SOLUTIONS, INC.

Final Report

Hoechst Celanese Chemical Group, Ltd.
Bay City, Texas
MIT/Fall-off Report
Injection Well WDW-110 (Well No. 1A)

FEB 26 1996
6 W-SU

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Hoechst Celanese Chemical Group, Ltd.
Bay City Plant
Bottom Hole Pressure Falloff and
Mechanical Integrity Testing
For WDW-110 (Well No. 1-A)

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January 1996

ECO Job No. 95045

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1.0 INTRODUCTION AND EXECUTIVE SUMMARY

1.1 INTRODUCTION

Hoechst Celanese Chemical Group, Ltd. (HCCG) contracted ECO Solutions, Inc. (ECO) to perform the annual mechanical integrity testing on their Class I nonhazardous injection well, WDW-110 (Well No. 1-A), located at their Bay City facility. A schematic drawing of WDW-110 is included as Figure 1. The attached report details the data and test results associated with the mechanical integrity testing.

The following provides an overview of the key elements of the testing on WDW-110 (Well No. 1-A).

- An Annulus Pressure Test (APT) was conducted to satisfy the annual mechanical integrity test (MIT) requirements of the Texas Natural Resource Conservation Commission's (TNRCC), Underground Injection Control (UIC) Program.
- A Radioactive Tracer (RAT) survey was conducted to satisfy the annual MIT requirements of the TNRCC.
- Bottom Hole Pressure (BHP) Falloff testing was conducted to satisfy the annual ambient monitoring requirements of the U.S. Environmental Protection Agency (EPA) and the TNRCC

HCCG personnel contacted the TNRCC personnel to inform them of the MIT schedule on WDW-110 and whether a field inspector would be present. TNRCC personnel informed HCCG that no field inspector would be present for this particular MIT.

The APT on WDW-110 (Well No.1-A) was conducted on Thursday, January 25, 1996, and was witnessed by Mr. Wesley Smith of ECO and Mr. Ray Horton of HCCG. The RAT was conducted on Thursday, January 25, 1996, and was witnessed by Mr. Wesley Smith of ECO and Mr. Ray Horton of HCCG.

The BHP/falloff test was conducted on Tuesday, January 23, 1996 through Thursday, January 25, 1996 and was witnessed by Mr. Wes Smith of ECO and Mr. Ray Horton of HCCG.

1.2 EXECUTIVE SUMMARY

Based on the successful results of the MIT conducted on January 25, 1996 on WDW-110, HCCG returned WDW-110 to injection service. A summary of the results of the MIT and BHP/Falloff surveys are as follows:

Radioactive Tracer Survey

The analysis of the RAT survey performed on January 25, 1996 demonstrated external mechanical integrity since no upward fluid movement from the injection interval adjacent to the long string casing is occurring. Additionally, this determination can be made as a result of (1) the favorable comparison of the before and after base gamma ray surveys, (2) the two multiple pass tracer surveys and the two stationary surveys conducted 20' above the perforated interval. All surveys showed no evidence of upward fluid movement. This interpretation was supported by an independent evaluation letter provided by Atlas Wireline Services (Atlas) and is included in Appendix A together with the RAT log.

Annulus Pressure Test

A demonstration of internal mechanical integrity was supported by an APT conducted on January 25, 1996. The annulus was pressurized to a maximum of 1113 pounds per square inch gauge (psig). The APT was monitored for sixty minutes. During the final 30 minutes the pressure loss was measured from 1107 to 1106 psig, or 1 pound per square inch (psi) (0.1%), which is well within the 5% pressure loss criteria set by the TNRCC. The APT data and plot are included in Appendix B.

Bottom Hole Pressure Falloff Survey

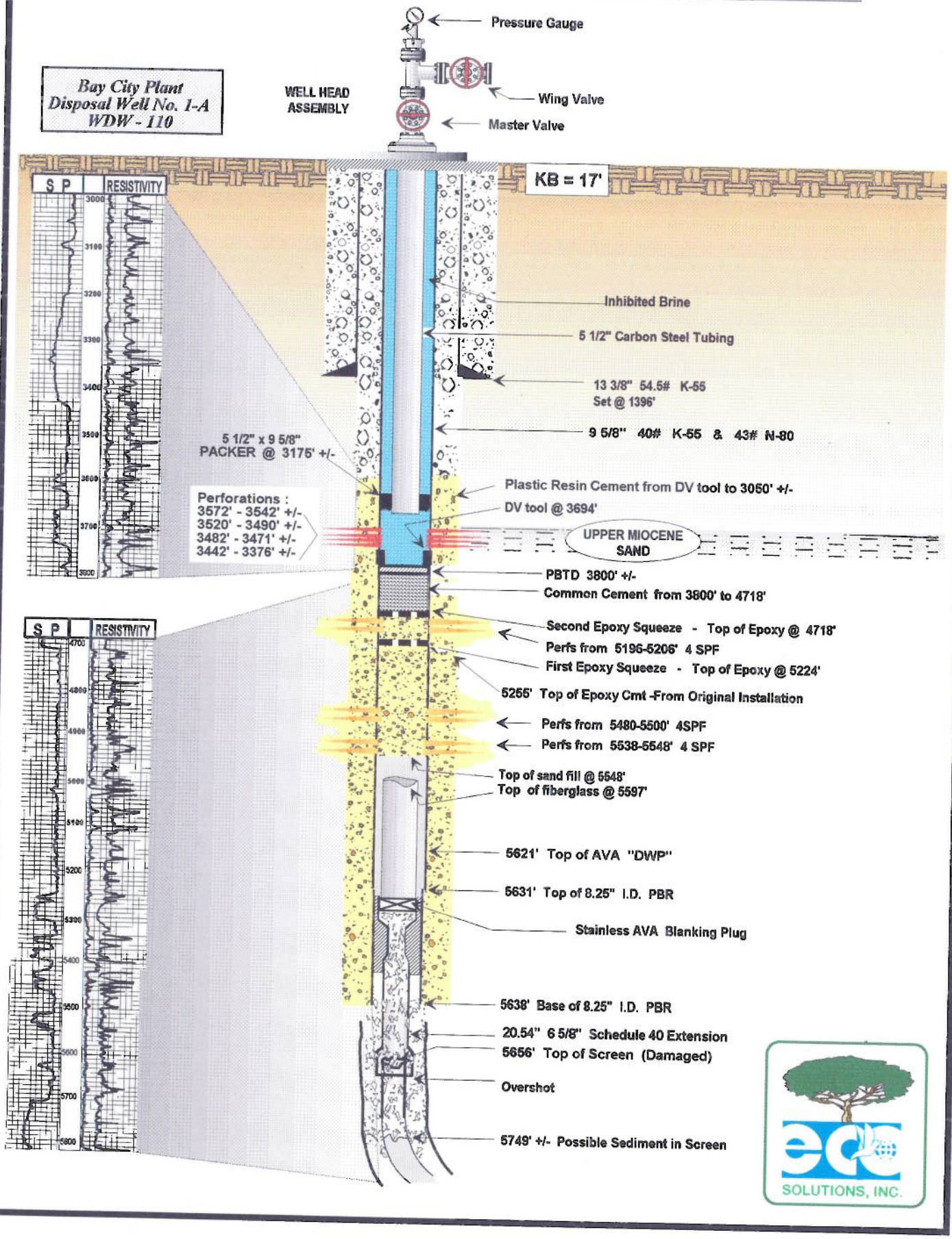
Waste effluent fluid was injected into WDW-110 at a steady rate of 215 gpm for 99-$^1/_4$ hours and was shut-in for a total of 30-$^3/_4$ hours. The shape of both the pressure and pressure derivative curves a log-log plots at early times are reasonable, and are similar to the test conducted in January 1995. A full discussion of the falloff analyses is presented in Section 4.0.

Conclusions

All field work associated with the MIT/BHP/Falloff survey on HCCG's WDW-110 at the Bay City Plant conducted from January 23 through 25, 1996 was successfully completed. WDW-110 has mechanically integrity at this time and is suitable for continued use as a Class I waste injection well.

In accordance with the TNRCC/UIC Program, 31TAC, 331.4 and 331.43, the mechanical integrity test conducted on WDW-110 demonstrated that (1) "there is no significant leak in the casing, tubing or packer" and (2) "there is no significant fluid movement into an underground source of drinking water (USDW) through vertical channels adjacent to the injection borehole."

HOECHST CELANESE CHEMICAL GROUP, LTD.



2.0 FIELD OPERATIONS SUMMARY

2.1 BOTTOM HOLE PRESSURE/FALLOFF SURVEY

Friday, January 19, 1996

Brought injection up from 123 to 215 gallons per minute (gpm) at 1800 hours.

Saturday, January 20 - Monday, January 22, 1996

Continued injecting at an average rate of 215 gpm.

Tuesday, January 23, 1996

Arrived at plant location at 0630, checked in with front gate security guard and went to site of WDW-110 at 0700 hours. Effluent was being injected at a well head pressure (WHP) = 402 pounds per square inch gauge (psig). At 0830 hours Mr. Ruben Garcia, Jr. (HCCG) processed Wes Smith (ECO), Doug Beall and Mike Staley with Milton M. Cooke Company (Cooke) through HCCG's contractor safety orientation check list. Cooke commenced rigging up on well. NOTE: All depths are referenced to rotary drive bushing (RKB) at 17' above ground level.

WDW-110 (Well No. 1-A)	active/injecting
WDW-14 (Well No. 2)	out of service
WDW-32 (Well No. 3)	out of service
WDW-49 (Well No. 4)	out of service

Checked with Paul Richardson in the control room. WDW-110 injecting approximately 215 gpm. At 0840 Cooke made run through gauge calibrations:

EPG 520 Serial # 69681 (Surface ReadOut) - Range 0 - 2500 psia.
EMS 725 Serial # 76651 (Back-up, Memory gauge)

Met with Ray Horton at 0900 hours to review test procedures and current condition of well. At 0910 hours placed tool string in lubricator (18 ft. length) as follows:

Length	Description
0.5'	Cable head
1'	Collar locator
1-1/2'	EPG 520 (SRO gauge)
5'	weight bar
5'	weight bar
4-1/2'	EPG 725 (memory gauge)

At 1045 hours opened master valve, pressured up lubricator, and prepared to go in hole. At 1056 hours check SRO gauge (WHP = 412.44 pounds per square inch absolute (psia)), going into hole. Attempted to tie into packer (1995 RAT log) using casing collar locator (CCL).

CCL unit not functioning. Pulled out of the hole and shut down waiting on a replacement CCL unit. Installed new CCL unit and rerun BHP tools into hole. BHP unit not working properly and pulled tools out of the hole. Shut down waiting on replacement BHP tool. Installed new BHP tool and ran into hole. BHP unit working all right, but CCL unit partly working. Based on CCL recorder, correlated tool depth to packer depth and pulled BHP tools up to 3300' at 1915 hours.

Monitoring injection operations at 1921 hours.

Injection rate	215 gpm
Down hole injection pressure	1816.29 psia
Surface injection pressure	410 psig

Continue monitoring injection period of test. Readings at 2030 hours:

Injection rate	215 gpm
Down hole injection pressure	1817.04 psia
Surface injection pressure	402 psig

Met with shift supervisor, prepared to shut-down injection operations. Stop injection pumps at 2119 hours and begin fall-off test. Double block @ injection and boiler feed water flow lines.

Final injection conditions:

Injection rate	215 gpm
Down hole injection pressure	1817.50 psia
Surface injection pressure	402 psig

Wednesday, January 24, 1996

Continue monitoring fall-off period of test (0800 hours).

Shut-in down hole pressure	1508.87 psia
Surface shut-in pressure	78 psig

2200 hours continue monitoring fall-off period of test.

Shut-in down hole pressure	1507.22 psia
Surface shut-in pressure	75 psig

Thursday, January 25, 1996

0200 hours continue monitoring fall-off period of test.

Shut-in down hole pressure	1506.75 psia
Surface shut-in pressure	75 psig

At 0422 hours stop recording downhole pressures, download ASCII data file, and printed preliminary BHP plots. At 0430 hours tagged bottom of borehole at 3558'. Pull out of hole with tool, making static gradient stops (15 minutes/stop) at 3000', 2000', 1000', 500' and surface.

Final shut-in pressures/temperature	
Shut-in down hole pressure	1506.59 psia
Shut-in down hole temperature	104.77 Deg. F
Surface shut-in pressure	75 psig

At 0830 hours gauges in lubricator and end of pressure falloff survey. Begin rigging down wireline equipment. Cooke crew leaving location at 0945 hours.

2.2 MECHANICAL INTEGRITY TEST

Thursday, January 25, 1996

At 0730 hours Mr. Wes Smith of ECO and Mr. Ray Horton of HCCG traveled to WDW-110 and met with Mr. Wilson Cupples with HCCG's instrument group. WDW-110 was shut-in with 75 psig on the tubing gauge and 873 psig on the annulus. HCCG's portable pressure recorder was used. Also, a certified calibrated pressure instrument, Eaton Pressure Sensor, Type UPC 5000 BACB with ranges from zero to 400, zero to 1,000 and zero to 2,000 psig, was installed onto the annulus outlet. NOTE: The zero to 2,000 psig

range was utilized for this test. HCCG personnel pressurized the annulus system using nitrogen. Surface valve leak detected. Shut down APT and bleed off nitrogen to 175 psig. Blocked off faulty valve and pressured the annulus system again with nitrogen. The annulus was tested to a maximum pressure of 1113 psig. The annulus was monitored for 60 minutes. During the final 30 minute period, the pressure loss on the annulus was measured from 1107 to 1106 psig, or 1 psi (0.1%). After completion of the APT, the nitrogen gas was bled off the annulus to 190 psig. WDW-110 was left shut-in.

At 1030 hours Atlas Wireline Service (Atlas) personnel arrived at HCCG's Bay City plant, checked through plant security and Atlas' personnel went through safety orientation. Moved in and rigged up Atlas' wireline unit including radioactive (RA) tools on WDW-110. At 1345 hours started the RAT survey as witnessed by Mr. Ray Horton of HCCG and Mr. Wes Smith of ECO. Ran tool to a maximum depth of 3550'. Ran base gamma ray (GR) log, a short repeat section and one statistical check. Ran multiple pass survey from 3550' to 2900' with an injection rate of 50 gpm, depicting that all injected fluid was entering the upper injection interval. Repeated multiple pass survey and obtained similar positive results. Set the RAT tool at 3356' for a stationary survey, injected a RA slug at the same injection rate and monitored for 20 minutes with no indicated upward flow. Repeated stationary survey with same results. Ran the final baseline GR log from 3550' to 2900' with hot spots indicated in the perforated interval. The GR hot spots were the result of the extra long shot duration to conduct the two stationary surveys. Completed the RAT survey at 1920 hours and pulled the tool out of the hole. Rigged down Atlas and moved the unit off site. WDW-110 was left operating at an injection rate of 50 gpm.

3.0 MECHANICAL INTEGRITY TESTING

3.1 ANNULUS PRESSURE TEST

An APT was conducted on Thursday, January 25, 1996 in order to demonstrate internal mechanical integrity. The APT was witnessed by Mr. Ray Horton of HCCG and Mr. Wesley Smith of ECO. The annulus was pressurized to a maximum pressure of 1113 psig with 73 psig on the tubing. The APT was monitored for sixty (60) minutes using a certified calibrated pressure gauge and portable recorder. During the final 30 minutes the pressure loss was measured from 1107 to 1106 psig, or 1 psi (0.1%), which was well within the 5% pressure loss criteria set by the TNRCC. APT data and plot are included in Appendix B.

3.2 RADIOACTIVE TRACER SURVEY

On Thursday, January 25, 1996 a RAT survey was conducted by Atlas to demonstrate external mechanical integrity and to insure that all fluids are entering the injection interval. Analysis of the RAT survey showed no upward fluid movement. Atlas and ECO conducted the RAT as follows:

1. Ran API gamma-ray (GR) tie-in strip.
2. Ran initial baseline GR log from 3550' to 2900'.
3. Ran repeat GR log from 3400' to 3220' to confirm tool repeatability.
4. Ran 5-minute statistical check at 3356'.
5. Made multiple pass survey #1 with RA slug ejected at 2900' and a pump rate of 50 gpm.
6. Made multiple pass survey #2 with a RA slug ejected at 2900' and a pump rate of 50 gpm.
7. Ran stationary survey #1 at 3356'. Watched RA slug pass tool and monitored for 20 minutes. Pump rate 50 gpm.
8. Ran stationary survey #2 at 3356'. Watched RA slug pass tool and monitored for 20 minutes. Pump rate 50 gpm.
9. Ran after survey base GR log from 3550' to 2900'.

3.3 ESTIMATED TIME TO RUN STATIONARY SURVEY SEQUENCE

The purpose of the estimate is to calculate the "worst case" time for the radioactive slug to move from the GR tool (1) down the tubing, (2) into the perforations, and (3) up the casing/borehole annulus to the tool depth.

Basic Data:

Capacities:	5-1/2" tubing	-	0.9314 gal/ft.
	9-5/8" casing	-	2.972 gal/ft.
	9-5/8" casing x 12-1/4" borehole	-	2.343 gal/ft.
Pump Rate:	50 gpm		

Note: RAT detection tool was held stationary at 3356 feet, or 44 feet above the top of the perforated section (receiving fluid) at +/-3400'.

Worst Case Calculations:

Volumes:	Tubing	- 24 ft. x 0.9314 gal/ft.	=	22.4
	Casing	- 20 ft. x 2.972 gal/ft.	=	59.4
	Casing/borehole	- 44 ft. x 2.343 gal/ft.	=	103.1
		TOTAL		184.9 gallons

Calculated time to circulate RA slug around the end of the tubing and casing strings:

= 184.9 gal / 50 gpm

= 3.7 minutes

Note: Actual time surveys were run = 20 minutes

4.0 BOTTOM HOLE PRESSURE FALLOFF

4.1 BOTTOM HOLE PRESSURE FALL-OFF ANALYSIS

Purpose Of Test: Required annual Reservoir Evaluation Test for year **1996.** Calculate the following reservoir characteristics: permeability, skin damage, pressure drop due to skin and flow efficiency.

Analysis Description - Fall-Off Test

Method Of Interpretation: The following analysis was performed by utilizing both Semi-Log and Log-Log analysis. **A)** The Semi-Log curve was generated by plotting the standard Horner plot, **Pressure vs** $[(t_p+\Delta t)/\ \Delta t]$, using an injection time (t_p) of 99.25 hours. The semi-log straight line was calculated by linear regression through the infinite acting flow period of the curve. The slope **m**, P_{1hr}, and P^* values were obtained from this curve and utilized for permeability and skin calculations. **B)** The Log-Log curves were generated by plotting ΔP and **Pressure derivative** vs the Agarwal Equivalent time function, $[t_p\ \Delta t/(t_p+\Delta t)]$. The Log-Log curves were simultaneously positioned over Gringarten type curves until a solution match was obtained. Permeability and skin values were calculated from this match and then compared with those obtained from the Semi-Log analysis.

A. Semi-Log (Horner): The straight line area of the semi-log curve was identified by first using the 1-1/2 log cycle rule to estimate the end of wellbore storage effects. Secondly, the time of the flat portion from the Pressure Derivative curve was used in determining the area of the semi-log curve in which the straight line was drawn. The semi-log straight line yielded a slope value of **5.5 psi/cycle** and a P_{1hr} of **1515 psi**. The pressure difference between P_{1hr} and the injection pressure, P_{inj} of **1818.5** psi compared with the calculated slope would give indications of positive skin damage and high permeability.

B. Log-Log (Gringarten Type Curves): Development of the unit slope line in the early portion of the derivative curve coupled with the high maximum of the derivative is indicative of a damaged well with wellbore storage. The flattening portion of the derivative curve at 0.3 P_d/P_d' indicates the beginning of the radial flow regime and was observed approximately 2.0 hours into the fall-off test. The flat portion of the derivative curve was the main factor used to obtain a type curve match yielding similar results to the semi-log analysis.

Conclusions: This particular well was diagnosed to be injecting into a homogeneous reservoir with a calculated permeability of **937 (md)** and skin damage of **+57** utilizing an h_{net} value of **165** feet. The flow efficiency of **13.68%** suggests that the near wellbore conditions impact the injection volume limitations. Also, the total pressure drop is primarily due to conditions within a small radius from the well.

The following Table is provided to give comparative results with the previous tests and calculations. The primary variables affecting the calculated results are included.

Table 4.1
SUMMARY OF RESULTS

Date MM/YY	Rate gpm	h_{net} ft	μ_w cp	slope psi/cycle	kh/μ	kh md-ft	k md	Skin
01/96	215	165	0.7100	5.5	217708	154573	937	+ 57
01/95	192	165	0.7100	4.299	249010	176797	1071	+ 40
02/94	279	165	0.5914	5.308	292995	173277	1050	+ 43
03/93	200	165	0.5560	3.200	348621	193833	1175	+ 29

The calculated results indicate a difference in transmissivity, (kh/μ) of **13%** coupled with a **43%** difference in skin values between 1995 and 1996. In addition, the results calculated from type curve analysis compare favorably to those calculated from the semi-log straight line analysis thus supporting the integrity of the calculated results.

The start time of the infinite acting flow period exceeded the time to exit the waste front, therefore the viscosity of the original reservoir fluid was used for the final analysis.

A homogeneous simulator was utilized to confirm the calculated results mentioned above. The main assumptions were as follows: a single well with infinite acting and radial flow conditions being injected at a constant rate with constant reservoir conditions such as porosity, permeability, and compressibility. Based on this particular reservoir the simulated data matched the actual data with a reasonable degree of accuracy.

The program used for final analysis and well simulation was "FAST", marketed by FEKETE.

Table 4.2

Water Well Test - BUILDUP

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25,1996

Production And Times

Cumulative Production (water)	=	-	bbl	<DEF>
Corrected Flow Time	tc =	99.250	hr	<DEF>
Final Water Rate	qw =	-7371.00	bbl/d	

Fluid Properties

Reference Pressure	pRef =	1800.0	psi	<DEF>
Water Formation Vol Factor	Bw =	1.00		<DEF>
Water Compressibility	cw =	3.000×10^{-06}	psi^{-1}	<DEF>
Water Viscosity	muw =	0.710	cp	
Oil Formation Vol Factor	Bo =	1.18		<DEF>
Oil Compressibility	co =	1.423×10^{-04}	psi^{-1}	<DEF>
Oil Viscosity	muo =	2.880	cp	<DEF>
Solution Gas Oil Ratio	Rso =	335.9	scf/bbl	<DEF>
Gas Formation Vol Factor	Bg =	1.25×10^{-03}		<DEF>
Gas Compressibility	cg =	6.229×10^{-04}	psi^{-1}	<DEF>

Table 4.2 Continued

Water Well Test - BUILDUP

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25,1996

Zone 1

Pressures

Initial Pressure	pi =	1800.0	psi
Extrapolated Pressure	p* =	1504.1	psi
Average Reservoir Pressure	pR =	-	psi
Final Flowing Pressure	pwfo =	1818.5	psi

Straight Line Results

Total Sandface Rate	QTBT =	-7371.00	bbl/d
Semilog Slope	msl =	5.5	psi/cycle
Transmissivity (Total)	kh/mu =	217707.77	md.ft/cp
Mobility (Total)	k/mu =	1319.441	md/cp
Flow Capacity (Water)	kh =	154572.52	md.ft
Permeability (Water)	k =	936.80	md
Skin Effect (Total)	s =	56.779	
Pressure Drop Due To Skin	delps =	271.4	psi
Flow Efficiency	FE =	1.85	
Damage Ratio	DR =	0.54	
Radius Of Investigation	r(inv) =	-	ft
@ Time Of Investigation	t(inv) =	-	hr

Table 4.2 Continued

Water Well Test - BUILDUP

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25,1996

Zone 1

Extended Rates

3 - Month Constant Rate	=	-	bbl/d	
6 - Month Constant Rate	=	-	bbl/d	

Stabilized Rate

Shape Code	=	R1A		<DEF>
Drainage Area	A =	160.0	acres	<DEF>
Time To Stabilize	ts =	27.362	hr	
Stabilized Rate @ Current Skin	qs =	-7560.31	bbl/d	
Stabilized Rate @ Skin Of 0	qs =	-58737.46	bbl/d	
Stabilized Rate @ Skin Of -4	qs =	-112282.48	bbl/d	

Table 4.2 Continued

Water Well Test - BUILDUP

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25,1996

Reservoir Parameters

Net Pay	h =	165.00	ft	
Total Porosity	phit =	330.00	%	
Water Saturation	Sw =	100.00	%	
Oil Saturation	So =	0.00	%	
Gas Saturation	Sg =	0.00	%	
Wellbore Radius	rw =	0.30	ft	<DEF>
Formation Temperature	T =	104.00	deg F	
Formation Compressibility	cf =	1.139×10^{-06}	psi^{-1}	<DEF>
Total Compressibility	ct =	4.139×10^{-06}	psi^{-1}	<DEF>

Figure 2

HORNER
PRESSURE BUILDUP PLOT

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25, 1996

$[k_1/u]_t$=1319.44 k_1=936.80 md s=56.8 p*=1504.1

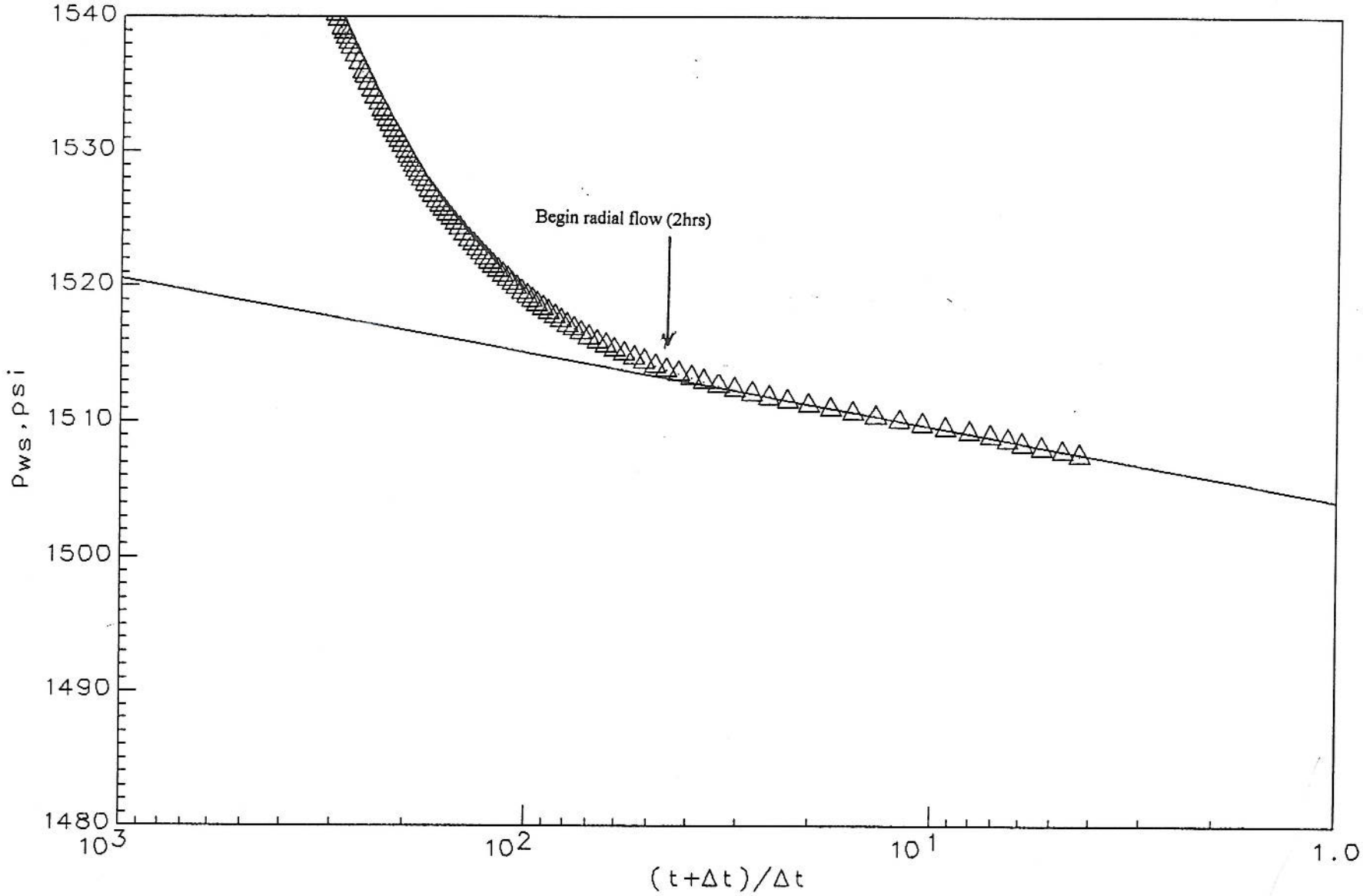


Figure 3

HORNER

PRESSURE BUILDUP PLOT

HOECHST CELANESE (BAY CITY)
WDW-110 WELL 1-A

PRESSURE FALL-OFF TEST
JANUARY 23-25, 1996

$[k_1/u]_t$=1327.24 k_1=942.34 md s=57.2 p*=1504.1

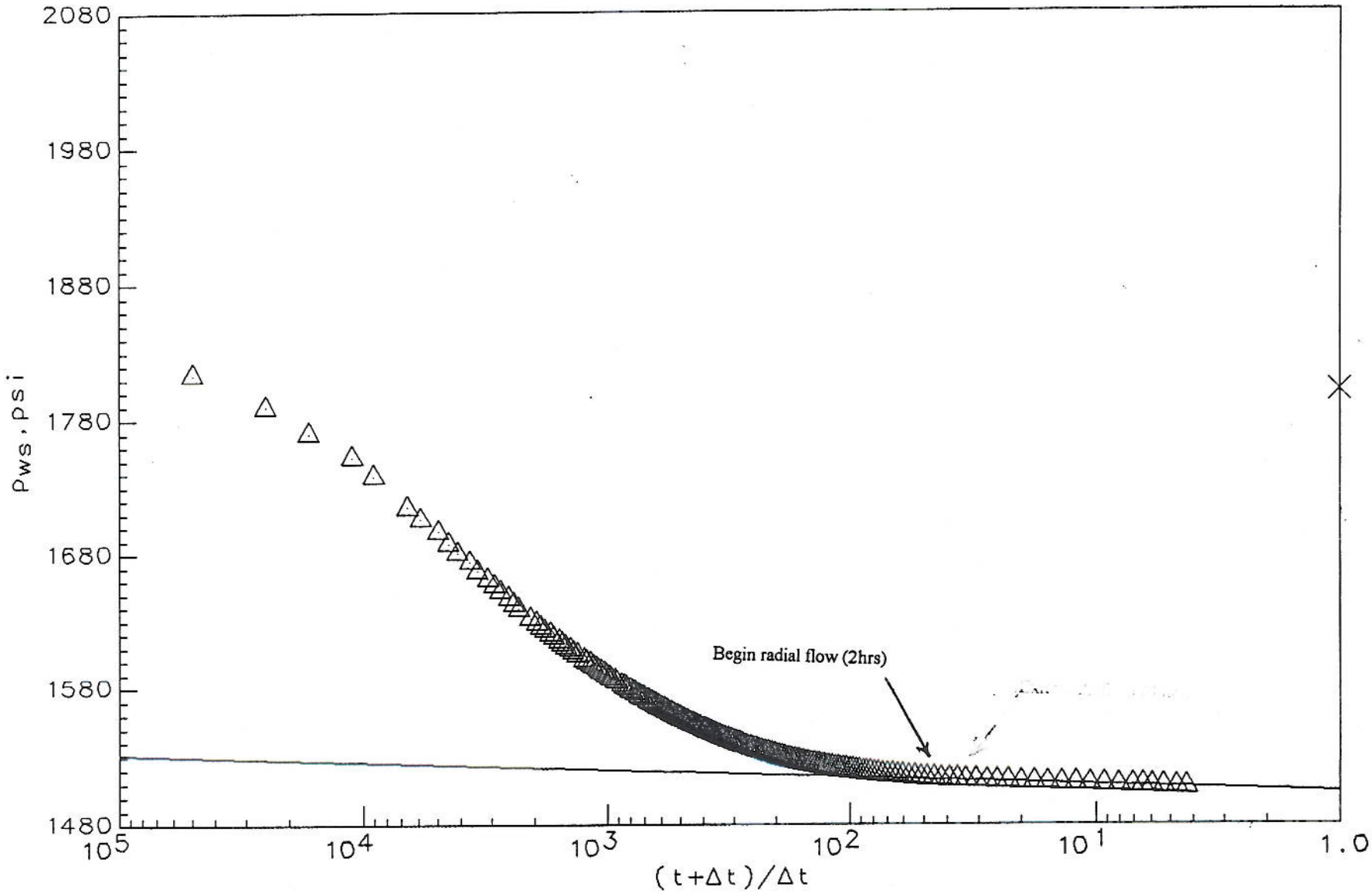


Figure 4

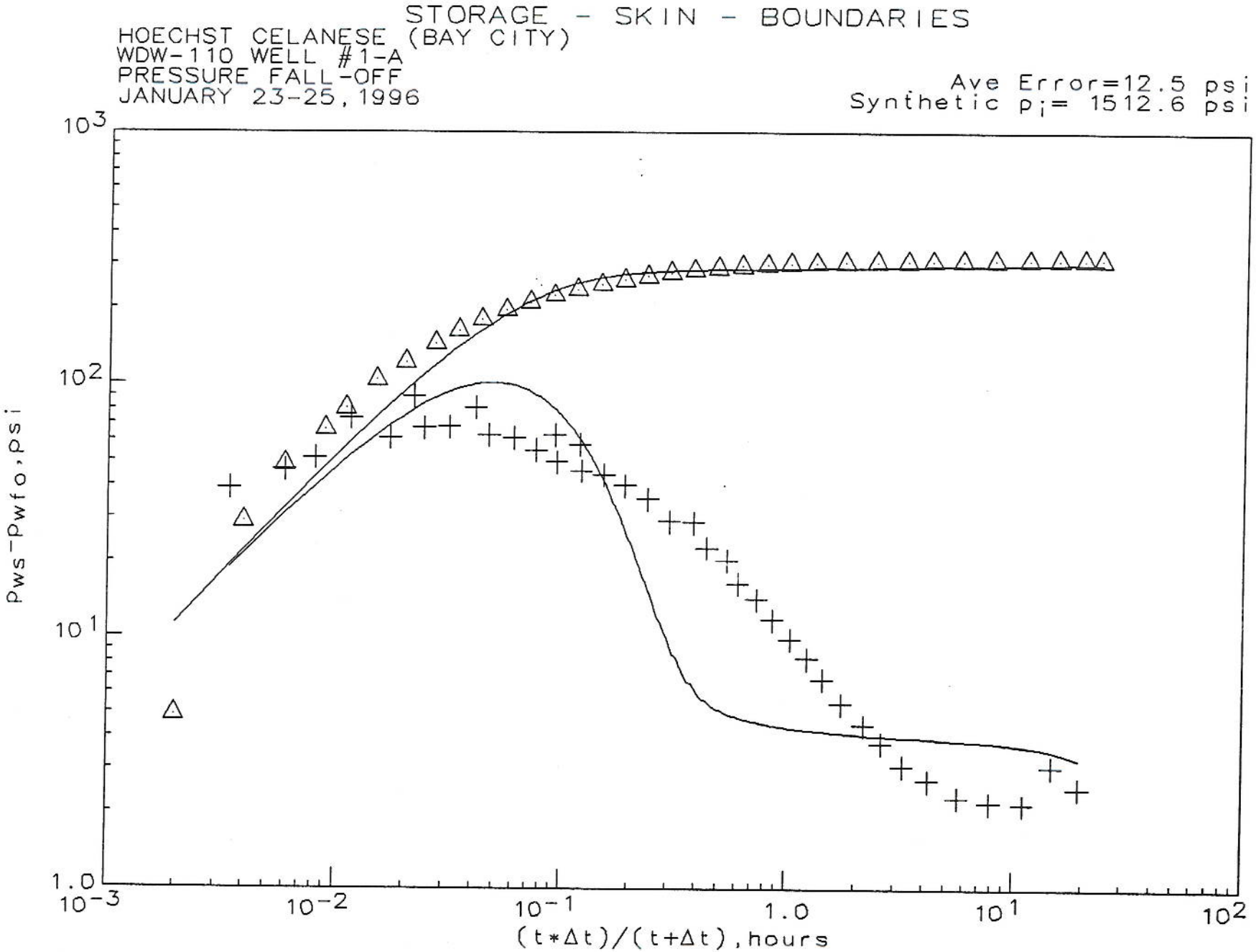
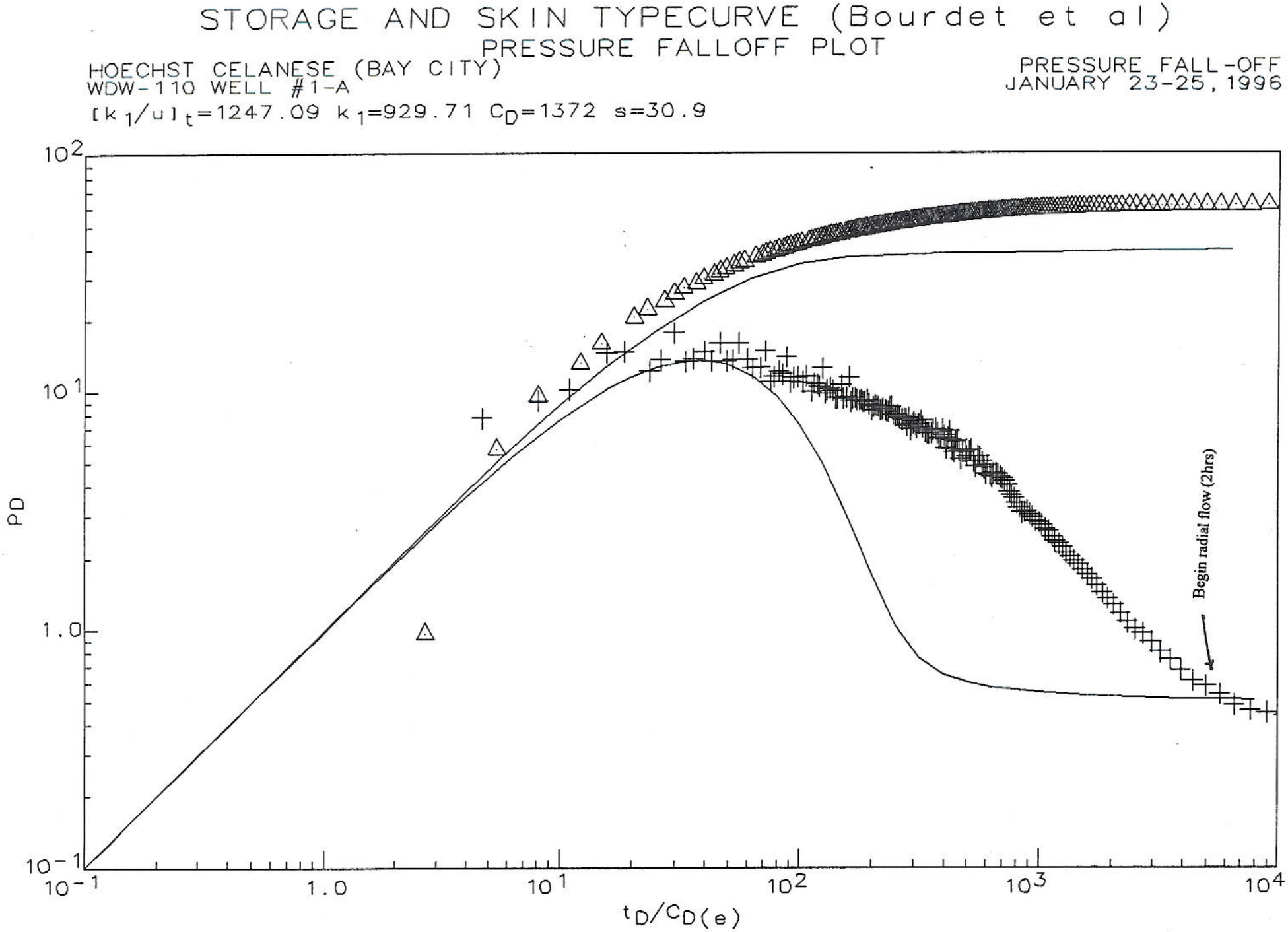

STORAGE - SKIN - BOUNDARIES
HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A
PRESSURE FALL-OFF
JANUARY 23-25, 1996
Ave Error=12.5 psi
Synthetic pi= 1512.6 psi
10^3
10^2
10^1
1.0
pws-pwfo,psi
10^-3
10^-2
10^-1
1.0
10^1
10^2
(t*Δt)/(t+Δt),hours

Figure 5


STORAGE AND SKIN TYPECURVE (Bourdet et al)
PRESSURE FALLOFF PLOT
HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A
[k1/u]t=1247.09 k1=929.71 CD=1372 s=30.9
PRESSURE FALL-OFF
JANUARY 23-25, 1996
PD
tD/CD(e)
Begin radial flow (2hrs)

Water Well Test - FALLOFF

Bourdet Et Al Type Curve Analysis

(Equivalent Time)

HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A

PRESSURE FALL-OFF
JANUARY 23-25,1996

Inner Zone

Match Curve	CDe2s	=	1.00×10^{30}	
Match Point (pressure Ratio)		=	5.1	psi
Match Point (time Ratio)		=	7.389×10^{-04}	hr
Dimensionless Storage Constant	CD	=	1372.18	
Wellbore Storage Constant	C	=	0.04	bbl/psi
Transmissivity (Total)	kh/mu	=	205769.86	md.ft/cp
Mobility (Total)	k/mu	=	1247.090	md/cp
Flow Capacity	kh	=	153401.43	md.ft
Permeability	k	=	929.71	md
Skin Effect (Total)	s	=	30.927	
Pressure Drop Due To Skin	delps	=	156.4	psi
Radius Of Investigation	r(inv)	=	-	ft
@ Time Of Investigation	t(inv)	=	-	hr
Number Of Points In Derivative		=	3	<DEF>

Dual Porosity

Inter Porosity Coeff	Lambda	=	-
Storativity Ratio	Omega	=	-

Table 4.3

Water Well Test - SYNTHESIZER

Model Parameters

Storage - Skin - Boundaries Model

HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A

PRESSURE FALL-OFF
JANUARY 23-25,1996

Synthetic Initial Pressure		=	1512.6	psi
Formation Parameters				
Transmissivity (Total)	kh/mu	=	132850.42	md.ft/cp
Mobility (Total)	k/mu	=	805.154	md/cp
Flow Capacity (Water)	kh	=	99039.99	md.ft
Permeability (Water)	k	=	600.24	md
Skin	s	=	29.279	
Wellbore Storage Constant (dim.)	CD	=	1624.75	
Inter Porosity Coeff	Lambda	=	-	
Storativity Ratio	Omega	=	-	
N. B. Origin At Lower Left Corner				
Reservoir Length	(xe)	=	10000	ft
Reservoir Width	(ye)	=	10000	ft
Active Well At	xw	=	5000	ft
Active Well At	yw	=	5000	ft

Table 4.3 Continued

Water Well Test - SYNTHESIZER

Storage - Skin - Boundaries Model

HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A

PRESSURE FALL-OFF
JANUARY 23-25,1996

Production And Pressure

Final Water Rate	qw =	-7371.00	bbl/d	
Final Flowing Pressure	Pwfo =	1818.5	psi	

Fluid Properties

Reference Pressure	pRef =	1506.0	psi	<DEF>
Water Formation Vol Factor	Bw =	1.05		
Water Compressibility	cw =	3.000×10^{-06}	psi^{-1}	<DEF>
Water Viscosity	muw =	0.710	cp	
Oil Formation Vol Factor	Bo =	1.15		<DEF>
Oil Compressibility	co =	1.919×10^{-04}	psi^{-1}	<DEF>
Oil Viscosity	muo =	3.372	cp	<DEF>
Solution Gas Oil Ratio	Rso =	276.3	scf/bbl	<DEF>
Gas Formation Vol Factor	Bg =	1.53×10^{-03}		<DEF>
Gas Compressibility	cg =	7.684×10^{-04}	psi^{-1}	<DEF>

Reservoir Parameters

Net Pay	h =	165.00	ft	
Total Porosity	phit =	33.00	%	
Water Saturation	Sw =	100.00	%	
Oil Saturation	So =	0.00	%	
Gas Saturation	Sg =	0.00	%	
Wellbore Radius	rw =	0.30	ft	<DEF>

Table 4.3 Continued

Water Well Test - SYNTHESIZER

Storage - Skin - Boundaries Model

HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A

PRESSURE FALL-OFF
JANUARY 23-25,1996

Formation Temperature	T =	104.00 deg F	
Formation Compressibility	cf =	2.962×10^{-06} psi^{-1}	<DEF>
Total Compressibility	ct =	5.962×10^{-06} psi^{-1}	<DEF>

Table 4.3 Continued

Water Well Test - SYNTHESIZER

Storage - Skin - Boundaries Model

HOECHST CELANESE (BAY CITY)
WDW-110 WELL #1-A

PRESSURE FALL-OFF
JANUARY 23-25,1996

Synthesis Results

Average Error		=	12.5	psi
Initial Pressure	pi	=	1506.0	psi
Average Reservoir Pressure	pR	=	1517.9	psi
Pressure Drop Due To Skin	delps	=	-	psi
Flow Efficiency	FE	=	1.76	
Damage Ratio	DR	=	0.57	

Extended Rates

3 - Month Constant Rate	=	-5402.65	bbl/d
6 - Month Constant Rate	=	-4222.50	bbl/d
1 - Year Constant Rate	=	-2942.33	bbl/d
1 - Year Constant Rate @ Skin Of 0	=	-4199.29	bbl/d
1 - Year Constant Rate @ Skin Of -4	=	-4459.56	bbl/d

4.2 STATIC GRADIENT SURVEY

A static gradient survey was conducted while pulling out of the hole immediately following the bottom hole pressure falloff test. Stops were made at 3000', 2000', 1000', 500' and surface. Data collected during the static gradient survey is included in Appendix G and presented graphically in Figure 7. Data collected at each stop were as follows:

Table 4.4
Static Gradient Survey Results

Depth (ft)	Pressure (psia)	PSI/ft
0	77.99	
500	292.00	0.428
1000	508.70	0.433
2000	941.92	0.433
3000	1375.99	0.434
3300	1506.59	0.435
3474*	1582.34	0.435

* Pressure extrapolated to mid-point perforations.

APPENDIX A

RADIOACTIVE TRACER LOG AND ATLAS WIRELINE'S INTERPRETATION LETTER

DIAGNOSTIC RADIOACTIVE TRACERLOG

Hoechst Celanese Chemical Group, Inc.
Waste Disposal Well #110
Bay City Plant
Matagorda County, Texas

Prepared for
ECO Solutions, Inc.
Houston, Texas

WESTERN ATLAS LOGGING SERVICES
WESTERN ATLAS INTERNATIONAL

January 25, 1996

Prepared by Freeman Hill, III

DISCLAIMER

In making interpretations of logs, our employees will give Customer the benefit of their best judgement, but since all interpretations are opinions based on inferences from electrical or other measurements, we cannot, and we do not guarantee the accuracy or the correctness of any interpretation. We shall not be liable or responsible for any loss, cost, damages, or expenses whatsoever incurred or sustained by the Customer resulting from any interpretation made/by any of our employees.

Disposal Well Background

The Hoechst Celanese Chemical Group, Inc.'s waste disposal well #110, located at the Bay City facility has been used for underground injection of waste fluids. In addition to surface casing, the well contains a string of 9 5/8 inch O.D. casing cemented from surface to 4,718 ft. with a PBTD of 3,550 ft. Five and a half inch pipe (5 1/2 inch) is within the 9 5/8" casing, and is from surface to 3,380 ft. Measured depth was at 3,545 ft. The Injection Interval is located from 3,376 ft. to 3,572 ft.

A logging program consisting of a Radioactive Tracerlog (ejector and two detector instrument), was used to evaluate the integrity of the casing and cement. This should also verify that the injection interval is accepting the disposed fluids.

Radioactive Tracerlog Survey

1. Logged base gamma ray detector pass from 3,536 ft. to 2,820 ft.

   Purpose: Base-line for radioactive tracer instrument and comparison for post survey.

   Analysis: Gamma ray instruments respond to naturally occurring and man-made radiation. For this logging run, we will only consider the naturally occurring radiation (e.g., potassium, uranium, and thorium) found in formations. Normally, shaly formations tend to contain more of these gamma ray producing elements than a sand formation.

2. Repeat step (1.) Base gamma ray pass from 3,407 ft. depth to 3,220 ft.

   Analysis: No anomalies noted.

3. Statistical stationary check. (5 minute)(3,356 ft)

   Purpose: To establish stability of instrumentation before proceeding with testing.

   Analysis: No anomalies found. Tool operating properly and stable.

4. While injecting into the well at a rate of 50 gpm, radioactive material (Iodine-131) was ejected from the radioactive tracer instrument (@ 2,900 ft.). The instrument was lowered further into the well and then logged in the upward direction in order to intercept radioactive slug as it moved down the well. By repeating this process of lowering the instrument and logging in the upward direction, the radioactive slug was traced through the casing packer and into the injection interval located below.

Purpose: Ensure injected fluids move through the tubing in a downward direction and that no upward or out of zone fluid movement through a cement channel is detected.

Analysis: The following table depicts the depths where the detectors intercepted the radioactive slug as it moved with the surface-injected fluids downward toward the injection interval.

Interception Number	Depth, ft.(Bottom Detector) (BDET)
1	2,999
2	3,165
3	3,335
4	3,393 and dispersing
5	dispersing
6	dispersing
7	dispersing
8	dispersing
9	dispersing

The radiation peak responses from the first pass to the ninth pass, become smaller, but cover a longer vertical interval, due to the movement of the wireline and instrument mixing the radioactive slug with the injected fluids. No anomalies seen.

5. Repeat step (4.) (50 gpm)

Analysis: The following table depicts the depths where the detector intercepted the second radioactive slug as it moved with the injected fluids downward toward the injection interval.

Interception Number	Depth, ft.(Bottom Detector) (BDET)
1	3,032
2	3,251
3	3,390 and dispersing
4	dispersing
5	dispersing
6	dispersing
7	dispersing

The radioactive peak responses from the first to the seventh pass, become smaller, but cover a longer vertical interval, due to the movement of the wireline and instrument mixing the radioactive slug with the injected fluids. The radioactive material appears to continually move in the downward direction and into the disposal interval. There is no evidence of any problems.

6. The tool was stationed at 3,356 ft., above the disposal interval, for a stationary reading. The radioactive isotope is released and after the initial response to the isotope passing by the detector in a downward motion, then the isotope or an increase in radiation, should not be monitored again. If the isotope is seen again, then communication (channel behind the pipe) is highly possible.

Purpose: Ensure injected fluids move downward and not back up on the outside of casing in a channel. (Pump rate 50 gpm) (20 minute test.)

Analysis: After initial response to the radioactive slug, the isotope did not come back in the tool's vicinity. No channel indicated.

7. Repeat step (6.) (Pump rate = 50 gpm) (20 minute test.)

Purpose: Ensure injected fluids are not channeling up.

Analysis: After the initial response to the radioactive slug, the isotope did not come back in the tool's vicinity. No channel indicated.

8. Logged gamma ray detectors from 3,537 ft. to 2,817 ft.

Purpose: Monitor any anomalies or changes in background baseline.

Analysis: There are gamma ray "hot spots" in the injection interval. This is probably due to the amount of time pumping and isotope released during the previous stationary tests. The isotope migrated to the lower part of the injection interval, where the fluid is dispersing into the formation at a much slower rate. No anomalies found above injection interval.

9. Repeat step (8.) Logged gamma ray detectors from 3,537 ft. to 3,232 ft.

Purpose: Monitor any anomalies or changes in background baseline.

Analysis: The gamma ray "hot spots" in the injection interval did repeat indicating no upward movement.

Conclusion:

In my opinion, the Hoechst Celanese Waste Disposal Well #110, located in the Bay City Plant, does not have any integrity problems that would result in disposed fluids migrating to intervals other than the injection interval. The logging program consisting of a radioactive tracer ejector and detector instrument should satisfy the annual mechanical integrity requirement.

Hoechst Celanese Chemical Group, Ltd.
RAT - Tracer Survey #1
WDW - 110

No. Pass	Depth Start	Depth Stop	Time Start	Time Stop	Slug Depth	Slug Time	Remarks
	2900		3:15:18				
1	3100	2900	3:51:34	3:53:00	2999	3:52:24	3 second
2	3300	2990	:54:15	:56:15	3164	:55:30	50gpm
3	3400	3150	:58:05	:59:15	3335	:58:45	
4	3500	3325	4:01:42	4:02:50	3393	4:03:30	
5	3470	3386	:04:10	:05:25	3403	:04:50	
6	3530	3350	:06:55	:08:10	3408	:08:00	
7	3545	3390	:10:08	:11:40	3418	:11:25	
8	3540	3398	:12:50	:14:20	3420	:13:55	
9	3540	3390	:16:20	:18:35	3422	:18:10	

Tracer #2

	2900		5:16:15				
1	3100	2900	:18:10	5:20:20	3032	5:18:15	3 sec
2	3294	3017	:22:55	:25:20	3252	:23:00	50 gpm
3	3440	3236	:27:20	:29:30	3390	:28:00	
4	3466	3365	:30:30	:32:00	3402	:31:40	
5	3580	3380	:33:05	:34:40	3410	:34:30	
6	3534	3360	:35:15	:36:45	3413	:36:30	
7	3528	3470	:35:40	:46:42	3423	:46:20	

Stationary Survey

No.	Depth	Start Survey	Survey Time
#1	3356'	6:03:09	20 minutes
#2	3356'	6:29:14	20 minutes

Final: 3550 - 2900 7:25:53 - 7:36:00

FEB 26 1996

WESTERN ATLAS

Atlas Wireline Services

PRODUCTION LOGGING SERVICES

FINAL PRINT

FILE NO.	95237
API NO.	
COMPANY	HOECHST CELANESE CHEMICAL GROUP, LTD.
WELL	WASTE DISPOSAL WELL NO. 1-A
FIELD	BAY CITY PLANT
COUNTY	MATAGORDA
STATE	TEXAS

LOCATION:

BAY CITY PLANT

SEC N/A TWP N/A RGE N/A

OTHER SERVICES

PERMANENT DATUM	GROUND LEVEL	ELEV.	N/A
LOGGING MEASURED FROM	RKB	17.0'	FT. ABOVE P.D.
DRILLING MEASURED FROM	RKB		

ELEVATIONS

KB	N/A
DF	N/A
GL	N/A

DATE	25-JAN-96	
RUN	1	
SERVICE ORDER	177454	
DEPTH-DRILLER	3550' PBTD	
DEPTH-LOGGER	3545'	
BOTTOM LOGGED INTERVAL	3545'	
TOP LOGGED INTERVAL	2820'	
TYPE FLUID IN HOLE	INJECTION WATER	
SALINITY PPM CL.	-----	
DENSITY LB/GAL.	-----	
LEVEL	FULL	
MAX. REC. TEMP. DEG. F	N/A	
OPR. RIG TIME	10 HRS.	
EQUIP. NO. / LOC.	ML-4110 PEARLAND	
RECORDED BY	HARBSTREIT	
WITNESSED BY	MR. WESS SMITH	

BOREHOLE RECORD

NO.	BIT	FROM	TO

FOLD HERE

IN MAKING INTERPRETATIONS OF LOGS OUR EMPLOYEES WILL GIVE CUSTOMER THE BENEFIT OF THEIR BEST JUDGEMENT, BUT SINCE ALL INTERPRETATIONS ARE OPINIONS BASED ON INFERENCES FROM ELECTRICAL OR OTHER MEASUREMENTS, WE CANNOT, AND WE DO NOT GUARANTEE THE ACCURACY OR CORRECTNESS OF ANY INTERPRETATION. WE SHALL NOT BE LIABLE OR RESPONSIBLE FOR ANY LOSS, COST, DAMAGES, OR EXPENSES WHATSOEVER INCURRED OR SUSTAINED BY THE CUSTOMER RESULTING FROM ANY INTERPRETATION MADE BY ANY OF OUR EMPLOYEES.

CASING RECORD

SIZE	WGT	FROM	TO
7.625	-----	SURFACE	3550
5.500	-----	SURFACE	3376

REMARKS RUN (1)

PURPOSE OF LOG WAS TO TEST THE MECHANICL INTEGRITY OF WELL NO. 1-A. A TOTAL OF 10 MCI OF IODINE 131 WAS USED. AT TIME OF LOGGING THE INJECTION RATE WAS 50 GPM STEADY. ALL TIME FILES ARE RECORDED AT 1/FOOT. NOTE: THE DETECTOR SPACING WAS 6 FEET.

AFTER LOG RESULTS INDICATE A GOOD M.I.T. TEST AND THAT ALL INJECTION FLUIDS APPEAR TO BE ENTERING COMPLETION ZONE OF 3376 TO 3572.

EQUIPMENT DATA

RUN	TRIP	TOOL	SERIAL NO.	SERIES NO.	POSITION

PURPOSE OF LOG IS TO CHECK
THE M.I.T. OF THE WELL
NO.1-A (WDW-110)

BEFORE LOG BASE PASS

****

FILE: 2

PARAMETERS

*** NONE ***

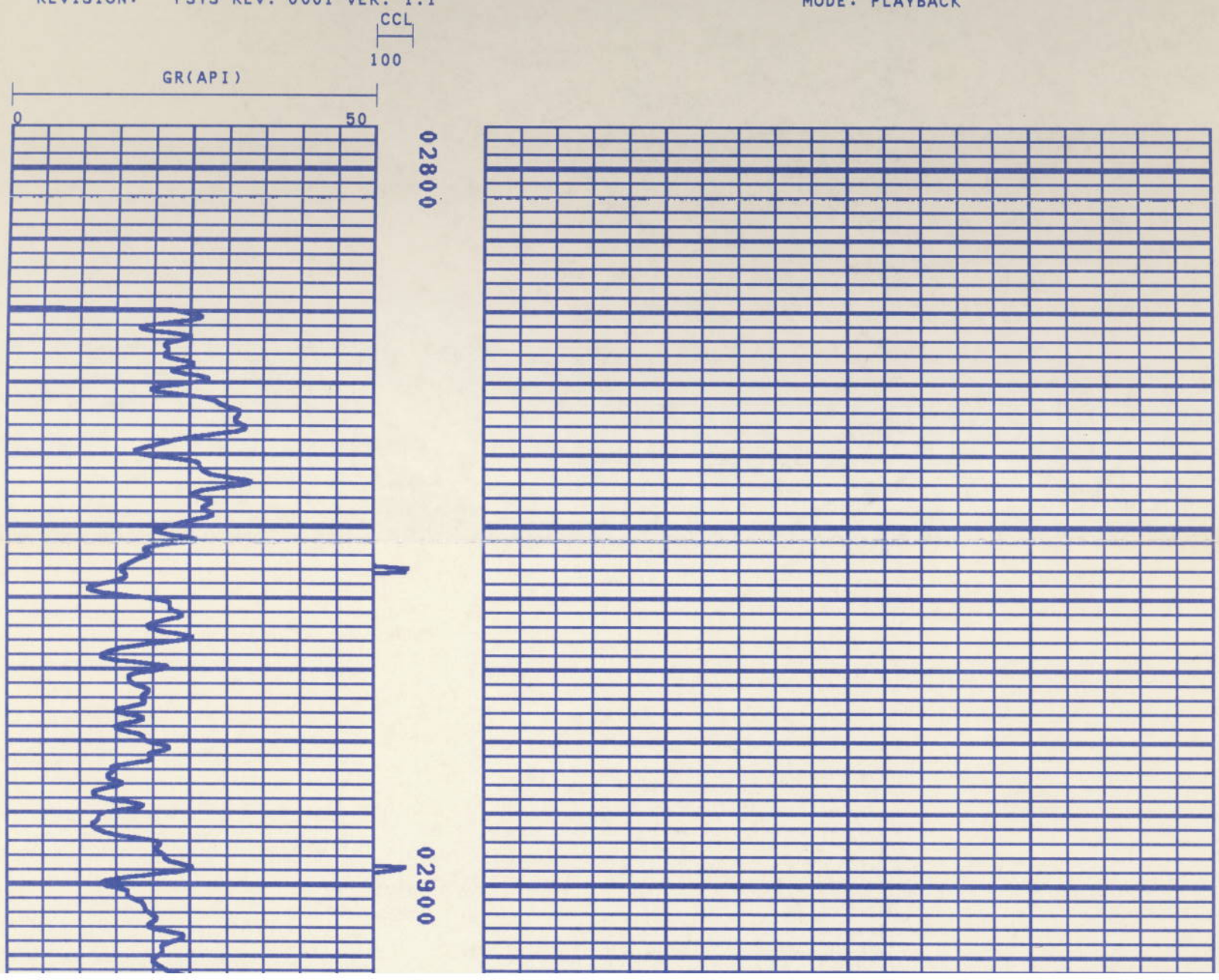
DISPLAY SCALE CHANGES

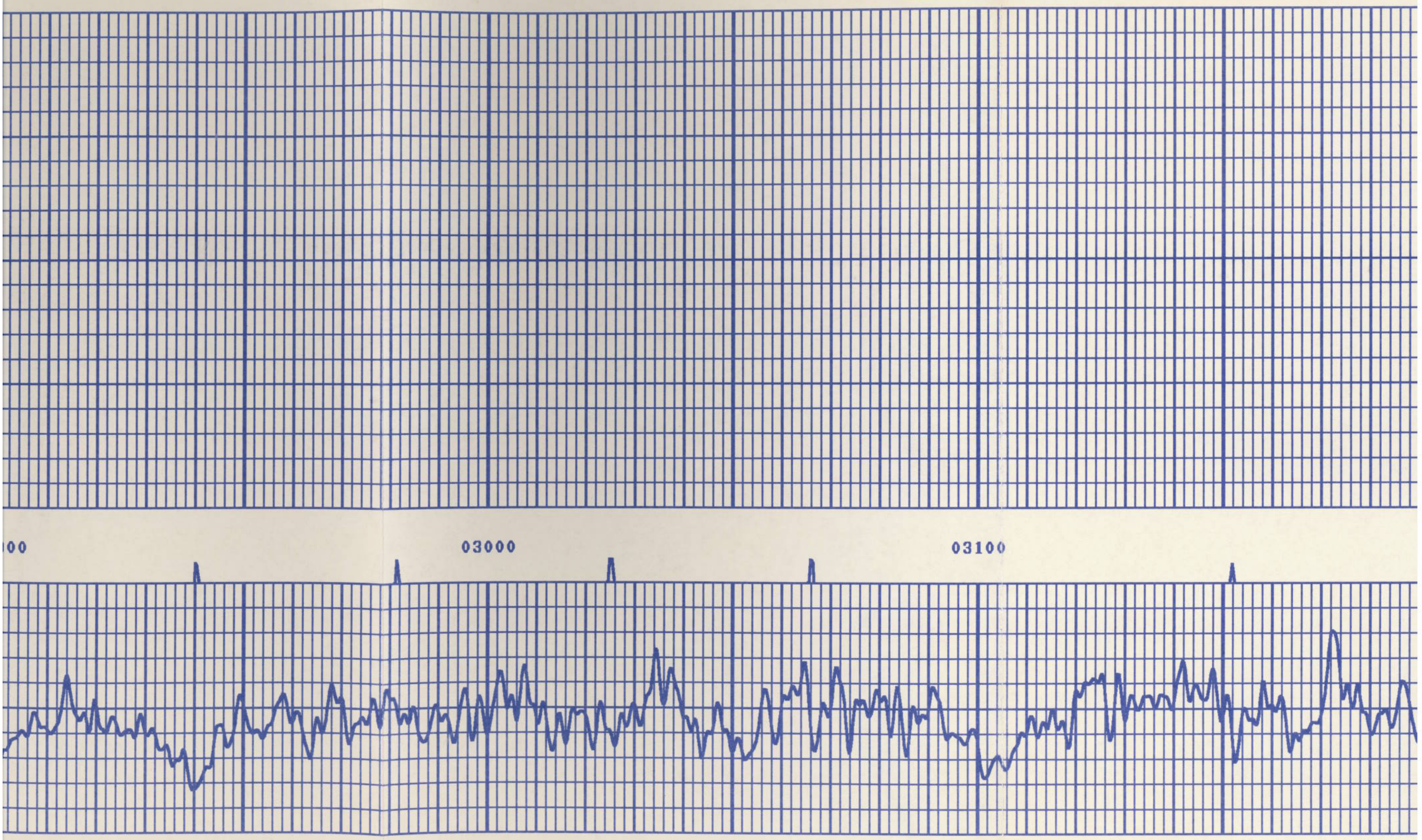
*** NONE ***

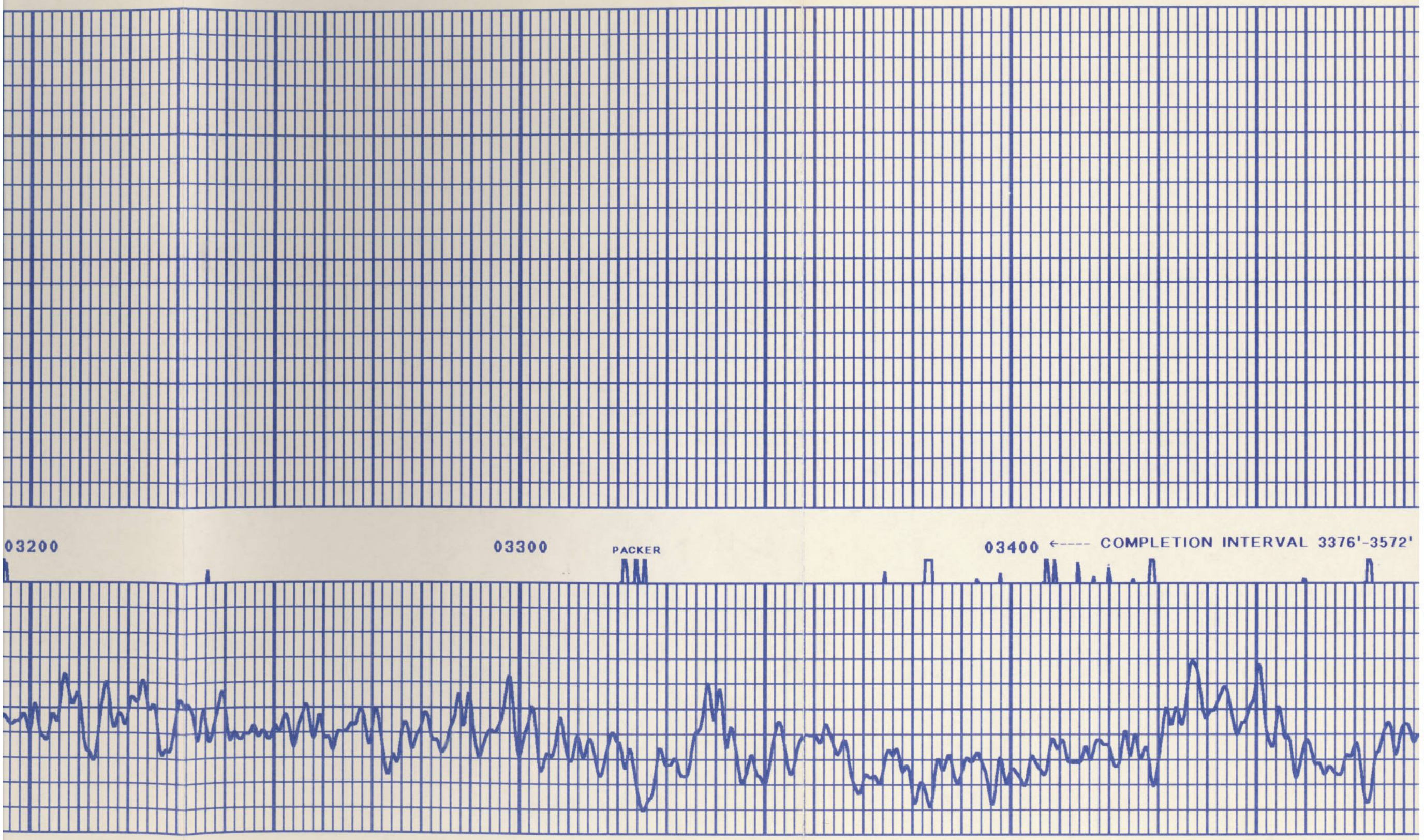
LTD

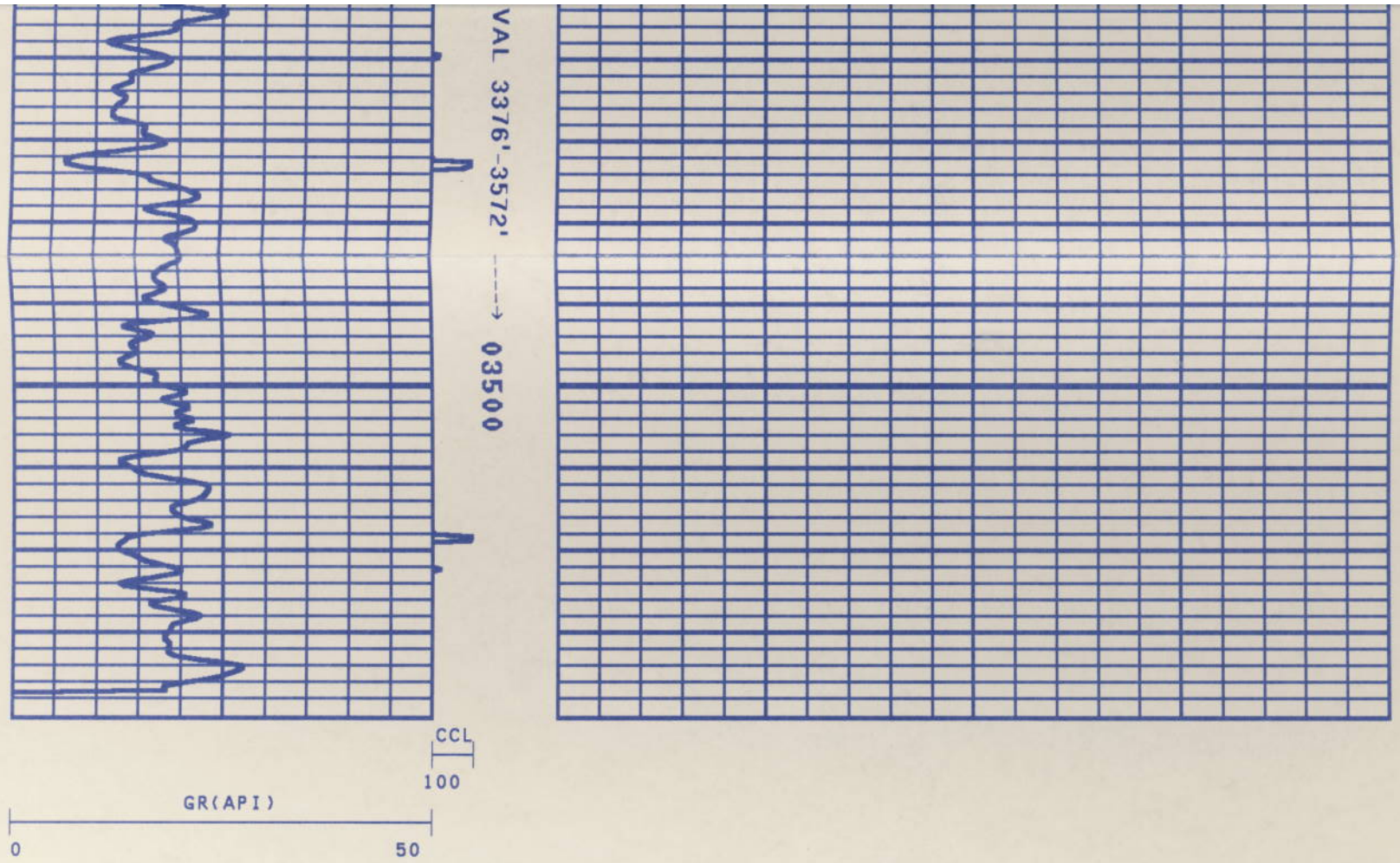
COMPANY: HOECHST CELANESE CHEMICAL GROUP, [redacted].
WELL NAME: WASTE DISPOSAL WELL NO.1-A
SERVICE: M 159P FILE: 2 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1

RUN: 1
TRIP: 1
TIME: 14:21:17
MODE: PLAYBACK




00
03000
03100


03200
03300
PACKER
03400
<---- COMPLETION INTERVAL 3376'-3572'



FILE: 2

****

BEFORE LOG BASE PASS REPEAT

****

FILE: 3

PARAMETERS

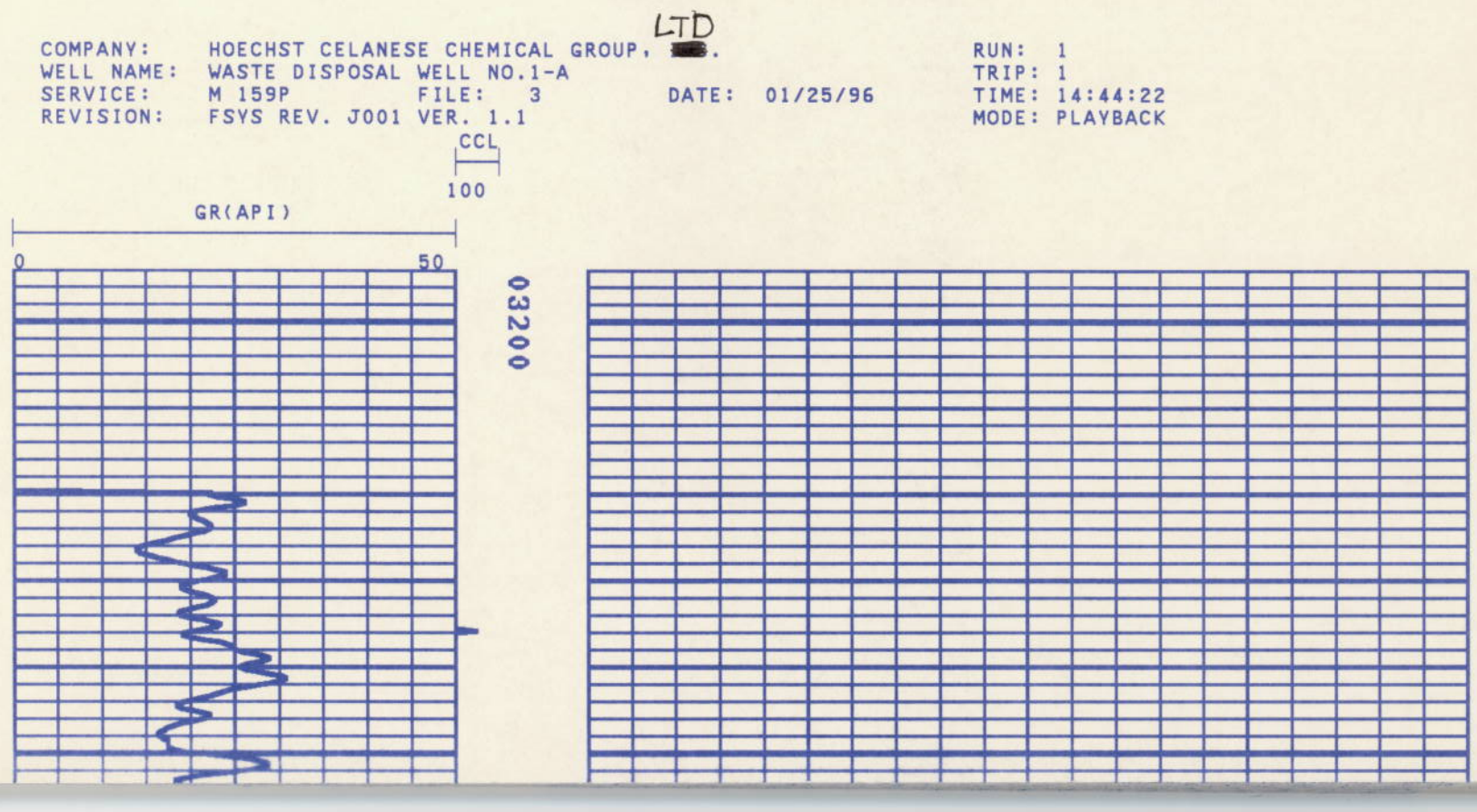
*** NONE ***

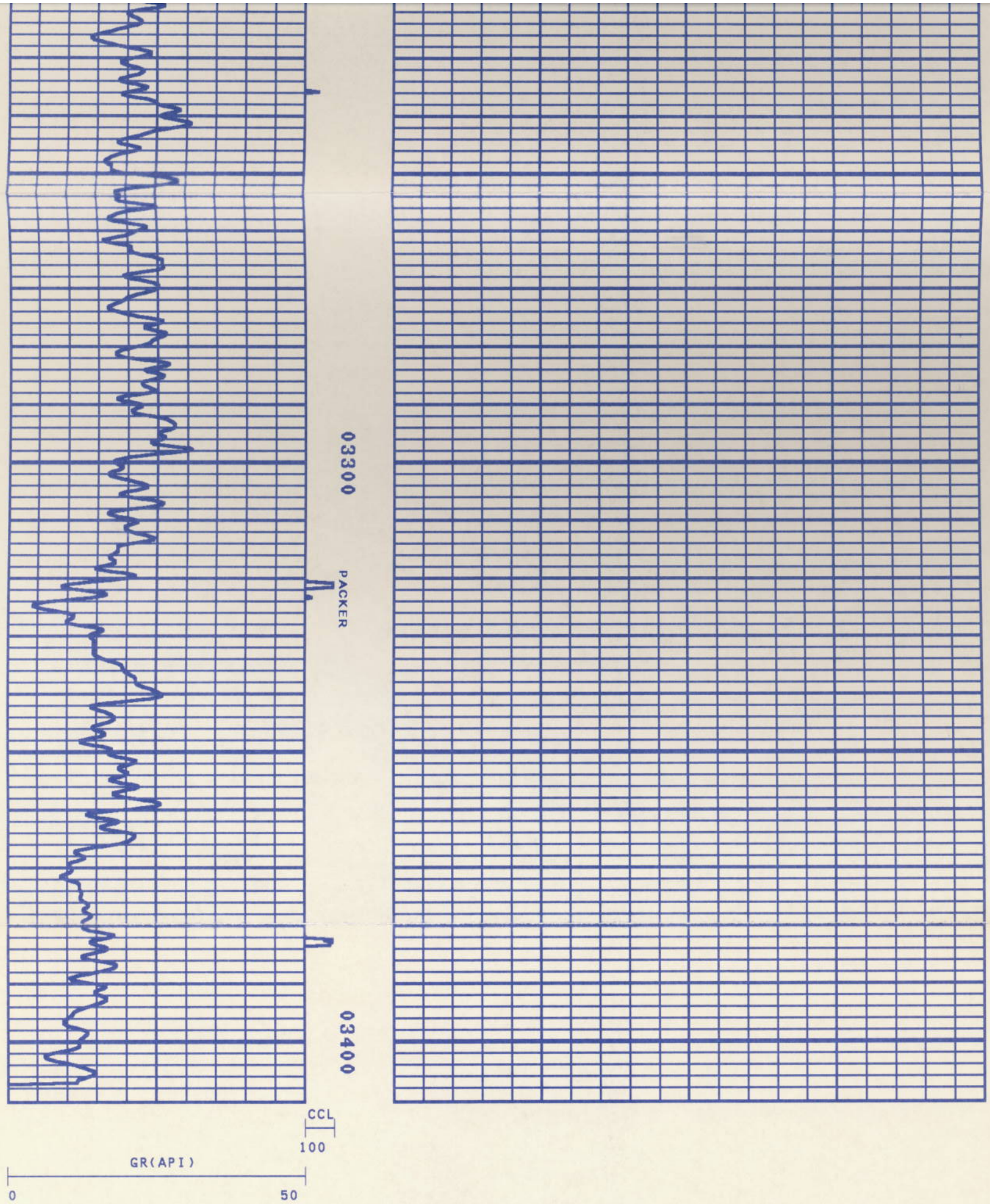
DISPLAY SCALE CHANGES

*** NONE ***

COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD [redacted].
WELL NAME: WASTE DISPOSAL WELL NO.1-A
SERVICE: M 159P FILE: 3 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1

RUN: 1
TRIP: 1
TIME: 14:44:22
MODE: PLAYBACK





FILE: 3

****

5 MIN STAT CHECK AT 3356'

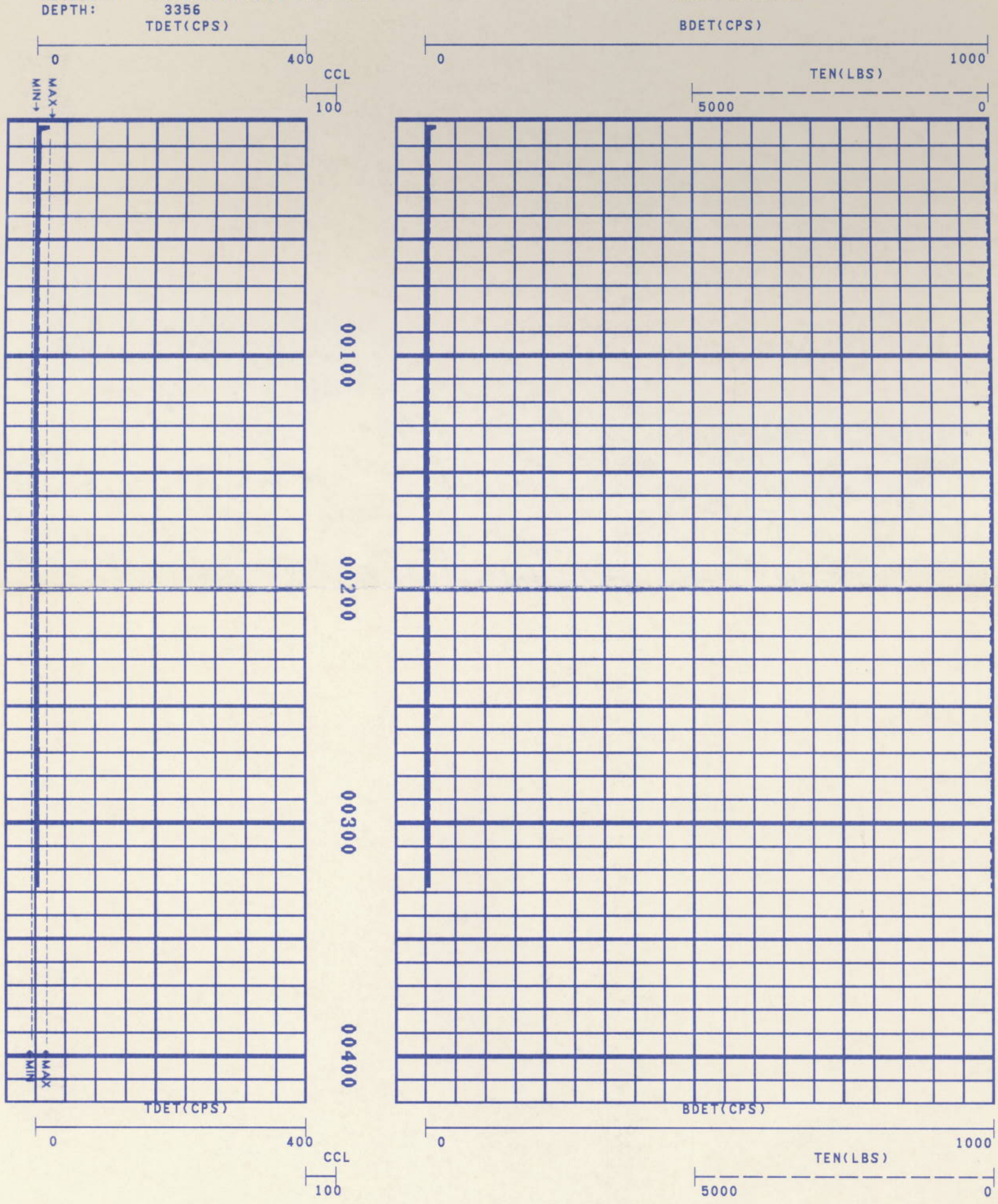
5 MIN STAT CHECK AT 3356'

****

FILE: 25

COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD [redacted].
WELL NAME: WASTE DISPOSAL WELL 1-A
SERVICE: M 150A FILE: 25 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1
DEPTH: 3356

RUN: 1
TRIP: 1
TIME: 17:55:38
MODE: PLAYBACK



DISPLAY SCALE CHANGES

*** NONE ***

0 400 CCL 100 | 0 1000 TEN(LBS) 5000 0

DISPLAY SCALE CHANGES

*** NONE ***

PARAMETERS

*** NONE ***

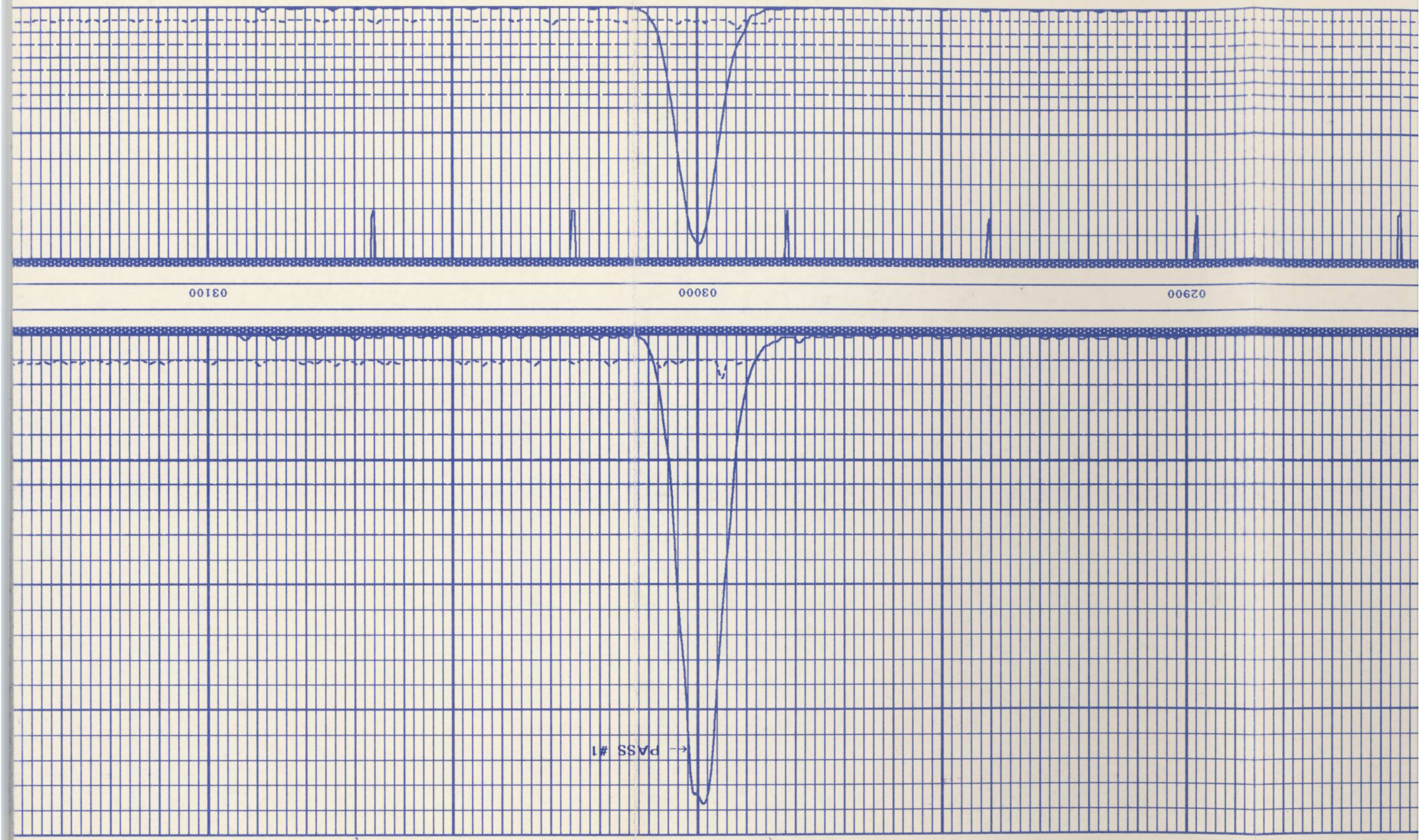
FILE: 25

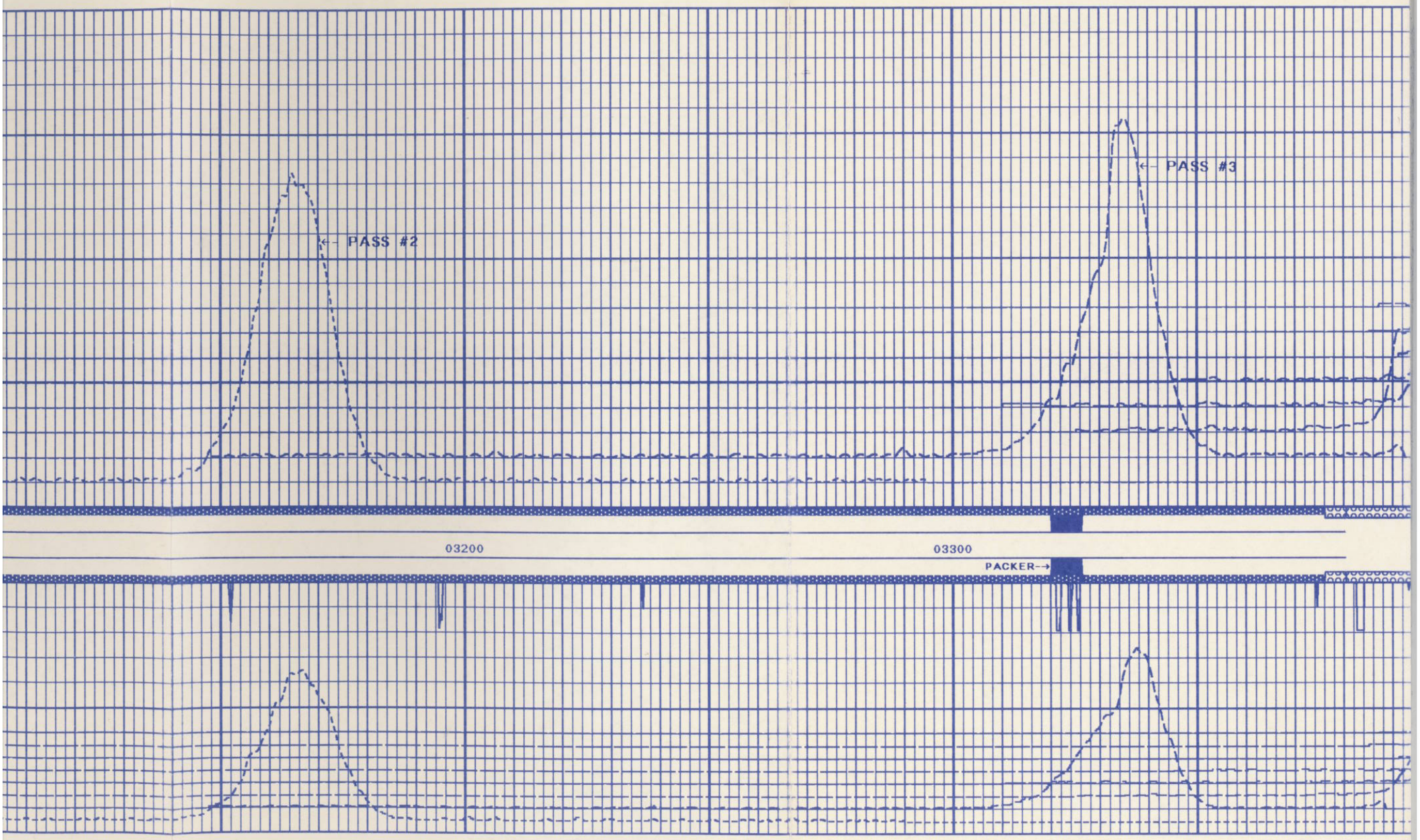
****

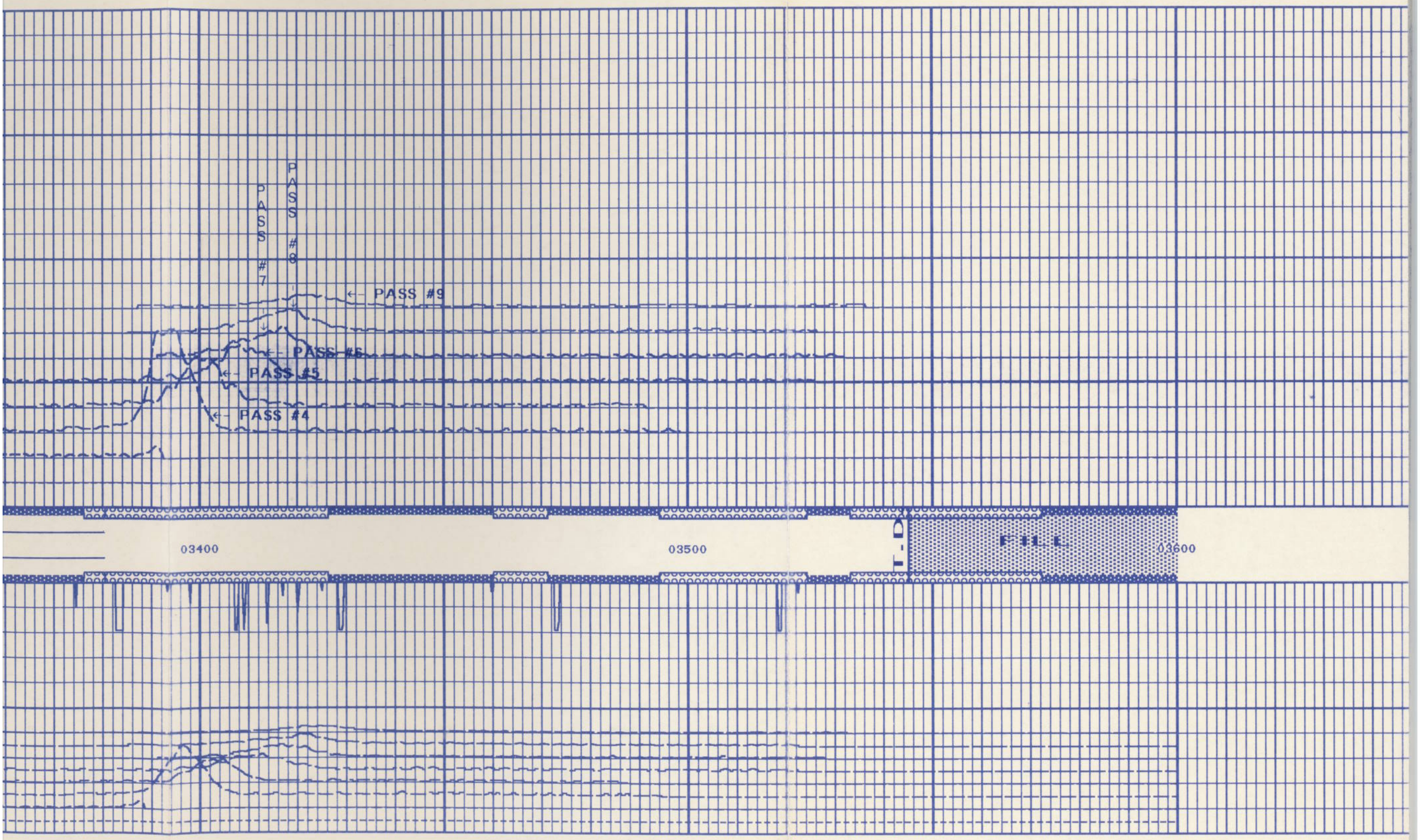
CHASE DOWN NO.1 SHOT SLUG AT 2900'
ALL DEPTHS REFERENCED TO BDET
RKB WAS +17'

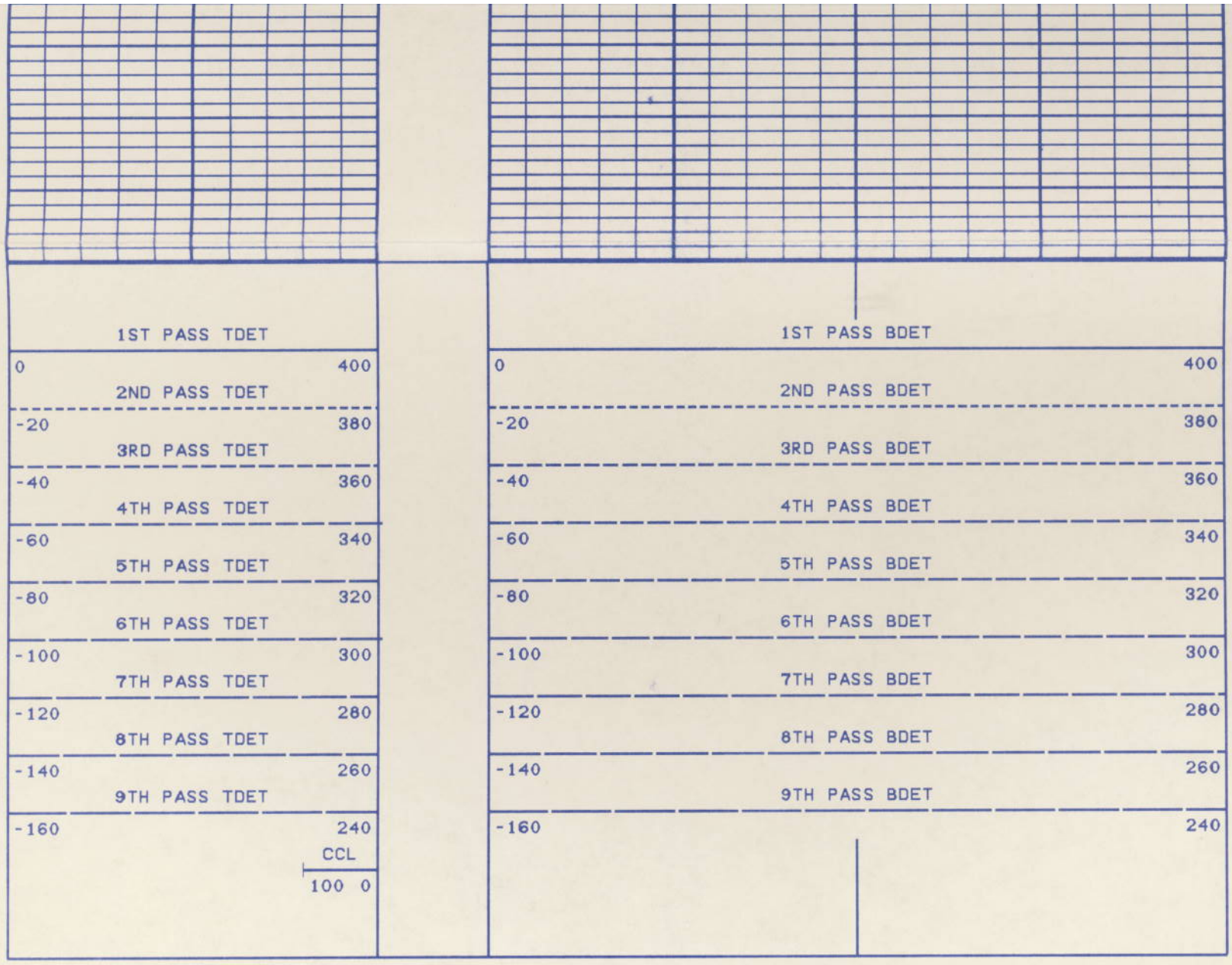
1ST PASS TDET		1ST PASS BDET	
0	400	0	400
2ND PASS TDET		2ND PASS BDET	
-20	380	-20	380
3RD PASS TDET		3RD PASS BDET	
-40	360	-40	360
4TH PASS TDET		4TH PASS BDET	
-60	340	-60	340
5TH PASS TDET		5TH PASS BDET	
-80	320	-80	320
6TH PASS TDET		6TH PASS BDET	
-100	300	-100	300
7TH PASS TDET		7TH PASS BDET	
-120	280	-120	280
8TH PASS TDET		8TH PASS BDET	
-140	260	-140	260
9TH PASS TDET		9TH PASS BDET	
-160	240	-160	240

CCL
100 0

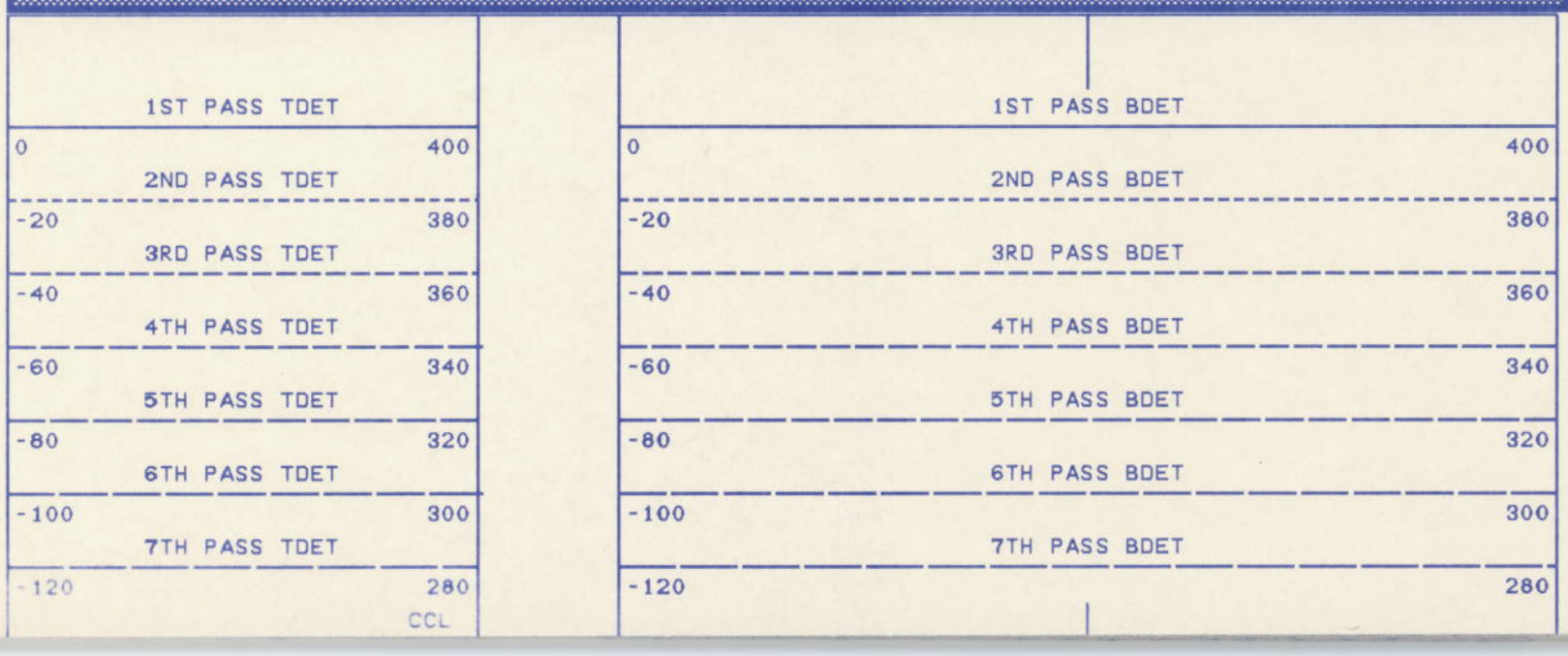

02900
03000
03100
← PASS #1 →

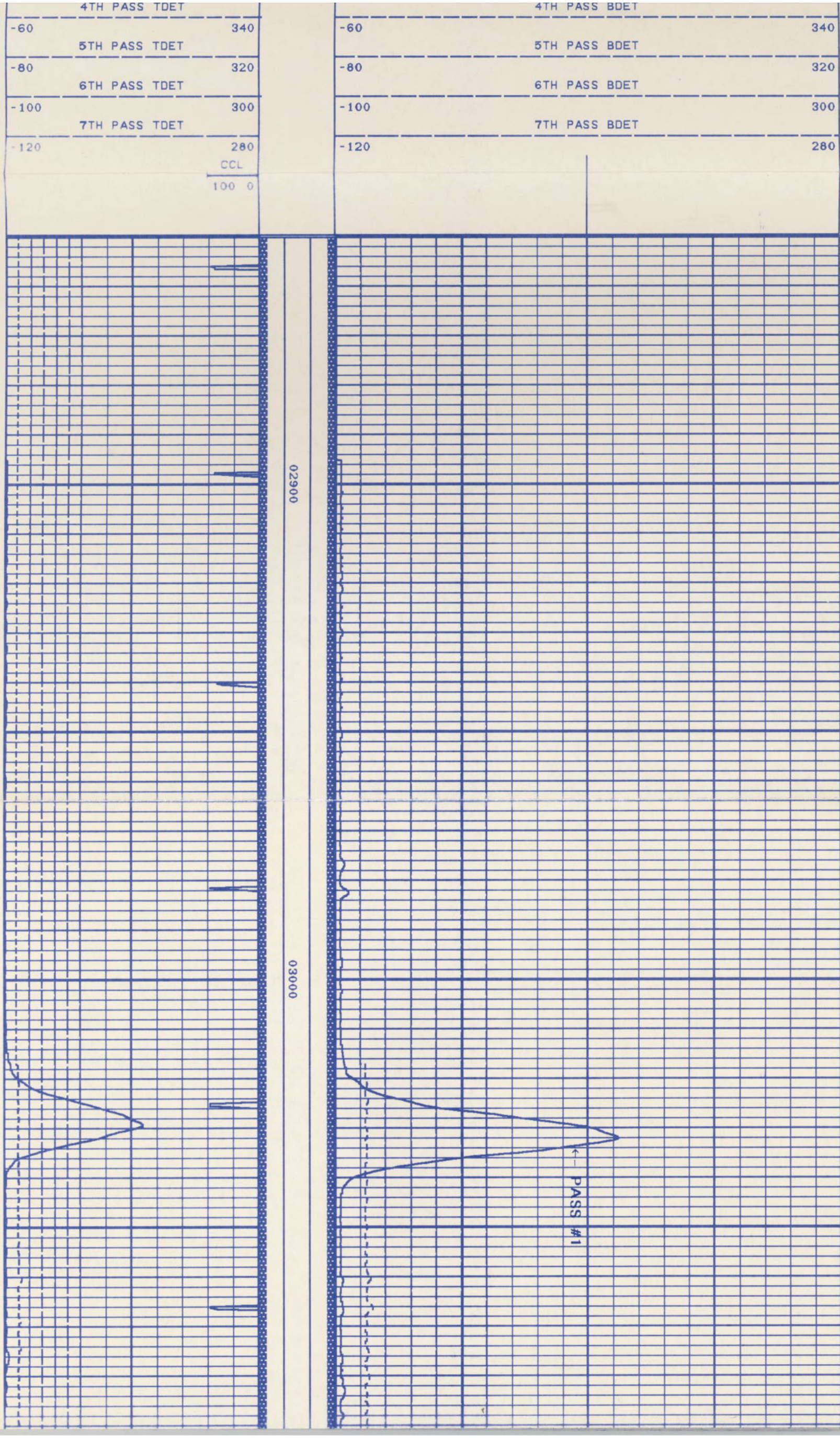

← PASS #2
← PASS #3
03200
03300
PACKER→

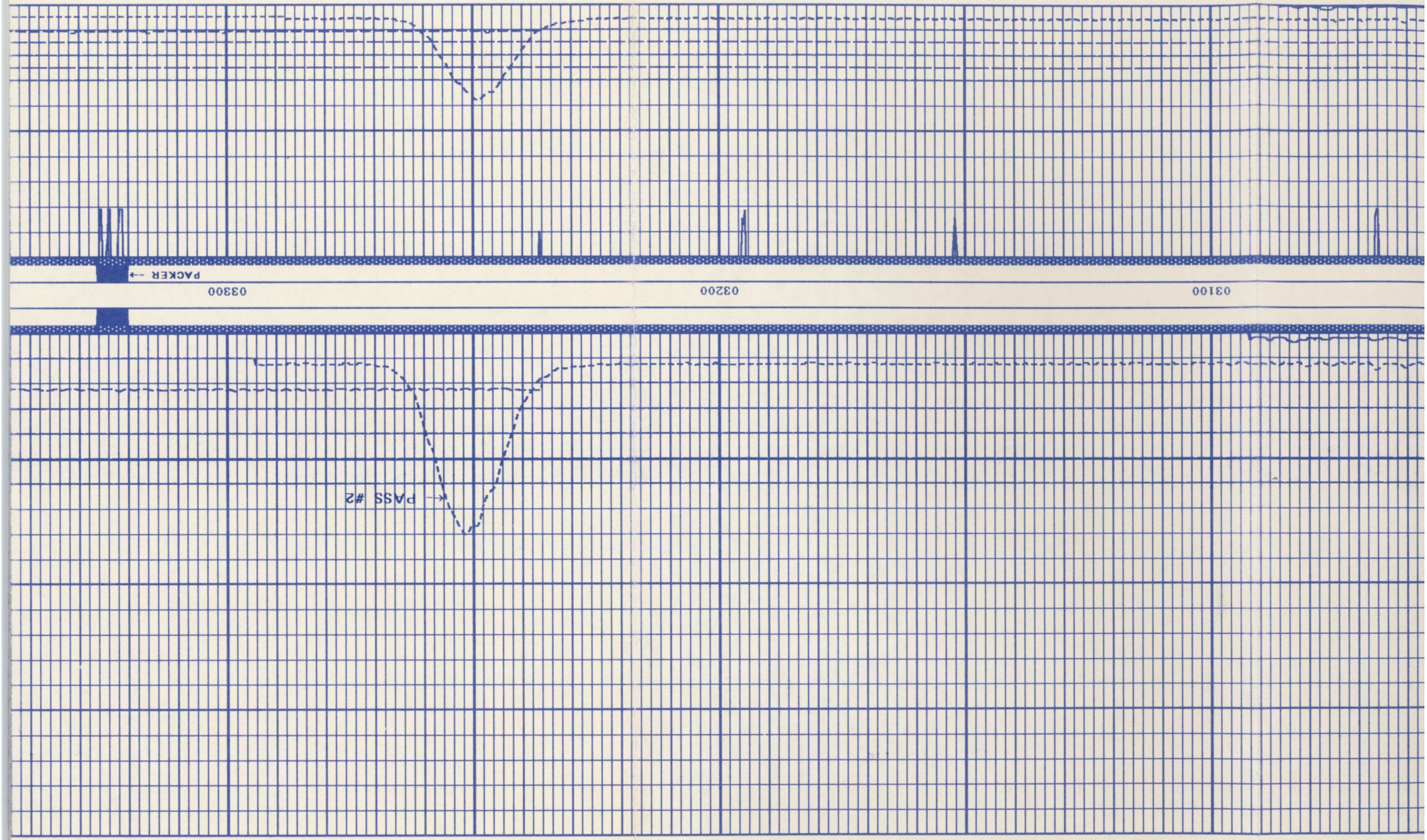

PASS #7
PASS #8
← PASS #9
← PASS #6
← PASS #5
← PASS #4
03400
03500
T-D
FILL
03600

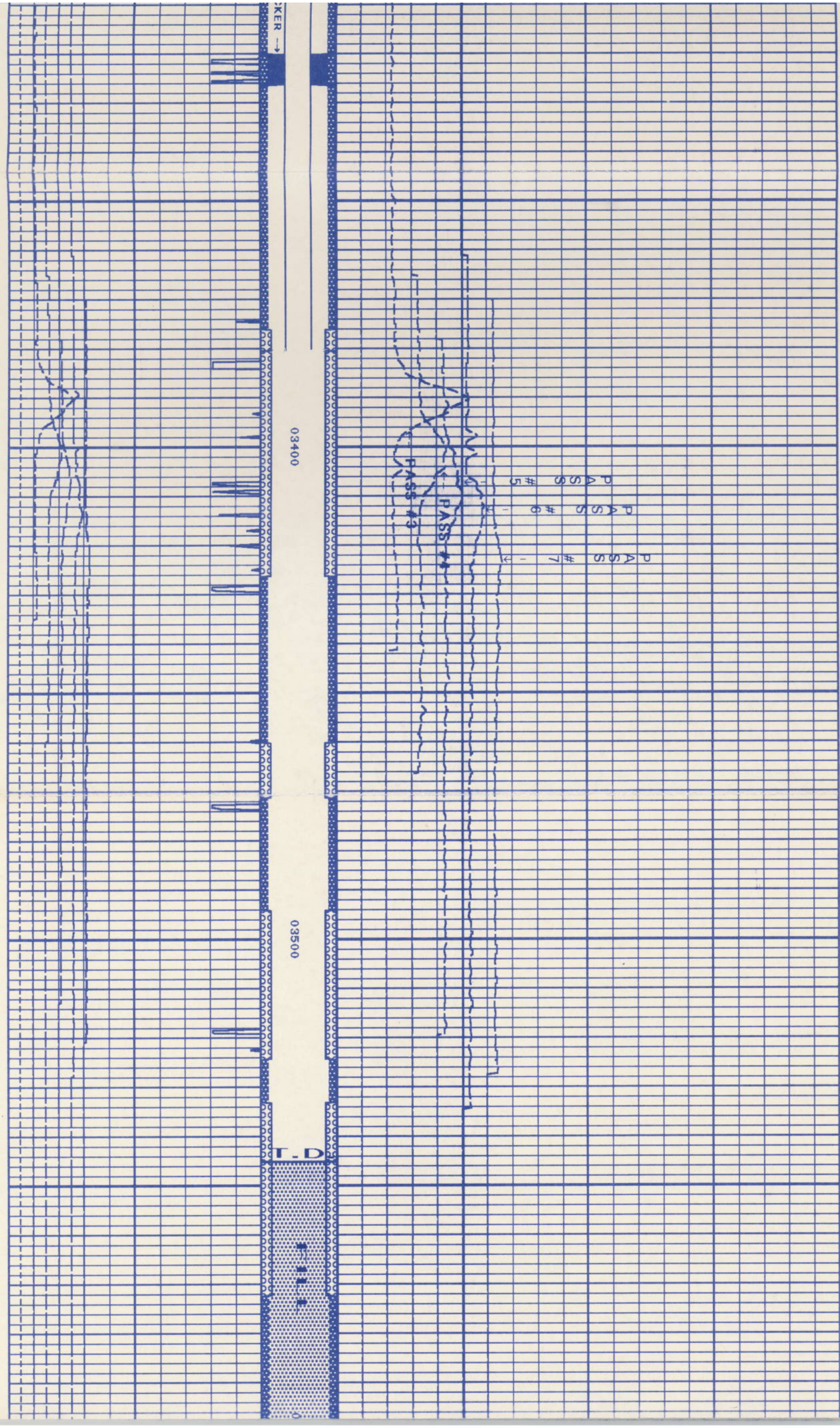


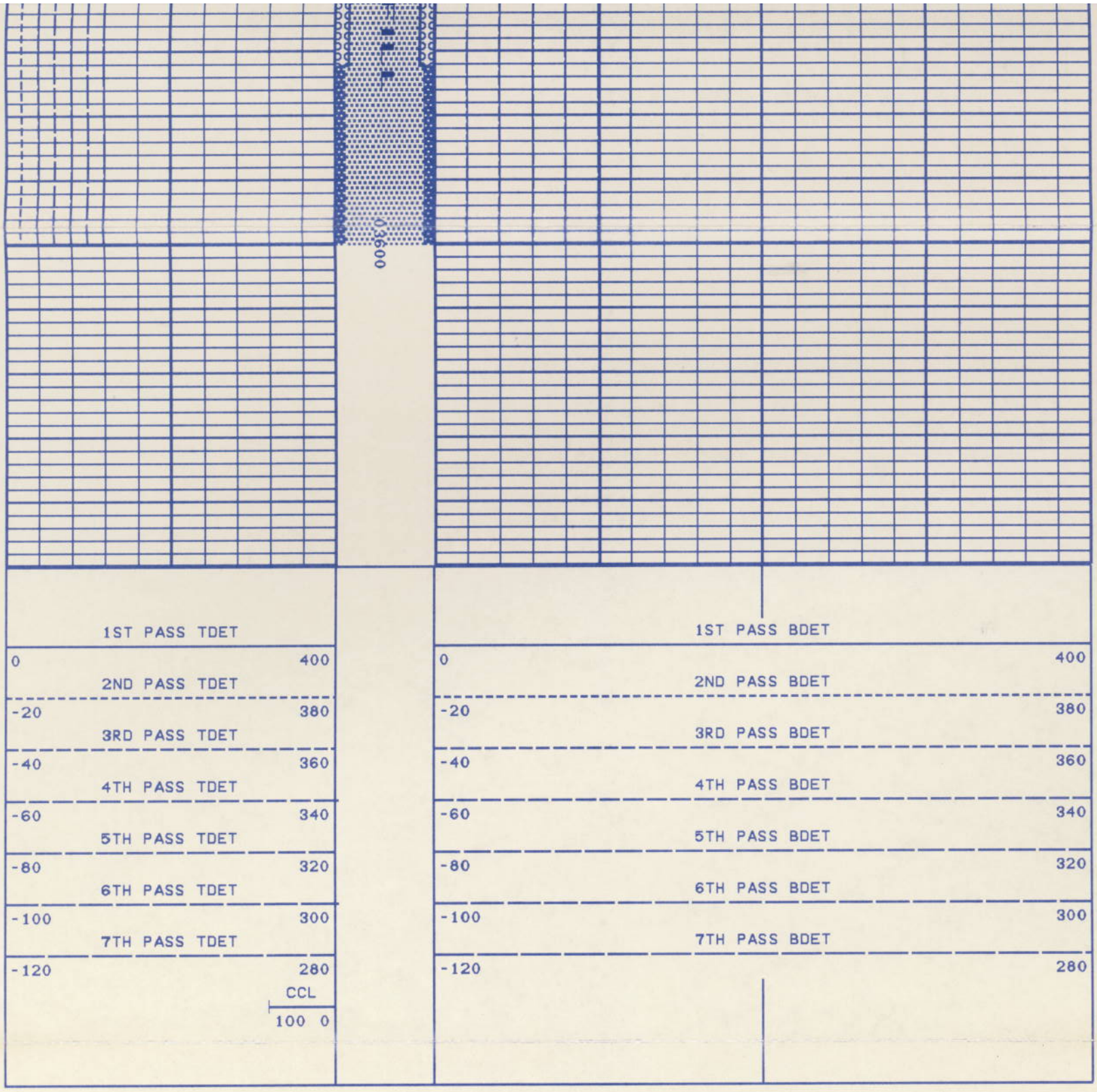
CHASE DOWN NO.2 SHOT SLUG AT 2900′
ALL DEPTHS REFERENCED TO BDET
RKB WAS +17′




4TH PASS TDET
-60
340
5TH PASS TDET
-80
320
6TH PASS TDET
-100
300
7TH PASS TDET
-120
280
CCL
100 0
4TH PASS BDET
-60
340
5TH PASS BDET
-80
320
6TH PASS BDET
-100
300
7TH PASS BDET
-120
280
02900
03000
← PASS #1


PACKER →
03300
03200
03100
← PASS #2


KER →
03400
03500
T.D
PASS #5
PASS #6
PASS #7
PASS #4
PASS #3



20 MIN. PERFORATIONS CHECK, SHOT SLUG AT 3356'. DURATION OF SHOT WAS 3 SECONDS.

****

FILE: 26

COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD.
WELL NAME: WASTE DISPOSAL WELL 1-A
SERVICE: M 150A FILE: 26 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1
DEPTH: 3356

RUN: 1
TRIP: 1
TIME: 18:03:14
MODE: PLAYBACK

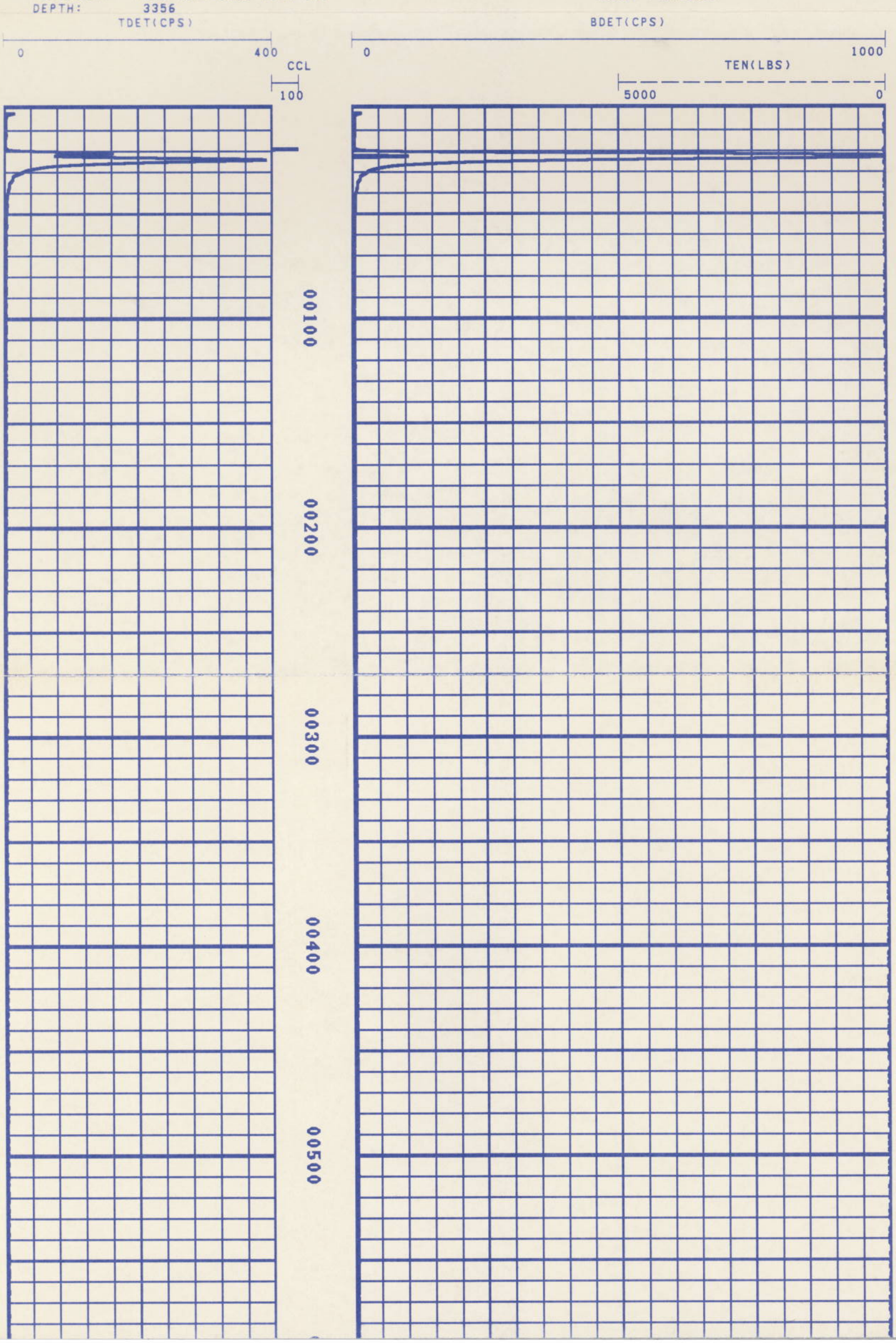
WAS 3 SECONDS.

****

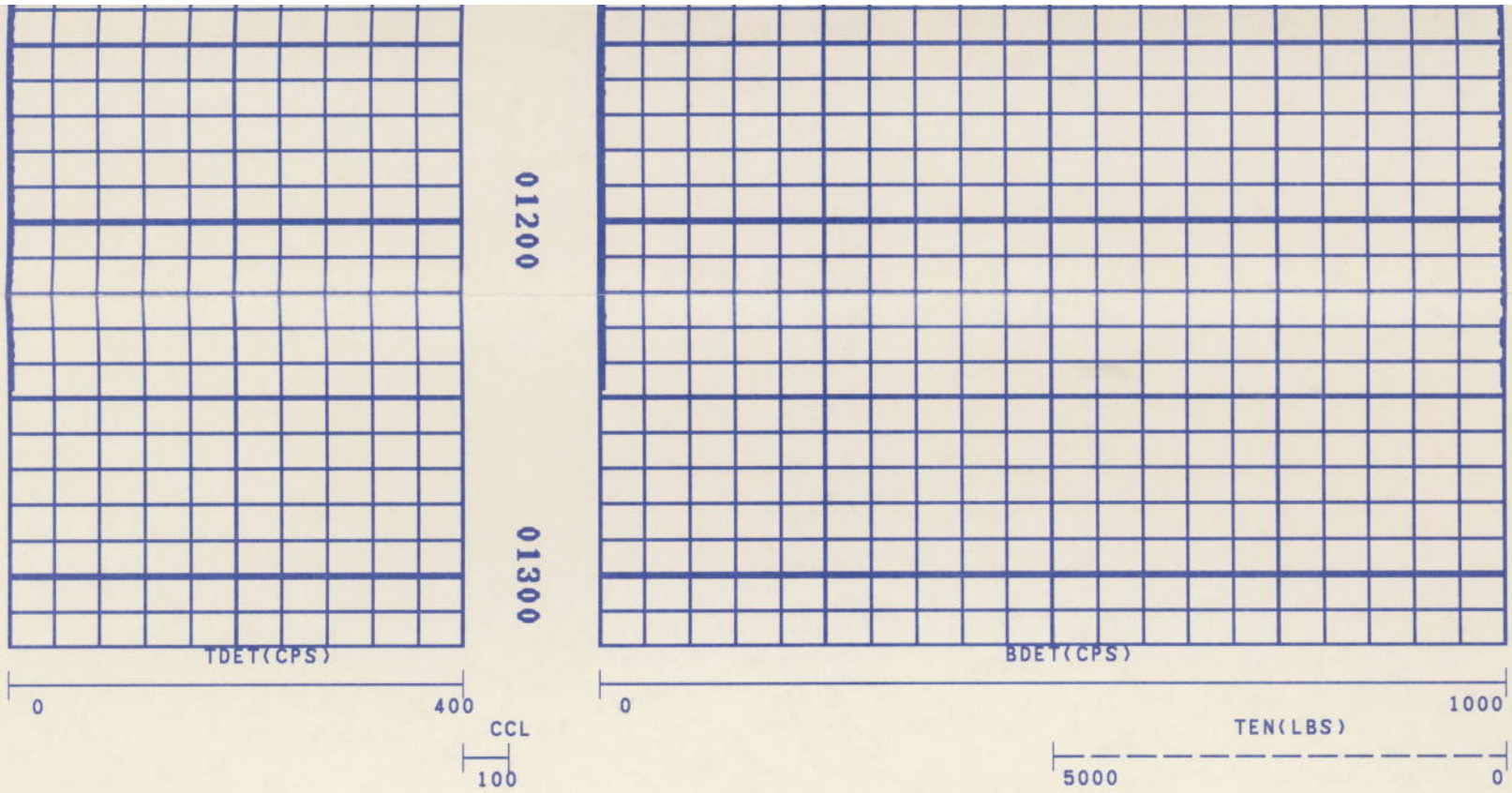
FILE: 26

COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD [redacted].
WELL NAME: WASTE DISPOSAL WELL 1-A
SERVICE: M 150A FILE: 26 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1
DEPTH: 3356

RUN: 1
TRIP: 1
TIME: 18:03:14
MODE: PLAYBACK



500 00600 00700 00800 00900 01000 01100 01200



DISPLAY SCALE CHANGES

*** NONE ***

PARAMETERS

*** NONE ***

FILE: 26

****

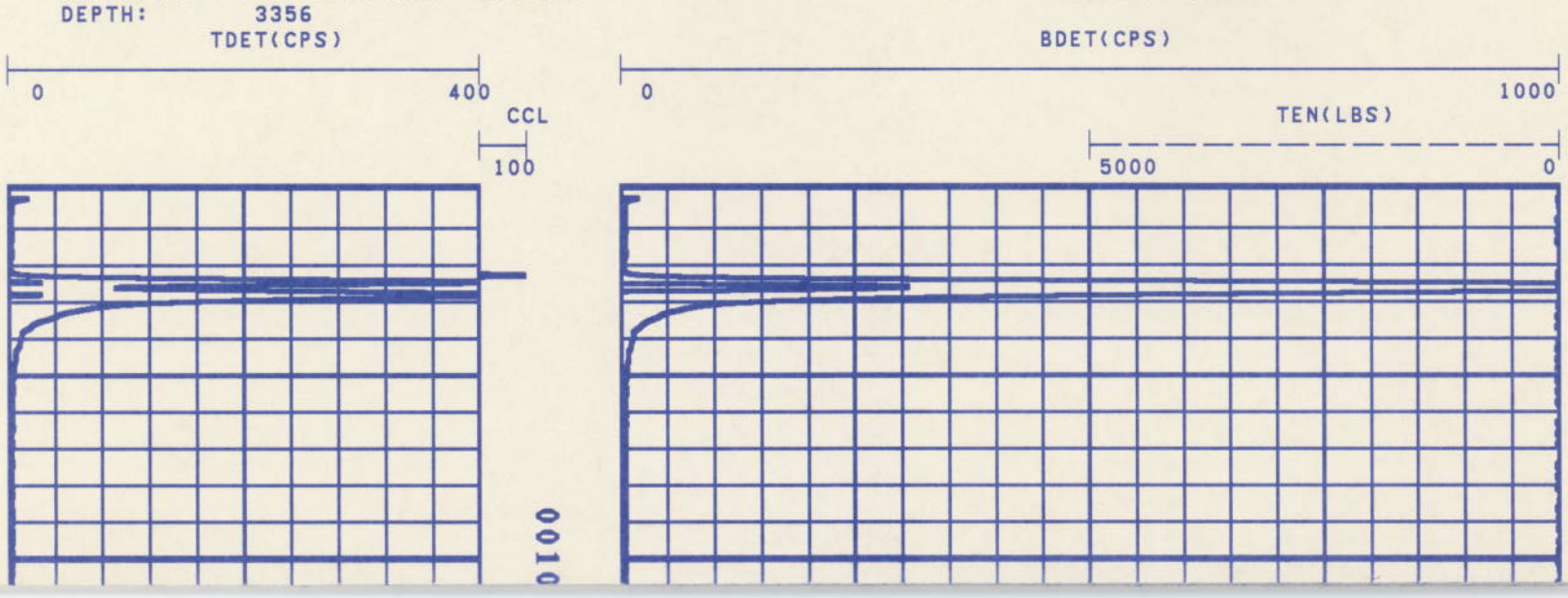
20 MIN. PERFORATIONS CHECK, SLUG SHOT AT 3356'. DURATION OF SHOT WAS 3 SECONDS.

****

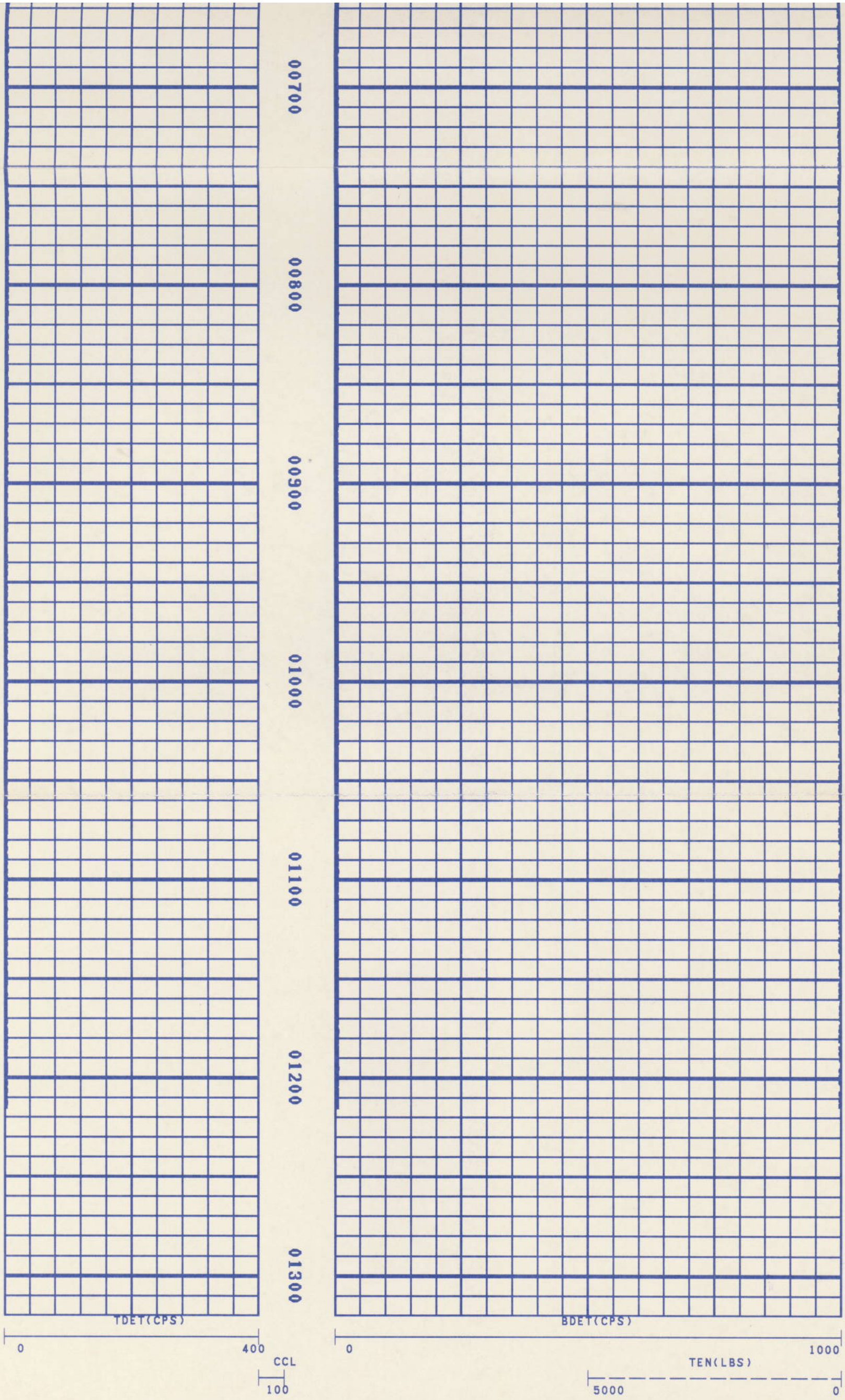
FILE: 27

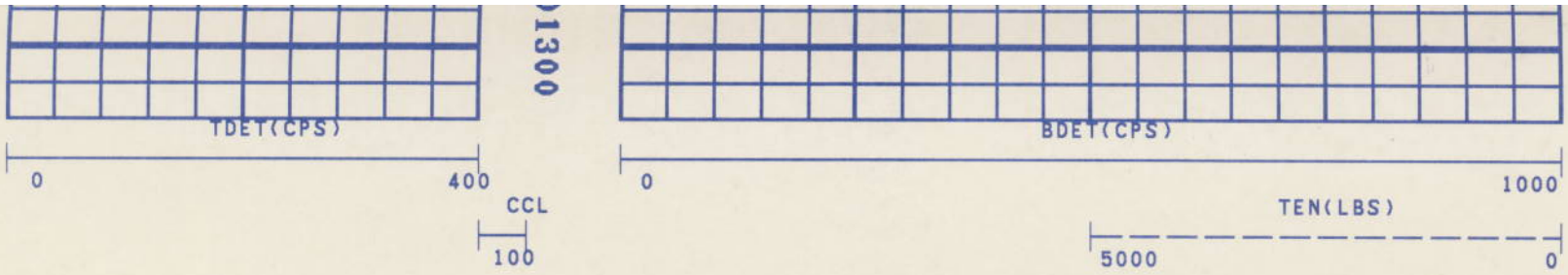
COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD [redacted].
WELL NAME: WASTE DISPOSAL WELL 1-A
SERVICE: M 150A FILE: 27 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1
DEPTH: 3356

RUN: 1
TRIP: 1
TIME: 18:29:19
MODE: PLAYBACK



00100 00200 00300 00400 00500 00600 00700


00700
00800
00900
01000
01100
01200
01300
TDET(CPS)
0
400
CCL
100
BDET(CPS)
0
1000
TEN(LBS)
5000
0



DISPLAY SCALE CHANGES

*** NONE ***

PARAMETERS

*** NONE ***

FILE: 27

****

AFTER LOG BASE PASS

NOTE: GAMMA RAY HOT SPOTS IN THE PERFORATED INTERVAL, ARE THE RESULT OF THE EXTRA LONG SHOT DURATION FOR THE STATIONARY CHECKS THESE HOT SPOT IN THE GAMMA RAY REPEATED AND IT IS EVIDENT THAT THERE IS NO UPWARD FLUID MOVEMENT.

****

FILE: 6

PARAMETERS

*** NONE ***

DISPLAY SCALE CHANGES

PARAMETERS

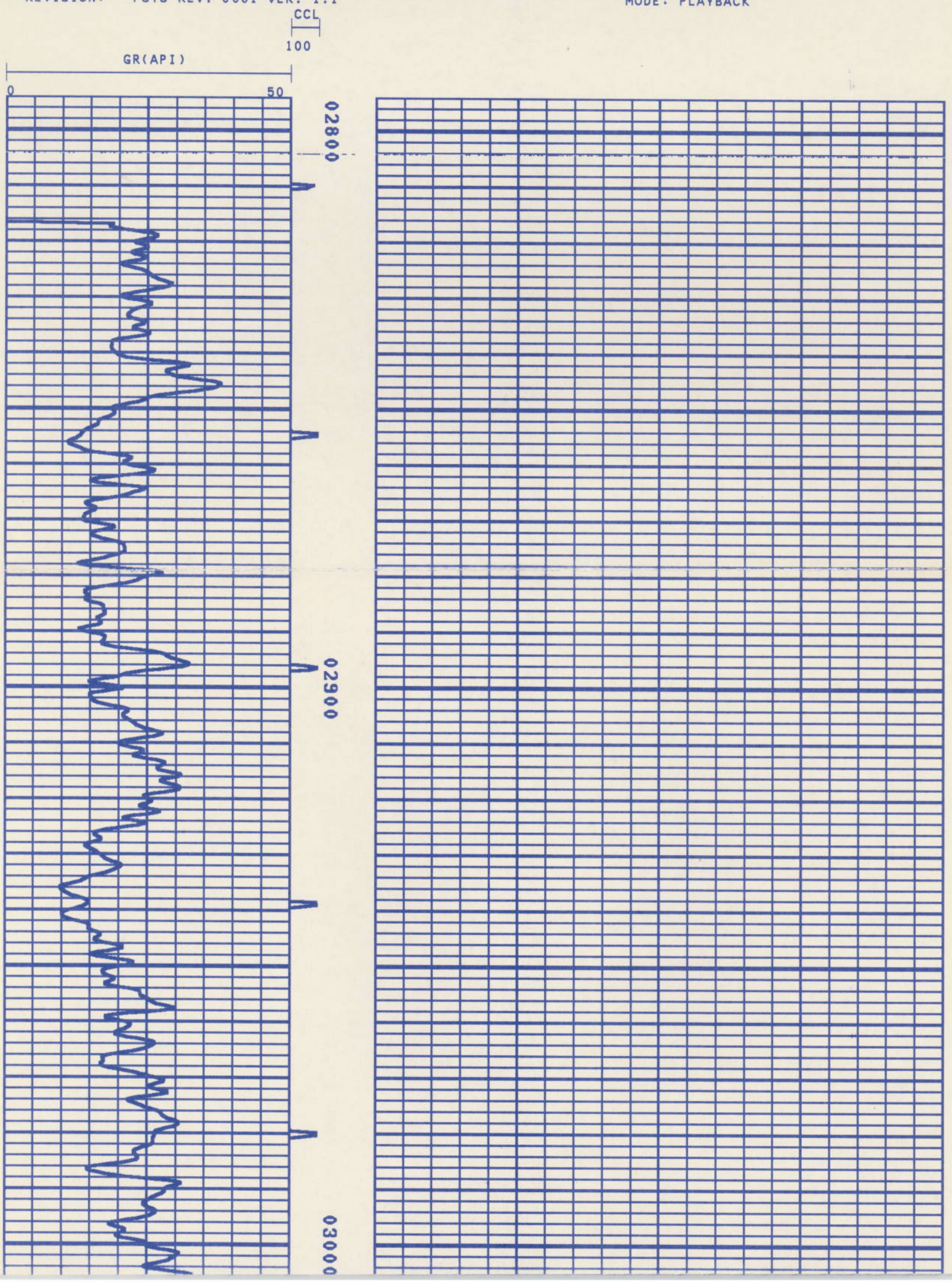
*** NONE ***

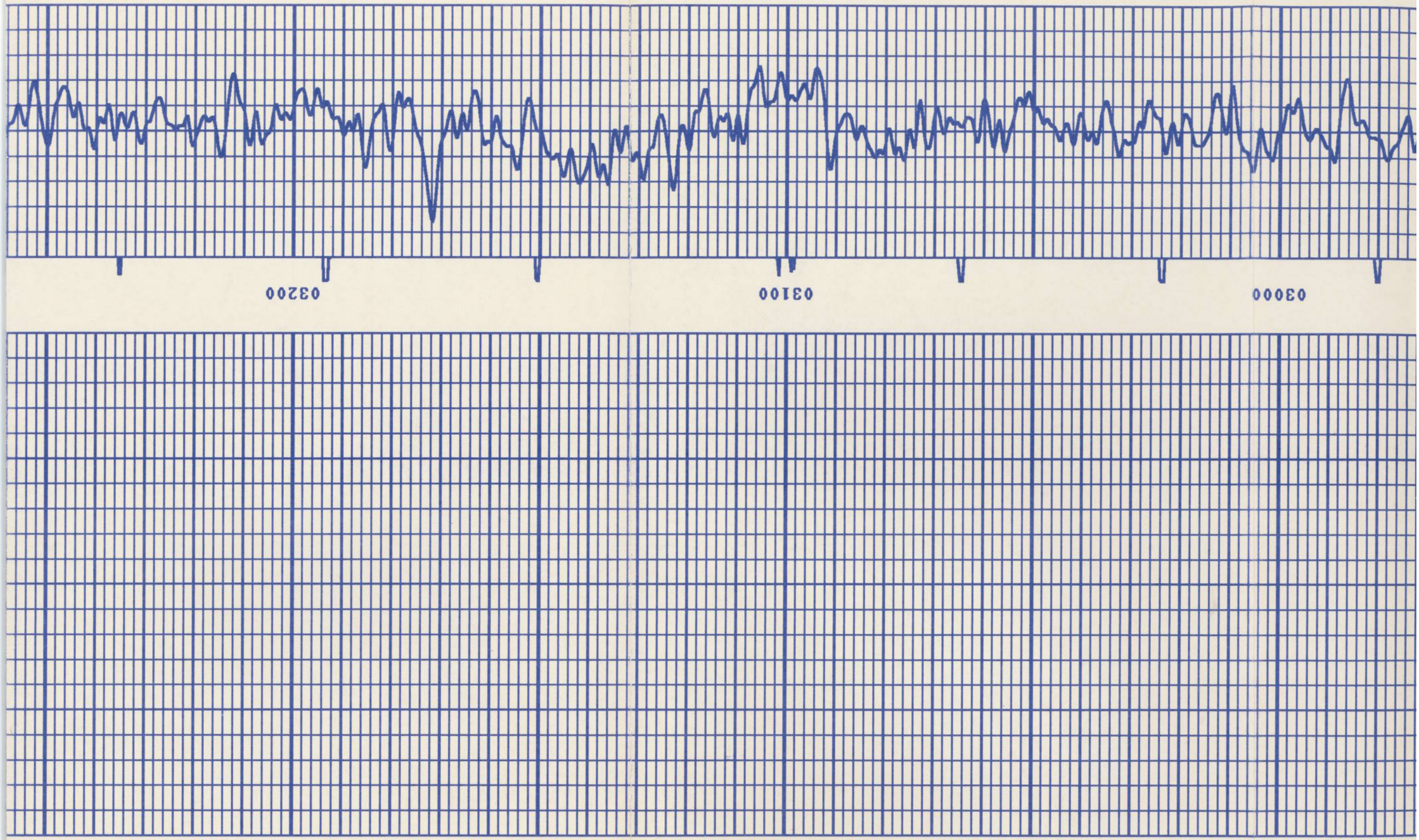
DISPLAY SCALE CHANGES

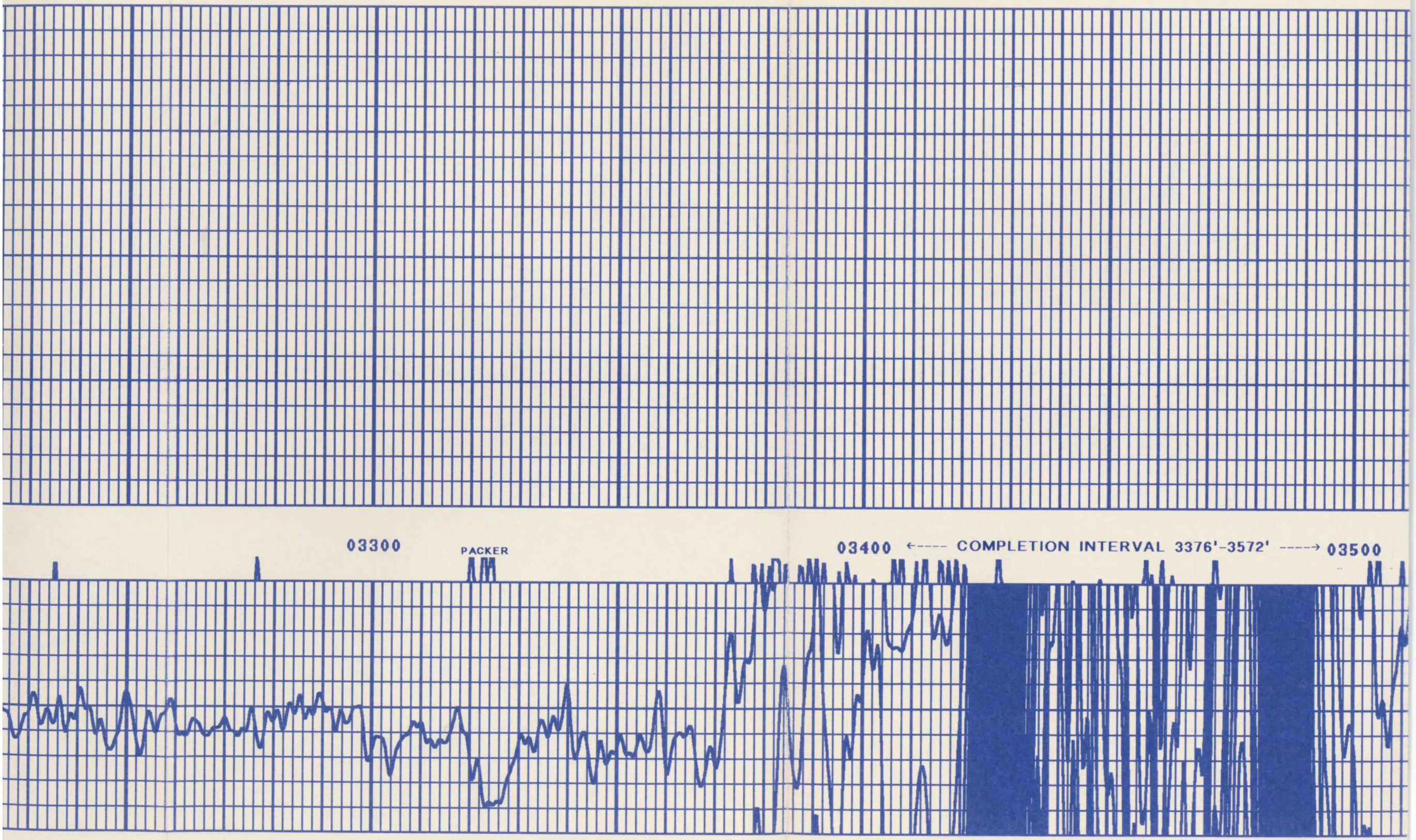
*** NONE ***

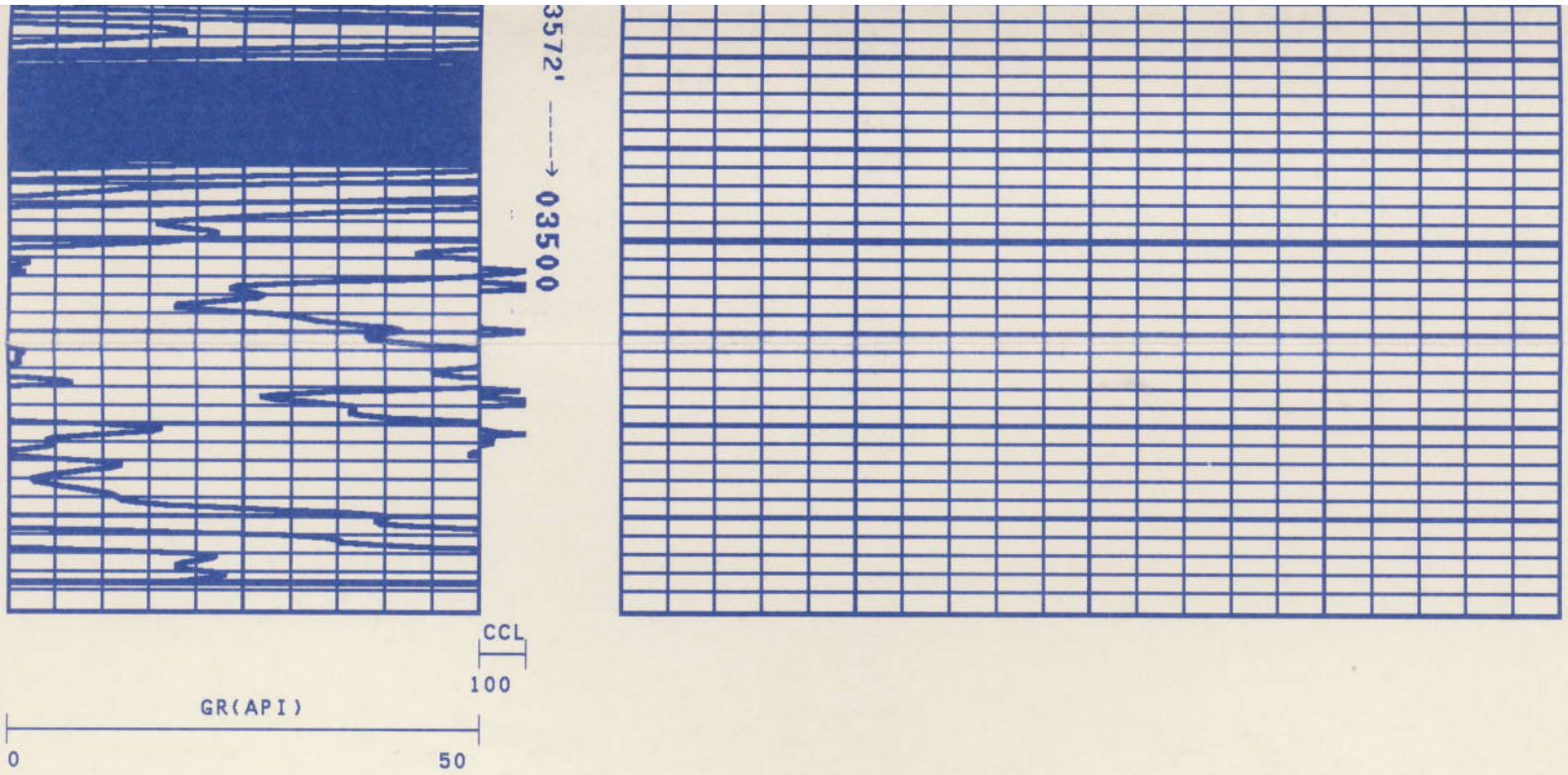
COMPANY: HOECHST CELANESE CHEMICAL GROUP, [redacted]. LTD
WELL NAME: WASTE DISPOSAL WELL NO.1-A
SERVICE: M 159P FILE: 6 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1

RUN: 1
TRIP: 1
TIME: 19:25:53
MODE: PLAYBACK




03000
03100
03200


03300
PACKER
03400 ←---- COMPLETION INTERVAL 3376'-3572' ----→ 03500



FILE: 6

****

AFTER LOG BASE PASS REPEAT
NOTE: NO UPWARD MOVEMENT

****

FILE: 4

PARAMETERS

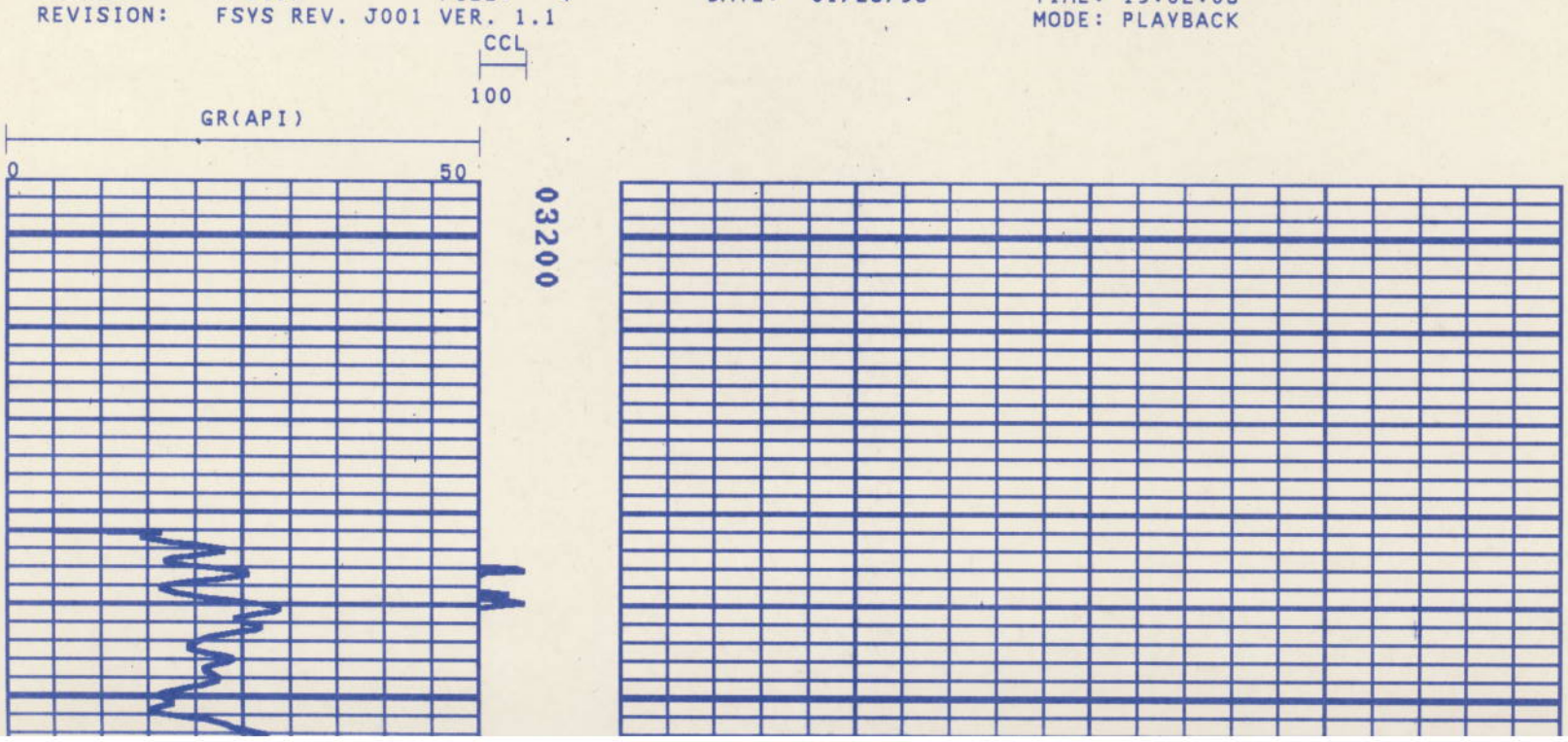
*** NONE ***

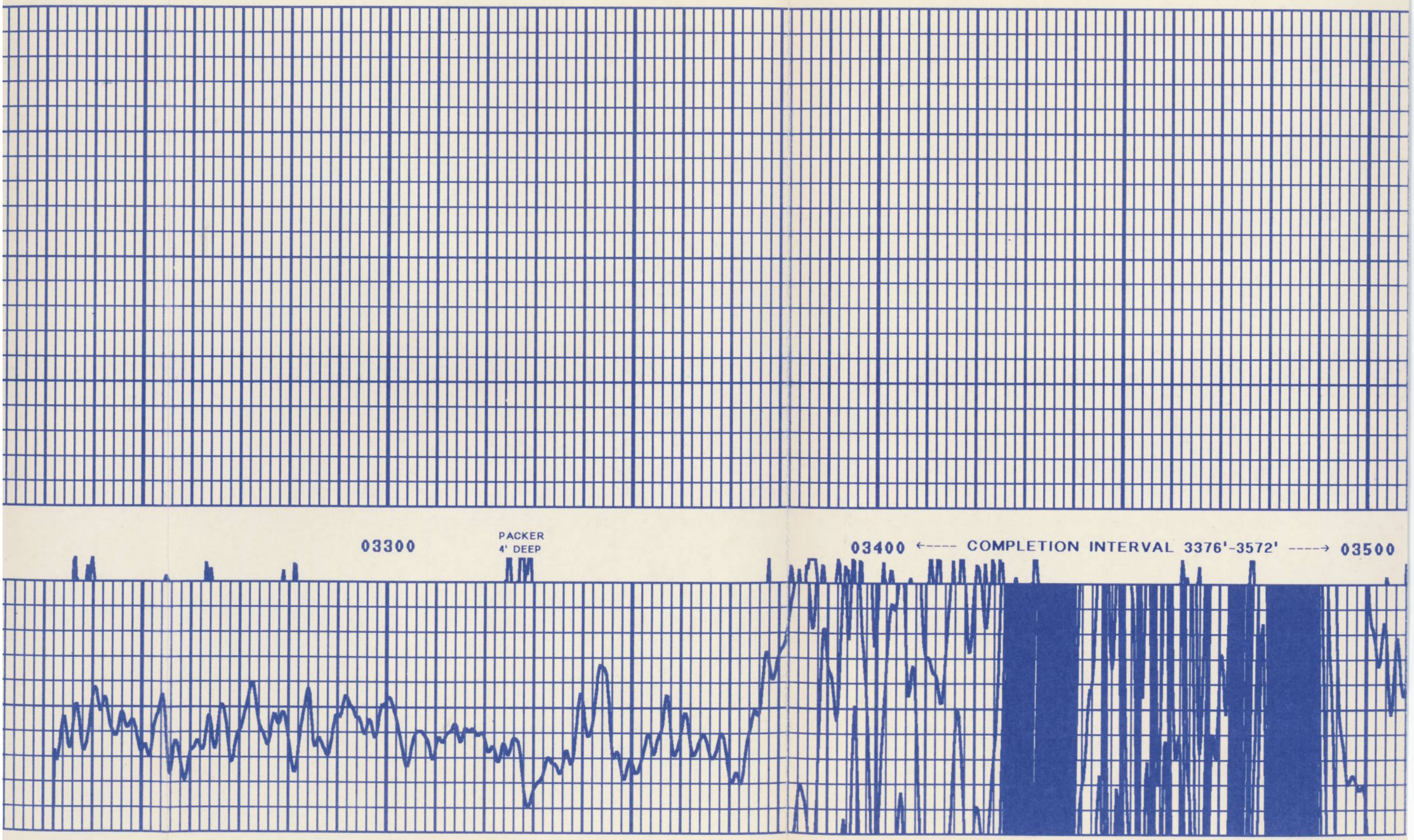
DISPLAY SCALE CHANGES

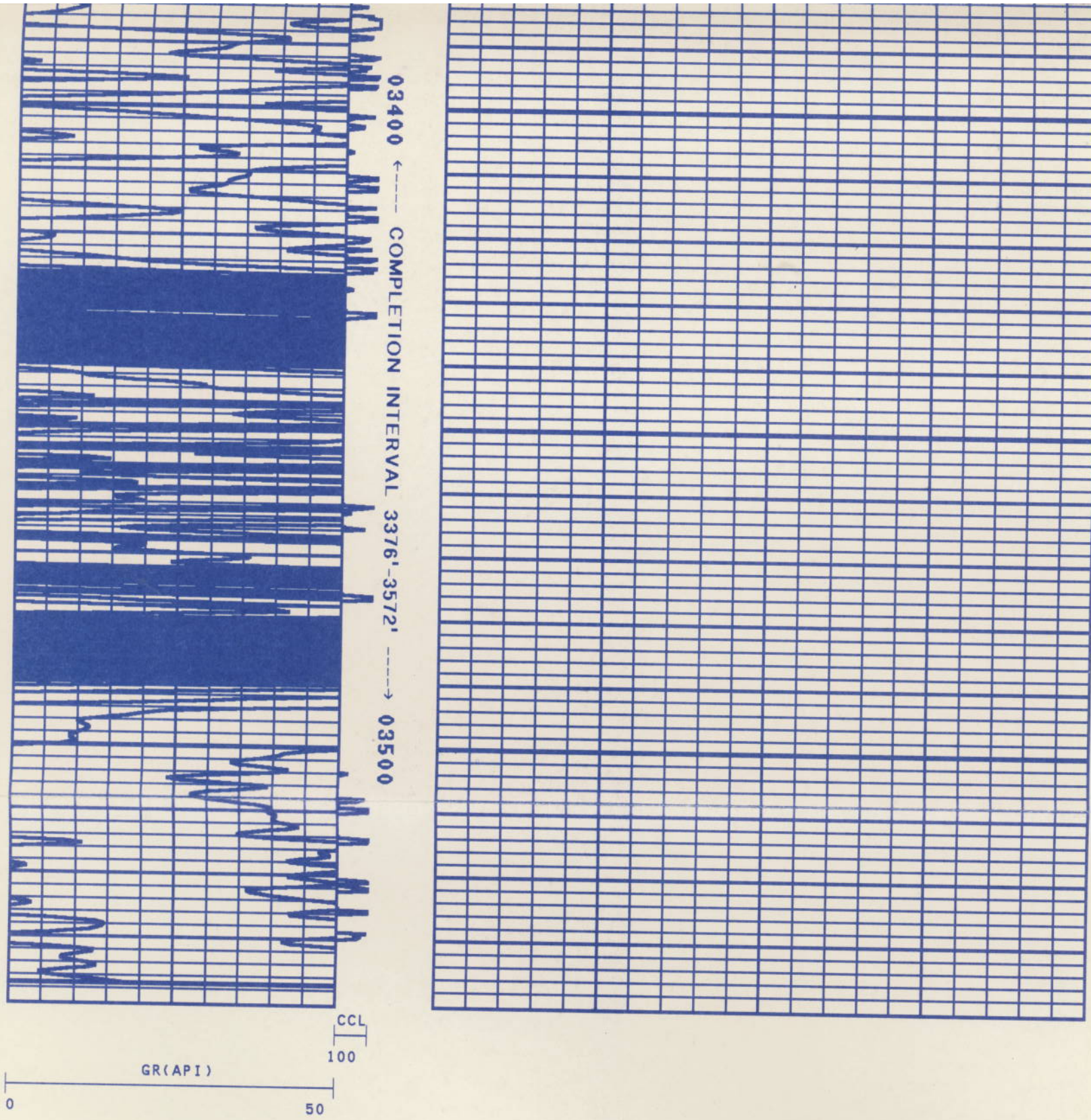
*** NONE ***

COMPANY: HOECHST CELANESE CHEMICAL GROUP, LTD.
WELL NAME: WASTE DISPOSAL WELL NO.1-A
SERVICE: M 159P FILE: 4 DATE: 01/25/96
REVISION: FSYS REV. J001 VER. 1.1

RUN: 1
TRIP: 1
TIME: 19:02:05
MODE: PLAYBACK




03300
PACKER
4' DEEP
03400 ←---- COMPLETION INTERVAL 3376'-3572' ----→ 03500



FILE: 4

****

WESTERN ATLAS LOGGING SERVICES