Hayward Pool Products Demonstration
CPSC Headquarters Bethesda, MD
February 11, 1998

Log of Meeting

Date of Log Entry: February 26, 1998

Source of Log Entry: Troy Whitfield, Mechanical Engineer, CPSC

Attendees:

Larry Paulick	
Leif Zars	Gary Pools Inc.
Sam Cristy	Product Safety Letter
Nicholas Marchica	CPSC/ESME
Troy Whitfield	CPSC/ESME
Suad Nakamura	CPSC/EHPS

Summary of Meeting

The meeting was held at the CPSC Headquarters at the request of Mr. Larry Paulick to discuss the results of testing conducted by Mr. Leif Zars and inspect a drain designed by Mr. Zars to protect against main drain suction hazards associated with drain covers. The meeting opened with Mr. Zars discussing the findings in his report - Suction Entrapment Tests - in which tests were conducted on several different designs of drain cover. A copy of the report was provided to CPSC for review.

The meeting shifted to Mr. Zars presentation of a drain sump and cover assembly that Gary Pools has developed and installed in a number of new pool installations. The meeting concluded with Mr. Zars requesting the CPSC staff's opinion on the drain assembly and the voluntary standards test requirements that the fixture would be required to meet. It was suggested to Mr. Zars that he draft language to be incorporated into the various standards which would included his design and present it to voluntary standards committees for consideration.

Attachments

February 1998

Leif A. Zars

Born: Munich, Germany
January 21, 1924

EDUCATION:

Graduated Harvard Business School, AMP 1968
Graduated Georgia Tech, Engineering School 1963

PROFESSIONAL EXPERIENCE:

- **Founder of Gary Pools, Inc. 1954 - present.**
  Builder of commercial and residential pools in Texas with over 14,000 installations, and an average of 160 employees.

- **World Waterpark Assoc. Standards Writing committee member 1997 - 1998.**

- **National Swimming Pool Institute Committees 1967 - present.**
  Voluntary Chairman of National Design writing standards committee for Reside-ential Swimming Pool Standards, Commercial Swimming Pool Design Standards, National Workmanship Standards, National Decking Standards, and member of committee for the revision to NSPI/ANSI Public Pool Standard, 1996 to present.

- **National Swimming Pool Foundation 1974 - present.**
  Chairman for 6 years during which the National Certified Pool Operator (CPO) program was implemented with now over 60,000 trained graduates nationwide. Presently on Board as Past Chairman.

- **Chairman Ad Hoc Committee overseeing Diving Safety Research at Arthur D. Little Inc., Cambridge, Mass. 1971 - 1996.**

- **Member of the Research and Information sub committees of the U.S. Consumer Product Safety Commission, Washington, D.C. 1985 - 1989.**

PUBLICATIONS:

"Suction Entrapment Studies" Report on tests for swimming pool drain entrapment 1998.

"Diving Geometry" from determining Diving Board Spring Constant through Underwater Trajectories 1996.

"Formulas for Progressive Dilution of Swimming Pool Water" 1973 Swimming Pool Weekly. Derivation of formulas for water filtration as a function of bather load, turbidity removal and pool turnover.

"Progressive Dilution as Related to Swimming Pool Filtration" 1972 Swimming Pool Weekly. Presentation of the mathematics of progressive dilution theory.

"Bits of Dirt" 1968 Swimming Pool Weekly. Discussion of the physical aspects of water filtration.

CONSULTING:

Expert Witness: Diving Safety as related to Swimming Pool geometry.

Review and evaluation of swimming pool and aquatic facilities nationwide.

SWIMMING POOL DESIGN CONSULTANT:

Fiesta Texas, San Antonio, TX
Hyatt Hill Country Resort, San Antonio, TX
Jewish Community Center, San Antonio, TX
Port Aransas City Park, Port Aransas, TX
Ciggarroo City Park, Laredo, TX
Crane Country Park, Crane, TX
Moody Garden Hotel Resort, Galveston, TX

Research Engineer through Marketing Dept. with Ethyl Corp. 1946 - 1954.
Design patent changing fluid blending plant design worldwide.

MILITARY: U.S. Navy 1941 - 1946. Lt.jg

SUCTION ENTRAPMENT TESTS

LEIF ZARS

2/6/98

GENERAL PARAMETERS OF TESTS

All Piping was 2" Schedule 40 PVC

Water flow was created by running two 2 HP pumps is series so as to provide the desired range of GPM as regulated by a discharge valve.

Water flow in GPM was monitored by a Dynasonics Ultrasonic Flow Meter.

Data was recorded by a Monarch Data Chart Paperless Recorder.

Input to the Data Chart was provided by a WIKA Tronic Pressure Transmitter.

All Data Chart input was from within the main drain sump.

Pressure sensitive pump control was achieved with a Mercoid Pressure Control activating a locking relay.

Some pump suction and discharge pressures were recorded but are not reported herein in as much as they are immaterial to the tests.

Main Drain blockage was performed mostly with a 3-3/4" by 12" by 12" foam block - and occasionally with a flexible 20 mil fabric reinforced plastic film.

Specified main drain covers were in place at all times.

When dual main drains were used they were spaced 3' apart with 2" PVC.

All data was plotted to the same scale throughout this report.

MAIN DRAINS TESTED

Main Drain #1	Sta-Rite 7017-0751	Rated 80 GPM
Main Drain #2	Hayward SP 1030AV	Rated 108 GPM
Main Drain #3	Hayward SP 1030	Rated 148 GPM
Main Drain #4	Hayward SP 1048	Rated 108 GPM
Main Drain #5	Hayward SP 1031	Rated 252 GPM
Main Drain #6*	Sta-Rite 7017-0751	Rated 80 GPM
Main Drain #7*	Sta-Rite 7017-0751	Rated 80 GPM

* Main Drain #6 Same as Main Drain #1 but was Mounted with not as much Flexible PVC Pipe.

* Main Drain #7 Same as Main Drain #1 but was Mounted with no Flexible PVC Pipe.

DESCRIPTION OF SUCTION GRAPHS

Left Scale - " Hg
Bottom Scale - Seconds
Plot - 1/50th Second Intervals
Top - First " Hg - Not Relevant
Top - Date and Time of Test

RELEVANT DANGER NUMBERS

2.2 p.s.i. - 5.08 Foot of Head - 4.48 "Hg

NORMAL DRAIN EVALUATIONS

#1 Main Drain - No Vent

Rated at 80 GPM

Entrapped at flow rates of 62 to 80 GPM

Removal effort - Foam in excess of 31#
Tests #1 & #2

Film Pealed with 5# Pull
Test #3

#2 Main Drain - No Vent

Rated at 108 GPM

Entrapped at flow rates of 108 GPM

Removal effort - Foam - Would not block off

Film Pealed with 10 to15# Pull
Test #4

#3 Main Drain - No Vent

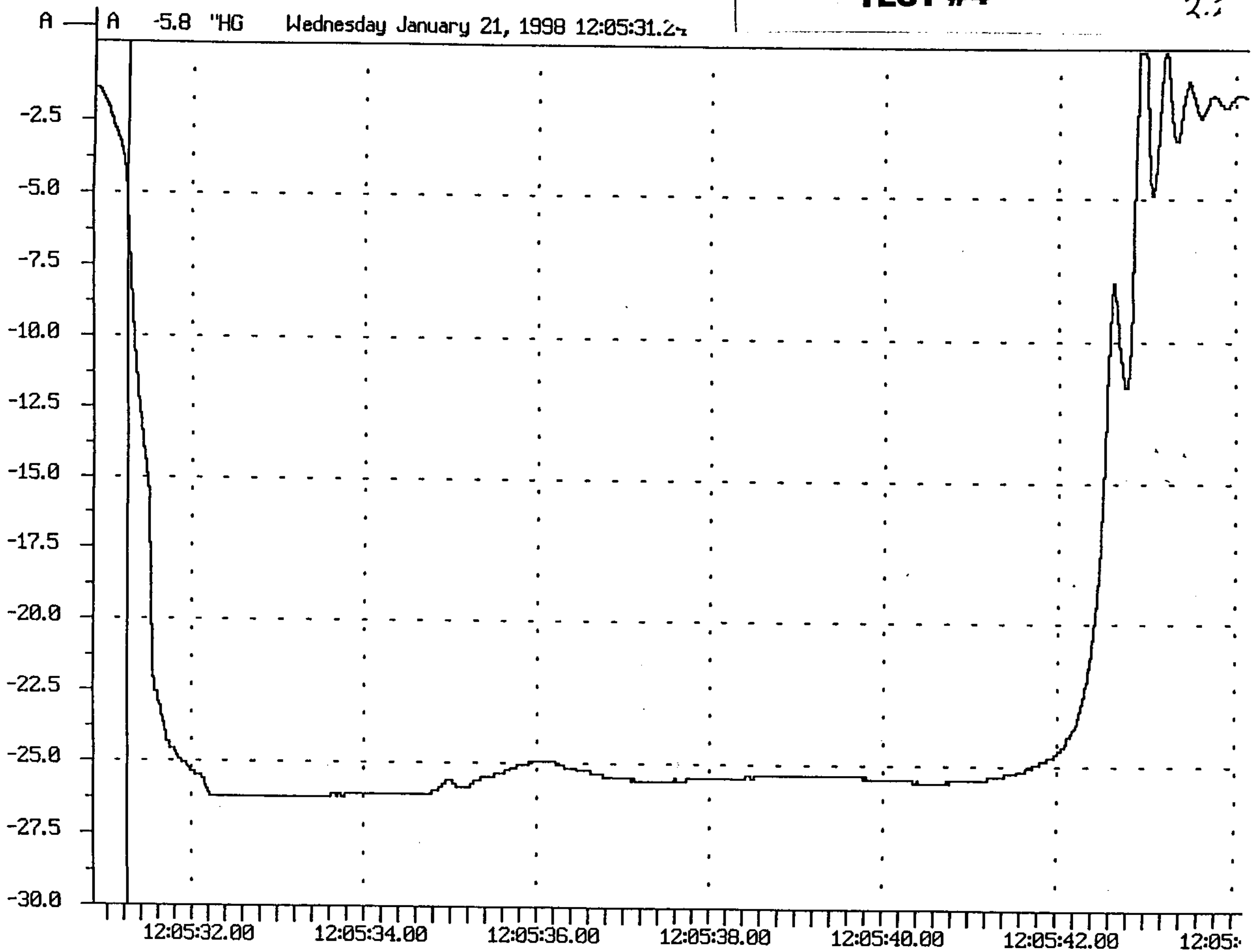
Rated at 148 GPM

Entrapped at flow rates of 62 to 109 GPM

Removal effort - Foam - Would not block off
Test #5

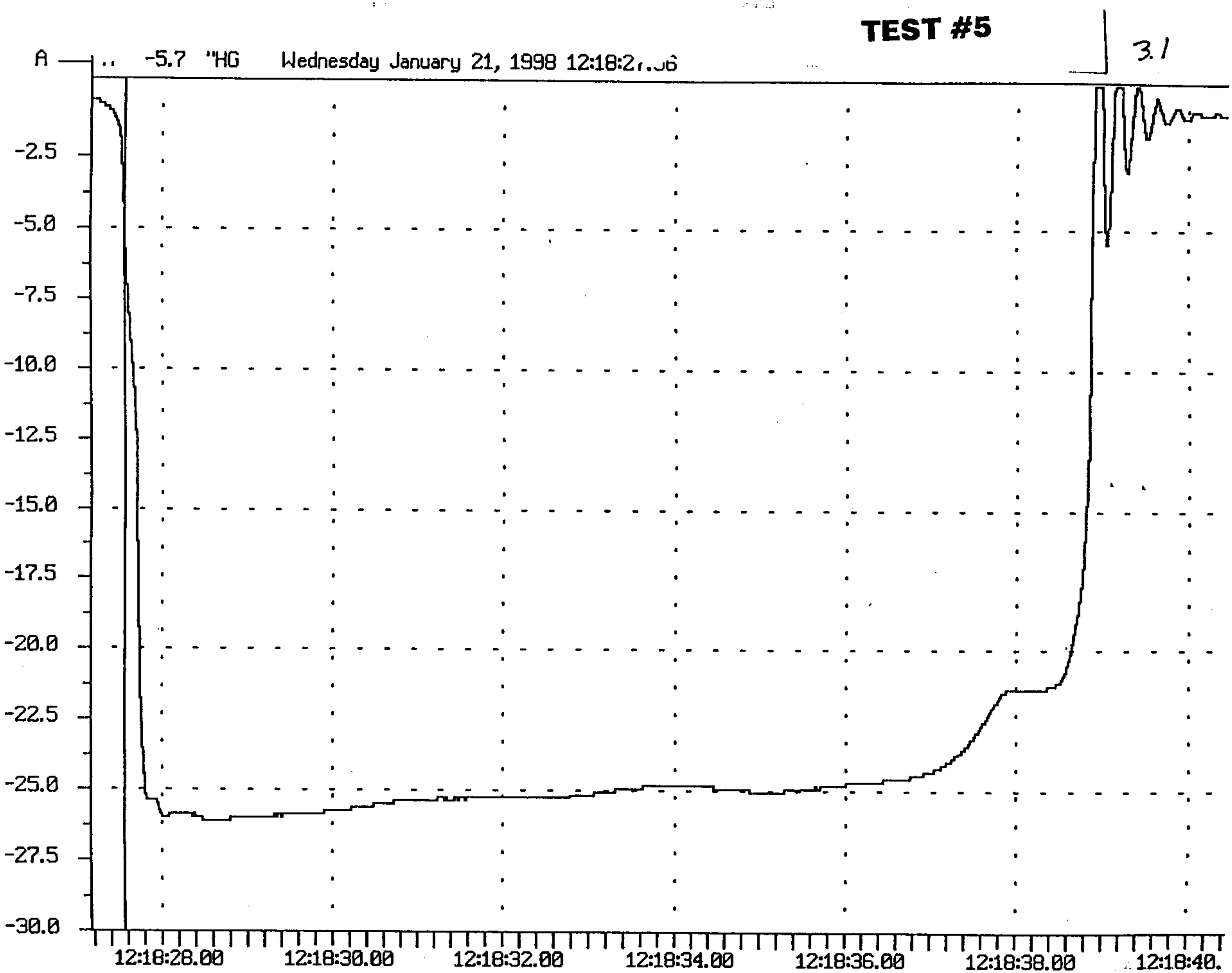
Film sometimes bounced off
Pealed with 15# Pull
Test #6

TEST #4

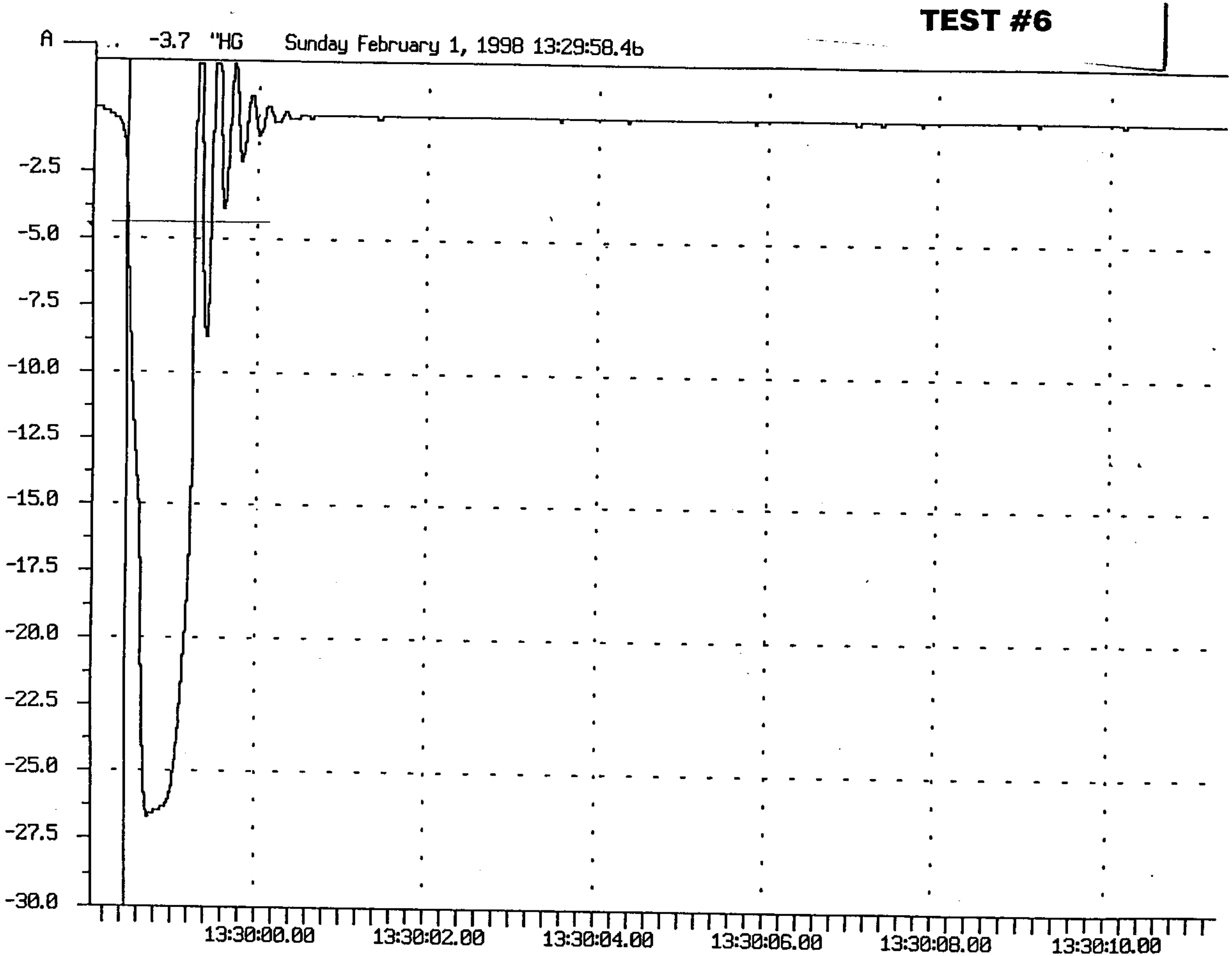


A
A -5.8 "HG Wednesday January 21, 1998 12:05:31.24
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
12:05:32.00
12:05:34.00
12:05:36.00
12:05:38.00
12:05:40.00
12:05:42.00

TEST #5


3.1
A
-5.7 "HG
Wednesday January 21, 1998 12:18:2r.J6
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
12:18:28.00
12:18:30.00
12:18:32.00
12:18:34.00
12:18:36.00
12:18:38.00
12:18:40.

TEST #6


A
-3.7 "HG
Sunday February 1, 1998 13:29:58.46
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
13:30:00.00
13:30:02.00
13:30:04.00
13:30:06.00
13:30:08.00
13:30:10.00

#4 Main Drain - No Vent

Rated at 108 GPM

Entrapped at flow rates of 60 to 105 GPM

Removal effort - Foam sometimes bounced off (65.55 Inch Sec)
Test #7

Film Pealed with 15# Pull
Test #8

#5 Main Drain - No Vent

Rated at 252 GPM

Entrapped at flow rates of 106 GPM

Removal effort - Foam
When stuck removal by hand almost impossible
Test #9
Film Pealed easily from corner
Test #10

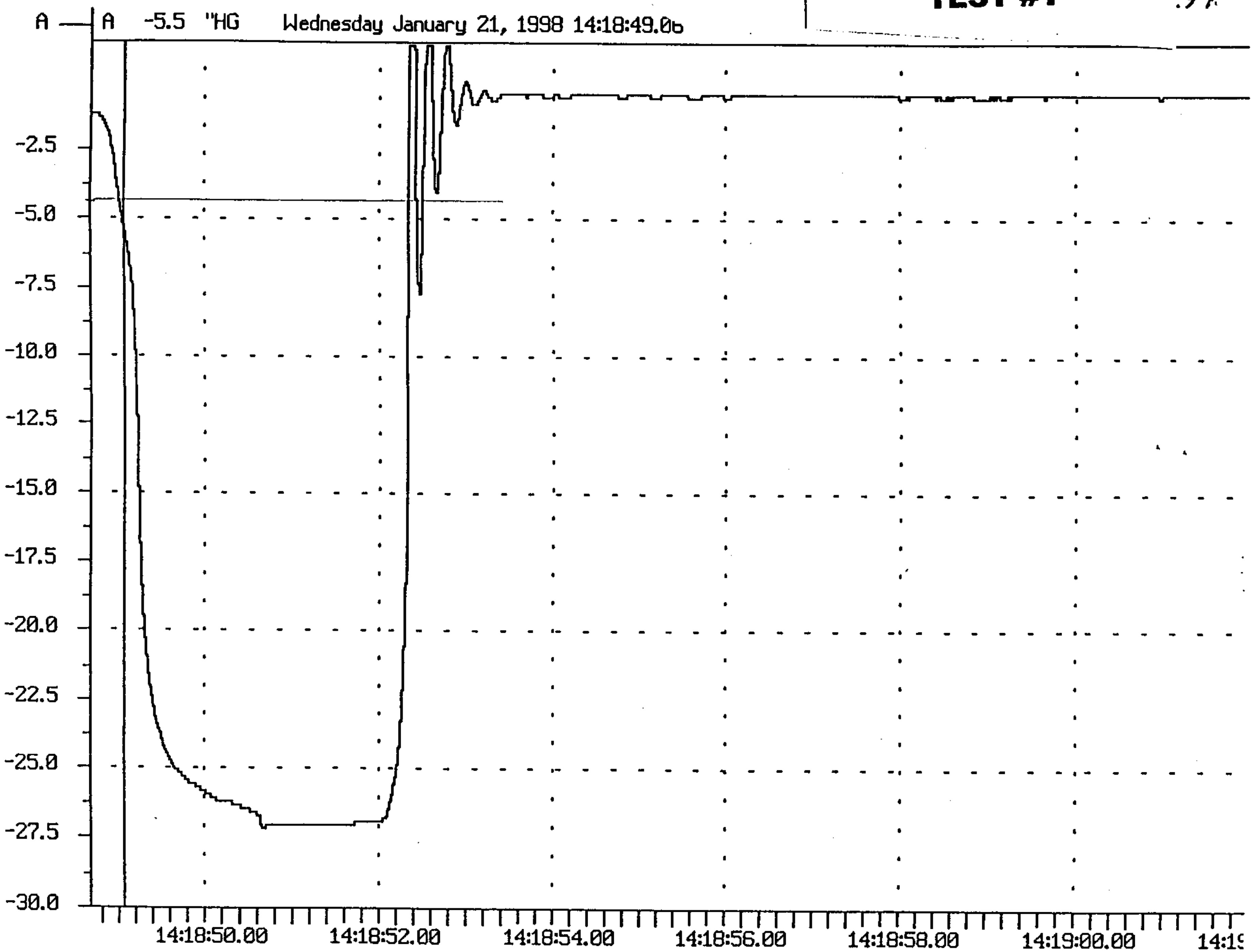
#6 Main Drain - No Vent

Rated at 148 GPM

Entrapped at flow rates of 63 to 118 GPM

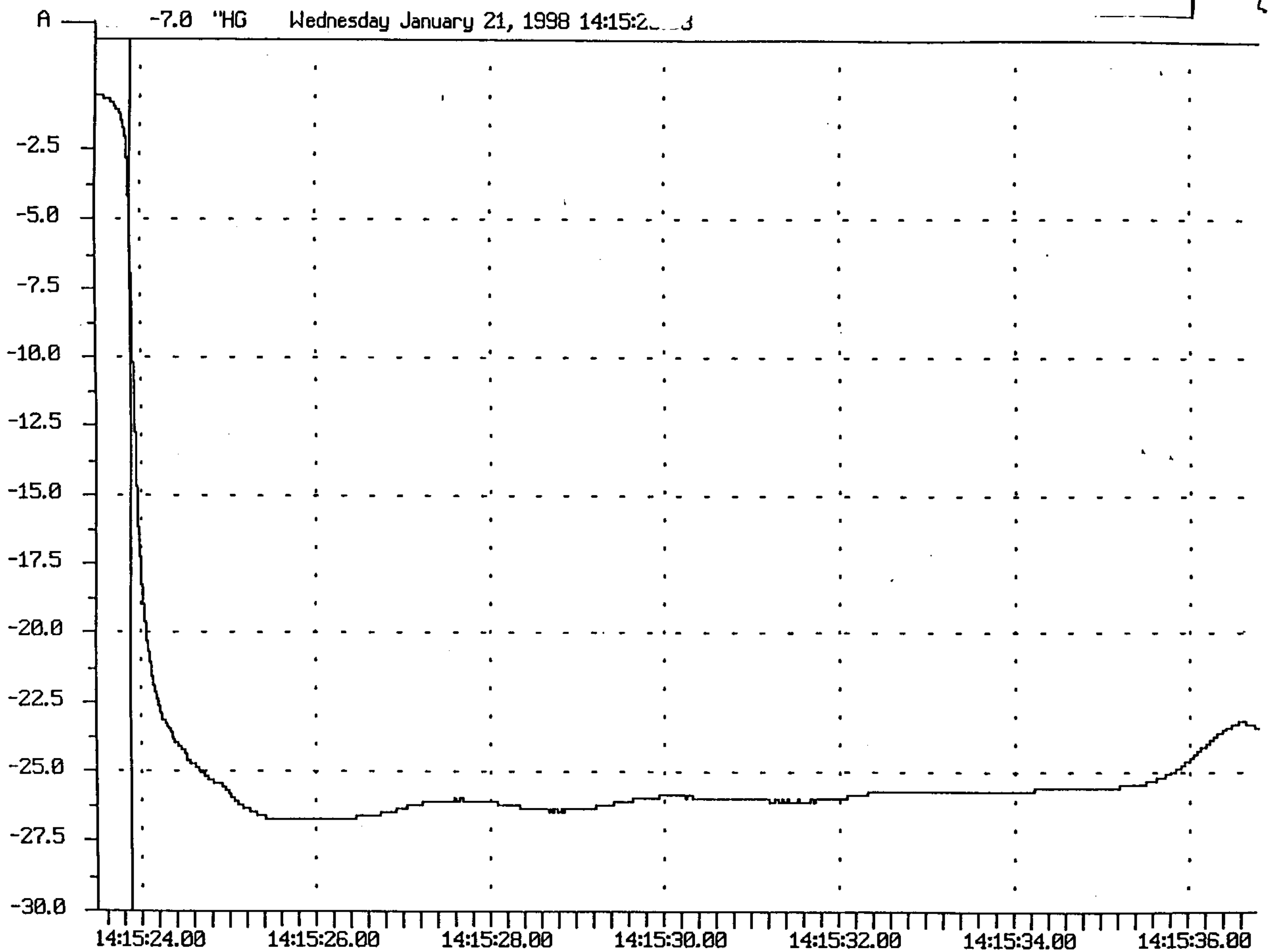
Removal effort - Foam Sometimes bounced off (12.23 Inch Sec)
Test #11
Sometimes Stuck
Test #12

TEST #7



A
A -5.5 "HG Wednesday January 21, 1998 14:18:49.06
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:18:50.00
14:18:52.00
14:18:54.00
14:18:56.00
14:18:58.00
14:19:00.00

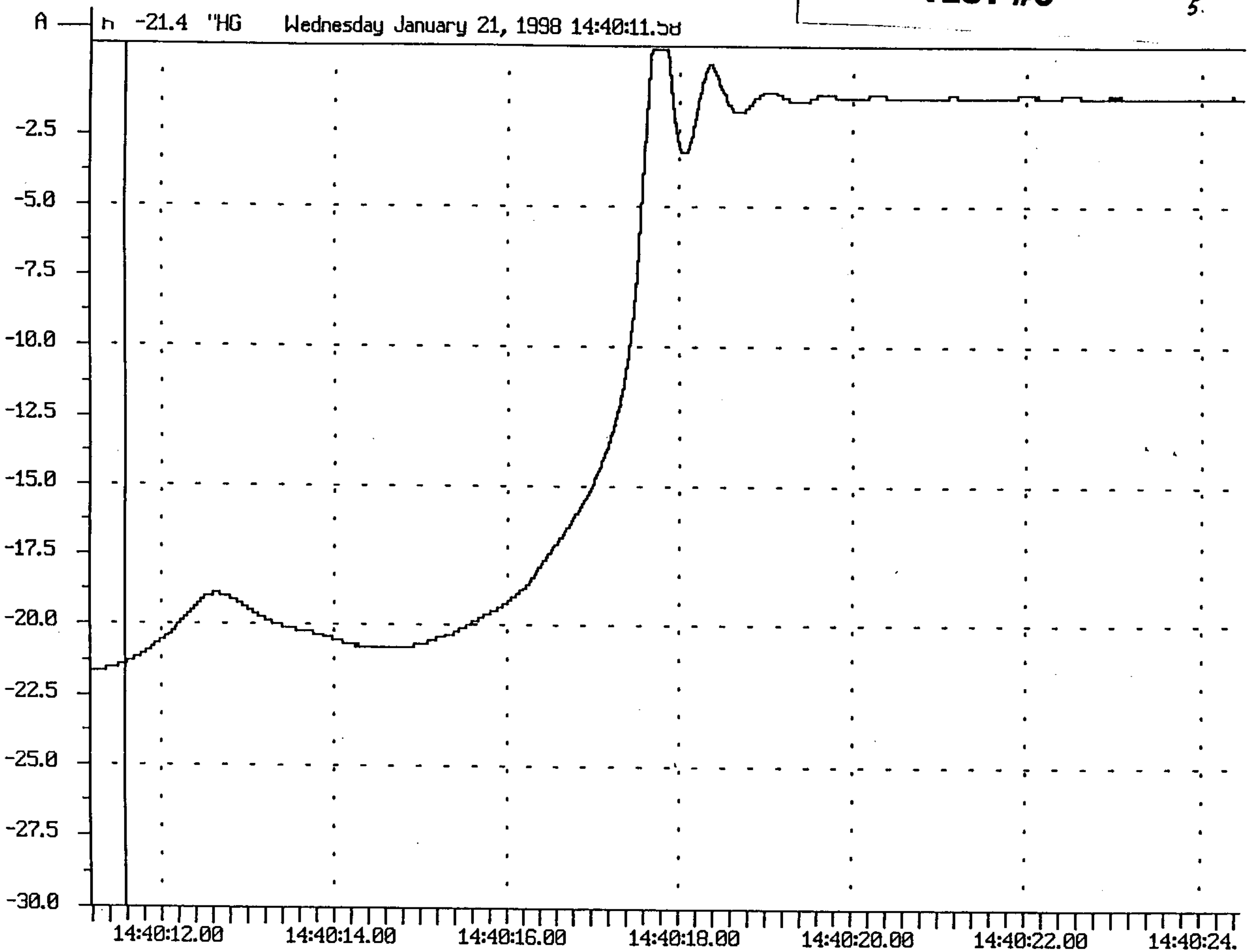
TEST #8



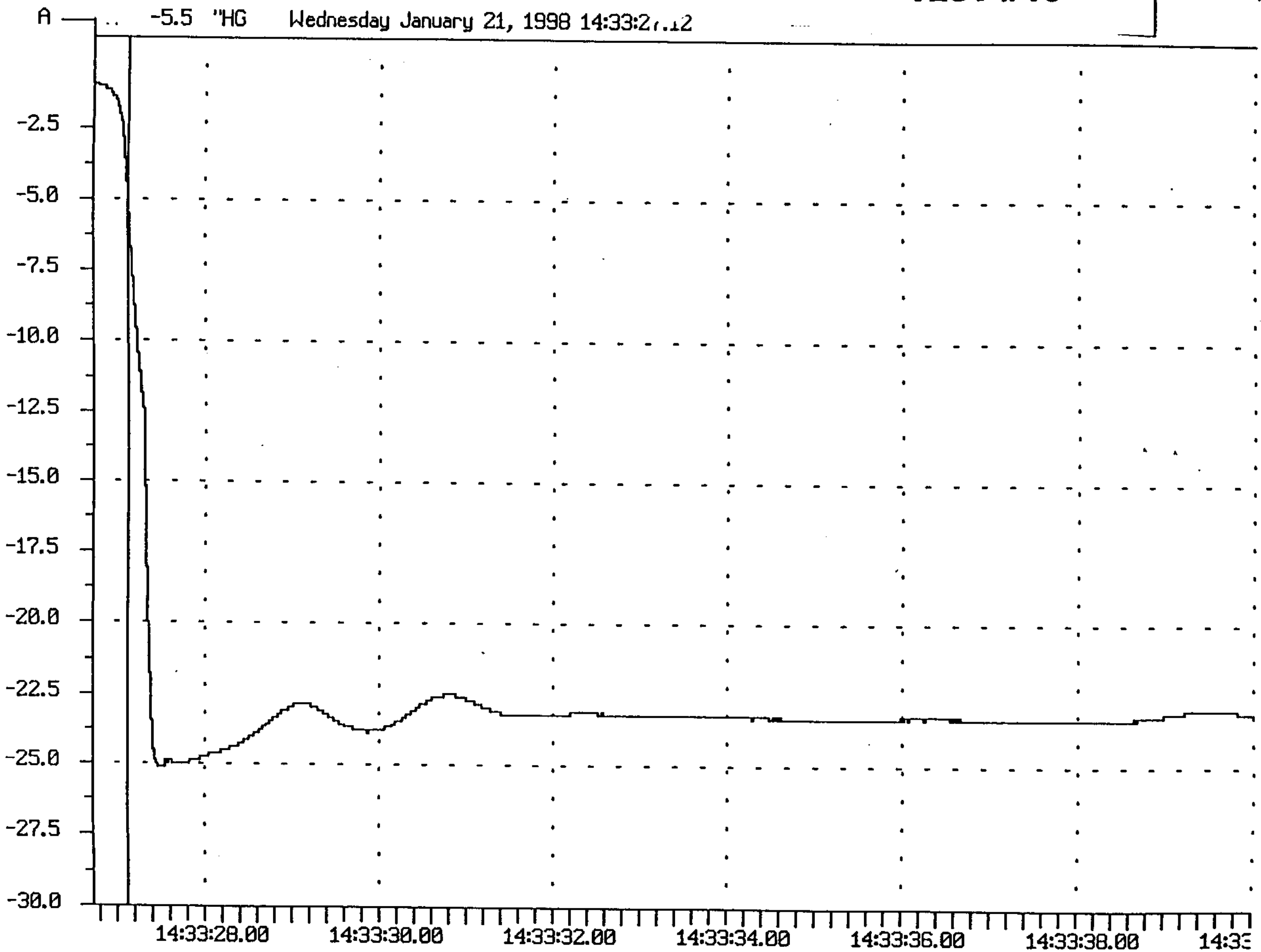
A
-7.0 "HG
Wednesday January 21, 1998 14:15:2
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:15:24.00
14:15:26.00
14:15:28.00
14:15:30.00
14:15:32.00
14:15:34.00
14:15:36.00

TEST #9

5.

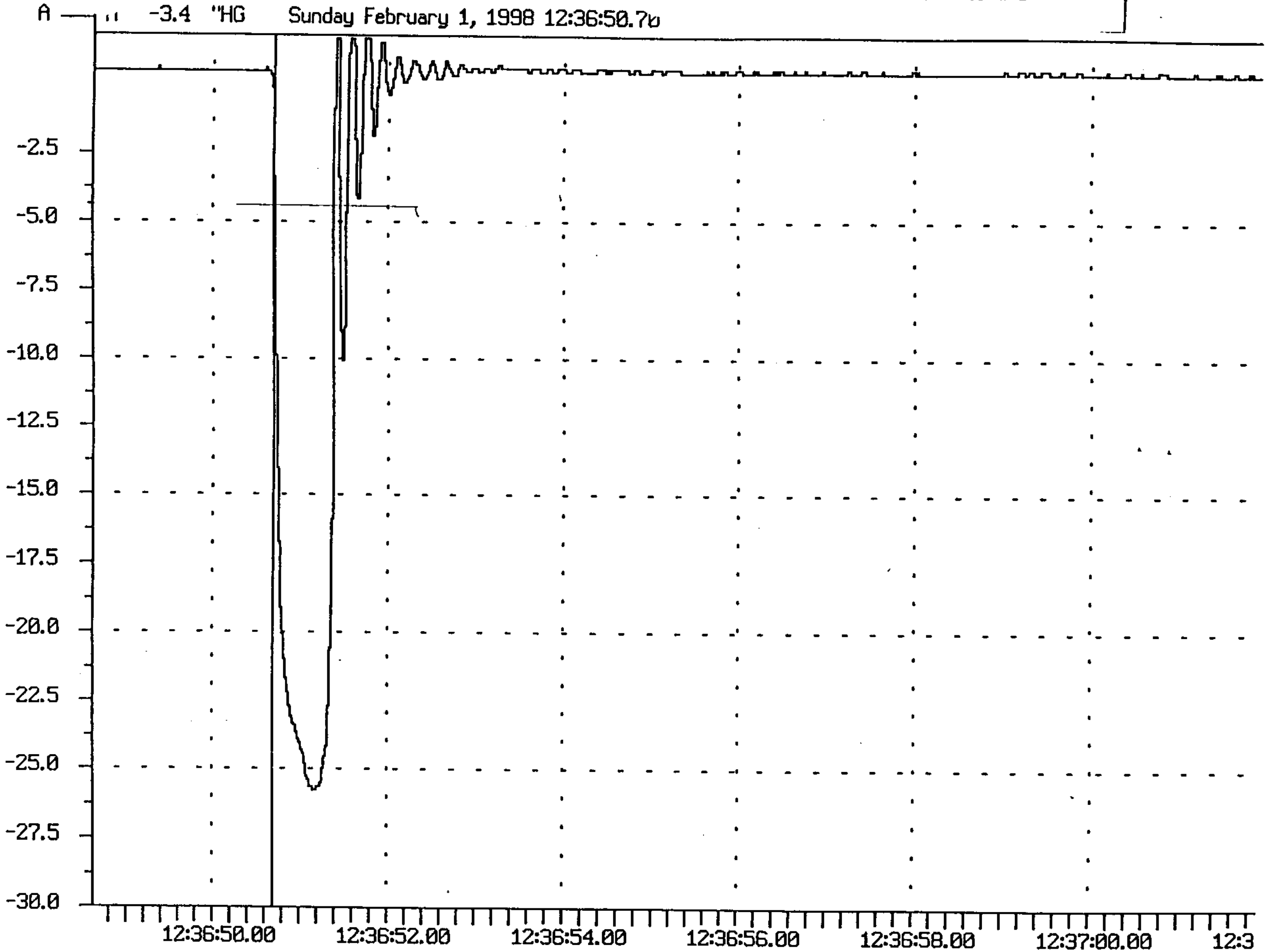

A
h -21.4 "HG Wednesday January 21, 1998 14:40:11.58
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:40:12.00
14:40:14.00
14:40:16.00
14:40:18.00
14:40:20.00
14:40:22.00
14:40:24.

TEST #10



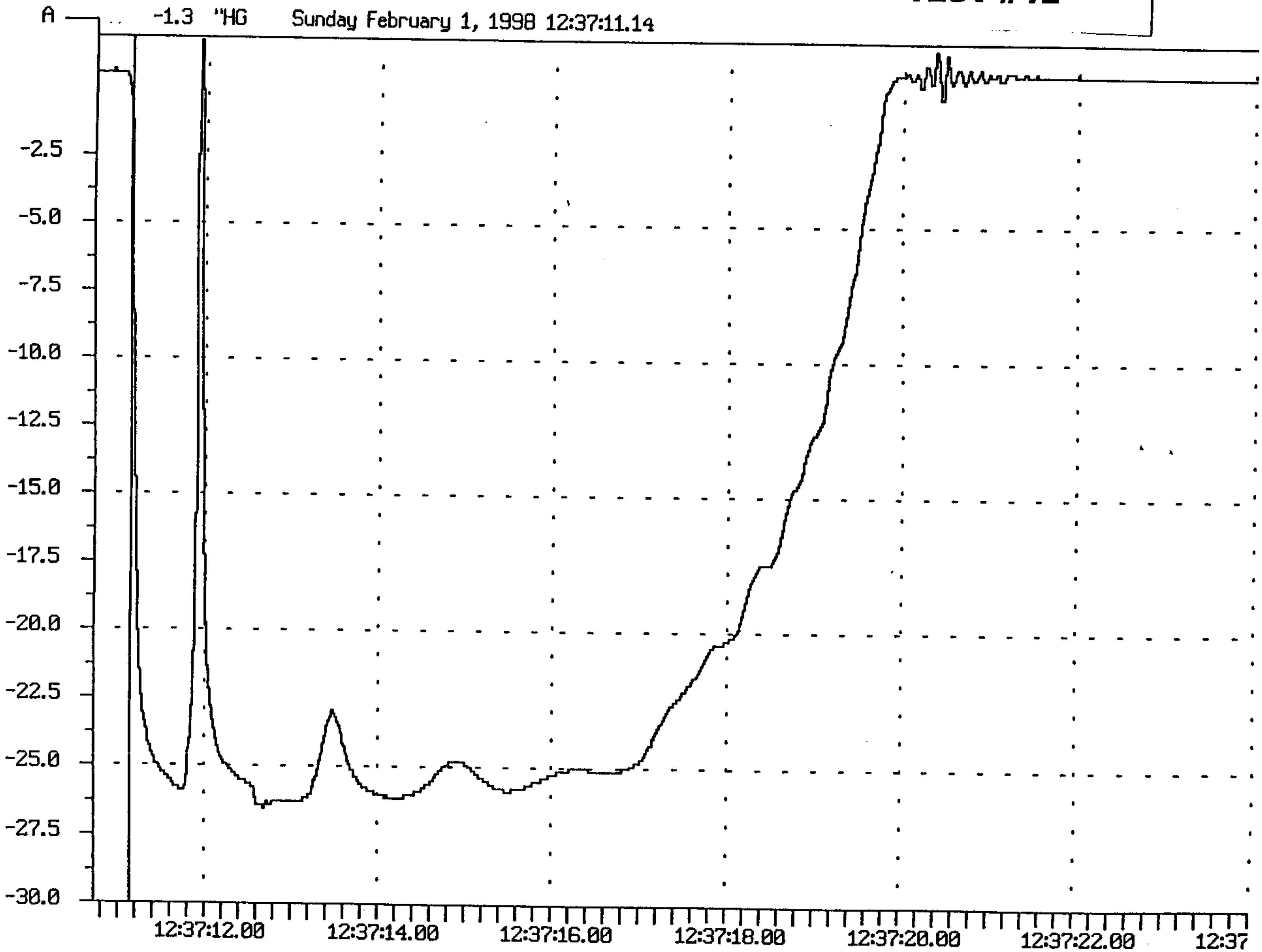
A
-5.5 "HG Wednesday January 21, 1998 14:33:2?.12
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:33:28.00
14:33:30.00
14:33:32.00
14:33:34.00
14:33:36.00
14:33:38.00

TEST #11



A
-3.4 "HG
Sunday February 1, 1998 12:36:50.70
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
12:36:50.00
12:36:52.00
12:36:54.00
12:36:56.00
12:36:58.00
12:37:00.00
12:3

TEST #12



A
-1.3 "HG
Sunday February 1, 1998 12:37:11.14
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
12:37:12.00
12:37:14.00
12:37:16.00
12:37:18.00
12:37:20.00
12:37:22.00
12:37

DUAL MAIN DRAINS

#6 Main Drain & #3 Main Drain - No Vent

Rated at 80 GPM and 148 GPM

At 118 GPM #6 Main Drain was blocked with Foam which left 100% of the flow through #3 Main Drain. The suction encountered under #6 Main Drain peaked at 5.9" Hg - Test #13 - indicating 0.14 Inch Seconds, and leveled off at between 2" and 3" Hg when Foam captured - Test #14 - indicating 0.17 Inch Seconds.

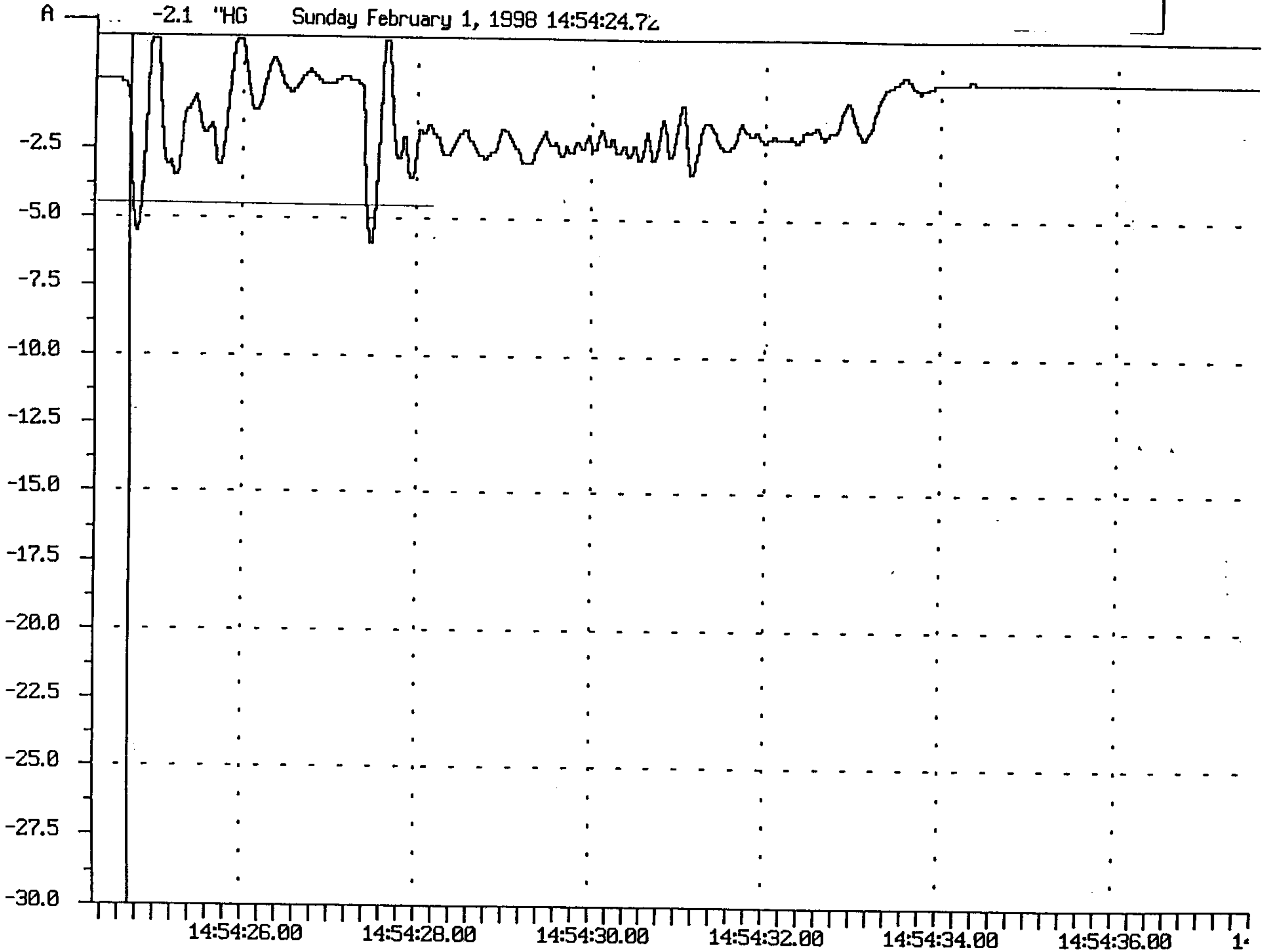
VACUUM CUT OFF SWITCH

Vacuum Mercury Cut Off Switch

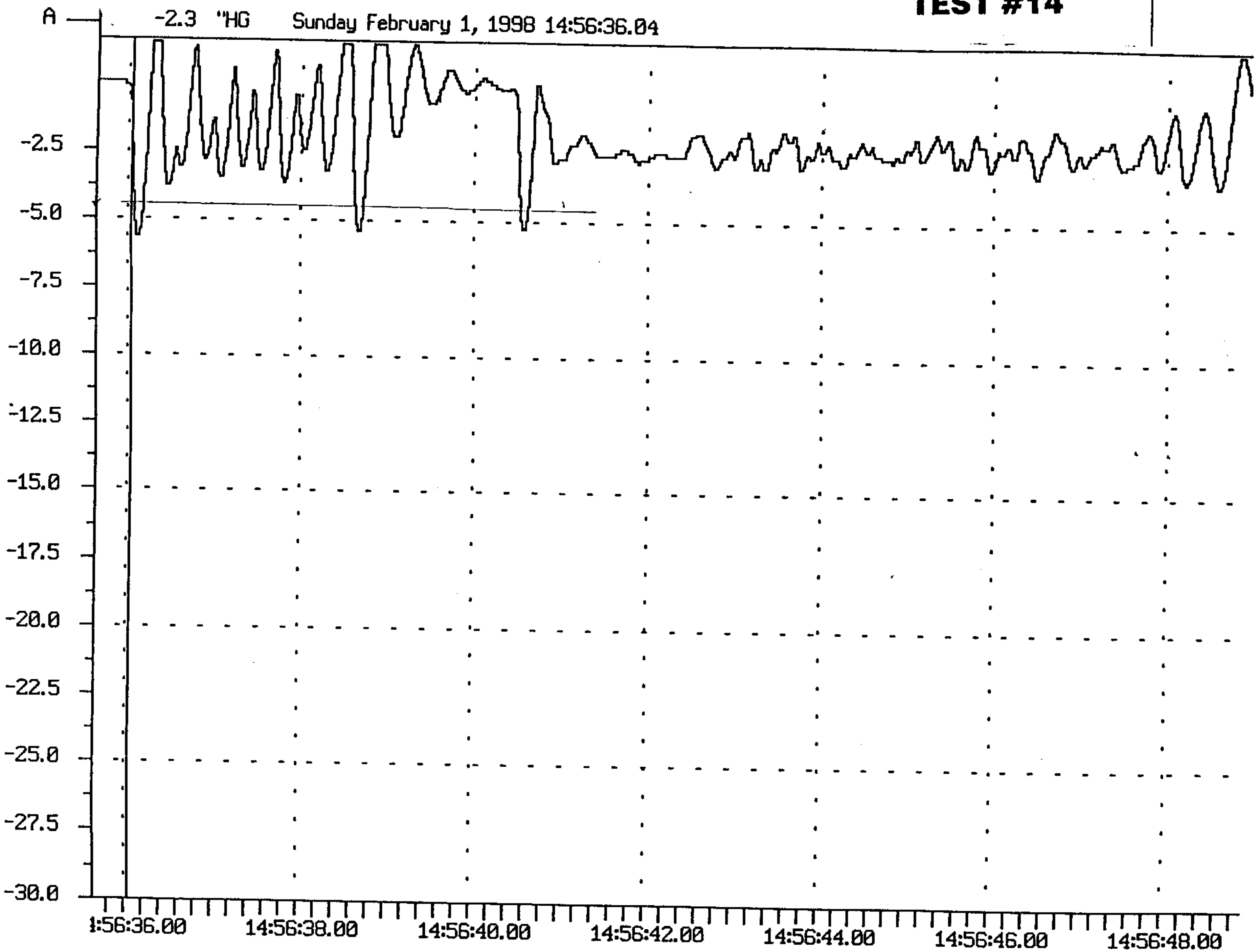
A vacuum mercury cutoff switch with latching relay was assembled from commercial components and set to trip at 8" Hg.

Tests conducted individually with #1 and #6 Main Drains at flow rates of from 60 to 62 GPM indicagted vacuum time curves raqnging from 24.88 Inch Seconds to 60.07 Inch Seconds with an average of 41.06 Inch Seconds - Typical Test #15

TEST #13

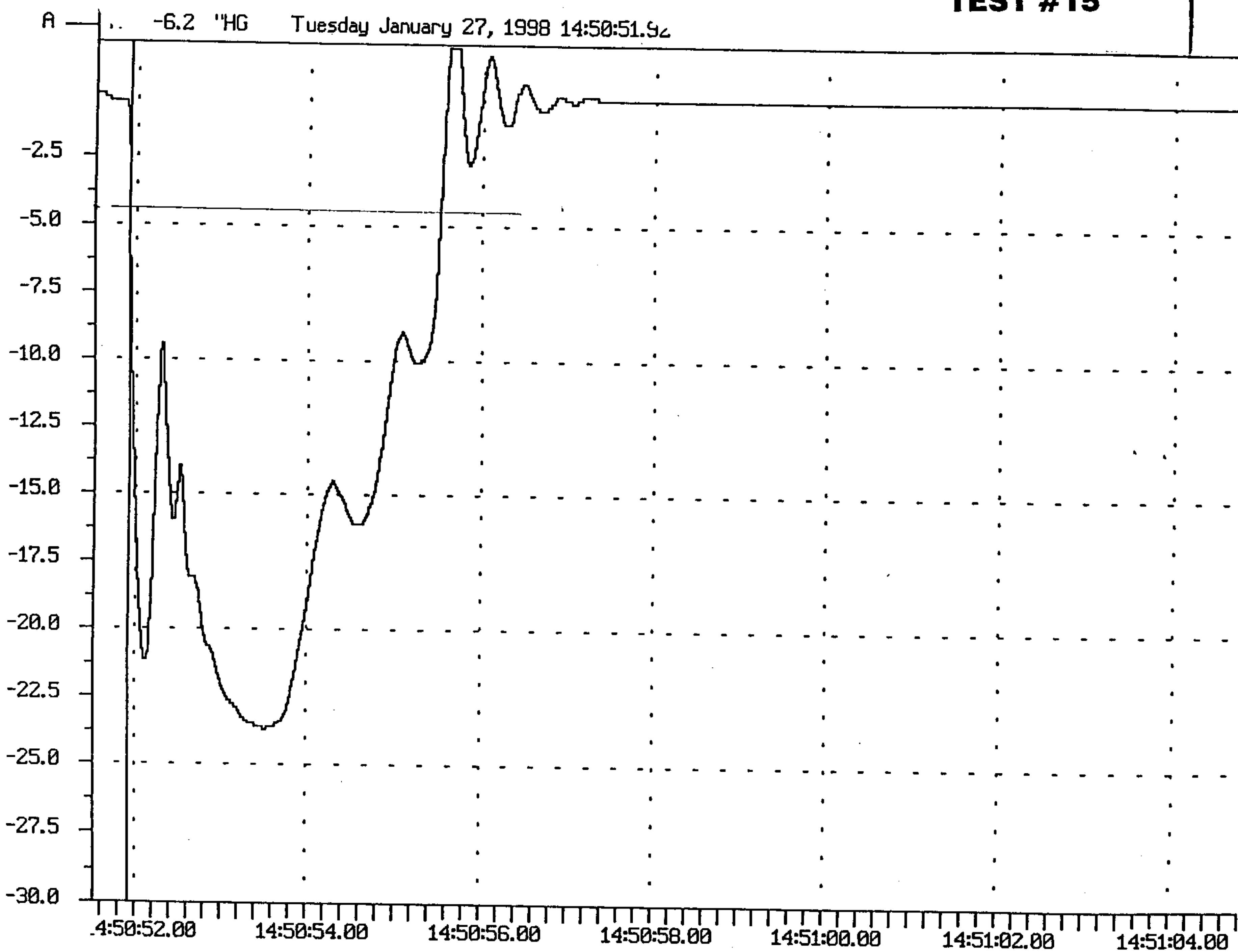

A
-2.1 "HG
Sunday February 1, 1998 14:54:24.72
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:54:26.00
14:54:28.00
14:54:30.00
14:54:32.00
14:54:34.00
14:54:36.00

TEST #14



A
-2.3 "HG
Sunday February 1, 1998 14:56:36.04
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
1:56:36.00
14:56:38.00
14:56:40.00
14:56:42.00
14:56:44.00
14:56:46.00
14:56:48.00

TEST #15


A
-6.2 "HG Tuesday January 27, 1998 14:50:51.92
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
.4:50:52.00
14:50:54.00
14:50:56.00
14:50:58.00
14:51:00.00
14:51:02.00
14:51:04.00

SUCTION LIMITING LOOP ("VENT") TESTS

Tests were conducted on 3/4" and 2" vents while using 2" PVC Main Drain Suction Lines. The 3/4" Vent was tested at a 42"depth and a 56" depth, while the 2" Vent was tested at a 56" depth only. Flow rates were from 42 to 56 GPM with the 42" depth Vent.

The 3/4" Vent at 42" depth showed two characteristics. One with some flexible PVC pipe in the suction system and the other without this flex PVC.

Tests with the flex PVC indicated a series of vacuum dips where as the ones without the flex PVC had only one major dip. The more rigid installations averaged only 0.16 Inch Seconds whereas the flexible PVC installations had a typical 6.29 Inch Seconds.

In general inground swimming pool installations would represent only the non flex condition since even if flex PVC were used it would be firmly held in place by concrete/gunite or the earth.

Typical of the flex graph is Test #16.
Typical of the non flex graph is Test #17.

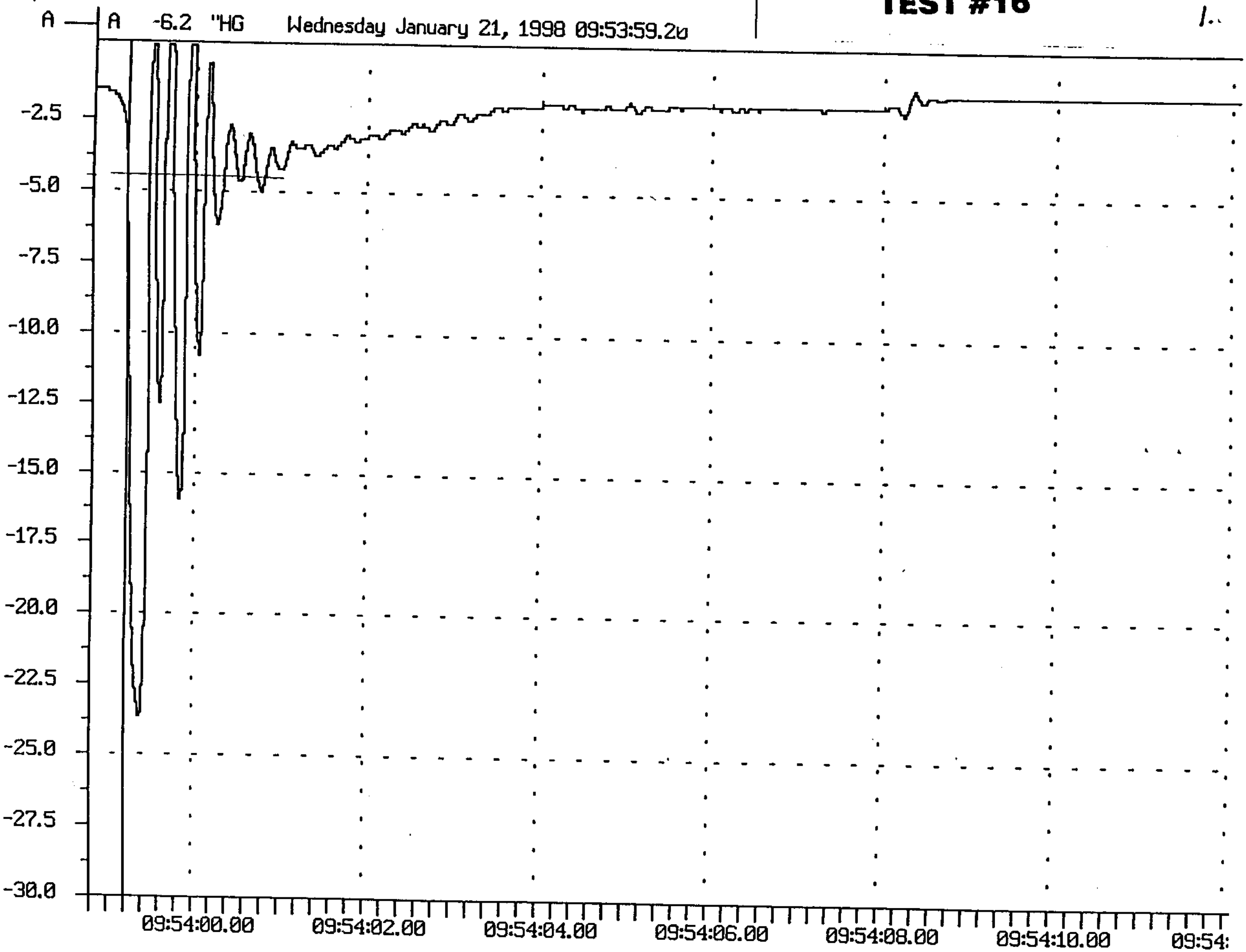
When the 3/4" Vent was located at a 56" depth flow rates could be increased ranging from 61.5 to 78 GPM.

The Inch Seconds differed only slightly between the flow rates (1% to 14%) however the difference between the #7 Main Drain (no flex) and the #6 Main Drain with flex showed the #6 Main Drain to have 296% more Inch Seconds.

This would indicate the necessity for rigid piping and fixtures in test work to produce field comparative results.

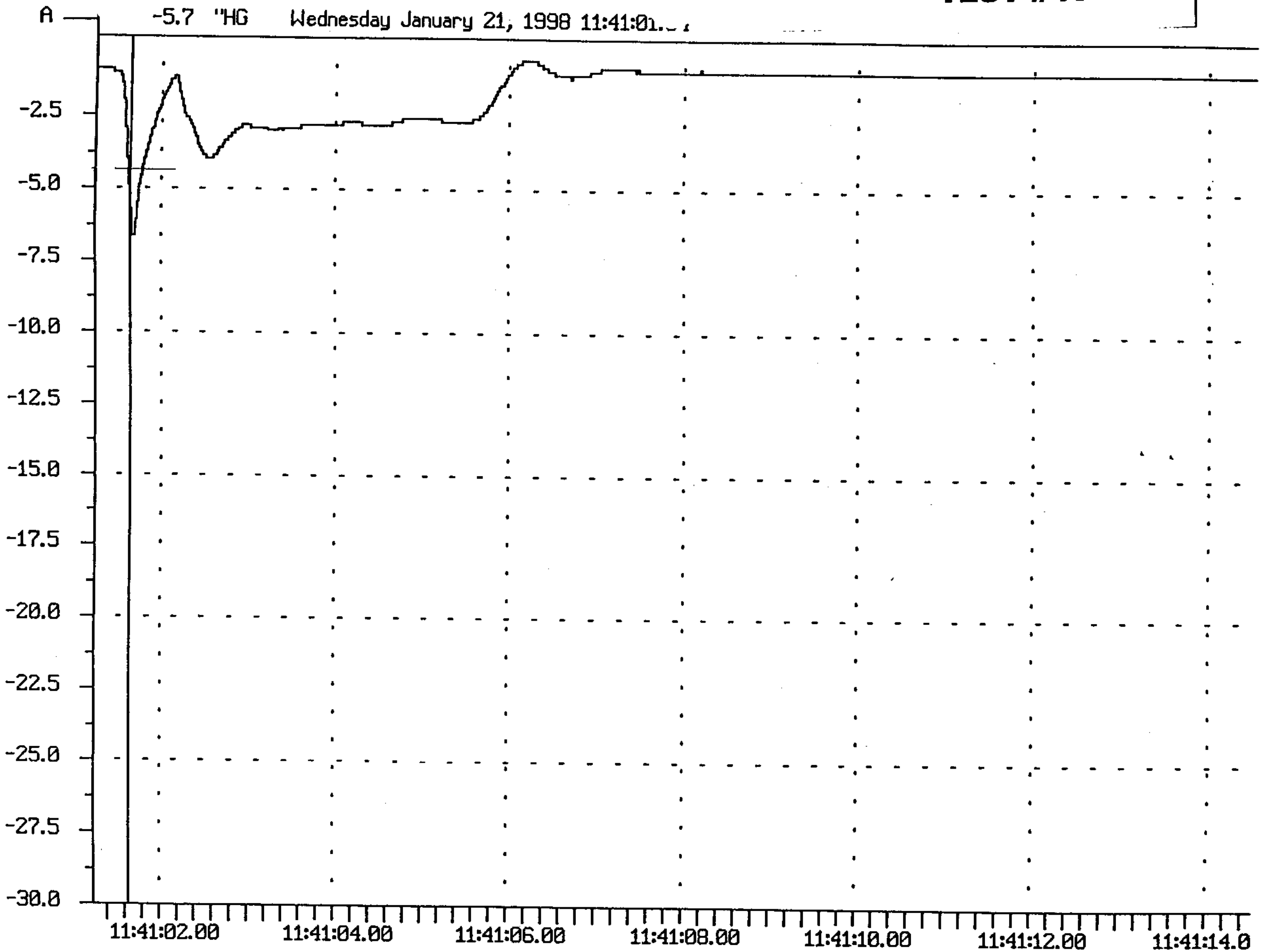
Typical graph of #6 Main Drain is Test #18.
Typical graph of #7 Main Drain is Test #19.

TEST #16



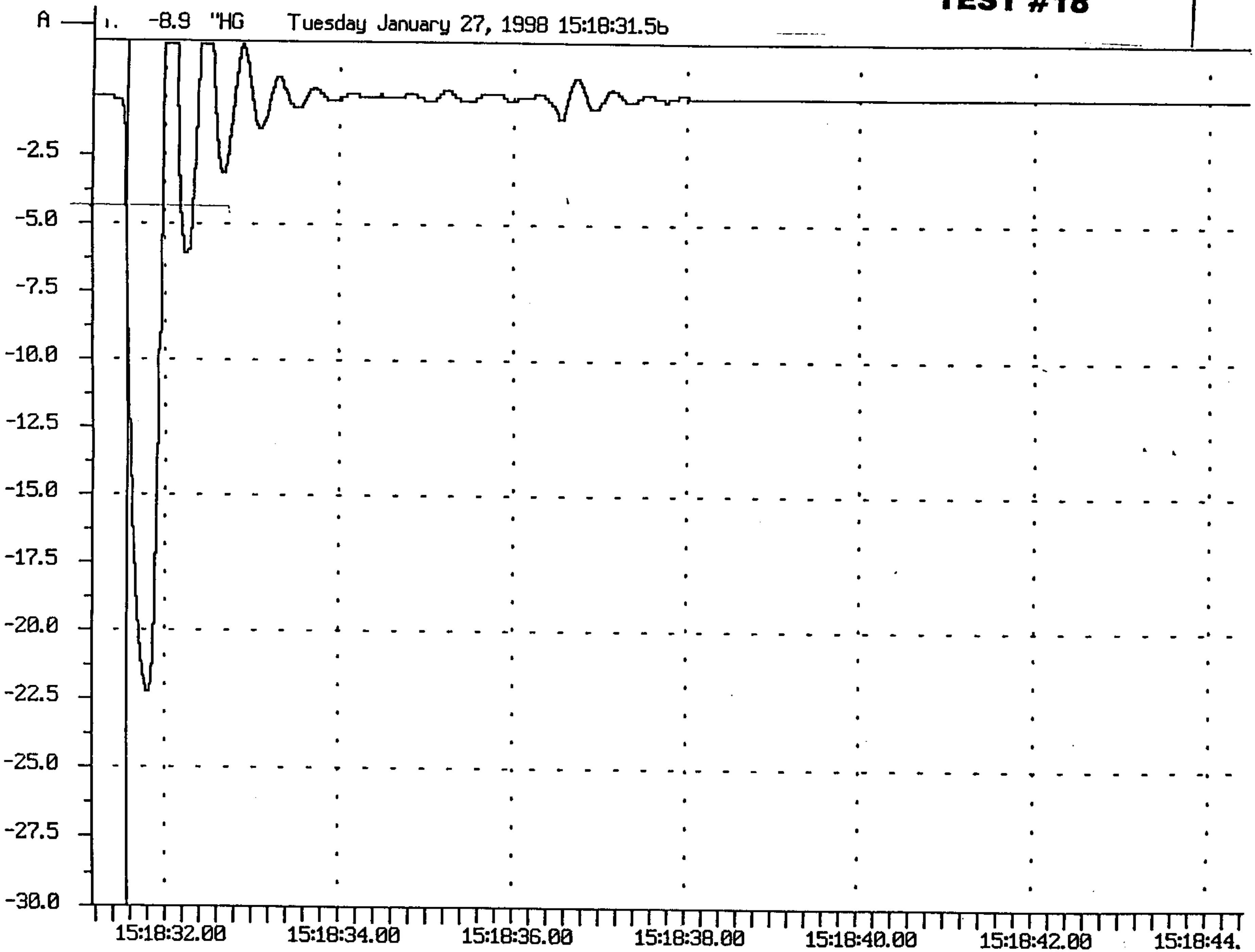
A
A -6.2 "HG Wednesday January 21, 1998 09:53:59.20
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
09:54:00.00
09:54:02.00
09:54:04.00
09:54:06.00
09:54:08.00
09:54:10.00
09:54:

TEST #17

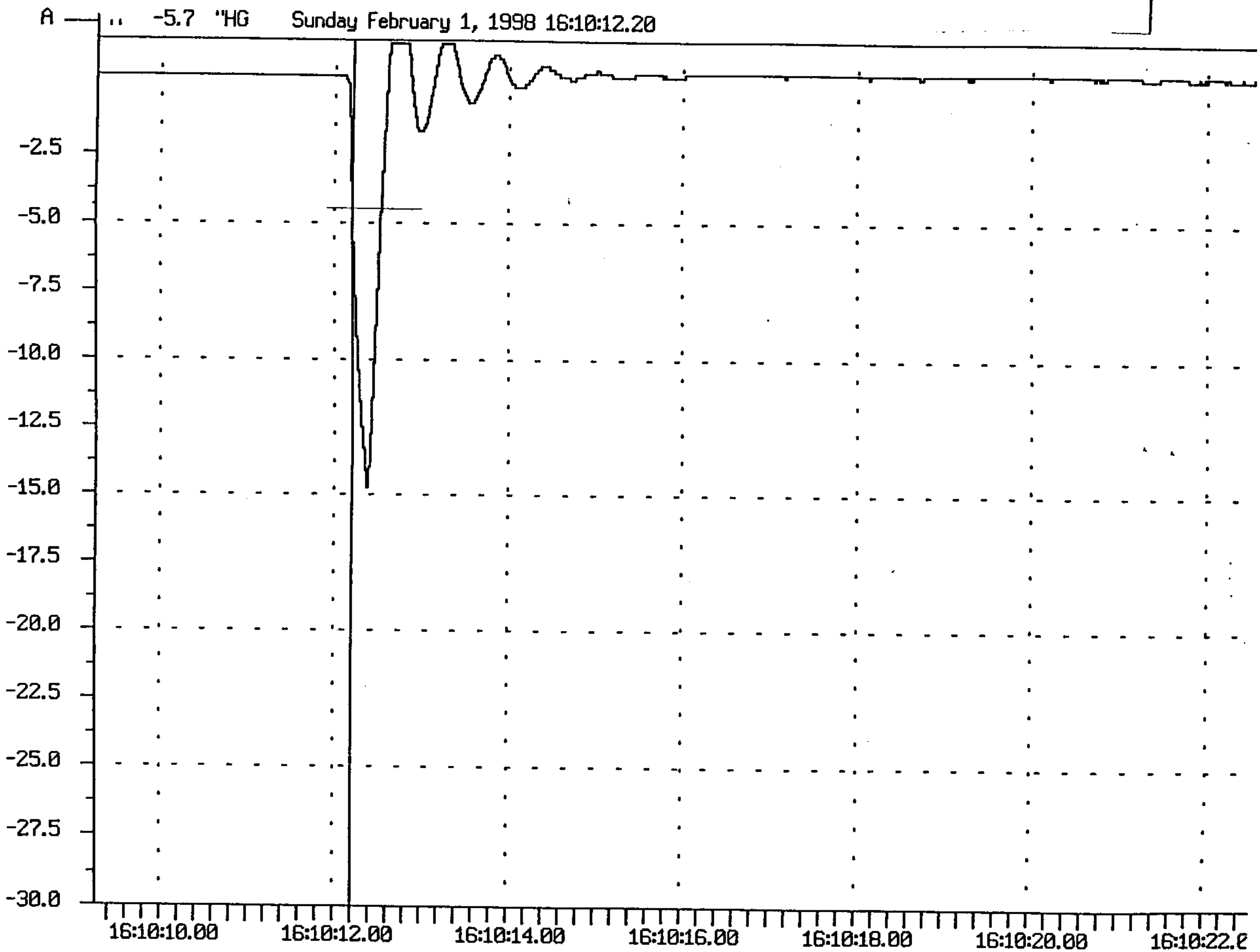


A
-5.7 "HG
Wednesday January 21, 1998 11:41:01
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
11:41:02.00
11:41:04.00
11:41:06.00
11:41:08.00
11:41:10.00
11:41:12.00
11:41:14.0

TEST #18


A
-8.9 "HG
Tuesday January 27, 1998 15:18:31.5b
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
15:18:32.00
15:18:34.00
15:18:36.00
15:18:38.00
15:18:40.00
15:18:42.00
15:18:44.

TEST #19


A
-5.7 "HG
Sunday February 1, 1998 16:10:12.20
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
16:10:10.00
16:10:12.00
16:10:14.00
16:10:16.00
16:10:18.00
16:10:20.00
16:10:22.0

Tests with a 2" Vent set at 56" and flow rates between 60 and 78 GPM indicated that the flexible piping to the #6 Main Drain as compared to the rigid #7 Main Drain showed an average of 3.40 Inch Seconds as compared to 1.52 Inch Seconds. Again showing the importance of rigid piping and fixtures to replicate field conditions.

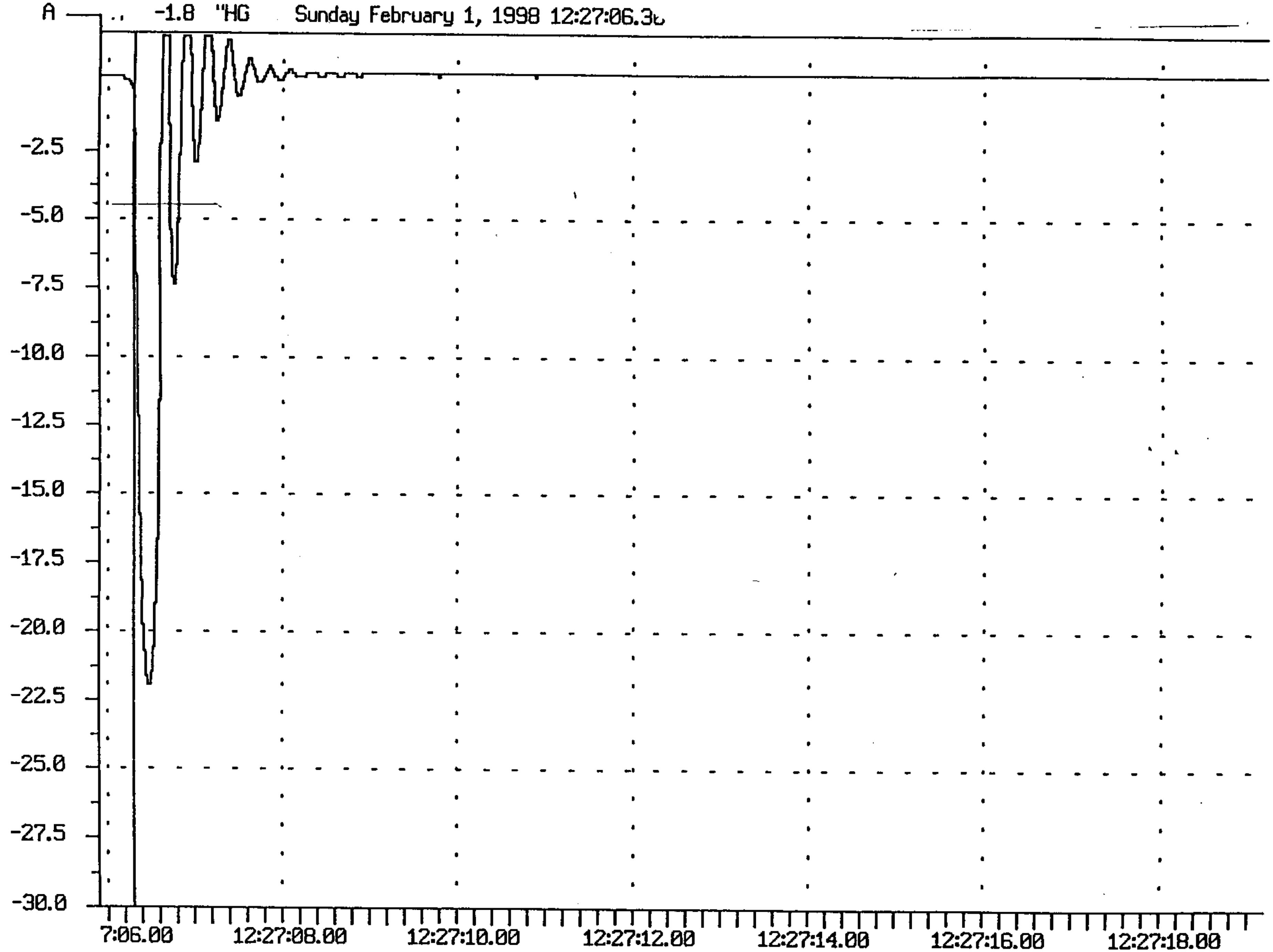
Typical graph of #6 Main Drain is Test #20.
Typical graph of #7 Main Drain is Test #21.

Further tests were run with a "Vacuum Eliminator". A device intended to remove from the contractor any real control over the design and installation of the "Vent". Pipe sizes and dimensions are captured in the unit so as to produce a consistent degree of protection. See Drawing A.

This device when flowed at 62 GPM produced an average of 1.58 Inch Seconds, and when attempted forced closure of the drain produced an average of 2.86 Inch Seconds - quite similar to the 2" Vent set at 56" depth.

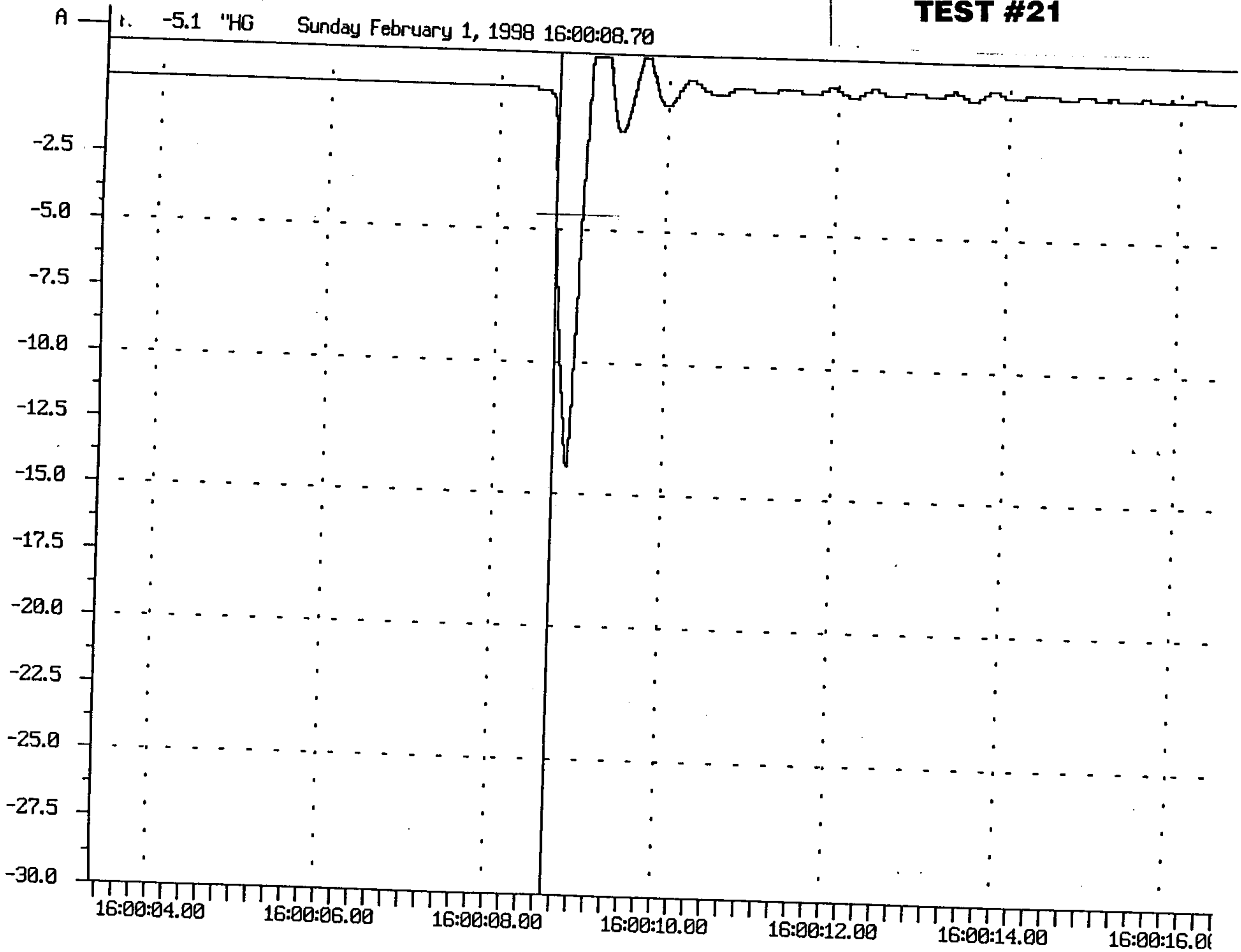
Typical graph of Vacuum Eliminator in Normal Mode is Test #22.
Typical graph of Vacuum Eliminator in Forced Mode is Test #23.

TEST #20



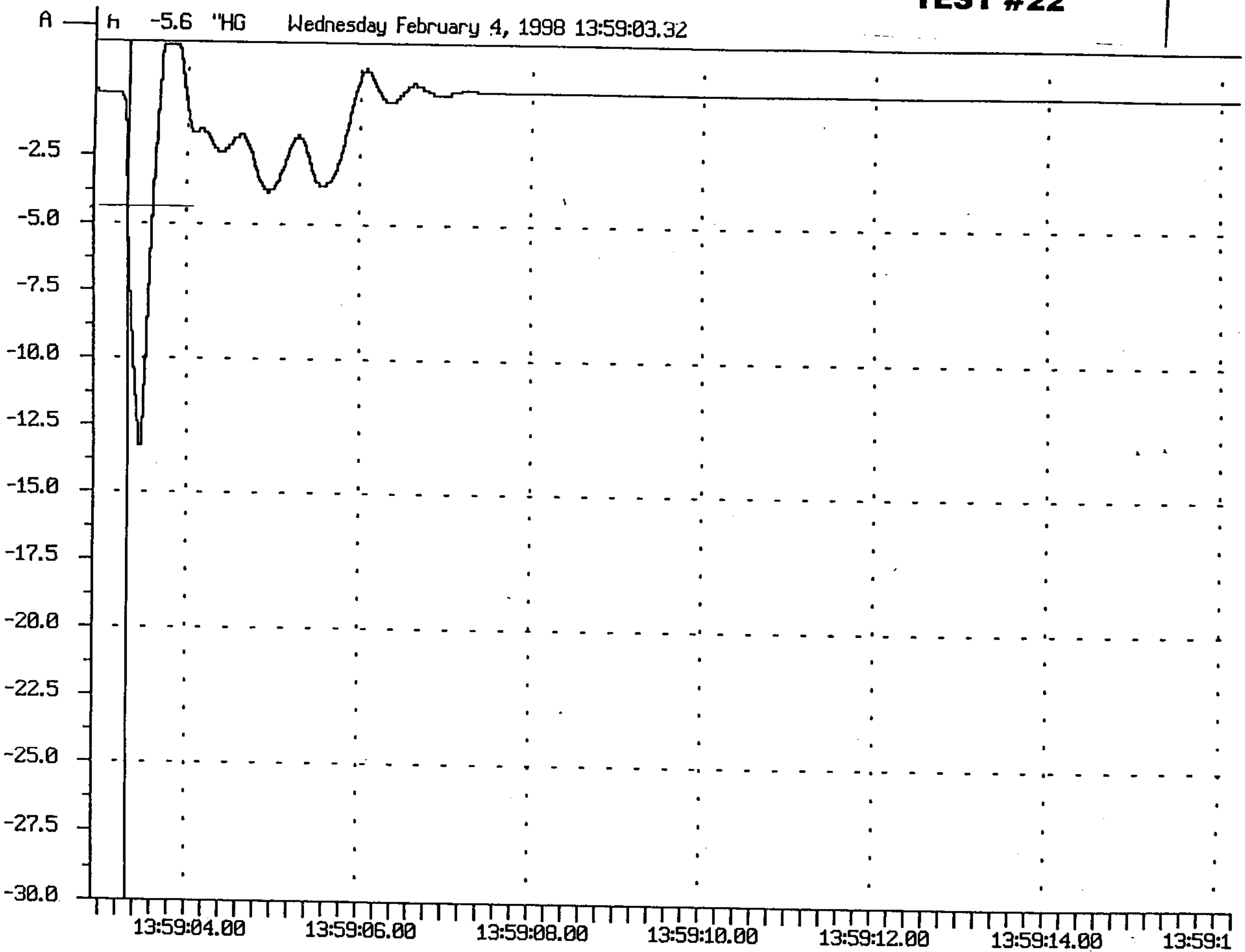
A
-1.8 "HG
Sunday February 1, 1998 12:27:06.3
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
7:06.00
12:27:08.00
12:27:10.00
12:27:12.00
12:27:14.00
12:27:16.00
12:27:18.00

TEST #21

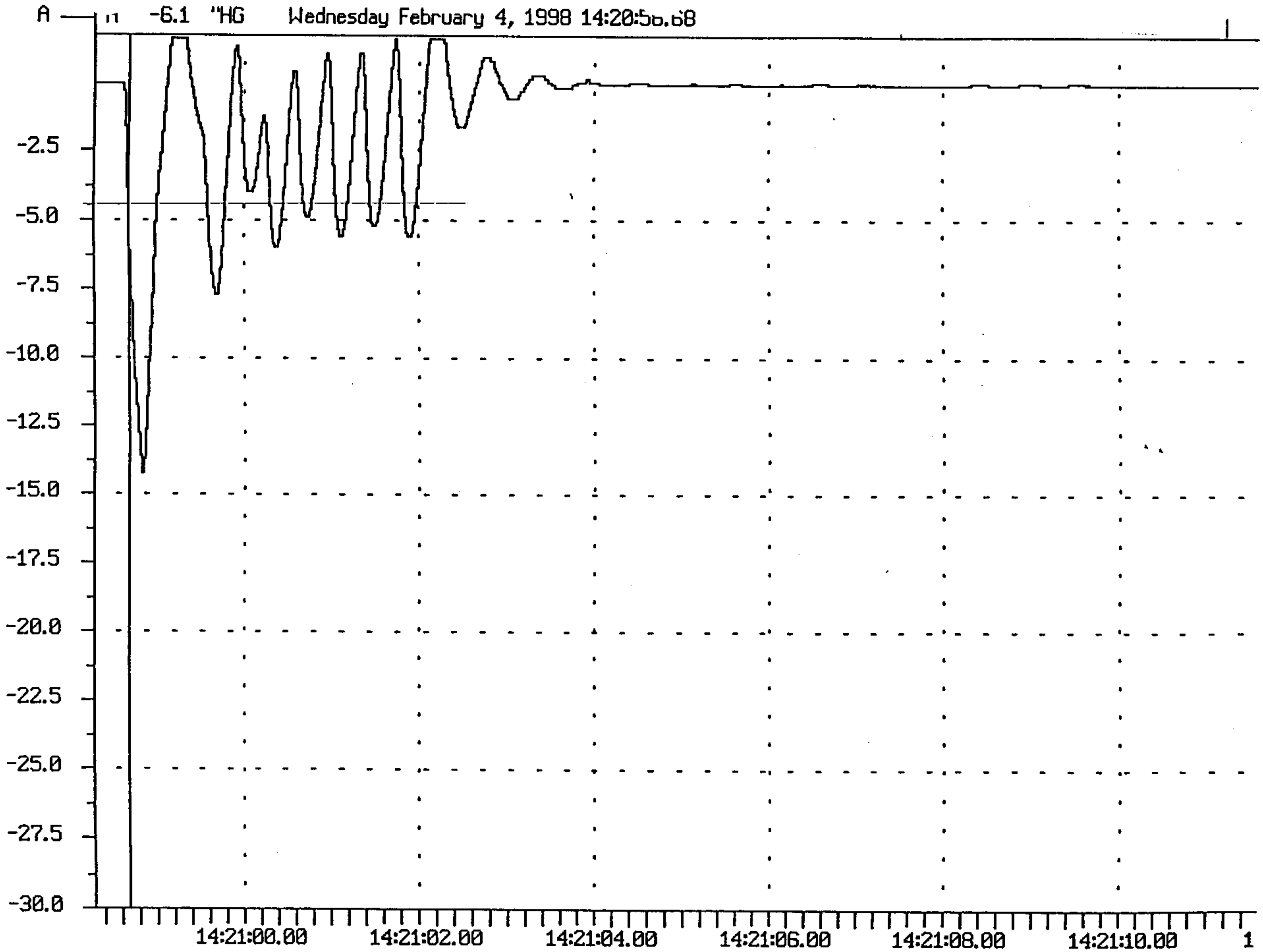


A
-5.1 "HG
Sunday February 1, 1998 16:00:08.70
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
16:00:04.00
16:00:06.00
16:00:08.00
16:00:10.00
16:00:12.00
16:00:14.00

TEST #22


A
h -5.6 "HG Wednesday February 4, 1998 13:59:03.32
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
13:59:04.00
13:59:06.00
13:59:08.00
13:59:10.00
13:59:12.00
13:59:14.00
13:59:1

TEST #23



A
-6.1 "HG Wednesday February 4, 1998 14:20:56.68
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0
-27.5
-30.0
14:21:00.00
14:21:02.00
14:21:04.00
14:21:06.00
14:21:08.00
14:21:10.00
1

SUMMARY OF RESULTS

#1 Main Drain	No Release
#2 Main Drain	No Release
#3 Main Drain	Occasional Bounce Release 13.1 Inch Seconds
#4 Main Drain	Occasional Bounce Release 70.81 Inch Seconds
#5 Main Drain	No Release
#6 Main Drain	Occasional Bounce Release 12.23 Inch Seconds
Dual Drains	Suction peaked at 5.9" Hg and leveled off between 2" and 3" Hg and averaged 0.15 Inch Seconds.
Mercury CutOff	Averaged 41.06 Inch Seconds
3/4" Vent @ 42"	
Rigid	0.16 Inch Seconds
Flex	6.29 Inch Seconds
3/4" Vent @ 56"	
Rigid	1.91 Inch Seconds
Flex	5.67 Inch Seconds
2" Vent @ 56"	
Rigid	1.52 Inch Seconds
Flex	3.40 Inch Seconds
Vacuum Eliminator	
Normal	1.58 Inch Seconds
Held	2.86 Inch Seconds

COMMENTS

It was determined that in order to record accurate suction pressures under the Main Drain Grate that the recording equipment be equalized to read zero when fully connected to the Sump before flow is started.

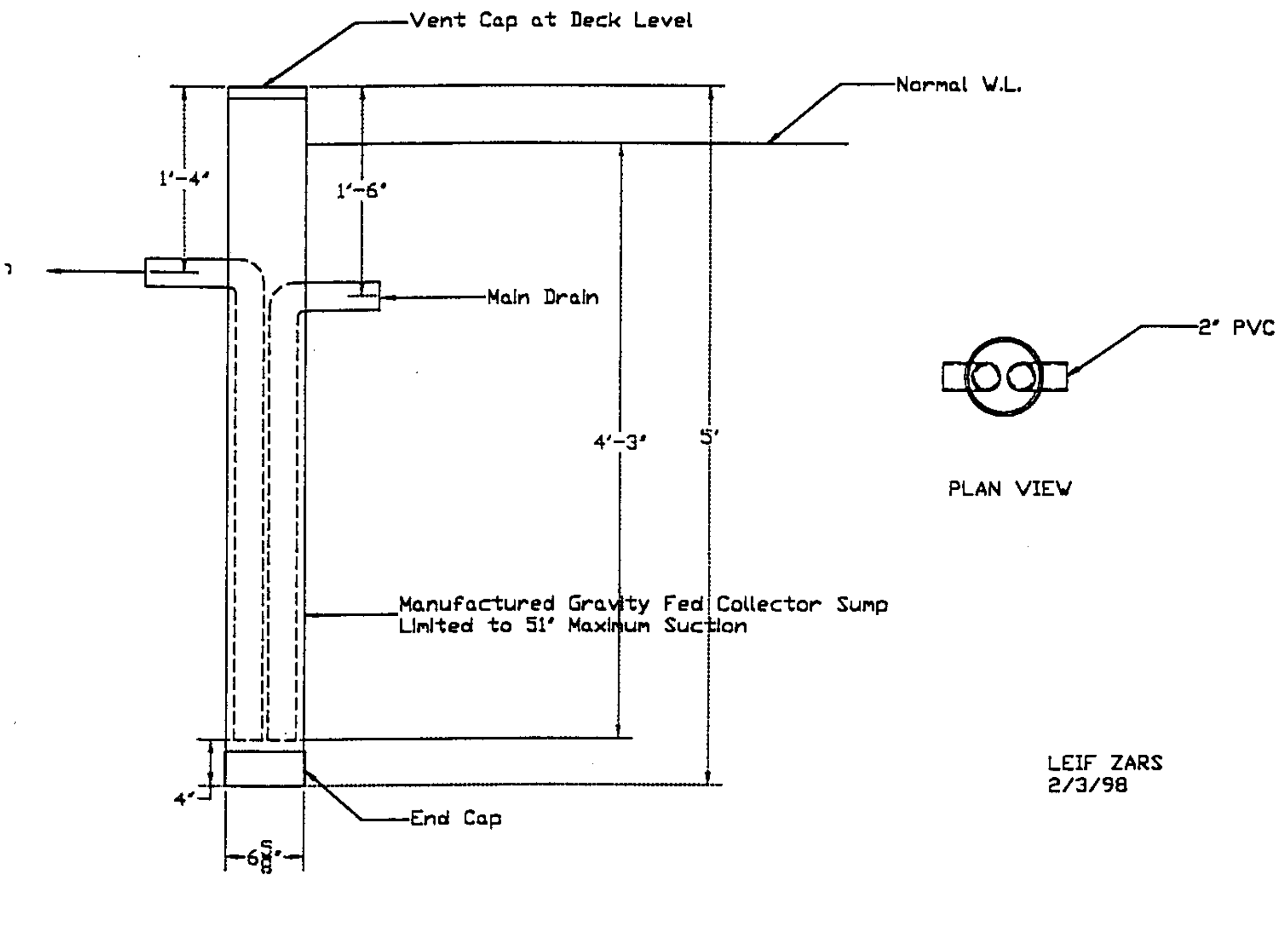
If a vacuum gauge alone is used to record this information it will not indicate the positive pressure head on the Main Drain from the water above it. It will merely carry a positive undisplayed pressure which must first be neutralized by a negative pressure equal to the height of the water over the recording point take off - thus rendering erroneous numbers by the feet of this head.

Sta-Rite AntiVortex Main Drain 7017-0741 rated at 60 GPM was not tested in as much as it's 100% side slot entry would preclude body coverage even with the film we used on some tests. Further, this work was not intended to evaluate Main Drains without covers in place.

A conversion chart from Ft. Head to "Hg to PSI is included for convenience in this report.

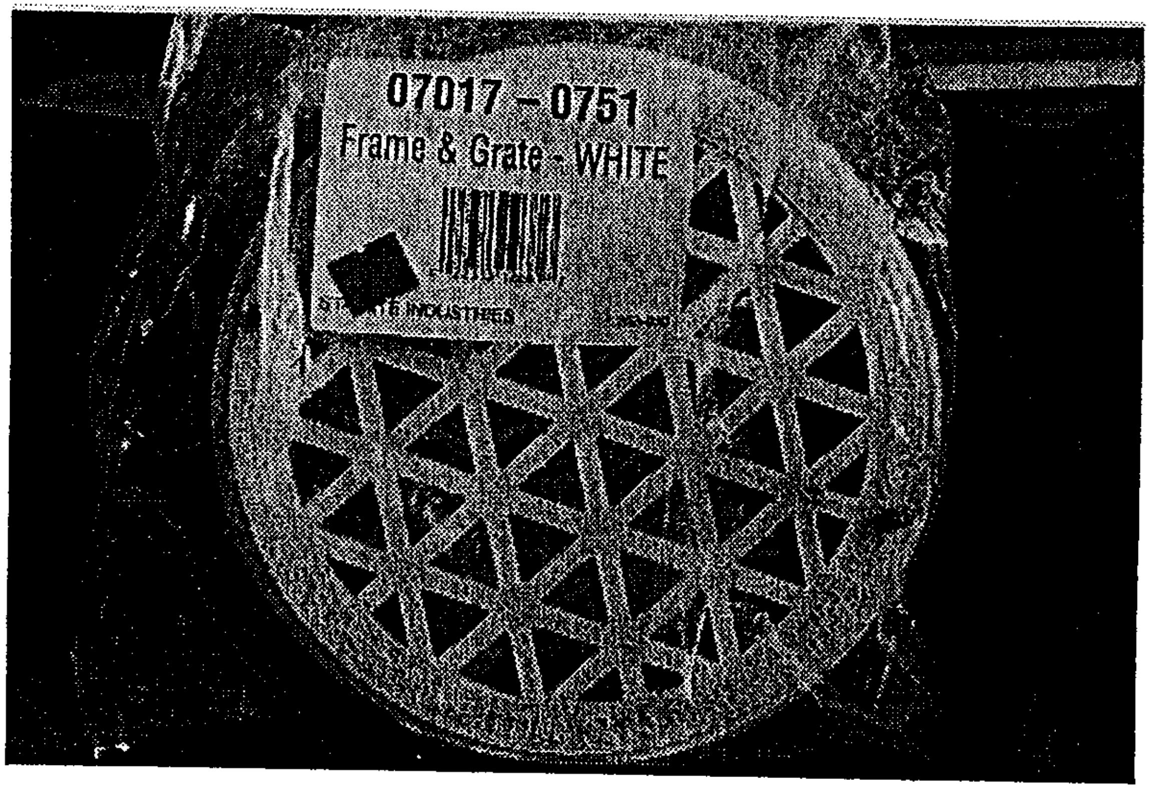
A slightly revised copy of my earlier report on "SWIMMING POOL SUCTION HAZARDS" is also included in this report.

DRAWING A

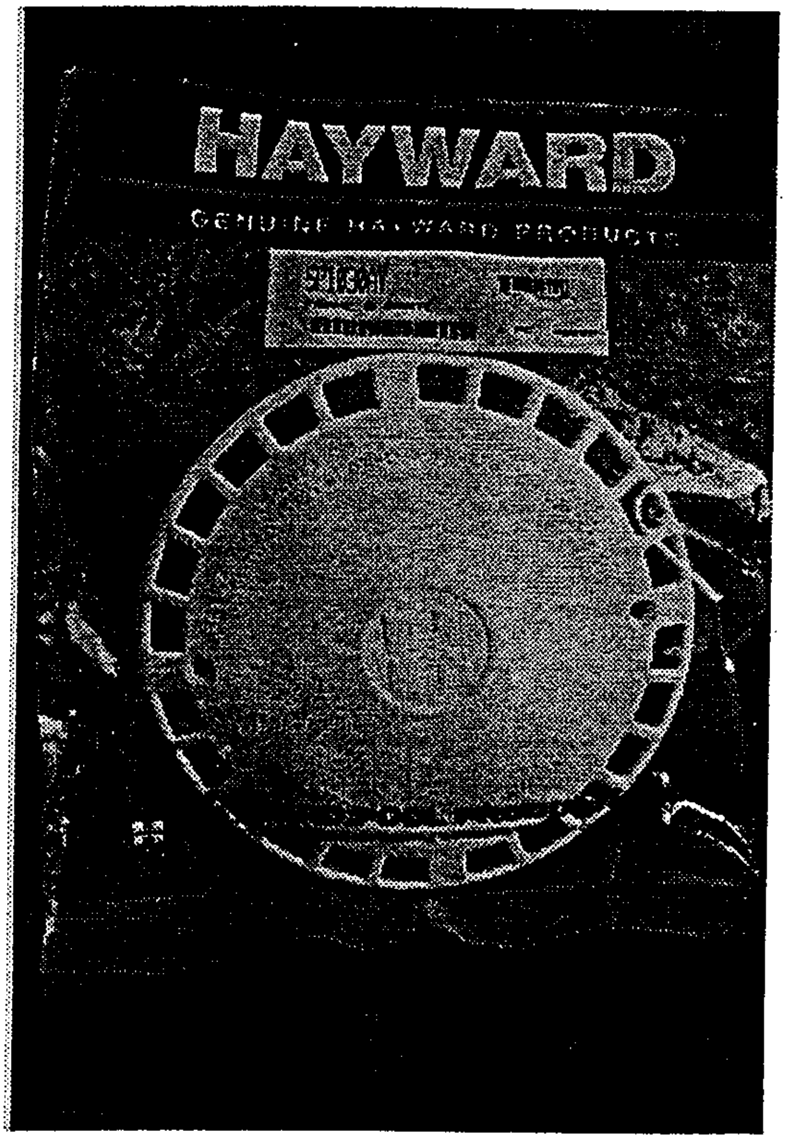


LEIF ZARS
2/3/98

"VACUUM ELIMINATOR"
TM

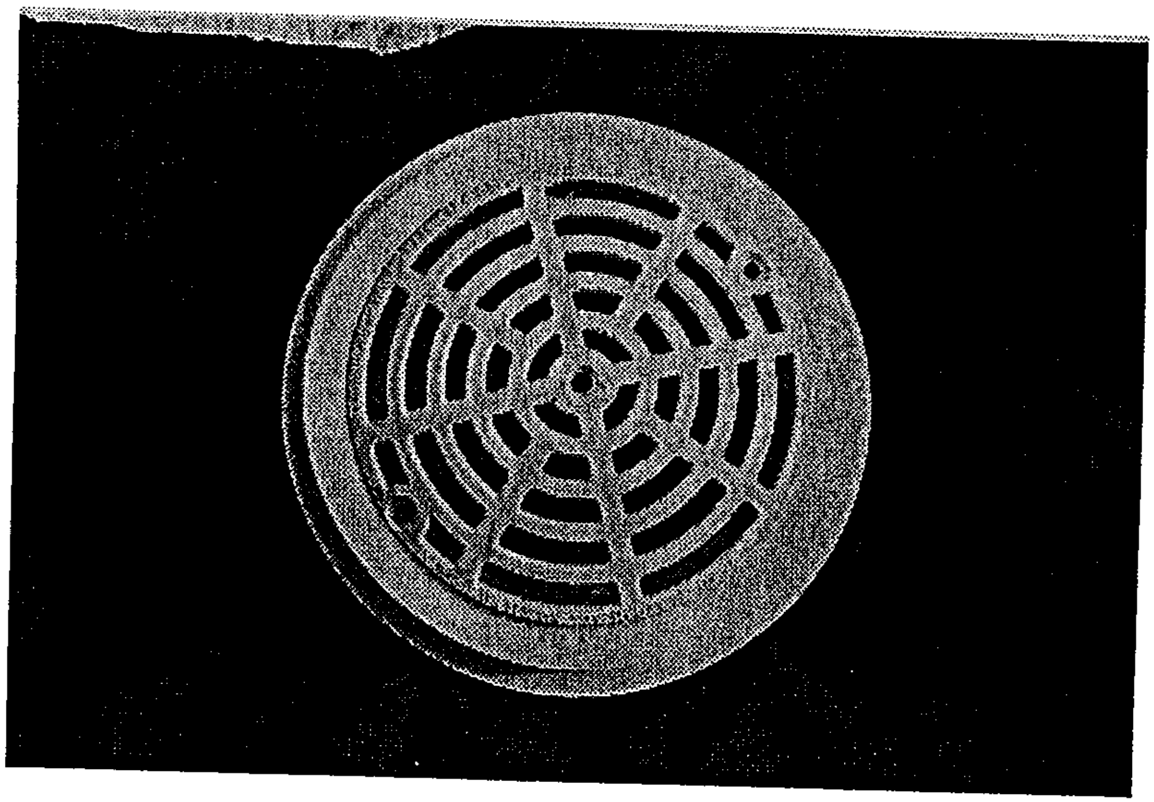


#1 MAIN DRAIN

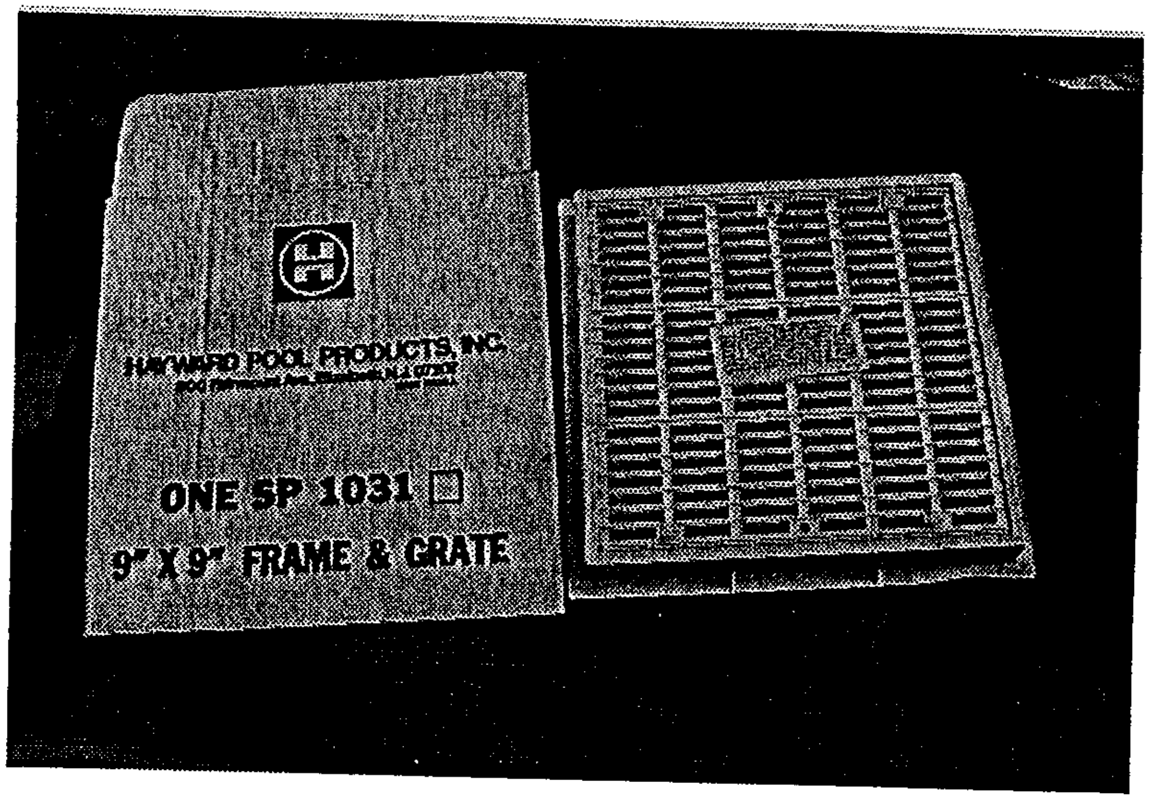


#2 MAIN DRAIN

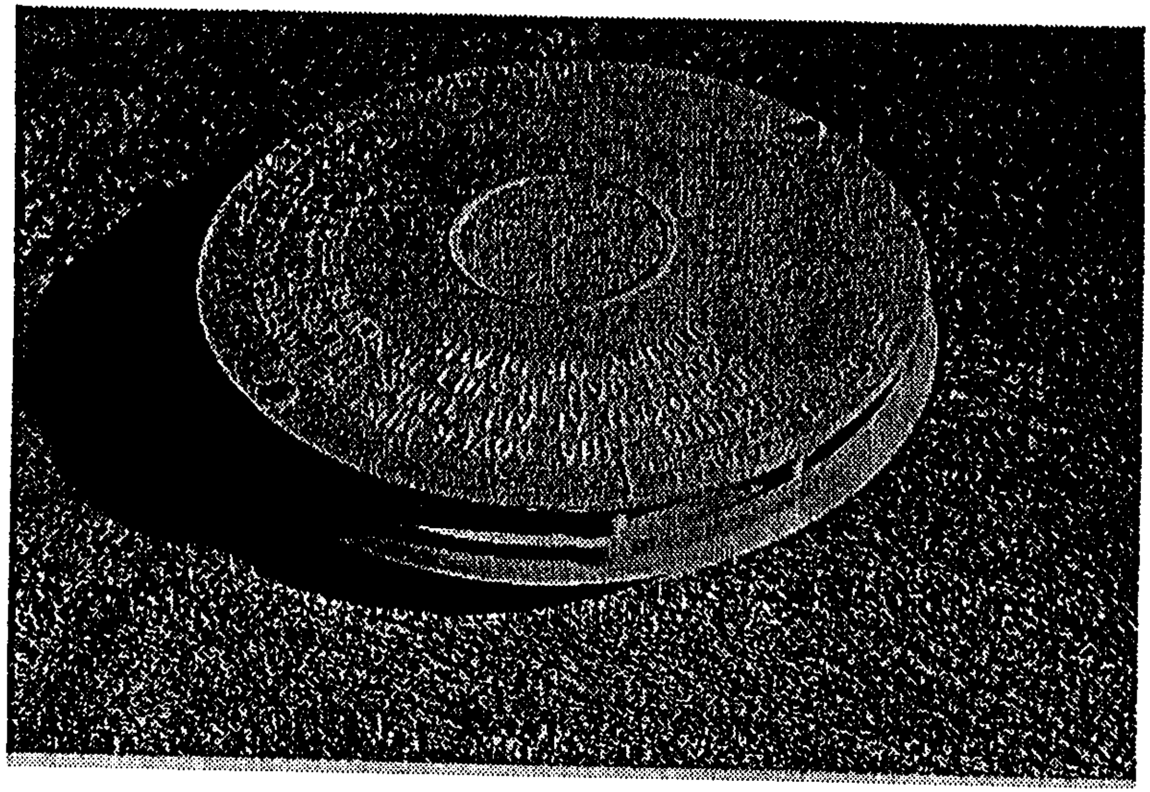
#3 MAIN DRAIN



#4 MAIN DRAIN

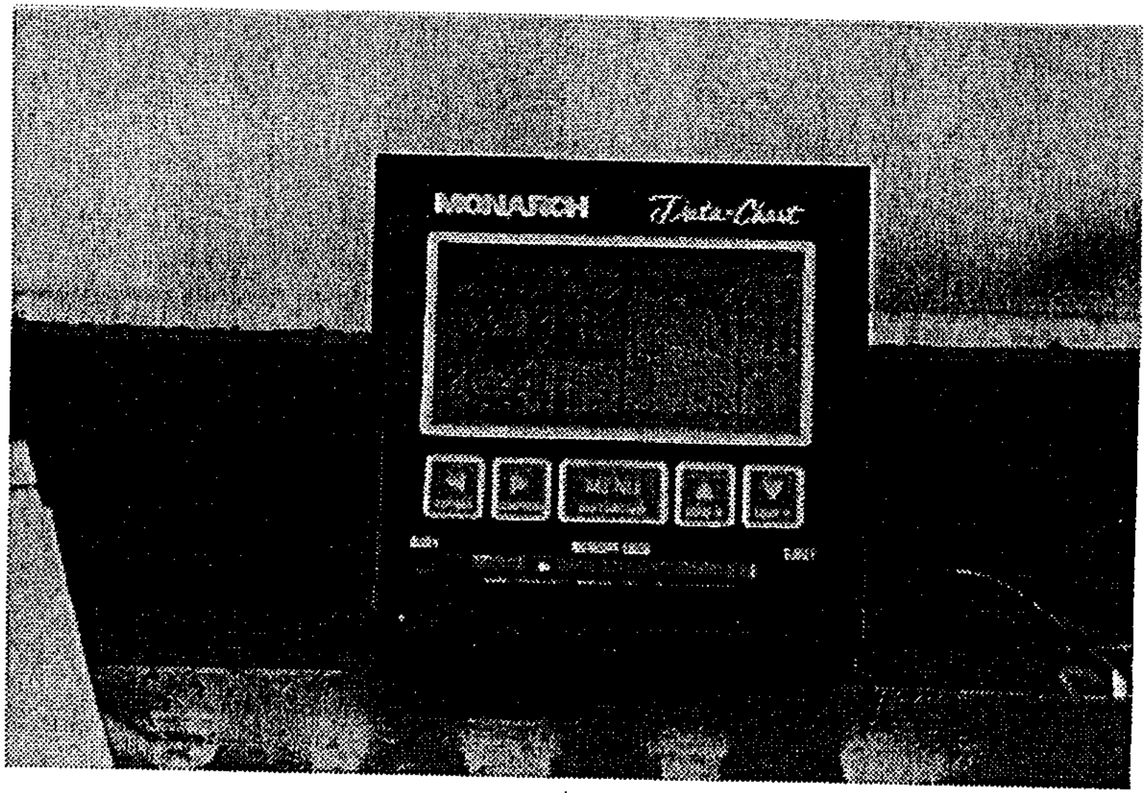


#5 MAIN DRAIN

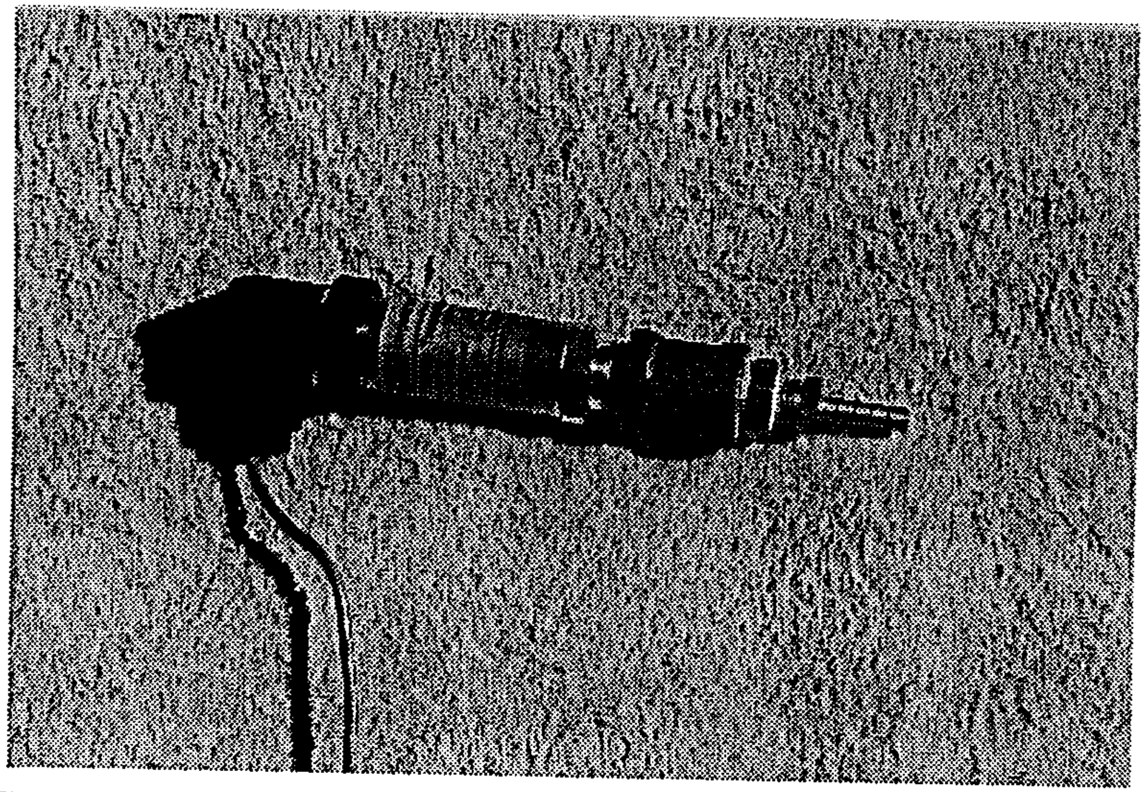


STA-RITE ANTI VORTEX MAIN DRAIN 07017-0741

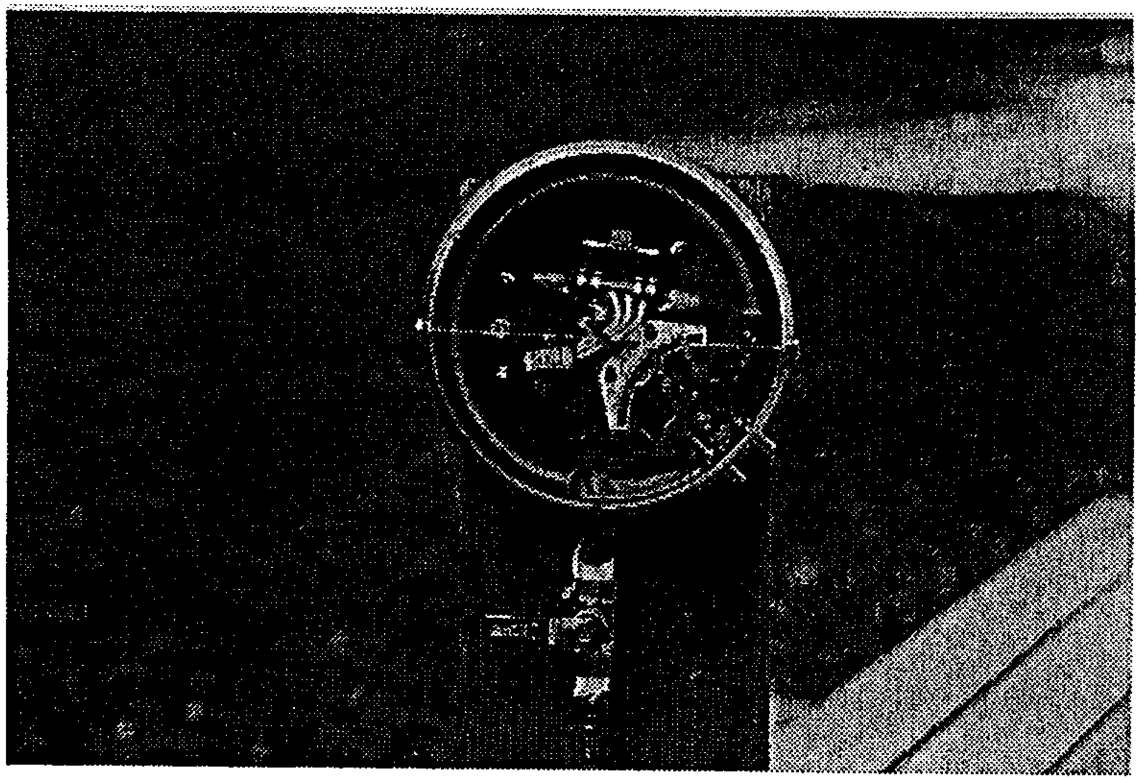
DYNASONICS ULTRASONIC FLOW METER



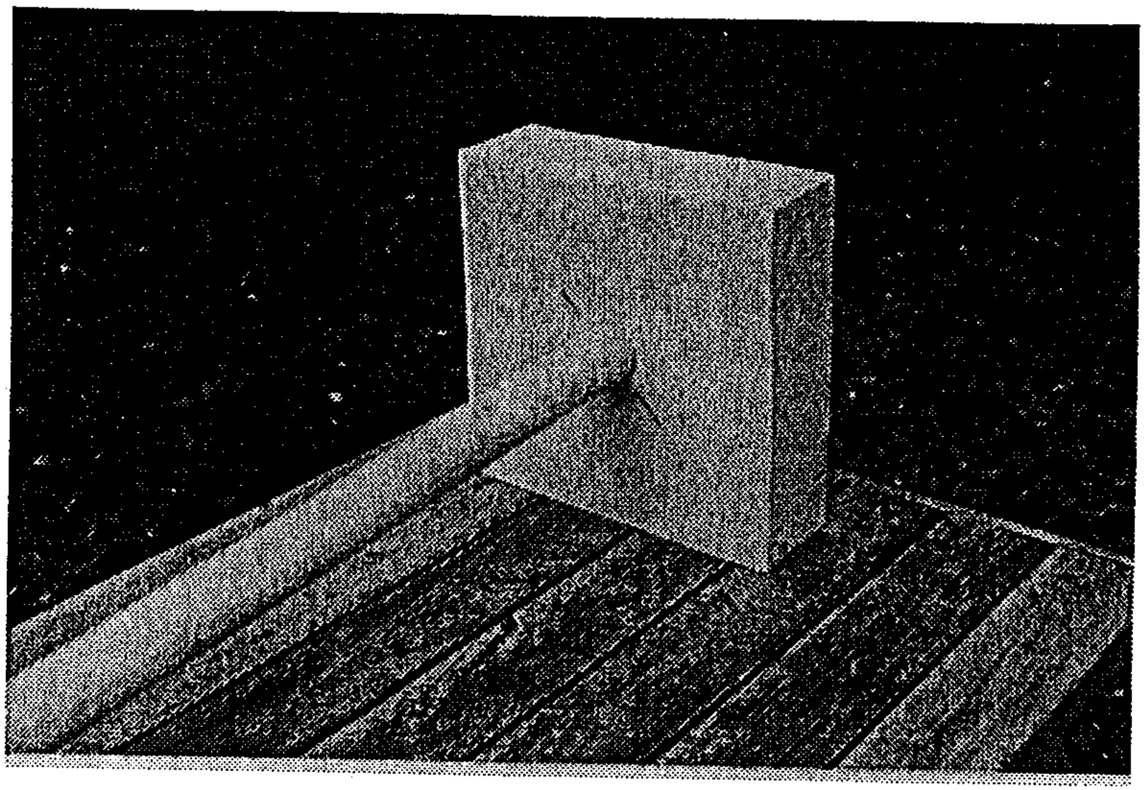
MONARCH PAPERLESS DATA RECORDER



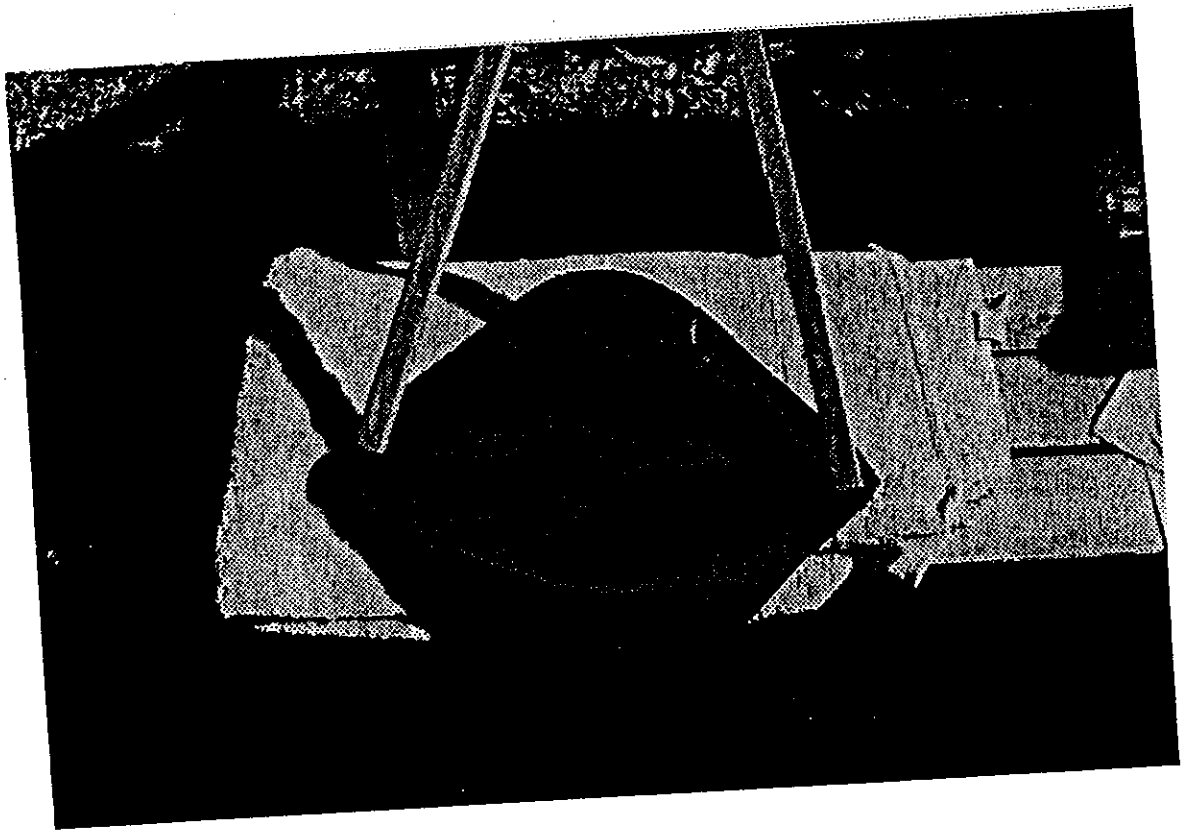
WIKA TRONIC PRESSURE TRANSMITTER



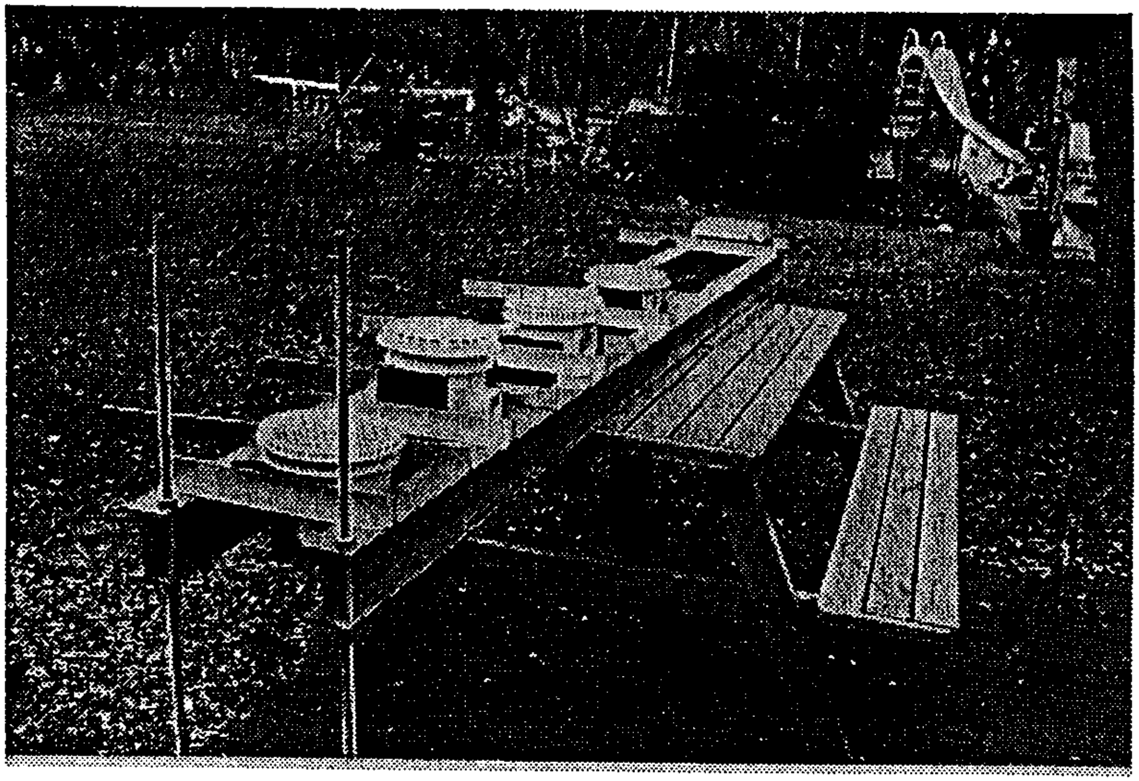
MERCOID PRESSURE CONTROL



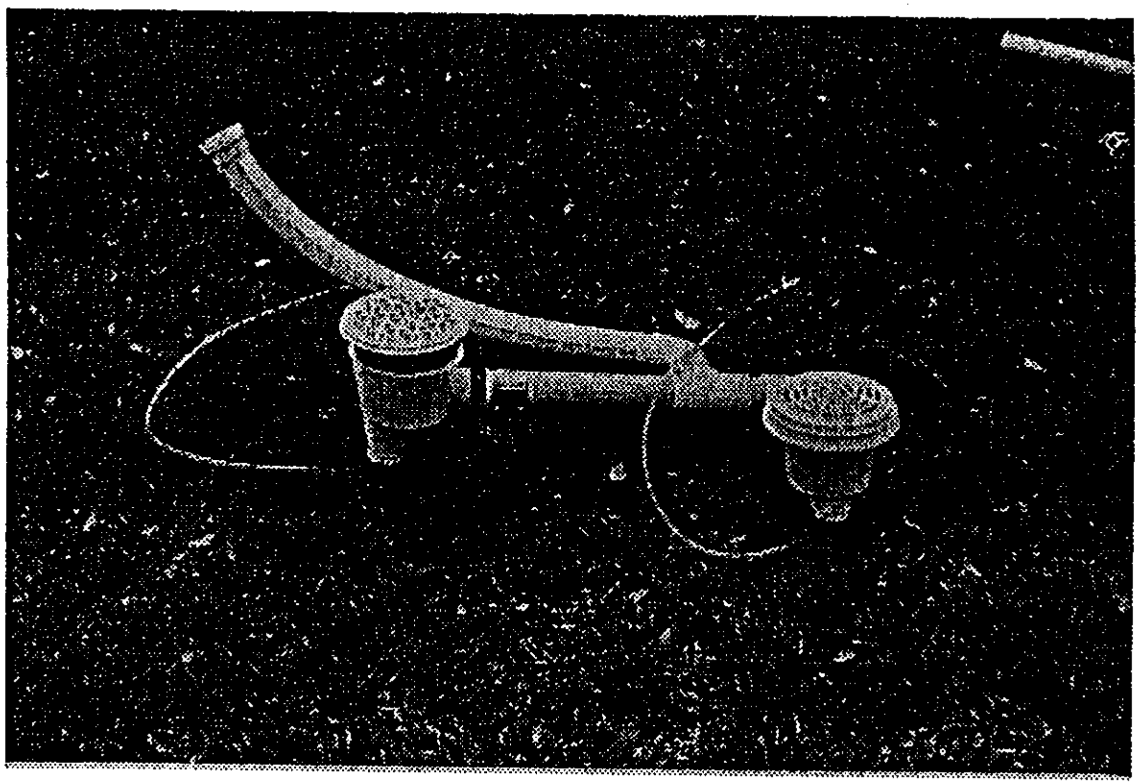
12" X 12" FOAM BLOCK



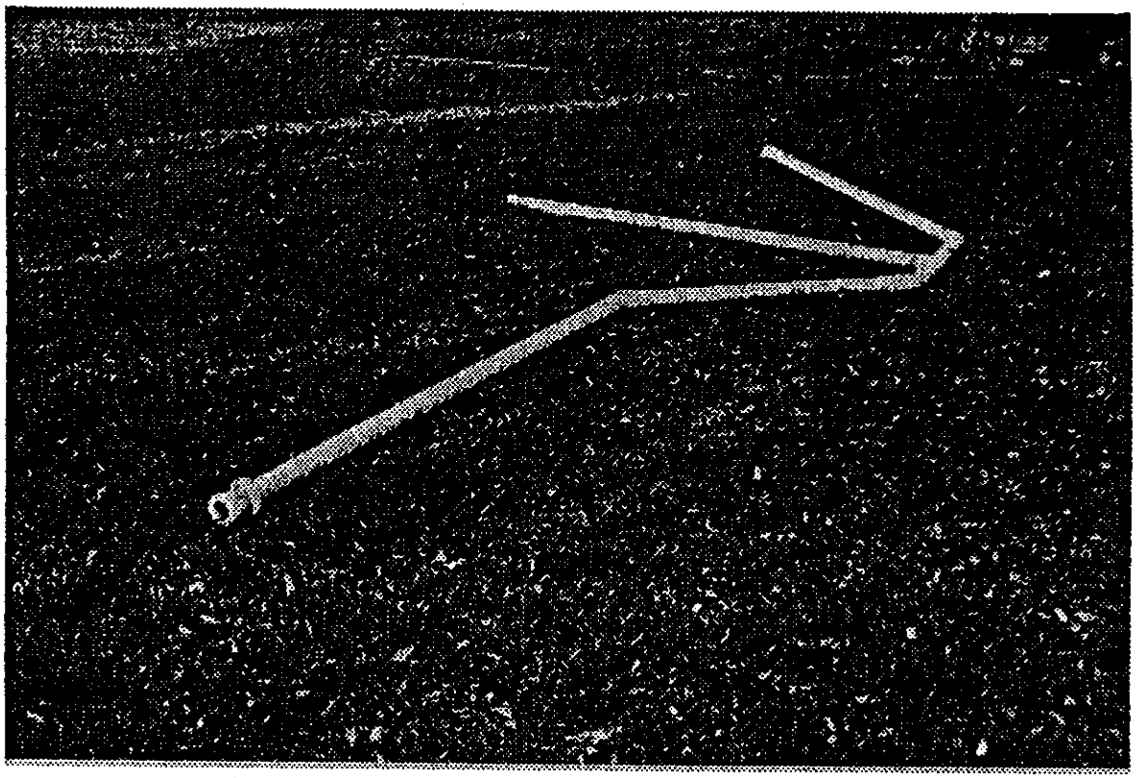
20 MIL REINFORCED FILM



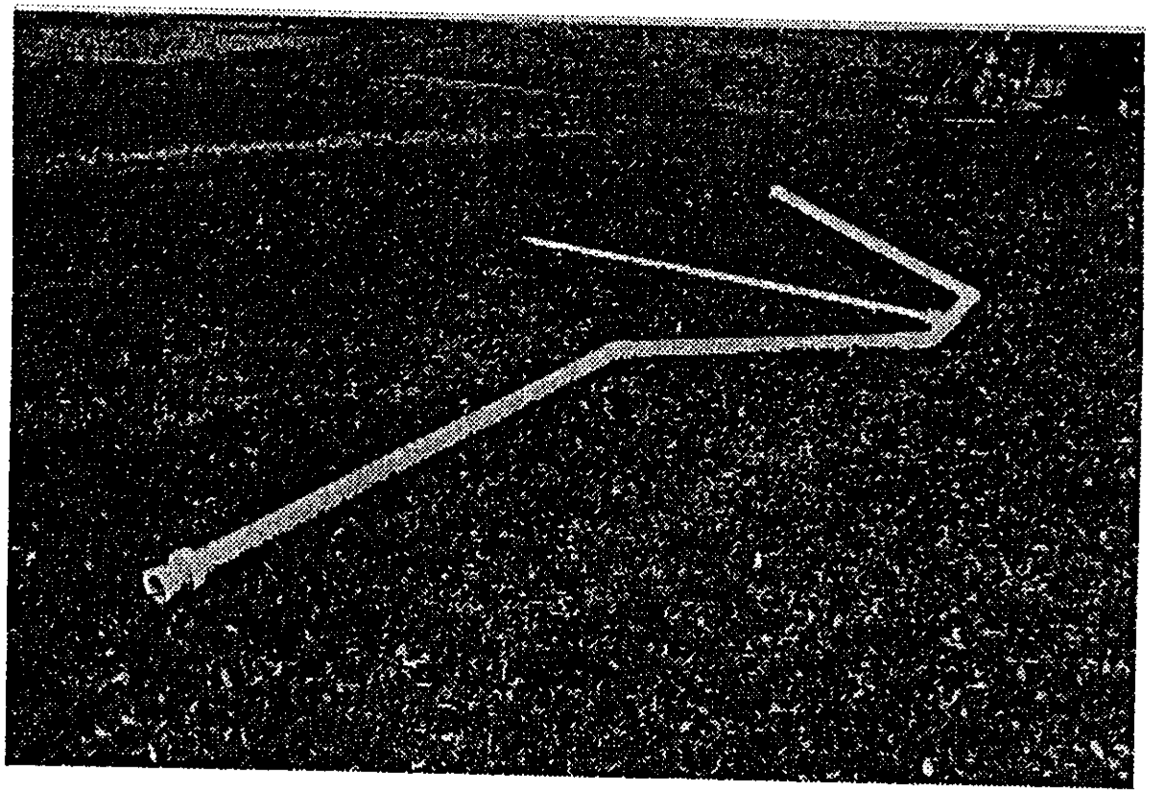
TEST BLOCK



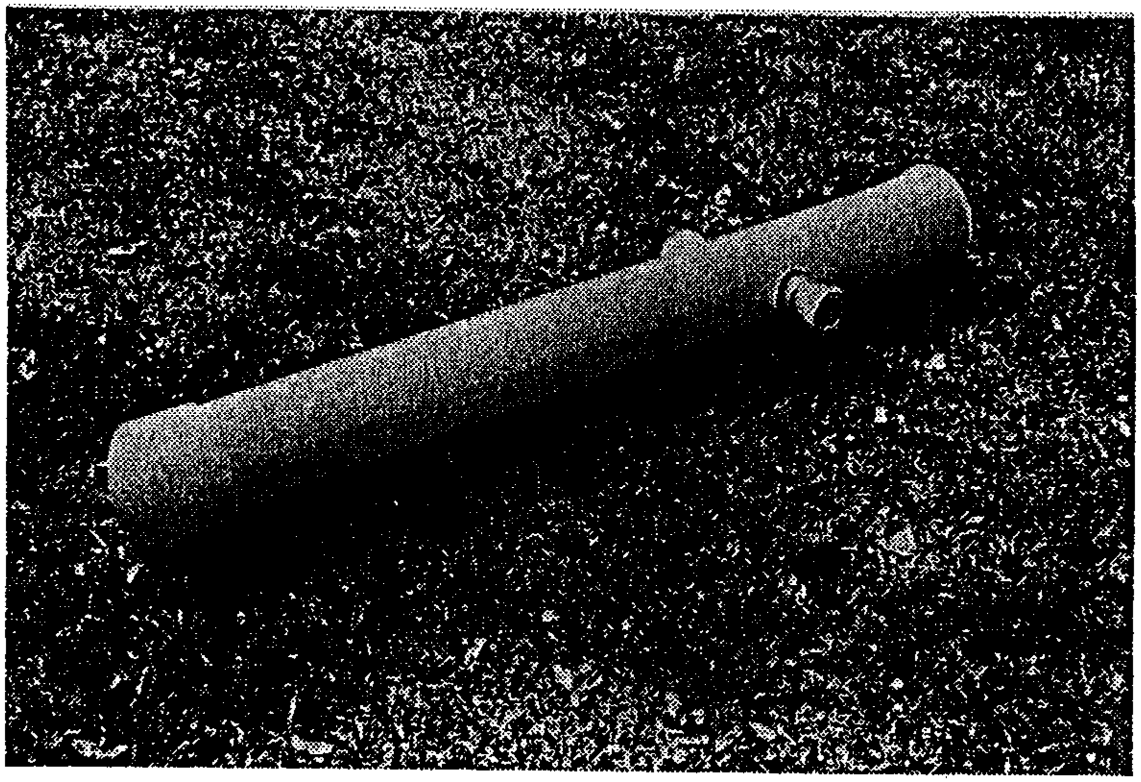
DUAL MAIN DRAINS



2" SUCTION LIMITING LOOP



3/4" SUCTION LIMITING LOOP



VACUUM ELIMINATOR

INCHESH

Atmosphe	PSI	In Hg	Ft Head
1	14.7	29.92	33.93

PSI	In Hg	Ft Head
1	2.04	2.31
2	4.07	4.62
3	6.11	6.92
4	8.14	9.23
5	10.18	11.54
6	12.21	13.85
7	14.25	16.16
8	16.28	18.47
9	18.32	20.77
10	20.35	23.08
11	22.39	25.39
12	24.42	27.70
13	26.46	30.01
14	28.50	32.31
15	30.53	34.62
2.2	4.48	5.08

Ft Head	In Hg	PSI
1	0.88	0.43
2	1.76	0.87
3	2.65	1.30
4	3.53	1.73
5	4.41	2.17
6	5.29	2.60
7	6.17	3.03
8	7.05	3.47
9	7.94	3.90
10	8.82	4.33
11	9.70	4.77
12	10.58	5.20
13	11.46	5.63
14	12.35	6.07
15	13.23	6.50
16	14.11	6.93
17	14.99	7.37
18	15.87	7.80
19	16.75	8.23
20	17.64	8.66
21	18.52	9.10
22	19.40	9.53
23	20.28	9.96
24	21.16	10.40
25	22.05	10.83
26	22.93	11.26
27	23.81	11.70
28	24.69	12.13
29	25.57	12.56
30	26.45	13.00
31	27.34	13.43
32	28.22	13.86
33	29.10	14.30
34	29.98	14.73

In Hg	Ft Head	PSI
1	1.13	0.49
2	2.27	0.98
3	3.40	1.47
4	4.54	1.97
5	5.67	2.46
6	6.80	2.95
7	7.94	3.44
8	9.07	3.93
9	10.21	4.42
10	11.34	4.91
11	12.47	5.40
12	13.61	5.90
13	14.74	6.39
14	15.88	6.88
15	17.01	7.37
16	18.14	7.86
17	19.28	8.35
18	20.41	8.84
19	21.55	9.33
20	22.68	9.83
21	23.81	10.32
22	24.95	10.81
23	26.08	11.30
24	27.22	11.79
25	28.35	12.28
26	29.48	12.77
27	30.62	13.27
28	31.75	13.76
29	32.89	14.25
30	34.02	14.74

A REPORT ON
REDUCTION TO

SWIMMING POOL SUCTION HAZARDS

BY

LEIF ZARS

The objective is to avoid 1)Suction disembowelment, 2) Suction entrapment, and 3) Underwater hair entanglement. The procedure I have is regarding the first two - although it could have a significant impact on the third.

It has been stated that a 2.2 pounds per square inch pressure is needed to cause disembowelment. This is equivalent to a 5.08 foot suction head, (most systems when primed and running will develop up to a 32 foot suction head when blinded off), or 4.48 in Hg. This proposed system is totally non-mechanical, relies upon the basic laws of physics, and is intended to keep this suction head at or below 4.3 feet.

NSPI codes (as do most other codes) limit suction flow velocities to 6 feet per second in public and semi public pools, and 8 feet per second * in residential pools. PVC pipe due to its smooth interior surfaces will flow at these velocities with very little actual head.

This limitation gives the maximum allowable flow through the various Schedule 40 PVC pipe sizes as shown in Col. A and B below.

Next let me state that for the below pipe sizes, the friction head loss for 100 feet of pipe when flowing at 6 feet per second is shown in Col. B below:

Pipe Size	Col A GPM	Col B GPM*	Col C Ft.Head	Col D Ft Head*	Col E Ft.Pipe	Col F Total Head	Col G Total Head*	Col H Air Pipe Size
1 1/2"	38	51	8.14	13.86	20	2.3	4.0	1 1/2
2"	63	84	6.08	10.36	30	2.5	4.3	2
2 1/2"	90	119	4.95	8.42	30	2.2	3.8	2 1/2
3"	138	184	3.84	6.54	30	2.1	3.5	3
4"	238		2.80		75	2.8		4
6"	540		1.74		75	2.0		6
8"	936		1.26		100	2.0		8

Col. E above shows some typical possible Main Drain pipe footages, including 90s etc. from the main drain sump to pool edge.

Col. F & G above shows the resultant pipe head loss due to this footage, plus a 0.7 ft. head loss through the drain opening for 6 feet per second, and 1.23 ft. for 8 feet per second. For example the 3" pipe with 50 feet of length would flow with a head loss ofonly one half of the 100 foot head loss - or 1.92 Ft. of head loss, again plus the 0.7 ft. head loss due to the drain opening.

What this shows is that with normal Main Drain pipe runs, a limited suction of from 2.0 feet to 4.3 feet (Col. F & G) would produce a flow in the corresponding pipe size that would reach its maximum allowable flow rate of 6 or 8 feet per second.

Keeping the above 2.0 foot to 4.3 foot water heights in mind, and the previously stated 5 foot maximum suction head, we can see that if we somehow limit the suction head to say 4.3 feet (reasonably below the 5 feet) that we could enjoy the full rated pipe flows and still stay below dangerous suction heads.

So the first realization is that we do not have to place excessive suction on swimming pool piping to effectively gain their rated allowable flow rates.

The next portion of this is of course how to effectively and safely limit this suction head. A Suction Limiting Loop as shown on the attached drawings would accomplish this without the aid of mechanical devices or expensive retrofits.

Going through the drawings, we can see the development of the Suction Limiting concept using a 42 inch water head.

Drawing "A" shows the "attainable" gravity flow rate into an open container, whereupon it is sucked up by the pump. Attainable is more or less the above figures in Col. A, (or more, as the height of water is increased).

Drawing "B" merely begins to close the open container.

Drawing "C" shows the effect of the larger pipe bringing in more water than the pump is removing.

Drawing "D" moves the pump suction to the side and removes the unnecessary lower tank.

Drawing "E" shows the reduction of the main drain line size and its effect on the water level in the "tank".

Drawing "F" removes the unnecessarily wide upper portion of the "tank", but still leaves it exposed to the atmosphere.

From here it becomes evident that if the pump were to suck more it would draw the "sump" empty thus allowing air to enter the suction line. The basic theory of hydraulics will state that up to this point and once that this happens, the maximum suction possible on the main drain is three and one half feet of water head, none of it caused by pump suction, but rather by gravity alone - just as in diagram A above.

We can completely control this maximum suction head as shown in drawing "J" where we have designed to allow a 5 foot 6 inch suction head (for example only) and drawing "L" where we have limited the suction head to one foot.

The long and the short of the design and installation of a Suction Limiting Loop are as follows:

1. Keep the loop close to where the main drain emerges from the pool so as to reduce the gravity fed portion of this pipe. From the loop on to the pump, it is of course under full available pump suction and can therefore handle current runs.

2. Calculate the pipe distance including the effect of 90s etc. (1 2" 90 is equal to 6' of pipe for example). Then by putting your pipe footage into Col. E above, recalculate Col. F or G, adding 0.7 oe 1.23 ft. of head for the drain opening and insure that you do not exceed a 4.3 head. For example, 50 feet of 2" pipe would give a 3.1 foot head loss (50/100x6.08), plus the 0.7 ft. head loss from the drain gives a total of 3.8 foot head loss.

3. For retrofit work the typical loops in drawings "G, H, & I" are suggested. They are designed so as to not exceed a 3'6" suction head.

4. Keep your loop simple and straight-forward - note the possible difficulties when redesigning such as in drawings "J", "K" & "M".

5. Regarding the air pipe sizing, experiments have shown the advantage of using the same size vent pipe size as the drain line it is serving. Col. H above will show these.

6. The open end of the gravity loop must be protected from closure and for the moment I have used a glued on PVC cap with 1/8" wide and 1/4" deep saw cuts through it and down the 1/4" cut depth on the side of the cap. This, when embedded in the pool deck or concrete this could perhaps come close to not being easily defeated. I am certain there are other more workable ideas for this.

7. On a typical commercial pool or spa, actual field retrofitting could be inexpensively accomplished by the installation of a 42" long, 1 1/2" vertical PVC loop connected to the main drain line where it emerges from under the deck - burying the loop into a hole at that location.

8. Keep the open end of the air pipe to the elevation of the top of the pool coping or deck.

9. To accurately determine the effective height of a Suction Limiting Loop, a measurement should be taken from the maximum pool water level down to the point where the air pipe allows air to enter the section piping - see H on drawing G - 42".

10. Pump size, line size, plugged drains, missing drain covers - all would be automatically limited to the gravity suction of a 2 to 4.3 foot water head as was built into the gravity loop. Generally it appears that a minimum of a 3.5 foot loop (3.08" Hg) and a maximum of a 4.3 foot loop (3.74" Hg) would work well.

11. In the design of new installations the concept of the Suction Limiting Loop could be easily (and inexpensively) incorporated. Retrofitting is similarly simple but will require digging a hole close to the pool edge.

12. Field tests have demonstrated the validity of this concept.

13. Of course where a pool was constructed with a 1 1/2" main drain attempting to flow at 60 GPM in order to maintain the required turn over rate, this system would be of no help. The pool is definitely outside of the recommended hydraulic parameters, and as such probably should be suitably retrofitted or closed.

14. Hair entanglement could conceivably be lessened by the absolute limitation placed on pipe velocities with this system. Non-the-less, I would favor a snap off grate, one that would come up with the bather's hair if entanglement occurred. And should such a grate remain off for short periods, the danger would be almost nil with the Suction Limiting Loop preventing any build up of suction on the fitting.

Rev. 2/3/98

MAIN DRAIN FITTINGS

This Standard applies to suction fittings intended to be equal to or better than those specifically described .

The openings in the grate of the fitting shall be at least 24" in length in any one given dimension. If any 20" of the fitting grate should be completely blocked the remaining open portion of the grate shall provide equivalent open area as the pipe serving the drain.

Grate openings shall be of a size so as to prevent the entrance of an object of 1/2" diameter.

Designed suction flow shall not exceed the allowable pipe flow serving the drain, and shall not exceed 1-1/2 feet per second through the open area of the grate.

The grate should not be able to be removed by the average child or adult's hands without the use of a tool.

The grate should completely remove itself without damage by an outward pull of not more that 7 pounds.

Deflection tests shall be in accordance with ASME/ANSI A112.19.8M- 1987 Section 4.2.1.1 and shall not exceed the stated value unless it can be demonstrated that such excessive deflection poses no safety hazard and further that after such deflection the unit returns substantially to normal.

Point loading tests shall be in accordance with ASME/ANSI A112.19.8M- 1987 Section 4.2.2.1.

Static load tests shall be performed to verify the ability of the grate to withstand 350 pound impact loads with a 5 pound tup without protrusion of the tup or failure of any portion of the grate to thereafter perform its function as before.

A DISCUSSION OF THE
"PRIMUS"
SWIMMING POOL MAIN DRAIN

1. The design of this swimming pool main drain is intended to eliminate the three basic hazards associated with swimming pool main drains.

SUCTION ENTRAPMENT

DISEMBOWELMENT

HAIR ENTRAPMENT

2. There are three parts to this drain:

The Sump

The Frame

The Grate

3. The sump serves as the forming shell to provide a water tight water gathering void for the water being sucked out of the pool at this location. It serves to hold the concrete from occupying this area when pouring or guniting a pool. In other forms of pool construction it serves to prevent either the dirt, sand, or other construction materials from occupying this area. The sump has a suction pipe connection at either end thus facilitating dual suction lines from the single unit.

4. The Frame fits snugly into the sump around the edges and serves to provide a means of leveling the top of the drain with the finished pool floor. It will slide within the sump to provide this leveling effect. It is generally held in place by the plaster coat in concrete/gunite type pools, and can be held in place in other types of construction with either a flange attached to the liner or fiberglass for these types of construction. The frame also has a slot at either end to receive the grate.

5. The Grate serves as a slotted cover for the sump, thus preventing entry of hands and feet, and providing a smooth surface for the floor of the pool in this area. The slots in the grate are of the size to preclude the ability of fingers to fit therein thus to remove the grate will require some type of "tool". They are also sized to allow the designed quantity of water flow to enter the sump.

6. The entire main drain is configured into a long narrow device which, by its shape, precludes it from it being covered by a swimmer's body. A body simply can not conform to blind off this grate. By being unable to be closed off by a body, the mere design thereby precludes the suction entrapment of a bather due to increased pump suction when closed off.

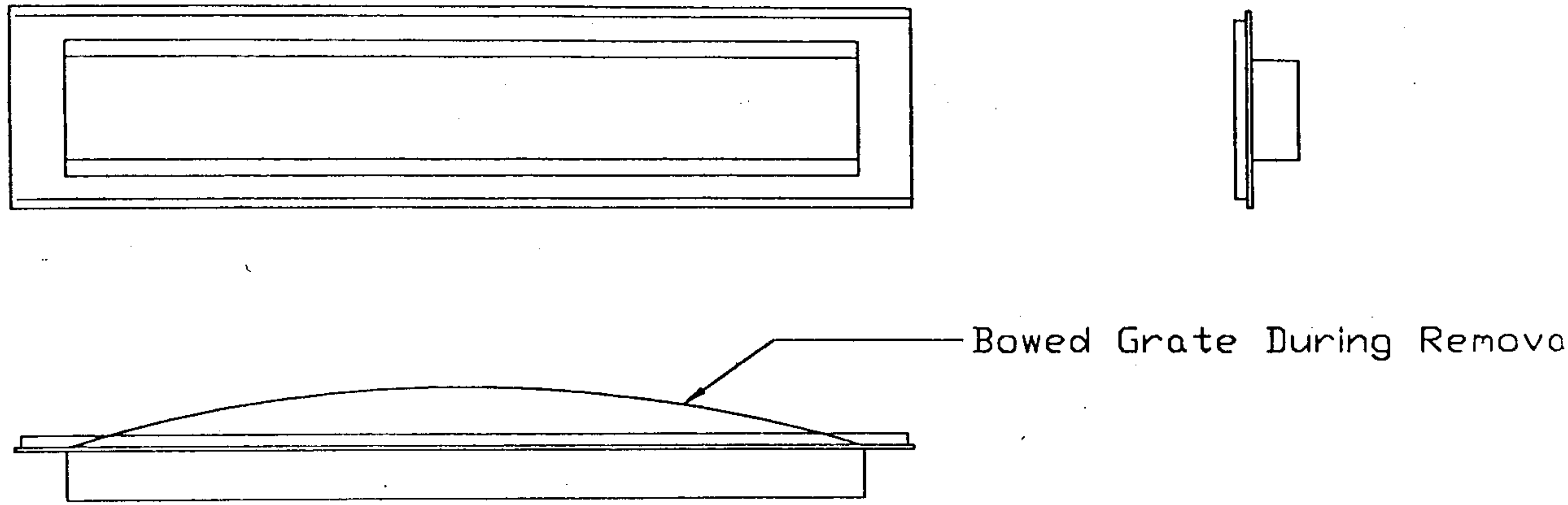
7. Disembowelment occurs when a bather (usually a small child) sits on top of a main drain, blinds it off with his or her buttocks (most frequently on drains where the grate is missing, but also on flat drain covers that can be so covered and collapse with the increased suction). The proposed "Primus" drain by its very design can not be blinded off with or without its grate in place - thus effectively eliminating the possibility of disembowelment.

8. The grate also serves as an effective means of eliminating the hazard of hair entrapment (usually young girls with long hair playing in a spa). Should the hair become entrapped in the grate, the grate will bow and thus release from its slots in the frame (about a 7 pound pull at the outer ends), allowing the bather to safely return to the surface where the entanglement can easily be removed. Further, due to the length of the slotted design grate, the water velocity through the grate is significantly reduced so that the usual turbulence associated with hair entanglement is significantly reduced.

Leif Alexander Zars

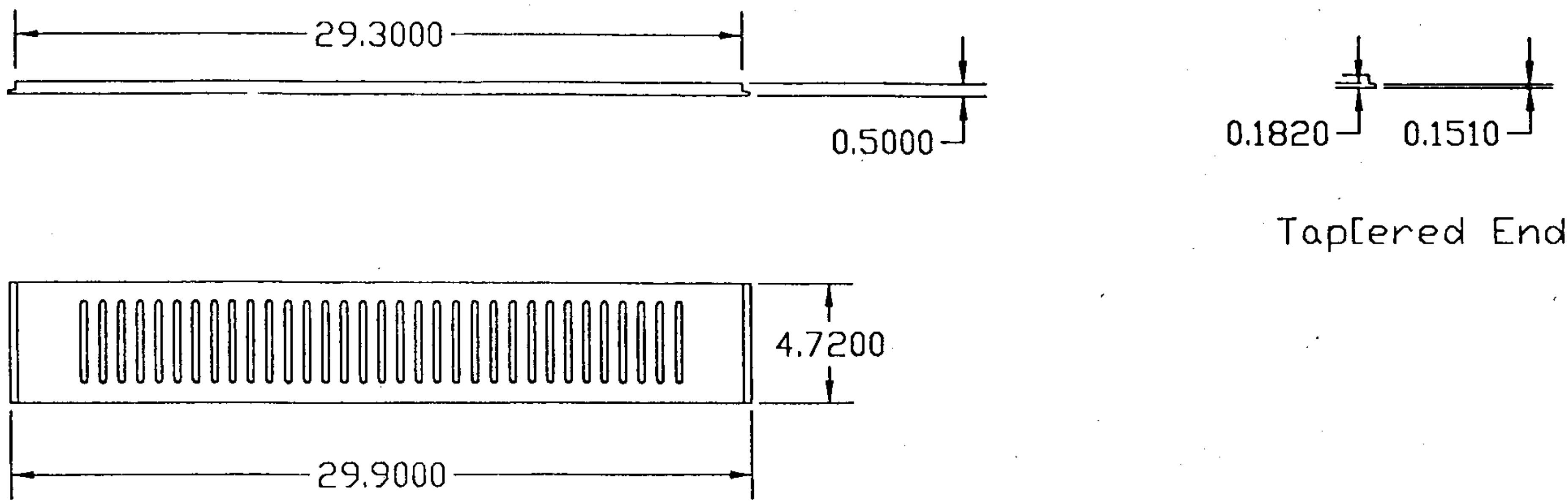
Leif Alexander Zars

Date 6-12-97



PRIMUS MAIN DRAIN FRAME

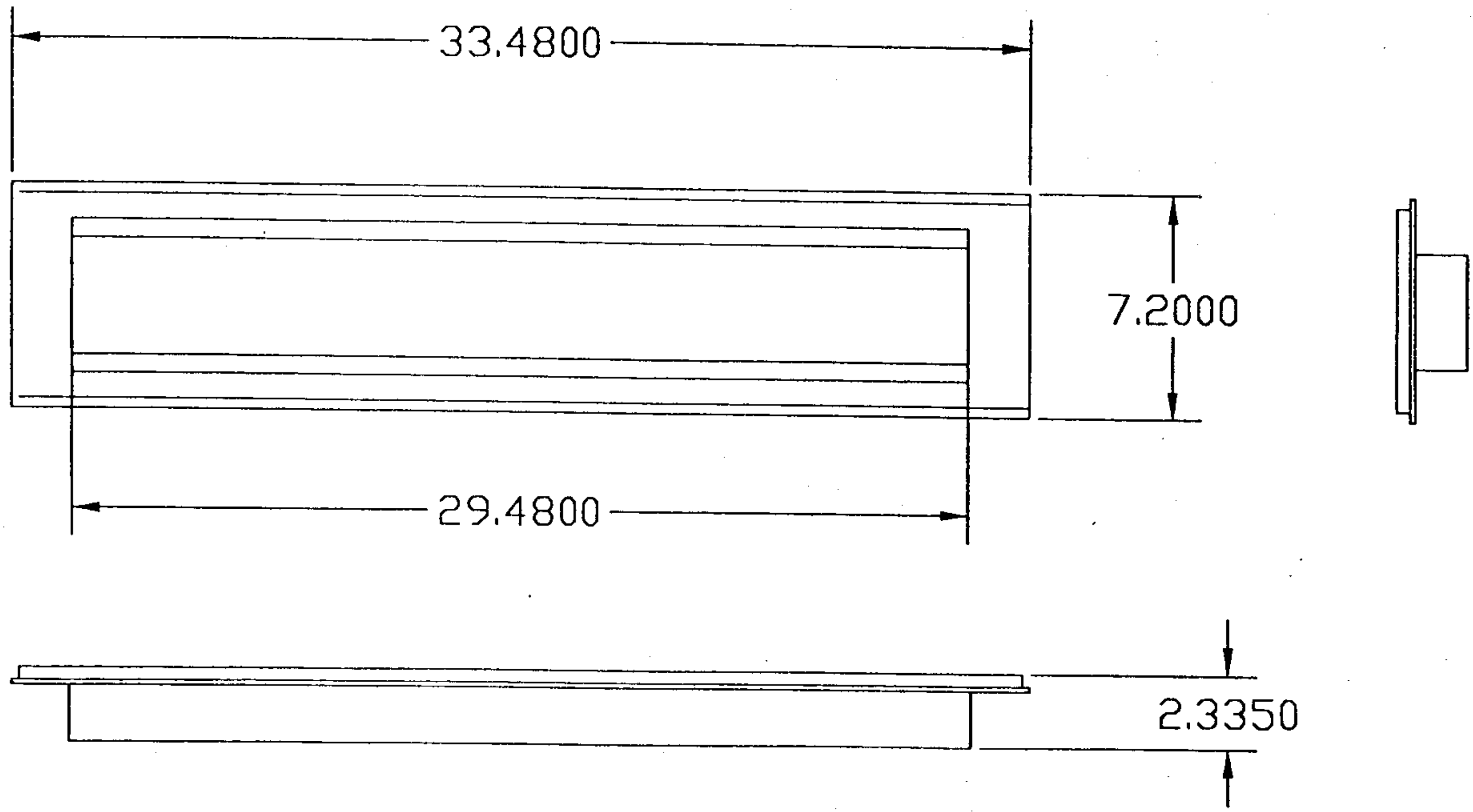
LEIF ZARS
1/30/97
Rev. 6/4/97



LEIF ZARS
1/30/97

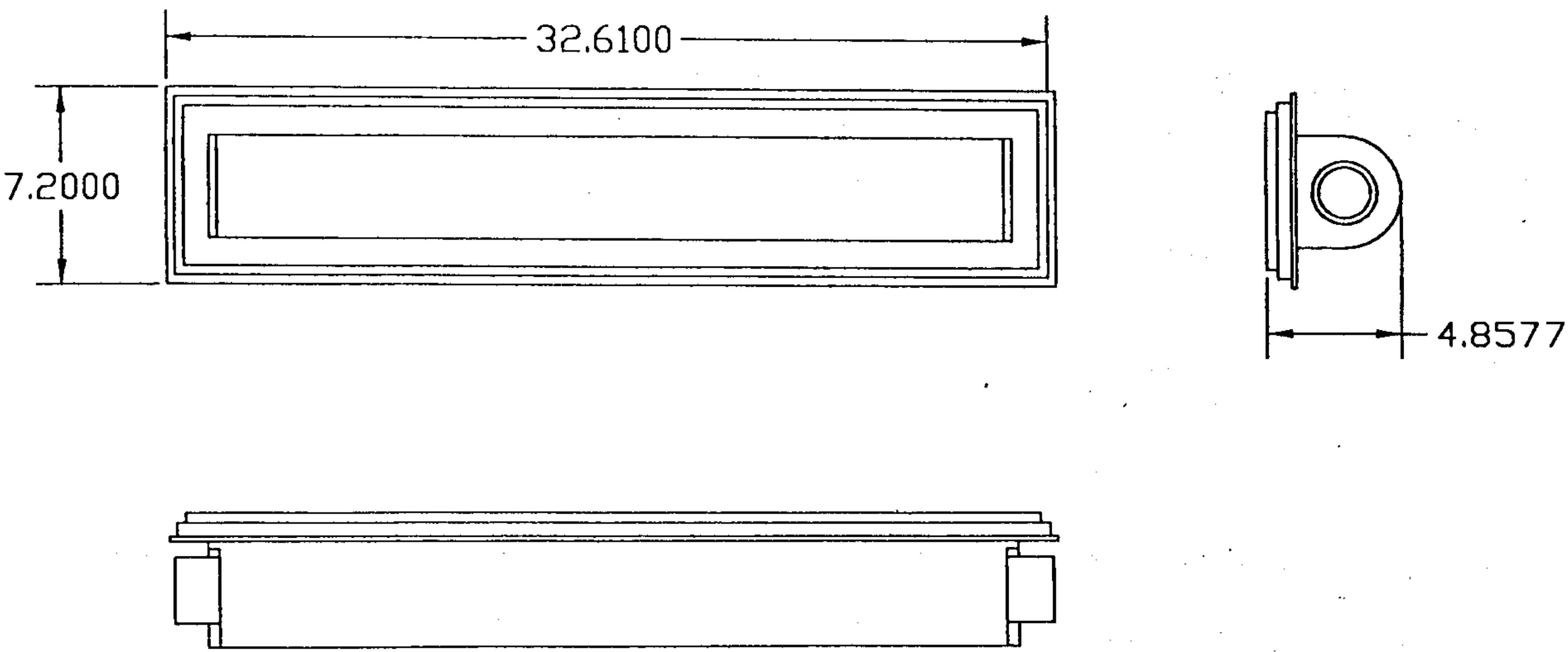
Rev. 6/4/97

PRIMUS MAIN DRAIN GRATE (26.04 Sq In Open)



PRIMUS MAIN DRAIN FRAME

LEIF ZARS
1/30/97
Rev. 6/4/97



PRIMUS MAIN DRAIN SUMP
(Total Depth 5.5")

LEIF ZARS
1/30/97

Rev.6/4/97

BRYANT-LEE
ASSOCIATES Metallurgical Engineering • Testing • Failure Analysis

January 27, 1998

Mr. Leif Zars
Gary Pools
438 Sandau Rd.
San Antonio, Texas 78216

Re: Drain Fitting Testing

Dear Mr. Zars:

Bryant-Lee Associates has performed loading tests on two of your drain fittings per ASME/ANSI Standard A112.19.8M-1987. The loading tests applicable to your horizontally mounted fitting are contained in paragraph 4.2, and include 4.2.1 "Deflection Testing of a Fitting Installed in the Horizontal Plane", and 4.2.2 "Point Load to Protrusion". The loads are applied with a 2 inch diameter steel tup with a 2½ inch radius nose. The Standard states that the testing of paragraph 4.2 "is intended to evaluate the fitting for the prevention of body entrapment".

Testing of two fittings per paragraph 4.2.1 revealed that the grates deflected 0.675 inch and 0.595 inch at the specified 300 pound load, and did not crack or disintegrate. The requirement of the Standard is no deflection in excess of 0.350 inch at the 300 pound load, and no cracking or disintegration. The grates meet the no cracking or disintegration requirement. The grates do not meet the deflection requirement portion of this paragraph, even though the grates can be loaded to 700 pounds or more without cracking or other damage. The grates return to their original shape after removal of a 300 pound load, and return to nearly their original shape after removal of a 700 pound load.

Testing of the same two fittings per paragraph 4.2.2 revealed that the tup protruded through the grates at loads of 730 pounds and 785 pounds, without disintegration of the grate. Disintegration is defined in the Standard as "the loss of any material from the fitting". The requirement of the Standard is that the fitting shall not disintegrate. Both fittings meet the requirement of this paragraph. No damage to the frame or sump of the fitting was observed, and these can be reused in future tests.

The attached test report details the results of the test and the test requirements. The Standard specifies that 6 consecutive fittings must pass the test, with no more than 1 in 12 fittings failing.

Please call if you have any questions.

Respectfully submitted,

Geert Aerts

Geert Aerts, P.E.

GA/jl

BRYANT-LEE
ASSOCIATES Metallurgical Engineering • Testing • Failure Analysis

DRAIN FITTING TEST REPORT

RESULTS		
Test Specimen	**Deflection Test (300 lb. load)**	**Point Load to Protrusion Test**
1	0.675 inch deflection. No cracking, no disintegration.	No disintegration at protrusion. (730 lb. load)
2	0.595 inch deflection. No cracking, no disintegration.	No disintegration at protrusion. (785 lb. load)
REQUIREMENTS		
	0.350 inch deflection maximum. No cracking, no disintegration.	No disintegration at protrusion.

Tested In Accordance With: ASME/ANSI Standard A112.19.8M-1987

Bryant-Lee Associates Laboratory Report No.: BL97231

Test Date: January 16, 1998

Tested By: ________, P.E.