UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION VI
1445 Ross Ave. at Fountain Place
Dallas, TX 75202-2733

EPA

FACSIMILE REQUEST AND COVER SHEET

4086

PLEASE PRINT IN BLACK INK ONLY

(409) 245-4871

PLEASE REMOVE ALL STAPLES

FACSIMILE NUMBER

CONFIRMATION NUMBER (409) 245-4871

TO

I. O. Coleman

OFFICE/PHONE

Hoechst Celanese Chemical Group

REGION/LAB

FROM

Minnie Howard

PHONE	MAIL CODE
(214) 655-7165	6W-SA

OFFICE

Region 6 EPA

DATE SENT	NUMBER OF PAGES TO INCLUDE THIS COVER SHEET
TIME SENT	8

Please number all pages

INFORMATION FOR SENDING FACSIMILE MESSAGES

EQUIPMENT	FACSIMILE NUMBER	VERIFICATION NUMBER
PANAFAX MV3000	FTS: 255-2142 COMM: (214) 655-2142	FTS: 255-2140 COMM: (214) 655-2140

PAGE 1 OF 8 PAGES

EPA Form 5040-5 (Rev. 12-83) Replaces EPA Form 5040-5A and the previous edition of EPA Form 5040-5, which are obsolete.

March 4, 1990

FACT SHEET

For proposed approval to allow injection of restricted hazardous wastes into the following injection well(s):

Applicant: Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Farm Road 3057
P. O. Box 509
Bay City, Texas 77414

Facility Location: Matagorda County

Permit Number	Well Number
WDW-14	2
WDW-32	3
WDW-49	4
WDW-110	1-A
WDW-277	5

Issuing Office: U.S. Environmental Protection Agency
Region 6
First Interstate Bank Tower
1445 Ross Avenue
Dallas, Texas 75202-2733

1. The Environmental Protection Agency (EPA) proposes to allow the injection of restricted hazardous wastes into the well(s) described above and in the petition demonstration document.

2. This fact sheet or similar statement of basis is required under Title 40 of the Code of Federal Regulations, §§ 124.7 and 124.8 (40 CFR §§ 124.7 and 124.8, as referenced by 40 CFR §§ 148.22 and 124.10).

3. The following is an explanation of the derivation of the proposed decision, which is categorized according to the criteria outlined in 40 CFR Part 148. [53 Fed. Reg., 28118, (1988)]

Summary

The EPA land disposal restrictions promulgated under § 3004 of the Resource Conservation and Recovery Act prohibit the injection of hazardous waste unless a petitioner demonstrates to the EPA that there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. These no migration demonstrations include a description of the well operations, geologic siting, and waste stream characteristics. They also include modeling

strategies which incorporate all the above mentioned information and utilize mathematical equations to predict pressure build up and waste movement.

The Hoechst Celanese - Bay City petition described its well operation through a discussion of the well construction, well stimulations, injection pressures, and injection volumes. The site location and geologic conditions were presented through a discussion of the depositional environment, well logs, cross-sections, well tests, geologic maps, and well records. The characteristics of the injection wastestream were described and evaluated for compatibility with the injection and confining zones. Hoechst Celanese incorporated all this information into a modeling strategy which predicted the pressure build up and waste movement for the Bay City site. The waste plume, under worst conditions, was predicted to move laterally approximately 7.3 miles southeast in the upper interval and 6.6 miles southeast in the lower interval in 10,000 years. Vertical movement is approximately 128 feet. Both of these distances are within the injection zone.

In addition to the reasonably conservative data and assumptions in the no migration demonstration, the following factors augment the demonstration of no migration:

(a) The petition over predicts pressure buildup and waste plume extent by modeling the injection rate at 750 gpm for the upper interval and 600 gpm for the lower interval which is more than the historic rate of 251 gpm for the upper interval and 190 gpm for the lower interval.

(b) The petition over predicts the injected hazardous constituent concentration by assuming the constituent concentration is two orders of magnitude greater than the measured value.

(c) The petition is reasonably conservative by not taking into account the degradation of the contaminant in the injection zone. Examples of degradation which were not considered are adsorption, oxidation, hydrolysis, temperature, and microbiological degradation.

(d) In the evaluation of artificial penetrations, the petition does not take into account the natural occurrence of wellbore closure. This occurs within the Gulf Coast region due to the unconsolidated sediments.

Therefore, after a detailed and thorough review of the Bay City site petition, the EPA proposes that Hoechst Celanese

has demonstrated, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the injection zone for a time period of 10,000 years.

The factors considered in the formulation of this proposed petition decision are described below.

Artificial Penetrations

The area around the Class I hazardous waste well cited in the petition must be evaluated to ensure that the injection activity will not endanger Underground Sources of Drinking Water (USDW) by causing movement of fluids into improperly sealed, completed, or abandoned wells. The petition applicant submitted information on all wells penetrating the injection or confining zones within 2.5 miles of the injection wells.

(a) Artificial penetrations within the 2.5 mile radius are plugged or constructed to prevent the endangerment to an USDW.

(b) There are 32 wells within the area of review (AOR) which meet this standard.

(c) The calculated cone of influence (COI) is less than 1230 feet.

In addition to the nonendangerment standard, some artificial penetrations must also meet the no-migration standard. These artificial penetrations are wells which penetrate the injection zone and are located within the area of the waste plume movement over 10,000 years.

(a) The artificial penetrations which penetrate the injection zone and are located within the area of the waste plume movement over 10,000 years are plugged or constructed to prevent the migration of hazardous waste from the injection zone.

(b) There are 13 wells within the area of the plume which meet the no-migration standard.

(c) All wells met this standard through a demonstration that waste movement due to pressure and molecular diffusion in an artificial penetration will remain within the injection zone.

Mechanical Integrity Testing (MIT) Information

To assure that the wastes will reach the injection zone, a petitioner must submit the results of pressure and radioactive tracer tests according to §148.20 (a)(2)(iv). A well has mechanical integrity when there is no significant leak in the casing, tubing, or packer, and when there is no significant fluid movement into an USDW through vertical channels adjacent to the injection well bore. The petition demonstrates that the active wells have been tested and do satisfy the above criteria.

Well No.	Date of Pressure Test	Date of Radioactive Tracer Survey
WDW-14	10-26-89	10-26-89
WDW-32	10-24-89	10-24-89
WDW-49	10-25-89	10-25-89
WDW-110	10-31-89	10-31-89
WDW-277	Not Drilled	

Injection well WDW-277 must meet the requirements of the Texas Water Commission injection permit. Results of the pressure and radioactive tracer tests must be submitted to the EPA Region 6 for approval prior to injection of restricted hazardous waste in well WDW-277. In addition, information obtained from the drilling and construction of the WDW-277 well shall be submitted to the EPA Region 6 to ensure the basis for the petition decision continues to remain valid. The information should include well logs, geologic core analysis of the confining and injection zones, a hydrogeologic compatibility determination, and formation tests.

Quality Assurance

According to §148.21 (a)(4), the Hoechst Celanese - Bay City petition demonstrates that proper quality assurance and quality control plans were followed in preparing the petition demonstrations.

Specifically, Hoechst Celanese has followed appropriate protocol in identifying and locating records for artificial penetrations within the Area of Review. Information regarding the geology, waste characterization, hydrology, reservoir modeling, and well construction has also been adequately verified or bounded by worst-case scenarios.

Regional and Local Geology

Class I hazardous waste injection wells must be located in areas that are geologically suitable. The injection zone must have sufficient permeability, porosity, thickness, and

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technical review of the submitted petition with supporting documents and consultations with the Texas Water Commission.

The HSWA Amendments provide that an exemption to these restrictions may be granted if the Administrator determines that the method of land disposal (i.e. injection well) is protective of human health and the environment. A method of land disposal may not be determined to be protective, "unless, upon application by an interested person, it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" [42 U.S.C. § 6924 (g)(5)]. Regulations establishing the criteria for petitioning for an exemption to the land disposal restrictions were published in Volume 53, Number 143 of the Federal Register, July 26, 1988, [53 Fed. Reg., 28118, (1988)].

A final decision to approve or deny the petition for an exemption to the land disposal restrictions will be made after the close of the comment period, which ends at close of business on April 20, 1990.

All persons, including the applicant, who wish to comment on the proposed decision to approve the exemption may do so by submitting comments, along with their name and address, to the address below. All written comments must be postmarked by April 20, 1990, to be considered in formulating a final decision.

A public hearing is scheduled at 6:30 p.m. on April 12, 1990, in the Bay City Service Center, 2105 Ave. M, Bay City, Texas. Anyone needing special provisions at the hearing site due to disabilities (i.e. interpreters for the hearing impaired, wheelchair access, etc.), is requested to contact the EPA, within ten (10) working days of the hearing date, at the address below so that these services can be provided.

Written comments, requests for information regarding the proposed decision on the petition, and requests for copies of the fact sheet (description of the reasons supporting the proposed decision) should be sent to EPA Region 6 at the following address:

U.S. Environmental Protection Agency - Region 6
Water Supply Branch (6W-SU)
1445 Ross Avenue
Dallas, Texas 75202-2733
(214) 655-7160

The administrative record for this petition decision is available for review between 8:00 a.m. and 4:00 p.m., Monday through Friday, for the extent of the comment period, at the address above. A copy of the final petition is also available for review at the Texas Water Commission and the Public Library during normal business hours. The locations of these offices are listed below.

Bay City Public Library
1900 5th Street
Bay City, Texas 77414
(409) 245-6931

Texas Water Commission
P.O. Box 13087, Capitol Station
1700 N. Congress Ave.
Austin, Texas 78711
(512) 463-8281

Pertinent EPA comment and public hearing procedures may be found in 40 CFR 124.10 and 124.12.

The EPA will notify the applicant and each person who has submitted written comments of the final exemption decision. The final decision will also be published in the Federal Register.

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Specifically, Hoechst Celanese has followed appropriate protocol in identifying and locating records for artificial penetrations within the Area of Review. Information regarding the geology, waste characterization, hydrology, reservoir modeling, and well construction has also been adequately verified or bounded by worst-case scenarios.

Regional and Local Geology

Class I hazardous waste injection wells must be located in areas that are geologically suitable. The injection zone must have sufficient permeability, porosity, thickness, and

areal extent to prevent migration of fluids into USDW's. The confining zone must be laterally continuous and free of transmissive faults or fractures to prevent the movement of fluids into an USDW and must contain at least one formation capable of preventing vertical propagation of fractures. The Hoechst Celanese-Bay City facility is sited in an area meeting the above criteria.

An evaluation of the structural and stratigraphic geology of the local and regional area has determined that the Hoechst Celanese-Bay City facility is located at a geologically suitable site. The injection zone is of sufficient permeability, porosity, thickness, and areal extent to meet requirements stated in 40 CFR Part 148. The confining zone is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into a USDW.

(1) Depth of Confining Zone: 2350 feet
Depth of Injection Zone: 2900 feet
Depth of Injection Intervals: 3350-3600 feet
5700-5950 feet

(2) The geologic conditions were presented through a discussion of the depositional environment, well logs, cross-sections, well tests, and geologic maps.

(3) The structure and isopach maps provided confidence in the geologic description.

(4) The geologic cross-sections demonstrated that the injection zone is laterally continuous. This justified some of the modeling assumptions.

(5) Pressure falloff tests support the injection zone permeability parameter in the modeling strategy.

Hydrogeology

According to §148.20 (a)(1), a petitioner must submit hydrogeologic information in order to study the effects of the injection well activity. Hoechst Celanese provided hydrogeologic information in the petition which demonstrates that USDW's are properly protected. The base of the lowermost USDW is at 1300 feet.

Characteristics of Injected Fluids

According to §148.22 (a), the characteristics of the injection wastestream must be adequately described in order to determine the wastestream's compatibility with the injection zone. These characteristics are described in the petition and the description is adequate and complete.

The waste contain the following EPA hazardous waste numbers: K009, K010, D001, D002, U001, U002, U031, U112, U123, U140, U154, U197, U226, F001, F002, Hexavalent Chromium

Geochemistry and Injected Waste Compatibility

According to §148.21 (b)(5), a petitioner must describe the geochemical conditions of the well site. The physical and chemical characteristics of the injection zone and the formation fluids in the injection zone were described in the petition. This description included a discussion of the compatibility of the injected waste with the injection zone.

(1) The geochemistry of the injection zone was described through the use of core data.

(2) Hoechst Celanese provided evaluations which demonstrated that the waste stream would not adversely alter the confining capabilities of the injection and confining zones.

Modeling Strategy

According to 40 CFR §148.21(a)(3), in demonstrating no-migration of hazardous constituents from the injection zone, predictive models shall have been verified and validated, shall be appropriate for the specific site and wastestreams, and shall be calibrated for existing sites. The modeling strategy consisted of a combination of analytical models. All the models used were identified as being verified and validated according to the information submitted in the petition. This information consisted of actual model documentation or references of methods or techniques that are widely accepted by the technical community. The petition describes the predictive models used and demonstrates that the above criteria are met.

According to 40 CFR §148.21(a)(5), reasonably conservative values shall be used whenever values taken from the literature or estimated on the basis of known information are used instead of site-specific measurements. Many variables were required to be quantified in order to employ the models used in the petition. All parameters were conservatively assigned to produce worst case conditions for either pressure buildup or waste movement.

According to 40 CFR §148.21 (a)(6), a petitioner must perform a sensitivity analysis in order to determine the effect of uncertainties associated with model parameters. Hoechst Celanese provided this sensitivity analysis in its petition. Through conservative model parameter assignments within this analysis, worst case scenarios for pressure buildup and waste movement were investigated and reported.

Results

1. Operational Life

Estimated Operational Life: Year 2000
Maximum Permitted Injection Rates:

WDW-14 WDW-32 WDW-39	Combined annual average of 750 gpm in upper interval
WDW-110 WDW-277	Combined annual average of 600 gpm in lower interval

Maximum Pressure Buildup [at wells]:

Upper interval	87 psi
Lower interval	86 psi

Maximum Lateral Waste Movement:

Upper interval	0.9 miles
Lower interval	0.8 miles

Maximum Vertical Waste Movement: <2.0 feet

2. 10,000 Year Post-Injection Period

Background Gradient or Velocity:

Upper interval	2.8 feet/year in southeast direction from site
Lower interval	3.2 feet/year in southeast direction from site

Waste Density Effects Yes__x__ N/A _____
Movement Due to Hydrocarbon Production Yes_____ N/A__X_

Maximum Waste Concentration Reduction Factor is 10^{-6}

Maximum Lateral Waste Movement:

Upper interval	7.3 miles in southeast direction from site
Lower interval	6.6 miles in southeast direction from site

Maximum Vertical Waste Movement is 128 feet in intact strata and 330 feet in mud.

(2)

WAT 18-6-5-9

RECEI
MAR 02
EPA 6W-
REGION

DU PONT ENVIRONMENTAL REMEDIATION SERVICES, INC.
140 Cypress Station Drive, Suite 140
Houston, TX 77090

DATAFAX MESSAGE COVER SHEET

TO: VINCE MALOTT COMPANY: EPA

FAX NO.:

FROM: DON SAUNDERS FAX NO.: (713) 586-5650

PLEASE NOTIFY DATAFAX OPERATOR AT (713) 586-5600 IF RESEND IS NECESSARY

NUMBER OF PAGES INCLUDING COVER: 4

COMMENTS:

VINCE,

Here is the data from AFC on AP #251 in the Celanese Bay City Plume that shows the well is still producing. I will be at the TWC tomorrow with Richard Merritt/Tom Roth if you need me.

DU PONT

Agency Information Consultants, Inc.
PO Box 2181 Austin, Texas 78768 2181 Tel (512) 478 8991 Fax (512) 478 5215

DATE: 3-1-90

TO: Don Squires
Du Pont - EMS
Re: GAS
Amoco/Butler Gas Unit #1

RECEIVED
MAR 02 1990
EPA 6W-S
REGION VI

FROM: (ORIGINATOR NAME AND TELEPHONE NO.) Ricky Lawson 512-478-8991

TOTAL NUMBER OF PAGES, INCLUDING THIS COVER SHEET: 3

IF YOU DO NOT RECEIVE ALL OF THE PAGES, PLEASE CALL THE ORIGINATOR AS SOON AS POSSIBLE.

ORIGINATOR COMMENTS (IF ANY): I have included the 1989 Annual production ledger and the March, 1990 Gas Schedule as evidence to prove this well is still productive. If you have any questions I will be in the office until 9 or 10 pm tonight.

Thx
Ricky

P.S. Smith Production Inc is now the operator of this well.

GAS PRORATION SCHEDULE - FEBRUARY 1990 DIST 3

PETKAS (FRIO 7650) 70890 500 CHAMBERS CO.ASSOCIATED--ONE WELL,DEPTH- 7658 ,DISC 11/02/59
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
DIAG. ,SPAC. ,ACRES ,TOL
FIELD REMARKS: 10-26-87 ONE WELL FIELD EFF. 11-1-87
NO WELLS

PETKAS (FRIO 7760) 70890 550 CHAMBERS CO.NON-ASSOC.--ONE WELL,DEPTH- 7753 ,DISC 2/06/84
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
DIAG. 00000 ,SPAC. 467/1200 ,ACRES ,TOL
NO WELLS

PETKAS (FRIO 7860) 70890 600 CHAMBERS CO.ASSOCIATED--49-B ,DEPTH- 8330 ,DISC 7/24/70
ANNUAL TESTING (G-10) SEP OCT NOV DUE DEC EFF JAN **
DIAG. ,SPAC. ,ACRES ,TOL
NO WELLS

PETKAS (FRIO 8170) 70890 700 CHAMBERS CO.ASSOC.-- EXEMPT ,DEPTH- 8169 ,DISC 9/26/61
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
NO WELLS

PETKAS (4400) 70890 900 CHAMBERS CO.NON-ASSOC.--EXEMPT ,DEPTH- 4410 ,DISC 2/20/63
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
NO WELLS

PETRUCHA (12,450) 70859 333 MATAGORDA CO.NON-ASSOC.--EXEMPT ,DEPTH-12452 ,DISC 3/07/62
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
NO WELLS

PETRUCHA (12,650) 70859 666 MATAGORDA CO.NON-ASSOC.--ONE WELL,DEPTH-13500 ,DISC 3/02/71
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
DIAG. 7500 ,CASSNG. TWDO ,SPAC. 467/2640 ,ACRES 320 ,TOL 32
FIELD R MARKS: 01-08-90 ONE WELL FIELD EFF. 1-1-90
00-00-00 EFF 2-1-79 PER DOCKET #20-68,382

IDENT	LEASE NAME	WELL	ACRES	WHP	DEL	G-1 POTE	G-10 EFF	GAS ALLOW NO.	9-1 MCF	STATUS	GATH	CONN	QANT	L-ANT	14B
SMITH PRODUCTION INC. 789662 P-5															
050014	PETRUCHA GAS UNIT	2	352.000		95	10288	3	2660N	379	AROCG	SCURL		100C	128L	
054526	BUTTER GAS UNIT	1	352.000	1200	115	6700	3	14790	1844-	AROCG	SCURL		53	124L	
TOTALS: WELLS - 2 0-P 1-L 1-S ALLOWABLE - 4,139 0-P 1,479-L 2,660-S															

PEVETO (6600) 71025 375 ORANGE CO.ASSOCIATED--ONE WELL,DEPTH- 6806 ,DISC 2/01/84
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
DIAG. ,SPAC. ,ACRES ,TOL
NO WELLS

PEVETO (9600) 71025 500 ORANGE CO.NON-ASSOC.--PRORATED,DEPTH- 9407 ,DISC 6/18/82
SEMI-ANNUAL TESTING (G-10) NOV DEC JAN DUE FEB EFF MAR ** MAY JUN JUL DUE AUG EFF SEP
DIAG. ,SPAC. ,ACRES ,TOL
WELLS- 5 , FIELD ALLOW- 133351 ,ASSIGNED ALLOW- 133351
ALLOC FORMULA. 100% & DEL (FACTOR) 25.3519011
2 BAL. SERICOS
a (DAILY)

IDENT	LEASE NAME	WELL	PER CENT	WHP	DEL	G-1 POTE	G-10 EFF	GAS ALLOW NO.	9-1 MCF	STATUS	GATH	CONN	QANT	L-ANT	14B
DYNAMIC PRODUCTION, INC. 237926 P-5															
105162	MCKEE	1				48000	3	SHUT IN		UNTTC	ENBTT			UL	
10759	MALONE GAS UNIT	1	62.36	3870	3280	67000	5	83154	121543	UNTTC	ENBTT			4067L	

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DUPONT

FILE (2)

CELANESE BAY CITY

RESERVOIR ENGINEERING/MODELING

1. Celanese should submit site specific information to substantiate the presence of 9.0 lb/gallon fluid at or near the ground surface in the abandoned boreholes. This information affects the no-migration and non-endangerment demonstrations.

Response:

A letter from an extremely experienced drilling engineer is attached that shows (based on his experience with wells in the Hoechst Celanese area) mud is expected to be within approximately 100 feet of the surface in abandoned wells.

The conservative assumption that abandoned boreholes contain 9.0#/gal. mud only to within 200 feet of the ground surface, will make an extremely small difference on the downward force of a 3,000 foot wellbore mud column. Realistically, any space not filled with drilling mud would be filled with formation water and would not be empty void space because all subsurface formations are water saturated at the site to within less that 100 feet of ground level.

The attached reference paper, Long-Term Properties Of Clay, Water-Based Drilling Fluids, shows that drilling mud properties such as fluid density, gel strength and mud solids are retained over time. This is further proof that mud plugs in wells along the Gulf Coast will provide very satisfactory obstacles to fluid flow in abandoned wells for very long periods of time. If anything, a review of the literature concerning the properties of drilling mud indicates that over time, the quality of the mud plugging becomes better as the mud cures, and sets up in the borehole.

WAT 18-6-5-9

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MELVIN KLOTZMAN
PETROLEUM CONSULTANT, INC.
REGISTERED ENGINEER

February 6, 1990

DuPont Environmental
Attn: Mr. Rick Greiner
140 Cypress Station Drive
Suite 140
Houston, Texas 77090

Dear Mr. Greiner:

Discussion: You have inquired about mud levels to be anticipated in wells drilled in the vicinity of Bay City, Matagorda County, Texas. The area you have pointed out as the focal point of this study area, the James Moore A-62 Survey, has had penetrations to 13,000±' with most wells drilled to 10,000'. The 10,000' to 10,300' wells penetrate the Upper Frio with 10#/gal. to 11.5#/gal. mud and wells below 10,300', penetrate Middle Frio and Lower Frio sands and require heavy mud weights from 13.5#/gal. to as high as 17#/gal. The mud levels in plugged wells in this area is usually no more than 100' below ground level because of the drilling depths and known pressures in the area. Listed below is a discussion regarding plugging the above wells and mud levels.

1) Upper Frio wells are usually drilled no deeper than approximately 10,300'. Most of the wells drilled in this particular area have 1,300' to 1,800' surface pipe and usually end up with 11#/gal. to 11.5#/gal. mud weight. These full strings of surface pipe protect the fresh water which lies above the deepest potentially useable Underground Source of Drinking Water (at about 10,000 ppm TDS at about 1,300' below ground level). In most cases, a study of the plugging records in this general area would indicate adequate plugs. I have personally re-entered holes along this trend and drilled wells in this same general area. The mud levels are usually around 50' to 100' below ground level while logging. Based upon my experience re-entering these sorts of wells, after plugging wells at this depth, in most cases, the mud levels usually occur 50' to 100' below ground level. This is due to the fact that a large portion of these wells are in rice fields and the pipe has to be cut off more than 4' below the surface. The drilling crews will not completely fill the hole up after setting the 100+' cement plug as they do not like to work down deep in a muddy cellar. Generally, the operators in this intensive agricultural area set adequate plugs because they do not want liabilities from deep irrigation wells and consequently, fluid level conditions never change in these wells after the initial plugging.

2) Middle & Deep Frio wells are drilled from 10,300' to 13,000'. Most of the wells drilled to this depth require not only surface pipe, but protection pipe which may be 7-5/8" or possibly 9-5/8" in some instances. The protection pipe may or may not be pulled. 10,000+' is the normal setting depth of the protection pipe and operators invariably practice good cementing practices, not only in cementing, but also use cast iron retainers on plugging. These wells are drilled with 13#/gal. to 17#/gal. mud. After plugging, the Barite partially settles out and when these wells are re-entered, even in cased pipe, it is sometimes harder to drill the hard mud than the formation. In some instances, the protection pipe is pulled at the base of the surface pipe and a cement plug is set similarly as in the case of a shallower 10,000' hole. The heavy mud weight is reduced to about 11#/gal. to cut the pipe, but the level of mud to be expected in these type wells is within 50' of the ground surface as operators are more cautious in plugging abnormal pressures in wells such as these.

In most cases, in both type wells described, the operators use 10 sacks or better for their top plug and in the two re-entries I have been on in the Blessing area of Matagorda County, Texas, these plugs were evident. Because of the precautions most operators practice in this area, it would be hard to find many wells that were not filled up to within 100' of the surface with mud.

The above information should satisfy your inquiry, however, please feel free to call me at my office for any further data related to this matter.

Yours very truly,

Melvin Klotzman

MK:dmn

EMW

LONG-TERM PROPERTIES OF CLAY, WATER-BASED DRILLING FLUIDS

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Abstract

Although drilling fluids play a major role in preventing vertical fluid migration from deep injection zones into underground sources of drinking water (USDW), very little long-term data are available concerning the properties of these fluids after they have been in the subsurface environment for an extended period of time.

In an effort to gain a more definitive view of actual long term mud properties, 735 feet of an undisturbed, 29 year old, mud column were removed from an abandoned well at the request of the Texas Water Commission (TWC). This continuous 735 foot mud sample was analyzed in the Envirocorp laboratory to determine mud density, gel strength, and shear strength as a function of depth.

As expected from laboratory and operational field data, mud density remained relatively unchanged over the 29 years, gel strength increased to 267 lbs/100 ft^2, and the mud remained fluid, even for samples with a gel strength of 7000 lbs/100 ft^2.

Introduction

The intent of this paper is to show that water-based drilling fluids, which contain bentonite or natural clays, provide adequate long-term protection against vertical fluid migration in abandoned wellbores along the Texas, Louisiana Gulf Coast and in other areas where similar geology is encountered. The basic approach taken in this paper is to provide a brief review of those mud properties relevant to the issue of vertical fluid migration, to predict the long-term behavior of these relevant mud properties from the available literature, and finally, to compare the predicted long-term mud properties with actual mud properties from a 29 year old field mud column. This mud sample was

removed in a single continuous operation from a previously plugged and abandoned wellbore. The field mud column was obtained in August of 1988 from an abandoned dry hole drilled in November of 1959. The well was located near Corpus Christi, Texas.

As will be seen throughout this paper, a significant number of references are used from George R. Gray and H. C. H. Darley's 1980 revised text, Composition and Properties of Oil Well Drilling Fluids. The reason for referencing this text, rather than the underlying literature, is to demonstrate that many of the topics addressed in this paper are fundamental to the drilling industry and have been the subject of investigations over the past 50 years. Although the perspective presented in this paper is slightly different, the data collected by previous investigators are relevant to the current concerns about the ability of drilling fluids to prevent vertical fluid migration in abandoned wellbores. The major mud properties discussed in this paper include:

- Fluid Density
- Gel Strength
- Mud Dehydration Potential
- Filtercake Buildup

Formation stresses and their effect on a mud column will also be discussed with respect to the ultimate forces acting within a mud column over an extended period of time.

Drilling Fluid Properties

As indicated by Gray and Darley (1980, p.4), drilling fluids serve a variety of functions in the drilling industry. However, from the standpoint of resistance to vertical migration, the most relevant functions performed by a drilling fluid are those that:

- Prevent the flow of reservoir fluids into the wellbore,
- Stabilize the uncased section of the wellbore,
- Prevent solids settling during quiescent periods, and
- Develop a filtercake to prevent excessive fluid loss from the wellbore into the formation.

These drilling fluid functions are controlled by fluid density, gel strength, and mud solids.

Fluid Density

Drilling fluid density is the only short-term property of a drilling mud which can prevent reservoir fluids from entering the wellbore. Fluid density is also the only mud property that can prevent formation collapse due to tectonic stresses or unconsolidation of the formation. In general, as indicated by Mitchell, Goodman, and Wood (1987), and by Gray and Darley (1980, p. 355) drillers commonly use a mud weight that will overbalance the highest formation fluid pressure encountered by a "safe margin" which will commonly range between 200 to 400 psi. The overbalanced mud weight is used to provide a conservative margin of error to prevent fluid flow into the wellbore.

Along the Gulf Coast, increased mud weight is also used to prevent the unconsolidated formation from sloughing into the well. As an example, a well recently drilled in the Upper Texas Coast under the supervision of Envirocorp required an 8.8 pound/gallon (lb/gal) mud to balance the formation fluid pressure during a gravel pack operation. However, the mud weight needed to be increased above 9.4 lb/gal to prevent the sides of the open hole from sloughing into the wellbore.

The above example, and the data provided by Mitchell, Goodman, and Wood (1987) demonstrate that the original mud column will commonly overbalance the highest static reservoir pressure encountered by 100 psi or more. The average overbalance pressure indicated by the data provided by the above authors is approximately 350 psi.

Mud weight can be increased by either increasing the salinity of the brine, or by adding insoluble solids to the mud. For onshore Gulf Coast drilling operations, barite ($BaSO_4$) is the weighting material of choice due to its comparatively low cost and ease of handling. Long-term maintenance of the mud weight is controlled by the gel strength developed in the mud.

Gel Strength

Gel strength serves two important functions in terms of preventing vertical fluid migration. First, gel strength is the mud property necessary for keeping the solid weighting materials suspended in the mud for extended periods of time. Second, long-term gel strength provides additional resistance to vertical migration due to the increased pressure required to initiate fluid movement.

To understand the buildup of gel strength within muds and why it occurs, it is necessary to review briefly the basic concepts which have been proposed to account for the gel strength of clay mud systems. As discussed by Gray and Darley (1980, Chapter 4), and the studies referenced in their text, the development of gel strength in a mud is associated with the charged surfaces of the clay particles used to develop mud viscosity. These authors point out that the edges of the clay particles have a different charge than their crystal or platelet faces. The difference in the charges on the faces and edges cause both electrostatic repulsive and attractive forces between the individual clay particles. During drilling operations, the mud is subjected to high shear forces which disturb the electrostatic interactions and allow only localized interactions to occur between individual platelets. The shearing action results in a lowering of the operating viscosity.

During static periods, when the drilling fluid is not being sheared, the charged surfaces cause the clay particles to align according to natural kinetic, steric, and thermodynamic forces. This natural development of a "gel" structure between the clay particles and the surrounding water can extend over a considerable distance. It is the formation of a structured relationship between clay particles and the water molecules which gives rise to the gel strength. Again, solid particle alignment, i.e. the gel structure, is due to the natural thermodynamic tendency to maximize the electrostatic attractive forces and minimize the repulsive forces. Thus, gel strength in clay, water-based drilling fluids is seen to be a natural phenomenon that can be explained using the basic chemical and physical laws of nature.

With the understanding that the formation of a gel structure is a natural and fundamental property of clay, water-based drilling fluids, it is easier to address the importance of gel strength from an empirical perspective. Empirical studies of gel strength have been performed by a variety of investigators and have been partially summarized by Davis (1986).

The intent of the following paragraphs is to briefly demonstrate that gel strength naturally increases with time, far exceeds the gel strength required to maintain the original fluid density, and will reach an ultimate strength approaching or in excess of 100 pounds/100 square feet (lbs/100 ft^2) in a matter of days.

The time dependence of gel strength was reported over 50 years ago. Garrison's original work, published in 1939, showed the gel strength of a montmorillonite clay, water system could be empirically correlated with time using the following equation:

$$t/S = t/S' + 1/S'k$$

Where:

- t = Time After Shearing Stopped
- S = Gel Strength at Time, t
- S' = Ultimate Gel Strength
- k = Rate of Gelation

Figure 1 is a plot of Garrison's data in Table 1 for gel strength versus time. Figure 2 presents the same data plotted as t/S versus t. As a point of reference, a gel strength of 1.0 dyne/cm^2 is equal to 0.21 lbs/100 ft^2.

TABLE 1

GEL STRENGTH MEASUREMENTS

BENTONITE PERCENT IN WATER	CURVE	ADDITIVES	GEL STRENGTH AFTER 135 MINUTES dynes/cm^2	lbs/100 ft^2
4.5	1	-------	34.4	7
5.5	2	-------	74.4	16
6.5	3	_____	114.0	24
5.5	4	0.1% Na Tannate	104.0	22
5.5	5	Sodium Hydroxide	99.7	21

(Revised from Garrison, 1939)

FIGURE 1

GEL STRENGTH IN RELATION TO TIME
AND RATE OF REACTION
(FROM GARRISON 1939)

SEE TABLE 1

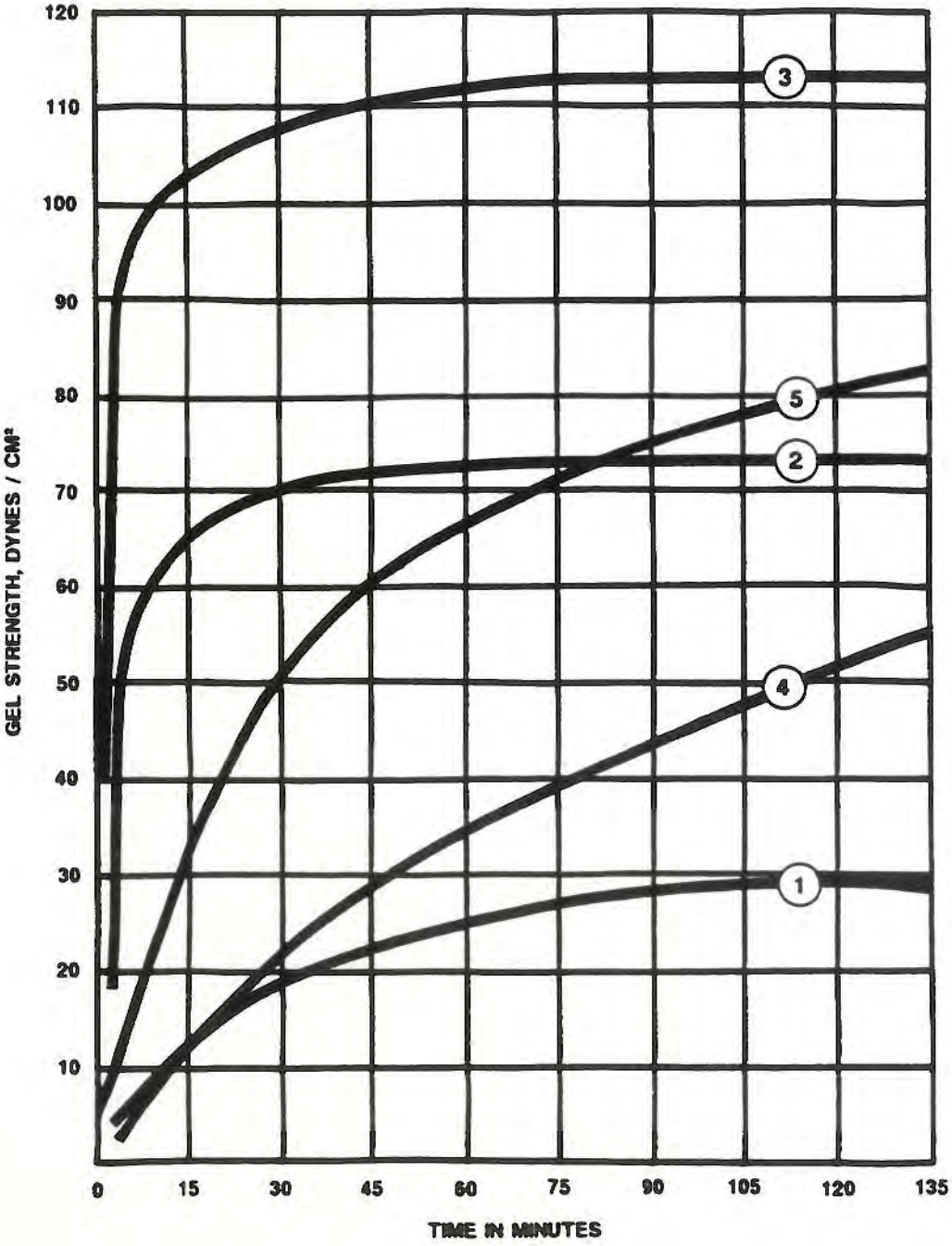
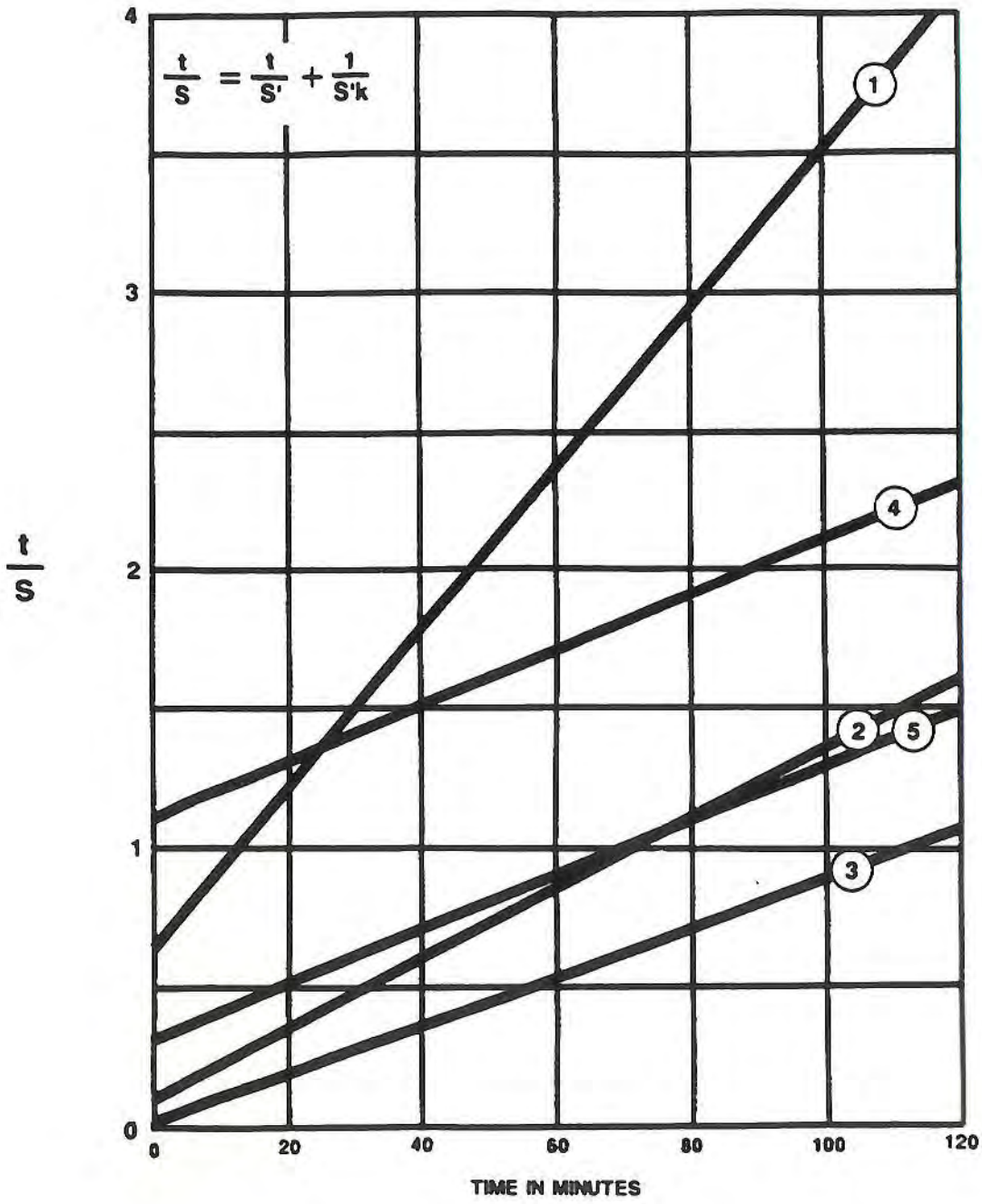


FIGURE 2
GEL STRENGTH AND RATE CONSTANTS
(FROM GARRISON 1939)

SEE TABLE 1



Weintritt and Hughes (1965) measured the gel strength of three field muds as a function of time. As mentioned by Gray and Darley (1980, p. 205), Weintritt and Hughes' data follow Garrison's model only at early times. For longer time periods, the gel strength continues to increase at a rate in excess of what Garrison's model would predict. Weintritt and Hughes' data, Table 2, are graphically presented in Figure 3 which demonstrates that for these field muds, gel strength is approximated more closely by a linear relationship with time after the first two hours. The importance of these data is not the exact relationship between gel strength and time, but rather, gel strength increases with time, and that a gel strength for clay-based field mud systems will normally exceed 25 lbs/100 ft^2 in a matter of days, if not hours.

The next step in the evaluation of the resistance a mud column provides against vertical fluid migration is the estimation of the minimum gel strength required to suspend solid weighting material indefinitely in the drilling fluid. The gel strength required to prevent a spherical solid of radius r from settling can be estimated using the following equation:

$$(\rho_b - \rho_f)g(4\pi r^3/3) = G\ (\pi r^2)$$

or

$$G = 4\ (\rho_b - \rho_f)gr/3$$

where:

ρ_b =	density of barite (4.2 g/cm^3)
ρ_f =	density of water (1.0 g/cm^3)
g =	acceleration due to gravity (981 cm/sec^2)
r =	radius of barite particle (cm)
G =	Gel Strength ($dynes/cm^2$)

If the maximum radius of barite is assumed to be 0.00635 cm (0.0025 inches) or larger, the largest 3% of the solids allowed in standard API barite (Gray and Darley, 1980, p. 533), the gel strength is calculated to be 26.6 $dynes/cm^2$ or 5.6 lbs/100 ft^2. This calculation shows that only a minimal gel strength is required to keep over 97% of the barite weighting material suspended. Since barite density is 4.2 g/cm^3, bentonite density is 2.8 g/cm^3, and the density of sandstone is 2.65 g/cm^3, it is clear that the gel strength in field muds will reach a value in excess of the gel strength required to maintain mud density in less than an hour. Only the larger drilled solids and the largest 3% of the barite have any potential for settling during this time period.

As indicated by the above calculation, a gel strength of 5.6 lbs/100 ft^2 is adequate to suspend the largest 3% of the barite particles in the mud. It should be noted that the development of a sufficient gel strength to prevent barite from settling does not mean that drilled solids do not settle from the mud. An examination of the settled solids, as discussed later in this paper, shows that the settled solids are composed mainly of drilled solids that are significantly larger than the barite used as weighting material. During the first twenty to thirty minutes of quiescence, these particles may be large enough to settle to the bottom. It may even be possible that the largest barite particles will also settle. However, the loss of these materials will not alter the mud weight significantly, since the large drill solids are removed at the surface, and are not included in the measured mud density. Furthermore, the largest barite particles with any potential to settle constitute less than 3% of the total

TABLE 2

COMPARISON OF MUD PROPERTIES WITH PROGRESSIVE GEL-STRENGTH TESTS
GYP-FERROCHROME LIGNOSULFONATE EMULSION MUDS

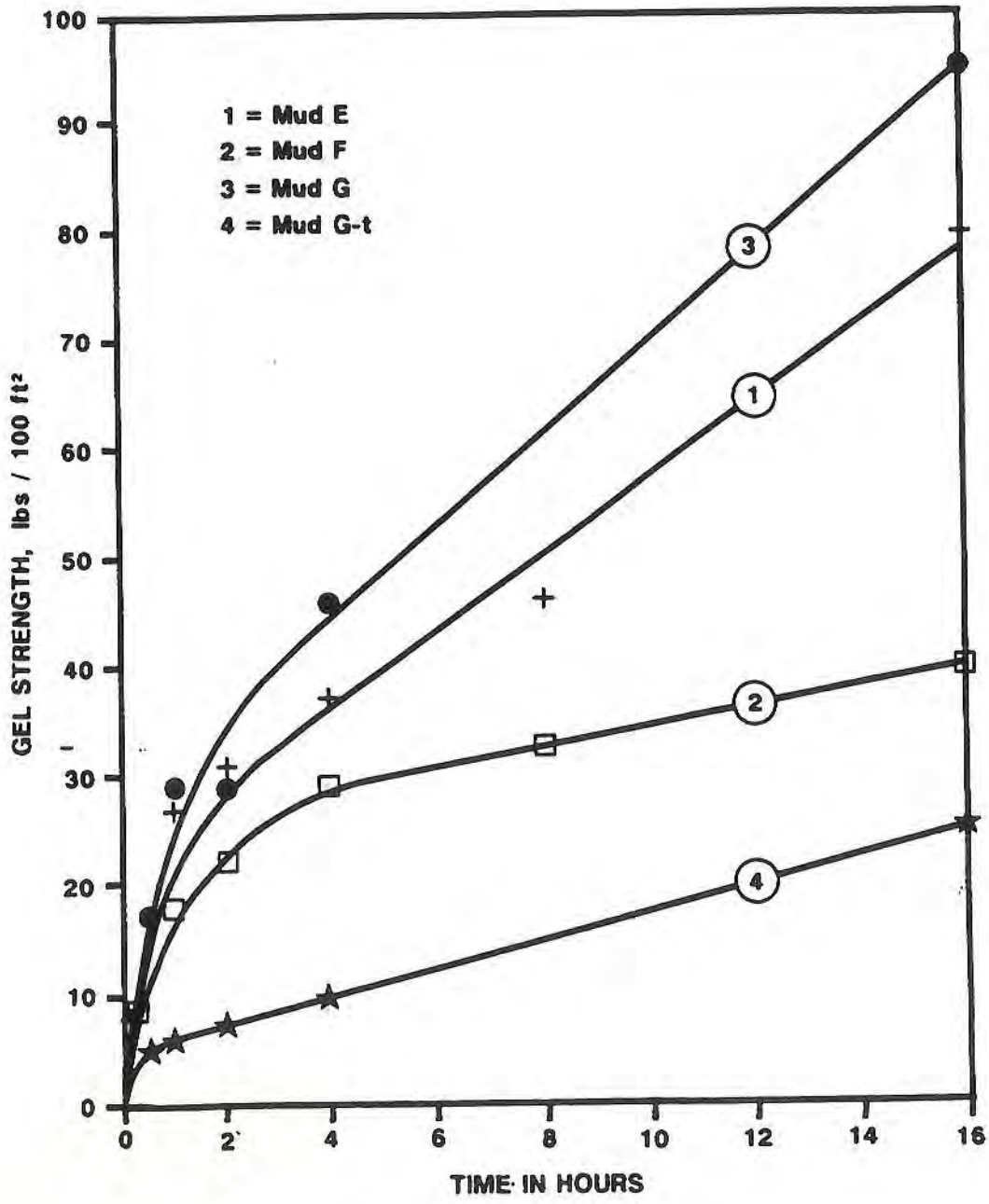
	SAMPLE			
	Mud E	Mud F	Mud G	
			No Treatment	3 lb/bbl PCL
Weight, unstirred, lb/gal	11.0	10.7	10.6	
Weight, stirred, lb/gal	11.0	10.3	10.7	
Plastic Viscosity, cp	14	23	16	15
Yield Point, lb/100 sq ft	3	6	2	1
10-sec gel, lb/100 sq ft	1	2	1	0
10-min gel, lb/100 sq ft	8	8	7	3
API filtrate, sl	6.2	3.3	5.2	2.9
pH	10.9	10.6	10.5	10.4
Composition:				
Water % by vol	76	63	75	
Oil, % by vol	5	11	9	
Solids, % by vol	19	16	16	
Solids, % by vol	39	36	37	
Solids, SG	2.7	2.9	3.0	
Filtrate Ion Analysis:				
Chlorides, ppm	3500	400	3000	
Sulfates, epm	250	300	130	
Carbonate, epm	24	28	12	
Bicarbonate, epm	12	160	12	
Calcium, epm	44	52	44	

Progressive Gel Strengths lb/100 sq ft	Temperature (°F)							
Time	75°	180°	75°	180°	75°	180°	75°	180°
0 minutes	1	1	2	2	1	1	0	0
3 minutes	2	3	2	5	3	8	1	1
10 minutes	8	18	8	12	7	26	3	3
30 minutes	15	40	11	18	17	58	5	5
60 minutes	27	90	18	16	29	91	6	6
2 hours	31	145	22	22	29	104	7	7
4 hours	37	190	29	42	46	172	10	10
8 hours	46	190	33	42				
16 hours	80	320	40	57	95	320	25	25

(From Weintritt and Hughes, 1965)

FIGURE 3
GEL STRENGTH vs. TIME
FOR 3 FIELD MUDS AT 75°F
(FROM WEINTRITT AND HUGHES, 1965)

SEE TABLE 2



barite in the mud. Therefore, the loss of these larger barite particles will not alter the mud density by more than 0.3%.

As an example consider a 10 lb/gal, mud system with the following formulation:

Component	Specific Gravity	Concentration (lbs/bbl)	Volume Percent
Bentonite	2.8	18	1.84
Barite	4.2	77	5.26
H_2O	1.0	325	92.9

A loss of 3% barite would lead to the following mud system:

Component	Specific Gravity	Concentration (lbs/bbl)	Volume Percent
Bentonite	2.8	18.1	1.84
Barite	4.2	74.7	5.08
H_2O	1.0	326	93.1

The weight of this second system is 9.97 lb/gal, which reflects a total reduction in mud weight of 0.3% or 4 psi per 1000 feet of mud column. This number is a conservative value since less than 3% of the barite is expected to settle, the radius of the largest particles has been over estimated, and the minimum gel strength required to prevent solids from settling will be reached in less than thirty minutes (Table 2).

Other areas which need to be reviewed concerning long-term mud properties are associated with the following relationship between the drilling fluid and the formation:

- Formation Stresses
- Mud Dehydration
- Filtercake Formation

Formation Stresses

Three phenomena, faulting, hole stability, and hydraulic fracturing; contribute to our knowledge of formation stresses. General experience and theoretical models continually demonstrate the existence of stresses in the underground which always act in a direction to close a borehole in unconsolidated formations along the Gulf Coast (Gray and Darley, 1980, Chapter 8). The existence of these stresses in Gulf Coast formations requires that, over a long period of time, the following relationship must hold:

Formation Friction + Mud Hydrostatic Forces + Gel Strength = Formation Stress

Since the general experience associated with deep wells is that the diameter of wellbores along the Gulf Coast will shrink due to plastic flow of shales, and long-term shale creep (Gray and Darley, 1980, Chapter 8 and Mitchell et al, 1987), an enclosed mud column must acquire the increased stresses imposed by the surrounding formation. Since the mud is a gelled fluid, these forces will

be transmitted as an increase in hydrostatic pressure throughout the mud column. The eventual limit of this increased stress will be the same force per unit area required to maintain an open fracture in the weakest exposed formation. The resistance offered by a drilling fluid to upward migration of fluids will approach or exceed that of the formation itself due to the hydrostatic nature of the mud.

Mud Dehydration

Some concern has been raised that drilling fluids can eventually be dehydrated and cracked. If this were to occur, it is speculated that an open conduit would exist for fluid flow up a wellbore. Again, the literature data provided by Gray and Darley (1980, p. 366) demonstrate that clays in general, and smectite clays in particular, are prone to adsorb water, and that these clays can develop significant swelling pressures due to water adsorption. This process of brine adsorption by bentonite has been demonstrated numerous times, and a most spectacular presentation of this swelling process can be observed in the 1972 Drilling Fluid Engineering Manual provided by Macobar (1972). It is interesting to note that compaction of these clay systems, due to compressing the water out of the clay samples, can result in fluid permeabilities on the order of 10^{-9} darcies (10^{-6} md) (Gray and Darley, 1980, p. 271).

The data provided by Gary and Darley and their cited references demonstrate that clay muds will remain hydrated while in contact with a source of water. Therefore, at a minimum, all the drilling fluid clays must remain hydrated below the top of the first continuous aquifer. Since the first aquifer in the Gulf Coast region is only tens of feet below the surface, it is improbable that dehydration will have any measurable effect on resistance to flow offered by the mud column, especially if a conservative estimate for gel strength of 25 lbs/100 ft^2 is used in an additive manner to calculate resistance. It is important to point out that if a dehydrated mud is later contacted with an aqueous fluid, the above data indicate that the mud would swell as it gained water. The swelling would close all cracks in the dehydrated mud, and therefore close off the existing path for fluid migration. This would also add hydrostatic pressure to the mud column once the clays were again fluidized.

In more inland areas, the top of the mud column can be conservatively located at the top of the first aquifer encountered below the surface. The effect of this correction will be site specific, and dependent upon the mud weights used, the gel strength of the mud, and the amount of formation stresses transferred to the mud column.

Filtercake Buildup

The ability of the mud column to resist upward flow of fluids is most dependent on the long-term density of the fluid. It has been suggested that drilling fluid solids may be squeezed into permeable formations, and therefore, a significant reduction in the hydrostatic head could occur. The loss of hydrostatic head would then allow fluids to flow more easily from the injection zone to a USDW.

A review of the filtration properties of clay-based drilling fluids and an understanding of gel strength can be used to alleviate this concern. One of the primary designed properties of a drilling mud is fluid loss control for

fluid flow into the formation. The clay-based systems use bentonite or the natural clays to provide viscosity, gel strength, and filtercake formation to control fluid loss. The fact that a filtercake forms with little invasion of solids into the formation (Gray and Darley, 1980, Chapter 6) demonstrates that the loss of drilling fluid solids into the reservoir is minimal under ordinary conditions. Basically, the solids are too large to migrate into the formation, and they must remain in the wellbore unless they are naturally fractured into the formation due to the accumulation of formation stresses encountered over a long period of time.

Since the solids must remain in the wellbore as demonstrated by filtercake buildup, the only mechanism available for relieving the formation stress accumulated in the mud column is the compaction of the mud column, and the movement of water into the formation. However, the loss of water into the formation must naturally be followed by three changes in the mud properties. First, the mud column will increase in density due to the loss of the lower density water. Second, the gel strength of the mud will increase, as the solids are brought into closer contact with each other. Third, the actual low permeability of the mud column to fluids must decrease. The reduced permeability reached by compaction of the clay mud could be as low as 10^{-9} darcies, although two to three orders of magnitude higher permeability would be sufficient to prevent significant vertical fluid migration (Gray and Darley, 1980, p. 271).

Expected Long-Term Mud Properties

The review of known mud properties for clay, water-based drilling fluids presented thus far leads to the following expectations for long-term mud properties:

1. The density of a clay, water-based drilling fluids should not be altered by more than 0.3% over an extended period of time, since adequate gel strength will be developed to prevent solids settling.

2. The mud density will overbalance original formation pressure by at least 100 psi or more.

3. Gel strength will reach a minimum of 25 lbs/100 ft^2 and will most likely exceed 100 lbs/100 ft^2 over an extended period of time.

4. For cased holes, the top of the mud column in abandoned wells will be close to the surface, since the mud must remain inside the hole after it is abandoned.

5. For an open hole in hard rock country, the major conservative consideration will be the location of the first water aquifer below ground level due to potential dehydration and cracking of the drilling fluid. Dehydration of muds below this point is highly improbable, if not impossible, due to the water adsorption properties of the clay. It should be realized that the point where dehydration causes loss of density and cracking of the mud could occur significantly higher in the mud column due to the water adsorping properties of the clay and capillary forces.

6. Recontacting a dehydrated mud with water will cause the clays to swell and close off any potential cracks in the dry cake.

7. For an open hole in regions such as the Gulf Coast, the stresses in the formation should load the mud column and increase the hydrostatic head with time. The expected increase in hydrostatic head is caused by a reduction in the wellbore diameter due to wellbore closure without a commensurate loss of material from the drilling fluid. The increase in hydrostatic head will provide resistance to vertical migration that approaches the pressure required to fracture the weakest exposed interval.

8. The solids in the mud cannot be forced into the formation by means other than fracturing of the weakest exposed formation.

9. Loss of water to the formation due to wellbore closure will increase both mud density and gel strength. If total compaction of the fluid in the wellbore occurs, the permeability of the compacted column could approach 10^{-9} darcies.

In all cases, for the mud systems reviewed, except for dehydration effects which have not yet been quantified in the literature, the long-term mud properties are expected to be more resistant to vertical migration of fluid than the original mud. Since the original mud density typically overbalances formation pore pressure by 100 psi or more, it is realistic to expect that mud filled wellbores will not provide a conduit for fluid flow from the injection zone to a USDW under the vast majority of operating conditions.

Measured Long-Term Drilling Fluid Properties

Before presenting the data for the mud properties of the 29 year old mud obtained from the abandoned well located near Corpus Christi, Texas, it is valuable to review the mud properties and the well schematic for the well after it was plugged and abandoned (Figure 4).

As the data in Figure 4 indicate, the mud density was recorded to be approximately 11.0 lb/gal. The 10 sec and 10 min gel strengths were recorded to be 0 and 3 lbs/100 ft^2. From the preceding arguments, the density of the mud would be expected to remain 11 lb/gal, and the gel strength should be at least 100 lbs/100 ft^2 as suggested by the data provided by Weintritt and Hughes (1965).

The data presented in Table 3 and Figure 4 show that the average density of the mud over the 740+ feet recovered was 11 lb/gal, and the average gel strength of the mud was 267 lbs/100 ft^2. The shear strength of the mud was also measured using the standard technique mentioned by Gray and Darley (1980, p. 101). The average shear strength was determined to be 260 lbs/100 ft^2.

It should be remembered when evaluating these data, that the operators are disposing of their mud at the end of the job and are no longer interested in maintaining the quality of the mud system at the same level required for drilling. The variations in density observed in Figure 4 are likely due to the final variation in mud properties in the mud pit as the mud was pumped downhole, and not to solids settling. This reasoning is supported by the fact that the mid level mud densities were the lightest encountered in the mud column. If

FIGURE 4

WELL : NORA SCHULZE No. 2

LOCATION : CORPUS CHRISTI AREA

MUD TYPE : LIGNOSULFATE ?

MUD DENSITY : 11.0 POUNDS/GALLON

GEL STRENGTH : 0/3 POUNDS FORCE/100 FEET^2

DRILLING COMMENCED : NOVEMBER 13, 1959

WELL P&A : NOVEMBER 25, 1959

DATE OF MUD SAMPLE : AUGUST 26, 1988

DEPTH OF MUD SAMPLES : 12' TO 754' BGL

WELL DIAGRAM

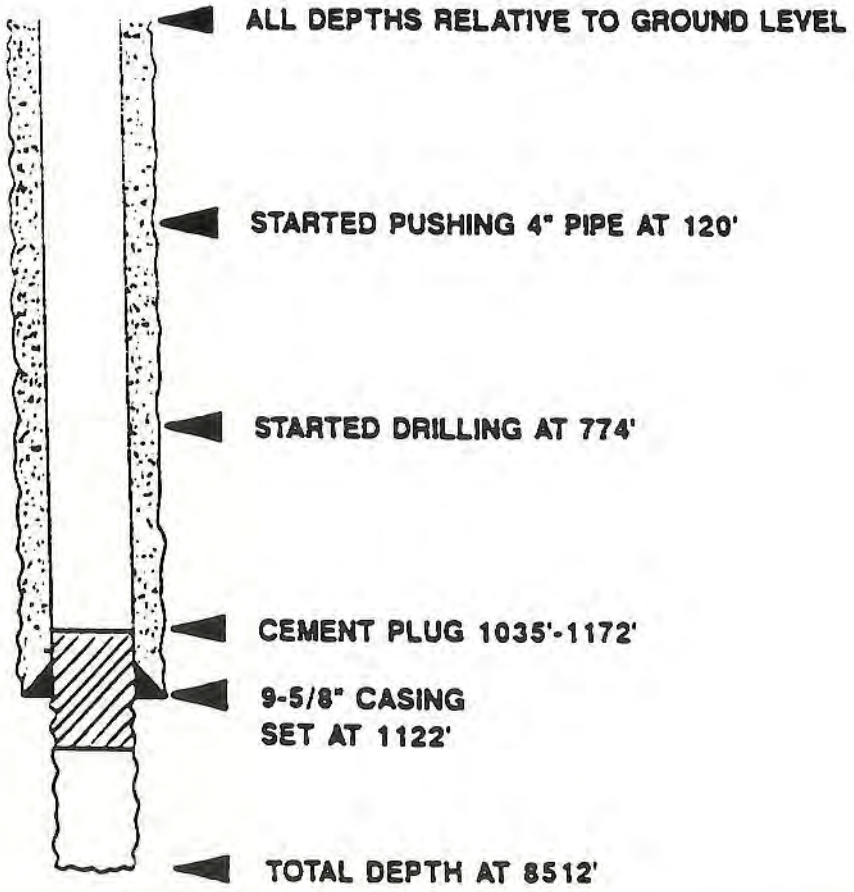


TABLE 3

RECOVERED MUD PROPERTIES FOR NORA SCHULZE NO. 2 WELL

SAMPLE NO.	DEPTH (ft)	MUD WEIGHT (lb/gal)	SHEAR STRENGTH (lbs/100 ft^2)	GEL STRENGTH (lbs/100 ft^2)
1	---	---	---	---
2	60	12.0	540	304
3	111	10.9	230	296
4	174	11.0	310	295
5	207	11.2	190	>320
6	240	10.9	170	284
7	273	10.7	180	237
8	306	10.9	285	254
9	339	10.5	190	288
10	372	10.9	245	272
11	405	11.1	280	220
12	438	11.1	255	222
13	471	11.1	301	292
14	504	11.1	300	230
15	537	11.0	490	292
16	570	11.0	225	217
17	603	10.9	240	236
18	636	11.3	650	>320
19	609	11.4	750	---
20	702	11.5	2100	---
21	719	10.9	4700	---
22	725	10.7	890	---
23	731	11.3	7000	---

Average mud weight using all samples - 11.1

Shear strength averaged for samples 3 through 17 - 260 lbs/100 ft^2

Average gel strength of samples 3 through 17 - 267 lbs/100 ft^2

settling was responsible for the density variation, then a regular increase in density from the top of the column to the bottom of the column would have been expected. This phenomenon was not observed.

The data presented in Figure 4 demonstrate that the long-term extrapolation of the short-term laboratory and field data is reliable for the clay-based mud systems. Currently available data do not indicate that the behavior of these mud systems over an extended time period should be anything other than what the current extrapolation of mud properties would indicate. In fact, all current data suggest that the use of the short-term measured properties of a clay, water-based mud system will provide a conservative long-term prediction of the actual mud properties.

Two important points remain to be discussed. First, all samples flowed from the collection tubing in the field except for the samples isolated in the last three pup joints. The shear strength of the last three samples ranged between 890 and 7000 lbs/100 ft^2. When these three samples were placed in 5 gallon pails in the laboratory, they showed the properties of a fluid, since they slowly flowed into the bottom of the pail rather than retaining the shape of tubing. Second, it was evident that a large amount of drill solids had settled to the 700 foot range, since large fragments of drill cuttings could be felt in the mud samples below this depth. The bottom samples felt gritty, while samples taken above this point did not have a gritty texture.

The first observation discussed in the previous paragraph shows that the mud removed from the hole remained fluid, demonstrating the ability of this mud to transmit hydrostatic pressure. This was true even for samples with 2000 to 7000 lbs/100 ft^2 shear strengths. Since the average density remained approximately 11 lb/gal, it was evident that the hydrostatic forces associated with the original mud were not altered. The second observation correlates with past observations in the oil field. Basically, some drilled solids, and potentially some barite will settle upon standing. However, the settling of these solids is not sufficient to cause a major change in the average mud density, although they will contribute to a significant increase in gel strength in the region where solids finally settle. The final settling point may not necessarily be the bottom of the hole.

Sample Collection

The samples from the reentered well were obtained by forcing 2-7/8 inch tubing into the well with a special coring device attached to the driving edge of the tubing. From a depth of 120 feet to approximately 740 feet, the tubing had to be pushed into the wellbore, because the tubing weight alone did not apply enough force to move the tubing through the mud. At a depth of approximately 740 feet, the tubing could no longer be pushed into the wellbore. The tubing was pulled from the well at that point, and the mud in each joint was allowed to flow into a 5 gallon plastic pail which was quickly sealed. The bottom three pup joints, each 6 feet in length, were sealed for shipment back to the laboratory because the mud in these joints did not flow easily from the tubing. From ±740 feet to ±1100 feet, the mud could not be cored using the above techniques, and it was therefore necessary to drill and circulate the remaining drilling fluid out of the hole.

Conclusions

The 29 year old mud properties measured in this study support the expectations associated with extrapolating short-term mud properties over an extended period of time. Mud density remained essentially unaltered, gel strength exceeded 100 lbs/100 ft^2, and, even for the most highly gelled samples, the mud remained fluid. This last property is extremely important since it supports the concept that formation stresses can be transmitted through the drilling fluid column over extended periods of time. All evidence gathered to date indicates clay, water-based drilling fluids provide adequate protection against vertical fluid migration over a 10,000 year time period.

References

Annis, M. R. 1967 "High Temperature Properties of Water-Base Drilling Fluids", J. Pet. Tech. Transactions AIME, Vol. 240, pp.1074-1080.

Davis, Ken E., "Factors Effecting the Area of Review For Hazardous Waste Disposal Wells", Proceedings of The International Symposium Subsurface Injection of Liquid Wastes, National Water Well Association, Dublin, Ohio, March 3-5, 1986.

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Gray, George R. and H. C. H. Darley. 1980 Composition and Properties of Oil Well Drilling Fluids, Gulf Publishing Company, Houston, Texas.

Hiller, K. H. 1963 "Rheological Measurements of Clay Suspensions at High Temperature and Pressures", J. Pet. Tech., Transactions AIME, Vol. 228, pp.779-789.

Magcobar Operations, Dresser Industries, Inc. 1972 Drilling Fluids Engineering Manual, Dresser Industries, Houston, Texas, Chapter 3.

Mitchell, R. F., M. A. Goodman, and E. T. Wood. "Borehole Stresses: Plasticity and the Drilled Hole Effect", SPE/IADC 1987 Drilling Conference, SPE/IADC 16053, New Orleans, Louisiana, March 15-18, 1987.

Weintritt, D. J. and R. G. Hughes. 1965 "Factors Involved in High-Temperature Drilling Fluids", J. Pet. Tech. Transactions AIME, Vol. 234, pp.707-716.

2. Celanese should submit information documenting the presence of 10.1 lb/gallon mud at or near the ground surface in the abandoned borehole for Artificial Penetration No. 9 in Table 4-1 and Figure 4/13. The documentation is necessary since the predicted pressure rise in the upper Miocene injection interval at Artificial Penetration No. 9 exceeded the pressure due to a 9.0 lb/gallon mud column in approximately 1969 and will exceed the pressure in approximately 1994.

Response:

The EPA has correctly recognized that Artificial Penetration No. 9 is an important well due to its proximity to the injection wells. The documentation provided in Section 4 of the petition indicates that AP No. 9 is actually a cased hole with casing set below the deepest injection interval (to 6600 feet-see information on AP No. 9 in Appendix 4-2, 4-14 and 4-15). Thus, the only possible conduit for upward fluid movement would be around the annular space between the casing and the surrounding formations, and this avenue of fluid movement is effectively sealed off by annular closure of geologic formations around the casing. Because no conduit for fluid movement exists in this well, the weight or level of fluid in this borehole is irrelevant, and the well meets the no-migration and non-endangerment standards. Documentation and discussion of the annular borehole closure process is provided here for EPA review.

Natural Borehole Closure

Natural closure of artificially created open spaces in the subsurface is a documented process that is known to exist along the Gulf Coast. This process causes the geologic formations to close around drill pipe or casing once pipe movement has ceased. The process operates on the Gulf Coast because the soft sediments are under tremendous overburden pressures and deform plastically, closing open spaces or moving in around casing strings, sealing them in place.

Natural Borehole Closure Significance to Petitions

The borehole closure process is very important to the Area of Review portion of Gulf Coast Petitions, because this process rapidly seals (in a matter of days) the space between casing strings and the surrounding geologic formations. Thus, borehole closure effectively seals a potential conduit of vertical fluid movement in two important cases of Area of Review (AOR) wells, i.e., 1) abandoned wells, and 2) currently productive wells, with long string casings set below the surface casing. Frequently, these long string casings are set below the deepest injection intervals, and borehole closure effectively seals the casing along its entire length to vertical fluid movement.

Natural Borehole Closure During Drilling and Logging

During well logging operations of newly drilled Gulf Coast wells, natural borehole closure is evidenced by the increasing ledges and "tight spots" seen on the caliper logs run with the logging tools. The natural borehole closure problem is such an important issue that many oil companies such as EXXON Co. USA, have a policy of reentering exploration boreholes with the drilling

assembly to reopen the borehole, within 24 hours of the time drilling operations have ceased. Reentering a well for a "wiper trip" with the drill string to reopen the borehole, in the middle of a logging job, greatly increases the rig time expense of logging a well. Still, reentering the boreholes is done because borehole closure can progress rapidly to a point where it causes the logging tools to become irretrievably stuck in the hole, sometimes resulting in the loss of the entire well.

Natural Borehole Closure Evidence From Casing Salvage Companies

Natural borehole closure has also been documented during well re-entries and while drilling wells. Additional hard evidence is available from casing salvage operations. Delta Seaboard well service company has operated along the Gulf Coast since the late 1950's, plugging wells and pulling casing. The pulled casing is a marketable commodity which is cleaned, inspected, and sold for installation in new wells. Each foot of casing pulled from a well during abandonment, increases potential profits, so as much casing as possible is pulled. Unfortunately for casing salvage companies such as Delta Seaboard, natural borehole closure usually assures that the majority of long string casing in Gulf Coast wells must be left in place and remain unrecovered.

To determine how much casing may be pulled, a "pulling nipple", or "jacking nipple" can be attached to the top of the casing string. Hydraulic jacks are then rigged up to apply upward tension on the casing string. By using a table comparing pulling pressure to pipe stretch, the approximate "free point" may be determined. Invariably, this "free point" is near the base of the surface casing.

After the many years of experience that the company has acquired while conducting their business on the Gulf Coast, Delta Seaboard only occasionally runs free point tests. This is largely because after three decades of operation they know that the casing is

sealed from just below surface casing by natural borehole closure. In November 1989, Delta Seaboard moved onto a site near El Campo, Texas where intermediate casing had been set in the Cox and Perkins, No. 1 Sample, just two weeks before. As described in the work report, surface casing was set at 2515′ and an attempt was made to pull 3013′ of intermediate casing. After repeated attempts without success, another cut was made just inside surface casing at 2492′. The casing still remained sealed in place. Finally, the casing was cut at 2450′ and worked free.

In another recent case, two Enex Resources wells were plugged and casings were removed. Jacks were rigged up on the No. 1 Wintermann well and stretch indicated that the 5 1/2" casing may be free as deep as 2806′. Surface casing was set at 2493′. Cuts were made at 4000′, 3500′, 3300′, 3001′, and finally at 2469′ where the casing came free. As in the earlier example, the casing was sealed in place from the base of the surface casing down. Similar results were obtained from the No. 2 well on the same lease.

Summary

In summary, based on a consensus of opinion among Gulf Coast geologists attesting to the veracity of borehole closure, the experiences of drilling crews while drilling, logging, and reentering Gulf Coast wells, and by the experiences of casing recovery companies such as Delta Seaboard, natural borehole closure is a documented process that will seal any potential conduits of fluid movement between long string casings and the surrounding geologic formation.

3. Celanese should demonstrate that, of the hazardous wastes that are injected at this facility, modeling of dichloroacetaldehyde will result in the maximum vertical and lateral plume movement.

Response:

A total of eight hazardous constituents were selected for evaluation in determining the maximum vertical and horizontal transport at this facility. The constituents are as follows:

Constituent	HBL	Det. Lim.	Max. Injected Concentration
(K009 Appendix VII Constituents)			
Chloroform	0.006 ppm(RSD)*	n/a	300 ppm
Formaldehyde	n/a	5 ppm	1000 ppm
Methylene Chloride	n/a	0.165 ppm	500 ppm
Methyl Chloride	n/a	0.21 ppm	500 ppm
Paraldehyde	n/a	0.02 ppm	500 ppm
Formic Acid	n/a	1 ppm	1000 ppm
(Appendix VII Constituent not on K009 List, Added for K010)			
Chloracetaldehyde	n/a	1 ppm	20,000 ppm
(Added Constituent in Case Deminimus Exclusion is Revoked)			
Isobutanol (Iso-butyl alchohol)	10ppm (Rfd)**	n/a	1,000 ppm

* RSD = Risk Specific Dose; from EPA UIC Petition Guidance Document No. 2, July 1989, p.28.

** Rfd = Reference doses; from EPA UIC document above, p. 26.

n/a = not applicable

$$\text{CRF} = \text{Concentration Reduction Factor} = \frac{\text{HBL (or Det. Lim.)}}{\text{Max. Inj'd Conc.}}$$

A worst case modeling approach was taken in modeling maximum lateral hazardous plume extent in 10,000 years, and maximum molecular diffusion in shale and boreholes. To do this the chloracetaldehyde constituent was selected for modeling because it will have the greatest average concentration in the injected waste (several thousand ppm vs less than 200 ppm for the other constituents). The chloracetaldehydes also have the largest maximum theoretical initial injected concentrations and greatest concentration reduction factor. Based on these characteristics modeling this constituent will provide the maximum vertical and horizontal extent. Since this maximum extent is shown to meet the no-migration and non-endangerment standard, the other constituents on the above list also meet the standard.

A large number of conservative assumptions are built in to the modeling of waste transport in order to bound the maximum possible extent of waste transport. This is particularly true of the molecular diffusion calculations. The dichloracetaldehyde species (from the 3 chloracetaldehyde species present) was selected for modeling at the facility, and this resulted in the following:

Constituent	Max. Inj. Conc.	CRF	Abd. BH Diffusion Brine	Mud(9#/gal)	Shale Diffusion
Dichlor-acetaldehyde	20,000 ppm	1 x10-5	410'*	289'**	212***

* Assumes Geometric Correction Factor for brine of 1.0.

** Assumes Geometric Correction Factor for 9#/gal mud of 0.5.

*** Assumes total shale porosity of 27% (from curve 6 in Porter/Newsom Appendix).

Because there is a minimum of approximately 425' of permitted containment interval in the injection zone above the uppermost injection interval, and the maximum vertical extent of fluid movement is less than this, the site meets this aspect of the no-migration and non-endangerment standard.

4. Celanese should submit the reference(s) documenting the health based limit of 1 ppm for dichloroacetaldehyde.

Response:

Attached are copies of a Core Laboratories report showing the 1 ppm detection limit for the chloracetaldehyde species. This report was obtained from Naresh Shah (Lab Organics Supervisor) at Core Labs where many of the waste analyses were performed. For further clarification of the detection limits, Naresh can be contacted at 713-972-6705 (or contact Larry Scott @ 713-943-9776 at another Houston Core Lab facility where additional Hoechst Celanese waste analyses were performed). One ppm is an optimistic detection limit assuming that there are very few other constituents in an analyzed waste sample that could mask detection. There are three chloracetaldehyde species present in the waste. The dichloracetaldehyde species was the one selected for specific calculations because, of the three, it is present in the greatest concentrations.

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CORE LABORATORIES

(L161) LABORATORY TESTS V2.10
(abbreviated form)

CODE	SHORT DESCRIPTION	UNITS OF MEASURE	DETECTION LMT	TEST METHOD
0427	Formaldehyde	mg/l	1	GC
0428	14-C4diol GC	mg/l	1	GC
0429	Butyric acid	mg/l	1	GC
0430	Clacetaldehyde	mg/kg	1	GC
0431	Formaldehyde	mg/kg	5	GC
0432	Formic acid	mg/kg	1	GC
0433	Paraldehyde	mg/kg	1	GC
V745	MeCl SM	mg/kg	0.21	EPA 8240/5030
V746	CH2Br2 SM	mg/kg	0.195	EPA 8240/5030
V747	CH2Cl2 SM	mg/kg	0.165	EPA 8240/5030

The analyses, opinions or interpretations contained in this report are based upon observations and material supplied by the client for whose exclusive and confidential use this report has been made. The

5. On page 6 of Appendix 2-11, it is stated that "The concentration of dichloroacetaldehyde in the "acid" waste stream is 4100 ppm based on a waste stream analysis performed on November 22, 1988". Celanese should submit the results of this test and any other information necessary to establish that this concentration level is conservative. Should the petition be approved, a stipulation would be made that Celanese not exceed the modeled concentration level of 4100 ppm since the projected extent of the waste migration would no longer be valid.

Response:

Attached is the referenced waste analysis report as well as additional recent facility waste analyses. As stated in the previous response, the modeled concentration of dichloracetaldehyde has been increased to 20,000 ppm. This new increased limit will always be greater than the true concentration of the injected dichloacetaldehyde constituent.

Acid Well
Waste Analyses

updated as of 1-29-90

Flows to V-693 (Acid Well Equalization Vessel)

Stream Designation	Average Flow	Percent
~~T-17 side stream (K016)~~	~~10 gpm~~	~~4.4~~ Recycled
• T-17 residue (K009)	150 gpm	69.3
• T-8 residue	60 gpm	27.7
V-17	0.3 gpm	0.14
• Backwash return pumps	3 gpm	1.4
• HCl scrubber tank (V-1225)	3 gpm	1.4
	~~220.3~~ 216.3	

Attachment II

HOECHST CELANESE CHEMICAL GROUP, INC.

Bay City, Texas Plant

Chlorinated Species Analysis

(all values in weight percent)

Stream	------ Chlorocetaldehydes ------ Mono-	Di-	Tri-	Total Chlorinated Species	Reference
T-17 Sidestream Aug-Sept, 1988	2.38	1.66	0.33	4.47	K. M. Nathan, KMN-38-88, Oct. 24, 1988
T-17 Residue Jul-Sept, 1988	0.14	0.43	0.08	0.65	K. M. Nathan, KMN-36-88, Oct. 4, 1988
T-6 Residue Jul-Sept, 1988	0.01	0.03	0.03	0.07	K. M. Nathan, KMN-36-88, Oct. 4, 1988
Acid Well Feed Nov, 1988	0.19	$\boxed{0.41}$	0.08	0.70	K. M. Nathan, KMN-40-88, Nov. 4, 1988

4100ppm

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CORE LABORATORIES

Total T-8, T-1753, T-17Re
is 97.2 vol. % of
1A well flow.

LABORATORY TESTS RESULTS
03/22/89

JOB NUMBER: 890215 CUSTOMER: Hoechst Celanese Chemical ATTN: Glenn McCarthy

SAMPLE NUMBER:0001 DATE RECEIVED:02/10/89 TIME RECEIVED:09:28 SAMPLE DATE:02/10/89 SAMPLE TIME:00:00

PROJECT ID: SAMPLE ID:ChloroAcetaldehyde 0.1% Water 99% T-8Res REM:1x1 qt glass bottle

26.5 vol. % of 1A well flow (60gpm)

TEST DESCRIPTION	FINAL TEST RESULT	UNITS OF MEASURE	TEST METHOD	DATE	TECHNICIAN
Acrolein	<24	ug/l	EPA 8240/5030 Heat	02/28/89	PHF
Chloroform	27	ug/l	EPA 8240/5030	02/28/89	PHF
1,1-Dichloroethane	<1.8	ug/l	EPA 8240/5030	02/28/89	PHF
Ethyl methacrylate	<19	ug/l	EPA 8240/5030	02/28/89	PHF
Methylene chloride	6	ug/l	EPA 8240/5030	02/28/89	PHF
Total Suspended Solids (TSS)	129	mg/l	EPA-600 160.2	03/21/89	LSS
Total Organic Carbon	386	mg/l	EPA-600 365.2	03/20/89	CHJ

APPROVED BY: [signature]

10201 Westheimer
Houston, TX 77042
(713) 972-6707

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LABORATORY TESTS RESULTS
03/22/89

JOB NUMBER: 890215 CUSTOMER: Hoechst Celanese Chemical ATTN: Glenn McCarthy

SAMPLE NUMBER:0002 DATE RECEIVED:02/10/89 TIME RECEIVED:09:28 SAMPLE DATE:02/10/89 SAMPLE TIME:00:00

PROJECT ID: SAMPLE ID:ChloroAcetaldehyde 0.1%Water 99% T-17Res REM:1x1 qt glass bottle

66.3 vol. % of 1A well flow (150gpm)

TEST DESCRIPTION	FINAL TEST RESULT	UNITS OF MEASURE	TEST METHOD	DATE	TECHNICIAN
Acrolein	71	ug/l	EPA 8240/5030 Heat	02/28/89	PHF
Chloroform	140	ug/l	EPA 8240/5030	02/28/89	PHF
1,1-Dichloroethane	<1.8	ug/l	EPA 8240/5030	02/28/89	PHF
Ethyl methacrylate	<19	ug/l	EPA 8240/5030	02/28/89	PHF
Methylene chloride	6	ug/l	EPA 8240/5030	02/28/89	PHF
Total Suspended Solids (TSS)	15	mg/l	EPA-600 160.2	03/21/89	LSS
Total Organic Carbon	5490	mg/l	EPA-600 365.2	03/20/89	CHJ

APPROVED BY: Da Stoner

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Neutral Wells
Waste Analyses

Western Atlas International

CORE LABORATORIES

LABORATORY TESTS RESULTS
04/22/89

JOB NUMBER: 890315 CUSTOMER: Hoechest Celanese Chemical Group ATTN: John D. Clemmer III

SAMPLE NUMBER:0001 DATE RECEIVED:02/24/89 TIME RECEIVED:12:06 SAMPLE DATE:02/13/89 SAMPLE TIME:00:00

PROJECT ID: SAMPLE ID:V-159 Residue Under Water REM:1x1 pt glass bottle

TEST DESCRIPTION	FINAL TEST RESULT	UNITS OF MEASURE	TEST METHOD	DATE	TECHNICIAN
Chloroacetaldehyde	<3	mg/kg	GC-ECD	04/21/89	LS
Formaldehyde	<50	mg/kg	GC	04/17/89	LS
Formic acid	<50	mg/kg	GC	04/17/89	LS
Paraldehyde	0.6	mg/kg	EPA 8240/5030 Heat	03/01/89	WJ
Chloroform	0.1	mg/kg	EPA 8240/5030	03/01/89	WJ
Methyl chloride	<0.21	mg/kg	EPA 8240/5030	03/01/89	WJ
Methylene chloride	0.2	mg/kg	EPA 8240/5030	03/01/89	WJ

APPROVED BY: Dale Schappelow

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6. Celanese should submit the pressure test data and calculations to verify the permeability value used in the model as stated on page 2-20.

Response:

The pressure test data and calculations used in the model have already been provided in the petition, and are located in the Selected Petition References volume. For this information refer to the references volume under Petition Section 3 - Reference # 16.

7. Celanese should submit information to verify the original pressure of the injection intervals.

Response:

The original formation pressure in the lower Miocene injection sand was derived from a bottomhole pressure measurement in WDW-110, prior to the start of injection. The pressure test is located in the selected petition references. The original formation pressure for the upper Miocene injection sand is based on two pieces of information. The first piece of data is a drill stem test performed in WDW-8, in June of 1964. The pressure gradient from this test was 0.449 psi/ft. The drill stem test was not sealed successfully and therefore the pressure value is suspect. The second piece of data is a report to the State of Texas in 1972, which stated the the original formation pressure gradient for the upper Miocene is 0.452 psi/ft. This conclusion was based on an evaluation of pressures for Miocene sands in the Bay City area. The pressure gradient used in the modeling was 0.452 psi/ft. This value should be considered conservative since the value from the drill stem test was less. (See selected petition references for documentation).

8. Celanese should provide information discussing the effect on the pressure buildup and plume migration for the upper Miocene injection interval due to thinning of the interval to 20 feet northwest of the facility.

Response:

The thinning of the upper Miocene injection interval to the northwest of the plant site has been modeled using a fault to represent the thinning. The fault was placed approximately 5.5 miles northwest of WDW-32, trending northeast to southwest. The average thickness of the injection interval was determined by performing a volumetric calculation on the net sand isopach of the upper Miocene injection interval (Appendix 3-11). The result of the calculation was an average thickness of 185 feet over the map. Two different modeling runs were made with the fault. In first run, the average thickness of 185 feet (from volumetrics) was employed and in the second run 165 feet was used for the injection interval thickness. All of the other parameters were unchanged. The model was run through the end of the year 2000, using maximum injection rates. The results at the end of year 2000 are displayed below.

CASE	UPWARD PERMEATION (FT) (1)	PRESSURE@ INJECTION WELL (PSI)(2)	PRESSURE@ AOR BOUNDARY (PSI)(3)	PLUME RADIUS (MILE) (4)
ORIGINAL	1.520	86.8	28.4	0.90
FAULT (185 FT)	1.520	88.1	36.4	0.85
FAULT (165 FAULT)	1.861	98.2	40.3	0.90

PLEASE NOTE:

(1) UPWARD PERMEATION AT WDW-14

(2) PRESSURE AT WDW-32

(3) PRESSURE AT MONITOR WELL 4

(4) PLUME MEASURED FROM WDW-32

Please note that the fault (thinning) had little impact on pressure buildup as compared to the original model when the average thickness was 185 feet. The buildup was only approximately 2 psi greater at the wells and only 8 psi greater at the AOR boundary. The increase at the boundary is to be expected since the fault does not allow the pressure to disperse as rapidly. The increase in pressure is greater when the fault is used with an average thickness of 165 feet. The increase at both the wells and AOR is approximately 12 psi over the original model. The impact on upward permeation and plume size is insignificant.

9. Celanese should provide the calculations used to determine the density values for formation fluids in the upper and lower Miocene injection intervals on page 2-23.

Response:

The formation fluid density values used in the 10,000 year plume model were derived from salinity values and formation temperatures. The salinity of the upper Miocene injection interval formation fluid is approximately 83,000 ppm and the salinity of the fluid in the lower Miocene is estimated to be 134,500 ppm. The formation temperatures in the upper and lower Miocene injection intervals are estimated to be 113 and 137 degrees F, respectively. The density of the fluid was estimated at 60 degrees F using the following equation and the density was determined at the formation temperature using a nomograph.

$$D = 1 + C \times (0.695 \times 10^{-6})$$

D = Density at 60 degrees F (g/cc)
C = Concentration of dissolved solids (ppm)

The density of the upper Miocene injection interval fluid at formation temperature was determined to be 1.045 g/cc. The density of the lower Miocene injection interval formation fluid was determined to be 1.072 g/cc at formation temperature.

The waste density was determined from reported values and then converted to formation temperature using a nomograph. The initial waste density for both intervals was estimated to be 1.002 g/cc. The waste density at formation temperature in the upper Miocene injection interval was 0.998 g/cc and the density of the waste in the lower Miocene injection interval was estimated to be 0.990 g/cc. The nomograph used in density conversions is from Chapter 24 of the Petroleum Engineering Handbook, Howard Bradley editor, 1987.

10. Celanese should demonstrate that the shale permeability and porosity values used in the model are either representative or conservative.

Response:

The shale values for porosity and permeability are compared with values from the literature in Tables 2-3a and 2-3b. The shale porosity values used in the model are the low end of the literature range and are therefore, conservative. Increasing shale porosity would only decrease the upward permeation distance. The shale permeability values used in the model are on the low end of the range from literature. Sensitivity analysis was run on shale permeability values for both sands (see Table 2-15 and 2-16). The permeability value was varied an order of magnitude in each direction. The permeability change had little impact on the lower Miocene injection sand. The effect on the upper Miocene injection sand was almost as small. The change in upward permeation with increased permeability was approximately 3 feet and value for upward permeation was less than 5 feet. A decrease in permeability had little impact on pressure buildup (1.4 psi at injection well).

11. The error bars for the modeled shut-in pressure curves encompass a range of 30 psi. The maximum pressure buildup shown in Figures 2-5, 2-6, and 2-7 for the upper Miocene is approximately 45 psi. Consequently, the error in the calculation of the pressure buildup is approximately 67% for the upper Miocene. Similarly, the maximum shut-in pressure buildup shown in Figure 2-8 for the lower Miocene was approximately 6 psi with an error of approximately 5 times the range of measurement. Celanese should therefore justify that the accuracy and precision of the pressure buildup model is adequate to confidently describe the pressure buildup in the injection sands. In addition, Celanese should justify the method used to calibrate the pressure buildup model, considering the errors involved.

Response:

In the upper Miocene injection interval, the pressure model has been calibrated with a total of 9 points in the three wells which utilize the sand. The calibration must be viewed as the combination of the three pressure matches shown in Figures 2-5 through 2-7. The model is depicting the trend in shut-in pressures in all three wells (if there is an increase in pressure the model is also predicting an increase). The error bars are based on the possible sources of error in the shut-in pressure measurements. The possible sources of error in the measurements include the error inherent to the instrument (there is more error in the older pressure bombs, 0.2 per cent or greater of instrument range is normal or 4 psi on an instrument rated to 2000 psi), depth of measurement errors, pressure conversion errors (to appropriate depth), reading errors and instrument calibration. The shut-in pressures calculated from wellhead pressures are sensitive to the density of the fluid in the well. All of these possible errors were considered in the selection of 15 psi error bars. The measured shut-in pressure is also impacted by the amount of time since injection ceased and the amount of formation damage or skin effect.

The fact the error bars on the measured pressures are plus or minus 15 psi and the maximum modeled pressure increase is approximately 45 to 50 psi, has no bearing on the calibration of the model. The error bars are a function of the confidence in the accuracy of the measured pressures and not a reflection of the accuracy of the model to predict pressure buildup. The size of the error bars is independent of the amount of pressure buildup, measured or modeled. The pressure match for the upper Miocene injection interval is reasonable. The model is overpredicting pressure for the most recent pressure measurement in two of the three wells (Figures 2-6 and 2-7).

In order to alleviate any concerns regarding the pressure model

calibration in the upper Miocene injection interval, the model was run with the permeability and thickness of the interval decreased as a possible worst-case situation. The thickness was decreased from 165 feet to 150 feet and the permeability was decreased from 1.35 darcies to 1.2 darcies. The model was run at maximum injection rates through the end of the year 2000. The model results are as follows:

CASE

	UPWARD PERMEATION (FT) (1)	PRESSURE@ INJECTION WELL (PSI) (2)	PRESSURE@ AOR BOUNDARY (PSI) (3)	PLUME RADIUS (MILE) (4)
ORIGINAL	1.520	86.8	28.4	0.90
WORST-CASE (150 FT AND 1.20 DARCIES)	1.861	106.3	34.0	0.94

PLEASE NOTE:

(1) UPWARD PERMEATION AT WDW-14

(2) PRESSURE AT WDW-32

(3) PRESSURE AT MONITOR WELL 4

(4) PLUME MEASURED FROM WDW-32

The pressure increase at the injection wells in the worst-case is approximately 20 psi greater than the increase in the original model. The increase at the AOR boundary is only 6 psi greater in the worst-case. The impact on upward permeation and plume size is insignificant. These results should eliminate any concerns over the pressure calibration since the pressure increase is not substantial and pressure decreases rapidly away from the injection wells. Please note that modeling at maximum injection rates every day of the years through the year 2000 is conservative in itself. The Bay City Plant currently has no intention to inject at maximum rates for any length of time, if ever.

12. The model has been calibrated on the basis of very few points. Figures 2-7 and 2-8 show only two calibration points. An

examination of Figure 2-8, the sole calibration data for the lower Miocene, indicates that the modeled pressure buildup does not compare well with the two actual pressure measurements. Therefore, Celanese should provide additional information in demonstration of the pressure buildup model calibration.

Response:

In order to alleviate any concerns regarding the pressure model calibration in the lower Miocene injection interval, the model was run with the permeability and thickness of the interval decreased as a possible worst-case situation. The thickness was decreased from 203 feet to 183 feet and permeability was decrease to 1.15 darcies from the original value of 1.3 darcies. The model was run at maximum injection rates through the year 2000 and evaluated. The model results are as follows:

CASE	UPWARD PERMEATION (FT) (1)	PRESSURE@ INJECTION WELL (PSI) (1)	PRESSURE@ AOR BOUNDARY (PSI) (2)	PLUME RADIUS (MILE) (1)
ORIGINAL	0.196	86.1	14.4	0.77
WORST-CASE (183 FT AND 1.15 DARCIES)	0.243	106.7	17.0	0.81

PLEASE NOTE:

(1) EVALUATED AT WDW-110

(2) EVALUATED AT MONITOR WELL 1

Please note that the pressure increase at the injection well is

only 20 psi greater than that in the original case and the pressure at the AOR Boundary is only 3 psi greater. This pressure increase is insignificant and therefore should demonstrate the reservoir quality of the interval. The plume and upward permeation results also show no significant change from the original model. It is also important to note that modeling using maximum injection rates is in itself very conservative. The Bay City Plant has historically not injected at these rates and there are no plans to do so in the future.

13. On page 2-33, it is stated that the pressures predicted by the model should be less than the measured pressures. Celanese should expand on the reason for this phenomenon. The modeled shut-in pressures are indeed less than the measured pressures in some cases as is shown in Figures 2-5 and 2-8. Therefore, Celanese should demonstrate that the model is conservative in this regard.

Response:

The statement that the model should predict a smaller shut-in pressure than the measured pressure is based on the fact that most measured shut-in pressures are taken with injection ceased from 6 to 12 hours or more. This may or may not be enough time for the formation to return to a steady state and read a true shut-in formation pressure. The model is based on monthly data and to predict a shut-in pressure the well has zero injection for the whole month. The formation therefore, has more time to relax and return to steady state. There are skin effects or wellbore damage problems to artificially increase the formation pressure.

The Figure 2-5 shows the model underpredicting shut-in pressures, but this is only one of three wells in the upper Miocene injection sand. The modeled pressure in the other 2 wells (Figures 2-6 and 2-7) is not consistently under the measured values. Please note that for the last calibration point for each

well, the model is overpredicting the shut-in pressure and is therefore, conservative. The pressure match for the sand must be viewed as the combination of all three wells in the upper Miocene injection sand not as discreet components. The predicted pressures for the lower Miocene injection sand are less but there is only limited data and the sand is showing very little pressure buildup. The sensitivity analysis also demonstrates the small pressure buildup, even with changes in parameters. The modeling of maximum rates for every minute of every day of the year is a very conservative assumption.

14. There was no discussion in the petition concerning external sources or sinks which could affect the pressure buildup or plume migration. Celanese should investigate this and demonstrate that external sources and sinks will not affect the model, or incorporate these effects into the model.

Response:

The investigation of external sources and sinks in the Bay City plant area included a search of Class I and Class II injection well permits. Water supply wells in the area could not serve as effective pressure sinks due to the shallow depth of the base of the Underground Source of Drinking Water compared to the injection intervals utilized by the Celanese wells. A search was also conducted of all producing oil and gas wells in the area that could potentially become pressure sinks and affect Celanese injection operations.

The only permitted Class I injection wells identified in the region are the Bay City Plant I injection plant wells.

The nearest permitted Class II injection well in the region is five miles east of the plant site in the Wadsworth Oil and Gas Field. It is not known whether this well is active, what the injection zone is, or what the injection rate is.

To determine the potential effect of this well on injection operations at the plant, a series of conservative assumptions have been made. First it was assumed that this well is currently active and has been since 1964. It has also been assumed that this well has been injecting saltwater into a formation correlative with the upper Miocene injection interval used by the Bay City Plant injection wells. Further, due to lack of data, the highest injection rate of any Class II injection well in the area has been used to obtain an injection rate of 4,500 barrels per day. The final conservative assumption is that the analysis for the upper Miocene injection interval will be more conservative than an analysis for the lower Miocene injection interval because the combined injection rate for the three wells injecting into the upper Miocene injection interval is greater than the rate used by the well injecting into the Lower Miocene injection interval.

During the period of time between 1964 and 1987, the three wells injecting into the upper Miocene injection interval have produced a build-up of injection pressure of about 10 1/2 psi at a distance of 2.5 miles from the injection wells. Converting the Class II injection well injection rate of 4,500 barrels per day to gallons per minute yields 132 gpm. This is less than the combined recent injection rate, produced by the three Hoechst Celanese wells.

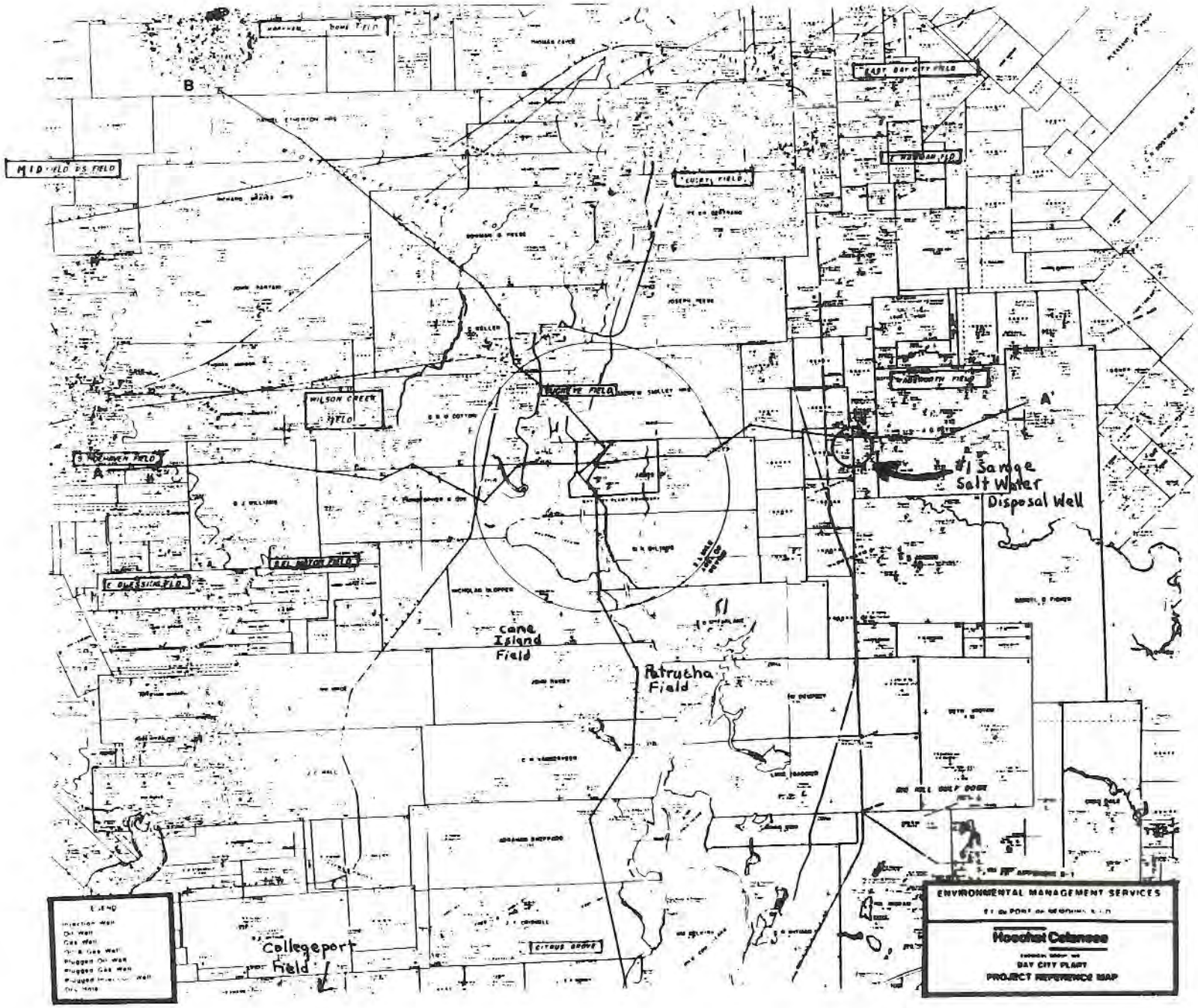
Given the similar geologic conditions in the area of the Class II injection well, it can be assumed that this well would produce pressure effects similar to the three plant wells, except of a lower magnitude. Given that the pressure effects 2.5 miles away from the 3 plant wells are small, even after 25 years of injection, it can be concluded that the Class II well will have only minimal effects on the pressure buildup surrounding the plant.

Other permitted Class II injection wells are located in East Bay

City Field, Wadsworth Field, Collegeport Field, Midfield Township Field and Markham Dome Field. All of these wells are more distant than five miles, and would also have no significant effect on injection operations at the plant for the same reasons.

Numerous oil and gas fields in the general area of the plant site which, if currently producing in equivalent strata to the injection zone, could act as pressure sinks. Most of these fields, including Lucky Field, East Bay City Field, Wadsworth Field, Petrucha Field, Cane Island Field, Citrus Grove Field, Blessing Field, East Blessing Field, El Maton Field, Tidehaven Field, Wilson Creek Field, Buckeye Field and Midfield Township Field produce oil and gas from Frio (Oligocene) age strata which are deeper than the injection zones utilized by the Celanese plant.

Markham Dome Field and Midfield Township Field produce oil and gas from Miocene age strata that is correlative to the injection intervals at the Celanese plant. Most of the wells in these two fields, completed in the Miocene, are no longer productive. These two fields are also located more than ten miles away from the Bay City Plant facility which precludes any possibility of potential pressure interference with injection pressure buildup.


B
A
A'
WILSON CREEK FIELD
#1 Savage Salt Water Disposal Well
Cane Island Field
Petrucha Field
Collegeport Field
ENVIRONMENTAL MANAGEMENT SERVICES
Hoechst Celanese
BAY CITY PLANT
PROJECT REFERENCE MAP

15. The plume boundary for the year 2000 in Appendices 2-13 and 2-14 was based on information presented in Figures 2-13 to 2-16. Celanese should also provide similar information to support the shape of the 10,000 year plumes in Appendices 2-13 and 2-14.

Response:

The DuPont 10,000-year plume model is in the process of being run and the output will be submitted upon completion.

16. Celanese should justify the average thickness of the injection intervals used in the model as conservative since these values have an effect on the pressure buildup, plume migration, and vertical waste permeation.

Response:

The average thickness of the upper Miocene injection interval is the value in question (the lower Miocene value is not an EPA concern on this point, as discussed in a conference call). The average thickness of the upper Miocene injection sand was determined from a volumetric calculation on the net sand isopach (Appendix 3-11). The sand thins to the northwest but thickens to the southeast. The result of the volumetric calculation was an average thickness of approximately 185 feet for the upper Miocene injection sand. This calculation was performed using a thickness value of 25 feet for the area less than 50 feet in thickness, and a thickness value of 275 feet for the region greater than 275. The average thickness used in the model was 165, which is conservative when compared to the calculated average of 185 feet.

17. In Section 2.1.5.3.4, up dip drift due to density differences between the injected waste and the formation fluid are discussed. The calculations assume that the injected waste migrates up dip en masse solely by virtue of its lower specific gravity.

Celanese should justify this "immiscible displacement" and demonstrate that the injected fluid does not mix with the formation fluid thus rendering density effects less important.

Response:

The DuPont 10,000-year plume model is in the process of being run and the output will be submitted upon completion. The density and dispersion effects are taken into account in the location of the plume. The documentation discussing this 10,000-year plume model will be submitted when the modeling is complete.

18. Permeability values used in the multiplying factor were taken from whole core measurements (page 2-21) while the permeability values used in the pressure buildup model were taken from pressure test data (page 2-20). Celanese should justify the use of permeability values from core measurements rather than from pressure test data in the multiplying factor.

Response:

The multiplying factor requires an average and maximum value for permeability, and therefore, core values were used in the calculation. If the pressure test permeability value is used for the average value in the calculations, the multiplying factors are as follows:

Upper Miocene Injection Sand

M = (1420/39.1)/(1350/35.5)
M = 0.96

Lower Miocene Injection Sand

M = (8270/36.7)/(1322/32.2)
M = 5.48

Please note that the value for the upper injection sand is less than the value used in modeling (0.96 to 2.0). The multiplying factor for the lower Miocene injection sand is similar to the value used in modeling (5.48 and 4.5). Both of these values are very conservative.

19. On page 2-40, it is stated: "The plant site will be modeled past the year 2000 after Waste Well 5 has been drilled and completed." According to information contained in the petition, the facility

has been modeled only to the year 2000 and Waste Well No. 5 has not been modeled. Therefore, in order to inject banned waste into Well No. 5, or to continue the injection of banned waste into any of the wells after the year 2000, Celanese will have to submit another petition.

Response:

In effect Well 5 has been modeled in the petition. Well 5 is meant to be a replacement and/or well backup well for WDW-110 and will be initially completed in the same interval as WDW-110. Well 5 will be located within about 400 feet of WDW-110, so for a modeling purposes, the two wells can be treated as a point source. Thus, as long as the flow rates for Well 5 and WDW-110 combined do not exceed the maximum permitted modeled flow rates for the currently active WDW-110, there is no effect on the petition demonstration, because the maximum rates have been modeled for the sand. The same holds true if Well 5 were to be completed in the upper injection interval. A maximum flow of 750 gpm has been modeled for this sand using the three "neutral" wells, and if Well 5 were to also inject into this sand, but not cause the maximum flow rate into the sand to exceed 750 gpm, the petition demonstration is still valid.

It is probable that the Bay City Plant will need to inject banned waste past the year 2000. It is expected that sometime in the next ten years, changes in plant operations or significant advances in modeling technology, will cause additional modeling to be required, and the Bay City Plant will lengthen the modeled horizon at that time. Under these inevitable circumstances, it seems illogical to require the Bay City Plant "to submit another petition". Instead, because such revisions only affect the modeling portion of the petition, it is expected that a modeling addendum or revision would be sufficient to show that under the set of new revised circumstances, the site still meets the no-migration and non-endangerment criteria.

20. On page 2-74, it is stated: "The net thickness of shale overlying the upper Miocene injection sand is in excess of 400 feet with at least 50 feet of this shale being located between the top of the injection interval and the top of the injection zone." Data contained in Figure 3-31 shows 450 feet between the top of the injection interval and the top of the injection zone. Celanese should correct this discrepancy between the statement on page 2-74 and Figure 3-31.

Response:

Figure 3-1 is correct. The statement on page 2-74 is incorrect and should have been changed along with all other similar references that were modified during a previous petition revision. A revised petition page reflecting the correct language will be supplied with the final revisions. {Note that there is no Figure 3-31, so it is assumed the question refers to the stratigraphic chart in Figure 3-1}

GEOLOGY

1. In Appendices 3-2 and 3-3, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

Response:

When the 10,000-year plume model is completed the information will be supplied showing the modeled plume boundaries.

2. In Appendix 3-5, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

Response:

See the response for the previous item.

3. In Appendix 3-7, the boundary of the 10,000 year plume for the upper Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-13. In addition, the structure map in Appendix 3-7 does not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should correct the discrepancy in plume boundaries and ensure that the structure map accurately represents the geology for the area surrounding the 10,000 year plume.

Response:

See the response for Geology item # 1.

4. In Appendices 3-8, 3-11, and 3-12, the contour intervals do not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should ensure that the map accurately represents the geology for the area surrounding the 10,000 year plume.

Response:

When the 10,000-year plume model is finalized, additional structural contours will be added to the exhibits if this is required.

COMPATIBILITY

1. Celanese should demonstrate that the current injected waste stream is similar to the waste stream in the compatibility studies of 1964, 1973, and 1984, described in Sections 6.1.1.1, 6.1.1.2, 6.1.1.3, and 6.1.1.4, to ensure the compatibility tests are valid and applicable.

Response:

The current waste streams at the Bay City Plant are shown by analysis (in attached Table # 1) to be compositionally similar to facility waste streams in years 1964, 1973, and 1984. Characteristic constituents of the waste streams fall within the typical range historically observed. This ensures that the compatibility studies performed in 1964, 1973 and 1984 are valid and applicable.

In addition, the most important demonstration of compatibility at the Bay City Plant lies not in the laboratory results, but in the over twenty five years of relatively trouble-free operation of the disposal wells. Significant compatibility problems would have manifested themselves long ago in well operations problems, or in the results of periodic MIT testing on the injection wells.

Table 1
Waste Stream Comparison

	TYPICAL RANGE	1964	7/14/74	10/13/76	8/1/78	7/24/79
NEUTRAL WELLS						
Specific conductance				26,500 umhos	12,000 umhos	13,500 umhos
Total organic carbon	0.1 - 2.0 wt%		0.6 wt%	1.24 wt%	9200 ppm	12,800 ppm
Nitrate	<0.01 - 0.5 wt%		0.1 wt%	750 ppm	9.25 ppm	550 ppm
Ash	<0.05 - 0.5 wt%		0.2 wt%	0.16 wt%	0.229 wt%	0.572 wt%
Total suspended solids	<10 - 500 ppm		50 ppm	28 ppm	30 ppm	40 ppm
Cu	<1 - 200 ppm	80 ppm	15 ppm	2.5 ppm	3.5 ppm	6 ppm
Vanadium	<1 - 25 ppm	20 ppm	3 ppm		.3 ppm	.34 ppm
pH	5.0 - 9.0	9	6.5	6.9	7.5	6.4
water wt% by (-)	99.8 - 95.0%	95.2%	98.5	98.5	98.55	97.72
Chemical oxygen demand				25,550 ppm	21,048 ppm	27,000 ppm
ACID WELL						
Specific conductance				5,450 umhos	11,500 umhos	4,200 umhos
Total organic carbon	0.1 - 5.0 wt%		1.4 wt%	0.53 wt%	6,900 ppm	4,300 ppm
Nitrate	<0.1 - 1.0 wt%		0.3 wt%	350 ppm	700 ppm	300 ppm
Ash	<0.1 - 2.0 wt%		0.6 wt%	0.011 wt%	0.022 wt%	0.03 wt%
Total suspended solids	<10 - 500 ppm		50 ppm	5 ppm	4 ppm	5 ppm
Cu	<10 - 10,000 ppm	80 ppm*	3000 ppm	0.3 ppm	1.7 ppm	19 ppm
Vanadium	<1 - 1,000 ppm	20 ppm*	250 ppm	.08 ppm	3.7 ppm	.91 ppm
Chlorinated organics	<0.1 - 1.0 wt%		0.3 wt%	4,772 ppm	32,000 ppm	8 ppm
Mn	<1 - 100 ppm	50 ppm*	15 ppm	<0.1 ppm	.02 ppm	.02 ppm
pH	<1 - 7.0	5	1.0	2.7	1.9	2.4
Water wt% by (-)	99.8 - 88.5%		96.7	98.9	96.02	99.51
Chemical oxygen demand				27,800 ppm	9,665 ppm	9,240 ppm

Table 1
Waste Stream Comparison (cont.)

	4/28/81	1/27/82	3/85	9/22/87	9/13/88
NEUTRAL WELLS					
Specific conductance	3,800 umhos	6,500 umhos	7,000 umhos	5,000 umhos	1,150 umhos
Total organic carbon	7,070 ppm	2,591 ppm	4,623 ppm	4,934 ppm	1,930 ppm
Nitrate	110 ppm	0.6 ppm	4 ppm	1.8 ppm	1.9 ppm
Ash	234 ppm	.0306 wt%	0.0132 wt%	0.081 wt%	0.0197 wt%
Total suspended solids	42 ppm	68 ppm	12 ppm	13 ppm	16 ppm
Cu	.15 ppm	1.35 ppm	1.1 ppm	2.79 ppm	0.63 ppm
Vanadium	15 ppm	.032 ppm	1.185 ppm	0.15 ppm	<.005 ppm
pH	6.7	6.6	6.3	6.41	6.5
water wt% by (-)	99.26	99.63	97.41	99.3	99.55
Chemical oxygen demand	26,800 ppm	8,778 ppm	12,692 ppm	19,101 ppm	5,653 ppm
ACID WELL					
Specific conductance	1,600 umhos	1,000 umhos	10,000 umhos	1,250 umhos	2,950 umhos
Total organic carbon	5,530 ppm	3,697 ppm	7,286 ppm	4,826 ppm	4,100 ppm
Nitrate	125 ppm	1,5 ppm	5 ppm	<0.1 ppm	6.9 ppm
Ash	81 ppm	.0136 wt%	0.0074 wt%	0.0147 wt%	0.0149 wt%
Total suspended solids	2 ppm	5 ppm	12 ppm	5 ppm	1 ppm
Cu	.3 ppm	.186 ppm	0.43 ppm	0.31 ppm	0.01 ppm
Vanadium	16 ppm	.004 ppm	<0.01 ppm	<0.005 ppm	<0.005 ppm
Chlorinated organics	8,955 ppm	2,656 ppm	17,284 ppm	1,772 ppm	1,727 ppm
Mn	.028 ppm	.017 ppm	.06 ppm	0.02 ppm	0.03 ppm
pH	2.5	2.9	5.6	2.07	2.6
Water wt% by (-)	98.54	99.31	97.26	99.29	99.51
Chemical oxygen demand	4,556 ppm	9,111 ppm	18,461 ppm	16,854 ppm	11,660 ppm

* in neutral well
** halogenated organic compounds

2. Celanese should demonstrate that the injected waste does not affect the confining capability of the confining material in the injection zone.

Response:

To demonstrate the compatibility of the injected waste with the confining material in the injection zone at the Hoechst Celanese facility, it is necessary to reference data on confining materials from shale core analyses and compatibility tests performed on correlative and similar geologic materials from the Du Pont Victoria plant site. The injection zone and confining zone of both these sites are comprised of Miocene age sediments of the Fleming Group. The lowermost unit of the Fleming Group, the Oakville Formation, serves as the lower portion of the injection zone for the Bay City Plant injection wells. The uppermost unit, the Lagarto Formation, serves both as the upper portion of the injection zone and as the major containment interval for the Hoechst Celanese injection wells. At the Du Pont Victoria site, the Oakville Formation serves as an upper containment interval for the immediately underlying Catahoula injection interval. The Lagarto Formation serves as the main confining zone for all injection activities at the Du Pont Victoria site.

Stratigraphic depositional interpretation of the Oakville and Lagarto Formations describes grading of lagoonal and shallow-water sediments to shore-zone and fluvial-deltaic sedimentation. The Lagarto Formation grades upward into deltaic sands representing a deepening basin and occasional regressive sands.

Because the environments of deposition are so similar in this Miocene section at these two sites, an inference can be made regarding the relative uniformity of shale composition for any two correlative intervals. The following shale composition data

is derived from extrapolation of the clay-fraction present in the injection interval at the Du Pont Victoria site.

Whole rock composition of the injection zone:

Quartz	77.2%
Feldspar	11.3%
Calcite	0.6%
Ankerite	1.0%
Heulandite	0.4%
Clay minerals	9.4%

Clay fraction normalized to 100%:

Illite/smectite	60.6%
Illite	21.9%
Kaolinite	17.5%

These data were used to determine waste/confining material interactions before actual shale core data was available at the Du Pont Victoria site. Subsequently, shale core data became available from the Nelson & Tucker, Du Pont #1 (oil and gas exploration well), drilled on the Victoria site in 1987. Relative clay abundance (normalized to 100%) was obtained by x-ray diffraction on shale core from this well:

Illite-smectite	84.0%
Illite	11.0%
Chlorite	1.0%
Kaolinite	4.0%

For purposes of chemical fate analysis in the Du Pont Victoria petition, all of the clay-fraction was assumed to be illite/smectite (also called montmorillonite) because this type of clay is the most reactive.

In low-pH/waste reactions it was found that, during injection, injected wastes will react with, at most, 2.8 inches per year of the shale arresting layer. After injection ceases, the injected waste will react with, at most, an additional 2.6 feet of shale arresting layer for all eternity. In the unlikely event that the arresting shale contains a vertical streak of a highly reactive mineral such as calcite, the waste could migrate 37 inches at most into this streak: 23 inches assuming 60 years of injection and 14 inches for all eternity after closure. Permeation through the arresting shale due to pressure build-up during injection is more important than shale-waste reactions in determining how far waste products can migrate into the arresting layer.

Neutral pH waste will have a much slower rate of reaction with the shale arresting layer because the primary driving reaction is that between alkaline pH and silica (SiO_2). Natural brines in carbonate formations have a pH of about 10 so one would not expect waste streams of pH < 9 to react significantly with arresting shales.

Thus, by analogy to the Du Pont Victoria site shale core data and chemical fate modeling, it can be demonstrated that low pH wastes will be neutralized by carbonate/acid reaction and by clay/acid reaction within short distances of the waste front. Neutral pH wastes will have even less effect.

Attached is a diagram showing the relative locations of the Victoria and Hoechst Celanese facilities.

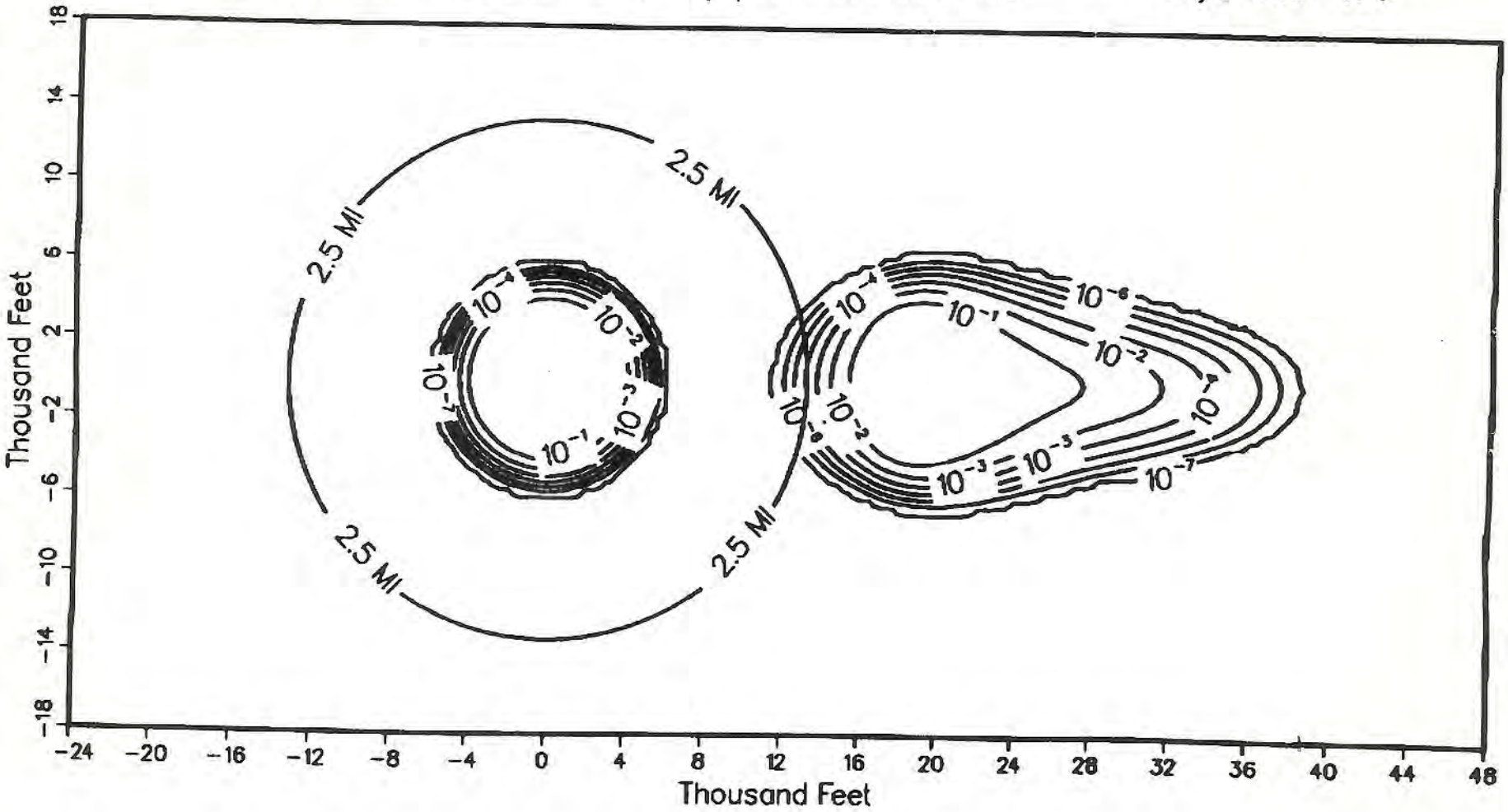
MECHANICAL INTEGRITY TESTS

1. The submitted radioactive tracer tests and pressure tests for all wells were performed in December of 1988. Celanese should submit information demonstrating that the wells continue to have mechanical integrity.

Response:

A report summarizing the recent MIT work performed in October 1989 has been supplied by the Bay City Plant to EPA Region VI already. An additional copy is being provided to make the second EPA petition copy a complete document. The October 1989 MIT work again documents the mechanical integrity of the injection well systems.

Hoechst–Celanese, Upper Miocene -- 10,000 Yr.



(mw 2/13/90

(2)

STERLING CHEMICALS

TO: TCC UIC Subcommittee Members

Amoco Oil	409-945-1338
ARCO Chemical	713-457-4540
B.P.	512-552-8229
BASF	409-239-3425
Celanese Bay City	409-245-4871 Ext. 4086
Celanese Bishop	512-584-3511 Ext. 4717
Celanese Houston	713-474-6291
DuPont Beaumont	409-727-9970
GAF	409-948-0205
Lyondell	713-457-8098
Monsanto Alvin	713-393-4578
Oxychem Corpus	512-242-8116

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EPA 6W-S
REGION VI

Ronnie Crossland, EPA, asked me to communicate the attached updated "Common Petition Deficiencies". In some cases, especially those who have already received NOD's from the EPA, these may not apply. However, each company should review their petition to assure they have addressed these concerns. Mr. Crossland also suggests that you submit the data or information necessary to address these concerns as soon as possible to expedite the review process.

Sam

Sam Chamberlain

/pm

Attachment

cc: Mike Gray - Monsanto
Jon Fisher - TCC
Ron Crossland - EPA

Sterling Chemicals, Inc.
P.O. Box 1311
Texas City, Texas 77592-1311
409-945-4431

2/5/90

REGION 6
COMMON PETITION DEFICIENCIES

GENERAL

1. In some instances, tables, figures and appendices are missing.

2. When utilizing non site specific parameters, operators failed to properly justify that these non site specific parameters are representative.

AOR

1. The operators do not submit the calculations of pressure buildup for the cone of influence determination. This should include parameters and a description of the applicable method.

2. The operators do not submit site specific data to substantiate the depth to the top of the mud columns and for the weight of the mud in the abandoned boreholes.

3. The operators did not submit enough data to properly address the abandoned wells for no-migration and non-endangerment. Location of cement plugs, mud weights of mud in the hole and casing data were missing for many wells within the AOR or within the path of the maximum plume movement in 10,000 years. In addition some operators did not consider molecular diffusion up an abandoned bore hole.

4. The operators did not submit documentation of initial bottom hole pressure of the injection interval.

MIT

1. The operators have not submitted the current MIT data .

Geology

1. Structure and isopach maps do not extend to the edge of the 10,000 year waste plume.

2. The plume outlines are not marked on the pertinent geologic maps (structure map on top of the Injection Zone, with all artificial penetrations spotted) and stratigraphic cross-sections.

3. Regional geologic maps do not contain significant geologic features, i.e. salt domes, regional faults, which may impact plume migration over 10,000 years.

4. No information is provided to verify the impact of nearby hydrocarbon production or waste injection into the injection zone, which may affect plume migration and pressure buildup calculations. The information provided should include an analysis of all sinks or sources, determination of impact, the magnitude and direction of impact, and life of impact.

Geochemistry

1. No information is provided to determine the composition of the confining strata in the injection zone. This would include X-Ray diffractions, thin sections, or site specific literature.

2. No information is provided to determine if the current injection waste stream is similar to past wastes used in compatibility studies.

3. No information is provided to demonstrate waste compatibility with the formation fluid in the injection zone and the confining strata in the injection zone. Proper chemical equations or actual compatibility tests would demonstrate waste compatibility.

Geologic Input Parameters to the Model

1. No justification of injection zone parameters such as porosity and permeability. Justification would include logs, cores, or site specific literature.

2. No justification of confining strata permeability and porosity. Justification would include logs, cores, or site specific literature.

3. Inadequate documentation of horizontal or vertical transmissivity of fault planes. Documentation would include pressure data, flow data, or proper siting of pertinent literature references.

4. Inadequate justification for average injection zone thicknesses in the model calculation. Few injection zones are of constant thickness. Operators should justify KH values picked for the model are representative for the model choosen throughout the area of maximum waste plume movement.

5. Failure to adequately consider boundaries for pressure calculations and waste plume migration. Boundaries include salt domes, non transmissive faults, and stratigraphic pince outs.

Model

1. Density differences between the injected waste and the formation fluid are not accounted for in predicting waste migration.

2. The intermediate step calculations are not provided to aid in verification of the final modeling values. These calculations demonstrate that the final values achieved are representative of the demonstration injection site.

3. Various parameters are not addressed in the sensitivity analysis. For example, the range of shale permeabilities should be investigated to evaluate their effects on vertical waste penetration distances.

4. Adequate justification for the background gradient value for the injection zone is not provided. For example, if a petition assumes a natural ground water velocity of 1 ft/yr, then documentation should be submitted to demonstrate this assumption is valid and representative of the site.

5. Failure to document the use of input values.

   (a) Injection rate, volume, pressure should be chosen to produce worst case predictions for pressure buildup and waste movement.
   (b) Tortuosity should be justified by comparable values from appropriate literature.
   (c) permeabilities should be justified with well tests, core values, literature values, etc.

DU PONT
ENVIRONMENTAL MANAGEMENT
SERVICES
Fabricated Products Department
140 Cypress Station Drive, Suite 140
Houston, Texas 77090
(713) 586-5600

RECEIVED
JAN 29 1990
EPA GW-S
REGION VI

January 26, 1990

Mr. Vincent Mallott
EPA Region VI
1445 Ross Avenue
Dallas, TX 75202-2733

Dear Mr. Mallott:

Letter Subject: EPA Petition Concerns-Partial Responses

In order to expedite the response process, I. O. Coleman at the Hoechst Celanese Bay City Plant has asked me to send you the enclosed responses to approximately half of the recent EPA list of petition concerns.

This list of concerns was received two and a half weeks ago, on January 9, 1990, and as in the past, the Bay City Plant is endeavoring to respond to these concerns as rapidly as possible. The remaining responses to the list of petition concerns will be submitted by mid-February.

After you have had a chance to review these responses, a conference call between the EPA and Hoechst Celanese representatives should be scheduled to discuss the responses.

As we have discussed, Hoechst Celanese is concerned that this unexpected list of additional EPA petition concerns, at this late stage of the review process (petition submission in September, 1988), has endangered an approval of the petition by the May 8, 1990, ban date. As you know, the Bay City Plant must be able to use the injection wells in order to operate the facility.

If you have any questions, please do not hesitate to call.

Sincerely,

D.H. Squyres

D. H. Squyres

DHS/cd

Enclosures
cc Mr. Glenn Mc Carthy - Bay City Plant
Mr. R. K. Goleman - Brown Maroney
Mr. Robert H. Maurer - Hoechst Celanese - Dallas

WAT 18-6-5-9

DU PONT

RECEIVED
JAN 29 1990
EPA 6W-S
REGION VI

CELANESE BAY CITY

RESERVOIR ENGINEERING/MODELING

1. Celanese should submit site specific information to substantiate the presence of 9.0 lb/gallon fluid at or near the ground surface in the abandoned boreholes. This information affects the no-migration and non-endangerment demonstrations.

2. Celanese should submit information documenting the presence of 10.1 lb/gallon mud at or near the ground surface in the abandoned borehole for Artificial Penetration No. 9 in Table 4-1 and Figure 4/13. The documentation is necessary since the predicted pressure rise in the upper Miocene injection interval at Artificial Penetration No. 9 exceeded the pressure due to a 9.0 lb/gallon mud column in approximately 1969 and will exceed the pressure in approximately 1994.

Response:

The EPA has correctly recognized that Artificial Penetration No. 9 is an important well due to its proximity to the injection wells. The documentation provided in Section 4 of the petition indicates that AP No. 9 is actually a cased hole with casing set below the deepest injection interval (to 6600 feet-see information on AP No. 9 in Appendix 4-2, 4-14 and 4-15). Thus, the only possible conduit for upward fluid movement would be around the annular space between the casing and the surrounding formations, and this avenue of fluid movement is effectively sealed off by annular closure of geologic formations around the casing. Because no conduit for fluid movement exists in this well, the weight or level of fluid in this borehole is irrelevant, and the well meets the no-migration and non-endangerment standards. Documentation and discussion of the annular borehole closure process is provided here for EPA review.

Texas in 1972, which stated the the original formation pressure gradient for the upper Miocene is 0.452 psi/ft. This conclusion was based on an evaluation of pressures for Miocene sands in the Bay City area. The pressure gradient used in the modeling was 0.452 psi/ft. This value should be considered conservative since the value from the drill stem test was less. (See selected petition references for documentation).

8. Celanese should provide information discussing the effect on the pressure buildup and plume migration for the upper Miocene injection interval due to thinning of the interval to 20 feet northwest of the facility.

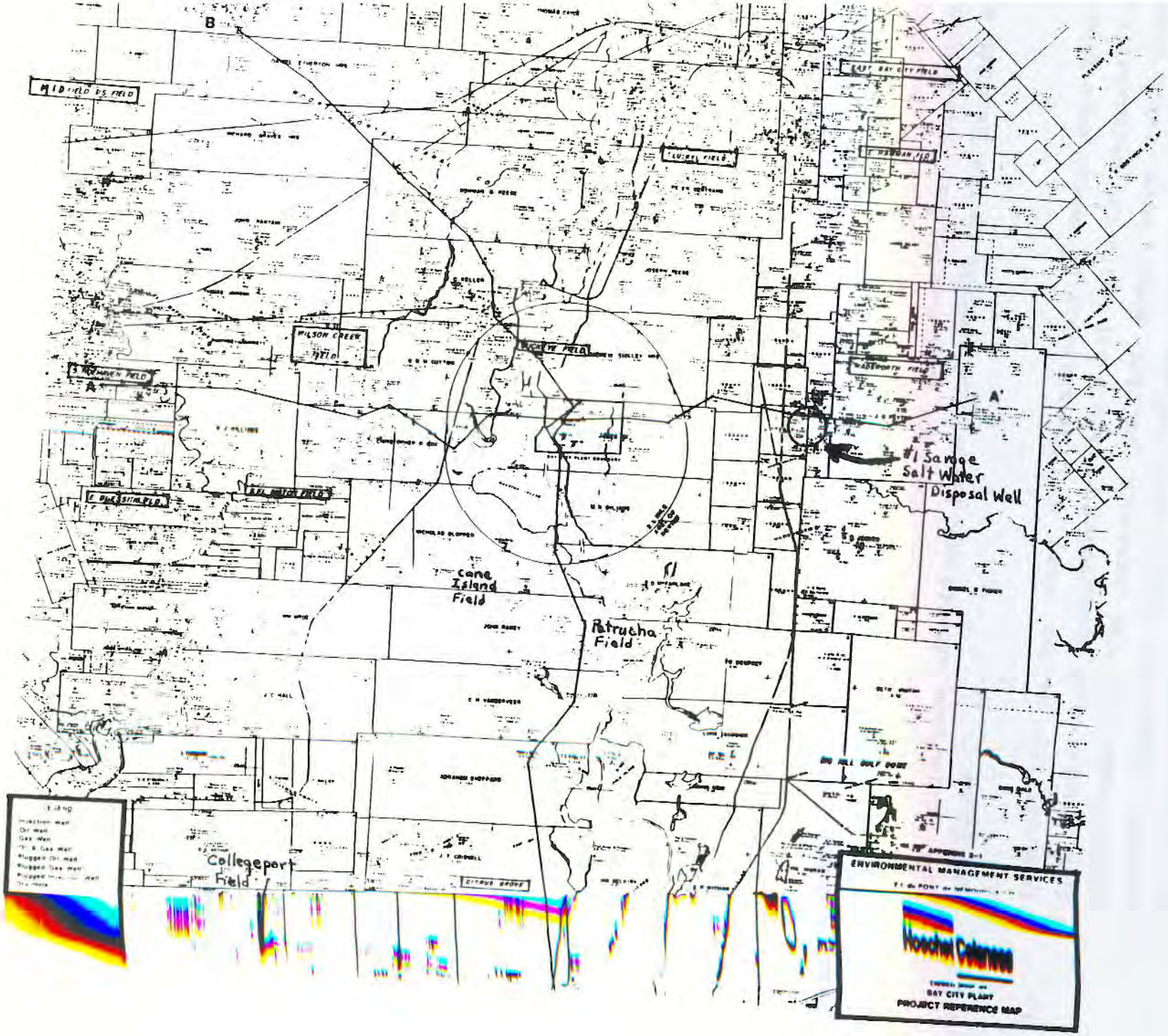
9. Celanese should provide the calculations used to determine the density values for formation fluids in the upper and lower Miocene injection intervals on page 2-23.

10. Celanese should demonstrate that the shale permeability and porosity values used in the model are either representative or conservative.

Response:

The shale values for porosity and permeability are compared with values from the literature in Tables 2-3a and 2-3b. The shale porosity values used in the model are the low end of the literature range and are therefore, conservative. Increasing shale porosity would only decrease the upward permeation distance. The shale permeability values used in the model are on the low end of the range from literature. Sensitivity analysis was run on shale permeability values for both sands (see Table 2-15 and 2-16). The permeability value was varied an order of magnitude in each direction. The permeability change had little impact on the lower Miocene injection sand. The effect on the upper Miocene injection sand was almost as small. The change in upward permeation with increased permeability was approximately 3

two fields are also located more than ten miles away from the Bay City Plant facility which precludes any possibility of potential pressure interference with injection pressure buildup.



B
A
A'
MID FIELD VS FIELD
EAST BAY CITY FIELD
LUCKY FIELD
WILSON CREEK FIELD
BUCKEYE FIELD
WADSWORTH FIELD
S HOCHAVEN FIELD
E BLESSING FLD
#1 Savage Salt Water Disposal Well
Cane Island Field
Patrucha Field
Collegeport Field
CITRUS GROVE
LEGEND
Injection Well
Oil Well
Gas Well
Oil & Gas Well
Plugged Oil Well
Plugged Gas Well
Plugged Injection Well
Dry Hole
ENVIRONMENTAL MANAGEMENT SERVICES
Hoechst Celanese
BAY CITY PLANT
PROJECT REFERENCE MAP

Natural Borehole Closure

Natural closure of artificially created open spaces in the subsurface is a documented process that is known to exist along the Gulf Coast. This process causes the geologic formations to close around drill pipe or casing once pipe movement has ceased. The process operates on the Gulf Coast because the soft sediments are under tremendous overburden pressures and deform plastically, closing open spaces or moving in around casing strings, sealing them in place.

Natural Borehole Closure Significance to Petitions

The borehole closure process is very important to the Area of Review portion of Gulf Coast Petitions, because this process rapidly seals (in a matter of days) the space between casing strings and the surrounding geologic formations. Thus, borehole closure effectively seals a potential conduit of vertical fluid movement in two important cases of Area of Review (AOR) wells, i.e., 1) abandoned wells, and 2) currently productive wells, with long string casings set below the surface casing. Frequently, these long string casings are set below the deepest injection intervals, and borehole closure effectively seals the casing along its entire length to vertical fluid movement.

Natural Borehole Closure During Drilling and Logging

During well logging operations of newly drilled Gulf Coast wells, natural borehole closure is evidenced by the increasing ledges and "tight spots" seen on the caliper logs run with the logging tools. The natural borehole closure problem is such an important issue that many oil companies such as EXXON Co. USA, have a policy of reentering exploration boreholes with the drilling

15. The plume boundary for the year 2000 in Appendices 2-13 and 2-14 was based on information presented in Figures 2-13 to 2-16. Celanese should also provide similar information to support the shape of the 10,000 year plumes in Appendices 2-13 and 2-14.

Response:

The DuPont 10,000-year plume model is in the process of being run and the output will be submitted upon completion.

16. Celanese should justify the average thickness of the injection intervals used in the model as conservative since these values have an effect on the pressure buildup, plume migration, and vertical waste permeation.

17. In Section 2.1.5.3.4, up dip drift due to density differences between the injected waste and the formation fluid are discussed. The calculations assume that the injected waste migrates up dip en masse solely by virtue of its lower specific gravity. Celanese should justify this "immiscible displacement" and demonstrate that the injected fluid does not mix with the formation fluid thus rendering density effects less important.

Response:

The DuPont 10,000-year plume model is in the process of being run and the output will be submitted upon completion. The density and dispersion effects are taken into account in the location of the plume.

18. Permeability values used in the multiplying factor were taken from whole core measurements (page 2-21) while the permeability values used in the pressure buildup model were taken from pressure test data (page 2-20). Celanese should justify the use of permeability values from core measurements rather than from pressure test data in the multiplying factor.

3. Celanese should demonstrate that, of the hazardous wastes that are injected at this facility, modeling of dichloroacetaldehyde will result in the maximum vertical and lateral plume movement.

4. Celanese should submit the reference(s) documenting the health based limit of 1 ppm for dichloroacetaldehyde.

Response:

Attached are copies of the pages of the original reference used to determine this heath based limit. Note that the only health based limit that was available was for chloracetaldehyde (1 ppm) and this was generalized to the nearly identical dichloroacetaldehyde molecule.

REGULATORY CHEMICALS OF HEALTH AND ENVIRONMENTAL CONCERN

William H. Lederer, Ph.D., J.D., 1985

VAN NOSTRAND REINHOLD COMPANY
New York

Response:

The multiplying factor requires an average and maximum value for permeability, and therefore, core values were used in the calculation. If the pressure test permeability value is used for the average value in the calculations, the multiplying factors are as follows:

Upper Miocene Injection Sand

M = (1420/39.1)/(1350/35.5)
M = 0.96

Lower Miocene Injection Sand

M = (8270/36.7)/(1322/32.2)
M = 5.48

Please note that the value for the upper injection sand is less than the value used in modeling (0.96 to 2.0). The multiplying factor for the lower Miocene injection sand is similar to the value used in modeling (5.48 and 4.5). Both of these values are very conservative.

19. On page 2-40, it is stated: "The plant site will be modeled past the year 2000 after Waste Well 5 has been drilled and completed." According to information contained in the petition, the facility has been modeled only to the year 2000 and Waste Well No. 5 has not been modeled. Therefore, in order to inject banned waste into Well No. 5, or to continue the injection of banned waste into any of the wells after the year 2000, Celanese will have to submit another petition.

Response:

In effect Well 5 has been modeled in the petition. Well 5 is

meant to be a replacement and/or well backup well for WDW-110 and will be initially completed in the same interval as WDW-110. Well 5 will be located within about 400 feet of WDW-110, so for a modeling purposes, the two wells can be treated as a point source. Thus, as long as the flow rates for Well 5 and WDW-110 combined do not exceed the maximum permitted modeled flow rates for the currently active WDW-110, there is no effect on the petition demonstration, because the maximum rates have been modeled for the sand. The same holds true if Well 5 were to be completed in the upper injection interval. A maximum flow of 750 gpm has been modeled for this sand using the three "neutral" wells, and if Well 5 were to also inject into this sand, but not cause the maximum flow rate into the sand to exceed 750 gpm, the petition demonstration is still valid.

It is probable that the Bay City Plant will need to inject banned waste past the year 2000. It is expected that sometime in the next ten years, changes in plant operations or significant advances in modeling technology, will cause additional modeling to be required, and the Bay City Plant will lengthen the modeled horizon at that time. Under these inevitable circumstances, it seems illogical to require the Bay City Plant "to submit another petition". Instead, because such revisions only affect the modeling portion of the petition, it is expected that a modeling addendum or revision would be sufficient to show that under the set of new revised circumstances, the site still meets the no-migration and non-endangerment criteria.

20. On page 2-74, it is stated: "The net thickness of shale overlying the upper Miocene injection sand is in excess of 400 feet with at least 50 feet of this shale being located between the top of the injection interval and the top of the injection zone." Data contained in Figure 3-31 shows 450 feet between the top of the injection interval and the top of the injection zone. Celanese should correct this discrepancy between the statement on

page 2-74 and Figure 3-31.

Response:

Figure 3-1 is correct. The statement on page 2-74 is incorrect and should have been changed along with all the other similar references that were changed during a previous petition revision. A revised petition page reflecting the correct language will be supplied with the final revisions. Note that there is no Figure 3-31, so it is assumed the question refers to the stratigraphic chart in Figure 3-1.

GEOLOGY

1. In Appendices 3-2 and 3-3, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

2. In Appendix 3-5, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

3. In Appendix 3-7, the boundary of the 10,000 year plume for the upper Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-13. In addition, the structure map in Appendix 3-7 does not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should correct the discrepancy in plume boundaries and ensure that the structure map accurately represents the geology for the area surrounding the 10,000 year plume.

4. In Appendices 3-8, 3-11, and 3-12, the contour intervals do not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should ensure that the map accurately

represents the geology for the area surrounding the 10,000 year plume.

COMPATIBILITY

1. Celanese should demonstrate that the current injected waste stream is similar to the waste stream in the compatibility studies of 1964, 1973, and 1984, described in Sections 6.1.1.1, 6.1.1.2, 6.1.1.3, and 6.1.1.4, to ensure the compatibility tests are valid and applicable.

Response:

The current waste streams at the Bay City Plant are shown by analysis (in attached Table # 1) to be compositionally similar to facility waste streams in years 1964, 1973, and 1984. Characteristic constituents of the waste streams fall within the typical range historically observed. This ensures that the compatibility studies performed in 1964, 1973 and 1984 are valid and applicable.

In addition, the most important demonstration of compatibility at the Bay City Plant lies not in the laboratory results, but in the over twenty five years of relatively trouble-free operation of the disposal wells. Significant compatibility problems would have manifested themselves long ago in well operations problems, or in the results of periodic MIT testing on the injection wells.

CHLORMADINONE ACETATE. [302-22-7]

IARC—carcinogenic in animals

CHLORNAPHAZINE. [494-03-1]

*RCRA 40 CFR 261
EPA hazardous waste no. U026

CHLOROACETALDEHYDE. [107-20-0]

*OSHA 29 CFR 1910.1000 Table Z-1
PEL(Ceiling): 1 ppm, 3 mg/m^3

ACGIH-TLV
TWA: ceiling limit, 1 ppm, 3 mg/m^3

*RCRA 40 CFR 261
EPA hazardous waste no. P023

alpha-CHLOROACETOPHENONE (PHENACYCHLORIDE). [532-27-4]

*OSHA 29 CFR 1910.1000 Table Z-1
PEL(TWA): 0.05 ppm, 0.3 mg/m^3

ACGIH-TLV
TWA: 0.05 ppm, 0.3 mg/m^3

CHLOROACETYL CHLORIDE. [79-04-9]

ACGIH-TLV
TWA: 0.05 ppm, 0.2 mg/m^3

NFPA—hazardous chemical
health—3, flammability—0, reactivity—0

CHLOROALKYL ETHERS.

OSHA Candidate List of Potential Occupational Carcinogens (EPA Carcinogen Assessment Group List), 45 FR 53672, August 12, 1980

CWA 304(a)(1), 45 FR 79318, November 28, 1980, Water Quality Criteria

Freshwater Aquatic Life

The available data for chloroalkyl ethers indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 238,000 μg/liter and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of chloroalkyl ethers to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with any chloroalkyl ether and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis-(chloromethyl)-ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels that may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are 0.038 ng/liter, 0.0038 ng/liter, and 0.00038 ng/liter, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 18.4 ng/liter, 1.84 ng/liter, and 0.184 ng/liter, respectively. Other concentrations representing different risk levels may be calculated by use of the guidelines. The risk estimate range is presented for information purposes and does not represent an agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis(2-chloroethyl) ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the nonthreshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels that may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are 0.3 μg/liter, 0.03 μg/liter, and 0.003 μg/liter, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 13.6 μg/liter, 1.36 μg/liter, 0.136 μg/liter respectively. Other concentrations representing different

risk levels may
guidelines. The
sented for infor
not represented
"acceptable" risk

For the protec
the toxic propert
ether ingested tl
nated aquatic or
criterion is deter

For the protec
the toxic propert
ether ingested th
organisms alone
is determined to

GAMMA-CHL
CHLORIDE. *S*
[542-75-6]

***m*-CHLOROAI**
chloro-, bromo-
[108-42-9]

***o*-CHLOROAN**
chloro-, bromo-
[95-51-2]

***p*-CHLOROAN**
chloro-, bromo-
[106-47-8]

NCI—may be c

*RCRA 40 CFI
EPA hazardous

CHLOROBEN
(MONOCHLO
[108-90-7]

*OSHA 29 CFI
PEL(TWA): 75

ACGIH-TLV
TWA: 75 ppm,

NFPA—hazard
health—2, flam

CWA 307(a)(1),

*CWA 311(b)(2
Discharge RQ
grams)

CAA 112

Table 1
Waste Stream Comparison

	TYPICAL RANGE	1964	7/14/74	10/13/76	8/1/78	7/24/79
NEUTRAL WELLS						
Specific conductance				26,500 umhos	12,000 umhos	13,500 umhos
Total organic carbon	0.1 - 2.0 wt%		0.6 wt%	1.24 wt%	9200 ppm	12,800 ppm
Nitrate	<0.01 - 0.5 wt%		0.1 wt%	750 ppm	9.25 ppm	550 ppm
Ash	<0.05 - 0.5 wt%		0.2 wt%	0.16 wt%	0.229 wt%	0.572 wt%
Total suspended solids	<10 - 500 ppm		50 ppm	28 ppm	30 ppm	40 ppm
Cu	<1 - 200 ppm	80 ppm	15 ppm	2.5 ppm	3.5 ppm	6 ppm
Vanadium	<1 - 25 ppm	20 ppm	3 ppm		.3 ppm	.34 ppm
pH	5.0 - 9.0	9	6.5	6.9	7.5	6.4
water wt% by (-)	99.8 - 95.0%	95.2%	98.5	98.5	98.55	97.72
Chemical oxygen demand				25,550 ppm	21,048 ppm	27,000 ppm
ACID WELL						
Specific conductance				5,450 umhos	11,500 umhos	4,200 umhos
Total organic carbon	0.1 - 5.0 wt%		1.4 wt%	0.53 wt%	6,900 ppm	4,300 ppm
Nitrate	<0.1 - 1.0 wt%		0.3 wt%	350 ppm	700 ppm	300 ppm
Ash	<0.1 - 2.0 wt%		0.6 wt%	0.011 wt%	0.022 wt%	0.03 wt%
Total suspended solids	<10 - 500 ppm		50 ppm	5 ppm	4 ppm	5 ppm
Cu	<10 - 10,000 ppm	80 ppm*	3000 ppm	0.3 ppm	1.7 ppm	19 ppm
Vanadium	<1 - 1,000 ppm	20 ppm*	250 ppm	.08 ppm	3.7 ppm	.91 ppm
Chlorinated organics	<0.1 - 1.0 wt%		0.3 wt%	4,772 ppm	32,000 ppm	8 ppm
Mn	<1 - 100 ppm	50 ppm*	15 ppm	<0.1 ppm	.02 ppm	.02 ppm
pH	<1 - 7.0	5	1.0	2.7	1.9	2.4
Water wt% by (-)	99.8 - 88.5%		96.7	98.9	96.02	99.51
Chemical oxygen demand				27,800 ppm	9,665 ppm	9,240 ppm

Table 1
Waste Stream Comparison (cont.)

	4/28/81	1/27/82	3/85	9/22/87	9/13/88
NEUTRAL WELLS					
Specific conductance	3,800 umhos	6,500 umhos	7,000 umhos	5,000 umhos	1,150 umhos
Total organic carbon	7,070 ppm	2,591 ppm	4,623 ppm	4,934 ppm	1,930 ppm
Nitrate	110 ppm	0.6 ppm	4 ppm	1.8 ppm	1.9 ppm
Ash	234 ppm	.0306 wt%	0.0132 wt%	0.081 wt%	0.0197 wt%
Total suspended solids	42 ppm	68 ppm	12 ppm	13 ppm	16 ppm
Cu	.15 ppm	1.35 ppm	1.1 ppm	2.79 ppm	0.63 ppm
Vanadium	15 ppm	.032 ppm	1.185 ppm	0.15 ppm	<.005 ppm
pH	6.7	6.6	6.3	6.41	6.5
water wt% by (-)	99.26	99.63	97.41	99.3	99.55
Chemical oxygen demand	26,800 ppm	8,778 ppm	12,692 ppm	19,101 ppm	5,653 ppm
ACID WELL					
Specific conductance	1,600 umhos	1,000 umhos	10,000 umhos	1,250 umhos	2,950 umhos
Total organic carbon	5,530 ppm	3,697 ppm	7,286 ppm	4,826 ppm	4,100 ppm
Nitrate	125 ppm	1,5 ppm	5 ppm	<0.1 ppm	6.9 ppm
Ash	81 ppm	.0136 wt%	0.0074 wt%	0.0147 wt%	0.0149 wt%
Total suspended solids	2 ppm	5 ppm	12 ppm	5 ppm	1 ppm
Cu	.3 ppm	.186 ppm	0.43 ppm	0.31 ppm	0.01 ppm
Vanadium	16 ppm	.004 ppm	<0.01 ppm	<0.005 ppm	<0.005 ppm
Chlorinated organics	8,955 ppm	2,656 ppm	17,284 ppm	1,772 ppm	1,727 ppm
Mn	.028 ppm	.017 ppm	.06 ppm	0.02 ppm	0.03 ppm
pH	2.5	2.9	5.6	2.07	2.6
Water wt% by (-)	98.54	99.31	97.26	99.29	99.51
Chemical oxygen demand	4,556 ppm	9,111 ppm	18,461 ppm	16,854 ppm	11,660 ppm

* in neutral well
** halogenated organic compounds

5. On page 6 of Appendix 2-11, it is stated that "The concentration of dichloroacetaldehyde in the "acid" waste stream is 4100 ppm based on a waste stream analysis performed on November 22, 1988". Celanese should submit the results of this test and any other information necessary to establish that this concentration level is conservative. Should the petition be approved, a stipulation would be made that Celanese not exceed the modeled concentration level of 4100 ppm since the projected extent of the waste migration would no longer be valid.

6. Celanese should submit the pressure test data and calculations to verify the permeability value used in the model as stated on page 2-20.

Response:

The pressure test data and calculations used in the model have already been provided in the petition, and are located in the Selected Petition References volume. For this information refer to the references volume under Petition Section 3 - Reference # 16.

7. Celanese should submit information to verify the original pressure of the injection intervals.

Response:

The original formation pressure in the lower Miocene injection sand was derived from a bottom hole pressure measurement in WDW-110, prior to the start of injection. The pressure test is located in the selected petition references. The original formation pressure for the upper Miocene injection sand is based on two pieces of information. The first piece of data is a drill stem test performed in WDW-8, in June of 1964. The pressure gradient from this test was 0.449 psi/ft. The drill stem test was not sealed successfully and therefore the pressure value is suspect. The second piece of data is a report to the State of

Table 1
Waste Stream Comparison (cont.)

	4/28/81	1/27/82	3/85	9/22/87	9/13/88
NEUTRAL WELLS					
Specific conductance	3,800 umhos	6,500 umhos	7,000 umhos	5,000 umhos	1,150 umhos
Total organic carbon	7,070 ppm	2,591 ppm	4,623 ppm	4,934 ppm	1,930 ppm
Nitrate	110 ppm	0.6 ppm	4 ppm	1.8 ppm	1.9 ppm
Ash	234 ppm	.0306 wt%	0.0132 wt%	0.081 wt%	0.0197 wt%
Total suspended solids	42 ppm	68 ppm	12 ppm	13 ppm	16 ppm
Cu	.15 ppm	1.35 ppm	1.1 ppm	2.79 ppm	0.63 ppm
Vanadium	15 ppm	.032 ppm	1.185 ppm	0.15 ppm	<.005 ppm
pH	6.7	6.6	6.3	6.41	6.5
water wt% by (-)	99.26	99.63	97.41	99.3	99.55
Chemical oxygen demand	26,800 ppm	8,778 ppm	12,692 ppm	19,101 ppm	5,653 ppm
ACID WELL					
Specific conductance	1,600 umhos	1,000 umhos	10,000 umhos	1,250 umhos	2,950 umhos
Total organic carbon	5,530 ppm	3,697 ppm	7,286 ppm	4,826 ppm	4,100 ppm
Nitrate	125 ppm	1,5 ppm	5 ppm	<0.1 ppm	6.9 ppm
Ash	81 ppm	.0136 wt%	0.0074 wt%	0.0147 wt%	0.0149 wt%
Total suspended solids	2 ppm	5 ppm	12 ppm	5 ppm	1 ppm
Cu	.3 ppm	.186 ppm	0.43 ppm	0.31 ppm	0.01 ppm
Vanadium	16 ppm	.004 ppm	<0.01 ppm	<0.005 ppm	<0.005 ppm
Chlorinated organics	8,955 ppm	2,656 ppm	17,284 ppm	1,772 ppm	1,727 ppm
Mn	.028 ppm	.017 ppm	.06 ppm	0.02 ppm	0.03 ppm
pH	2.5	2.9	5.6	2.07	2.6
Water wt% by (-)	98.54	99.31	97.26	99.29	99.51
Chemical oxygen demand	4,556 ppm	9,111 ppm	18,461 ppm	16,854 ppm	11,660 ppm

* in neutral well
** halogenated organic compounds

2. Celanese should demonstrate that the injected waste does not affect the confining capability of the confining material in the injection zone.

MECHANICAL INTEGRITY TESTS

1. The submitted radioactive tracer tests and pressure tests for all wells were performed in December of 1988. Celanese should submit information demonstrating that the wells continue to have mechanical integrity.

Response:

A report summarizing the recent MIT work performed in October 1989 has been supplied by the Bay City Plant to EPA Region VI already. An additional copy is being provided to make the second EPA petition copy a complete document. The October 1989 MIT work again documents the mechanical integrity of the injection well systems.

UNITED S TES ENVIRONMENTAL PROTECTION A ICY

2/8/90

(2)

1 26 JAN 1990

REPLY TO: 6W-SU

Mr. I.O. Coleman
Environmental Manager
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Bay City, Texas 77414

Dear Mr. Coleman:

Enclosed is a list of comments that were discussed with you and your technical representative regarding the petition exemption for Celanese Chemical Company, Bay City Plant. As discussed with Mr. Squyres, Celanese will need to respond to these comments so that EPA can continue the review of the Celanese Bay City petition. In order to expedite the review process, this petition should be revised by January 31, 1990.

If you have any questions, please call Ronnie Crossland or Vincent Malott at (214) 655-7160.

Sincerely yours,

Oscar Cabra, Jr., P.E.
Chief
Water Supply Branch (6W-S)

Enclosure

cc: Mr. Tom Roth, TWC
Mr. Bob Pennington, Celanese Bay City Plant

CONCURRENCES

SYMBOL	6W-SU:1/10/90:MALOTT:kk:C:®WP50®VM®COLEMAN.LTR:FILE CODE:WAT 18-6-5-9						
	6W-SU	RDC 1/26/90					
SURNAME	WEAVER	Crossland					
DATE	1/26						

VM 1/26/90

EPA Form 1320-1 (12-70)

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RESERVOIR ENGINEERING/MODELING

1. Celanese should submit site specific information to substantiate the presence of 9.0 lb/gallon fluid at or near the ground surface in the abandoned boreholes. This information affects the no-migration and non-endangerment demonstrations.

2. Celanese should submit information documenting the presence of 10.1 lb/gallon mud at or near the ground surface in the abandoned borehole for artificial penetration no. 9 in Table 4-1 and Figure 4-13. The documentation is necessary since the predicted pressure rise in the upper Miocene injection interval at artificial penetration no. 9 exceeded the pressure due to a 9.0 lb/gallon mud column in approximately 1969 and will exceed the pressure in approximately 1994.

3. Celanese should demonstrate that, of the hazardous wastes that are injected at this facility, modeling of dichloroacetaldehyde will result in the maximum vertical and lateral plume movement.

4. Celanese should submit the reference(s) documenting the health based limit of 1 ppm for dichloroacetaldehyde.

5. On page 6 of Appendix 2-11 it is stated that "The concentration of dichloroacetaldehyde in the "acid" waste stream is 4100 ppm based on a waste stream analysis performed on November 22, 1988." Celanese should submit the results of this test and any other information necessary to establish that this concentration level is conservative. Should the petition be approved, a stipulation would be made that Celanese not exceed the modeled concentration level of 4100 ppm since the projected extent of the waste migration would no longer be valid.

6. Celanese should submit the pressure test data and calculations to verify the permeability value used in the model as stated on page 2-20.

7. Celanese should submit information to verify the original pressure of the injection intervals.

8. Celanese should provide information discussing the effect on the pressure buildup and plume migration for the upper Miocene injection interval due to thinning of the interval to 20 feet northwest of the facility.

9. Celanese should provide the calculations used to determine the density values for formation fluids in the upper and lower Miocene injection intervals on page 2-23.

10. Celanese should demonstrate that the shale permeability and porosity values used in the model are either representative or conservative.

11. The error bars for the modeled shut-in pressure curves encompass a range

for the upper Miocene. Similarly, the maximum shut-in pressure buildup shown in Figure 2-8 for the lower Miocene was approximately 6 psi with an error of approximately 5 times the range of measurement. Celanese should therefore justify that the accuracy and precision of the pressure buildup model is adequate to confidently describe the pressure buildup in the injection sands. In addition, Celanese should justify the method used to calibrate the pressure buildup model, considering the errors involved.

12. The model has been calibrated on the basis of very few points. Figures 2-7 and 2-8 show only two calibration points. An examination of Figure 2-8, the sole calibration data for the lower Miocene, indicates that the modeled pressure buildup does not compare well with the two actual pressure measurements. Therefore, Celanese should provide additional information in demonstration of the pressure buildup model calibration.

13. On page 2-33 it is stated that the pressures predicted by the model should be less than the measured pressures. Celanese should expand on the reason for this phenomenon. The modeled shut-in pressures are indeed less than the measured pressures in some cases as is shown in Figures 2-5 and 2-8. Therefore, Celanese should demonstrate that the model is conservative in this regard.

14. There was no discussion in the petition concerning external sources or sinks which could affect the pressure buildup or plume migration. Celanese should investigate this and demonstrate that external sources and sinks will not affect the model, or incorporate these effects into the model.

15. The plume boundary for the year 2000 in Appendices 2-13 and 2-14 was based on information presented in Figures 2-13 to 2-16. Celanese should also provide similar information to support the shape of the 10,000 year plumes in Appendices 2-13 and 2-14.

16. Celanese should justify the average thicknesses of the injection intervals used in the model as conservative since these values have an effect on the pressure buildup, plume migration, and vertical waste permeation.

17. In Section 2.1.5.3.4, up dip drift due to density differences between the injected waste and the formation fluid are discussed. The calculations assume that the injected waste migrates up dip en masse solely by virtue of its lower specific gravity. Celanese should justify this "immiscible displacement" and demonstrate that the injected fluid does not mix with the formation fluid thus rendering density effects less important.

18. Permeability values used in the multiplying factor were taken from whole core measurements (page 2-21) while the permeability values used in the pressure buildup model were taken from pressure test data (page 2-20).

Celanese should justify the use of permeability values from core measurements rather than from pressure test data in the multiplying factor.

19. On page 2-40 it is stated: "The plant site will be modeled past the year 2000 after Waste Well 5 has been drilled and completed." According to information contained in the petition, the facility has been modeled only to the year 2000 and Waste Well No. 5 has not been modeled. Therefore, in order to inject banned waste into Well No. 5, or to continue the injection of banned waste into any of the wells after the year 2000, Celanese will have to submit another petition.

20. On page 2-74 it is stated: "The net thickness of shale overlying the upper Miocene injection sand is in excess of 400 feet with at least 50 feet of this shale being located between the top of the injection interval and the top of the injection zone." Data contained in Figure 3-31 shows 450 feet between the top of the injection interval and the top of the injection zone. Celanese should correct this discrepancy between the statement on page 2-74 and figure 3-31.

GEOLOGY

1. In Appendices 3-2 and 3-3, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

2. In Appendix 3-5, the boundary of the 10,000 year plume for the lower Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-14. Celanese should correct this discrepancy in plume boundaries.

3. In Appendix 3-7, the boundary of the 10,000 year plume for the upper Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-13. In addition, the structure map in Appendix 3-7 does not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should correct the discrepancy in plume boundaries and ensure that the structure map accurately represents the geology for the area surrounding the 10,000 year plume.

4. In Appendices 3-8, 3-11, and 3-12, the contour intervals do not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should ensure that the map accurately represents the geology for the area surrounding the 10,000 year plume.

COMPATIBILITY

1. Celanese should demonstrate that the current injected waste stream is

and 1984, described in Sections 6.1.1.1, 6.1.1.2, 6.1.1.3, and 6.1.1.4., to ensure the compatibility tests are valid and applicable.

2. Celanese should demonstrate that the injected waste does not affect the confining capability of the confining material in the injection zone.

MECHANICAL INTEGRITY TESTS

1. The submitted radioactive tracer tests and pressure tests for all wells were performed in December of 1988. Celanese should submit information demonstrating that the wells continue to have mechanical integrity.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

(2)

REPLY TO: 6W-SU

I. O. Coleman
Environmental Affairs
Celanese Chemical Company
Bay City Plant
Post Office Box 509
Bay City, Texas 77414

Dear Mr. Coleman:

Attached is a list of comments that were discussed with Mr. Don Squyres on January 5, 1990, regarding the petition exemption for Celanese Chemical Company, Bay City Plant. As discussed with Mr. Squyres, Celanese will need to respond to these comments before EPA can proceed further in the decision process on the petition. Due to these deficiencies, the EPA may be unable to make a decision on this petition by May 8, 1990. In order to minimize the delay in the petition process, this petition should be revised by January 22, 1990.

If you have any questions, please call Ronnie Crossland or Vincent Malott at (214) 655-7160.

Sincerely yours,

Oscar Cabra, Jr., P.E.
Chief
Water Supply Branch (6W-S)

cc: Mr. Bob Pennington, Plant Manager

WAT 18-6-5-9

VM 1/09/90

CONCURRENCES

SYMBOL	6W-SU:MALOTT:sm:01/08/90:DISK:C:WP50:VN:CELANESE:C-NOD.LET							
	6W-SU							
SURNAME	WEAVER	Crossland						
DATE	1/9	RDC 1/9/90						

EPA Form 1320-1 (12-70)

OFFICIAL FILE COPY

1/9/90

Celanese Bay City

RESERVOIR ENGINEERING/MODELING

1. Celanese should submit site specific information to substantiate the presence of 9.0 lb/gallon fluid at or near the ground surface in the abandoned boreholes. This information affects the no-migration and non-endangerment demonstrations.

2. Celanese should submit information documenting the presence of 10.1 lb/gallon mud at or near the ground surface in the abandoned borehole for artificial penetration no. 9 in Table 4-1 and Figure 4-13. The documentation is necessary since the predicted pressure rise in the upper Miocene injection interval at artificial penetration no. 9 exceeded the pressure due to a 9.0 lb/gallon mud column in approximately 1969 and will exceed the pressure in approximately 1994.

3. Celanese should demonstrate that, of the hazardous wastes that are injected at this facility, modeling of dichloroacetaldehyde will result in the maximum vertical and lateral plume movement.

4. Celanese should submit the reference(s) documenting the health based limit of 1 ppm for dichloroacetaldehyde.

5. On page 6 of Appendix 2-11 it is stated that "The concentration of dichloroacetaldehyde in the "acid" waste stream is 4100 ppm based on a waste stream analysis performed on November 22, 1988." Celanese should submit the results of this test and any other information necessary to establish that this concentration level is conservative. Should the petition be approved, a stipulation would be made that Celanese not exceed the modeled concentration level of 4100 ppm since the projected extent of the waste migration would no longer be valid.

6. Celanese should submit the pressure test data and calculations to verify the permeability value used in the model as stated on page 2-20.

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9. Celanese should provide the calculations used to determine the density values for formation fluids in the upper and lower Miocene injection intervals on page 2-23.

10. Celanese should demonstrate that the shale permeability and porosity values used in the model are either representative or conservative.

11. The error bars for the modeled shut-in pressure curves encompass a range of 30 psi. The maximum pressure buildup shown in Figures 2-5, 2-6, and

2-7 for the upper Miocene is approximately 45 psi. Consequently, the error in the calculation of the pressure buildup is approximately 67% for the upper Miocene. Similarly, the maximum shut-in pressure buildup shown in Figure 2-8 for the lower Miocene was approximately 6 psi with an error of approximately 5 times the range of measurement. Celanese should therefore justify that the accuracy and precision of the pressure buildup model is adequate to confidently describe the pressure buildup in the injection sands. In addition, Celanese should justify the method used to calibrate the pressure buildup model, considering the errors involved.

12. The model has been calibrated on the basis of very few points. Figures 2-7 and 2-8 show only two calibration points. An examination of Figure 2-8, the sole calibration data for the lower Miocene, indicates that the modeled pressure buildup does not compare well with the two actual pressure measurements. Therefore, Celanese should provide additional information in demonstration of the pressure buildup model calibration.

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14. There was no discussion in the petition concerning external sources or sinks which could affect the pressure buildup or plume migration. Celanese should investigate this and demonstrate that external sources and sinks will not affect the model, or incorporate these effects into the model.

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18. Permeability values used in the multiplying factor were taken from whole core measurements (page 2-21) while the permeability values used in the pressure buildup model were taken from pressure test data (page 2-20).

Celanese should justify the use of permeability values from core measurements rather than from pressure test data in the multiplying factor.

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3. In Appendix 3-7, the boundary of the 10,000 year plume for the upper Miocene injection interval does not correspond with the plume boundary for the same interval in Appendix 2-13. In addition, the structure map in Appendix 3-7 does not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should correct the discrepancy in plume boundaries and ensure that the structure map accurately represents the geology for the area surrounding the 10,000 year plume.

4. In Appendices 3-8, 3-11, and 3-12, the contour intervals do not extend to the boundary of the 10,000 year plume as shown in Appendix 2-13. Celanese should ensure that the map accurately represents the geology for the area surrounding the 10,000 year plume.

COMPATIBILITY

1. Celanese should demonstrate that the current injected waste stream is similar to the waste stream in the compatibility studies of 1964, 1973,

and 1984, described in Sections 6.1.1.1, 6.1.1.2, 6.1.1.3, and 6.1.1.4., to ensure the compatibility tests are valid and applicable.

2. Celanese should demonstrate that the injected waste does not affect the confining capability of the confining material in the injection and confining zones and is compatible with the fluid in the confining zone.

MECHANICAL INTEGRITY TESTS

1. The submitted radioactive tracer tests and pressure tests for all wells were performed in December of 1988. Celanese should submit information demonstrating that the wells continue to have mechanical integrity.

BROWN MARONEY & OAKS HARTLINE
ATTORNEYS

1300 WORTHAM TOWER
2727 ALLEN PARKWAY
HOUSTON, TX 77019
(713) 529-3110
FAX (713) 529-4639

1400 ONE CONGRESS PLAZA
111 CONGRESS AVENUE
AUSTIN, TX 78701
(512) 472-5456
FAX (512) 479-1101

3012 FAIRMOUNT
DALLAS, TX 75201
(214) 871-2121
FAX (214) 855-0806

WRITER'S DIRECT NUMBER:
512/479-9707

December 22, 1989

Mr. Oscar Cabra
Water Supply Branch
U.S. Environmental Protection Agency, Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Re: Hoechst Celanese Chemical -
Bay City Plant, UIC No-Migration Petition

Dear Oscar:

I appreciated very much receiving the telecopy of the December 19, 1989, Region 6 Petition Status Report for pending no-migration petitions for underground injection control facilities located in the State of Texas.

As I mentioned in our telephone conversation on that date, my client is extremely concerned regarding the delay that is occurring in the final review of the pending referenced no-migration petition and the scheduling of the publication of the public notice. It appears from the telecopy you sent that all but two of the no-migration petitions for Texas facilities should have been through Second Review or will have missed the targeted date for such review by January 8, 1990. Thus, we would appreciate your scheduling a meeting during the week of January 8, 1990 (preferably during the afternoon on January 10) for Hoechst Celanese Chemical representatives to meet with Messrs. Knudson, Crossland and you in order that we can be advised relative to the agency's plans for the specific timing for completion of the review of the Bay City Plant petition and the publication.

In reviewing the information which I have received to date, I am still unable to ascertain the justification for further

WAT 18-6-5-9

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REGION VI

delay in the processing of the Bay City Plant petition, while other applicants with poorer track records in meeting target dates appear to not be having their pending petitions delayed.

Your early response regarding the scheduling of the requested meeting will be greatly appreciated.

Wishing you a Joyous Holiday Season, I am

Very truly yours,

R. Kinnan Golemon

4810Y

Ron
Vince
Joe

Hoechst Celanese

(2)

Chemical Group
Bay City Plant
Hoechst Celanese Corporation
PO Box 509, FM 3057
Bay City, TX 77404-0509
409 245 4871

December 6, 1989
IOC-325-89

Mr. Thomas P. Roth,
Chief
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
1700 North Congress Avenue
Austin, Texas 78711-3087

WAT 18-6-5-9

Subject: Request for Minor Permit Revisions
Reference Permit Nos.: WDW-14, 32, 49 and 110

Dear Mr. Roth:

Based on recent conversations between you and our injection well consultants (Du Pont), the Hoechst Celanese Bay City Plant is requesting the following injection zones for each Class 1 injection well be specified in the current Class 1 injection well permits. The current well permits were written prior to the promulgation of 40 CFR Part 148, and the recent amendments to 40 CFR Part 146 and do not contain a description of the "injection zone", as that term is defined by the new rules. The requested changes to the well permits will make the permitted injection zones in the well permits equivalent to the "injection zones" defined in the Bay City Plant Class 1 Injection Well "No Migration Petition".

The requested changes are as follows:

Well Name	Requested Injection Zone*
WDW-14	Approximately 2900 to 3700 feet
WDW-32	Approximately 2900 to 3700 feet
WDW-49	Approximately 2900 to 3700 feet
WDW-110	Approximately 2900 to 5950 feet

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*Measured Well Log Depths

It is my understanding that these revisions to the permits are categorized as "minor" permit modifications since they add a limiting term not currently included in the permits. We would appreciate expeditious processing of these

If you should require any additional information, please do not hesitate to telephone me at 409/245-4871, Ext. 4197 or Mr. G. J. McCarthy at Ext. 4205.

Sincerely,

I. O. Coleman, Jr.

IOC/las

cc: Mr. Russell S. Kimble, Chief
Hazardous and Solid Waste Enforcement
Hazardous and Solid Waste Division
Texas Water Commission
P. O. Box 13087, Capitol Station
1700 North Congress Avenue
Austin, Texas 78711-3087

Mr. Richard Merritt,
Geologist
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711-3087

Mr. Ronald D. Crossland
Environmental Engineer
U.S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

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DU PONT
ENVIRONMENTAL MANAGEMENT
SERVICES

Fabricated Products Department
140 Cypress Station Drive, Suite 140
Houston, Texas 77090
(713) 586-5600

December 5, 1989

Mr. Ronald Crossland
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Dear Mr. Crossland:

The following letter explains two sets of revisions that have been made to the Hoechst Celanese Bay City Plant Class I Injection Well Petition. The first set of revisions was submitted to your office during our November 21, 1989, meeting. These revisions were requested by the Texas Water Commission (TWC) and primarily resulted from adding abandoned borehole diffusion calculations to the petition.

During our November 21 meeting, your office requested that abandoned borehole diffusion calculations also be performed, assuming brine and not mud-filled boreholes. The revised pages resulting from this are attached. Additional revisions necessitated by the November 21 revisions are also attached. Each revised page or exhibit is stamped with the revision date, and two copies of each revision are provided. To revise the petition copies, remove the old pages/exhibits from the petition binders, and insert the new pages or exhibits in their place.

These revisions have also been forwarded to the Texas Water Commission.

The revisions are discussed by petition section, as an attachment to this letter.

Sincerely,

D.H. Squyres

D.H. Squyres

DHS/ld
Enclosure

cc Mr. I.O. Coleman - Bay City Plant
Mr. Glenn McCarthy - Bay City Plant

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REGION VI

WAT 18-6-5-9

DUPONT

November 21, Revisions

Master Petition Table of Contents

- The overall petition Table of Contents has been revised to reflect revisions that were made in each section.

Section 1

- The pages that describe the injection zone have been revised to account for abandoned borehole diffusion. The new top of the injection zone is at approximately 2,900 feet instead of 3,300 feet. This change was made at the TWC's request to accommodate diffusion in abandoned boreholes.

Section 2

- Page 2-43 was changed to reflect that the "upper Miocene confining zone" has been changed to "upper Miocene containment interval".

- Page 11 of Appendix 2-11 has been changed to reflect that there is now 450 feet of permitted containment interval above the top of the upper Miocene injection interval.

- The type log was revised to reflect the newly specified 2,900 foot permitted injection zone top.

- Pages 2-76 to 2-78 were revised at the request of the TWC, in order to use a new value in the calculation of hydraulic conductivity. This changed the plume locations, and new plume location calculations, as well as new plume location maps, are supplied.

Section 3

- The Appendices list in the Table of Contents, and the one just before Appendix 3-1, were revised to show the revised names for the maps in Appendices 3-8, 3-12, 3-14, 3-15, and 3-16. The titles for these maps changed when the permitted injection zone top was specified to be 2,900 feet.

- Maps included in the above-listed Appendices are provided which reflect the new map names in the title blocks.

- New strike and dip cross sections are provided which reflect the 2900 foot permitted injection zone revision.

- Type log prints reflecting the above revision are supplied.

Section 4

- Page iii of the Appendices list has been revised to show the names of the maps in Appendix 4-3.

- Appendix 4-3a is being supplied for the first time, due to a request by the Texas Water Commission. Many of the other revisions resulted from the addition of this Appendix to the petition.

- Revised pages of Section 4 are supplied that reflect the TWC requested revisions to the 10,000 year plume location. Due to the revised location of the plume, the status of a number of wells versus the no-migration/non-endangerment has changed, and the data associated with these wells in Section 4 was revised.

- New plume location maps are supplied, because the change in hydraulic conductivity resulted in changes in the 10,000 year plume locations.

December 5, Revisions

Master Petition Table of Contents

- The map title of Appendix 3-20 was changed, on Page xi, from Regional Structure Maps: Approximate Top of Confining Zone; to Approximate Top of Permitted Injection Zone.

Section 3

- The same revision noted above was made in the Section 3 Table of Contents.

- Figure 3-1 on Page 3-4 has been changed to reflect the revised stratigraphic position of the permitted injection zone and confining zone.

- The last paragraph on Page 3-12, was revised to show that the previously described confining zone is now the containment interval.

- The last sentence in the middle paragraph (3.2.2.4) had added to it "and the Goliad includes the site confining zone".

- On Page 3-16b, the word nearly, before "nearly 2,000 feet" was removed.

- The first sentence on Page 3-17 was changed to reflect that Pliocene age sediments are also included in the injection and confinement system.

- The last two paragraphs on Page 3-20 were revised to reflect the new positions of the injection and confining zones in the stratigraphic section.

- The same revision noted under the December 5, changes to the "Master Petition Table of Contents" was made on Page 3-38 as well.

- Pages 3-46, 50, 52, 53, and 58 were changed to reflect the new map titles for Appendices 3-8, 12, 14, 15, 16, and 20.

- Revised maps for Appendices 3-20 are supplied to reflect the new map title.

- The stick-on labels for Appendices 3-8, 12, 14, 15, and 20 have been revised to reflect the new map names.

Section 4

- The abandoned borehole diffusion Appendix (4-3a) has been revised to reflect diffusion in a hypothetical brine filled borehole, as requested by EPA Region VI, at the November 21 petition meeting.

Ruckman
Roth
Kimble

November 2, 1989

Oscar Cabra, Jr., P.E.
Chief, Water Supply Branch
U. S. Environmental Protection Agency
Region VI
1445 Ross Avenue
Dallas, Texas 75202

Re: 40 CFR 148 Land Ban "No-migration" Petition Summary
Hoechst Celanese Chemical Group, Inc. - Bay City

Dear Mr. Cabra:

Enclosed is the HSWA petition review and summary report prepared by the Underground Injection Control Unit of my staff for the above cited facility. The report is a result of an extensive staff review of the land ban petition submitted by the facility pursuant to 40 CFR Part 148 Subpart C.

The staff has determined that the petition is in compliance with the petition standards and procedures of Subpart C. If you have any questions please contact Mr. Thomas P. Roth of my staff at 512/463-8425.

Sincerely,

Russell S. Kimble, Chief
Hazardous and Solid Waste Enforcement Section
Hazardous and Solid Waste Division

DR/da

Enclosure

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REGION VI

WAT 18-6-5-9

11-22-89 EPA Dallas Re ie Crossland

HSWA PETITION REVIEW AND SUMMARY
FOR THE INJECTION OF RESTRICTED HAZARDOUS WASTE

ADMINISTRATIVE INFORMATION

FACILITY NAME:	Hoechst Celanese Chemical Group, Inc. Bay City Plant
ADDRESS:	Farm Road 3057 P.O. Box 509
CITY:	Bay City
STATE:	Texas
ZIP CODE:	77414
CONTACT:	I.O. Coleman, Jr.
PHONE NUMBERS:	(409) 245-4871 Ext 4197
WELL NUMBERS:	2, 3, 4, 1-A and proposed Well 5
UIC PERMIT NUMBER:	WDW-14, 32, 49, 110 and proposed WDW-277
RCRA ID NUMBER:	TXD 026040709
LEGAL LOCATION:	See Below

(Petition volume/page number references in parentheses)

WDW-14

The well is located 5,230 feet south and 2,220 feet west of the most northerly northwest corner of the company property which is located on the James Moore League, Abstract No. 62, Matagorda County, Texas. (1-15)

WDW-32

Located 4,292 feet south and 2,029 feet west of the most northerly 1-20 northwest corner of company property which is located on the James Moore League, Abstract No. 62, Matagorda County, Texas. (1-20)

WDW-49

The well is located 3,489 feet north and 2,442 feet east of the southwest corner of company property which is located on the James Moore League Abstract No. 62, Matagorda County, Texas. (1-23)

WDW-110

Located on company property 18,050 feet from the east line and 2,200 feet from the north line of the James Moore League, Abstract No.62, Matagorda County, Texas. (1-26)

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WAT 18-6-5-9

WDW-277

Not yet drilled; permit application submitted to TWC in 1988

The well will be located approximately 400 feet north, northeast of WDW-110. Approximate coordinates for the proposed well site are 17,225 feet from the east line and 2,000 feet from the north line of the James Moore League, Abstract No. 62, Matagorda County, Texas. (1-30)

A final review of the submitted petition on the above wells has been performed. This petition was done in accordance with 40 CFR 148.20, to demonstrate to a reasonable degree of certainty that:

(i) Fluid movement conditions are such that the injected fluids will not migrate within 10,000 years:
(a) vertically upward out of the injection zone; or,
(b) laterally within the injection zone to a point of discharge or interface with a USDW.

WASTE PROPOSED TO BE EXEMPTED FROM LAND BAN RESTRICTIONS

The petition has been submitted in order to allow the injection of the following hazardous waste(s):

There are two waste streams injected by the Bay City Plant. The first stream is known as "acid" waste, and the other stream is known as "neutral" waste. (1-5)

ACID WASTE STREAM

The "acid" waste stream is generated from the manufacture of acetaldehyde, n-butyl alcohol, n-propyl alcohol, isobutyl alcohol and vinyl acetate. The "acid" waste stream is composed principally of water containing small amounts of halogenated organic compounds (HOC's), ash and trace quantities of metals. The HOC's derive from distillation side cuts (K010) and distillation bottoms (K009) from the production of acetaldehyde from ethylene. The "acid" waste stream is hazardous as a result of the K009 and K010 components. Ammonia (NH_3) or sodium hydroxide (NaOH) is used to adjust the pH of the waste prior to injection. The typical pH of the injected "acid" waste stream is about 2.2, with a range of 2 to 3 (the pH is always controlled to be greater than 2.0). (1-6)

NEUTRAL WASTE STREAM

The "neutral" waste stream is primarily contaminated rainwater and washwater generated from the manufacture of acetaldehyde, vinyl acetate, n-buytl alcohol, n-propyl alcohol, iso-buytl

alcohol, heptanoic acid, nonanoic acid, hydrogen, synthesis gas, heptanal and nonanal.

Normally, the waste stream consists principally of water containing small amounts of ash, oil and grease, and trace quantities of metals. In addition, contaminated rainwater runoff, and washwaters can at times be added to the waste stream and injected as part of the " neutral" waste. Ammonia (NH_3) or sodium hydroxide (NaOH) is added to the waste stream to adjust the pH prior to injection, with the typical pH of the injected waste stream being about 6.2 with a range between 6.0 and 6.5.

Although the "neutral" waste is non-hazardous, the "neutral" well system is being petitioned to allow injection of the "acid" waste waste stream, during shutdown of WDW-110. In an abundance of precaution, it is assumed that this waste stream, at the time of injection into the "neutral" well system, is impacted by the "acid" waste ban date. (1-7)

WELLBORE SCHEMATICS (attached Figures)

WELL HISTORY (see attached Appendix 1)

AREA OF REVIEW EVALUATION:

1. Discuss procedure used for identifying all artificial penetrations.

Several data sources were utilized to locate pertinent information regarding each artificial penetration. Revised or updated base maps from Tobin Surveys, Inc., Cambe Geological Services, Inc., the Matagorda County oil and gas base map maintained by the Railroad Commission of Texas (RRC) and the RRC Buckeye Field Map Number 567 were utilized to initially identify and establish a general background on the wells in the Area of Review. State agency files along with state libraries were researched by Agency Information Consultants, Incorporated (AIC) for descriptive well documentation. The regional libraries of Cambe Geological Services, Inc., a commercial log service company, were researched for well logs and scout tickets applicable to each well identified in the Area of Review. Additional records data were obtained through the University of Texas, Balcones Research Center. Where discrepancies existed among data sources, data contained in state forms were considered to be most accurate. (4-88)

2. How many wells within the AOR penetrated the confining zone?

In the record search submitted by the petitioner, thirty-one artificial penetrations were identified in the Area of Review.

There are no currently active wells in the 2.5 mile Area of Review and all thirty-one wells have been plugged and abandoned. (4-21)

3. What method was used to determine that each well, which penetrated the confining zone within the AOR, was constructed or plugged adequately to prevent the migration of waste from the injection zone?

Each artificial penetration (active/abandoned) was evaluated as to the adequacy of construction and plugging to determine the potential of the penetration to convey fluid from an injection zone into the overlying USDWs (non-endangerment) and the potential of the penetration to covey the injected waste out of the injection zone (no migration). Potential problem wells were identified and were subsequently evaluated or modeled to determine the need for corrective action. (4-88)

Proper Plugging

For purposes of the Artificial Penetration Review Protocol, the "Statewide Rules For Oil, Gas and Geothermal Operations", from the State of Texas was used to determine proper plugging requirements for the protocol, as the rules are very specific and stringent. The Railroad Commission of Texas , under Statewide Rule 14, (1967), demands all formations bearing USDWs, and oil, gas, or geothermal resources be protected with type-specific cement plugs and mud-laden fluid. Uncemented areas in the abandoned wellbore must be filled with a mud-laden fluid weighing at least 9.5 lb/gal. Setting depths for cement plugs are dependent upon the construction of the well and the geological environment. Wells abandoned with only surface casing should be plugged across the base of the lowermost USDW regardless of casing depth. When insufficient surface casing is set to protect all USDWs and such strata are exposed to the open wellbore, a cement plug must be placed across the exposed strata with an additional cement plug set across the surface casing shoe. When sufficient surface casing has been set to protect all USDWs, a cement plug must be set across the surface casing shoe.

For wells abandoned with protection and/or production casing that have been cemented through all USDW bearing strata, all productive horizons must have cement plugs placed inside the casing and centered opposite the base of the lowermost USDW. For wells abandoned with protection and/or production casing set back to surface, the casing must be perforated at the depths required to protect all productive horizons and the lowermost USDW with cement placed outside of the casing by squeeze cementing. Wells determined to be improperly plugged by the above criteria were labeled as "potential problem wells" and were evaluated or modeled for potential upward movement of fluids. (4-88)

Proper Well Construction

For the purpose of this protocol, a properly constructed active well is defined as a well in which the annulus between the borehole and a casing string has been effectively sealed by cement across and/or above the correlated injection interval(s) thereby preventing vertical fluid movement. Wells that were drilled into or through the injection interval and abandoned with protection and/or production casing left in the hole pose potential problems. If cement was not circulated to a depth above the correlated injection interval, only drilling fluid would be present in the annulus. Although the drilling fluid in the annulus would provide the same resistance to vertical fluid movement as a mud plug in the wellbore, active wells that were constructed improperly were also listed as potential problem wells and evaluated or modeled for possible vertical fluid movement.

Cement volume calculations were made on each well that has full protection and/or production casing left intact in the well. Only conservative data values were used in the calculations. One inch was added to the borehole diameter and all slurry volumes were calculated using Class H cement (1.06 ft3/sack-slurry volume).

4. Were adequate construction and plugging records submitted for all wells that penetrated the confining zone? If not, discuss all deficiencies.

Incomplete Records

A search of all records available did not produce completion and plugging reports for United North & South Development Co. L. V. Stoddard No. 8. AIC did locate a permit dated February 3, 1943. All base maps available were examined including those contained in the hearing files: Adobe Oil and Gas Corporation, Buckeye South Field, file No. F-10-B, June 6, 1983, F. B. Lacy, Inc., Buckeye West Field, file No. 913, and the United North and South Development Company, Buckeye Field Discovery File No. 4310. The Adobe Oil and Gas Field map failed to show the well in question, but the remaining hearing file maps did include the L. V. Stoddard No. 8 well. AIC also examined previous permits for the Bay City Plant on file with the Texas Water Commission (TWC) which were dated July 22, 1971. These documents stated that the well in question was never drilled. Cambe and the Balcones Research Center had no records of a No. 8 well drilled by United North & South Development Company. It was noted in the research of the RRC files, the driller's logs at the Balcones Research Center and the scout tickets of Cambe, that records were available for the wells numbered below and above the well on this lease. Based on this fact, it can be reasonably concluded that this well was probably never drilled. Adequate records were submitted for all other known artificial penetrations within the area of review. (4-20 & 4-21)

5. Were all wells with sufficient information adequately constructed or plugged to prevent the migration of waste from the injection zone?

Twelve artificial penetrations within the 2.5-mile Area of Review are improperly plugged pursuant to the non-endangerment criteria outlined in the Artificial Penetration Protocol (Appendix 4-1) as there are no cement plugs between the injection intervals and the USDW. All twelve non-endangerment potential problem wells (see Appendix 4-3) were modeled to determine if they presented a potential threat to a USDW due to injection operations (Section 4.5). Nineteen artificial penetrations within the 10,000 year plume paths are improperly plugged pursuant to the no migration criteria as there are no cement plugs above the injection intervals within the injection zone (six of these wells were modeled as non-endangerment potential problem wells). Maps in Appendix 4-3 show the artificial penetrations within the plume paths for the upper Miocene and lower Miocene injection intervals at year end 2000 and in 10,000 years. Artificial Penetration No. 10 (where pressures are greater than at any other no migration potential problem well) was conservatively chosen to be modeled, thereby presenting a worst-case modeling scenario. (4-24 & 4-25)

6. Were all deficiencies identified in steps 4 and 5 properly addressed with a corrective action plan?

The modeling results detailed in the petition show that Artificial Penetration 10 is safe as currently abandoned because the pressure buildup at the artificial penetration over time is much less than that necessary to displace the static mud column in the borehole. Since the increased formation pressure rapidly declines once injection has ceased, Artificial Penetration No. 10 will not serve as a conduit for waste movement at any time in the future. The petitioner considered the other eighteen no migration potential problem wells to be safe now, as well as in the future, since they are subjected to much lower pressures than Artificial Penetration No. 10 due to their greater distance from the injection wells. The petitioner considered the twelve non-endangerment potential problem wells to be safe since these wells satisfied the stricter no migration standard. The twelve (12) non-endangerment potential problem wells were also considered safe by the petitioner since these wells satisfied the stricter no migration standard. (4-3)

The petition states that based on the results of the artificial penetration modeling study, no corrective action is necessary for any of the potential problem wells in the Area of Review of Hoechst Celanese Bay City Plant, Injection Wells WDW-110, WDW-14, WDW-32, WDW-49 and proposed WDW-277, pursuant to 40 CFR 146.64(C).

7. Summarize the proposed corrective action strategy for all deficiencies.

Within the scope of this review, no corrective action is required based on computer modeling of the potential problem wells. (4-3)

REGIONAL GEOLOGY (pages 3-2 to 3-15)

1. Summary of stratigraphic and structural features.

The following descriptions and characterizations of the regional geology are interpretations based on the available data (primarily well logs and core studies), (1) obtained from established service companies, state and federal geologic surveys, regulatory agencies, and professional geologic societies, and (2) presented in the Celanese-Bay City petition. The Bay City Plant is located in central Matagorda County, on the Texas Gulf Coastal Plain approximately 10 miles southwest of Bay City, Texas. There are approximately 40,000 feet of sediments underlying the plant site ranging in age from Triassic to Holocene (page 3-2). The stratigraphic section for the Bay City area is shown on the attached copy of Figure 3-1 (page 3-4). Wastes are currently being injected into Miocene age sands (Tertiary Period), which are confined by shales which are also of Miocene age.

During the Tertiary Period, sediments were deposited along the margin of the Gulf Coast basin, an extracratonic basin characterized by rapid subsidence in areas of sediment loading. Three major structural provinces have been defined along the Texas Gulf Coast; these provinces are, from north to south, the Houston Embayment, the San Marcos Platform (or Arch) and the Rio Grande Embayment (Galloway, et al, 1982). The Bay City Plant is located in the northeastern portion of the broadly defined San Marcos Platform adjacent to the Houston Embayment (see attached Figure 3-2) (Bebout, et al, 1978). The Houston Embayment is characterized by salt diapirism with its associated faulting and large salt withdrawal sub-basins (Bishop, 1978). In contrast, the San Marcos Platform is characterized by linear belts of growth faults and associated shale ridges and diapirs, with the underlying salt being thin or absent. As the Oligocene-Holocene section thickens basinward, major fault and diapiric displacement sometimes extends upward through the unit, and deformation becomes increasingly complex. In contrast, the updip portions of progradational wedges are relatively undisturbed by faulting and diapirism.

2. Historical seismic activity in the region. (petition pages 3-3 to 3-9)

The Texas Gulf Coast is historically an area of low seismicity with naturally occurring earthquakes being rare and of low magnitude. This is demonstrated by the seismic risk map of the United States (see attached Figure 3-3, after Algermissen,

1969) and a map of earthquake locations and magnitudes in Texas (see attached Figure 3-4 , modified from Davis, et al, 1985)).

Based on historical data, the likelihood of an earthquake is considered extremely remote at the Bay City Plant. All of the earthquakes recorded within 150 miles of the plant have been of a magnitude 4.4 or less, which the petition indicates, would cause no noticeable damage to man-made structures. Therefore, the probability of an earthquake with the magnitude to damage the injection well systems appears very low.

Although earthquakes induced by fluid injection and fluid withdrawl from oilfield operations have been documented along the Texas Gulf Coast, these events were associated with much higher injection pressure and or injection/withdrawl volumes than encountered in the Bay City area from Celanese injection wells or oil production wells in the area (page 3-8). No earthquakes have been known or postulated to have resulted from relatively low volume, low pressure injection operations such as those at the Celanese Bay City plant (Davis, et al, 1987).

3. Information submitted on the regional geology.

The Texas Gulf Coast has been subjected to intensive geologic investigation and exploration for oil and gas, and mineral deposits since the early part of this century. Accordingly, the sources of geologic information for the petition include well logs from exploratory drilling and oil and gas production, and numerous publications of the Texas Bureau of Economic Geology (TBEG), and the American Association of Petroleum Geologists (AAPG). Data on the historical seismic activity were summarized from Gulf Coast Assoc. Geol. Socs., 1985. Other sources of geologic information include reports and files of the Texas Water Commission (and its predecessors), and the Texas Railroad Commission.

Regional geology is presented in Section 3.2 of the petition. Within this section are included discussions of stratigraphy, structure, and seismicity.

Important figures are as follows:

Figure 3-1 (page 3-4) - Stratigraphic Column for the Bay City Plant
Figure 3-2 (page 3-5) - Structure Contour Map on the Top of the Frio Formation
Figure 3-3 (page 3-6) - Seismic Risk Map of the United States
Figure 3-4 (page 3-7) - Earthquake Epicenters and Magnitudes in the State of Texas
Appendix 3-1 (page 3-39) - Project Reference Map
Appendix 3-2 (page 3-40) - Cross Section A-A' (West - East)

Appendix 3-3 (page 3-41) - Cross Section B-B' (North - South)
Appendix 3-4 (page 3-42) - Type Logs
Appendix 3-20 (page 3-58) - Regional Structure Maps: Approximate Top of Confining Zone

4. Does the petition contain adequate information to accurately describe the regional geology?

The petition's characterization of regional geology appears to be consistent with and to be based on extensive geologic reports from sources listed above in summary report item number 3. Collectively, these sources reflect the HSWA, 1984 standard of being "best available" sources of geologic information, which are commonly used and relied on for mineral resource exploration, injection well permit applications, and other environmental engineering projects. The study of regional geology is generally acknowledged by experts to provide a background for detailed study of local geology, and for this reason, regional geology should be considered an appropriate part of the Celanese-Bay City petition. As such, the petition's presentation of regional geology appears to be consistent with 40 CFR 148.20 and 40 CFR 148.21, which specify the necessary requirements for successful petition demonstrations.

LOCAL GEOLOGY

1. Summary of stratigraphic and structural features. (petition pages 3-16 to 3-20, and 2-9 and 2-10)

The following descriptions and characterizations of the local geology are interpretations based on the available data (primarily well logs and core studies), which are both (1) obtained from established service companies, state and federal geologic surveys, regulatory agencies, and professional geologic societies, and (2) presented in the Celanese-Bay City petition. The local stratigraphic section is depicted schematically in the attached copy of petition Figure 3-1 (page 3-4). The following summary of stratigraphy at the Celanese Bay City site is presented from the deepest (oldest) strata upward to the land surface.

The Anahuac Shale directly underlies the injection zone. This unit of calcareous shale with localized limestone units is found on well logs throughout the Texas Gulf Coast, and should be a good barrier against downward movement of fluids from the Celanese injection zone.

The Miocene section (Fleming Group) overlies the Anahuac, and contains the Celanese injection and confining zones. Although delineated in some locales into a lower formation (Oakville) and an upper formation (Lagarto), the entire Miocene is undifferentiated at the Bay City plant (page 3-17). The lower Miocene is characterized by prominent strike-oriented sandstone

belts representing barrier-strandplain depositional systems which are bounded up and down dip by finer-grained sediments (page 3-12). The upper Miocene is characterized by massive shales with thin to medium bedded sandstones, representative of cycles of sediment progradation alternating with periods of shoreline stability. (pages 3-12 and 3-14)

Conformably overlying the Miocene section are the Pliocene age sediments of the Goliad Formation, composed of interbedded fluvial and deltaic sandstones with occasional minor conglomerates (page 3-14). The Goliad Formation is roughly equivalent to the Evangeline aquifer. (page 3-14)

Conformably overlying the Pliocene age sediments of the Willis, Lissie, and Beaumont Formations which were deposited under the influence of complex glacial and interglacial sea level cycles. The Willis Formation is characterized as a fluvial and deltaic unit; the Lissie and Beaumont are predominantly fluvial. (pages 3-14 and 3-15)

The Pleistocene sediments grade conformably into the overlying Holocene depositional units (page 3-15). The combined Pleistocene and Holocene units constitute the Chicot (or Gulf Coast) aquifer. The undifferentiated Holocene section at the Bay City plant is characterized by fluvial sands and muddy floodplain deposits. (page 3-15)

Based upon the foregoing generalized summary of the localized stratigraphic section at the Celanese site, the geology of the injection and confining zones is summarized as follows. The undifferentiated Miocene section the Celanese site, contains the injection and confining zones for the waste disposal well operation. Within the injection zone, there are two injection intervals, designated as the upper and lower Miocene injection intervals. These two injection intervals, the petition indicates, are separated within the injection zone by approximately 2,000 feet of shale section with interbedded sands (Figure 3-1). WDW-14, 32, and 49 are injecting wastes into the upper Miocene injection interval, and WDW-110 is injecting wastes into the lower Miocene injection interval. When proposed waste disposal well number 5 is drilled and completed, it will also inject waste into the lower Miocene injection interval.

The lower Miocene injection interval is laterally continuous within the AOR, with a net permeable sand thickness from 150 to 250 feet (Appendix 3-9). The lateral continuity of this sand interval is also exhibited in strike and dip cross sections, Appendices 3-2 and 3-3. On this basis, an average value of 203 feet was selected as the average thickness of this unit for modeling in Section 2 of the petition (Table 2-1). The sand in this interval thins to the north and northwest of the AOR. (page 3-18)

The thick shale layer overlying the lower Miocene injection interval is composed of shale and thin sands. Within the AOR, the thickness of this shale interval ranges from approximately 150 to 250 feet (Appendix 3-10). Also, it is interpreted to be laterally continuous as shown in the strike and dip cross sections (Appendices 3-2 and 3-3). The layer is approximately 75% shale with generally non-continuous sand strata intermixed (Appendix 2-7).

The upper Miocene injection interval is interpreted to be laterally continuous over the AOR, with a net permeable sand thickness ranging from less than 50 feet, northwest of the plant site, to over 250 feet east of the plant (Appendix 3-11). The strike and dip cross sections display the lateral variation in sand thickness in this interval around the Celanese plant. Based on this data, an average value of 165 feet was selected as the average thickness of the upper injection interval for use in the modeling in Section 2 of the petition. (Table 2-1)

Immediately above the top of the upper Miocene injection interval is a shale layer approximately 50 to 75 feet thick, which is part of the permitted injection zone (Appendix 2-7). According to the petition's modeling, this shale layer is the unit into which the upward waste movement at the site will occur (due to various transport processes), and in which the waste will be contained for 10,000 years (page 3-20). Since this predominantly shale unit is based on regulatory terminology, and is not specifically defined as a stratigraphic unit based on time markers, it has not been mapped as a specific unit in the petition.

The confining zone is located immediately above the top of the permitted injection zone, and is predominantly shale with minor discontinuous sand lenses (page 3-20). The thickness of the confining zone ranges from approximately 375 feet to 450 feet within the AOR (Appendix 3-12). The lateral continuity of the confining zone is exhibited in the strike and dip cross sections (Appendices 3-2 and 3-2). The confining zone is approximately 90% shale with continuous and discontinuous sand units interspersed. This zone is the principal confining zone for the Celanese Bay City site, since all waste injection takes place below this zone, and according to the petition's modeling, all upward waste movement at the site will be contained in the permitted injection zone below this confining zone.

The Bay City Plant is located in the broadly defined San Marcos Platform bordering the Houston Embayment. The major structural style in the San Marcos Platform is linear belts of growth faults associated with shale ridges and diapirs, while the Houston Embayment is characterized by salt diapirism and associated faulting and deformation (page 3-16). The region surrounding the plant exhibits features from both structural provinces. Linear belts of growth faults dominate the structural style at the Frio structural level (see Figure 3-2), with

regional dip being to the south, southeast at approximately 100 to 150 feet per mile. (page 3-16)

The only fault effecting the Miocene section in the AOR is a small, discontinuous fault located northwest of the plant site on the AOR boundary. The displacement on this fault is less than 50 feet, and only the lower portion of the Miocene section is affected as shown on Appendices 3-5 and 3-6, and Figure 3-5a. The presence of this fault is judged in the petition, to be inconsequential with regard to flow and containment of injected waste, because the waste plume will only reach the location of this fault near the end of the 10,000-year time frame, and in a worst case, the waste could only move up the fault plane to the point at which the fault dies out (below a subsurface depth of 5,000 feet). Therefore, in a worst case, the waste would still be confined nearly 2,000 feet below the top of the permitted injection zone. (pages 3-16, 3-16a, and 3-16b)

Further, undiscovered faults and fractures should not affect the integrity of Gulf Coast confining layers when operating pressures are maintained within permitted limits. As described in petition pages 2-9 and 2-10, Gulf Coast shales are known to exhibit viscoelastic deformational behavior (Aumman, 1966), (Neuzil, 1986), which causes any natural fractures present to close very rapidly under the action of the in-situ compressive stresses (Bowden and Curran, 1984), (Collins, 1986). Evidence of this rapid fracture closure is often encountered while drilling and running casing (Johston and Knape, 1986), and (Clark, Howard, and Sparks, 1987). Further, old abandoned boreholes have been observed to heal across shale sections to the extent that reentering them requires drilling a new hole (Clark, Howard, and Sparks, 1987). Petition Appendix 2-5, titled "Effect of Gulf Coast Faults on Containment of Injected Liquid Wastes", identifies the conditions governing potential fluid migration along faults. Based on these references from the literature, the vast majority of Gulf Coast faults are very unlikely to be vertically transmissive over large distances at the depths of concern to underground injection processes.

In addition to the growth faults, there is some salt diapirism in the area, with the closest salt dome (Markham Dome) being approximately 10 miles north of the Bay City Plant (page 3-16). At this distance, Markham Dome will not exert adverse influence on the injection zone as a contained waste disposal reservoir.

Within the AOR, the major structural feature is a low relief, structural nose plunging to the east (see Appendices 3-1 to 3-16). The structural nose is present at all structural levels from the Anahuac through the injection and confining zones (Miocene section). The genesis of this structural feature is interpreted to be related to a post-depositional deep seated salt or shale movement (page 3-16)

2.

Zones	Depths (Subsurface in feet)*	Formation(s)
Base of lowermost USDW	1,300	(Chicot Aquifer)
Confining zone	2,900 to 3,300	Miocene
Injection zone	3,300 to 5,950	Miocene Upper
Injection interval	3,350 to 3,600	Miocene Lower
Injection interval	5,700 to 5,950	Miocene

* Depths are approximate measured log depths, as shown on Figure 3-1 (page 3-4), and taken from Type Log (map ID #9) in Appendix 3-4 (page 3-42).

3. Information submitted on the local geology

The petition's coverage of local geology is based largely on maps and cross sections constructed by E. I. duPont de Nemours Environmental Management Services, from well logs including the four Celanese injection wells, and from literature published by the Texas Bureau of Economic Geology (TBEG), the Texas Railroad Commission, the Texas Water Commission (or its predecessors), the American Association of Petroleum Geologists, and from Core Labs and other consulting and service companies.

Local geology is presented in Section 3.3 of the petition. Within this section are discussions of injection and confining zone stratigraphy and structure.

Important figures and tables are as follows:

Figure 3-5a - Cross Section of Small Lower Miocene Fault
Appendix 2-7 - Type Log
Appendix 2-13 - Plume Extent in Upper Miocene Injection Sand
Appendix 2-14 - Plume Extent in Lower Miocene Injection Sand
Appendix 2-15 - Modeled Layers Stratigraphic Cross Section A-A'
Appendix 2-16 - Modeled Layers Stratigraphic Cross Section B-B'
Appendix 3-4 - Four Type Logs
Appendix 3-5 - Structure Map: Top of Lower Miocene Injection Interval
Appendix 3-6 - Structure Map: Top of Lower Miocene Shale Layer
Appendix 3-7 - Structure Map: Top of Upper Miocene Injection Interval
Appendix 3-8 - Structure Map: Top of Upper Miocene Confining Zone
Appendix 3-9 - Net Sand Isopach: Lower Miocene Injection Interval
Appendix 3-10 - Gross Interval Isopach: Lower Miocene Shale Layer
Appendix 3-11 - Net Sand Isopach: Upper Miocene Injection Interval
Appendix 3-12 - Gross Interval Isopach: Upper Miocene

Confining Zone
Appendix 3-13 - Base of Lowermost Potentially Usable Source of Drinking Water (USDW)
Appendix 3-14 - Gross Interval Isopach: Base of USDW to Top of Upper Miocene Confining Zone
Appendix 3-15 - Net Shale Isopach: Upper Miocene Confining Zone
Appendix 3-16 - Gross Interval Isopach: Permitted Injection Zone (WDW-110)

4. Verification of geologic information in the petition (petition page 7-12)

References listed on petition pages 3-34 to 3-36 were checked and determined to be predominantly from the Texas Bureau of Economic Geology, the American Association of Petroleum Geologists, the Texas Water Commission (or its predecessors), and core study reports by a variety of service companies. Oil and gas well records and records of exploratory drilling were obtained chiefly from the files of the Texas Railroad Commission. These literature sources are commonly used as the geologic basis for siting and development of injection well projects in Texas. Maps and cross sections prepared by the E. I. duPont de Nemours Environmental Management Services team, were verified from well logs submitted as Appendix 4-15 of the petition.

Verification of porosity and permeability data, and other parameters used in modeling are discussed in the Hydrology section of this summary report. It therefore appears that the petition comprises the best available analysis of geologic conditions in the area of the Celanese-Bay City injection wells. (40 CFR 148.20 and 40 CFR 148.21)

5. Comparison of geologic data with data used in the model (petition pages 2-81b)

This section of the summary report addresses the relation of geologic layer thickness to the actual model input. Other parameters used in modeling are detailed in the Hydrology section of this report. (page 2-81b)

The Celanese-Bay City petition model uses a 16-layer system, as detailed in Table 2-1 and Appendix 3-4. Layer thickness determination was based primarily on geophysical logs of the Celanese injection wells, plus logs of two additional oil and gas test wells.

In order to demonstrate the relationship between model layers and the geologic strata in the vicinity of the Bay City Plant, two stratigraphic cross sections were constructed. The cross sections are located in Appendix 2-15 (north-south) and Appendix 2-16 (west-east), with the location of the sections depicted on the waste plume location maps in Appendices 2-13 and 2-14. The model layers may be compared with the actual geologic strata in

the cross sections and the type logs in Appendix 3-4. In making comparisons between geologic strata and modeling layers, the petition states that the model layers are idealized units alternating between either all shale or all sand. In general, the log-indicated net thickness of noncharacteristic sediments in a layer, i.e., sand or shale, was added to the underlying layer to obtain layer thicknesses for model input. However, layers labeled as overlying confining shales and injection sands, were kept intact (no additional shale or sand was added from adjacent layers). The thickness of each model layer is represented to be an average thickness over the areal extent of the layer; these model layer thicknesses are based primarily on the geology close to the injection wells but are adjusted to reflect the geology within the AOR. (page 2-81b)

The thickness of the injection sands and confining shales, and their lateral extent, are key questions in the petition review (40 CFR 148.21). The cross sections demonstrate the continuity of the injection sands and overlying confining shales within the area. The thicknesses of the injection sands vary across the area, but the model injection sand layers depict an average thickness over the AOR. Considering the idealized nature of the model layers, they correspond reasonably to the actual strata at the site. (40 CFR 148.21)

6. Conservative estimation of all non-site specific parameters (petition pages 2-15 to 2-25d)

There is no recorded site-specific information for the following parameters: 1) shale layer (confining layer) porosities 2) shale layer permeabilities, 3) fluid viscosity in shale layers, and 4) rock compressibility for all layers (sand and shale). The values for rock compressibility, shale porosity, and shale permeability were conservatively estimated from published and unpublished studies (see Tables 2-3a and 2-3b, pages 2-25c and 2-25d, and 40 CFR 148.21). The fluid viscosity in the shale layers is estimated from the viscosity value from the closest sand layer. (Refer to the Hydrology section of this summary report.)

7. Does the petition contain adequate information to accurately describe the local geology?

The petition's characterization of the local geology appears to be consistent with and to be based on extensive geologic reports by established oil field service companies, state and federal geologic surveys (Texas Bureau of Economic Geology and the U. S. Geologic Survey), regulatory agencies (the Texas Water commission and the Texas Railroad Commission), and various professional geologic societies. Collectively, these sources reflect the HSWA, 1984 standard of being "best available" sources of geologic information, which are commonly used and relied on by experts in the field for mineral resource exploration, injection well permit applications, and other environmental engineering

projects. Using these sources, the petition's coverage of the local geology appears to itself comprise the best available report on the local geology of the Celanese plant area, in the context of injection well operations. As such, the petition's section on local geology appears to be consistent with 40 CFR 148.20 and 40 CFR 148.21, which specify the necessary requirements for successful petition demonstrations.

HYDROGEOLOGY

1. Hydrogeology of the injection and confining zones.

Lower Miocene Injection Interval/Confining Zone (pages 3-17 and 3-18)

The lower Miocene injection sand interval was deposited in a shoreline or beach-barrier island depositional environment and is interpreted to be in the Oakville or lower half of the undifferentiated Miocene section at the site (page 3-17). Within the Area of Review (defined by a 2.5 mile radius circle around the injection wells), the injection sand is laterally continuous with a net permeable sand thickness ranging from approximately 150 feet to 250 feet (see Appendix 3-9). The lateral continuity of the sand is also exhibited in the strike and dip cross sections (see Appendices 3-2 and 3-3). On this basis an average value of 203 feet was selected as the average thickness of this unit for the modeling in Section 2 of this petition (page 3-18). It should be noted that the sand does begin to pinchout to the north and northwest of the Area of Review.

Porosity and permeability values for this unit were obtained from core samples taken in WDW-110 (Core Labs, Inc., 1973, included in petition as Appendix 2-9) The average porosity of the injection sand is 32.2% and the average permeability to air is 1606 millidarcies (page 3-18). A porosity and permeability of 32% and 1300 millidarcies were selected as the average values of this unit for the modeling in Section 2 of this petition (the downward adjustment of permeability is described in Section 2). Copy of the original core report is contained in Section 2 of the petition (see Appendix 2-9). Based on core lithology descriptions, the injection sand is fine to medium grained with minor calcareous intervals. Based on x-ray diffraction of two core samples from this sand it has: 1) a quartz content ranging from 65% to 71%, 2) feldspar content ranging from 5% to 9%, 3) mixed layer clay content from 16% to 30%, and 4) a calcite and kaolinite content averaging 0.5% and 1.5% respectively (Halliburton Chemical Laboratory, 1973).

A chemical analysis of the lower Miocene formation fluid has been performed and the data is included in Section 6 of this petition (see Table 6-25).

The thick shale layer overlying the lower Miocene injection sand is composed of shales and sands interpreted to also be part of the Oakville or lower half of the undifferentiated Miocene section at the site. Within the AOR, the thickness of this shale layer ranges from approximately 150 feet to 250 feet (see Appendix 3-10). Also, it is laterally continuous as shown in the strike and dip cross section (see Appendices 3-2 and 3-3). The layer is approximately 75% shale with generally non-continuous sand units intermixed. (page 3-18)

Upper Miocene Injection Interval/Confining Zone (pages 3-19 and 3-20)

The depositional environment of the upper Miocene injection interval is interpreted to have been nearshore marine to non-marine, and similar to the lower Miocene injection interval (page 3-19). The top of the upper Miocene injection interval is approximately 2,400 feet above the top of the lower Miocene injection interval, and is interpreted in the petition to be part of the Lagarto or upper half of the undifferentiated Miocene section at the site. The upper Miocene injection interval is laterally continuous over the AOR with a net permeable sand thickness ranging from less than 50 feet, northwest of the plant site, to over 250 feet east of the plant (see Appendix 3-11). The strike and dip cross sections display the lateral variation in sand thickness in the area surrounding the Bay City Plant. Based on this, an average value of 165 feet was selected as the average thickness of this unit for use in modeling in Section 2 of this petition (page 3-19).

The physical properties of the injection sand have been determined from whole and sidewall core samples taken from WDW-8, 14 and 32 (Appendix 2-9). The average porosity from all core samples is 33.3%, with a range from 35.4% in WDW-8 to 30.1% in WDW-14 (page 3-19). Based on this, an average value of 33% was used as the porosity of this unit in modeling in Section 2 of this petition. Copies of the original core reports for these wells are contained in Section 2 of the petition (see Appendix 2-9). The permeability values range from 854 millidarcies in WDW-8 to 161 millidarcies in WDW-14. The permeability obtained from WDW-32 (465 millidarcies) lies between the preceding values. Another source of permeability data is the analysis of pressure tests in WDW-14 and WDW-49, where permeability is expressed as a product of permeability and injection sand thickness (kh) (Collins, 1975). If an injection sand thickness of 165 feet is used, then the permeability values for WDW-14 and WDW-49 are 1394 and 1364 millidarcies, respectively (page 3-19). Based on this, an average value of 1350 millidarcies was selected as the average permeability of this unit in the modeling in Section 2 of this petition. The permeability values obtained from pressure tests are generally considered to be more reliable than core measurements because pressure tests occur under subsurface conditions with formation fluids (page 3-20).

The exact mineralogical composition of the upper Miocene injection sand has not been determined, but based on tests of core samples from WDW-8, the injection sand has significant clay content (Appendix 2-9). The overall composition of the sand is probably similar to the lower Miocene injection sand (deposited in similar environments) with a somewhat higher clay content(page 3-20).

A chemical analysis of the upper Miocene formation fluid has been performed and the data is included in Section 6 of this petition (see Tables 6-26 and 6-27).

Immediately above the top of the upper Miocene injection interval is a shale layer approximately 50 - 75 feet thick that is part of the permitted injection zone (Type Log, Appendix 2-7). This is the shale layer into which the upward waste movement at the site (due to the various transport processes) will be contained for 10,000 years. Page 3-20 of the petition notes that since this containing unit is based on the regulatory and permitting terminology and is not a specifically defined geological unit based on time markers, it has not been isolated and mapped as a specific unit.

The confining zone is located immediately above the top of the permitted injection zone and is predominately shale with minor discontinuous sand lenses (page 3-20). These sediments are interpreted in the petition to be also part of the Lagarto or upper half of the undifferentiated Miocene section at the site. The thickness of the confining zone ranges from approximately 375 feet to 450 feet within the AOR (see Appendix 3-12). The lateral continuity of the confining zone is exhibited in the strike and dip cross sections. The confining zone is approximately 90% shale with continuous and discontinuous sand units interspersed, and this is the principal confining unit for the site since all injection at the Bay City Plant takes place below this geologic unit, and all upward waste movement at the site should be contained in the permitted injection zone below this confining unit (see section of this summary report covering modeling).

2. Numerical values used in calculations
(pages 2-17, 2-19, 2-96, and 2-98, and attached Table 2-1)

Q = Injection rate (bbls/day)

T = Transmissivity (mdft)
S = Storage coefficient
t = Time since injection began (hours)
u = viscosity (centipoise)
K = Reservoir permeability (millidarcies)
b = Reservoir thickness (ft)
c = Compressibility (psi^{-1})
o = porosity (decimal)

The values used in the modeling for viscosity, permeability, thickness, compressibility and porosity are displayed in Table 2-1, page 2-17. The historical monthly injection rates (in gallons per minute) for injection through the end of 1987 are displayed in Appendix 2-8, page 2-96. The yearly injection rate (gallons per minute) for the average and maximum injection cases through the year 2000 are displayed in Appendix 2-10, page 2-98 (see yearly job files, average and maximum permitted injection rates). The transmissivity values for the upper and lower injection intervals, as derived from reservoir tests, are 225,000 and 268,268 millidarcy feet, respectively (see Table 2-2, page 2-19). The storage coefficients derived in the model for the upper and lower injection intervals are 0.0004291 and 0.0005253, respectively (see derived parameters in the computer printouts from modeling, Appendix 2-10, page 2-98).

RESERVOIR HEAD/PRESSURE (ft/psi): (pages 2-24 & 2-25)

1) upper injection interval original formation pressure at 3440 feet BGL (below ground level) was 1554 psi, calculated from a drill stem test on WDW-8.
2) lower injection interval original formation pressure at 5793 feet BGL was 2631 psi, determined by a pressure measurement in WDW-110.

Method used to determine the reservoir head/pressure: (pages 2-14 and 2-25)

The original formation pressure in the upper injection interval was derived from drill stem test data and bottom hole pressures reported in the area (page 2-24). The original formation pressure in the lower injection interval was determined from a bottom hole pressure measured in WDW-110, prior to the start of injection (page 2-25).

LOWERMOST USDW HEAD/PRESSURE (ft/psi): 1350 feet (estimated)

Method used to determine the lowermost USDW head/pressure:

There are no data currently available on the pressure head of the lowermost USDW at the Bay City plant site, since the lowermost aquifers have not been utilized for water supply. However, publications of the TBEG and TDWR/TWC indicate that the Evangeline Aquifer system has hydrologic continuity with the aquifer sand outcrops, and that the system is not abnormally pressured. Consequently, it is a reasonable assumption to place the potentiometric surface of the aquifer sands at or near ground level (1350 feet of head). Water with a TDS of 10,000 ppm would have a density of approximately 1.007, which would result in a BHP at 1350 feet BGL of 589 psi.

OTHER ZONES HEAD/PRESSURE (ft/psi):

Aquifer	Depth	Head	Reference
Chicot	200-700	9 BGL	(Figure 3-7, page 3-25)
Chicot	300-1000	17 BGL	(Figure 3-8, page 3-26)

3. Information submitted on the hydrogeology of the injection and confining zone. (pages 2-15 to 2-25d, 3-17 to 3-20)

Appendix 2-9 - Laboratory Results (Core Reports)
Appendix 3-4 - Type Logs
Appendix 3-5 - Structure Map: Top of Lower Miocene Injection Interval
Appendix 3-6 - Structure Map: Top of Lower Miocene Shale Layer
Appendix 3-7 - Structure Map: Top of Upper Miocene Injection Interval
Appendix 3-8 - Structure Map: Top of Upper Miocene Confining Zone
Appendix 3-9 - Net Sand Isopach: Lower Miocene Injection Interval
Appendix 3-10 - Gross Interval Isopach: Lower Miocene Shale Layer
Appendix 3-11 - Net Shale Isopach: Upper Miocene Injection Interval
Appendix 3-12 - Gross Interval Isopach: Upper Miocene Confining Zone
Appendix 3-13 - Base of Lowermost Potentially-Usable Source of Drinking Water (USDW)
Appendix 3-14 - Gross Interval Isopach: Base of USDW to Top of Upper Miocene Confining Zone
Appendix 3-15 - Net Shale Isopach: Upper Miocene Confining Zone
Appendix 3-16 - Gross Interval Isopach: Permitted Injection Zone, WDW-110
Section 2, Reference 36 - Halliburton, 1964 (Drill Stem Test Report for WDW-8)
Section 2, Reference 40 - Funk, R. J., 1972 (Report to TWQB on Bottom Hole Pressures at Celanese-Bay City Plant)
Section 2, Reference 41 - Cooke, M. M., 1973, (Bottom Hole Pressure Survey for WDW-110)

4. Verification of the petition's hydrogeologic information on the injection and confining zones. (pages 7-12 and 7-13)

Much of the information provided was determined from published literature or field evidence (laboratory tests, pressure tests and measurements). Interpretation of the available data was performed by E. I. du Pont de Nemours Environmental Management Services and other reliable consultants and service companies. Maps and cross sections prepared for Celanese-Bay City by the duPont team were verified from well logs submitted as Appendix 4-15 of the petition. These sources of

information are commonly used and relied on by experts in the field for both petroleum engineering applications and for injection well projects. It appears that the petition represents the best available presentation of the local geohydrology, in the context of injection well operations.

5. Comparison of actual hydrogeologic data with data used in the simulator, and conservative estimation of all non-site specific parameters. (pages 2-25a, 2-25b, 2-25c [Table 2-3a], and 2-25d [Table 2-3b])

The actual hydrogeologic data compares very favorably to the parameters used in the model. The actual value was used in the modeling whenever available and judged appropriate for modeling.

There is no recorded site-specific inbformation for the following parameters: (1) shale layer [confining layer] porosities, (2) shale layer permeability, (3) fluid viscosity in shale layers, and (4) rock compressibility for all layers [sand and shale]. The values for rock compressibility, shale porosity, and shale permeability were conservatively estimated from published and unpublished studies (see Table 2-3a [page 2-25c] and Table 2-3b [page 2-25d] and 40 CFR 148.21).

6. Comparison between actual data and simulator data. (pages 2-25c and 2-25d)

The actual data and model parameters were compared in table form (see Tables 2-3a and 2-3b).

7. Does the petition contain adequate information pursuant to 40 CFR 148.21 to describe the hydrogeology of the injection and confining zones to a reasonable degree of certainty?

The petition's presentation of the geohydrology of the site appears to be consistent with and to be based on logs, core studies, field test data and reports by established service companies and consultant groups, state and federal geologic surveys, regulatory agencies, and various professional geologic societies. Collectively, these sources constitute the best available geohydrologic information for the site area, in the context of injection well operations. The identified sources of the petition's geohydrologic information are among those commonly used and relied on by experts in the field. As such, the petition's presentation of the geohydrology of the site appears to be consistent with 40 CFR 148.20 and 40 CFR 148.21, which specify the necessary requirements for successful petition demonstrations.

GEOCHEMISTRY

1. Geochemistry of the injection and confining zones.

The petition's information on geochemistry includes the following:

1) Formation Fluid Analysis	discussion follows
2) X-Ray Diffraction Studies	answered previously see HYDROGEOLOGY question #1
3) Core Reports	answered previously see HYDROGEOLOGY question #1

Formation Fluid Analysis - Upper and Lower Miocene (pages 6-38 & 6-39)

Chemical analyses of the formation water for the upper Miocene injection interval (1969) and lower Miocene injection interval (1976) are presented in Section 6 of the petition.

In the 1976 analyses samples of the lower Miocene injection interval fluid were obtained from three 55-gallon lined drums containing the fluid samples (page 6-38). These drums of formation fluid were obtained during the drilling of WDW-110 in the second quarter of 1973. The chemical analyses of the lower Miocene fluid samples are shown in Table 6-25.

As can be seen from the chloride analysis of all three samples, the formation water has a high salinity concentration. Sample II, while identical with Samples I and III on chlorides, differs significantly in total suspended and volatile solids, organic carbon, and color. It is believed that this particular sample was contaminated since all three samples were taken at the same point in the formation (page 6-39). Chemical analyses of the upper Miocene formation fluid were done in 1969 and the results are shown in Table 6-26.

Formation Fluid Properties - Upper Miocene (page 6-40)

As part of an engineering study (Core Labs, 1964), the characteristics of the formation fluid of the upper Miocene injection sand were also analyzed and reported in Table 6-27.

Formation Fluid Viscosity and Density (page 2-21 to 2-23)

Formation fluid viscosity has been reasonably determined from the sodium chloride concentration and the formation temperature. The formation temperatures for the injection sands were derived from temperatures recorded during drill stem tests, bottom hole pressure tests and temperature surveys. Based on this data, the formation temperatures for the upper and lower Miocene injection interval are 113°F and 137°F, respectively (page 2-21). Fluid samples recovered in WDW-110 from the lower Miocene injection interval contained 134,500 ppm sodium chloride (page 2-21).

Fluid samples from the upper Miocene injection sand averaged 83,000 ppm sodium chloride (page 2-23).

Using the above values, the viscosities for the upper and lower Miocene injection interval fluids are 0.71 centipoise (cp) and 0.64 cp, respectively (page 2-23). The formation fluid viscosities for the non-injection sand layers and shale layers were extrapolated from the injection interval fluid viscosities (pages 2-23).

The densities of the formation fluids have been determined from formation temperatures and salinities. Based on the above values, the density of the formation fluid in the upper Miocene injection interval is approximately 1.045 gm/cc (page 2-23). The formation fluid in the lower Miocene injection interval has a density of approximately 1.067 gm/cc (page 2-23).

The range of density for the waste being injected into the upper Miocene injection interval is from 1.0012 gm/cc to 1.0034 gm/cc. The average density of waste injected into the lower Miocene injection interval is approximately 1.00155 gm/cc (page 2-23). In both injection sands the formation fluid is denser than the injected waste, therefore the waste would tend to rise towards the top of the injection sand (page 2-23).

2. Information submitted on the geochemistry of the injection and confining zones. (pages 2-21 to 2-23, 3-17 to 3-20, and 6-38 to 6-40)

Important tables and referenced reports on the geochemistry of the injection and confining zones are as follows.

Table 6-25 - Lower Miocene Fluid Analyses, Celanese Bay City Plant
Table 6-26 - Chemical Characteristics of the Upper Miocene Formation Fluid, Celanese Bay City Plant
Table 6-27 - Fluid Properties - Upper Miocene Injection Sand, Celanese Bay City Plant
Appendix 2-9 - Laboratory Results (Core Reports)

3. Verification of geochemical information on the injection and confining zones.

Answered previously- see LOCAL GEOLOGY question #4

4. Comparison of geochemical data with the data used in the simulator, and conservative estimation of all non-site specific parameters.

Question answered previously-see HYDROGEOLOGY question #5 and LOCAL GEOLOGY question #5.

5. Methods used for the comparison of hydrogeologic data and simulator input.

Question answered previously-see HYDROGEOLOGY question # 6.

6. Does the petition contain adequate information pursant to 40 CFR 148.21 to describe the geochemistry of the injection and confining zones to a reasonable degree of certainty?

The petition's presentation of geochemical information for the injection and confining zones appears to be consistent with and to be based on core studies, field test data, and reports from established well service companies and consultant groups. Collectively, these sources are the best available for the petition area, and are the types of information commonly used and relied on by experts in the field of petroleum engineering and injection well projects. Therefore, the petition's presentation of the geochemistry of the injection and confining zones appears to be consistent with 40 CFR 148.20 and 40 CFR 148.21, which specify the necessary requirements for successful petition demonstrations.

CHARACTERISTICS OF INJECTED FLUIDS

1. Chemical and physical characteristics of the injected fluid.

Answered previously in section "WASTE PROPOSED TO BE EXEMPTED FROM LAND BAN RESTRICTIONS".

2. Compatibility of the injected fluids with the:
(a) injection zone and confining zone rock materials;
(b) injection zone and confining zone fluids; and
(c) well materials.

(a) Laboratory tests were done at the Bay City Plant where core material from the injection zone was exposed to the injected waste fluids. The tests indicated no significant compatibility problems exist at the Bay City Plant. This conclusion has been validated by the successful injection operations at the site from 1964 to present. (6-2 to 6-22)

(b) Injected fluids were indirectly tested for compatibility with formation fluids by flowing the injected waste through formation fluid saturated core plugs and measuring permeability reductions. No substantial incompatibilities were expected based on these tests. (6-2 to 6-22)

(c) Well material compatibility tests prove that adequate materials of construction were selected for both the "acid" and "neutral" injection wells. Properly selected materials of construction will minimize corrosion, reduce maintenance and repairs, provide for smooth operations and ensure a sound well design. All of these are important factors which will assure safe and efficient operations of the injection

system. Laboratory tests were done on various materials of construction at the Bay City Plant and no well materials compatibility problems were expected based on these tests. (6-22 to 6-33)

3. Information submitted on the chemical/physical characteristics of the injected fluids and compatibility of waste streams with rocks and fluids of the injection and confining zones and the well materials.

Petition text pages 6-1 through 6-40, and Tables 6-1 through 6-27 were submitted to describe chemical/physical characteristics of the injected fluids and compatibility.

4. Verification of chemical/physical and compatibility information for injected fluids.

Compatibility has been demonstrated over time by a history of safe, successful injection operations at the site from 1964 to the present. Also, the original data from laboratory reports has been included in the "Selected Petition References" Petition volume. (page 6-1)

5. Comparison of waste stream data with simulator input, and conservative estimation of non-site specific parameters.

There are no inputs to the model for waste characteristics. The model assumes that the density and viscosity of the waste and formation fluid are the same. However, variations in density are accounted for in the Plume Model by the "M" factor and in the Pressure Model by other means. See Discussion under COMPUTER SIMULATOR OR CODE Question # 7. (pages 2-81a and 2-81b)

Density Effects

The assumption has been made in both the Basic Plume Model and the Multilayer Pressure Model that the formation fluid and the waste have the same density. The density of the waste and formation fluid are not the same at the Bay City Plant. Miller, et al, (1986) studied the magnitude of the effect of density variations on the models. It was demonstrated that the influence of density variations can be included within the Basic Plume Model through the use of the multiplying factor. The effect of the density variations on the pressure distribution was also addressed. The pressure effect approaches zero at the center of the injection sand or interval, and remains small within the waste plume. The pressure effect is no greater than the product of the density difference (gm/cc) and half the injection sand or interval height (feet), with the effect expressed in psi. Using the lower Miocene injection sand as an example, the maximum pressure effect would be less than 3 psi within the waste plume. The pressure effect in the upper Miocene injection sand would be even less due to a smaller density contrast. Outside the waste

plume, the pressure effect would rapidly decrease and, therefore, have little influence on the pressure distribution. It is important to note that model pressure matching is achieved at the midpoint of the injection sands where the density effect is near zero. (2-81a)

6. Methods used for comparison of waste stream data with simulator input data?

See COMPUTER SIMULATOR OR CODE Question # 5

7. Does the petition contain adequate information pursuant to 40 CFR 148.21 to describe the chemical/physical characteristics and compatibility of the injected fluids to a reasonable degree of certainty?

The petition's presentation of information on the chemical and physical characteristics and compatibility of the injected fluids is based on tests performed on well cores, the Celanese injected waste streams, injection interval fluids, and the well materials of construction. Collectively, these sources constitute the best available information on the Celanese-Bay City injection fluids and their possible interactions with both the rock matrix and fluids of the injection zone and with the well materials of construction. The petition's presentation of this information appears to be consistent with 40 CFR 148.20 and 40 CFR 148.21, which specify the necessary requirements for successful petition demonstrations.

JUSTIFICATION OF ASSUMPTIONS REQUIRED FOR MODEL VALIDITY

The Flow and Containment Model used in the Celanese-Bay City Plant petition makes the following assumptions (page 2-89):

a) No barriers (faults or pinchouts) exist within the AOR that significantly effect fluid flow.
b) Properties and thicknesses of the layers do not vary greatly with position, a single value for each parameter can adequately represent the layer.
c) Flow is horizontal in the high permeability layers, and vertical in the low-permeability layers.
d) Density of the waste and formation fluid are equal.

The following justifications, a. through d., are referenced to the above-listed assumptions of corresponding designation:

a) Detailed geologic mapping and analysis indicate no barriers of significance were identified within the AOR.

b) The thickness of layers was evaluated through detailed mapping and cross sections. Successful calibration (pressure matching and waste encounters or

non-encounters) of the models demonstrates that all the parameters can be adequately represented by a single value.

c) The permeability contrast between the sand and shales in the area assure that horizontal flow in the sands will be the dominant component of waste movement. Each successive sand above the injection interval will serve to bleed off or dissipate the pressure drive for subsequent waste movement into the adjacent overlying shale. Although a component of horizontal waste movement will exist in a shale, the overriding concern for "no-migration" demonstrations is the distance of vertical travel of waste through a confining shale (40 CFR 148.21). Appendix 2-2 of the petition cites Neuman and Witherspoon, 1969, in justifying the assumption in question, whenever the permeability of the high permeability layer is at least 100 times greater than that of the adjacent aquitards (shales). Such condition is virtually always satisfied at Gulf Coast underground injection sites.

d) Differences in the density of the waste and formation fluid have only a minor impact on the pressure model (see page 2-81a) and the use of the multiplying factor in the plume model accounts for the difference. The multiplying factor's use in the plume model also accounts for the variations in permeability within the injection intervals (for a detailed discussion see Miller, et al. (1986) in Section 2 References). There are no inputs to the model for waste characteristics. The model assumes that the density and viscosity of the waste and formation fluid are the same. However, variations in density are accounted for in the Plume Model by the "M" factor and in the Pressure Model by other means. See Discussion under COMPUTER SIMULATOR OR CODE Question # 7.

COMPUTER SIMULATOR OR CODE

1. Name of simulator.

Five simulators were used: The Basic Plume Model, the Multilayer Vertical Permeation Model, the Flow Resistance Model, the Multilayer Pressure Model, and the Molecular Diffusion Model. (p. 2-4, 2-7, 2-11, 2-12, 2-74; Appendices 2-11, 2-12)

2. Name of developer.

The simulators were developed by Chet Miller, E. I. du Pont de Nemours & Company Incorporated.

3. Brief summary of the simulator.

Basic Plume Model

The Basic Plume Model, which was introduced in Miller, et al, (1986), calculates the time-dependent lateral movement of the waste plumes during injection. It is set up as a single layer calculation, which neglects the vertical exchange of fluids between geologic strata. Therefore, a separate calculation is required for each layer into which waste is injected. The model includes the effects of multiple well interactions.

The Basic Plume Model accounts for the effects of geologic non-uniformities within the injection stratum by means of a multiplying factor concept. (p. 2-4)

Multilayer Vertical Permeation Model

The Multilayer Vertical Permeation Model is used to predict the distance of vertical waste movement due to convection within the injection zone. This model is an extension of an earlier development presented by Miller, et al, (1986), that includes the effects of multilayer stratigraphy and aquitard compressibility.

The Multilayer Vertical Permeation Model actually consists of two submodels that perform separate calculations for each of two time frames. The Short Term Submodel focuses on the injection period, and includes the effects of compressive fluid storage in the aquitard layers. The Long Term Submodel calculates the residual seepage obtained at very long times in the future. (p. 2-7)

Flow Resistance Model

The Flow Resistance Model, which calculates the critical injection zone pressure required to initiate displacement of fluid from an abandoned borehole, was originally developed by Barker (1981). This model is an expression of the force balance between: (1) the weight of the fluid column in the borehole and (2) the pressure force at the base of the fluid column. The model neglects flow resistance due to drilling mud gel strength. (p. 2-11, 2-12)

Multilayer Pressure Model

The Multilayer Pressure Model is used to calculate the pressure distribution within the injection formation. The model is an extension of an earlier methodology presented by Miller, et al, (1986) that was based on the Theis (1935) equation. The enhanced approach recognizes the multilayer nature of the subsurface and

the ability of the various permeable strata to communicate with one another, both by seepage through the aquitards and by crosstalk through wellbores perforated into multiple horizons. The model neglects the ability of the aquitard layers to compressively store fluids. (p. 2-12)

Molecular Diffusion Model

The Molecular Diffusion Model is used to predict the amount of vertical movement of a contaminant species due to molecular diffusion during the 10,000 year post-operational period. The model is based on the "complementary error function" solution to Fick's Second Law of diffusion, presented by Freeze and Cherry (1979).

The model calculates the concentration profile of any prescribed contaminant species within the overlying aquitard layer. This profile is calculated for the vertical region above the leading edge of the waste front that is advancing due to convection. (p. 2-74; Appendix 2-11, p. 3)

4. <u>What information submitted in the petition was reviewed to determine the nature and suitability of the simulator for the injection activity?</u>

Documentation of the theory and implementation of the simulators was reviewed. (p. 2-4, 2-7, 2-11, 2-12, 2-74; Appendices 2-1, 2-2, 2-3, 2-11, 2-12)

5. <u>How was it determined that the simulator was/was not suitable for the injection activity?</u>

The programs were developed specifically for injection well modeling for no-migration demonstration.

6. <u>How was the simulator verified/validated?</u>

The Basic Plume Model results were favorably compared to an analytical solution by Muskat (1946) and numerical solutions by Collins (1961) and Javandal, et al, (1984). (p. 2-81a; Appendix 2-1, p. 28 through 30)

The Vertical Permeation Model results were compared to hand calculations for specific pressure histories and to an analytic solution presented in Miller, et al, (1986). (Appendix 2-3, p. 26 through 28)

The Flow Resistance Model performs a simple hydrostatic pressure calculation. Therefore, verification of the solution of the equation was not discussed. (p. 2-11, 2-12)

The Multilayer Pressure Model results were compared to the work of Theis (1935), Hantush and Jacob (1955), Hunt (1985), and Bear

(1972). It was found to closely duplicate their results. (p. 2-81a; Appendix 2-2, p. 18, 19)

The Molecular Diffusion Model evaluates a simple mathematical expression, using the "complementary error function", which is available in published tabulations and computer function libraries. Therefore, verification of the solution of the equation was not discussed. (Appendix 2-12, p. 6)

7. <u>How were the assumptions of the simulator addressed?</u>

The assumptions for the Basic Plume Model are as follows:

a. The flow is incompressible.
b. Permeation from the injection interval into the overlying and underlying aquitards is negligible.
c. Properties of the injection interval do not vary with position.
d. Densities of the waste and formation fluids are equal.
e. The fluid viscosity is uniform within the injection interval.
f. The injection interval is fully perforated.

The assumptions are conservative, their impact is small, or they are accounted for through the use of the multiplying factor. (Appendix 2-1, p. 5 through 8)

The assumptions for the Multilayer Vertical Permeation Model are as follows:

a. Flow is horizontal in the high-permeability layers, and vertical in the low-permeability layers.
b. The properties and thicknesses of the layers do not vary with position.
c. Fluid viscosity is uniform within each layer of the model.
d. The injection intervals are fully perforated.
e. Hydrodynamic dispersion can be discounted in the aquitard layers.

The assumptions are conservative or their impact is small. (Appendix 2-3, p. 11 through 14)

The assumptions for the Flow Resistance Model are as follows:

a. Abandoned boreholes contain a column of drilling mud that extends to the surface.
b. The only available exit for the drilling mud is the ground surface at the top of the borehole (the drilling mud will not exit the borehole at the depth of the USDW because the pores of that formation will be obscured by the suspended particles in the mud).

The first assumption is generally accepted. The second assumption makes flow resistance a function of the total mud column height (height of the mud column above the injection interval), not just the height of the USDW. (p. 2-11, 2-12)

The assumptions for the Multilayer Pressure Model are as follows:

a. The flow is horizontal in the high-permeability layers, and vertical in the low-permeability layers.
b. The properties and thicknesses of the layers do not vary with position.
c. The density of the waste is the same as that of the formation fluid.
d. Viscosities of the waste and formation fluid are equal.
e. Compressive storage in the low-permeability layers is negligible.
f. The injection interval is fully perforated.

The assumptions are conservative or their impact is small. (Appendix 2-2, p. 9 through 13)

The assumptions for the Molecular Diffusion Model are as follows:

a. The contaminant concentration at the leading edge of the waste front that is advancing due to convection is equal to the concentration in the waste stream at all times.
b. Chemical interaction with the aquitard material is negligible.
c. Horizontal waste movement is negligible.
d. The waste is not heavier than the formation brine.
e. Chemical fate of the contaminants is negligible.

The assumptions are conservative. (Appendix 2-11, p. 3 through 5; Appendix 2-12, p. 28 through 31)

BOUNDARY CONDITIONS

1. Brief summary of the boundary conditions used in the model.

No boundaries were modeled.

2. How was it determined that the boundary conditions did/did not assimilate natural physical conditions?

With exception of a small fault located northwest of the site, and with exception of minor thinning several miles from the site, no potential boundaries were observed in the geological study. The length and displacement of the fault is quite small, and the thinning of the injection interval sands is insignificant. (p. 2-81b, 2-81c, 3-16 through 3-16b; Appendices 3-2, 3-3, 3-5, 3-6, 3-7, 3-8)

3. State any concerns related to the boundary conditions.

Boundary conditions used were considered by the petitioner to be appropriate for the site.

GRID DISCRETIZATION

1. Brief summary of the model grid network.

An analytical modeling methodology was used rather than a grid model methodology.

CALIBRATION

1. Brief summary of how the model was calibrated.

Model calibration involved an interactive process. The geologic inputs were varied within a range of values until a "best fit" was achieved between the model's predictions and measured data. (p. 2-27)

The Basic Plume Model is calibrated against historical observations of lateral waste movement. These observations are based on the examination of fluids extracted from newly constructed wells at the site. (p. 2-4, 2-28 through 2-32)

The Multilayer Pressure Model is calibrated to the observed history of shut-in pressures at the wells. (p. 2-12, 2-31 through 2-42)

2. How was it determined that the model was/was not sufficiently calibrated?

Exhibits presented in the petition clearly indicate the adequacy of the calibration of the Basic Plume Model and The Multilayer Pressure Model. The Multilayer Vertical Permeation Model, the Flow Resistance Model, and the Molecular Diffusion Model are not subject to calibration, since appropriate historical measurements cannot be obtained. (p. 2-27 through 2-42)

PREDICTIVE SIMULATIONS

1. Brief summary of injection scenario(s) used in the model.

Calculations of the present day waste distribution (through the end of 1987) were based on historical monthly injection rates. Calculations of the near future waste distribution (through the end of the year 2000) and the post-injection waste distribution were based on two scenarios: (1) injection to the end of the year 2000 at projected average injection rates (based on the average of 1986 and 1987 yearly injection rates), and (2) injection to the end of the year 2000 at maximum permitted injection rates. (p. 2-40 through 2-78)

2. Brief summary of the results from the predictive simulations.

Present Day Waste Distribution

The calculated distribution of waste and pressure within the upper Miocene injection sand at the end of 1987 is as follows: (1) the composite waste plume was contained within an approximate radius of 0.7 miles from WDW-32, (2) maximum permeation into the overlying confining layer was 0.833 feet at WDW-14, and (3) maximum pressure increase over original formation pressure was approximately 30 psi at WDW-14.

Within the lower Miocene injection sand, the calculated distribution of waste and pressure at the end of 1987 is as follows: (1) the waste plume was circular with a radius of approximately 0.4 miles from WDW-110, (2) maximum permeation into the overlying confining layer was 0.062 feet at WDW-110, and (3) maximum pressure increase was approximately 31 psi at WDW-110. (p. 2-40 through 2-46, 2-77)

Near Future Waste Distribution

The modeling results for the upper Miocene injection sand at the end of the year 2000, using maximum permitted injection rates are as follows: (1) the composite waste plume will be contained within a 0.90 mile radius of WDW-32, (2) maximum vertical permeation will be 1.520 feet at WDW-14, and (3) maximum pressure increase will be 87 psi at WDW-14.

The modeling results at the end of the year 2000 within the lower Miocene injection sand, using maximum permitted injection rates are as follows: (1) the waste plume will be contained within a 0.77 mile radius of WDW-110 (p. 2-77 says 0.75 miles), (2) maximum vertical permeation will be 0.196 feet at WDW-110, and (3) maximum pressure increase would be 86 psi at WDW-110. (p. 2-46 through 2-59, 2-77)

Post-Injection Waste Distribution

Based on maximum permitted injection rates, post-injection modeling results for the upper Miocene injection sand are as follows: (1) pressure at WDW-14 will decline to 16 psi above original formation pressure in 1 year and to less than 3 psi above original formation pressure in 30 years, (2) maximum vertical permeation will be 1.551 feet, (3) the molecular diffusion distance through intact rock will be 43.1 feet in 10,000 years, (4) the combined distance of vertical movement due to convection and molecular diffusion through intact rock will be 44.65 feet, and (5) the waste plume will be contained within a 5 mile radius of the plant site for 10,000 years.

Post-injection modeling results for the lower Miocene injection sand, based on maximum permitted injection rates, are as follows: (1) pressure at WDW-110 will decline to less than 8 psi above

original formation pressure in 1 year and to 1.23 psi above original formation pressure in 30 years, (2) maximum vertical permeation will be 0.202 feet, and (3) the waste plume will be contained within a 2.5 mile radius of the plant site for 10,000 years. (p. 2-59 through 2-76e, 2-78; Appendix 2-11, p. 9 through 11)

3. How was it determined that the results were/were not accurate?

See SENSITIVITY ANALYSIS and CONCLUSIONS.

SENSITIVITY ANALYSIS

1. Brief summary of the method used in performing the sensitivity analysis.

The sensitivity of the Basic Plume Model, the Multilayer Vertical Permeation Model, and the Multilayer Pressure Model to changes in input parameters was evaluated by varying the input values for injection sand thickness, injection sand porosity, injection sand permeability, and formation fluid viscosity by approximately 10% from the original value, and by varying the input values for injection sand compressibility and confining layer permeability by one order of magnitude from the original value. The corresponding input parameters for each injection sand were varied one at a time until all parameters had been evaluated. The sensitivity analysis was based on injection at maximum permitted injection rates into both injection sands.

The sensitivity of the Molecular Diffusion Model to changes in input parameters was also evaluated. The input value for the porosity of the shale layers above the injection interval was varied from 12% to 10% and from 12% to 14%, and the input value for the free water diffusion coefficient for the diffusing molecule was varied 10% from the original value. (p. 2-78, 2-79; Appendix 2-11, p. 9, 10)

2. Discuss the consequence of the sensitivity analysis in relation to the model results.

Within the range of input values considered in the sensitivity analysis, the predicted plume radius at the end of the year 2000 is within 0.04 miles of the maximum value, the predicted pressure increase over original formation pressure at the end of the year 2000 is within 11 psi of the maximum value, the predicted upward permeation into the overlying confining shale at the end of the year 2000 is within 4 feet of the maximum value, the predicted molecular diffusion distance through intact rock at the end of 10,000 years is within 7.5 feet of the maximum value, and the predicted combined distance of vertical movement due to convection and molecular diffusion through intact rock at the end of 10,000 years is within 11 feet of the maximum value. (p. 2-80, 2-81, Appendix 2-11, p. 10)

CONCLUSIONS

1. Discussion of sources of possible model error.

The petition expresses concern over health based limits uncertainty and the determination of appropriate concentration reduction factors. (p. 2-76d; Appendix 2-11, p. 10)

Molecular diffusion through an abandoned borehole is not considered.

2. Discussion of potential problems in the migration analysis.

An appropriate concentration reduction factor must be used to correctly determine the lateral dispersion of the plume and to correctly determine vertical molecular diffusion distances.

In other petitions, the Molecular Diffusion Model has been used to calculate not only the distance of molecular diffusion through intact rock, but also the distance of molecular diffusion through an abandoned borehole. Application of the model to calculate the distance of molecular diffusion through an abandoned borehole at this site is easily accomplished, and doing so indicates a distance of vertical waste movement that is greater than the maximum distance of vertical waste movement currently presented in this petition.

3. Discussion of how the model results did/did not meet the requirements stated in the regulations.

The depth of the top of the injection zone is not correctly stated in the petition. The petition indicates that the top of the injection zone is at a depth of 3300 feet, 50 feet above the top of the upper Miocene injection sand. In reality, the injection well permits establish the top of the injection interval at a depth of 3300 feet. Adequate confining material is thought to exist for establishment of an injection zone and a confining zone that are protective of USDW (including consideration of molecular diffusion in an abandoned wellbore).

According to EPA regulations, the operator must demonstrate, to a reasonable degree of certainty, that there will be no migration of hazardous constituents, over a time span of 10,000 years, vertically out of the injection zone or laterally to a point of discharge or interface with a USDW. In order to demonstrate that there will be no migration vertically out of the injection zone, the distance of molecular diffusion in an abandoned wellbore should be submitted by the petitioner.

RECOMMENDATIONS

The petitioner has followed the regulations set forth in 40 CFR Part 148 and has shown in the petition that the site meets the criteria set forth in the regulations. Best available sources of information were utilized and the modeling appears to be appropriate for the site. The only point of contention at this time would be the lack of discussion as to the extent of molecular diffusion up an abandoned wellbore.

This report is a review and summary of the petition document and is not intended to act as a substitute for petition review by the EPA. EPA's final decision should only be made on the basis of it's own thorough review of the petition document.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

11-22

22 NOV 1989

REPLY TO: 6W-SU

Mr. Russ Kimble
Chief
Hazardous and Solid Waste
Enforcement Section
Texas Water Commission
P.O. Box 13087, Capitol Station
Austin, Texas 78711

RE: TWC Hoechst Celanese Petition Evaluation - Bay City Plant

Dear Mr. Kimble:

This is to confirm the information regarding the subject document discussed in the telephone conversation between Mr. Tom Roth (TWC) and Mr. Ronnie Crossland (EPA) on November 16, 1989. The following is a summation of the items discussed during the above conversation:

- The evaluation is intended to be a comprehensive integrated summary and an assessment of the petition demonstration. This intention inherently requires all sections of the evaluation to present a united discussion regarding the petition. Procedures should be established to ensure that there are no discrepancies concerning descriptions within the evaluation. For example, Question 1 of the Hydrogeology section (page 16) indicates that the Lower Miocene injection interval sand does begin to pinchout to the north and northwest of the Area of Review. However, within the Computer Simulator section (Boundary Conditions, page 31) there is no discussion concerning how this boundary is considered in the pressure buildup and waste migration predictions.

- Within each major section there are questions concerning, (1) What information was submitted on a certain topic, and (2) How was it determined from this information that all assumptions or data were valid. All answers to question Number 1 are adequate in providing a listing of the information submitted. However, the answer to question Number 2 is inadequate by only stating that the information in question Number 1 was reviewed. This type answer does not fulfill the intent of question Number 2, or more generally, does not fulfill the intent of the evaluation as stated in the previous comment. The answer to question Number 2 should describe what procedures and thought processes were used to determine the information was valid or invalid.

CONCURRENCES

SYMBOL	6W-SU:11/21/89:CROSSLAND:kk:C:®WP50®MH®KIMBLE:FILE CODE: WAT-1816-5-9 Sect 2							
SURNAME	6W-SU WEAVER							
DATE	11/21							

EPA Form 1320-1 (12-70)

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★U.S. GPO: 1988-0-206-471

- Regarding the recommendation given in the evaluations

  (1) It is unclear if the recommendation is for approval or denial of the petition demonstration.

  (2) It is evident within the evaluation that certain issues were not addressed in the petition document. Because of these issues above, it is not clear how a recommendation can be formulated. Therefore, if it is assumed the recommendation is for approval, then the recommendation conflicts with the information within the evaluation.

  The TWC should ensure that the recommendation is clear and is consistent with its assessment of the petition.

- Page 2 of the evaluation states that a preliminary review of the submitted petition has been performed. This statement indicates that the review of the petition is not complete. Since the evaluation form is a final assessment of the petition, the language within the evaluation should reflect that the review is complete. Also, terms such as "appears to be", "generally acknowledged", "the petition indicates", and "should" indicates that a final assessment and determination has not been made. For example, Page 12 states that the Markham Dome should exert no adverse influence on the injection zone. This indicates that the petition apparently does not definitively justify whether or not the Markham Dome has an adverse influence on the injection reservoir which indicates that the review was not complete. Therefore, the TWC should include definitive language in the evaluation regarding the completeness and final assessment of the technical review.

- Question Number 1 of the Hydrogeology section (Page 17) describes pressure tests on which model permeability values were based. However, there is no indication within the evaluation that these tests were verified as being valid and representative.

Based on the document of the TWC's evaluation of the Celanese (Bay City) petition, the TWC should take steps to correct this document and to ensure these issues are addressed in future TWC evaluation reports. If you have any questions or comments, please call me or Mac Weaver at (214) 655-7160.

Sincerely yours,

Oscar Cabra, Jr. P.E.
Chief
Water Supply Branch (6W-S)

cc: Tom Roth, TWC

Ronnie 6W-S

(2)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION VI
1445 Ross Ave. at Fountain Place
Dallas, TX 75202-2733

EPA

FACSIMILE REQUEST AND COVER SHEET

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FACSIMILE NUMBER
CONFIRMATION NUMBER

TO
MR. RUSS KIMBLE, Chief

OFFICE/PHONE
HAZARDOUS AND Solid WASTE ENFORCEMENT SECTION
TEXAS WATER Commission (512) 463-8281

REGION/LAB
P.O. BOX 13087, CAPITOL STATION
AUSTIN, TEXAS 78711

FROM
BARBARA CONRLIN
UIC

PHONE
655-7160

MAIL CODE
6W-SU

OFFICE
WATER MANAGEMENT DIVISION
WATER SUPPLY BRANCH

DATE SENT 11-21-89 / 11-22-89
TIME SENT 2:43 P. Rungow

NUMBER OF PAGES TO INCLUDE THIS COVER SHEET 3

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WAT 18-6-5-9 / Sect. 2

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PAGE 1 OF 3 PAGES

EPA Form 5040-5 (Rev. 12-83) Replaces EPA Form 5040-5A and the previous edition of EPA Form 5040-5, which are obsolete.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TEXAS 75202

REPLY TO: 6W-SU

Mr. Russ Kimble
Chief
Hazardous and Solid Waste
Enforcement Section
Texas Water Commission
P.O. Box 13087, Capitol Station
Austin, Texas 78711

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Sincerely yours,

for Oscar Cabra, Jr. P.E.
Chief
Water Supply Branch (6W-S)

cc: Tom Roth, TWC

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REGION VI

DU PONT
ENVIRONMENTAL MANAGEMENT
SERVICES
Fabricated Products Department
140 Cypress Station Drive, Suite 140
Houston, Texas 77090
(713) 586-5600

November 21, 1989

Mr. Ronald Crossland
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

-DRAFT-

Dear Mr. Crossland:

The following letter explains a number of revisions that have been made to the Hoechst Celanese Bay City Plant Class I Injection Well Petition. These revisions were requested by the Texas Water Commission ( ) and the revised pages/exhibits are attached. Each revised page or exhibit is stamped with the revision date, and two copies of each revision are provided. To revise the petition copies, remove the old pages/ exhibits from the petition binders, and insert the new pages or exhibits in their place.

The revisions are discussed by petition section, as an attachment to this letter.

Sincerely,

D.H. Squyres

D.H. Squyres

DHS/cd

CC: I.O. Coleman - Bay City Plant
Glenn McCarthy - Bay City Plant

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WAT 18-6-5-9

DUPONT

Master Petition Table of Contents

o The overall petition Table of Contents has been revised to reflect changes that were made in each section.

Section 1

o The pages that describe the injection zone have been revised to account for abandoned borehole diffusion. The new top of the injection zone is at approximately 2900 feet instead of 3300 feet. This change was made at the TWC's request to accommodate diffusion in abandoned boreholes.

Section 2

o Page 2-43 was changed to reflect that the "upper Miocene confining zone" has been changed to "upper Miocene containment interval".

o Page 11 of Appendix 2-11 has been changed to reflect that there is now 450 feet of permitted containment interval above the top if the upper Miocene injection interval.

o The type log was revised to reflect the newly specified 2900 foot permitted injection zone top.

o Pages 2-76 to 2-78 were revised at the request of the TWC, in order to use a new value in the calculation of hydraulic conductivity. This changed the plume locations, and new plume location calculations, (as well as new plume location maps) are being supplied.

Section 3

o The Appendices list in the Table of Contents, and the one just before Appendix 3-1, were revised to show the revised names for the maps in Appendices 3-8, 3-12, 3-14, 3-15, 3-16. The titles for these maps changed when the permitted injection zone top was specified to be 2900 feet.

o Map prints for the above listed Appendices are provided which reflect the new map names in the title blocks.

o New strike and dip cross sections are provided which reflect the 2900 foot permitted injection zone revision.

o Type log prints are supplied also reflecting the above revision.

Section 4

o Page iii of the Appendices list has been revised to show the names of the maps in Appendix 4-3.

o Appendix 4-3a is being supplied for the first time due to a request

by the Texas Water Commission. Many of the other revisions resulted from the addition of this Appendix to the petition.

o Revised pages of Section 4 are being supplied to reflect the TWC requested revisions to the 10,000 year plume location. Due to the revised location of the plume, the status of a number of wells versus the no-migration/non-endangerment has changed and the data associated with these wells in Section 4 was revised.

o New plume location maps are being supplied.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION VI
1445 Ross Ave. at Fountain Place
Dallas, TX 75202-2733

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FACSIMILE REQUEST AND COVER SHEET

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FACSIMILE NUMBER
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TO
NANDAN KENKEREMATH

OFFICE/PHONE
OFFICE OF GENERAL COUNSEL
FAX 382-7615
FTS 382-7700

REGION/LAB
EPA HEADQUARTERS MAILCODE: LE-132W

FROM
MIKE HEBERT

PHONE
FTS ~~655~~ 255-7160

MAIL CODE
6W-SU

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EPA REGION 6 WATER MANAGEMENT DIVISION
WATER SUPPLY BRANCH

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NANDAN,
I COULD NOT FIND ANY OTHER INFORMATION. RONNIE WILL PROBABLY CALL ME ON 6/9/89 AND I WILL FILL HIM IN ON THIS SITUATION AND SEE IF HE KNOWS OF ANY OTHER DOCUMENTS. LET ME KNOW IF YOU NEED ANYTHING ELSE.

Mike Hebert

PAGE 1 OF 9 PAGES

EPA Form 5040-5 (Rev. 12-83) Replaces EPA Form 5040-5A and the previous edition of EPA Form 5040-5, which are obsolete.

Hoechst Celanese

Crossland

Chemical Group
Bay City Plant
Hoechst Celanese Corporation
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

December 27, 1988
IOC-320-88

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JAN 3 1989
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REGION VI

Mr. Ronald D. Crossland
Environmental Engineer
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Subject: Submittal of Supplement to Hoechst Celanese Chemical Group, Inc., Bay City Plant, Bay City, Texas Injection Wells' Demonstration Petition Documents

Dear Mr. Crossland:

As follow up to our meeting with Ms. Stephaine Johnson and you in Dallas, Texas on Thursday, December 22, 1988, please find enclosed herewith the following as supplement to the subject Petition documents:

- Two copies of the signature certification sheet for insertion in each of the two petition documents which were previously submitted on September 19, 1988 and

- One additional copy of the November, 1988 Mechanical Integrity Testing Results Report on Bay City Plant Class I Injection Wells': WDW-14, 32, 49 and 110

Submittal of: (1) The signature certification sheets, (2) the Mechanical Integrity Testing Results Reports and (3) the December, 1988 Petition revisions (provided you at our December 20, 1988 meeting) should render our petition documents as administratively complete.

I remind you that we are impacted by the June 8, 1989 "Ban Date" for the listed waste streams, k009 and k010, resulting from Acetaldehyde production. I, therefore, urge you to please initiate the review of our Petition as soon as practical. An approved Petition would insure uninterrupted operation of our Acetaldehyde Unit post June 8, 1989 without severe adverse economic impact on the Hoechst Celanese Corporation.

Hoechst

We are willing to work with you to facilitate the Petition review process. Just let us know how we can assist you.

Please contact by telephone Mr. G. J. McCarthy at 409/245-4871, Ext. 4205 or me at Ext. 4197 if you have any comments or questions about this matter.

Yours very truly,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Ms. Stephanie D. Johnson - w/o Attach.
Environmental Engineer
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Mr. Robert Layton, Jr. - w/o Attach.
Regional Administrator
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Mr. Oscar Cabra - w/o Attach.
Branch Chief
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

1/5/89

Oscar,

As mentioned in this letter, we met with Celanese Bay City on December 22, 1988. During this meet Celanese submitted revisions to their petition. We also discussed their concern with the June 8, 1989 ban date.

I informed them that their petition was the next petition to be reviewed. I also contacted Headquarters about the 2nd thirds package to determine if the K009 and K010 would receive a capacity variance. Headquarters stated that the 2nd thirds package would be published in the Federal Register sometime in January. They also said that the package proposes a two year capacity variance for the K009 and K010 waste. This would change the effective date to June 8, 1991.

I called I.O. Coleman with Celanese and told him that I anticipated EPA to propose a capacity variance for K009 and K010. I also told him that the 2nd thirds package which addresses these wastes will be published in the Federal Register in January.

Thanks
Ronnie

SUGGESTED AGENDA

NOD RESPONSE MEETING-EPA

HOECHST CELANESE CHEMICAL GROUP, INC.,

BAY CITY PLANT

May 23, 1989

I. Meeting Objective

o To respond to the TWC NOD list.

o NOD's were responded to in two stages for the TWC, May 17 and one on April 4.

o This meeting will cover both stages.

II. Meeting Overview

o Introductory comments.

o Review of NOD responses.

o General questions/discussion.

III. Brief Site Review

o Four active wells.

o Two injection intervals.

o Two waste streams.

o Both streams are less dense than Fm. Fl.

o "Acid" and "Neutral" Waste.
LOWER UPPER

o Hazardous and Non-Haz.

o June 8, 1989 ban date.

o Site Summary-Excellent Site for Safe Injection

IV. Review of NOD responses.

o All NOD revised pages stamped revised in lower right hand corner with April 4 or May 17 revision date.

o All NOD's on NOD list have been responded to as of this meeting.

o Additional Selected Petition References are being added.

o Containment interval terminology has not been used.

AOR NOD's - Will Review After Modeling NOD's

SUGGESTED AGENDA
NOD RESPONSE MEETING-EPA
HOECHST CELANESE CHEMICAL GROUP, INC.,
BAY CITY PLANT
May 23, 1989

I. Meeting Objective

o To respond to the TWC NOD list.

o NOD's were responded to in two stages for the TWC, May 17 and one on April 4.

o This meeting will cover both stages.

II. Meeting Overview

o Introductory comments.

o Review of NOD responses.

o General questions/discussion.

III. Brief Site Review

o Four active wells.

o Two injection intervals.

o Two waste streams.

o Both streams are less dense than Fm. Fl.

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#1) Figure 3-1 has been modified to show the Inj. Interval, Inj. Zone, and Confining Zone.

#2) Regional map w/in 50 feet of the top of the C.Z. is being provided. Could not locate regional I.Z. map. Note: only about 400' difference in fm. tops between I.Z. and C.Z.

#3) Figure 3-4 concerning earthquake magnitudes has been modified.

#4) Section 3.2.2 has been modified to incorporate positions of I.I., I.Z., and C.Z.

#5) The position of the Bay City Plant has been shown on Figure 3-5.

#6) Cross Sections have been extended out to cover approx. 400 square mile area and a basemap included. North section is anchored in the Markham dome as recommended by the TWC.

Local Geology

#1) Geologic exhibits have been revised to be concordant with new regulatory concepts and terminology of I.I., I.Z. and C.Z.. The 10,000 year plume locations have been plotted on the cross sections and structure maps.

#2) Plumes have been plotted on structure maps and cross sections.

#3) Sources of maps are on all map prints. Datums are subsea.

#4) Depths have been flagged every 1,000 feet.

#5) Annotated type logs are being provided with full scale cross sections.

#6) Annotated type logs are being provided for all active injection wells.

#7) Cross Section(8 1/2 x 11) has been constructed to show fault characteristics.

#8) Markham Dome.

#9) Type log showing modeled layers is being provided.

#10) A ninth petition Section labeled "Selected Petition References" are being provided.

Hydrogeology

#1 and #2) See #10 above.

Geochemistry

#1) Diffusion Appendices 2-11 and 2-12 are being submitted.

Modeling Comments

#1) See Geochemistry comment #1.

#2) Section 2.1.7 directs reviewer to proper appendices for validation discussion.

#3) A dispersion equation and calculation is being used to show concentration reduction instead of a multiplying factor for 10,000 year dispersion.

#4) Density effects are discussed in 2.1.5.3.4.

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#6) See Appdx. 2-13 and 2-14.

#7) See Section 2.1.7.3.

#8) Additional information(Frio, Chicot, and recharge/elevation discussion has been added to bolster discussion regarding direction of gradient.

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Area of Review

o AOR has been completely revised to reflect no-migration/ non-endangerment standard.

#1) Site is still modeled based on injection thru year 2000.

- o Modeling past year 2000 would likely involve repermitting to lower injection rates, and expand injection zone.
- o After proposed 2 year capacity variance is signed modeling time frame will be addressed when time is available for repermitting.
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- o Assumes 9 # gal. mud in wellbores.

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#5) Wells have been evaluated for non-endangerment/no-migration standard and modeled if necessary.

Additional Data Provided with NOD Responses

o Discussion of Well Stimulations and their effect on the Injection and Confining Zone - Section 6.

o Added recent well MIT data to Section 6 well history discussion.

o Slight revisions have been made to the injection well construction diagrams.

o Vertical Gradients are addressed in relation to vertical transport over 10,000 years in Section 2.

V. <u>General Questions/Discussion</u>

o Status of Gibralter/others?

o Case by Case extensions-Other options?

o Earliest Celanese petition approval date?.

o Any information on status of variances?

o Horiz. diffusion - status of issue?

FILE CODE
WAT 18-6-5-9

PETITION MEETING FORM

Date: 5-23-89

Facility Name: CELANESE BAY CITY PLANT

Facility Contact: I.O. COLEMAN

Phone:

Expected date of petition submission:

Contractor Name: DUPONT

Contractor Contact (Administrative):

Phone:

Contractor Contact (Modeler):

Phone:

Simulator Code:

Description of modeling strategy:

BASICALLY ONLY 50-75 FEET OF CONFINING MATERIAL AT TOP OF INJECTION ZONE
PROPOSED WELL IS NOT IN THE MODEL, HOWEVER THIS WELL WILL BASICALLY NOT MAKE ANY DIFFERENCE
BECAUSE THE VOLUMES AND RATES WILL NOT CHANGE.

Remarks:

FURTHER PROPOSED REGS ON ADDITIONAL WASTES
DISCUSSION ON CASE-BY-CASE EXTENSION

SUGGESTED AGENDA

NOD RESPONSE MEETING-EPA

HOECHST CELANESE CHEMICAL GROUP, INC.,

BAY CITY PLANT

May 23, 1989

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o Any information on status of variances?

o Horiz. diffusion - status of issue?

(2)

1/5/89

Oscar,

As mentioned in this letter, we met with Celanese Bay City on December 22, 1988. During this meet Celanese submitted revisions to their petition. We also discussed their concern with the June 8, 1989 ban date.

I informed them that their petition was the next petition to be reviewed. I also contacted Headquarters about the 2nd thirds package to determine if the K009 and K010 would receive a capacity variance. Headquarters stated that the 2nd thirds package would be published in the Federal Register sometime in January. They also said that the package proposes a two year capacity variance for the K009 and K010 waste. This would change the effective date to June 8, 1991.

I called I.O. Coleman with Celanese and told him that I anticipated EPA to propose a capacity variance for K009 and K010. I also told him that the 2nd thirds package which addresses these wastes will be published in the Federal Register in January.

Thanks
Ronnie

Hoechst Celanese

Crossland

Chemical Group
Bay City Plant
Hoechst Celanese Corporation
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

December 27, 1988
IOC-320-88

RECEIVED
JAN 3 1989
EPA 6W-S
REGION VI

Mr. Ronald D. Crossland
Environmental Engineer
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Subject: Submittal of Supplement to Hoechst Celanese Chemical Group, Inc., Bay City Plant, Bay City, Texas Injection Wells' Demonstration Petition Documents

Dear Mr. Crossland:

As follow up to our meeting with Ms. Stephaine Johnson and you in Dallas, Texas on Thursday, December 22, 1988, please find enclosed herewith the following as supplement to the subject Petition documents:

- Two copies of the signature certification sheet for insertion in each of the two petition documents which were previously submitted on September 19, 1988 and

- One additional copy of the November, 1988 Mechanical Integrity Testing Results Report on Bay City Plant Class I Injection Wells': WDW-14, 32, 49 and 110

Submittal of: (1) The signature certification sheets, (2) the Mechanical Integrity Testing Results Reports and (3) the December, 1988 Petition revisions (provided you at our December 20, 1988 meeting) should render our petition documents as administratively complete.

I remind you that we are impacted by the June 8, 1989 "Ban Date" for the listed waste streams, k009 and k010, resulting from Acetaldehyde production. I, therefore, urge you to please initiate the review of our Petition as soon as practical. An approved Petition would insure uninterrupted operation of our Acetaldehyde Unit post June 8, 1989 without severe adverse economic impact on the Hoechst Celanese Corporation.

We are willing to work with you to facilitate the Petition review process. Just let us know how we can assist you.

Please contact by telephone Mr. G. J. McCarthy at 409/245-4871, Ext. 4205 or me at Ext. 4197 if you have any comments or questions about this matter.

Yours very truly,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Ms. Stephanie D. Johnson - w/o Attach.
Environmental Engineer
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Mr. Robert Layton, Jr. - w/o Attach.
Regional Administrator
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Mr. Oscar Cabra - w/o Attach.
Branch Chief
U. S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, Texas 75202-2733

Hoechst Celanese

Crossland

Chemical Group
Bay City Plant
Hoechst Celanese Corporation
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

WAT 18-6-5-9

RECEIVED
EPA REGION VI
JAN 3 PM 2 03

December 27, 1988
IOC-320-88

RECEIVED
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Hoechst

UNIT ATES ENVIRONMENTAL PROTECTI ENCY

(2)

21 SEP 1988

REPLY TO: 6W-SU

Mr. I.O. Coleman Jr.
Hoechst Celanese
Bay City Plant
P.O. Box 509
Bay City, Texas 77414

Dear Mr. Coleman:

The Environmental Protection Agency (EPA) acknowledges the receipt of your petition on September 19, 1988, for an exemption from the hazardous waste land disposal restrictions.

If you have any questions concerning the status of your petition, please contact Ronnie Crossland or Stephanie Johnson at (214) 655-7160.

Sincerely yours,

Oscar Cabra, Jr., P.E.
Chief
Water Supply Branch (6W-S)

CONCURRENCES

SYMBOL	6W-SU:9/20/88:JOHNSON:kk:DISK:SJ9/20:FILE CODE WAT 18-1	RDC 9/20/88						
SURNAME	6W-SU							
DATE	WEAVER	BK 9/20/88						

EPA Form 1320-1 (12-70)

OFFICIAL FILE COPY

Containment not chem fate

Injection Well Petition Summary
Hoechst Celanese Chemical Group. Inc.,
Bay City Plant
September, 1988

Basis of Petition Demonstration: Flow and containment(not Chem. Fate)

Petition Conclusion: The site complies with the no-migration demonstration in 148.20 Subpart C (using the proposed 146/146 regs).

"Draft" Petition is Submitted:
- o This is a draft petition which was completed just before the final 146/148 regs. came out.
- o To be administratively complete the petition still needs;
  - MIT results
  - Molecular Diffusion
  - Removal of x,4x,10x
  - References to "proposed 146/148" regs.
  - Anything else EPA/TWC requests.
- o Strategy due to 1989 ban date is to submit draft petition for review and get comments on additional data required by the regulatory bodies.
  - -While review is taking place Celanese will be working to supply MIT data, molecular diffussion data , etc. Not finished Next month or s

Sept 27 meeting w/TWC

Add additional information we request also.

affected by 1989 ban date

Permit Application:A permit application for an additional injection well is also being submitted with the petition, to provide a backup to WDW-110.

Wells Petitioned:

"Neutral Wells"	"Acid" Wells
WDW-14(Well 2)	WDW-110(Well 1-A)
WDW-32(Well 3)	Proposed Waste Disp. Well 5
WDW-49(Well 4)	

Wells Plugged and Secured: WDW-8(Well 1) injecting 14X

USDW:Approximately 1300' - 10,000 ppm

Injection Intervals:
- o "Neutral" wells inject into the same upper Miocene injection sand @ approx. 3350 feet, and are in pressure communication.
- o "Acid" well injects into the lower Miocene injection sand @ approx. 5700 feet.

Ban Date: o Due to K009 and K010

- o These are second one third listed wastes.
- o EPA may set restrictions by June 8, 1989; if not,"soft hammer" applies and waste will be banned until May 8, 1990.
- o K009 and K010 only in "acid" waste.
- o "Neutral" waste is non-hazardous but is being petitioned as if it was hazardous to maintain site flexibility.
- o HOC's are present in the "acid" waste but no ban date results because the HOC's are not on the Appendix III List to Part 268.

Plume/Pressure Modeling Results:{does not include diffusion}

- o Three time frames were modeled
  - -Historical injection through the end of 1987.
  - -Projected injection through the end of 2000.
  - -30 years post-injection from 2001 to 2030
- o Two cases for the last two time frames
  - - Modeled using projected average injection rates
  - - Modeled using projected maximum permitted rates
- o The plume distribution and pressure buildup was analyzed for each time.
  - -For the upper Miocene injection sand, using maximum permitted injection rates, at the end of the year 2000; 1) the max. upward permeation would be 1.52 feet; 2) the composite waste plume would be contained within a 0.9 mile radius of WDW-32; 3) the max. pressure buildup would be 87 psi at the inj. wells, and less than 30 psi at the AOR boundary.
  - -For the lower Miocene injection sand, using maximum permitted inj. rates, at the end of the year 2000; 1) the max. upward permeation would be o.196 feet; 2) the waste plume would be contained within a 0.75 mile radius of WDW-110; 3) the max. pressure buildup would be 86 psi at WDW-110 and 15 psi at the AOR boundary.
  - -During post injection using max. inj. rates, the max. upward permeation would be 1.551(site "x" under prop. regs.) and 0.202 feet for the upper and lower Miocene injection sands, respectively.

Area Of Review(2.5 miles):

- o 31 artificial penetrations in AOR
- o 12 wells modeled as potential problem wells.
  - - 5 modeled due to incomplete records.
  - - 7 due to improper construction or improper plugging.
  - - See Petition Sec. 4 for details.

We are willing to work with you to facilitate the Petition review process. Just let us know how we can assist you.

Please contact by telephone Mr. G. J. McCarthy at 409/245-4871, Ext. 4205 or me at Ext. 4197 if you have any comments or questions about this matter.

Yours very truly,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

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Mr. Oscar Cabra - w/o Attach.
Branch Chief
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o Modeling determined no wells need remediation in order to inject safely in the future at the plant.

Plant MIT Status: o MIT and related tests are scheduled for the site.

Summary of Petition Section Contents:

SECTION

I. Introduction
- Executive Summary
- Regulatory Position ← Regulatory: Classification check at HOCs, no bandate they say.
- Site Description

II. Class I Well Siting
- Plume and Pressure Computer Modeling

III. Site Geology
- Expanded Geology Writeup (Regional and Site Geology)
- Geologic Cross-Sections/Maps

IV. Area of Review (AOR)
- Summary
- Determination of AOR
- Artificial Penetrations in the AOR
- Modeling Potential Problem Wells

V. Well Construction
- Injection Well Diagrams
- Injection Well Information

VI. Well Operations
- Compatibility Demonstrations
- Well Operation and Mechanical Integrity History

VII. Testing and Monitoring
- Mechanical Integrity Schedule (MIT/RA)
- Quality Control

VIII. Appendix
- Current Permit

LA - No new hazardous [illegible] wells drilled after 1989.

WAT-15-6-5-9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
ALLIED BANK TOWER AT FOUNTAIN PLACE
1445 ROSS AVENUE
DALLAS, TEXAS 75202

SECOND NOTICE TO OPERATORS

OF FACILITIES WITH HAZARDOUS WASTE INJECTION WELLS

The Hazardous and Solid Waste Amendments of 1984 (HSWA) to the Resource Conservation and Recovery Act (RCRA) will prohibit the injection of restricted hazardous wastes beginning in August 1988, unless specific provisions identified in the HSWA are met. In response to these amendments, the Environmental Protection Agency (EPA) developed regulations for injection wells (40 CFR Part 148) which were proposed in the August 27, 1987, Federal Register. These regulations establish the framework for implementing the land disposal restrictions of RCRA for injection wells. A summary of the options available to operators who are injecting restricted wastes is given below:

1. Treat the waste in accordance with the requirements of 40 CFR Part 268 pursuant to Part 3004(m) of the RCRA.

2. Demonstrate to the satisfaction of the EPA Administrator that there will be no migration of hazardous constituents for as long as the waste remains hazardous. This demonstration must be prepared in the form of a petition and submitted to the EPA Region VI and the State agency in accordance with 40 CFR Part 148. This petition must be submitted as soon as possible in a completed form to assure a timely review of the petition.

3. The remaining alternative would be to discontinue injecting the restricted waste by the specified date the ban takes effect.

The effective ban dates listed in the May 28, 1986, Federal Register Parts 268.10, 268.11, and 268.12, are identified respectively as August 8, 1988, June 8, 1989, and May 8, 1990, dependent on the type of waste injected. If you plan to continue injection, you must determine which date affects your operation and prepare your petition or treatment proposal for submission. If you plan to shut in the well, you must also notify EPA and the State as soon as possible.

The following is list of wastes proposed to be prohibited on August 8, 1988. This list is expected to become final within the next two weeks.

Solvents

F001 ≥ 1% in concentration
F002 ≥ 1% in concentration
F003 ≥ 1% in concentration
F004 ≥ 1% in concentration
F005 ≥ 1% in concentration

Dioxins

F020
F021
F023
F026
F027
F028

California list

PCB ≥ 50 ppm
HOC ≥ 1% in concentration

Listed waste

K019
K030

The following wastes have not been proposed to be banned as of this date, however, based on preliminary information, they are expected to be prohibited on August 8, 1988.

F006
K016 ≥ 1% in concentration
K083
K086 (solvent wastes and sludges)
K103

For a detailed description of the above mentioned waste, please refer to 40 CFR §261.31 and §261.32. Other wastes initially included in the August ban date are currently being considered for a variance due to a lack of treatment capacity or have not had treatment standards set.

We will be working closely with the State agencies to review and make a final determination on the submitted petitions, and will assist you in any way possible to comply with the provisions of the land disposal restrictions.

Please respond immediately to EPA with your effective ban date and proposed strategy for meeting the requirements of Part 148.

If you have any questions, please contact Ronnie Crossland or Stephanie Johnson at (214) 655-7160. Thank you for your cooperation in this matter.

RECORD OF COMMUNICATION	☐ PHONE CALL ☐ DISCUSSION FIELD TRIP ☐ CONFERENCE ☒ OTHER (SPECIFY) letter - attached (Record of item checked above)	
TO: Stephanie Johnson	FROM: Glenn McCarthy Celanese, Bay City	DATE 3/16/88 TIME

SUBJECT WDW 32, well #3
Celanese, Bay City Plant

SUMMARY OF COMMUNICATION

Attached is the information on when Celanese began monitoring this Class I well continuously. The well was put into service on 7/27/67. The well has a good mechanical integrity record and the well is constructed adequately. It has been determined that no prior or existing releases have occurred at this well.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA HQ FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Hoechst Celanese

Chemical Group
Bay City Plant
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

March 16, 1988
GJM-304-88

Mr. Richard E. Merritt
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Subject: Continuous Monitoring Instrumentation On Hoechst Celanese Chemical Group, Inc. Bay City Plant Waste Disposal Wells

Dear Mr. Merritt:

On February 24, 1988, you called me to ask when we began keeping records resulting from continuous monitoring of the annulus and injection pressures and the temperature associated with the waste water injected via our disposal well systems.

As I discussed in my telephone conversation with Tom Roth on March 16, 1988, a check of our records indicates that the continuous monitoring instrumentation was installed on our Acid Waste Disposal Well System (WDW-110, our well 1A) in August, 1973. The instrumentation for the Neutral Waste Disposal Wells System (WDW-14, WDW-32, and WDW-49, our wells 2, 3 and 4, respectively) was installed in January of 1983.

Records were kept starting immediately, but, of course, some time was required to get the new systems operational, so some of the very early records are not continuous.

I trust that this is the information you require.

If you have further questions, I may be reached at (409) 245-4871, extension 4205, or you may contact I. O. Coleman, Jr. at extension 4197.

Sincerely,

Glenn McCarthy

GJM/las

Glenn McCarthy

cc: Mr. Tom Roth
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

I. O. Coleman, Jr.
R. H. Maurer - Dallas
Environmental File No. 204.4

Hoechst

RECORD OF COMMUNICATION

☐ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE
☒ OTHER (SPECIFY) letter - attached
(Record of item checked above)

TO: Stephanie Johnson

FROM: Glenn McCarthy
Celanese, Bay City

DATE: 3/16/88

TIME:

SUBJECT: WDW-14 well #2
Bay City

SUMMARY OF COMMUNICATION

Attached is the ~~[illegible]~~ information on when Celanese began monitoring this Class I well continuously. The well was put into service on 4/1/65. The well has a good mechanical integrity record and the well is constructed adequately. It has been determined that no prior or existing releases have occurred at this well.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES
TO:

EPA Form 1300-6 (7-72) REPLACES EPA NO FORM 5300-3 WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED.

Hoechst Celanese

Chemical Group
Bay City Plant
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

March 16, 1988
GJM-304-88

Mr. Richard E. Merritt
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Subject: Continuous Monitoring Instrumentation On Hoechst Celanese Chemical Group, Inc. Bay City Plant Waste Disposal Wells

Dear Mr. Merritt:

On February 24, 1988, you called me to ask when we began keeping records resulting from continuous monitoring of the annulus and injection pressures and the temperature associated with the waste water injected via our disposal well systems.

As I discussed in my telephone conversation with Tom Roth on March 16, 1988, a check of our records indicates that the continuous monitoring instrumentation was installed on our Acid Waste Disposal Well System (WDW-110, our well 1A) in August, 1973. The instrumentation for the Neutral Waste Disposal Wells System (WDW-14, WDW-32, and WDW-49, our wells 2, 3 and 4, respectively) was installed in January of 1983.

Records were kept starting immediately, but, of course, some time was required to get the new systems operational, so some of the very early records are not continuous.

I trust that this is the information you require.

If you have further questions, I may be reached at (409) 245-4871, extension 4205, or you may contact I. O. Coleman, Jr. at extension 4197.

Sincerely,

Glenn McCarthy

GJM/las

Glenn McCarthy

cc: Mr. Tom Roth
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

I. O. Coleman, Jr.
R. H. Maurer - Dallas
Environmental File No. 204.4

Hoechst

Hoechst Celanese

Chemical Group
Bay City Plant
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

March 16, 1988
GJM-304-88

Mr. Richard E. Merritt
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Subject: Continuous Monitoring Instrumentation On Hoechst Celanese Chemical Group, Inc. Bay City Plant Waste Disposal Wells

Dear Mr. Merritt:

On February 24, 1988, you called me to ask when we began keeping records resulting from continuous monitoring of the annulus and injection pressures and the temperature associated with the waste water injected via our disposal well systems.

As I discussed in my telephone conversation with Tom Roth on March 16, 1988, a check of our records indicates that the continuous monitoring instrumentation was installed on our Acid Waste Disposal Well System (WDW-110, our well 1A) in August, 1973. The instrumentation for the Neutral Waste Disposal Wells System (WDW-14, WDW-32, and WDW-49, our wells 2, 3 and 4, respectively) was installed in January of 1983.

Records were kept starting immediately, but, of course, some time was required to get the new systems operational, so some of the very early records are not continuous.

I trust that this is the information you require.

If you have further questions, I may be reached at (409) 245-4871, extension 4205, or you may contact I. O. Coleman, Jr. at extension 4197.

Sincerely,

Glenn McCarthy

Glenn McCarthy

GJM/las

cc: Mr. Tom Roth
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

I. O. Coleman, Jr.
R. H. Maurer - Dallas
Environmental File No. 204.4

Hoechst

Hoechst Celanese

Chemical Group
Bay City Plant
PO Box 509, FM 3057
Bay City, TX 77414
409 245 4871

March 16, 1988
GJM-304-88

Mr. Richard E. Merritt
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Subject: Continuous Monitoring Instrumentation On Hoechst Celanese Chemical Group, Inc. Bay City Plant Waste Disposal Wells

Dear Mr. Merritt:

On February 24, 1988, you called me to ask when we began keeping records resulting from continuous monitoring of the annulus and injection pressures and the temperature associated with the waste water injected via our disposal well systems.

As I discussed in my telephone conversation with Tom Roth on March 16, 1988, a check of our records indicates that the continuous monitoring instrumentation was installed on our Acid Waste Disposal Well System (WDW-110, our well 1A) in August, 1973. The instrumentation for the Neutral Waste Disposal Wells System (WDW-14, WDW-32, and WDW-49, our wells 2, 3 and 4, respectively) was installed in January of 1983.

Records were kept starting immediately, but, of course, some time was required to get the new systems operational, so some of the very early records are not continuous.

I trust that this is the information you require.

If you have further questions, I may be reached at (409) 245-4871, extension 4205, or you may contact I. O. Coleman, Jr. at extension 4197.

Sincerely,

Glenn McCarthy

Glenn McCarthy

GJM/las

cc: Mr. Tom Roth
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

I. O. Coleman, Jr.
R. H. Maurer - Dallas
Environmental File No. 204.4

Hoechst

Mac W

CELANESE
CHEMICAL COMPANY, INC.

November 28, 1987

IOC-332-87

RECEIVED
DEC 4 1987
6W-S
REGION VI

Mr. Oscar Cabra, Jr., P.E.
Chief
Water Supply Branch (6W-S)
United States Environmental Protection Agency
Region VI
Allied Bank Tower At Fountain Place
1445 Ross Avenue
Dallas, Texas 75202

Re: Facilities With Hazardous Waste Injection Wells

Dear Mr. Cabra:

In response to your letter dated October 6, 1987, Celanese Chemical Company, Inc., Bay City Plant, Bay City, Texas submits the following:

I. EFFECTIVE DATE:

The Bay City Plant presently operates four Class I injection wells which inject restricted wastes. Certain hazardous constituents of the waste stream are specified in 3004(d)(2), termed the "California" list as well as the wastes listed in Part 268 pursuant to sections 3004(g)(5) and 3004(n) and therefore subject to the August 8, 1988 effective ban date.

II. CIRCUMSTANCE UNDER WHICH CELANESE CHEMICAL COMPANY, INC., BAY CITY PLANT, BAY CITY, TEXAS MAY CONTINUE TO INJECT:

Celanese Chemical Company, Inc., Bay City Plant, will Petition to continue its injection operations by demonstrating to the Environmental Protection Agency (EPA) Administrator that there will be no migration of hazardous constituents for as long as the wastes remain hazardous.

III. STATUS OF PETITION

Celanese Chemical Company, Inc., Bay City Plant, has contracted an outside consulting firm for Petition preparation. The final Petition document is expected to be submitted to EPA during April, 1988.

Should you or your staff have any comments or questions pertaining to this matter, please contact Mr. G. J. McCarthy at 409/245-4871, Extension 4205 or me at Extension 4197.

Yours very truly,

I. O. Coleman, Jr.

IOC/las

cc: Mr. Larry R. Soward,
Executive Director
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Mr. Samuel B. Pole, Chief
Hazardous and Solid Waste Enforcement Section
Hazardous and Solid Waste Division
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

May 9, 1994
IOC-043-94

FEDERAL EXPRESS MAIL - 8635790590

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: WDW-49 (PLANT WELL NUMBER 4)
WORKOVER AND MECHANICAL INTEGRITY TESTING REPORT
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

Two copies of the Workover and Mechanical Intergity Testing report on WDW-49 are enclosed. These reports are provided for your review and approval. As you are aware, the workover and mechanical integrity testing were performed between March 3rd and March 18, 1994 by our Contractor, ECO Solutions, Inc.

Please contact me at 409/241-4197 or Mr. Ray Horton at 409/241-4076 if you have comments or questions about the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Mr. Laurence G. Walker - w/o report
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger (CERTIFIED MAIL) - w/ report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

April 27, 1994
IOC-038-94

CERTIFIED MAIL

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: **PRESSURE FALLOFF MECHANICAL INTEGRITY TESTING (MIT) REPORT FOR WDW-110**

Dear Mr. Knape:

Enclosed are two copies of the Pressure Falloff and MIT report for WDW-110 which are provided for your review and approval. As you are aware, the testing occurred between February 21st and March 28th, 1994 and was performed by our Contractor, ECO Solutions, Inc., Houston, Texas.

Please don't hesitate to contact me at 409/241-4197 if you have comments and/or questions concerning the report.

Very truly yours,

I. O. Coleman, Jr./cjs

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

cc: Mr. Laurence G. Walker, Geologist
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger - **CERTIFIED MAIL** - w/report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

April 26, 1994
IOC-037-94

CERTIFIED MAIL

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: **PRESSURE FALLOFF MECHANICAL INTEGRITY TESTING (MIT) AND FALLOFF REPORT FOR WDW-14**

Dear Mr. Knape:

Enclosed are two copies of the Pressure Falloff and MIT report for WDW-14 which are provided for your review and approval. As you are aware, the testing occurred between February 16th and February 22nd, 1994 and was performed by our Contractor, ECO Solutions, Inc., Houston, Texas.

Please don't hesitate to contact me at 409/241-4197 if you have comments and/or questions concerning the report.

Very truly yours,

I. O. Coleman, Jr. / cjs

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

cc: Mr. Laurence G. Walker, Geologist
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger - **CERTIFIED MAIL** - w/report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

(4)

(mb) 4/12/94

APR 14 1994

CERTIFIED MAIL Z 013 011 515 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

We have completed the review of the pressure falloff test conducted in November 1993 for well WDW-32. Based on this review, the EPA has determined that Hoechst Celanese Corporation has fulfilled Petition Approval Condition No. 8 for the year May 4, 1993, to May 4, 1994.

If you have any questions or comments please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs Section (6W-SU)

cc: Ben Knape, TNRCC

(mb) 4/12/94
6W-SU:4/7/94:HOWARD:H:\LBAN\WP50\CELANESE\CELANESE.BA\FLOFFAPR.93

6W-SU	6W-SU	6W-SU
KORDZI	DELLINGER	WEAVER
J.K 4/7/94		MW 4/11/94

file

(4)

RECORD OF COMMUNICATION

TO: Celanese Bay City File
FROM: Phil Dellinger
DATE: February 23, 1994
TYPE OF COMM: Phone Call
SUBJECT: Mechanical Integrity Test for WDW-14

SUMMARY: Tom Jones of Eco Solutions, Inc. called to report that the mechanical integrity testing on Celanese Bay City Well WDW-14 indicated a hole in the casing below the packer and the well had been shut in. I told him to send the testing info to us soon.

CONCLUSION, ACTION TAKEN OR REFERRED:

FILE COPIES TO:

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

February 2, 1994
IOC-013-94

CERTIFIED MAIL

Mr. Mac A. Weaver, P. E., Chief
UIC State Programs Section (6W-SU)
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: Response To NOD Letter Dated January 12, 1994
Class I Injection Well Permit, No. WDW-32
Hoechst Celanese Chemical Group, Inc.,
Bay City Plant, Bay City, Texas
(Attachment I, NOD Letter Dated 1/12/94 Enclosed
For Your Quick Reference)

Dear Mr. Weaver:

Enclosed in report format is our response to your request for additional information relative to the 1993 annual report previously submitted for WDW-32. This report is provided for your consideration and approval.

I can be contacted by telephone at 409/241-4197 if you have any comments and/or questions concerning the information in the report.

Very truly yours,

I. O. Coleman, Jr./cjs

I. O. Coleman, Jr.

RECEIVED
FEB - 8 1994
6 W-SU

IOC/cjs
attachment

Hoechst

cc: Mr. Joe Kordzi
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Mr. Ben Knape, Chief
UIC Section
Texas Natural Resource Conservation Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711-3087

RECEIVED
FEB - 8 1994
6 W-SU

ATTACHMENT 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

January 12, 1994

CERTIFIED MAIL P 873 011 248 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

Your 1993 annual report for WDW-32 has been reviewed. Please provide the following by February 10, 1994:

1. A detailed summary of events in real time. This should include information on the following: the length of the injection period prior to falloff, rate changes including any that occurred during running of the gauges, problems encountered, etc.

2. A discussion of how the falloff testing was analyzed, including what software was employed, the type of simulation that was performed, assumptions, etc.

3. Worked through calculations, with appropriate explanative text for t_p, the injection period; the time to exit the waste front; the flowing bottomhole pressure; and radius of investigation.

4. A comparison of the static and flowing bottomhole pressures with those predicted by the petition.

In general your report lacks any explanative text and is merely a summary of the data and well analysis. This type of presentation makes it extremely difficult to review your well test. In addition, many of the above comments are covered in the "Pressure Falloff Testing Guideline, First Revision", which was sent to you several months ago. Please ensure that your contractor follows this document in conducting future tests.

RECEIVED
FEB - 8 1994
6 W-SU

If you have any questions, please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A Weaver

Mac A. Weaver, P.E.
Chief
UIC State Programs

RECEIVED
FEB - 8 1994
6 W-SU

JAN 12 1994

CERTIFIED MAIL P 873 011 248 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

Your 1993 annual report for WDW-32 has been reviewed. Please provide the following by February 10, 1994:

1. A detailed summary of events in real time. This should include information on the following: the length of the injection period prior to falloff, rate changes including any that occurred during running of the gauges, problems encountered, etc.

2. A discussion of how the falloff testing was analyzed, including what software was employed, the type of simulation that was performed, assumptions, etc.

3. Worked through calculations, with appropriate explanative text for t_p, the injection period; the time to exit the waste front; the flowing bottomhole pressure; and radius of investigation.

4. A comparison of the static and flowing bottomhole pressures with those predicted by the petition.

In general your report lacks any explanative text and is merely a summary of the data and well analysis. This type of presentation makes it extremely difficult to review your well test. In addition, many of the above comments are covered in the "Pressure Falloff Testing Guideline, First Revision", which was sent to you several months ago. Please ensure that your contractor follows this document in conducting future tests.

6W-SU:1/10/94:KORDZI:MH:H:\LBAN\WP50\CELANESE\CELANESE.BA\
CELBAY93.ANL
6W-SU 6W-SU
DELLINGER WEAVER

PD 1/11/94 MW 1/11/94

If you have any questions, please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

December 7, 1993
IOC-097-93

CERTIFIED MAIL

Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

SUBJECT: WDW-110 & WDW-14
5-YEAR MIT/FALLOFF TEST SCHEDULE
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

For your review and approval, please find attached the schedule and proposed procedures for the 5-year mechanical integrity testing and annual bottom hole pressure falloff test on WDW-14 and WDW-110.

Your consideration of our request is appreciated.

Please review and comment on the attached procedures as soon as possible.

If you have any questions, contact me at (409) 241-4197.

Respectfully,

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

Hoechst

cc:

Mr. Larry Walker, Geologist
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

Mr. Chuck Green
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, TX 78711-3087

Mr. Phil Dellinger, USEPA Region VI
Environmental Protection Agency, Region VI
Emergency Response Branch (6E-E)
1445 Ross Ave.
Dallas, Tx 75202-2733

Mr. Tom Jones, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

RECEIVED
DEC 20 1993
6 W-S

Mr. Bob Hall, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

MECHANICAL INTEGRITY/FALLOFF TESTING SCHEDULE
WDW NOS. 14 & 110

HOECHST CELANESE - CHEMICAL GROUP
BAY CITY, TEXAS

Prepared by ECO Solutions Inc.

Two key assumptions were made in the preparation of the following 5-year mechanical integrity test schedule. The schedule assumes that 1) WDW-49 will remain brined in and that 2) WDW-14 can be either shut-in or in non-hazardous service during the aldehyde unit shut down. The aldehyde unit shutdown will extend from February 11, 1994 thru February 28, 1994.

Friday, February 11, 1994

WDW-14 shall be placed in non-hazardous service. Flowrates should be maintained at maximum constant operating conditions or as well conditions allow. WDW-14 is to be shut-in for falloff testing on February 15, 1993.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 will be taken out of service on February 13, 1993.

Saturday, February 12, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 and WDW-110 will be taken out of service on February 13, 1993.

Sunday, February 13, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 and WDW-110 should be taken out of service at 7:00 A.M.. WDW-32 will remain out of service until the completion of testing on February 25th. WDW-110 will remain out of service until February 18th.

Monday, February 14, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Tuesday, February 15, 1994

WDW-14, move in and rig up logging unit. Run surface readout bottom hole pressure gauges into WDW-14. Maintain constant flowrates into well while the bottom hole pressure gauges record bottom hole flowing pressures for several hours. Shut well in.

WDW-14 will remain out of service until the completion of testing on WDW-110 on February 24th. However, HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey scheduled for February 18th

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Wednesday, February 16, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Thursday, February 17, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

December 7, 1993
IOC-096-93

FEDERAL EXPRESS MAIL

Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

SUBJECT: WDW-49 (PLANT WASTE DISPOSAL WELL #4)
STATUS UPDATE
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

This letter outlines the Bay City Plant's strategy and schedule in addressing the annulus pressure-test failure of WDW-49. Also included with this transmittal are the well repair/5-year mechanical test procedures for your review and approval. Currently the well is not in service and filled with brine. No changes in this status are anticipated at this time.

We propose that the attached repair procedures or another alternate plan be implemented within the next 24 months. The extended schedule will allow us maximum flexibility in addressing future plant disposal requirements.

We will be considering various options over the next 24 months to determine the ultimate disposition of the well. Several options that will be considered are:

1. Conduct the 5-year mechanical integrity test and install new injection string (see attached procedures, Addendum I).

2. Recomplete WDW-49 in the existing formation.

3. Potentially deepen the well to the lower Miocene for the disposal of acidic waste.

4. Plug and abandon WDW-49.

Hoec

Mr. Larry Walker, Geologist
UIC Team
UIC, uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

Mr. Chuck Green,
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, TX 78711-3087

Mr. Phil Dellinger, USEPA Region VI
Environmental Protection Agency, Region VI
Emergency Response Branch (6E-E)
1445 Ross Ave.
Dallas, Tx 75202-2733

Mr. Tom Jones, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

RECEIVED
DEC 20 1993

Mr. Bob Hall, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

May 9, 1994
IOC-043-94

FEDERAL EXPRESS MAIL - 8635790590

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: WDW-49 (PLANT WELL NUMBER 4)
WORKOVER AND MECHANICAL INTEGRITY TESTING REPORT
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

Two copies of the Workover and Mechanical Intergity Testing report on WDW-49 are enclosed. These reports are provided for your review and approval. As you are aware, the workover and mechanical integrity testing were performed between March 3rd and March 18, 1994 by our Contractor, ECO Solutions, Inc.

Please contact me at 409/241-4197 or Mr. Ray Horton at 409/241-4076 if you have comments or questions about the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Mr. Laurence G. Walker - w/o report
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger (CERTIFIED MAIL) - w/ report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

April 27, 1994
IOC-038-94

CERTIFIED MAIL

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: **PRESSURE FALLOFF MECHANICAL INTEGRITY TESTING (MIT) REPORT FOR WDW-110**

Dear Mr. Knape:

Enclosed are two copies of the Pressure Falloff and MIT report for WDW-110 which are provided for your review and approval. As you are aware, the testing occurred between February 21st and March 28th, 1994 and was performed by our Contractor, ECO Solutions, Inc., Houston, Texas.

Please don't hesitate to contact me at 409/241-4197 if you have comments and/or questions concerning the report.

Very truly yours,

I. O. Coleman, Jr./cjs

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

cc: Mr. Laurence G. Walker, Geologist
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger - **CERTIFIED MAIL** - w/report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

April 26, 1994
IOC-037-94

CERTIFIED MAIL

Mr. Ben K. Knape - Head
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: **PRESSURE FALLOFF MECHANICAL INTEGRITY TESTING (MIT) AND FALLOFF REPORT FOR WDW-14**

Dear Mr. Knape:

Enclosed are two copies of the Pressure Falloff and MIT report for WDW-14 which are provided for your review and approval. As you are aware, the testing occurred between February 16th and February 22nd, 1994 and was performed by our Contractor, ECO Solutions, Inc., Houston, Texas.

Please don't hesitate to contact me at 409/241-4197 if you have comments and/or questions concerning the report.

Very truly yours,

I. O. Coleman, Jr. / cjs

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

cc: Mr. Laurence G. Walker, Geologist
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger - **CERTIFIED MAIL** - w/report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

(4)

MW 4/2/94

APR 14 1994

CERTIFIED MAIL Z 013 011 515 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

We have completed the review of the pressure falloff test conducted in November 1993 for well WDW-32. Based on this review, the EPA has determined that Hoechst Celanese Corporation has fulfilled Petition Approval Condition No. 8 for the year May 4, 1993, to May 4, 1994.

If you have any questions or comments please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs Section (6W-SU)

cc: Ben Knape, TNRCC

MW 4/7/94

6W-SU:4/7/94:HOWARD:H:\LBAN\WP50\CELANESE\CELANESE.BA\FLOFFAPR.93

6W-SU	6W-SU	6W-SU
KORDZI	DELLINGER	WEAVER
J.K 4/7/94		MW 4/11/94

file

(1)

RECORD OF COMMUNICATION

TO: Celanese Bay City File
FROM: Phil Dellinger
DATE: February 23, 1994
TYPE OF COMM: Phone Call
SUBJECT: Mechanical Integrity Test for WDW-14

SUMMARY: Tom Jones of Eco Solutions, Inc. called to report that the mechanical integrity testing on Celanese Bay City Well WDW-14 indicated a hole in the casing below the packer and the well had been shut in. I told him to send the testing info to us soon.

CONCLUSION, ACTION TAKEN OR REFERRED:

FILE COPIES TO:

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

February 2, 1994
IOC-013-94

CERTIFIED MAIL

Mr. Mac A. Weaver, P. E., Chief
UIC State Programs Section (6W-SU)
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: Response To NOD Letter Dated January 12, 1994
Class I Injection Well Permit, No. WDW-32
Hoechst Celanese Chemical Group, Inc.,
Bay City Plant, Bay City, Texas
(Attachment I, NOD Letter Dated 1/12/94 Enclosed
For Your Quick Reference)

Dear Mr. Weaver:

Enclosed in report format is our response to your request for additional information relative to the 1993 annual report previously submitted for WDW-32. This report is provided for your consideration and approval.

I can be contacted by telephone at 409/241-4197 if you have any comments and/or questions concerning the information in the report.

Very truly yours,

I. O. Coleman, Jr./cjs

I. O. Coleman, Jr.

RECEIVED
FEB - 8 1994
6 W-SU

IOC/cjs
attachment

Hoechst

cc: Mr. Joe Kordzi
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Mr. Ben Knape, Chief
UIC Section
Texas Natural Resource Conservation Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711-3087

RECEIVED
FEB - 8 1994
6 W-SU

ATTACHMENT I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

January 12, 1994

CERTIFIED MAIL P 873 011 248 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

Your 1993 annual report for WDW-32 has been reviewed. Please provide the following by February 10, 1994:

1. A detailed summary of events in real time. This should include information on the following: the length of the injection period prior to falloff, rate changes including any that occurred during running of the gauges, problems encountered, etc.

2. A discussion of how the falloff testing was analyzed, including what software was employed, the type of simulation that was performed, assumptions, etc.

3. Worked through calculations, with appropriate explanative text for t_p, the injection period; the time to exit the waste front; the flowing bottomhole pressure; and radius of investigation.

4. A comparison of the static and flowing bottomhole pressures with those predicted by the petition.

In general your report lacks any explanative text and is merely a summary of the data and well analysis. This type of presentation makes it extremely difficult to review your well test. In addition, many of the above comments are covered in the "Pressure Falloff Testing Guideline, First Revision", which was sent to you several months ago. Please ensure that your contractor follows this document in conducting future tests.

RECEIVED
FEB - 8 1994
6 W-SU

If you have any questions, please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A Weaver

Mac A. Weaver, P.E.
Chief
UIC State Programs

RECEIVED
FEB - 8 1994
6 W-SU

JAN 12 1994

CERTIFIED MAIL P 873 011 248 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman, Jr.
Hoechst Celanese Corporation
Bay City Plant
P. O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

Your 1993 annual report for WDW-32 has been reviewed. Please provide the following by February 10, 1994:

1. A detailed summary of events in real time. This should include information on the following: the length of the injection period prior to falloff, rate changes including any that occurred during running of the gauges, problems encountered, etc.

2. A discussion of how the falloff testing was analyzed, including what software was employed, the type of simulation that was performed, assumptions, etc.

3. Worked through calculations, with appropriate explanative text for t_p, the injection period; the time to exit the waste front; the flowing bottomhole pressure; and radius of investigation.

4. A comparison of the static and flowing bottomhole pressures with those predicted by the petition.

In general your report lacks any explanative text and is merely a summary of the data and well analysis. This type of presentation makes it extremely difficult to review your well test. In addition, many of the above comments are covered in the "Pressure Falloff Testing Guideline, First Revision", which was sent to you several months ago. Please ensure that your contractor follows this document in conducting future tests.

G. K 1/11/94

6W-SU:1/10/94:KORDZI:MH:H:\LBAN\WP50\CELANESE\CELANESE.BA\
CELBAY93.ANL
6W-SU 6W-SU
DELLINGER WEAVER

PD 1/11/94 MW 1/11/94

If you have any questions, please contact Joe Kordzi at (214) 655-7186 or Phil Dellinger at (214) 655-7142.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

December 7, 1993
IOC-097-93

CERTIFIED MAIL

Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

SUBJECT: WDW-110 & WDW-14
5-YEAR MIT/FALLOFF TEST SCHEDULE
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

For your review and approval, please find attached the schedule and proposed procedures for the 5-year mechanical integrity testing and annual bottom hole pressure falloff test on WDW-14 and WDW-110.

Your consideration of our request is appreciated.

Please review and comment on the attached procedures as soon as possible.

If you have any questions, contact me at (409) 241-4197.

Respectfully,

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

Hoechst

cc:

Mr. Larry Walker, Geologist
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

Mr. Chuck Green
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, TX 78711-3087

Mr. Phil Dellinger, USEPA Region VI
Environmental Protection Agency, Region VI
Emergency Response Branch (6E-E)
1445 Ross Ave.
Dallas, Tx 75202-2733

Mr. Tom Jones, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

RECEIVED
DEC 20 1993
6 W-S

Mr. Bob Hall, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

MECHANICAL INTEGRITY/FALLOFF TESTING SCHEDULE
WDW NOS. 14 & 110

HOECHST CELANESE - CHEMICAL GROUP
BAY CITY, TEXAS

Prepared by ECO Solutions Inc.

Two key assumptions were made in the preparation of the following 5-year mechanical integrity test schedule. The schedule assumes that 1) WDW-49 will remain brined in and that 2) WDW-14 can be either shut-in or in non-hazardous service during the aldehyde unit shut down. The aldehyde unit shutdown will extend from February 11, 1994 thru February 28, 1994.

Friday, February 11, 1994

WDW-14 shall be placed in non-hazardous service. Flowrates should be maintained at maximum constant operating conditions or as well conditions allow. WDW-14 is to be shut-in for falloff testing on February 15, 1993.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 will be taken out of service on February 13, 1993.

Saturday, February 12, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 and WDW-110 will be taken out of service on February 13, 1993.

Sunday, February 13, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 and WDW-110 should be taken out of service at 7:00 A.M.. WDW-32 will remain out of service until the completion of testing on February 25th. WDW-110 will remain out of service until February 18th.

Monday, February 14, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Tuesday, February 15, 1994

WDW-14, move in and rig up logging unit. Run surface readout bottom hole pressure gauges into WDW-14. Maintain constant flowrates into well while the bottom hole pressure gauges record bottom hole flowing pressures for several hours. Shut well in.

WDW-14 will remain out of service until the completion of testing on WDW-110 on February 24th. However, HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey scheduled for February 18th

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Wednesday, February 16, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Thursday, February 17, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Friday, February 18, 1994

WDW-14, conduct annulus pressure test, temperature survey and radioactive tracer survey. HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey. Rig down and release logging equipment. WDW-14 will remain out of service until the completion of testing on WDW-110 on February 24th.

WDW-110, conduct annulus pressure test, temperature survey and radioactive tracer survey. HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey. Rig down and release logging equipment. Place well back in service.

WDW-32, out of service until the completion of testing on February 24th.

Saturday, February 19, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Sunday, February 20, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Monday, February 21, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Tuesday, February 22, 1994

WDW-110, move in and rig up logging unit. Run surface readout bottom hole pressure gauges into WDW-110. Maintain constant flowrates into well while the bottom hole pressure gauges record bottom hole flowing pressures for several hours. Shut well in and monitor bottom hole pressure.

Friday, February 18, 1994

WDW-14, conduct anr
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14 will remain out of
February 24th.

WDW-110, conduct an
tracer survey. HCCG's
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Saturday, February 19, 1994

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Sunday, February 20, 1994

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Monday, February 21, 1994

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Tuesday, February 22, 1994

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Monday, February 14, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Tuesday, February 15, 1994

WDW-14, move in and rig up logging unit. Run surface readout bottom hole pressure gauges into WDW-14. Maintain constant flowrates into well while the bottom hole pressure gauges record bottom hole flowing pressures for several hours. Shut well in.

WDW-14 will remain out of service until the completion of testing on WDW-110 on February 24th. However, HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey scheduled for February 18th

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Wednesday, February 16, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

Thursday, February 17, 1994

WDW-14, monitor bottom hole pressure falloff with surface readout bottom hole pressure gauges and allow well to thermally stabilize.

WDW-32 will remain out of service until the completion of testing on February 24th. WDW-110 will remain out of service until February 18th.

MECHANICAL INTEGRITY/FALLOFF TESTING SCHEDULE
WDW NOS. 14 & 110

HOECHST CELANESE - CHEMICAL GROUP
BAY CITY, TEXAS

Prepared by ECO Solutions Inc.

Two key assumptions were made in the preparation of the following 5-year mechanical integrity test schedule. The schedule assumes that 1) WDW-49 will remain brined in and that 2) WDW-14 can be either shut-in or in non-hazardous service during the aldehyde unit shut down. The aldehyde unit shutdown will extend from February 11, 1994 thru February 28, 1994.

Friday, February 11, 1994

WDW-14 shall be placed in non-hazardous service. Flowrates should be maintained at maximum constant operating conditions or as well conditions allow. WDW-14 is to be shut-in for falloff testing on February 15, 1993.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 will be taken out of service on February 13, 1993.

Saturday, February 12, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

WDW-32 and WDW-110 flowrates should be held constant to minimize flow/pressure transients in the reservoir prior to testing WDW-14. WDW-32 and WDW-110 will be taken out of service on February 13, 1993.

Sunday, February 13, 1994

WDW-14 should be held at maximum constant operating conditions until the bottom hole pressure falloff test on February 15th.

Friday, February 18, 1994

WDW-14, conduct annulus pressure test, temperature survey and radioactive tracer survey. HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey. Rig down and release logging equipment. WDW-14 will remain out of service until the completion of testing on WDW-110 on February 24th.

WDW-110, conduct annulus pressure test, temperature survey and radioactive tracer survey. HCCG's neutral effluent and injection pumps will be required for the radioactive tracer survey. Rig down and release logging equipment. Place well back in service.

WDW-32, out of service until the completion of testing on February 24th.

Saturday, February 19, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Sunday, February 20, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Monday, February 21, 1994

WDW-110 should be held at maximum constant operating conditions, or as plant constraints allow, until the bottom hole pressure falloff test on February 22nd.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Tuesday, February 22, 1994

WDW-110, move in and rig up logging unit. Run surface readout bottom hole pressure gauges into WDW-110. Maintain constant flowrates into well while the bottom hole pressure gauges record bottom hole flowing pressures for several hours. Shut well in and monitor bottom hole pressure.

WDW-14 and WDW-32 shall remain out of service until February 24th.

Wednesday, February 23, 1994

WDW-110, continue monitoring bottom hole pressure falloff with surface readout bottom hole pressure gauges.

WDW-14 and WDW-32 will remain out of service until February 24th.

Thursday, February 24, 1994

WDW-110, pull out of the hole with surface readout bottom hole pressure gauges. Rig down and release logging unit. Place well back in service.

WDW-32, place well back in service at the completion of testing on WDW-110.

WDW-14, place well back in service at the completion of testing on WDW-110.

FIELD OPERATIONS COMPLETE

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

December 7, 1993
IOC-096-93

FEDERAL EXPRESS MAIL

Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

SUBJECT: WDW-49 (PLANT WASTE DISPOSAL WELL #4)
STATUS UPDATE
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Knape:

This letter outlines the Bay City Plant's strategy and schedule in addressing the annulus pressure-test failure of WDW-49. Also included with this transmittal are the well repair/5-year mechanical test procedures for your review and approval. Currently the well is not in service and filled with brine. No changes in this status are anticipated at this time.

We propose that the attached repair procedures or another alternate plan be implemented within the next 24 months. The extended schedule will allow us maximum flexibility in addressing future plant disposal requirements.

We will be considering various options over the next 24 months to determine the ultimate disposition of the well. Several options that will be considered are:

1. Conduct the 5-year mechanical integrity test and install new injection string (see attached procedures, Addendum I).

2. Recomplete WDW-49 in the existing formation.

3. Potentially deepen the well to the lower Miocene for the disposal of acidic waste.

4. Plug and abandon WDW-49.

Hoec

The attached temperature log was conducted on October 29, 1993 as part of the mechanical integrity testing program (prior to the annulus pressure test). The log provides evidence that WDW-49 has mechanical integrity with the exception of a small leak in a threaded connection in the injection tubing at 3,020'. The temperature log also indicates that:

- No interformational transfer of fluids is occurring between aquifers above the injection zone.
- All fluids being injected are being confined to the injection interval.
- The presence of a tubing leak in a threaded connection at 3,020'.

If you have any questions, please contact me at (409) 241-4197.

Respectfully,

Mr. I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachments

Mr. Larry Walker, Geologist
UIC Team
UIC, uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, TX 78711-3087

Mr. Chuck Green,
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, TX 78711-3087

Mr. Phil Dellinger, USEPA Region VI
Environmental Protection Agency, Region VI
Emergency Response Branch (6E-E)
1445 Ross Ave.
Dallas, Tx 75202-2733

Mr. Tom Jones, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

RECEIVED
DEC 20 1993

Mr. Bob Hall, ECO
ECO Solutions
10333 Richmond Avenue
Suite 250
Houston, TX 77042

ADDENDUM I

REPAIR PROCEDURES
HOECHST CELANESE BAY CITY PLANT
WELL NUMBER 4

The following plan was developed by Eco Solutions, Inc., to repair the leak in the injection tubing and satisfy five-year Mechanical Integrity Test requirements on Hoechst Celanese number 4 (WDW-49) injection well at Bay City, Texas. Please note that a temperature log was conducted on October 29, 1993.

1. Obtain approval from Texas Natural Resource Conservation Commission

2. Move in an rig up workover rig.

3. Disassemble wellhead and nipple up blowout preventor.

4. Release 5½" injection tubing from packer and pull out of the hole with same.

5. Run electromagnetic casing inspection log from packer depth back to surface.

6. Go in the hole with test seal assembly on workstring and engage packer.

7. Pressure test annulus to 1,000 psig from 30 minutes.

8. Pull out of the hole with test seal assembly - lay down workstring.

9. Go in the hole with redressed seal assembly on new 5½" 20#/ft. N-80 LT&C injection string.

10. Displace annulus with corrosion inhibited brine.

11. Engage packer, nipple down blowout preventor and reassemble wellhead.

12. Pressure test annulus to 1000 psig for 30 minutes.

13. Rig down workover rig.

14. Conduct annulus pressure test and radioactive tracer survey for mechanical integrity test.

15. Place well in non-hazardous service for one week.

16. Perform bottom hole pressure falloff test with non-hazardous effluent.

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

RECEIVED
DEC 10 1993
6 W-S

December 6, 1993
IOC-095-93

CERTIFIED MAIL

Mr. Laurence G. Walker, Geologist
UIC Team
UIC, Uranium and Radioactive Waste Section
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: **MECHANICAL INTEGRITY TEST (MIT) REPORT FOR WDW-32**

Dear Mr. Walker:

Enclosed are two copies of the MIT report for WDW-32 which are provided for your review and approval. As you are aware the testing occurred between October 25th and October 28th 1993 and was performed by our contractor, ECO Solutions, Inc., Houston, Texas.

Please don't hesitate to contact me at 409/241-4197 if you have comments and/or questions concerning the report.

Very truly yours,

I. O. Coleman, Jr./cjs

I. O. Coleman, Jr.
Environmental Section Leader

IOC/cjs
attachment

cc: Mr. Ben K. Knape, Head - w/o
UIC Team
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Texas 78711-3087

Mr. Phil Dellinger - **CERTIFIED MAIL** - w/report
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Hoechst Celanese

(4)

RECEIVED
NOV 4 1993
6 W-S

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

November 3, 1993
IOC-088-93

FEDERAL EXPRESS

Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission (TNRCC)
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087
And
Park 35 Circle Colonnade Building
12015 North IH 35
Austin, Texas 78723

Subject: WDW-49
Mechanical Integrity Testing (MIT) Update
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas

Dear Mr. Knape:

On Friday, October 29, 1993, the annual scheduled MIT was performed on WDW-49. During the annulus pressure test, the annulus was pressurized to 1100 psi and a pressure decline of 3 to 7 psi per minute was observed.

This letter documents the failure of WDW-49 of the annular pressure test. As you are aware, the testing was witnessed by Mr. Larry Walker of your Austin, Texas Office.

WDW-49 was filled with brine and shut-in prior to the MIT and will remain shut-in until a strategy is generated and implemented to address the failure. Just prior to the annulus pressure test, a temperature log was performed and indicates that the probable cause of the failure is a tubing leak associated with a connection at a depth of 3020 feet.

A workover plan and a tentative schedule will be prepared and submitted to you (within 30 working days) on or before December 13, 1993.

Please contact me at 409/241-4197 if any additional information is needed.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Mr. Chuck Green
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, Tx 78711-3087

Mr. Larry Walker
Texas Natural Resource Conservation Commission
P. O. Box 13087
Austin, TX 78711-3087

Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

RECEIVED
NOV - 4 1993
6 W-SU

RECORD OF COMMUNICATION	☒ PHONE CALL ☐ DISCUSSION ☐ FIELD TRIP ☐ CONFERENCE ☐ OTHER (SPECIFY) (Record of item checked above)	
TO: I. O. COLEMAN CELANESE BAY CITY	FROM: PHIL DELLINGER	DATE 11/1/93 TIME 9:30

SUBJECT
ANNUAL WELL TEST FOR WDW 49-4

SUMMARY OF COMMUNICATION

I. O. COLEMAN CALLED TO DISCUSS POSTPONING THE ANNUAL WELL TEST FOR WDW 49-4. THE WELL HAS A TUBING LEAK AND IS SHUT IN. A WORKOVER TO REMEDIATE THE PROBLEM HAS NOT BEEN COMPLETED. THE LAST WELL TEST RUN FOR WDW 49-4 WAS 9/22/92. I TOLD I. O. THAT ~~[illegible]~~ THE WELL TEST FOR WDW 49-4 SHOULD BE RAN AFTER THE WELL HAS BEEN RETURNED TO INJECTION.

CONCLUSIONS, ACTION TAKEN OR REQUIRED

INFORMATION COPIES
TO: CELANESE BAY CITY FILE

R6-123 (2-84)

(4)

September 21, 1993

Mr. I. O. Coleman
Hoechst Celanese Chemical Group, Inc.
P.O. Box 509
Bay City, Texas 77414

Dear Mr. Coleman:

Enclosed is the EPA Region 6 Pressure Falloff Testing Guideline - First Revision. This guideline should be followed in the performance of future falloff testing in fulfillment of the applicable petition condition outlined in your approved no migration petition exemption.

If you have any questions, please contact Joe Kordzi at (214) 655-7186.

Sincerely,

Mac A. Weaver, P.E.
Chief
UIC State Programs

Enclosure

6W-SU:9/20/93:HOWARD:H:\LBAN\WP50\CELANESE\CELANESE.BA\1REVGUID.R6

6W-SU	6W-SU	6W-SU
KORDZI	DELLINGER	WEAVER
J.K. 9/21/93	J.K. 9/21/93	MW 9/21/93

PRESSURE FALLOFF TESTING GUIDELINE
FIRST REVISION
REGION 6
September 14, 1993

BACKGROUND

The Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act mandated prohibitions on the land disposal of hazardous waste. These prohibitions are known as the land disposal restrictions and EPA promulgated regulations to implement these requirements for injection wells on July 26, 1988. The land disposal restrictions for injection wells are codified in 40 CFR Part 148. In addition to specifying the effective dates of the restrictions on injection of specific hazardous wastes, these regulations outline the requirements for obtaining an exemption to the restrictions.

Facilities which have received an exemption to the land disposal restrictions under 40 CFR Part 148 have demonstrated that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. As part of this approval, facilities are required by Region 6 to meet approval conditions including annual monitoring in accordance to 40 CFR 148.20(d)(2).

Region 6 has adopted the 40 CFR 146.68(e)(1) requirements for monitoring Class 1 hazardous waste disposal wells. Under 40 CFR 146.68(e)(1), operators are required to annually monitor the pressure buildup in the injection zone, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure falloff curve.

PURPOSE OF GUIDELINE

This guideline has been developed by the Region 6 office of the EPA to assist operators in preparing an annual monitoring report. These reports, in most instances, should consist of a falloff test and a comparison of the reservoir parameters derived from the test with those of the petition demonstration. The primary function of this guideline is not to establish boundaries within which enforcement action can be taken. Rather, this guideline is intended to provide direction as to the correct performance of injection well falloff testing. Consequently, the annual report is viewed not as an enforcement tool, but as an annual reaffirmation that the petition demonstration continues to be valid. This constitutes the first revision of this guideline.

ANNUAL PRESSURE TESTING REQUIREMENTS

Basically, a falloff test consists of injecting at a constant rate, shutting in the well, and measuring the pressure falloff. The falloff test must be properly designed so that valid results are obtained. The following points should be kept in mind when planning or conducting a falloff test:

1. The injection rate should be held constant throughout the injection portion of the test. Small, normal fluctuations due to the design of the pump are acceptable. This rate should be at a high enough rate, for a period of time sufficient to produce a pressure buildup, which will result in a valid test. The amount of pressure buildup required will depend largely on the resolution of the pressure gauge used, and the specific properties of the formation. The injection rate must result in a pressure buildup such that a semilog straight line can be determined from the Horner plot.

2. Bottom hole pressure measurements are considered superior to surface pressure measurements. However, surface pressure measurements can be employed if it is demonstrated that a positive pressure is maintained at the surface throughout the falloff portion of the test. The surface pressure gauge must be located at the wellhead. For either surface or bottomhole pressure measurements, the well must be shutin <u>at the wellhead</u> in order to minimize wellbore storage and afterflow.

3. If surface pressure measurements will be employed and it is anticipated that the injection well will go on vacuum during the test, a two-rate test should be used in order to maintain a positive pressure. Failure to maintain a positive pressure would result in changing wellbore storage effects, making analysis of the test difficult. A relatively high initial rate should be followed by a decreased rate. The pressure decrease as a result of the rate decrease is then analyzed. Choosing the two rates correctly results in a positive surface pressure during the falloff portion of the test and the interpretation problem resulting from changing wellbore effects is thus eliminated.

4. The viscosity and density of the injected fluid should be held as constant as possible throughout the test. Operators are encouraged to use their normal waste streams as injectate, if enough volume will be available so that the guidelines in No. 1 above, concerning the injection rate, can be followed. The value of the viscosity employed in analyzing the test should be that of the fluid through which the pressure transients propagate. Note: This is not necessarily the viscosity of the injected fluid and may be the viscosity of the waste plume or the formation fluid, depending on the size of the waste plume. This is covered in more detail below.

5. Ideally, no injection in nearby facility wells should occur in the interval being tested. In addition, the pressure buildup in the injection interval due to offset wells should be stabilized prior to the shutin of the test well. Should operational problems prohibit this, the following steps should be taken:

   a) The offset well should maintain as constant a rate as possible for several days prior to and throughout the test. The injection history of the offset injector just prior to shutin is the most influential to the falloff testing results.

   b) The injection rate of the offset well should be recorded before and during the falloff period.

   c) The falloff test should then be simulated, including the pressure influence due to the offset injection. The results of the simulation should then be compared to the observed falloff. Several commercially available software packages have this capability, or it can be done with simple in-house developed computer programs.

   Following the above procedures does not, however, guarantee good results. Shutting in all injection in communicable zones nearby, and allowing the reservoir pressure to stabilize prior to falloff is strongly recommended. EPA has had success in assisting the coordination of cooperative well testing between nearby facilities.

6. The depth to any fill in the well tested should be tagged and recorded with the test. Operators are encouraged to conduct a flow profile survey in conjunction with the falloff testing in order to better define the thickness receiving flow.

7. The falloff portion of the injection well test should be run long enough such that enough data points lie well within the infinite acting period and the semilog straight line is well developed. Usually, if at least one log cycle of the semilog straight line is present, this will be satisfied.

8. A log-log plot with a semilog derivative should be supplied to enable identification of the end of the wellbore storage period. The beginning of the infinite acting portion of the test should be identified on both plots.

9. A Horner plot of the data should be submitted. In addition, the entire infinite acting portion of the Horner plot should be reproduced on an expanded scale in order to permit a closer inspection of any data fluctuations. The slope employed to calculate the kh/μ product should be drawn on both plots. In

addition, the beginning of the infinite acting portion of the test should be identified on both plots.

10. A photocopy of an SP or gamma ray log through the injection zone, with the completion perforations or screened areas annotated, should be submitted. The entire log is not necessary.

11. A cartesian graph (not a circular or strip chart) of the injection rate for at least 48 hours prior to shutin, or from the last time the well was shutin and the reservoir pressure stabilized should be submitted for all communicable wells in the formation being tested.

12. All data, including verification of the viscosity of the fluid through which the pressure transients of the infinite acting portion of the test were propagating, should be submitted. All equations used in the analysis should be provided with the appropriate parameters substituted into the equations. Any abnormal data fluctuations should be explained.

13. A 3-1/2 inch diskette containing the <u>unedited</u> falloff test data must be submitted. The data associated with the buildup portion of the test, if available, should also be included. This data should be in the form of an ASCII file and should include the time, pressure, and rate data of the test. In addition, the parameter units format (hh:mm:ss, hours, etc.) should be indicated. More than one falloff test data set can be contained on a diskette.

14. Any test that was not shutin long enough to develop an infinite acting period, or one that cannot be properly analyzed for the kh/μ parameter group using Horner techniques, should be rerun unless other arrangements have been made with EPA staff.

15. Any unorthodox testing procedure, or any testing of a well with known or anticipated problems, should be discussed with EPA staff prior to performing the test.

<u>COMPUTER SOFTWARE</u>

Due to the accuracy and high frequency of data acquisition of modern pressure gauges, the use of well testing computer software is now a standard tool of falloff test analysis. EPA Region 6 has acquired such a software package and will be using it to analyze falloff tests, especially those that are complicated by unusual events or those that result in anomalous conclusions. Therefore, a diskette containing the unedited falloff test data is required to be submitted along with the test. Operators are encouraged to employ well testing software that has the capability of pressure

history simulation using non-linear regression. This feature allows operators to simulate the entire falloff test, including transitional periods, and to compare this simulation to the actual data. This is done by using either a fixed set of parameters calculated by the falloff test analysis, or by allowing these parameters to vary within a selected range, until the simulation most closely matched the actual data. Confidence intervals can then be calculated as a check of how well the simulated data matches the actual data. This type of analysis is particularly useful in the recognition of boundaries, or unusual reservoir characteristics, such as dual porosity. It should be noted that type curve matching is not considered a substitute, but is a compliment to, a traditional Horner based analysis.

APPROPRIATE FLOW RATE

In theory, the time required to achieve a particular radius of investigation is independent of the flow rate. However, in practice, the flow rate must be large enough such that pressure changes with time can be recorded with sufficient precision to be useful for analysis. This is especially important for very transmissive reservoirs in which pressure transients are dissipated rapidly.

It is common practice in the performance of a falloff test to begin by shutting in the well to allow the reservoir pressure to stabilize. Following this, brine is usually brought in and the injection portion of the test is begun. This ensures that only those pressure transients propagated during the injection portion of the test influence the falloff portion of the test. However, if the wellhead is rigged for a lubricator, it is possible to employ the wastestream as the injection fluid and lower the pressure gauge into the well without any interruption of the injection rate. Alternatively, the use of a surface gauge affords the same opportunity to use the waste stream as the injection fluid without interruption of the injection rate. Use of the waste stream as the injection fluid affords several distinct advantages:

a) Brine does not have to be purchased.

b) The length of the injection period is not limited by economics - the amount of brine purchased. This can result in a better test due to a greater pressure buildup in the reservoir. Consequently, more pressure falloff can occur during the infinite acting portion of the test, which minimizes the effect of data fluctuations.

c) The overall test period is reduced due to the elimination of a separate injection period. This results in less down time.

Regardless of the injection fluid employed, the injection rate should be held as constant as possible. As stated earlier, the significance of rate interruptions or changes in rate increase as they occur closer to the shutin period. If a rate change occurs during the injection portion of the test, such as when a lubricator is rigged up, several methods are available to treat this occurrence:

a) The well can be shutin until the reservoir pressure equilibrates and the injection period started over.

b) The injection rate can be held constant from this point forward until the effect of the rate interruption is insignificant. The additional injection time required for the rate interruption to have an insignificant effect on the falloff test will depend on the particular reservoir parameters under consideration.

c) The rate change can be accounted for by using the principal of superposition in time. In this method, the effects of individual rate changes are added together as if they were separate wells injecting at the same location. However, a gradual change in rate may be difficult to treat in this manner.

PRESSURE DERIVATIVE ANALYSIS

The pressure derivative curve is a log-log plot of the change in slope of the semilog plot of pressure with respect to time. It may be employed for several reasons, such as recognition of the beginning of the infinite acting portion of the test and other flow regimes, and restrictive boundaries. The derivative plot allows a more accurate determination of the start of the infinite acting portion of the test, in comparison with the traditional method of simply proceeding one and one half log cycles past the end of the unit slope line on the log-log plot of the pressure versus time data. Indeed, it is advantageous to have the ability to plot a derivative curve while the falloff test is being performed in order to ensure that the well has been shutin long enough to be comfortably in the infinite acting flow regime. Characteristically, this period can be identified by a flattening out of the derivative curve. The start of the infinite acting portion of the test must be displayed on both the derivative and Horner plots.

The derivative must be displayed on a log P′ vs. log delta t scale, a log P′ vs. log "equivalent time" scale, or in unusual circumstances, some other time format. The equivalent time concept is credited to R. G. Agarwal and is employed to account for the injection history prior to shutin. This time is calculated as follows:

$$t_{eqv} = \frac{t_p \Delta t}{t_p + \Delta t}$$

where t_{eqv} = Agarwal equivalent time, hours
t_p = injection time, hours
delta t = shutin time, hours

The use of equivalent time can be more appropriate than a log delta time scale, which ignores the injection history and may distort the derivative plot to the point where nonexistent boundaries are perceived. This can occur because the transient due to the injection period preceding shutin influences the shape of the derivative. EPA frequently encounters reports in which the derivative is only displayed on a log P_D' (dimensionless pressure) vs. log t_D / C_D (dimensionless time divided by dimensionless wellbore storage coefficient) scale. This presents a problem to the reviewer in that points cannot be directly transferred from the derivative plot to the Horner plot. In addition, the only way to display the dimensionless plot is by first knowing the dimensionless quantities, which are functions of, in part, the kh/μ product. This requires that the dimensionless plot be constructed from either a curve matching technique, or that the Horner analysis is done first and the dimensionless quantities then calculated. In either case the derivative displayed using dimensionless quantities can only be constructed after the well test has been analyzed, which defeats one of the principal purposes of constructing the derivative - the detection of the infinite acting portion of the test. This knowledge should be acquired before the well test is analyzed. Following a conventional Horner analysis, a dimensionless derivative plot may be matched by a curve fitting technique to further support the analysis.

VISCOSITY SELECTION

It is not unusual, in cases in which the viscosity of the historically injected fluid varies significantly from that of the formation fluid, for the resulting mobility ratio $(k/\mu)_w/(k/\mu)_f$ change (where the subscripts "w" and "f" refer to the waste and formation fluid, respectively) to be reflected in the Horner plot by a change in slope. The infinite acting portion of the derivative curve should also change and level to another value. Eliminating alternative geologic causes, such as a sealing fault, multiple layers, dual porosity, etc., leads to the interpretation of this change in slope as representing the boundary of the two fluid banks.

This problem is most commonly resolved by first assuming that the pressure transients were propagating through the formation fluid during the infinite acting portion of the test, and later verifying that this assumption was correct. This is generally a good strategy except for a few facilities with exceptionally long injection histories, and consequently, large waste plumes. The time for the pressure transient to exit the waste front is first calculated. This time is then plotted on the derivative and Horner plots. The start of the infinite acting portion of the test is then verified to have occurred after this time. The specific steps involved are as follows:

The time necessary for a pressure transient to traverse a given radius can be calculated as follows (Lee, J.: *Well Testing*, Society of Petroleum Engineers of AIME, Dallas (1982), page 15, Equation 1.47):

$$t = \frac{948 r_i^2 \phi \mu c_t}{k}$$

where
- r_i = radius of investigation, ft
- k = permeability, md
- t = time injected, hrs
- ϕ = porosity, fraction
- c_t = total compressibility, psi^{-1}
- μ = viscosity of fluid at reservoir conditions, cp

The distance to the waste front can then be estimated volumetrically using the following equation:

$$r = \left(\frac{0.13368V}{\pi h \phi}\right)^{1/2}$$

where
- V = cumulative injection into completed interval only, gal
- r = estimated distance to waste front, ft
- h = interval thickness, ft
- ϕ = porosity, fraction
- π = approximately 3.14

It follows that the time necessary for a pressure transient to exit the waste front can be found by substituting the radius equation into the time equation:

$$t_w = \frac{126.73\mu c_t V}{\pi k h}$$

where V = cumulative injection into completed interval only, gal
h = interval thickness, ft
ϕ = porosity, fraction
π = approximately 3.14
μ_w = viscosity of historic waste plume at reservoir conditions, cp

This time should be plotted on both the derivative and Horner plots. If, the time necessary for a pressure transient to exit the waste front occurs before the start of the infinite acting period, the assumption that the pressure transients were propagating through the reservoir fluid during the infinite acting period was correct. The viscosity of the reservoir fluid is then the appropriate viscosity to use in analyzing the well test. If not, then the viscosity of historic waste plume should be employed. In either case, adequate information must be presented in order that the viscosity of the appropriate fluid, at reservoir conditions, can be verified. The thickness of the injection interval should also be justified. This should include the disclosure of the existence and top of any wellbore fill, and whether or not the injection interval is composed of hydraulically isolated units or a single massive unit. In certain instances, particularly when hydraulically isolated sands are present, it may be necessary to define the amount of flow entering the fill through the use of a flow profile survey. In order to avoid interpretation problems, operators are encouraged to regularly remove any fill from the wellbore.

HORNER PLOT ANALYSIS

The start of the infinite acting portion of the test should be transferred from the derivative plot to the Horner plot. In addition, if other than a direct reading scale was employed in the derivative plot, such as Agarwal time, any information necessary to convert this point from the derivative plot to the Horner plot should be provided. This time approximates the point when the pressure transient has moved beyond the influence of the altered zone near the well and when wellbore storage has ceased distorting the pressure falloff test data. At this time the semilog straight line whose slope is related to formation permeability can be observed on the Horner plot. This straight line ordinarily will continue until the radius of investigation reaches one or more reservoir boundaries, massive heterogeneities, a fluid/fluid contact, or runs out of measurable pressure transients. The slope

of the Horner plot (m) is used to determine the (kh/μ) parameter group from the following equation:

$$\frac{kh}{\mu} = \frac{162.6qB}{m}$$

where: m = slope of the Horner plot, psi/cycle
q = injection rate, bpd
B = formation volume factor, rvb/stb
h = interval thickness, ft
μ = appropriate viscosity at reservoir conditions, cp
k = permeability, md

The slope employed in the above equation should be drawn on the Horner plot and expanded Horner plot. It should represent only the infinite acting portion of the test, as indicated by the derivative plot.

WELLBORE SKIN AND FLOWING BOTTOMHOLE PRESSURE

In theory, wellbore skin is treated as an infinitesimally thin sheath surrounding the wellbore, through which a pressure drop occurs due to either damage or stimulation. Industrial injection wells deal with a variety of waste streams that alter the near wellbore environment due to precipitation, fines migration, ion exchange, bacteriological processes, and other mechanisms. It is reasonable to expect, and there is evidence to support the fact, that this alteration often exists as a zone surrounding the wellbore and not a skin. Therefore in practice, at least in the case of industrial injection wells, the assumption that skin exists as a thin sheath is not always valid. This does not pose a serious problem to the correct interpretation of falloff testing except in the case of a large zone of alteration, or in the calculation of the flowing bottomhole pressure. EPA has seen several instances in which large zones of alteration were suspected of being present. These cases have been matched using composite reservoir simulations with mixed results. This is obviously an area which could benefit by additional research. In the interim, EPA will rely on the traditional approach. The equation typically employed to characterize skin is as follows:

$$S = 1.1513\left[\frac{p_{1hr}-p_{wf}}{m}-\log\left(\frac{kt_p}{(t_p+1)\phi\mu c_t r_w^2}\right)+3.2275\right]$$

where: s = skin factor, dimensionless
p_{1hr} = pressure intercept along the straight line portion of the Horner plot at a shutin of 1 hour, psi.
p_{wf} = measured flowing bottomhole pressure at delta t=0, psi
μ = appropriate viscosity at reservoir conditions, cp
m = slope of the Horner plot, psi/cycle
k = permeability, md
ϕ = porosity, fraction
c_t = total compressibility, psi^{-1}
r_w = wellbore radius, feet
t_p = injection time, hours

It can be seen that this equation deviates from the usual equation employed for skin in that the factor, $t_p/(t_p$ +delta t), where delta t=1hr, appears in the log term. This term is usually assumed to result in a negligible contribution to the skin factor and is therefore left out of the equation. However, for relatively short injection periods this term can be significant.

Although the skin factor concept is useful for estimating the degree of damage or stimulation to the well, its use in this guideline is limited to the calculation of the flowing bottomhole pressure. The adjusted flowing bottomhole pressure is calculated by subtracting the pressure due to skin, in the usual case of a damaged well, from the flowing bottomhole pressure:

$$p_{wfa} = p_{wf} - 0.868ms$$

where: P_{wfa} = adjusted bottomhole flowing pressure, psi

p_{wf} = measured flowing bottomhole pressure at delta t=0, psi
s = skin factor, dimensionless
m = slope of the Horner plot, psi/cycle

From the above equation, it can be seen that the adjusted bottomhole flowing pressure is directly dependant on a single point - the last flowing pressure recorded prior to shutin. Therefore, an accurate recording of this point is an important step in obtaining the skin factor in this manner. Consequently, any unusual data fluctuations or nonstandard pressure responses in the immediate area of this point should be viewed with suspicion.

PRESSURE GAUGES

Calibration checks of gauges should be made before and after each test using a dead weight tester. Gauges should also be calibrated by the manufacturer at least annually, or when the dead weight tester indicates that the gauge is out of the manufacturer's specifications. Manufacturer's recommendations, if different than this calibration interval, should be followed. Along with the falloff testing report, the manufacturer's recommended frequency of calibration, and a gauge calibration certificate should be provided demonstrating that this practice has been followed.

COMPARISON TO PETITION DATA

A comparison between the falloff test results and the parameters used in the no migration petition demonstration should be made. Specifically, the following should be demonstrated:

1. Both the flowing and static bottom hole pressures measured during the test should be at or below those which were predicted to occur by the pressure buildup model for the same point in time.

2. It should be shown that the (kh/μ) parameter group calculated from the current falloff data is the same or greater than that employed in the pressure buildup modeling.

3. If in the original petition, the permeability calculated from falloff testing was employed in determining a background reservoir velocity, that permeability should be compared to that derived from the current falloff test.

REPORT FOR EPA

A detailed report should be submitted to Region 6 summarizing the results of the falloff test with the parameters used in the no migration demonstration. The report should include all raw data, a discussion of the testing procedure, all graphs and calculations, interpretations and conclusions from the test, and a comparison of all parameters with those used in the petition demonstration including references where the parameters can be found in the petition. The report should include the following data:

A. Falloff Test Data

1) General Test Information

Date of test
Time since reservoir pressure was last stabilized

Cumulative injection into completed interval
Wellbore radius
Completed interval
Type of completion
Depth to fill
Justified interval thickness
Average historical waste fluid viscosity
Formation fluid viscosity
Porosity
Total compressibility
Formation volume factor
Initial formation bottom hole pressure and temperature

2) Injection Period

Time of injection period
Test fluid
Injection rate graph for all wells completed in the test interval
Pumps used for test
Injection fluid viscosity
Method and times viscosity tested
Final injection pressure and temperature
Gauge type (Panex, HP, etc)
Gauge resolution and calibration check
Gauge depth

3) Falloff Period

Total shutin time
Final shutin pressure and temperature

B. Calculated Test Data

Distance to waste front
Radius of investigation
Time to beginning of infinite acting portion of test (from derivative)
Horner time to beginning of infinite acting portion of test
Slope or slopes from Horner plot
kh/μ
Permeability (range based on values of h)
Skin

C. Gauge calibration certification

TIMING OF REPORT SUBMISSION **(PLEASE NOTE REVISIONS)**

The testing discussed above must be conducted within one year from the date of petition approval, unless prior authorization for an extension or alternative due date has been granted by EPA. In

AUG 19 1993

AUG - 9 1993

CERTIFIED MAIL P 106 970 818 RETURN RECEIPT REQUESTED

Mr. I.O. Coleman, Jr.
Environmental Affairs Section Leader
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, TX 77404-0509

Dear Mr. Coleman:

The EPA has reviewed the revised falloff test procedures for WDW-32 and WDW-49 dated July 16, 1993 and finds them acceptable. The EPA falloff testing guidelines recommend all offset wells be shut in prior to and during the falloff test. Celanese has stated that shutting in all offset wells is not feasible at the Bay City site. Celanese has proposed a procedure that should minimize the effects of offset injection. Celanese will be responsible for running valid well tests. Should these procedures result in well tests that are unanalyzable, Celanese may be required to rerun the tests using an alternate procedure.

Celanese is strongly urged to review the falloff testing guidelines prior to submitting the falloff test report. The format of previous reports submitted by Celanese has not included the data requested in the guidelines, therefore resulting in numerous deficiencies prior to evaluation of the test. The report should be submitted within 45 days of the test date. This report should include the requested documentation of parameters, calculations, and data.

Please contact Phil Dellinger at (214) 655-7142 if you have any questions.

Sincerely yours,

OPTIONAL FORM 99 (7-90)
FAX TRANSMITTAL
# of pages ▶ 1
To: I.O. Coleman
From: Phil Dellinger
Dept./Agency: Celanese
Phone #: (214) 655-7142
Fax #: (409) 241 4141
Fax #:
NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

Mac A. Weaver, P.E.
Chief
UIC State Programs Secti

cc: Ben Knape, TWC

6W-SU:8/19/93:DELLINGER:MH:H:\LBAN\WP50\CELANESE.BA\BAYCPROC.LTR

PD 8/19/93

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

July 16, 1993
IOC-062-93

FEDERAL EXPRESS

Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

SUBJECT: REVISED ANNUAL 1993 BOTTOM HOLE PRESSURE FALLOFF PROCEDURES, WASTE DISPOSAL WELLS, WDW-32 AND WDW-49, HOECHST CELANESE CHEMICAL GROUP, INC., BAY CITY PLANT, BAY CITY, TEXAS (REF. LETTER, IOC-046-93, DATED JUNE 4, 1993)

Dear Mr. Dellinger:

For your review and approval, please find attached the revised (7/16/93) field procedures (Addendum I) prepared by Golden Environmental Services for the annual bottom hole pressure falloff tests on WDW-32 and WDW-49. Falloff testing on these wells is anticipated to be performed late September or early October 1993.

Please comment in writing on these procedures as soon as possible, preferably on or before August 2, 1993. The quick comment period is requested to allow sufficient time to modify our Plant operations to accomodate the approved test procedures.

If you have any questions, contact me at 409/241-4197.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

IOC/cjs
attachment

RECEIVED
WATER SUPPLY BRANCH
93 JUL 19 PM 2:06
6W-S

Hoechst

cc: Mr. Mac A. Weaver, P.E., Chief
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Mr. Richard Merritt, Permit Coordinator
Underground Injection Control Unit
Industrial and Hazardous Waste Division
Texas Water Commission
P. O. Box 13087
1700 North Congress Ave.
Austin, TX 78711-3087

RECEIVED
JUL 19 1993
6 W-SU

BOTTOM HOLE PRESSURE FALLOFF TESTING
WDW NOS. 32 & 49

HOECHST CELANESE - CHEMICAL GROUP
BAY CITY, TEXAS

Prepared by Golden Environmental Services

1) WDW-49 is to be brined in prior to conducting bottom hole pressure falloff testing.

2) At least 48 hour prior to conducting bottom hole pressure testing, reduce the injection rates as low as possible on the wells remaining in service, WDW-110 and WDW-14, during the falloff testing.

3) Maintain high constant injection rates on WDW-32 prior to conducting falloff test on same.

4) Install surface readout bottom hole pressure gauges in WDW-32.

5) Conduct bottom hole pressure falloff testing on WDW-32.

6) Remove bottom hole pressure gauge from WDW-32. Leave WDW-32 shut-in.

7) Place WDW-49 back in service for approximately one week prior to conducting falloff testing on same.

8) At least 48 hour prior to conducting bottom hole pressure testing on WDW-49, reduce the injection rates as low as possible on WDW-14 and WDW-110.

9) Maintain high constant injection rates on WDW-49.

10) Conduct bottom hole pressure test on WDW-49.

11) Place wells back in service.

RECEIVED
JUL 19 1993
6 W-SU

FILE

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

July 12, 1993
IOC-059-93

CERTIFIED MAIL

Mr. Mac A. Weaver, P. E.
Chief
UIC State Programs Section (6W-SU)
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: **Response To EPA Letter (Attached as Addendum I) Dated March 25, 1993 Relative To 1992 and 1993 Falloff Tests Conducted On WDW-32, WDW-49 and WDW-110**
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas

Dear Mr. Weaver:

Enclosed herewith, in a report format, is our response to the list of deficiencies attached to the above letter. The report, generated by our consultants, Golden Environmental Services, Inc., is provided for your review and approval.

Please contact me by telephone at 409/241-4197 should you have questions and/or comments pertaining to the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

RECEIVED
WATER PROGRAMS DIVISION
93 JUL 14 PM 3:03
6W-S

cjs
attachment

Hoechst

cc: Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi - w/o attachment
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ben Knape
Geologist
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, TX 78711-3087

Mr. Richard Merritt, Geologist
Texas Water Commission
P. O. Box 13087, Capitol Station
1700 North Congress Ave.
Austin, TX 78711-3087

RECEIVED
JUL 14 1993
6 W-SU

ADDENDUM I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

June 25, 1993

CERTIFIED MAIL P 176 167 075 RETURN RECEIPT REQUESTED

Mr. I.O. Coleman, Jr.
Environmental Affairs Section Leader
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, TX 77404-0509

Dear Mr. Coleman:

The proposed pressure falloff procedures for WDW-32 and WDW-49 have been reviewed and comments enclosed. The responses to the March 3, 1993, deficiencies have also been evaluated and additional deficiencies identified. Please respond to these deficiencies by July 12, 1993.

Please contact Phil Dellinger at (214) 655-7142 if you have any questions.

Sincerely yours,

Phil Dellinger

for Mac A. Weaver, P.E.
Chief
UIC State Programs

RECEIVED
JUL 14 1993
6 WQSU

Printed on Recycled Paper

EPA COMMENTS ON PROPOSED 1993 FALLOFF TEST PROCEDURES FOR WDW-32 AND WDW-49
June 25, 1993

Item No. 1: No comment.

Item No. 2: It is recommended the falloff tests for WDW-32 and WDW-49 be run separately to prevent any interference between the two wells. A falloff test and corresponding interference test may also be considered as an option.

It is further recommended Celanese use a constant injection rate of 200 gpm for the injectivity period prior to falloff to test both WDW-32 and WDW-49. Celanese is proposing to inject 50 gpm into WDW-32 and 40 gpm into WDW-49. These rates are well below the 87 gpm and 80 gpm injected into the wells during the 1992 well tests. The 1992 well test for WDW-14 and the 1993 well test for WDW-110 both injected at a 200 gpm rate prior to shut in. The falloff tests for WDW-14 and WDW-110 had clearly defined regions of radial flow. The 1992 falloff tests for WDW-32 and WDW-49 did not result in well defined radial flow regions. The injection rates prior to shut in appear to have a strong impact on the falloff test results.

Celanese stated that nonhazardous waste will be injected into WDW-32 and WDW-49 prior to falloff. Plant waste can be used as the injected fluid provided it is of a relatively constant viscosity and there are no compatibility problems with the pressure gauge.

Item No. 3: Celanese should also record the injection rates for WDW-14 and WDW-110 during the falloff testing period. These rates should be submitted on a cartesian graph in the report to the EPA.

Item No. 4: No comment.

Item No. 5: No comment.

Item No. 6: A falloff period of 48 hours may not be required. The falloff test should be run long enough so that several data points lie within the radial flow portion and the semilog straight line should be well developed. In the 1993 falloff test for WDW-110, the falloff test was run for 18 hours.

Item No. 7: No comment.

Item No. 8: No comment.

injection time (t) and a final falloff time of 48 hours (delta t), the resulting Horner time and Agarwal equivalent time do not correspond to the end points observed on the semilog and log-log plots shown for WDW-49. Celanese should verify that the proper units were assigned to the input data. Celanese should provide a revised log-log plot, semilog plot, and analysis for the WDW-49 1992 falloff test.

2. Celanese should provide a diskette containing the unedited falloff test data. Celanese should specify the parameter and units for each column of data submitted.

(4)

JUN 25 1993

CERTIFIED MAIL P 176 167 075 RETURN RECEIPT REQUESTED

Mr. I.O. Coleman, Jr.
Environmental Affairs Section Leader
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, TX 77404-0509

Dear Mr. Coleman:

The proposed pressure falloff procedures for WDW-32 and WDW-49 have been reviewed and comments enclosed. The responses to the March 3, 1993, deficiencies have also been evaluated and additional deficiencies identified. Please respond to these deficiencies by July 12, 1993.

Please contact Phil Dellinger at (214) 655-7142 if you have any questions.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs

6W-SU:6/25/93:DELLINGER:MH:H:\LBAN\WP50\CELANESE\CELANESE.BA\
BAYCTY93.TST

EPA COMMENTS ON PROPOSED 1993 FALLOFF TEST PROCEDURES
FOR WDW-32 AND WDW-49
June 25, 1993

Item No. 1: No comment.

Item No. 2: It is recommended the falloff tests for WDW-32 and WDW-49 be run separately to prevent any interference between the two wells. A falloff test and corresponding interference test may also be considered as an option.

It is further recommended Celanese use a constant injection rate of 200 gpm for the injectivity period prior to falloff to test both WDW-32 and WDW-49. Celanese is proposing to inject 50 gpm into WDW-32 and 40 gpm into WDW-49. These rates are well below the 87 gpm and 80 gpm injected into the wells during the 1992 well tests. The 1992 well test for WDW-14 and the 1993 well test for WDW-110 both injected at a 200 gpm rate prior to shut in. The falloff tests for WDW-14 and WDW-110 had clearly defined regions of radial flow. The 1992 falloff tests for WDW-32 and WDW-49 did not result in well defined radial flow regions. The injection rates prior to shut in appear to have a strong impact on the falloff test results.

Celanese stated that nonhazardous waste will be injected into WDW-32 and WDW-49 prior to falloff. Plant waste can be used as the injected fluid provided it is of a relatively constant viscosity and there are no compatibility problems with the pressure gauge.

Item No. 3: Celanese should also record the injection rates for WDW-14 and WDW-110 during the falloff testing period. These rates should be submitted on a cartesian graph in the report to the EPA.

Item No. 4: No comment.

Item No. 5: No comment.

Item No. 6: A falloff period of 48 hours may not be required. The falloff test should be run long enough so that several data points lie within the radial flow portion and the semilog straight line should be well developed. In the 1993 falloff test for WDW-110, the falloff test was run for 18 hours.

Item No. 7: No comment.

Item No. 8: No comment.

HOECHST CELANESE BAY CITY PLANT
Notice of Deficiencies for the 1992 and 1993 Falloff Tests
June 25, 1993

1993 Falloff test for WDW-110:

1. Celanese should provide a delta P (psi) vs delta t (hours) log-log plot with derivative. This plot should be scaled to include all analyzed data. The start of radial flow should be identified on the plot. A dimensionless pressure vs dimensionless time scaled log-log plot represents a problem to the reviewer in that time cannot be directly read and converted for use on the Horner plot. In addition, calculation of the dimensionless parameters require knowing quantities which are functions, in part, of the kh/μ product.

2. Celanese should provide a diskette containing the unedited falloff test data. Celanese should specify the parameter and units for each column of data submitted.

WDW-32 (Well No. 3) September 14-15, 1992 falloff test:

1. The May 3, 1993 Deficiency No. 1 requested Celanese to state and justify the injection time interval used to calculate the Horner time of the semilog plot and the Agarwal equivalent time on the log-log plot. The response by Celanese did not address this deficiency. For the September, 1992 test for WDW-32, Celanese should state the value used for the injection time (t), used to determine Horner time [(t + delta t)/delta t] and Agarwal equivalent time [(t * delta t)/(t + delta t)]. Celanese reported a corrected flow time of 8760 hrs for the test in the analysis. Using the final shut-in delta t of 46.46 hrs and an injection time, t = 8760 hrs, the corresponding Horner time would be 189.5 and the corresponding Agarwal equivalent time would be 46.2, neither of which appear as the final points on the corresponding plots. Celanese should verify the values assigned for delta t and injection time (t). Celanese should revise the log-log plot, semilog plot, and falloff test analysis submitted.

corrected on orig. —

2. Celanese should provide a diskette containing the unedited falloff test data. Celanese should specify the parameter and units for each column of data submitted.

WDW-49 (Well No. 4) September 19-22, 1992 falloff test:

1. Celanese stated in the response to the March 3, 1993 Deficiency No. 2, that the corrected flow time of 8760 hours equaled the total elapsed time. Using 8760 hours for the

injection time (t) and a final falloff time of 48 hours (delta t), the resulting Horner time and Agarwal equivalent time do not correspond to the end points observed on the semilog and log-log plots shown for WDW-49. Celanese should verify that the proper units were assigned to the input data. Celanese should provide a revised log-log plot, semilog plot, and analysis for the WDW-49 1992 falloff test.

2. Celanese should provide a diskette containing the unedited falloff test data. Celanese should specify the parameter and units for each column of data submitted.

(4) Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

June 4, 1993
IOC-046-93

FEDERAL EXPRESS

Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

SUBJECT: ANNUAL 1993 BOTTOM HOLE PRESSURE FALLOFF PROCEDURES WASTE DISPOSAL WELLS, WDW-32 AND WDW-49 HOECHST CELANESE CHEMICAL GROUP, INC., BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Dellinger:

For your review and approval, please find attached the field procedures (Addendum I) prepared by Golden Environmental Services for the annual bottom hole pressure falloff tests on WDW-32 and WDW-49. Falloff testing on these wells is anticipated to be performed late September or early October 1993.

Please comment in writing on these procedures as soon as possible, preferably on or before June 23, 1993. The quick comment period is requested to allow sufficient time to modify our Plant operations to accomodate the approved test procedures.

Falloff testing on our other two wells, WDW-14 and WDW-110, will occur in February 1994. Bottom hole pressure falloff procedures will be submitted for these wells when the falloff testing is closer at hand.

If you have any questions, contact me at 409/241-4197.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

JUN - 7 1993

IOC/cjs
attachment

Hoechst

cc: Mr. Mac A. Weaver, P.E., Chief
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Mr. Richard Merritt, Permit Coordinator
Underground Injection Control Unit
Industrial and Hazardous Waste Division
Texas Water Commission
P. O. Box 13087
1700 North Congress Ave.
Austin, TX 78711-3087

bcc: J. L. Popejoy - w/o attached document
N. C. Stafford - " " "
Mr. Tom Jones - Golden Strata - " " "
K. Williams
R. S. O'Neal
H. R. Horton
E. H. Chiu
R. E. Bennett
B. A. Logue
E. A. Wilson
Anne Conely-Pitchell - Bridgewater
Environmental File No. 203.16

JUN - 7

TEST PROGNOSIS FOR HOECHST CELANESE BAY CITY WDW 32 AND 49

1. At least 48 hours prior to shut-in, injection rates into WDW 110 and WDW 14 should be reduced to as low a level as operations permit.

2. Inject nonhazardous waste into WDW 32 and WDW 49 at constant flowrate for at least 48 hours. Recommended rates are 50 gpm and 40 gpm respectively.

3. Record injection rates in all wells for at least 48 hours prior to the projected start of the falloff test.

4. Move in and rig up wireline unit, lubricator and surface read-out bottom hole pressure gauges on WDW 32 and WDW 49. While maintaining constant flow, run gauges and hang at approximately 3350 feet (datum = 3440 feet) in both wells.

5. Take samples of injectants of both wells, record injection temperatures and send to laboratory for measurement of viscosities and specific gravities at injection temperature and reservoir temperature (105 °F).

6. After pressure gauges have been set at approximately 3350' for at least 2 hours to equilibrate with temperature, shut-in wells simultaneously as quick as possible and record pressure fall-off for 48 hours.

7. Retrieve pressure gauges, making 3-5 minute gradient stops every 500 feet.

8. Return wells to service.

JHH:rsm

(4)

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

May 20, 1993
IOC-042-93

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MAY 24 1993
6 W-S

Mr. Mac A. Weaver, P. E.
Chief
UIC State Programs Section (6W-SU)
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: **Response To EPA Letter Dated March 3, 1993 Relative To 1990, 1991, 1992 and 1993 Bottom Hole Pressure Falloff Tests Conducted On WDW-14, WDW-32, WDW-49 and WDW-110 Hoechst Celanese Chemical Group, Inc.**
Bay City Plant, Bay City, Texas

Dear Mr. Weaver:

Enclosed herewith, in a report format, is our response to the list of deficiencies attached to the above letter. The report, generated by our consultants, Golden Environmental Services, Inc., is provided for your review and approval.

It should be noted that several of the deficiencies were on pressure falloff tests conducted in 1990 and 1991. As such, these tests were performed prior to issuance of the EPA Region 6 "Pressure Falloff Testing Guidelines".

Please contact me by telephone at 409/241-4197 should you have questions and/or comments pertaining to the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cjs
attachment

Hoechst

cc: Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi - w/o attachment
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ben Knape
Geologist
Texas Water Commission
P. O. Box 13087, Capitol Section
Austin, TX 78711-3087

MAY 24 1993

TEST PROGNOSIS FOR HOECHST CELANESE BAY CITY
WDW 32-3 AND 49-4

1. The potential for interference exists from the other two wells. (WDW 110-A and WDW 14-2). At least 48 hours prior to shut-in, injection rates in these two wells should be reduced to as low a level as operations permit.

2. Inject waste into WDW 32-3 and WDW 49-4 at constant rate for at least 48 hours. Recommended rates are 50 gpm and 40 gpm respectively.

3. Record injection rates in all wells for at least 48 hours.

4. Move in and rig up wireline unit, lubricator and surface read-out bottom hole pressure gauges. Run gauges and hang at approximately 3350 feet (datum = 3440 feet) in both wells.

5. Take samples of injectants of both wells, record injection temperatures and send to laboratory for measurement of viscosities and specific gravities at injection temperature and reservoir temperature (105 °F).

6. After pressure gauges have been on bottom for at least 2 hours to equilibrate with temperature, shut-in wells simultaneously and record pressure fall-off for 48 hours.

7. Retrieve pressure gauges, making gradient stops every 500 feet.

8. Download pressure data to 3½" disk in ASCII format and forward to Golden Environmental Services.

9. Provide Golden with monthly injection volumes from the two test wells from the time that they were last shut-in.

10. Return wells to service.

JHH:rsm

(4)

MAY 3 1993

CERTIFIED MAIL P 176 167 084 RETURN RECEIPT REQUESTED

Mr. I.O. Coleman, Jr.
Environmental Affairs Section Leader
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, TX 77404-0509

Dear Mr. Coleman:

The EPA has reviewed all well falloff tests for the Celanese Bay City facility and the responses to EPA deficiencies from its initial review of the tests. The original reports submitted did not include the documentation of parameters, calculations, or data as outlined in the Region 6 Pressure Falloff Testing Guidelines. Several well tests appear to have been influenced by offset injection. The EPA recommends that Celanese submit the testing procedures for future 1993 falloff tests for comment prior to testing.

Attached are comments and deficiencies identified during this review. Please respond to these deficiencies by May 21, 1993.

Please contact Phil Dellinger at (214) 655-7142 if you have any questions.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs

for MAW 5/4/93

6W-SU:5/4/93:DELLINGERz:MH:H:\LBAN\WP50\CELANESE\CELANESE.BA\TEST

MW
5/4/93

bcc:

J. L. Popejoy	-	Without	Attached	Document
K. Williams	-	"	"	"
Mr. Don Squyers - Dupont	-	"	"	"
Mr. Tom Jones - Golden Strata	-	"	"	"
Anne Conely-Pitchell - Bridgewater				
Environmental File No. 203.13				

MAY 2 4 1993

HOECHST CELANESE BAY CITY PLANT
Comments and Notice of Deficiencies
1990, 1991, 1992, and 1993 Pressure Tests
May 3, 1993

1. For all four wells, Celanese should provide a xerox copy of the 1" scaled Induction Log of the Upper Miocene injection interval.

2. Celanese used 0.556 cp as the formation fluid viscosity in the 1993 analysis for WDW-110. A viscosity of 0.71 cp was used for the Upper Miocene Formation in the analysis for the other three wells. Celanese should clarify which viscosity value is correct or use the appropriate value for the viscosity of the Upper Miocene Formation.

3. In the response to Deficiency No. 4 of the March 1, 1993 NOD, Celanese was requested to determine the radius of investigation at the start of radial flow for the 1992 well tests for WDW-32 and WDW-49. In the calculations shown on Attachment 4, Celanese used a delta t of 88.5 hours. Celanese should justify this value. In addition, Celanese was also requested to estimate the waste front radii. Celanese should justify the use of 165 ft as the interval thickness. A review of recent radioactive tracer surveys and the spinner results from WDW-110 indicates the majority of flow entering the top portion of the Upper Miocene interval.

WDW-110 (Well No. 1-A) February 16-17, 1993 falloff test:

1. The data on the log-log and derivative plot included in Appendix E of the recompletion report submitted for WDW-110 exceed the time scale of the plot. Celanese should submit a delta t vs delta t (hours) plot scaled so that all the test data is included on the plot. The start of radial flow should be identified on the plot. The log-log plot submitted incorporating the use of type curves may be used to support the results of the semilog analysis.

2. No early time data is shown on the log-log plot in Appendix E. Celanese should explain why no pressures were recorded during this interval. Celanese should also note the type of gauge used to measure pressures, when the gauge was last calibrated, and the accuracy of the gauge.

3. Celanese should submit an expanded Horner plot with the radial flow portion identified on the plot.

4. The falloff analysis submitted in Appendix E reported a corrected flow time of 265.5 hours. The daily field operations summary reported in Appendix F reported WDW-110 was closed in at 2:30 pm February 16, 1993 (the day before the falloff test). Celanese should justify the use of 265.5 hours in the analysis.

WDW-14 (Well No. 2) November 29-30, 1992 falloff test:

1. Type curve solutions by themselves are not considered acceptable by the EPA since there is often not a single unique type curve match. However, a type curve match may be used to support the semilog analysis. The type curve provided for WDW-14 is not considered an adequate match of the log-log and derivative curves. Celanese should provide a log-log plot with derivative using a time scale in which delta t can be easily identified. The radial flow period should be illustrated on the log-log and an expanded Horner plot. The semilog straight line included on the semilog plot.

2. In the analysis, Celanese uses a thickness of 210 ft. The December 1, 1992 and October 29, 1991 radioactive tracer surveys show the slug going into the upper perforations with little or no flow entering the fill. Celanese should justify the 210 ft thickness used for calculations or employ a more conservative value of h.

WDW-14 (Well No. 2) October 31, 1990 falloff test:

1. The responses to the September 2, 1992 NOD stated that the pressure dropped to 1584 psi in 13 minutes and became static at 1565 psi after only one hour of shut in. A review of the data in Appendix A.4 of the November, 1990 report submitted in June, 1992 showed an elapsed time of 3.14 hours to reach a pressure of 1584 psi. The pressure data between a delta time of 4.05 to 17.90 hours was omitted. Celanese should verify that all the pressure data were included on the log-log and semilog plots.

2. Celanese should explain the pressure fluctuations observed in the pressure data listed in Appendix A.4 of the November, 1990 report. Several of the pressures recorded after 20 hours into the falloff test exceeded the injection pressure of 1649 psi prior to falloff.

3. The derivative plot included as Figure 4 in the response to the September 2, 1992 NOD does not appear to reach radial flow. Should additional pressure points be obtained, the

log-log and semilog plots should be resubmitted. Celanese should define how the infinite acting period was determined on the expanded Horner plot provided in Figure 1 of the response to the October 27, 1992 NOD.

4. Celanese should justify the injection time used to calculate the Horner time.

WDW-32 (Well No. 3) September 14-16, 1992 falloff test:

1. Celanese should state and justify the injection time interval used to calculate the Horner time of the semilog plot and the Agarwal equivalent time on the log-log plot.

WDW-49 (Well No. 4) September 19-22, 1992 falloff test:

1. The derivative curve included in Attachment 1a in the response to the March 1, 1993 NOD is characteristic of a test dominated by constant pressure. No radial flow portion (flattening of the derivative curve) was observed. Celanese should define how the infinite acting portion of the semilog plot was determined.

2. Celanese should justify the use of a corrected flow time of 8760 hours.

WDW-49 (Well No. 4) October 29-30, 1991 falloff test:

1. The derivative curve included as Figure 6 in the response to the September 2, 1992 NOD, demonstrates a characteristic of a test with a closed boundary. No radial flow portion was observed on the plot. Celanese should define how the infinite acting portion of the semilog plot was determined. The expanded Horner submitted in Figure 2 of the responses to the October 27, 1992 NOD was reported as having a slope of 3.6 psi/cycle.

The following issues should be addressed in future falloff test reports to the EPA.

1. The March 17, 1993 response to Deficiency No. 5 of the March 1, 1993 NOD stated that the 1992 Injection Zone Annual Report was prepared to satisfy the reporting requirements for Injection Well Permits and the document was not prepared to satisfy any of the EPA requirements concerning annual falloff testing. The falloff testing guideline mailed to

all operators in June, 1992 specifically states that reports should be submitted to the EPA within 45 days following the test date. The falloff tests for WDW-32 and WDW-49 were conducted between September 14 and 22, 1992. The EPA must assume since no other report was received that the report dated October 27, 1992 was the falloff report submitted for WDW-32 and WDW-49. Celanese should submit future falloff reports to the EPA within 45 days of the test date.

2. Celanese should annotate the pressure-time data identifying the time injection started or ceased in addition to any operating problems that may generate pressure fluctuations in the test.

3. The start of radial flow should be identified on the log-log with derivative plot, Horner plot, and expanded Horner plot.

4. The log-log and derivative plots should be shown on a delta P vs delta t (hrs) plot in addition to any type curve plots (dimensionless time). The start of radial flow is determined from the log-log and derivative plots. The resulting start of radial flow delta t is used to calculate the corresponding Horner time to determine where the semilog straight line analysis should begin on the Horner plot. The EPA does not always agree with the match between the type curve and actual data and therefore requires a log-log plot with a direct reading time scale.

5. When surface pressures have been used to measure the pressure falloff, the conversion factor used to correlate the surface pressures to bottom hole should be provided. The specific gravity of the fluid used in the calculation should be justified. Celanese should deduct the friction pressure in addition to the pressure due to skin from the final injection pressure to represent the reservoir pressure. Any friction table used should be provided.

6. For future tests in which a radial flow portion is not identified, Celanese should either retest, simulate the pressure response to define the anomalies observed, or run an interference/pulse test between wells demonstrating communication between the wells.

7. The rate history of each well should be provided 48 hours prior to and during each falloff test.

8. The injection time prior to the falloff should be stated for each test. This should represent the time value used to calculate the corresponding Horner time.

9. State the type of gauge used to measure pressures, date calibrated, and accuracy of the gauge.

10. The falloff test pressures and parameters should be compared to the results of the approved no migration petition.

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

March 18, 1993
IOC-024-93

MAR 19 1993
6W-S

Mr. Mac A. Weaver, P. E.
Chief
UIC State Programs Section (6W-SU)
United States Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: Response To EPA Letter Dated March 1, 1993 Relative To 1992 Bottom Hole Pressure Falloff Tests Conducted On WDW-14, WDW-32 and WDW-49
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas

Dear Mr. Weaver:

Enclosed herewith, in a report format, is our response to the list of deficiencies attached to the above letter. The report, generated by our consultants, Golden Environmental Services, Inc., is provided for your review and approval.

For convenience, the report is separated into seven sections. Each section provides our response and corresponds to the deficiencies in chronological order.

Please contact me by telephone at 409/241-4197 should you have questions and/or comments pertaining to the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

MAR 19 1993

cjs
attachment

Hoechst

cc: Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi - w/o attachment
UIC State Programs Section (6W-SU)
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1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ben Knape
Geologist
Texas Water Commission
P. O. Box 13087, Capitol Section
Austin, TX 78711-3087

DEC 6 1993

(4) Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

March 12, 1993
IOC-022-93

RECEIVED
MAR 19 1993

Mr. Mac A. Weaver, P. E.
Chief
UIC State Program Section (6W-SU)
EPA Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: Response To EPA's Request For Additional Information Associated With The NO. 2 Notice Of Deficiency Relative To 1992 Injection Well Falloff Testing Results/Data [References: (1) Your Letter To Ms.Kaymartha Williams Dated October 27, 1992 And (2) A December 8, 1992 Meeting With Mr. Joe Kordzi And Ms. Susie Lopez]

Dear Mr. Weaver:

The enclosed document, generated by our consultants, DuPont Environmental Remediation Services, Inc., and Golden Environmental Services, Inc., is: (1) provided in response to EPA's requests to provide additional Horner plots and a graph of the petition model predicted pressures for the life of the petition exemption and (2) submitted for your review and approval.

Don't hesitate to contact me by telephone at 409/241-4197 if you have any comments or questions regarding the information in the response document.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cjs
attachment

Hoechst

cc: Mr. Phil Dellinger - w/o attachment
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi - w/o attachment
UIC State Programs Section (6W-SU)
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ben Knape
Geologist
Texas Water Commission
P. O. Box 13087, Capitol Section
Austin, TX 78711-3087

(4)

3-1-93 SD

CERTIFIED MAIL # P 885 487 994 - RETURN RECEIPT REQUESTED

REPLY TO: 6W-SU

Mr. I.O. Coleman, Jr.
Environmental Affairs Section Leader
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Mr. Coleman:

The EPA has reviewed the 1992 bottom hole pressure falloff tests submitted for WDW-14, WDW-32, and WDW-49. Attached is a list of deficiencies for the 1992 tests. All deficiencies should be addressed and submitted to EPA's Region 6 office by March 19, 1993.

Also enclosed is another copy of the Pressure Falloff Testing Guideline sent to Celanese, June 17, 1992. Celanese should review the guideline and verify that all pertinent information is included in the falloff reports.

Please contact Phil Dellinger at (214) 655-7142 if you have any questions.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs Section (6W-SU)

Enclosure

6W-SU:PDELLINGER:X7142:sd:3/1/93:DISK:LBAN:CELANESE:CELANESE:BAY LET.

PD 3/2/93

mm
3/2/93

HOECHST CELANESE BAY CITY PLANT
Notice of Deficiencies
1992 Annual Pressure Tests
March 1, 1993

1. Celanese ran a falloff test on WDW-32 and WDW-49 during September, 1992. The pressure data was supplied with a log-log plot and MDH plot but no falloff analysis was included in the report. Celanese has submitted a Horner plot and an expanded Horner plot for Well No. WDW-32 in the response to deficiencies for the 1990 and 1991 tests.

   a) Celanese should analyze the pressure test data and supply EPA with a delta P vs delta t (hrs), log-log plot with derivative for both wells. A Horner plot and expanded Horner plot should be submitted for WDW-49. The start of radial flow should be identified on all plots. The semilog straight line should be drawn on the semilog plots.

   b) Celanese should include the injection rates of all wells in the formation tested 48 hours prior to and during the falloff tests. Celanese should report when each well was last stabilized.

2. Celanese conducted an annual mechanical integrity test and falloff test in WDW-14 during November, 1992.

   a) Celanese submitted a log-log plot with derivative in the report for WDW-14. Celanese should submit an additional delta P vs delta t (hrs) log-log plot with derivative with the start of radial flow identified.

   b) Celanese submitted the radioactive tracer survey for Celanese Clear Lake WDW-45 instead of Celanese Bay City WDW-14. Celanese should submit the RAT for WDW-14.

   c) Celanese should submit the injection rates of all three wells completed in the Upper Miocene 48 hours prior to and during the falloff test. Celanese reported a corrected flow time of 6184 hrs. Celanese should report when the well was last stabilized.

   d) Celanese should submit a table of pressure and time data acquired from the falloff. The gauge depth and tagged fill depth should also be included.

3. Celanese should justify the parameters used in the analyses of all three wells and compare the results to those of the approved no migration petition.

4. Celanese should determine the waste front radius and the radius of investigation at the time radial flow begins to determine the appropriate viscosity to use in the analysis.

5. Celanese compared modeled and measured shut in pressures for WDW-32 and WDW-49 in Section 2.3 of the 1992 Injection Zone Annual Report. The modeling results shown in Appendix B provide a yearly value of flowing pressure buildup for the three wells completed in the Upper Miocene injection interval. Celanese should compare the modeled flowing pressures to those measured in all three wells. The measured flowing pressures should be corrected for skin and friction if applicable.

6. The location of the 4 monitoring wells listed on the model output should be identified on the pressure isopleth. In addition, the location of the nearest and worse case artificial penetrations should be identified.

7. Celanese determined an average injection rate from 1991 and 1992 to forecast pressure buildup to year 2000. The resulting rates for each well were less than the 1992 rates. Celanese should use the maximum rates used in the petition demonstration to forecast pressure buildup.

Hoechst Celanese

(4)

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

January 7, 1993
IOC-004-93

Mr. Richard E. Merritt,
Permit Coordinator
Underground Injection Control Team Permits Section
Office Of Waste Management and Pollution Cleanup
Texas Water Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-2087

Subject: Annual (1992) Mechanical Integrity Testing (MIT) Report
Class I Injection Well, WDW-14
Hoechst Celanese Chemical Group, Inc.,
Bay City Plant, Bay City, Texas
(Reference Letter, HRH-9-93, Dated January 7, 1993 Attached as Addendum I)

Dear Mr. Merritt:

Enclosed herewith is a copy of the final MIT report on WDW-14 for your review and approval.

As you are aware: (1) the MIT of the well was performed by Golden Environmental Services, Inc.(GES), on December 1 and 2, 1992, (2) the final MIT report was prepared by GES and (3) WDW-14 demonstrated mechanical intergity as required by Texas Water Commission Underground Control Program and 31 TAC, Sections, 331.4 and 331.43.

Please don't hesitate to contact Mr. H. R. Horton at 409/241-4076 or me at 409/241-4197 if you have any questions concerning the report.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

cc: Mr. Phillip B. Dellinger
UIC Program Section 6W-SU
Water Supply Branch
Environmental Protection Agency
Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Mr. Ben K. Knape
Underground Control Section
Texas Water Commission
P. O. Box 13087
1700 North Congress Ave.
Austin, Texas 78711-3087
(Without Enclosures)

ADDENDUM I

Interoffice Memo

Hoechst Celanese

Date: January 7, 1993

HRH-9-93

To: As Listed

From: H. R. Horton

Dept/Location:

Dept/Location: Maintenance Engineering

Subject: Mechanical Integrity Test Report

I. O. Coleman
J. L. Popejoy
E. H. Chiu → R. E. Bennett

pc: W. G. Cornman - Without Attachment
R. S. O'Neal - Without Attachment

File: 11.13.0.01 - With Attachment

Mechanical integrity tests were conducted on neutral waste injection well, WDW-14 (#2) on December 1 and 2, 1992.

The State of Texas requires all Class I waste disposal wells to demonstrate mechanical integrity on a yearly basis as outlined in 31 TAC ¶ 331.43. These tests are performed to demonstrate that no significant leaks exist in the casing, tubing or packer and that no significant fluid movement into any underground source of drinking water can occur.

Well WDW-14 (#2) is considered to be mechanically sound and in good condition at this time and suitable for use as a Class I waste injection well.

Attached is the complete report of test as submitted by Golden Strata Services, Inc.

H. R. Horton

dls
attachment

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

November 23, 1992
IOC-119-92

Mr. Mac A Weaver, P. E.
Chief
UIC State Program Section (6W-SU)
EPA Region VI
1445 Ross Avenue
Suite 1200
Dallas, Texas 75202-2733

Subject: Response To An EPA Letter Dated September 2, 1992 Delineating Notice Of Deficiencies On 1990 And 1991 Falloff Testing Results Associated With Hoechst Celanese Chemical Group, Inc., Bay City Plant Injection Wells
References: (1) Your Letter Dated October 27, 1992 And
(2) Ms. Kaymartha Williams' Letter, KW-217-92, Dated November 6, 1992

Dear Mr. Weaver:

The attached document, generated by our consultants, DuPont Environmental Remediation Services, Inc., is: (1) our response to the Notice Of Deficiency (NOD) letter (reference above) regarding the 1990 and 1991 falloff testing results associated with our Class I injection wells and (2) submitted for your review and approval.

Per information in the response document, we believe: (1) the injection wells are operating in a safe manner and (2) the wells' operational parameters are consistent with our approved "No-Migration Injection Well Petition".

Your consideration of our request to review and approve our response to the NOD letters is appreciated.

Please contact Ms. Kaymartha Williams at (409) 241-4123 or me at (409) 241-4197 if there are any questions concerning the information in the response document.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.

DEC

Hoechst

cc: Mr. Phil Dellinger
UIC State Programs Section (6W-SU)
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Joe Kordzi
UIC State Programs Section (6W-SU)
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Mr. Ben Knape
Geologist
Texas Water Commission
P.O. Box 13087, Capital Section
Austin, TX 78711-3087

DEC - 1 1992

bcc: With Attached Document
K. Williams
Environmental File No. 206.1G
Environmental File No. 203.13

Without Attached Document
C. R. Pennington
H. P. Heathman
W. G. Cornman
N. C. Stafford
B. L. Fritz
R. S. O'Neal
G. J. McCarthy
K. A. Kouri
Mr. Don Squyers-Dupont
Mr. Bob Hall-Golden Strata
Mr. Tom Jones-Golden Strata

DEC - 1 1992

Hoechst Celanese

(4)

6W-5
page 137
Row# (11)

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WATER MANAGEMENT
92 NOV 19 AM 9:41
6W-EA

HOECHST CELANESE CHEMICAL COMPANY

P.O. BOX 509, BAY CITY, TEXAS 77414

409 - 245 - 4871

FAX TRANSMITTAL

DATE: November 19, 1992

TIME: 8:30 AM / PM

TO: Joe Kordzi

COMPANY: Environmental Protection Agency - Dallas, Texas

DEPT: UIC Permit Section

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NOV 19 1992
6 W-SU

FROM: Keymartha Williams

3 PAGES (INCLUDING COVER)

If transmission is interrupted or of poor quality, please notify sender immediately, 409-241-4087

Our FAX number is 409-241-4086

Hoechst

Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
Injection Well Volumes (Gallons)

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NOV 19 1992
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YEAR	WDW-8(NO.1)	WDW-14(NO.2)	WDW-32(NO.3)	WDW-49(NO.4)	WDW-110(NO.1A)
1964	14,932,800	0	0	0	0
1965	81,700,000	51,700,000	0	0	0
1966	95,400,000	95,400,000	0	0	0
1967	130,800,000	121,900,000	51,000,000	0	0
1968	148,600,000	170,143,000	94,185,000	0	0
1969	152,900,000	181,000,000	85,600,000	51,200,000	0
1970	151,339,000	136,018,000	144,910,000	153,121,000	0
1971	157,068,000	99,164,720	99,591,840	103,453,920	0
1972	157,638,560	81,656,640	85,053,600	91,293,120	0
1973	14,843,520	78,708,960	112,011,840	124,671,840	41,541,120
1974	0	61,452,529	79,047,526	93,178,652	148,359,080
1975	0	59,912,560	65,005,776	90,296,424	114,675,264
1976	0	57,535,200	92,311,200	115,643,760	121,790,880
1977	0	75,935,560	94,078,180	113,813,280	131,012,640
1978	0	79,655,040	81,007,200	136,696,320	152,156,080
1979	0	115,836,480	108,322,560	121,121,280	173,524,320
1980	0	126,914,400	67,021,920	92,155,680	142,744,320
1981	0	93,955,680	72,112,920	63,895,680	54,728,960
1982	0	62,120,160	63,470,880	55,572,480	78,488,640

RECEIVED
NOV 19 1992

Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
Injection Well Volumes (Gallons)

YEAR	WDW-8(NO.1)	WDW-14(NO.2)	WDW-32(NO.3)	WDW-49(NO.4)	WDW-110(NO.1A)
1983	0	58,181,760	50,875,200	51,962,924	81,384,480
1984	0	34,912,440	49,909,760	50,427,360	63,735,880
1985	0	57,803,040	53,062,560	55,402,560	56,823,840
1986	0	56,307,660	39,581,290	34,165,540	89,974,080
1987	0	41,011,200	41,626,080	41,215,680	110,021,760
1988	0	45,616,320	39,124,800	37,116,000	101,702,880
1989	0	36,887,040	34,760,150	32,346,880	75,382,520
1990	0	42,357,500	35,235,400	35,762,500	89,273,400
1991	0	50,696,000	33,799,700	35,411,200	76,088,800
1992	0	36,656,000	43,464,000	45,563,000	0
TOTAL	1,105,215,880	2,395,745,568	1,856,550,062	1,859,652,020	2,018,379,024

NOTE: 1. Hazardous Waste include K009(Distillation bottoms from Acetaldehyde production from ethylene).
2. Hazardous Waste include K010(Distillation side-cuts from Acetaldehyde production from ethylene).
3. 1992 totals are for the months of January, 1992 to October, 1992.

break down

(4)

OCT 2~~8~~ 1 1992

OCT 2 8 1992

CERTIFIED MAIL P 399 862 228 RETURN RECEIPT REQUESTED

Ms. Kaymartha Williams
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, TX 77404-0509

Dear Ms. Williams:

The EPA has reviewed the responses to the September 2, 1992 Notice of Deficiencies on the falloff tests for the Celanese Bay City injection wells. These responses are not considered to be adequate. One of the primary reasons for running the falloff tests is to compare existing bottomhole pressures with those predicted by the computer model in the petition to insure that the maximum predicted pressure is not exceeded. The September 2, 1992 deficiencies requested Celanese to compare flowing reservoir pressure with that determined in the approved petition demonstration. Celanese has not provided this response. Celanese should specifically address the attached deficiencies by November 9, 1992 or notify the EPA as to the reasons why this deadline cannot be met.

Please contact Phil Dellinger or Joe Kordzi at (214) 655-7160 if you have any questions.

Sincerely,

Mac A. Weaver, P.E.
Chief
UIC State Programs Section

cc: Ben Knape, TWC

PD 10/28/92

6WUS:10/27/92:DELLINGER:MH:H\LBAN\WP50\CELANESE\CELANESE.BA\
BAYCTY2.YES

6W-SU 6W-SU
KORDZI for WEAVER
for PD 10/28/92 for PD 10/28/92

HOECHST CELANESE BAY CITY PLANT
Notice of Deficiencies No. 2
1990 and 1991 Annual Pressure Tests
October 27, 1992

1. Celanese should provide an expanded Horner plot for WDW-14 and WDW-49. The semilog straight line should be included on the plot.

2. Celanese states that due to the model used in the petition demonstration and limited output, a fair comparison between actual and predicted pressures is not possible. Celanese should compare the flowing reservoir pressure less delta P due to skin with the maximum pressure buildup predicted at the end of the operational period. Celanese should also compare the calculated transmissivity and permeability with that used in the petition. EPA suggests Celanese to refer to Section 2 of their approved petition for data input into the model. If Celanese is unable to compare data then a new pressure buildup model should be run in which pressures, transmissivity and permeability can be checked.

3. Celanese was requested to include the injection rates of the wells in the same formation prior to and during the falloff test of WDW-49.

(4)

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

October 1, 1992
KW-162-92

Mr. Mac A. Weaver, P.E.
Chief - UIC State Programs Section (6W-SU)
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Re: Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
Response to USEPA Letter Dated September 2, 1992

Dear Mr. Weaver:

This letter is in response to your letter dated September 2, 1992 letter (Addendum I), concerning the requirements of Petition Condition No. 8 (Annual Pressure Tests) for the years 1990 and 1991. The bottom hole pressure analysis (Addendum II) was prepared by Golden Environmental Services and addresses those deficiencies outlined in the above referenced letter.

If you need any additional information, please do not hesitate to telephone me at (409)241-4123 or Mr. I. O. Coleman, Jr. at (409)241-4197.

Sincerely yours,

Kaymartha Williams

Kaymartha Williams
Environmental Engineer

RECEIVED
OCT - 6 1992

Attach.

cc: Mr. Ben Knape
Geologist
Texas Water Commission
P.O. Box 13087, Capitol Section
Austin, Texas 78711-3087

bcc: C. R. Pennington - w/o attachments
H. P. Heathman - " "
I. O. Coleman, Jr. - " "
G. J. McCarthy - " "
K. A. Kouri - w/o attachments
Environmental File No. 206.1F
Environmental File No. 203.15 - w/o attachments

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6 W-SU

ADDENDUM I

RECEIVED
OCT - 6 1992

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

September 2, 1992

Ms. Kaymartha Williams
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Ms. Williams:

The EPA has reviewed the 1990 and 1991 bottom hole pressure falloff tests submitted June 29, 1992. Celanese is required in Petition Condition No. 8 to provide a falloff test for each of its four wells. However, Celanese notified the EPA that WDW-110 was plugged and temporarily abandoned after losing its injectivity prior to the 1991 falloff test for this well. Celanese submitted only one test for the remaining three wells (WDW-14, WDW-32, and WDW-49) which are all completed in the 3350 to 3600 injection interval. However, no data were submitted to demonstrate that WDW-14, WDW-32 and WDW-49 are in communication and that a single well test would satisfy the requirements of Condition No. 8. Future well tests should be conducted for each well or an interference test demonstrating the wells are in communication should be performed to show that a single falloff test is representative for all three wells.

Attached is a list of deficiencies for the 1990 and 1991 well tests. All deficiencies should be addressed and submitted to EPA's Region 6 office by October 2, 1992.

If you have any questions, please contact Phil Dellinger or Joe Kordzi at (214) 655-7160.

Sincerely yours,

Mac A. Weaver

Mac A. Weaver, P.E.
Chief
UIC State Programs Section (6W-SU)

cc: Ben Knape, Texas Water Commission

Printed on Recycled Paper

HOECHST CELANESE BAY CITY PLANT
Notice of Deficiencies
1990 and 1991 Annual Pressure Tests
September 2, 1992

1. Celanese ran a falloff test on WDW-14 and WDW-110 during October, 1990. The pressure data was supplied but no falloff analysis or comparison of reservoir parameters with the approved petition demonstration were included in the reports. Celanese is requested to review the EPA Region 6 guidelines for falloff testing dated June 17, 1992 and submit the following for each test:

   a) Celanese should analyze the pressure test data and supply EPA with a log-log plot with derivative, Horner plot, and expanded Horner plot. The end of wellbore storage should be identified. The semilog straight line should be drawn on both semilog plots.

   b) Celanese should include the injection rates of all wells in the formation tested 48 hours prior to and during the falloff test of WDW-14.

   c) Celanese should justify the parameters used in the analysis and show all calculations.

   d) Celanese should compare the flowing reservoir pressure, transmissivity, and permeability with those used in the approved petition demonstration.

2. Celanese conducted a falloff test on WDW-49 during October, 1991. Celanese submitted the pressure data and two plots for the well test. Celanese should submit similar data requested above for this WDW-49 falloff test.

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, Tx 77404-0509

September 1, 1992
IOC-72-92

Mr. Richard E. Merritt, Permit Coordinator
Underground Injection Control Team Permits Section
Industrial and Hazardous Waste Division
Office of Waste Management and Pollution Cleanup
Texas Water Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Subject: Annual (1992) Mechanical Integrity Testing
Of Class I Injection Well, WDW-14
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
(Reference Kaymartha Williams' Letter, KW-128-92.
Dated August 7, 1992, Attached As Addendum I)

Dear Mr. Merritt:

Due to Acetaldehyde market demands through December, 1992, the Bay City Plant would like to delay shutting down its Acetaldehyde production unit to perform Mechanical Integrity Testing (MIT) on WDW-14 which was tentatively scheduled for September 20, 1992 per the subject reference letter.

As you are aware, due to the temporary abandonment status of WDW-110, we are currently disposing the process waste water resulting from Acetaldehyde production via Injection Well, WDW-14. Also, the annual (1991) MIT was performed on this well on October 29th. We therefore, request a sixty-day extension from the October 29, 1992 anniversary date to perform the annual (1992) MIT on WDW-14. This would allow for uninterrupted Acetaldehyde production through mid to late December, 1992 to meet market demands.

We proposed to perform MIT on WDW-14 on or about December 29th. Per our "No-Migration" petition, pressure falloff and bottom hole pressure tests are required to be performed on an annual bases within twelve months of the petition's anniversary date. Since our petition's anniversary date is May 4th each year, granting this request still provides us with the opportunity to perform the annual MIT as well as the pressure falloff and bottom hole pressure tests within the required time frame.

Your earliest reply to this request is appreciated. I can be contacted by telephone at (409) 241-4197 if you have any questions pertaining to this request.

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.
IOC/rm

cc: Mr. Ben K. Knape
Underground Control Section
Texas Water Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

Mr. Phillip B. Dellinger
UIC Program Section 6W-SU
Water Supply Branch
Environmental Protection Agency
Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Hoechst Celanese

ADDENDUM I

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

August 7, 1992
KW-128-92

Mr. Richard Merritt, Geologist
Underground Injection Control Section
Texas Water Commission
1700 North Congress Avenue
Austin, Texas 77811-3087

Subject: Mechanical Integrity Testing (MIT) of Wells WDW-14, -32, and -49
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
Facility Registration Number 30134

Dear Mr. Merritt:

The Hoechst Celanese Chemical Group, Inc. Bay City Plant request approval to demonstrate the mechanical integrity of waste injection wells numbered WDW-14, -32, and -49, per the attached letter (HRH-462-92, July 30, 1992). The MIT is tentatively scheduled for September 16, 1992 thru September 20, 1992.

If you have questions concerning this document and the attachment, please contact me. My telephone number is (409)241-4123.

Sincerely,

Kaymartha Williams

Kaymartha Williams
Environmental Engineer

Attachment

cc: Mr. Ben Knape
Underground Injection Control Section
Texas Water Commission
1700 North Congress Avenue
Austin, Texas 77811-3087

Ms. Susan Bredehoest, Manager
Hazardous/Solid Waste Division
Texas Water Commission - District 7
5144 E. Sam Houston Parkway North
Houston, Texas 77015

bcc: C. R. Pennington
H. P. Heathman
B. L. Fritz
W. G. Cornman
G. E. Organ
N. C. Stafford
I. O. Coleman, Jr.
E. H. Chiu
H. R. Horton - w/o attachment
G. J. McCarthy
C. J. Schaefer - Dallas
G. M. Rowen - Bridgewater

Interoffice Memo

Hoechst Celanese

Date July 30, 1992

HRH-462-92

To I. O. Coleman

From H. R. Horton

Dept/Location Lab

Dept/Location Maintenance Engineering

Subject Mechanical Integrity Testing (MIT), WDW-14, 32, and 49

Section Work Plan
I. A.

pc: W. G. Cornman
R. S. O'Neal
N. C. Stafford
H. P. Heathman
G. J. McCarthy
B. A. Logue
R. M. Hall - Golden Strata Services, Inc.
E. H. Chiu
E. A. Wilson
R. E. Bennett
G. E. Organ
B. L. Fritz
R. Allsup - Clear Lake
C. Gross - Bishop
L. T. Johnston - Pampa
D. Horn - Edmonton
A. Rakhe - HCCGTC

Please request and secure approval from the Texas Water Commission to demonstrate mechanical integrity on our waste injection wells, WDW Nos. 14, 32, and 49.

Annulus pressure test (APT) will be conducted on WDW-14 at 800 psig ΔP for 60 minutes and WDW-32 and 49 at 1000 psig ΔP for 30 minutes.

A pressure falloff/bottomhole pressure test (BHP) will be conducted on WDW-32. There will be no BHP performed on WDW-14 and WDW-49 because they are in the same upper Miocene injection sand as WDW-32. All three wells are in pressure communication and one pressure test will be representative of all three.

The mechanical integrity test for WDW-Nos. 32 and 49 are tentatively scheduled for September 16 and 17, 1992 and for WDW-14 on September 20, 1992.

Attached is the complete proposed procedures to demonstrate mechanical integrity testing as submitted by Golden Strata Services, Inc.

H. R. Horton

H. R. Horton

lrk
attachments

PROPOSED PROCEDURES TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-14 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

1) **Request and secure approval from the TWC to demonstrate MIT (HCCG & GES).**

* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG .
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and the estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.
* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.
* Close well in 24 hours prior to performing annulus pressure test.

4) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. Also, HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-800 psig. The annulus is reportedly filled with inhibited brine.

* Monitor casing pressure for a minimum period of 60 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

5) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector containes +/-5 millicuries of Iodine 131 radioactive (R/A) solution.

* Run initial base G/R log from just below perforated section up to +/-300' above the packer (@3162'), or up to +/-2800. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3150'.

* Commence pumping effluent fluid down tubing using HCCG's injection pumps at a steady rate.

* Release first R/A slug inside tubing at +/-2800' while pumping fluid down the tubing at the rate of +/-40 gpm. Note: This injection rate will be used on all wells. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-2800' and run tool to +/-3150'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of perforated section up to +/-2800' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

6) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

7) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW No. 14.

* Submit draft report to HCCG for comments and approval (GES).

* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.

* HCCG will submit report to the TWC for review and approval.

* HCCG will receive TWC's acceptance of the MIT report.

8) **Mechanical Integrity Testing Complete.**

PROPOSED PROCEDURES TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-32 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

1) **Request and secure approval from the TWC to demonstrate MIT (HCCG & GES).**

* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG.
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Since a bottom hole pressure (BHP) bomb will be run while injecting process fluid into the well, a full-opening valve (minimum 2" inside diameter) should be installed on top of the wellhead above the inlet effluent flowline prior to starting MIT.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.

* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.

4) **Perform pressure fall-off and static bottom hole pressure (BHP) survey with SPIDR.**

* Inject neutral process fluid into well at stable low rates for a minimum of two days prior to performing falloff test.

* Install SPIDR surface pressure gauges on WDW-32.

* Maintain constant injection rates a minimum of two hours prior to shutting well in.

* Shut-in well. Leave well shut-in for +/- 24 hours to obtain pressure decay data. Data obtained at the end of this test will provide static BHP.

5) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-1,000 psig. The annulus is filled with inhibited brine.

* Monitor casing pressure for a minimum period of 30 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

6) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector contains +/-5 millicuries of Iodine 131 radioactive (R/A) solution. Install lubricator on top of wellhead.

* Run initial base G/R log from base of screen liner section up to +/-300' above the packer (@3192'), or to +/-2900'. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3225'.

* Commence pumping effluent fluid down tubing using HCCG's injection pumps at a steady rate.

* Release first R/A slug inside tubing at +/-2900' while pumping fluid down the tubing at the rate of +/-40 gpm. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-2900' and run tool to +/-3225'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of screened section up to +/-2900' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

7) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

8) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW No. 32.

* Submit draft report to HCCG for comments and approval (GES).

* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.

* HCCG will submit report to the TWC for review and approval.

* HCCG will receive TWC's acceptance of the MIT report.

9) **Mechanical Integrity Testing Complete.**

PROPOSED PROCEDURE TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-49 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

1) **Request and secure approval from the TWC to demonstrate MIT (HCCG & GES).**

* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG (GES).
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and the estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.
* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.

4) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. Also, HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-1,000 psig. The annulus is reportedly filled with inhibited brine.

* Monitor casing pressure for a minimum period of 30 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

5) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector contains +/-5 millicuries of Iodine 131 radioactive (R/A) solution.

* Run initial base G/R log from just below perforated (or screen liner) section up to +/-300' above the packer (@3316'), or up to +/-3000'. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3300'.

* Release first R/A slug inside tubing at +/-3000' while pumping fluid down the tubing at the rate of +/-40 gpm. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-3000' and run tool to +/-3300'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of screened section up to +/-3000' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

6) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

7) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW-49.
* Submit draft report to HCCG for comments and approval (GES).
* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.
* HCCG will submit report to the TWC for review and approval.
* HCCG will receive TWC's acceptance of the MIT report.

8) **Mechanical Integrity Testing Complete.**

(4)

Hoechst Celanese

file

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

August 31, 1992
IOC-71-92

RECEIVED
SEP 9 1992
6 W-S

Mr. Phillip B. Dillinger
UIC Program Section 6W-SU
Water Supply Branch
Environmental Protection Agency
Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Subject: Annual (1992) Mechanical Integrity Testing
Of WDW - 14, 32 and 49
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City Texas

Dear Mr. Dellinger,

Per your request during our telephone conversation on today, I have enclosed copies of the following documents for your information and records:

- ATTACHMENT I - Ms. Kaymartha Williams' letter, KW-128-92, dated August 7, 1992 to Mr. Richard Merritt requesting approval of proposed procedures to demonstrate mechanical integrity testing of WDW-14, 32, and 49.

- ATTACHMENT II - Mr. H. R. Horton's letter, HRH-462-92, dated July 30, 1992 with the "Proposed Procedures To Demonstrate Mechanical In-Testing Of WDW - 14, 32, and 49" which were generated by our contractor, Golden Environmental Services, Inc.

Please don't hesitate to contact me by telephone at (409) 241-4197 if you have any comments and/or questions concerning the information in the above ATTACHMENTS.

5

409 245-4871
ext. 4152

Very truly yours,

I. O. Coleman, Jr.

I. O. Coleman, Jr.
IOC/rm

Hoechst

cc: Mr. Oscar Cabra - w/o ATTACHMENTS
Water Supply Branch 6W-S
Environmental Protection Agency
Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Mr. Richard E. Merritt, Permit Coordinator - w/o ATTACHMENTS
Underground Injection Control Team Permits Section
Industrial and Hazardous Waste Division
Texas Water Commission
P. O. Box 13087
1700 North Congress Avenue
Austin, Texas 78711-3087

bcc: H. P. Heathman - w/o ATTACHMENTS
K. Williams - " "
G. J. McCarthy - " "
G. M. Rowen - " " , Bridgewater
R. K. Golemon - " " , Austin (File Copy Only)
Environmental File No., 202.14

Hoechst Celanese

ATTACHMENT I

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City TX 77404-0509

August 7, 1992
KW-128-92

Mr. Richard Merritt, Geologist
Underground Injection Control Section
Texas Water Commission
1700 North Congress Avenue
Austin, Texas 77811-3087

Subject: Mechanical Integrity Testing (MIT) of Wells WDW-14, -32, and -49
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas
Facility Registration Number 30134

Dear Mr. Merritt:

The Hoechst Celanese Chemical Group, Inc. Bay City Plant request approval to demonstrate the mechanical integrity of waste injection wells numbered WDW-14, -32, and -49, per the attached letter (HRH-462-92, July 30, 1992). The MIT is tentatively scheduled for September 16, 1992 thru September 20, 1992.

If you have questions concerning this document and the attachment, please contact me. My telephone number is (409)241-4123.

Sincerely,

Kaymartha Williams

Kaymartha Williams
Environmental Engineer

Attachment

cc: Mr. Ben Knape
Underground Injection Control Section
Texas Water Commission
1700 North Congress Avenue
Austin, Texas 77811-3087

Ms. Susan Bredehoest, Manager
Hazardous/Solid Waste Division
Texas Water Commission - District 7
5144 E. Sam Houston Parkway North
Houston, Texas 77015

bcc: C. R. Pennington
H. P. Heathman
B. L. Fritz
W. G. Cornman
G. E. Organ
N. C. Stafford
I. O. Coleman, Jr.
E. H. Chiu
H. R. Horton - w/o attachment
G. J. McCarthy
C. J. Schaefer - Dallas
G. M. Rowen - Bridgewater

Interoffice Memo

ATTACHMENT 11

Hoechst Celanese

Date: July 30, 1992

HRH-462-92

To: I. O. Coleman

From: H. R. Horton

Dept/Location: Lab

Dept/Location: Maintenance Engineering

Subject: Mechanical Integrity Testing (MIT), WDW-14, 32, and 49

Section Work Plan
I. A.

pc: W. G. Cornman
R. S. O'Neal
N. C. Stafford
H. P. Heathman
G. J. McCarthy
B. A. Logue
R. M. Hall - Golden Strata Services, Inc.
E. H. Chiu
E. A. Wilson
R. E. Bennett
G. E. Organ
B. L. Fritz
R. Allsup - Clear Lake
C. Gross - Bishop
L. T. Johnston - Pampa
D. Horn - Edmonton
A. Rakhe - HCCGTC

Please request and secure approval from the Texas Water Commission to demonstrate mechanical integrity on our waste injection wells, WDW Nos. 14, 32, and 49.

Annulus pressure test (APT) will be conducted on WDW-14 at 800 psig ΔP for 60 minutes and WDW-32 and 49 at 1000 psig ΔP for 30 minutes.

A pressure falloff/bottomhole pressure test (BHP) will be conducted on WDW-32. There will be no BHP performed on WDW-14 and WDW-49 because they are in the same upper Miocene injection sand as WDW-32. All three wells are in pressure communication and one pressure test will be representative of all three.

The mechanical integrity test for WDW-Nos. 32 and 49 are tentatively scheduled for September 16 and 17, 1992 and for WDW-14 on September 20, 1992.

Attached is the complete proposed procedures to demonstrate mechanical integrity testing as submitted by Golden Strata Services, Inc.

H. R. Horton

H. R. Horton

lrk
attachments

PROPOSED PROCEDURES TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-14 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

1) **Request and secure approval from the TWC to demonstrate MIT (HCCG & GES).**

* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG .
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and the estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.
* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.
* Close well in 24 hours prior to performing annulus pressure test.

4) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. Also, HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-800 psig. The annulus is reportedly filled with inhibited brine.

* Monitor casing pressure for a minimum period of 60 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

5) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector containes +/-5 millicuries of Iodine 131 radioactive (R/A) solution.

* Run initial base G/R log from just below perforated section up to +/-300' above the packer (@3162'), or up to +/-2800. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3150'.

* Commence pumping effluent fluid down tubing using HCCG's injection pumps at a steady rate.

* Release first R/A slug inside tubing at +/-2800' while pumping fluid down the tubing at the rate of +/-40 gpm. Note: This injection rate will be used on all wells. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-2800' and run tool to +/-3150'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of perforated section up to +/-2800' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

6) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

7) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW No. 14.

* Submit draft report to HCCG for comments and approval (GES).

* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.

* HCCG will submit report to the TWC for review and approval.

* HCCG will receive TWC's acceptance of the MIT report.

8) **Mechanical Integrity Testing Complete.**

PROPOSED PROCEDURES TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-32 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

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* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG.
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Since a bottom hole pressure (BHP) bomb will be run while injecting process fluid into the well, a full-opening valve (minimum 2" inside diameter) should be installed on top of the wellhead above the inlet effluent flowline prior to starting MIT.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.

* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.

4) **Perform pressure fall-off and static bottom hole pressure (BHP) survey with SPIDR.**

* Inject neutral process fluid into well at stable low rates for a minimum of two days prior to performing falloff test.

* Install SPIDR surface pressure gauges on WDW-32.

* Maintain constant injection rates a minimum of two hours prior to shutting well in.

* Shut-in well. Leave well shut-in for +/- 24 hours to obtain pressure decay data. Data obtained at the end of this test will provide static BHP.

5) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-1,000 psig. The annulus is filled with inhibited brine.

* Monitor casing pressure for a minimum period of 30 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

6) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector contains +/-5 millicuries of Iodine 131 radioactive (R/A) solution. Install lubricator on top of wellhead.

* Run initial base G/R log from base of screen liner section up to +/-300' above the packer (@3192'), or to +/-2900'. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3225'.

* Commence pumping effluent fluid down tubing using HCCG's injection pumps at a steady rate.

* Release first R/A slug inside tubing at +/-2900' while pumping fluid down the tubing at the rate of +/-40 gpm. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-2900' and run tool to +/-3225'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of screened section up to +/-2900' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

7) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

8) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW No. 32.

* Submit draft report to HCCG for comments and approval (GES).

* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.

* HCCG will submit report to the TWC for review and approval.

* HCCG will receive TWC's acceptance of the MIT report.

9) **Mechanical Integrity Testing Complete.**

PROPOSED PROCEDURE TO DEMONSTRATE MECHANICAL INTEGRITY TESTING HOECHST CELANESE - CHEMICAL GROUP WDW-49 BAY CITY FACILITY

The following step-by-step proposed mechanical integrity testing (MIT) procedures were developed in accordance with the Underground Injection Control (UIC) and the Hazardous Waste Disposal Injection Restrictions (HWDIR) Programs issued by the United States Environmental Protection Agency (US EPA) and promulgated by the Texas Water Commission (TWC). Except where noted, all steps of this procedure will be performed by Golden Environmental Services' (GES) personnel.

1) **Request and secure approval from the TWC to demonstrate MIT (HCCG & GES).**

* Define annulus pressure test, type logging tools and downhole logging procedures and submit to HCCG (GES).
* HCCG will draft a letter which will provide formal notification to the TWC of the intent to demonstrate MIT.
* HCCG will issue the letter to the TWC for review and acceptance.
* Receive approval letter from TWC on proposed MIT.

2) **Notify the TWC field inspector of the scheduled MIT (HCCG).**

* Verbally notify the field inspector of the date field work is scheduled and the estimated starting time for the first test to be witnessed by the TWC.
* Determine the intent of TWC to field witness MIT.
* Determine desire of TWC for any special documentation of test results.

3) **Prepare well for MIT (HCCG).**

* Test master valve to make sure that it will open, close and seal off properly.
* Check wellhead valves to insure that standard fittings can be installed during the MIT. GES requests that a 2" NPT connection, or standard oil field size adapter, be available on the tubing and casing outlets.
* HCCG's personnel will be set-up to maintain proper annulus pressure while conducting the radioactive tracer (RAT) survey.

4) **Perform annulus pressure test.**

* Install calibrated pressure gauge onto the annulus. Also, HCCG will furnish and install a pressure recorder.

* HCCG's personnel will slowly pressurize the annulus using nitrogen gas to +/-1,000 psig. The annulus is reportedly filled with inhibited brine.

* Monitor casing pressure for a minimum period of 30 minutes. Maximum allowable pressure leak-off rate during test is 5% of maximum test pressure.

* Gradually bleed off annulus pressure to normal operating level.

5) **Run radioactive tracer (RAT) survey.**

* Rig up electrical wireline service unit including a gamma ray (G/R) detector, casing collar locator (CCL) and radioactive tracer (RAT) ejector tool. Ejector contains +/-5 millicuries of Iodine 131 radioactive (R/A) solution.

* Run initial base G/R log from just below perforated (or screen liner) section up to +/-300' above the packer (@3316'), or up to +/-3000'. Make repeat G/R run in cased section to prove G/R tool repeatability.

* Run one (1) five-minute statistical log at a depth of 3300'.

* Release first R/A slug inside tubing at +/-3000' while pumping fluid down the tubing at the rate of +/-40 gpm. Make multiple recorded passes following the R/A slug (1) down the tubing, (2) into the borehole and (3) into the disposal zone until the R/A slug virtually disappears and cannot be distinguished from the normal background G/R radioactivity.

* Release second R/A slug from tool at +/-3000' and run tool to +/-3300'. Hold tool stationary. Place recorder on time-drive sequence. Logging time will be predetermined based on actual injection rate and as agreed upon with the TWC inspector.

* Run final base G/R from just below base of screened section up to +/-3000' (same interval as original base G/R log) to verify that all R/A materials have been flushed into the disposal zone and that no fluid is migrating up behind the casing strings. Pull tool out of the hole.

6) **MIT field work is completed.**

* Rig down all rental equipment and either move to the next injection well or off the location.

* Advise TWC of test results and that each injection well is, or is not, ready to resume injection service. If MIT fails, submit a workover procedure to the TWC. Note: The latter work is not included in the scope of this project.

7) **Submit MIT report (HCCG & GES).**

* Prepare a draft MIT report detailing the demonstration of MIT on WDW-49.
* Submit draft report to HCCG for comments and approval (GES).
* GES will correct the MIT report as required and issue 5 copies of the final report to HCCG.
* HCCG will submit report to the TWC for review and approval.
* HCCG will receive TWC's acceptance of the MIT report.

8) **Mechanical Integrity Testing Complete.**

(4)

SEP 2 1992

Ms. Kaymartha Williams
Hoechst Celanese Corporation
Bay City Plant
P.O. Box 509
Highway 3057
Bay City, Texas 77404-0509

Dear Ms. Williams:

The EPA has reviewed the 1990 and 1991 bottom hole pressure falloff tests submitted June 29, 1992. Celanese is required in Petition Condition No. 8 to provide a falloff test for each of its four wells. However, Celanese notified the EPA that WDW-110 was plugged and temporarily abandoned after losing its injectivity prior to the 1991 falloff test for this well. Celanese submitted only one test for the remaining three wells (WDW-14, WDW-32, and WDW-49) which are all completed in the 3350 to 3600 injection interval. However, no data were submitted to demonstrate that WDW-14, WDW-32 and WDW-49 are in communication and that a single well test would satisfy the requirements of Condition No. 8. Future well tests should be conducted for each well or an interference test demonstrating the wells are in communication should be performed to show that a single falloff test is representative for all three wells.

Attached is a list of deficiencies for the 1990 and 1991 well tests. All deficiencies should be addressed and submitted to EPA's Region 6 office by October 2, 1992.

If you have any questions, please contact Phil Dellinger or Joe Kordzi at (214) 655-7160.

Sincerely yours,

Mac A. Weaver, P.E.
Chief
UIC State Programs Section (6W-SU)

cc: Ben Knape, Texas Water Commission

6W-SU:PDELLINGER:X7160:9/2/92:DISK:LBAN:CELANESE.BA:BAYCITY.2TST

PD 7/2/92 MW 9/2/92

HOECHST CELANESE BAY CITY PLANT
Notice of Deficiencies
1990 and 1991 Annual Pressure Tests
September 2, 1992

1. Celanese ran a falloff test on WDW-14 and WDW-110 during October, 1990. The pressure data was supplied but no falloff analysis or comparison of reservoir parameters with the approved petition demonstration were included in the reports. Celanese is requested to review the EPA Region 6 guidelines for falloff testing dated June 17, 1992 and submit the following for each test:

   a) Celanese should analyze the pressure test data and supply EPA with a log-log plot with derivative, Horner plot, and expanded Horner plot. The end of wellbore storage should be identified. The semilog straight line should be drawn on both semilog plots.

   b) Celanese should include the injection rates of all wells in the formation tested 48 hours prior to and during the falloff test of WDW-14.

   c) Celanese should justify the parameters used in the analysis and show all calculations.

   d) Celanese should compare the flowing reservoir pressure, transmissivity, and permeability with those used in the approved petition demonstration.

2. Celanese conducted a falloff test on WDW-49 during October, 1991. Celanese submitted the pressure data and two plots for the well test. Celanese should submit similar data requested above for this WDW-49 falloff test.

Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509
409 245 4871

June 25, 1992
KW-112-92

RECEIVED
JUN 29 1992
MUNIC. FAC. BRANCH. 6W-M

Mr. Oscar Cabra, Jr., P.E.
Chief - Municipal Facilities (6w-M)
U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Re: Mechanical Integrity Test Reports for Injection Wells WDW-14, WDW-32, WDW-49, and WDW-110 covering the periods of May 4, 1990 to May 4, 1991 and May 4, 1991 to May 4, 1992
Hoechst Celanese Chemical Group, Inc.
Bay City Plant, Bay City, Texas Registration No. 30134

Dear Mr. Cabra:

This letter is in response to your June 18, 1992 letter (Addendum I) to Mr. I.O. Coleman, Jr. Environmental Section Leader, concerning the falloff test results for Injection Wells WDW-14, WDW-32, WDW-49 and WDW-110 covering the periods of May 4, 1990 to May 4, 1991 and May 4, 1991 to May 4, 1992 per 40 CFR 146.68(e)(1). Enclosed are copies of the mechanical integrity test (MIT) reports for the year 1990 and 1991 (Addendum II-1990 MIT Report and Addendum III-1991 MIT Report), which includes the falloff test results for the above mentioned periods.

If you need any additional information, please do not hesitate to telephone me at (409)241-4123 or Mr. I. O. Coleman, Jr. at (409)241-4197.

Sincerely yours,

Kaymartha Williams

Kaymartha Williams
Environmental Engineer

Attach.

ADDENDUM I

RECEIVED
JUN 29 1992
6 W-SU

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TEXAS 75202-2733

June 18, 1992

CERTIFIED MAIL P 176 166 855 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman
Hoechst Celanese Chemical Group, Inc.
P.O. Box 509
Bay City, TX 77404-0509

Dear Mr. Coleman:

Our records indicate that Hoechst Celanese Chemical Group, Inc. (Celanese) has not submitted falloff tests for Well Nos. WDW-14, WDW-32, WDW-49, and WDW-110 as required by Condition No. 8 of the December 11, 1991 reissuance approval letter (May 4, 1990 petition approval). Condition No. 8 states:

> Hoechst Celanese shall annually submit to EPA the results of bottom hole pressure surveys for WDW-14, WDW-32, WDW-49, WDW-110, and WDW-277 (if drilled). These surveys shall have been performed after shutting in each well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with 40 CFR 146.68(e)(1). This annual report shall include a comparison of reservoir parameters determined from the falloff tests with parameters used in the approved no migration petition.

According to 40 CFR 146.68(e)(1), Celanese is required to annually monitor the pressure buildup in the injection zone, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure falloff curve.

Celanese has not submitted the results of falloff tests for the period May 4, 1990 to May 4, 1991. These tests should have been submitted to the EPA Region 6 office no later than May 4, 1991. In addition, Celanese has not submitted the results of falloff tests for the period May 4, 1991 to May 4, 1992. These tests should have been submitted to the EPA Region 6 office no later than May 4, 1992. As stated in the original petition approval letter mentioned above, "Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR 148.24(a)(1)." Consequently, Celanese has jeopardized its exemption to the land disposal restrictions by not fulfilling Condition No. 8.

RECEIVED
JUN 29 1992

Celanese should submit an annual report for Well Nos. WDW-14, WDW-32, WDW-49, and WDW-110 covering the time periods May 4, 1990 to May 4, 1991; and May 4, 1991 to May 4, 1992 by July 17, 1992. These reports should include an analyzable falloff test for each well performed according to the enclosed guideline. If the above deadlines cannot be met, a valid justification should immediately be provided by letter.

If you have any questions, please contact Phil Dellinger or Joe Kordzi at (214) 655-7160.

Sincerely,

Oscar Cabra, Jr., P.E.
Chief
Municipal Facilities (6w-M)

cc: Ben Knape

RECEIVED
JUN 29 1992
6 W-SU

(4)

JUN 18 1992

CERTIFIED MAIL P 176 166 855 RETURN RECEIPT REQUESTED

Mr. I. O. Coleman
Hoechst Celanese Chemical Group, Inc.
P.O. Box 509
Bay City, TX 77404-0509

Dear Mr. Coleman:

Our records indicate that Hoechst Celanese Chemical Group, Inc. (Celanese) has not submitted falloff tests for Well Nos. WDW-14, WDW-32, WDW-49, and WDW-110 as required by Condition No. 8 of the December 11, 1991 reissuance approval letter (May 4, 1990 petition approval). Condition No. 8 states:

> Hoechst Celanese shall annually submit to EPA the results of bottom hole pressure surveys for WDW-14, WDW-32, WDW-49, WDW-110, and WDW-277 (if drilled). These surveys shall have been performed after shutting in each well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with 40 CFR 146.68(e)(1). This annual report shall include a comparison of reservoir parameters determined from the falloff tests with parameters used in the approved no migration petition.

According to 40 CFR 146.68(e)(1), Celanese is required to annually monitor the pressure buildup in the injection zone, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure falloff curve.

Celanese has not submitted the results of falloff tests for the period May 4, 1990 to May 4, 1991. These tests should have been submitted to the EPA Region 6 office no later than May 4, 1991. In addition, Celanese has not submitted the results of falloff tests for the period May 4, 1991 to May 4, 1992. These tests should have been submitted to the EPA Region 6 office no later than May 4, 1992. As stated in the original petition approval letter mentioned above, "Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR 148.24(a)(1)." Consequently, Celanese has jeopardized its exemption to the land disposal restrictions by not fulfilling Condition No. 8.

6W-SU:6/17/92:KORDZI:MH:C:WP50:CELANESE\CELANESE.BA\TESTS.ANL
6W-SU 6W-SU
DELLINGER WEAVER
PD 6/18/92 BW 6/18/92 JK 6/18/92

Celanese should submit an annual report for Well Nos. WDW-14, WDW-32, WDW-49, and WDW-110 covering the time periods May 4, 1990 to May 4, 1991; and May 4, 1991 to May 4, 1992 by July 17, 1992. These reports should include an analyzable falloff test for each well performed according to the enclosed guideline. If the above deadlines cannot be met, a valid justification should immediately be provided by letter.

If you have any questions, please contact Phil Dellinger or Joe Kordzi at (214) 655-7160.

Sincerely,

Oscar Cabra, Jr., P.E.
Chief
Municipal Facilities (6w-M)

cc: Ben Knape

(4)

JUN 17 1992

JUN 16 1992

Mr. I. O. Coleman
Hoechst Celanese Chemical Group, Incorporated
P.O. Box 509
Bay City, Texas 77404-0509

Dear Mr. Coleman:

Enclosed is the final form of the EPA Region 6 Pressure Falloff Testing Guideline. This guideline should be followed in the performance of future falloff testing in fulfillment of the applicable petition condition.

If you have any questions, please contact Joe Kordzi at (214) 655-7160.

Sincerely,

Oscar Cabra, Jr., P.E.
Chief
Municipal Facilities Branch (6W-M)

Enclosures

6W-SU:6/16/92:KORDZI:MH:C:WP50:CELANESE\CELANESE.BA\GUIDELIN.R6
6W-SU
WEAVER
MM
6/16

J.K
6/16/92

PRESSURE FALLOFF TESTING GUIDELINE
Region 6
May 22, 1992

BACKGROUND

The Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act mandated prohibitions on the land disposal of hazardous waste. These prohibitions are known as the land disposal restrictions and EPA promulgated regulations to implement these requirements for injection wells on July 26, 1988. The land disposal restrictions for injection wells are codified in 40 CFR Part 148. In addition to specifying the effective dates of the restrictions on injection of specific hazardous wastes, these regulations outline the requirements for obtaining an exemption to the restrictions.

Facilities which have received an exemption to the land disposal restrictions under 40 CFR Part 148 have demonstrated that, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. As part of this approval, facilities are required by Region 6 to meet approval conditions including annual monitoring in accordance to 40 CFR 148.20(d)(2).

Region 6 has adopted the 40 CFR 146.68(e)(1) requirements for monitoring Class 1 hazardous waste disposal wells. Under 40 CFR 146.68(e)(1), operators are required to annually monitor the pressure buildup in the injection zone, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure falloff curve.

PURPOSE OF GUIDELINE

This guideline has been developed by the Region 6 office of the EPA to assist operators in preparing an annual monitoring report. These reports, in most instances, should consist of a falloff test and a comparison of the reservoir parameters derived from the test with those of the petition demonstration. The primary function of this guideline is not to establish boundaries within which enforcement action can be taken. Rather, this guideline is intended to provide direction as to the correct performance of injection well falloff testing. Consequently, the annual report is viewed not as an enforcement tool, but as an annual reaffirmation that the petition demonstration continues to be valid. This guideline may be periodically updated.

ANNUAL PRESSURE TESTING REQUIREMENTS

A falloff test consists of injecting at a constant rate, shutting

in the well, and measuring the pressure falloff. The falloff test should be properly designed so that valid results are obtained. The following points should be kept in mind when planning or conducting a falloff test:

1. The injection rate should be held constant throughout the injection portion of the test. Small, normal fluctuations due to the design of the pump are acceptable. This rate should be at a high enough rate, for a period of time sufficient to produce a pressure buildup, which will result in a valid test. The amount of pressure buildup required will depend largely on the sensitivity of the pressure gauge used, and the specific properties of the formation. The injection rate must result in a pressure buildup such that a semilog straight line can be determined from the Horner plot.

2. Bottom hole pressure measurements are considered superior to surface pressure measurements. However, surface pressure measurements can be employed if it is demonstrated that a positive pressure is maintained at the surface throughout the falloff portion of the test.

3. If surface pressure measurements will be employed and it is anticipated that the injection well will go on vacuum during the test, a two-rate test should be used in order to maintain a positive pressure. Failure to maintain a positive pressure would result in changing wellbore storage effects, making analysis of the test difficult. A relatively high initial rate should be followed by a decreased rate. The pressure decrease as a result of the rate decrease is then analyzed. Choosing the two rates correctly results in a positive surface pressure during the falloff portion of the test and the interpretation problem resulting from changing wellbore effects is thus eliminated.

4. The viscosity and density of the injected fluid should be held as constant as possible throughout the test. Operators are encouraged to use their normal waste streams as injectate, if enough volume will be available so that the guidelines in No. 1, above, concerning the injection rate, can be followed. The value of the viscosity employed in analyzing the test should be that of the fluid through which the pressure transients propagate. Note: This is not necessarily the viscosity of the injected fluid and may be the viscosity of the waste plume or the formation fluid, depending on the size of the waste plume. This is covered in more detail in the mobility ratio discussion.

5. No injection in nearby facility wells should occur in the interval being tested. The pressure buildup in the injection interval due to offset wells should be stabilized prior to testing. Should operational problems prohibit shutting in offset well injection into the interval being tested, a rate near the planned test rates should be maintained prior to and throughout the test. The injection rates and surface pressures of the offset well should be recorded before and during the test period. This, however, does not guarantee good results. Shutting in all injection in communicable zones nearby is the recommended procedure, but EPA realizes that this may not be possible in cases where facilities are located close together and utilize the same injection interval.

6. The depth to any fill in the well tested should be tagged and recorded with the test to assist in the determination of the thickness available to flow.

7. The falloff portion of the injection well test should be run such that enough data points lie well within the infinite acting period and the semilog straight line is well developed.

8. A Horner plot of the data should be submitted with a Miller-Dyes-Hutchinson (MDH) type plot being optional. Additionally, the straight line portion of the Horner plot should be reproduced on an expanded scale in order to permit a closer inspection of any data fluctuations. The semilog straight line should be drawn on the Horner plots.

9. A log-log plot with a semilog derivative should be supplied to enable identification of the end of the wellbore storage period. The end of wellbore storage effects should be identified on both plots.

10. All data including verification of the viscosity should be submitted. All equations used in the analysis should be provided with the appropriate parameters substituted into the equations. Any abnormal data fluctuations should be explained. If the falloff test data is determined to be unanalyzable, a new test should be carefully planned and completed to obtain meaningful results.

TREATMENT OF SIGNIFICANT MOBILITY RATIO CHANGES

It is not unusual, in cases in which the viscosity of the historically injected fluid varies significantly from that of the formation fluid, for the resulting mobility ratio $(k/\mu)_w/(k/\mu)_f$

change (where the subscripts "w" and "f" refer to the waste and formation fluid, respectively) to be reflected in the falloff plot. This may be manifested by a change of slope. The radial flow portion of the derivative curve should also change and level to another value. Eliminating alternative geologic causes, such as a sealing fault, leads to the interpretation of this change in slope as representing the boundary of the two fluid banks.

The correct interpretation of this type of Horner plot proceeds by first calculating the radius of the historical waste plume volumetrically. This radius should then be used in the evaluation of the Horner plot to determine which fluid viscosity is appropriate for use in the analysis (waste or formation fluid).

$$r = \left(\frac{0.13368q}{\pi h \phi}\right)^{1/2}$$

where
- q = cumulative injection into completed interval only, gal
- r = estimated distance to waste front, ft
- h = interval thickness, ft
- ϕ = porosity, fraction
- π = approximately 3.14

The thickness of the injection interval should be justified. This should include the disclosure of the existence and top of any wellbore fill, and whether or not the injection interval is composed of hydraulically isolated units or a single massive unit. In certain instances, particularly when hydraulically isolated sands are present, it may be necessary to define the amount of flow entering the fill. In order to avoid interpretation problems, operators are encouraged to regularly clean any fill out of the wellbore.

The radius of investigation, r_i, should then be calculated and compared to the radius of the waste front in order to determine the predominant fluid through which the pressure transients were propagating. (Lee, J.: Well Testing, Society of Petroleum Engineers of AIME, Dallas (1982), page 15, Equation 1.47):

$$r_i = \left(\frac{kt}{948\phi\mu c_t}\right)^{1/2}$$

where r_i = radius of investigation, ft

Hoechst Celanese

WAT 18-6-5-9

Chemical Group
Bay City Plant
Hoechst Celanese Corporation
PO Box 509, FM 3057
Bay City, TX 77404-0509
409 245 4871

January 23, 1990
IOC-24-90

Vince
File

RECEIVED
JAN 29 1990
EPA GW-S
REGION VI

Mr. Ronald D. Crossland
Environmental Engineer
Underground Injection Control Section
U.S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Subject: Submittal of the 1989 Mechanical Integrity Testing (MIT) Report For WDW-14, 32, 49 and 110

Dear Mr. Crossland:

Enclosed herewith is a copy of the subject MIT report, prepared by Golden StrataServices, Inc. (GSS), for the Hoechst Celanese Chemical Group, Inc., Bay City Plant, Bay City, Texas four Class I Injection Wells: WDW-14, 32, 49 and 110.

This report is provided as our response to item #1 under Mechanical Integrity Tests on the January 9, 1990 Notice of Comments which states the following:

> "The submitted radioactive tracer tests and pressure tests for all wells were performed in December of 1988. Celanese should submit information demonstrating that the wells continue to have mechanical integrity."

The mechanical integrity testing was conducted by GSS per procedures approved by Texas Water Commission (TWC). All of the wells demonstrated mechanical integrity as required by TWC Underground Injection Control Program and 31 TAC, Sections, 331. 4 and 331.43.

Please contact me by telephone at (409)245-4871, Ext. 4197 if you have any comments or questions about the enclosed MIT report.

Yours very truly,

I. O. Coleman, Jr.

IOC/las
Attach.

WAT 18-6-5-9

Hoechst

cc: Mr. Oscar Cabra, Chief w/o Attach. Report
Underground Injection Control
U.S. Environmental Protection Agency
Region VI
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Mr. Vincent Malott w/o Attach. Report
Environmental Engineer
U.S. Environmental Protection Agency
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Mr. Russell S. Kimble, Chief w/o Attach. Report
Hazardous and Solid Waste Enforcement Section
Hazardous Solid Waste Division
Texas Water Commission
P. O. Box 13087, Capitol Station
1700 North Congress Ave.
Austin, TX 78711-3087

Mr. Tom Roth, Chief w/o Attach. Report
Underground Injection Control Section
Texas Water Commission
P. O. Box 13087, Capitol Station
1700 North Congress Ave
Austin TX 78711-3087

MEMORANDUM

Subject: Transmittal of RCRA Facility Assessment Evaluation

From: Erlece P. Allen, Chief
Technical Section (6H-CT)

To: William K. Honker, Chief
Permit Section (6H-CP)

Attached please find a copy of the following RCRA Facility Assessment Evaluation:

- Facility Name: Celanese Chemical Company
- EPA ID Number: TXD026040709

Please advise us if more information is required and/or if you need further assistance.

Attachment

cc: Sam Becker (6H-C)

RCRA FACILITY ASSESSMENT EVALUATION

PRELIMINARY REVIEW AND VISUAL SITE INSPECTION

(NO SAMPLING VISIT)

Region VI, Technical Compliance Section

FACILITY'S NAME(S): Celanese Chemical Company (Bay City)

EPA ID NUMBER: TXD026040709

ADDRESS: P.O. Box 509 Bay City, Texas 77414

LOCATION: Nine miles on FM 3057 Southeast of Bay City, Matagorda County, TX

DATE OF INSPECTION: May 11, 1987

SITE DESCRIPTION: Chemical Manufacturing Plant

PREPARED BY: TWC DATE PREPARED: September 8, 1987

REVIEWED BY: Jon Rinehart DATE REVIEWED: _____

ANTICIPATED PERMIT DATE: September 30, 1988

ANY ON-GOING STATE/FED 264, 265, or 270 CORRECTIVE ACTION OR CERCLA ACTION:
The State felt that there was a violation in the Part B.
EPA does not take that position. They felt that there was a LOIS violation

DOES FACILITY HAVE A CERCLA FILE? YES X NO ____

Was a CERCLA PA/SI performed at this facility: Yes February 1983

DOES FACILITY HAVE UIC WELL? YES X NO ____

TYPE OF DRINKING WATER SUPPLY WITHIN A 3-MILE RADIUS: There are twelve domestic water wells within one mile of the facility from the Chicot. One well is located downgradient. The public water supply is nine miles away in Bay City.

TARGET POPULATION WITHIN A 3-MILE RADIUS: The town of Bay City has a population of 17,984 as of the 1980 census, and is located nine miles from the facility. Approximately 300 people live within a three mile radius.

RECOMMENDATIONS: ____ S.V. X R.F.I. ____ I.M. ____ No Further Action under R

(Indicate only one unless I.M. is marked)

X 3004(u) ____ 3007

Possible Enforcement Action: ____ 3008(a) ____3008(h)

Form Rev. 6/17/87

B. NUMBER OF SWMU INVESTIGATED DURING THE PR/VSI: 76

	LIST OF SWMU	REGULATED BY RCRA*	STATUS**	SUBJECT TO GWM SUBPART F
1)	Boiler 4/5/6 (01)	Y	A	N
2)	F-4B (Class IH) Landfill (02)	Y	A	Y(?)
3)	F-8 (05) Landfill	Y	A/C	Y(?)
4)	WDW-14/32/49/110 (07) Injection Wells (2,3,4,1-A)	Y	A	N
5)	V-683 Boiler Oil Feed Tank (09)	Y	A	N
6)	Retention Pond (13)	Y	A	Y(?)
7)	V-159 Storage Tank (14)	Y	A	N
8)	V-680 Surge Tank (15)	Y	A	N
9)	V-248/V-987 Barge Dock Tanks(17)	Y	A	N
10)	V-901 Dirty Water Skimmer(18) Tank	Y	A	N
11)	Bulk Storage Area (19) Barrel Warehouse	Y	A	?
12)	Bulk Storage Area (20) Building 525	Y	A	?
13)	V-871 Surge Tank (21)	Y	A	N
14)	V-150 Prim. Filter Tank (X01)	Y	A	N
15)	V-151 "	Y	A	N
16)	V-833 "	Y	A	N
17)	V-152 Polish Filter Tank (X02)	Y	A	N
18)	V-153 "	Y	A	N
19)	V-662 "	Y	A	N
20)	V-663 "	Y	A	N
21)	V-1059 Prim. Filter Tank (X03)	Y	A	N
22)	V-1060 "	Y	A	N
23)	V-1061 "	Y	A	N
24)	V-1062 "	Y	A	N
25)	V-162 Polish Filter Tank (X04)	Y	A	N
26)	V-163 "	Y	A	N
27)	V-656 "	Y	A	N
28)	V-657 "	Y	A	N
29)	V-757 "	Y	A	N
30)	V-758 "	Y	A	N
31)	V-693 Neutralization Tank (X05)	Y	A	N
32)	M-1885 Well Sump (X06)	Y	A	N
33)	Emergency Storage Pond (X07)	Y	A	Y(?)
34)	V-877 Surge Tank (X08)	Y	A	N
35)	M-1897 Oil Sump (X09)	Y	A	N
36)	V-698 Tank (X10)	Y	A	N

* Y-Yes, N-No, ?-Unknown
** Active, Inactive, or Closed (A, I, or C)
*** GWM-Groundwater Monitoring

k = permeability, md
t = time injected, hrs
ϕ = porosity, fraction
c_t = total compressibility, psi^{-1}
μ = viscosity of fluid, cp

If it is determined that the pressure transients were primarily propagating through the waste plume, then the viscosity of the historically injected waste is the appropriate viscosity to use in the analysis. This may be the case for an older well with a long injection history and a large historical waste plume. It then follows that the proper viscosity to use in interpreting a well test in a relatively new well with little or no historical plume development would be that of the formation fluid. In either case, adequate information <u>must</u> be presented in order that the viscosity of the appropriate fluid, at reservoir conditions, can be verified.

If sufficient semilog straight line data exists on both sides of the slope change, then the use of the appropriate viscosities should produce approximately the same kh product for both sides of the slope change. If both slopes are analyzable, the kh product should be calculated and compared for both slopes.

APPROPRIATE FLOW RATE

In theory, the time required to achieve a particular radius of investigation is independent of flow rate. However, in practice, the flow rate must be large enough such that pressure changes with time can be recorded with sufficient precision to be useful for analysis.

HORNER PLOT ANALYSIS

The time determined at which the end of wellbore storage occurs should be converted to Horner time. This time approximates the point when the pressure transient has moved beyond the influence of the altered zone near the well and when wellbore storage has ceased distorting the pressure falloff test data. At this time the semilog straight line whose slope is related to formation permeability can be observed on the Horner plot. This straight line ordinarily will continue until the radius of investigation reaches one or more reservoir boundaries, massive heterogeneities, a fluid/fluid contact, or runs out of measurable pressure transients.

The slope of the Horner plot (m) is used to determine the (kh/μ) parameter group from the following equation:

$$\frac{kh}{\mu} = \frac{162.6qB}{m}$$

where: m = slope of the Horner plot, delta p/cycle
q = injection rate, bpd
B = formation volume factor, rvb/stb
h = interval thickness, ft
μ = viscosity, cp
k = permeability, md

The interval thickness (h) used in the equation should represent only the formation interval influenced by injection. It should be realized that this value may periodically change. This thickness may be more or less than the completed interval, or that value employed in the petition demonstration, due to factors such as wellbore fill, wellbore damage, and completions that do not closely correspond to the full thickness of the interval.

PRESSURE DERIVATIVE ANALYSIS

The pressure derivative curve is a log-log plot of the change in slope of the semilog plot of pressure with respect to time. Although it may be employed for several reasons, such as the detection of the end of the wellbore storage period, and the detection of restrictive boundaries, the former case is the only purpose for which this tool will be employed in the analysis of the annual reports. Either the natural logarithm of time or Horner time may be employed. The derivative curve should be presented on a log-log scale with the pressure versus time plot superimposed. The derivative plot emphasizes the infinite acting radial flow portion of the test. This allows the start of this period to be readily identified. Characteristically, the end of the wellbore storage period (and consequently the beginning of the infinite acting radial flow period) can be identified by a flattening out of the derivative curve. The derivative plot allows a more accurate determination of this time period, in comparison with the traditional method of simply proceeding one and one half log cycles past the end of the unit slope line on the log-log plot of the pressure versus time data. The end of wellbore storage effects should be identified on the log-log and derivative plots.

COMPARISON TO PETITION DATA

A comparison between the falloff test results and the parameters used in the no migration petition demonstration should be made. Specifically, the following should be demonstrated:

1. The bottom hole pressure should be at or below that which was temporally predicted by the pressure buildup model.

2. It should be shown that the (kh/μ) parameter group calculated from the current falloff data is the same or greater than that employed in the pressure buildup modeling.

3. If in the original petition, the permeability calculated from falloff testing was employed in determining a background reservoir velocity, that permeability should be compared to that derived from the current falloff test.

REPORT FOR EPA

A detailed report should be submitted to Region 6 summarizing the results of the falloff test with the parameters used in the no migration demonstration. The static bottom hole pressure should be below that predicted by the pressure buildup model. The kh/μ parameter grouping and permeability values calculated from the falloff test should lie within the range used in the petition. The report should include all raw data, a discussion of the testing procedure, all graphs and calculations, interpretations and conclusions from the test, and a comparison of all parameters with those used in the petition demonstration including references where the parameters can be found in the petition. The comparison of parameters should include an evaluation of the impact of parameter changes on the no migration demonstration. The summary should include the following data:

A. Falloff Test Data

1) Pre-test period

Date of test
Shut-in time prior to test
Stabilized pressure and temperature prior to test
Cumulative injection into completed interval
Wellbore radius
Completed interval
Type of completion
Depth to fill
Justified interval thickness
Average historical waste fluid viscosity

Formation fluid viscosity
Porosity
Total compressibility
Formation volume factor
Initial formation bottom hole pressure and temperature

2) Injection Period

Time of injection period
Test fluid
Injection rate
Pumps used for test
Injection fluid viscosity
Method and times viscosity tested
Final injection pressure and temperature
Gauge type (Panex, Amerada, etc)
Gauge sensitivity
Gauge depth

3) Falloff Period

Total shut-in time
Final shut-in pressure and temperature

B. Calculated Test Data

Distance to waste front
Radius of investigation
Time to end of wellbore storage (from derivative)
Horner time at end of wellbore storage
Slope or slopes from Horner plot
kh/μ
Permeability (range based on values of h)
Skin

TIMING OF REPORT SUBMISSION

The report discussed above is due at EPA Region 6 within one yea from the date of petition approval. It will not be acceptable t have simply completed the testing by the deadline, without submission of a complete report. This does not mean that all correspondence between Region 6 and the facility must be settle by the deadline, but a complete report must have been received. In addition, this report should be submitted no later than 45 days following the test.

The deadline for successive reports will be in yearly intervals from the date of the original petition, and not from the date o the last test. In no case should the time interval between successive tests be less than nine months. This will ensure th the tests will be performed at relatively even intervals throughout the duration of the petition approval period. Operators can, at their discretion, plan these tests to coinci with the performance of their annual State MIT requirements as long as the above requirements are met.

Failure to submit a complete report by the appropriate date wi be considered as a violation of one of the conditions of the petition approval and may result in revocation of the petitior

C. NUMBER SWMU TO BE INCLUDED IN
(Except RCRA units subject to

LIST OF SWMU	MEDIA
1) F-8 Landfill 05 (SWMU #3)	S GW SW
2) Landfill F-4A, C, D, 02 (SWMU #58)	S GW SW
3) F-1 Landfill 03 (SWMU #59)	S G S

approval.

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LIST OF SWMU	MEDIA	RATIONALE
4) F-2 and F-3 Landfill 04 (SWMU #60)	S GW SW	This unit is two landfills operated from 1962 to 1965 and closed in 1979. This unit has no artificial liner installed, no leachate collection system, runoff managed by plant runoff control system, 2-3 foot thick clay covers between lifts, and a final clay cover of 2-3 feet of clay with permeability of 10^{-7} to 10^{-9} cm/sec. The wastes managed at these landfills are: plant trash, water treater sludge, surface impoundment cleanout from surge pond and NPDES sump cleanout material, construction rubble, and sump cleanouts with spent copper chromite catalyst. No evidence of release was identified in the documents reviewed or during the VSI. Due to the construction and the hazardous waste that was handled in this unit the likelihood of a release to soil, groundwater, and surface water is high.
5) F-5 Landfill 06 (SWMU #61)	S GW SW	This unit is a landfill which has a clay bottom, no leachate collection system, runoff managed by runoff collection system, and covered by 2-6 feet of clay with 10^{-7} to 10^{-9} cm/sec permeability. The wastes that have been disposed of in this unit are: HMD (Carbidox) catalyst, and activated sludge Raney Nickel. No evidence of release was identified in the document search or during the VSI. The possibility of release to soil, groundwater and surface water is high.
6-9) Leveling, Surge and Settling Pond; Clean Water Skimmer 11 (SWMU #64, 65, 66, and 67)	S GW SW	This unit consists of a skimmer, three surface impoundments (leveling, surge, and settling ponds) used in conjunction with the Aeration Lagoons for NPDES

LIST OF SWMU	MEDIA	RATIONALE
		permitted treatment of process wastewater and contaminated stormwater runoff. The ponds do not appear to be lined with synthetic liners.The cooling tower blowdown contains chromium which has been disposed of in this unit. The likelihood of a release to soil, groundwater, and surface water is very high.
10-11) Aeration Ponds Primary, Secondary Lagoon 12 (SWMU #68 and 69)	S GW SW	This unit consists of two surface impoundments which were activated in 1963 and are still active. The units are permitted under TWC WQ 455 and NPDES TX006017 permits. No construction date was in the documents reviewed. The cooling water tower blowdown contains chromium, which has been disposed of in this unit . The sludges may also contain toxic levels of chromium, which may have released to soil, groundwater, and surface water.
12-13) BOD Ponds #1 and #2, Paddy Ponds Y01 (SWMU #73 and 74)	S GW SW	The BOD Ponds #1 and #2 was constructed of native soils with an estimated working depth of 6 inches. The Paddy Pond was constructed of native soils with an estimated working depth of 6 inches. All three of the impoundments were closed in 1970 by allowing the impoundments to dry and then scrapping the accumulated solids into pits. These pits are located as follows: one each in the HW corner of BOD Ponds 1 and 2, and two in Paddy Ponds, one at the NE and one at the SW corner of the impoundment. No cover construction details were found. The wastes that were handled in these units were: acetaldehyde U001, chloroacetaldehyde P023, acetic acid U112, acetaldol, butanol U031, and crotonaldehyde U053, which were then disposed of in the injection well WDW-8.

LIST OF SWMU	MEDIA	RATIONALE
		Contamination has probably occurred to soil, groundwater and surface water due to the unlined nature of the impoundments and the listed wastes disposed. The closure pits also need to be examined for soil contamination.
14) F-O Landfill Y02 (SWMU #75)	S GW SW	This unit is a landfill with a clay bottom and closed with a 2-3 foot cover of clay with a permeability of 10^{-7} to 10^{-9} cm/sec. The wastes that were disposed of in this unit was sump and tank bottom sludges and office trash. This unit was closed in 1970. This landfill was probably used to dispose wastes of similar nature to material disposed presently in Landfill F-4B which includes chromium and chromium compounds. The contamination that has occurred would be soil, groundwater and surface water. Soil samplings needs to be conducted.

D. NUMBER OF SWMU WITH NO INDICATED RELEASES: 60
(Documentation is necessary for a SWMU to be included in this category.)

LIST OF SWMU	RATIONALE
1) Industrial Boiler 4/5/6 (SWMU #1) 01	This unit burns liquid hazardous wastes which may contain Appendix VIII constituents such as toluene, triphenylphosphine, isobutanol and butanol. There was no evidence of release in the documents reviewed or during the inspection.
2) F-4B Landfill (SWMU #2) 02	This unit handles process wastes, spent catalysts, contaminated dirt and sludges from sumps, containers and tanks chromium and chromium compounds are constituents which are included in these wastes. There was no evidence of release in the documents reviewed or during the inspection. RCRA regulated.

LIST OF SWMU	RATIONALE
3) V-683 Boiler Oil Feed Tank 09 (SWMU #5)	This unit is a carbon steel pressure vessel which is surrounded by a concrete process slab with trench drains. The vessel is also fitted with a relief valve which vents to the atmosphere. No stains or evidence of spills were noted during the VSI.
4) Retention Pond 13 (SWMU #6)	Celanese plans to initiate unit closure, as required under HWSA Provision 3005(j), by November 8, 1988. Since this a RCRA Regulated Unit, no groundwater release investigations under HSWA Section 3004(u) are required. Surface releases were not observed during the VSI. Ground-water monitoring is accomplished by four wells; the upgradient well is CBC-14 and the downgradient wells are CBC-5, CBC-16, and CBC-17.
5) V-248/V-987 Barge Dock Run Down Tanks 17 (SWMU #9)	This unit consists of two carbon steel, unlined tank. The tanks rest on saddles on the sandy soil of the dock area. No signs of release were observed during the VSI and none were indicated in the file review.
6) M-901 Dirty Water Skimmer 18 (V) (SWMU #10)	This unit is a two celled, internally elevated below-grade, concrete vessel. The unit is designed, constructed and operated appropriately. No structural flaws or evidence of release were noted. In the documents reviewed no evidence of release was reported.
7) Bulk Storage Area 19 Barrel Warehouse (SWMU #11)	The unit is designed,constructed, and operated to safely handle spent catalyst material, which is a nickel catalyst. No evidence of release was documented during the file review or during the VSI.
8) Bulk Container Storage Area 20 Building 525 (SWMU #12)	This unit is a pre-fabricated steel building set on a concrete slab at grade. The unit stores asbestos prior to disposal. There were no evidence of release during the VSI or in the file documents that were reviewed.

LIST OF SWMU	RATIONALE
9) V-871 Acid Well Surge Tank 21 (SWMU #13)	This unit is an atmospheric pressure cone-roof, 316 stainless steel vessel. Based on a review of all available information and a visual site inspection there is no evidence of release.
10) V-150 Acid Well Primary Filter Tank X01 (SWMU #14)	This unit consists of three pressure vessels. The vessels are set on individual raised concrete foundations surrounded by a concrete process area slab. No curbed secondary containment system is installed. There is no evidence of release during the VSI or in the files reviewed.
11) V-151 Acid Well Primary Filter Tank (SWMU #15)	" "
12) V-833 Acid Well Primary Filter Tank (SWMU #16)	" "
13) V-152 Acid Well Polish Filter Tank X02 (SWMU #17)	This unit consists of four pressure vessels. The vessels are set on individual raised concrete foundations surrounded by a concrete process area slab. No curbed secondary containment system is used. There was no evidence of release indicated in the documents reviewed or during the VSI.
14) V-153 Acid Well Polish Filter Tank (SWMU #18)	" "
15) V-662 Acid Well Polish Filter Tank (SWMU #19)	" "
16) V-663 Acid Well Polish Filter Tank (SWMU #20)	" "
17) V-1059 Neutral Well Primary Filter Tank X03 (SWMU #21)	This unit consists of four pressure vessels, which are set on individual raised concrete foundations surrounded by a concrete process area slab. No curbed secondary containment system is used. No evidence of release was documented in the files reviewed or during the VSI.

LIST OF SWMU	RATIONALE
18) V-1060 Neutral Well Primary Filter Tank (SWMU #22)	This unit consists of four pressure vessels, which are set on individual raised concrete foundations surrounded by a concrete process area slab. No curbed secondary containment system is used. No evidence of release was documented in the files reviewed or during the VSI.
19) V-1061 Neutral Well Primary Filter Tank (SWMU #23)	" "
20) V-1062 Neutral Well Primary Filter Tank (SWMU #24)	" "
21) V-162 Neutral Well Polish Filter Tank X04 (SWMU #25)	This unit consists of six pressure vessels. The vessels are set on individual raised concrete foundations surrounded by a concrete process area slab with no curbed secondary containment system utilized. No evidence of release was identified during the review or the VSI.
22) V-163 Neutral Well Polish Filter Tank (SWMU #26)	" "
23) V-656 Neutral Well Polish Filter Tank (SWMU #27)	" "
24) V-657 Neutral Well Polish Filter Tank (SWMU #28)	" "
25) V-757 Neutral Well Polish Filter Tank (SWMU #29)	" "
26) V-758 Neutral Well Polish Filter Tank (SWMU #30)	" "
27) V-693 Acid Well Neutralization Tank X05 (SWMU #31)	This unit is a vessel that is equipped with 2 gooseneck vents for pressure control. The vessel is elevated 15 feet above grade but there is no secondary containment. There is no evidence of release documented in the file review or during the VSI.
28) M-1885 Neutral Well Neutralization Sump X06 (SWMU #32)	This unit consists of concrete sump with an 8" overflow line. No evidence of release was documente in the file review or during the

LIST OF SWMU	RATIONALE
29) Emergency Storage Pond X07 (SWMU #33)	This unit is a rectangular, diked pond with a working volume of 43 million gallons and covers 11 acres. The unit was constructed by shallow excavation of native clay soils. Ground water monitoring is accomplished with one upgradient well CBC-14, and three downgradient wells, CBC-3, CBC-11 and CBC-20. No evidence of release was noted during the file review or the VSI.
30) Emergency Storage Pond Surge Tank V-877 X08 (SWMU # 34)	This unit is an unlined, stainless steel vertical vessel with a nominal working capacity of 17,600 gallons. No evidence of release was indicated in the documents reviewed or during the VSI.
31) M-1897, Oil Sump X09 (SWMU #35)	This unit is a two celled, internally coated, below-grade, concrete vessel commonly known as the dirty water skimmer, Celanese has identified both cells with a vessel number, M-901 for the skimmer side and M-1897 for the oil retention side. There is no evidence of release documented in the file review or during the VSI.
32) V-698, T-29 Overhead Accumulator X10 (SWMU #36)	This unit is an unlined, stainless steel horizontal vessel with 850 gallon nominal working capacity. It rests on a curbed process slab. There is no evidence of release documented in the file review or during the VSI.
33) V-519,Neutral Well Waste Oil Surge Tank X11 (SWMU #37)	This unit is a stainless steel horizontal vessel of a capacity of 25,000 gallons. There is no evidence of release identified in the documents reviewed or during the VSI.
34) V-1041, VA Waste Oil Tank X12 (SWMU #38)	This unit is an unlined, stainless steel vertical vessel with a nominal working capacity of 20,300 gallons. It is placed on a concrete process slab with 6" curb. There no evidence of release documented in the files reviewed or during the VSI.

LIST OF SWMU	RATIONALE
36) V-17, T-146 Overhead Receiver X14 (SWMU #39)	This unit is a rubber lined tank which is equipped with a relief valve, insulation and full level instrument control. There is no evidence of release identified in the review of the files or during the VSI.
37) Ditches A, B, and C X15 (SWMU # 40)	This unit consists of four below grade, unlined, ditches which are located throughtout the operating plant site. The known waste constituents are isobutanol, vinyl acetate, and acetic acid. Release to soil and ground water may have occurred from this TWC feels that the monitor wells already installed should intercept any possible contaminants.
38) Purge Waste Acid Tank V-388 (SWMU #41)	This unit consists of an unlined, stainless steel tank vertically oriented with 5,075 gallon capacity. Celanese intends to close V-388 under interim status regulations. There is no evidence of release identified from the documents reviewed or during the VSI.
39) M-1886 Lab Sump X19 (SWMU #42)	This unit is a stainless steel vaulted sump. The sump has a fixed cover with a full instrument level controls. No evidence of release was identified in the file review or during the VSI.
40) V-658, No. 2 Precoat Tank X20 (SWMU #43)	This unit is an unlined, carbon steel tank vertically oriented with a nominal capacity of 1500 gallons. As of June 1984, the unit was no longer in service. Celanese is planning to close this unit under interim status. No evidence of release was indicated in the file review or during the VSI
41) V-681 No. 3 Clearwell Tank X21 (SWMU #44)	This unit is a galvanized, carbon steel, vertical steel with a nominal working capacity of 35,200 gallons. No evidence of release was identified in the documents reviewed or during the VSI.

LIST OF SWMU	RATIONALE
42) V-682, No. 3 Precoat Tank X22 (SWMU #45)	There were no unit design data included in the documents reviewed. No evidence of release was identified in the file review or during the VSI. This unit has been scheduled for interim status closure.
43) V-708 Clarifier Tank X23 (SWMU #46)	This unit consists of two vessels, V-708 and V-793, with 79,310 and 6,768 gallon capacity respectively. There is evidence of release identified in the documents reviewed or during the VSI.
44) V-793 Cone Bottom Settler Tank (SWMU #47)	" "
45) V-761, No. 4 Tank X25 (SWMU #48)	This unit is an unlined, carbon steel vertical tank with nominal capacity of 1,682 gallons. No evidence of release was identified in the documents reviewed or during the VSI. This unit has been inactive since June 1984 and has been scheduled for interim status closure.
46) V-778 CHOX H_2O/Oil Separator X26 (SWMU #49)	This unit is an unlined stainless steel horizontal tank with nominal capacity of 23,385 gallons. There is no evidence of release documented in the files that were reviewed or during the VSI.
47) V-792, Sulfuric Acid Waste Tank X29 (SWMU #50)	This unit is a rubber-lined, carbon steel vessel. No evidence of release was identified in the documents reviewed or during the VSI.
48) V-1035, SFA Catalyst Tank X30 (SWMU #51)	This unit is an unlined, stainless steel tank with a nominal capacity of at least 75,000 gallons. It does not have a surrounding process slab. No evidence of release was identified in the documents reviewed or during the VSI.
49) V-1042, Waste Oil Surge Tank X30 (SWMU #52)	This unit is an unlined, stainless steel tank with a nominal capacity of 1,600 gallons. No evidence of release was identified in the documents reviewed during the VSI.

LIST OF SWMU	RATIONALE
50) V-1043, CHOX Oil/Water Coalescer X32 (SWMU #53)	This unit is an unlined, stainless steel, horizontal tank with nominal working capacity of 283 gallons. This unit is no longer in service as of June 1984 and has been scheduled for interim status closure. No evidence of release was identified in the documents reviewed or during the VSI.
51) M(V)-1881, Area I Sump X33 (SWMU #54)	This unit is a concrete sump with a street cover. It has a capacity of 2334 gallons. No evidence of release was identified in documents reviewed or during the VSI.
52) V-1882, ADA-Nylon Salt Sump X34 (SWMU #55)	The unit is a thick-walled concrete sump, which is not covered. No evidence of release was identified in the documents reviewed or during the VSI.
53) V-1883, CHOX Sump X35 (SWMU #56)	This unit is a concrete sump with a steel cover. It has a capacity of 2334 gallons. No evidence of release was identified in the documents reviewed or during the VSI.
54) Liquid Incinerators 1 and 2 X36 (SWMU #57)	This unit was shut down but remains standing. No evidence of release was identified in the documents reviewed or during the VSI.
55) F-9 Landfill (08) (SWMU #62)	This unit was never built but was recommended by TWC for a RFI. After a conversation with Rex McDonnel III (permits writer) he said that this unit should be under " No Further Action".
56) F-7 Open Pit Incinerator 10 (SWMU #63)	This unit is a forced air burning pit with cage enclosure. No evidence of release was observed during the VSI or identified in the documents that were reviewed.
57) Day Chemical Warehouse 16 Container Storage Area (SWMU #70)	This unit is in a large shipping/receiving warehouse. The unit is designed constructed and operated to safely handle catalyst material. No evidence of release was identified in documents reviewed or during the VSI.

LIST OF SWMU	RATIONALE
58) V-782 Brine Tank X27 (SWMU #71)	These units are tanks which are served to store brine used in the injection well annulus leak detection system. No evidence of release was identified in the file reviewed or during the VSI.
59) V-783 Brine Tank X28 (SWMU #72)	" "
60) Injection Well WDW-8 (SWMU #76)	This unit was operated from from 1964 to 1973 when it failed due to "metallurigical failure". The unit has been referred to UIC.

E. SUPPLEMENTAL INFORMATION ON RCRA REGULATED UNITS: 4
(Describe any problems identified or suspected from regulated units including identified releases to groundwater)

LIST OF SWMU	CONCERNS
1) F-8 Landfill 05 (SWMU #3)	This unit has received asbestos, Dirty Water Skimmer sludge which included listed wastes: formaldehyde U122, acrylic acid U008 formic acid U123 trichloroethane F001, acetone F003, methanol F005, and MEK U159. These wastes were indicated in Inspection 5 and 6 which were a CERCLA Site Investigation and a CMI conducted by TDWR respectively. It appears that this unit may have lost interim status since it was not included in the Part B permit application. This unit has been referred to the TWC Enforcement Section for appropriate L.O.I.S. action. The TWC subsequently passed the case to EPA for action.
2) Injection Wells (SWMU #4) WDW-14/32/49/110	WDW 14/32/49 were permitted to dispose of wastes with the following compositions, hexanols, hexamethylene imine, ammonia, cyclohexane, amyl alcohol, nitric acid, maleric acid, nylon salt, sodium nitrite, sodium nitrate, sodium bicarbonate, sodium carbonate, methanol, dodecane, and hexamethylene diamine. WDW-110 was permitted to dispose of wastes with the following components: copper,

LIST OF SWMU	CONCERNS
	vanadium, nitric acid, chlorinated organics, acetic acid, methyl acetate, acetaldehyde, C_1-C_6 hydrocarbons, cyclohexane, cyclohexanone, and cyclohexanol. The wells appear to be operated with no indication of release. Inspection 11 of Attachment B.3 of the RFA Report indicated WDW-32 and WDW-49 are failing to maintain a properly functioning annulus leak detection system. This issue should be referred to the UIC program.
3) V-159 Storage Tank 14 (SWMU #7)	This unit is an atmospheric, cone roof carbon steel vessel. Based on other similar vessels nearby, it is not likely that this unit has a curbed, concrete secondary containment structure; rather the unit relies on trenches in the fully-surrounding concrete process area slab for spill control. No problems were indicated in the file review or during the VSI.
4) V-680 Neutral Well Surge Tank 15 (SWMU #8)	This unit is an atmospheric pressure, cone-roof, carbon steel vessel. Based on other similar vessels nearby, it is not likely that this unit has a curbed concrete secondary containment structure; rather, the unit relies on trenches in the partially surrounding concrete process area slab for spill control. Based on the review of all information and the visual site inspection of this unit no problems were indicated.

II. FINDINGS

A. RECOMMENDATIONS:

The State recommends that the following units be included in a RFI: 1) Landfill F-4A, C, D 02 (SWMU #58); 2) Landfill F-1 03 (SWMU #59); 3) Landfill F-2, 3 04 (SWMU #60); 4) Landfill F-8 05 (SWMU #3); 5) Landfill F-5 06 (SWMU #61); 6) Landfill F-9 08 (SWMU #62); 7) Surface Impoundment Leveling Pond, Surge Pond, Settling Pond, Tank Skimmer 11 SWMU #64, 65, 66, and 67); 8) Surface Impoundment Aeration Lagoons, Primary and Secondary Lagoons 12 (SWMU #68 and 69); 9) Surface Impoundment BOD Ponds 1 and 2 Paddy Ponds Y01 (SWMU #73 and 74) and 10) Landfill F-0 Y02 (SWMU #75).

The EPA concurs with the recommendations of the State on the SWMUs to be included in the RFI. F-9 08 Landfill was recommended by the State for a RFI but it appears that this unit was never built as a landfill. Therefore no further action is recommended. This was confirmed by a conversation with Rex McDonnel III on December 2, 1987.

B. Additional Comments:

The following units V-119, V-122, and V-123, which are T-107 Residue Storage. These units were originally listed as SWMUs but it has been determined that they serve as process stream storage and therefore are not SWMUs.

Unit V-710 OH Receiver X24, which was listed as a SWMU. It has been determined during the VSI that this handles process product and and not waste material.

Unit F4A, C, D + Sump 02 (SWMU #58) was recommended by the State for a RFI to confirm the adequacy of the GWM program according to the following checklist:

1. Well Location (upgradient, downgradient, depth) confirmation of geology/hydrogeology (logs, borings, etc.)
2. Well Installation/Completion
   Confirmation of construction including screened interval
3. Monitoring Data
   A. Confirmation of indicator parameter adequacy
   B. Review of past sampling data

The unit F-1 Landfill 03 (SWMU #59) requires the same information as SWMU #58 F-A, C, D + Sump Landfill. This information needs to be assembled for further evaluation. No evidence of release in either the document search or during the VSI.

Injection well WDW-8 (SWMU #76) was operated from 1964 to 1973 when it failed due to "metallurgical failure". This well was plugged in 1973. This well was permitted to dispose of wastes with the following composition: acetaldehyde, chloroacetaldehyde, acetic acid, acetaldol, water, butanol, and crotonaldehyde. The manner in which this well was plugged should be investigated. It has been referred to UIC. This unit is to be addressed under corrective action scheduled for December 1, 1987, by TWC.

M-1907 Area I Tank Farm Sump X17 had no information available on the description of this unit. It is no longer in the plant. No evidence of release was identified in the plant. No evidence of release was identified in the documents reviewed and because it is no longer present at the facility it could not be inspected during the VSI.

Purge Waste Acid Tank V-387 is an unlined stainless steel tank vertically oriented. This unit was decontaminated and sent to the Celanese Clear Lake facility in 1982

CONCUR: LYDIA M. BOADA CLISTA DATE: 12\24\87

Golden StrataServices, Inc.
711 Louisiana • Suite 1600 • Houston, Texas 77002 • 713/222-9600

GSS#J89050

November 17, 1989

Hoechst Celanese Chemical Group, Inc.
P.O. Box 509
Bay City, Texas 77414

Attn: Ray Horton, Superintendent
Corrosion Section

RE: Mechanical Integrity Testing - 1989, Hoechst Celanese Chemical Company, Inc., WDW Well 14, 32, 49 & 110, Bay City Plant

Dear Mr. Horton:

Enclosed are ten (10) bounded copies of the mechanical integrity testing (MIT) final report covering field activities required under the Texas Water Commission TWC) Underground Injection Control (UIC) Program,31TAC (Texas Administrative Code), 331.4 and 331.43, mechanical integrity for Class I injection wells in State of Texas. We understand that Celanese will transmit a copy of this report to the TWC.

Again, GSS appreciates this opportunity to provide consultant field supervision services to Hoechst Celanese.

Sincerely,

Wesley W. Smith

Wesley W. Smith, P.E.
Project Supervisor

Enclosure

cc: I.O. Coleman(Celanese)
Thomas Jones(GSS)

HOECHST CELANESE CHEMICAL GROUP, INC.

BAY CITY PLANT

MECHANICAL INTEGRITY TEST REPORT

WASTE DISPOSAL WELL 14, 32, 49 & 110

GSS PROJECT #J89050

PREPARED BY:
WESLEY SMITH

GOLDEN STRATASERVICES, INC.
711 LOUISIANA, SUITE 1600
HOUSTON, TEXAS 77002

SUBMITTED:
NOVEMBER, 1989

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2.4 WDW 110 (Well No. 1-A)

3.0 CONCLUSIONS.....7

APPENDIX:

A. WASTE DISPOSAL WELL 14

1. Mechanical Integrity Test Data
   a. Annulus Pressure Data
   b. Certificates of Calibration (For WDW Nos. 14, 32, 49 & 110)
   c. Radioactive Tracer Survey Data
   d. Estimated Time To Run Stationary RAT Sequence
   e. Radioactive Tracer Survey (Final Copy)
   f. Gulf Coast's Log Interpretation Letter
2. Well Schematic Drawing

B. WASTE DISPOSAL WELL 32

1. Mechanical Integrity Test Data
   a. Annulus Pressure Data
   b. Radioactive Tracer Survey Data
   c. Estimated Time To Run Stationary RAT Sequence
   d. Radioactive Tracer Survey
   e. Gulf Coast's Log Interpretation Letter
2. Fall-Off & Static Bottom Hole Pressure Data Certification of Calibration
3. Well Schematic Drawing

C. WASTE DISPOSAL WELL 49

1. Mechanical Integrity Test Data
   a. Annulus Pressure Data
   b. Radioactive Tracer Survey Data
   c. Estimated Time To Run Stationary RAT Sequence
   d. Radioactive Tracer Survey (Final Copy)
   e. Gulf Coast's Log Interpretation Letter
2. Well Schematic Drawing

D. WASTE DISPOSAL WELL 110

1. Mechanical Integrity Test Data
    a. Annulus Pressure Data
    b. Radioactive Tracer Survey Data
    c. Estimated Time To Run Stationary RAT Sequence
    d. Radioactive Tracer Survey (Final Copy)
    e. Gulf Coast's Log Interpretation Letter
2. Static & Fall-Off Bottom Hole Pressure Data
3. Well Schematic Drawing

E. Correspondence

1.0 INTRODUCTION

All Class I waste disposal wells in the State of Texas must demonstrate mechanical integrity as required by the Texas Water Commission (TWC) Underground Injection Control (UIC) Program, 31TAC (Texas Administrative Code), 331.4 and 331.43, mechanical integrity of Class I injection wells.

Mechanical integrity testing is performed to demonstrate 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 wellbore".

A copy of the test procedures for conducting MITs on Hoechst Celanese Chemical Group, Inc. (HCCG), Bay City Plant's waste disposal wells, WDW 14, 32, 49 and 110 was submitted to the TWC, Austin, Texas, prior to performing the field tests. Additionally, the TWC (Richard Merritt) was contacted by telephone of the scheduled MIT prior to the field work. Appendix D contains copies of Hoechst Celanese's correspondences relating to these MITs.

The test procedures for HCCG's WDW 14, 32, 49 and 110 include two to three major events as follows:

WDW 32 & 110:

* The 5-1/2" x 9-5/8" annuluses each tested to a maximum differential pressure of 1,100 and 750 psig for a minimum of 30 and 60 minutes on WDW 32 and 110, respectively.
* Fall-off & static bottom hole pressure (BHP) surveys.
* Radioactive tracer (RAT) survey.

WDW 14, & 49:

* The 5-1/2" x 9-5/8" (WDW 14) and 5-1/2" x 7-5/8" (WDW 49) annuluses tested to a maximum differential pressure of 900 & 1,100 psig for a minimum period of 60 and 30 minutes, respectively.
* RAT surveys.

Note: WDW 14 and 110 each tested for longer test periods due to lowered approved test pressures.

2.0 SUMMARY OF RESULTS

The MITs on HCCG's WDW 14, 32, 49 and 110 were performed and witnessed by Messrs. Ray Horton and Ralph Riley representing HCCG and Wesley Smith with Golden StrataServices, Inc. (GSS). Mr. Richard Merritt representing the TWC witnessed all MITs with the exception of the MIT on WDW 110.

The static and fall-off BHPs were run on WDW Nos. 32 and 110 and a RAT survey run on all four injection wells by Mr. Stony Johnson, service representative with Gulf Coast Well Analysis. APTs were performed on all four wells by Mr. Ray Horton.

2.1 WDW 14:

The annulus was pressurized using nitrogen gas to a maximum of 900 psig. After the well stabilized the pressure leaked off 6 (six) psi (891 to 885 psi) during the last 60 minute period for a leak-off rate of 0.7 of 1%.

A RAT survey was run with the first radioactive (R/A) slug graphically depicting that all injected fluids moved down the tubing and cased sections and into the injection interval through the casing between 3395' and 3400'. Note: All depth in this report are measured from kelly bushing (KB). This interval is just above the perforated interval, i.e. 3450-3510' and 3520'-3550', but below the top of the authorized permitted disposal interval (@3300'). Further, the RAT survey revealed the leak-free condition of the tubing and casing strings and packer within

the test interval and that no injected fluids were migrating upward outside the cemented casing string.

Two stationary time-sequence tests were run on WDW 14 at depths of 3140′ and 3430′. These two tests were each conducted for periods of 10 and 20 minutes, respectively. Each of the tests was positive revealing that all of the injected fluid was entering only the disposal interval and not migrating upward behind the casing string. Comparison of the first and final base G/R logs were excellent and further confirmed that there is no upward migration of injected fluid at this time.

2.2 WDW 32:

A static and fall-off BHP survey, using a Panex digital BHP tool was run to a depth of 3300′ KB. After injecting fluid for a half hour the well was shut-in. A fall-off survey was conducted and BHP stabilized after appropriately one hour; however, the well was left shut-in for 20 hours revealing a maximum BHP of 1,535.4 psia at a bottom hole temperature (BHT) of 105.2^{o}F. Extrapolated BHP at a depth of 3400′ was 1563.9 psig (1989) as compared to 1574.3 psig in 1988.

The annulus was pressurized to a maximum of 1,100 psig. The pressure stabilized and revealed a leak-off of 6 psi (1093 to 1087 psig) during the last 30 minute period for a leak-off rate of 0.5 of 1%. A maximum leak-off of 5% is allowed by the TWC.

The RAT survey revealed the leak-free condition of the tubing and casing strings and packer within the test interval as well as depicting graphically that all of the injected fluids move down the tubing and through the apparent accumulation of formation sand contained in the liner and into the injection interval. Further, the recording of the R/A slugs indicated that there is no upward migration of injected fluids above the injection zone.

2.3 WDW 49:

The annulus was pressurized to 1,097 psig. The pressure stabilized and revealed a leak-off of 10 psi (1086 - 1076 psig) during the last 30 minute period for a leak-off rate of 0.9 of 1.0%.

The RAT survey revealed the leak-free condition of the tubing and casing strings and packer within the test interval as well as depicting graphically that all of the injected fluids move down the tubing and liner section, through the accumulation of formation sands contained in the liner and into the disposal interval. Further, the recording of the R/A slugs during the tracer as well as during the two stationary time-sequence tests indicated that there is no upward migration of injected fluids above the injection zone.

2.4 WDW 110:

A static and fall-off BHP survey was run to a depth of 5640'. Static BHP was 2,573.7 psia @ BHT 121.7^{o}F. WDW 110 had been shut-in 19-1/2 hours prior to starting the BHP survey.

Extrapolated BHP was 2569.5 psig at a depth of 5660'. This compares to a BHP of 2557.7 psig (@5660') in 1988.

The annulus was pressurized to 750 psig. The pressure stabilized and leaked off 1 psi (750 psig to 749 psig) with a 0.1 of 1% leak-off rate during the 60 minute test period.

A RAT survey was run which revealed the leak-free condition of the tubing and casing strings and packer within the test interval as well as depicting graphically that all of the injected fluids moved down the tubing and packer and into the injection interval. The recordings of the R/A slugs further indicated that there is no upward migration of injected fluids above the injection interval.

3.0 CONCLUSION

All field work associated with the MITs on HCCG's WDW's 14, 32, 49 and 110 at their Bay City Plant conducted on October 23 through 31, 1989, was successfully completed. All three neutral wells (WDW 14, 32 & 49) and the acid well (WDW 110) are considered to be mechanically sound at this time and suitable for use as Class I waste injection wells. Results of the RAT surveys on the four HCCG injection wells were further confirmed by Gulf Coast's interpretation letters (See Appendix A.1.f, B.1.e, C.1.e and D.1.e).

In accordance with the TWC/UIC Program, 31TAC, 331.4 and 331.43, the mechanical integrity tests conducted on HCCG's WDW 14, 32, 49 and 110 demonstrated that (1) "there is no significant leak in the casing, liner, tubing or packer" and (2) "there is no significant fluid movement into a USDW through vertical channels adjacent to the injection borehole".

APPENDIX A

WASTE DISPOSAL WELL 14

APPENDIX A.1

MECHANICAL INTEGRITY FIELD TEST DATA

APPENDIX A.1.a

ANNULUS PRESSURE DATA

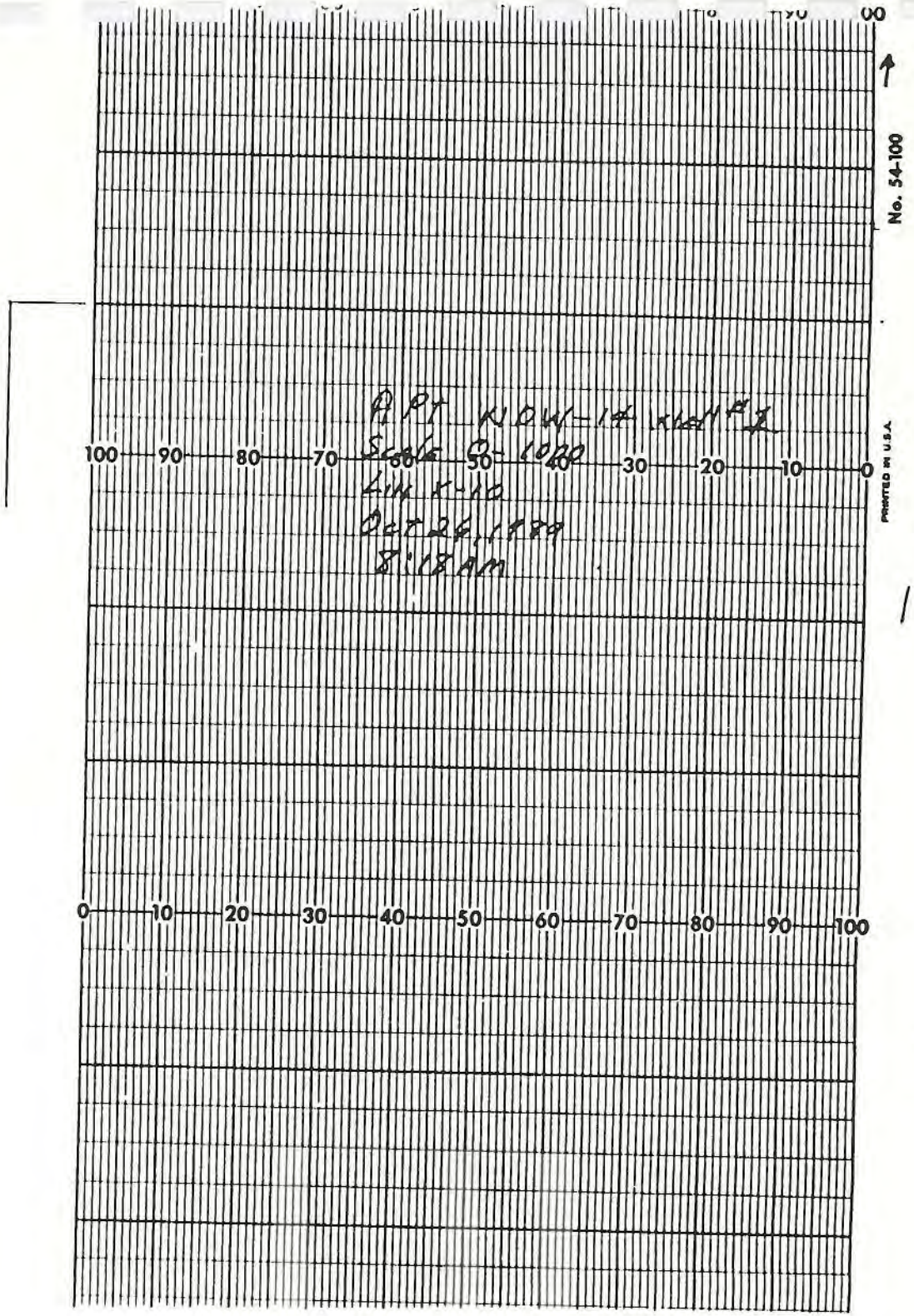
Annulus Pressure Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 14
October 26, 1989

Time (am)	Casing Pressure (Psig)	Remarks
8:15	220.0	Well shut-in 24-1/4 hours
8:20	450.0	Started pressurizing annulus.
8:24	700.0	
8:27	900.0	Well Stabilizing.
8:30	898.0	
8:38	891.0	
8:40	891.0	Started APT.
8:45	890.0	
8:50	890.0	
8:55	889.0	
9:00	889.0	
9:05	888.0	
9:10	888.0	
9:15	888.0	
9:20	887.0	
9:25	887.0	
9:30	886.0	
9:35	886.0	
9:40	885.0	End of APT.
9:42	600.0	Started bleeding off pressure.
9:50	200.0	Test pressure bled off.

Results: The pressure leaked-off 6 psi (891 to 885 psig) during the last 60 minute period, or 0.7 of 1% leak-off rate. Maximum allowable leak-off is 5% per 30 minutes.

Pressure was measured using an 3-D Instruments, Inc. Test Gauge, 0 to 1,500 psi gauge, Serial No. 8807007 (4-1/2" dial face) with 10 psi inclement and equipped with a reflective glass backing. The gauge was calibrated against pressure standard Mansfield and Green, Drawing No. 2633, on October 5, 1989.

Also used HCCG's well test transmitter pressure recorder with range 0 - 1,000 psi, calibrated to a dead weigh tester traceable to National Bureau of Standard, on October 20, 1989 by W.H. Heller (See Appendix A.1.b).


No. 54-100
PRINTED IN U.S.A.
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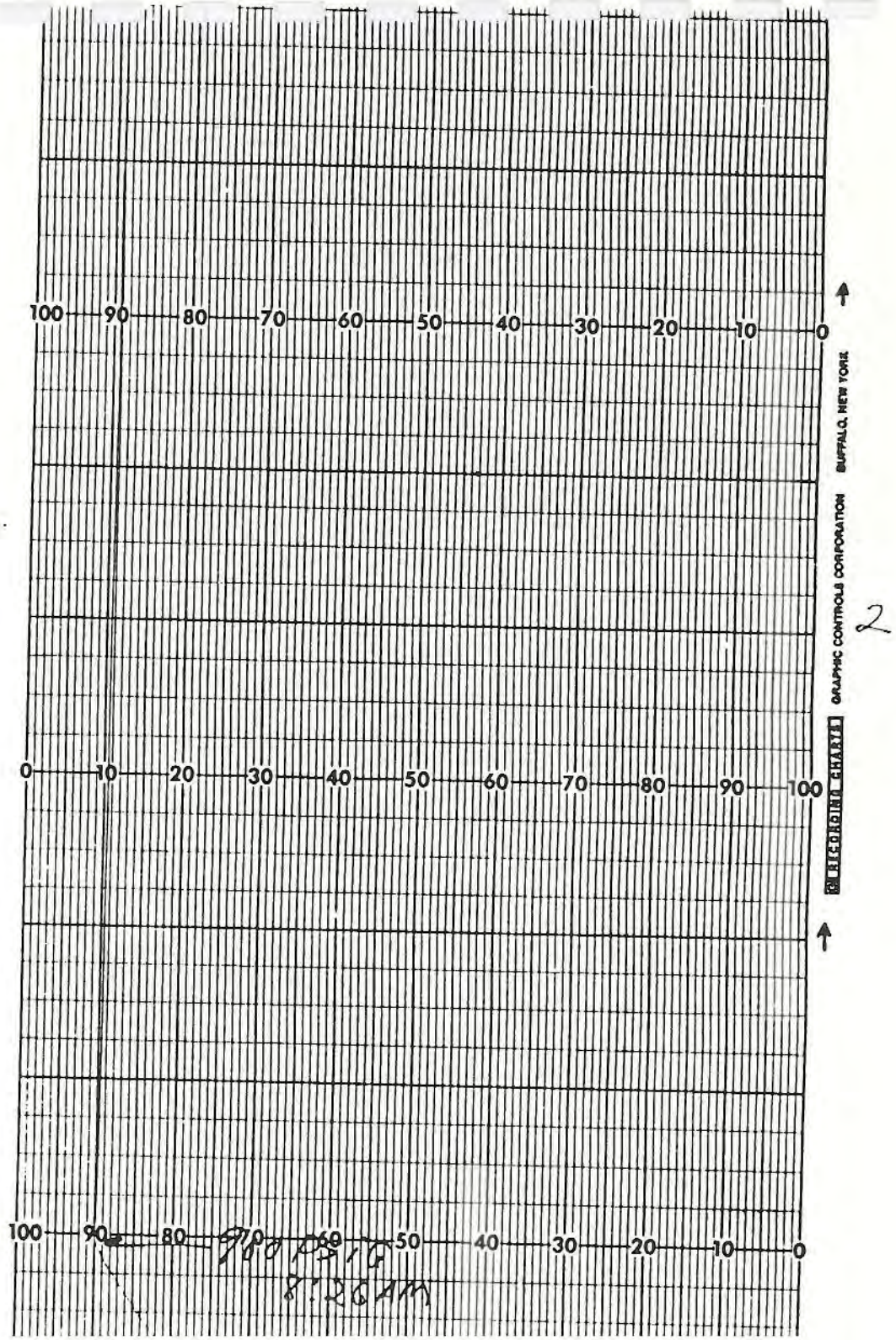
0 10 20 30 40 50 60 70 80 90 100
Scale 0-1000
Lin X-10
Oct 26, 1989
8:18 AM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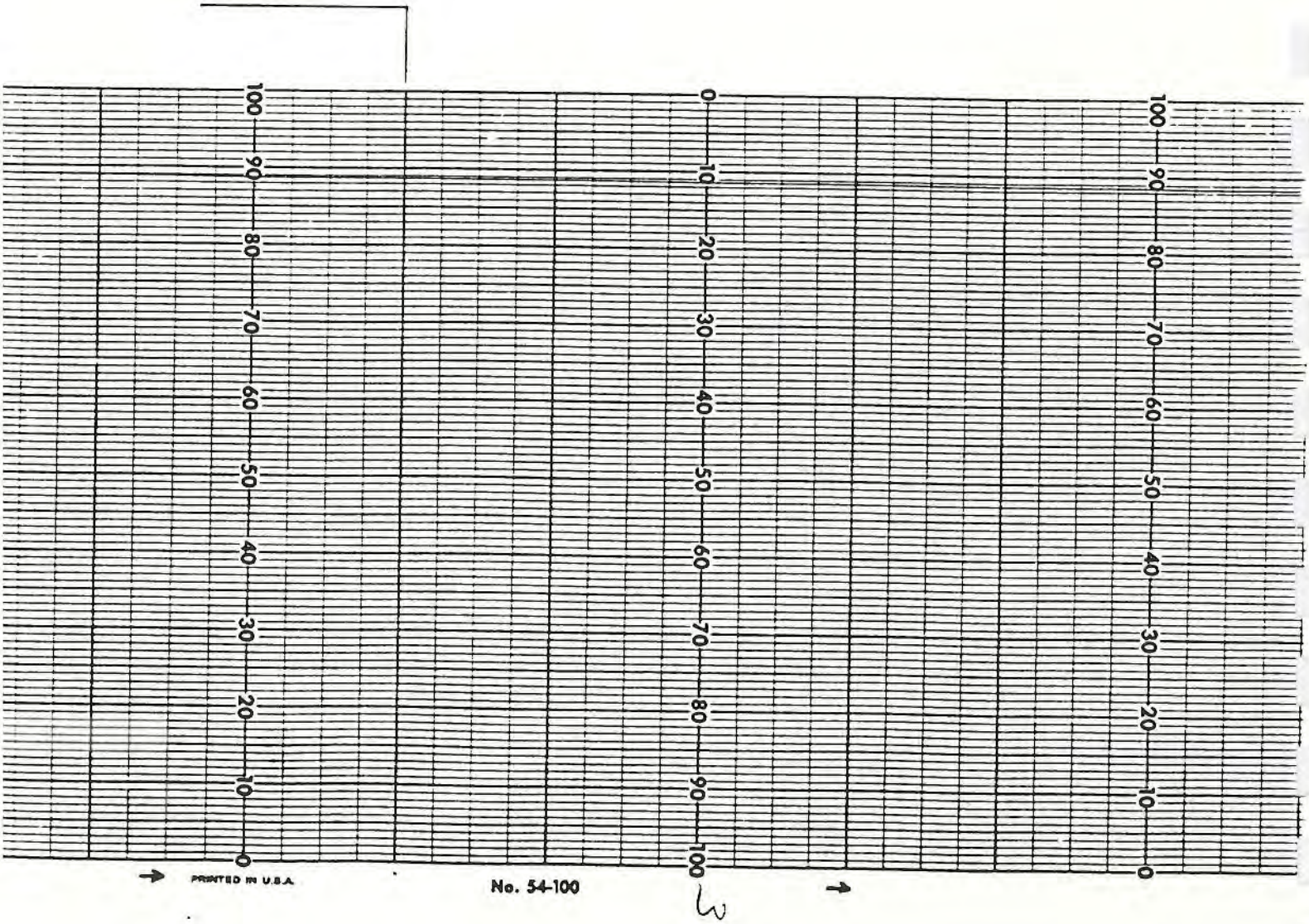
8:26AM
RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

2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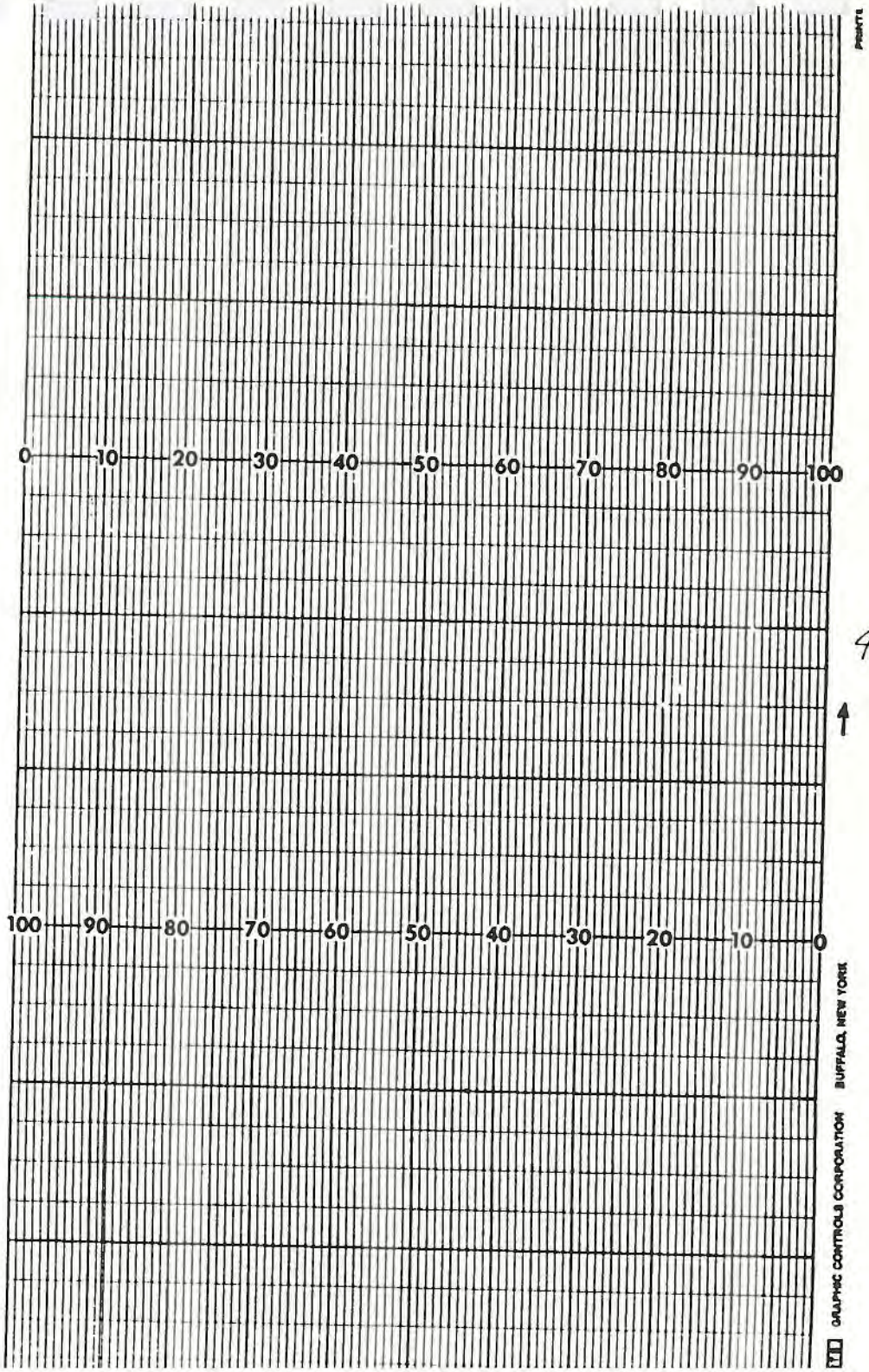
PRINTED IN U.S.A.
No. 54-100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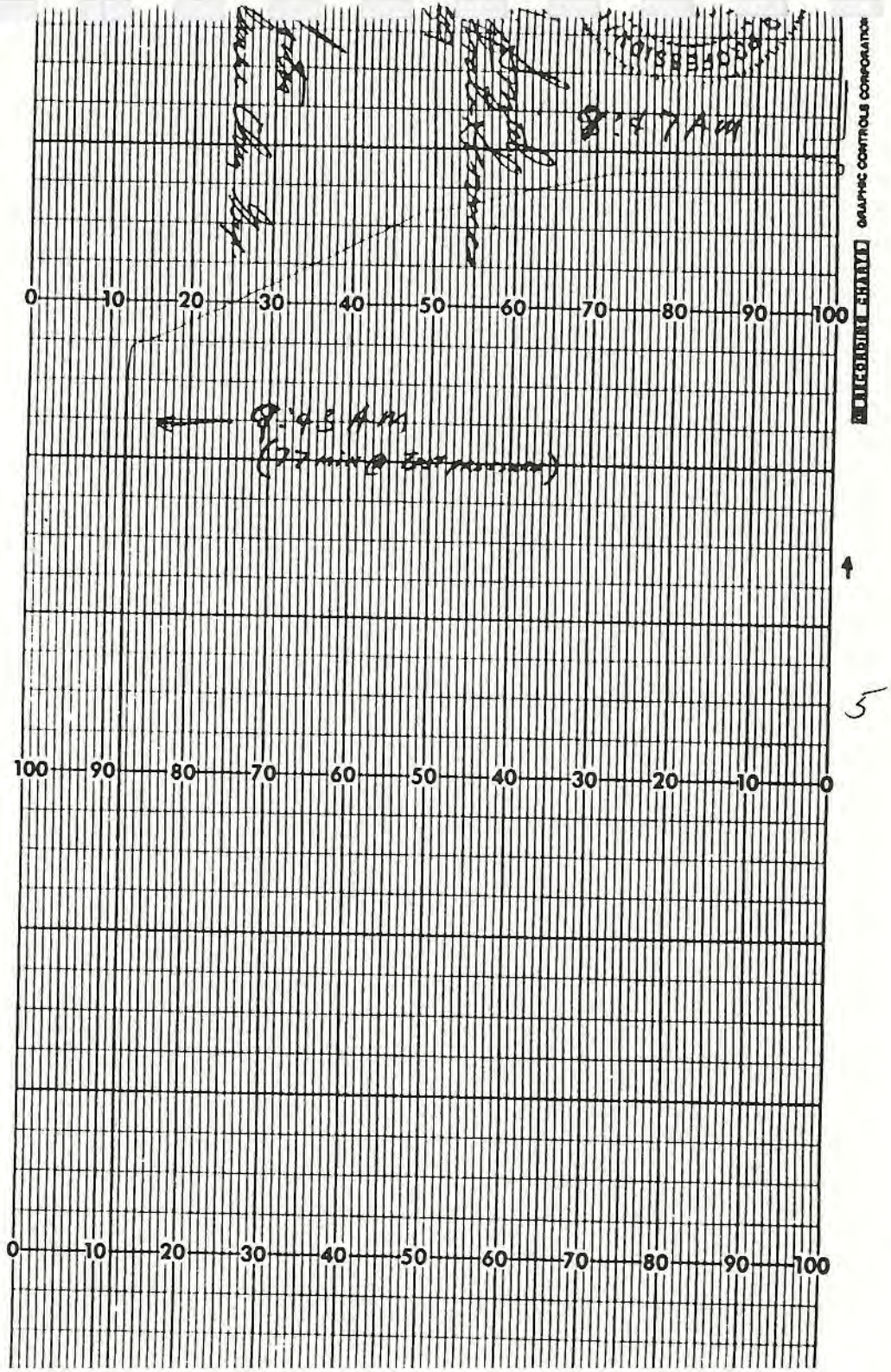
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

4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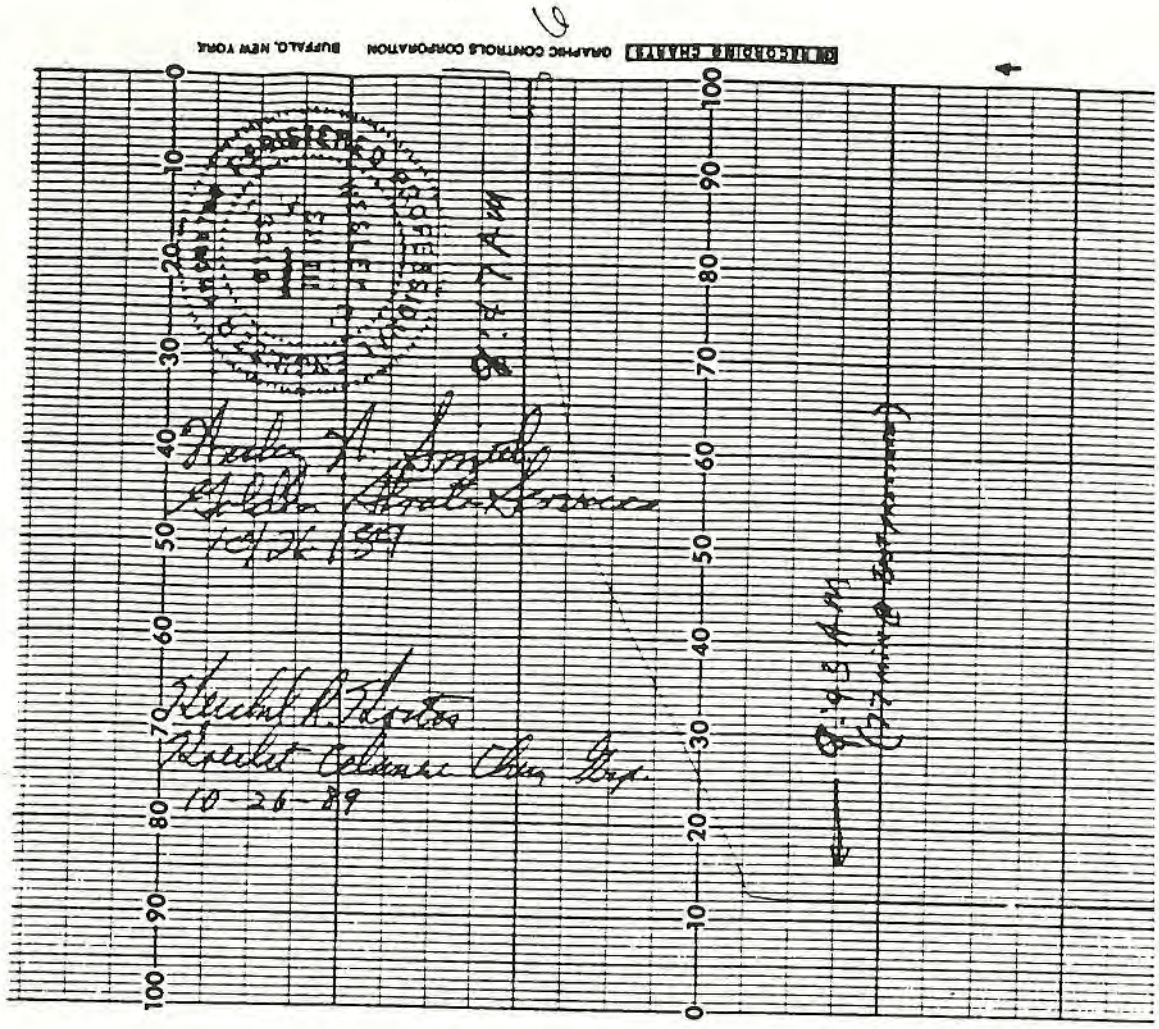
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
GRAPHIC CONTROLS CORPORATION
4
5


RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
9:47 AM
9:43 AM
10/26/89
10-26-89

APPENDIX A.1.b

CERTIFICATE OF CALIBRATION
(WDW 14, 32 49 & 110)

CALIBRATION CERTIFICATE

3D Instruments Inc.

PRESSURE GAUGE

PART NUMBER 25544-31614 **SERIAL NUMBER** 8807007

PRESSURE RANGE 0-1500 **P.S.I. ACCURACY ±** 1/4 **% FULL SCALE (±** 3.75 **P.S.I.)**

CALIBRATION

INCREASING PRESSURE			DECREASING PRESSURE		
Applied Press.	Indicated Press.	Difference	Applied Press.	Indicated Press.	Difference
0	0	0	1500	1497	- 3
300	297	- 3	1200	1198	- 2
600	598	- 2	900	899	- 1
900	898	- 2	600	599	- 1
1200	1197	- 3	300	298	- 2
1500	1497	- 3	0	0	0

Calibrated in Vertical Position. Temp. 74 ° F.

This is to certify that this gauge has been inspected and tested against Pressure Standard Mansfield & Green D.W.G. 2480 traceable to the National Bureau of Standards, traceability reference Test 41856, compensated to local acceleration due to gravity.

Special Conditions:

DATE OF CALIBRATION 10-03-89 INSPECTOR T. Chanthavisay

3D Instruments Inc. 15542 Chemical Lane, Huntington Beach, Calif. 92649

Interoffice Memo

Hoechst Celanese

Date October 23, 1989

MEMO

To Ray Horton

From W. H. Heller

Dept/Location Bay City Plant

Dept/Location Bay City Plant

Subject **Well Test Transmitter Certification**

On October 20, 1989 a certification of the Well Test Transmitter was performed. The following test equipment and methods were used:

- Chandler Model 15-1 Dead Weight Tester, Cert NBS Ref 221.07/2210607
- Fluke Model 3330B Programmable Voltage/Current Calibrator
  NBS Certified 8-4-87 (Certificate can be provided)
- Fluke Model 8060A Digital Multimeter - calibrated to voltage standard
- Precision 250 ohm .01# accuracy Resistor

A Rosemount 1151 dp Transmitter calibrated against a Chandler Model 15-1 Dead Weight Tester will be the method of measurement at the wells. The transmitter was connected to a 24 Volt power supply and the multimeter was connected in series (with the resistor) to the transmitter positive terminal. The multimeter provided an accurate 4-20ma to 1-5 volt conversion. Finally the dead weight tester input was connected to the process input of the transmitter.

Calibration of the transmitter was completed as follows:

TRANSMITTER lbs. Input	OUTPUT Volts	OUTPUT Percent
0 lbs.	1.000V	0.000%
100 lbs.	1.396V	9.900%
200 lbs.	1.795V	19.875%
300 lbs.	2.198V	29.950%
400 lbs.	2.600V	40.000%
500 lbs.	2.995V	49.875%
600 lbs.	3.398V	59.950%
650 lbs.	3.597V	64.925%
700 lbs.	3.799V	69.975%
800 lbs.	4.197V	79.925%
900 lbs.	4.597V	89.925%
1000 lbs.	4.999V	99.975%

This data is respectfully submitted by:

W. H. Heller

W. H. Heller

Instrument Mechanic

Hoechst

APPENDIX A.1.c

RADIOACTIVE TRACER SURVEY DATA

Radioactive Tracer Survey Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 14
October 26, 1989

A. First Base G/R Log: 3462′ to 2800′ (8:25 am to 8:45 am).

B. Second Base G/R Log: 3150′ to 2800′ (8:50 am to 8:58 am) (Ran to confirm repeatability of tool).

C. One - Five (5) minute statistical check with tool stationary at a depth of 3430′ (9:06 am to 9:11 am) and 3140′ (9:14 am to 9:19 am).

D. First Radioactive Slug Ejection. The following RAT data and injection rate reflects the downward movement of the injected fluid.

Pass No.	Time From (am)	Time To (pm)	Depth(Ft.) From	Depth(Ft.) To	Top Slug Depth (Ft.)	Remarks
	10:12:30		2800			Ejected R/A slug (3 sec)
1	10:12:51	10:13:30	2850	2800	2825	Injection rate - 33 gpm
2	10:14:03	10:15:05	2900	2810	2874	
3	10:15:52	10:17:02	2970	2860	2945	
4	10:17:55	10:19:22	3050	2930	3030	
5	10:20:28	10:22:40	3160	3010	3137	Injection rate - 73 gpm
6	10:23:55	10:26:10	3280	3100	3256	
7	10:27:30	10:30:15	3400	3240	3372	
8	10:31:24	10:33:15	3462	3350	?(*)	Stopped RAT survey.

* - Missed last R/A slug. Slug displaced into a disposal interval, i.e. 3395′ - 3400′ as confirmed by a series of velocity shots made from 3370′ to 3430′.

E. Second R/A slug ejection (First Stationary-Time Sequence):

Time (am)	Depth (Ft.)	Remarks
11:19:25	3350	Released R/A slug (2 Sec.)
11:19:45	3430	Moved tool to 3430′ and stopped. Left tool stationary and turned on time-drive recorder. Injection rate of 73 gpm.
11:20:25	3430	Recorded R/A slug peak. Started test.

11:40:25	3430	Survey stopped. R/A slug displaced into disposal zone. (See Appendix A.1.d).

F. Third R/A slug ejection (Second Stationary-Time Sequence):

Time (pm)	Depth (Ft.)	Remarks
12:00:20	3140	Released R/A slug (2 Sec.)
12:00:25	3140	Left tool stationary and turned on time-drive recorder. Injection rate of 73 gpm.
12:00:35	3140	Recorded R/A slug peak. Started test.
12:10:35	3140	Survey stopped. R/A slug displaced into disposal zone.

G. Final base log: 3462' to 2800' (12:23 pm to 12:43 pm)

APPENDIX A.1.d

ESTIMATED TIME TO RUN STATIONARY RAT SEQUENCE
(Waste Disposal Well 14)

Estimated Time To Run Stationary RAT Sequence
Waste Disposal Well 14
(RAT of October 26, 1989)

Problem: Calculate "worse case" time for the radioactive slug to move from the G/R tool (1) down the tubing, (2) into the wellbore and (3) up the casing/borehole annulus to the tool depth.

Basic Data:

Capacities:	5-1/2" tubing	- 1.000 gal/ft
	9-5/8" casing	- 3.180 gal/ft
	9-5/8" casing x 12-1/4" borehole	- 2.340 gal/ft
Pump Rate:	73 gpm	

Note: RAT detection tool was held stationary at 3140 ft, or 310 ft above the top perforation.

Worse Case Calculations:

Volumes:	Tubing	- 22 ft x 1.000 gal/ft =	22.0 gal
	Casing	- 233 ft x 3.180 gal/ft =	740.9 "
	Casing/borehole	- 255 ft x 1.606 gal/ft =	409.5 "
			1172.4 gal

Calculated time to circulate R/A slug around the end of the tubing and casing strings:

= 1172.4 gal/73 gal/min

= 16.1 minutes

Note: Actual time survey ran = 20 minutes

APPENDIX A.1.e

RADIOACTIVE TRACER SURVEY

Gulf Coast Well Analysis

RADIOACTIVE TRACER LOG

MECHANICAL INTEGRITY TEST

FILING NO. _____

COMPANY HOECHST CELANESE

WELL WASTE DISPOSAL WELL # 14 WELL # 2

FIELD BAY CITY PLANT

COUNTY MATAGORDA STATE TEXAS

LOCATION

SEC. _____ TWP. _____ RGE. _____

OTHER SERVICES: NONE

PERMANENT DATUM GROUND LEVEL ELEV N.A.

LOG MEASURED FROM KELLY BUSHING 11.0 FT. ABOVE PERM. DATUM

DRILLING MEASURED FROM KELLY BUSHING

ELEV. K.B. N.A. D.F. N.A. G.L. N.A.

Date	OCT 26, 1989
Run No.	ONE
Type Log	R.A.T.
Depth-Driller	N.A.
Depth-Logger	3463
Bottom logged interval	3462
Top logged interval	2800
Type fluid in hole	WASTE FLUID
Max rec. temp., deg. F.	N.A.
Operating rig time	MAST
Recorded by	JOHNSON
Witnessed by	MR. WES SMITH

Bore-Hole Record

Run No.	Bit	From	To

Casing Record

Size	Wgt.	From	To
9 5/8	40	SURF.	T.D.

Tubing Record

Size	Wgt.	From	To
5.5	15.5	SURF	3162

Liner

Size	Wgt.	From	To

Form 110-H

NOTICE: All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

Gulf Coast Well Analysis

EQUIPMENT DATA

Gamma Ray				Neutron			
Run No.	ONE			Run No.			
Tool Model No.	CRC			Log Type			
Diameter	1.43			Tool Model No.			
Detector Model No.	G-1			Diameter			
Type	GEIGER			Detector Model No.			
Length	12"			Type			
Distance to N. Source				Length			
				Source Model No.			
General				Serial No.			
Hoist Truck No.	101			Spacing			
Instrument Truck No.	101			Type			
Tool Serial No.	1234-2			Strength			
District	PEARLAND						

LOGGING DATA

General				Gamma Ray				Neutron			
Run No.	Depths From	Depths To	Speed Ft/Min.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API G.R. Units per Log Div.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API N. Units per Log Div.
1	3462	2800	40	1	1000/100	2-L	6 API				
1	3462	2800	40	1	100/100	0-L	25 API				

Reference Literature: LOG WAS CORRECTED TO CELANESE TUBING RECORD @ PACKER @ 3162
TOP DETECTOR TO CCL = 3'
CCL TO INJECTOR = 2'
INJECTOR TO BOTTOM DETECTOR = 12.5'
TOP DETECTOR TO BOTTOM DETECTOR = 12.5'

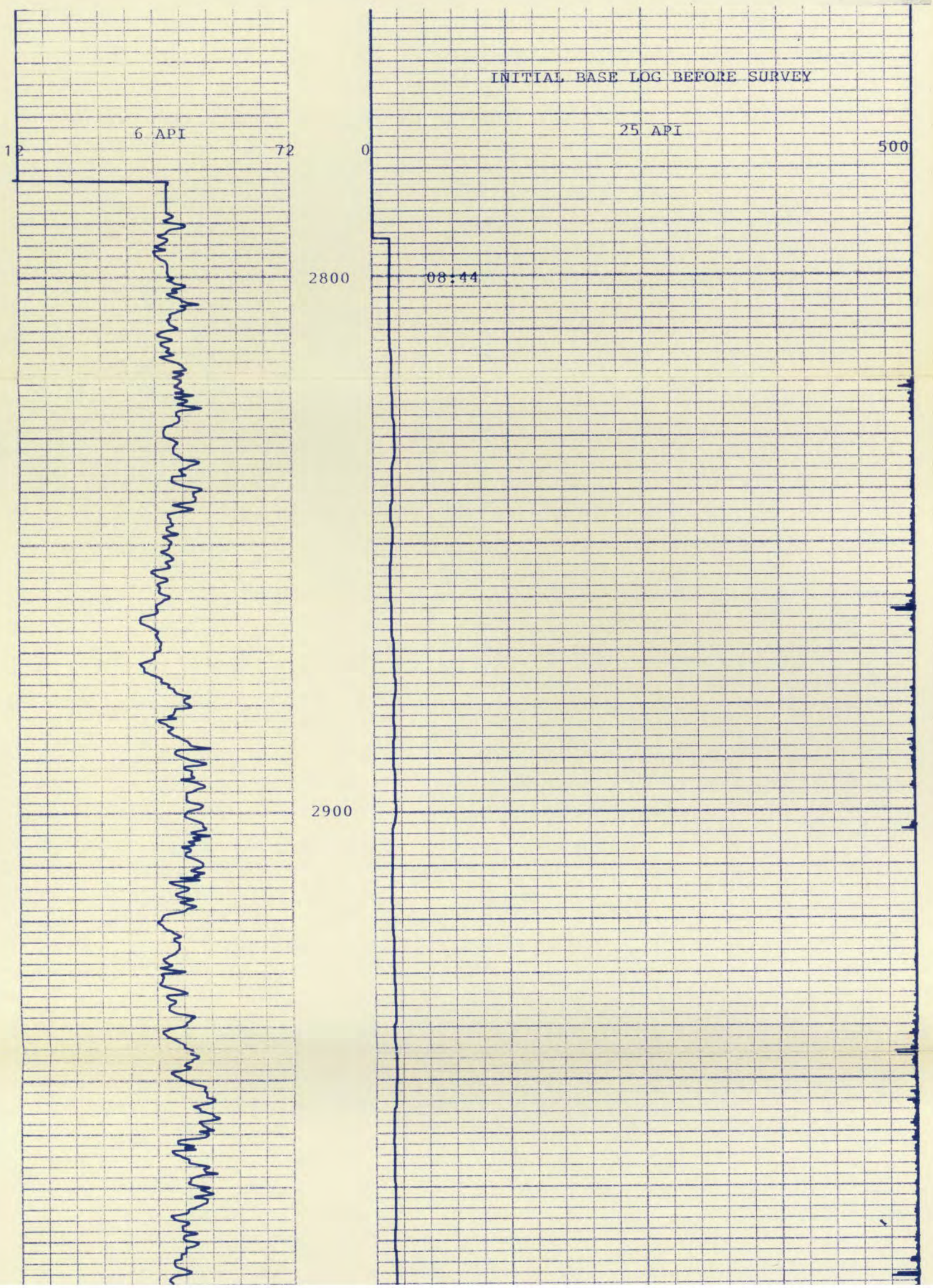
Remarks: RADIOACTIVE TRACER LOG INDICATES THAT ALL FLUID IS GOING INTO 3395 TO 3400. NO INDICATION OF ANY FLUID GOING INTO PERFORATED ZONE, NO INDICATION OF FLUID MIGRATION UP HOLE BEHIND CASING OR TUBING @ THIS TIME.

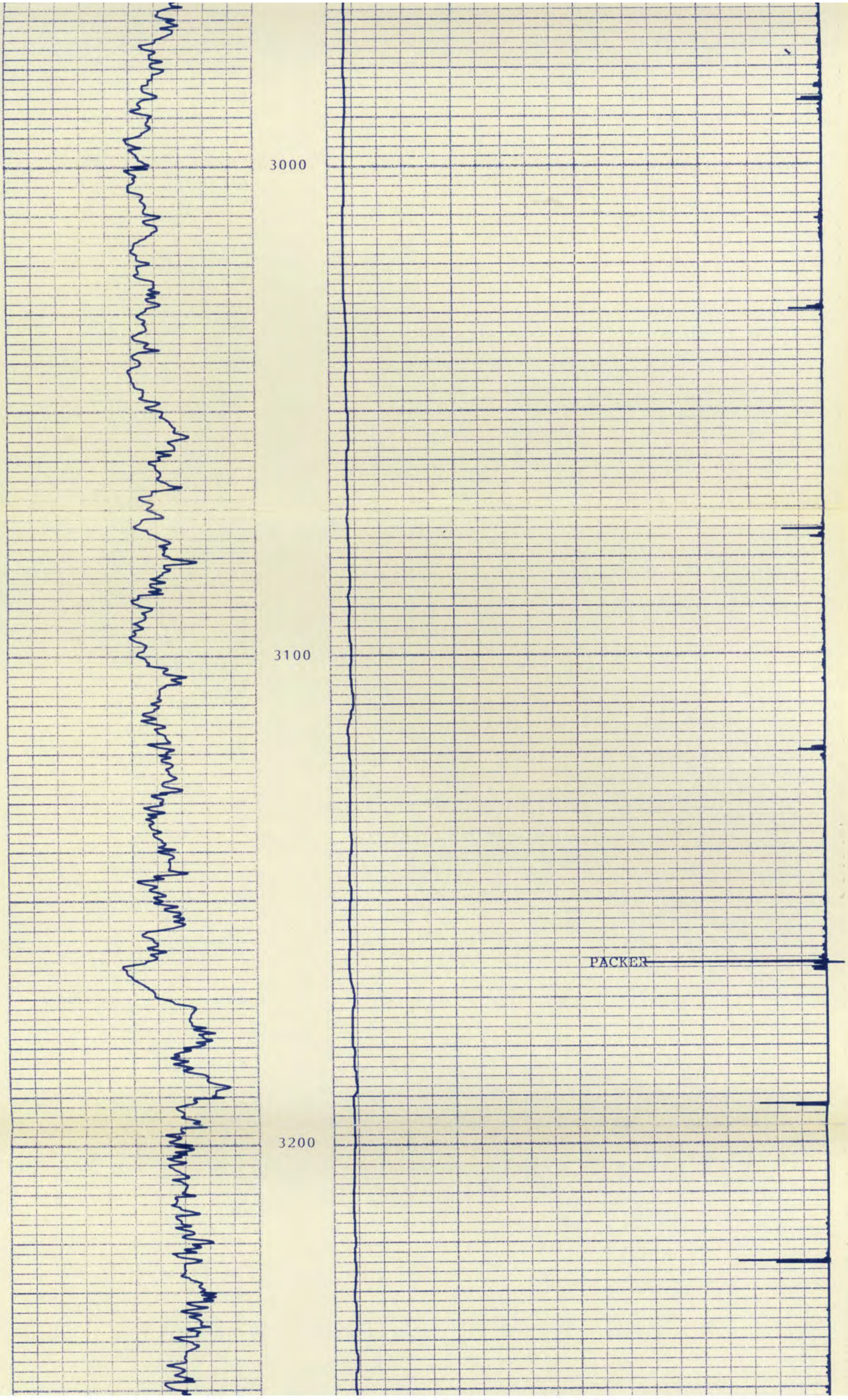
Fold Here

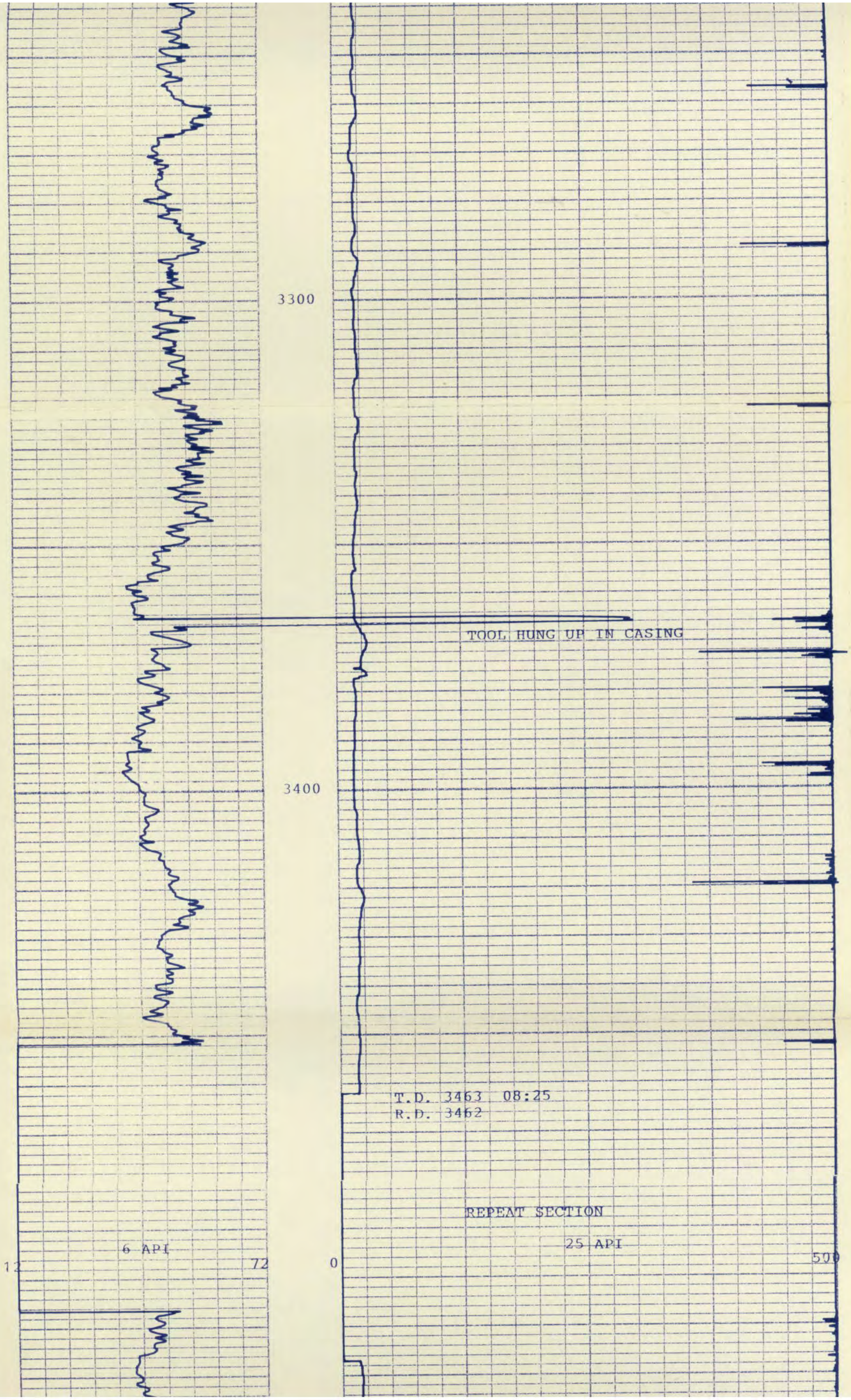
GAMMA RAY	DEPTHS	NEUTRON

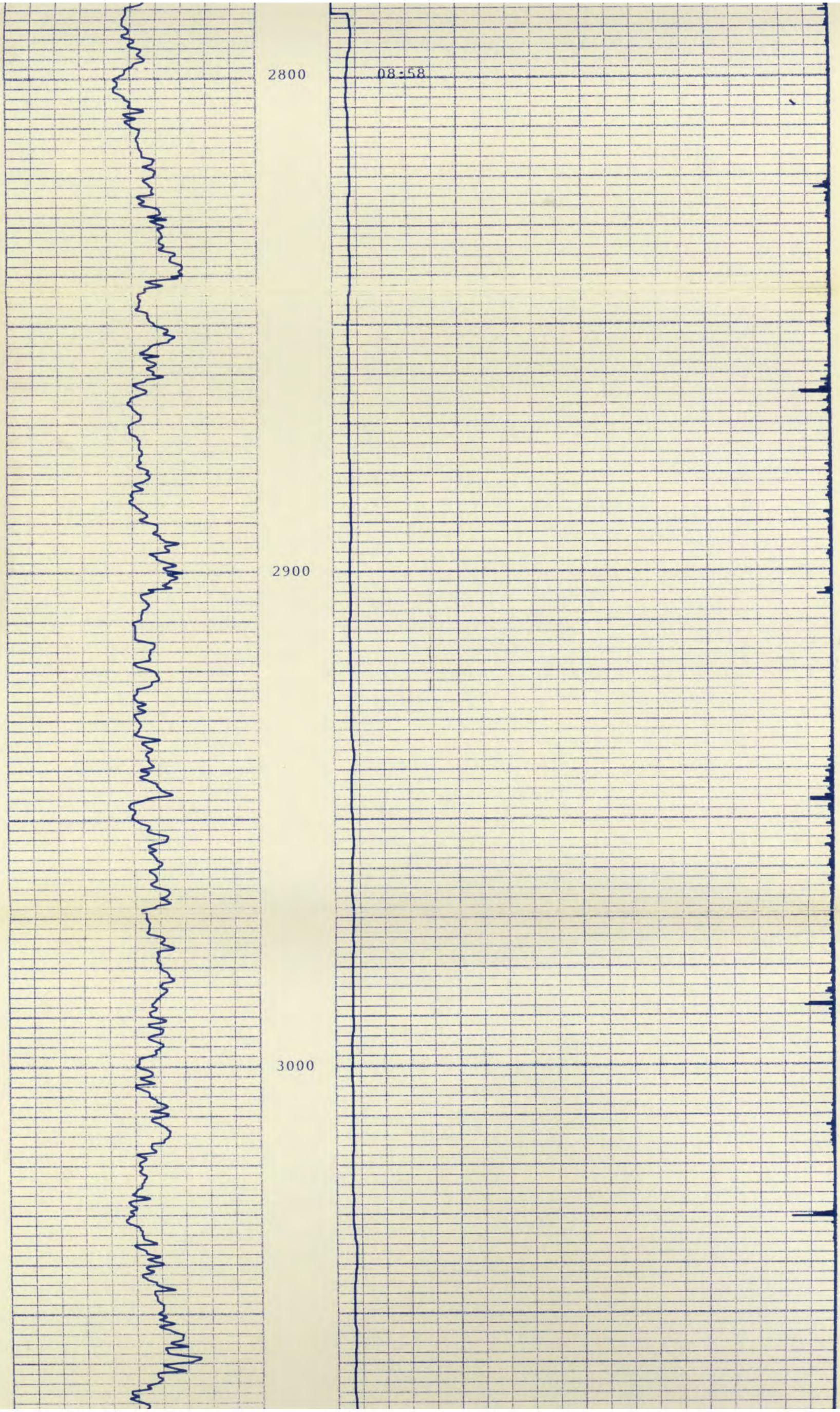
Fold Here

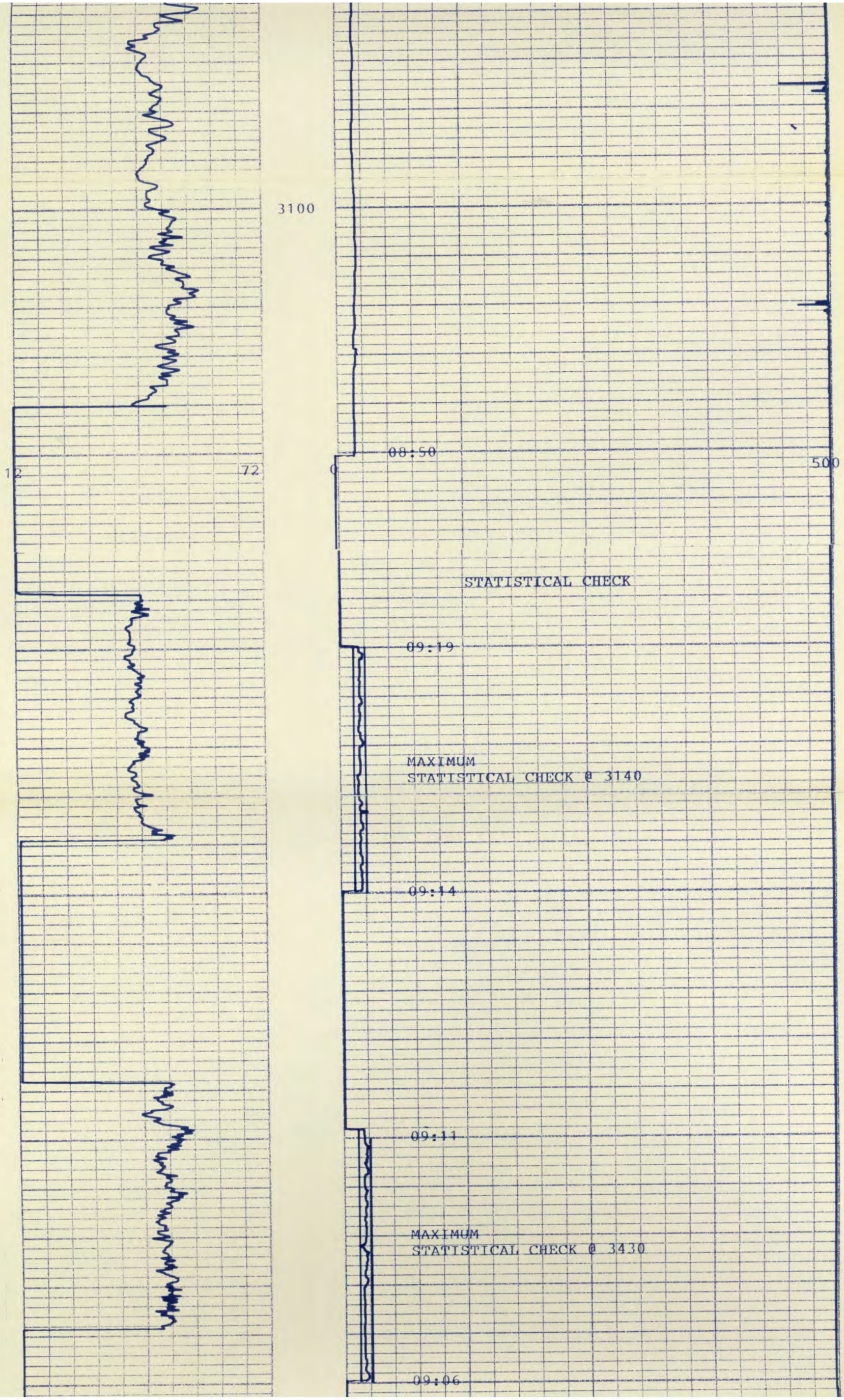
GAMMA RAY	DEPTHS	NEUTRON
API GAMMA-RAY UNITS		API NEUTRON UNITS

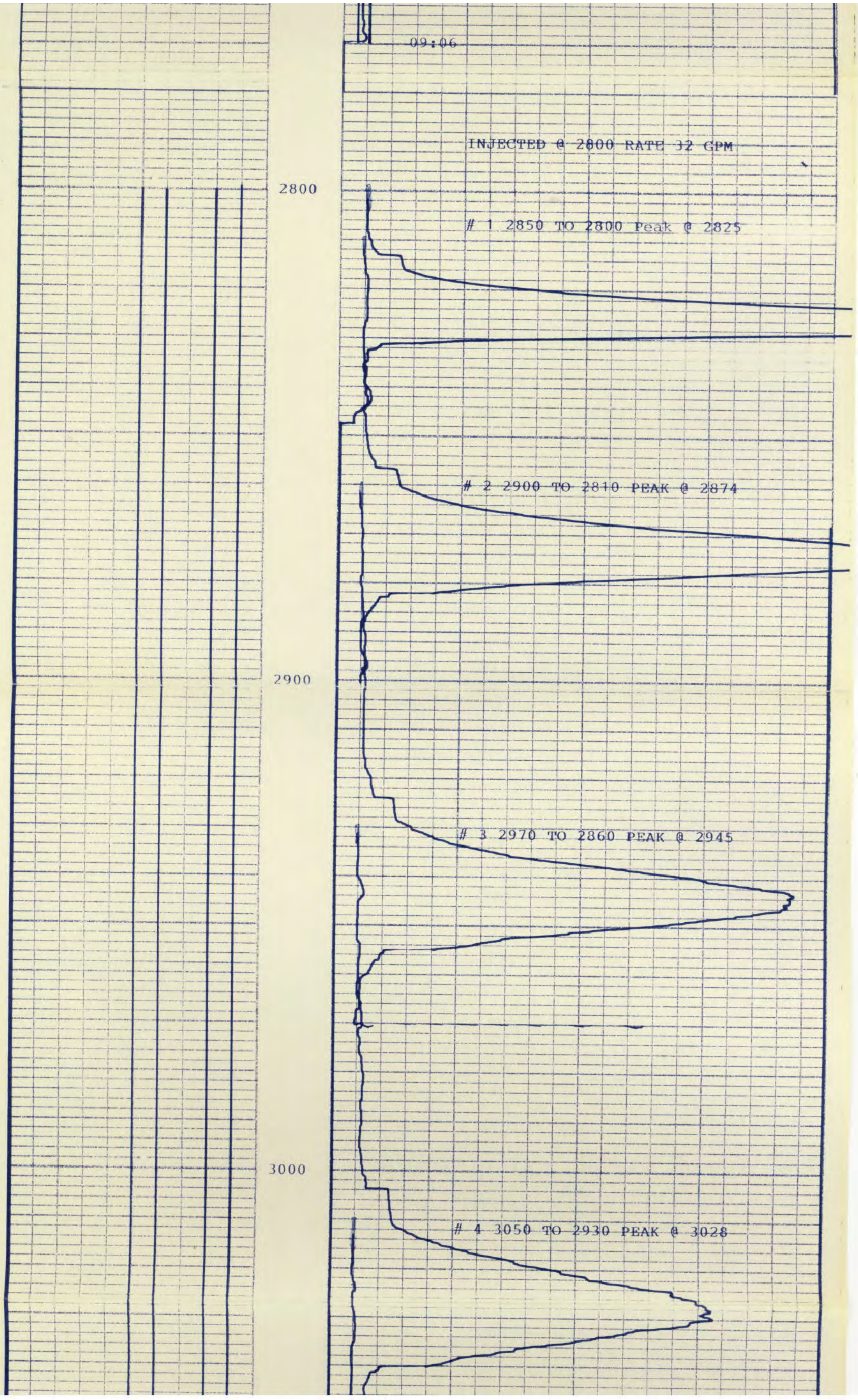


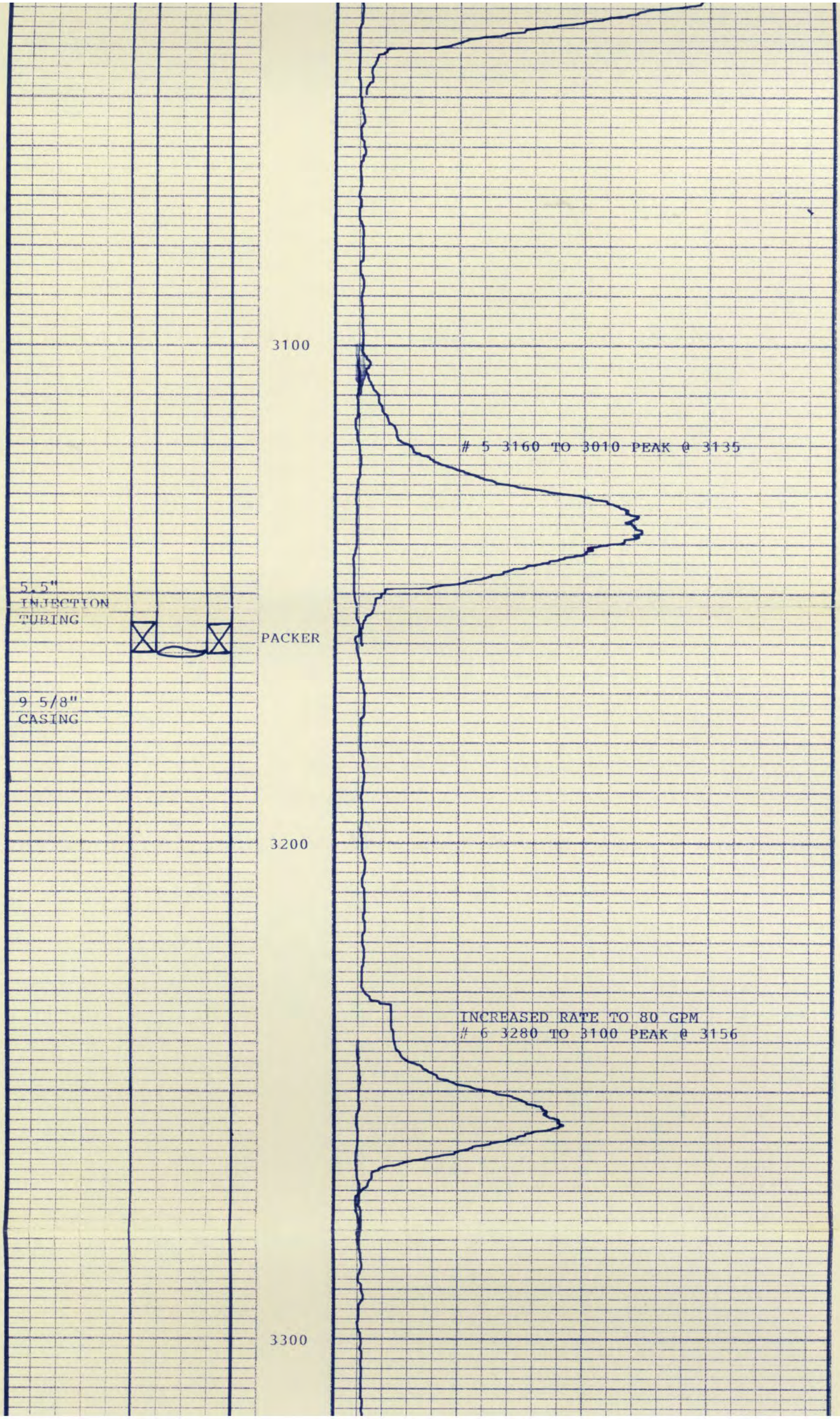

3000
3100
PACKER
3200

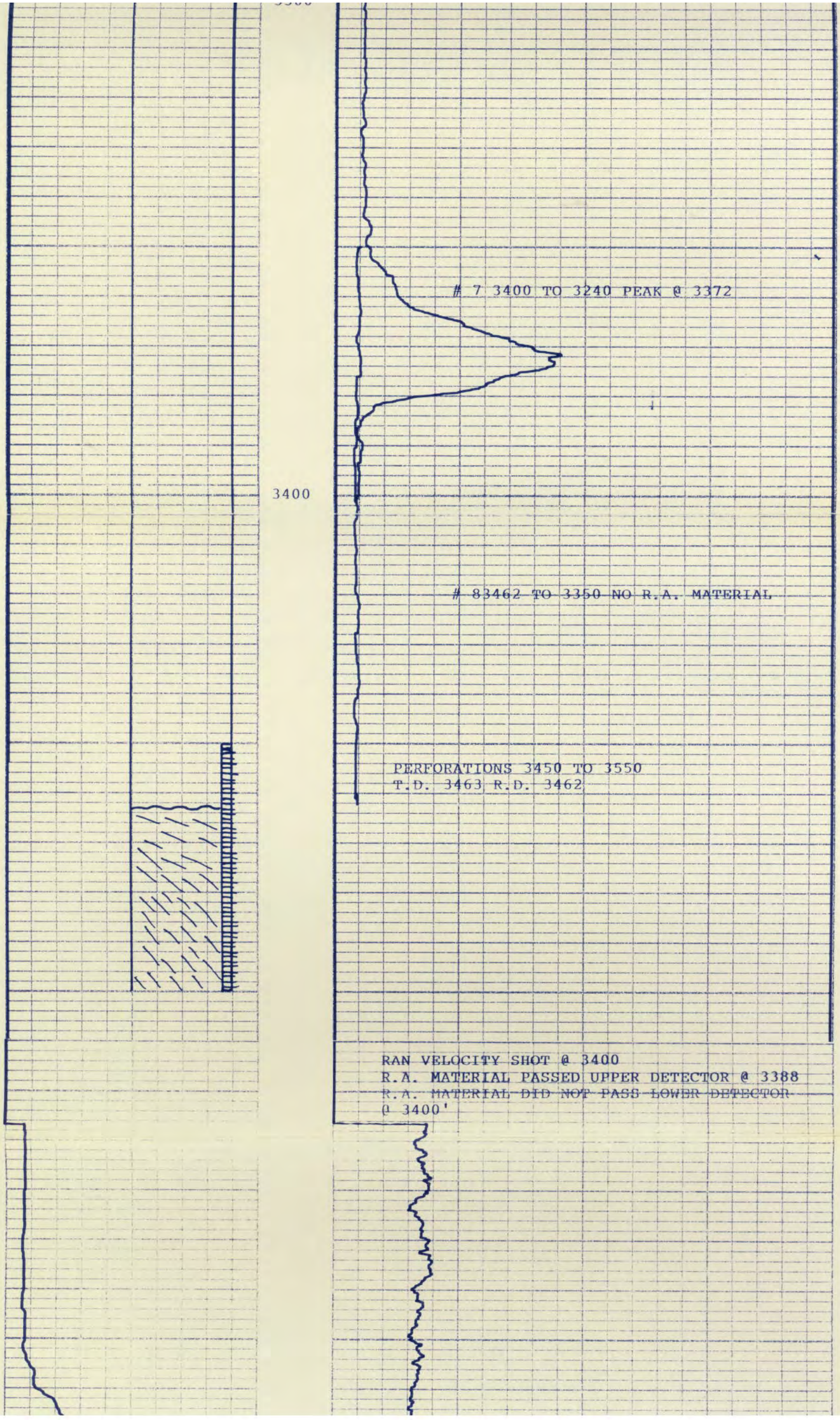

3300
3400
TOOL HUNG UP IN CASING
T.D. 3463 08:25
R.D. 3462
REPEAT SECTION
6 API
12
72
25 API
0
500

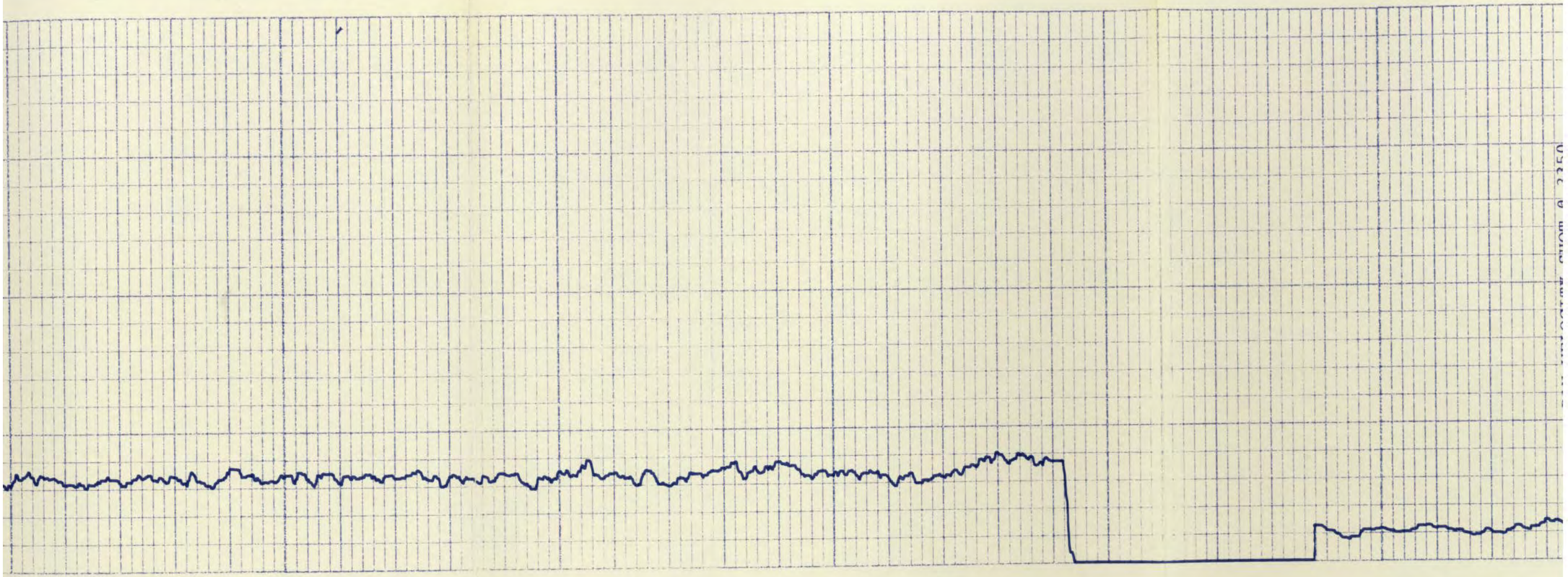

2800
08:58
2900
3000

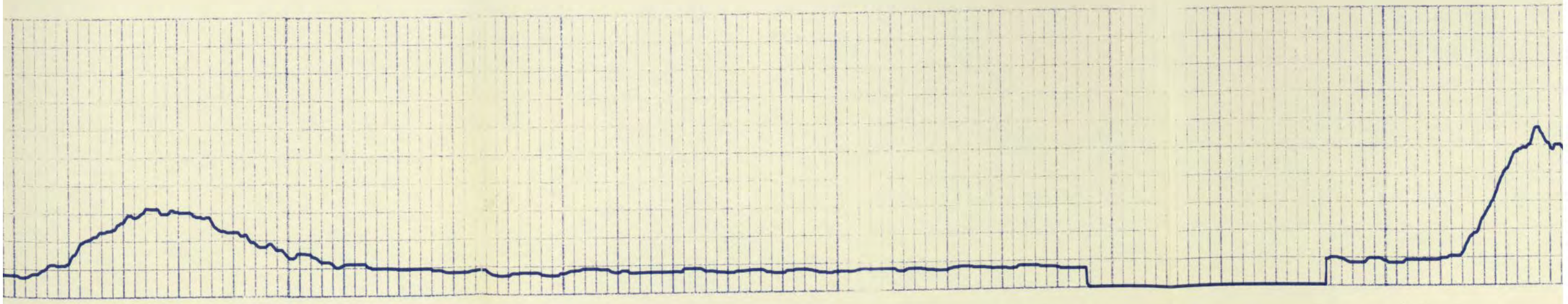

3100
12
72
0
500
08:50
STATISTICAL CHECK
09:19
MAXIMUM
STATISTICAL CHECK @ 3140
09:14
09:11
MAXIMUM
STATISTICAL CHECK @ 3430
09:06

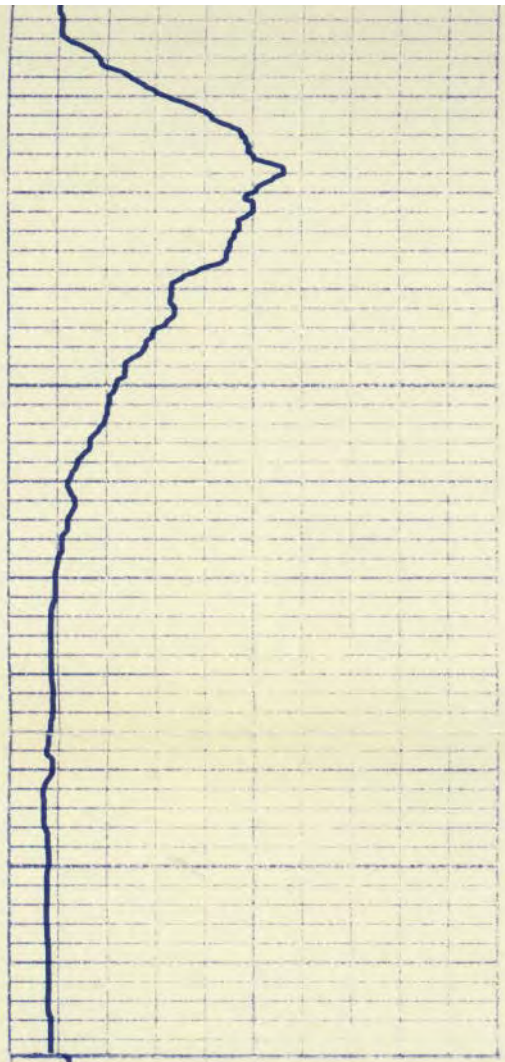

09:06
INJECTED @ 2800 RATE 32 GPM
2800
1 2850 TO 2800 Peak @ 2825
2 2900 TO 2810 PEAK @ 2874
2900
3 2970 TO 2860 PEAK @ 2945
3000
4 3050 TO 2930 PEAK @ 3028

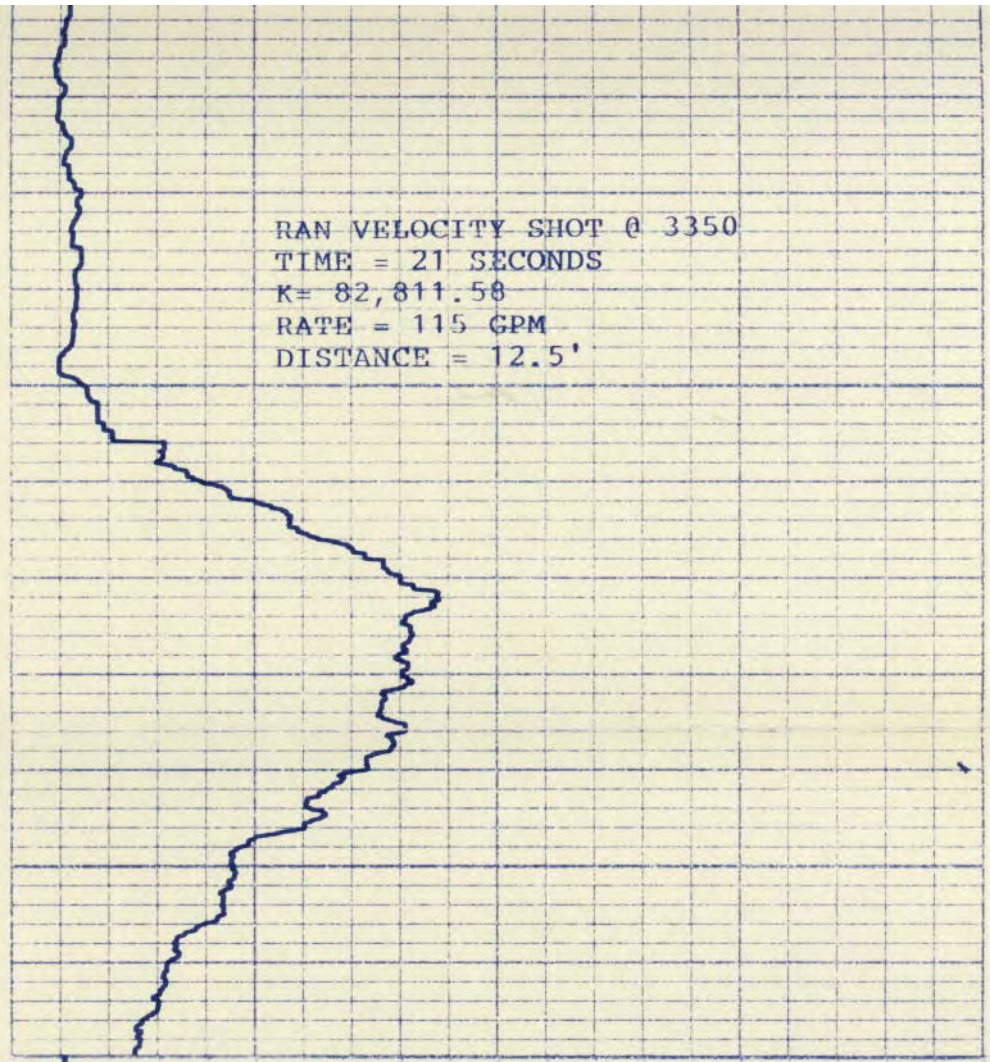

3100
5 3160 TO 3010 PEAK @ 3135
5.5"
INJECTION
TUBING
PACKER
9 5/8"
CASING
3200
INCREASED RATE TO 80 GPM
6 3280 TO 3100 PEAK @ 3156
3300

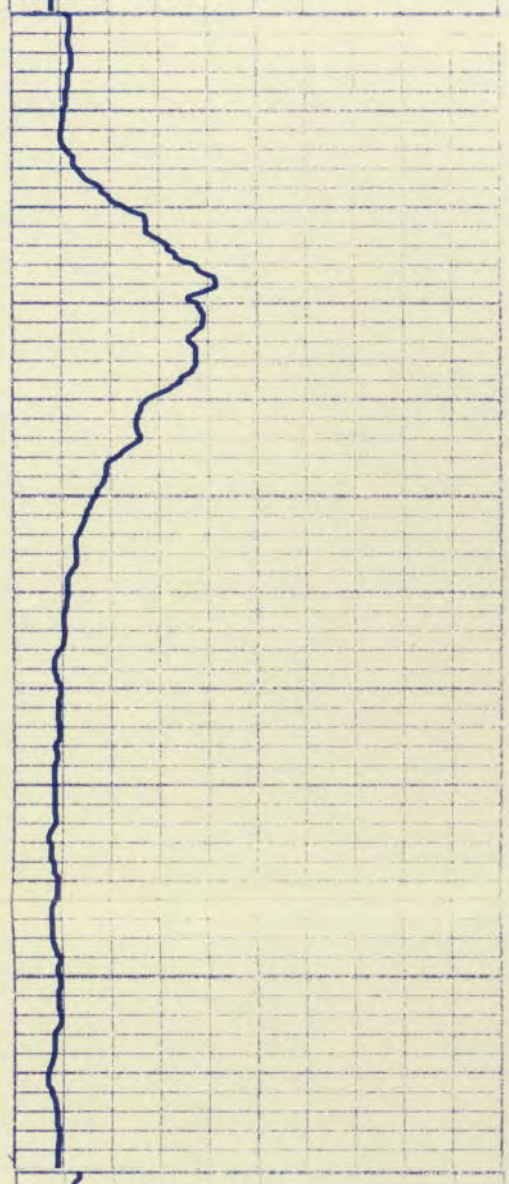

3400
7 3400 TO 3240 PEAK @ 3372
83462 TO 3350 NO R.A. MATERIAL
PERFORATIONS 3450 TO 3550
T.D. 3463 R.D. 3462
RAN VELOCITY SHOT @ 3400
R.A. MATERIAL PASSED UPPER DETECTOR @ 3388
R.A. MATERIAL DID NOT PASS LOWER DETECTOR
@ 3400'

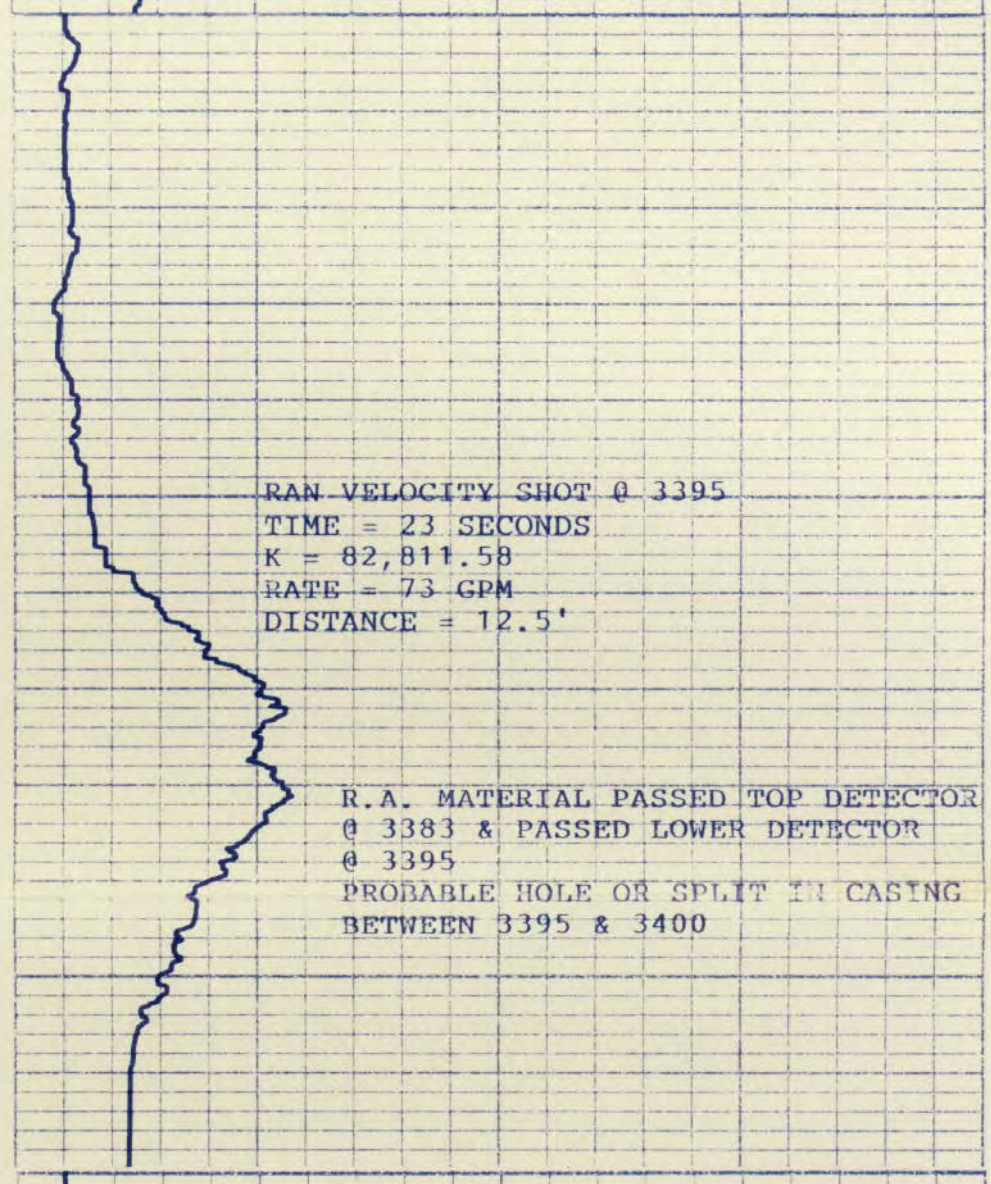


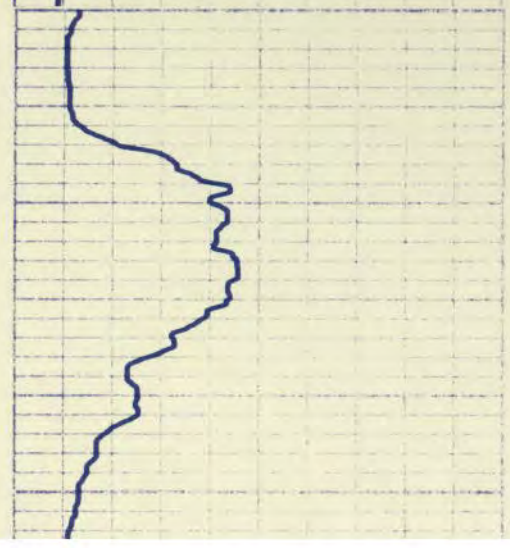


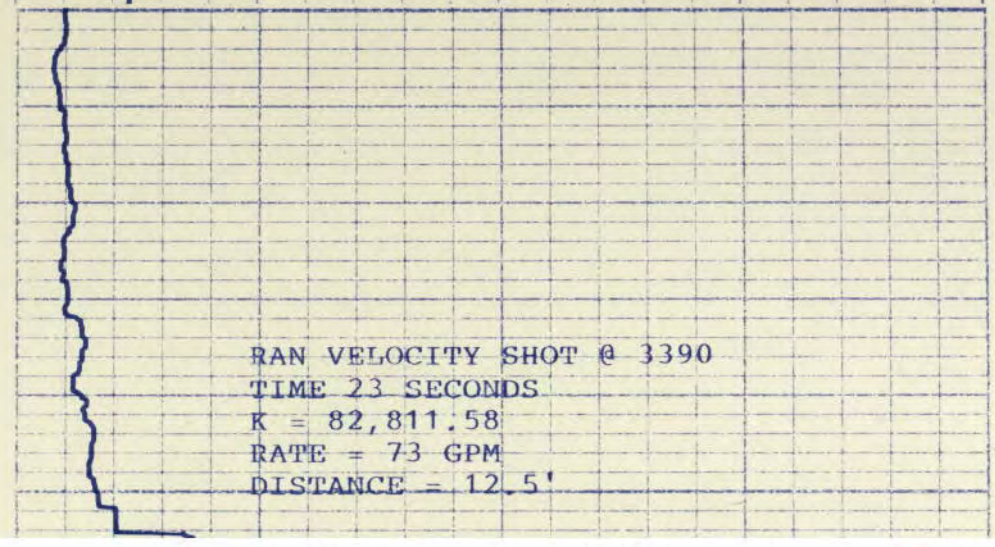


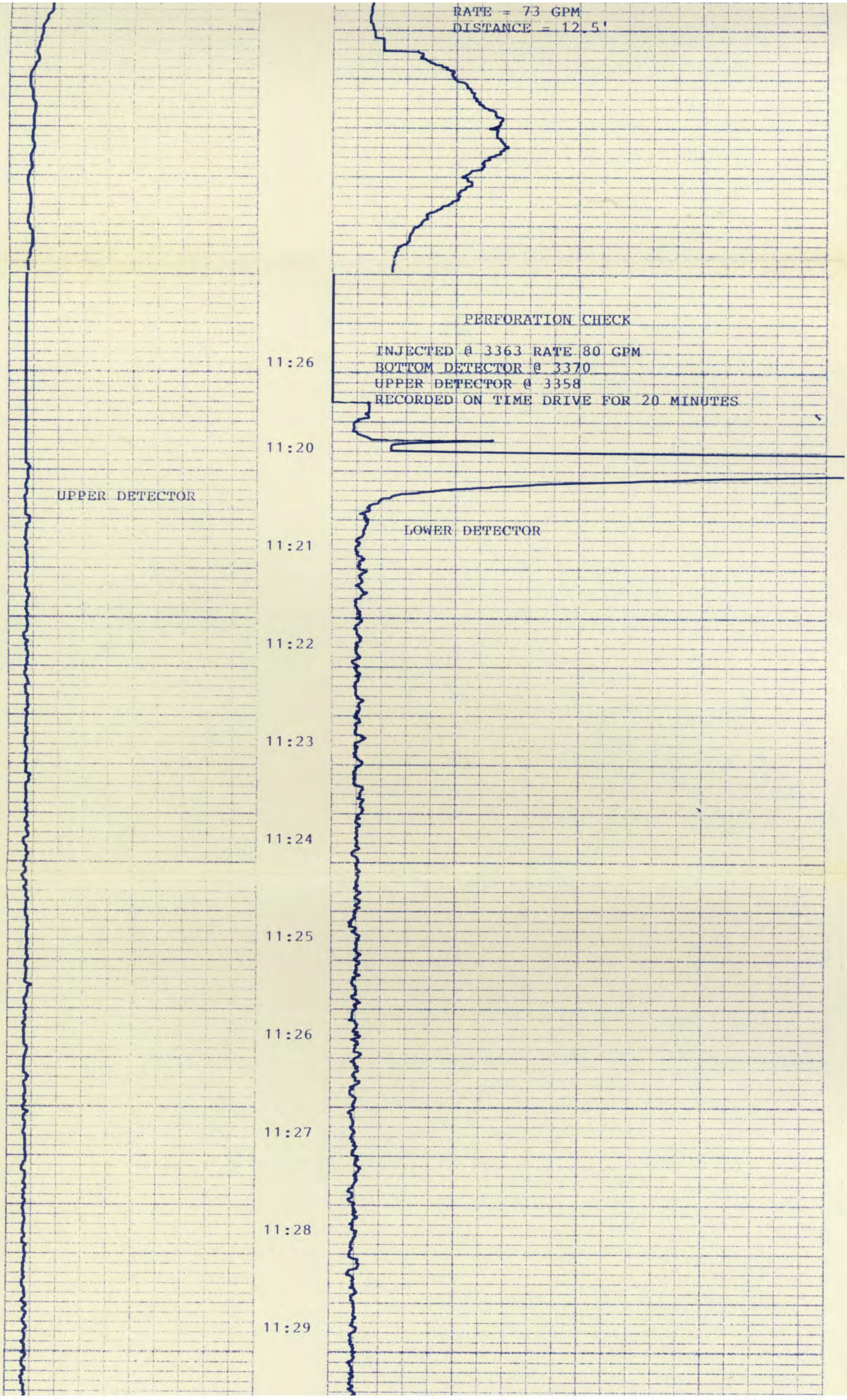

RAN VELOCITY SHOT @ 3350
TIME = 21 SECONDS
K= 82,811.58
RATE = 115 GPM
DISTANCE = 12.5'

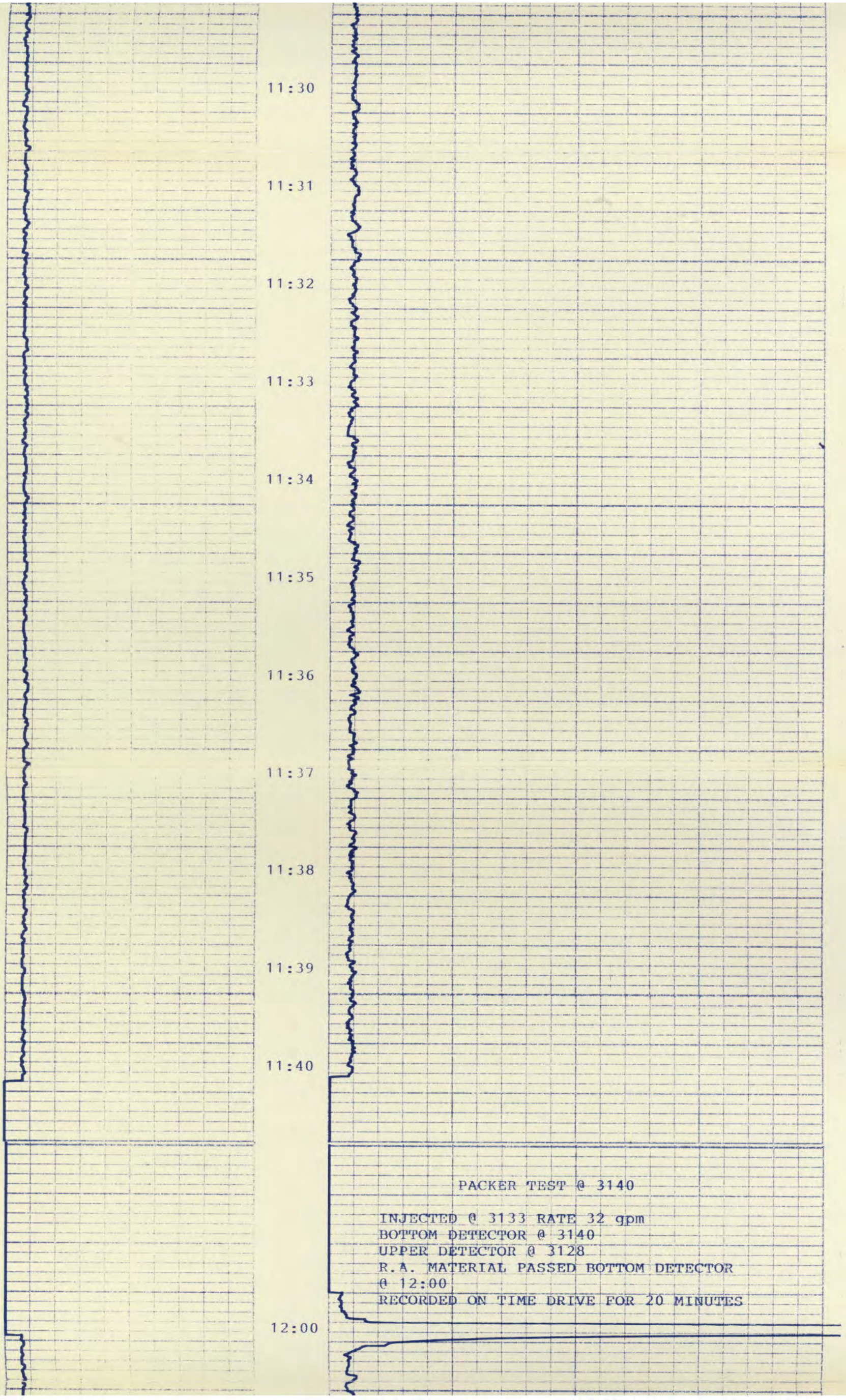


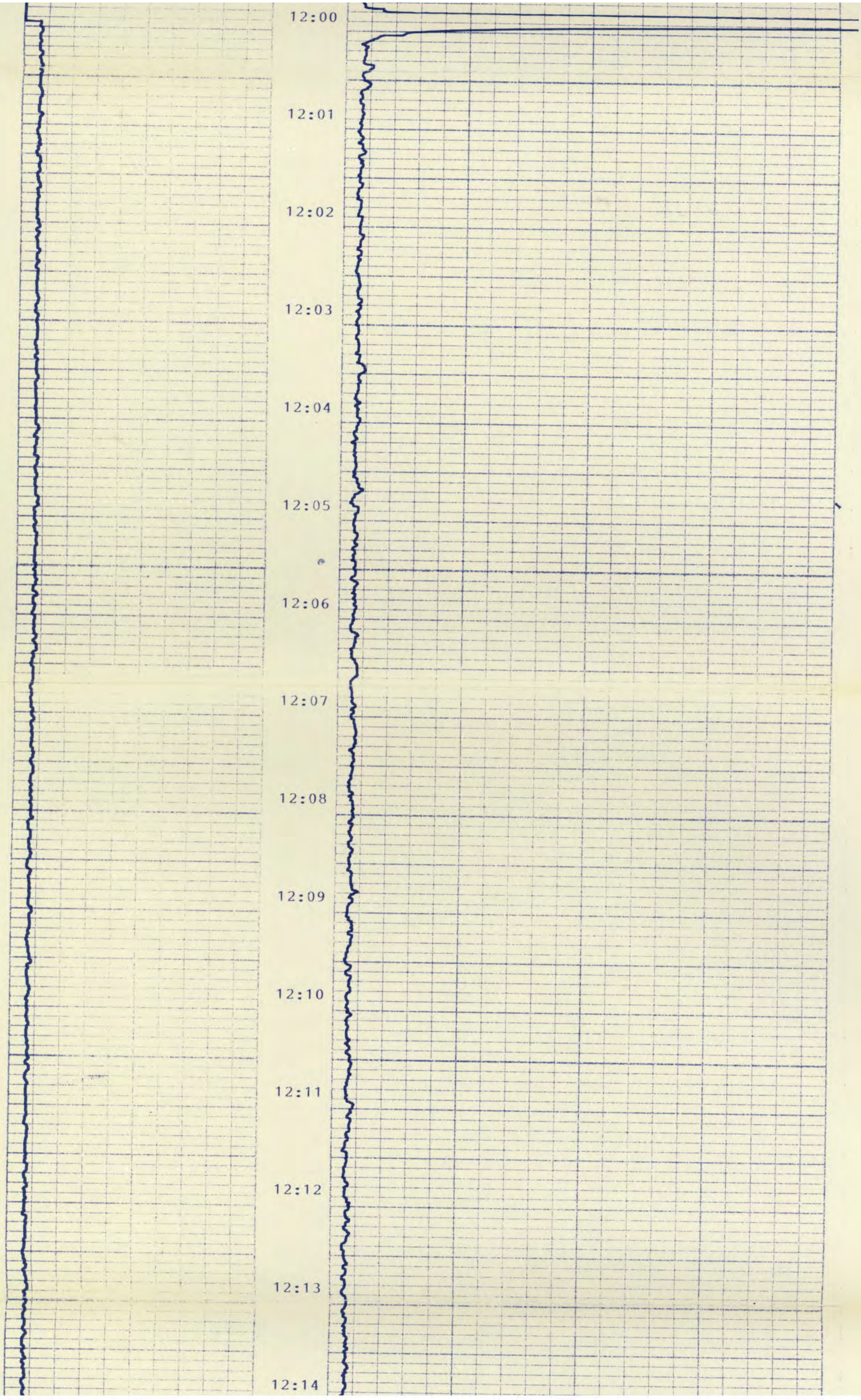

RAN VELOCITY SHOT @ 3395
TIME = 23 SECONDS
K = 82,811.58
RATE = 73 GPM
DISTANCE = 12.5'
R.A. MATERIAL PASSED TOP DETECTOR
@ 3383 & PASSED LOWER DETECTOR
@ 3395
PROBABLE HOLE OR SPLIT IN CASING
BETWEEN 3395 & 3400

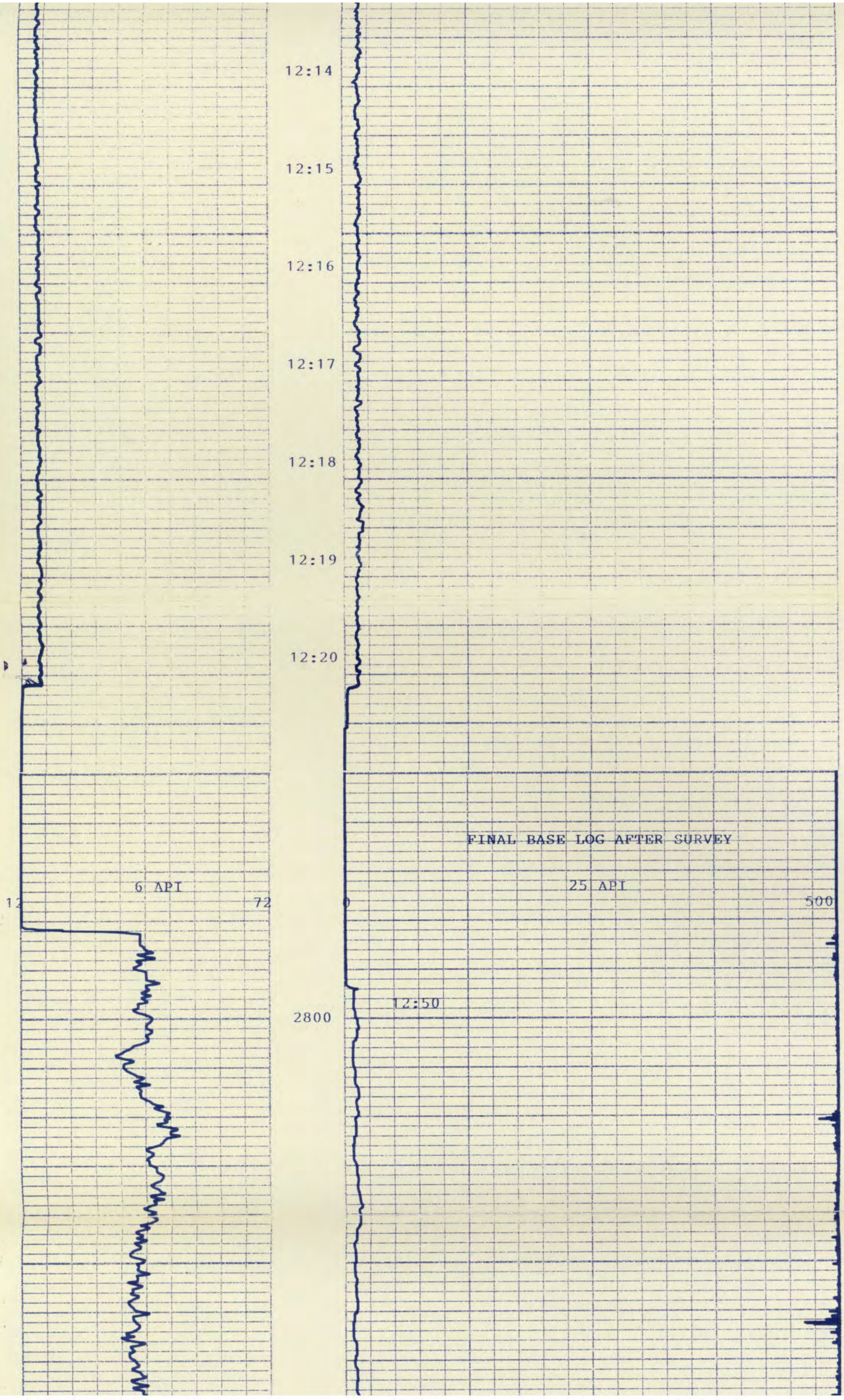


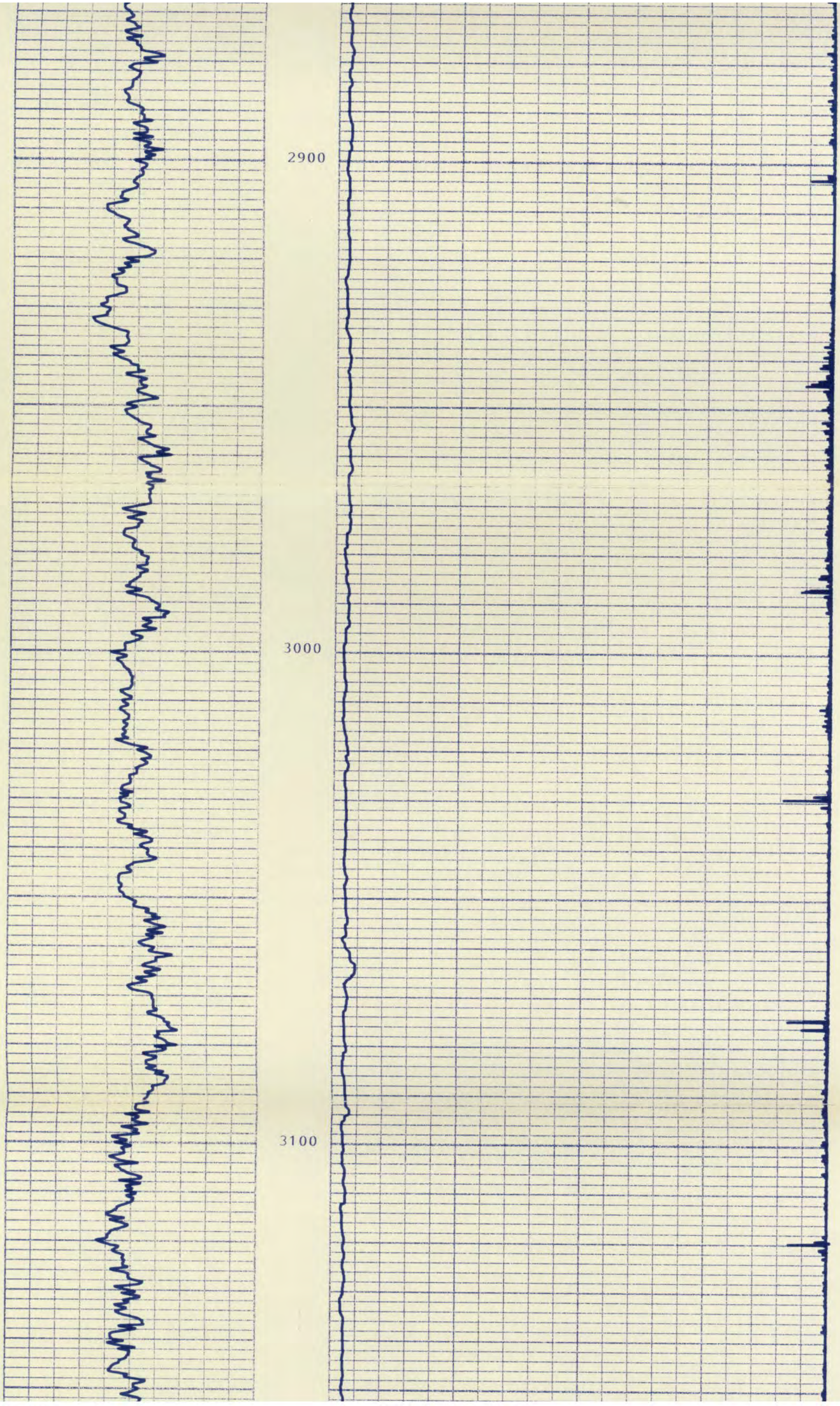

RAN VELOCITY SHOT @ 3390
TIME 23 SECONDS
K = 82,811.58
RATE = 73 GPM
DISTANCE = 12.5'

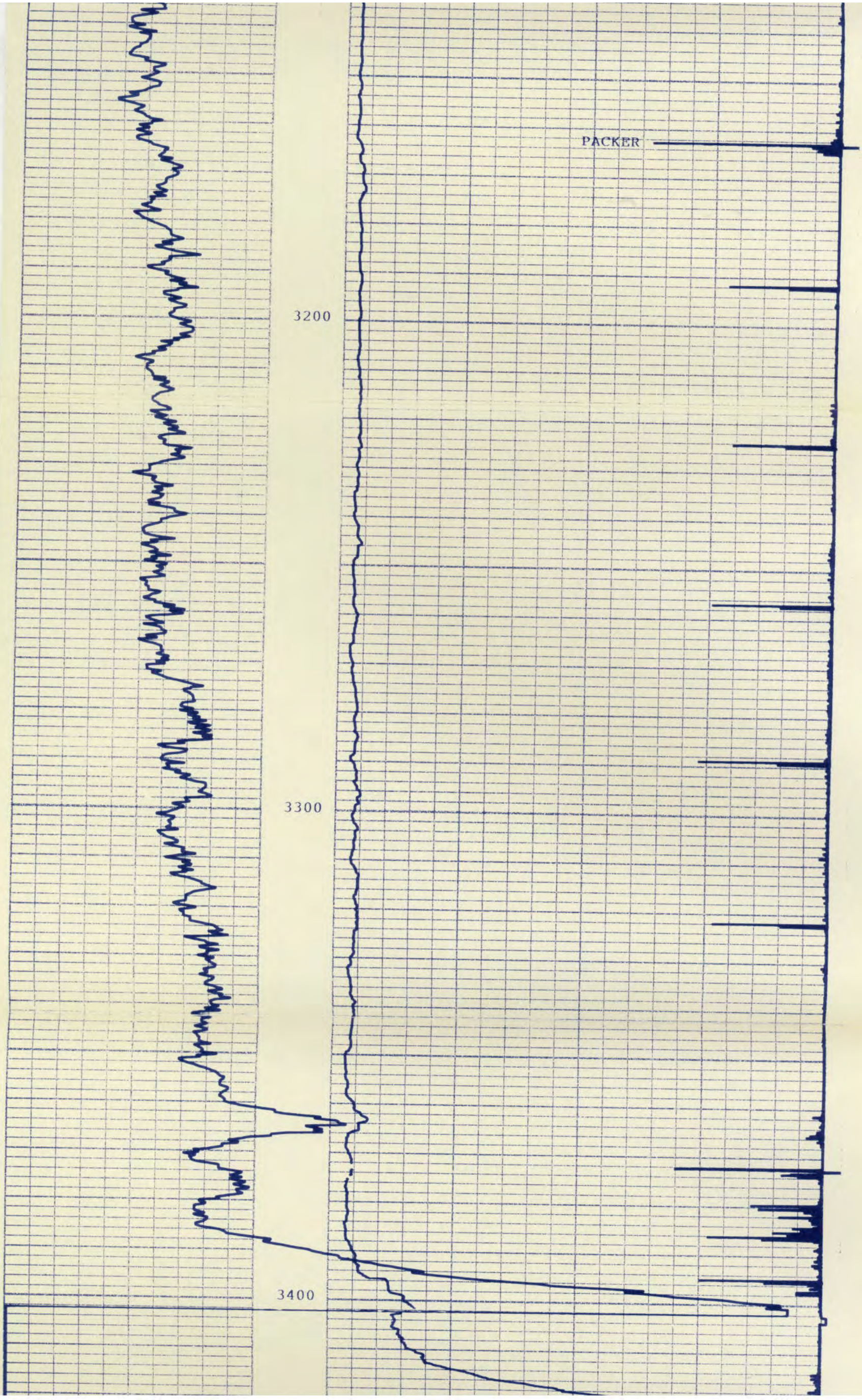

RATE = 73 GPM
DISTANCE = 12.5'
PERFORATION CHECK
INJECTED @ 3363 RATE 80 GPM
BOTTOM DETECTOR @ 3370
UPPER DETECTOR @ 3358
RECORDED ON TIME DRIVE FOR 20 MINUTES
11:26
11:20
UPPER DETECTOR
LOWER DETECTOR
11:21
11:22
11:23
11:24
11:25
11:26
11:27
11:28
11:29

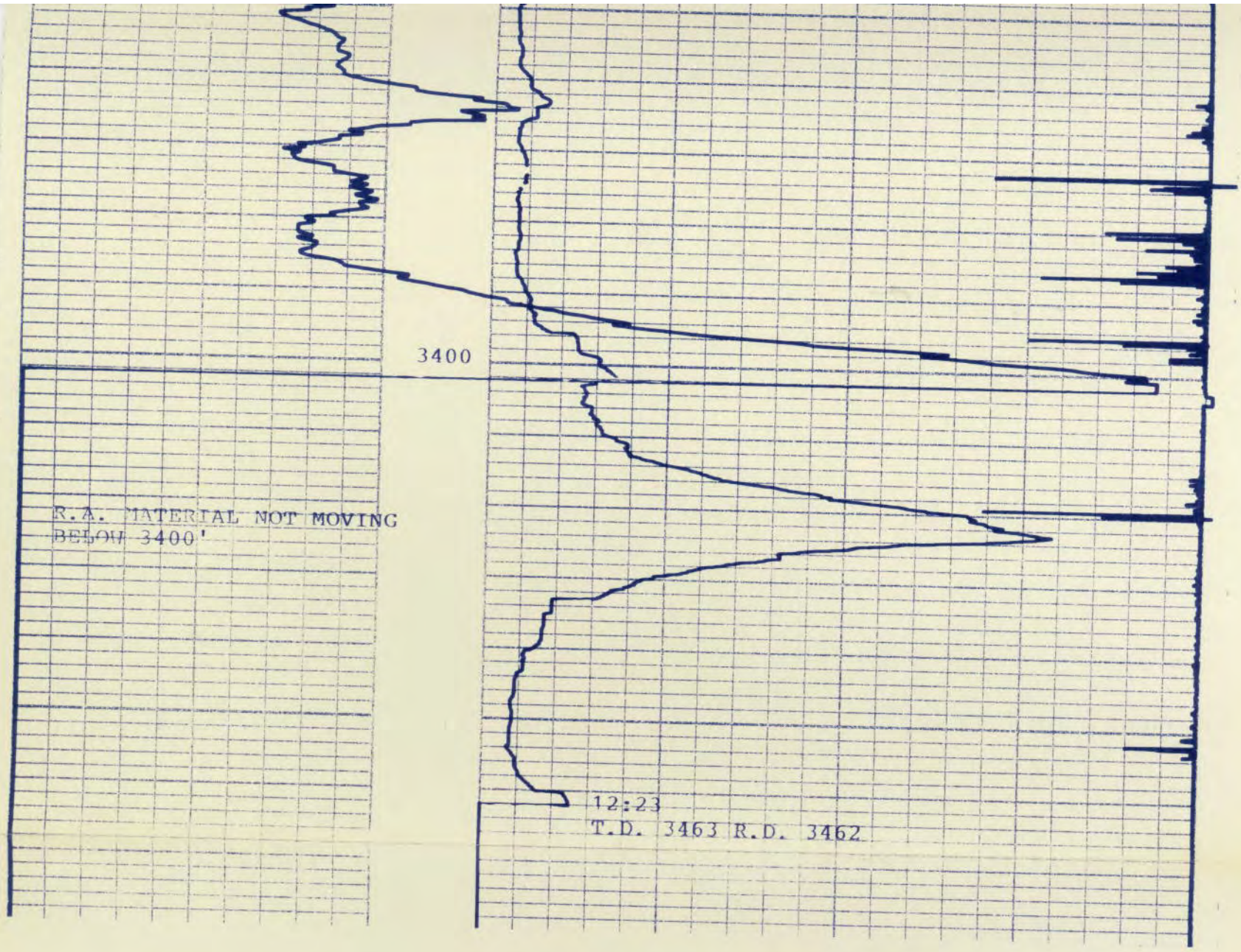

11:30
11:31
11:32
11:33
11:34
11:35
11:36
11:37
11:38
11:39
11:40
PACKER TEST @ 3140
INJECTED @ 3133 RATE 32 gpm
BOTTOM DETECTOR @ 3140
UPPER DETECTOR @ 3128
R.A. MATERIAL PASSED BOTTOM DETECTOR
@ 12:00
RECORDED ON TIME DRIVE FOR 20 MINUTES
12:00


12:00
12:01
12:02
12:03
12:04
12:05
12:06
12:07
12:08
12:09
12:10
12:11
12:12
12:13
12:14


12:14
12:15
12:16
12:17
12:18
12:19
12:20
FINAL BASE LOG AFTER SURVEY
6 API
12
72
25 API
0
500
12:50
2800


2900
3000
3100


PACKER
3200
3300
3400


3400
R.A. MATERIAL NOT MOVING
BELOW 3400'
12:23
T.D. 3463 R.D. 3462

APPENDIX A.1.f

GULF COAST'S LOG INTERPRETATION LETTER

GULF
COAST
WELL
ANALYSIS

COASTAL WIRELINE SERVICES, INC.

HOECHST CELANESE INC.
BAY CITY PLANT
MATAGORDA COUNTY, TEXAS
WASTE DISPOSAL WELL # 14 WELL # 2 OCTOBER 26, 1989

TO WHOM IT MAY CONCERN:

RADIOACTIVE TRACER LOG INDICATES THAT ALL FLUID IS GOING INTO 3395 TO 3400. NO INDICATION OF ANY FLUID GOING INTO PERFORATED ZONE, PACKER LEAKING, OR FLUID MIGRATION UP HOLE AT THIS TIME. THIS CONCLUDES GULF COAST WELL ANALYSIS INTERPERTATION FOR W.D.W. # 14 WELL # 2.

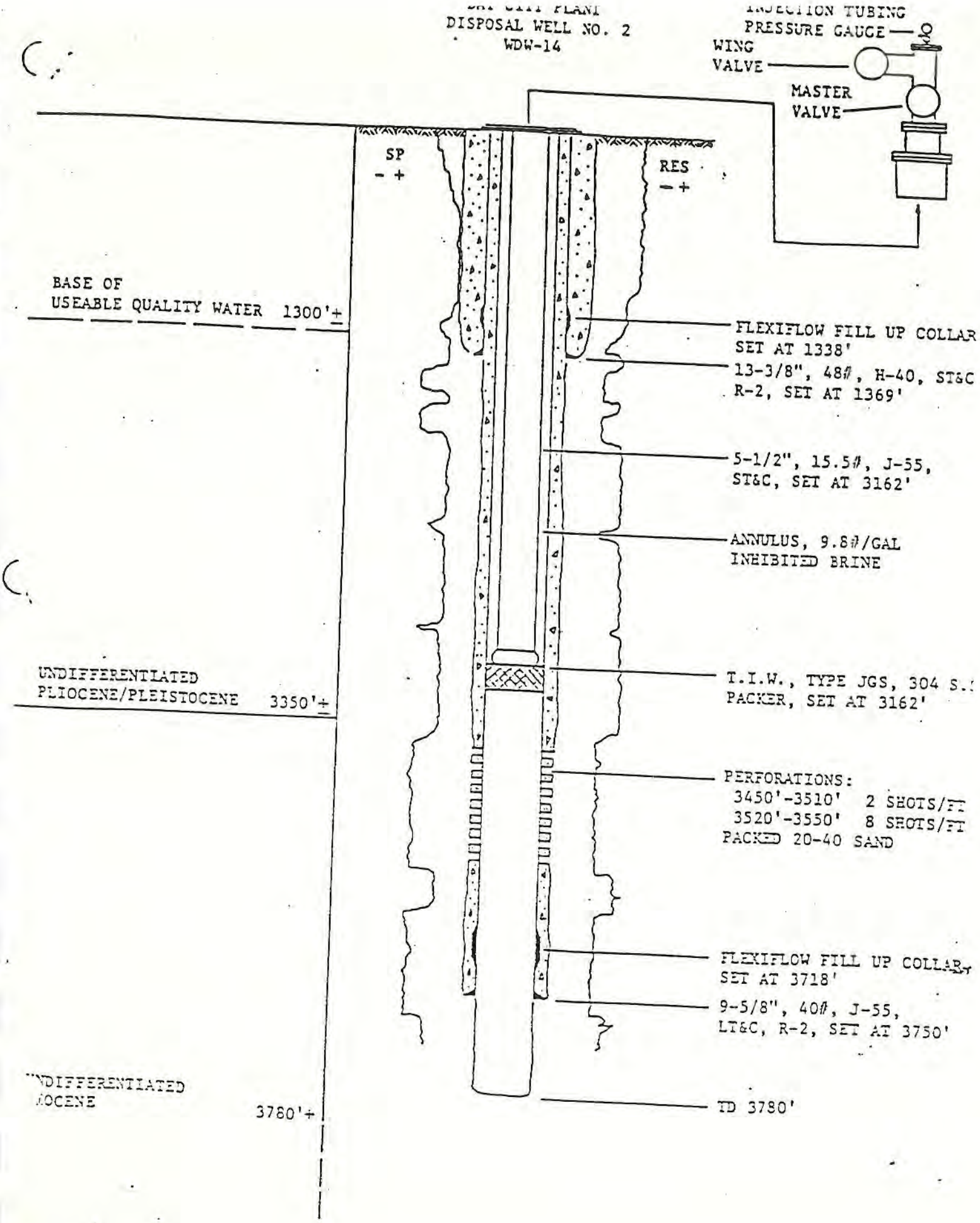
SINCERELY

STONEY JOHNSON
ENGINEER G.C.W.A.

P.O. Box 2308 Pearland, Texas 77588 (713) 485-6548

APPENDIX A.2

WELL SCHEMATIC DRAWING


DISPOSAL WELL NO. 2
WDW-14
INJECTION TUBING
PRESSURE GAUGE
WING
VALVE
MASTER
VALVE
SP
- +
RES
- +
BASE OF
USEABLE QUALITY WATER 1300'±
FLEXIFLOW FILL UP COLLAR
SET AT 1338'
13-3/8", 48#, H-40, ST&C
R-2, SET AT 1369'
5-1/2", 15.5#, J-55,
ST&C, SET AT 3162'
ANNULUS, 9.8#/GAL
INHIBITED BRINE
UNDIFFERENTIATED
PLIOCENE/PLEISTOCENE 3350'±
T.I.W., TYPE JGS, 304 S.
PACKER, SET AT 3162'
PERFORATIONS:
3450'-3510' 2 SHOTS/FT
3520'-3550' 8 SHOTS/FT
PACKED 20-40 SAND
FLEXIFLOW FILL UP COLLAR
SET AT 3718'
9-5/8", 40#, J-55,
LT&C, R-2, SET AT 3750'
NDIFFERENTIATED
OCENE
3780'+
TD 3780'

APPENDIX B

WASTE DISPOSAL WELL NO. 32

APPENDIX B.1

MECHANICAL INTEGRITY TEST DATA

APPENDIX B.1.a

ANNULUS PRESSURE DATA

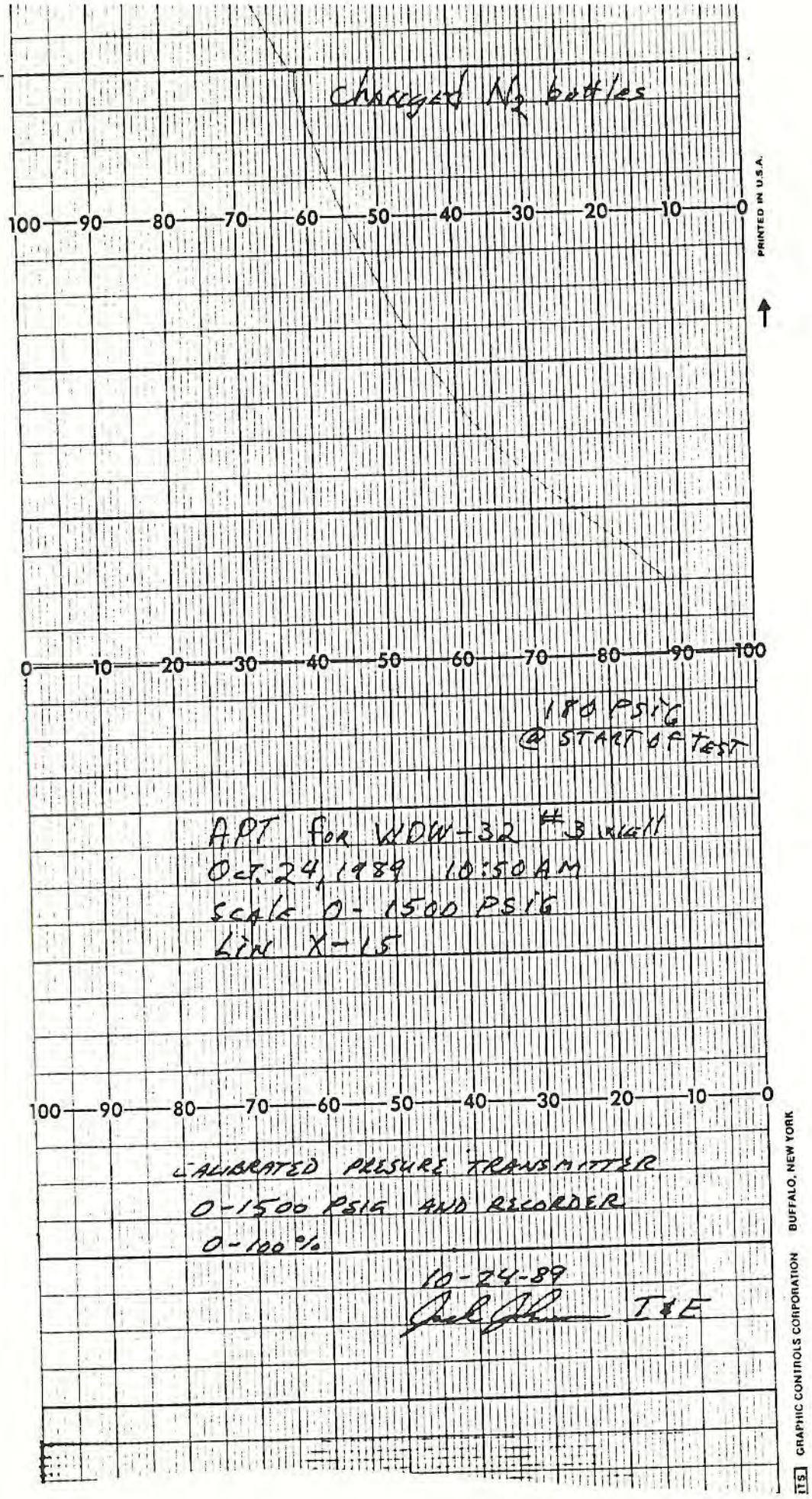
Annulus Pressure Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 32
October 24, 1989

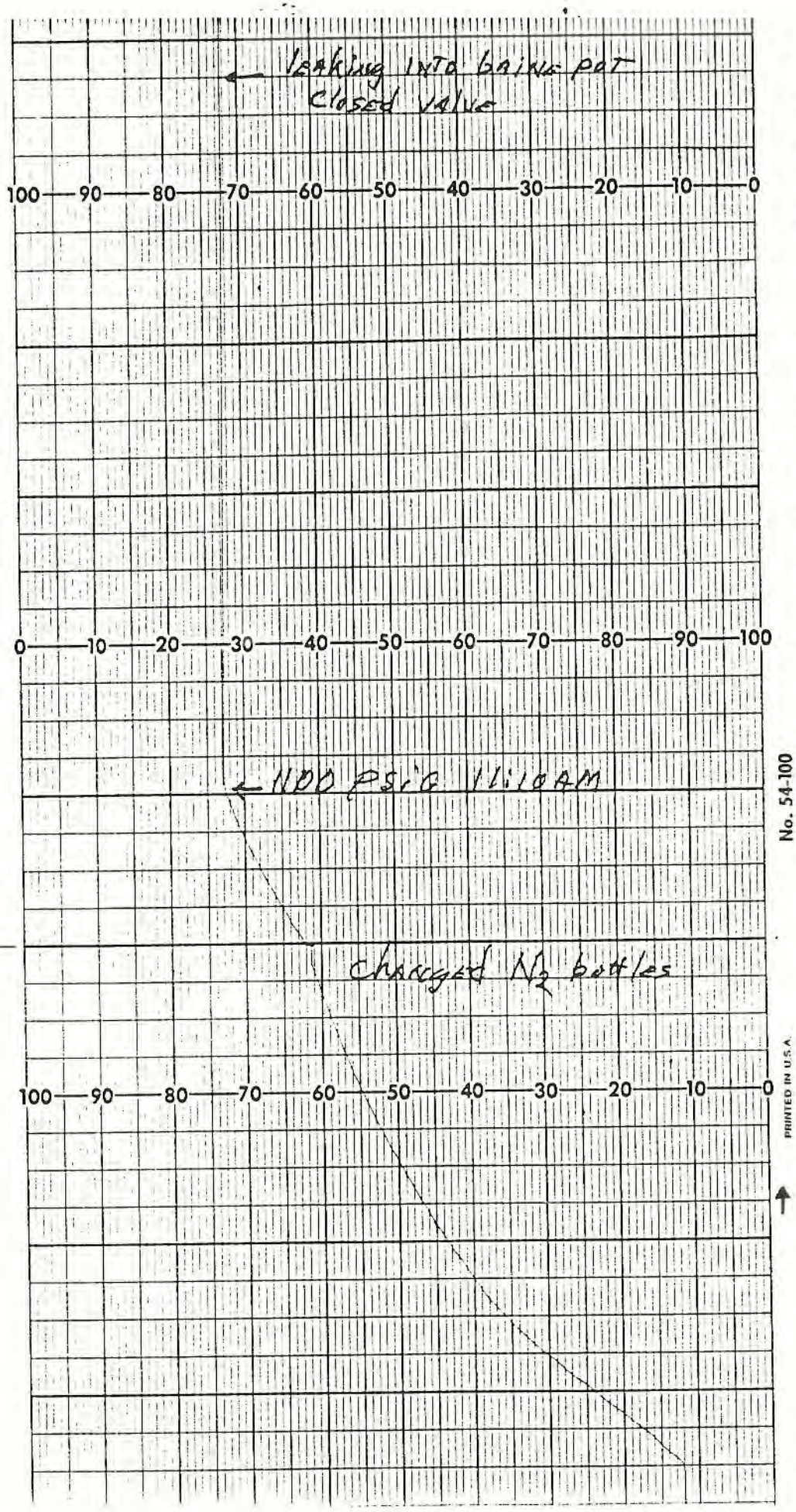
Time (am)	Casing Pressure (Psig)	Remarks
8:38	191.0	Well shut-in 20 hours.
10:57	300.0	Started pressurizing annulus.
11:00	750.0	
11:06	1000.0	
11:09	1100.0	Closed off nitrogen gas source.
11:10	1096.0	
11:15	1093.0	Started APT.
11:20	1092.0	
11:25	1090.0	
11:30	1090.0	
11:35	1089.0	
11:40	1088.0	
11:45	1087.0	End of APT.
(pm)		
12:00	500.0	Bleeding off pressure.
12:40	200.0	Bled off pressure.

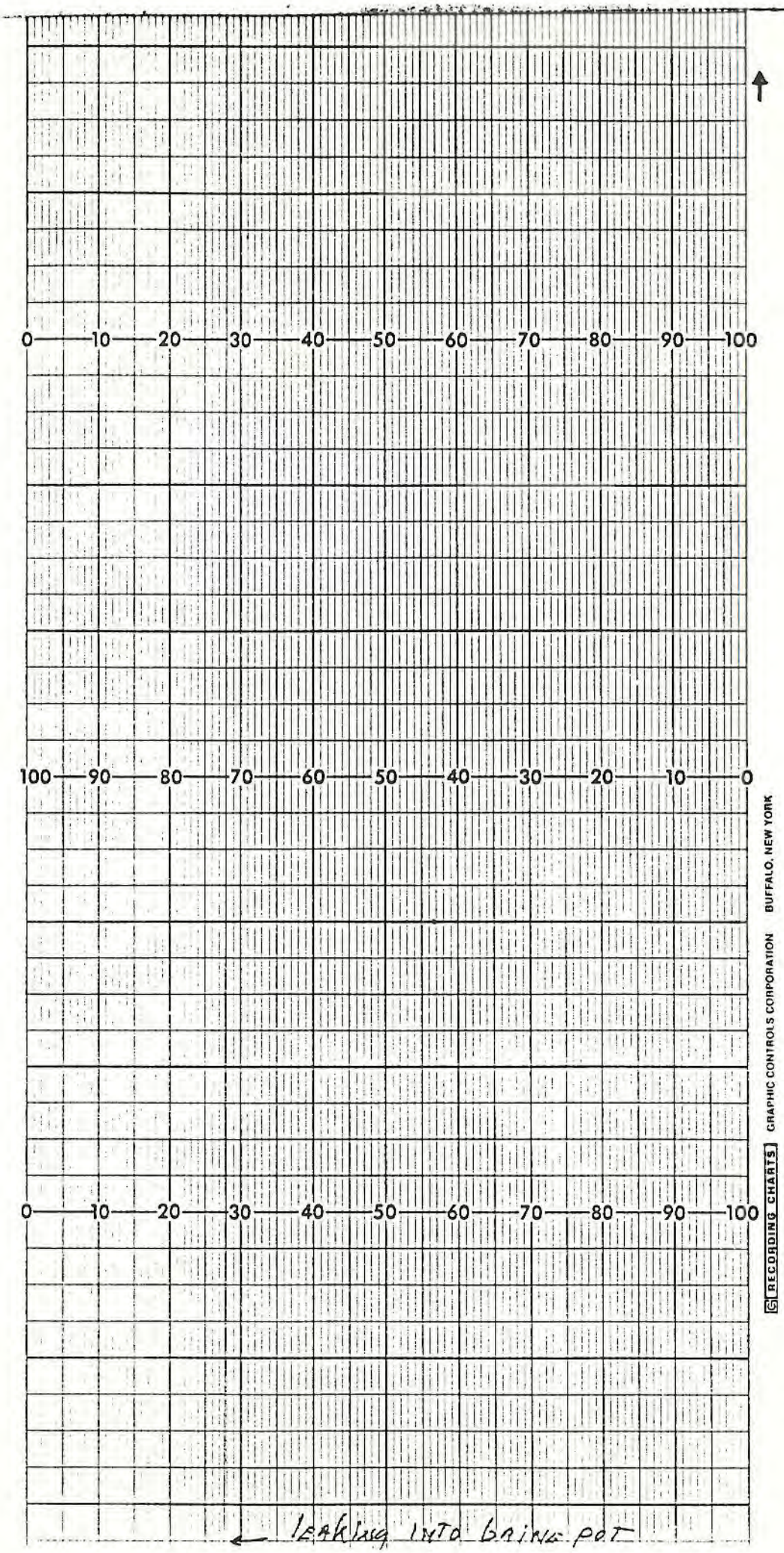
Results: The pressure leaked-off 6 psi (1093 to 1087 psig) during the last 30 minutes, or a leak-off rate of 1/2 of 1%. Maximum allowable leak-off is 5% per 30 minutes.

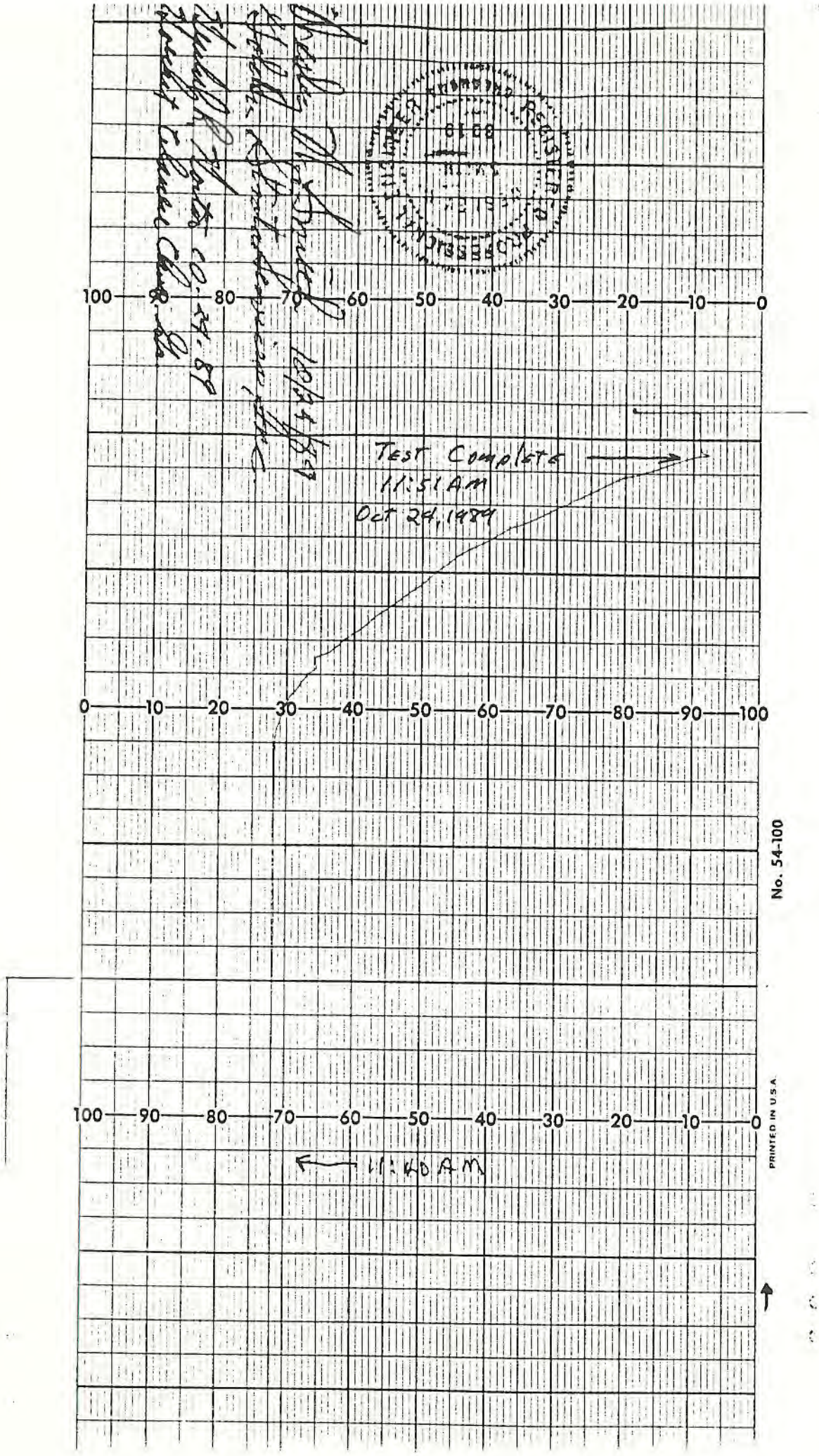
Pressure was measured using a 3-D Instruments, Inc. Test Gauge, 4-1/2" diameter, range 0 - 1,500 psi, Serial No. 8807007 with 10 psi inclement. Gauge calibrated against pressure standard Mansfield and Green, Drawing No. 2633, on October 5, 1989.

Also, used HCCG's well test transmitter pressure recorder with range 0 - 1,500 psi, calibrated to a dead weigh tester traceable to National Bureau of Standards, on October 20, 1989 by W.H. Heller (See Appendix A.1.b).


Charged N2 bottles
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
180 PSIG
@ START OF TEST
APT for WDW-32 #3 Well
Oct. 24, 1989 10:50 AM
Scale 0 - 1500 PSIG
Lin X-15
100 90 80 70 60 50 40 30 20 10 0
CALIBRATED PRESURE TRANSMITTER
0-1500 PSIG AND RECORDER
0-100%
10-24-89
T&E
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK


leaking into brine pot
closed valve
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
1100 PSIG 11:10AM
charged N2 bottles
100 90 80 70 60 50 40 30 20 10 0
No. 54-100
PRINTED IN U.S.A.


0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
leaking into brine pot


Test Complete
11:51 AM
Oct 24, 1989
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
11:40 AM
No. 54-100
PRINTED IN U.S.A.

APPENDIX B.1.b

RADIOACTIVE TRACER SURVEY DATA

Radioactive Tracer Survey Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 32
October 24, 1989

A. First Base G/R Log: 3390′ to 2900′ (11:49 am to 11:59 am)

B. Second Base G/R Log: 3250′ to 2900′ (12:02 pm to 12:08 pm)
(Ran to confirm repeatability of tool)

C. One - Five (5) minute statistical check with tool stationary each at depths of 3225′ (12:12 pm to 12:17 pm) and 3170′ (12:17 pm to 12:22 pm)

D. First Radioactive Slug Ejection. The following RAT data and injection rate reflects the downward movement of the injected fluid.

Pass No.	Time From (pm)	Time To (pm)	Depth(Ft.) From	Depth(Ft.) To	Top Slug Depth (Ft.)	Remarks
	1:20:00		2900			Eject R/A slug(3 sec.).
1	2:22:33	2:23:27	2950	2900	2925	
2	2:24:15	2:25:22	3000	2910	2978	Injection rate - 33 gpm.
3	2:26:15	2:28:00	3070	2960	3050	
4	2:29:02	2:31:08	3150	3030	3136	
5	2:32:23	2:35:15	3380	3120	3260	
6	2:36:37	2:39:07	3390	3240	?(*)	Stopped RAT Survey.

* - Missed last R/A slug peak. Slug pumped below PBTD (@3390′) and into the disposal interval.

E. Second R/A slug ejection: (First Stationary Time Sequence):

Time (pm)	Tool Depth (Ft.)	Remarks
1:49:20	3170	Released R/A slug (2 Sec.). Left tool stationary and turned on time-drive recorder. Pump rate 33 gpm
1:49:25	3170	Recorded R/A slug peak. Started test.
1:59:25	3170	Survey stopped. R/A slug displaced into disposal interval.

Note: See attached Estimated Time to Run Stationary RAT Sequence. (See Appendix B.1.c)

F. Third R/A slug ejection (Second Stationary Time Sequence):

Time (pm)	Tool Depth (Ft.)	Remarks
2:02:37	3225	Released R/A slug (2 Sec.). Left tool stationary and turned on time-drive recorder. Pump rate - 33 gpm.
2:02:48	3225	Recorded R/A slug peak. Started test.
2:12:48	3225	Survey stopped. R/A slug displaced into disposal interval.

G. Final base log: 3390′ to 2900′ (2:17 pm to 2:27 pm).

APPENDIX B.1.c

ESTIMATED TIME TO RUN STATIONARY RAT SEQUENCE
(Waste Disposal Well 32)

Estimated Time To Run Stationary RAT Sequence
Waste Disposal Well 32
(RAT of October 24, 1989)

Problem: Calculate "worse case" time for the radioactive slug to move from the G/R tool (1) down the tubing, (2) into the wellbore and (3) up the casing/borehole annulus to the tool depth.

Basic Data:

Capacities:	5-1/2" tubing	- 1.000 gal/ft
	9-5/8" casing x 12-1/4" borehole	- 2.340 gal/ft
Pump Rate:	33 gpm	

Note: RAT detection tool was held stationary at 3170 ft, or 55 ft above the end of the casing shoe.

Worse Case Calculations:

Volumes:	Tubing	- 55 ft x 1.000 gal/ft	= 55.0 gal
	Casing/borehole	- 55 ft x 2.340 gal/ft	= 128.7 "
			183.7 gal

Calculated time to circulate R/A slug around the end of the tubing and casing strings:

= 183.7 gal/33 gal/min

= 5.6 minutes

Note: Actual time survey ran = 10 minutes

APPENDIX B.1.d

RADIOACTIVE TRACER SURVEY
(FINAL COPY)

Gulf Coast Well Analysis

RADIOACTIVE TRACER LOG

MECHANICAL INTEGRITY TEST

FILING NO. _____

COMPANY HOECHST CELANESE

WELL WASTE DISPOSAL WELL # 32 WELL # 3

FIELD BAY CITY PLANT

COUNTY MATAGORDA STATE TEXAS

LOCATION:

SEC. _____ TWP. _____ RGE. _____

OTHER SERVICES: B.H.P.

PERMANENT DATUM: GROUND LEVEL ELEV: N.A.

LOG MEASURED FROM KELLY BUSHING 11.0 FT. ABOVE PERM. DATUM

DRILLING MEASURED FROM KELLY BUSHING

ELEV.: K.B. N.A. D.F. N.A. G.L. N.A.

Date	OCT 24, 1989
Run No.	ONE
Type Log	R.A.T.
Depth-Driller	N.A.
Depth-Logger	3390
Bottom logged interval	3390
Top logged interval	2900
Type fluid in hole	WASTE WATER
Max rec. temp., deg. F.	N.A.
Operating rig time	MAST
Recorded by	JOHNSON
Witnessed by	MR. WES SMITH

Bore-Hole Record

Run No.	Bit	From	To

Tubing Record

Size	Wgt.	From	To
5.5	15.5	SURF.	3192

Casing Record

Size	Wgt.	From	To
9 5/8	N.A.	SURF.	3245

Liner

Size	Wgt.	From	To
4.5	N.A.	3192	T.D.

NOTICE: All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

Gulf Coast Well Analysis

EQUIPMENT DATA

Gamma Ray			
Run No.	ONE		
Tool Model No.	CRC		
Diameter	1.44		
Detector Model No.	G-1		
Type	GEIGER		
Length	12"		
Distance to N. Source			
General			
Hoist Truck No.	101		
Instrument Truck No.	101		
Tool Serial No.	1234-2		
District	PEARLAND		

Neutron			
Run No.			
Log Type			
Tool Model No.			
Diameter			
Detector Model No.			
Type			
Length			
Source Model No.			
Serial No.			
Spacing			
Type			
Strength			

LOGGING DATA

General				Gamma Ray				Neutron			
Run No.	Depths From	Depths To	Speed Ft/Min.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API G.R. Units per Log Div.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API N. Units per Log Div.
1	3390	2900	50	1	1000/200	2-L	6				
1	3390	2900	50	1	100/200	0-L	25				

Reference Literature: SPACING BETWEEN DETECTORS = 4.0'
SPACING FROM TOP DETECTOR TO CCL = 2.0'
SPACING FROM CCL TO INJECTOR PORT = 5.0'

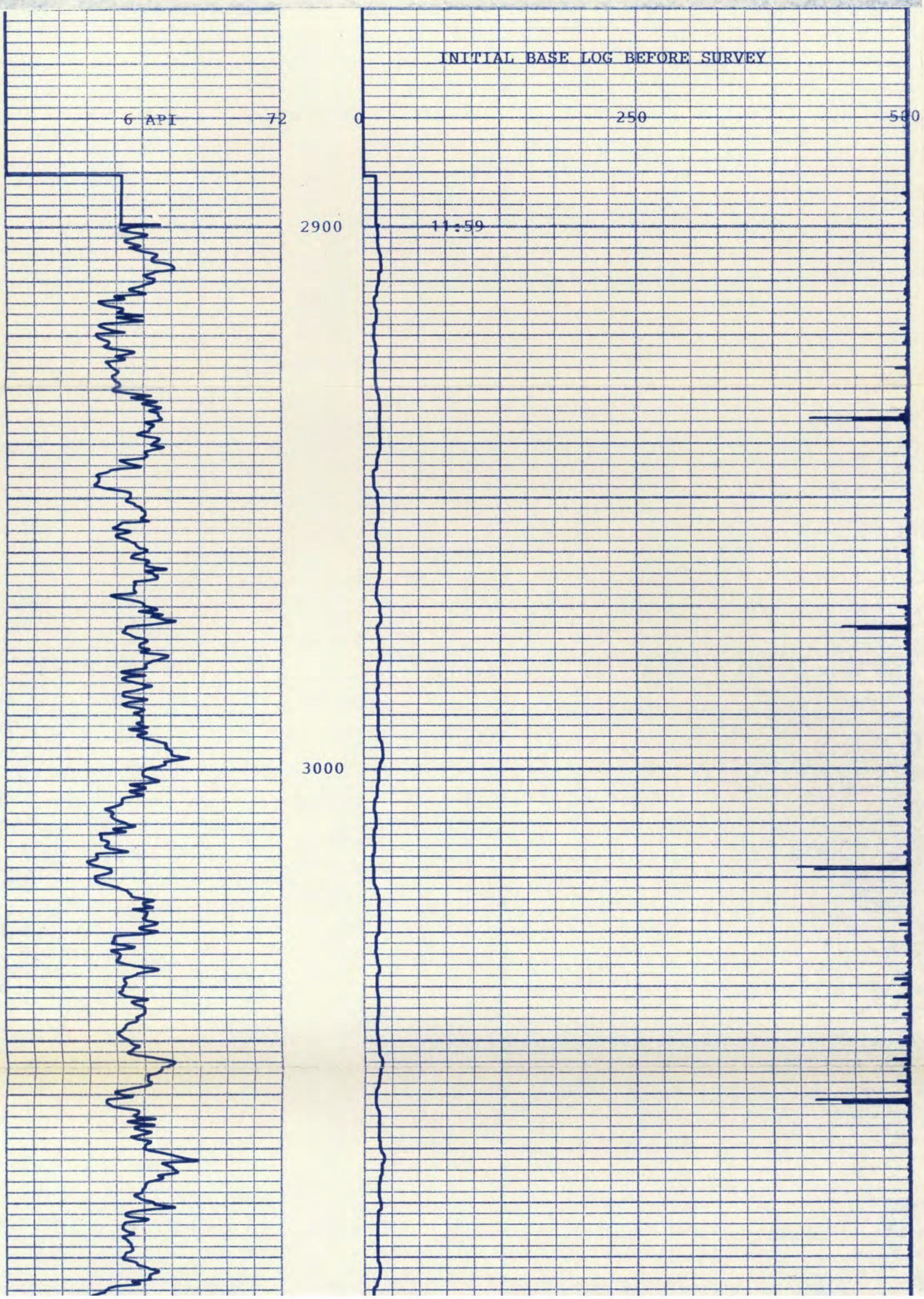
Remarks: RADIOACTIVE TRACER LOG INDICATES THAT ALL FLUID IS GOING INTO DISPOSAL ZONE AT THIS TIME. NO INDICATIONS OF FLUID MIGRATION UP HOLE OR PACKER LEAKING.

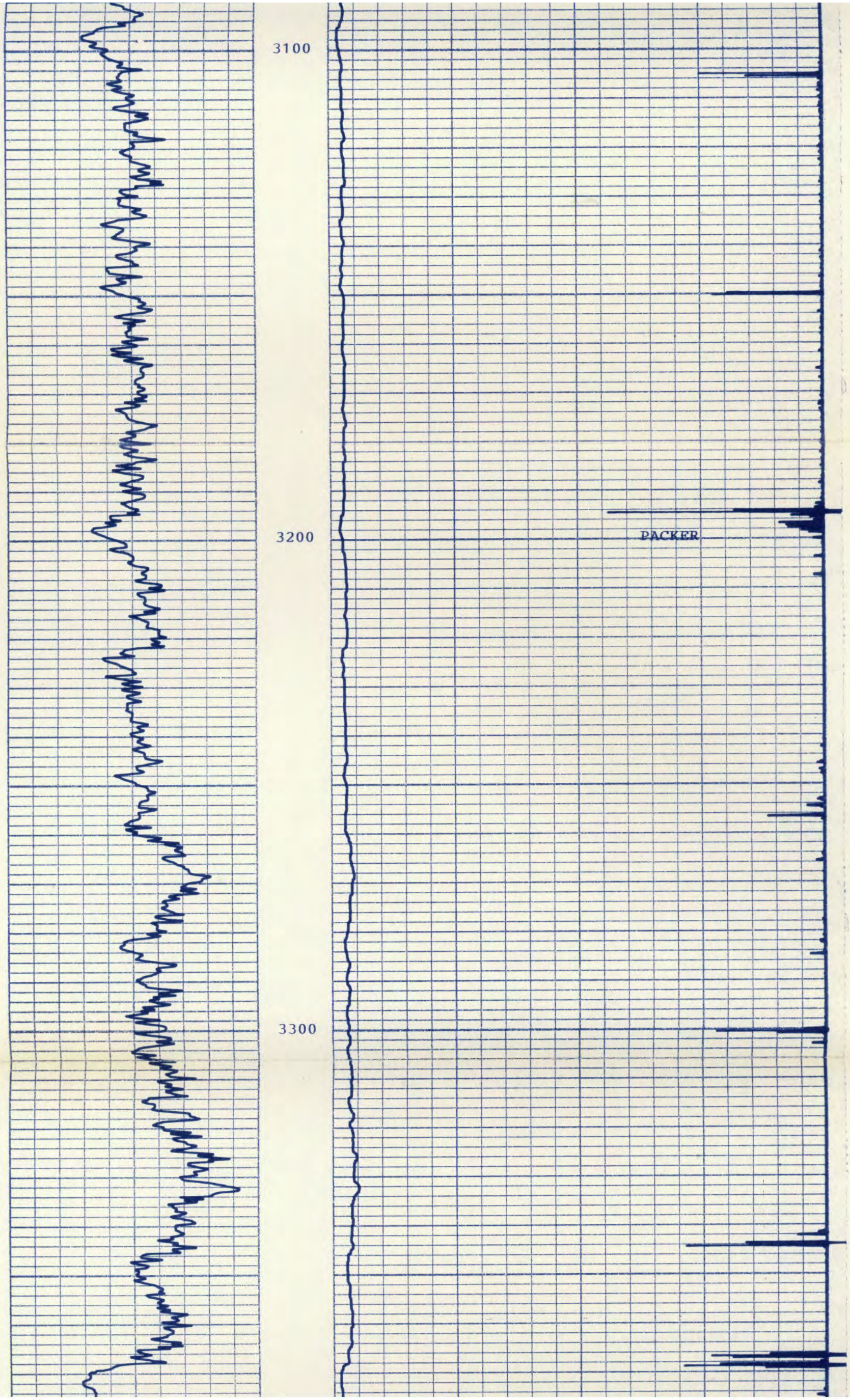
Fold Here

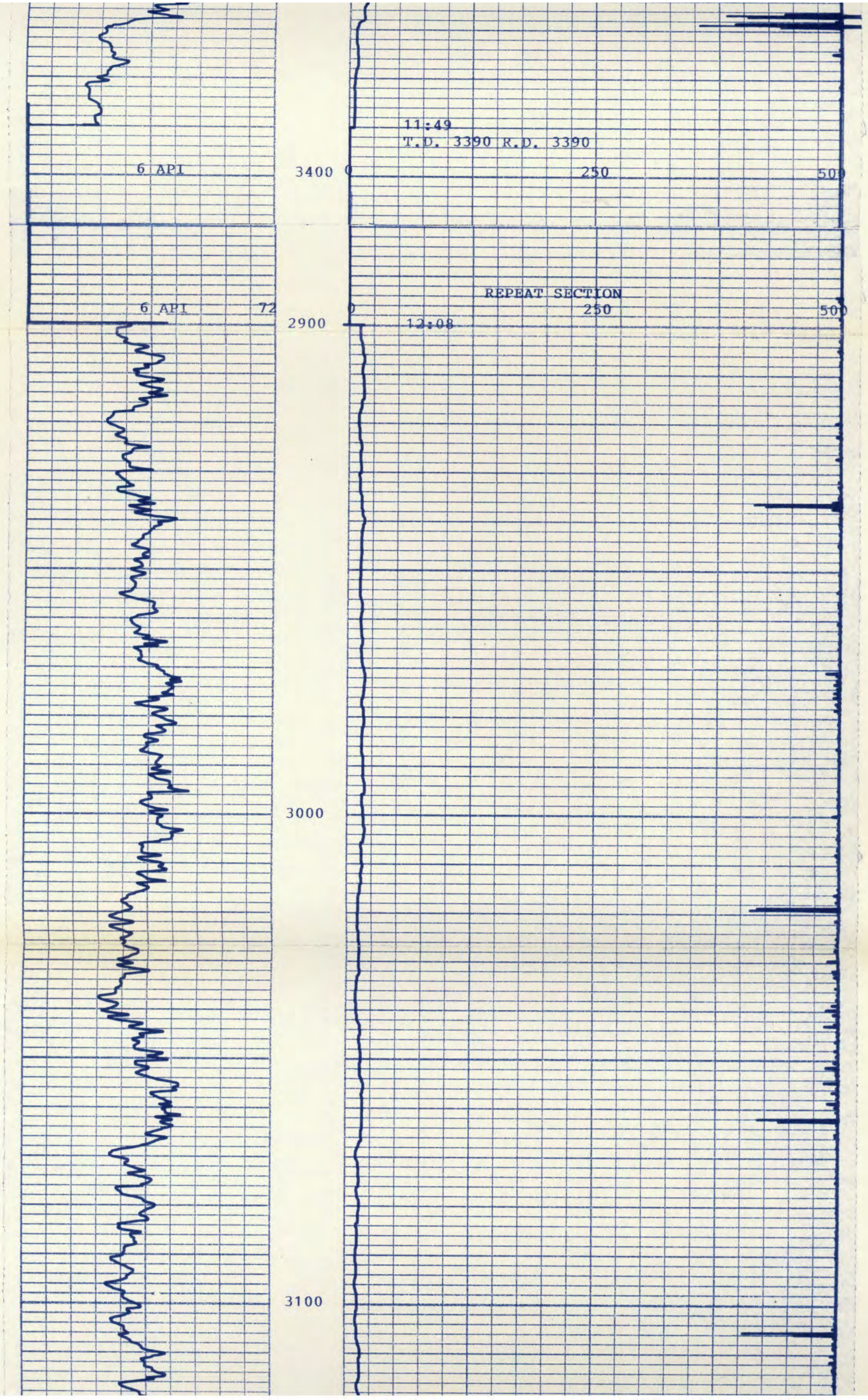
BEARING:

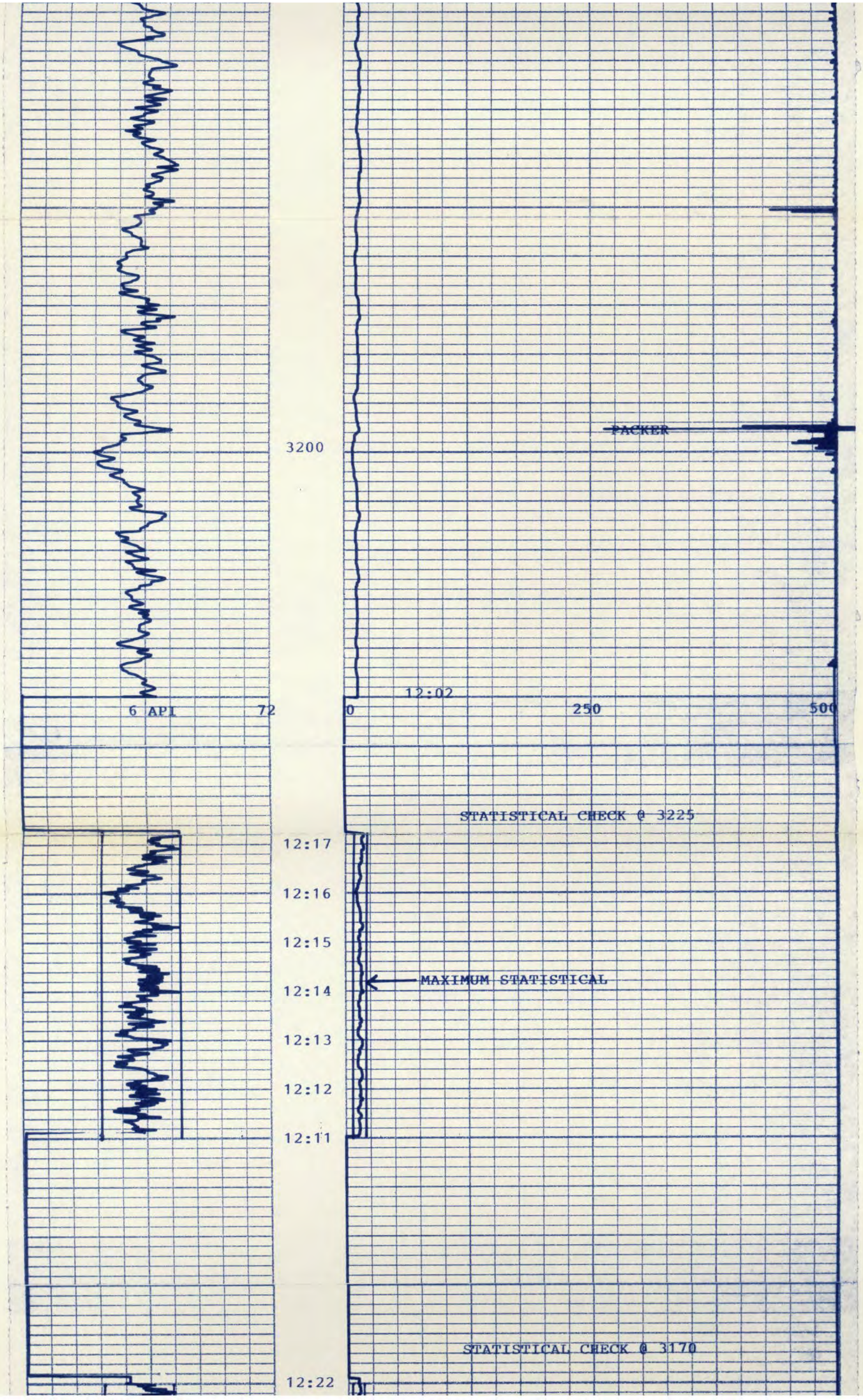
Fold Here

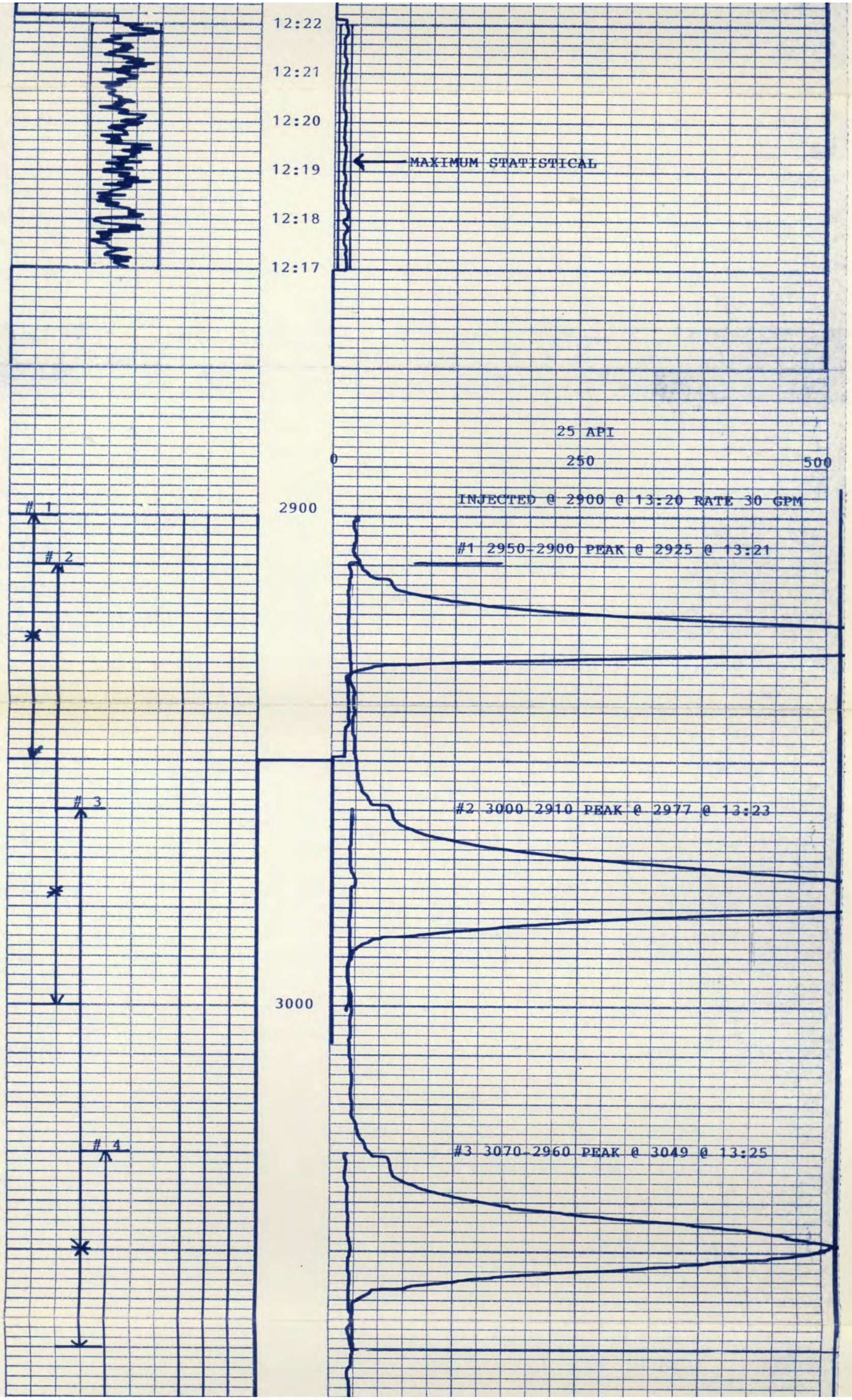
GAMMA RAY	DEPTHS	NEUTRON
API GAMMA-RAY UNITS		API NEUTRON UNITS

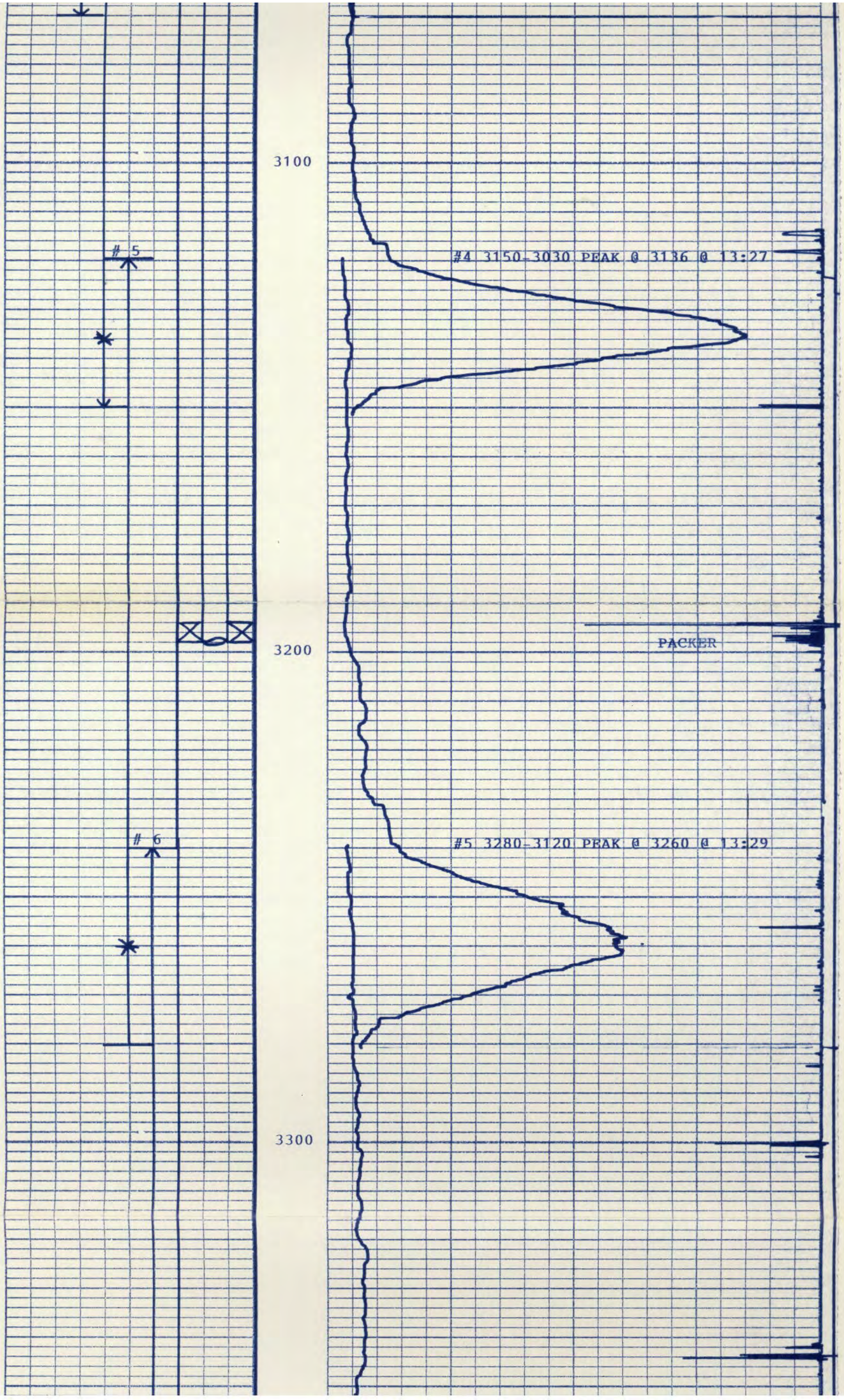


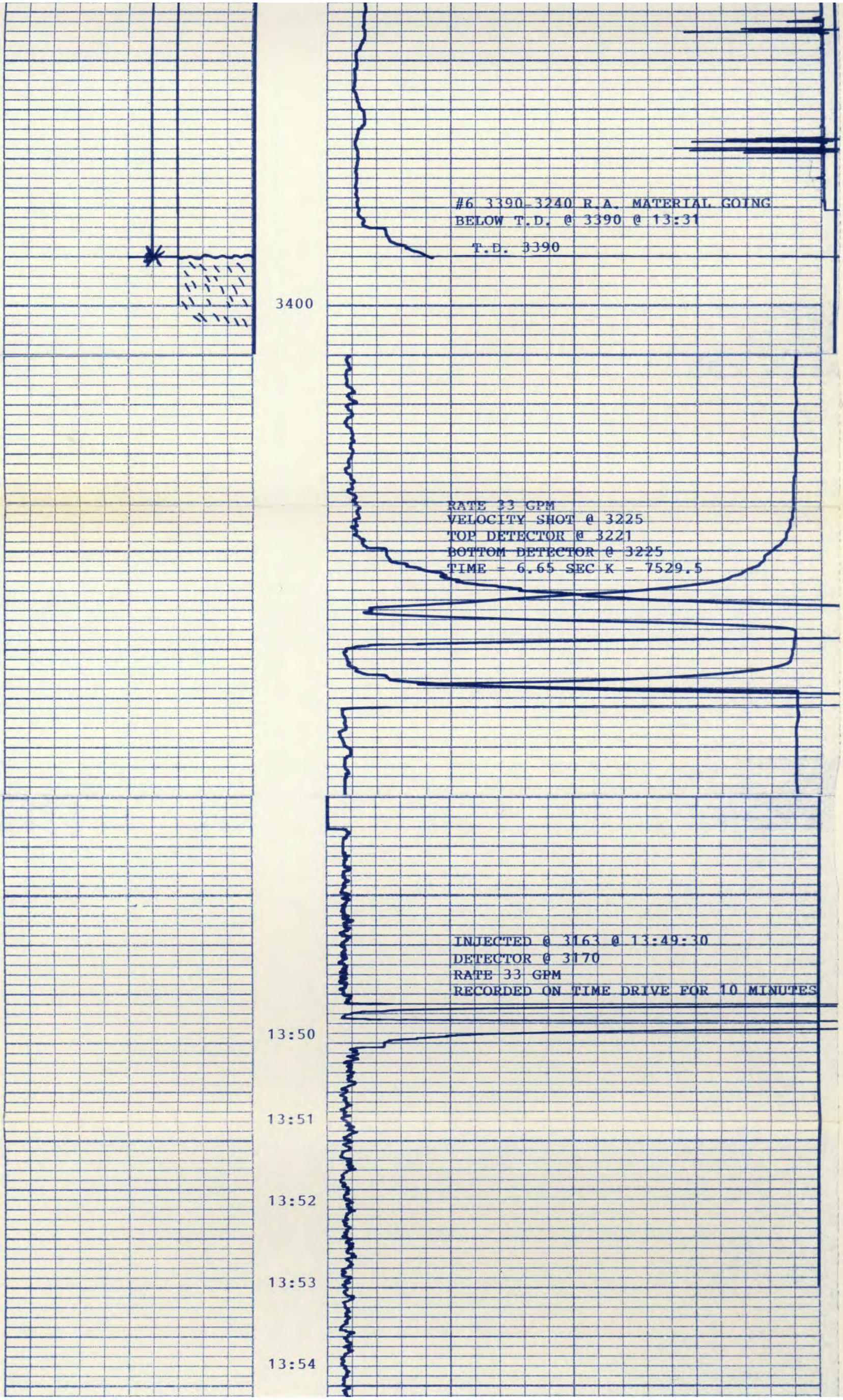

3100
3200
PACKER
3300

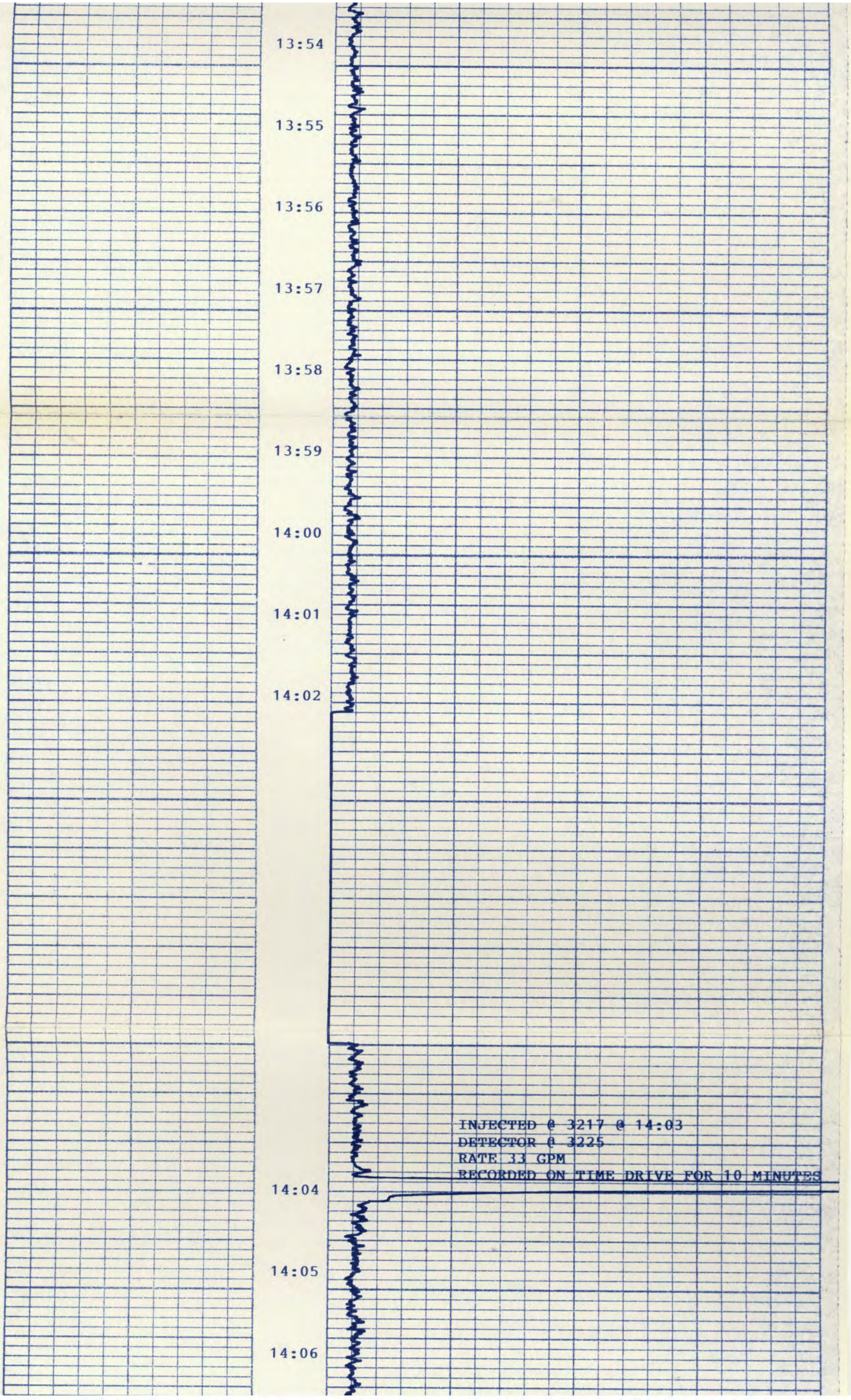

11:49
T.D. 3390 R.D. 3390
6 API
3400
0
250
500
REPEAT SECTION
6 API
72
0
250
500
2900
12:08
3000
3100

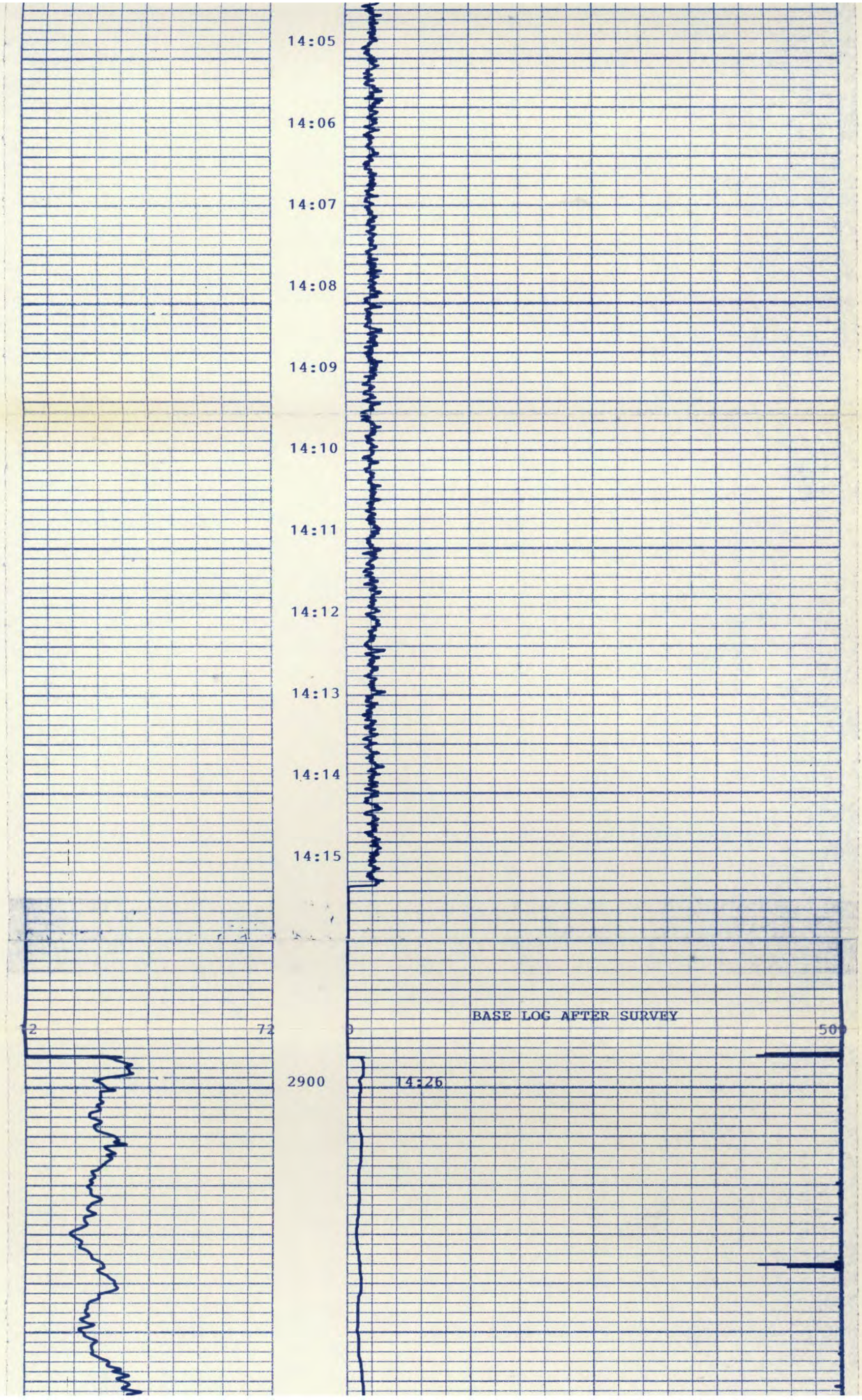

3200
PACKER
12:02
6 API
72
0
250
500
STATISTICAL CHECK @ 3225
12:17
12:16
12:15
12:14
12:13
12:12
12:11
MAXIMUM STATISTICAL
STATISTICAL CHECK @ 3170
12:22

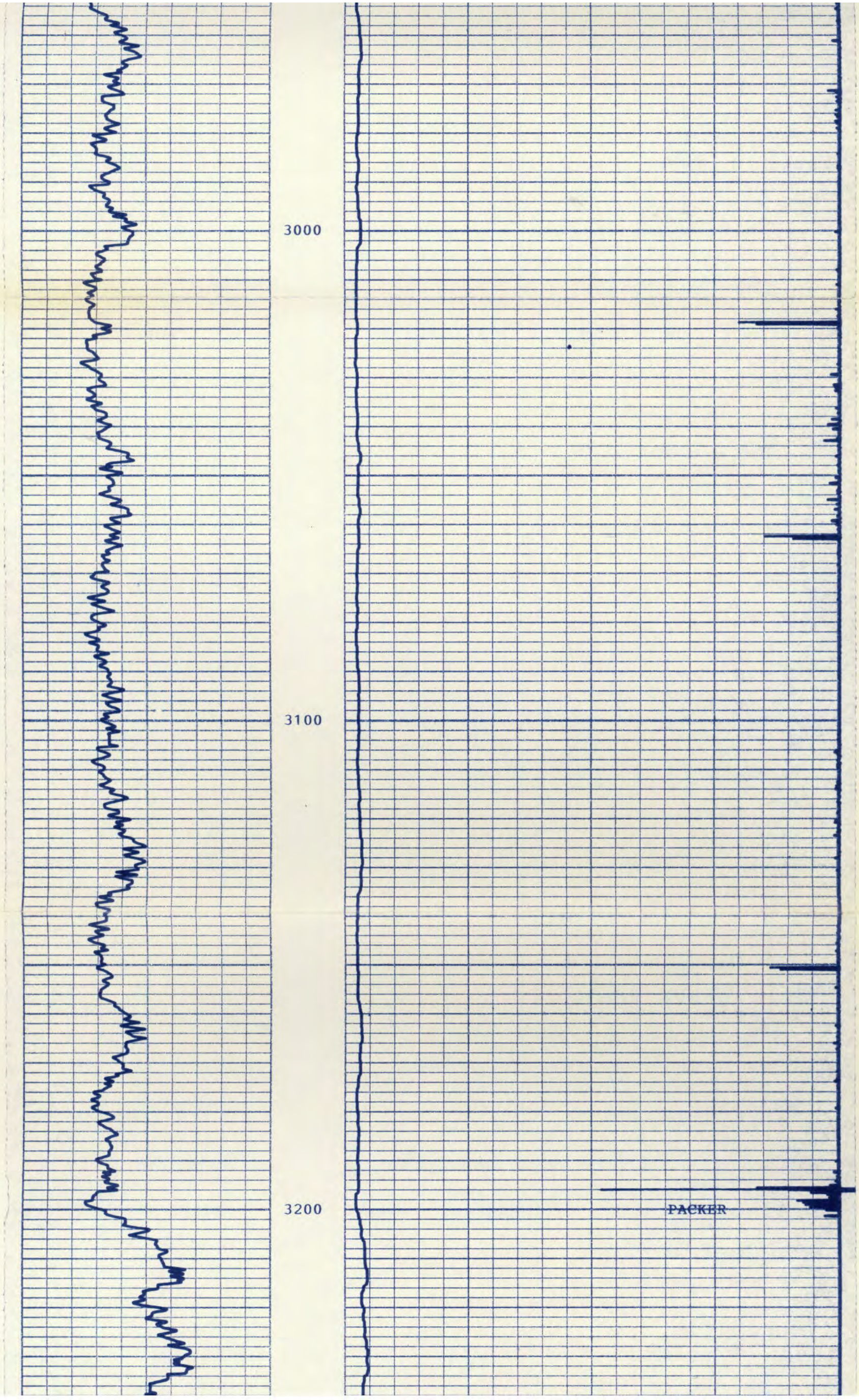

12:22
12:21
12:20
12:19
12:18
12:17
MAXIMUM STATISTICAL
25 API
0
250
500
INJECTED @ 2900 @ 13:20 RATE 30 GPM
2900
#1 2950-2900 PEAK @ 2925 @ 13:21
#2 3000-2910 PEAK @ 2977 @ 13:23
3000
#3 3070-2960 PEAK @ 3049 @ 13:25
1
2
3
4

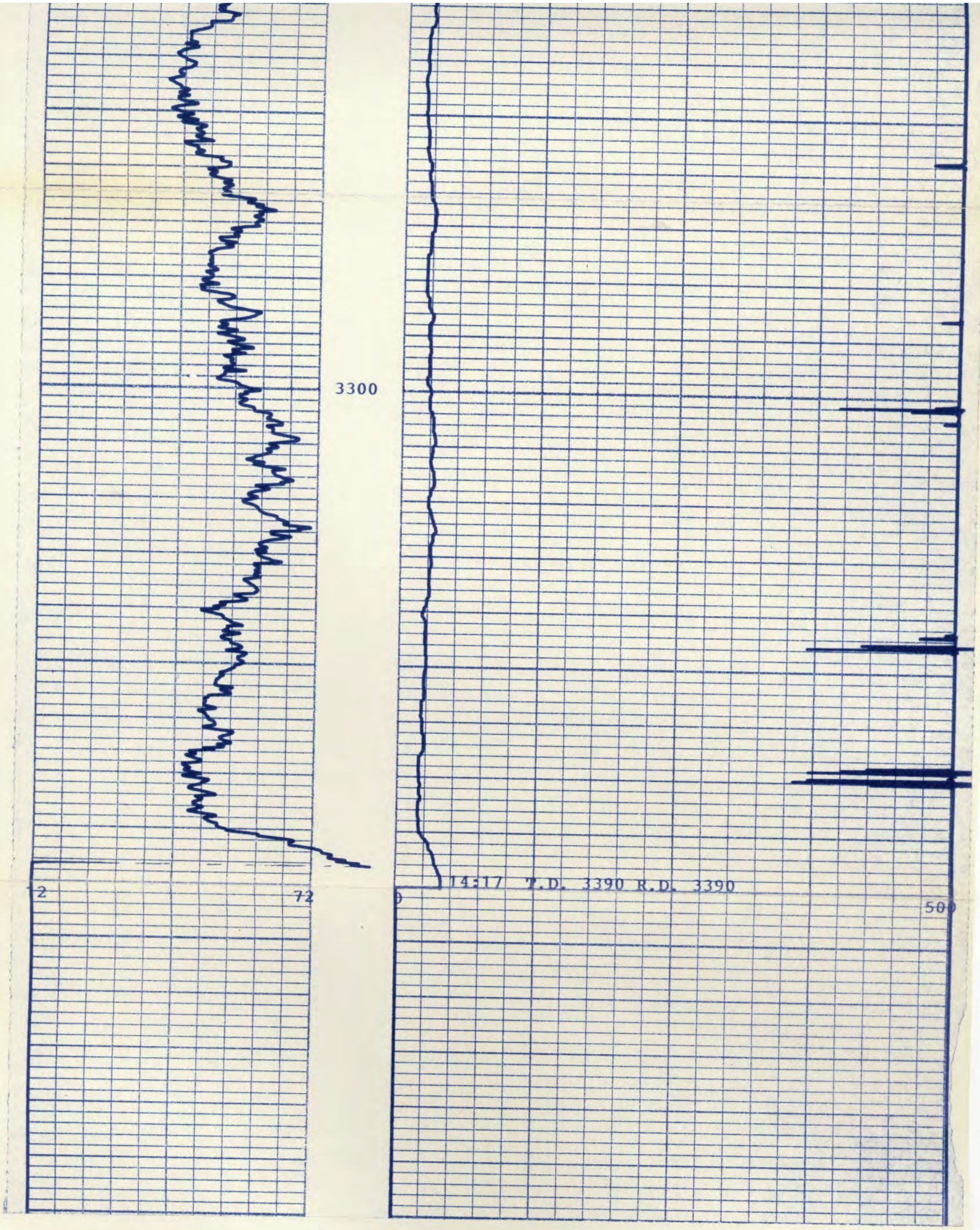

3100
3200
3300
5
6
#4 3150-3030 PEAK @ 3136 @ 13:27
PACKER
#5 3280-3120 PEAK @ 3260 @ 13:29


#6 3390-3240 R.A. MATERIAL GOING
BELOW T.D. @ 3390 @ 13:31
T.D. 3390
3400
RATE 33 GPM
VELOCITY SHOT @ 3225
TOP DETECTOR @ 3221
BOTTOM DETECTOR @ 3225
TIME = 6.65 SEC K = 7529.5
INJECTED @ 3163 @ 13:49:30
DETECTOR @ 3170
RATE 33 GPM
RECORDED ON TIME DRIVE FOR 10 MINUTES
13:50
13:51
13:52
13:53
13:54


13:54
13:55
13:56
13:57
13:58
13:59
14:00
14:01
14:02
14:04
14:05
14:06
INJECTED @ 3217 @ 14:03
DETECTOR @ 3225
RATE 33 GPM
RECORDED ON TIME DRIVE FOR 10 MINUTES


14:05
14:06
14:07
14:08
14:09
14:10
14:11
14:12
14:13
14:14
14:15
BASE LOG AFTER SURVEY
72
50
2900
14:26


3000
3100
3200
PACKER


3300
2
72
14:17 T.D. 3390 R.D. 3390
0
500

APPENDIX B.1.e

GULF COAST'S LOG INTERPRETATION LETTER

APPENDIX B.2

FALL-OFF & STATIC BOTTOM HOLE PRESSURE DATA
&
CERTIFICATION OF CALIBRATION

GULF COAST WELL ANALYSIS
STATIC GRADIENT SURVEY

COMPANY	DATE
HOECHST CELANESE	OCTOBER 24, 1989
LEASE/WELL #	FIELD
W.D.W. # 32 WELL # 3	BAY CITY PLANT

DEPTH (FEET) MD	TVD	OBSERVED TEMPERATURES IN DEGREES FAHRENHEIT	TEMP. GRADIENTS IN DEGREES F/100 FEET	OBSERVED PRESSURES AT DEPTH IN PRESSURE PER SQUARE INCH	PRESSURE GRADIENTS PSI PER FOOT	MIN/ STOP
10	10	86.62		119.580		10
500	500	99.55	2.64	331.750	.433	10
1000	1000	99.52	-.01	547.940	.432	10
1500	1500	101.26	.35	762.280	.429	10
2000	2000	103.15	.38	977.430	.430	10
2500	2500	105.02	.37	1191.890	.429	10
3000	3000	106.63	.32	1405.480	.427	10
3300	3300	105.24	-.46	1535.410	.433	10

GULF COAST WELL ANALYSIS
INJECTION TEST

FINAL REPORT

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(o)	P (n-1)	(*) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 11	11:16:00	.0167	105.79	1612.240	-.020	1612.240		317.020		82.99
1- 12	11:17:00	.0334	105.90	1612.290	.030	.050		317.470		82.77
1- 13	11:18:00	.0501	105.90	1612.230	-.030	-.060		316.850		82.56
1- 14	11:19:00	.0668	105.92	1686.010	73.750	73.780		316.370		82.44
1- 15	11:20:01	.0835	105.94	1740.240	127.980	54.230		315.700		82.69
1- 16	11:21:00	.1000	105.96	1740.230	127.970	-.010		315.200		82.22
1- 17	11:22:00	.1167	105.96	1740.210	127.950	-.020		314.770		82.10
1- 18	11:23:00	.1334	105.96	1740.210	127.950	0.000		314.490		81.99
1- 19	11:24:00	.1500	105.97	1740.330	128.070	.120		314.170		81.91
1- 20	11:25:01	.1670	105.97	1740.290	128.030	-.040		312.970		81.91
1- 21	11:26:00	.1834	105.98	1740.150	127.890	-.140		312.610		81.85
1- 22	11:27:00	.2001	106.00	1740.340	128.080	.190		312.210		81.86
1- 23	11:28:00	.2168	105.93	1740.300	128.040	-.040		311.180		81.88
1- 24	11:29:01	.2335	105.94	1740.260	128.000	-.040		309.800		82.05
1- 25	11:30:00	.2500	105.95	1739.890	127.630	-.370		308.360		82.15
1- 26	11:31:00	.2667	105.96	1739.900	127.640	.010		307.970		82.16
1- 27	11:32:00	.2834	105.98	1739.940	127.680	.040		307.270		82.26
1- 28	11:33:00	.3001	105.91	1740.120	127.860	.180		307.680		82.15
1- 29	11:34:00	.3168	105.92	1740.120	127.860	0.000		307.690		82.16
1- 30	11:35:01	.3335	105.92	1740.100	127.840	-.020		307.720		82.10
1- 31	11:36:01	.3502	105.93	1740.240	127.980	.140		307.710		82.12
1- 32	11:37:01	.3669	105.95	1740.250	127.990	.010		307.980		82.04
1- 33	11:38:01	.3836	105.89	1740.310	128.050	.060		308.440		81.95
1- 34	11:39:01	.4003	105.89	1740.300	128.040	-.010		308.290		81.95
1- 35	11:40:01	.4170	105.90	1740.300	128.040	0.000		307.980		81.96
1- 36	11:41:01	.4337	105.90	1740.300	128.040	0.000	160.690	307.980		81.96
1- 37	11:42:01	.4504	105.90	1740.230	127.970	-.070	98.304	307.700		81.98
1- 38	11:43:02	.4671	105.90	1740.230	127.970	0.000	30.011	307.830		81.91
1- 39	11:44:02	.4838	105.90	1740.230	127.970	0.000	.055	307.800		81.92
1- 40	11:45:00	.5000	105.91	1740.230	127.970	0.000	.095	307.800		81.92
1- 41	11:46:00	.5167	105.92	1740.310	128.050	.080	.173	306.220		81.18
1- 42	11:47:00	.5334	105.93	1740.330	128.070	.020	.247	305.820		82.26
1- 43	11:48:00	.5501	105.87	1740.290	128.030	-.040	.293	304.480		82.51
1- 44	11:49:00	.5668	105.88	1740.270	128.010	-.020	.397	304.370		82.53
1- 45	11:50:01	.5835	105.88	1740.230	127.970	-.040	.457	304.370		82.53
1- 46	11:51:01	.6002	105.88	1740.220	127.960	-.010	.430	304.370		82.53
1- 47	11:52:01	.6169	105.89	1740.160	127.900	-.060	.481	304.440		82.65
1- 48	11:53:01	.6336	105.89	1740.170	127.910	.010	.521	304.440		82.65
1- 49	11:54:01	.6503	105.91	1740.180	127.920	.010	.549	304.440		82.65
1- 50	11:55:01	.6670	105.91	1740.190	127.930	.010	.365	305.500		82.65
1- 51	11:56:01	.6837	105.92	1740.180	127.920	-.010	.167	305.460		82.67
1- 52	11:57:01	.7004	105.92	1740.140	127.880	-.040	-.042	305.460		82.67
1- 53	11:58:02	.7171	105.95	1740.130	127.870	-.010	-.158	305.460		82.67
1- 54	11:59:02	.7338	105.83	1740.060	127.800	-.070	-.313	306.000		82.60
1- 55	12:00:00	.7500	105.84	1740.010	127.750	-.050	-.505	306.000		82.60
1- 56	12:01:00	.7667	105.84	1740.000	127.740	-.010	-.615	306.000		82.60
1- 57	12:02:00	.7834	105.85	1739.990	127.730	-.010	-.713	307.430		82.37
1- 58	12:03:00	.8001	105.85	1739.980	127.720	-.010	-.768	307.430		82.37
1- 59	12:04:00	.8168	105.85	1739.940	127.680	-.040	-.837	307.430		82.37
1- 60	12:05:01	.8335	105.86	1739.790	127.530	-.150	-.971	306.960		82.38

* SLOPE DEFINITION:DELTA TIME vs. PRESSURE

GULF COAST WELL ANALYSIS
INJECTION TEST

FINAL REPORT

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(p)	P (n-1)	(%) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 61	12:06:01	.8502	105.88	1739.770	127.510	-.020	-1.094	306.960		82.38
1- 62	12:07:01	.8669	105.83	1739.760	127.500	-.010	-1.239	306.780		82.40
1- 63	12:08:01	.8836	105.83	1739.720	127.460	-.040	-1.384	306.080		82.49
1- 64	12:09:01	.9003	105.84	1739.740	127.480	.020	-1.495	305.630		82.61
1- 65	12:10:01	.9170	105.84	1739.740	127.480	0.000	-1.584	305.630		82.61
1- 66	12:11:01	.9337	105.86	1739.700	127.440	-.040	-1.624	303.490		82.97
1- 67	12:12:01	.9504	105.88	1739.630	127.370	-.070	-1.663	302.800		83.11
1- 68	12:13:02	.9671	105.89	1739.570	127.310	-.060	-1.727	302.790		83.19
1- 69	12:14:02	.9838	105.83	1739.540	127.280	-.030	-1.786	301.880		83.46
1- 70	12:15:00	1.0000	105.83	1739.470	127.210	-.070	-1.874	301.250		83.68
1- 71	12:16:00	1.0167	105.83	1739.480	127.220	.010	-1.928	301.530		83.69
1- 72	12:17:00	1.0334	105.84	1739.490	127.230	.010	-1.978	301.530		83.69
1- 73	12:18:00	1.0501	105.84	1739.500	127.240	.010	-1.986	301.530		83.69
1- 74	12:19:00	1.0668	105.84	1739.460	127.200	-.040	-1.978	302.320		83.83
1- 75	12:20:01	1.0835	105.84	1739.450	127.190	-.010	-1.937	302.320		83.83
1- 76	12:21:01	1.1002	105.84	1739.410	127.150	-.040	-1.890	302.320		83.83
1- 77	12:22:01	1.1169	105.84	1739.400	127.140	-.010	-1.837	302.390		84.00
1- 78	12:23:01	1.1336	105.85	1739.390	127.130	-.010	-1.761	302.390		84.00
1- 79	12:24:01	1.1503	105.85	1739.380	127.120	-.010	-1.698	302.390		84.00
1- 80	12:25:01	1.1670	105.85	1739.380	127.120	0.000	-1.634	303.970		83.94
1- 81	12:26:01	1.1837	105.85	1739.370	127.110	-.010	-1.553	304.680		83.87
1- 82	12:27:01	1.2004	105.85	1739.380	127.120	.010	-1.443	305.440		83.80
1- 83	12:28:02	1.2171	105.86	1739.420	127.160	.040	-1.289	305.440		83.80
1- 84	12:29:02	1.2338	105.86	1739.410	127.150	-.010	-1.138	307.170		83.49
1- 85	12:30:00	1.2500	105.86	1739.360	127.100	-.050	-1.082	307.280		83.42
1- 86	12:31:00	1.2667	105.88	1739.310	127.050	-.050	-1.044	306.890		83.47
1- 87	12:32:00	1.2834	105.82	1739.250	126.990	-.060	-1.025	306.740		83.48
1- 88	12:33:00	1.3001	105.82	1739.190	126.930	-.060	-1.039	306.600		83.48
1- 89	12:34:00	1.3168	105.82	1739.190	126.930	0.000	-1.017	306.890		83.34
1- 90	12:35:01	1.3335	105.82	1739.200	126.940	.010	-.964	306.890		83.34
1- 91	12:36:01	1.3502	105.85	1739.250	126.990	.050	-.882	307.680		83.26
1- 92	12:37:01	1.3669	105.87	1739.390	127.130	.140	-.744	308.100		83.16
1- 93	12:37:11	1.3697	105.87	1739.290	127.030	-.100	-.694	308.100		83.16
1- 94	12:37:21	1.3725	105.87	1739.300	127.040	.010	-.648	308.070		83.16
1- 95	12:37:31	1.3753	105.87	1739.300	127.040	0.000	-.639	308.070		83.16
1- 96	12:37:41	1.3781	105.87	1739.300	127.040	0.000	-.619	308.070		83.16
1- 97	12:37:51	1.3809	105.90	1739.300	127.040	0.000	-.585	308.370		83.16
1- 98	12:38:01	1.3837	105.91	1739.340	127.080	.040	-.514	308.370		83.16
1- 99	12:38:11	1.3865	105.91	1739.300	127.040	-.040	-.479	308.370		83.16
1- 100	12:38:21	1.3893	105.91	1739.300	127.040	0.000	-.439	308.370		83.16
1- 101	12:38:32	1.3921	105.85	1739.300	127.040	0.000	-.421	308.870		82.99
1- 102	12:38:42	1.3949	105.86	1739.270	127.010	-.030	-.418	308.830		82.99

GULF COAST WELL ANALYSIS
FALL-OFF TEST

FINAL REPORT

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(o)	P (n-1)	(*) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 104	12:39:02	.0030	105.87	1729.320	-8.610	-9.950		295.600		82.93
1- 105	12:39:12	.0058	105.87	1721.860	-16.070	-7.460		287.340		82.93
1- 106	12:39:22	.0086	105.87	1711.820	-26.110	-10.040		276.890		82.94
1- 107	12:39:32	.0114	105.89	1695.940	-41.990	-15.880		278.510		82.94
1- 108	12:39:42	.0142	105.89	1678.170	-59.760	-17.770		237.900		82.95
1- 109	12:39:52	.0170	105.89	1665.190	-72.740	-12.980		226.510		82.95
1- 110	12:40:02	.0198	105.89	1654.770	-83.160	-10.420		216.200		82.85
1- 111	12:40:12	.0226	105.89	1645.150	-92.780	-9.620		207.260		82.87
1- 112	12:40:22	.0254	105.93	1637.670	-100.260	-7.480		199.340		82.87
1- 113	12:40:33	.0282	105.95	1631.330	-106.600	-6.340		192.740		82.88
1- 114	12:40:43	.0310	105.95	1625.710	-112.220	-5.620		187.410		82.82
1- 115	12:40:53	.0338	105.89	1620.940	-116.990	-4.770		182.410		82.82
1- 116	12:41:03	.0366	105.91	1616.550	-121.380	-4.390		177.820		82.82
1- 117	12:41:13	.0394	105.91	1612.630	-125.300	-3.920		173.950		82.82
1- 118	12:41:23	.0422	105.92	1609.180	-128.750	-3.450		170.240		82.84
1- 119	12:41:33	.0450	105.92	1605.610	-132.320	-3.570		166.630		82.84
1- 120	12:41:43	.0478	105.94	1602.710	-135.220	-2.900		163.510		82.91
1- 121	12:41:53	.0506	105.94	1600.940	-136.990	-1.770		160.780		82.92
1- 122	12:42:03	.0534	105.94	1597.630	-140.300	-3.310		158.170		82.92
1- 123	12:42:13	.0562	105.94	1595.250	-142.680	-2.380		155.640		82.92
1- 124	12:42:23	.0590	105.97	1593.160	-144.770	-2.090		153.400		82.92
1- 125	12:42:33	.0618	105.91	1591.180	-146.750	-1.980		151.240		82.94
1- 126	12:42:44	.0646	105.93	1589.100	-148.830	-2.080		149.170		82.96
1- 127	12:42:54	.0674	105.93	1587.420	-150.510	-1.680		147.140		82.98
1- 128	12:43:04	.0702	105.95	1585.570	-152.360	-1.850		145.350		82.98
1- 129	12:43:14	.0730	105.89	1584.000	-153.930	-1.570	.	143.750		82.99
1- 130	12:43:24	.0758	105.90	1582.510	-155.420	-1.490	.	142.150		82.99
1- 131	12:43:34	.0786	105.90	1581.020	-156.910	-1.490	.	140.700		82.99
1- 132	12:43:44	.0814	105.90	1579.730	-158.200	-1.290	.	139.260		82.99
1- 133	12:43:54	.0842	105.90	1578.360	-159.570	-1.370	.	137.910		82.99
1- 134	12:44:04	.0870	105.90	1577.110	-160.820	-1.250	.	136.650		82.99
1- 135	12:44:14	.0898	105.91	1575.990	-161.940	-1.120	-940.838	135.410		83.00
1- 136	12:44:24	.0926	105.93	1574.810	-163.120	-1.180	-864.404	134.270		83.00
1- 137	12:44:34	.0954	105.93	1573.800	-164.130	-1.010	-798.690	133.090		83.00
1- 138	12:44:45	.0982	105.89	1572.780	-165.150	-1.020	-741.434	132.040		83.01
1- 139	12:44:55	.1010	105.90	1571.820	-166.110	-.960	-691.330	131.000		83.01
1- 140	12:45:05	.1038	105.91	1570.790	-167.140	-1.030	-646.852	130.010		83.03
1- 141	12:45:15	.1066	105.93	1569.970	-167.960	-.820	-606.978	128.940		83.05
1- 142	12:45:25	.1094	105.87	1569.040	-168.890	-.930	-571.374	128.020		83.05
1- 143	12:45:35	.1122	105.87	1568.280	-169.650	-.760	-538.621	127.090		83.09
1- 144	12:45:45	.1150	105.88	1567.510	-170.420	-.770	-509.920	126.700		83.09
1- 145	12:45:55	.1178	105.88	1566.720	-171.210	-.790	-483.714	125.920		83.00
1- 146	12:46:05	.1206	105.88	1565.930	-172.000	-.790	-456.547	124.890		83.06
1- 147	12:46:15	.1234	105.88	1565.270	-172.660	-.660	-433.758	124.120		83.06
1- 148	12:46:25	.1262	105.88	1565.270	-172.660	0.000	-410.580	123.460		83.06
1- 149	12:46:35	.1290	105.88	1564.640	-173.290	-.630	-388.706	123.460		83.06
1- 150	12:46:45	.1318	105.88	1563.990	-173.940	-.650	-368.212	122.670		83.06
1- 151	12:46:56	.1346	105.89	1563.300	-174.630	-.690	-349.951	121.990		83.08
1- 152	12:47:06	.1374	105.91	1562.680	-175.250	-.620	-332.646	121.400		83.08
1- 153	12:47:16	.1402	105.91	1562.070	-175.860	-.610	-317.162	120.740		83.09

* SLOPE DEFINITION:DELTA TIME vs. PRESSURE

GULF COAST WELL ANALYSIS
FALL-OFF TEST

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(o)	P (n-1)	(*) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 154	12:47:26	.1430	105.86	1561.680	-176.250	-.390	-302.115	120.190		83.09
1- 155	12:47:36	.1458	105.88	1560.980	-176.950	-.700	-288.566	119.610		83.09
1- 156	12:47:46	.1486	105.89	1560.550	-177.380	-.430	-275.841	119.090		83.09
1- 157	12:47:56	.1514	105.89	1559.970	-177.960	-.580	-264.011	118.550		83.09
1- 158	12:48:06	.1542	105.90	1559.580	-178.350	-.390	-252.931	118.090		83.09
1- 159	12:48:16	.1570	105.90	1558.960	-178.970	-.620	-243.201	117.620		83.09
1- 160	12:48:26	.1598	105.92	1558.760	-179.170	-.200	-233.143	117.150		83.10
1- 161	12:48:36	.1626	105.85	1558.070	-179.860	-.690	-224.841	116.650		83.10
1- 162	12:48:46	.1654	105.86	1557.610	-180.320	-.460	-217.063	116.180		83.11
1- 163	12:48:57	.1682	105.86	1557.380	-180.550	-.230	-209.239	115.700		83.13
1- 164	12:49:07	.1710	105.86	1556.780	-181.150	-.600	-202.591	115.690		83.13
1- 165	12:49:17	.1738	105.86	1556.390	-181.540	-.390	-196.775	115.210		83.06
1- 166	12:49:27	.1766	105.87	1556.170	-181.760	-.220	-190.657	114.780		83.06
1- 167	12:49:37	.1794	105.88	1556.710	-181.220	.540	-182.288	114.380		83.06
1- 168	12:49:47	.1822	105.93	1555.500	-182.430	-1.210	-177.236	113.990		83.08
1- 169	12:49:57	.1850	105.87	1554.940	-182.990	-.560	-173.269	113.540		83.10
1- 170	12:50:07	.1878	105.88	1554.570	-183.360	-.370	-169.890	113.510		83.04
1- 171	12:50:17	.1906	105.90	1554.360	-183.570	-.210	-166.687	113.130		83.04
1- 172	12:50:27	.1934	105.84	1553.940	-183.990	-.420	-164.047	112.770		83.04
1- 173	12:50:37	.1962	105.84	1553.740	-184.190	-.200	-158.953	112.440		83.05
1- 174	12:50:47	.1990	105.84	1553.260	-184.670	-.480	-154.525	112.150		83.05
1- 175	12:50:57	.2018	105.84	1553.050	-184.880	-.210	-149.984	111.810		83.05
1- 176	12:51:08	.2046	105.85	1552.830	-185.100	-.220	-145.626	111.410		83.07
1- 177	12:51:18	.2074	105.85	1552.410	-185.520	-.420	-141.992	111.400		83.01
1- 178	12:51:28	.2102	105.85	1552.240	-185.690	-.170	-138.275	111.080		83.02
1- 179	12:51:38	.2130	105.86	1552.050	-185.880	-.190	-133.876	110.720		83.03
1- 180	12:51:48	.2158	105.88	1551.640	-186.290	-.410	-130.684	110.410		83.05
1- 181	12:51:58	.2186	105.89	1551.280	-186.650	-.360	-127.648	110.240		83.05
1- 182	12:52:08	.2214	105.91	1551.130	-186.800	-.150	-124.632	109.760		83.07
1- 183	12:52:18	.2242	105.93	1550.780	-187.150	-.350	-121.734	109.500		83.07
1- 184	12:52:28	.2270	105.84	1550.660	-187.270	-.120	-119.027	109.520		83.01
1- 185	12:52:38	.2298	105.86	1550.320	-187.610	-.340	-115.876	109.380		83.01
1- 186	12:52:48	.2326	105.86	1550.170	-187.760	-.150	-113.365	109.060		83.02
1- 187	12:52:58	.2354	105.86	1549.790	-188.140	-.380	-111.580	108.780		83.02
1- 188	12:53:09	.2382	105.86	1549.680	-188.250	-.110	-108.830	108.620		83.03
1- 189	12:53:19	.2410	105.86	1549.540	-188.390	-.140	-106.569	108.240		83.03
1- 191	12:53:07	.2378	105.88	1549.000	-188.930	-.540	-107.380	107.260		83.13
1- 192	12:53:18	.2408	105.82	1548.560	-189.370	-.440	-108.177	106.860		83.14
1- 193	12:53:24	.2425	105.84	1548.500	-189.430	-.060	-105.151	106.720		83.14
1- 194	12:53:44	.2481	105.84	1548.300	-189.630	-.200	-103.954	106.570		83.14
1- 195	12:54:06	.2541	105.85	1548.140	-189.790	-.160	-101.975	106.260		83.14
1- 196	12:54:17	.2571	105.85	1547.920	-190.010	-.220	-100.104	106.000		83.16
1- 197	12:54:27	.2600	105.85	1547.720	-190.210	-.200	-97.748	105.880		83.16
1- 198	12:54:36	.2626	105.85	1547.570	-190.360	-.150	-95.666	105.480		83.18
1- 199	12:54:47	.2655	105.87	1547.410	-190.520	-.160	-93.014	105.430		83.18
1- 200	12:54:57	.2683	105.89	1547.280	-190.650	-.130	-90.799	105.120		83.18
1- 201	12:55:07	.2711	105.78	1546.910	-191.020	-.370	-88.968	105.000		83.18
1- 202	12:55:17	.2739	105.84	1546.840	-191.090	-.070	-86.451	104.870		83.19
1- 203	12:55:27	.2767	105.84	1546.780	-191.150	-.060	-83.997	104.740		83.19
1- 204	12:55:37	.2795	105.85	1546.660	-191.270	-.120	-81.027	104.350		83.21

* SLOPE DEFINITION:DELTA TIME vs. PRESSURE

GULF COAST WELL ANALYSIS
FALL-OFF TEST

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC &	REAL TIME DATA		BH	BOTTOM HOLE PRESSURE				SURFACE INFORMATION		
SAMPLE	TIME	dTIME	TEMP.	PRESSURE	DELTA PRESSURE IN PSI		(*)	TUBING	WDW152	WHT
NUMBER	HH:MM:SS	IN HOURS	(F)	IN PSI	P(p)	P (n-1)	SLOPE	IN PSI	IN PSI	DEGREES F
1- 205	12:55:47	.2823	105.85	1546.450	-191.480	-.210	-77.949	104.260		83.21
1- 207	12:55:30	.2774	105.84	1546.840	-191.090	.390	-75.692	104.870		83.19
1- 209	12:55:37	.2794	105.84	1546.780	-191.150	-.060	-73.551	104.740		83.19
1- 210	12:55:47	.2822	105.85	1546.660	-191.270	-.120	-70.787	104.330		83.21
1- 211	12:55:57	.2850	105.85	1546.450	-191.480	-.210	-68.426	104.260		83.21
1- 212	12:56:07	.2878	105.85	1546.270	-191.660	-.180	-65.580	104.090		83.23
1- 213	12:56:17	.2906	105.85	1546.110	-191.820	-.160	-63.042	103.800		83.23
1- 214	12:56:27	.2934	105.86	1546.050	-191.880	-.060	-59.822	103.760		83.24
1- 215	12:56:37	.2962	105.86	1545.850	-192.080	-.200	-57.347	103.620		83.24
1- 216	12:56:47	.2990	105.87	1545.700	-192.230	-.150	-54.490	103.240		83.29
1- 217	12:56:57	.3018	105.82	1545.540	-192.390	-.160	-51.437	103.130		83.30
1- 218	12:57:08	.3046	105.82	1545.400	-192.530	-.140	-50.670	103.040		83.30
1- 219	12:57:18	.3074	105.83	1545.270	-192.660	-.130	-51.138	102.780		83.30
1- 220	12:57:28	.3102	105.85	1545.220	-192.710	-.050	-51.182	102.680		83.31
1- 221	12:57:38	.3130	105.85	1545.040	-192.890	-.180	-50.979	102.640		83.31
1- 222	12:57:48	.3158	105.85	1544.890	-193.040	-.150	-50.166	102.480		83.31
1- 223	12:57:58	.3186	105.86	1544.750	-193.180	-.140	-49.632	102.330		83.31
1- 224	12:58:08	.3214	105.86	1544.590	-193.340	-.160	-49.408	102.200		83.31
1- 225	12:58:18	.3242	105.86	1544.520	-193.410	-.070	-48.971	102.090		83.32
1- 226	12:58:28	.3270	105.86	1544.350	-193.580	-.170	-48.753	101.980		83.32
1- 227	12:58:38	.3298	105.86	1544.310	-193.620	-.040	-48.129	101.630		83.37
1- 228	12:58:48	.3326	105.87	1544.190	-193.740	-.120	-48.311	101.510		83.38
1- 229	12:58:58	.3354	105.88	1544.040	-193.890	-.150	-48.379	101.460		83.38
1- 230	12:59:09	.3382	105.81	1543.870	-194.060	-.170	-48.370	101.430		83.34
1- 231	12:59:19	.3410	105.81	1543.750	-194.180	-.120	-48.278	101.320		83.34
1- 232	12:59:29	.3438	105.82	1543.590	-194.340	-.160	-48.495	100.670		83.45
1- 233	12:59:39	.3466	105.82	1543.540	-194.390	-.050	-47.995	100.800		83.39
1- 234	12:59:49	.3494	105.83	1543.430	-194.500	-.110	-47.288	100.800		83.40
1- 235	12:59:59	.3522	105.83	1543.260	-194.670	-.170	-46.651	100.700		83.40
1- 236	13:00:09	.3550	105.85	1543.200	-194.730	-.060	-46.027	100.600		83.42
1- 237	13:00:19	.3578	105.86	1543.140	-194.790	-.060	-45.352	100.650		83.36
1- 238	13:00:29	.3606	105.86	1542.990	-194.940	-.150	-44.882	100.650		83.36
1- 239	13:00:39	.3634	105.86	1542.940	-194.990	-.050	-43.934	100.600		83.36
1- 240	13:00:49	.3662	105.86	1542.810	-195.120	-.130	-43.275	100.560		83.37
1- 241	13:00:59	.3690	105.87	1542.750	-195.180	-.060	-42.514	100.610		83.31
1- 242	13:01:09	.3718	105.87	1542.610	-195.320	-.140	-41.975	100.610		83.31
1- 243	13:01:20	.3746	105.88	1541.520	-196.410	-1.090	-44.725	99.660		83.33
1- 244	13:02:20	.3913	105.90	1541.110	-196.820	-.410	-46.532	99.240		83.35
1- 245	13:03:20	.4080	105.92	1540.700	-197.230	-.410	-46.298	98.870		83.35
1- 246	13:04:20	.4247	105.82	1540.310	-197.620	-.390	-44.701	98.560		83.35
1- 247	13:05:20	.4414	105.83	1539.890	-198.040	-.420	-42.580	98.210		83.37
1- 248	13:06:20	.4581	105.83	1539.730	-198.200	-.160	-39.655	98.210		83.32
1- 249	13:07:20	.4748	105.84	1539.370	-198.560	-.360	-37.150	97.470		83.41
1- 250	13:08:20	.4915	105.84	1538.950	-198.980	-.420	-35.110	95.650		83.71
1- 251	13:09:21	.5082	105.84	1538.940	-198.990	-.010	-32.759	94.200		83.95
1- 252	13:10:21	.5249	105.84	1538.750	-199.180	-.190	-30.564	94.160		83.95
1- 253	13:11:21	.5416	105.85	1538.370	-199.560	-.380	-28.869	94.160		83.96
1- 254	13:12:21	.5583	105.85	1538.240	-199.690	-.130	-27.234	94.300		83.96
1- 255	13:13:21	.5750	105.85	1538.120	-199.810	-.120	-25.690	94.920		83.87
1- 256	13:14:21	.5917	105.86	1537.910	-200.020	-.210	-24.314	95.020		83.87

* SLOPE DEFINITION:DELTA TIME vs. PRESSURE

GULF COAST WELL ANALYSIS
FALL-OFF TEST

COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	TUESDAY -- OCTOBER 24, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(o)	P (n-1)	(*) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 307	16:11:26	3.5431	105.63	1535.170	-202.760	-.050	-.252	89.550		83.24
1- 308	16:26:26	3.7931	105.61	1535.150	-202.780	-.020	-.229	93.950		82.74
1- 309	16:41:26	4.0431	105.60	1535.160	-202.770	.010	-.207	97.810		81.53
1- 310	16:56:26	4.2931	105.61	1535.140	-202.790	-.020	-.189	93.070		81.73
1- 311	17:11:26	4.5431	105.64	1535.160	-202.770	.020	-.171	95.450		81.46
1- 312	17:26:26	4.7931	105.54	1535.150	-202.780	-.010	-.155	94.720		81.16
1- 313	17:41:26	5.0431	105.58	1535.170	-202.760	.020	-.139	95.420		81.16
1- 314	17:56:26	5.2931	105.62	1535.140	-202.790	-.030	-.127	97.480		80.37
1- 315	18:11:26	5.5431	105.66	1535.140	-202.790	0.000	-.115	100.080		78.49
1- 316	18:26:26	5.7931	105.70	1535.140	-202.790	0.000	-.105	98.880		77.08
1- 317	18:41:26	6.0431	105.52	1535.120	-202.810	-.020	-.094	97.950		75.69
1- 318	18:56:26	6.2931	105.63	1535.100	-202.830	-.020	-.086	96.850		74.69
1- 319	19:11:26	6.5431	105.51	1535.140	-202.790	.040	-.076	96.050		73.73
1- 320	19:26:26	6.7931	105.50	1535.130	-202.800	-.010	-.066	95.720		72.98
1- 321	19:41:26	7.0431	105.45	1535.100	-202.830	-.030	-.056	95.470		72.04
1- 322	19:56:26	7.2931	105.56	1535.150	-202.780	.050	-.044	94.520		71.51
1- 323	20:11:26	7.5431	105.41	1535.100	-202.830	-.050	-.032	93.370		71.10
1- 324	20:26:26	7.7931	105.38	1535.120	-202.810	.020	-.027	93.490		70.72
1- 325	20:41:26	8.0431	105.54	1535.080	-202.850	-.040	-.024	93.410		70.36
1- 326	20:56:26	8.2931	105.35	1535.090	-202.840	.010	-.021	93.050		70.07
1- 327	21:11:26	8.5431	105.43	1535.090	-202.840	0.000	-.019	93.340		69.58
1- 328	21:26:26	8.7931	105.35	1535.110	-202.820	.020	-.017	94.070		68.90
1- 329	21:41:26	9.0431	105.32	1535.080	-202.850	-.030	-.017	93.760		68.27
1- 330	21:56:26	9.2931	105.31	1535.100	-202.830	.020	-.015	93.270		67.81
1- 331	22:11:26	9.5431	105.36	1535.110	-202.820	.010	-.013	92.430		67.38
1- 332	22:26:26	9.7931	105.35	1535.090	-202.840	-.020	-.012	92.310		67.17
1- 333	22:41:26	10.0431	105.27	1535.110	-202.820	.020	-.012	92.120		66.92
1- 334	22:56:26	10.2931	105.19	1535.130	-202.800	.020	-.010	92.620		66.56
1- 335	23:11:26	10.5431	105.17	1535.090	-202.840	-.040	-.010	91.930		66.40
1- 336	23:26:26	10.7931	105.16	1535.160	-202.770	.070	-.007	91.610		66.35
1- 337	23:41:26	11.0431	105.26	1535.120	-202.810	-.040	-.005	91.450		66.27
1- 338	23:56:26	11.2931	105.19	1535.120	-202.810	0.000	-.003	91.190		66.34
1- 339	00:11:26	11.5431	105.29	1535.130	-202.800	.010	-.001	91.800		65.97
1- 340	00:26:26	11.7931	105.23	1535.140	-202.790	.010	.001	91.850		65.71
1- 341	00:41:26	12.0431	105.11	1535.090	-202.840	-.050	.001	91.370		65.62
1- 342	00:56:26	12.2931	105.12	1535.150	-202.780	.060	.003	91.510		65.49
1- 343	01:11:26	12.5431	105.14	1535.200	-202.730	.050	.005	92.110		65.10
1- 344	01:26:26	12.7931	105.20	1535.090	-202.840	-.110	.005	91.330		64.98
1- 345	01:41:26	13.0431	105.33	1535.190	-202.740	.100	.008	91.080		64.87
1- 346	01:56:26	13.2931	105.22	1535.200	-202.730	.010	.011	91.130		64.82
1- 347	02:11:26	13.5431	105.25	1535.190	-202.740	-.010	.014	90.780		64.87
1- 348	02:26:26	13.7931	105.09	1535.050	-202.880	-.140	.011	91.720		64.64
1- 349	02:41:26	14.0431	105.16	1535.150	-202.780	.100	.012	91.070		64.62
1- 350	02:56:26	14.2931	105.30	1535.160	-202.770	.010	.012	91.030		64.69
1- 351	03:11:26	14.5431	105.17	1535.170	-202.760	.010	.012	91.300		64.57
1- 352	03:26:26	14.7931	105.10	1535.180	-202.750	.010	.012	91.290		64.50
1- 353	03:41:26	15.0431	105.12	1535.110	-202.820	-.070	.010	91.390		64.33
1- 354	03:56:26	15.2931	105.15	1535.170	-202.760	.060	.010	91.490		64.28
1- 355	04:11:26	15.5431	105.04	1535.140	-202.790	-.030	.008	90.770		64.44
1- 356	04:26:26	15.7931	105.09	1535.130	-202.800	-.010	.007	91.340		64.40

* SLOPE DEFINITION:DELTA TIME vs. PRESSURE

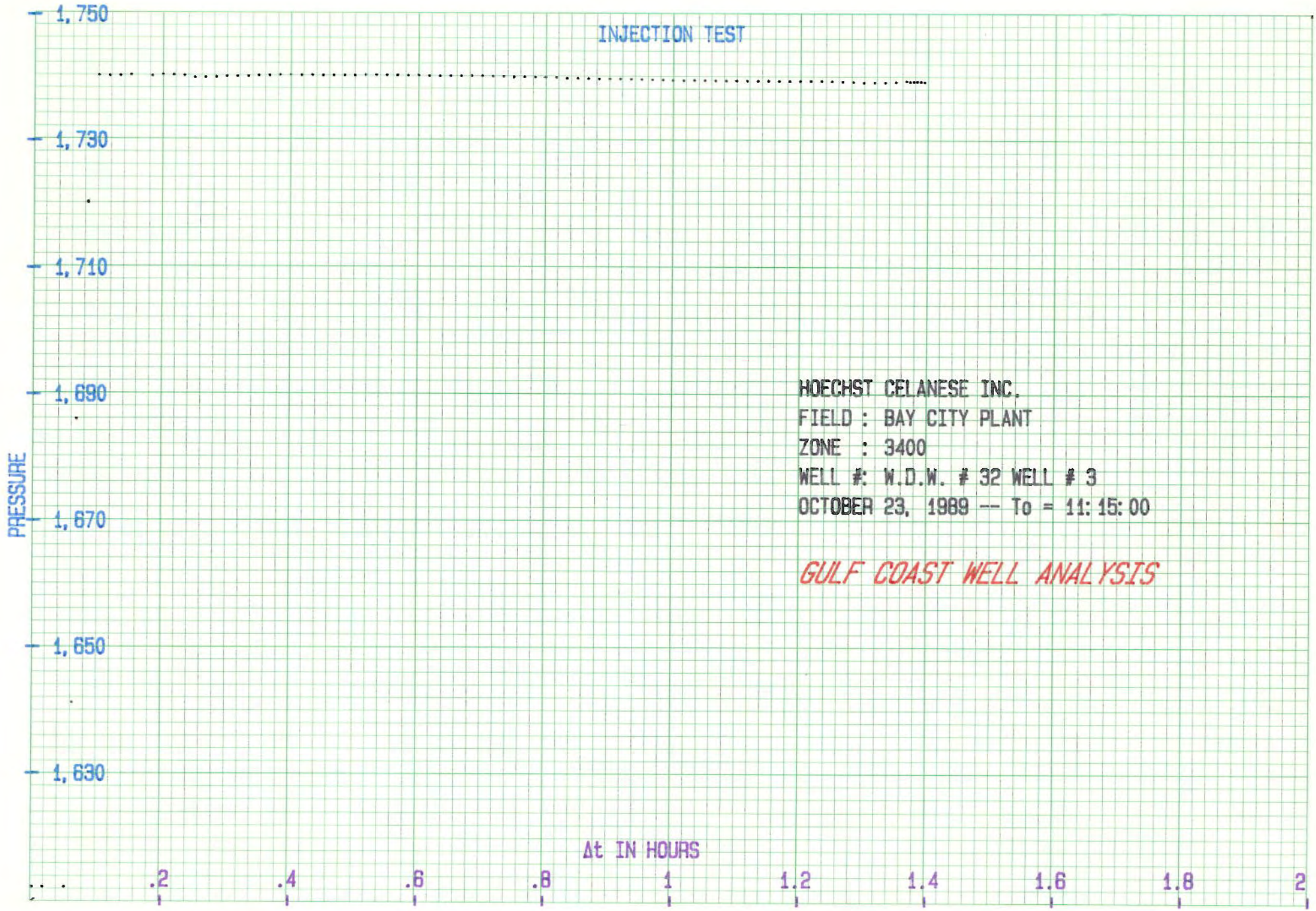
GULF COAST WELL ANALYSIS

FALL-OFF TEST

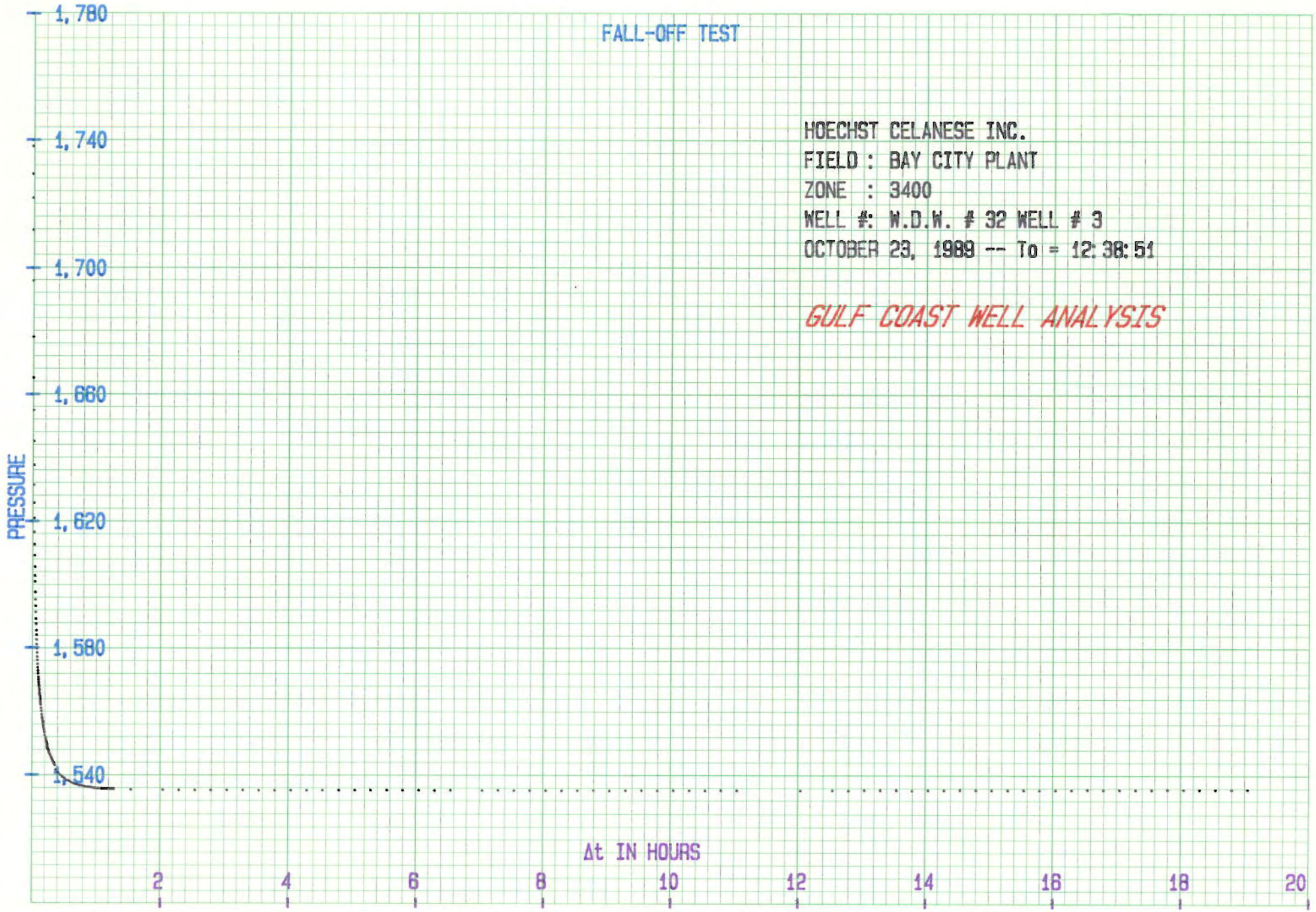
COMPANY	LEASE/WELL	DATE
HOECHST CELANESE INC.	W.D.W. # 32 WELL # 3	WEDNESDAY -- OCTOBER 25, 1989
FIELD	MEASURED AND TRUE VERTICAL TOOL DEPTHS	MID-PERF TVD AND GRADIENT
BAY CITY PLANT	3500 FEET -- 3500 FEET	3500 FEET -- .44 PSI/FOOT

DISC & SAMPLE NUMBER	REAL TIME DATA TIME HH:MM:SS	dTIME IN HOURS	BH TEMP. (F)	BOTTOM HOLE PRESSURE PRESSURE IN PSI	DELTA PRESSURE IN PSI P(o)	P (n-1)	(%) SLOPE	SURFACE INFORMATION TUBING IN PSI	WDW152 IN PSI	WHT DEGREES F
1- 357	04:41:26	16.0431	105.02	1535.160	-202.770	.030	.006	92.120		64.18
1- 358	04:56:26	16.2931	105.10	1535.200	-202.730	.040	.007	91.970		63.94
1- 359	05:11:26	16.5431	105.17	1535.310	-202.620	.110	.012	91.870		63.69
1- 360	05:26:26	16.7931	105.06	1535.180	-202.750	-.130	.011	91.720		63.51
1- 361	05:41:26	17.0431	105.10	1535.240	-202.690	.060	.014	91.520		63.47
1- 362	05:56:26	17.2931	105.08	1535.200	-202.730	-.040	.014	91.490		63.52
1- 363	06:11:26	17.5431	105.10	1535.210	-202.720	.010	.014	90.660		63.74
1- 364	06:26:26	17.7931	105.17	1535.340	-202.590	.130	.019	91.520		63.65
1- 365	06:41:26	18.0431	105.21	1535.340	-202.590	0.000	.024	90.960		63.79
1- 366	06:56:26	18.2931	105.21	1535.330	-202.600	-.010	.026	91.050		63.85
1- 367	07:11:26	18.5431	105.24	1535.310	-202.620	-.020	.028	91.050		64.00
1- 368	07:26:26	18.7931	105.10	1535.320	-202.610	.010	.033	91.450		64.01
1- 369	07:41:26	19.0431	105.12	1535.360	-202.570	.040	.034	89.670		64.39
1- 370	07:56:26	19.2931	105.24	1535.400	-202.530	.040	.040	85.660		66.14

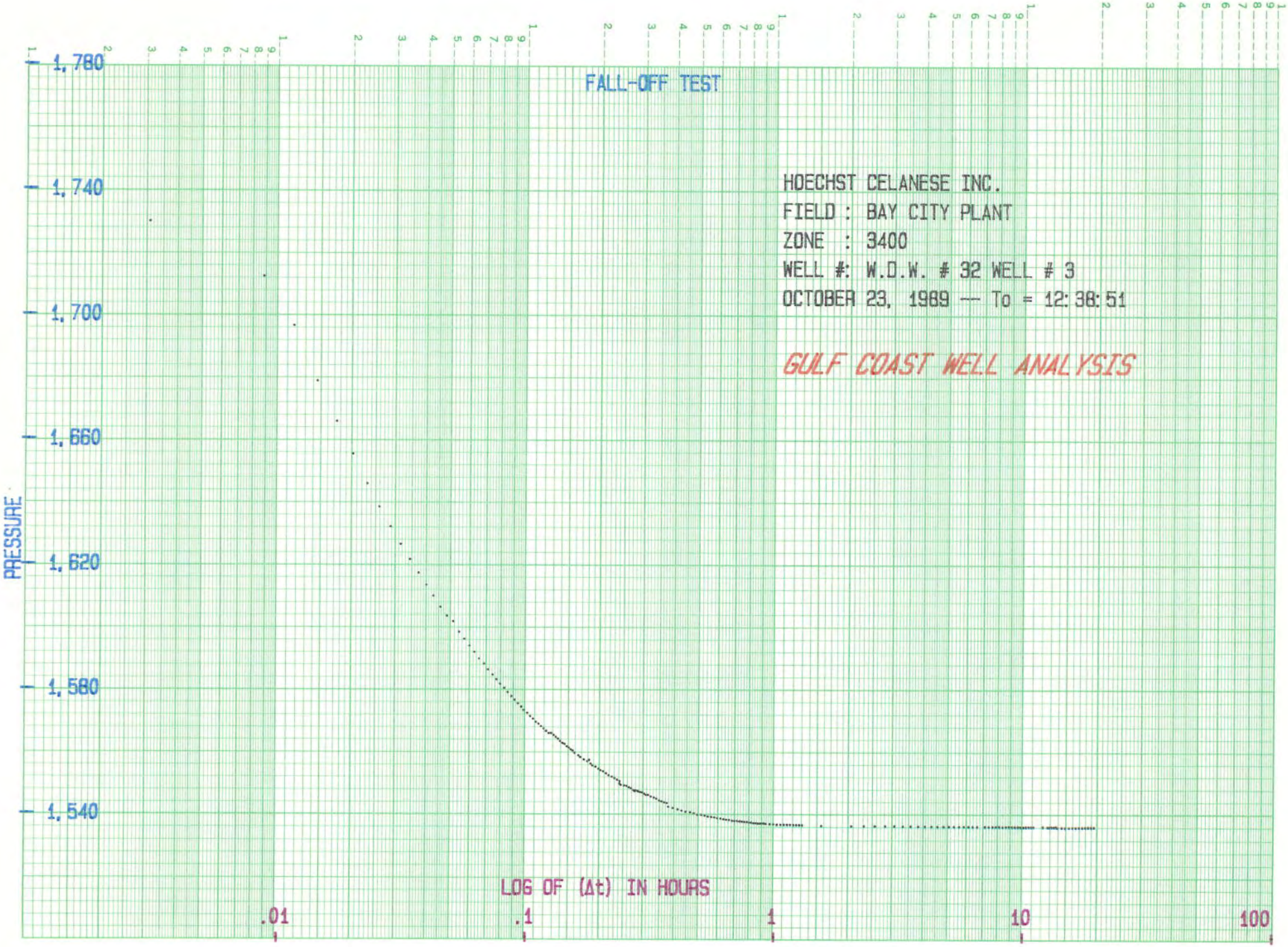
K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 0700

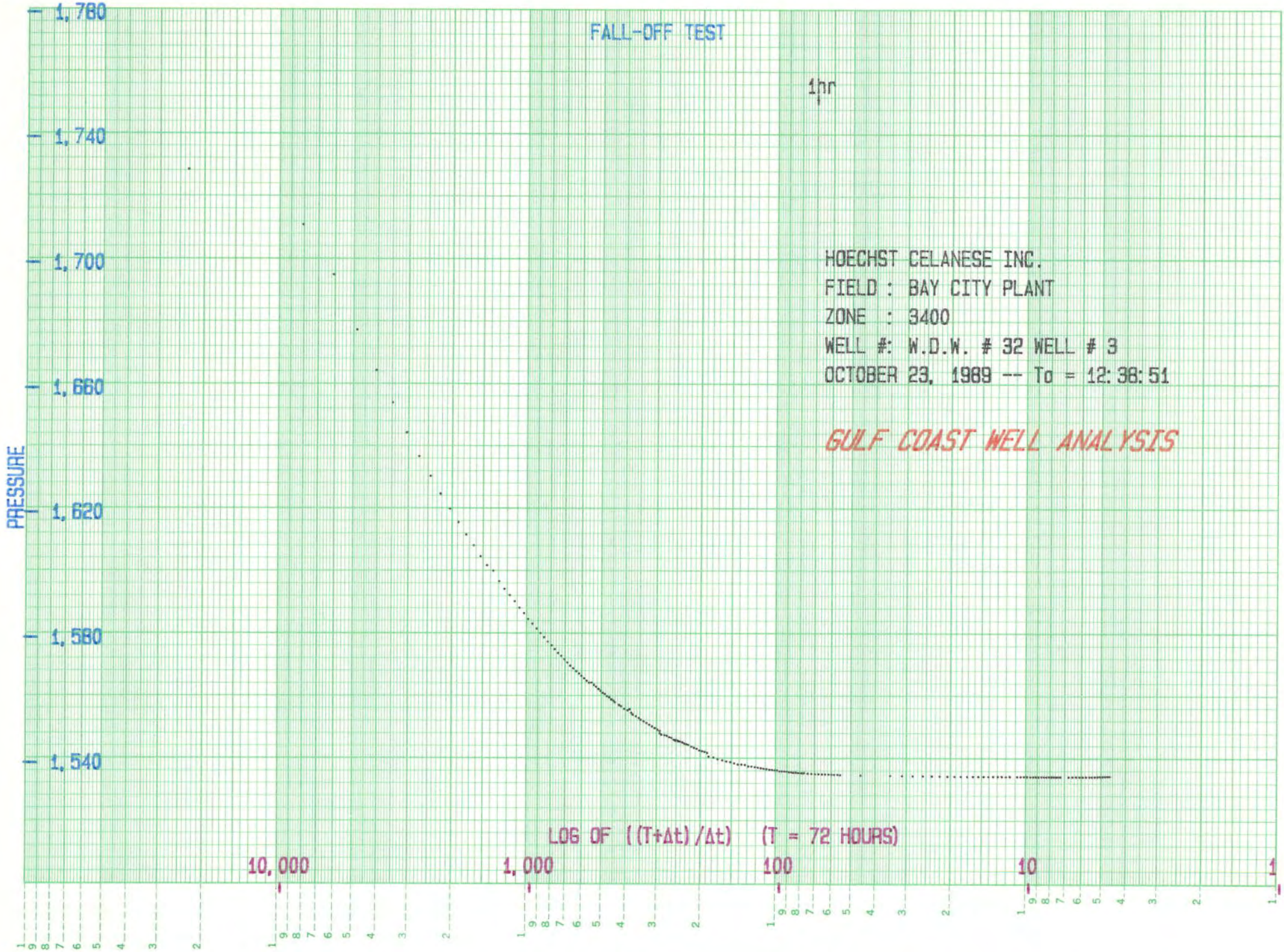


K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 0700



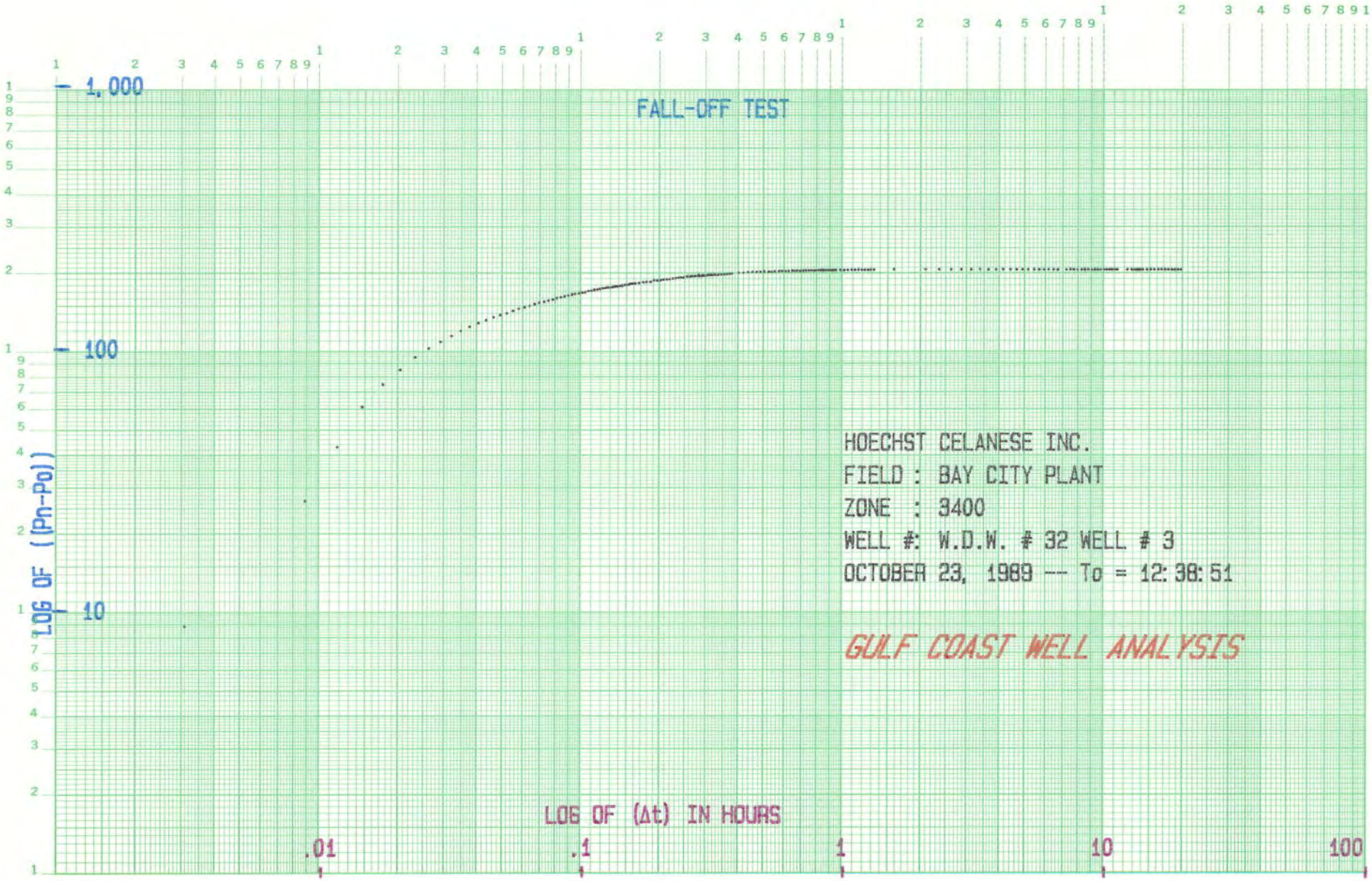
K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6210

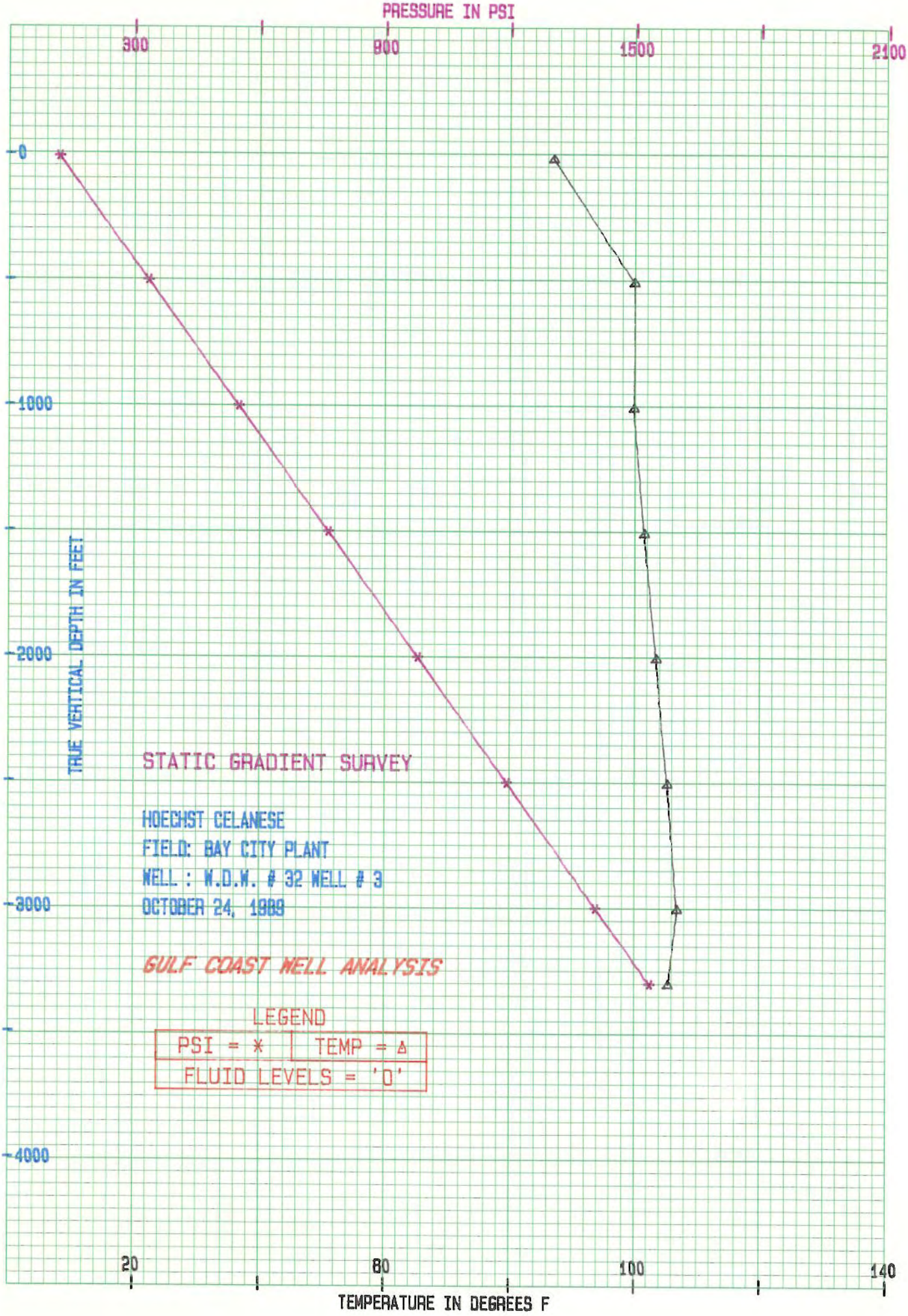




K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 6210

K+E LOGARITHMIC 3 x 5 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 7520





46 0700
K&E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

PANEX CALIBRATION CERTIFICATE

Model 1320 Cal. Run # 509

Serial # 9-0004

L.B.# 732

Cell # UU1001K

Full Scale 10000 psia 68966 kpa

Temperature range 00 Deg C to 163 Deg C
Temperature range 32 Deg F to 325 Deg F

Date Calibrated 05-22-1989 Location: Sugar Land

C0	C1	C2	C3	C4
0.0	-35061.9	19582.6	80577.5	-7290
C5	C51	C52	C53	C54
-52.2276	-.011158	-.205485	2.08559	-.005589
C6	C61	C62	C63	C64
-51.4949	.083679	1.31296	-9.08369	.024011
C7	C71	C72	C73	C74
2.0248	-.141019	14.7642	-136.916	.415086
C8	C80	C81	C82	C83
0	-582.112	9.24653	-37.5749	131.117
C9				
12				

The above listed equipment was manufactured, assembled, and tested in compliance with Panex engineering specifications and applicable industry standards.
All callibrations are performed in a controlled environment, using instrumentation and methods which assure that the specifications claimed are reliable.

Susan A. Knight — Certifying Technician

May 26 1989 — Date

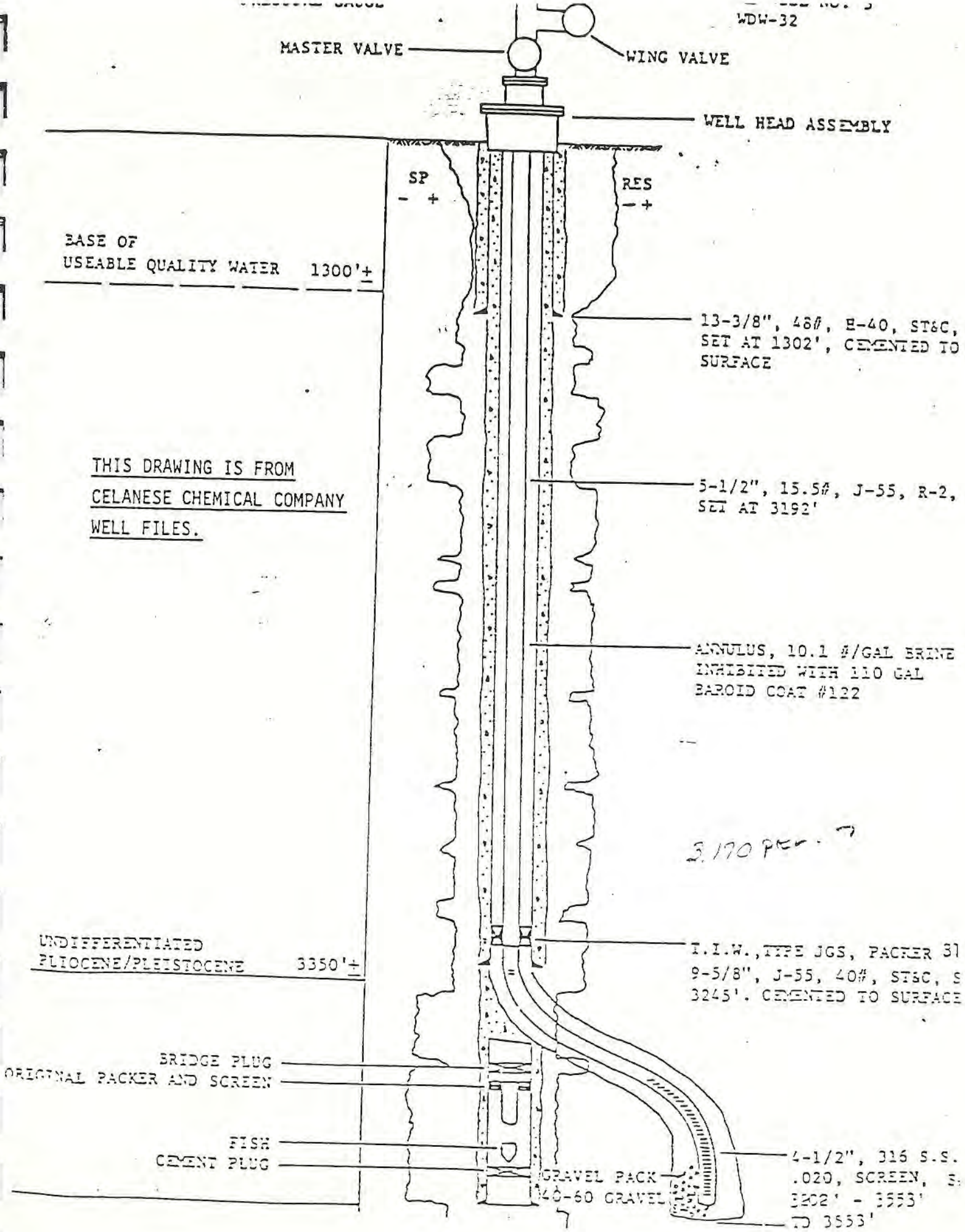
James L. McKesson — Certifying QA Inspector

PANEX CORPORATION APPROVED

APPENDIX B.3

WELL SCHEMATIC DRAWING

WDW-32


MASTER VALVE
WING VALVE
WELL HEAD ASSEMBLY
SP
- +
RES
- +
BASE OF
USEABLE QUALITY WATER 1300'±
13-3/8", 48#, H-40, ST&C,
SET AT 1302', CEMENTED TO
SURFACE
THIS DRAWING IS FROM
CELANESE CHEMICAL COMPANY
WELL FILES.
5-1/2", 15.5#, J-55, R-2,
SET AT 3192'
ANNULUS, 10.1 #/GAL BRINE
INHIBITED WITH 110 GAL
BAROID COAT #122
3,170 PSI
UNDIFFERENTIATED
PLIOCENE/PLEISTOCENE 3350'±
T.I.W., TYPE JGS, PACKER 31
9-5/8", J-55, 40#, ST&C, S
3245'. CEMENTED TO SURFACE
BRIDGE PLUG
ORIGINAL PACKER AND SCREEN
FISH
CEMENT PLUG
GRAVEL PACK
40-60 GRAVEL
4-1/2", 316 S.S.
.020, SCREEN, S
3202' - 3553'
TD 3553'

APPENDIX C

WASTE DISPOSAL WELL 49

APPENDIX C.1

MECHANICAL INTEGRITY FIELD TEST DATA

APPENDIX C.1.a

ANNULUS PRESSURE DATA

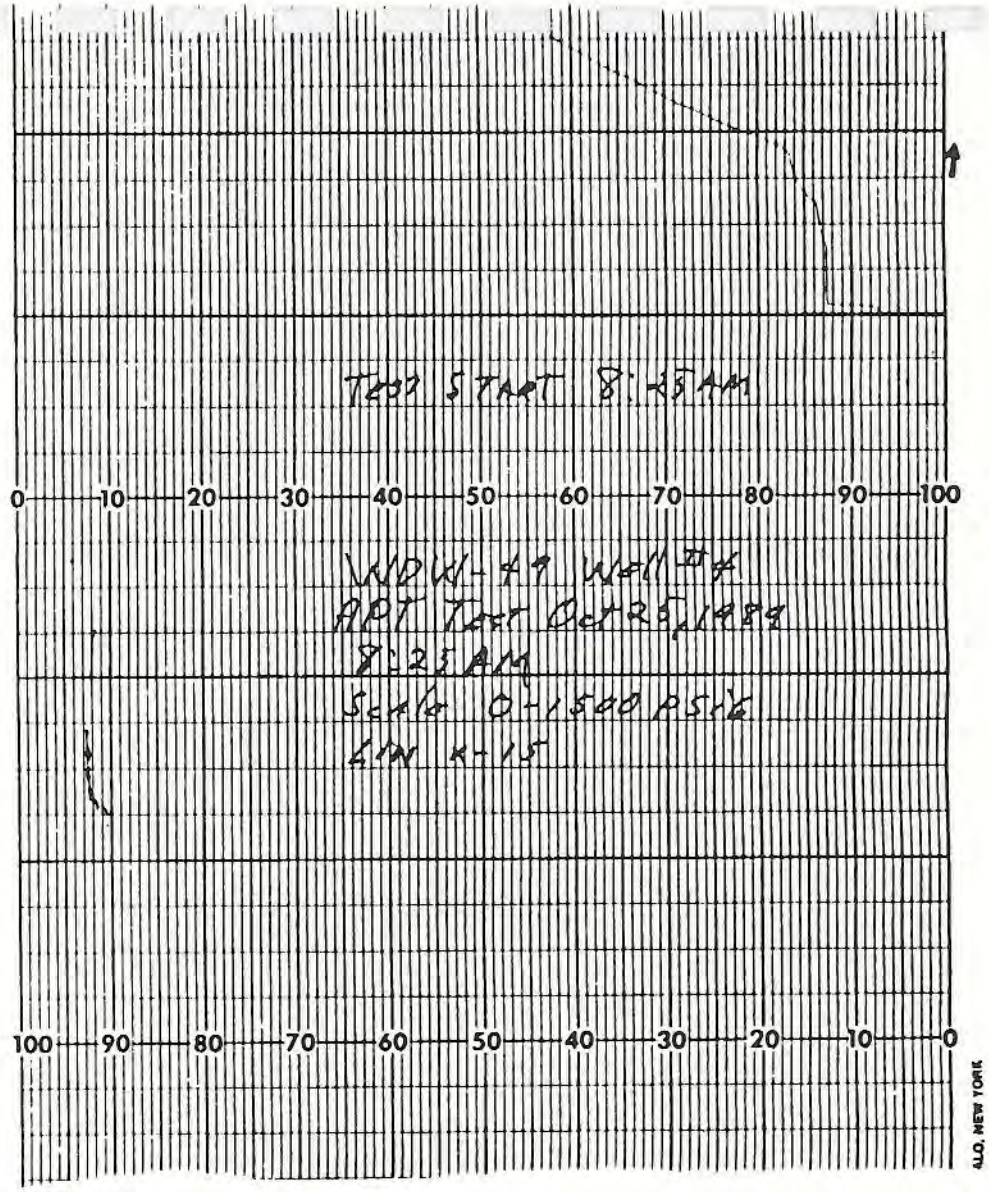
Annulus Pressure Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 49
October 25, 1989

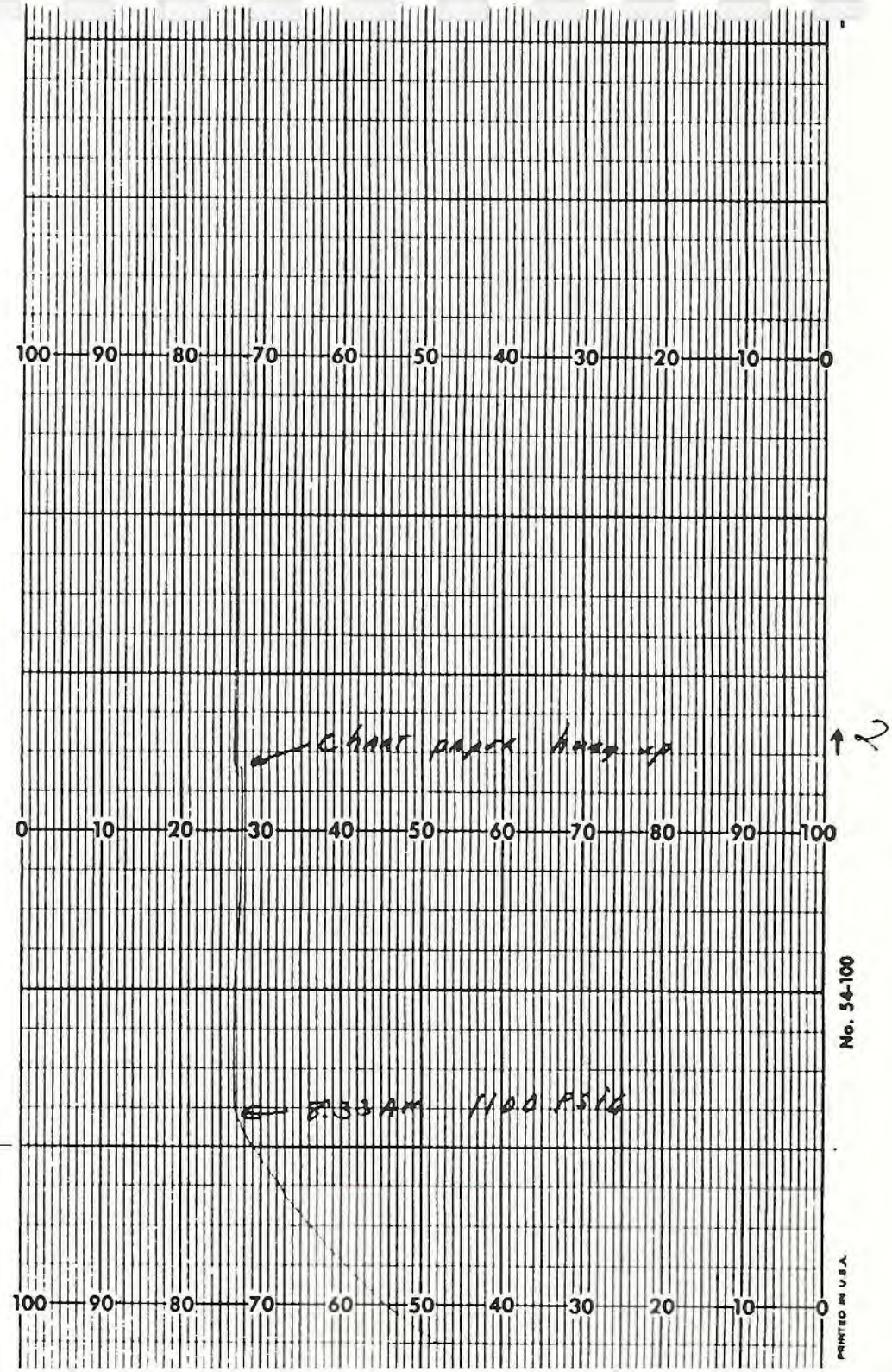
Time (pm)	Casing Pressure (Psig)	Remarks
8:15	190.0	Well shut-in 23-1/2 hours.
8:26	300.0	Start pressurizing annulus.
8:33	1097.0	Well stabilizing.
8:35	1094.0	
8:40	1092.0	
8:45	1090.0	
8:50	1088.0	
8:55	1086.0	Started APT.
9:00	1085.0	
9:05	1083.0	
9:15	1080.0	
9:20	1078.0	
9:25	1076.0	End of APT.
9:27	900.0	Bleeding off pressure.
9:29	200.0	Pressure bled off.

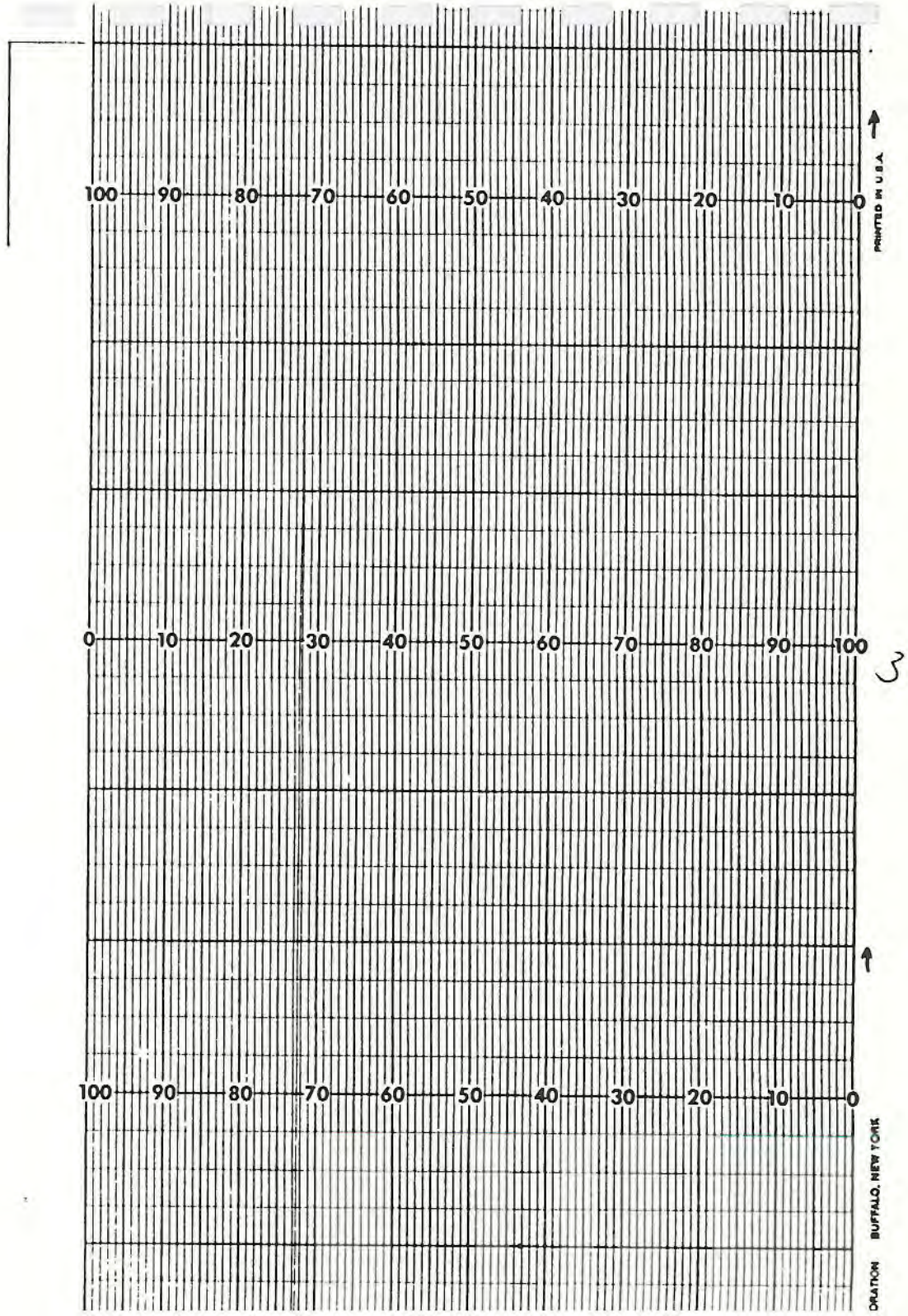
Results: The pressure leak-off was 10 psi (1086 to 1076 psig), during the last 30 minute period, or 0.9 of 1.0% leak-off rate. Maximum allowable leak-off is 5% per 30 minutes.

Pressure was measured using a 3-D Instruments, Inc. Test Gauge, 0 to 1,500 psi gauge, Serial No. 8807007, 4-1/2" dial face with 10 psi inclement and equipped with a reflective glass backing. The gauge was calibrated against pressure standard Mansfield and Green, Drawing No. 2633 on October 5, 1989.

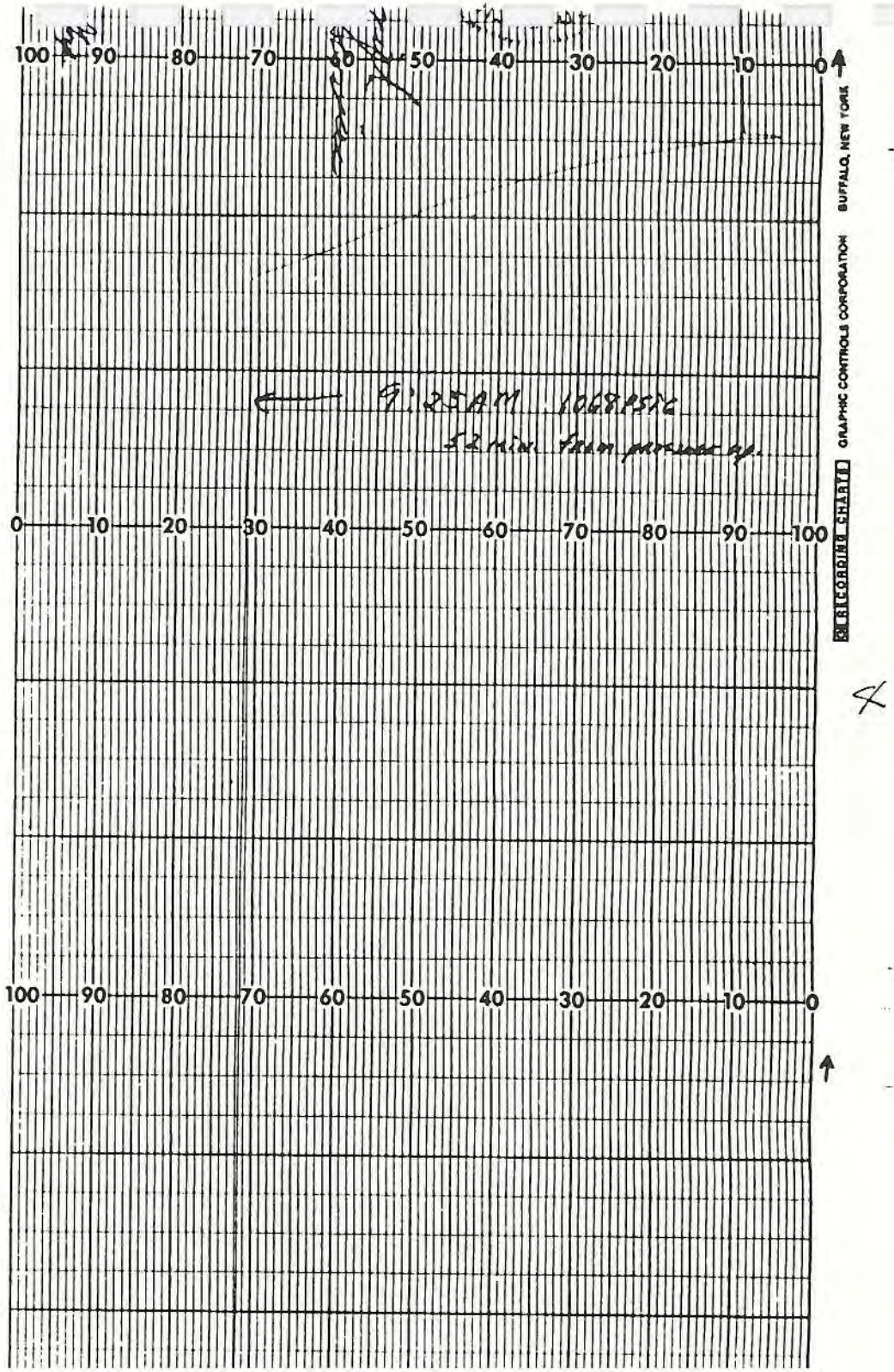
Also, used HCCG's well test transmitter pressure recorder with range 0 - 1,500 psi calibrated to a dead weight tester traceable to National Bureau of Standard on October 20, 1989 by W.H. Heller (See Appendix A.1.b).

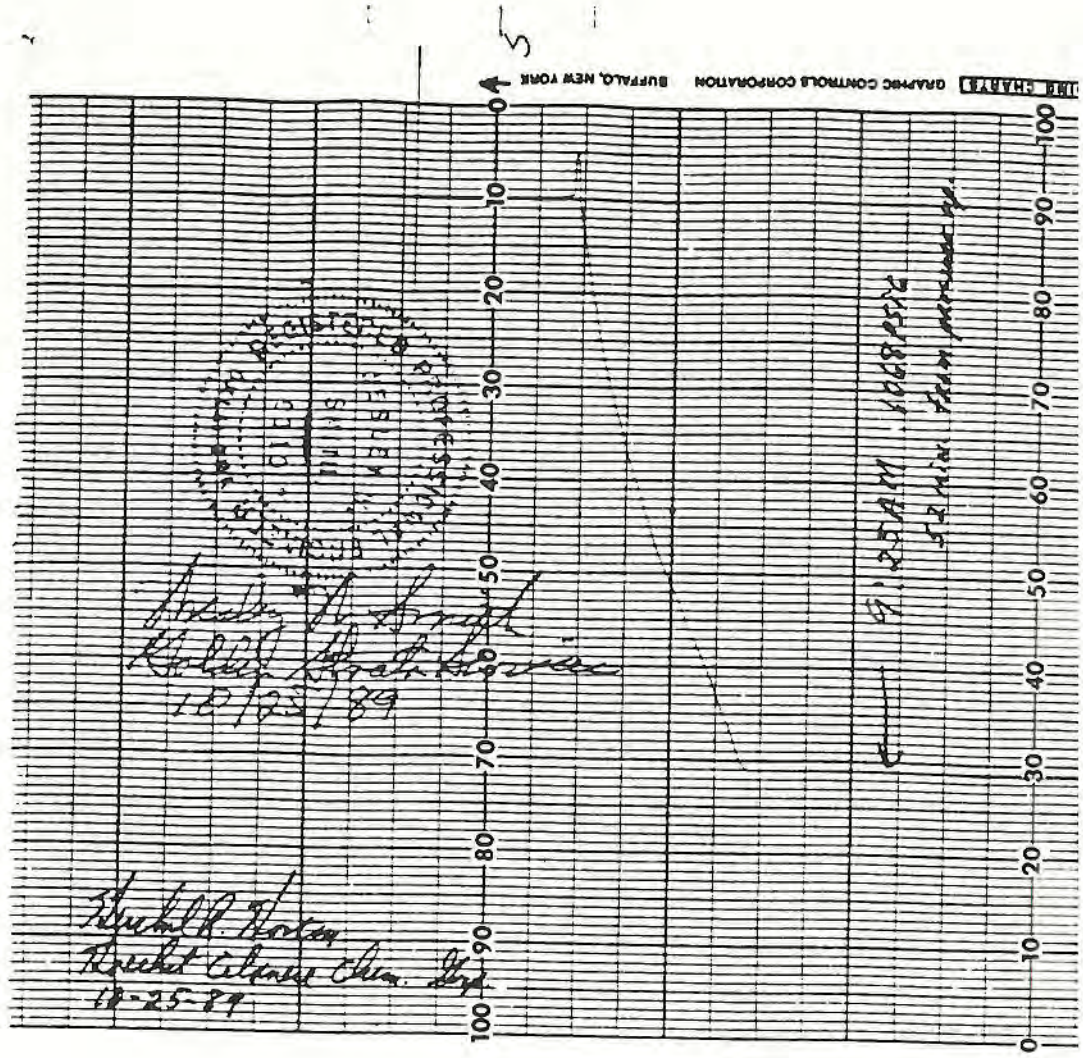

TEST START 8:25 AM
0 10 20 30 40 50 60 70 80 90 100
WDW-49 Well #4
APT Test Oct 25, 1989
8:25 AM
Scale 0-1500 PSIG
LIN X-15
100 90 80 70 60 50 40 30 20 10 0
ALD, NEW YORK


100 90 80 70 60 50 40 30 20 10 0
Chart paper hung up
0 10 20 30 40 50 60 70 80 90 100
8:33 AM 1100 PSIG
100 90 80 70 60 50 40 30 20 10 0
No. 54-100
PRINTED IN U.S.A.


100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
PRINTED IN U.S.A.
DRAFTON BUFFALO, NEW YORK

3


100 90 80 70 60 50 40 30 20 10 0
9:25AM 1068PSIG
52 min. from pressure up.
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
RECORDING CHART
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK


GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
9:25 AM 1068 PSIG
52 min from pressure up.
10/25/89
10-25-89

APPENDIX C.1.b

RADIOACTIVE TRACER SURVEY DATA

Radioactive Tracer Survey Data
Hoechst Celanese Chemical Group, Inc.
Bay City Plant
Waste Disposal Well 49
October 25, 1989

A. First Base G/R Log: 3422′ to 3000′ (9:45 am to 9:52 am)

B. Second Base G/R Log: 3300′ to 3000′ (9:57 am to 10:05 am)
(Ran to confirm repeatability of tool)

C. Five (5) minute statistical check with tool stationary at a depth of 3350′ (10:07 am to 10:12 am) and 3295′ (10:18 am to 10:23 am).

D. First Radioactive Slug Ejection. The following RAT data and injection rate reflects the downward movement of the injected fluid.

Pass No.	Time From (am)	Time To (am)	Depth(Ft.) From	Depth(Ft.) To	Top Slug Depth (Ft.)	Remarks
	10:37:15		3000			Eject R/A slug(2 sec.)
1	10:37:42	10:38:05	3050	3000	3025	Injection rate-40 gpm
2	10:38:28	10:39:15	3100	3010	3072	
3	10:39:50	10:40:28	3150	3060	3135	
4	10:41:10	10:41:57	3240	3120	3220	
5	10:42:42	10:43:45	3350	3200	3325	
6	10:44:27	10:45:35	3422	3310	?(*)	End of RAT Survey.

* - Estimated peak at 3435′, or below the top of the PBTD.

E. Second R/A slug ejection: (First Stationary Time Sequence):

Time (pm)	Tool Depth (Ft.)	Remarks
11:17:00	3300	Released R/A slug (2 Sec.). Left tool stationary and turned on time-time-drive recorder. Pump rate - 40 gpm.
11:17:03	3300	Recorded R/A slug peak. Started test.
11:27:03	3300	Survey stopped. R/A slug displaced into disposal interval.

Note: See attached Estimated Time to Run Stationary RAT Sequence. (See Appendix C.1.c).

F. Third R/A slug ejection (Second Stationary Time Sequence):

Time (pm)	Tool Depth (Ft.)	Remarks
11:29:00	3295	Released R/A slug (2 Sec.). Left tool stationary and turned on time-drive recorder. Pump rate - 50 gpm.
11:29:03	3295	Recorded R/A slug peak. Started test.
11:39:03	3295	Survey stopped. R/A slug displaced into disposal interval.

G. Final base log: 3422′ to 3000′(11:44 am to 11:51 am)

APPENDIX C.1.c

ESTIMATED TIME TO RUN STATIONARY RAT SEQUENCE
(Waste Disposal Well 49)

Estimated Time To Run Stationary RAT Sequence
Waste Disposal Well 49
(RAT of October 25, 1989)

Problem: Calculate "worse case" time for the radioactive slug to move from the G/R tool (1) down the tubing, (2) into the wellbore and (3) up the casing/borehole annulus to the tool depth.

Basic Data:

Capacities:	5-1/2" tubing	- 1.000 gal/ft
	4-1/2" screen	- 0.653 gal/ft
	4-1/2" screen x 8-3/4" borehole	- 2.300 gal/ft
	7-5/8" casing x 8-3/4" borehole	- 0.752 gal/ft
Pump Rate:	40 gpm	

Note: RAT detection tool was held stationary at 3295 ft, or 73 ft above the end of the casing shoe.

Worse Case Calculations:

Volumes:	Tubing	- 21 ft x 1.000 gal/ft	=	21.0 gal
	Screen	- 55 ft x 0.653 gal/ft	=	35.9 "
	Screen/borehole	- 3 ft x 2.300 gal/ft	=	6.9 "
	Casing/borehole	- 73 ft x 0.752 gal/ft	=	54.9
		correct		118.7 gal

Calculated time to circulate R/A slug around the end of the tubing and casing strings:

= 118.7 gal/40 gal/min

= 3.0 minutes

Note: Actual time survey ran = 10 minutes

APPENDIX C.1.d

RADIOACTIVE TRACER SURVEY

Gulf Coast Well Analysis

RADIOACTIVE TRACER LOG

MECHANICAL INTEGRITY TEST

FILING NO. _____

COMPANY HOECHST CELANESE

WELL WASTE DISPOSAL WELL # 49 WELL # 4

FIELD BAY CITY PLANT

COUNTY MATAGORDA STATE TEXAS

LOCATION:

SEC. _____ TWP. _____ RGE. _____

OTHER SERVICES: NONE

PERMANENT DATUM: GROUND LEVEL ELEV: N.A.

LOG MEASURED FROM KELLY BUSHING 12.0 FT. ABOVE PERM. DATUM

DRILLING MEASURED FROM KELLY BUSHING

ELEV.: K.B. N.A. D.F. N.A. G.L. N.A.

Date	OCT 25, 1989
Run No.	ONE
Type Log	R.A.T.
Depth-Driller	N.A.
Depth-Logger	3422
Bottom logged interval	3421
Top logged interval	3000
Type fluid in hole	WASTE WATER
Max rec. temp., deg. F.	N.A.
Operating rig time	MAST
Recorded by	JOHNSON
Witnessed by	MR. WES SMITH

Bore-Hole Record

Run No.	Bit	From	To	Size	Wgt.	From	To
				5.5	15.5	SURF.	3316

Tubing Record

Casing Record

Size	Wgt.	From	To
7 5/8	N.A.	SURF.	3368

Liner

Size	Wgt.	From	To
4.5	~~8S~~	3316	T.D.

NOTICE: All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

Gulf Coast Well Analysis

Form 110-H

EQUIPMENT DATA

Gamma Ray			
Run No.	ONE		
Tool Model No.	CRC		
Diameter	1.43		
Detector Model No.	G-1		
Type	GEIGER		
Length	12"		
Distance to N. Source			
General			
Hoist Truck No.	101		
Instrument Truck No.	101		
Tool Serial No.	1225-35		
District	PEARLAND		

Neutron			
Run No.			
Log Type			
Tool Model No.			
Diameter			
Detector Model No.			
Type			
Length			
Source Model No.			
Serial No.			
Spacing			
Type			
Strength			

LOGGING DATA

General				Gamma Ray				Neutron			
Run No.	Depths From	Depths To	Speed Ft/Min.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API G.R. Units per Log Div.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API N. Units per Log Div.
1	3422	3000	40	1	1000/140	2-L	6 API				
1	3422	3000	40	1	100/240	0-L	25 API				

Reference Literature: TOP DETECTOR TO CCL = 3'
CCL TO INJECTOR = 2'
INJECTOR TO BOTTOM DETECTOR = 7.5'
TOP DETECTOR TO BOTTOM DETECTOR = 12.5'

Remarks: RADIOACTIVE TRACER LOG INDICATES THAT ALL FLUID IS GOING INTO DISPOSAL ZONE AT THIS TIME. NO INDICATION OF FLUID MIGRATION UP HOLE.

Fold Here

Gulf Coast Well Analysis

RADIOACTIVE TRACER LOG

MECHANICAL INTEGRITY TEST

FILING NO. _____

COMPANY HOECHST CELANESE

WELL WASTE DISPOSAL WELL # 49 WELL # 4

FIELD BAY CITY PLANT

COUNTY MATAGORDA STATE TEXAS

LOCATION:

SEC. _____ TWP. _____ RGE. _____

OTHER SERVICES: NONE

PERMANENT DATUM: GROUND LEVEL ELEV: N.A.

LOG MEASURED FROM KELLY BUSHING 12.0 FT. ABOVE PERM. DATUM

DRILLING MEASURED FROM KELLY BUSHING

ELEV.: K.B. N.A. D.F. N.A. G.L. N.A.

Date	OCT 25, 1989
Run No.	ONE
Type Log	R.A.T.
Depth-Driller	N.A.
Depth-Logger	3422
Bottom logged interval	3421
Top logged interval	3000
Type fluid in hole	WASTE WATER
Max rec. temp., deg. F.	N.A.
Operating rig time	MAST
Recorded by	JOHNSON
Witnessed by	MR. WES SMITH

Bore-Hole Record

Run No.	Bit	From	To	Size	Wgt.	From	To
				5.5	15.5	SURF.	3316

Tubing Record

Casing Record

Size	Wgt.	From	To
7 5/8	N.A.	SURF.	3368

Liner

Size	Wgt.	From	To
4.5	SS	3316	T.D.

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Gulf Coast Well Analysis

Form 110-H

EQUIPMENT DATA

Gamma Ray			
Run No.	ONE		
Tool Model No.	CRC		
Diameter	1.43		
Detector Model No.	G-1		
Type	GEIGER		
Length	12"		
Distance to N. Source			
General			
Hoist Truck No.	101		
Instrument Truck No.	101		
Tool Serial No.	1225-35		
District	PEARLAND		

Neutron			
Run No.			
Log Type			
Tool Model No.			
Diameter			
Detector Model No.			
Type			
Length			
Source Model No.			
Serial No.			
Spacing			
Type			
Strength			

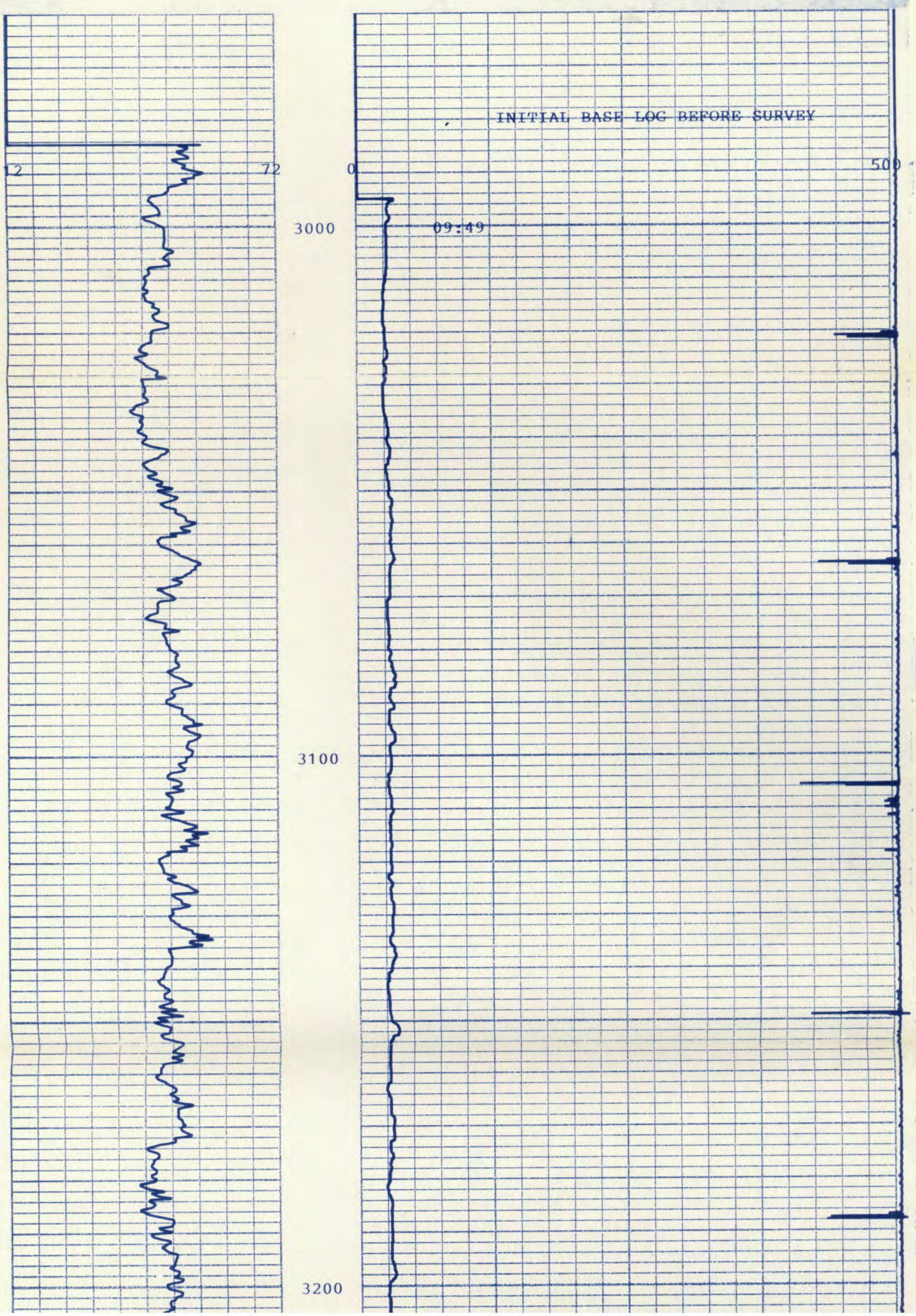
LOGGING DATA

General				Gamma Ray				Neutron			
Run No.	Depths From	Depths To	Speed Ft/Min.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API G.R. Units per Log Div.	T.C. Sec.	Sens. Settings	Zero Div. L or R	API N. Units per Log Div.
1	3422	3000	40	1	1000/140	2-L	6 API				
1	3422	3000	40	1	100/240	0-L	25 API				

Reference Literature: TOP DETECTOR TO CCL = 3'
CCL TO INJECTOR = 2'
INJECTOR TO BOTTOM DETECTOR = 7.5'
TOP DETECTOR TO BOTTOM DETECTOR = 12.5'

Remarks: RADIOACTIVE TRACER LOG INDICATES THAT ALL FLUID IS GOING INTO DISPOSAL ZONE AT THIS TIME. NO INDICATION OF FLUID MIGRATION UP HOLE.

Fold Here

Fold Here

GAMMA RAY	DEPTHS	NEUTRON
API GAMMA-RAY UNITS		API NEUTRON UNITS