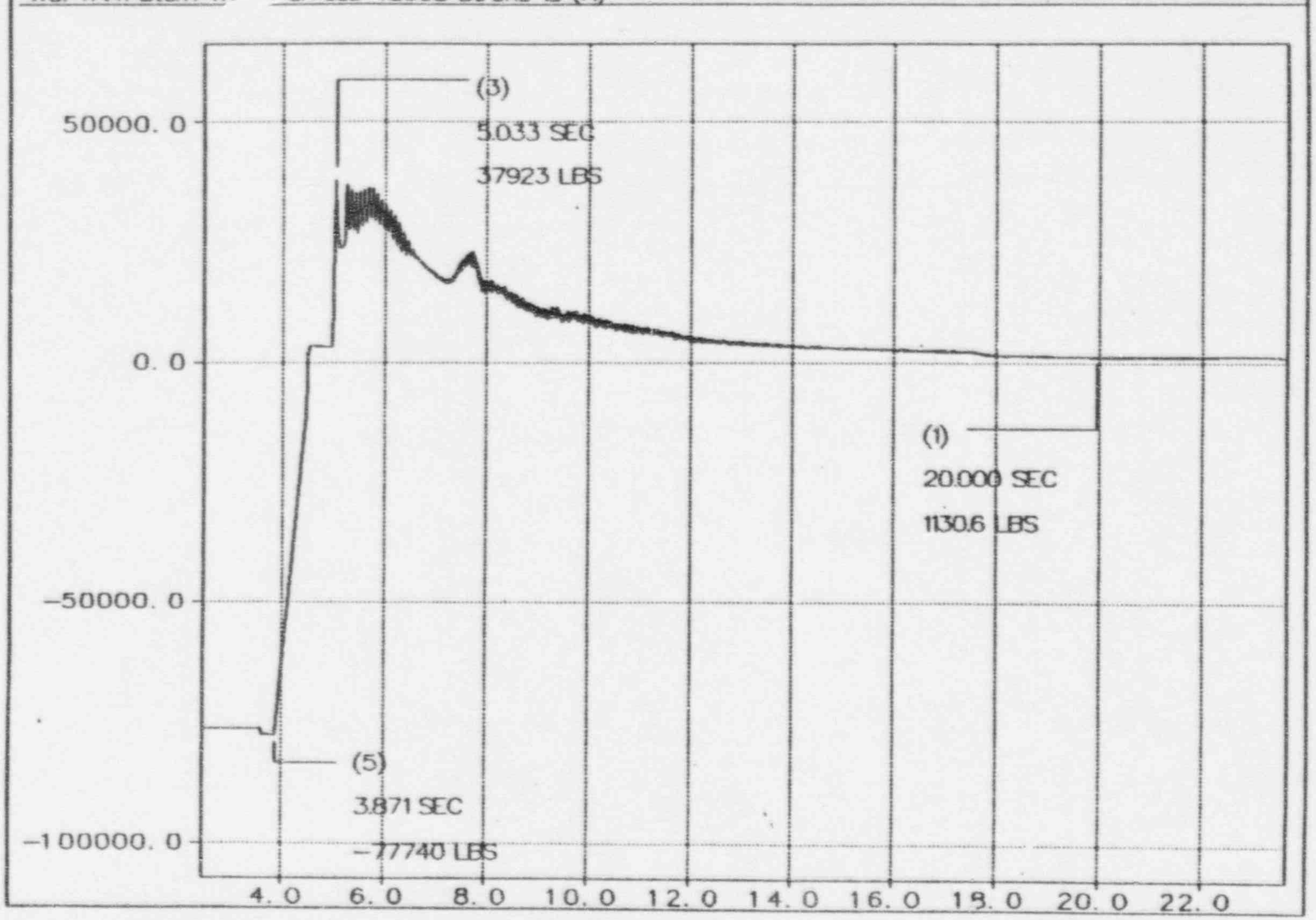
* VALUE TAKEN ON PS3; PS1 SATURATED AT THIS POINT; PS3 TRACKS PS1 [illegible] TO THIS POINT.

Analyzed by: [signature]

Verified by: [signature] 2/16/93


THR1 STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 13 (H)
Pounds
60000. 0
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
5.861 SEC
32,735.3 LBS
(2)
5.218 SEC
28,195.7 LBS
(4)
5. 0
5. 2
5. 4
5. 6
5. 8
6. 0
6. 2
6. 4
6. 6
secs

W3: THR1 Stem Thr[illegible] on Job 43008 Stroke 13 (H)



Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-11-93	**Test Time**	10:16:52
Test Description	500 PSID, 9000 GPM	**Stroke #**	14(H)
Data File	D43008	**Data Set**	017

OPEN STROKE

Running Current ______ amps RMS   Unseating Current ______ amps RMS
Running Power ______ watts   Stroke Time ______ sec
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______   Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 16.864 amps RMS   Stroke Time 11.998 sec
Running Power 8491 watts   Rate of Loading Yes
Contactor Drop-out Time 0.017 sec
Disk Factor (Standard) at Max dP N/A   Disk Factor (NMAC) at Max dP N/A

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	-487.8	44.883	====	502.73	====	N/A
2. Max. dP	N/A	N/A	N/A	====	N/A	N/A	N/A
3. Minimum Available	====	79577	1268.92	====	====	====	====
4. Just Prior to Wedging	20.147	-41900	710.51	.07584	====	====	====
5. Wedging	20.259	-42526	730.66	.07837	648.02*	N/A	====
6. Torque Switch Trip	20.727	-80065	1313.8	.22024	====	====	0.1055
7. Total	20.837	-86360	1513.4	.24349	====	====	====
8. Inertia	====	6295	====	.02325	====	====	====

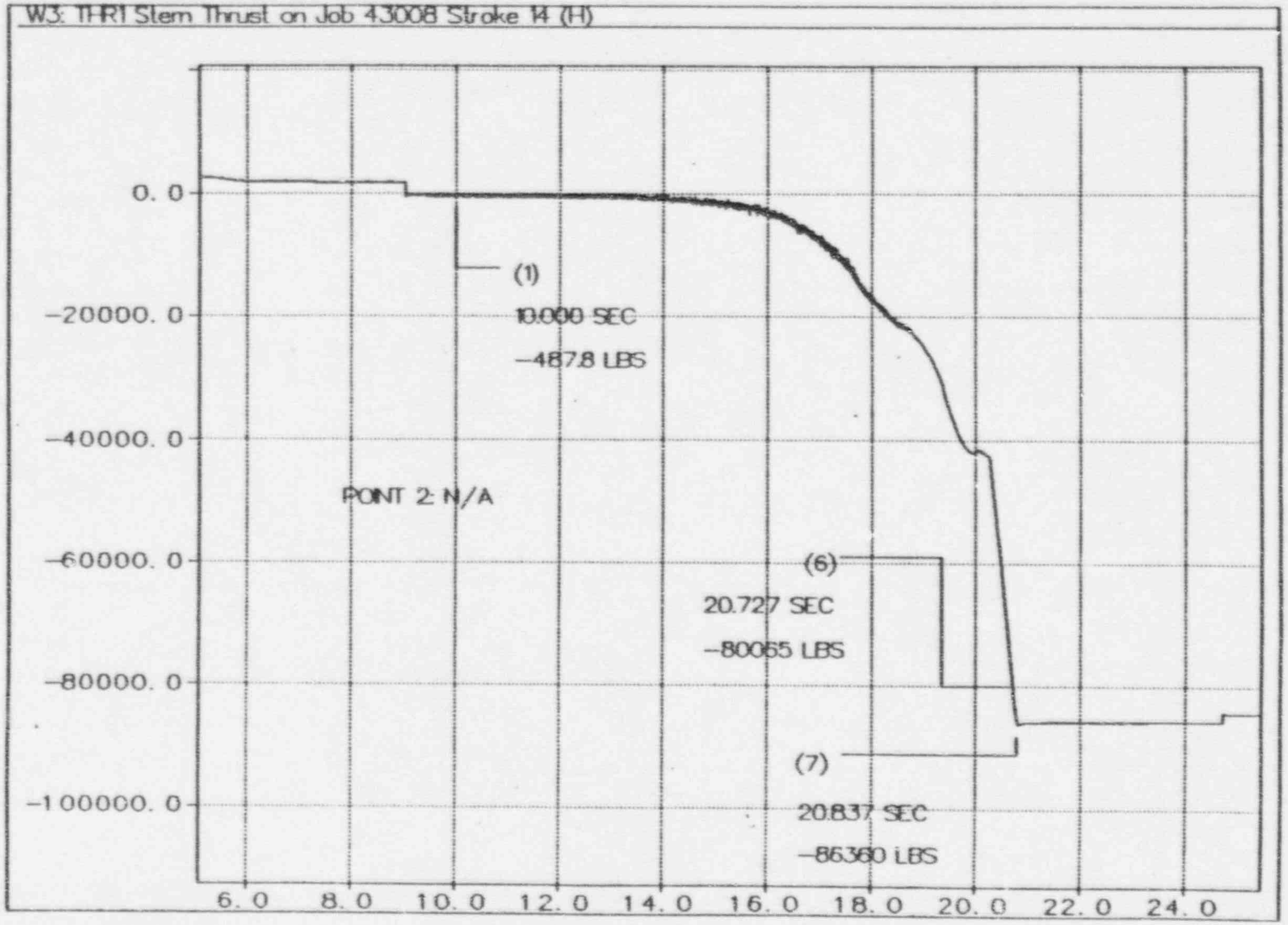
Note: All values annotated above are actual values, with no correction for static conditions.

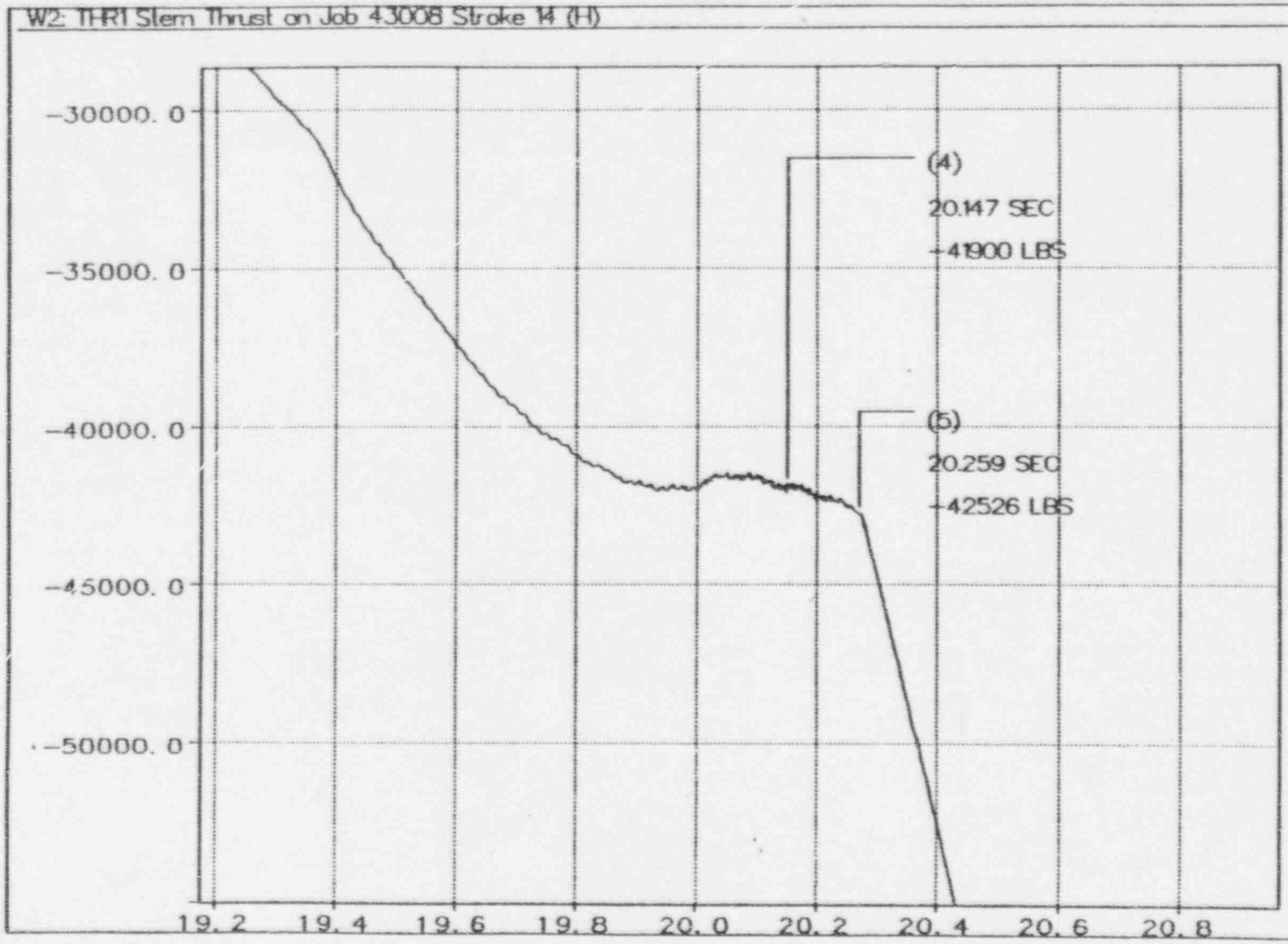
Remarks

Valve DP and Upstream pressure became saturated. Unable to determine point 2 or calculate disk factor.
* Value taken from bonnet pressure.

Analyzed by: Daniel Kessler 2/12/93

Verified by: [signature] 2/15/93


W3: THR1 Stem Thrust on Job 43008 Stroke 14 (H)
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
24. 0
(1)
10.000 SEC
-487.8 LBS
POINT 2: N/A
(6)
20.727 SEC
-80065 LBS
(7)
20.837 SEC
-86360 LBS



W2: THR1 Stem Thrust on Job 43008 Stroke 14 (H)
-30000. 0
-35000. 0
-40000. 0
-45000. 0
-50000. 0
19. 2
19. 4
19. 6
19. 8
20. 0
20. 2
20. 4
20. 6
20. 8
(4)
20.147 SEC
-41900 LBS
(5)
20.259 SEC
-42526 LBS

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-11-93	Test Time	11:52:16
Test Description	500 PSID 9000 GPM C→O	Stroke #	15 (H)
Data File	D43008	Data Set	18

OPEN STROKE

Running Current 15.9 amps RMS — Unseating Current 26.3 amps RMS
Running Power 6370.2 watts — Stroke Time 18.4 sec
Contactor Drop-out Time 0.010 sec
Disk Factor (Standard) at Max dP .5498 — Disk Factor (NMAC) at Max dP .6266

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	20.036	1406.1	-21.49	====	*635.13	====	N/A
2. Max. dP	6.314	33,561.7	-482.63	====	507.07	510.90	.0838
3. Unseating	5.600	46,411.3	-636.19	-0.051	====	====	====
4. Just After Unseating	5.732	33,383.8	-479.61	-0.037	507.09	499.64	====
5. Hammer Blow	4.438	-76,242.6	====	+0.020	====	====	====

CLOSE STROKE

Running Current ______ amps RMS — Stroke Time ______ sec
Running Power ______ watts — Rate of Loading ______
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ — Disk Factor (NMAC) at Max dP ______

	(se..)	..rust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Di..erential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

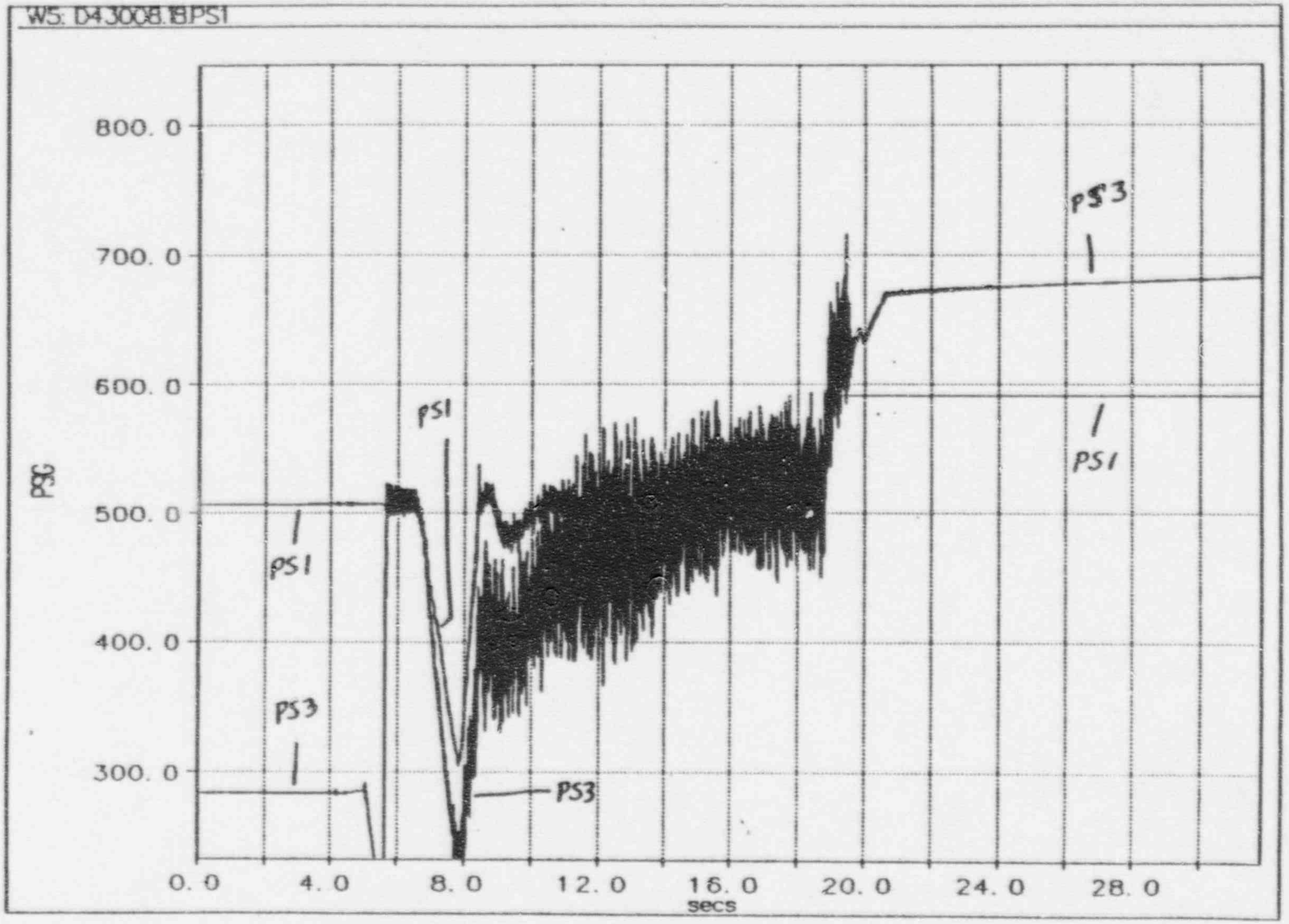
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

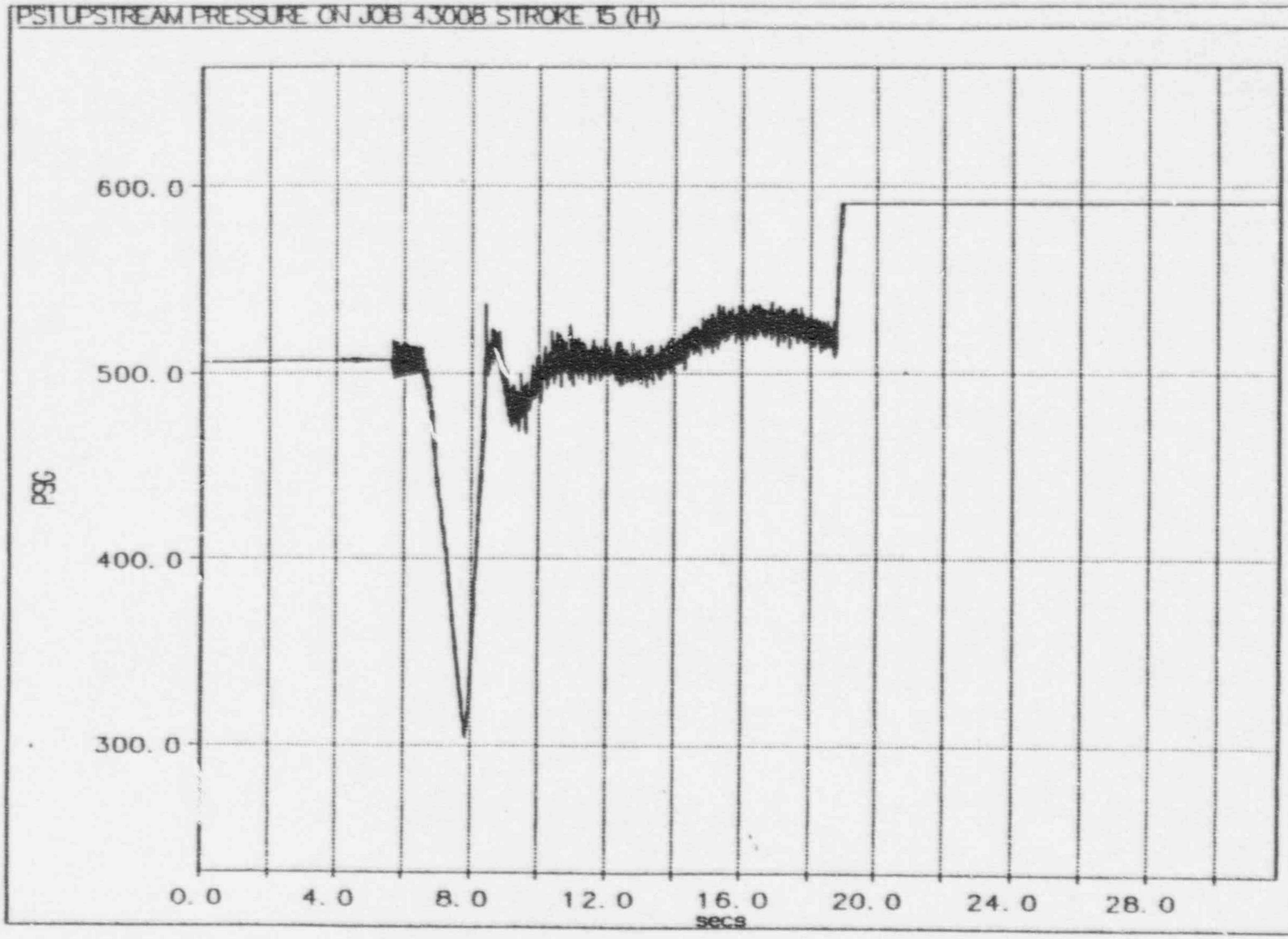
* OBTAINED FROM PS3; PS1 WAS SATURATED AT THIS POINT. COMPARISON OF OTHER OPENING STROKES SHOW THAT PS3 AND PS1 HAVE SAME/SIMILAR PRESSURE AT "RUNNING." [initials]
UNSEATING IN TWO STEPS!

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93

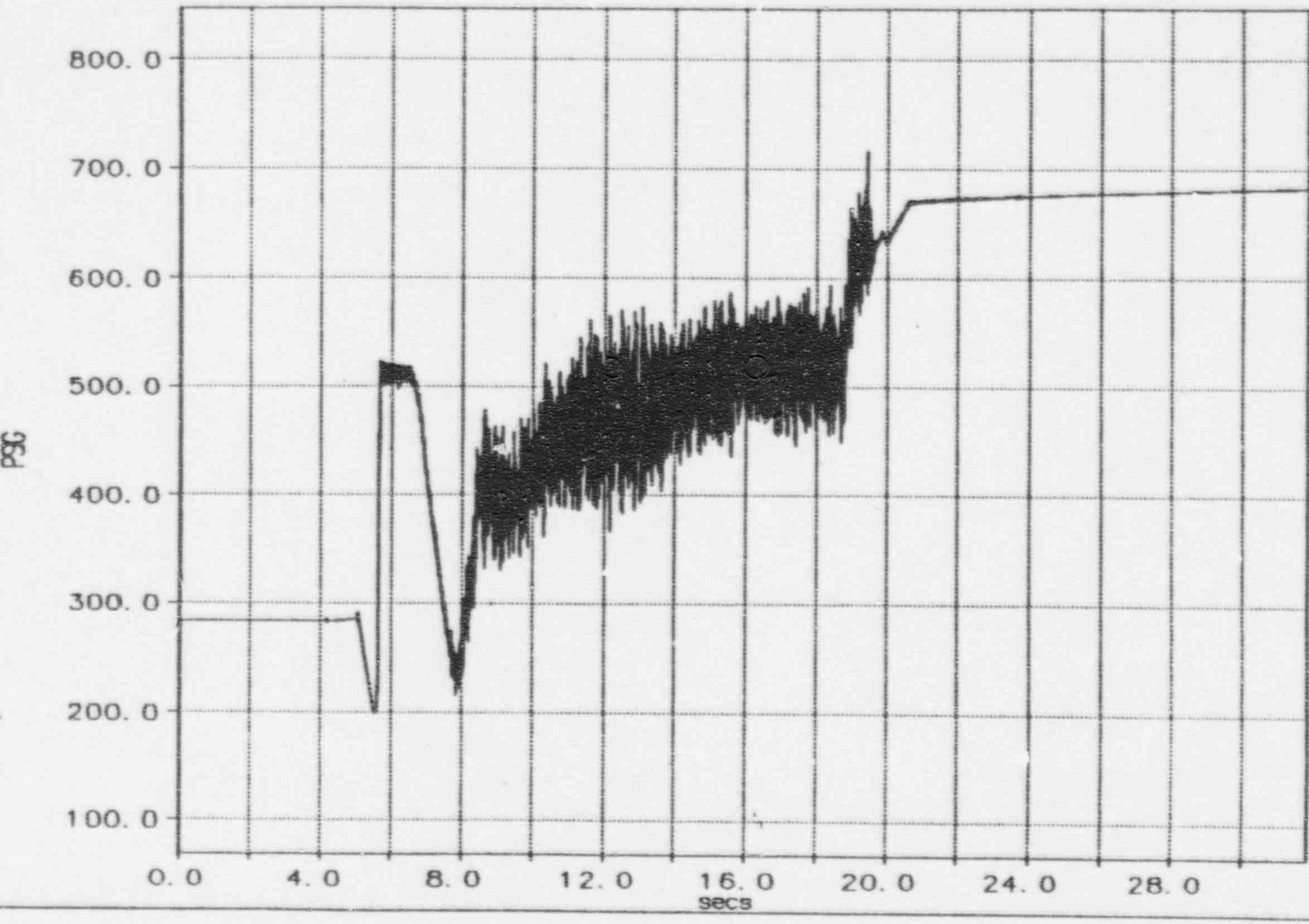


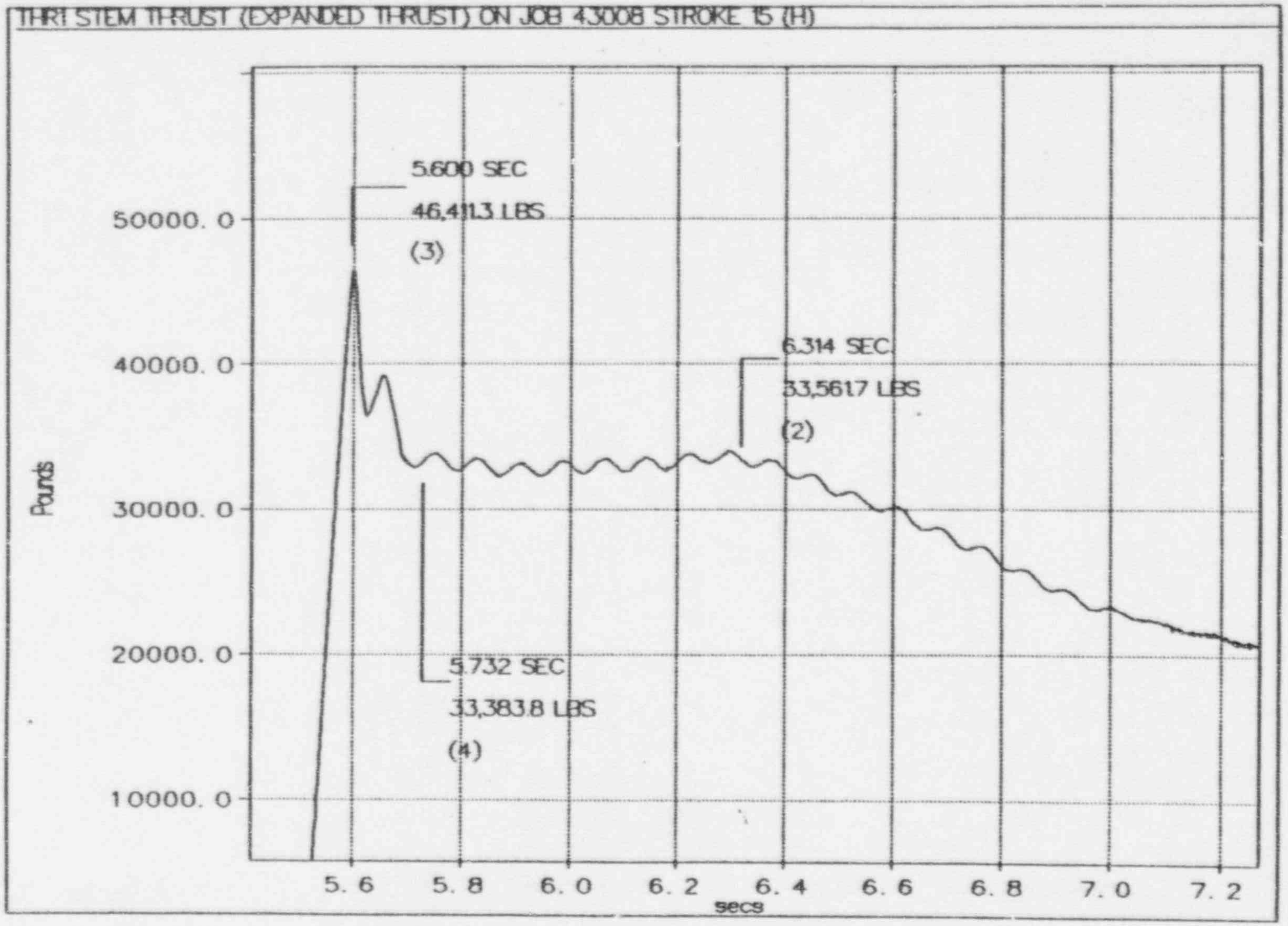
W5: D43008.18PS1
PSIG
800.0
700.0
600.0
500.0
400.0
300.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
secs
PS1
PS3
PS1
PS3
PS3
PS1

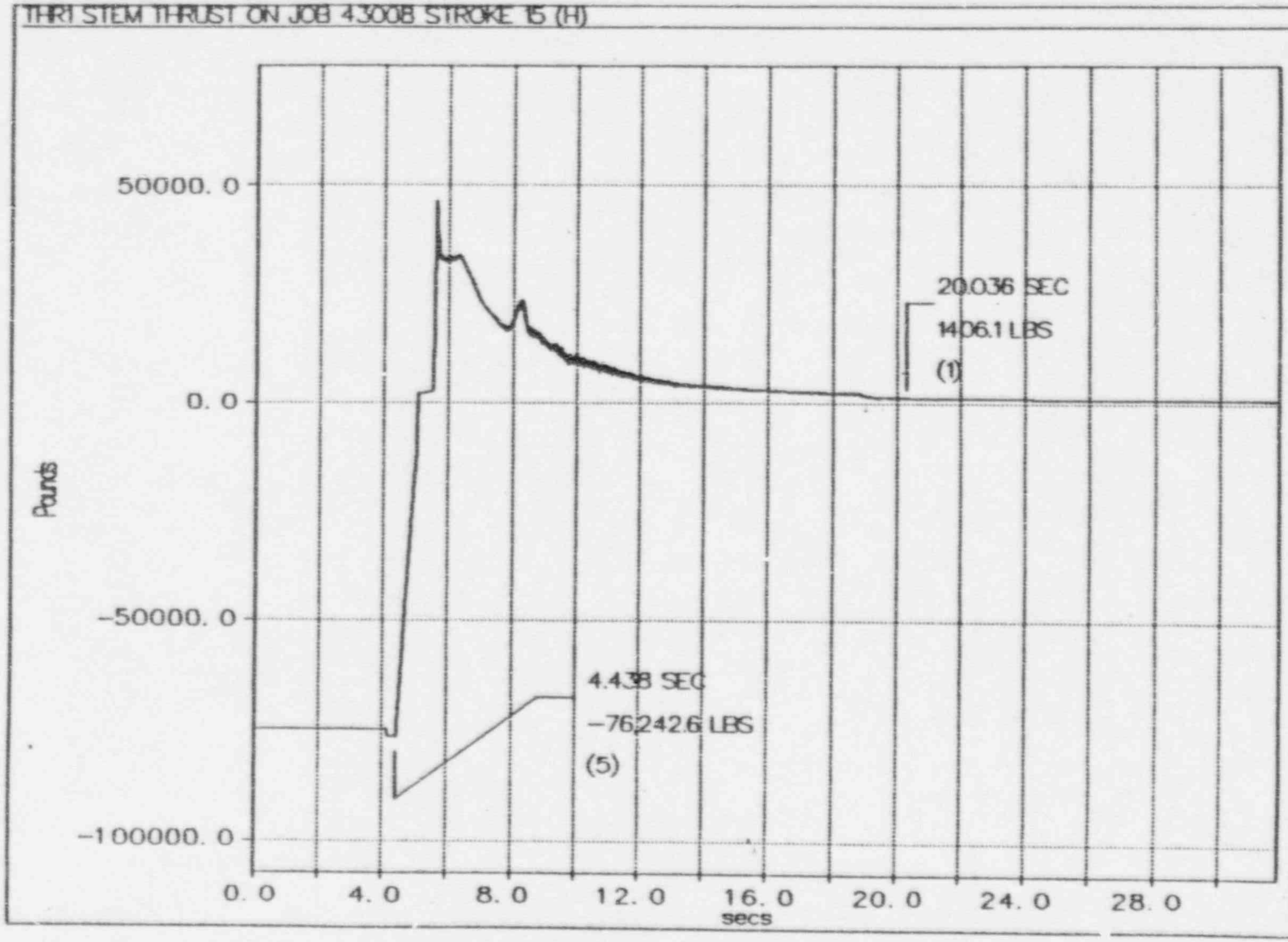


PSI UPSTREAM PRESSURE ON JOB 43008 STROKE 15 (H)
PSIG
600.0
500.0
400.0
300.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
secs

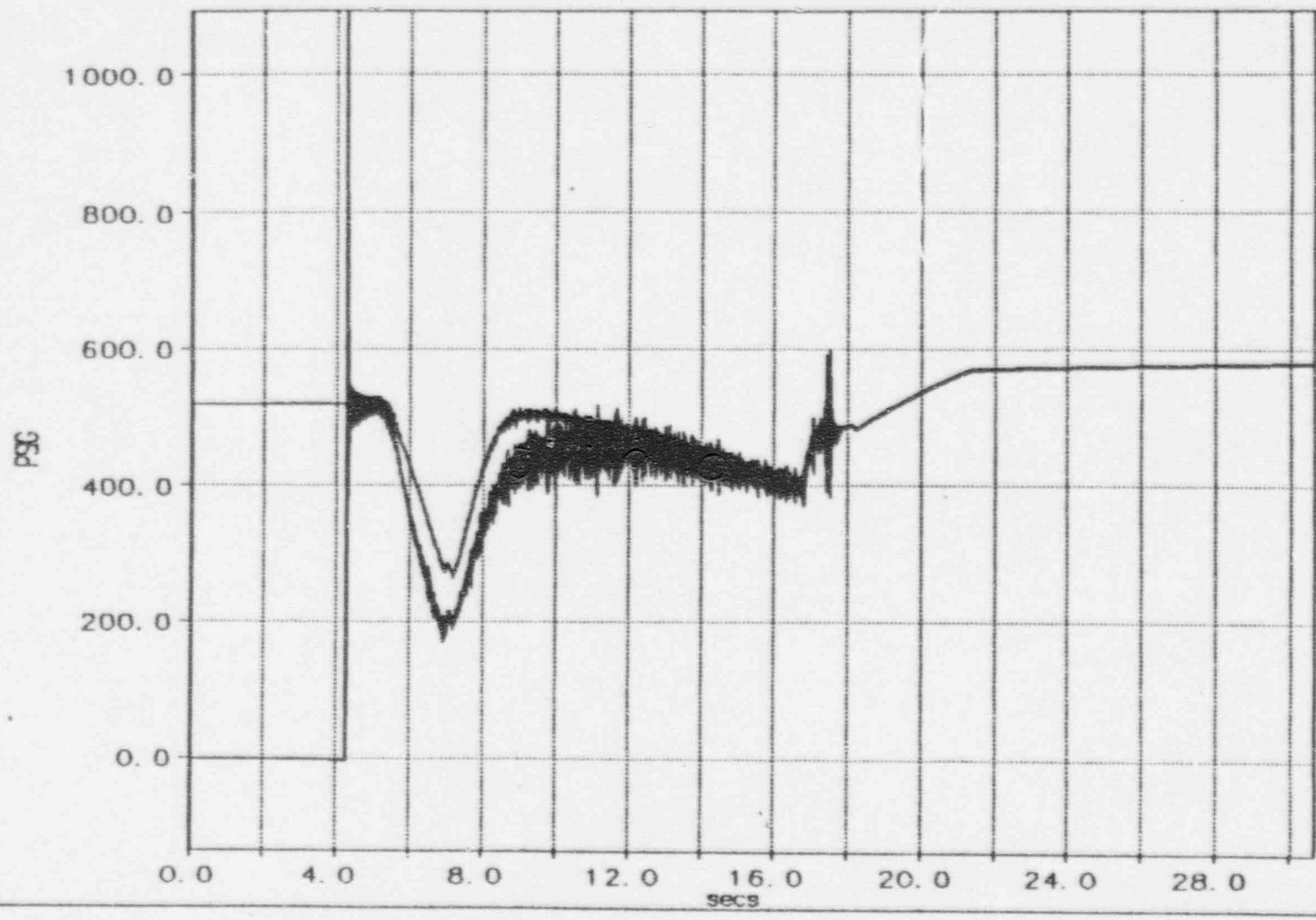
PS3 BONNET PRESSURE ON JOB 43008 STROKE 15 (H)




THRI STEM THRUST (EXPANDED THRUST) ON JOB 43008 STROKE 15 (H)
5.600 SEC
46,411.3 LBS
(3)
6.314 SEC
33,561.7 LBS
(2)
5.732 SEC
33,383.8 LBS
(4)
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
Pounds
5. 6
5. 8
6. 0
6. 2
6. 4
6. 6
6. 8
7. 0
7. 2
secs


THR1 STEM THRUST ON JOB 43008 STROKE 15 (H)
Pounds
50000. 0
0. 0
-50000. 0
-100000. 0
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
28. 0
secs
20.036 SEC
1406.1 LBS
(1)
4.438 SEC
-76,242.6 LBS
(5)

OVERPLOT OF PS1 AND PS3 ON JOB 43008 STROKE 17R (H)



Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-11-93	**Test Time**	14:09:41
Test Description	500 psid 9000 GPM O->C	**Stroke #**	16 (H)
Data File	D43008	**Data Set**	19

OPEN STROKE

Running Current ______ amps RMS — Unseating Current ______ amps RMS

Running Power ______ watts — Stroke Time ______ sec

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______ — Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 16.8 amps RMS — Stroke Time 11.9 sec

Running Power 7377.3 watts — Rate of Loading YES SLIGHTLY

Contactor Drop-out Time 0.015 sec

Disk Factor (Standard) at Max dP .3174 — Disk Factor (NMAC) at Max dP .3700

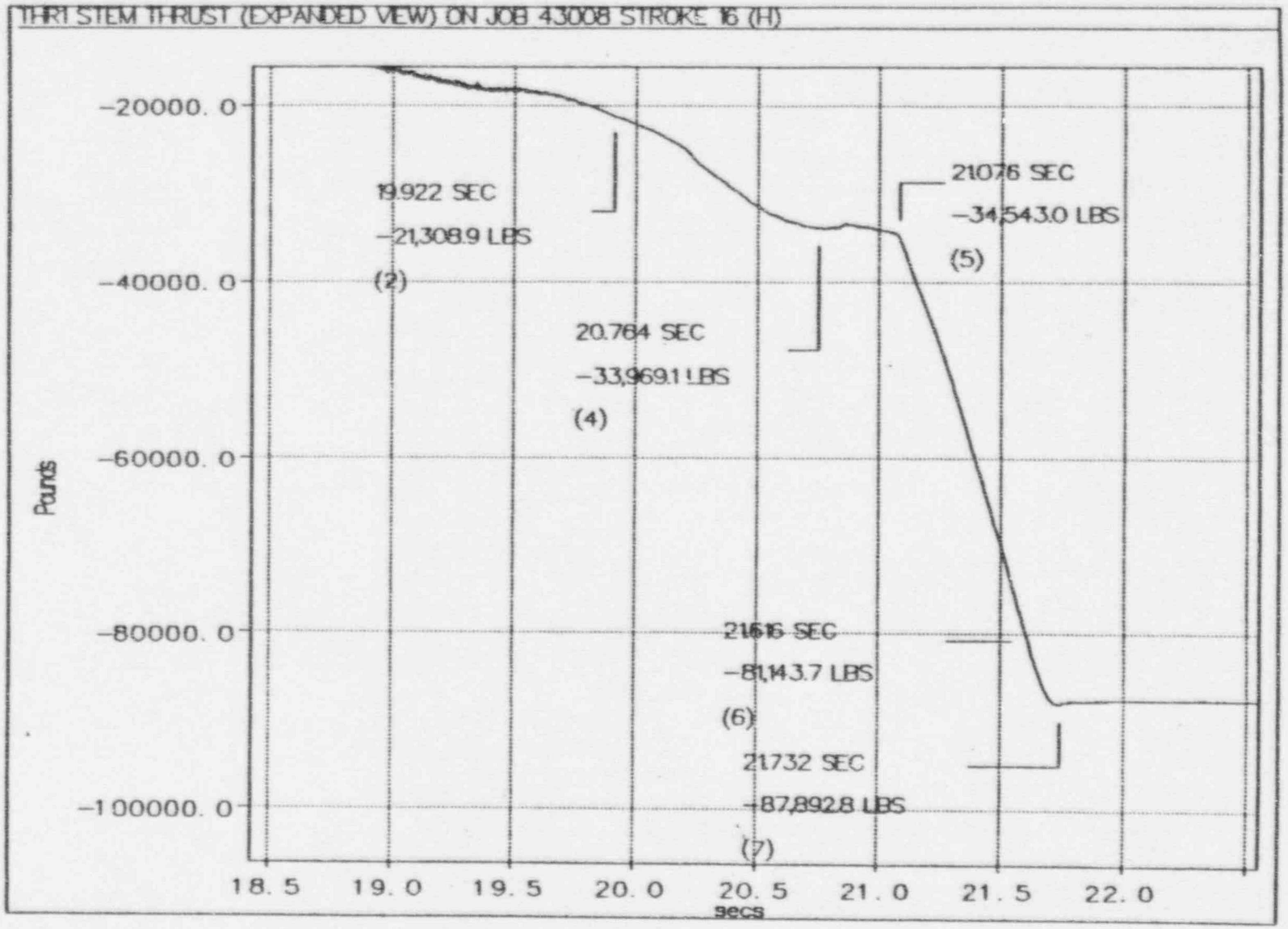
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	12.164	-585.4	45.89	====	507.7	====	N/A
2. Max. dP	19.922	-21,308.9	384.25	====	547.5	544.7	.1229
3. Minimum Available	====	80,558.3	1280.56	====	====	====	====
4. Just Prior to Wedging	20.764	-33,964.1	574.19	0.0432	====	====	====
5. Wedging	21.076	-34,543.0	594.56	0.0442	540.3	540.2	====
6. Torque Switch Trip	21.616	-81,143.7	1326.45	0.2203	====	====	.1048
7. Total	21.732	-87,892.8	1536.20	0.2471	====	====	====
8. Inertia	====	6749.1	====	——	====	====	====

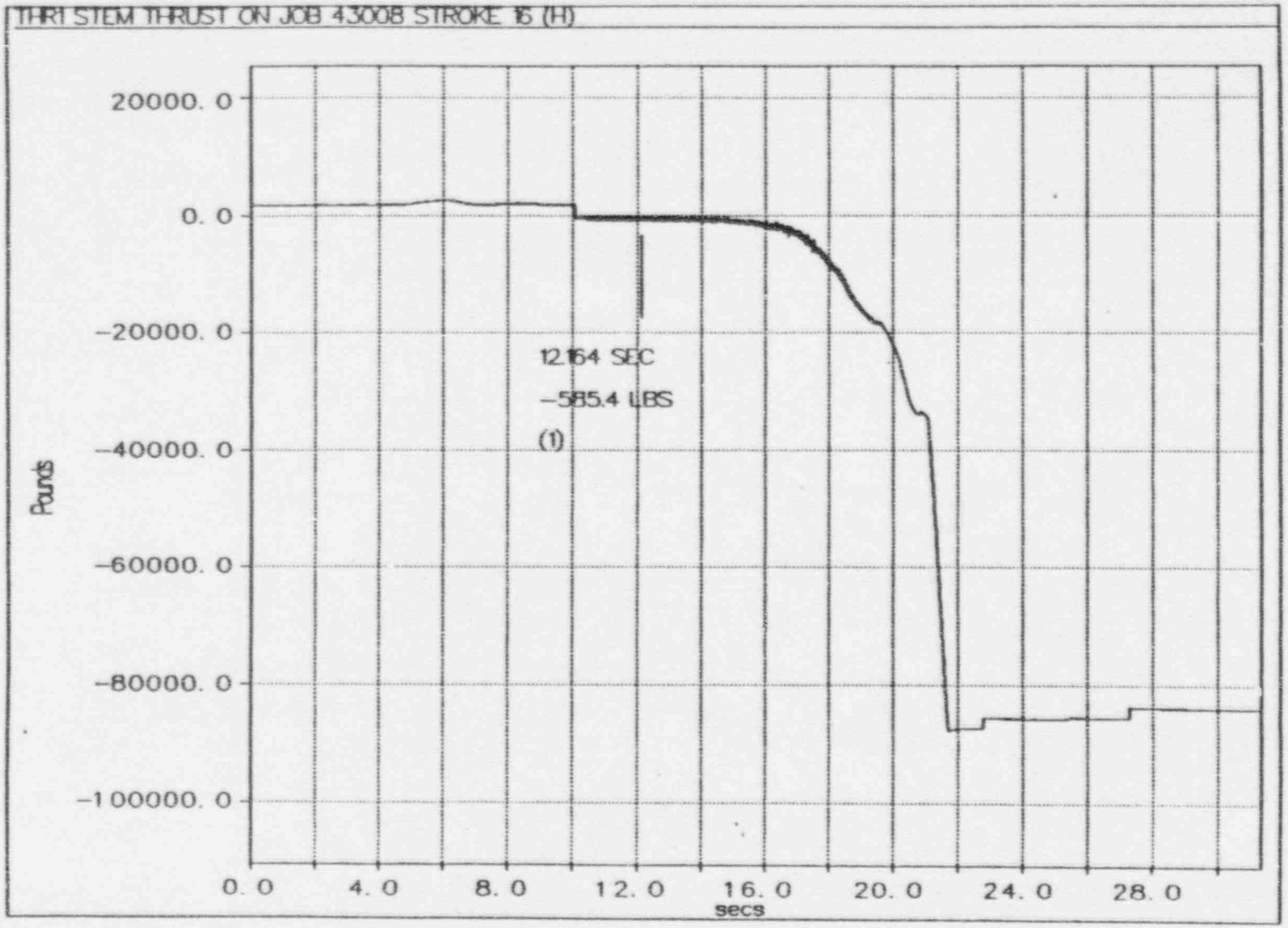
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/15/93

Verified by: [signature] 2/15/93


THRT STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 16 (H)
Pounds
-20000.0
-40000.0
-60000.0
-80000.0
-100000.0
18.5
19.0
19.5
20.0
20.5
21.0
21.5
22.0
secs
19.922 SEC
-21,308.9 LBS
(2)
20.764 SEC
-33,969.1 LBS
(4)
21.076 SEC
-34,543.0 LBS
(5)
21.616 SEC
-81,143.7 LBS
(6)
21.732 SEC
-87,892.8 LBS
(7)


THR1 STEM THRUST ON JOB 43008 STROKE 16 (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
12.164 SEC
-585.4 LBS
(1)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
28. 0
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-13-93 **Test Time** 14:58:30
Test Description 500 psid 9000 RPM C+U **Stroke #** 17R (H)
Data File D43008 **Data Set** 33

OPEN STROKE

Running Current 15.5 amps RMS
Running Power 6435.4 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP .4909

Unseating Current 23.1 amps RMS
Stroke Time 18.4 sec
Disk Factor (NMAC) at Max dP .5517

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.851	1905.4	-19.587	====	534.4	====	N/A
2. Max. dP	5.177	31,294.8	-464.39	====	518.5	518.9	.0887
3. Unseating	4.227	38,979.3	-515.87	-0.0430	====	====	====
4. Just After Unseating	4.372	32,287.6	-458.12	-0.0340	522.2	517.6	====
5. Hammer Blow	3.041	-80,288.6	====	-0.0070	====	====	====

CLOSE STROKE

Running Current ____ amps RMS
Running Power ____ watts
Contactor Drop-out Time ____ sec
Disk Factor (Standard) at Max dP ____

Stroke Time ____ sec
Rate of Loading ____
Disk Factor (NMAC) at Max dP ____

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

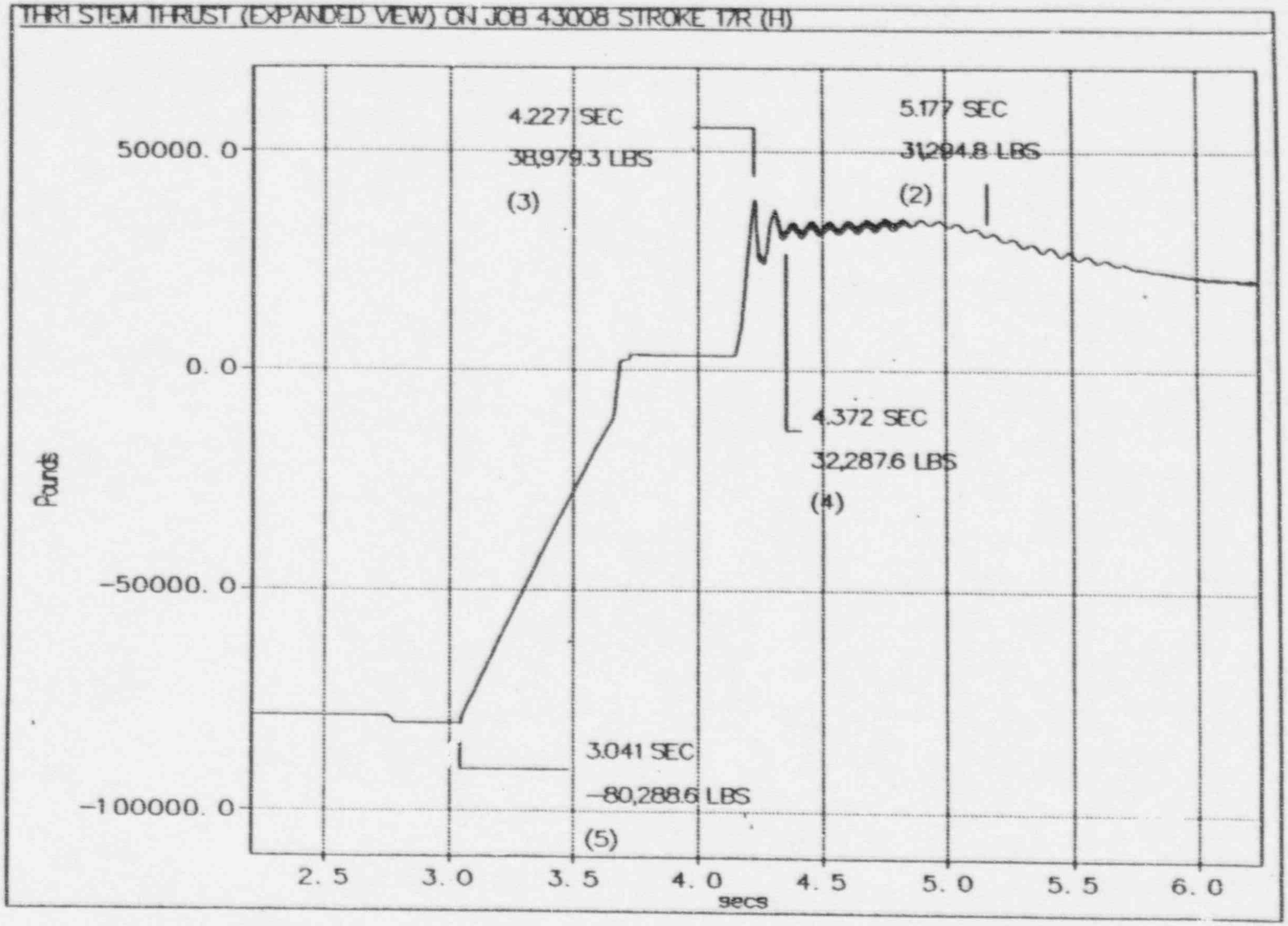
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

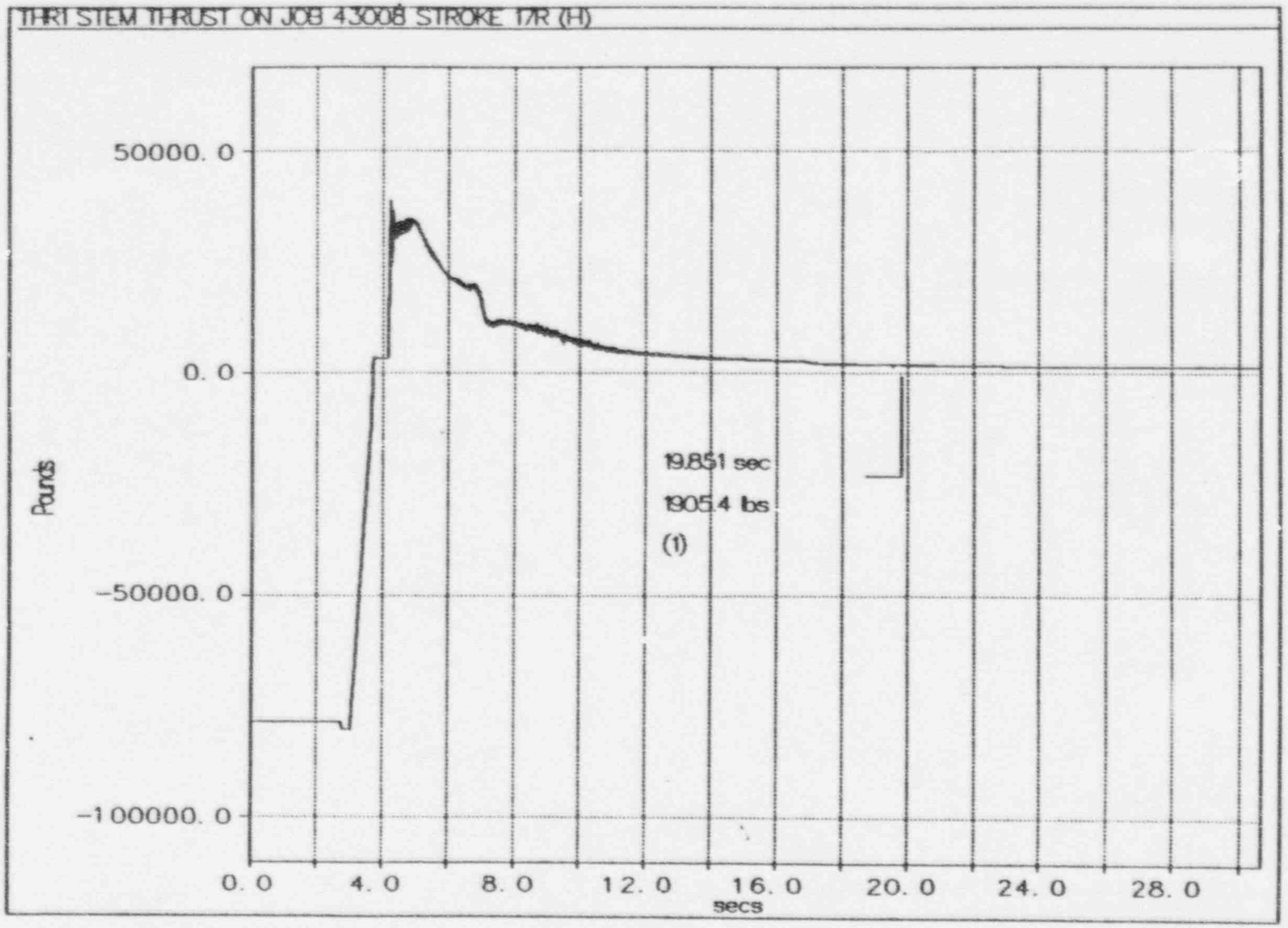
UNSEATING IN TWO STEPS.

Analyzed by: [signature] 2/10/93

Verified by: [signature] 2/15/93



THR1 STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 17R (H)
4.227 SEC
38,979.3 LBS
(3)
5.177 SEC
31,294.8 LBS
(2)
4.372 SEC
32,287.6 LBS
(4)
3.041 SEC
-80,288.6 LBS
(5)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
2. 5
3. 0
3. 5
4. 0
4. 5
5. 0
5. 5
6. 0
secs


THRI STEM THRUST ON JOB 43008 STROKE 17R (H)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
19.851 sec
1905.4 lbs
(1)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
28. 0
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-11-93	**Test Time**	18:27:52
Test Description	500 PSID 9000 GPM O-C	**Stroke #**	18 (H)
Data File	D4300B	**Data Set**	21

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	16.1	amps RMS	Stroke Time	12.6	sec
Running Power	7899.6	watts	Rate of Loading	NO	
Contactor Drop-out Time	0.010	sec			
Disk Factor (Standard) at Max dP	.3258		Disk Factor (NMAC) at Max dP	.3744	

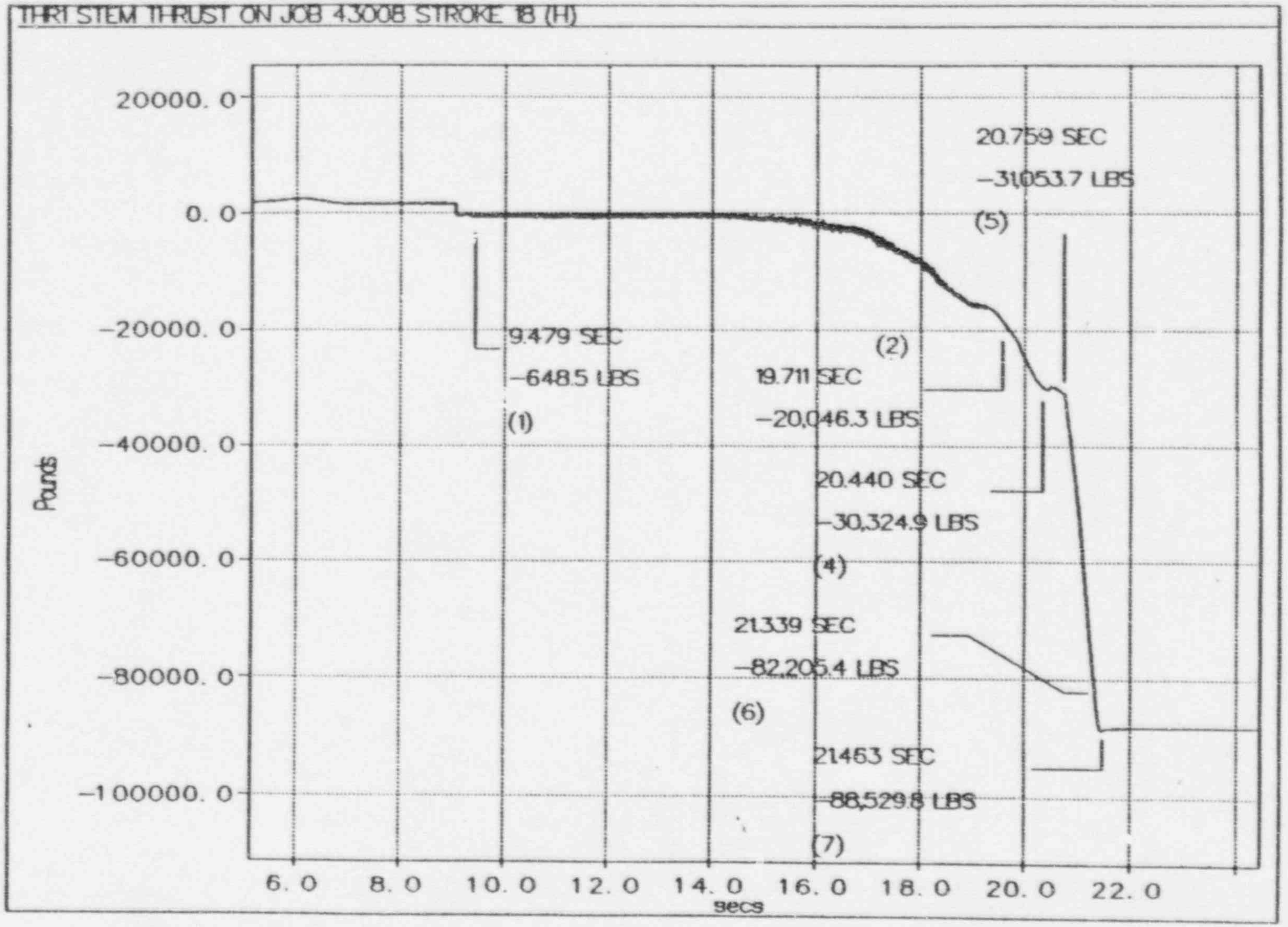
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.479	-648.5	46.56	====	536.9	====	N/A
2. Max. dP	19.711	-20,046.3	365.21	====	494.1	498.7	.1248
3. Minimum Available	====	81,556.9	1284.92	====	====	====	====
4. Just Prior to Wedging	20.440	-30,324.9	521.02	+0.0291	====	====	====
5. Wedging	20.759	-31,053.7	532.44	+0.0298	491.6	492.2	====
6. Torque Switch Trip	21.339	-82,205.4	1331.48	+0.2209	====	====	.1032
7. Total	21.463	-88,529.8	1498.25	+0.2510	====	====	====
8. Inertia	====	6324.4	====	——	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/11/93

Verified by: [signature] 2/15/93


THR1 STEM THRUST ON JOB 43008 STROKE 18 (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
6. 0
8. 0
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
22. 0
secs
9.479 SEC
-648.5 LBS
(1)
19.711 SEC
-20,046.3 LBS
(2)
20.440 SEC
-30,324.9 LBS
(4)
20.759 SEC
-31,053.7 LBS
(5)
21.339 SEC
-82,205.4 LBS
(6)
21.463 SEC
-88,529.8 LBS
(7)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-12-93	Test Time	11:26:20
Test Description	500 PSId 9000 GPM C->O	Stroke #	19 (H)
Data File	D43008	Data Set	23

OPEN STROKE

Running Current	15.8	amps RMS	Unseating Current	26.5	amps RMS
Running Power	7374.8	watts	Stroke Time	18.5	sec
Contactor Drop-out Time	0.011	sec			
Disk Factor (Standard) at Max dP	.5403		Disk Factor (NMAC) at Max dP	.5979	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.054	1780.7	-17.91	====	*625.1	====	N/A
2. Max. dP	4.716	33,223.1	-456.55	====	510.5	512.6	.0769
3. Unseating	4.055	41,768.4	-577.92	-.00490	====	====	====
4. Just After Unseating	4.194	32,626.2	-439.43	-0.0410	511.2	511.3	====
5. Hammer Blow	2.872	-77,522.4	====	+0.0780	====	====	====

CLOSE STROKE

Running Current		amps RMS	Stroke Time		sec
Running Power		watts	Rate of Loading		
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====		====	====	====

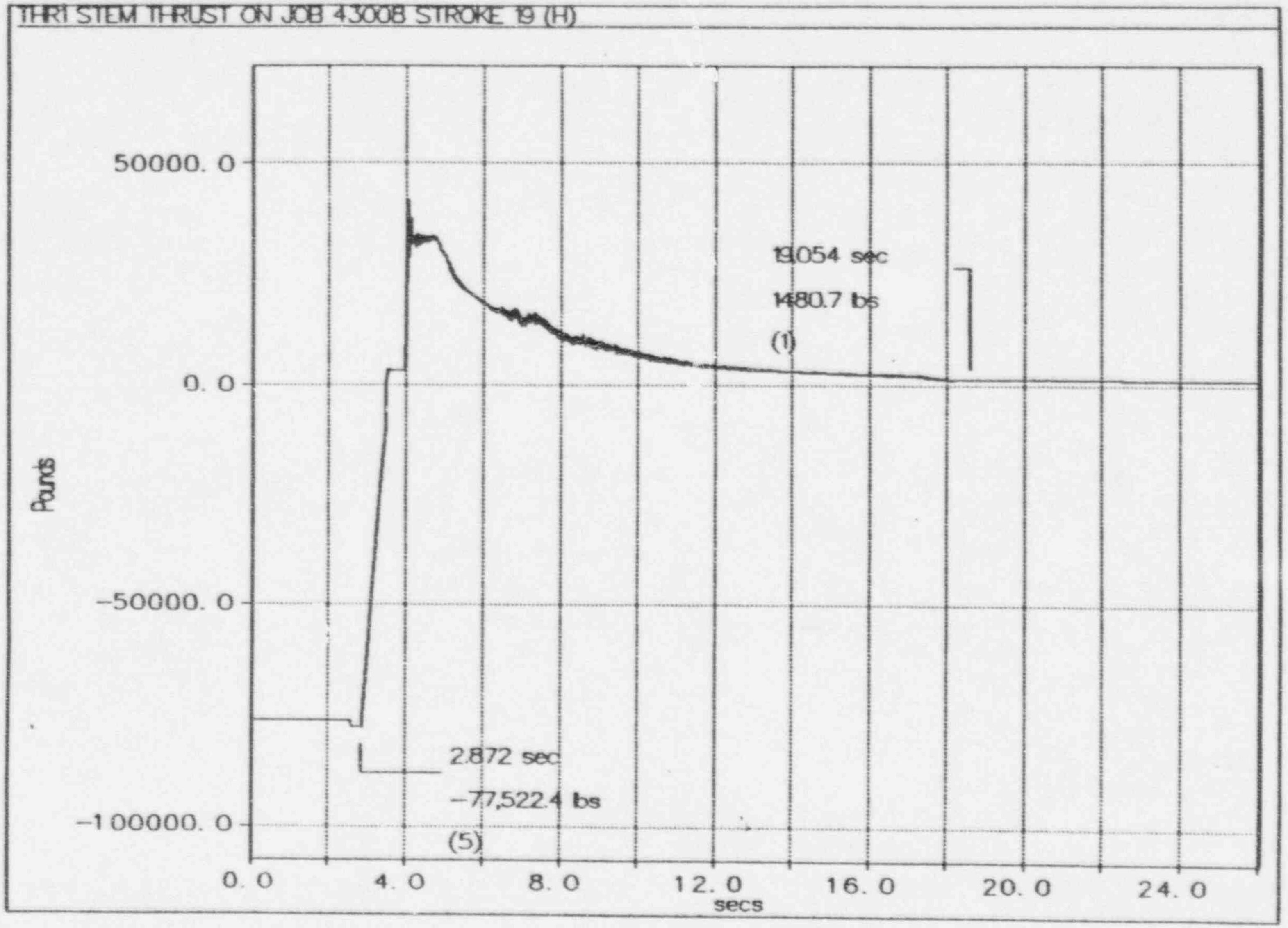
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

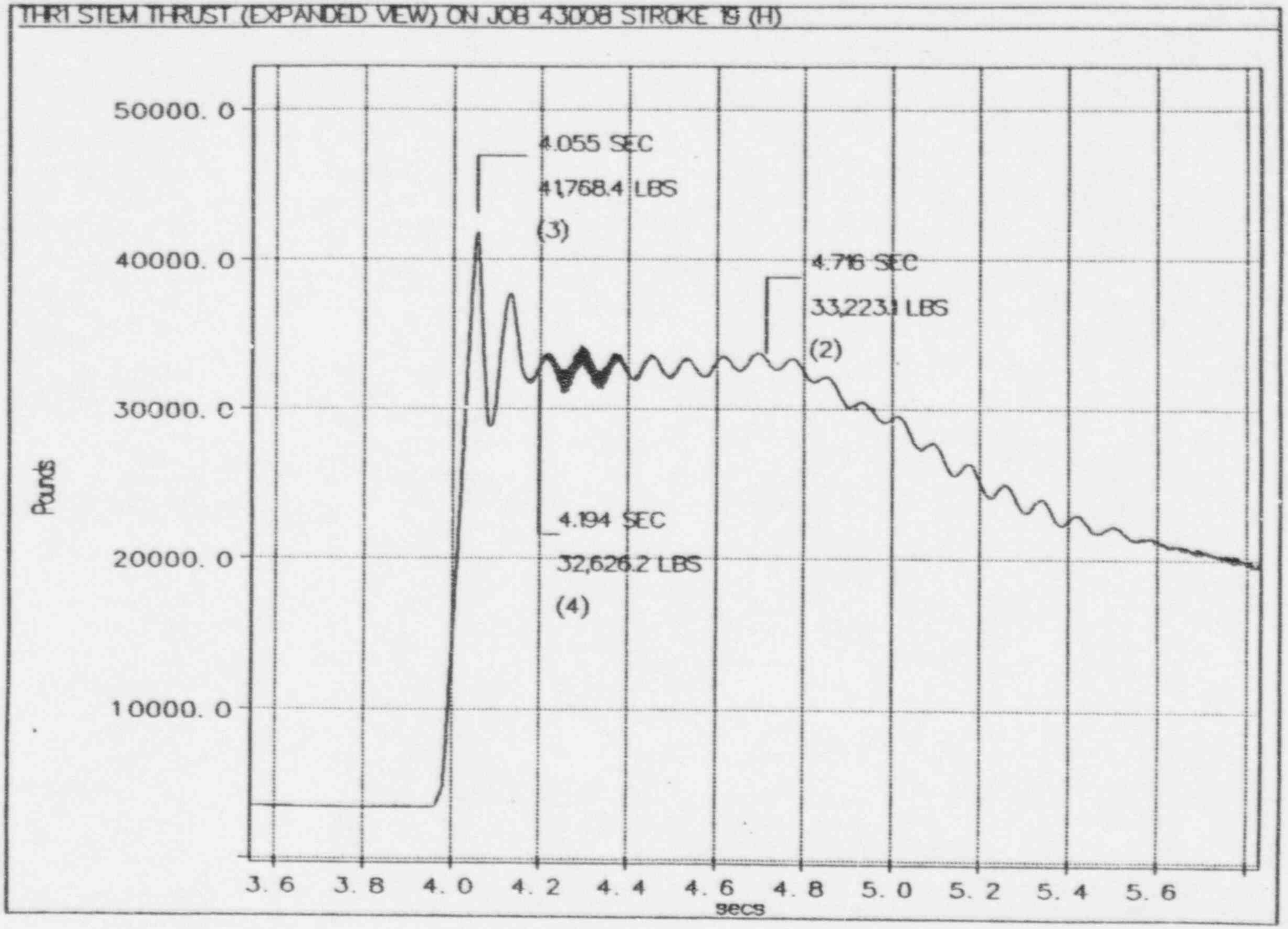
*OBTAINED FROM PS3; PS1 SATURATED AT THIS POINT. PS3 TRACKS WITH PS1 UNTIL ITS SATURATION.
UNSEATING IN TWO STEPS.

Analyzed by: [signature] 2/11/93

Verified by: [signature] 2/15/93



THR1 STEM THRUST ON JOB 43008 STROKE 19 (H)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
19.054 sec
1480.7 lbs
(1)
2.872 sec
-77,522.4 lbs
(5)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
secs


THR1 STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 19 (H)
4.055 SEC
41,768.4 LBS
(3)
4.716 SEC
33,223.1 LBS
(2)
4.194 SEC
32,626.2 LBS
(4)
Pounds
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
3. 6
3. 8
4. 0
4. 2
4. 4
4. 6
4. 8
5. 0
5. 2
5. 4
5. 6
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-12-93	**Test Time**	13:02:43
Test Description	500 PSId 9000 GPM	**Stroke #**	20 (H)
Data File	D43008	**Data Set**	2V

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP		

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	18.6	amps RMS	Stroke Time	11.7	sec
Running Power	11,230.0	watts	Rate of Loading	YES	
Contactor Drop-out Time	0.015	sec			
Disk Factor (Standard) at Max dP	.3075		Disk Factor (NMAC) at Max dP	.3628	

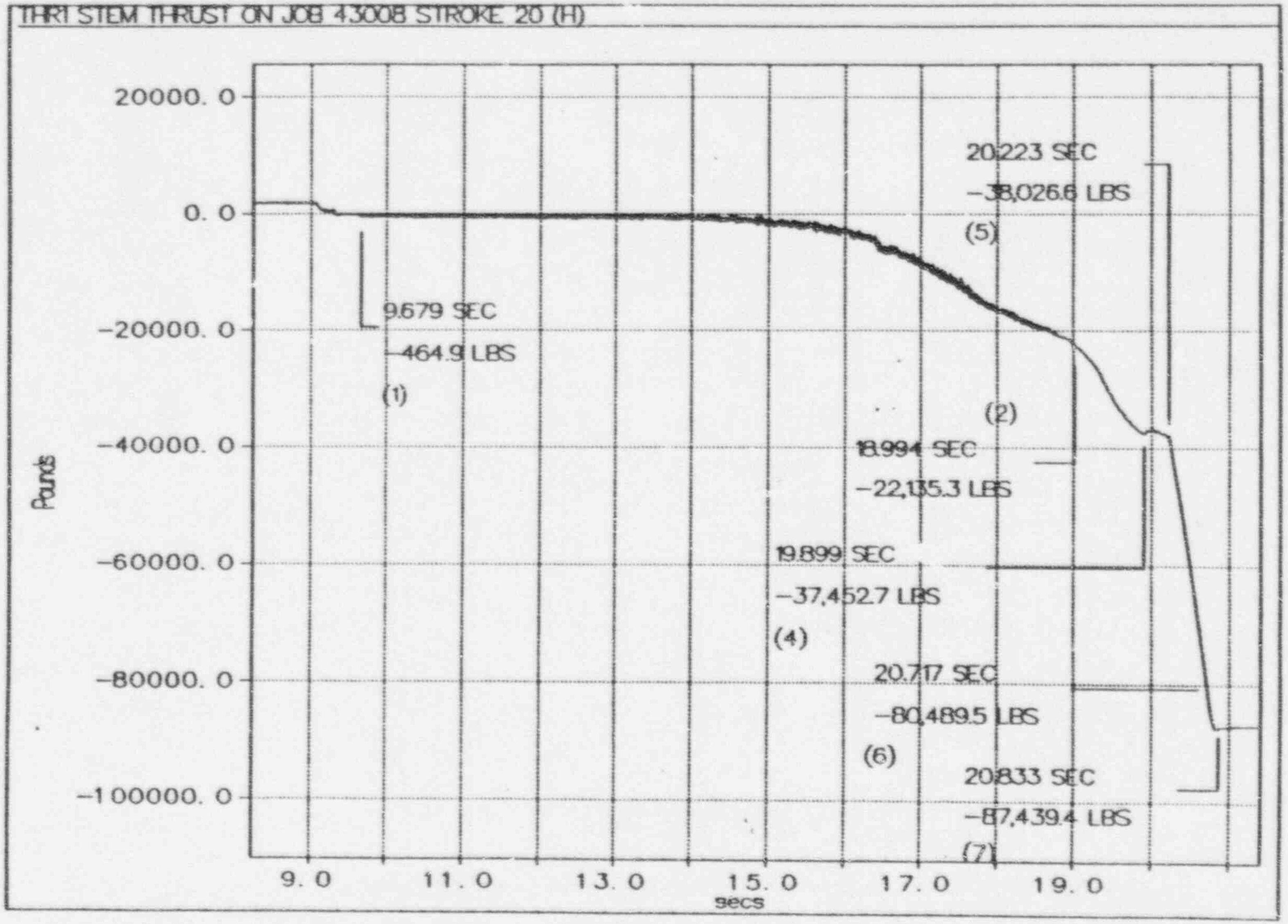
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.679	-464.9	46.34	====	534.7	====	N/A
2. Max. dP	18.994	-22,135.3	394.54	====	584.9	586.3	.1206
3. Minimum Available	====	80,024.6	1251.45	====	====	====	====
4. Just Prior to Wedging	19.899	-37,452.7	621.08	0.0585	====	====	====
5. Wedging	20.223	-38,026.6	648.73	0.0637	577.4	576.7	====
6. Torque Switch Trip	20.717	-80,489.5	1297.79	0.2191	====	====	.1025
7. Total	20.833	-87,439.4	1521.42	0.2460	====	====	====
8. Inertia	====	6949.9	====	——	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/11/93

Verified by: [signature] 2/15/93


THR1 STEM THRUST ON JOB 43008 STROKE 20 (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
9. 0
11. 0
13. 0
15. 0
17. 0
19. 0
secs
9.679 SEC
-464.9 LBS
(1)
(2)
18.994 SEC
-22,135.3 LBS
20.223 SEC
-38,026.6 LBS
(5)
19.899 SEC
-37,452.7 LBS
(4)
20.717 SEC
-80,489.5 LBS
(6)
20.833 SEC
-87,439.4 LBS
(7)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-20-93 | Test Time 15:43:27
Test Description 400 PSId 8000 GPM C→O | Stroke # 21R (H)
Data File D430081 | Data Set 7

OPEN STROKE

Running Current 14.2 amps RMS | Unseating Current 24.6 amps RMS
Running Power 6126.0 watts | Stroke Time 18.4 sec
Contactor Drop-out Time 0.006 sec
Disk Factor (Standard) at Max dP .5465 | Disk Factor (NMAC) at Max dP .6033

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.406	-5291.4	-95.59	****	463.0	****	N/A
2. Max. dP	4.398	18,066.4	-428.57	****	372.3	373.1	.1833
3. Unseating	3.702	40,247.6	-717.45	-0.063	****	****	****
4. Just After Unseating	3.822	18,433.7	-434.28	-0.014	371.7	372.6	****
5. Hammer Blow	2.494	-89,706.3	****	+0.034	****	****	****

CLOSE STROKE

Running Current ______ amps RMS | Stroke Time ______ sec
Running Power ______ watts | Rate of Loading ______
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ | Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				****		****	
2. Max. dP				****			
3. Minimum Available	****			****	****	****	****
4. Just Prior to Wedging					****	****	****
5. Wedging							****
6. Torque Switch Trip					****	****	
7. Total					****	****	****
8. Inertia	****		****		****	****	****

Note: All values annotated above are actual values, with no correction for static conditions.

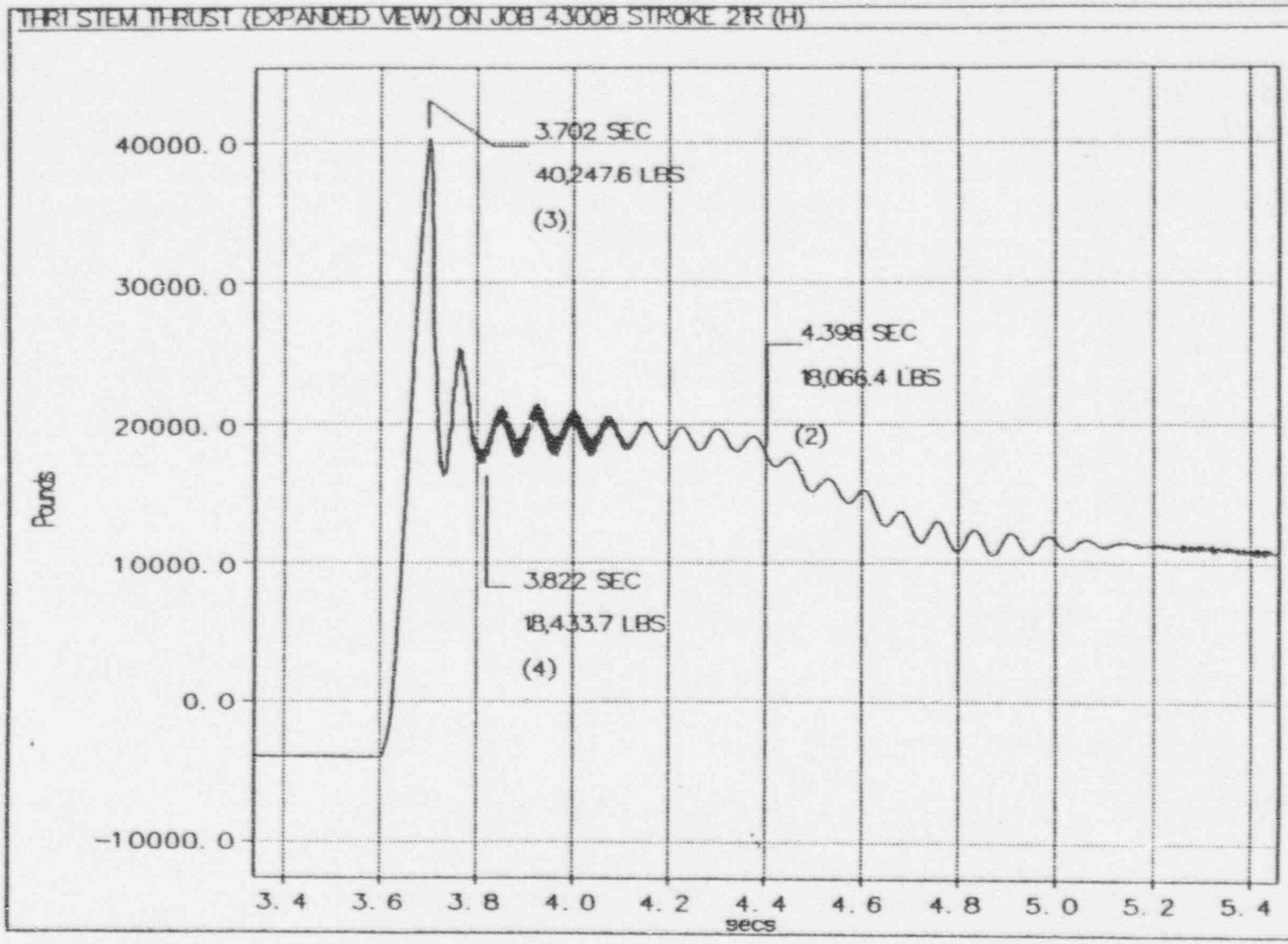
Remarks

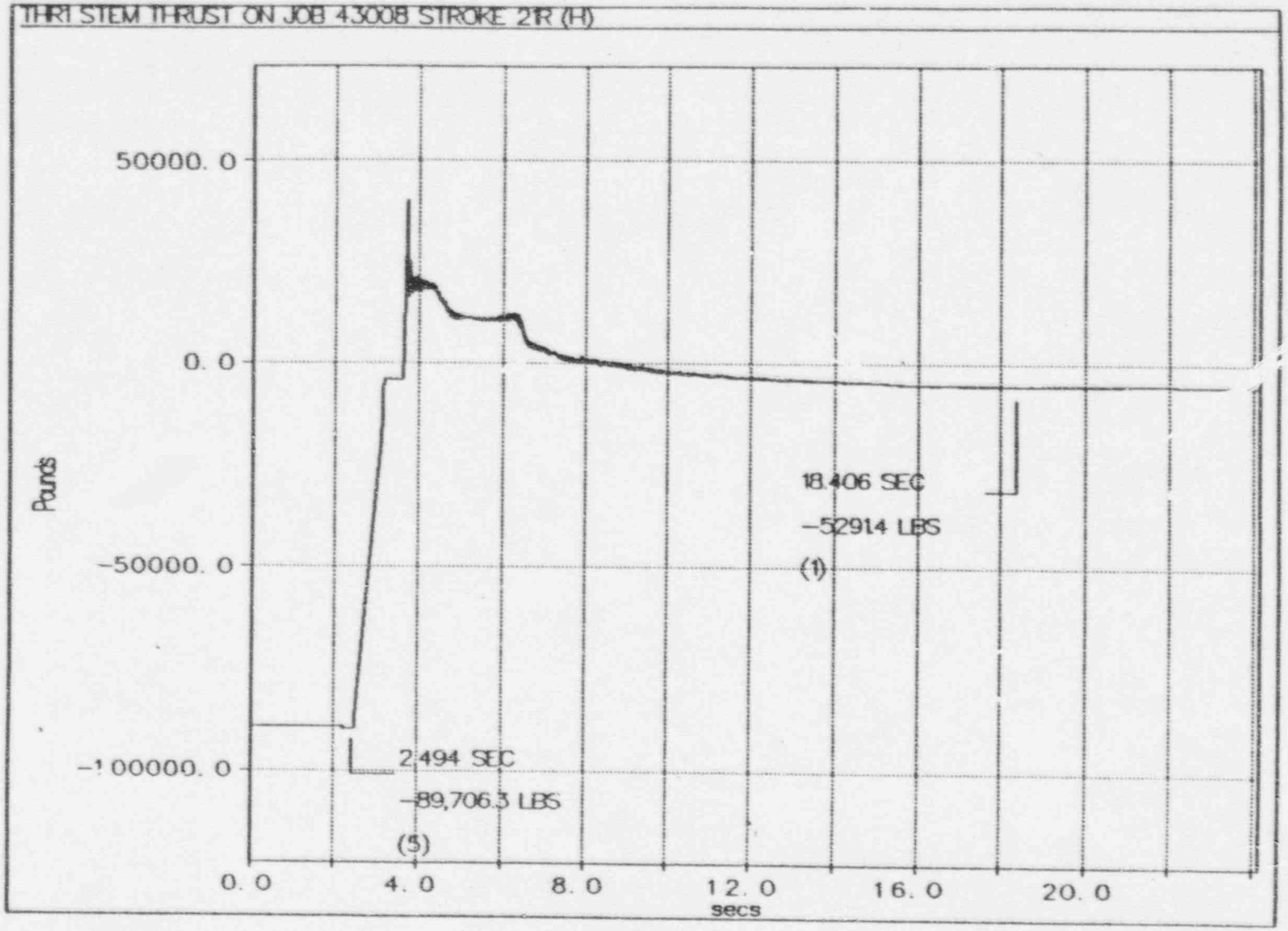
NOTED HIGH RUNNING THRUST AND HIGH STEM FACTOR (H)

UNSEATING IN TWO STEPS

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93


THRT STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 2R (H)
3.702 SEC
40,247.6 LBS
(3)
4.398 SEC
18,066.4 LBS
(2)
3.822 SEC
18,433.7 LBS
(4)
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
-10000. 0
Pounds
3. 4
3. 6
3. 8
4. 0
4. 2
4. 4
4. 6
4. 8
5. 0
5. 2
5. 4
secs


THRI STEM THRUST ON JOB 43008 STROKE 2R (H)
50000. 0
0. 0
-50000. 0
-100000. 0
Pounds
18.406 SEC
-52914 LBS
(1)
2.494 SEC
-89,706.3 LBS
(5)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-14-93	**Test Time**	15:22:00
Test Description	400 PSId 8000GPM 0-7C	**Stroke #**	22 R (H)
Data File	D4300B	**Data Set**	42

OPEN STROKE

Running Current ________ amps RMS
Running Power ________ watts
Contactor Drop-out Time ________ sec
Disk Factor (Standard) at Max dP ________

Unseating Current ________ amps RMS
Stroke Time ________ sec
Disk Factor (NMAC) at Max dP ________

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 15.9 amps RMS
Running Power 7223.2 watts
Contactor Drop-out Time 0.010 sec
Disk Factor (Standard) at Max dP .3277

Stroke Time 11.6 sec
Rate of Loading NO
Disk Factor (NMAC) at Max dP .3702

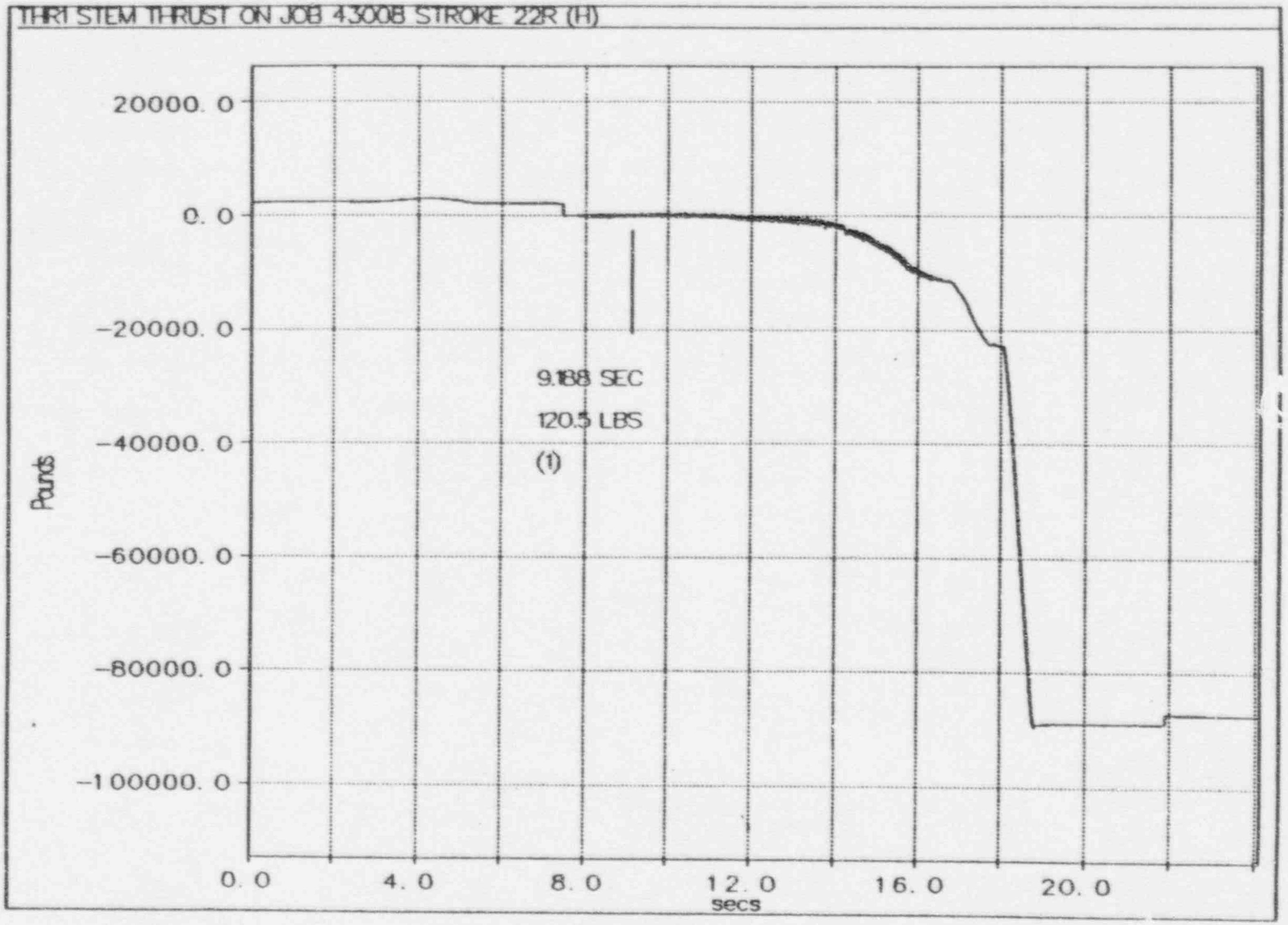
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	9.188	120.5	37.38	====	432.8	====	N/A
2. Max. dP	17.059	-14,014.6	272.77	====	356.7	361.7	.1381
3. Minimum Available	====	82,859.7	1305.18	====	====	====	====
4. Just Prior to Wedging	17.735	-22,502.6	397.79	0.0090	====	====	====
5. Wedging	18.060	-22,892.9	400.36	0.0055	356.7	358.2	====
6. Torque Switch Trip	18.704	-82,739.2	1342.56	0.2265	====	====	.1036
7. Total	18.816	-89,557.1	1577.50	0.2596	====	====	====
8. Inertia	====	6817.9	====	———	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

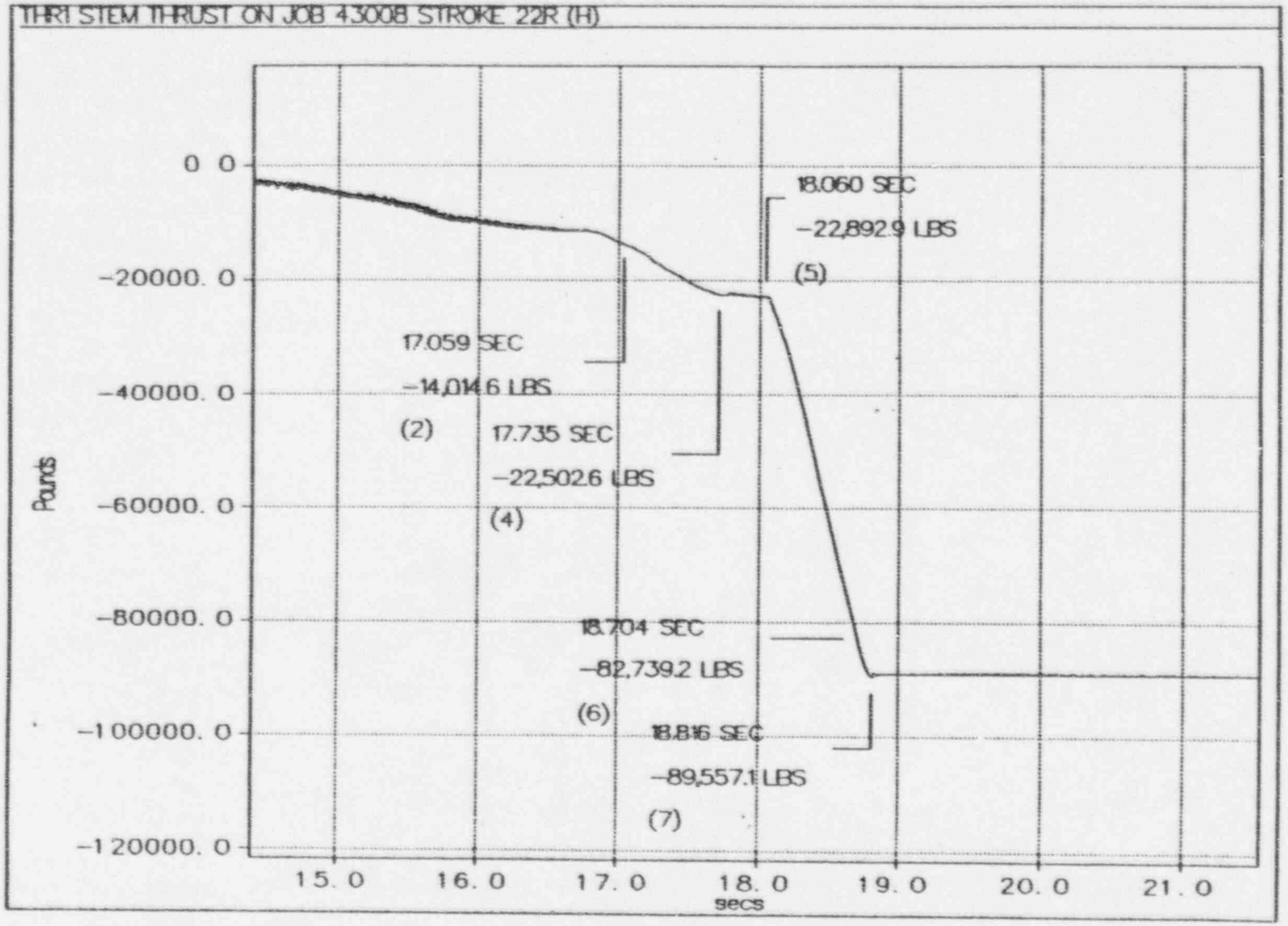
Remarks

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



THR1 STEM THRUST ON JOB 43008 STROKE 22R (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
secs
9.188 SEC
120.5 LBS
(1)



THRI STEM THRUST ON JOB 43008 STROKE 22R (H)
0.0
-20000.0
-40000.0
-60000.0
-80000.0
-100000.0
-120000.0
Pounds
15.0
16.0
17.0
18.0
19.0
20.0
21.0
secs
18.060 SEC
-22,892.9 LBS
(5)
17.059 SEC
-14,014.6 LBS
(2)
17.735 SEC
-22,502.6 LBS
(4)
18.704 SEC
-82,739.2 LBS
(6)
18.816 SEC
-89,557.1 LBS
(7)

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1-14-93 **Test Time** 12:58:46
Test Description 300 PSid 7000 GPM C->O **Stroke #** 23R (H)
Data File D4300B **Data Set** 41

OPEN STROKE

Running Current 14.3 amps RMS
Running Power 5939.4 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP .4876
Unseating Current 24.1 amps RMS
Stroke Time 18.4 sec
Disk Factor (NMAC) at Max dP .5416

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	19.102	2898.2	-14.77	----	369.7	----	N/A
2. Max. dP	4.442	20,993.3	-300.64	----	319.5	321.6	.0831
3. Unseating	3.576	47,501.7	-648.84	-0.067	----	----	----
4. Just After Unseating	3.639	20,029.1	-279.15	-0.016	320.3	321.4	----
5. Hammer Blow	2.366	-83,445.1	----	-0.008	----	----	----

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				----		----	
2. Max. dP				----			
3. Minimum Available	----			----	----	----	----
4. Just Prior to Wedging					----	----	----
5. Wedging							----
6. Torque Switch Trip					----	----	
7. Total					----	----	----
8. Inertia	----		----		----	----	----

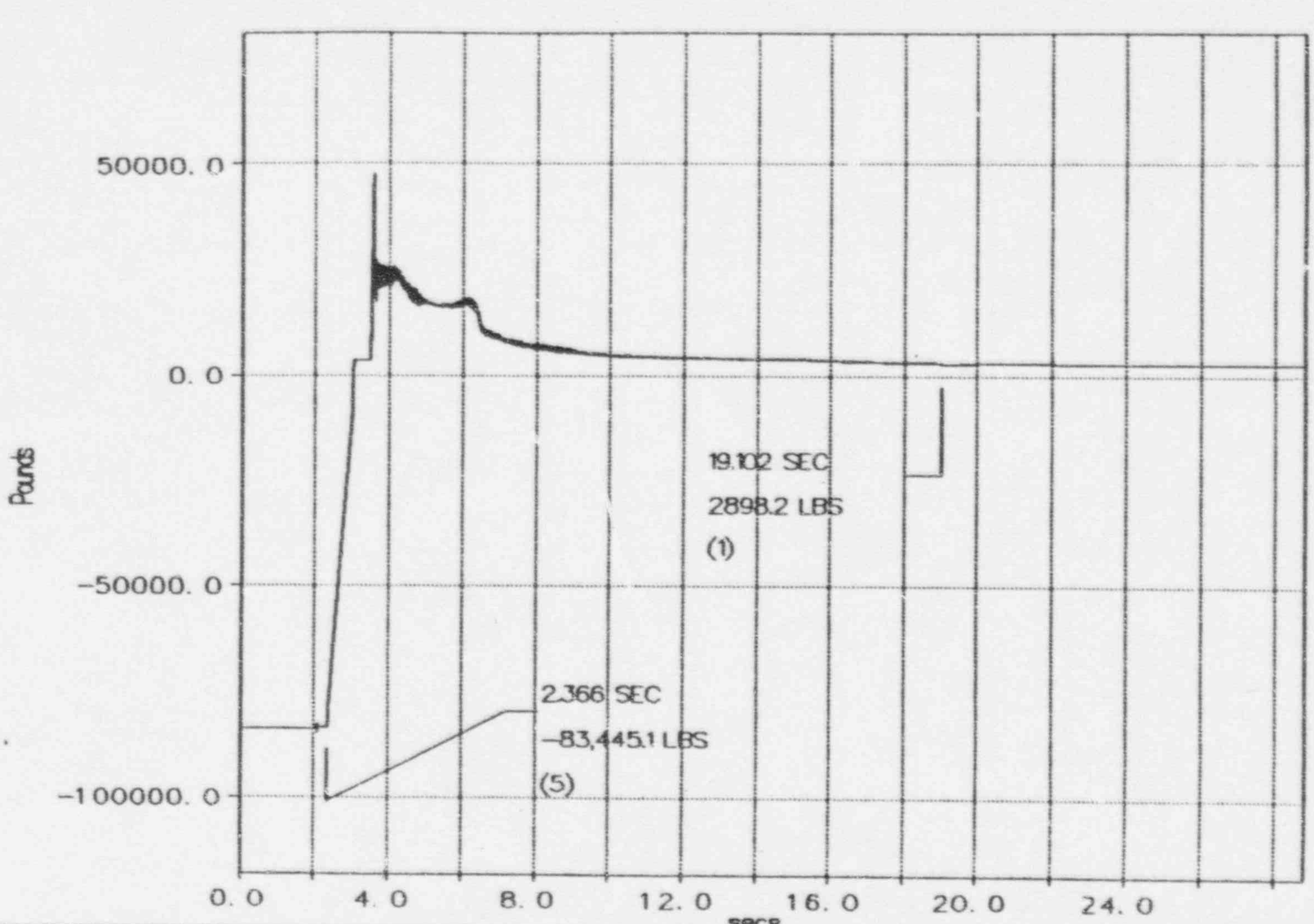
Note: All values annotated above are actual values, with no correction for static conditions.

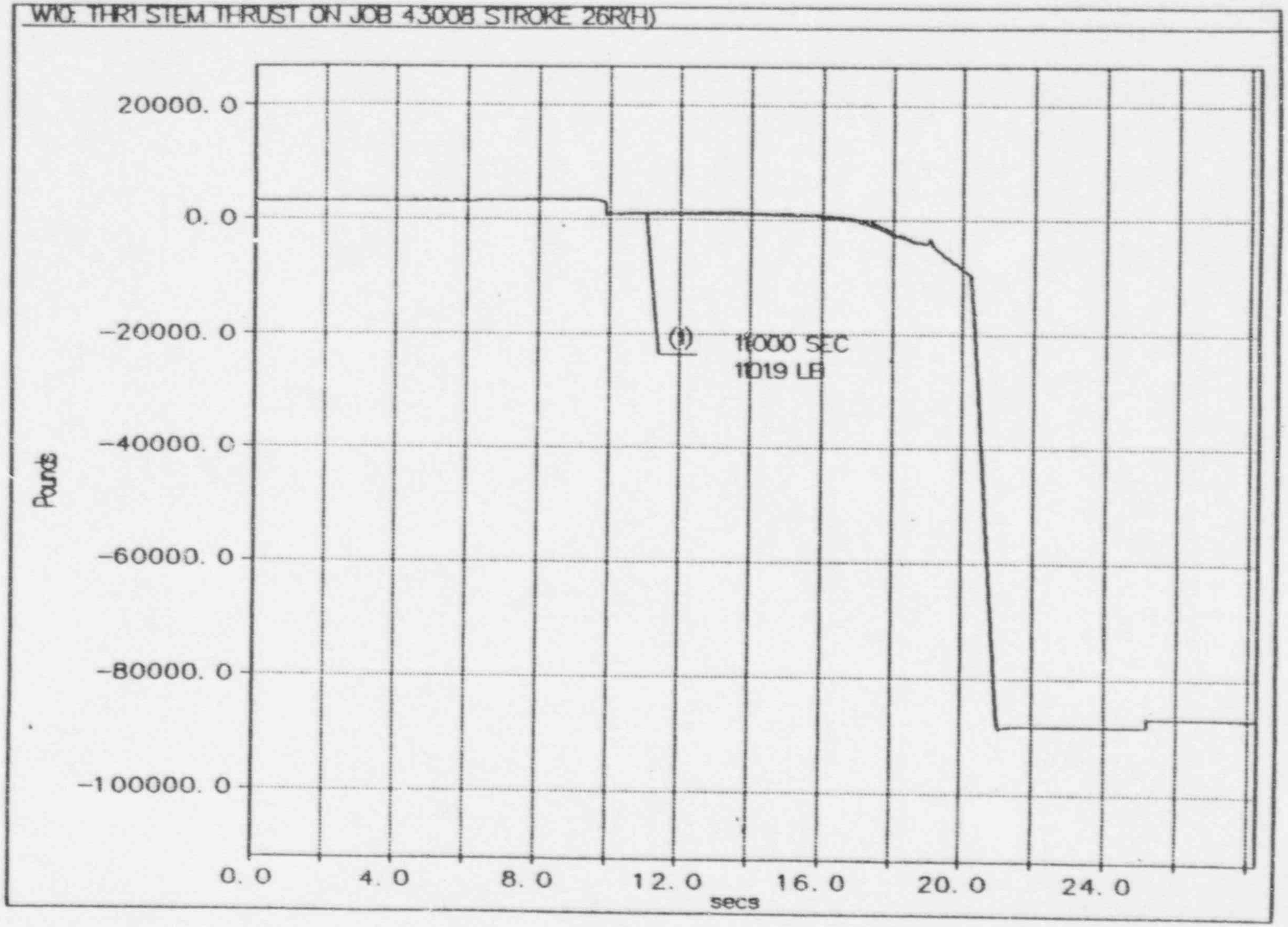
Remarks

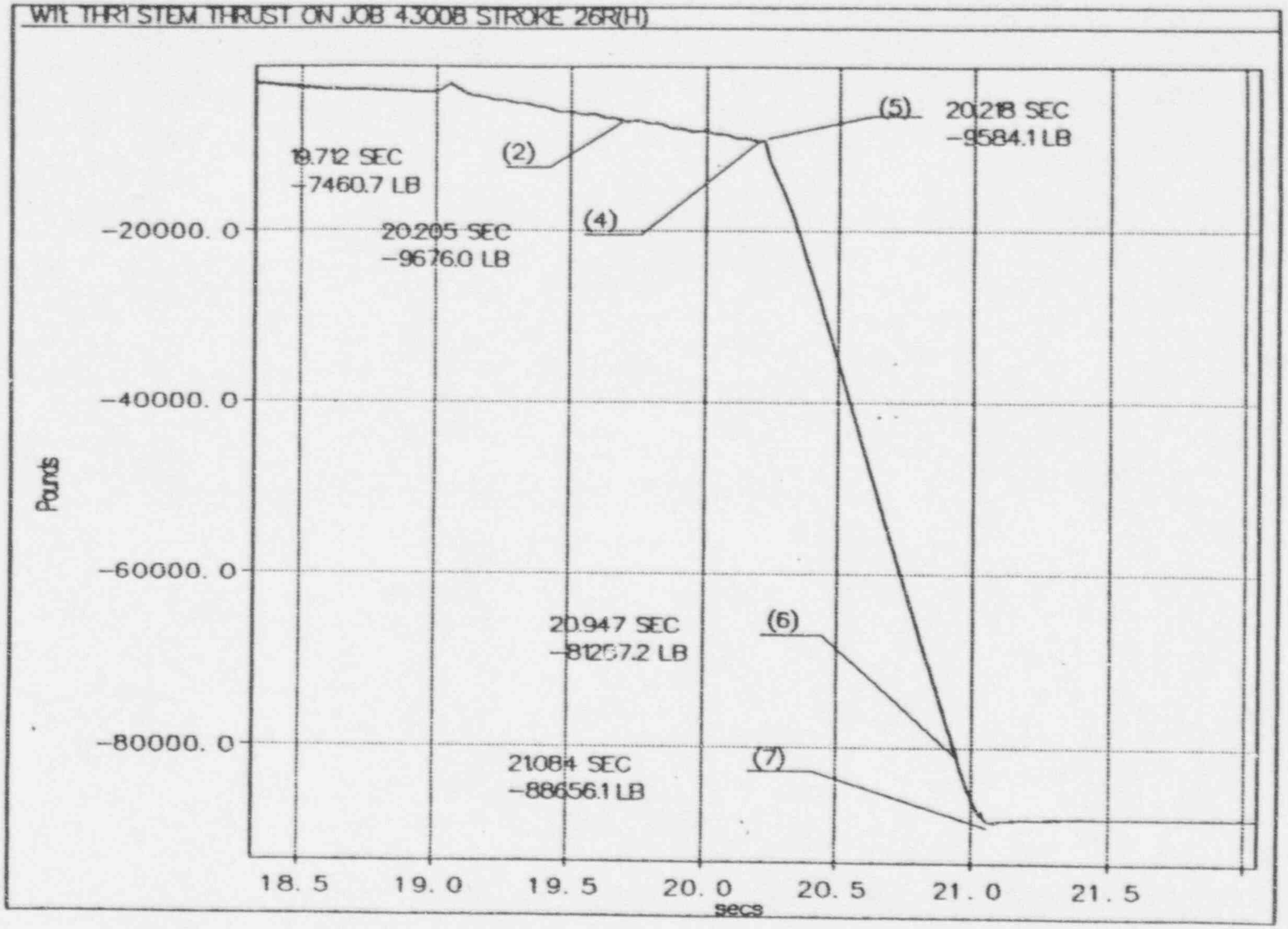
Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93

THR1 STEM THRUST ON JOB 43008 STROKE 23R (H)




W10: THR1 STEM THRUST ON JOB 43008 STROKE 26R(H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
secs
(1)
11.000 SEC
1019 LB



WIt THR1 STEM THRUST ON JOB 43008 STROKE 26R(H)
19.712 SEC
-7460.7 LB
(2)
(5)
20.218 SEC
-9584.1 LB
(4)
20.205 SEC
-9676.0 LB
-20000. 0
-40000. 0
-60000. 0
-80000. 0
Pounds
20.947 SEC
-81257.2 LB
(6)
21.084 SEC
-88656.1 LB
(7)
18. 5
19. 0
19. 5
20. 0
20. 5
21. 0
21. 5
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/13/93 **Test Time** 12:42:38
Test Description C-O, 100 PSID, 4000 GPM **Stroke #** 27(H)
Data File D43008 **Data Set** 031

OPEN STROKE

Running Current 14.45 amps RMS Unseating Current 24.83 amps RMS
Running Power 6908.8 watts Stroke Time 18.420 sec
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.5354 Disk Factor (NMAC) at Max dP 0.5968

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	20.000	4235.4	-37.2	■■■■	69.4	■■■■	-----
2. Max. dP	5.658	11380.4	-138.9	■■■■	115.3	116.4	0.0604
3. Unseating	5.562	50887.7	-684.8	-0.0723	■■■■	■■■■	■■■■
4. Just After Unseating	5.607	13607.2	-183.0	-0.0196	119.0	120.2	■■■■
5. Hammer Blow	4.351	-82234.1	■■■■	-0.0115	■■■■	■■■■	■■■■

CLOSE STROKE

Running Current ______ amps RMS Stroke Time ______ sec
Running Power ______ watts Rate of Loading ______
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

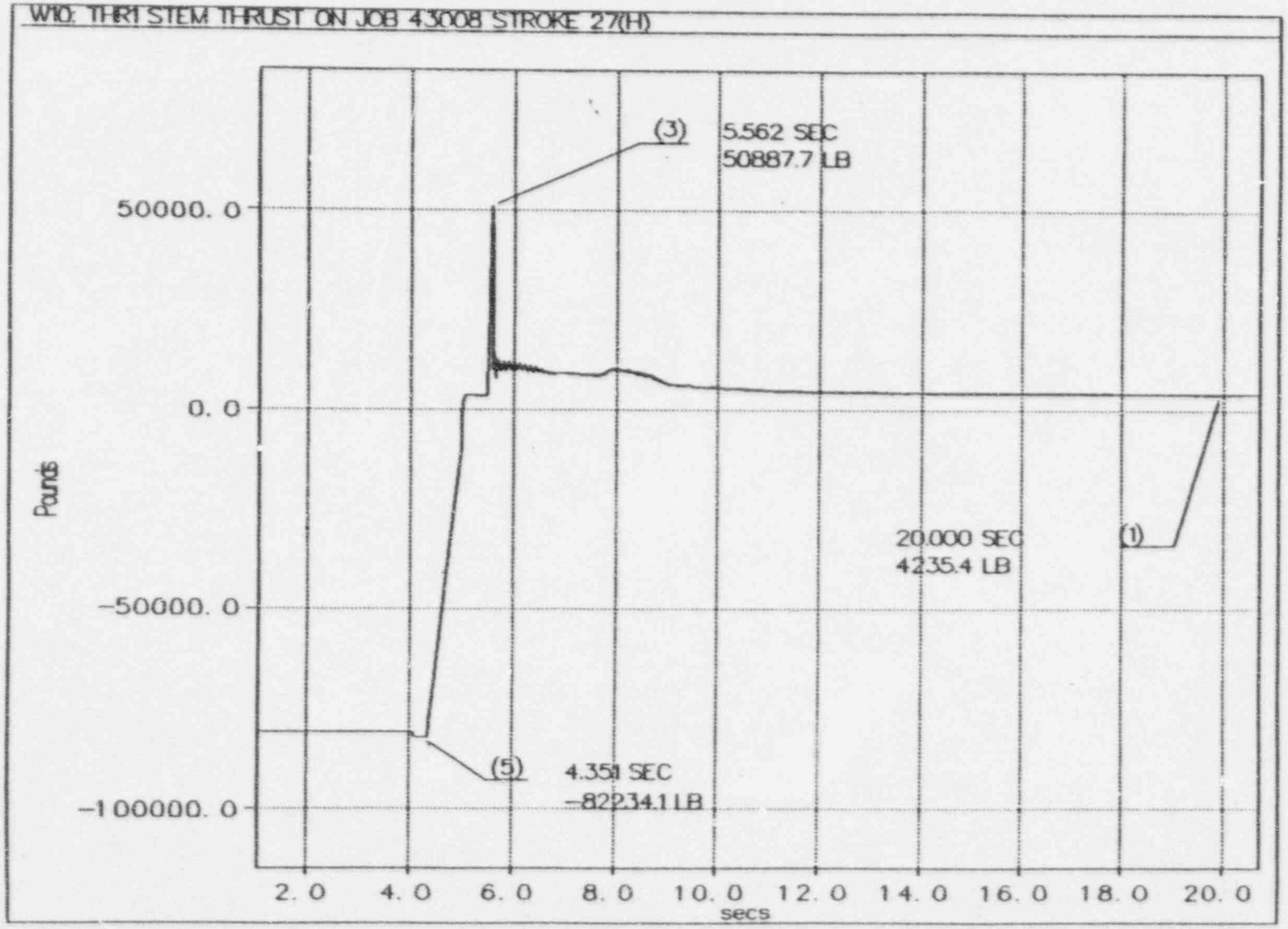
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				■■■■		■■■■	
2. Max. dP				■■■■			
3. Minimum Available	■■■■			■■■■	■■■■	■■■■	■■■■
4. Just Prior to Wedging					■■■■	■■■■	■■■■
5. Wedging							■■■■
6. Torque Switch Trip					■■■■	■■■■	
7. Total					■■■■	■■■■	■■■■
8. Inertia	■■■■		■■■■		■■■■	■■■■	■■■■

Note: All values annotated above are actual values, with no correction for static conditions.

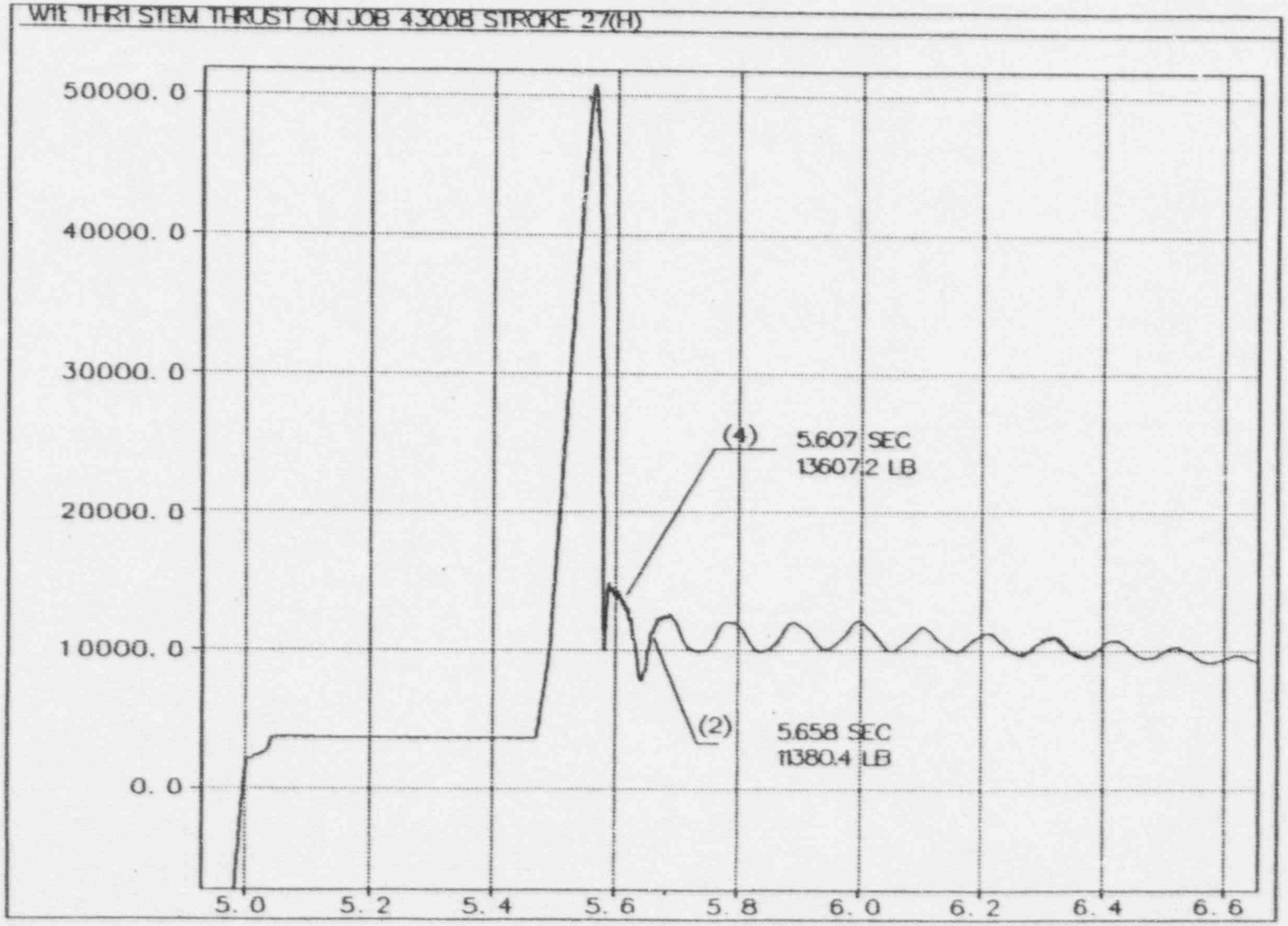
Remarks

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



W10: THR1 STEM THRUST ON JOB 43008 STROKE 27(H)
(3) 5.562 SEC 50887.7 LB
(1) 20.000 SEC 4235.4 LB
(5) 4.351 SEC -82234.1 LB
50000.0
0.0
-50000.0
-100000.0
Pounds
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
secs



WIt THR1 STEM THRUST ON JOB 43008 STROKE 27(H)
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
5. 0
5. 2
5. 4
5. 6
5. 8
6. 0
6. 2
6. 4
6. 6
(4)
5.607 SEC
13607.2 LB
(2)
5.658 SEC
11380.4 LB

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/13/93 **Test Time** 12:49:14
Test Description O→C, 100 PSID, 4000 GPM **Stroke #** 28 (H)
Data File D43008 **Data Set** 032

OPEN STROKE

Running Current ______ amps RMS Unseating Current ______ amps RMS
Running Power ______ watts Stroke Time ______ sec
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______ Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 17.23 amps RMS Stroke Time 10.702 sec
Running Power 8141.3 watts Rate of Loading NO
Contactor Drop-out Time 0.013 sec
Disk Factor (Standard) at Max dP 0.6369 Disk Factor (NMAC) at Max dP 0.5581

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	10.000	1233.9	18.69	====	92.3	====	-----
2. Max. dP	18.292	-6904.0	139.2	====	124.1	126.3	0.1455
3. Minimum Available	====	-82107.9	1271.7	====	====	====	====
4. Just Prior to Wedging	18.403	-7345.9	146.8	0.0003	====	====	====
5. Wedging	18.423	-7236.9	146.6	-0.0007	128.3	126.5	====
6. Torque Switch Trip	19.159	-80874.0	1290.4	0.2196	====	====	0.1007
7. Total	19.300	-88547.0	1487.5	0.2525	====	====	====
8. Inertia	====	7673.0	====	-----	====	====	====

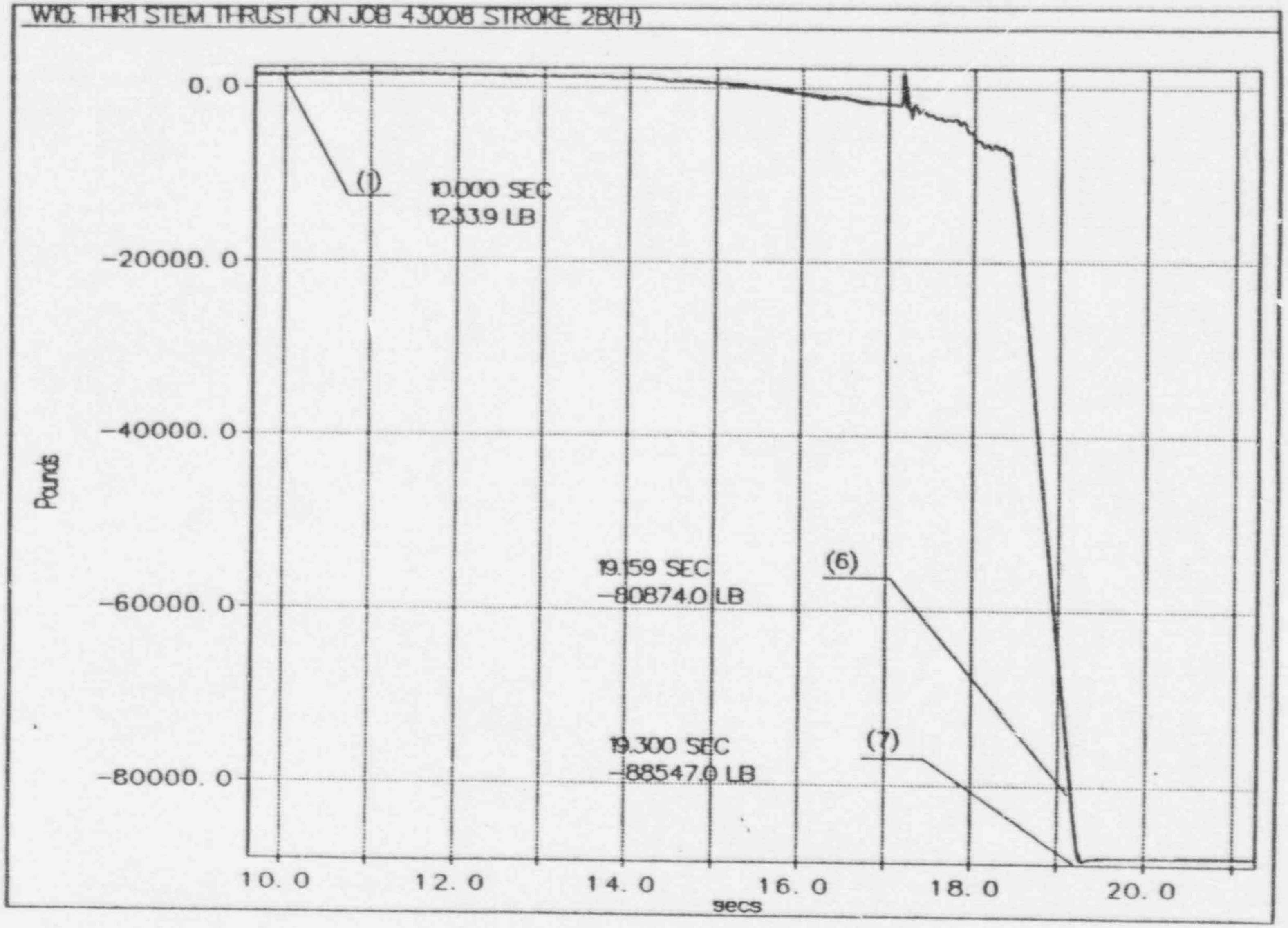
Note: All values annotated above are actual values, with no correction for static conditions.

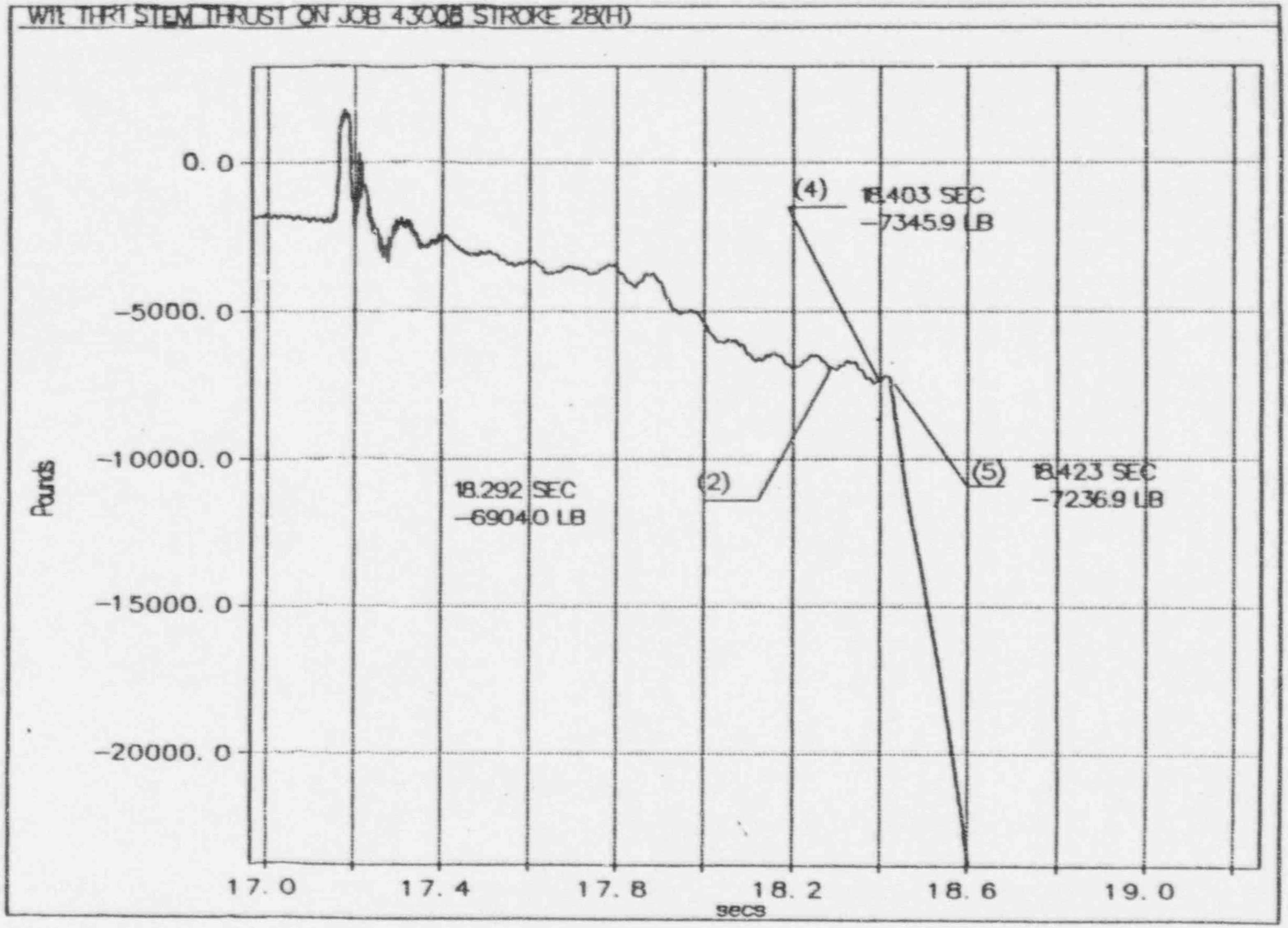
Remarks

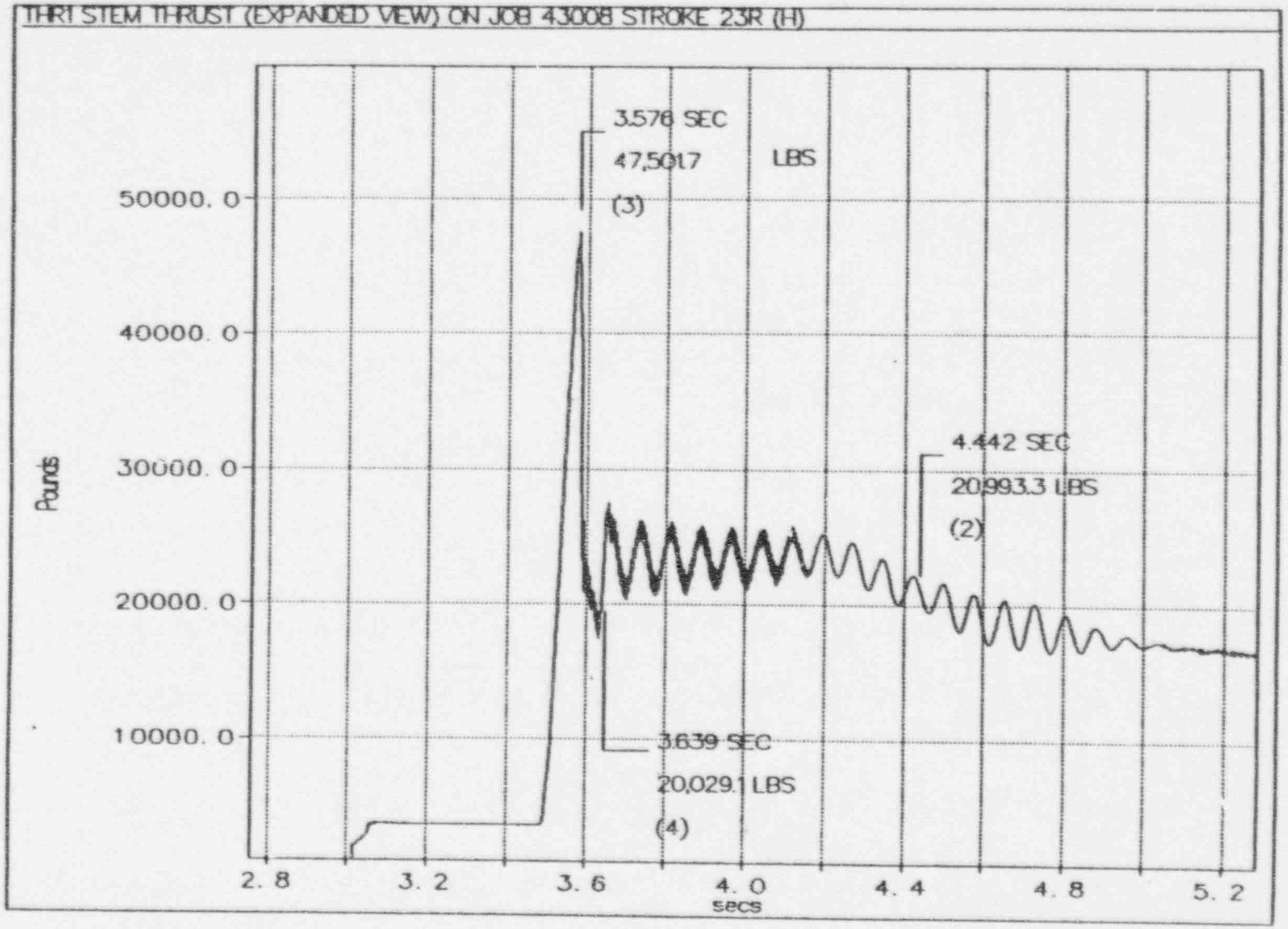
* MAX DP IS LOCAL MAX PRIOR TO WEDGING

Analyzed by: [signature] 2/13/93

Verified by: [signature] 2/15/93


W10: THR1 STEM THRUST ON JOB 43008 STROKE 2B(H)
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
Pounds
(1)
10.000 SEC
1233.9 LB
(6)
19.159 SEC
-80874.0 LB
(7)
19.300 SEC
-88547.0 LB
10. 0
12. 0
14. 0
16. 0
18. 0
20. 0
secs


WII: THRI STEM THRUST ON JOB 4300B STROKE 28(H)
0.0
-5000.0
-10000.0
-15000.0
-20000.0
Pounds
17.0
17.4
17.8
18.2
18.6
19.0
secs
(4)
18.403 SEC
-7345.9 LB
(2)
18.292 SEC
-6904.0 LB
(5)
18.423 SEC
-7236.9 LB


THRI STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 23R (H)
3.576 SEC
47,5017
LBS
(3)
4.442 SEC
20,993.3 LBS
(2)
3.639 SEC
20,029.1 LBS
(4)
Pounds
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
2. 8
3. 2
3. 6
4. 0
4. 4
4. 8
5. 2
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1-14-93	**Test Time**	12:53:32
Test Description	300 PSid 7000GPM O-7C	**Stroke #**	24 RR (M)
Data File	D43008	**Data Set**	40

OPEN STROKE

Running Current ______ amps RMS

Running Power ______ watts

Contactor Drop-out Time ______ sec

Disk Factor (Standard) at Max dP ______

Unseating Current ______ amps RMS

Stroke Time ______ sec

Disk Factor (NMAC) at Max dP ______

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current 16.3 amps RMS

Running Power 7437.4 watts

Contactor Drop-out Time 0.011 sec

Disk Factor (Standard) at Max dP .2855

Stroke Time 11.1 sec

Rate of Loading NO

Disk Factor (NMAC) at Max dP .3135

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)*	Stem Factor
1. Running	11.784	154.45	39.62	====	418.8	====	N/A
2. Max. dP	18.559	-8602.8	176.40	====	248.7	253.6 *	.1492
3. Minimum Available	====	82,871.15		====	====	====	====
4. Just Prior to Wedging	19.280	-15,328.9	280.27	0.0028	====	====	====
5. Wedging	19.556	-15,214.1	269.00	0.0028	243.7	245.3 *	====
6. Torque Switch Trip	20.272	-82,716.2	1324.32	0.2233	====	====	.1012
7. Total	20.403	-89,677.6	1510.45	0.2564	====	====	====
8. Inertia	====	6961.4	====	——	====	====	====

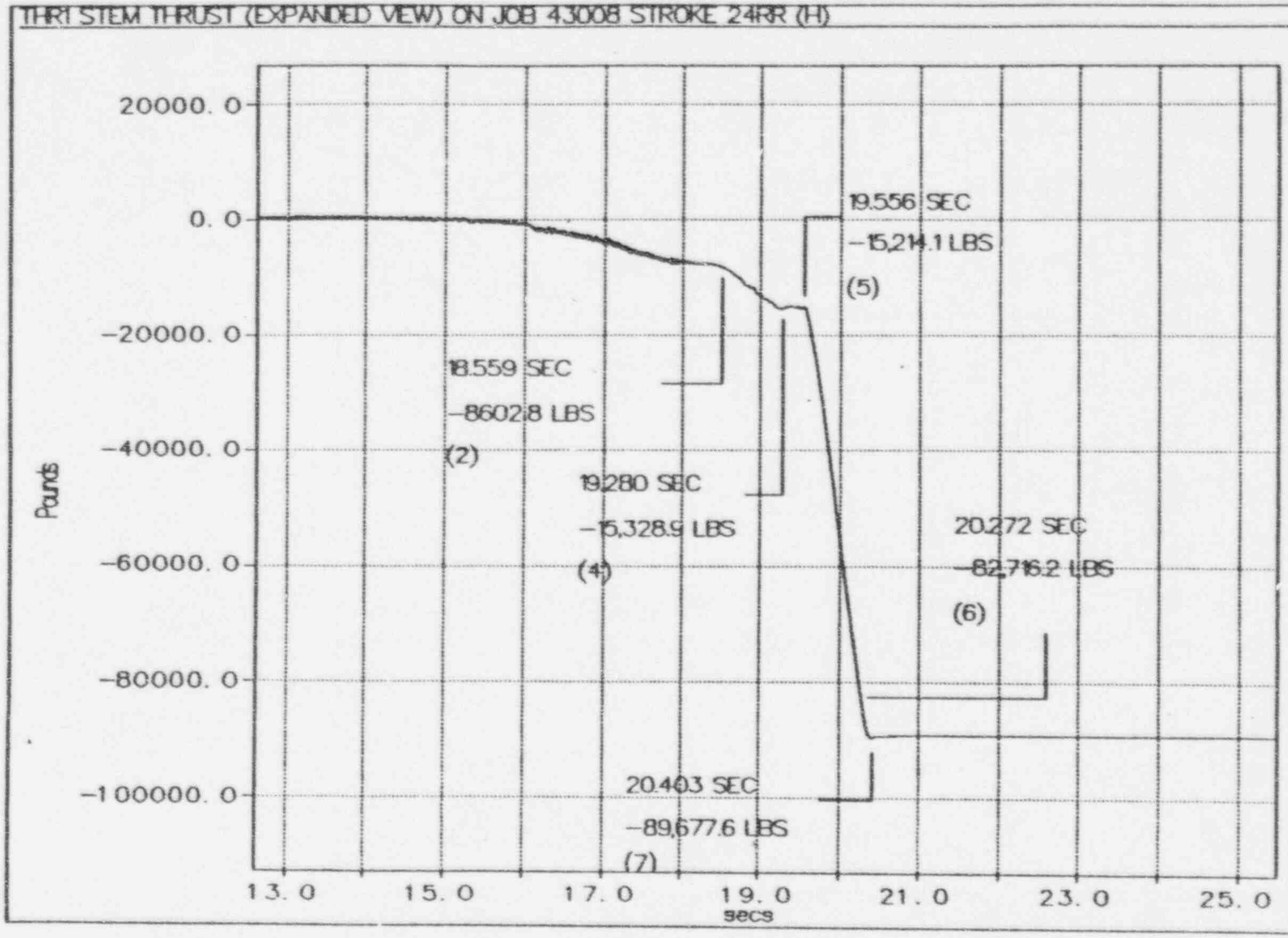
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

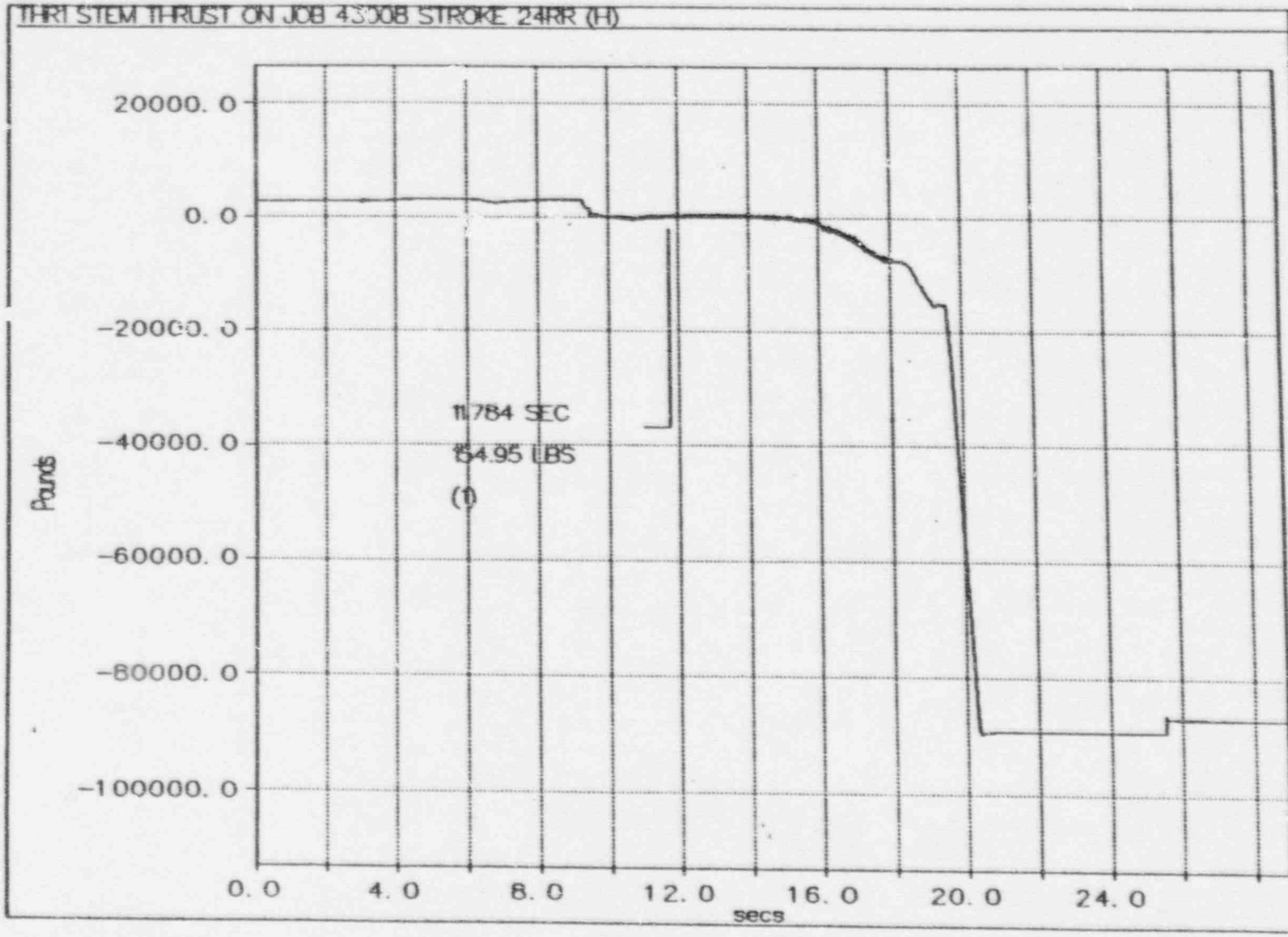
* DP2 READ LOWER THAN TEST DESCRIPTION REQUIREMENT.

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93



THRI STEM THRUST (EXPANDED VIEW) ON JOB 43008 STROKE 24RR (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
13. 0
15. 0
17. 0
19. 0
21. 0
23. 0
25. 0
secs
19.556 SEC
-15,214.1 LBS
(5)
18.559 SEC
-8602.8 LBS
(2)
19.280 SEC
-15,328.9 LBS
(4)
20.272 SEC
-82,716.2 LBS
(6)
20.403 SEC
-89,677.6 LBS
(7)



THRI STEM THRUST ON JOB 43008 STROKE 24RR (H)
20000. 0
0. 0
-20000. 0
-40000. 0
-60000. 0
-80000. 0
-100000. 0
Pounds
11.784 SEC
154.95 LBS
(1)
0. 0
4. 0
8. 0
12. 0
16. 0
20. 0
24. 0
secs

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date 1/13/93
Test Description C-O, 200 PSID, 5500 GPM
Data File D43008.
Test Time 9:25:26
Stroke # 25 (H)
Data Set 029

OPEN STROKE

Running Current 15.1 amps RMS
Running Power 7239.5 watts
Contactor Drop-out Time 0.011 sec
Disk Factor (Standard) at Max dP 0.6203
Unseating Current 27.2 amps RMS
Stroke Time 18.432 sec
Disk Factor (NMAC) at Max dP 0.6774

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	18.000	3655.7	-29.10	====	223.0	====	----
2. Max. dP	3.894	16,024.0	-213.6	-0.0191	174.22	175.5	0.0724
3. Unseating	3.818	51,312.4	-689.6	-0.0706	====	====	====
4. Just After Unseating	3.863	15,047.6	-202.5	-0.0215	175.6	176.9	====
5. Hammer Blow	2.612	-81,384.7	====	0.0077	====	====	====

CLOSE STROKE

Running Current ______ amps RMS
Running Power ______ watts
Contactor Drop-out Time ______ sec
Disk Factor (Standard) at Max dP ______
Stroke Time ______ sec
Rate of Loading ______
Disk Factor (NMAC) at Max dP ______

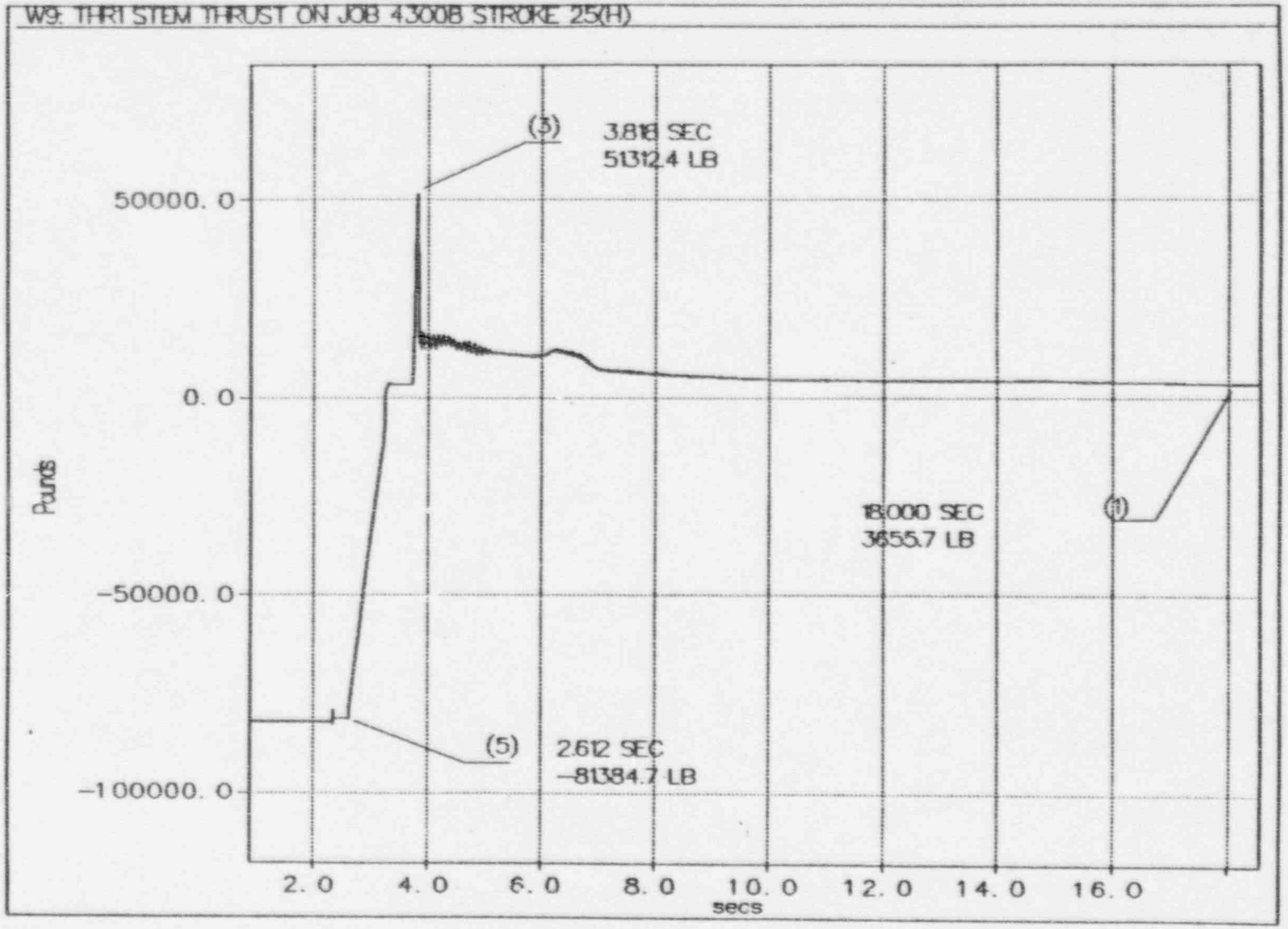
	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	----
2. Max. dP				====			
3. Minimum Available	====			====	====	====	====
4. Just Prior to Wedging					====	====	====
5. Wedging							====
6. Torque Switch Trip					====	====	
7. Total					====	====	====
8. Inertia	====		====	----	====	====	====

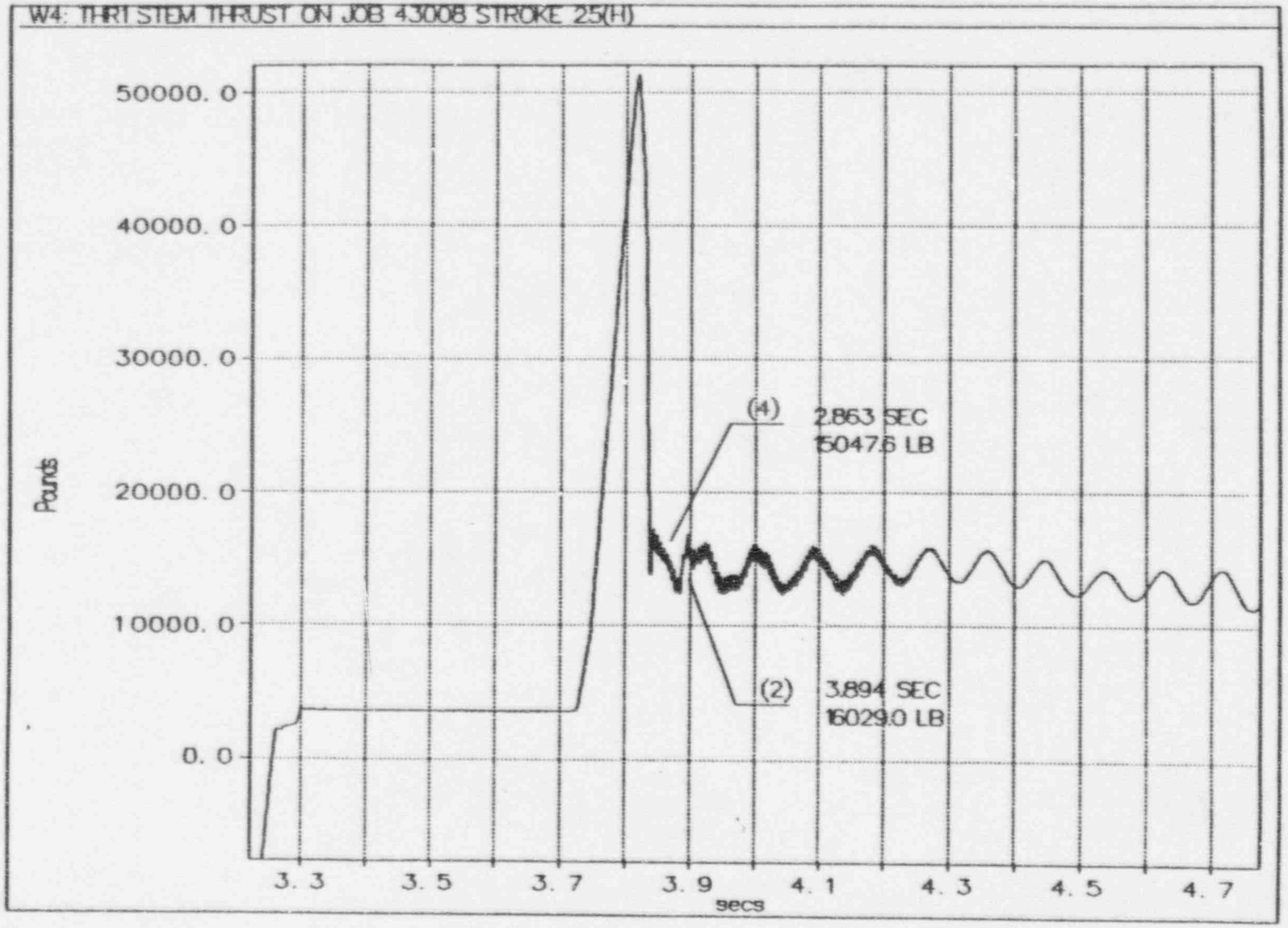
Note: All values annotated above are actual values, with no correction for static conditions.

Remarks

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93


W9: THRI STEM THRUST ON JOB 4300B STROKE 25(H)
(3)
3.818 SEC
51312.4 LB
50000.0
0.0
-50000.0
-100000.0
Pounds
18.000 SEC
3655.7 LB
(1)
(5)
2.612 SEC
-81384.7 LB
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
secs


W4: THRT STEM THRUST ON JOB 43008 STROKE 25(H)
Pounds
50000. 0
40000. 0
30000. 0
20000. 0
10000. 0
0. 0
3. 3
3. 5
3. 7
3. 9
4. 1
4. 3
4. 5
4. 7
secs
(4)
2.863 SEC
15047.6 LB
(2)
3.894 SEC
16029.0 LB

Gate Valve Test Analysis Data Sheet

Wm. Powell 14" 600 lb. Serial Number 67770-6

Test Date	1/13/93	Test Time	15:23:30
Test Description	O→C, 200 PSID, 5500 GPM	Stroke #	26R (H)
Data File	D4300B	Data Set	034

OPEN STROKE

Running Current		amps RMS	Unseating Current		amps RMS
Running Power		watts	Stroke Time		sec
Contactor Drop-out Time		sec			
Disk Factor (Standard) at Max dP			Disk Factor (NMAC) at Max dP	-	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running				====		====	
2. Max. dP				====			
3. Unseating					====	====	====
4. Just After Unseating							====
5. Hammer Blow			====		====	====	====

CLOSE STROKE

Running Current	16.2	amps RMS	Stroke Time	11.399	sec
Running Power	7650.0	watts	Rate of Loading	ND	
Contactor Drop-out Time	0.016	sec			
Disk Factor (Standard) at Max dP	0.5305		Disk Factor (NMAC) at Max dP	0.4624	

	Time (sec)	Thrust (lbs)	Torque (ft-lbs)	Spring Pack Displacement (in)	Upstream Pressure (psig)	Valve Differential Pressure (psid)	Stem Factor
1. Running	11.000	1101.9	23.1	====	144.3	====	-----
2. Max. dP	19.712	-7460.7	155.4	====	155.7	161.3	0.1526
3. Minimum Available	====	82389.1	1276.9	====	====	====	====
4. Just Prior to Wedging	20.205	-9676.0	181.6	0.0019	====	====	====
5. Wedging	20.218	-9584.1	180.0	0.0023	162.4	163.6	====
6. Torque Switch Trip	20.947	-81287.2	1300.1	0.2224	====	====	0.1011
7. Total	21.084	-88656.1	1493.9	0.2568	====	====	====
8. Inertia	====	7368.9	====	-----	====	====	====

Note: All values annotated above are actual values, with no correction for static conditions.

Remarks: 1) MAX. DP IS A LOCAL MAX. PRIOR TO WEDGING

Analyzed by: [signature] 2/12/93

Verified by: [signature] 2/15/93

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 19, 1997

MEMORANDUM TO: Richard H. Wessman, Chief
Mechanical Engineering Branch
Division of Engineering, NRR

FROM: Michael E. Mayfield, Chief
Electrical, Materials, and Mechanical Engineering Branch
Division of Engineering Technology, RES

SUBJECT: TRANSMITTAL OF SUPPLEMENTARY PRESSURE LOCKING DATA FROM FLEXIBLE WEDGE GATE VALVE TESTS

The subject data in the attachment is being transmitted as requested in discussions with Mr. Weidenhamer of my staff. The attachment also includes dimensional information for the Walworth flexible wedge gate valve and on the steps used by the Idaho National Engineering Laboratory for performing the tests.

The data is supplementary since it was obtained early in the test program during the friction surface preconditioning process. For these early tests, the disk-to-seat friction factors ranged from 0.10 to 0.16 and are lower than the friction factors for the fully conditioned surfaces reached later in the test program. The data that was obtained after the friction surfaces were fully conditioned was forwarded to you in my memorandum, dated June 25, 1996, and a copy was also sent to the Public Document Room at that time. The disk-to-seat friction factors corresponding to the later data ranged from 0.46 to 0.64. The phenomenon of surface conditioning has been shown to be dependent on operational and thermal exposure and has been observed in previous INEL and EPRI MOV tests.

The results from these early tests are being provided to give pressure locking data over a full range of friction factors. The data will be useful for evaluating analytical methods for predicting opening thrusts for valves that may experience pressure locking conditions.

A copy of this memorandum and the attachment is being sent to the Public Document Room to be made available to others outside the NRC as requested in the discussions with Mr. Weidenhamer.

If you have any questions on the attachment, please call Gerald Weidenhamer on 415-6015.

Attachment: As stated

Dopu 1p.
~~9703200149~~