RESULTS OF PERFORMANCE TESTS PERFORMED ON THE JOHN WATTS WW CASING CONNECTION ON 7" PIPE

Prepared For
JOHN WATTS
Houston, Texas

Project Funded By
Grant Award DE-FG01-95EE-15608
U.S. Department of Energy
In Support of the Energy Related Inventions Program

FEBRUARY, 2000

STRESS ENGINEERING SERVICES, INC.
Houston, Texas

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DISCLAIMER

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John D. Watts, P.E. (281)463-2312 phn or fax 5054 Stanhope, Houston, Tx 77084-3033

PHASE 2 PROJECT OVERVIEW Conducted Under Assistance Award DE-FG01-95EE-15608

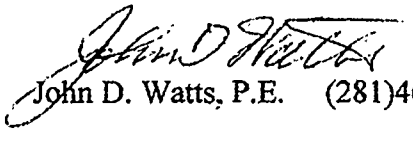
Phase 1 of this project proved that a Flush O.D. 7" Threaded Pipe Connection made in accord with principals taught in my patents will: seal against high pressure dry gas up to pipe stress at 90% of the pipe body yield stress which in this case was 14,620 psi; will seal against high pressure gas when under a tension load that stresses the pipe body to 90% of its yield strength which in this case was 1,026 kips. (See tests on sample 2.) However, these tests also proved that like most all threaded connections, it was susceptible to damage by overtorque. I then decided to combine the square load flank of these specimens with wedge thread feature to overcome the torque problem, which then led to a Patent Application.

To develop the new square wedge thread invention, was the thrust of Phase 2 which proved:

1. A very wide acceptable torque range.
2. Ease of assembly with little fear of damage;
3. A relatively wide angular mis-alignment allowance;
4. A machining technique for use on standard numerical controlled lathes;
5. A thread seal against dry gas, up to the yield pressure of the structure;
6. A Flush O.D. and Flush I.D. Integral Connection having 75% efficiency;
7. Substantially 100% strength when used with a double-pin coupling, a collar, or as an Integral Connection made in accord with my patents.

I have written a computer program that designed the connection tested in Phase 2, that requires input of only: pipe O.D.; pipe I.D.; pipe material strength; and the type of connection desired as stated in Item #7 above. The program prints out: the connection % efficiency; X / Z end co-ordinates for N.C. machining; dimensions required for inspection; dimensions for form ground threading inserts; and the allowable torque range. I plan to add the capability to print out the machine drawing.

The U.S. government has a Non-Exclusive Paid-Up License under the patent for government use, and I shall be pleased to co-operate with the agencies who may need such a connection.



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Prepared By W. T. Asbill
W. T. Asbill, P. E.

PN 6924

STRESS ENGINEERING SERVICES
Houston, TX

February, 2000

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1.0 INTRODUCTION & SUMMARY

INTRODUCTION - Stress Engineering Services (SES) was contracted by Mr. John Watts to test his "WW" threaded connection developed for oilfield oil and gas service. This work was a continuation of testing performed by SES as reported in August of 1999.

CONNECTION DESIGN – The connection design tested was identified as "WW". The samples were all integral (no coupled connections) and contained a wedge thread form with 90° flank angles relative to the pipe centerline. The wedge thread form is a variable width thread that primarily engages on the flanks. This thread form provides very high torque capacity and good stabbing ability and makeup.

TEST PROCEDURE - The test procedure selected for one of the samples was the newly written ISO 13679 procedure for full scale testing of casing and tubing connections, which is currently going through the ISO acceptance process. The ISO procedure requires a variety of tests that includes makeup/breakout testing, internal gas sealability/external water sealability testing with axial tension, axial compression, bending, internal gas thermal cycle tests and limit load (failure) tests). This test procedure was performed with one sample. Four samples were tested to failure.

SUMMARY OF TASKS PERFORMED AND RESULTS - Table 1 contains a summary of the tasks performed by SES. The project started with the delivery of test samples by Mr. Watts. Pipe from the previous round of tests was used for the new samples. Figure 1 shows the structural and sealing results relative to the pipe body.

Sample 1 was used to determine the torque capacity of the connection. Torque was applied to the capacity of SES's equipment which was 28,424 ft-lbs. From this, an

initial recommended torque range of 7,200 to 8,800 ft-lbs. was selected. The sample was disassembled and while there was no galling observed in the threads, the end of the pin had collapsed inward. Sample 2 received three makeups. Breakouts 1 and 2 also had collapsing of the pin end, with no thread galling. From these make/breaks, it was decided to reduce the amount of lubricant applied to the connection by applying it to the box or pin only and reducing the amount applied. Samples 3 and 4 received one makeup only. Sample 5 initially received two make/breaks to test for galling resistance before final makeup. No galling was observed. Later, three additional make/breaks were performed with no pin end collapse and galling over ½ a thread occurring on one of the breakouts.

During the make/break tests, the stabbing and hand tight makeup of the WW connection was found to be very easy and trouble free. There was no tendency to crossthread, even when stabbed at an angle, and it screwed together very smoothly up to hand tight. During power tight makeup, there was no heat generated in the box (as checked by hand contact) and no jerkiness associated with any of the makeups or breakouts.

Sample 2 was tested in pure compression. The maximum load obtained was 1,051 kips and the connection was beginning to significantly deform as the sample buckled. Actual pipe yield was 1,226 kips.

Sample 3 was capped-end pressure tested to failure. The capped-end yield pressure of the pipe was 16,572 psi and the sample began to leak at 12,000 psi.

Sample 4 was tested in pure tension. The maximum load obtained was 978 kips and the connection failed by fracture at the pin critical section. Actual pipe yield was 1,226 kips.

Sample 5 was tested in combined tension/compression and internal gas pressure. The sample was assembled, setup and tested four times. The first time was with a torque of 7,298 ft-lbs and the connection leaked half way to ISO Load Point 2 with loads of 693 kips and 4,312 psi. The second time the torque was increased to 14,488 ft-lbs and a leak occurred at 849 kips and 9,400 psi, which was ISO Load Point 2. The third time the makeup torque was again increased, to 20,456 ft-lbs, and a leak occurred at 716 kips and 11,342 psi, ISO Load Point 4. The fourth test was with the same torque as before, 20,617 ft-lbs, and the connection successfully tested up to load step 56, ISO Load Point 6 (second round) before leaking at 354 kips and 11,876 psi. At this point, time and funds prevented additional testing to be performed.

2.0 TEST SAMPLES & PREPARATION

2.1 PIPE SIZE

The pipe size selected for this project was as follows:

- 7" nominal outside diameter
- 32 pounds per foot weight (0.453" wall)
- 6.094" nominal inside diameter

This pipe size is commonly used as a production casing string in oil and gas wells and is often used for testing of casing connections.

2.2 PIPE MATERIAL

The pipe material grade was API 5CT grade P-110. Tensile tests were performed in the previous testing for the pipe purchased for this test and the reports are given in that report. The API specified and actual strengths were as follows:

- API Specified Yield Strength = 110,000 – 140,000 psi
- API Specified Ultimate Strength = 125,000 psi minimum
- Pipe (pup) Stock = 124,000 psi yield strength, 131,000 psi ultimate strength
  = 121,000 psi yield strength, 131,000 psi ultimate strength

This gave an average pipe yield strength of 122,500 psi which was used to determine the test loads.

2.3 MACHINED CONNECTIONS

One thread form was made and tested. The samples had a wedge thread form with 90° load and stab flanks relative to the pipe centerline. Five samples were provided and all pins and boxes were coated with zinc phosphate for added galling resistance which is a common OCTG practice. The connection design did not include a torque shoulder.

3.0 MAKEUP/BREAKOUT TEST RESULTS

The results of the makeup/breakout tests are summarized in Table 2. All data including torque/turn plots are given in Appendix A. Sample 1 was madeup first to the maximum capacity of the SES equipment. The purpose of this was to determine the yield torque of the connection and to set a recommended makeup torque. The torque reached was 28,424 ft-lbs (30% pipe yield) and the torque/turn plot showed that the connection did not yield. The connection was disassembled and did not have any galling; however, the pin end had collapsed (displaced inward) at one point which was later corrected by changing the application of lubricant. An initial recommended makeup torque was set at-

- Minimum torque = 7,200 ft-lbs
- Optimum torque = 8,000 ft-lbs
- Maximum torque = 78,800 ft-lbs

However, it is clear that the connection has much more capacity.

Sample 2 received three makeups. No galling was observed but again the pin end collapsed at one location. For the second makeup the lubricant procedure was changed to doping the pin threads only and not the box threads, but to no avail. For both breakouts, pin collapse occurred and it was forced into the round position by slightly hammering on the inside of the pin end. The third makeup used half as much lubricant on the box (20 grams) and it was thought that from the torque/turn plot that the pin collapse did not occur again (pipe ends were closed with welded end caps and inspection of the inside could not be made).

Samples 3 and 4 were madeup one time. Sample 3 had lubricant applied to the box. After some discussion, lubricant application was changed from the box to the pin to prevent a buildup of lubricant at the end of the pin and hopefully to prevent pin end

collapse. Similar to sample 2, samples 3, 4 and 5 had end caps and could not be inspected for pin collapse in the assembled condition.

Sample 5 initially received three makeups to evaluate the pin end collapse problem as well as galling resistance. Torques were at the recommended values and no pin collapse or galling occurred. Later, three more makeups and breakouts were performed in an attempt to increase sealing ability. Makeup #4 doubled the torque to 14,488 ft-lbs with slight galling found over ½ of the first pin thread and mating box thread. Makeups #5 and #6 were to 20,000 ft-lbs with no problems found after breakout.

During the make/break tests, the stabbing and hand tight makeup of the WW connection was found to be very easy and trouble free. There was no tendency to crossthread, even when stabbed at an angle, and it screwed together very smoothly up to hand tight. During power tight makeup, there was no heat generated in the box (as checked by hand contact) and no jerkiness associated with any of the makeups or breakouts.

4.0 STRUCTURAL & SEALING TEST RESULTS

4.1 SAMPLE 2 RESULTS

Sample 2 was tested in compression to failure and test data is given in Appendix B. After about 950 kips, yielding is evident in the load vs displacement plot. The maximum load reached was 1,051 kips (94.2% pipe body) and buckling then began to occur. Connection deformation occurred as expected.

4.2 SAMPLE 3 RESULTS

Sample 2 was tested by capped-end pressure with water to failure. Pressure was applied in 1,000 psi increments up to 7,000 psi and then 500 psi increments beyond 7,000 psi. Each increment was held for 10 minutes. Pressure was plotted in time for all increments. No bubbles were observed until 10,500 psi, with increasing bubbles collected with each additional hold. At 12,000 psi, a pressure drop was first experienced and pressure drops increased beyond this point. At 14,000 psi, the leak tube filled with water and it was obvious that the connection was leaking. From this data, it was concluded that leakage most probably occurred at 12,000 psi (72.4% pipe body). Appendix C contains test data and documentation.

4.3 SAMPLE 4 RESULTS

Sample 4 was tested in tension to failure and test data is given in Appendix D. Yielding is evident in the load vs displacement plot beyond 900 kips. The maximum load reached was 978 kips (87.7% pipe body) and then failure by pin critical section fracture occurred.

4.4 SAMPLE 5 RESULTS-

Test Series B of ISO 13679 was the procedure used for sample 5. The Organization for International Standards (ISO) is currently developing a number of new documents for use in the petroleum and natural gas industry. ISO CD 13679 is a new

test procedure that was recently completed by workgroup ISO/TC 67/SC5/WG2 and dated October 1, 1998. The title of the document is "**Petroleum and natural gas industries – Testing procedures for casing and tubing connections – Recommended practice**". The recommended practice is presently a Committee Draft (CD) and is going through the ISO acceptance process. Therefore, at this time it is not a finalized ISO document. However, the document is currently being used for tubing and casing connection testing.

- ISO Series B requires testing to 95% of the pipe yield or connection service rating. The connection must be tested in two quadrants of axial load and pressure: Q1 = tension and internal pressure and Q2 = compression and internal pressure. Test temperature is ambient temperature.

The sample was tested four different times and leaked each time as follows:

Test Attempt No.	Makeup	Tension at Leak, kips	Pressure at leak, psi
1	7,298 ft-lbs lubricant on box only	693	4,312
2	14,488 ft-lbs lubricant on pin only	849	9,400
3	20,456 ft-lbs lubricant on pin only	716	11,342
4	20,617 ft-lbs lubricant on pin plus lubricant added to last 5 box threads	354	11,876

Test documentation is given in Appendix E.

Photographs of the samples and equipment are given in Appendix F.

TABLE 1
SUMMARY OF TASKS PERFORMED BY STRESS ENGINEERING

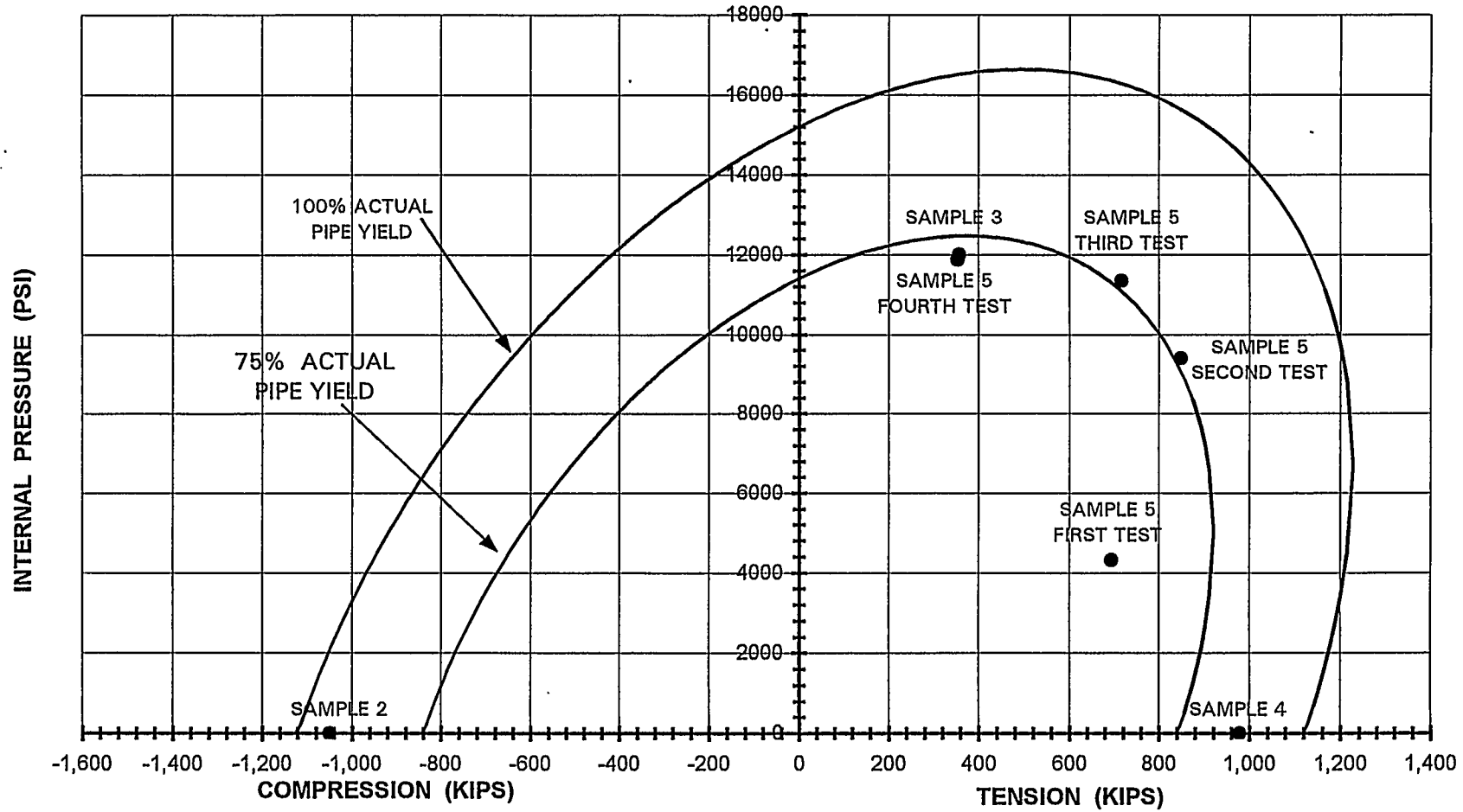
DATE	TASK PERFORMED	RESULTS
27-Jan	Makeup/breakout test of square wedgethread form connections Sample #1 = 1 m/b, #2 = 3 makeups, #3 & #4 = 1 makeup and #5 = 3 makeups	All 5 samples performed well.
28-Jan	Baked sample #5	
29-Jan	Baked sample #3	
31-Jan	Tested sample #3 - Capped end internal water pressure to failure	Leaked - 12,000 psi
31-Jan	Tested sample #5 at 80% pipe efficiency	Leaked - 693 kips & 4,312 psi
01-Feb	Disassembled & madeup to higher torque (14,488 ft-lbs)	
01-Feb	Tested sample #5 at 80% pipe efficiency	Leaked - 849 kips & 9,400 psi
02-Feb	Disassembled & madeup to higher torque (20,456 ft-lbs)	
02-Feb	Tested sample #5 at 80% pipe efficiency	Leaked - 716 kips & 11,342 psi
02-Feb	Disassembled & madeup to higher torque (20,456 ft-lbs)	
02-Feb	Tested sample #5 at 75% pipe efficiency	Leaked - 354 kips & 11,876 psi
04-Feb	Disassembled sample #5 and no more testing on this sample	
07-Feb	Tested sample #2 - compression to failure	Connection failed at -1,050 kips
	Tested sample #4 - tension to failure	Connection failed at 978 kips
10-Feb	Report preparation completed	

TABLE 2
WEDGE THREAD SAMPLES MAKEUP/BREAKOUT SUMMARY
JOHN WATTS 7" WW FLUSH JOINT CONNECTION

THREAD LUBRICANT WAS API 5A2 HIGH PRESSURE MODIFIED (SHELL 72732).

SAMPLE NO.	MAKEUP NO.	LUBR. GRAMS	FULL MAKEUP		SPEED RPM	BREAKOUT TORQUE	COMMENTS
			TORQUE	TURNS			
1	1	API-82	28,424	1.637	5	29,169	No galling, pin end collapsed
2	1	API-80	8,468	1.574	5	7,488	No galling, pin end collapsed
	2	API-40	8,554	1.061	5	7,666	No galling, pin end collapsed
	3	API-20	8,181	0.636+	5	NONE	
3	1	API-20	8,041	0.834+	5	NONE	
4	1	API-19	8,064	0.893	5	NONE	
5	1	API-19	8,869	0.992	5	8,836	No galling
	2	API-21	8,962	0.951	5	9,074	No galling
	3	API-20	7,298	0.881	5	12,346	No galling
	4	API-21	14,488	0.45	5	9,361	Galling over 1/2 of pin first thread
	5	API-19	20,456	0.595	5	15,073	No galling
	6	API-25	20,617	0.651	5	14,242	No galling

FIGURE 1
JOHN WATTS 7" 32# WW SAMPLES
SUMMARY OF FAILURES & LEAKS



APPENDIX A
MAKEUP/BREAKOUT DATA

STRESS ENGINEERING SERVICES
MAKEUP/BREAKOUT TEST LOG

DATE: 1-27-2000
OPERATOR: BC/GS
PN: 6924
PAGE 1 OF

CLIENT: JOHN WATTS PIPE SIZE: 7.0"

TT REC NO.	MU/BO NO.	PIN NO.	BOX NO.	TARGET TORQUE	MAXIMUM		SHOULDER		BREAKOUT TORQUE	COMMENTS
					TORQUE	TURNS	TORQUE	TURNS		
78	MU1	1P	1B	28000	28424	1.1646				SHELL 72732
79	BO1	1P	1B						29169	END OF PIN COLLAPSED
80	MU1	2P	2B	8400	8468	1.576				
81	BO1	2P	2B						7488	END OF PIN SLIGHTLY COLLAPSED
		USED HAMMER TO STRAIGHTEN PIN END					COLLAPSED	SECTION.		
82	MU2	2P	2B	8400	8554	1.063				
83	BO2	2P	2B						7666	END OF PIN SLIGHTLY COLLAPSED
		USED HAMMER TO STRAIGHTEN PIN END COLLAPSED							SECTION.	
84	MU3	2P	2B	8000	8181	.641				
85	MU1	3P	3B	3000	2932	.592				
	- WAIT 40 MIN. BEFORE COMPLETING MAKE-UP TO 8000 ft. lbs.									
86	MU1	3P	3B	8000	8041	.247				
87	MU1	4P	4B	8000	8064	.859				
88	MU1	5P	5B	8800	8869	.993				
89	BO1	5P	5B						8836	
90	MU2	5P	5B	8800	8962	.954	*M/U	1 3/8"	PAST POSITION ON MU #1	
91	BO2	5P	5B						9074	
92	MU3	5P	5B	7200	7298	.882				FINAL

D:\Kimberly\my files 99\Asbill, W. T\300makeup-breakout table.doc

FINAL MU ON #5 = 1 3/16" PAST POSITION OF MU #1

THREAD COMPOUND APPLICATION LOG

PN 6924WTA

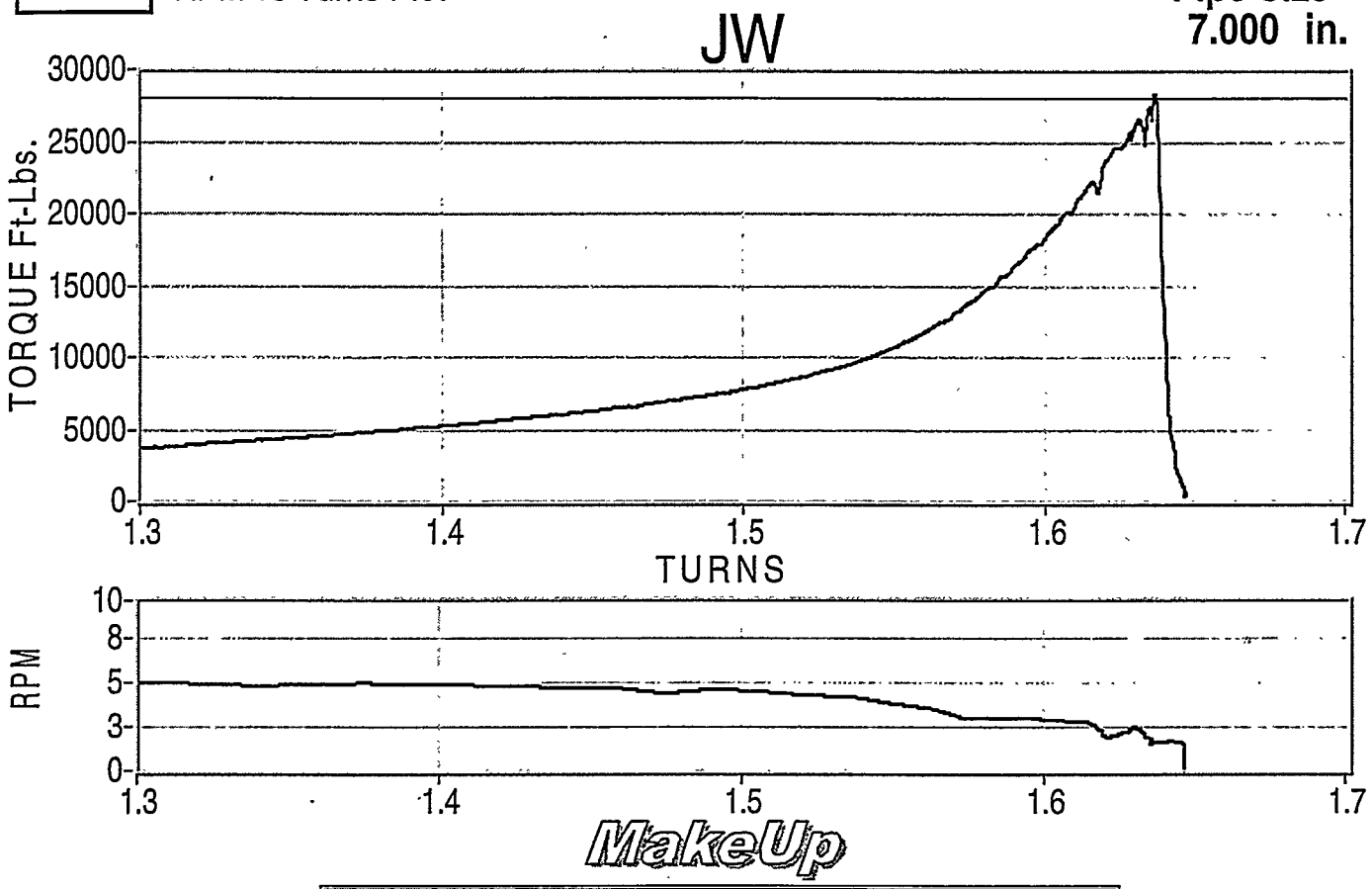
TEST NO. _____ PIPE SIZE 7.0" DATE 1-27-2000 BY BC/GS

MAKEUP NO.	PIN END NO.	BOX END NO.	WEIGHT, GRAMS		
			PIN	BOX	TOTAL
1	1P	1B	40	42	82
1	2P	2B	40	40	80
2	2P	2B	40	0	40
3	2P	2B	0	20	20
1	3P	3B	0	20	20
1	4P	4B	19	0	19
1	5P	5B	19	0	19
2	5P	5B	21	0	21
3	5P	5B	20	0	20

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp

MakeUp # 1		
Pin Id : 1P	Box Id : 1B	
File Name : TT_0078.dat		
Maximum Torque	28424	Ft-Lbs
Shoulder Torque	294	Ft-Lbs
Delta Torque	28130	Ft-Lbs
Turns @ Max. Torque	1.637	Turns
Shoulder Turns	0.140	Turns
Delta Turns	1.497	Turns
Total Turns	1.646	Turns
Pin Dope	40	Grams
Box Dope	42	Grams

Operator:
BC/GS

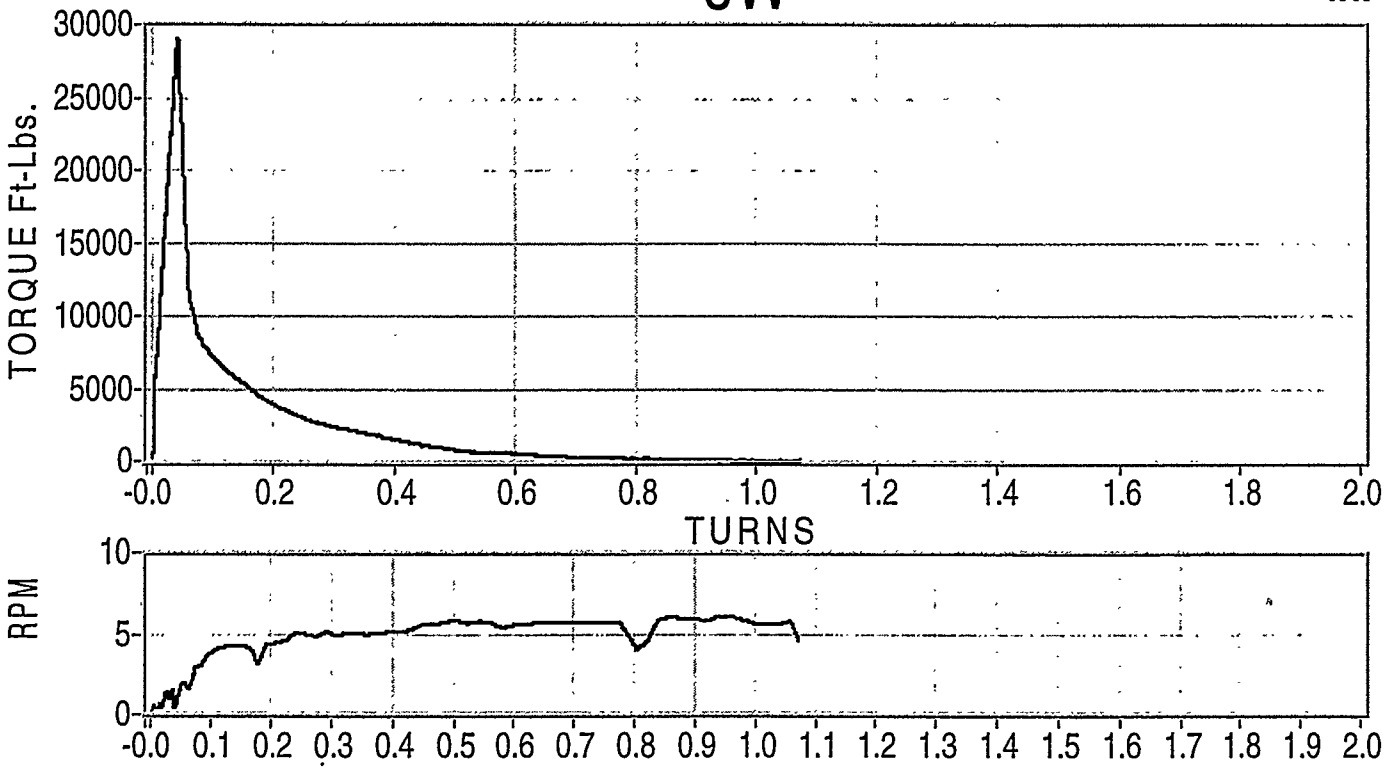
Date:Time of Test
01/27/2000 : 10:42:35 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 1	
Pin Id : 1P	Box Id : 1B
File Name : TT_0079.dat	
Maximum Torque	29169 Ft-Lbs

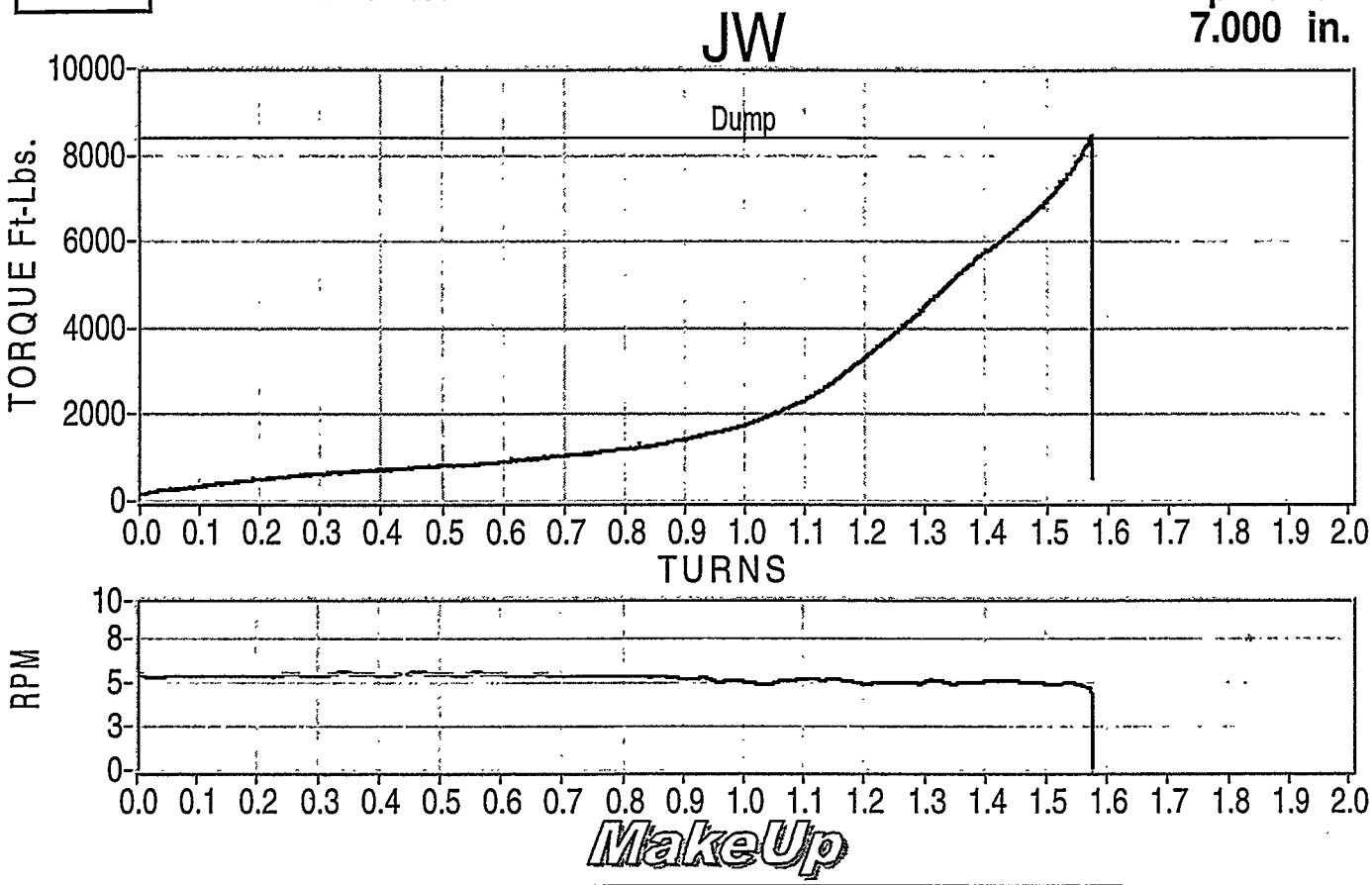
Operator :
BC/GS

Date : Time of Test
01/27/2000 : 10:44:58 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 1		
Pin Id : 2P	Box Id : 2B	
File Name : TT_0080.dat		
Maximum Torque	8468	Ft-Lbs
Shoulder Torque	396	Ft-Lbs
Delta Torque	8072	Ft-Lbs
Turns @ Max. Torque	1.574	Turns
Shoulder Turns	0.141	Turns
Delta Turns	1.433	Turns
Total Turns	1.576	Turns
Pin Dope	40	Grams
Box Dope	40	Grams

Operator:
BC/GS

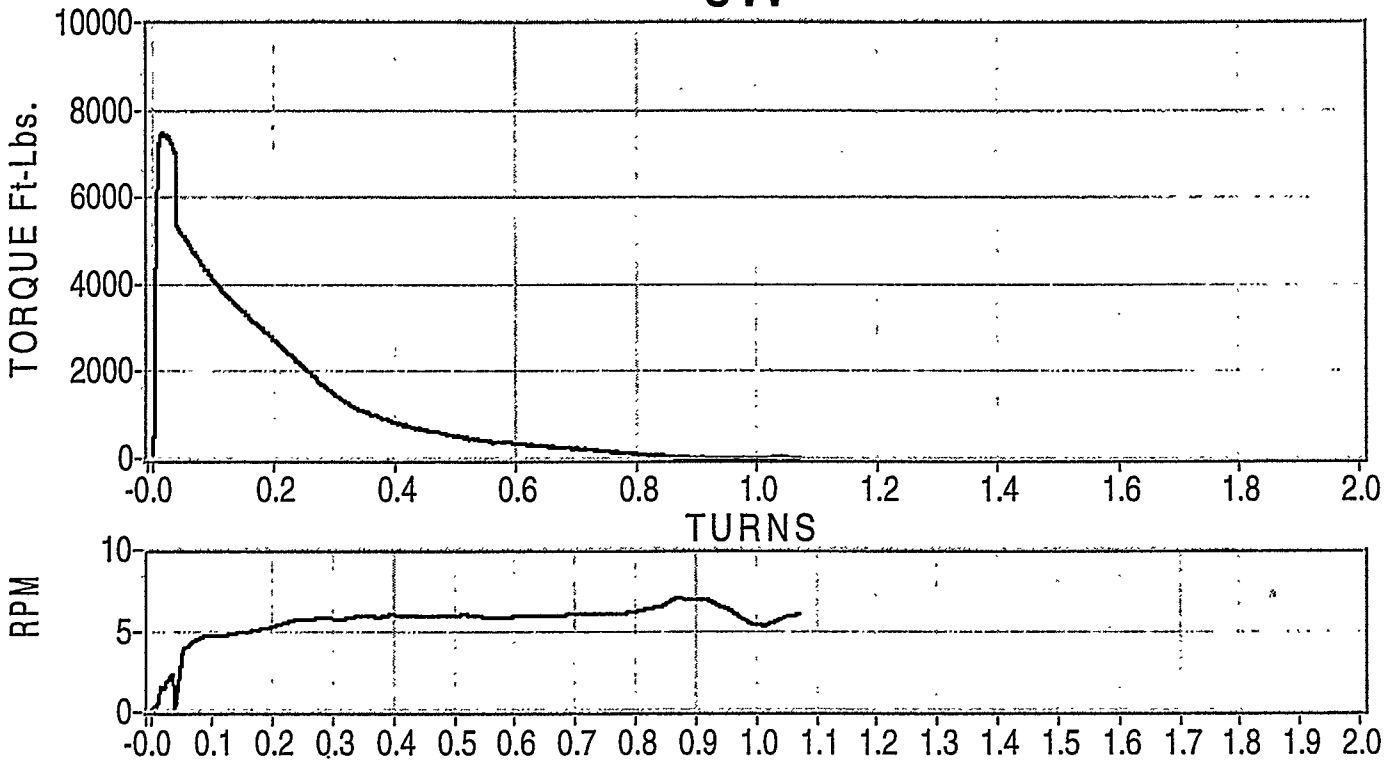
Date:Time of Test
01/27/2000 : 11:22:22 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 1	
Pin Id : 2P	Box Id : 2B
File Name : TT_0081.dat	
Maximum Torque	7488 Ft-Lbs

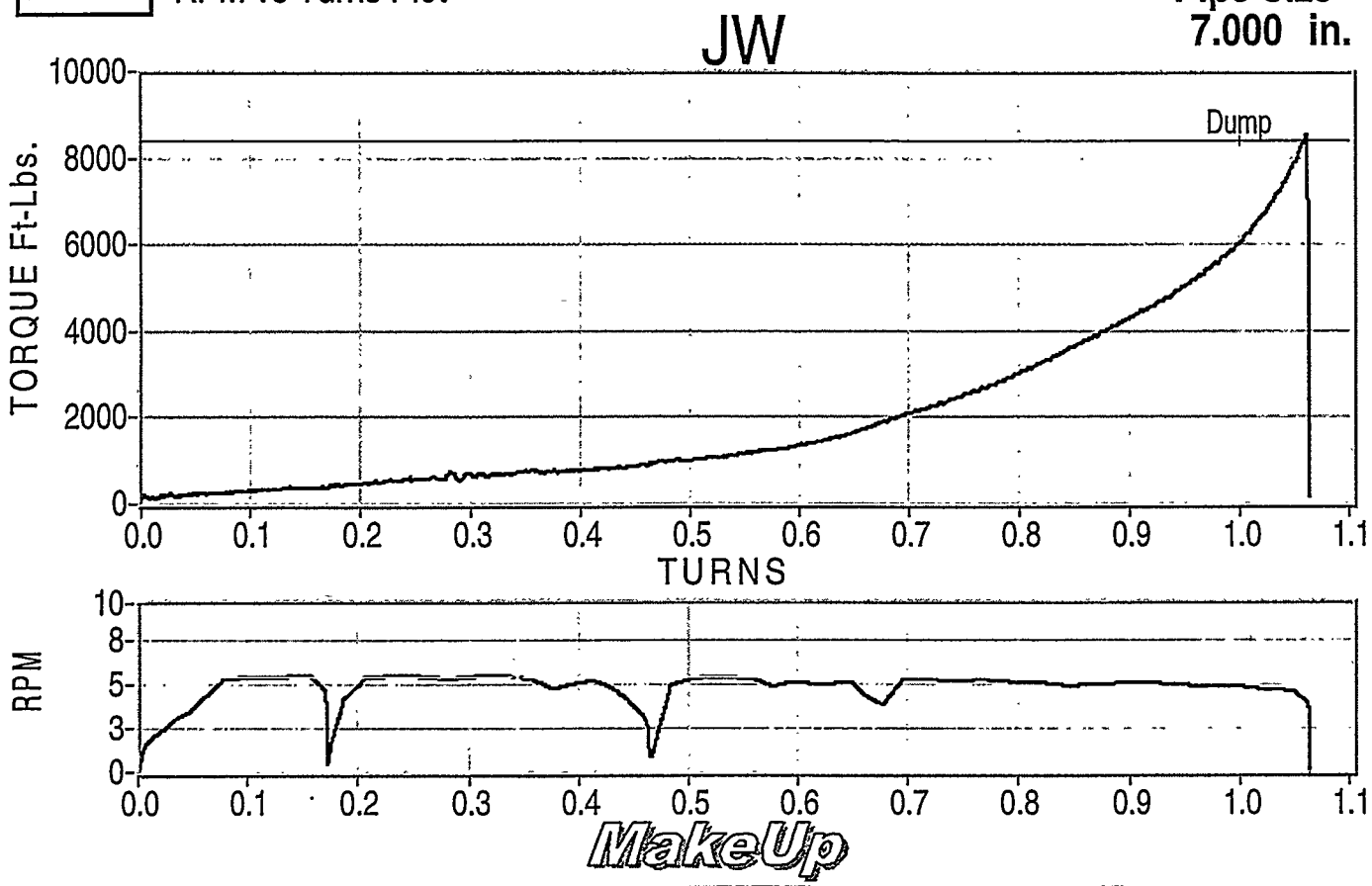
Operator :
BC/GS

Date : Time of Test
01/27/2000 : 11:24:51 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp

MakeUp # 2		
Pin Id : 2P	Box Id : 2B	
File Name : TT_0082.dat		
Maximum Torque	8554	Ft-Lbs
Shoulder Torque	235	Ft-Lbs
Delta Torque	8319	Ft-Lbs
Turns @ Max. Torque	1.061	Turns
Shoulder Turns	0.069	Turns
Delta Turns	0.993	Turns
Total Turns	1.063	Turns
Pin Dope	0	Grams
Box Dope	40	Grams

Operator:
BC/GS

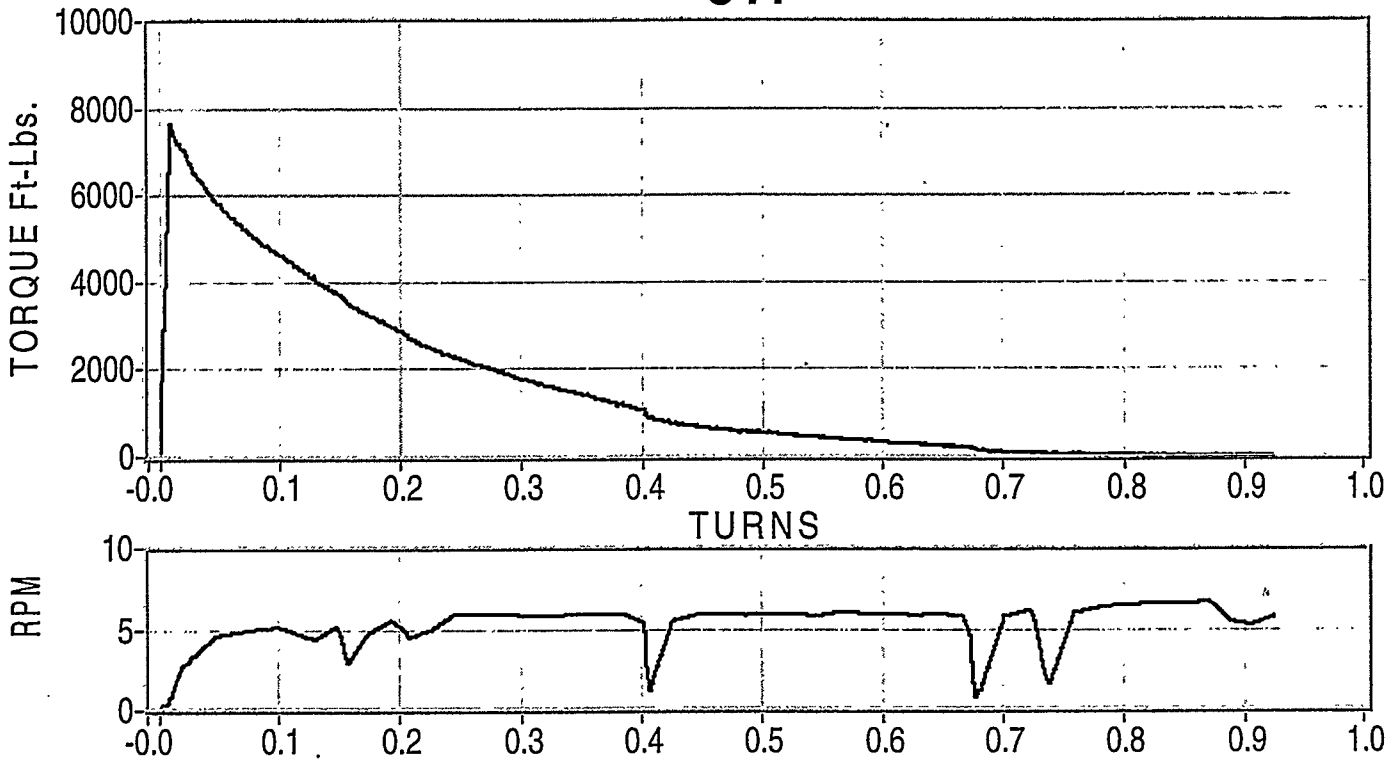
Date:Time of Test
01/27/2000 : 12:29:41 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size
7.000 in.

JW



BreakOut

BreakOut # 2	
Pin Id : 2P	**Box Id : 2B**
File Name : TT_0083.dat	
Maximum Torque	**7666 Ft-Lbs**

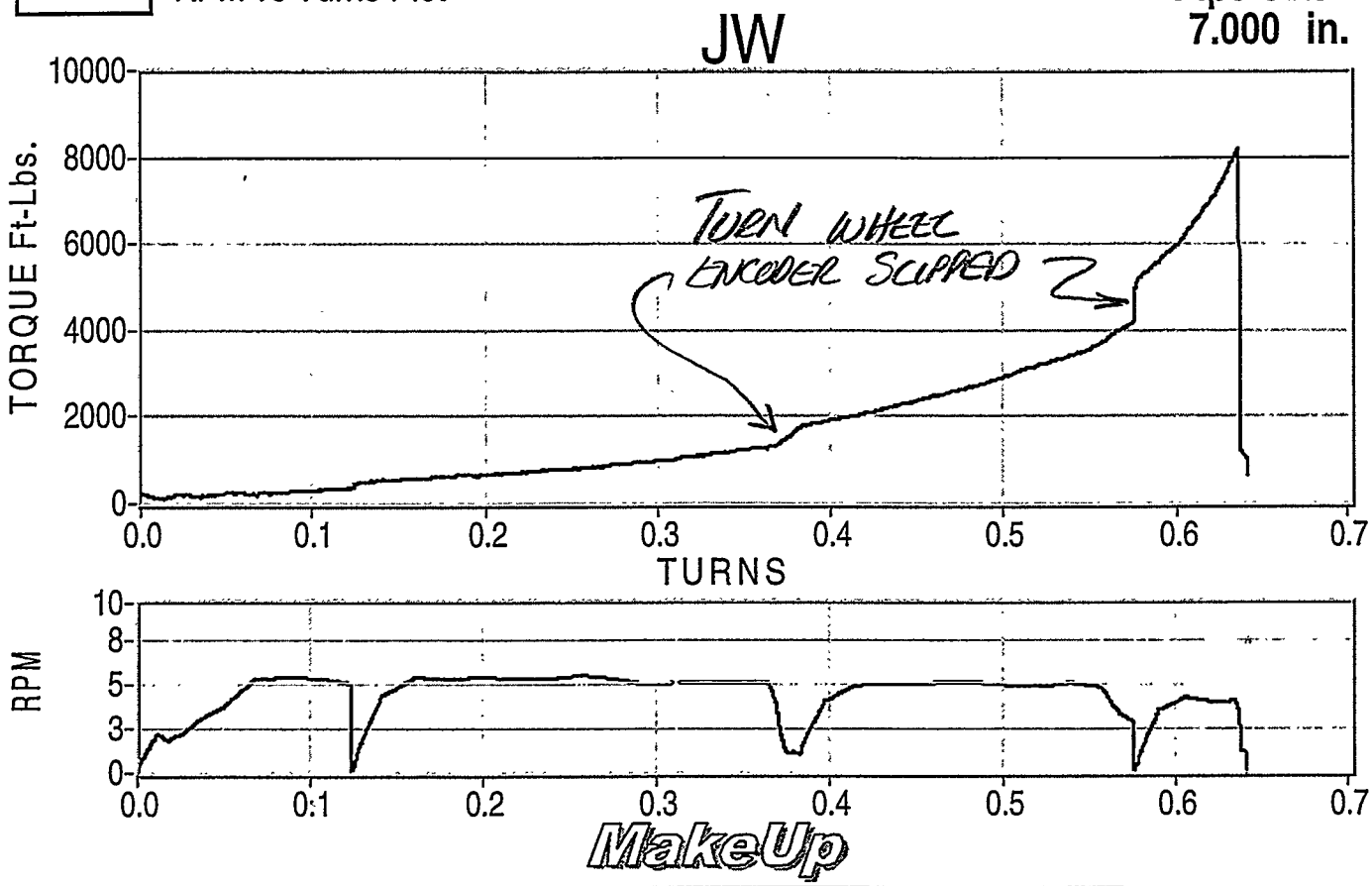
Operator :
BC/GS

Date : Time of Test
01/27/2000 : 12:31:37 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 3		
Pin Id : 2P	Box Id : 2B	
File Name : TT_0084.dat		
Maximum Torque	8181	Ft-Lbs
Shoulder Torque	238	Ft-Lbs
Delta Torque	7943	Ft-Lbs
Turns @ Max. Torque	0.636	Turns
Shoulder Turns	0.077	Turns
Delta Turns	0.559	Turns
Total Turns	0.641	Turns
Pin Dope	0	Grams
Box Dope	20	Grams

Operator:
BC/GS

Date:Time of Test
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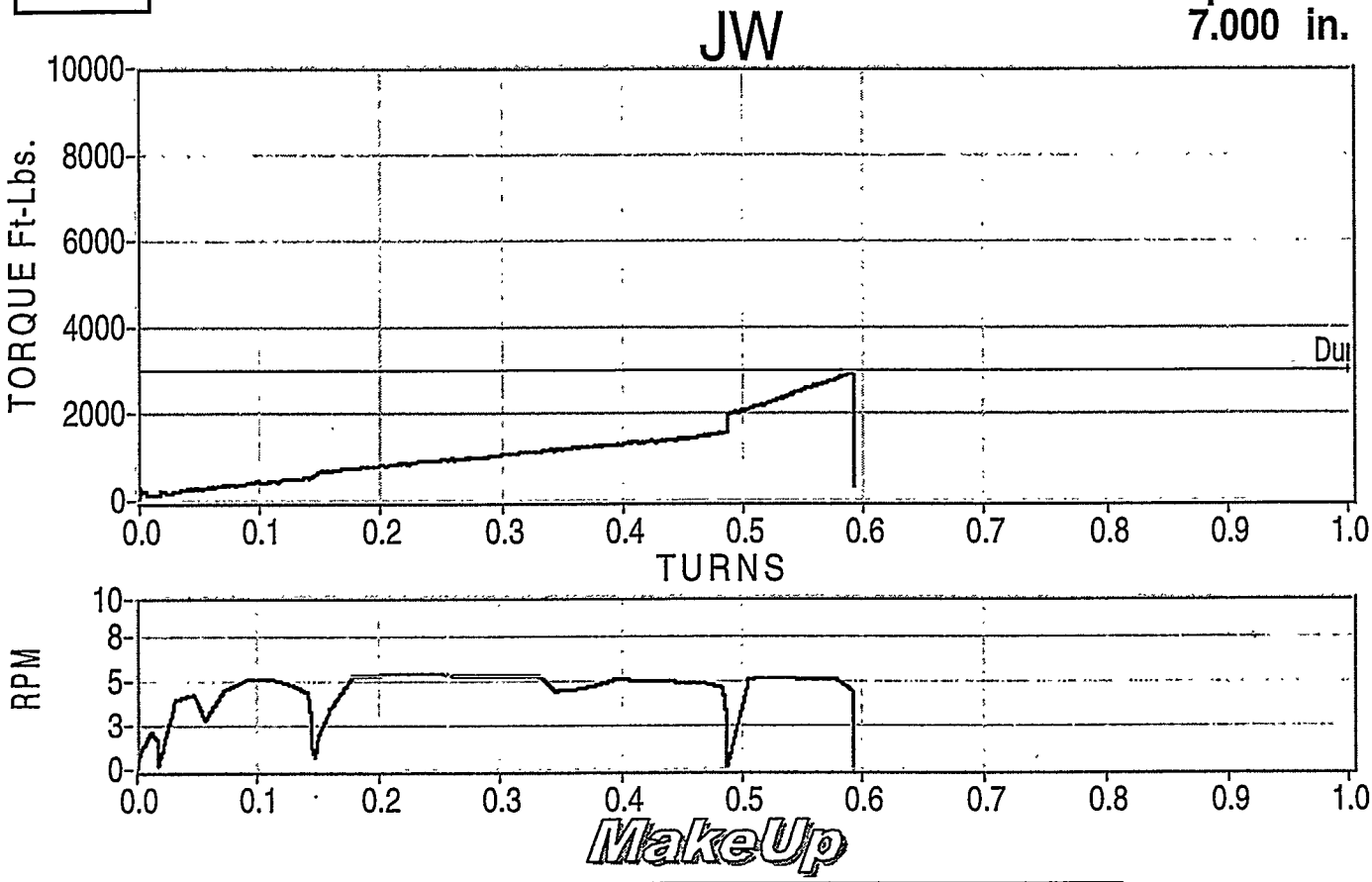
Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 1		
Pin Id : 3P	**Box Id : 3B**	
File Name : TT_0085.dat		
Maximum Torque	**2932**	**Ft-Lbs**
Shoulder Torque	**174**	**Ft-Lbs**
Delta Torque	**2759**	**Ft-Lbs**
Turns @ Max. Torque	**0.588**	**Turns**
Shoulder Turns	**0.024**	**Turns**
Delta Turns	**0.563**	**Turns**
Total Turns	**0.592**	**Turns**
Pin Dope	**0**	**Grams**
Box Dope	**20**	**Grams**

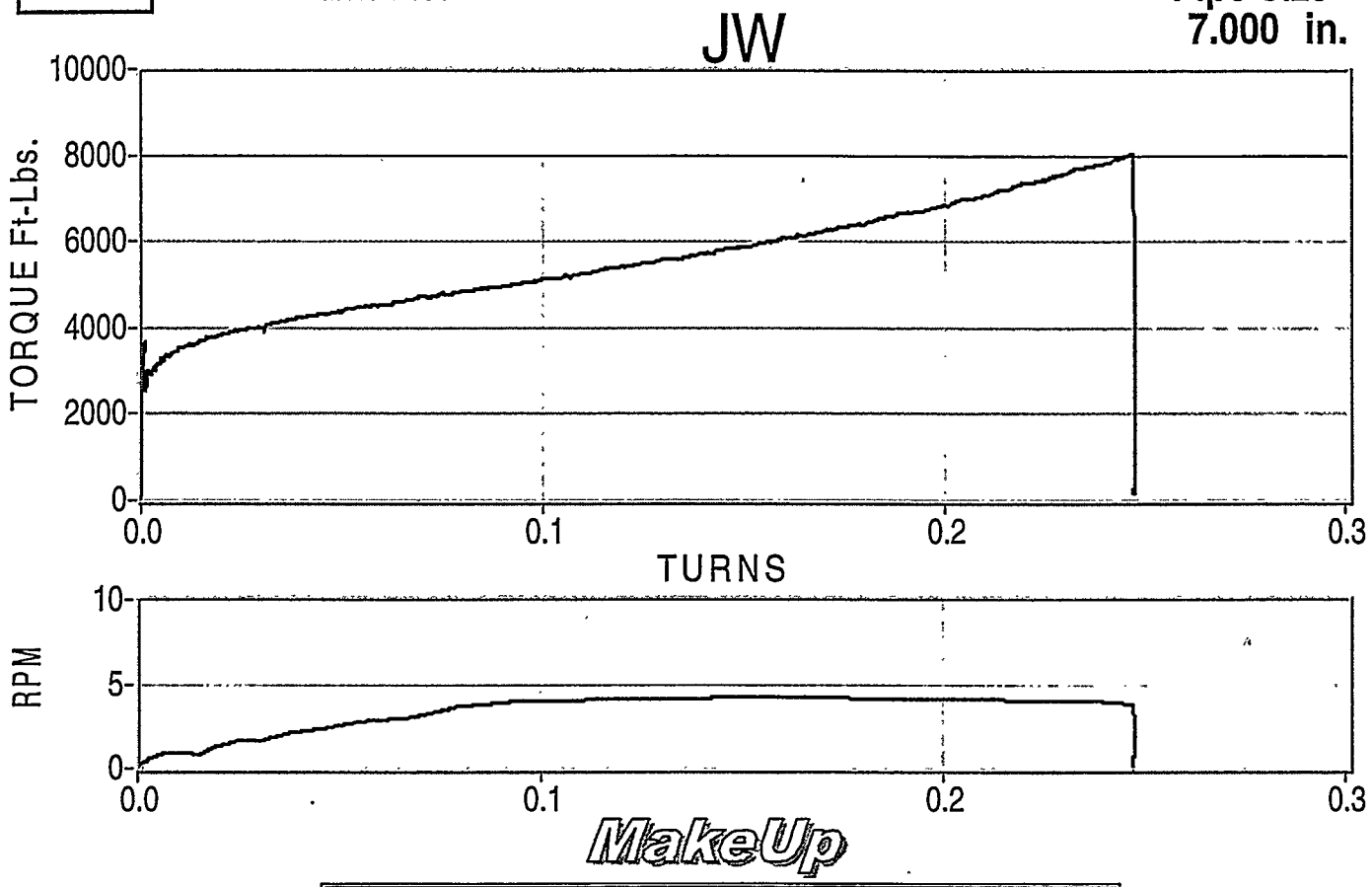
Operator:
BC/GS

Date:Time of Test
01/27/2000 : 1:46:56 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp

MakeUp # 1		
Pin Id : 3P	Box Id : 3B	
File Name : TT_0086.dat		
Maximum Torque	8041	Ft-Lbs
Shoulder Torque	447	Ft-Lbs
Delta Torque	7593	Ft-Lbs
Turns @ Max. Torque	0.246	Turns
Shoulder Turns	0.000	Turns
Delta Turns	0.246	Turns
Total Turns	0.247	Turns
Pin Dope	0	Grams
Box Dope	20	Grams

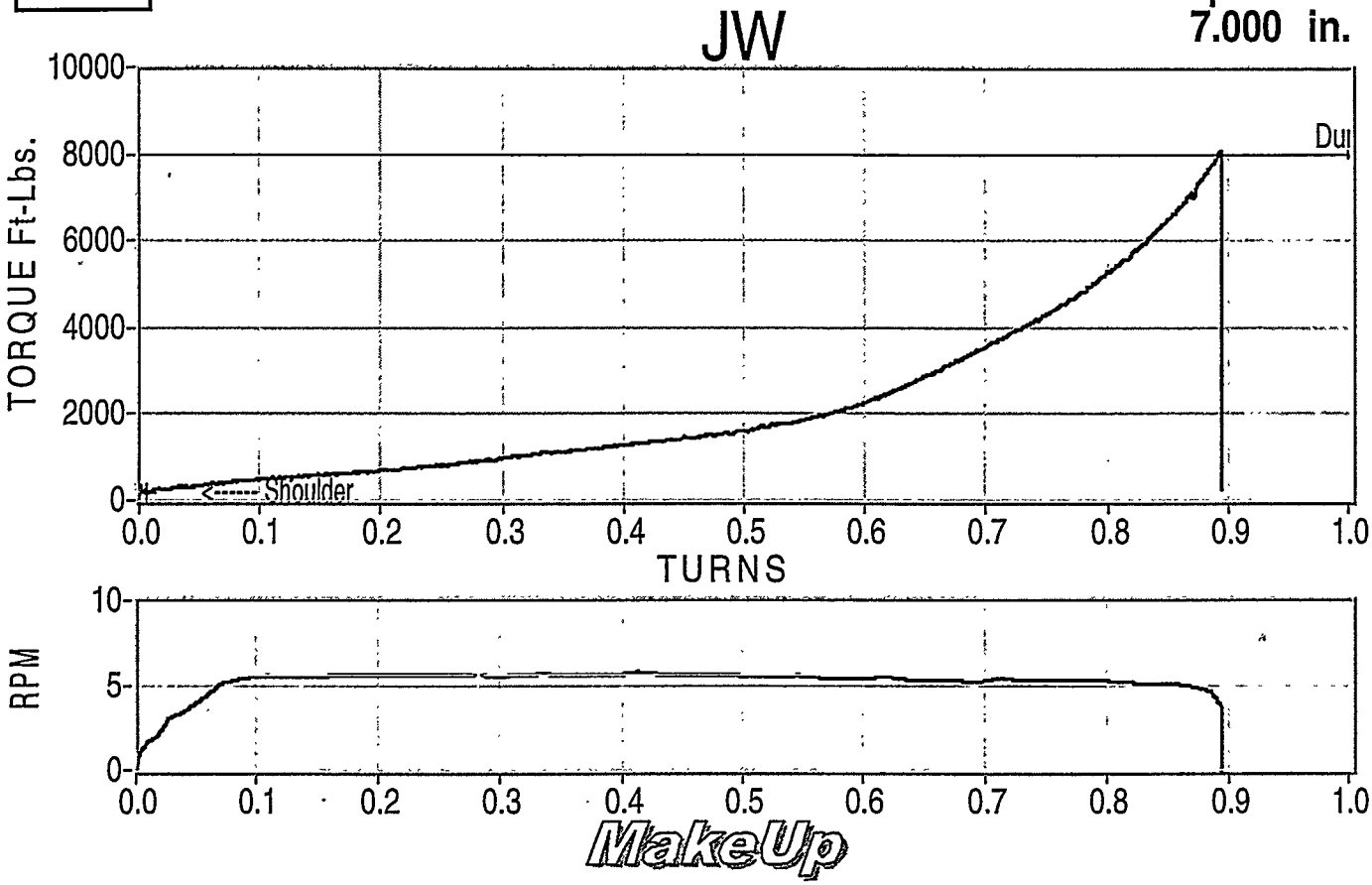
Operator:
BC/GS

Date:Time of Test
01/27/2000 : 2:30:20 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size
7.000 in.



MakeUp

MakeUp # 1		
Pin Id : 4P	Box Id : 4B	
File Name : TT_0087.dat		
Maximum Torque	8064	Ft-Lbs
Shoulder Torque	157	Ft-Lbs
Delta Torque	7907	Ft-Lbs
Turns @ Max. Torque	0.893	Turns
Shoulder Turns	0.007	Turns
Delta Turns	0.887	Turns
Total Turns	0.895	Turns
Pin Dope	19 ~~8~~	Grams
Box Dope	0 ~~15~~	Grams

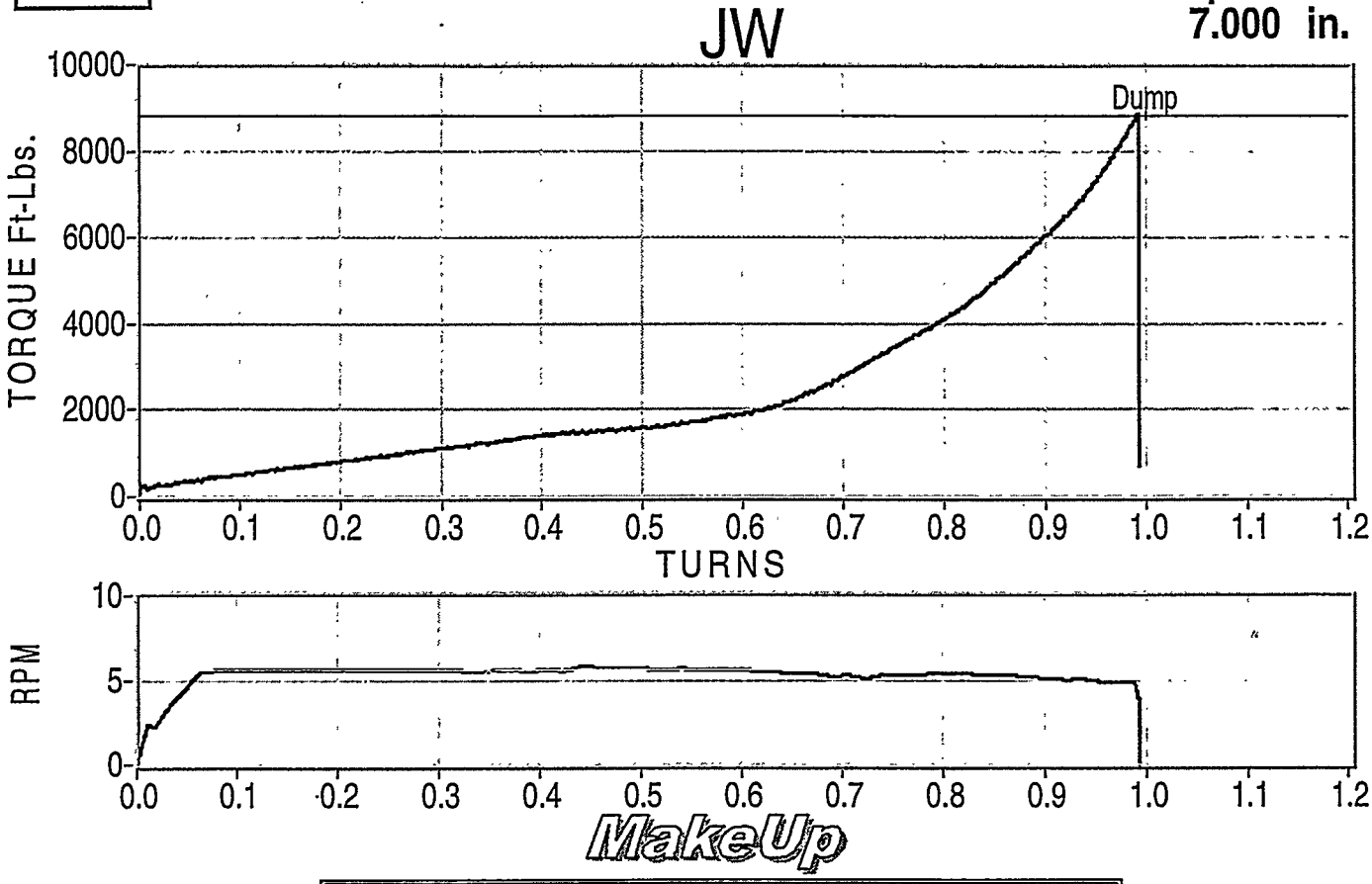
Operator:
BC/GS

Date:Time of Test
01/27/2000 : 3:10:06 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 1		
Pin Id : 5P	Box Id : 5B	
File Name : TT_0088.dat		
Maximum Torque	8869	Ft-Lbs
Shoulder Torque	365	Ft-Lbs
Delta Torque	8504	Ft-Lbs
Turns @ Max. Torque	0.992	Turns
Shoulder Turns	0.052	Turns
Delta Turns	0.939	Turns
Total Turns	0.993	Turns
Pin Dope	19 ~~0~~	Grams
Box Dope	0 ~~19~~	Grams

Operator:
BC/GS

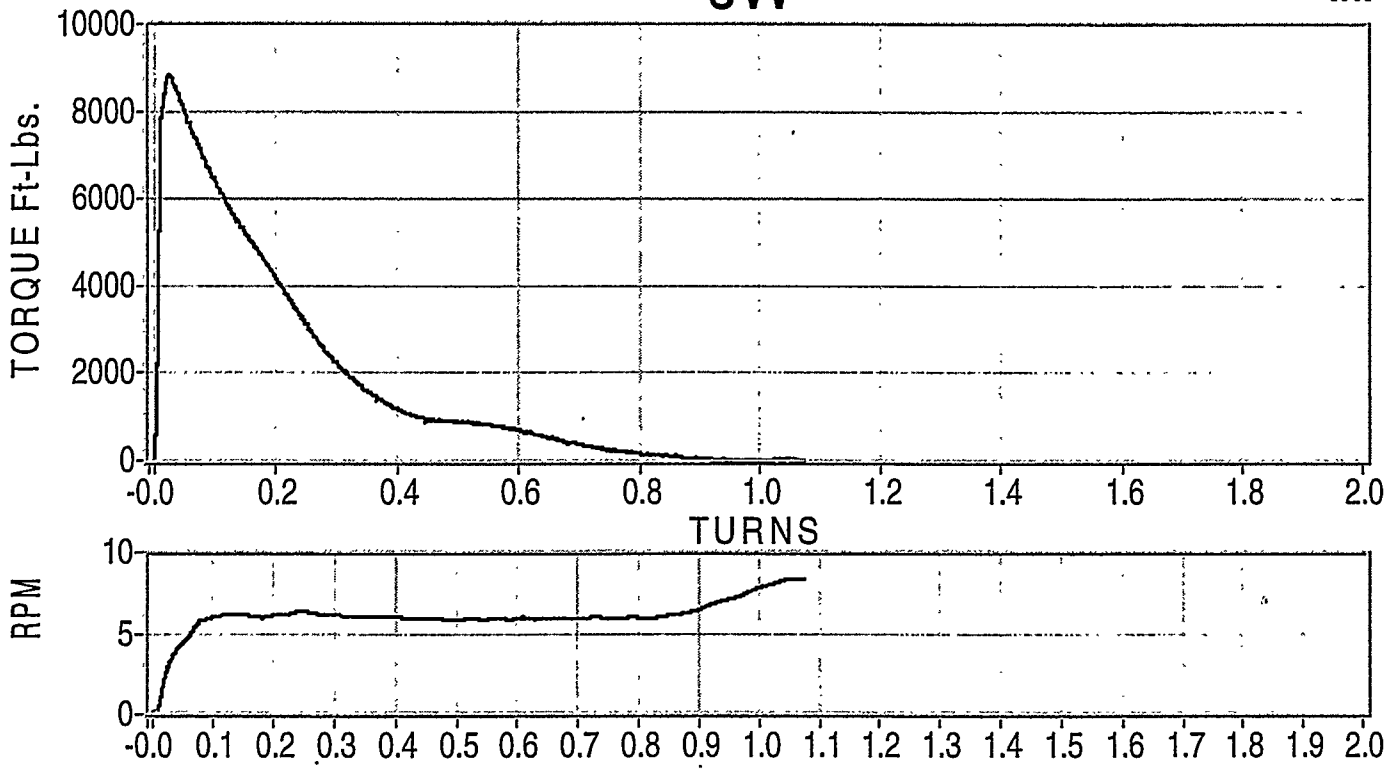
Date:Time of Test
01/27/2000 : 3:39:56 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size
7.000 in.

JW



BreakOut

BreakOut # 1	
Pin Id : 5P	**Box Id : 5B**
File Name : TT_0089.dat	
Maximum Torque	**8836 Ft-Lbs**

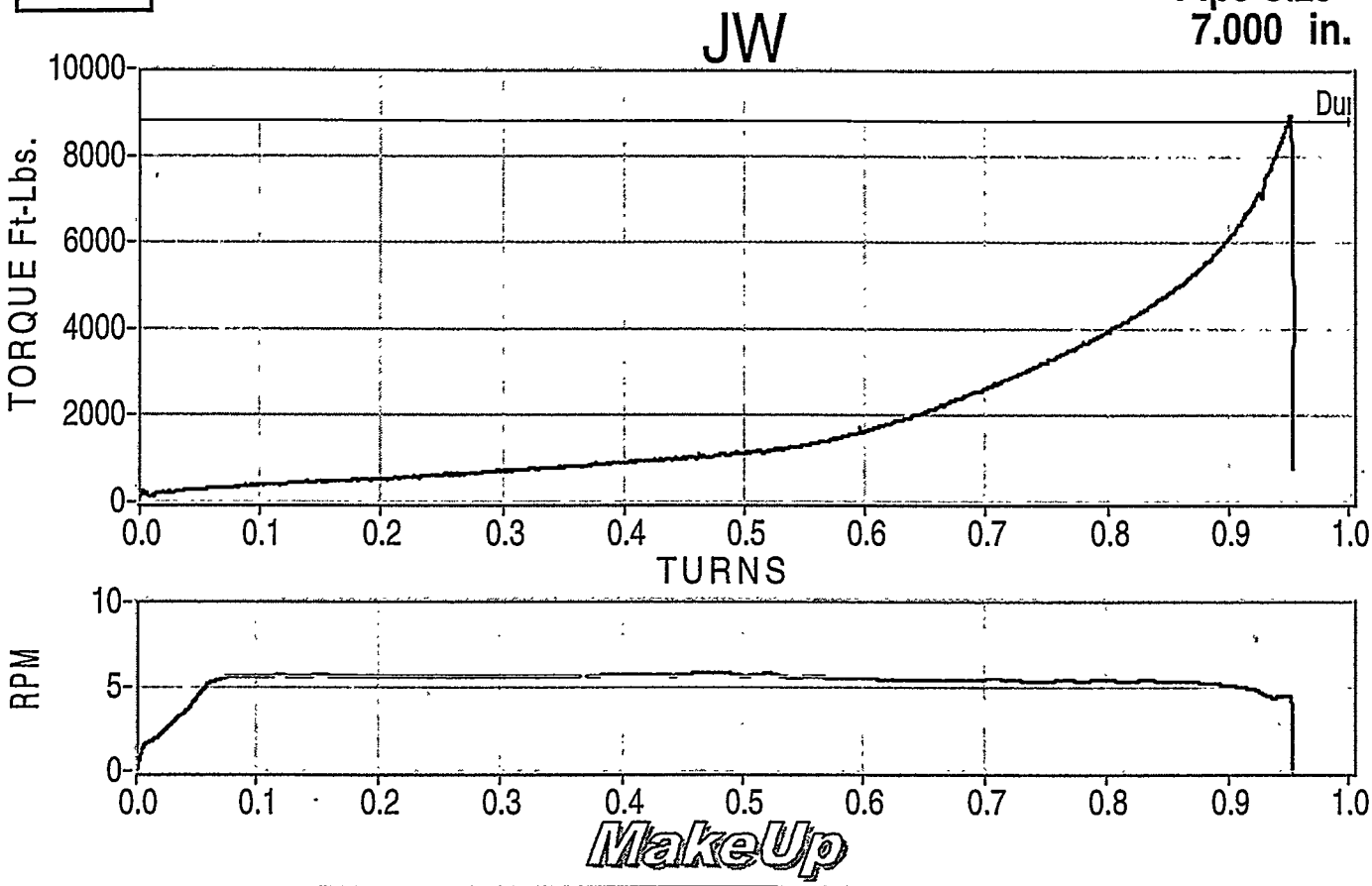
Operator :
BC/GS

Date : Time of Test
01/27/2000 : 3:42:36 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 2		
Pin Id : 5P	**Box Id : 5B**	
File Name : TT_0090.dat		
Maximum Torque	**8962**	**Ft-Lbs**
Shoulder Torque	**342**	**Ft-Lbs**
Delta Torque	**8620**	**Ft-Lbs**
Turns @ Max. Torque	**0.951**	**Turns**
Shoulder Turns	**0.068**	**Turns**
Delta Turns	**0.883**	**Turns**
Total Turns	**0.954**	**Turns**
Pin Dope	21 ~~0~~	**Grams**
Box Dope	0 ~~21~~	**Grams**

Operator:
BC/GS

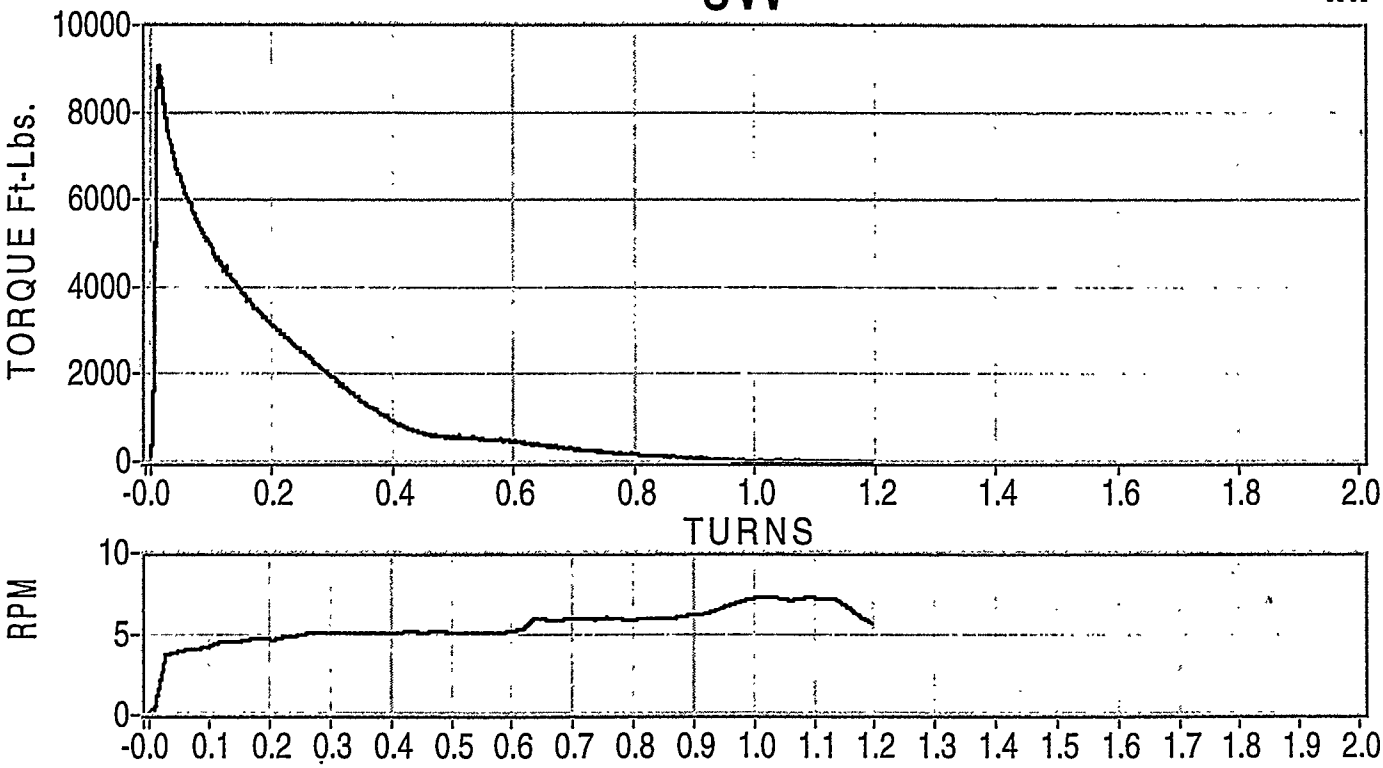
Date:Time of Test
01/27/2000 : 3:54:03 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 2	
Pin Id : 5P	Box Id : 5B
File Name : TT_0091.dat	
Maximum Torque	9074 Ft-Lbs

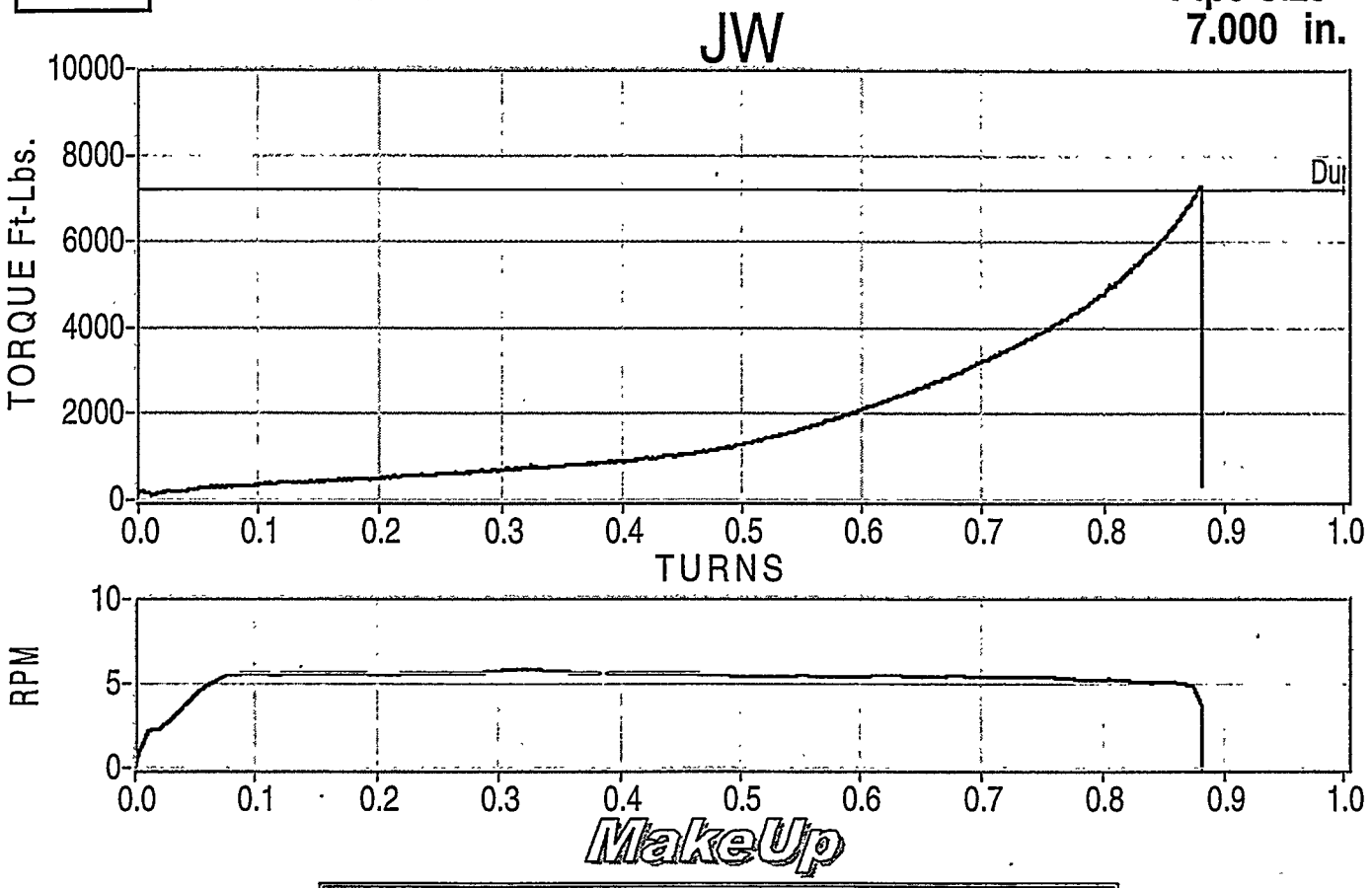
Operator :
BC/GS

Date : Time of Test
01/27/2000 : 3:56:40 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 3		
Pin Id : 5P	Box Id : 5B	
File Name : TT_0092.dat		
Maximum Torque	7298	Ft-Lbs
Shoulder Torque	312	Ft-Lbs
Delta Torque	6986	Ft-Lbs
Turns @ Max. Torque	0.881	Turns
Shoulder Turns	0.085	Turns
Delta Turns	0.795	Turns
Total Turns	0.882	Turns
Pin Dope	20 ~~0~~	Grams
Box Dope	0 ~~20~~	Grams

Operator:
BC/GS

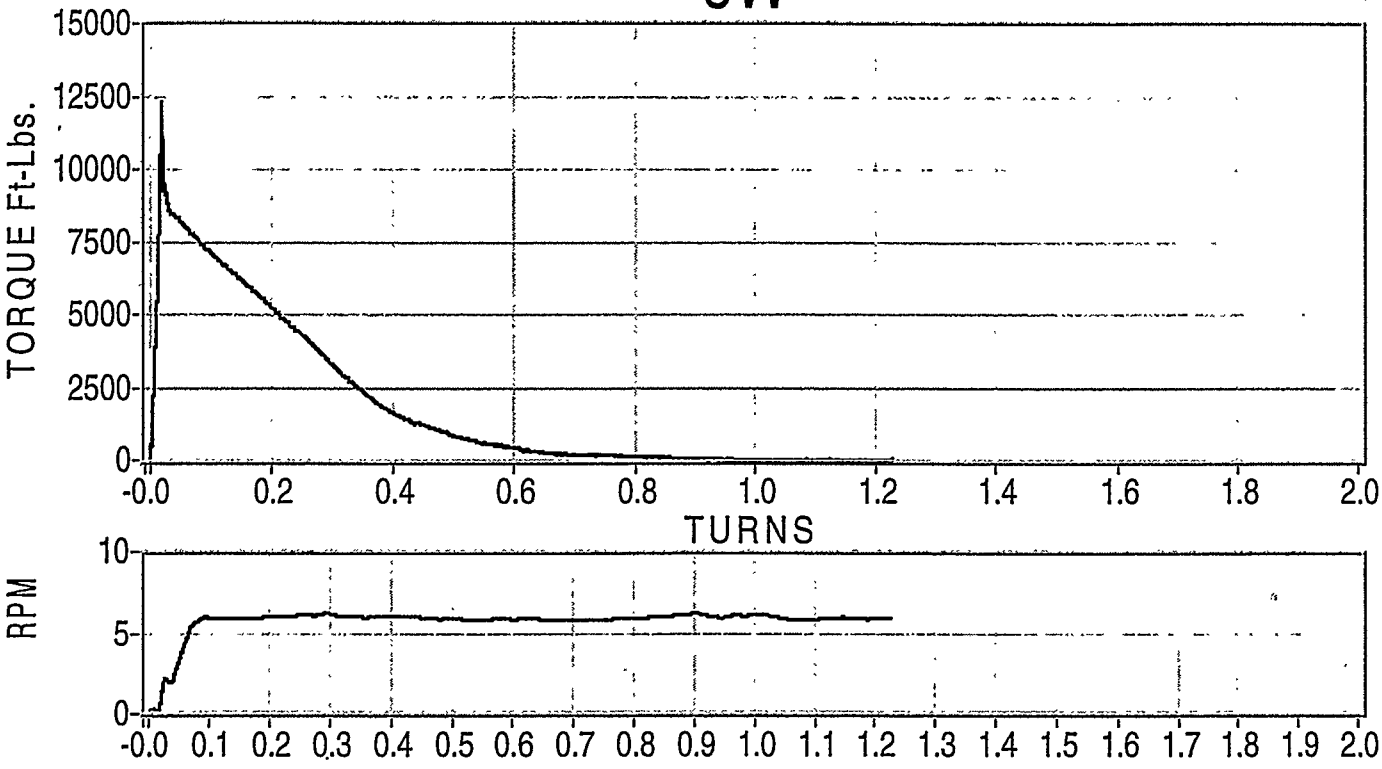
Date:Time of Test
01/27/2000 : 4:17:04 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size
7.000 in.

JW



BreakOut

BreakOut # 3	
Pin Id : 5P	**Box Id : 5B**
File Name : TT_0078.dat	
Maximum Torque	**12346 Ft-Lbs**

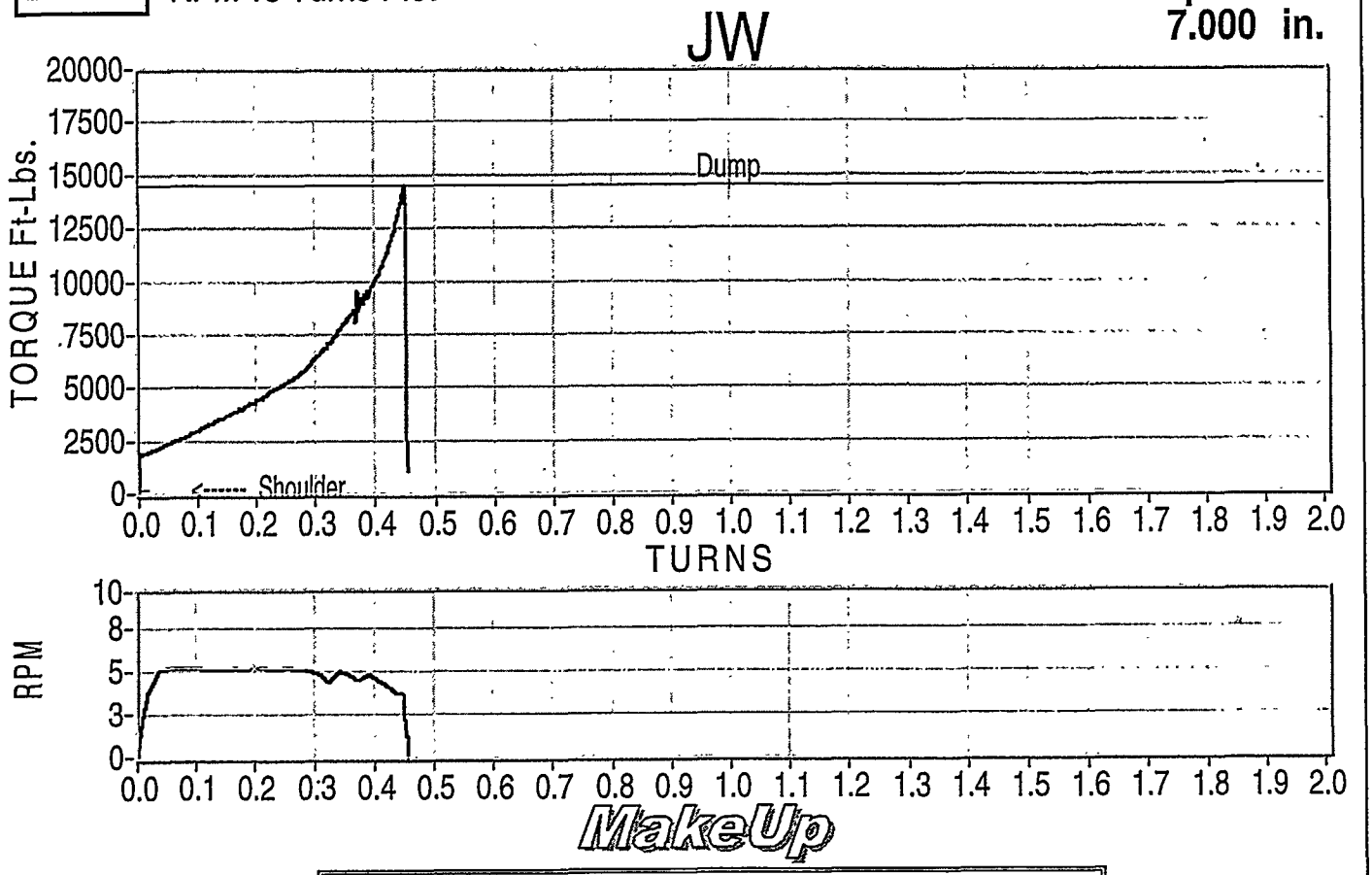
Operator :
BC/GS

Date : Time of Test
02/01/2000 : 7:49:22 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 4		
Pin Id : 5P	Box Id : 5B	
File Name : TT_0079.dat		
Maximum Torque	14488	Ft-Lbs
Shoulder Torque	129	Ft-Lbs
Delta Torque	14359	Ft-Lbs
Turns @ Max. Torque	0.450	Turns
Shoulder Turns	0.000	Turns
Delta Turns	0.450	Turns
Total Turns	0.456	Turns
Pin Dope	21	Grams
Box Dope	0	Grams

Operator:
BC/GS

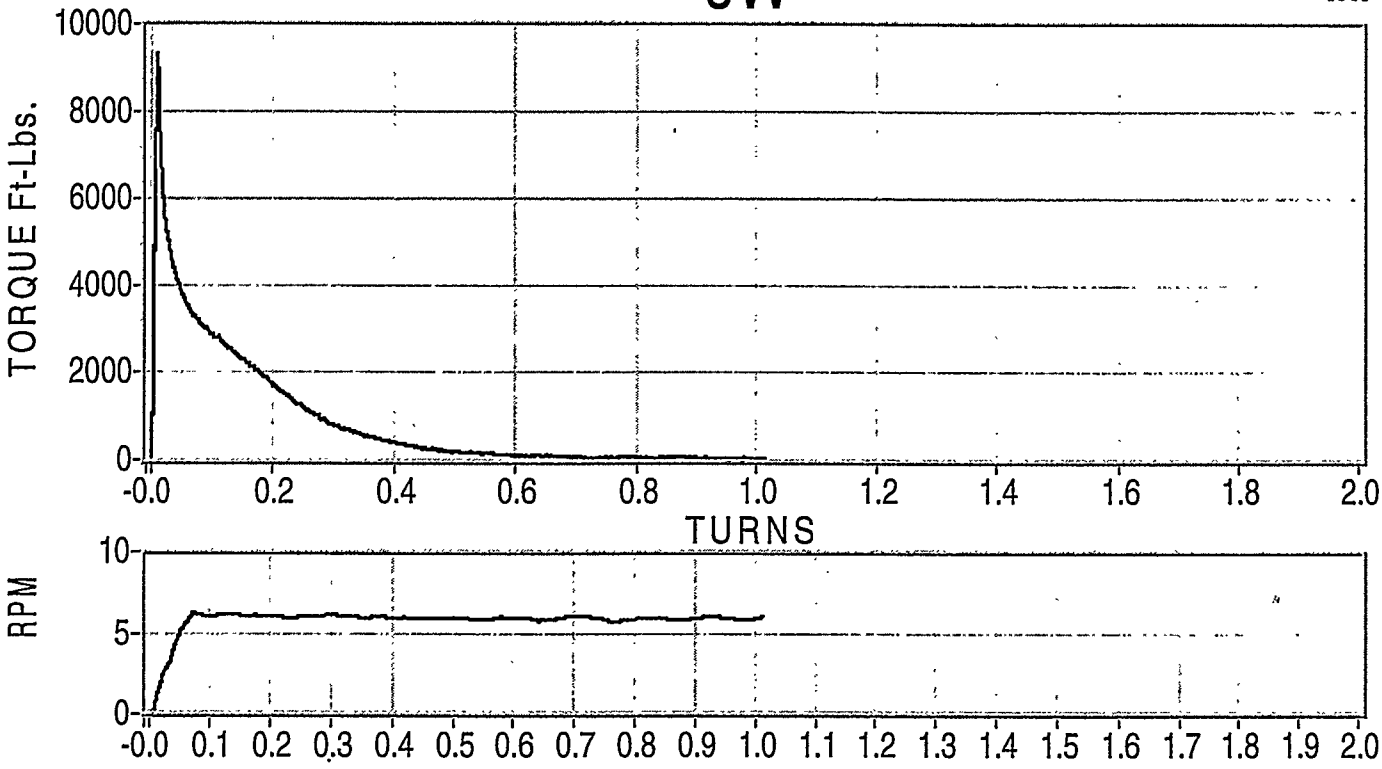
Date:Time of Test
02/01/2000 : 11:01:12 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 4	
Pin Id : 5P	**Box Id : 5B**
File Name : TT_0080.dat	
Maximum Torque	**9361 Ft-Lbs**

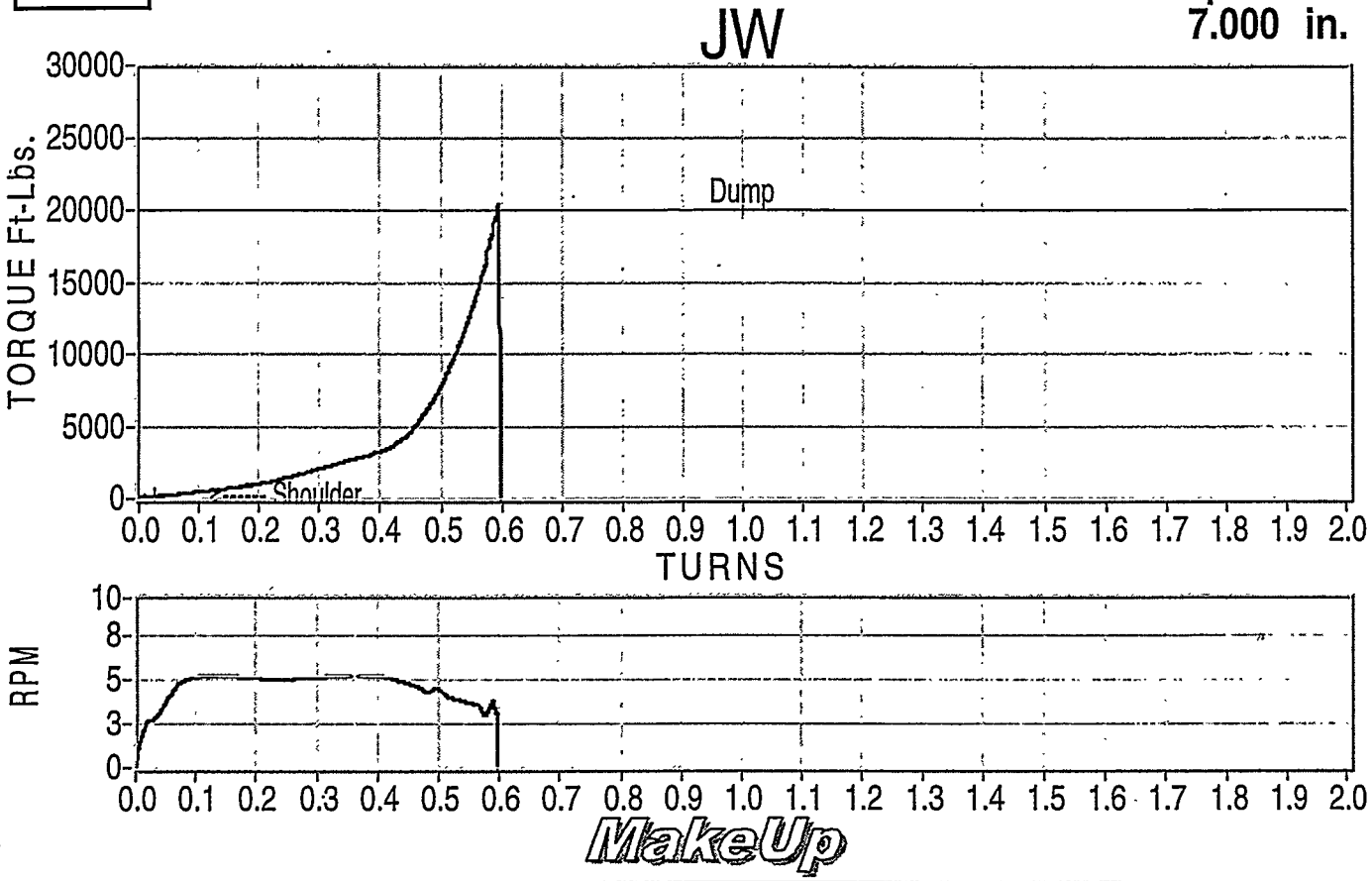
Operator :
BC/GS

Date : Time of Test
02/02/2000 : 7:12:15 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 5		
Pin Id : 5P	Box Id : 5B	
File Name : TT_0081.dat		
Maximum Torque	20456	Ft-Lbs
Shoulder Torque	164	Ft-Lbs
Delta Torque	20292	Ft-Lbs
Turns @ Max. Torque	0.595	Turns
Shoulder Turns	0.028	Turns
Delta Turns	0.567	Turns
Total Turns	0.598	Turns
Pin Dope	19	Grams
Box Dope	0	Grams

Operator:
BC/GS

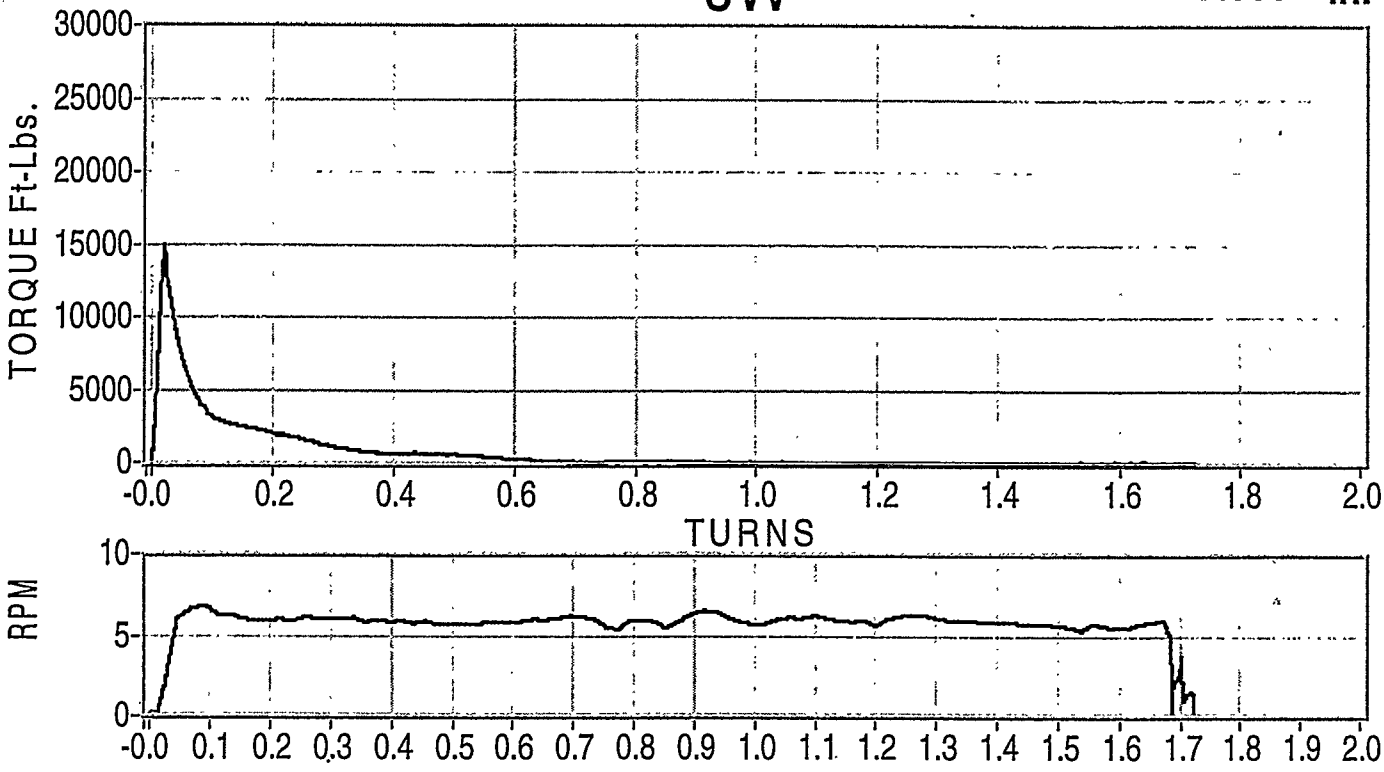
Date:Time of Test
02/02/2000 : 9:04:54 AM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 5	
Pin Id : 5P	Box Id : 5B
File Name : TT_0082.dat	
Maximum Torque	15073 Ft-Lbs

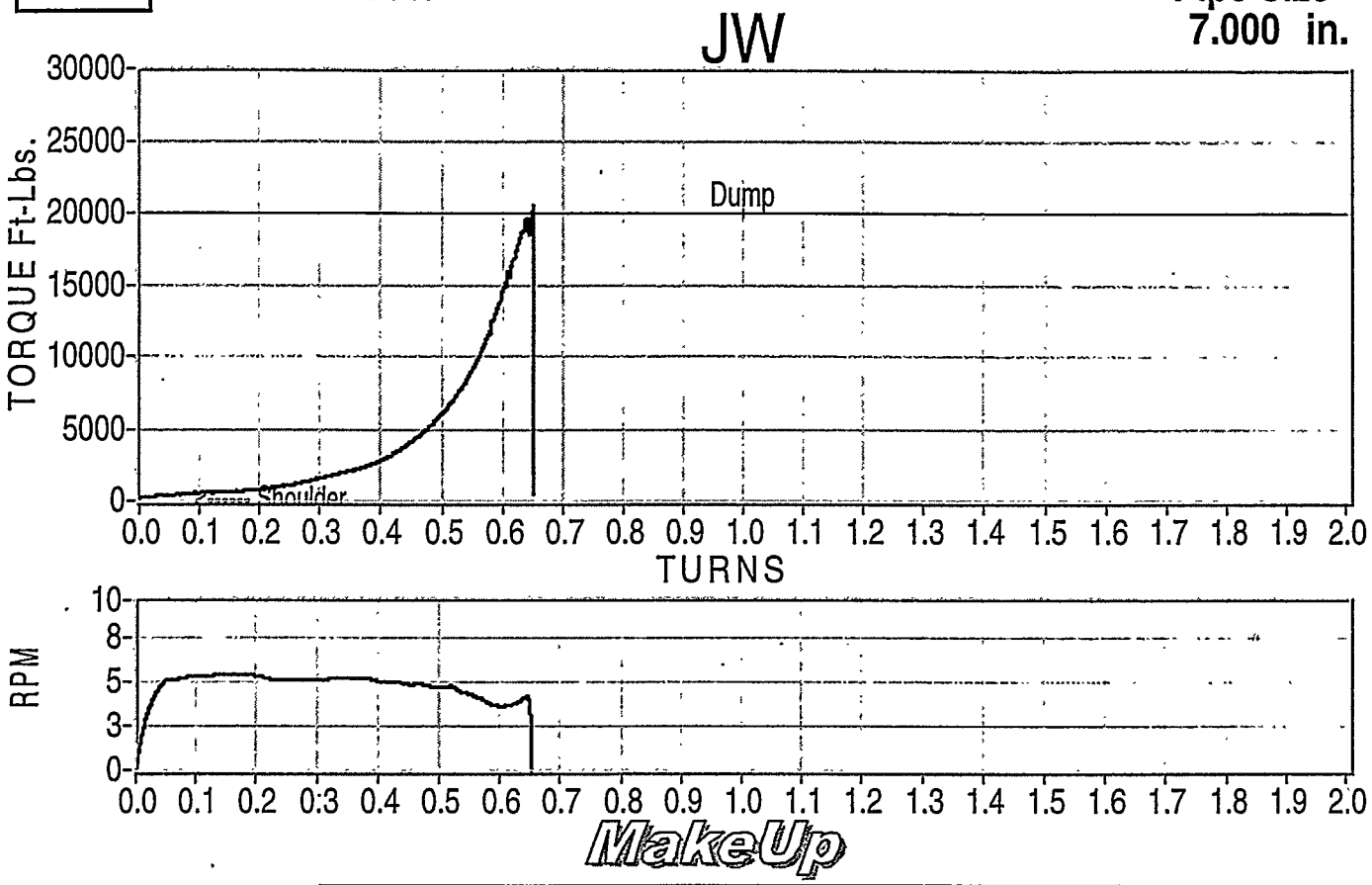
Operator :
BC/GS

Date : Time of Test
02/02/2000 : 3:07:26 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number : 6924

Pipe Size 7.000 in.



MakeUp # 6		
Pin Id : 5P	Box Id : 5B	
File Name : TT_0083.dat		
Maximum Torque	20617	Ft-Lbs
Shoulder Torque	-21	Ft-Lbs
Delta Torque	20638	Ft-Lbs
Turns @ Max. Torque	0.651	Turns
Shoulder Turns	0.000	Turns
Delta Turns	0.651	Turns
Total Turns	0.652	Turns
Pin Dope	19	Grams
Box Dope	6	Grams

Operator:
BC/GS

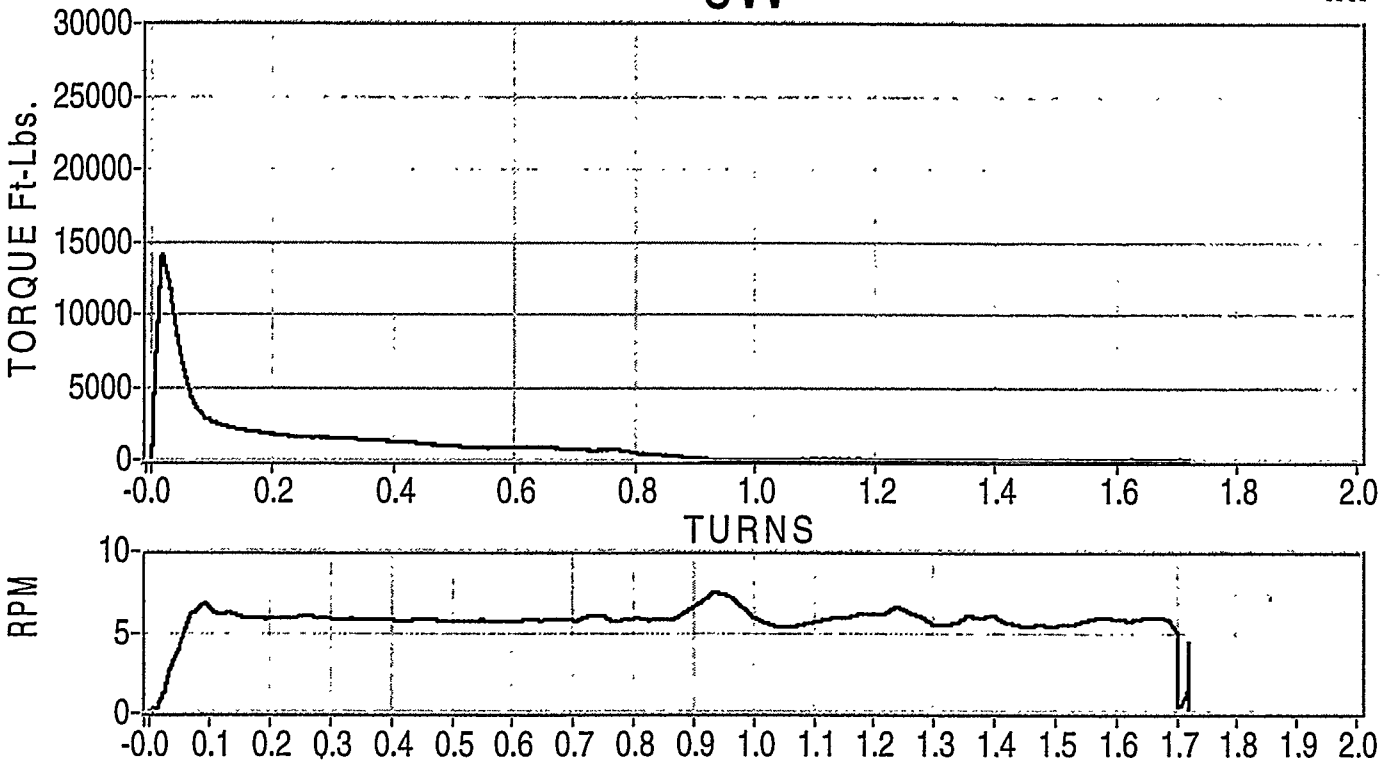
Date:Time of Test
02/02/2000 : 4:02:18 PM

Stress Engineering Services
Torque vs Turns Plot
RPM vs Turns Plot

Project Number: 6924

Pipe Size 7.000 in.

JW



BreakOut

BreakOut # 6	
Pin Id : 5P	**Box Id : 5B**
File Name : TT_0086.dat	
Maximum Torque	**14242 Ft-Lbs**

Operator :
BC/GS

Date : Time of Test
02/04/2000 : 11:32:33 AM

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.127

Ctrl Gain	Ctrl Offset
2703.20	-0.129

Cal time date

01/27/2000 10:13 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	-0.127	Volts
Load Cell	0.78	Lbs
Torque	2.34	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.127	Volts

Control Board

Raw Volts	-0.129	Volts
Load Cell	0.17	Lbs
Torque	0.51	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.129	Volts

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.127

Ctrl Gain	Ctrl Offset
2703.20	-0.129

Cal time date

01/27/2000 10:13 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	2.551	Volts
Load Cell	7239.83	Lbs
Torque	21719.48	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.127	Volts

Control Board

Raw Volts	2.549	Volts
Load Cell	7239.81	Lbs
Torque	21719.42	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.129	Volts

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing ▽ 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.128

Ctrl Gain	Ctrl Offset
2703.20	-0.129

Cal time date

02/01/2000 6:36 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	2.549	Volts
Load Cell	7238.69	Lbs
Torque	21716.06	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.128	Volts

Control Board

Raw Volts	2.549	Volts
Load Cell	7239.29	Lbs
Torque	21717.87	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.129	Volts

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.128

Ctrl Gain	Ctrl Offset
2703.20	-0.129

Cal time date

02/01/2000 6:36 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	-0.128	Volts
Load Cell	0.96	Lbs
Torque	2.87	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.128	Volts

Control Board

Raw Volts	-0.129	Volts
Load Cell	0.06	Lbs
Torque	0.18	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.129	Volts

Stress Engineering Services
Torque Turn
Test Setup Information

Project Number	6924
Client	JW
Pipe Size	7.00
Pipe Weight	32 ppf
Pipe Grade	P-110
Connection	WW
Operator	BC/GS
Thread Compound	Shell 72732

	Pin	**Box**
Surface Treatment	Phosphate	Phosphate

Test Setup File

C:_Project\Torque Turn\DATA\6924.su

02/01/2000 6:37 AM

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.127

Ctrl Gain	Ctrl Offset
2703.20	-0.128

Cal time date

02/02/2000 7:07 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	2.551	Volts
Load Cell	7239.87	Lbs
Torque	21719.62	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.127	Volts

Control Board

Raw Volts	2.549	Volts
Load Cell	7238.65	Lbs
Torque	21715.95	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.128	Volts

Stress Engineering Services
Torque Turn
Calibration

Load Cell

S/N: 1210

Capacity: 10k Lbs.

Shunt: 7238.00 Lbs.

Power Tong

Casing 36.00 Inches

Daq Gain	Daq Offset
2703.40	-0.127

Ctrl Gain	Ctrl Offset
2703.20	-0.128

Cal time date

02/02/2000 7:07 AM

Calibration File

C:_Project\Torque Turn\1210.cal

Daq Board

Raw Volts	-0.127	Volts
Load Cell	-1.82	Lbs
Torque	-5.45	Ft Lbs
Gain	2703.40	Ft Lbs/V
Offset	-0.127	Volts

Control Board

Raw Volts	-0.129	Volts
Load Cell	-0.29	Lbs
Torque	-0.87	Ft Lbs
Gain	2703.20	Ft Lbs/V
Offset	-0.128	Volts

Stress Engineering Services
Torque Turn
Test Setup Information

Project Number	6924
Client	JW
Pipe Size	7.00
Pipe Weight	32 ppf
Pipe Grade	P-110
Connection	WW
Operator	BC/GS
Thread Compound	Shell 72732

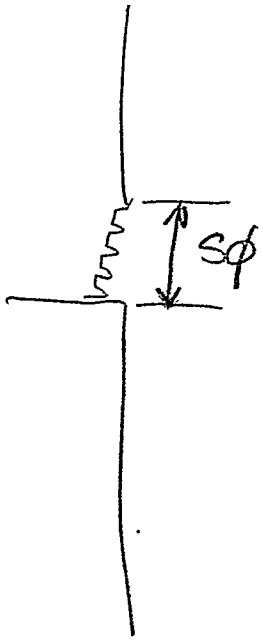
	Pin	**Box**
Surface Treatment	Phosphate	Phosphate

Test Setup File

C:_Project\Torque Turn\DATA\6924.su

02/02/2000 7:08 AM

Client	Project No.	Page No. of	By	Date 4/27/00
Subject			Checked By	Date



SAMPLE #	Sϕ
1	.683
2	.673

Client	Project No.	Page No. of	By	Date
Subject			Checked By	Date

PIPE YIELD TORQUE:

OD = 7

ID = 6.094

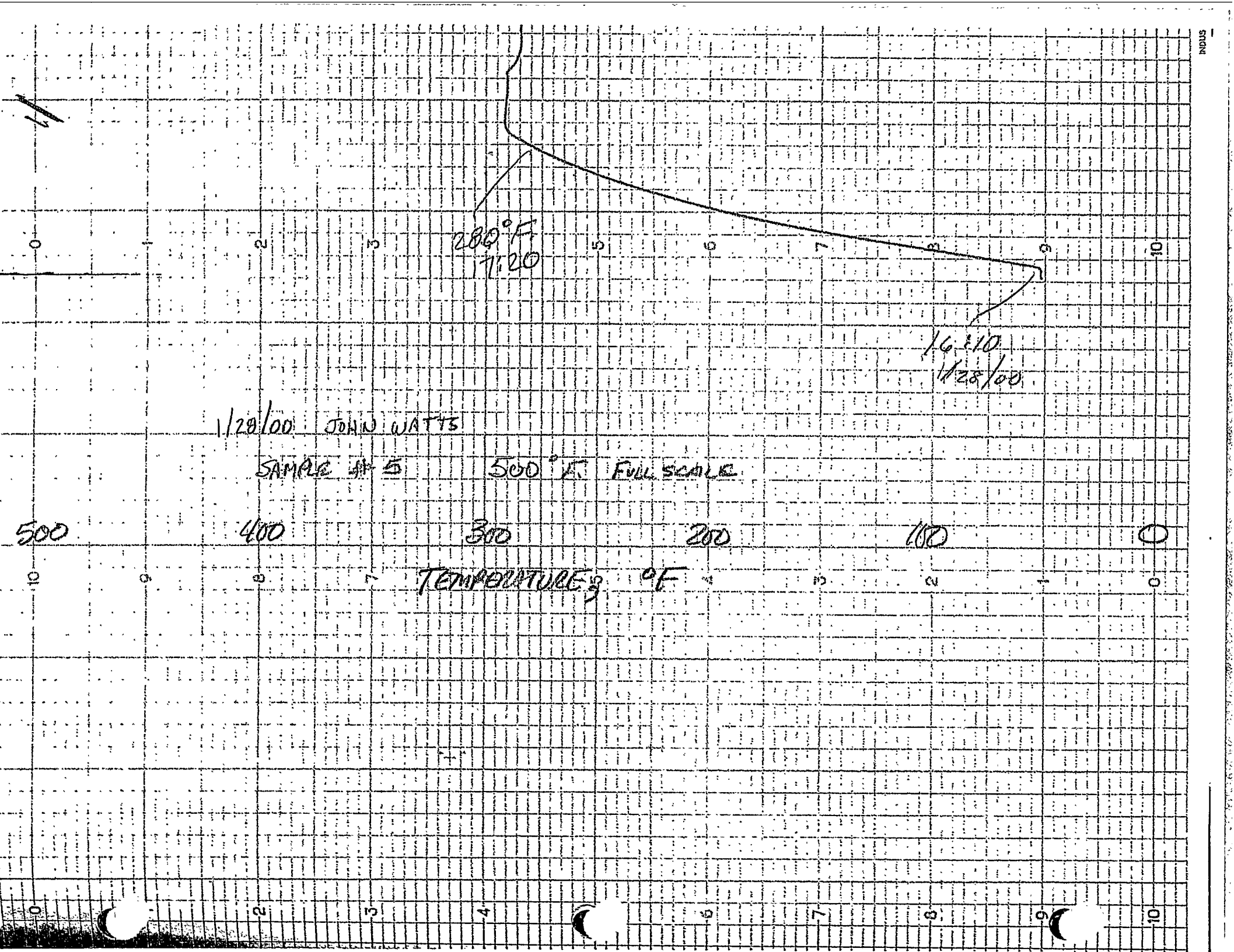
A = 9.317 in²

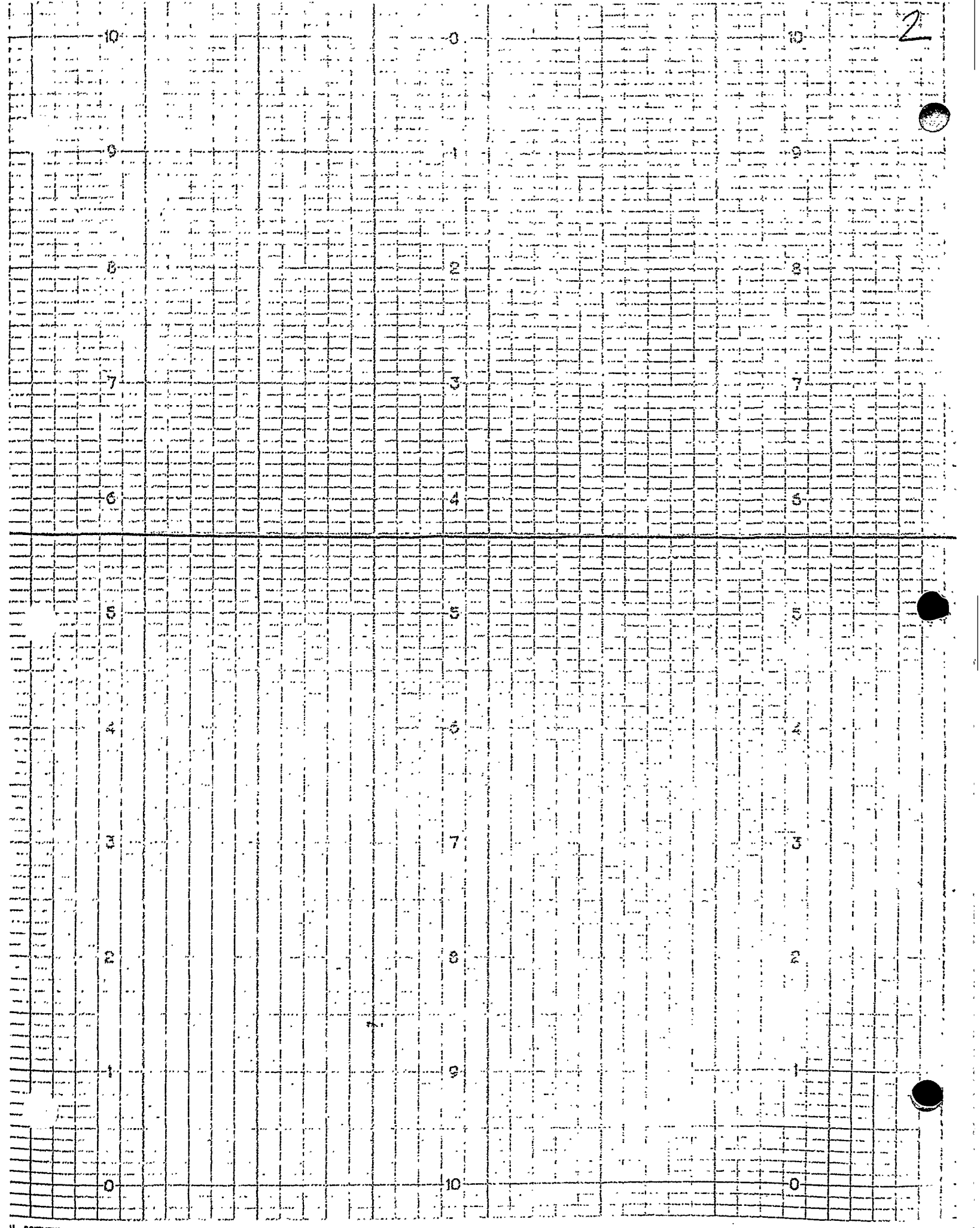
I = 50.1

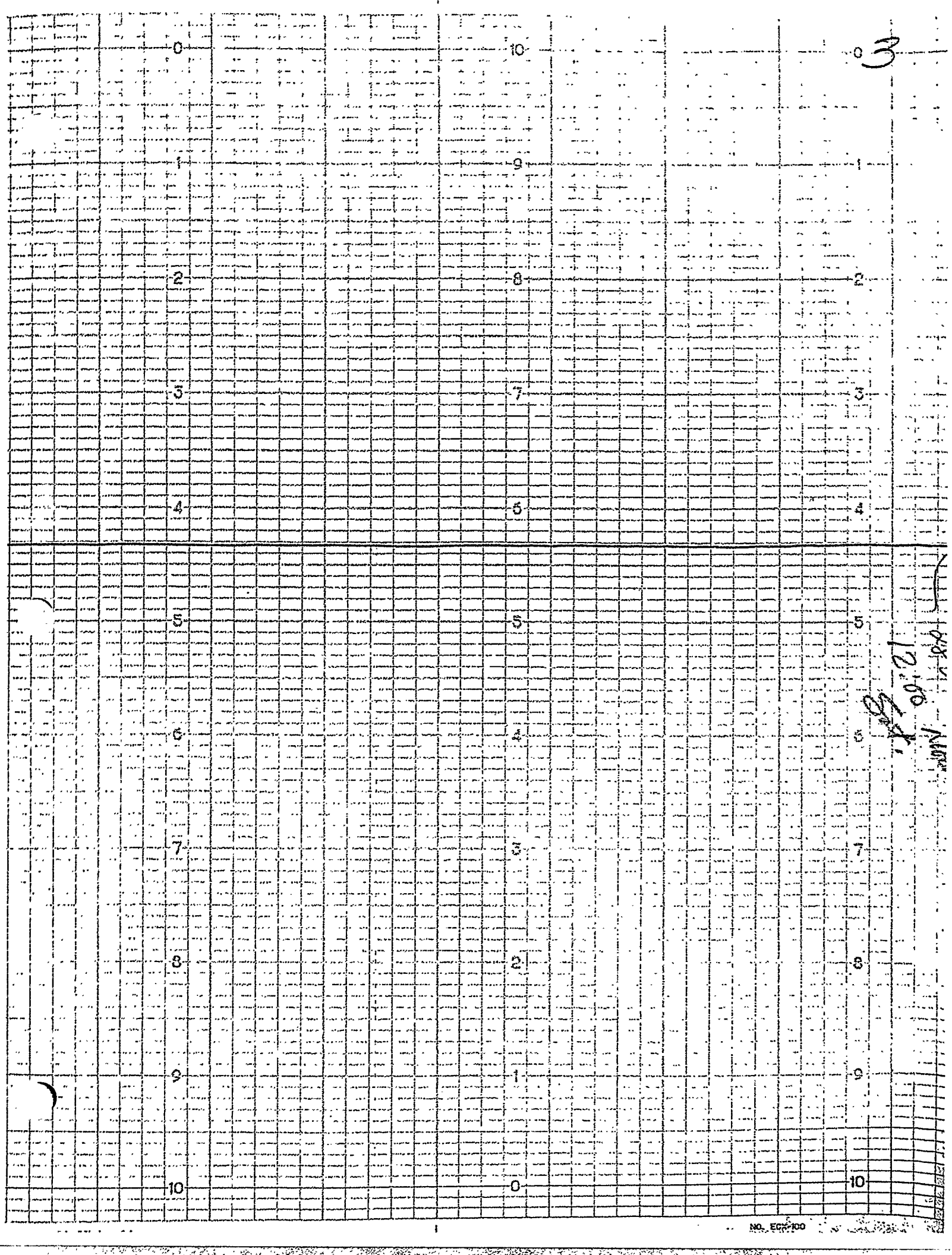
$$\tau = \frac{Tc}{J}$$

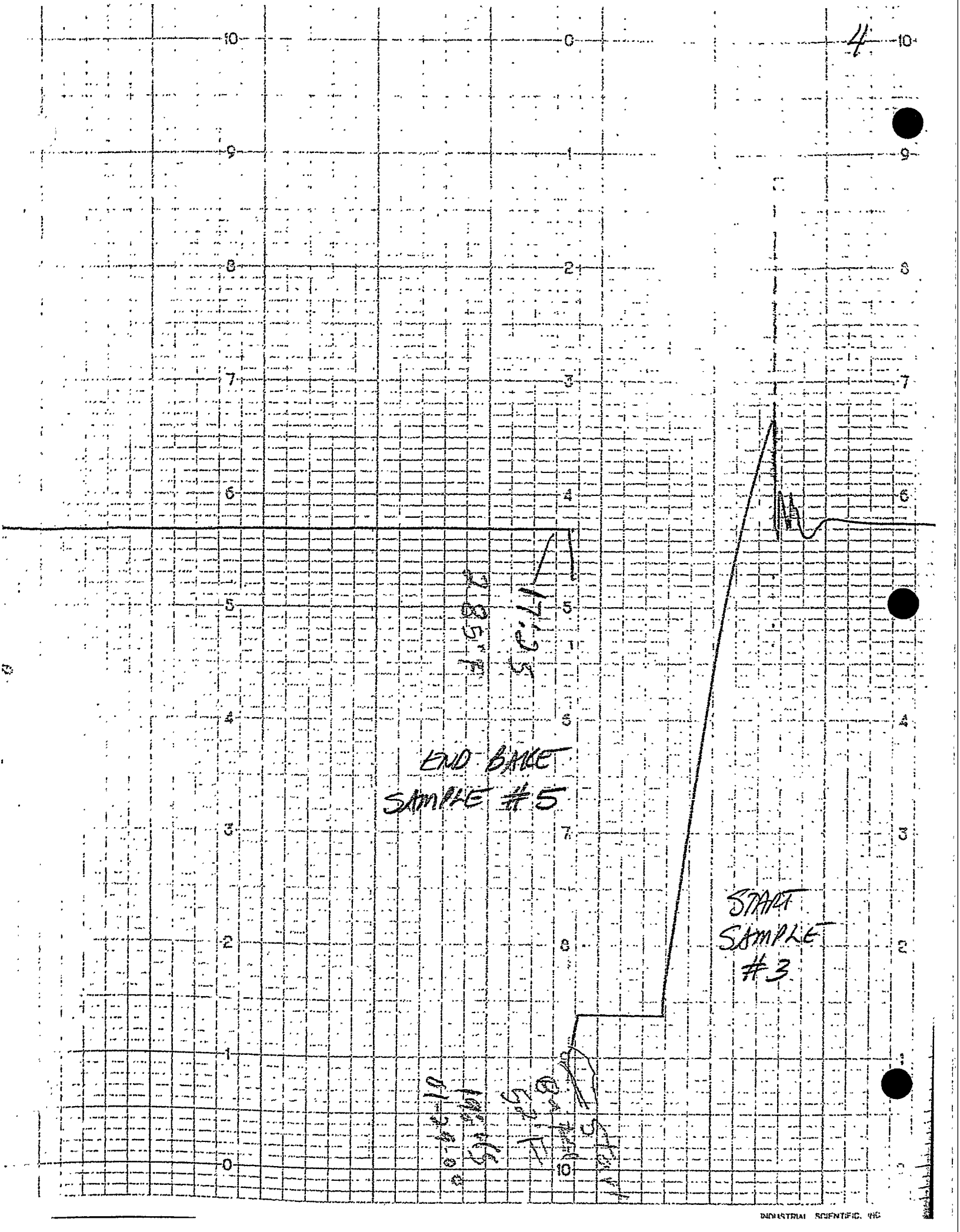
$$T = \frac{\tau J}{c} = \frac{(137{,}000)(.6)(50.1)}{3.5}$$

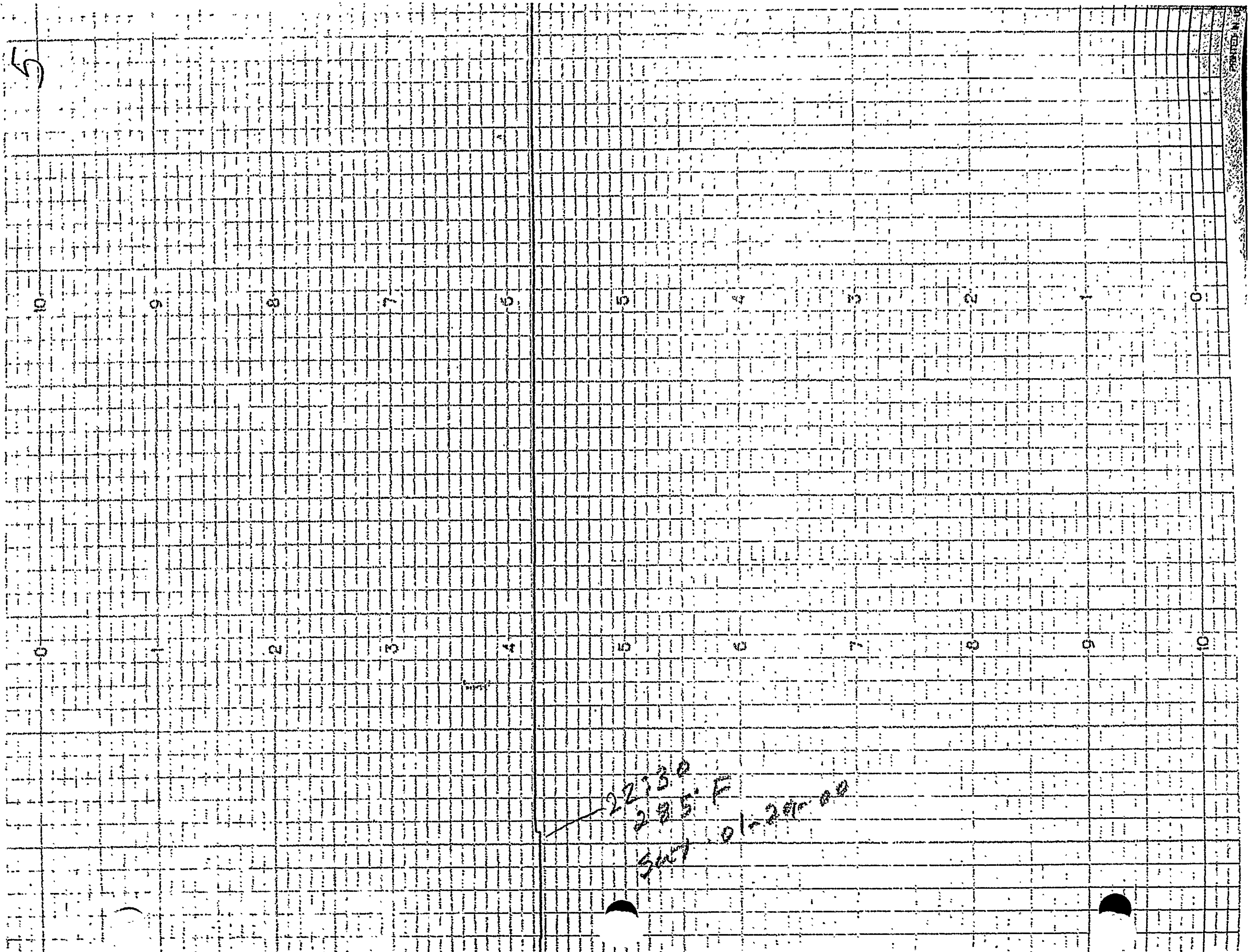
$$= 94{,}400 \text{ Ft-\#}$$


280°F
7:20
16:10
1/28/00
1/28/00 JOHN WATTS
SAMPLE # 5
500° F FULL SCALE
500
400
300
200
100
0
TEMPERATURE °F

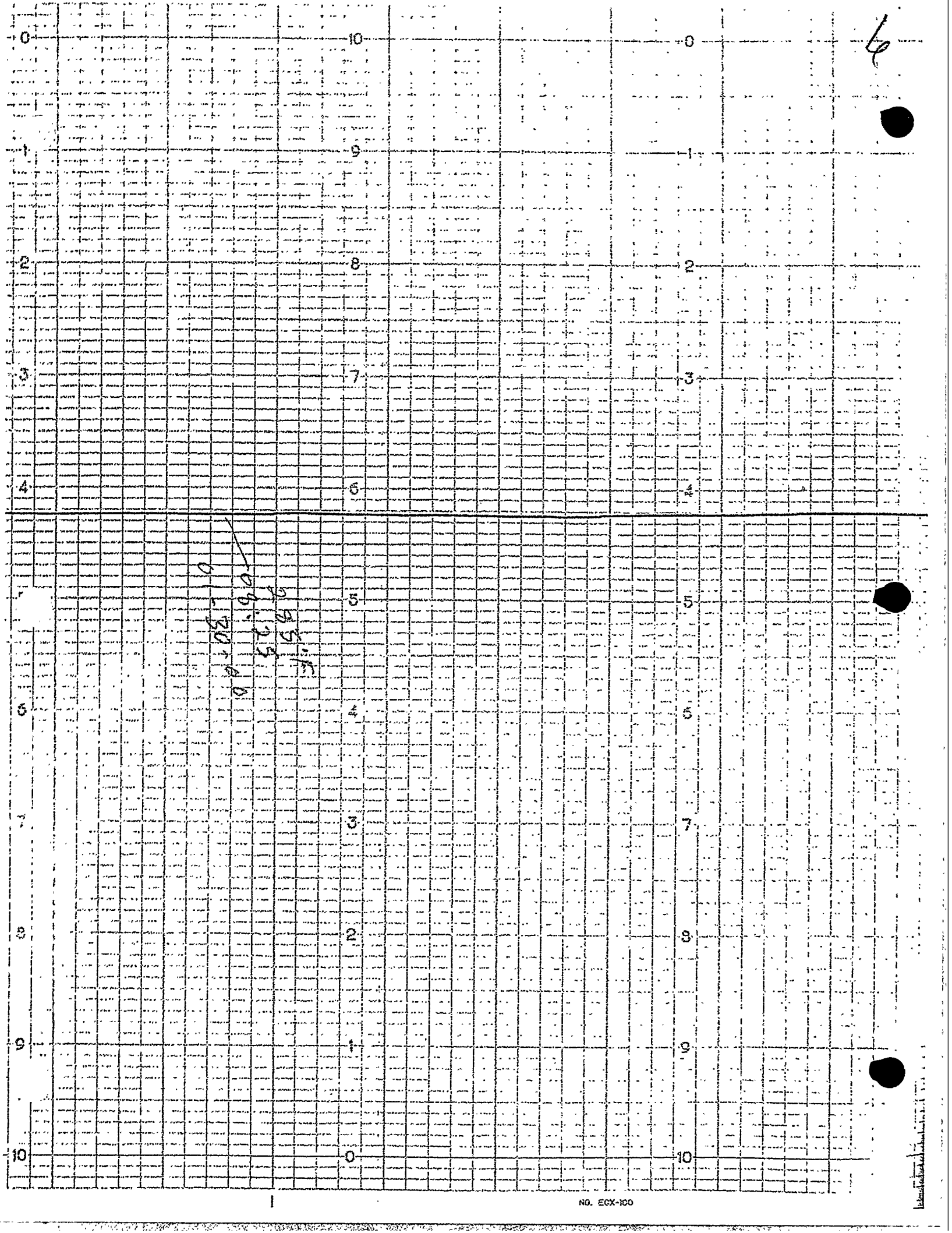



3
12-08 Sat.
NO. EC9-100


4
END BAKE
SAMPLE #5
START
SAMPLE
#3
INDUSTRIAL SCIENTIFIC INC

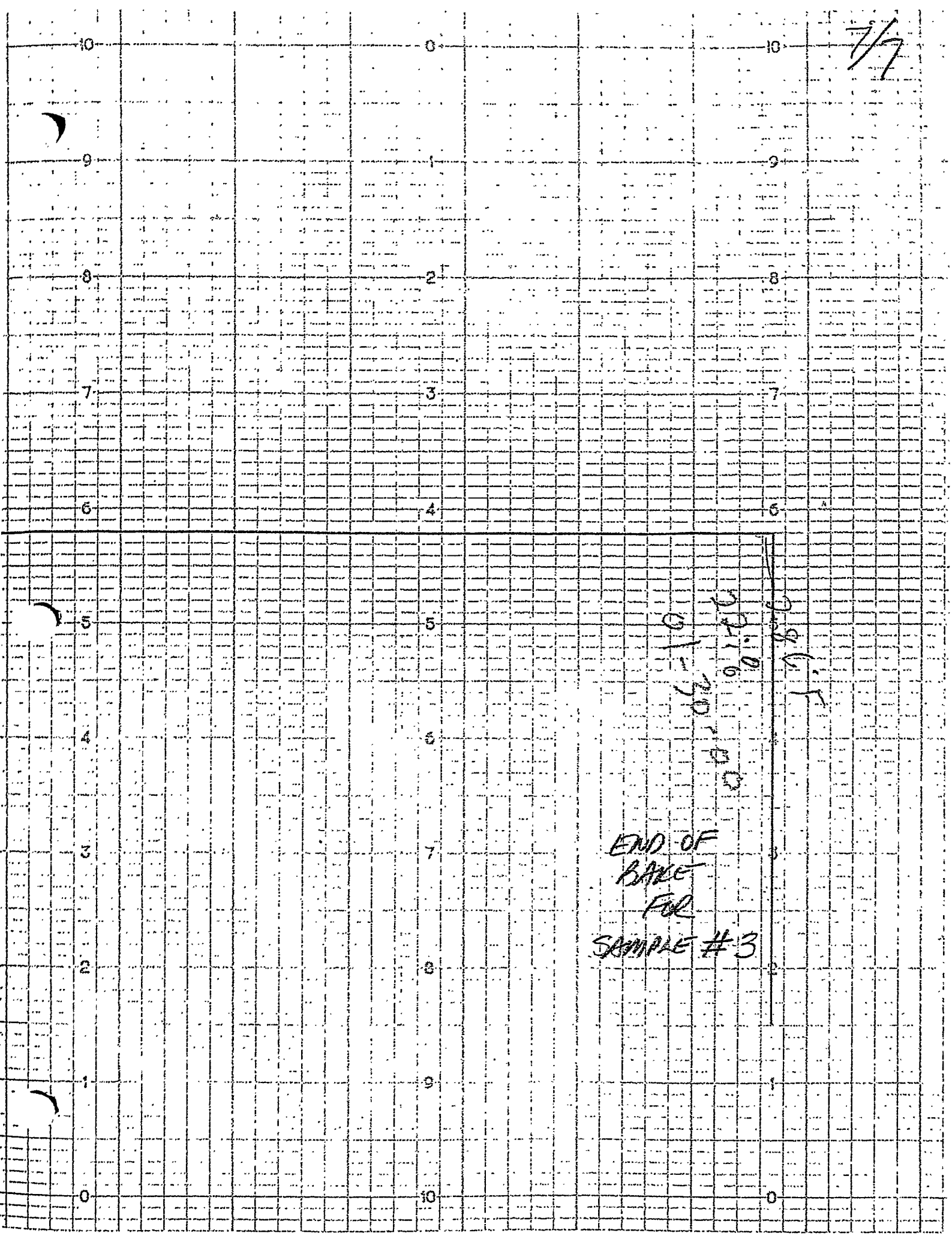


5
10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10
22:30
285° F
Start 01-24-00

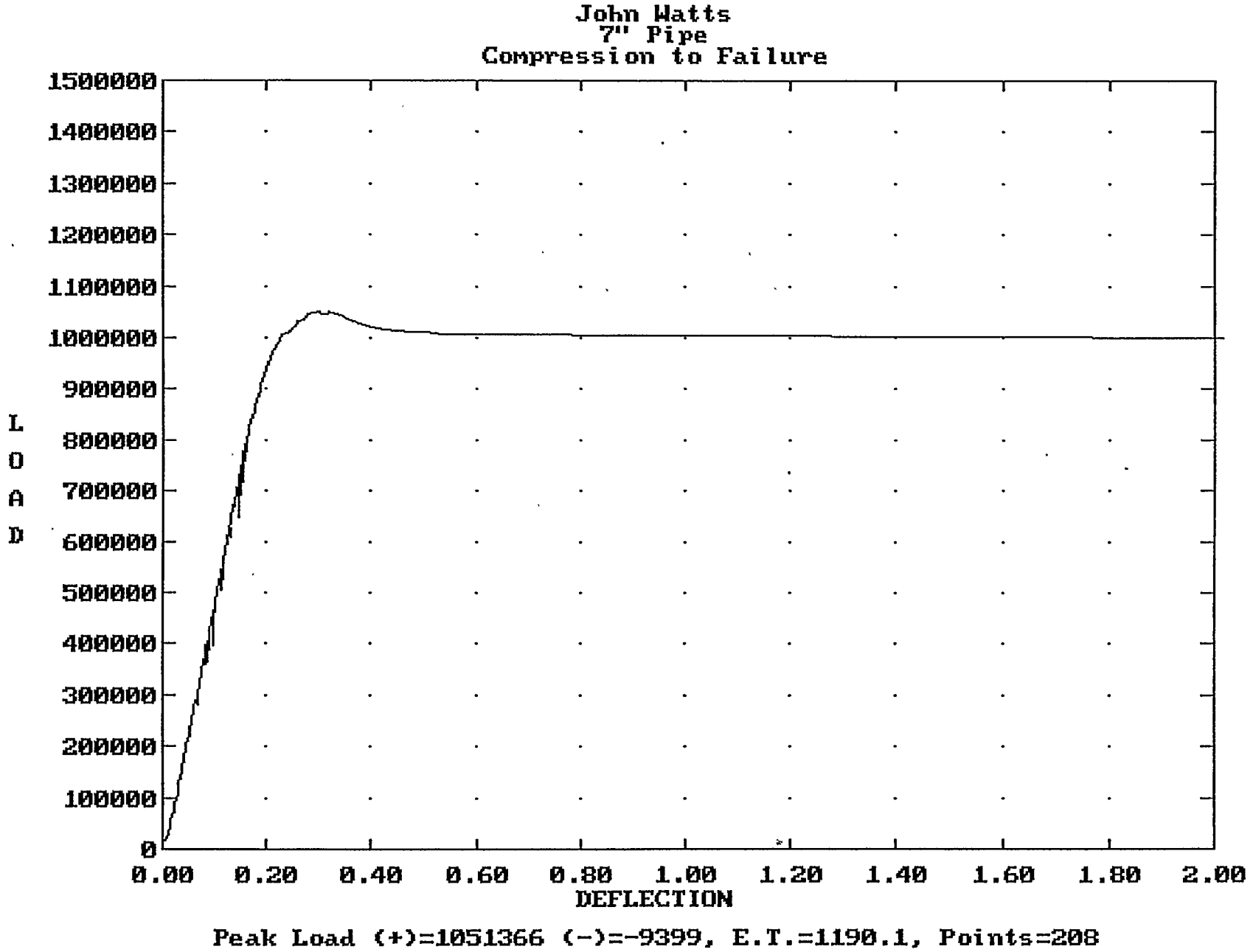


NO. ECX-100

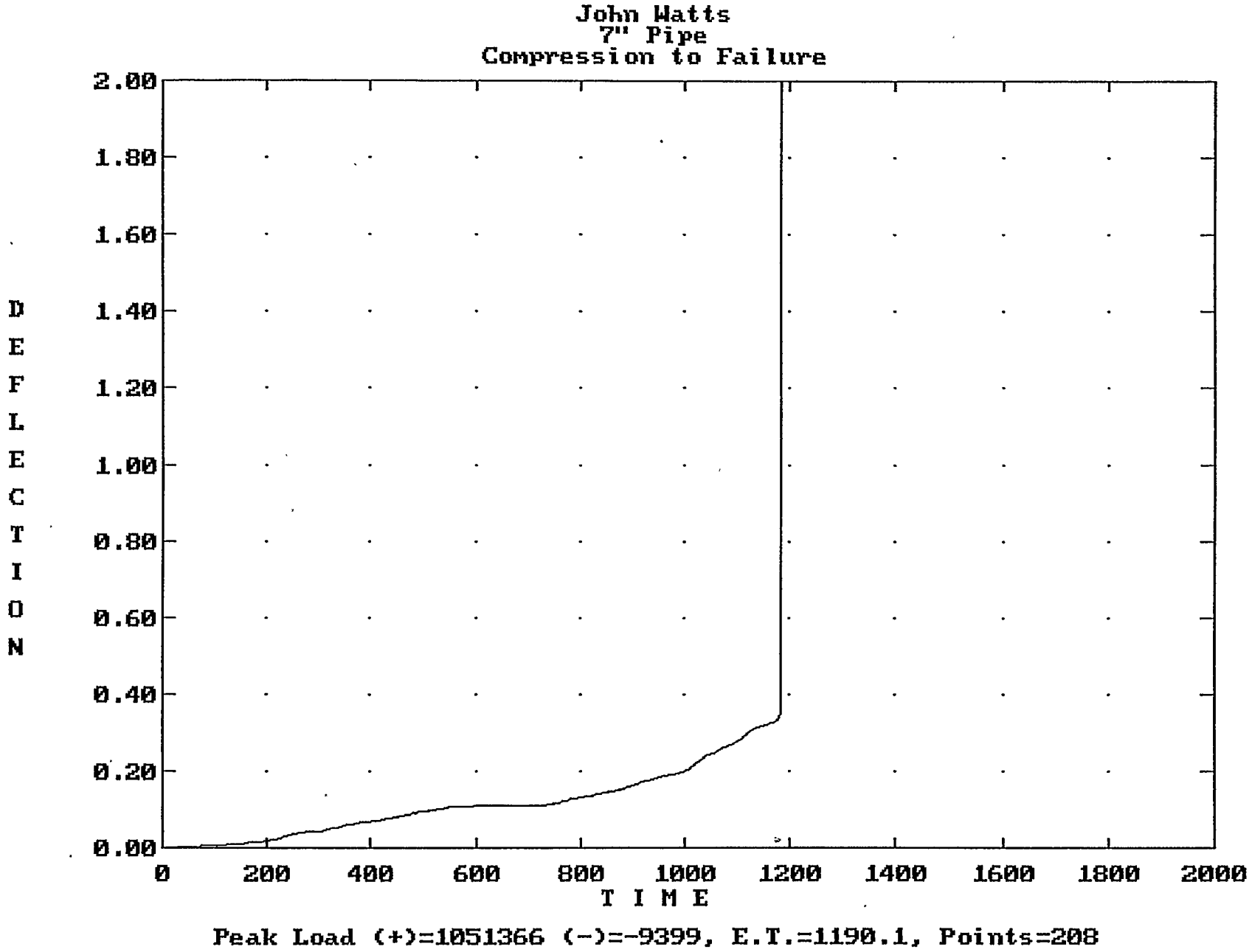
7/7



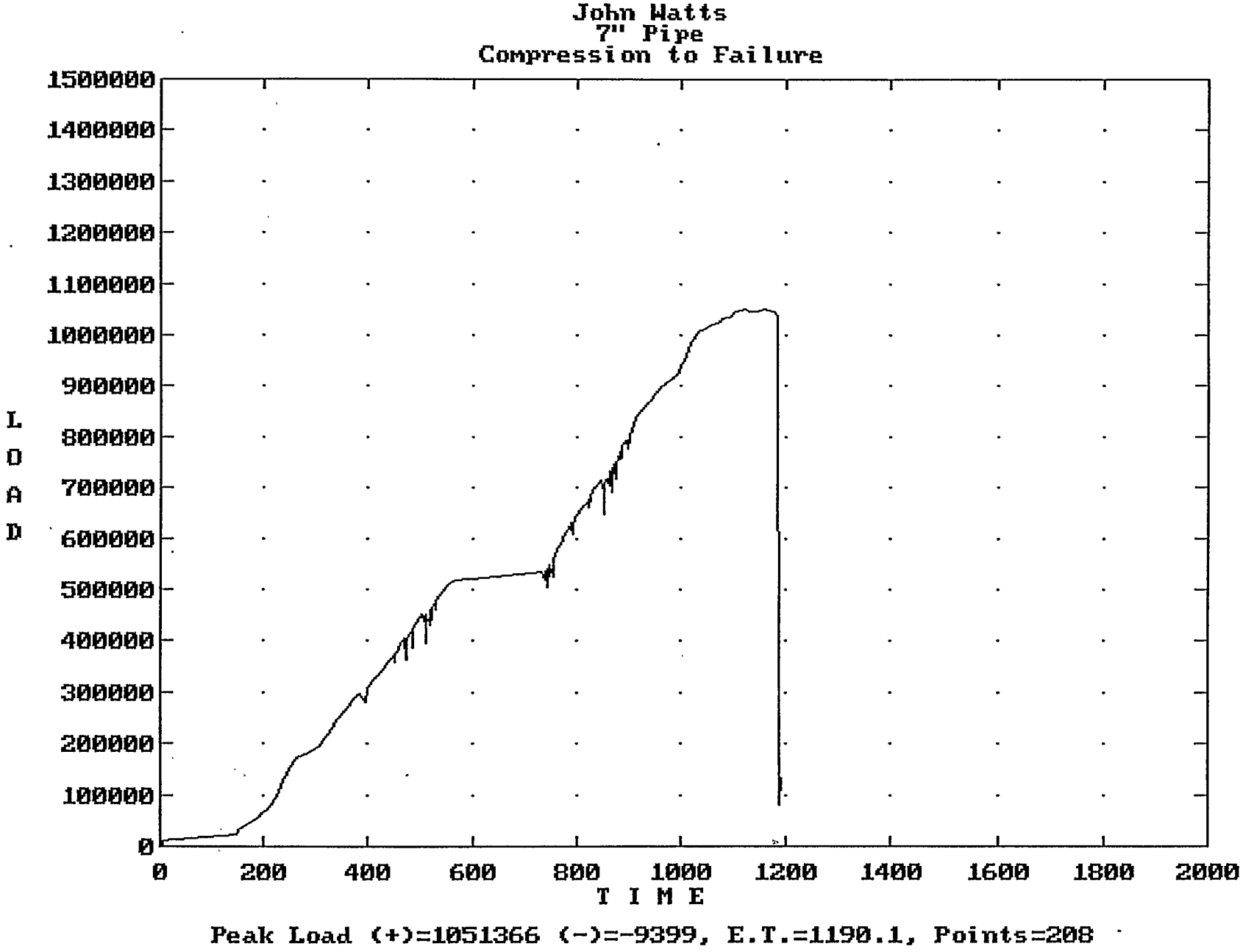
APPENDIX B
SAMPLE 2 TEST PROCEDURE AND RESULTS



Peak Load (+)=1051366 (-)=-9399, E.T.=1190.1, Points=208



Peak Load (+)=1051366 (-)=-9399, E.T.=1190.1, Points=208


John Watts
7" Pipe
Compression to Failure
1500000
1400000
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
L
O
A
D
0
200
400
600
800
1000
1200
1400
1600
1800
2000
T I M E
Peak Load (+)=1051366 (-)=-9399, E.T.=1190.1, Points=208

John Watts
7" Pipe
Compression to Failure
11:55:42 02/07/2000

#	E.T.	LOAD	EXT#1	#	E.T.	LOAD	EXT#1	#	E.T.	LOAD	EXT#1
1	0.0	-9399	0.0006	71	530.4	474405	0.1006	141	876.2	716517	0.1538
2	4.4	1075	-0.0002	72	534.8	486380	0.1024	142	876.4	747225	0.1532
3	4.8	11336	0.0004	73	546.8	497626	0.1044	143	878.2	757364	0.1536
4	145.4	22690	0.0088	74	553.8	508697	0.1066	144	883.6	768552	0.1546
5	151.8	33409	0.0098	75	566.1	519069	0.1086	145	885.0	755645	0.1558
6	168.5	44900	0.0140	76	625.4	523935	0.1098	146	885.2	767736	0.1570
7	188.3	55144	0.0164	77	733.7	535560	0.1114	147	885.9	777934	0.1560
8	201.0	66055	0.0186	78	741.0	519127	0.1134	148	887.8	758734	0.1576
9	210.9	76351	0.0214	79	741.9	536084	0.1134	149	888.0	781372	0.1578
10	218.7	86604	0.0230	80	744.2	524139	0.1136	150	893.0	791977	0.1596
11	225.8	98031	0.0258	81	744.4	540746	0.1130	151	897.8	776564	0.1628
12	229.8	108129	0.0282	82	746.2	504764	0.1140	152	898.0	793900	0.1628
13	233.6	118308	0.0296	83	746.4	545465	0.1144	153	898.2	778225	0.1622
14	237.9	129511	0.0310	84	746.7	534715	0.1142	154	898.4	792705	0.1620
15	245.0	140332	0.0338	85	748.0	549428	0.1158	155	899.6	780352	0.1622
16	250.0	151129	0.0362	86	754.2	524984	0.1168	156	900.7	792559	0.1618
17	257.4	161184	0.0382	87	754.4	557877	0.1156	157	902.0	803281	0.1630
18	263.0	172351	0.0402	88	757.8	568162	0.1180	158	905.2	814352	0.1648
19	285.6	182822	0.0432	89	761.4	578592	0.1192	159	908.9	826589	0.1670
20	304.2	193066	0.0444	90	769.4	588818	0.1216	160	913.9	836874	0.1702
21	313.7	203773	0.0466	91	774.2	599190	0.1232	161	919.6	847537	0.1724
22	321.2	214055	0.0494	92	778.2	609562	0.1246	162	927.7	857764	0.1752
23	327.4	224133	0.0514	93	785.3	619760	0.1280	163	940.0	868136	0.1774
24	333.3	234776	0.0532	94	790.8	630219	0.1284	164	948.0	878245	0.1810
25	339.4	245512	0.0562	95	791.2	614341	0.1300	165	954.3	888501	0.1828
26	348.1	256432	0.0582	96	791.6	626869	0.1298	166	963.6	899194	0.1868
27	356.5	266728	0.0608	97	791.9	609155	0.1300	167	975.7	909216	0.1894
28	364.5	276800	0.0618	98	792.1	619410	0.1296	168	988.4	919238	0.1924
29	371.7	287932	0.0636	99	792.4	608572	0.1300	169	995.4	929290	0.1962
30	385.0	297969	0.0668	100	792.6	625499	0.1294	170	1001.8	939808	0.1990
31	396.5	281106	0.0678	101	792.8	610844	0.1290	171	1006.6	951054	0.2026
32	397.1	306491	0.0676	102	793.0	627043	0.1294	172	1011.3	961338	0.2074
33	405.4	317676	0.0700	103	798.5	639572	0.1310	173	1015.4	972497	0.2122
34	412.3	328497	0.0718	104	803.0	651138	0.1326	174	1020.2	982782	0.2170
35	424.6	339190	0.0744	105	810.5	663520	0.1348	175	1026.8	995193	0.2248
36	430.7	350144	0.0756	106	821.6	673659	0.1364	176	1032.2	1005798	0.2302
37	440.5	361798	0.0782	107	822.3	661219	0.1372	177	1041.5	1008770	0.2402
38	448.0	372054	0.0794	108	822.6	673281	0.1378	178	1057.4	1019055	0.2464
39	452.7	359934	0.0816	109	827.6	683857	0.1392	179	1071.3	1022988	0.2566
40	453.0	375055	0.0814	110	827.8	672552	0.1382	180	1080.4	1033302	0.2608
41	457.1	385106	0.0820	111	828.2	682837	0.1390	181	1094.9	1034933	0.2710
42	464.1	395275	0.0840	112	831.2	692889	0.1412	182	1107.0	1045422	0.2796
43	470.2	406317	0.0868	113	839.8	704309	0.1428	183	1115.4	1048540	0.2904
44	472.3	363022	0.0872	114	846.6	714536	0.1452	184	1125.4	1049792	0.3006
45	472.5	389768	0.0872	115	851.2	703843	0.1458	185	1132.7	1046995	0.3060
46	472.7	401393	0.0870	116	851.8	690616	0.1466	186	1144.9	1046267	0.3164
47	477.1	412056	0.0886	117	852.1	707340	0.1462	187	1157.2	1050492	0.3208 ← MAX.
48	483.4	422457	0.0912	118	853.0	696093	0.1456	188	1175.6	1046558	0.3314
49	485.0	411998	0.0910	119	853.4	706990	0.1458	189	1182.0	1044927	0.3424
50	485.9	387117	0.0904	120	854.1	683798	0.1462	190	1182.9	1037847	0.3524
51	486.2	403432	0.0902	121	854.4	647001	0.1460	191	1183.3	1023513	0.3908
52	486.4	419835	0.0908	122	854.6	707077	0.1454	192	1183.5	1016782	0.4248
53	489.3	430644	0.0920	123	857.1	717537	0.1464	193	1183.8	1014918	0.4510
54	497.5	440783	0.0938	124	860.0	707281	0.1466	194	1184.0	1011596	0.4780
55	503.9	451534	0.0954	125	862.1	718294	0.1462	195	1184.2	1011392	0.5042
56	508.2	438540	0.0952	126	863.0	702591	0.1474	196	1184.5	1006265	0.5386
57	508.4	449087	0.0960	127	864.8	721441	0.1470	197	1184.7	995368	3.1248
58	510.2	432159	0.0968	128	865.0	731755	0.1476	198	1185.0	633162	8.7750
59	510.4	396498	0.0974	129	868.4	692335	0.1492	199	1185.8	619148	8.7738
60	510.7	408793	0.0964	130	868.7	734464	0.1492	200	1186.2	608980	8.7720
61	510.9	450806	0.0968	131	869.6	715876	0.1494	201	1187.4	591353	8.7735
62	518.2	431577	0.0972	132	869.8	739446	0.1504	202	1188.2	469452	8.7724
63	518.4	447747	0.0978	133	870.5	727530	0.1500	203	1188.5	282796	8.7725
64	519.3	461003	0.0970	134	870.7	742476	0.1500	204	1188.8	165947	8.7731
65	521.6	448650	0.0980	135	870.9	726423	0.1506	205	1189.1	114238	8.7730
66	522.0	461440	0.0978	136	871.2	742680	0.1500	206	1189.4	93311	8.7729
67	523.0	439531	0.0980	137	872.5	731201	0.1508	207	1189.7	79617	8.7728
68	523.2	461003	0.0982	138	872.8	747575	0.1512	208	1190.1	133494	8.7727
69	528.0	472133	0.1002	139	873.9	737174	0.1516				
70	530.2	461469	0.1008	140	874.1	750488	0.1516				

C E R T I F I C A T E O F V E R I F I C A T I O N

THIS IS TO CERTIFY THAT THE

Test Frame 009-1.5 Six 18in Cylinders 1.5 Mlb Tension
Sensotec XDCR: M/ TJE/743-06 S/ 453489 (Cyls: ABCDE&F)
Daytronic Indr: M/ 3370 S/ T03817 Shunt Cal: 2588
Zero Offset: -33 psi Software Full Scale: 1486231

LOCATED AT

H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

was calibrated on 30 June 1999 according to the current ASTM Standard E-4 and determined to indicate load within the specified 1.0 percent tolerance on the ranges listed below. Maximum error observed was 0.28 percent.

MACHINE RANGE, LB	LOADING RANGE, LB MINIMUM - MAXIMUM
1,500,000	148,197 - 1,486,155

Devices used were verified as noted below by National Standards Testing Laboratory according to the current ASTM Standard E-74.

INSTRUMENTS USED.....	SERIAL NO	CLASS `A' LOADING RANGE.....LB	VERIFIED. .....DATE
E M E Load Cell	8512.02	56,000 - 1,500,000	12 Oct 98
E M E Load Cell	9709.05	50,000 - 1,500,000	13 Oct 98

RCN Enterprises, Inc.
11115 Mills Road, Suite 122
Cypress Texas 77429

30 June 1999

RCN Enterprises, Inc.
11115 Mills Road, Suite 122
Cypress Texas 77429

30 June 1999

C A L I B R A T I O N R E P O R T

OWNER: H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

MACHINE: Test Frame 009-1.5 Six 18in Cylinders 1.5 Mlb Tension
Sensotec XDCR: M/ TJE/743-06 S/ 453489 (Cyls: ABCDE&F)
Daytronic Indr: M/ 3370 S/ T03817 Shunt Cal: 2588
Zero Offset: -33 psi Software Full Scale: 1486231

CALIBRATION DATA:	RANGE. LB	LOAD.....LB INDICATED	TRUE	MACHINE ERROR LB	PERCENT
	1500000	148197.	148089.	108.	0.07
		297155.	297975.	-820.	0.28
		445732.	446543.	-811.	0.18
		594690.	595218.	-528.	0.09
		743077.	743753.	-676.	0.09
		891560.	892478.	-918.	0.10
		1040518.	1040766.	-248.	0.02
		1189895.	1189431.	464.	0.04
		1337482.	1337819.	-337.	0.03
		1486155.	1486485.	-330.	0.02

True loads were recorded at the values of indicated load listed above according to the current ASTM Standard E-4.

DEVICE DATA:	INSTRUMENTS USED.....	SERIAL NO	CLASS `A' LOADING RANGE.....LB	VERIFIED. .....DATE
	E M E Load Cell	8512.02	56,000 - 1,500,000	12 Oct 98
	E M E Load Cell	9709.05	50,000 - 1,500,000	13 Oct 98

Instruments were verified as noted above by National Standards Testing Laboratory according to current ASTM Standard E-74. Instruments were compensated for effect of temperature on zero and span by the manufacturer(s).

H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

Test Frame 009-1.5 Six 18in Cylinders 1.5 Mlb Tension
Sensotec XDCR: M/ TJE/743-06 S/ 453489 (Cyls: ABCDE&F)
Daytronic Indr: M/ 3370 S/ T03817 Shunt Cal: 2588

Calibration Date: 30 June 1999

Instrumentation:
E M E Load Cell 8512.02
E M E Load Cell 9709.05

FITTED LINEAR EQUATION:

[Gage Rdg] = 3.35010490E+01 + 3.36421398E-03 * [Load]

R M S Error, Linear : 2071.41 lb

Equation Offset: -33.50

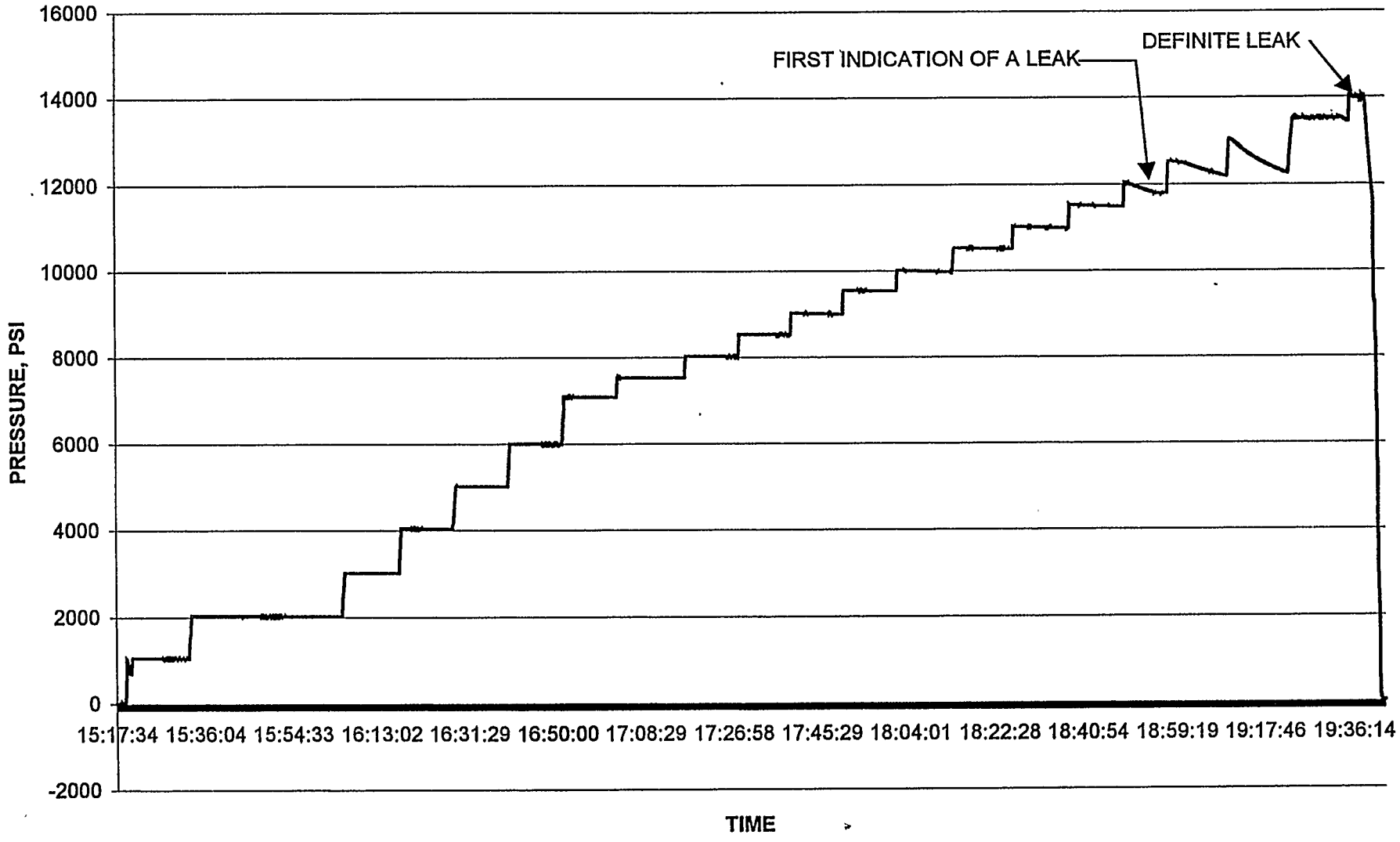
Average Effective Area: 291.35 Equation Effective Area: 297.25

Software Full Scale Value: 1456750 Equation Full Scale Value: 1486231

Point Index	Gage Rdg.	Observed Load	Predicted Load	Error..... Absolute	Pct.	Pct.-FS
1	503	138411	139557	1146	0.83	0.08
2	1002	285482	287883	2401	0.84	0.16
3	1501	434502	436209	1707	0.39	0.11
4	2001	582396	584832	2436	0.42	0.16
5	2501	730915	733455	2539	0.35	0.17
6	3000	879321	881781	2460	0.28	0.16
7	3500	1028417	1030404	1987	0.19	0.13
8	4000	1177449	1179027	1578	0.13	0.11
9	4500	1325992	1327650	1658	0.13	0.11
10	5000	1474357	1476273	1916	0.13	0.13
-11	500	143940	138665	-5275	-3.66	-0.35
-12	1001	293458	287585	-5872	-2.00	-0.39
-13	1500	441849	435911	-5938	-1.34	-0.40
-14	2000	589961	584534	-5427	-0.92	-0.36
-15	2500	738513	733158	-5356	-0.73	-0.36
-16	3000	887037	881781	-5257	-0.59	-0.35
-17	3500	1035386	1030404	-4982	-0.48	-0.33
-18	4000	1183736	1179027	-4709	-0.40	-0.31
-19	4500	1332281	1327650	-4630	-0.35	-0.31
-20	5000	1480902	1476273	-4629	-0.31	-0.31
21	500	139960	138665	-1295	-0.93	-0.09
22	1000	289463	287288	-2175	-0.75	-0.15
23	1500	438213	435911	-2301	-0.53	-0.15
24	2000	586909	584534	-2375	-0.40	-0.16
25	2501	735578	733455	-2123	-0.29	-0.14
26	3000	883985	881781	-2204	-0.25	-0.15
27	3500	1032293	1030404	-1889	-0.18	-0.13
28	4000	1180819	1179027	-1792	-0.15	-0.12
29	4501	1329765	1327947	-1818	-0.14	-0.12
30	5000	1478130	1476273	-1857	-0.13	-0.12

APPENDIX C
SAMPLE 3 TEST PROCEDURE AND RESULTS

JOHN WATTS SAMPLE 3 BURST TEST



SAMPLE #3 CAPPED-END BURST
JOHN WATTS WW 7" INTEGRAL CONNECTION
01/31/2000

DATE: 1/31/00 PAGE 1 OF

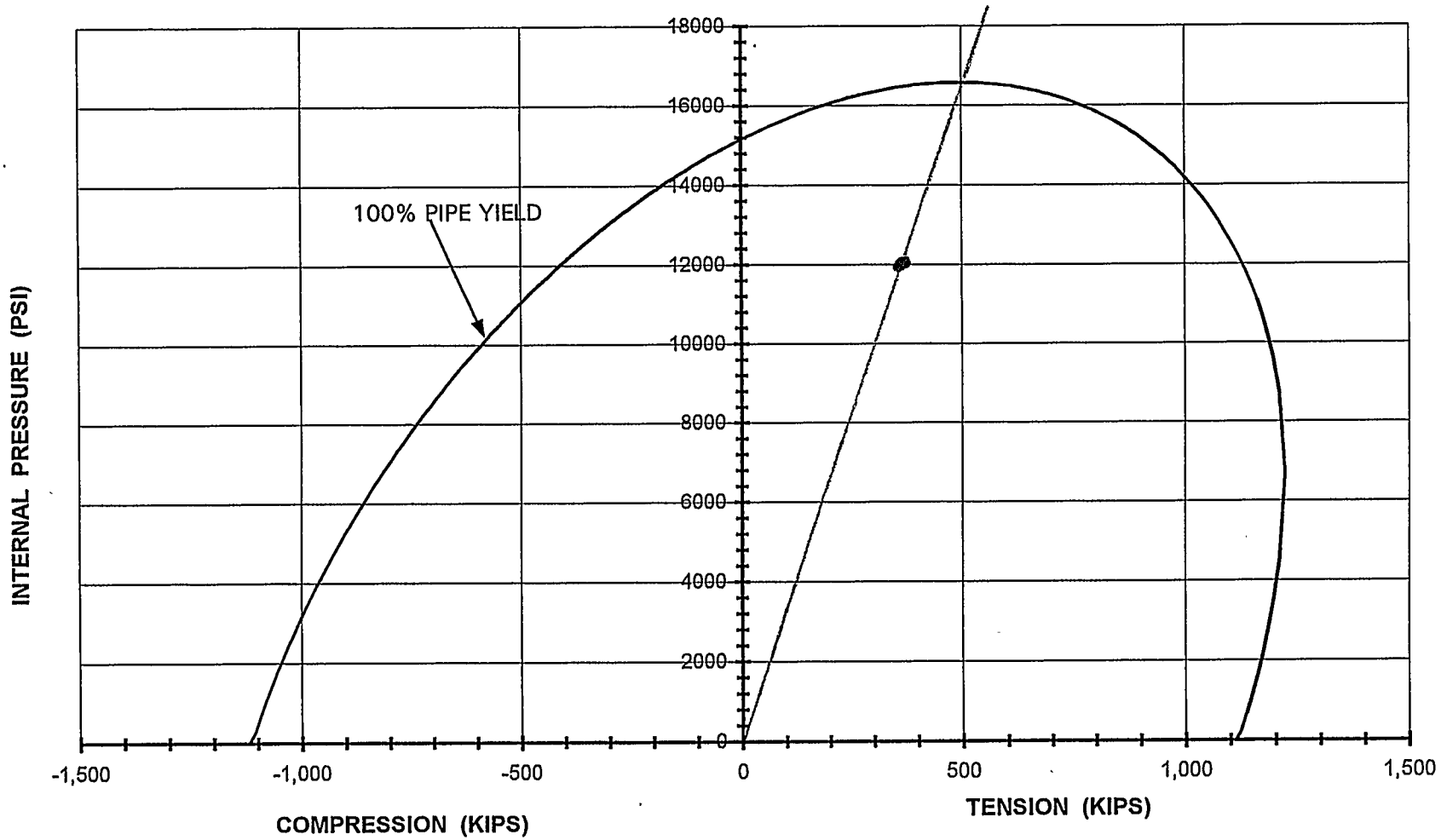
TIME 24 HR	PRESSURE PSI	BUBBLES CC	COMMENTS TSN_0009.PRN
15:20	0	0	START TEST
15:24	1040	0	—
15:34	1040	0	—
15:35	2030	0	~~CHAIN DOWN SAMPLE~~ +
16:07	2022	0	COVER TEST PIT
16:08	3015	0	—
16:18	3012	0	—
16:20	4043	0	—
16:30	4038	0	—
16:31	5025	0	—
16:41	5020	0	—
16:43	6004	0	—
16:53	5998	0	—
16:54	7088	0	—
17:04	7080	0	—
17:05	7534	0	—
17:19	7524	0	—
17:20	8020	0	—
17:30	8014	0	—
17:31	8525	0	—
17:41	8518	0	—
17:42	9017	0	—
17:52	8994	0	—
17:53	9541	0	—
18:03	9531	0	—
18:04	10,010	0	—
18:14	9,975	0	—
18:15	10,527	0	—
18:26	10,508	.5cc	—

SAMPLE #3 CAPPED-END BURST
JOHN WATTS WW 7" INTEGRAL CONNECTION
01/31/2000

DATE: PAGE OF

TIME 24 HR	PRESSURE PSI	BUBBLES CC	COMMENTS
18:28	11,022	1	—
18:38	10,992	5	—
18:40	11,526	6	—
18:50	11,486	10	—
18:51	12,031	10	—
18:58	11,790	12	VALVE PACKING LEAKING
19:00	12,526	13	—
19:05	12,381	19	—
19:10	12,212	28	—
19:13	13,030	31	—
19:24	12,315	55	—
19:27	13,495	60	— MAINTAINED PRESS.
19:37	13,504	100	DURING HOLD
19:38	14,006	—	REFILLED TUBE
			SAMPLE STEADILY LEAKING
			AT 14,000. END TEST

FIGURE
JOHN WATTS WW CONNECTION
SAMPLE 3 CAPPED-END FAILURE



Stress Engineering Services, Inc.

VON MISES TRI-AXIAL EQUIVALENT YIELD ELLIPSE

VALUES AT THE INSIDE SURFACE OF A CYLINDER

Date: 01/31/2000

Project Number: PN 6924

SAMPLE 3

Input Information:

Outer Diameter =	7.034	inches		
Inner Diameter =	6.155	inches		
Yield Strength =	122,500	psi		
Ellipse 1 Strength =	122,500	psi,	based on	100% ACTUAL AVG. YIELD
Ellipse 2 Strength =		psi,	based on	
Joint Efficiency =	100.00	% ,	based on input diameters	

Ellipse 1 Maximum Loads for Internal Pressure

Tension =	1,219.5	kips
Tension / Compression (Pi = 0) =	1,115.4	kips
Capped-End Yield Pressure =	16,572	psi
Pressure (T/C = 0) =	15,157	psi

Ellipse 1 Maximum Loads for External Pressure

Compression =	-1,287.9	kips
Tension / Compression (Pe = 0) =	-1,115.4	kips
Capped-End Yield Pressure =	-16,572	psi
Pressure (T/C = 0) =	-14,352	psi

Ellipse 1 User Selection of Point on the VME Ellipse

Select : Axial Force =	0.00	kips
Internal Pressure (+ root) =	----------	psi
Internal Pressure (- root) =	----------	psi
External Pressure (+ root) =	----------	psi
External Pressure (- root) =	----------	psi

*API Internal Yield Pressure**

Yield Pressure (87.5%) =	13,395	psi
Yield Pressure (100%) =	15,308	psi

*Burst Pressure**

Burst Pressure = 18,882 psi

*Based on Input Yield Strength

API Collapse Resistance Pressure

For Ellipse 1 Strength of	122,500	psi,	Collapse Pressure =	10,681 psi
For Ellipse 1 Strength and Axial Tension of	358.0	kips,	Collapse Pressure =	9,275 psi
For Input Yield Strength =	122,500	psi,	Collapse Pressure =	10,681 psi

Bending Information, for 10 degrees/100 feet

Radius of Curvature =	573	ft
Bending Moment =	18,076	ft-lbs
Bending Stress =	15,345	psi

2.0 TEST SAMPLES & PREPARATION

2.1 PIPE SIZE

The pipe size selected for this project was as follows:

- 7" nominal outside diameter
- 32 pounds per foot weight (0.453" wall)
- 6.094" nominal inside diameter

This pipe size is commonly used as a production casing string in oil and gas wells and is often used for testing of casing connections. A slightly thicker pipe was needed for the coupling stock and 7" 41 pound per foot pipe was used for this.

2.2 PIPE MATERIAL

The pipe material grade was API 5CT grade P-110. Tensile tests were performed for the pipe purchased for this test and the reports are given in Appendix A. One 40' long joint of pipe was purchased for the 32 pound per foot pup samples. One 12' long piece of 41 pound per foot was purchased for the couplings. The two ends of the 7" 32 pound joint of pipe and one end of the 7" 41 pound pipe were material tested. The API specified and actual strengths were as follows:

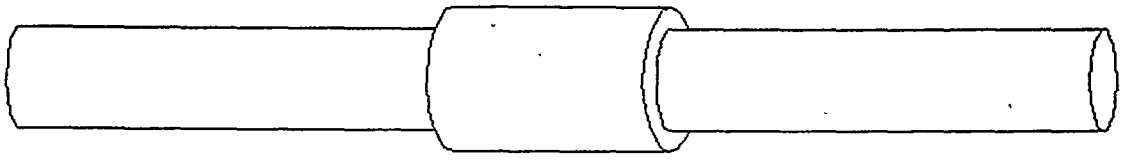
- API Specified Yield Strength = 110,000 – 140,000 psi
- API Specified Ultimate Strength = 125,000 psi minimum
- Coupling Stock = 132,000 psi yield strength, 142,000 psi ultimate strength
- Pipe (pup) Stock = 124,000 psi yield strength, 131,000 psi ultimate strength
  = 121,000 psi yield strength, 131,000 psi ultimate strength

This gave an average pipe yield strength of 122,500 psi which was used to determine the test loads. Mr. Watts had requested that the coupling stock be 10 ksi stronger in yield than the pup stock. The materials purchased gave 9.5 ksi stronger which was acceptable.

Stress Engineering Services

PN 6924
Date 1/31/00
Inspector GS.

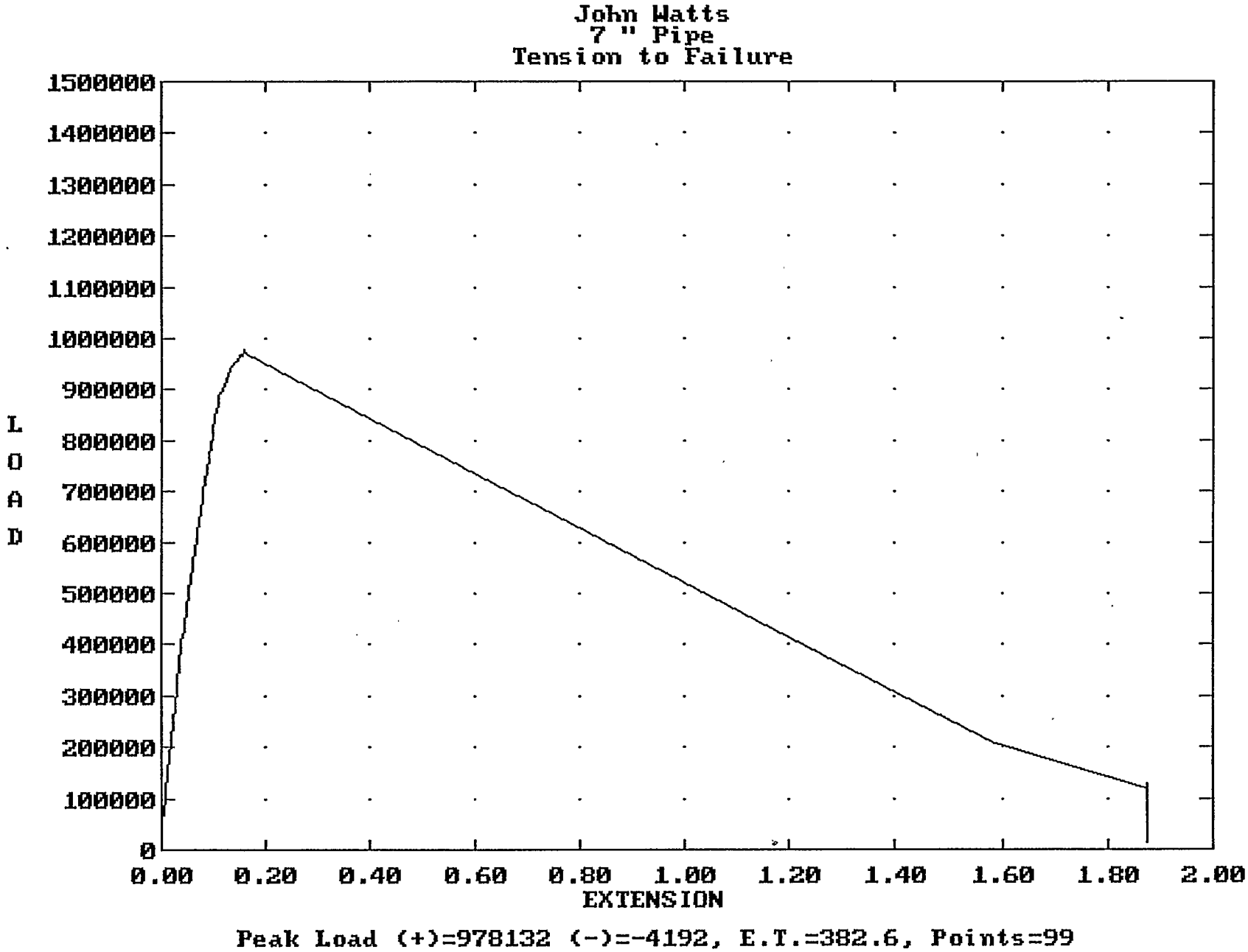
Customer JOHN WATTS
Sample # 3
T & C or Flush

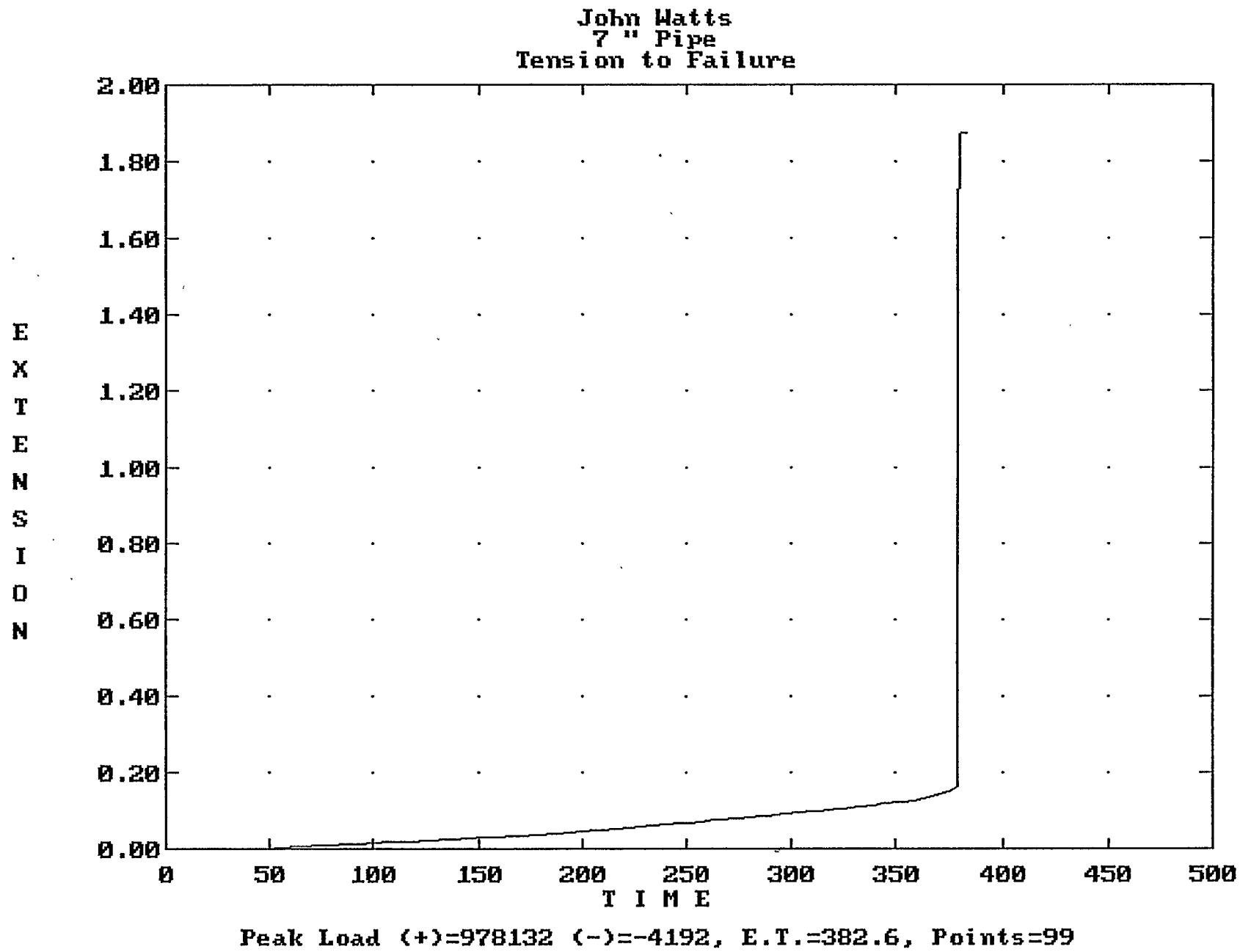


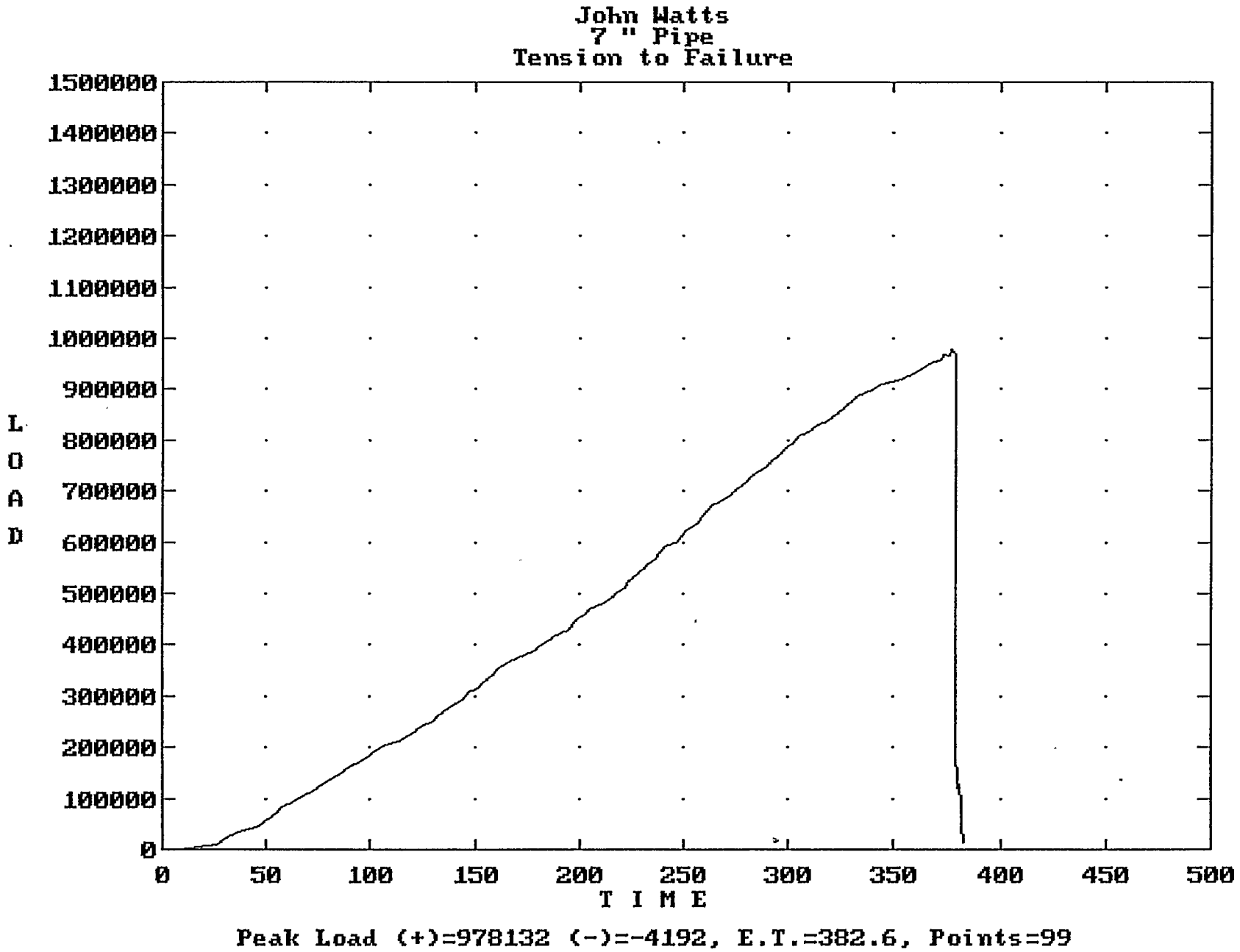
	Side PIN		Side BOX	
Wall	0° 0.424		0° 0.443	
	90° 0.451		90° 0.436	
	180° 0.447		180° 0.428	
	270° 0.445		270° 0.439	
	Avg. Wall 0.442		Avg. Wall 0.437	
OD	0°-180° 7.039		0°-180° 7.023	
	90°-270° 7.044		90°-270° 7.029	
	Avg. OD 7.042	7.034	Avg. OD 7.026	
	Avg. ID 6.158	6.155	Avg. ID 6.152	

(OD - 2x Avg. Wall)

APPENDIX D
SAMPLE 4 TEST PROCEDURE AND RESULTS


John Watts
7 " Pipe
Tension to Failure
1500000
1400000
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
L
O
A
D
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
EXTENSION
Peak Load (+)=978132 (-)=-4192, E.T.=382.6, Points=99


John Watts
7 " Pipe
Tension to Failure
EXTENSION
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
50
100
150
200
250
300
350
400
450
500
T I M E
Peak Load (+)=978132 (-)=-4192, E.T.=382.6, Points=99


John Watts
7 " Pipe
Tension to Failure
1500000
1400000
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
L
O
A
D
0
50
100
150
200
250
300
350
400
450
500
T I M E
Peak Load (+)=978132 (-)=-4192, E.T.=382.6, Points=99

John Watts
7 " Pipe
Tension to Failure
13:10:01 02/08/2000

#	E.T.	LOAD	EXT#1	#	E.T.	LOAD	EXT#1	#	E.T.	LOAD	EXT#1
1	0.0	-4192	0.0000	71	299.0	784596	0.0926				
2	26.4	9648	0.0001	72	303.0	795929	0.0945				
3	30.3	20429	0.0008	73	304.4	806025	0.0959				
4	36.1	31479	0.0007	74	309.0	816600	0.0980				
5	46.1	45998	-0.0001	75	313.2	827853	0.0995				
6	50.9	59022	0.0011	76	318.7	838347	0.1017				
7	54.3	70926	0.0030	77	321.7	848363	0.1032				
8	57.4	83763	0.0043	78	325.3	859936	0.1051				
9	62.9	94641	0.0058	79	329.0	873144	0.1074				
10	67.2	104896	0.0070	80	332.4	888028	0.1108				
11	71.9	115307	0.0081	81	339.2	899401	0.1150				
12	76.2	126632	0.0091	82	344.2	910015	0.1187				
13	81.1	138771	0.0103	83	353.2	920311	0.1228				
14	85.1	148807	0.0113	84	359.4	930765	0.1273				
15	89.5	160966	0.0125	85	363.0	940901	0.1321				
16	94.7	171680	0.0137	86	367.1	950598	0.1375				
17	98.4	182630	0.0148	87	369.8	954628	0.1427				
18	102.4	193284	0.0159	88	372.6	957900	0.1477				
19	106.5	203707	0.0170	89	373.0	968315	0.1488				
20	114.8	213843	0.0182	90	375.5	964524	0.1543				
21	119.7	225487	0.0195	91	376.6	978132	0.1569	← MAX.			
22	124.4	238930	0.0210	92	378.7	970749	0.1622				
23	129.7	250654	0.0225	93	379.2	207430	1.5874				
24	132.8	262298	0.0238	94	379.5	118835	1.8720				
25	135.2	272574	0.0248	95	381.0	129844	1.8748				
26	139.8	282677	0.0261	96	381.7	84158	1.8748				
27	143.6	293292	0.0273	97	381.9	36601	1.8748				
28	147.0	305634	0.0283	98	382.1	25356	1.8749				
29	151.6	316580	0.0293	99	382.6	13123	1.8749				
30	153.8	327187	0.0299								
31	157.8	339752	0.0308								
32	160.9	352733	0.0321								
33	165.8	364677	0.0338								
34	171.4	375020	0.0352								
35	177.2	386253	0.0365								
36	180.4	396404	0.0376								
37	184.7	407290	0.0393								
38	187.8	418052	0.0410								
39	194.3	428431	0.0436								
40	196.1	438487	0.0444								
41	198.0	448603	0.0453								
42	202.4	459058	0.0470								
43	204.8	469872	0.0484								
44	211.7	481125	0.0501								
45	215.1	491380	0.0517								
46	218.0	501596	0.0529								
47	221.4	512330	0.0542								
48	223.7	524581	0.0556								
49	226.7	534796	0.0572								
50	230.1	545251	0.0588								
51	232.1	556025	0.0600								
52	236.5	566520	0.0615								
53	238.9	580566	0.0631								
54	241.2	591540	0.0645								
55	246.9	601875	0.0666								
56	248.7	612130	0.0676								
57	251.5	623304	0.0691								
58	256.7	635514	0.0709								
59	258.3	646049	0.0720								
60	260.3	657342	0.0736								
61	263.3	669792	0.0754								
62	268.0	680566	0.0771								
63	272.8	691380	0.0786								
64	276.2	705387	0.0806								
65	279.9	715921	0.0825								
66	282.1	726576	0.0835								
67	285.5	738467	0.0853								
68	290.5	749361	0.0873								
69	292.6	760654	0.0888								
70	296.7	773663	0.0910								

C E R T I F I C A T E O F V E R I F I C A T I O N

THIS IS TO CERTIFY THAT THE

Test Frame 001-2 -- Eight Cylinders -- 2.0 MLb Tension
Sensotec XDCR: M/ TJE/743-06, S/ 235675
Sensotec Indr: M/ 450-D S/ 208164 Shunt Cal: 2512
Zero Offset: -62 psi Software Full Scale: 1995210

LOCATED AT

H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

was calibrated on 30 March 1999 according to the current ASTM Standard E-4 and determined to indicate load within the specified 1.0 percent tolerance on the ranges listed below. Maximum error observed was 0.31 percent.

MACHINE RANGE, LB	LOADING RANGE, LB MINIMUM - MAXIMUM
2,000,000	199,856 - 1,973,103

Devices used were verified as noted below by National Standards Testing Laboratory according to the current ASTM Standard E-74.

INSTRUMENTS USED.....	SERIAL NO	CLASS `A' LOADING RANGE.....LB	VERIFIED. .....DATE
E M E Load Cell	8512.01	60,400 - 1,500,000	6 Oct 97
E M E Load Cell	8512.02	56,000 - 1,500,000	12 Oct 98
E M E Load Cell	9709.05	50,000 - 1,500,000	13 Oct 98

RCN Enterprises, Inc.
11115 Mills Road, Suite 122
Cypress Texas 77429

30 March 1999

H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

Test Frame 001-2 -- Eight Cylinders -- 2.0 MLb Tension
Sensotec XDCR: M/ TJE/743-06, S/ 235675
Sensotec Indr: M/ 450-D S/ 208164 Shunt Cal: 2512

Calibration Date: 30 March 1999

Instrumentation:
E M E Load Cell 8512.01
E M E Load Cell 8512.02
E M E Load Cell 9709.05

FITTED LINEAR EQUATION:

[Gage Rdg] = 6.16009407E+01 + 2.50600255E-03 * [Load]

R M S Error, Linear : 1818.703 lb

Equation Offset: -61.60

Average Effective Area: 384.80 Equation Effective Area: 399.04

Software Full Scale Value: 1924000 Equation Full Scale Value: 1995210

Point Index	Gage Rdg.	Observed Load	Predicted Load	Error..... Absolute	Pct.	Pct.-FS
1	500	176028	174940	-1089	-0.62	-0.05
2	1000	373773	374461	687	0.18	0.03
3	1500	572127	573982	1854	0.32	0.09
4	2000	771076	773502	2426	0.31	0.12
5	2500	970657	973023	2367	0.24	0.12
6	3000	1170157	1172544	2387	0.20	0.12
7	3500	1369821	1372065	2244	0.16	0.11
8	4000	1569567	1571586	2020	0.13	0.10
9	4501	1769835	1771506	1671	0.09	0.08
10	5000	1970262	1970628	367	0.02	0.02
11	500	177105	174940	-2166	-1.22	-0.11
12	1000	375797	374461	-1337	-0.36	-0.07
13	1501	575354	574381	-973	-0.17	-0.05
14	2000	774200	773502	-697	-0.09	-0.03
15	2500	973834	973023	-810	-0.08	-0.04
16	3000	1173656	1172544	-1112	-0.09	-0.06
17	3501	1373130	1372464	-666	-0.05	-0.03
18	4000	1573327	1571586	-1741	-0.11	-0.09
19	4499	1772945	1770708	-2237	-0.13	-0.11
20	5000	1973828	1970628	-3200	-0.16	-0.16

RCN Enterprises, Inc.
11115 Mills Road, Suite 122
Cypress Texas 77429

30 March 1999

C A L I B R A T I O N R E P O R T

OWNER: H O MOHR Research and Engineering
12237 F M 529
Houston Texas 77041

MACHINE: Test Frame 001-2 -- Eight Cylinders -- 2.0 MLb Tension
Sensotec XDCR: M/ TJE/743-06, S/ 235675
Sensotec Indr: M/ 450-D S/ 208164 Shunt Cal: 2512
Zero Offset: -62 psi Software Full Scale: 1995210

CALIBRATION DATA:	RANGE. LB	LOAD.....LB INDICATED	TRUE	MACHINE ERROR LB	PERCENT
	2000000	199856.	200484.	-628.	0.31
		399341.	398895.	446.	0.11
		598842.	598403.	439.	0.07
		797366.	797168.	198.	0.02
		998922.	997952.	970.	0.10
		1197206.	1196370.	836.	0.07
		1397126.	1396389.	737.	0.05
		1596048.	1596491.	-443.	0.03
		1795210.	1795627.	-417.	0.02
		1973103.	1973133.	-30.	0.00

True loads were recorded at the values of indicated load listed above according to the current ASTM Standard E-4.

DEVICE DATA:	INSTRUMENTS USED.....	SERIAL NO	CLASS 'A' LOADING RANGE.....LB	VERIFIED. .....DATE
	E M E Load Cell	8512.01	60,400 - 1,500,000	6 Oct 97
	E M E Load Cell	8512.02	56,000 - 1,500,000	12 Oct 98
	E M E Load Cell	9709.05	50,000 - 1,500,000	13 Oct 98

Instruments were verified as noted above by National Standards Testing Laboratory according to current ASTM Standard E-74. Instruments were compensated for effect of temperature on zero and span by the manufacturer(s).

APPENDIX E
SAMPLE 5 TEST PROCEDURE AND RESULTS

ISO TEST SERIES B - TEST LOG
JOHN WATTS 7" WW PIPE COUPLED CONNECTION
SAMPLE # 5
80% OPT. (MU#3)

DATE: 1-31-2000 BY: BD FILE NAME: JWSAM5CCW

LOAD STEP	TIME 24 HR.	FRAME KIPS	PRESSURE PSI	BUBBLES CC	COMMENTS
—	16:48	0	0	0	- TENSION TO 848 KIPS
1	16:55	848	0	0	- 5 MIN HOLD
	17:00	848	0	0	- END HOLD
	17:05	565	4312	100 CC / 5 SECS.	- HOLDING
	17:08	565	4248	100 CC / 31 SECS.	- HOLDING
	17:24	567	4205	100 CC / 19 SECS.	- HOLDING
	17:42	566	4165	100 CC / 18 SECS.	- LOWER TENSION TO ZERO
	17:45	325	4131	-	- BUBBLES STOPPED
	17:50	0	0	-	- STOPPED TEST
		Round # 2	(MU#4)		
2-1-00	13:15	checked cal's & Zeroed By NTH / GS			
—	13:21	401	Pulled Ten to Set Bending Rings		
—	13:23	399	Bending Rings Set		
—	13:34			0	Start Test
1-1	13:39	850	0	0	5 min Hold
	13:42	850	0	0	End Hold
2-1A	13:43	568	0	0	—
3-2	13:50	568	9503	0	Start 1 Hr. Hold
	14:20	570	9428	0	
	14:35	569	9400	Leaking	Leak Blow out 100 cc +
	14:44	568	9070	100 cc / 4 sec.	
	14:50	567	8939	100 cc / 4 sec.	
	15:05	567	8679	100 cc / 4 sec.	
	15:10	0	0	—	End Test

ISO TEST SERIES B - TEST LOG
JOHN WATTS 7" WW PIPE COUPLED CONNECTION
SAMPLE # 5

DATE: 2-2-00 BY: NTH PAGE 2 OF 2

LOAD STEP	TIME 24 HR.	FRAME KIPS	PRESSURE PSI	BUBBLES CC	COMMENTS
		Round #3	(MU#5)		
	11:20	checked Cals & zeroed By NH/BL			
	11:25	403	Tightened Bend Rings		
	11:30	78	0	0	Start Test
1-1	11:33	851	0	0	5 min Hold
	11:38	851	0	0	End Hold
2-1A	11:39	570	0	0	
3-2	11:45	570	9570	0	Start 1 Hr Hold
	12:45	568	9481	0	End Hold
7-3B	12:46	378	9530	0	
8-4	12:48	378	11392	0	15 min Hold
	12:50	378	11342	Leak	Blow Out
	12:52	384	9300	100 cc/sec	
	12:56	392	6345	100 cc/sec	
	13:05	0	3850	Bubbles	Leaking
	13:10	0	3808	Bubbles	Leaking
	13:14	0	0	—	Stop Test

ISO TEST SERIES B LOAD POINTS
JOHN WATTS WW 7" 32# P-110 SAMPLE #5
01/31/2000

PIPE PROPERTIES:	ACTUAL AVERAGE OD =	7.034	INCH
	ACTUAL AVERAGE ID =	6.155	INCH
	CROSS SECTION AREA =	9.105	SQ. IN.
	ACTUAL AVERAGE ID =	6.155	INCH
	INT. PRESS. END LOAD =	29.754	x Pi, KIPS
	PIPE ACTUAL MINIMUM YIELD STRENGTH =	122,500	PSI
	PIPE BODY YIELD =	1,115	KIPS
	CONNECTION YIELD =	892	KIPS

CONNECTION LIMITED IN TENSION & COMPRESSION TO 80% PIPE BODY YIELD

LOAD POINT	TOTAL AXIAL LOAD		BENDING	PRESSURE
	% YIELD	*KIPS*	*DEG/100 FT.*	*PSI*
1	95	848	0	0
2	95	848	0	9,431
3-BT	95	848	20	9,431
3-BC	-	#VALUE!	20	9,431
4	80	714	0	11,338
5-BT	80	714	20	11,338
5-BC	-	#VALUE!	20	11,338
6	CEYP	376	0	12,638
7	0	0	0	11,561
8-BC	0	0	20	11,561
8-BT	-	0	20	11,561
9	-50	-446	0	7,705
10-BC	-50	-446	20	7,705
10-BT	-	#VALUE!	20	7,705
11	-80	-714	0	3,511
12-BC	-80	-714	20	3,511
12-BT	-	#VALUE!	20	3,511
13	-95	-848	0	0

PN 6924

	A	B	C	D	E	F	G	H
42	**ISO TEST SERIES B LOAD POINTS**							
43	**JOHN WATTS WW 7" 32# P-110 SAMPLE #5**							
44	**01/31/2000**							
45								
46								
47	TESTING IN GUADRANTS I & II, WITHOUT BENDING							
48								
49	DIRECTION AROUND	LOAD STEP	VME LOAD	TOTAL FORCE	FRAME FORCE	BENDING	PRESSURE	HOLD TIME
50								
51	VME CURVE		POINT	*KIPS*	*KIPS*	DEG/100 FT.	*PSI*	MIN.
52		1	1	848	848	0	0	5
53		2	1a	567	567	0	0	-
54		3	2	848	567	0	9,431	60
58		7	3b	657	376	0	9,431	-
59		8	4	714	376	0	11,338	15
63		12	5b	337	0	0	11,338	-
64		13	6	376	0	0	12,638	15
65		14	6a	344	0	0	11,561	-
66	CCW	15	7	0	-344	0	11,561	15
70		19	8b	-115	-344	0	7,705	
71		20	9	-446	-675	0	7,705	15
75		24	10b	-571	-675	0	3,511	-
76		25	11	-714	-818	0	3,511	15
80		29	12b	-818	-818	0	0	-
81		30	13	-848	-848	0	0	5
82		31	13a	0	0	0	0	-
83		32	1a	567	567	0	0	-
84		33	2	848	567	0	9,431	15
88		37	3aa	567	0	0	9,431	-
89		38	13a	0	0	0	0	-

4

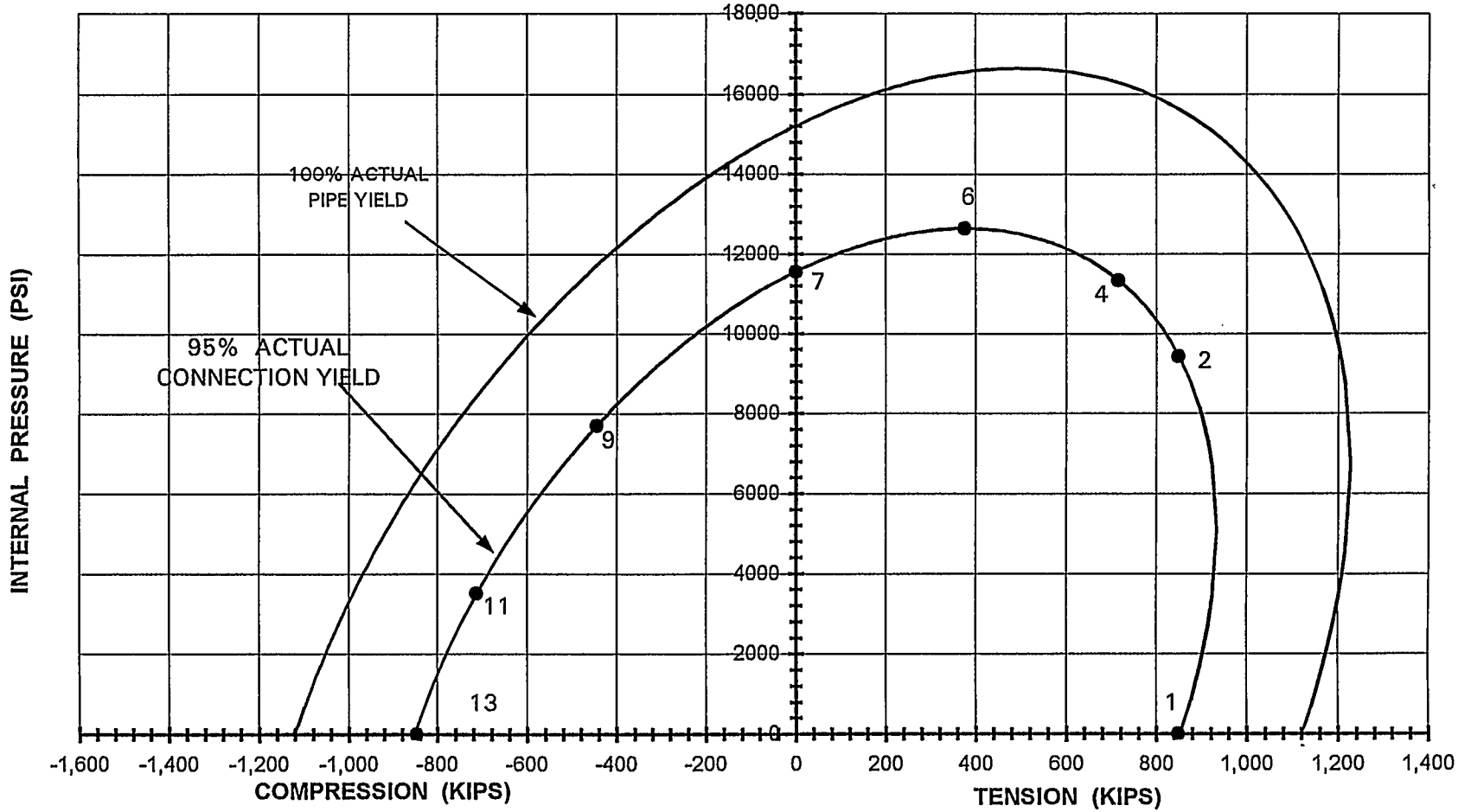
	A	B	C	D	E	F	G	H
90	DIRECTION	LOAD	VME	TOTAL	FRAME	BENDING	PRESSURE	HOLD
91	AROUND	STEP	LOAD	FORCE	FORCE			TIME
92	VME CURVE		POINT	*KIPS*	*KIPS*	DEG/100 FT.	*PSI*	MIN.
93		39	13	-848	-848	0	0	5
94		40	12b	-818	-818	0	0	-
98		44	11	-714	-818	0	3,511	15
99		45	10b	-571	-675	0	3,511	-
103		49	9	-446	-675	0	7,705	15
104		50	8b	-115	-344	0	7,705	
108	CW	54	7	0	-344	0	11,561	15
109		55	6a	344	0	0	11,561	-
110		56	6	376	0	0	12,638	15
111		57	5b	337	0	0	11,338	-
115		61	4	714	376	0	11,338	15
116		62	3b	657	376	0	9,431	-
120		66	2	848	567	0	9,431	15
121		67	1a	567	567	0	0	-
122		68	1	848	848	0	0	5
123		69	13a	0	0	0	0	-

2 1/2

	A	B	C	D	E	F	G	H
124	DIRECTION	LOAD	VME	TOTAL	FRAME	BENDING	PRESSURE	HOLD
125	AROUND	STEP	LOAD	FORCE	FORCE			TIME
126	VME CURVE		POINT	*KIPS*	*KIPS*	DEG/100 FT.	*PSI*	MIN.
127	▲	70	1	848	848	0	0	5
128		71	1a	567	567	0	0	-
129		72	2	848	567	0	9,431	30
133		76	3b	657	376	0	9,431	-
134		77	4	714	376	0	11,338	30
138		81	5b	337	0	0	11,338	-
139		82	6	376	0	0	12,638	30
140		83	6a	344	0	0	11,561	-
141	CCW	84	7	0	-344	0	11,561	30
145		88	8b	-115	-344	0	7,705	
146		89	9	-446	-675	0	7,705	30
150		93	10b	-571	-675	0	3,511	-
151		94	11	-714	-818	0	3,511	30
155		98	12b	-818	-848	0	0	-
156		99	13	-848	-848	0	0	5
157		100	13a	0	0	0	0	-
158		101	1a	567	567	0	0	-
159		102	2	848	567	0	9,431	30
163		106	3aa	567	0	0	9,431	-
164	▼	107	13a	0	0	0	0	-

5

JOHN WATTS 7" 32# WW SAMPLE #5
ISO SERIES B TEST LOAD POINTS
1/31/00



5/5

ISO TEST SERIES B - TEST LOG
JOHN WATTS 7" WW PIPE COUPLED CONNECTION
SAMPLE # 5
75% EFF. (MU #6)
ROUND #4

DATE: 2-3-00 BY: NH PAGE 1 OF 3

LOAD STEP	TIME 24 HR.	FRAME KIPS	PRESSURE PSI	BUBBLES CC	COMMENTS
	5:50	Round #4			75% Loads 19G Box 6G Pin
		checked Cals & zeroed OK			Bottom 5 Threads
					check By NH / BC
	6:00	0	0	0	Start Test
	6:04	409	0	0	Adjust Bending Rings
	6:07	407	0	0	Lid on Frame Ready
1-1	6:10	800	0	0	5 min Hold
	6:15		0	0	End Hold
2-1A	6:16	539	0	0	
3-2	6:25	537	8835	0	1 Hr Hold
	6:55	533	8772	0	
	6:56	540	8769	0	
	7:25	538	8762	0	End Hold
7-3B	7:26	359	8800	0	
8-4	7:28	354	10700		15 min Hold
	7:44	355	10666	0	End Hold
12-5B	7:46	0	10767	0	
13-6	7:49	0	12010	0	15 min Hold
	8:04	0	11975	0	End Hold
14-6A	8:06	1	10885	0	
15-7	8:09	-322	10919	0	15 min Hold
	8:24	-323	10911	0	End Hold
19-8B	8:26	-330	7264	0	
20-9	8:52	-633	7249	0	15 min Hold Hydro Leak Hose Fitting
	9:07	-633	7247	0	End Hold
24-10B	9:09	-618	3280	0	
25-11	9:20	-770	3303	0	15 min Hold Hydro Leak Hose Fitting
	9:35	-769	3300		End Hold
29-12B	9:37	-765	30	0	

ISO TEST SERIES B - TEST LOG
JOHN WATTS 7" WW PIPE COUPLED CONNECTION
SAMPLE # 5

DATE: 2-3-00 BY: NH PAGE 2 OF

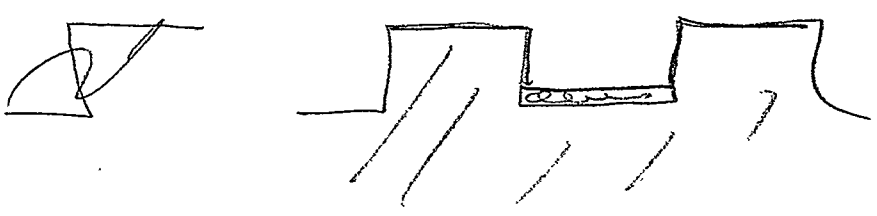
LOAD STEP	TIME 24 HR.	FRAME KIPS	PRESSURE PSI	BUBBLES CC	COMMENTS
30-13	9:38	-796	3	0	5 min Hold
	9:43	-795	0	0	End Hold
31-13A	9:45	1	0	0	
32-1A					Frame Problems: will not
33-2					build tension
		Recal	& Zero	By NH/LW	Fixed Frame
37-1A	16:20	537	0	0	restart
33-2	16:27	536	8855	0	15 min Hold
	16:43	535	8800	0	End Hold
37-3AA	16:44	0	8919	0	
38-13A	16:50	2	0	0	Stop Test Restart
					Fri 4th 2000
2-4-00	5:15	Checked & Zeroed Cals			OK re Start test
38-13A	5:22	2	0	0	
39-13	5:30	-796	0	0	5 min Hold
	5:35	-794	0	0	End Hold
40-12B	5:35	-759	0	0	
44-11	5:39	-767	3348	0	15 min Hold
	5:54	-765	3338	0	End Hold
45-10B	5:55	-623	3330	0	
49-9	5:59	-635	7300	0	15 min Hold
	6:14	-634	7274	0	End Hold
50-8B	6:15	-319	7216	0	
54-7	6:17	-325	10910	0	15 min Hold
	6:32	-325	10877	0	End Hold
55-6A	6:33	1	10766	0	

ISO TEST SERIES B - TEST LOG
JOHN WATTS 7" WW PIPE COUPLED CONNECTION
SAMPLE # 5

DATE: 2-4-00 BY: NH PAGE 3 OF 3

LOAD STEP	TIME 24 HR.	FRAME KIPS	PRESSURE PSI	BUBBLES CC	COMMENTS
56-6	6:35	0	11910	0	15 min Hold
	6:41	0	11576	Blow out	100 + cc / Sec 6 min in Hold
	6:46	1	4260		100+ cc / Sec
	6:50	1	3724		100+ cc / Sec
	7:03	1	2800		100+ cc/ sec
	7:20	1	2200		100+cc / sec
	7:48	1	1825		100 cc / 4 sec
	8:02	1	1717		100 cc / 4 sec
	8:07	0	0		End Test

	A	B	C	D	E	F	G	H
42	**ISO TEST SERIES B LOAD POINTS**							
43	**JOHN WATTS WW 7" 32# P-110 SAMPLE #5**							
44	**2/2/00**							
45	75% EFF.							
46								
47	TESTING IN GUADRANTS I & II, WITHOUT BENDING							
48								
49	DIRECTION	LOAD	VME	TOTAL	FRAME	BENDING	PRESSURE	HOLD
50	AROUND	STEP	LOAD	FORCE	FORCE			TIME
51	VME CURVE		POINT	*KIPS*	*KIPS*	DEG/100 FT.	*PSI*	MIN.
52		1	1	795	795	0	0	5
53		2	1a	534	534	0	0	-
54		3	2	795	534	0	8,752	60
58		7	3b	613	353	0	8,752	-
59		8	4	669	353	0	10,633	15
63		12	5b	316	0	0	10,633	-
64		13	6	353	0	0	11,848	15
65		14	6a	322	0	0	10,838	-
66	CCW	15	7	0	-322	0	10,838	15
70		19	8b	-108	-322	0	7,225	
71		20	9	-418	-633	0	7,225	15
75		24	10b	-535	-633	0	3,299	-
76		25	11	-669	-767	0	3,299	15
80		29	12b	-767	-767	0	0	-
81		30	13	-795	-795	0	0	5
82		31	13a	0	0	0	0	-
83		32	1a	534	534	0	0	-
84		33	2	795	534	0	8,752	15
88		37	3aa	534	0	0	8,752	-
89		38	13a	0	0	0	0	-



	A	B	C	D	E	F	G	H
90	DIRECTION	LOAD	VME	TOTAL	FRAME	BENDING	PRESSURE	HOLD
91	AROUND	STEP	LOAD	FORCE	FORCE			TIME
92	VME CURVE		POINT	*KIPS*	*KIPS*	DEG/100 FT.	*PSI*	MIN.
93		39	13	-795	-795	0	0	5
94		40	12b	-767	-767	0	0	-
98		44	11	-669	-767	0	3,299	15
99		45	10b	-535	-633	0	3,299	-
103		49	9	-418	-633	0	7,225	15
104		50	8b	-108	-322	0	7,225	
108	CW	54	7	0	-322	0	10,838	15
109		55	6a	322	0	0	10,838	-
110		56	6	353	0	0	11,848	15
111		57	5b	316	0	0	10,633	-
115		61	4	669	353	0	10,633	15
116		62	3b	613	353	0	8,752	-
120		66	2	795	534	0	8,752	15
121		67	1a	534	534	0	0	-
122		68	1	795	795	0	0	5
123		69	13a	0	0	0	0	-

	A	B	C	D	E	F	G	H
124	DIRECTION AROUND VME CURVE	LOAD STEP	VME LOAD POINT	TOTAL FORCE *KIPS*	FRAME FORCE *KIPS*	BENDING DEG/100 FT.	PRESSURE *PSI*	HOLD TIME MIN.
127	▲ CCW ▼	70	1	795	795	0	0	5
128		71	1a	534	534	0	0	-
129		72	2	795	534	0	8,752	30
133		76	3b	613	353	0	8,752	-
134		77	4	669	353	0	10,633	30
138		81	5b	316	0	0	10,633	-
139		82	6	353	0	0	11,848	30
140		83	6a	322	0	0	10,838	-
141		84	7	0	-322	0	10,838	30
145		88	8b	-108	-322	0	7,225	
146		89	9	-418	-633	0	7,225	30
150		93	10b	-535	-633	0	3,299	-
151		94	11	-669	-767	0	3,299	30
155		98	12b	-767	-795	0	0	-
156		99	13	-795	-795	0	0	5
157		100	13a	0	0	0	0	-
158		101	1a	534	534	0	0	-
159		102	2	795	534	0	8,752	60 30
163		106	3aa	534	0	0	8,752	-
164		107	13a	0	0	0	0	-

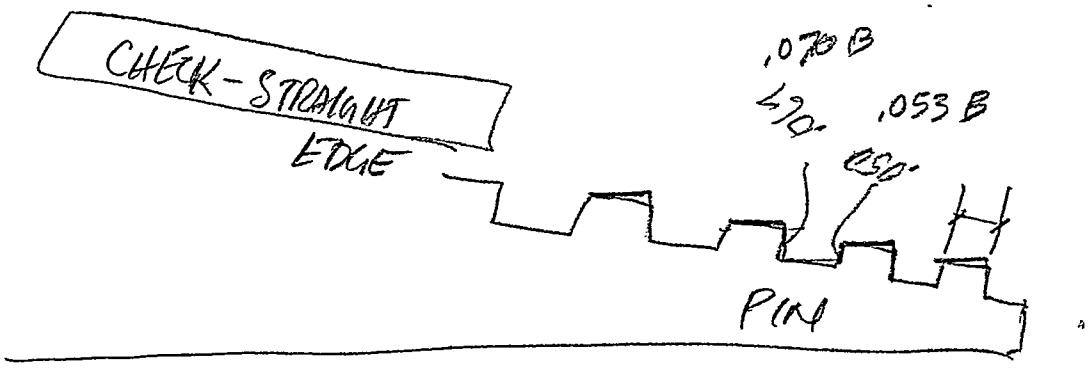
ISO TEST SERIES B LOAD POINTS
JOHN WATTS WW 7" 32# P-110 SAMPLE #5
2/2/00

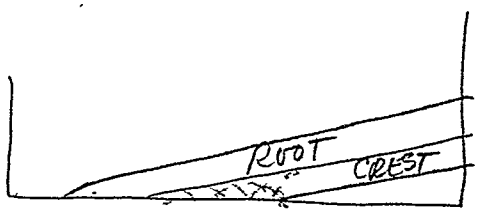
PIPE PROPERTIES:	ACTUAL AVERAGE OD =	7.034	INCH
	ACTUAL AVERAGE ID =	6.155	INCH
	CROSS SECTION AREA =	9.105	SQ. IN.
	ACTUAL AVERAGE ID =	6.155	INCH
	INT. PRESS. END LOAD =	29.754	x Pi, KIPS
	PIPE ACTUAL MINIMUM YIELD STRENGTH =	122,500	PSI
	PIPE BODY YIELD =	1,115	KIPS
	CONNECTION YIELD =	837	KIPS

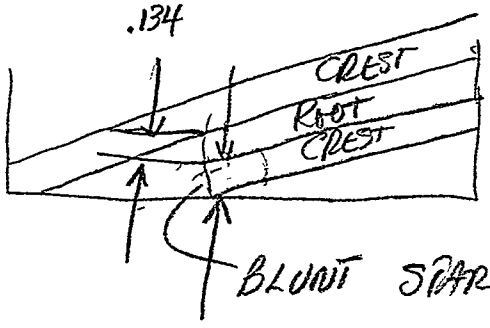
CONNECTION LIMITED IN TENSION & COMPRESSION TO 75% PIPE BODY YIELD

LOAD POINT	TOTAL AXIAL LOAD		BENDING	PRESSURE
	% YIELD	*KIPS*	*DEG/100 FT.*	*PSI*
1	95	795	0	0
2	95	795	0	8,752
3-BT	95	795	20	8,752
3-BC	-	#VALUE!	20	8,752
4	80	669	0	10,633
5-BT	80	669	20	10,633
5-BC	-	#VALUE!	20	10,633
6	CEYP	353	0	11,848
7	0	0	0	10,838
8-BC	0	0	20	10,838
8-BT	-	0	20	10,838
9	-50	-418	0	7,225
10-BC	-50	-418	20	7,225
10-BT	-	#VALUE!	20	7,225
11	-80	-669	0	3,299
12-BC	-80	-669	20	3,299
12-BT	-	#VALUE!	20	3,299
13	-95	-795	0	0

Client	Project No.	Page No. of	By	Date
Subject			Checked By	Date







.050" AT START

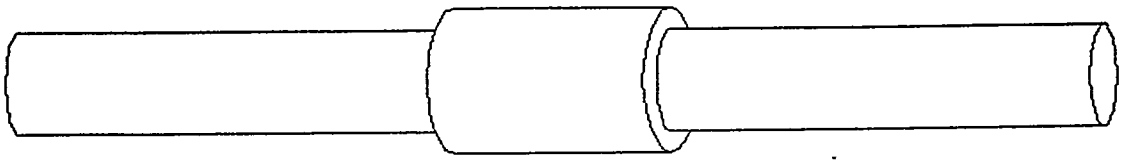
1 TURN = +.005"

3 Copies

Stress Engineering Services

PN 6924
Date 1-31-2000
Inspector BD

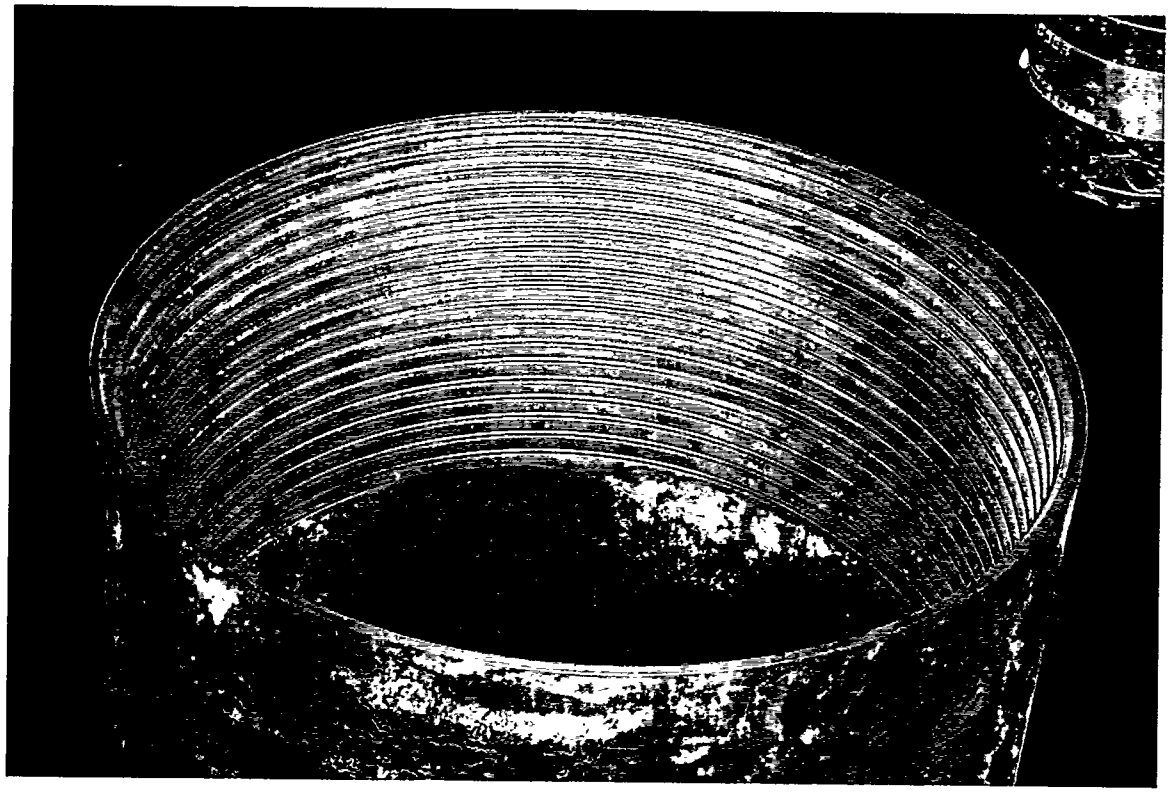
Customer JW
Sample # SAMPLE #5
T & C or Flush FLUSH



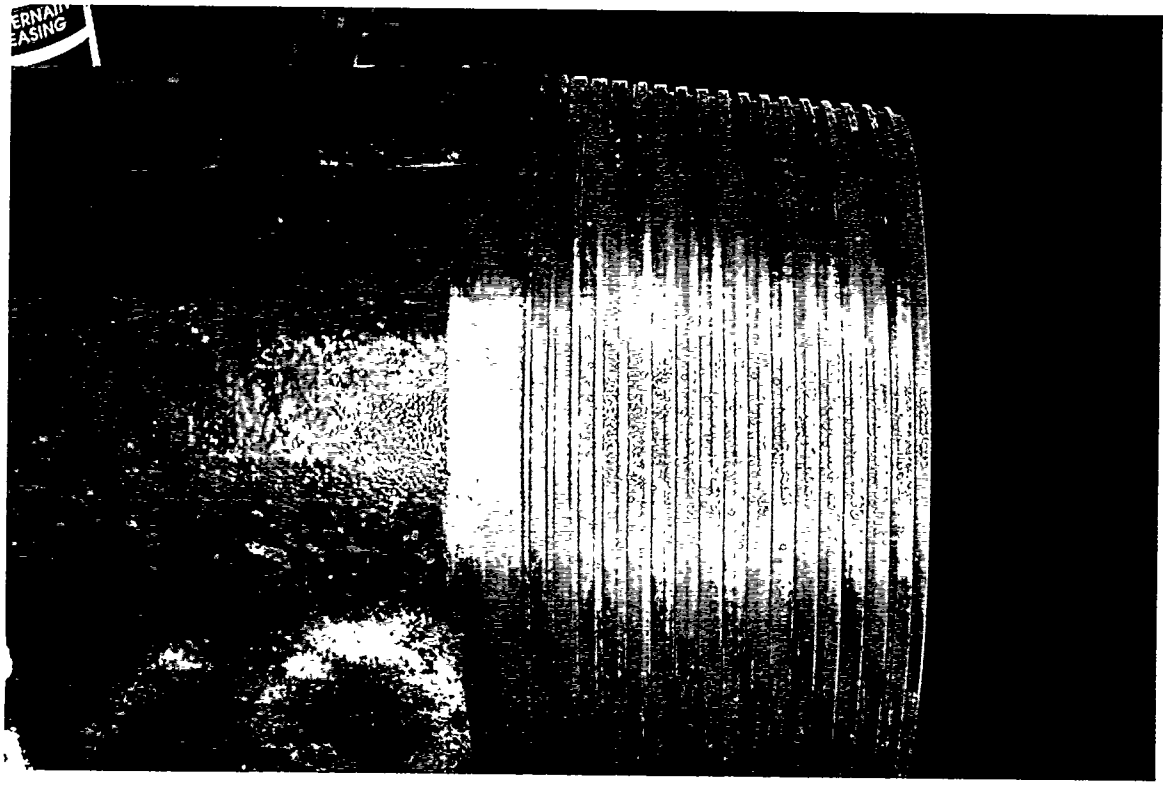
		Side PIN		Side BOX
Wall	0°	.439	0°	.439
	90°	.434	90°	.445
	180°	.449	180°	.420
	270°	.440	270°	.443
	Avg. Wall	.441	Avg. Wall	.437
OD	0°-180°	7.033	0°-180°	7.039
	90°-270°	7.043	90°-270°	7.044
	Avg. OD	7.038	7.040 Avg. OD	7.042
	Avg. ID	6.156	6.157 Avg. ID	6.168

(OD - 2x Avg. Wall)

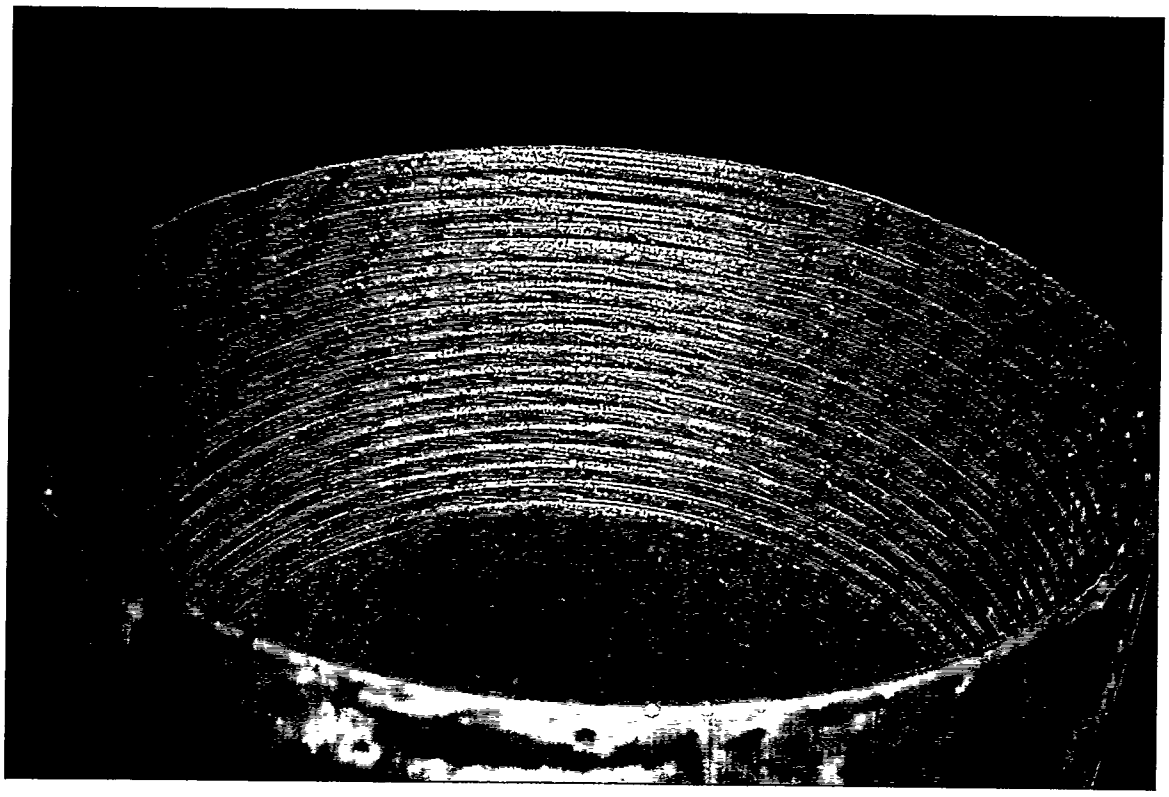
APPENDIX F
PHOTOGRAPHS OF TEST SAMPLES AND EQIUPMENT



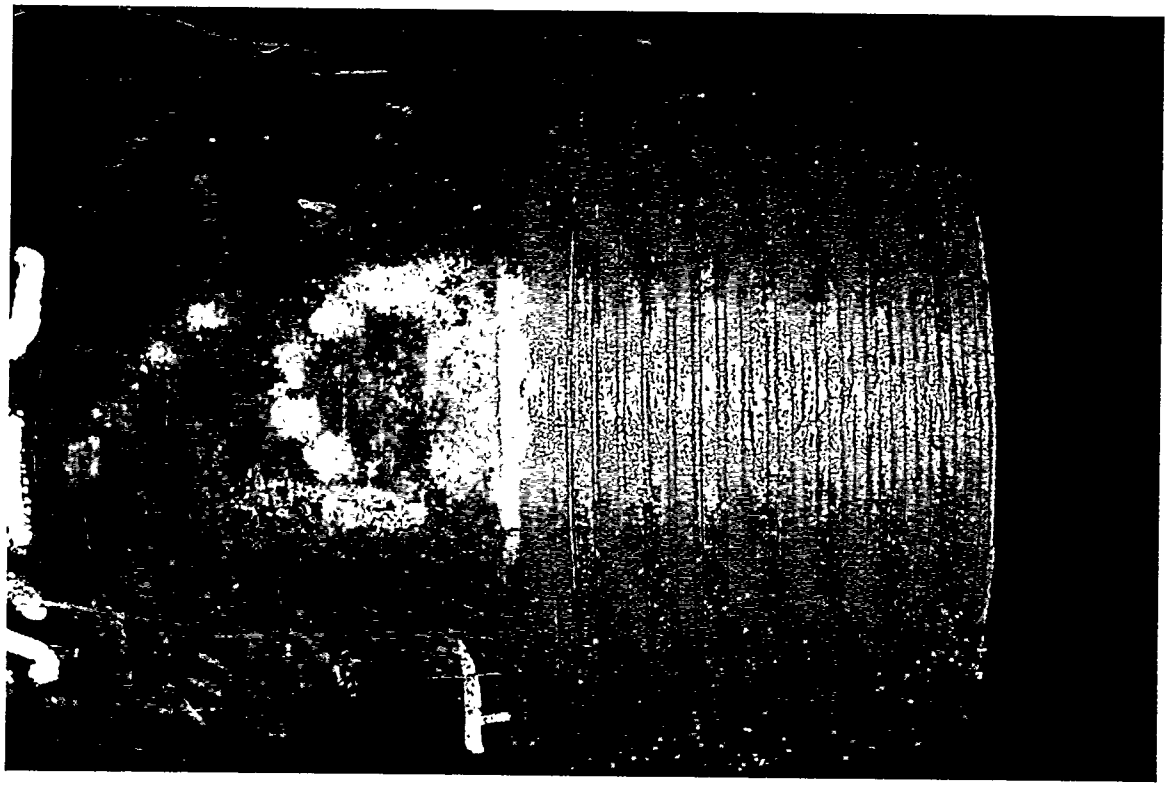
NEW THREADED BOX



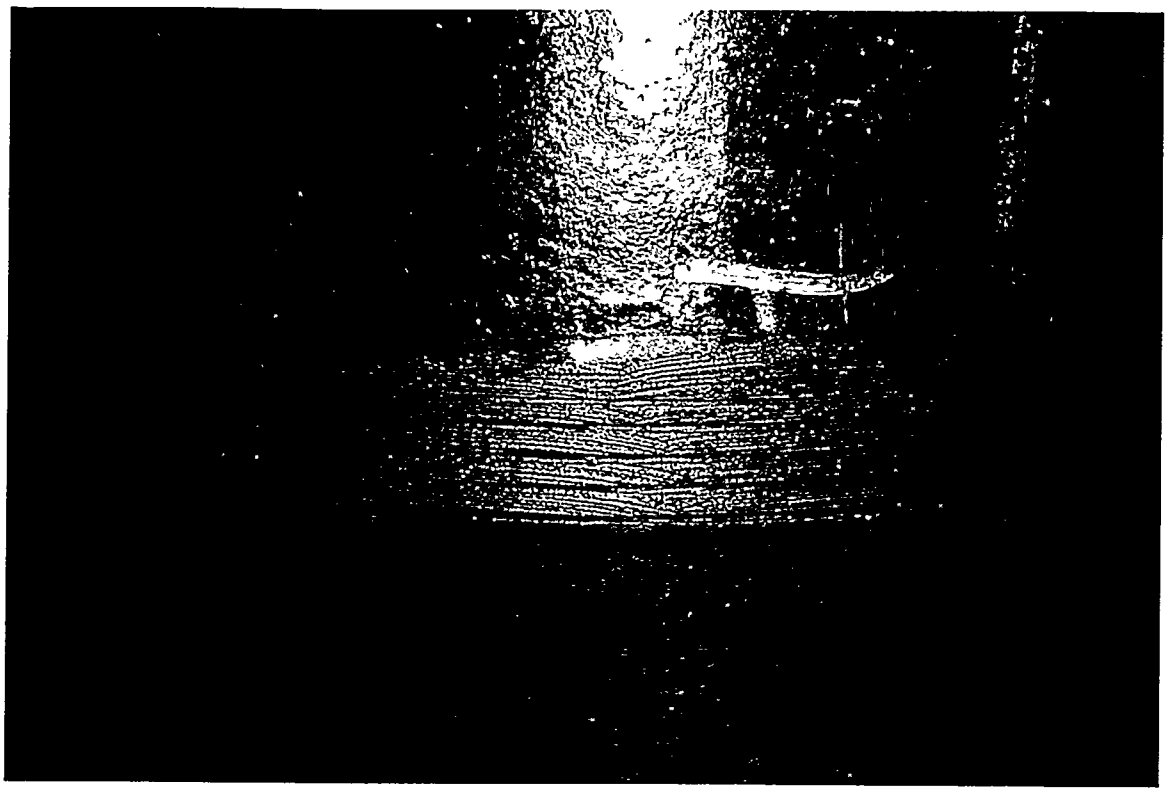
NEW THREADED PIN



LUBRICANT APPLIED TO BOX

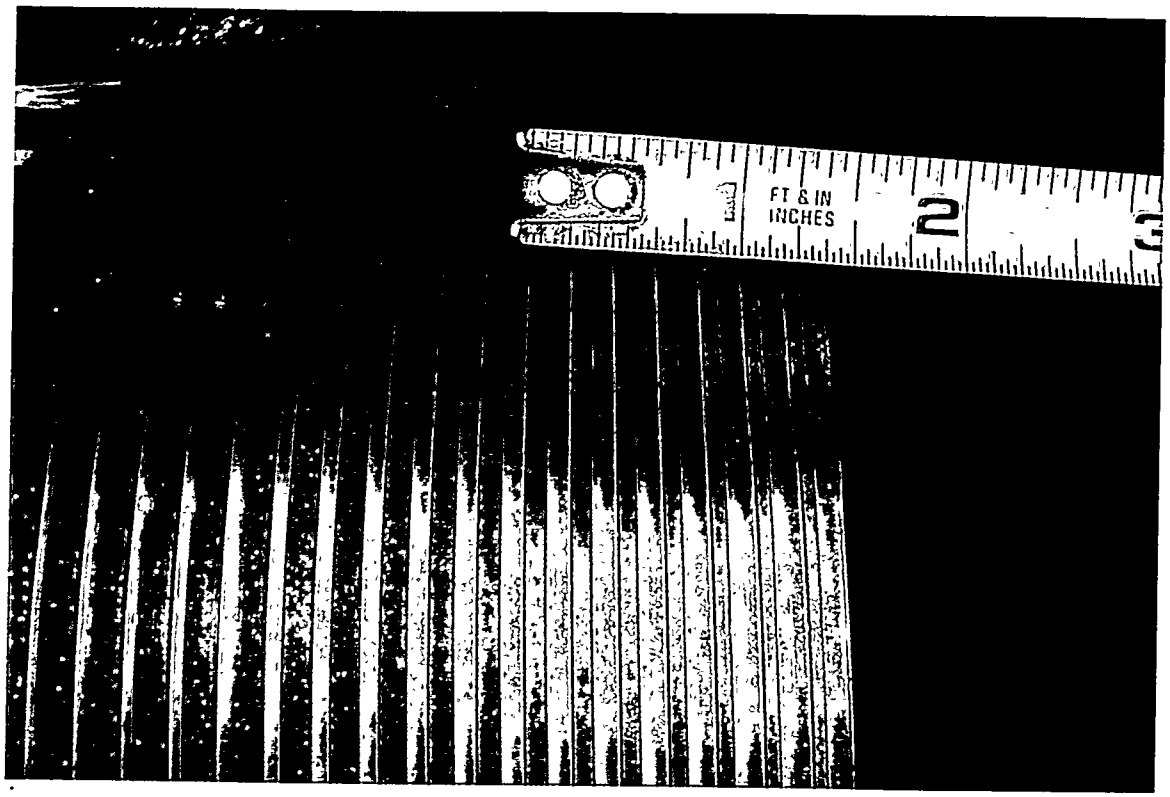


LUBRICANT APPLIED TO PIN

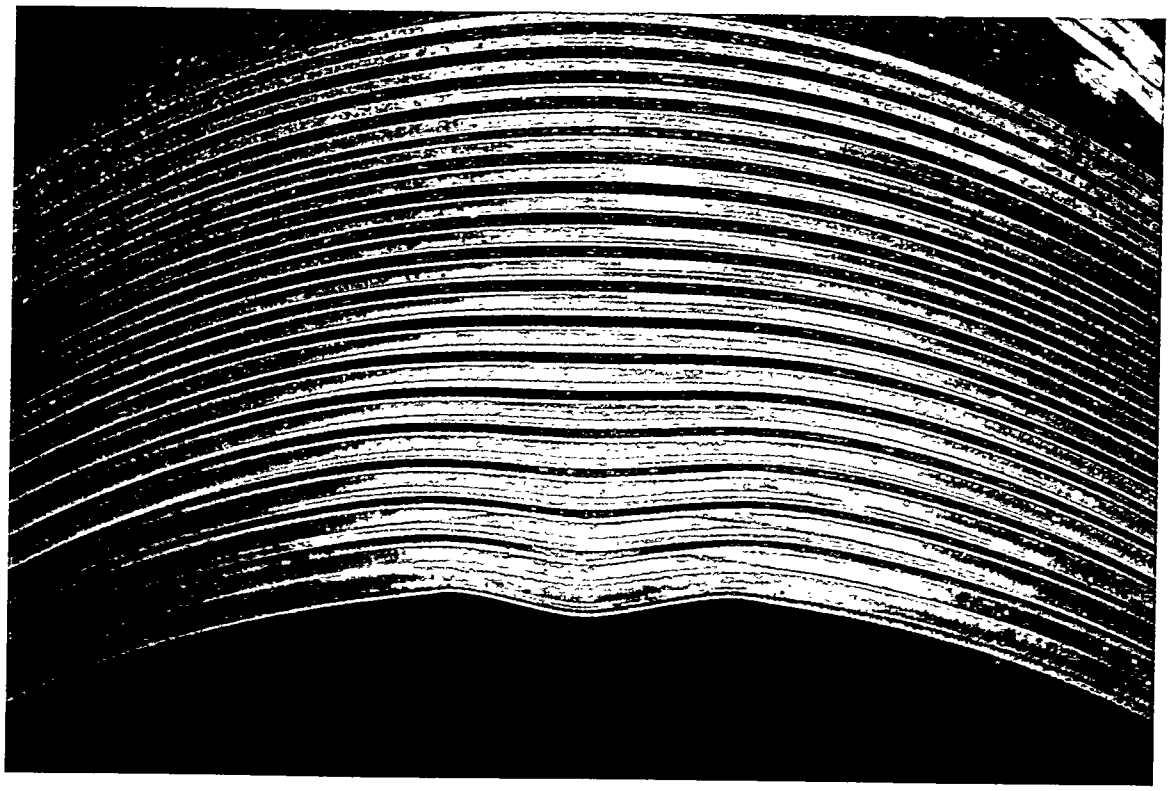


HAND TIGHT POSITION

STABBING AT AN ANGLE



TYPICAL PIN END COLLAPSE



COMPRESSION TO FAILURE SAMPLE

TENSION TO FAILURE SAMPLE – PIN FRACTURE