MASTER

**INVESTIGATION AND EVALUATION OF
GEOPRESSURED-GEOTHERMAL WELLS**

**Final Report: Tenneco Fee "N" No. 1 Well,
Terrebonne Parish, Louisiana**

**By
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**September 1980
Date Published**

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**Gruy Federal, Inc.
Houston, Texas**

**U. S. DEPARTMENT OF ENERGY
Geothermal Energy**

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EXECUTIVE SUMMARY

The Tenneco Fee "N" No. 1 well was originally drilled for Tenneco Exploration and Production Co. by Two-R Drilling Co. to 17,276 ft and a 4-1/2 inch liner was run to total depth. Several geothermal-geopressured sands were penetrated which met DOE selection criteria for geopressured-geothermal testing.

Tenneco assisted in the preparation of the well prognosis and completion design. They also supplied on-site supervisory and operating personnel. This was the first active participation by a major oil and gas company in the well-of-opportunity program.

The well was designed for higher flow rates (20,000 to 30,000 B/D), and a longer test period (60 to 90 days) than had been standard in the well-of-opportunity program.

A contract with Atlantic Pacific Marine Corporation for its barge rig no. 1 was approved and the barge was moved to the location on January 9, 1980. Subsequent reentry operations could not be completed because of the difficulty of obtaining a cement seal around the 4-1/2 inch liner and because of a hole that later developed in the 4-1/2 inch liner at 13,920 ft. This breach allowed shale, gas, and salt water to enter the well bore. It was not practical to attempt further cementing operations inside the small liner to correct this condition and the decision was made to abandon.

The drill barge was released April 22, 1980, after having plugged the well in accordance with state regulations.

The cost of the reentry attempt was approximately \$5,250,000. Tubulars, wellhead, and test equipment having a value of approximately \$1,000,000 were salvaged for use on future wells of opportunity. The net cost of the aborted test attempt was approximately \$4,227,000.

1. INTRODUCTION

Tenneco Oil Exploration and Production (Tenneco) No. 1 Fee "N" Well was completed by Tenneco as a dry hole at 17,276 ft in January 1979. The well had penetrated a series of well-developed geopressured sand bodies which met established DOE criteria for geopressured-geothermal resource assessment test sites. Gruy Federal first recommended the well for short- to intermediate-term production testing in January 1979.

Thereafter, Tenneco withdrew its original offer of the well for a test site, but offered the well again in late 1979. After DOE approval of a revised Gruy Federal prognosis and recommendation, recompletion operations were begun in January 1980 under an arrangement which provided for joint planning by Gruy Federal and Tenneco and on-site operation and supervision by Tenneco. Gruy Federal provided purchasing services, liaison with DOE, and on-site observation and advisory services.

For mechanical reasons, probably associated with the failure to obtain a cement shut-off when the liner was originally installed, it was not possible to conduct the contemplated production test of the geopressured aquifers. Repeated attempts were made to re-cement and seal off the top of the 4-1/2 inch liner and to clean out the liner to total depth prior to perforating for the first production test. The completion attempt had to be aborted when the liner wall was breached.

This report describes the reservoir conditions that led to the choice of the Tenneco Fee "N" No. 1 as the fifth well of opportunity,* as well as the attempts to complete the well for high-volume brine production. The Appendix contains individual opinions concerning underlying and contributing causes for the liner failure.

Since no test data were obtained, the conclusions in this report are limited to those involving drilling and completion matters.

*The DOE/Gruy Federal "Well-of-Opportunity" Program was designed to obtain short-term flow test data from geopressured aquifers in wells drilled by industry but non-productive of conventional hydrocarbons.

2. TENNECO AGREEMENT

The offer of the Tenneco No. 1 Fee "N" well to the DOE-Gruy Federal well-of-opportunity (WOO) program was made on the following conditions:

1. Tenneco would participate in the well planning together with Gruy Federal technical personnel and Gruy Federal technical sub-contractors.
2. Testing would be limited to the lowermost Geo² sand penetrated unless specified production rates were not obtained, in which case successively higher sands would be made available for testing.
3. The flow test period was not to exceed 90 days on any sand, except that if a long-term test of one or more sands appeared practical, Tenneco had the option to reopen negotiations for a DOE-supported long-term high-volume test or to reacquire operations for their sole benefit.

It was Tenneco's plan, and a condition of granting Gruy-DOE the use of this well, to attempt a completion capable of producing at sustained rates of 20,000 to 30,000 B/D for test periods of up to 90 days. Tenneco granted Gruy and DOE the option to test each of the sands in this well successively for similar periods of time until a sustained producing capacity of at least 20,000 B/D had been established from one sand group. The first such sand group scheduled for testing was the lowermost MG Tex W 5D sand, occurring in the gross interval from 17,098 to 17,185 ft. For purposes of funding, the initial test was designed for approximately 60 days.

In the event any sand group tested at a rate of at least 20,000 B/D, Gruy-DOE and Tenneco had the option, if mutually agreeable, to continue comprehensive long-term testing. Alternatively, Tenneco had the option to submit a proposal directly to DOE to conduct extended tests with DOE support on such sands for long-term evaluation, or to proceed to continue testing independently of either Gruy or DOE.

The granting of WOO test rights and well use for the MG Tex W 5D sand and other zones was further contingent upon:

1. The payment to Tenneco of \$500,000 as partial reimbursement of the cost incurred in installing a liner to protect the open hole prior to temporary abandonment. (Gruy's independent estimate of the cost of materials, services, and rig time exceeded this amount by approximately 10 percent.)
2. Tenneco providing personnel to handle field supervision and operations at actual cost to Tenneco for the personnel involved. (Tenneco was in direct charge of operating within a mutually agreed-upon plan.)

3. GEOPRESSURED-GEOTHERMAL PROSPECT

3.1 Location

The Tenneco No. 1 Fee "N" well is located near the western edge of the Terrebonne embayment in a coastal marsh approximately 20 air miles S.45° E. of Houma, as shown on the composite of USGS topographic sheets "Montegut, La." and "Lake Bully Camp, La." (Fig. 1).

The specific well location is 2,046 ft from the north line and 3,100 ft from the east line of Section 38, T.19 S., R.19 E. in Terrebonne Parish, La. The site is near the southern terminus of Louisiana State Highway 665 at the village of Isle de St. Jean Charles.

Figure 2 shows the location to be in the lowland marsh, accessible by canal and inland waters and requiring a 5-minute boat ride for crew changes and a 12-hour barge haul from Dulac, La., for movement of heavy equipment and services.

3.2 Geology

The lower geologic section is characterized by a series of thick Miocene sands of Marginulina Textularia Warreni age at depths from 14,750 ft to at least 17,245 ft.

Figure 3 is a structural interpretation on the top of the MG Tex W 2 aquifer, which occurs about mid-depth of the geopressured section between 14,750 and 17,245 ft. This datum is above the objective zone for the first proposed test. The overlay shows the total net sand thickness of the geopressured section penetrated by each well.

The structural map was prepared utilizing a Tenneco seismic interpretation adjusted to the actual well control shown on the map. It incorporates dipmeter data obtained from the Tenneco No. 1 Fee "N" well.

Fault A has some 150 ft of throw and is down-to-the-north. This stress-relief fault was found in the Humble No. 2-A LaTerre Co. well in Section 35, T. 19 S., R. 19 E. Tenneco seismic records confirm its presence. The southern extremity of Fault A was positioned south of the Humble-Pennzoil No. 1A LaTerre in Section 41 in order to be consistent with gas accumulations in the downthrown fault block centered in Section 34. This accumulation is associated with the LaTerre field complex. Fault B is a major down-to-the-coast seismic fault with one cut point in the California Company No. 2 LL&E well in Section 30. This fault is generally associated with the Bayou Jean LaCroix Field to the east and appears to have some 3,000 ft of throw. Fault C, a bifurcation of Fault B, is also down-to-the-coast and exhibits about 1,300 ft of throw. It is positioned by seismos and adjusted to be mid-point between the Tenneco No. 1 Fee "N" Well in Section 38 and the Humble No. D-12 LaTerre Co. well in Section 2, T. 20 S., R. 19 E.

ROAD CLASSIFICATION

Heavy-duty	————	Light-duty
Medium-duty	- - - -	Unimproved dirt
○ State Route		

MONTEGUT, LA.
NE/4 DULAC 15' QUADRANGLE
N2922.5—W9030/7.5

1963
PHOTOINSPECTED 1972
AMS 7842 I NE—SERIES V885

LAKE BULLY CAMP, LA.
NW/4 LAKE FELICITY 15' QUADRANGLE
N2922.5—W9022.5/7.5

1964
PHOTOINSPECTED 1972
AMS 7842 IV NW—SERIES V885

GRUY FEDERAL, INC.
Houston, Texas

LOCATION MAP
BAYOU JEAN La CROIX AREA
TERREBONNE PARISH, LOUISIANA

FIGURE 1

Figure 2.--Tenneco Oil Co. map showing location of Tenneco Fee "N" No. 1 well.

No diagnostic paleo data were available within the MG Tex W section to confirm electric log correlations used in the preparation of the structural subsurface interpretations.

The areal extent and geometry defined for the MG Tex W2 sand is believed to be more or less equally applicable to each of the aquifers within the geopressed MG Tex W sand series.

3.3 Reservoir Characteristics

The following table shows the depth at which each geopressed sand was penetrated. The electric log for the lower part of the hole is shown in Fig. 4.

Depth, ft		Geo ² sand	Shale Content (Vsh)	Calculated Average Porosity, %	Net Sand Thickness, ft	Estimated Pressure Gradient, psi/ft
From	to					
14,750	14,850	MG TexW 2A	10.2	25.2	82	0.92
15,018	15,100	MG TexW 2B	5.0	23.0	62	0.910
15,375	15,460	MG TexW 2D	8.5	23.6	65	0.900
15,560	15,660	MG TexW 3A	12.5	23.6	83	0.920
15,810	15,880	MG TexW 3C	13.8	21.3	61	0.926
16,906	17,005	MG TexW 5B	2.3	22.6	61	0.936
17,098	17,185	MG TexW 5D	1.0	21.6	72	0.936
					<u>486</u>	

These geopressed aquifers are characterized by:

- a. a possible drainage area of approximately 10 square miles, uncomplicated by known major faulting;
- b. a postulated total geopressed net sand volume of approximately one cubic mile;
- c. net sand thickness varying from 61 to 83 ft in individual sand groups;
- d. seven distinct Geo² sands;
- e. apparent depositional continuity, uniform dip, and structural conformity.

These sands were drilled using a slightly overbalanced mud column equivalent to 17.9 lb/gal from 14,750 ft to total depth. At approximately 14,750 ft the well kicked 17.2 lb/gal mud. Figure 5 is a pore-pressure plot which shows pressure gradients and mud weights employed while drilling the well. Attention is called to the "kick" at approximately 13,820 ft, which required 18-lb/gal mud to control. On the basis of the mud temperature

Figure 4.--Electric log, Tenneco Fee "N" No. 1 well.

recorded at 17,257 ft, the average formation temperature is estimated at approximately 282°F (139°C).* The calculated porosity of individual sands varies from 21 to 25 percent. The shale content varies from 1 to 14 percent. No core data are available to measure permeabilities; however, oil and gas production from equivalent sands associated with adjacent structures suggests favorable permeability characteristics. On the basis of the mud weights required to drill the well, and from pore pressure determined from the electric log (Fig. 4), it appears that the reservoir pressure gradients are in the range of 0.86 to 0.90 psi per foot of depth.

3.4 Resource and Deliverability Projections

The amount of water and natural gas contained in the first objective test aquifer (MG Tex W 5D) was estimated by volumetric calculation using the following assumptions:

- a. 10 square miles of aquifer
- b. net thickness of the MG TexW 5D sand of 72 feet
- c. average porosity of 21.6 percent.

The volume of in-situ water thus calculated is 0.77 billion barrels.

Assuming a gas solubility of 25 scf/bbl, a total of 19.3 Bscf of dissolved gas is present. If the aquifer had delivered 30,000 B/D, at the end of 60 days less than 0.3 percent of the water in place and 45 MMcf of gas would have been produced.

Using an effective system compressibility of 6×10^{-6} psi⁻¹, it was calculated that the static aquifer pressure would have dropped 375 psi by the end of the test period.

*The estimated formation temperature after applying the AAPG correction factors for South Louisiana is 303°F (151°C). However, experience in two previous well tests indicates that this formula is not applicable to these wells and that the actual formation temperature is only one or two degrees above the recorded mud temperature.

4. COMPLETION OPERATIONS

4.1 Tenneco Liner Completion

Tenneco drilled to 16,698 ft, ran ISF-sonic-GR-dipmeter and velocity logs, and then drilled to total depth of 17,276 ft. While making a 15-stand short trip before running the logs it was necessary to ream through tight spots to get back to bottom. While circulating, awaiting the arrival of the 4-1/2 inch liner, the drill pipe stuck with the bit at 17,250 ft. Circulation was continued and no mud was lost to the formation, but the drill pipe could not be rotated.

Oil-base mud was spotted around the drill collars and after 15 hours of soaking the pipe was worked free. Two short trips were made, with no drag, while waiting for the 4-1/2 inch liner to arrive. Twelve hours were spent with the pipe out of the hole, waiting for lift plugs to handle the liner. When the plugs arrived, the liner (4,077 ft) was run to 17,276 ft.

The 4-1/2 inch liner was cemented with 700 sacks of Class "H" cement. While the cement was being displaced, the wiper plug was inadvertently not released from the TIW plug container. Cement was displaced from the drill pipe and liner with 231 bbl of mud. The liner-setting tools were pulled up 2 stands and 196 bbl of mud was circulated. A part of the pre-flush used in cementing was circulated up. Pulling out with the setting tool was resumed and the next two stands pulled were wet. An attempt to reverse-circulate at this depth produced no returns through the drill pipe. While these two stands were being pulled the hole was swabbing and flowing through the annulus. After the kelly was installed, 100 bbl of 17.8-lb/gal mud was pumped into the well before pulling up to 12,200 ft. When the well was shut in, pressure on the drill pipe was 300 psi and pressure on the casing was 450 psi. The well was circulated on a choke using 18.2-lb/gal mud, but the operator was unable to reduce the pressure on the drill pipe and casing annulus, and the well continued to flow back.

With the bottom of the setting tools at 12,200 ft, 980 ft above the liner top, two squeeze jobs were performed. The first used 1,000 sacks of Class "H" cement, the second, 500 sacks. After time was allowed for the cement to set after placing the second plug, the drill pipe was stripped into the hole to 12,937 ft and the top of the cement plug held 30,000 lb of drill pipe weight. Ten minutes after the Hydril was opened, the well started flowing, and when the Hydril was closed the casing pressure was 750 psi.

Another 500-sack cement plug was squeezed below the drill pipe at 11,937 ft. When the cement had set, it was found that this plug had killed the bottom flow. As a safety precaution, another cement plug (87 sacks) was spotted from 11,937 to 11,637 ft. The drill pipe was laid down, a blank flange was installed on the 13-3/8 inch casing housing, and the rig was moved off location.

The condition of the well at takeover is shown in Fig. 6.

Figure 6.--Condition of Tenneco Fee "N" No. 1 well at time of re-entry.

4.2 Gruy-Tenneco Operations

After DOE approval of the project was received, the Atlantic-Pacific Marine Drilling Barge No. 1 was contracted for the reentry completion of the Tenneco Fee "N" No. 1. The rig was towed to the entrance to Lake Barre, where it stopped and was escorted across various oyster reefs by an "oyster consultant" in order to minimize possible claims for damage and to provide an expert witness if needed. The rig arrived at the well site at 4:30 p.m. on January 9, 1980.

The barge was spotted, sunk, and leveled, and the derrick was raised. Since the pressures anticipated during completion were greater than the 5,000-psi working pressures of the choke manifold and blowout preventers provided with the rig, this equipment was replaced with 10,000-psi rental units which were installed on the casing housing and pressure-tested to 10,000 psi.

After the rig mud tanks were filled with 16.8 lb/gal drilling fluid, an 8-1/2 inch drill bit, two 6-1/2 inch drill collars, and 30 joints of heavy-wall 4-1/2 inch drill pipe were picked up and run in the hole. A firm bridge was encountered at 300 ft. The kelly was picked up and the bridge was cleaned out without rotation. The 9-5/8 inch casing was washed out to 11,670 ft (top of cement plug in the 9-5/8 inch), and mud was circulated to equalize the drilling fluid at 17.6 lb/gal. The cement plug was drilled to 12,306 ft (top of 7-inch liner) and the hole was circulated while the mud was treated for cement contamination. At no time was there any show of salt water or gas in the mud returns. The blowout preventers were closed and the 9-5/8 inch casing was pressured to the equivalent of a 19.0-lb/gal mud column. This pressure was held for 45 minutes with no leakoff. The 8-1/2 inch bit was pulled and the 6-1/2 inch bottomhole assembly laid down. A 5-7/8 inch mill and 30 joints of heavy-wall 3-1/2 inch drill pipe were picked up and run in the hole. After drilling cement from 12,306 to 12,417 ft, a very slight show of gas appeared in the mud returns.

The blowout preventers were used to check the 7-inch x 9-5/8 inch liner seal by pressuring up to 900 psi with 17.5-lb/gal mud in the hole. There was no leakoff after a 30-minute test. Numerous voids in the cement and increasing amounts of gas in the mud returns had been encountered while cleaning out the 7-inch liner from 12,417 to 13,040 ft, 108 ft above the top of the 4-1/2 inch liner, at which depth the well started flowing. When the blowout preventers were closed, pressure was 1,600 psi on the casing and 1,300 psi on the drill pipe with a drilling fluid weight of 17.6 lb/gal, equivalent to a bottomhole pressure of 13,234 psi. With the BOP's closed Halliburton was rigged up and all lines were tested to 5,000 psi; 17.6 lb/gal mud was then pumped into the casing annulus at a rate of 2 bbl/min and an initial pump-in pressure of 2,000 psi. After pumping 106 barrels this was reduced to 1,000 psi. The kelly was removed, and with the 5-7/8 inch mill at 12,998 ft the pump truck was connected to the drill pipe.

Five hundred sacks of cement was mixed and displaced below the 5-7/8 inch mill at 12,998 ft at a maximum pump-in pressure of 2,400 psi at 2-1/2 bbl/min. The shut-in pressures at the end of the displacement were 1,200

psi on the casing and 1,250 psi on the tubing.

After waiting 22-1/2 hours for cement to set, the casing was pressured to 2,000 psi and 1/4 barrel of mud was displaced below the mill. An additional 5 barrels of mud was pumped down the drill pipe at 3/4 bbl/min with 2,300 psi. Thus the cement had not held, and the material for a second squeeze job was ordered.

A 200-sack cement mixture was displaced below the mill at 12,998 ft with a maximum pressure of 3,100 psi on the drill pipe and 1,400 psi on the casing annulus. The job was completed at 2:30 p.m. on January 21, 1980. After waiting on cement 17-1/2 hours, Halliburton pressured up to 2,100 psi on the drill pipe and 2,400 psi on the casing. There was no leakoff, and the pressures were bled off to zero.

When the drill pipe was checked for movement it was found to be stuck. Working the drill pipe enabled it to be pulled free and the gas-cut mud was circulated out of the hole. A 5-stand short trip was made before washing down to 13,032 ft and drilling cement to 13,090 ft. No cement was found below this depth to the top of the 4-1/2 inch casing at 13,148 ft. During bottoms-up circulation the well started to flow and was closed in. The shut-in pressures were 60 psi on the casing and 700 psi on the drill pipe.

In order to kill the well, 33 bbl of 17.7-lb/gal mud was pumped down the casing and 30 bbl of 19.6-lb/gal mud down the drill pipe. The drill pipe was then pulled through the BOP stack so that the 5-7/8 inch mill was located at 12,525 ft.

The system was circulated and equalized with 17.6 lb/gal mud. Static pressures were 800 psi on the casing and 960 psi on the drill pipe. A third cement job was attempted using Halliburton to spot 400 sacks of cement below the 5-7/8 inch mill at 12,525 feet. A maximum pressure of 2,400 psi was obtained while displacing the cement. The average pump-in pressure was 2,100 psi at 3-1/4 bbl/min. Upon completion of the squeeze job the shut-in pressures were 1,150 psi on the drill pipe and 1,100 psi on the casing.

After the cement was allowed to set for 30 hours, 2,600 psi was applied on the drill pipe; this leaked off to 2,300 psi in 15 minutes. After another 5-1/2 hours, 2,600 psi was applied and there was no leakoff in 15 minutes. The pressure was then released and the well started flowing when the drill-pipe pressure had dropped to 500 psi. During the next 18 hours the valve on the drill pipe was opened every 3 hours to determine whether the flow had been shut off. The well was still flowing after this time, and preparations were made for the fourth squeeze job. At 7:30 p.m. on January 25, 1980, 200 sacks of Class "H" cement mixture was displaced below the mill at 12,525 ft with an average pressure of 2,100 psi at 3-1/5 bbl/min. The last 15 sacks were staged over a one-hour period in 1/4-barrel increments. The shut-in pressures at the end of the squeeze job were 1,180 psi on the casing and 1,100 psi on the drill pipe.

At 5 p.m. on January 26 the drill pipe was moved through the blowout

preventers to see if it was free. At 9 a.m. on the 27th, all the pressure was bled off slowly. When there was no flow after 3 hours with zero pressure on the annulus, it was assumed that there was a competent cement plug in the top of the 4-1/2 inch liner. After circulating to condition the mud, the mill was lowered in the hole to 13,148 ft (top of the 4-1/2 inch liner) without encountering cement. The hole was conditioned at this depth and the mill pulled.

Schlumberger was rigged up and ran a cement bond log-variable density log-gamma ray log from 12,304 to 6,500 ft and an electromagnetic thickness log from 12,304 ft to the surface. The 9-5/8 inch casing was found to be in excellent condition.

A 3-1/2 inch x 5-3/32 inch polish mill was picked up and run in the hole to 13,148 ft and used to dress the polished bore receptacle (PBR) on top of the 4-1/2 inch liner. After conditioning the mud and checking to see that the PBR was dressed and ready to receive the seal assembly, a short trip was made preparatory to running the 5 x 7-inch tieback casing. The hook was changed out for one of 500-ton capacity and the drill line was cut.

A combination 5 x 7-inch tieback casing string with a 5-inch seal assembly on the bottom was run in the hole, testing each connection with 10,000 psi. When the seal assembly reached the top of the 4-1/2 inch PBR, repeated attempts to sting the seals into the PBR were unsuccessful. The casing string was rotated in an attempt to work into the PBR and weight was applied while rotating, but it was impossible to engage the seals within the PBR on top of the 4-1/2 inch liner. It was planned to leave the assembly as shown in Figure 7a. It was considered unsafe to attempt to pull the casing out of the hole since the BOP rams could not be adapted to a combination 5 x 7-inch casing string. Tenneco management decided to cement the tieback casing on top of, but not engaged in, the 4-1/2 inch liner top, as shown in Figure 7b. This decision was supported by the fact that while the tieback casing was being run there was no indication of the well attempting to flow. It was therefore assumed that the 4-1/2 inch liner top was sealed off, and with the 5-inch cemented the risk of a leak appeared to be very low, much less than the danger of pulling the casing to redress the liner top.

This decision was further influenced by the estimated time to pull the tieback casing, redress the 4-1/2 inch liner top and rerun the tieback casing. It was estimated that this operation would require five days, assuming no trouble. Basically, however, it was believed that a cement seal could be obtained by cementing the assembly in the disengaged position, since the liner top had already been effectively cemented off.

To cement the tieback casing string, 375 sacks of Class "H" cement was displaced down the casing at 4-1/2 bbl/min. The wiper plugs reached bottom at 8:30 a.m. on February 2. A pressure of 2,200 psi was maintained on the casing and the annulus pressure was regulated at 1,000 psi. These pressures were maintained for 21-1/2 hours and then released so that the tubing head could be installed. The blowout preventers and manifold were re-installed and pressure-tested.

Figure 7.--Schematic showing 4-1/2" PBR and 5" tieback seal assembly,
Tenneco Fee "N" No. 1 well: (a) proposed, (b) actual.

A 5-5/8 inch cement mill and 7-inch casing scraper were picked up on 3-1/2 inch drill pipe and run in the hole to top of the PBR in the 7-inch casing at 12,183 ft. Since there was no cement in the 7-inch casing, after conditioning the mud the mill was pulled.

A 3-3/4 inch cement mill was run in the hole, tagging the top of the cement in the 5-inch tieback casing at 12,789 ft. Cement was drilled to 12,982 feet, the rubber displacement plugs were drilled from 12,982 to 12,985 ft, and firm cement was drilled to 13,139 ft. After the mud was conditioned, the mill was pulled.

A 3-5/16 inch cement mill was run in the hole on 2-3/8 inch flush joint drill pipe. This should have had 1/16 inch of clearance inside the 4-1/2 inch liner (nominal ID 3-3/8 inches). Firm cement was drilled to 13,159 ft and mud was washed to 13,705 ft, where a tight spot was found in the 4-1/2 inch liner. This spot required 1,500 units of torque to rotate and clean out to 13,708 ft. This is not considered an abnormally high torque for normal conditions, but represented an arbitrarily chosen upper limit for the somewhat fragile 2-3/8 inch flush joint drill pipe. The power tong controls were therefore set at this upper limit. Bottoms-up circulation showed no increase in the gas or chloride content of the mud. This was the first indication that the liner was defective.

The 3-5/16 inch cement mill was pulled and replaced, and the inside of the liner was washed and reamed to 14,447 ft. Firm cement was drilled from 14,447 to 15,435 ft,* and the hole was washed and reamed to total depth (17,226 ft). When the mud had been conditioned, the casing liner was pressure-tested to the equivalent of 19.0-lb/gal mud, but failed to hold pressure. The blowout preventers were closed to seal off annulus circulation and the mud was displaced at the rate of 1/2 to 1 bbl/min with 2,100 psi pump pressure. It was assumed that the mud was pumped out the 4-1/2 inch liner float shoe.

Before attempting to displace cement through the bottom of the 4-1/2 inch liner, an attempt was made to run gamma ray, cement bond, and variable density logs (GR-CBL-VDL). The logging sondes would not go past the top of the 4-1/2 inch liner at 13,145 ft. However, a 3-inch OD gauge ring was worked past the liner top at 13,148 ft but stopped at 13,700 ft.

A 3-5/16 inch mill was run and reamed through the top of the 4-1/2 inch liner and the tight spot at 13,700 ft. A bridge was encountered at 16,989 ft, but was washed out and the liner was again cleaned out to TD.

Schlumberger was rigged up and a 10-foot 2-5/8 inch dummy casing gun was

*This cement was probably displaced on this depth during one of the squeeze jobs before the liner tools were pulled out of the hole. After the top of the 4-1/2 inch liner was partially sealed off, some of the cement was displaced down the 4-1/2 inch liner and the mud below it was moved through the float shoe before the liner top broke down again and took all the fluid being pumped.

run in the hole, but stopped at 13,700 ft. After several attempts to get deeper, the gun was pulled and a CBL tool, with sinker bars but not fully centralized, was run and worked by the 13,700 ft restriction and reached TD. The CBL was run from total depth to 12,000 ft. Basically this indicated that bonding was poor to non-existent over all except the following zones:

<u>From</u>	<u>To</u>	<u>Feet</u>	<u>% Relative Bonding Average</u>
17,217	17,204	13	90
15,208	15,203	5	85
15,000	14,985	15	97
14,318	14,314	4	80
14,227	14,223	4	90
14,208	14,194	14	97
14,167	14,160	7	91
13,930	13,921	9	90
13,916	13,904	12	87
13,758	13,747	11	98
13,710	13,706	4	90
13,623	13,617	6	95
TOTAL FEET		104	

Some other footage showed 70 percent bonding over short intervals, but could not be considered to have enough bond to provide isolation between sands.

Between 13,787 and 13,412 ft an abnormally high reading of the gamma ray log was obtained which could not be accounted for by the addition of radioactive materials to any of the cement mixtures used in squeezing the 4-1/2 inch liner. In old wells, high gamma-ray readings have been observed when there has been a bottomhole flow between two zones. The zone being injected shows the higher gamma-ray reading. This is one explanation for the difference between the two gamma ray logs. It should be pointed out, however, that the earlier lithology logs indicate that this is a shale interval.

In order to complete the well according to the prognosis, it was necessary to set a bridge plug at 17,200+ ft to seal the bottom of the 4-1/2 inch liner. Preparatory to running a bridge plug, a 3-5/16 inch cement mill was run to ensure a full opening through the liner. No obstruction was encountered until a depth of 13,683 ft was reached. After reaming from 13,675 to 13,720 ft, the obstruction was removed and the mill could be moved through this interval without an indicated drag on the weight indicator. Having cleared out this zone, the mill was lowered to 13,978 ft, where it again took weight.

While reaming from 13,978 to 13,980 ft, the drill pipe torqued up, and before rotation through this interval was free a small amount of metal cuttings was recovered from the shale shaker. Since each of the cement-type mills was worn and the stabilizers were of soft metal designed for wear with use, it was assumed that the small amount of metal cuttings coming over the shaker came from normal wear of the stabilizers. When the

metal cuttings appeared, the mill was pulled above 13,970 ft, rotation was stopped, and the hole was circulated until no more metal cuttings appeared on the shaker.

The 3-5/16 inch mill was then pulled and a 5-7/32 inch shaving mill was run to dress the polished bore receptacle at the junction of the 5-inch and 7-inch tieback casing at 12,151 ft. By engaging the seals with the PBR it would be possible to determine whether there was a leak around the bottom of the 5-inch tieback casing at the point where the tieback assembly did not properly engage, or through the 4-1/2 inch liner or the liner shoe. The 5-inch seal assembly was run on 3-1/2 inch drill pipe and stung into the PBR at the top of the 5-inch casing at 12,151 ft. The annulus was pressured to 1,000 psi to test the PBR seal, after which 20 bbl of mud was pumped down the drill pipe at 3 bbl/min with 2,400 psi. Upon stopping the pump the drill pipe pressure was 1,200 psi. After 5 bbl had flowed back from the drill pipe the pressure was 1,100 psi. It was assumed at this point that the liner shoe had broken down.

In order to repair what was assumed to be a leak in the float shoe-float collar assembly, preparations were made to recement at that point. Halliburton was rigged up and after 14 bbl had been bled out of the drill pipe, the pressure decreased from 1,050 psi to zero. A 300-sack cement mixture followed by a wiper plug was displaced with mud below the PBR at 12,151 ft; the volume was calculated to place the top of the cement plug at 16,990 ft inside the 4-1/2 inch liner. After 15 minutes, the static drill pipe pressure was 850 psi.

After waiting on cement for 52 hours a slick line was rigged up and sinker bars were run into the hole. A mushy bottom was encountered at 13,162 ft. A pull of 800 lb in excess of normal line weight was required to free the sinker bars, which were then pulled out of the hole and the slick line unit was rigged down. Discovery of the top of the cement at 13,162 ft confirmed that the point of leakage was at the top and not the bottom of the 4-1/2 inch liner. Had there been a seal, the top of the cement would have been at 16,990+ ft.

To obtain a seal at the point of leakage between the 5-inch tieback casing, the 4-1/2 inch liner, and the 7-inch liner, a 300-sack cement mixture was displaced down the drill pipe. When the plug top was estimated to be at 12,650 ft, the pump-in pressure was 5,400 psi. Upon releasing the pressure after waiting on cement for 11-1/2 hours, there was no back flow out of the drill pipe, so Halliburton was rigged down and the seal assembly was pulled out of the hole.

The 5-inch seal assembly was pulled and a 3-3/4 inch cement mill was run in the hole to clean the cement out of the 5-inch tieback casing. The top of the cement plug was found at 12,510 ft. Solid cement was drilled inside the 5-inch tieback casing to the top of the 4-1/2 inch liner at 13,148 ft.

The 3-3/4 inch mill was pulled and a 3-5/16 inch mill was run to 13,148 ft. Before any cement was milled out of the top of the 4-1/2 inch liner, 1,500 psi pressure was applied below the BOP's; this pressure held for 15 minutes. The cement plug at 13,148 ft was drilled and the mill was used to

wash down to 13,700 ft, where the tight spot was encountered. This and other tight spots at 14,500 and 14,706 ft were milled through without abnormal torquing or metal appearing on the shale shakers while washing to the plugback total depth of 17,242 ft.

The BOP's were closed and the hole was pressured to 1,100 psi, but this pressure could not be held. This confirmed that the 4-1/2 inch liner was not sealed off. Since the top of the liner withstood the 1,500 psi pressure before the cement plug from 13,148 to 13,154 ft was drilled, it was assumed that the leak was at the float shoe at 17,242 ft. A special pill of low-viscosity mud was prepared and displaced to bottom so that wireline tools could be run to a bridge to 17,200 ft in the 4-1/2 inch liner. After the mill was pulled, a wireline truck was rigged up and a 3-inch gauge ring was run. This stopped at 13,146 ft, corresponding to the top of the 4-1/2 inch liner, so it was pulled and a 2.84-inch gauge ring run. This ring passed through the top of the 4-1/2 inch liner top but stopped at 13,577 ft. While pulling out of the hole the gauge ring again stuck at 13,146 ft. While attempting to free it, the wireline was pulled out of the rope socket of the gauge ring. The wireline was then pulled, leaving the gauge ring as a fish at 13,146 ft.

An overshot was run on drill pipe, tagged the top of the fish at 13,146 ft, and pushed it down the hole to 13,816 ft. The fishing tool was pulled and found to be packed with barite, which accounted for the failure to recover the gauge ring. The fishing tools were redressed and run in the hole. After working through a tight spot at 13,710 to 13,713 ft and washing down to 13,782 ft, a hard bottom was tagged. Upon pulling out of the hole the top portion of the fish was recovered.

A friction socket was then rerun. It was necessary to wash from 12,120 to 12,214 ft and 13,650 to 13,773 ft. The fish was tagged at 13,795 ft and pushed down to 13,821 ft. Another part of the fish was recovered when the friction socket was pulled. A 3-1/8 inch OD overshot was then run to 13,810 ft without encountering tight spots. After the drill pipe volume was circulated, the overshot was lowered to the top of the fish at 13,829 ft. The fish was pushed down to 13,866 ft and 10,000 lb weight was applied. When the overshot was pulled, the remainder of the fish was recovered.

A 3-5/16 inch mill was run into the hole to 13,152 ft. There was a momentary drag when picking up, but on repeat operations there was no drag. After rotating through a tight spot at 13,742 ft, washing was continued to 13,935 ft. Seven hours were required to wash and ream from 13,897 to 13,935 ft. Fine steel cuttings appeared on the shaker. When the mill was pulled it was found to be worn down on the outside, leaving a flat center section. The stabilizer above the mill were also worn, which could account for the metal cuttings. This suggested that the 4-1/2 inch liner had been deformed into a spiral and the mill and drill collars would not bend around the turns.

A 3-1/4 inch mill was run and washed through a bridge from 13,742 to 13,746 ft and washed to 13,865 ft. While reaming from 13,865 to 13,870 ft

excessive torque was required to rotate, but after working down there was no further torquing while moving through this area. The hole was free to 13,935 ft. While reaming from 13,935 to 14,005 ft the rate of penetration was reduced to 10 to 12 feet per hour, compared to 60 ft/hr while washing down with only rotation. When circulation was resumed, gas-cut mud and an increase in the chloride content of the filtrate were observed. There was also a small volume increase in the mud pits. After 11 stands had been pulled, the BOP's were closed and the hole was checked for fluid entry. There was no pressure buildup. The hole was circulated while 800 psi backpressure was held on the annulus. When circulation was stopped the annulus pressure was 230 psi, which quickly bled off to 210 psi. This pressure was bled off and 10 bbl of mud was pumped into the well at the rate of 1-1/2 bbl/min. The formation breakdown was 1,250 psi. When the displacement stopped, the well began to flow, indicating that a new point of entry into the 4-1/2 inch liner had developed. After the BOP's were closed, the static drill pipe pressure was 600 psi. This made it impossible to remove any additional drill pipe without stripping through the Hydril BOP.

With the 3-1/4 inch mill at 12,566 ft, a 250-sack cement mixture was displaced down the drill pipe with enough mud to leave the estimated top of the cement at 12,950 ft. When the cement had taken its initial set, the pressure was released and the hole was circulated to condition the mud before making a trip to run a new mill.

A 3-11/16 inch cement mill was run in the hole to 12,801 ft. Firm cement was milled from 12,801 to 12,822 ft. While waiting on orders, firm cement was milled from 12,822 to 12,922 ft. There was firm cement down to 13,144 ft (top of 4-1/2 inch liner), at which point the mill was pulled.

The 5-inch stinger was picked up and set in the PBR at 12,191 ft. The seals were pulled out of the PBR and the hole was pressured to 1,570 psi and held for 15 minutes with no bleedoff. The drill pipe was filled with enough water to establish a 2,000-psi differential pressure and the seals set down in the PBR. This created a 2,000-psi differential pressure to the well bore. The pressure on the drill pipe was released, and after 20 minutes there was no flow, which confirmed that the liner leak was below 13,144 ft. The water was reversed out and the seal assembly pulled out of the hole.

While going in the hole with a 3-5/16 inch cement mill, a pin from the safety clamp was dropped in the hole. (These clamps are necessary when running flush joint tubing and in this case the weld holding the pin and chain to the tubing parted.) A run with a Cavins bailer was made, but the bailer and two crossover subs were left in the hole, compounding the difficulty. Two trips with an overshot were necessary to recover the lost tools and the lost pin from the safety clamp.

A 3-5/16 inch mill was then run to continue cleaning the cement from the 4-1/2 inch liner. Cement was milled from 13,146 to 13,763 ft. A tight spot was encountered from 13,760 to 13,763 ft. Because of the lack of

progress, the mill was pulled and it was found that the blades were missing. A Cavins bailer was used to recover the blades.

Another 3-5/16 inch mill was run and milled firm cement from 13,763 to 13,920 ft. Below this point there was a void to 13,960 ft. It was necessary to ream from 13,910 to 13,960 ft because of a very tight spot at 13,914 ft. When bottoms were circulated up there was a show of gas cutting the mud from 17.6 to 17.1 lb/gal and formation shale was coming over the shakers. This was clear evidence that the liner had been breached. The mud weight was increased to 17.8 lb/gal to control the entry of gas and shale.

While pulling out of the hole, the quantity of mud required to replace the volume of the drill pipe was less than the normal volume required, indicating flow into the well from the formation. The mill was run back to a bridge at 13,804 ft and then reamed to 13,960 ft. While circulating 18.0 lb/gal mud, partial returns (95%) were obtained. The drill pipe was pulled off bottom while waiting for the hole to heal. With the drill pipe at 13,424 ft, slow circulation was started while building mud volume. When the mill was run back to bottom, a 6-foot fill was encountered. The hole was reamed out to 13,960 ft and circulated clean before pulling out of the hole.

A gamma-ray casing collar log, a 3-arm casing caliper log, and a gyro were run at DOE's instructions, in an attempt to determine the size and configuration of the leak in the 4-1/2 liner below 13,920 ft. The maximum depth reached with these tools was 13,922 ft, hence no useful information was obtained.

5. ABANDONMENT OPERATIONS

Orders were issued at 6 p.m. on April 8, 1980, by DOE/Nevada Operations Office to plug and abandon the test well. At 6:30 p.m. verbal permission was given by the Louisiana Department of Conservation to start plugging. Open-ended drill pipe was then run to 13,950 ft and a 125-sack cement mixture was displaced through the drill pipe to 11,145 ft. While waiting on cement some of the 2-3/8 inch drill pipe was laid down. The 3-1/2 inch drill pipe was run into the hole and the top of the cement plug in the 4-1/2 inch liner found to be at 12,086 ft. By order of the Department of Conservation, 10,000 lb of weight was applied to the top of the cement plug to confirm that the cement had hardened properly.

The density of the mud was reduced from 18.5 to 17.0 lb/gal. The drill pipe was pulled and the remainder of the 2-3/8 inch laid down. The tubing head was removed and the rental BOP's and choke manifold were returned to vendors. The original 5,000-psi BOP's (standard rig equipment) were reinstalled.

A 7-inch mechanical cutter was picked up and run in the hole to 9,519 ft. The power swivel was used to cut the 7-inch casing at 9,500 ft and a 7-inch casing spear was run. Pulls of up to 495,000 lb were applied without any downhole movement of the casing.

During the next several days the 7-inch casing was cut at 9,000, 8,000, 7,000, 6,489, 6,000, 5,500, and 5,000 ft with no downhole movement in excess of casing stretch.

The mechanical casing cutter was then used to cut the 7-inch casing 30 ft below the rotary and this section was pulled and laid down. The 7-inch casing spear was used in an attempt to pull up the section from 5,000 ft, but without success.

The 7-inch casing was then cut at 4,000 ft. The casing spear engaged the top of the pipe, but after repeated pulls of 400,000 lb there was no down-hole movement. The spear was released and pulled, and a spear with a pack-off was run, in an attempt to circulate around the 7-inch casing. The top of the casing had been damaged, however, and the pack-off would not enter the casing. The spear was laid down, the 3-1/2 inch drill pipe run in the hole to 4,400 ft, and the mud weight cut from 17.0 to 10.0 lb/gal.

The 7-inch and the 9-5/8 inch casing strings were perforated from 4,600 to 4,604 ft with eight shots. The 10.0 lb/gal mud was pumped down the drill pipe through the perforations and up to the surface through the 9-5/8 - 13-3/8 casing annulus. The 3-1/2 inch drill pipe was lowered and a 75-sack cement mixture displaced at 5,452 ft. This cement plug was checked after setting and found to be at 4,963 feet inside the 7-inch casing.

The drill pipe was pulled and a 7-inch retainer was run on drill pipe and set at 4,200 ft. After testing the seal of the retainer with 500 psi, 500 sacks of Class "H" neat cement was mixed, 475 sacks were displaced below the retainer and 25 sacks were spotted on top of the retainer. The drill pipe was pulled and the excess laid down.

The 7-inch casing cutter was used to cut the casing at 3,000, 2,000 and 1,000 ft. Pulls made after each cut produced no downhole movement. A final cut was made 62 ft below the mud line and this section pulled and laid down.

The 3-1/2 inch drill pipe was run into the hole to check the top of the cement above the retainer, which was found at 4,050 ft. All the drill pipe was then pulled and laid down.

The 9-5/8, 13-3/8 and 20-inch casings were cut at 62 ft. The 9-5/8 inch casing was pulled, and an 80-sack cement plug was spotted from 244 to 62 ft. After washing around the 13-3/8 inch and 20-inch casing with the rig pumps and failing to pull, the drilling barge started to rig down and move off location. The actual move started at 4 p.m. on April 21, 1980, and after resolving some difficulties with a local oyster fisherman and negotiating to cross some oyster beds, the rig was in deep water and released at 6 p.m. on April 22, 1980.

A Delta Construction spud barge was used to complete the prescribed abandonment procedure. The 13-3/8 inch and 20-inch casing was cut and pulled and all pilings were removed. This work was completed on April 23, 1980. The plug and abandonment report was submitted to the Louisiana Department of Conservation on April 29, 1980, as a final step for the termination of work on the Tenneco Fee "N" No. 1 Well.

Figure 8 is a schematic of the condition of the Gruy/DOE/Tenneco Fee "N" No. 1 when the abandonment work was completed.

The total time charged to the reentry and abandonment by the drilling barge and spud barge was 2,561 hours. Figure 9 shows how this time was divided among various functions. The times charged to the 10 functions shown were obtained from the daily drilling reports and represent the summation of 47 various daily operations as noted on those reports.

Figure 8.--Condition of Tenneco Fee "N" No. 1 well
after plugging and abandonment.

Figure 9.--Time distribution of operations,
Tenneco Fee "N" No. 1 well.

6. CONCLUSIONS

The failure to properly cement the 4-1/2 inch liner when the well was originally drilled permitted conditions to develop which made it impossible to complete the well and necessitated the eventual abandonment of the operation.

With the 4-1/2 inch liner uncemented, potential problems were:

1. Fluid flow behind the liner.
2. Local enlargement of well bore by sloughing.
3. Linear movement due to thermal expansion caused by temperature differential due to intermittent circulation in unsupported hole.
4. Pressure differential across liner.
5. Separation of liner due to combination of 1, 2, 3, and 4.
6. Transferred bottomhole pressure to top of liner (less head of water column), thereby causing the hole to flow with 17.6 lb/gal mud in hole.
7. Hole in liner caused by reduced wall thickness resulting from wear while milling cement and rotating while conditioning mud.

There is some question whether the liner was hung or set on bottom before releasing the liner hanger. The Tenneco reports are not specific on this point. If it was set on bottom, rather than hung in tension, it would tend to "corkscrew" in an enlarged hole. This condition, coupled with temperature differentials and continued milling, could eventually have caused liner failure at one of the tight spots. It is not known why the tight spots continued to appear after they had been wiped out by milling, but it is possible that some combination of the above factors caused separation at a collar. The wear pattern on at least one of the worn cement mills appears to suggest this. Tenneco considers that the liner became separated at a collar, which would account for the apparent periodic movement of the pipe to cause the recurrence of tight spots.

It was known that the 4-1/2 inch liner had a leak, but its exact location, prior to finding the bottom of the cement plug at 13,920 feet, had been assumed to be in the float shoe on bottom because of the minimal amount of steel cuttings observed and the extra heavy weight and wall thickness of the 4-1/2 inch liner.

Faulting within wells drilled in the Gulf Coast of Louisiana is expected, and displacement can be from a few feet to 3,000 ft or more. As noted on the structural map (Fig. 3), numerous growth faults were penetrated by the Tenneco Fee "N" No. 1. Since geologically all of this formation is Miocene or younger, it is probable that movement is going on now. With a 4-1/2 inch liner in place, lateral movement of a fraction of an inch or more

would cause enough damage to make it difficult to run wireline tools through it. It is possible to shear casing by downhole movement as a result of faulting. There is no way of confirming that such a movement happened after the liner was run, but such a movement is quite possible.

In conclusion, Gruy Federal considers that Tenneco performed the operations as a prudent operator. They controlled the constant tendency of the well to attempt to blow out. They avoided twistoffs and major fishing jobs on the macaroni drill pipe.

The cooperation between Tenneco as operator and Gruy Federal as observer was excellent. At no time did Tenneco take or suggest any important step without the full concurrence of Gruy Federal. If a mistake was made, it was the failure to realize the full extent of the problems associated with the improperly cemented liner and the extreme difficulty of effecting a cement job at the top of the liner.

APPENDIX A

TENNECO INTERNAL REPORT EVALUATING THE RE-ENTRY ATTEMPT

I. Narrative

Atlantic and Pacific Marine Corporation's Rig #1 arrived on location on January 9, 1980, was spotted and leveled, and safety equipment installed and tested. After preparing the rig and all surface equipment for the anticipated work, entry into the well was started with an 8-1/2" bit. The plug-back bottom was encountered at 11,670'. Using a 17.5 ppg ligno-sulfonate drilling fluid system, cement was drilled inside of the 9-5/8" protection pipe from 11,670' to the top of the 7" liner at 12,306'.

On January 15th, the 7" liner top was pressure tested to 600 psi or an equivalent mud weight of 18.5 ppg at 12,306'. The subsurface assembly was then changed out and entry into the 7" liner was started with a 5-7/8" cement type mill. Firm cement was encountered inside of the 7" liner from its top at 12,306' until a depth of 12,417' was reached on January 16th. At that depth, gas was first detected in the circulating drilling fluid. The well was again shut in and the 7" liner top tested to 900 psi or an equivalent mud weight of 19.2 ppg at 12,306'. Drilling of firm cement continued in the 7" liner with gas continually observed in the circulated returns. On January 17th, when a depth of 13,040' was reached, the mill drilled through cement and entered a void. The pumps were stopped and the well was observed to have a substantial flow back of the 17.5 ppg drilling fluid. Immediate steps were taken to halt the flow by shutting the blowout preventers. Shut-in pressures stabilized at 1,280 psi on the drill pipe and 1,650 psi on the casing.

The blowout preventers remained shut in with pressure on the well from January 18th until January 27th. During this time, remedial action

consisting of four applications of cement was taken. Slurry volumes of 610 cubic feet, 244 cubic feet, 488 cubic feet and 244 cubic feet were pumped into the well using the Bradenhead technique in an effort to seal off the top of the 4-1/2" liner. The fourth application apparently produced a competent barrier because it was only then that all pressure was bled from the well and the blowout preventers allowed to remain open. With the well again under control and the 5-7/8" mill still in the hole, the 7" liner was cleaned out to the top of the 4-1/2" liner.

On January 29th, Schlumberger was called out to the location and rigged up. A combination gamma ray/cement bond log was run from the top of the 7" liner at 12,304' to 6,500' and an inspection log of the 9-5/8" casing was run from 12,304' back up to the surface. These logs were for the purpose of safety and correlation. The 9-5/8" casing was found to be in excellent condition.

From January 30th to February 5th, the 5" by 7" tieback string was run and cemented and the surface equipment modified to continue with the project. Difficulty was encountered in running the 5" by 7" tieback as a mechanical seal was not established with the liner tieback equipment. After due consideration of the alternatives and discussions with other parties, and due to the well condition and the joint makeup procedures the tieback was cemented in place without an indication of a mechanical seal. A 2-3/8" bottomhole assembly was picked up together with a 3-3/4" cement type mill. Entry into the tieback started on February 6th and cement was encountered at 12,789'. Firm cement was drilled from 12,789' to 12,982' where the rubber cement wiper plug was located. After drilling the plug, firm cement was again drilled from 12,982' to 13,139'. At

13,139' the bottom of the tieback sleeve was encountered and the 3-3/4" mill was pulled out of the hole. The pipe was carefully measured as it was being pulled from the hole and a corrected depth of 13,148' was observed and recorded. This revised depth correlates with the casing measurements as well as with electric logs which were run at later dates.

On February 9th, a 3-5/16" cement type mill was run into the well and firm cement was drilled from 13,148' to 13,159'. The 4-1/2" liner was cleaned out from 13,159' to 13,705' by washing and reaming, with little indication of cement encountered. At 13,705' an obstruction was located. One hour was spent trying to get through it, during which time only 3' of penetration was accomplished. The hole was circulated clean at 13,708' and the return drilling fluid carefully observed for metal cuttings. Some cuttings were detected, as well as some gas, but were considered minimal. It was impossible to distinguish the source of metal as being the casing or the drilling assembly. The 3-5/16" mill was pulled out of the hole.

A 3-1/8" cement type mill was then run into the hole. The area between 13,700' and 13,750' was penetrated and cleaned out. However, torque and drag and some gas were evident throughout that interval. It should be pointed out that the 3-1/8" mill was 1/4" smaller than the drift diameter of the liner.

The cleaning out of the 4-1/2" liner continued from February 10th through the 12th, when a total depth of 17,226' was reached. Firm cement was encountered between 14,447' and 15,188' and soft cement between 15,188' and 15,435'. The rest of the liner was free of any major obstructions or cement. Gas was evident in small quantities.

Upon reaching 17,226', preparations were made to test the 4-1/2" liner shoe. The hole was circulated clean after which the blowout preventers were closed. Pressure was applied to the casing up to 1,200 psi, or 19.0 ppg equivalent mud weight at 17,226' with 17.7 ppg mud in the hole. The pressure leaked off to 500 psi. Pressure was again applied and a pump-in rate of 1 barrel per minute at 2,100 psi was established. After all pressure was bled from the casing and the well observed to be dead, the blowout preventers were opened and the 3-1/8" mill pulled from the hole.

On February 14th, Schlumberger was mobilized on the location in an unsuccessful effort to log the 4-1/2" liner. Four separate attempts were made to go in the hole with different size and type tools. Tools measuring 3-3/16" OD, 3" OD and 2-1/8" OD were run and even the smallest would not go below 13,700'. Schlumberger was rigged down and released.

A 3-5/16" cement type mill, with a 3-1/4" string reamer 2 joints above, was run in the hole and those areas near the tieback sleeve at 13,148' and near 13,700' were reamed through. This assembly was worked all the way to the bottom at 17,226' and the hole circulated clean. The 3-5/16" mill and 3-1/4" string reamer were pulled out of the hole. Again some indications of gas were evident.

On February 17th, Schlumberger was again mobilized on location to attempt to log the 4-1/2" liner. A dummy gun measuring 2-1/8" OD by 44' long was rigged up and started into the hole. The dummy gun would not go past 13,740' and had 300# to 400# of pickup drag. With Schlumberger still on location, the mill was run back into the hole and a highly treated low-solids mud pill was spotted inside the 4-1/2" liner. Schlumberger

tried to run the logging tools without weights but could not get below 13,700'. Sinker bars were added to the tool string and successfully run to a corrected total depth of 17,242' (wireline measurement). Three attempts were necessary to work the tools past 13,700'. A cement bond/variable density/gamma ray/casing collar log was run from 17,234' up to 12,000'. Indications of cement bond were scant to non-existent over the entire length of the 4-1/2" liner.

An attempt to wipe out the restrictions at 13,700' was made on February 20th. A 3-5/16" mill was run with a 9-blade string reamer, measuring 3-3/8" OD by 6.78' long, located 9 joints above the mill. A 30' tight spot was located and reamed through from 13,683' to 13,713' (reamer at 13,407' to 13,437'). The assembly washed down freely from 13,713' to 13,978', but severe torque was again encountered at 13,978'. Two feet of penetration was made from 13,978' to 13,980' with the reamer at 13,702' to 13,704'. However, at this point excessive torque made it necessary to pull the assembly out of the hole. Gas was observed in the circulating drilling fluid, but there was no associated increase in chlorides. It was estimated that the gas was from a slight leak at the 4-1/2" liner shoe.

Preparations to squeeze the 4-1/2" liner shoe were started February 24th. A 5-7/32" polishing mill was run in the hole, and the polished bore receptacle located at the 5" by 7" crossover was milled out from 12,151' to 12,189'. The polishing mill was pulled out of the hole and a 5-1/4" Texas Iron Works seal assembly run back in. Located above the assembly was a wiper plug for the 5" by 4-1/2" liner. The seal assembly

was lowered into the polished bore receptacle. Halliburton was mobilized on the location and pressured up on the casing to 1,000 psi. Twenty barrels of mud were then pumped down the 3-1/2" drill pipe at 3 barrels per minute and 2,400 psi pump-in pressure. The shut-in pressure after pumping was 1,200 psi. Five barrels were bled off in an attempt to bleed off all pressure. The flowing pressure stabilized at 1,100 psi. At this time, the indications were that the 4-1/2" liner top had broken down.

The well was left shut in for observation for 20 hours at the end of which time an attempt was again made to bleed off all pressure. All pressure was bled off and the well observed to be dead. This, of course, changed the evaluation of observations from that of pressure communication at the top of the 4-1/2" liner, to a residual pressure charge on the formation at the 4-1/2" liner shoe which had dissipated during the elapsed 20 hours. Preparations resumed to squeeze the 4-1/2" liner shoe.

The seal assembly was pulled out of the polished bore receptacle. Halliburton mixed and pumped a 366 cubic foot cement slurry down the 3-1/2" drill pipe. Upon completion of the mixing operation, the seal assembly was lowered back into the polished bore receptacle and the wiper plug released. Sufficient mud was pumped behind the plug to displace the cement to 16,990'. The well was shut in for 60 hours waiting on cement during which time four unsuccessful attempts were made to bleed the pressure off the drill pipe. The shut-in pressure stabilized at 900 psi. Otis Wireline Service was moved to the location and sinker bars run into the well under pressure. An obstruction was located at 13,162'. The Otis Wireline truck was rigged down and preparations were made to re-cement the top of the 4-1/2" liner.

Since the well was alive with 900 psi shut-in pressure, it was necessary to leave the seal assembly in the seal bore receptacle. Halliburton was rigged up and a 366 cubic foot cement slurry was mixed and pumped down the drill pipe. A wiper plug was then dropped and displaced with sufficient fluid to locate the top of the cement at approximately 12,650'. The well was left shut in for 12 hours waiting on cement after which all pressure was bled off. Halliburton was rigged down and the seal assembly pulled out of the hole.

A 3-3/4" cement type mill was run in the hole and cement tagged at 12,510'. Hard cement was drilled in the 7" liner from 12,510' to 13,148' during the period February 29th to March 4th. On March 5th, the 3-3/4" mill was pulled and replaced with a 3-5/16" cement type mill. With a 3-5/16" mill on bottom, the blowout preventers were closed and the 4-1/2" liner top successfully tested to 1,500 psi with 17.5 ppg mud in the hole. This corresponds to an equivalent mud weight of 19.7 ppg at 13,148'. All pressure was bled off the well and the plugs in the top of the 4-1/2" liner were milled on from 13,148' to 13,152'. At 13,152' the mill fell through with no indications of cement below. The 3-5/16" mill was then run all the way into the hole hitting tight spots at 13,700', 14,500' and 14,706'. Upon reaching bottom at 17,242' on March 6th, the well was shut in and a leakoff test run on the 4-1/2" liner. The 4-1/2" casing shoe broke down and mud was pumped in at 1,100 psi. Gas-cut mud was circulated out and a highly treated low-solids mud was spotted in the 4-1/2" liner in preparation to set a cast iron bridge plug in the bottom of the 4-1/2" liner.

A GO International wireline truck was mobilized on location. An attempt to run a 3" OD gauge ring was made but the tool could not be worked below

13,146'. A 2.840" OD gauge ring was then run and worked through the tight spot at 13,146'. However, it could not be worked down past 13,577'. While attempting to pull the tool out of the hole it became stuck at 13,146'. Six and one-half hours were spent trying to pull the tool loose. The wireline finally came free, but it pulled out of the rope socket leaving the tool in the hole.

During four trips made between March 8th and March 12th, the hole was cleaned and all pieces of the tool recovered. At least one piece of the fish was recovered on each trip except one. A different fishing tool was used each time. Gas was observed in the circulated fluid returns during each attempt.

A 3-5/16" OD mill, with a 3-1/4" OD string reamer located 2 joints above, was run in the hole. A tight spot was encountered at 13,152' which was wiped out by rotating through it two times. As the mill was lowered into the hole, a bridge was hit at 13,742'. The bridge was washed out and the hole cleaned to 13,935'. Excessive torque of up to 2,000 foot-pounds, with a penetration rate of as little as 5 feet per hour, was encountered in the last 38' from 13,897' to 13,935'.

The 3-5/16" OD mill was pulled from the hole and replaced with one measuring 3-1/4" OD. A 4' bridge was washed out from 13,742' to 13,746'. Excessive torque was again encountered at 13,870'. The hole was cleaned out by slowly milling down at 10 to 12 feet per hour to a depth of 14,005'. Up to 2,000 foot-pounds torque was required to rotate the pipe and the background gas in the circulated returns was observed to continually increase with a resulting cut in mud weight from 17.5 ppg to 16.7 ppg.

The chloride content also increased from 19,200 PPM to 22,500 PPM.

The well was shut in and 1,250 psi placed on the casing. The pressure bled off, so pumping continued until a rate of 3/4 barrels per minute at 1,800 psi pump-in pressure was established, and 5-1/2 barrels were pumped. An attempt to bleed the pressure off was unsuccessful. The well was left shut in for 12-1/2 hours and the casing pressure observed to rise from 650 psi to 820 psi.

Halliburton was mobilized on location and rigged up to pump into the well. A rate of two barrels per minute at 4,600 psi was established and a total of 30 barrels of mud pumped. 305 cubic feet of cement were pumped down the drill pipe and sufficient mud was displaced behind it to locate the top at 12,950'. The well was shut in and cement allowed to set for 24 hours.

All pressure was released and the well observed to be dead. The 3-1/4" mill was pulled from the hole and replaced with one measuring 3-11/16" OD. The new mill was run into the hole and cement tagged at 12,801'. Hard cement was drilled from 12,801' to the top of the 4-1/2" liner at 13,144'. No indications of gas were observed in this interval.

On March 23rd, the 3-11/16" mill was pulled from the hole and the 5" seal assembly run back in. The blowout preventers were closed and a leakoff test to 1,575 psi was run. The pressure was bled off and fresh water circulated down the 3-1/2" drill pipe to a depth of 4,250'. The seal assembly was lowered into the polished bore receptacle and 2,000 psi shut-in drill pipe pressure was bled off. The well remained dead, indicating the

seal at the top of the 4-1/2" liner was competent to a negative differential pressure of 2,000 psi. After observing the well for 30 minutes, the seal assembly was pulled out of the polished bore receptacle and the water allowed to "U-tube" out of the drill pipe. The seal assembly was then pulled out of the hole.

Hildenbrand Pipe Inspectors were mobilized at the location to inspect the 2-3/8" drill pipe connections. Of the 183 joints inspected, 6 were rejected. During the inspection process, it was necessary to break out every connection, tripling the use of the 2-3/8" safety clamp. The chain which firmly attaches the pin connector to the clamp parted and the pin was lost in the hole. A Cavens Hydrostatic bailer was used to fish for the pin. During the fishing operations, the bailer's junk basket was left in the hole. An overshot and grapple were used to fish for the junk basket, which was recovered after two trips. Upon examination of the basket, it was discovered that the pin had also been recovered.

On March 27th, a 3-5/16" cement type mill was run into the hole and 15' of firm cement drilled in the top of the 4-1/2" liner from 13,150' to 13,165'. Spotty cement was then drilled from 13,165' to 13,332'. Firm cement was again encountered from 13,332' to 13,760'. From 13,760' to 13,763' penetration stopped and the mill was pulled from the hole. When the mill arrived at the surface, it was discovered that all three blades of the cutting structure were missing. A Cavens Hydrostatic bailer was again used to clean out the hole, which was accomplished in two trips.

With the hole again free of junk, a mill was run in and firm cement drilled from 13,763' to 13,920'. Severe torque and drag were encountered

at 13,920' and the hole was circulated clean at that point. Cuttings from the circulated returns were recovered and analyzed. Samples of these cuttings were submitted to Core Laboratories, Inc. of Houma, Louisiana, and determined to be formation shale. Associated with the cuttings were gas and a corresponding increase in chlorides. This was the first gas observed since the well had been cemented off on March 26th. The mill was again lowered to the bottom in an effort to clean the hole out in preparation for logging. A tight spot was wiped out from 13,914' to 13,920' and the hole cleaned to 13,960'.

The drill pipe was started out of the hole with the amount of replacement mud carefully monitored. The volume of mud required to maintain the fluid level in the well was insufficient to compensate for the volume of pipe removed, indicating the influx of some unknown material in the bottom of the well. The pipe was lowered into the hole and an obstruction encountered at 13,803' for a loss of 157' of depth. The well was cleaned out from 13,803' to 13,960' at which point the mud weight was increased to 18.5 ppg. After circulating the heavier mud completely around in the well, the pipe was pulled out of the hole.

On April 7th, a GO International electric wireline truck was moved out to the location. A gamma ray/casing collar locator logging tool was run into the hole to a depth of 13,910'. Attempts to get deeper were unsuccessful. A gamma ray/casing collar log was run from 13,910' up to 12,100'. The tool was then pulled out of the hole and replaced with a 3-arm caliper. The caliper was run in the hole but would not go below 13,922'. A caliper survey was run from 13,922' up to 12,800'. Efforts were made to locate a casing inspection tool that could be run in the ID of the pipe under existing

temperature and pressure conditions. These efforts proved futile, whereupon the wireline truck was rigged down and the decision was made to plug and abandon.

The Louisiana Conservation Department was notified of the decision to abandon the well and a cement plug from 12,080' to 13,950' was spotted with their permission. Numerous attempts to cut and recover the 7" casing were made down to 9,500' between April 11th and April 12th. All attempts proved unsuccessful. Cement plugs were left in the 7" casing at 5,452' to 4,963' and from 4,050' to 4,600'. The 7" and 9-5/8" casings were perforated at 4,600' and cement pumped in the 7" by 9-5/8" annulus as well as the 9-5/8" by 13-3/8" annulus from 3,000' to 4,600'. This was accomplished by setting a cement retainer in the 7" casing at 4,200' and establishing circulation first up the 9-5/8" by 13-3/8" annulus, shutting it in, and then circulating up the 7" by 9-5/8" annulus. A final plug was spotted from 52' to 244'. All casing was cut off 20' below the mud line and the abandonment completed by dismantling the wellhead structure. The rig was released at 6:00 p.m. on April 22, 1980.

Attached are wellbore schematics showing the various operations discussed above. Also attached are sections of the gamma ray logs showing the high radiation levels and the cement bond log.

II. Major Events

1. Jan. 18 - Pressure in excess of 17.5 PPG gradient encountered at 13,040'.

KNOWN: A) Shut-in casing pressure - 1600 PSI

B) Shut-in drill pipe pressure - 1300 PSI

C) Volume increase in tanks - approximately 50 BBL

D) Leak from below 13,040 (7" liner top @ 12,306 was tested to 600 PSI on January 15 with cement from 12,306 to 13,040 below; to 650 PSI on January 16 with cement from 12,417 to 13,040 below; to 900 PSI on January 16 with cement from 12,459 to 13,040 below. All tests with 17.5 PPG mud in hole).

E) Pore pressure plot of pressures to TD.

INDICATIONS: Pressure gradient = 1,250 PSI + hydrostatic pressure of 13,040' of 17.6 PPG mud (from stable shut-in drill pipe pressure at 1800 hr. on January 19, 1980) = 19.45 PPG @ 13,040'.

DIAGNOSIS: Pressure communication from the outside of and around the top of the 4-1/2" liner. Pressure data and pore pressure plot data indicated source of flow could be in the 13,500' to 15,700' interval. However, accuracy of pressure measurements makes the source calculation only qualitative in nature.

ACTION: Four applications of cement

A) January 19 - 6 BBL 17.6 PPG Sam 5 spacer ahead;

500 sk Class H + 35% Okla No. 1 + 3/4% CFR-2 + 0.2%

HR 5 (610 CF slurry @ 17.6 PPG); tailed slurry with

3 BBL 17.6 PPG Sam - 5 + 177.0 BBL 17.6 PPG mud
(180.0 BBL total displacement)

- B) January 21 - 5 BBL 17.6 PPG Sam 5 spacer ahead; 200 sk Class H + 35% Okla N⁰ 1 + 3/4% CFR-2 + 0.2% HR-5 (244 CF slurry @ 17.6 PPG); tailed slurry with 2 BBL 17.6 PPG Sam-5 + 177 BBL 17.6 PPG mud (179.0 BBL total displacement)
- C) January 23 - 7 BBL 17.6 PPG Sam 5 spacer ahead; 400 sk Class H + 35% Okla N⁰ 1 + 3/4% CFR 2 + 0.2% HR 5 (488 CF slurry @ 17.6 PPG); tailed slurry with 2 BBL 17.6 PPG Sam-5 + 177 BBL 17.6 PPG mud (179 BBL total displacement)
- D) January 25 - 8 BBL 17.6 PPG Sam 5 spacer ahead; 200 sk Class H + 35% Okla N⁰ 1 + 3/4% CFR 2 + 0.3% HR-5; 100 sk Class H + 35% Okla N⁰ 1 + 3/4% CFR 2 + 0.1% HR 5 (366 CF slurry @ 17.6 PPG) tailed slurry with 2 BBL 17.6 PPG Sam-5 + 174 BBL 17.6 PPG mud (176 BBL total displacement)

RESULTS: January 27 - The last cement application bridged off the pressure communication; however, no cement was left in the 7" liner above the top of the 4-1/2" liner. This is inconsistent with the volumes of displacement.

CONCLUSIONS: The location of the leak was not positively identified at this stage. However, two conclusions could be drawn: the leak was (a) below 12998 and (b) not appreciably deeper than the top of the 4-1/2" liner. These conclusions are justified because of the facts that (a) the pipe was not

cemented in the hole from 12998 up (the deepest location of the mill during cementing operations); (b) no cement was located in the 7" liner above the 4-1/2" liner nor in the 4-1/2" liner.

2. February 9 - cleaned out top of 4-1/2" liner. Only 11 feet of cement were encountered.
3. February 9 - tight spot first encountered in the vicinity of 13700' with 3-5/16" mill.
4. February 11 & February 12 - the well was cleaned out to a total depth of 17226' with a 3-1/8" mill. Press up on csg to 1200 with 17.7 PPG mud in hole. Press bled off to 500 PSI. Bled off all pressure. Well dead.
5. February 16 - cleaned hole to 17226 with 3-5/16" mill.
6. February 19 - Schlumberger worked logging tools to 17242 with sinker bars. Logged GR-CCL-CBL-VDL.

KNOWN: A) Well clean to 17242 wireline measure

B) Well cannot withstand shut in pressure greater than 500 PSI.

INDICATIONS: 4-1/2" liner leak. Cement bond log indicates bond was poor to non-existent. Radiation anomaly exists between 13400 and 13800.

DIAGNOSIS: Cement bond over the entire length of the 4-1/2" liner was questionable, particularly at the top and at the bottom. A leak existed, and since there was no pressure on the well, it could be assumed to have been at the shoe. A radiation anomaly indicated a possible flow from 13,800± to the 7" liner.

ACTION:

- A) February 23 - HOWCO pumped in well but pressure could not be bled off. A shut-in pressure of 1200 PSI was observed. The well was left shut in for 20 hours. On this date it was estimated that the 4-1/2" liner top was broken down.
- B) February 24 - Shut-in pressure down to 1050. All pressure was bled from well. With the well dead the estimate was revised from communication at the top of the 4-1/2" liner to that of a formation charge at the 4-1/2" shoe.
- C) February 24 - Using a seal assembly in the PBR at 12189, cemented as follows: 10 BBL bay water; 300 sk Class "H" + 35% Okla N^o 1 + 1.2% CFR-2 + 18% salt + 0.1% HR-15. Dropped wiper plug. Displaced cement with 5 BBL water + 151 BBL 17.5 PPG mud. (Sufficient to displace mud to shoe.) Changed cement slurry design and cement procedure to provide better rheology conditions.
- D) February 25 & February 26 - Well live with 700 PSI SIP. An obstruction was located at 13162'. It was then apparent that the 4-1/2" liner top had indeed broken down and that is where the cement had been over displaced.
- E) February 27 - Recement 4-1/2" liner top as follows: Pumped 10 BBL gelled water; 25 BBL bay water; 10 BBL fresh water; 300 sk Class "H" cement + 35% Okla N^o 1 + 1.2% CFR-2 (366 CF slurry @ 17.8 PPG). Dropped wiper

plug and displaced with 5 BBL fresh water + 93 BBL 17.5 PPG mud. Staged 1/2 BBL and 3/4 BBL in 15 min. intervals. Pressure up to 5000. Changed cement procedure to provide large water flush ahead of cement.

RESULTS: March 5 - Milled cement to 13,148. Located and milled plug at 13,148. No indications of cement under plug (below 13,148) tight spot again encountered at 13,700. March 6 - Cleaned out hole to T.D. Tested shoe to 1100 and pumped in.

CONCLUSIONS: a) 4-1/2" liner top has been sealed off; b) 4-1/2" shoe or liner continued to leak; c) there is a mechanical problem at 13,700.

An effort to seal off the bottom of the well with a wireline bridge plug will be made.

7. March 7 - Could not get wireline tools to bottom. Lost tools in hole.

KNOWN: A) Fish consisted of: 1 - 1-5/16" x 6" fishing neck
1 - 1-11/16" x 7'0" sinker bar
1 - 2-1/8" x 1'6" csg collar locator
1 - 1-7/16" x 8" crossover
1 - 1-7/16" x 3'0" span jars
1 - 2.840" x 1'6" gauge ring

B) Fish at or below 13,146.

C) Recovery must take place inside 3.375" drift ID (max. tool OD 3-5/16").

DIAGNOSIS: 3-1/8" washpipe is difficult to obtain and not recommended because of the mechanical weakness of the threaded connections. This eliminated the use of extensions and limited the length of fish that could be caught with standard fishing tools. The next washpipe size available is 3-1/2" OD.

ACTION: The hole was cleaned out in four trips with tools of different design including one non-standard.

- A) March 9 - Trip No. 1 was made with a 3-1/8" overshot equipped with a 1-3/8" basket grapple (basket grapples will catch $\pm$ 1-1/16" in OD). Did not recover anything; overshot plugged off with barite.
- B) March 10 - Trip No. 2 was made with the same overshot and grapple. Recovered the fishing neck only, the bottom threads had parted.
- C) March 11 - Trip No. 3 was made with a fishing tool of field design. The tool consisted of the bottom portion of a joint of 2-7/8" EUE tubing complete with upset. The ID of the tool was deformed to provide a friction grasp and was long enough to contain the entire fish down to the 2.840" gauge ring. This tool was used because it was the only alternative available with an ID large enough to accommodate the 2-1/8" OD casing collar locator. After the tool engaged the fish at 13,795', an effort was made to push it to bottom where it could be left. However, a hard bottom was encountered at 13,821'. The sinker bar and casing collar locator were recovered.
- D) March 12 - Trip No. 4 was made with a 3-1/8" overshot equipped with a bottom catch 1-3/4" basket grapple. (An overshot 3' long was used so as to get over the jars and latch onto the shaft above the gauge ring.) The jars and gauge ring were recovered.

RESULTS: All junk was recovered and the hole cleaned out to 13,821'. The sinker bars and jars were twisted into a corkscrew when recovered.

8. March 25 - Lost pin from safety clamp in hole. While fishing for the pin with a hydrostatic bailer, a junk basket was also left in the hole.

ACTION: A) March 26 - Trip No. 1 was made with a 3-5/8" OD overshot with a 2-7/32" basket grapple (in this instance, fishing took place in the 4.044" ID portion of the well, allowing the use of larger tools). Did not recover anything.

B) March 26 - Trip No. 2 was made with a 3-3/4" overshot with a 2-1/2" basket grapple. The junk basket with the pin in it was recovered.

RESULTS: All junk was recovered and the hole cleaned out to 13,148'.

9. March 14 - Could not clean out hole below 14,005'. Well kicked.

KNOWN: A) Shut-in casing pressure - 660

B) Shut-in drill pipe pressure - 600

INDICATIONS: Top of liner again leaking.

ACTIONS: A) March 15 - Pump cement as follows: 10 BBL gel water; 10 BBL bay water; 10 BBL fresh water; 250 sk Class "H" cement + 35% Okla No. 1 + 1.2% CFR-2 + 0.1% HR 5. Displaced cement to 12,950 with 17.5 PPG mud. WOC.

B) March 17 - Bled off all pressure. Well dead.

RESULTS: A) March 18 - April 4 - Drilled cement to top of 4-1/2" liner at 13,148, then inside 4-1/2" liner to 13,920. Drilled out of cement at 13,920.

B) April 5 - Drilled from 13,920 to 13,960. Recovered formation shale and gas-cut mud (no gas observed until 13,920 reached).

CONCLUSIONS: A) Since cement was found below 13,148, the leak had to be below 13,148.

B) Since: the bit drilled out of cement at 13,920; gas and formation shale were recovered from 13,920 to 13,960; the hole had to be at 13,920.

C) At this point, the decision to plug and abandon was made.

Conclusions

The lack of success in the effort to complete this well can be directly attributed to the condition of the 4-1/2" liner. Pressure was encountered during the initial entry into the well which indicated a leak at the very top of the liner. After remedial steps established a seal there, the bottom, or shoe, or the liner was observed to leak. As a result of these leaks it was impossible to change out the weighted drilling fluid system. This, in turn, made any further remedial action involving wireline procedures virtually impossible. It must be remembered that the ability of the liner to provide pressure containment was absolutely necessary to safely control the flowing test and to provide an environment in which valid data could be gathered.

In order to analyze the cause of the ultimate failure of the 4-1/2" liner at approximately 13,900', the conditions and activities involving that vicinity should be examined. A significant amount of activity took place in the general area between 13,700 and 13,900'. This included one trip with a 3-1/8" mill; two trips with a 3-5/16" mill; and 5 trips with a 3-5/16" mill in tandem with a 3-1/4" string reamer. Some metal cuttings were recovered, but not what could be expected if a hole had been drilled through the casing. Additionally, on only two occasions was there any reaming done at 13,900', and then for periods of not more than one hour each. Therefore any holes which may have developed as a result of internal activity should have occurred at 13,700' and not 13,900'. The other aspect of the failure concerns the condition of the outside of the 4-1/2" liner at 13,900'. A comparison of the open hole gamma ray log run in the autumn of 1978 was made with the cased hole log run during February 1980. An area of abnormally high radiation from 13,850' to 13,400' was detected on the log of February 19, 1980. This radiation

anomaly was not present in the open hole log. This, of course, indicates that a significant change occurred during the year that the well was left shut in. Radiation curves of this type are interpreted as indications of the deposition of radioactive salts associated with a movement of formation water. Assuming that to be true in this case, deformations to the liner OD in the form of erosion and/or corrosion could be significant. The possibility of external damage to the casing is also indicated on the casing collar log run over this section by GO International Wireline Services on April 8, 1980. Correlative with the interval of high radiation is an area of high activity recorded by the casing collar tool. While considering those conditions external to the casing, it should also be remembered that the bore hole had penetrated an active fault zone at approximately this depth. This raises the possibility of deformations resulting from tectonic forces. The caliper associated with the dipmeter log also indicates hole washout to 7" to 8" in the major axis of the 4-arm dipmeter in the shale sections. A change in temperature or sticking of the liner in the sand intervals could have caused buckling forces to deform the casing in the 13,700' and 13,900'± intervals. A gamma ray correlation log run on February 19, 1980, showed tension when pulling the tools through the 13,700' and 13,900' intervals.

These observations have led to a conclusion that the casing collapsed or otherwise failed at 13,920'. At that point the mill departed the casing and penetrated formation. The occurrence of the failure would have to be sometime between March 6 and March 16. March 6 was the last date that a mill had been run below 13,900'. March 16 is the date of the last cement job.

The use of liners by the petroleum industry in drilling deep abnormally pressured wells introduces yet another risk into an already high contingency operation. Every operation and procedure involved could cause a failure in

the successful completion of a well. In spite of these objectionable attributes affecting the completion aspect, liners do provide a safe means of successfully drilling the well. The failure to set a liner often results in the occurrence of uncontrollable well conditions. Within the past two years the operator of the East Lirette Field has experienced the loss of a rig and the forced abandonment of a development well. Both of these occurrences were within 5 miles of the Tenneco Fee N-1 and both were the result of a failure to set a drilling liner before penetrating too deep into the geopressured section.

In the narrative and in the major events sections it was indicated there were mechanical problems and unexplained shows of gas encountered. Reviewing the information obtained and the log information available, it appears that mechanical tubular problems in the 4-1/2" liner existed around 13,700' and 13,900'. The attached logs and hole cross-section drawing support a conclusion for a mechanical problem in these intervals. The open hole logs obtained were the ISF-Sonic and dipmeter and the cased hole logs are a gamma ray correlation log and a CBL-VDL log across the intervals. In addition, a caliper and a gamma ray correlation log were run after the mill started drilling shale formation to approximately 13,920'.

The dipmeter log has an anomaly around 13,900' possibly indicating a fault zone. The caliper run in conjunction with the dipmeter shows an enlarged hole outside of the sand sections in the shale intervals. Hole size in the enlarged section varies by about 6" x 7" to 6" x 8". The attached hole cross-section depicts in actual size a 6" x 7" hole with 4 1/2" corkscrewed pipe. The CBL-VDL log also has transit time anomalies in the 13,700' and 13,900' areas indicating a decentralization of the bonding

tool, supporting buckling of the 4½" casing. At 13,900' ± 10' there is indication of cement bonding. Also the logs run indicate a threaded connection could be around 13,920'; however, the type of threaded connection used causes difficulty in locating the connections by log response. The gamma ray correlation log shows an increase in line tension in the 13,700' and 13,900' intervals. This information, coupled with the wireline difficulties and the tension behavior when attempting to run the wireline tools, suggests a mechanical buckling of the 4½" casing in the 13,700' and 13,900' intervals. Mechanically and from the data available it is postulated that a threaded connection at 13,920'± parted or jumped the threads and the resulting temperature change cycles from the cleanout operations eventually resulted in the jumped or parted threads' upper pipe section setting on top of and off center to the lower section sufficiently to cause a drillout into the formation. The amount of time exposed to this condition became a risk factor involved in permitting the offset pipe condition to occur and be substantial enough in amount of offset to result in the drillout. The amount of gas observed and the inability to load the hole with gas-free mud in the 13,900' interval indicate the mechanical condition was present at the start of operations and was aggravated to the eventual failure experienced from the long exposure period during the cleanout effort.

Original condition of well Jan. 9, 1980

Well cleaned out to PBDT Feb. 12, 1980

Well with tie back. Leak at top of 4" liner.

Well with leak at top of 4" liner cemented off Mar. 6, 1980

Condition of well after abandonment Apr. 22, 1980

Tenneco Oil Company TOC Fee "N"-1 example 6" x 7" hole cross-section
(with buckled 4½" casing)

13500

13600

13700

13800

13900

GAMMA RAY OF 12/19/78
(OPEN HOLE)

13400

13500

13600

13700

13800

13900

14000

GAMMA RAY OF 2/14/80²
(CASED HOLE)

Tenneco Oil
Exploration and Production
A Tenneco Company

Tenneco Building
P.O. Box 251
Houston, Texas 77001
(713) 757-2131

APPENDIX B

March 18, 1980

RECEIVED
GRUY FEDERAL, INC.
HOUSTON, TEXAS

JUL 20

1980

Mr. Bob Holliday
Department of Energy
Washington, DC

Dear Mr. Holliday:

This letter is to inform you of the status of the Gruy Federal, DOE, Tenneco "N" 1 Well in Terrebonne Parish, Louisiana as of the morning of March 18, 1980 and of our suggested course of action to complete this well for a geopressured dissolved methane test. At report time this morning we were in the process of running a cement mill on drill pipe to drill out the cement repair job on the 4½" liner top. The cement repair has been tested to 2600 PSI for ten minutes. After drilling out through the tie back point at 13148 feet, we will again test the liner top. If the liner top holds pressure, we would propose to continue the operation of cleaning out inside the 4½" liner with 2-3/8" drill pipe and a junk mill until the liner is cleaned out to the plug back total depth of 17230 feet. Once the liner is cleaned out and the drilling mud circulated and conditioned, we would recommend pulling out of the hole and running the 5" tubing and installing the Christmas tree bottom master valve. The rig would then be released from the "N" 1 location and moved to the salt water disposal well site to drill and complete the salt water disposal well. On the completion of this work the drilling rig could be released and preparation made to move in the production test equipment.

In the event the pressure test of the liner top is not successful after drilling out the cement in the 5" casing, two options would be available; one would be to make another attempt to seal off the liner top with another cement job and continue the operation as described in the above paragraph; the second option would be to completely abandon this well. While we realize the operation to date has cost more than anticipated and that there are mechanical conditions in the well bore that are less than perfect, we feel it is still possible to complete the well and test these very deep high pressured, high temperature zones. However, the decision to continue this test would be completely in the hands of the Department of Energy.

Tenneco Oil

Mr. Bob Holliday

Page 2

March 18, 1980

We feel that the operation to date has been conducted in a manner that reflects the professional attitude and performance of the Tenneco personnel involved in this project. However, it should be remembered that when dealing with bore holes of the great depth and small diameters as we are in the "N" 1, it is difficult and costly to secure good cement jobs and to avoid and/or correct certain mechanical problems that may occur. This fact is general knowledge in the oil and gas producing industry but I believe it has been overlooked to a large extent in published reports concerning the economic viability of the geopressured/geothermal dissolved methane resource. In order to reach the zones with the highest energy potential, it will be extremely expensive to drill and complete the bore holes and as you have discovered in other Geo² projects not all such attempts will be successful.

If you have any questions concerning this matter, please do not hesitate to contact me at (713) 757-2545.

Very truly yours,

TENNECO OIL COMPANY

M. W. Braden, Jr.
Manager

Frontier Production Projects

das

cc: D. B. Johnson
W. C. Melnar
O. N. Goode, Jr.
R. J. Dobson - Gruy Federal
R. T. Stearns - DOE
J. K. Westhusing - DOE

APPENDIX C

COMMENTS ON EVENTS LEADING TO FAILURE OF THE 4 1/2 IN. LINER TENNECO FEE "N" NO 1 TEST WELL

The following is in response to the letter request of Mr. R. J. Dobson, April 24, 1980.

Briefly, the fact that the 4 1/2 in. liner was not properly cemented on the original attempt is, in my opinion, the primary reason for the ensuing difficulties and eventual need to abandon the well.

According to drill reports the liner was set at or on bottom and cemented at 17,276 ft. The plug was intended to be behind the cement did not leave the liner and displacement was made based on volume. This could easily have resulted in overdisplacement. It is not clear whether the liner was set on bottom or hung off, but after cementing, the pipe was pulled two stands and the hole reversed out. Upon attempt to pull more pipe (2 stds) it was found the pipe was pulling wet due to contaminated (thick) mud in the drill pipe. When an attempt was made to reverse, the hole took mud. Pipe was pulled to 12,400 ft. The well was swabbing and flowing. While circulating to condition the hole, 100 bbl of mud was lost. Subsequently, three attempts were made to pump cement down to and around the liner top, but pressure tests did not show the liner overlap to be sealed after the first two. The third one held and plugs were set to temporarily abandon the well.

These events lead to the conclusion that the formation was thoroughly broken down, very probably at a depth near the 7 in. casing shoe. The squeeze cement would be expected to be badly contaminated and mostly to go out the fracture. It is also probable that an annular salt water flow started which would have wiped out the liner cement job. This was confirmed during later work on the well by a CBL which showed almost no bonding of the liner. Also, high radioactivity was logged indicating a salt water flow had occurred or was still occurring.

This left the well subject to several potential difficulties:

1. Pressures from down the hole would be transmitted to the liner top, requiring greater mud density to control the well than was required to drill at that depth.
2. Leaks at the liner top during subsequent completion operations.
3. Buckling (helical spiraling) of the liner which could cause difficulty in running tools and a vulnerability to wear and cutting by drill pipe and cement mills.
4. With no backup of the liner, increased mud density inside, applied pressures and wear, there would be a susceptibility to burst.

These conditions were repeatedly evident when attempts were made for the geopressured methane completion.

When drilling out cement in the 7 in. casing down to the liner top, the well began to flow and there was a gain of 50 bbl. Salt water was entering at the top of the liner. Four cement squeezes were made to seal the liner top before the well was free of pressure and the PBR top could be cleaned out. This left a tenuous seal at the liner top.

Casing was run but the seal assembly would not stab into the PBR and would not pressure test. Because of the possibility of the well beginning to flow through the liner top, and the casing string having no back pressure valve for protection if flow began, a decision was made to cement the string rather than pull it. Had an adequate cement job been obtained originally the string could have been safely pulled with the possibility of later making a sure tie back and eliminating any future problems at the liner top.

Cement was drilled out of the 7 in. casing. A 3 5/16 in. mill was used to wash and drill cement out of the liner. There was a light spot from 13705 - 708. The bit was changed to 3 1/8 in. and bottom was tagged at 17226. Upon attempt to test casing the well took mud at 1/2 to 1 bpm at 2100 psi indicating either a leak at the liner top or at the bottom of the liner. Again, the inadequate original liner cementing was having an effect.

A 3 3/16 in. wireline junk basket would not go below 13690 ft. and had 1700 lbs. drag. It would not go deeper on repeated attempts. A log sonde would not go below 13145 ft., the top of the liner. A 3 in. OD gage ring and junk basket was worked through the top of the liner but stopped at 13,700 ft. It was pulled with drag. A 3 5/16 in. mill was used to ream through the tie-back point and to wash and ream from 13676 ft. to 14944 ft. Each joint was reamed twice. This mill was used to wash and ream to 17226 ft. A run with a 2 1/8 in. dummy log sonde would not go below 13740 ft. and had drag on being pulled. Using a power swivel and 3 5/16 in. mill the hole was washed and reamed from 13705 - 15554 and the bit run to 17226 ft.

An attempt was made to log but the sonde would not go below 13700 ft. Sinker bars were then used and after three attempts a bond log sonde went past 13700 ft. to 17226 ft. The log indicated very little bonding and a radioactivity increase as previously mentioned. The annulus could have bridged at intervals by this time accounting for some short intervals being bonding.

A 3 5/16 in. mill stopped at 13683 ft. and 30 ft. was reamed. The mill washed freely to 13978 ft. but it was necessary to ream to 13980 ft. Torque was high and some metal cuttings came back in mud. Some gas showed in the mud.

A 5 7/32 in. mill was used to dress the top of the liner. On a pressure test the well took 20 bbl mud at 3 rpm and 1100 psi.

The repeated difficulties with the liner ID are the type that would occur if the liner was in a buckled condition (See references at end of discussion). Several factors could have contributed. Any original washouts would be increased with salt water flow, allowing clearance for severe buckling. There could have been some sharp changes in hole direction. A greater mud density inside the liner than outside would promote buckling as would temperature increase from the salt water flowing from a greater depth. If the liner was not set in full tension this too could have contributed and any pressure applied internally would promote buckling. Had cement been behind the liner these conditions would reasonably have been prevented.

A 300 sack cement job was run by stabbing into the PBR at the 5 in. x 7 in. crossover and displacing with enough mud to place the plug at 16990 ft. After WOC there was pressure on the well which would not allow bleed off indicating the top of the 4 1/2 in. liner was open. A sinker bar run confirmed cement at the liner top.

Another 300 sack cement job was displaced to the liner top with strong pressure increase noted as cement passed liner top. Cement was milled to the liner top.

A 3 5/16 in. mill was used to mill a cement plug at the liner top and was run in hole to a tight spot at 13700 ft. This was reamed reamed. Other tight spots were found at 14500 ft. and 14705 ft. and on a pressure test the well broke down at 1100 psi.

A 3 in. gage ring would not go below 13146 ft. A 2.84 in. OD ring tagged up at 13577 ft. The tool stuck at 13146 ft. The fish was chased down the hole with wireline tool but would not go below tight spot at 13816 to 13841 ft. Overshot was found to be packed with barite. After several efforts fish was recovered.

A 3 5/16 in. flat bottom mill was run and bit bridge at 13742 ft. Rotated and washed to 13935 ft. The last 38 ft. was at 5 ft./hr rate. Steel shavings were caught. The mill was worn on the outside. A new mill hit a bridge at 13742 ft. This was reamed to 13746 ft., the liner washed to 13865 ft. and washed and reamed to 14005 ft. Milling was done at 10 to 12 ft/hr to 14005 ft. Torque was evident at 13870 ft. and slow milling began at 13935 ft. There was a slow pit gain, gas in mud and an increase in chlorides after reaming, indicating possible liner failure.

After conditioning mud, pipe was pulled to 12566 ft. While circulating on choke to condition mud the well broke down. A total of 10 bbls was pumped in at 1250 psi but the well started flowing back. A 250 sack cement job was displaced to 12950 ft.

The cement plug was dressed off to 12822 and to 12922 ft., then to liner top. A TIW seal assembly was run to the PBR at 12191 ft. A pressure test of 1570 psi held and a reduced pressure test was run by displacing water to 2000 ft and stabbing seals. This held 20 min. indicating a good seal at liner top.

After a fishing job for a liner clamp a 3 5/16 in. mill was run to 13150 and cement milled to 13165. Cement was milled to 13763 where a tight spot was again found. After losing blades of a mill and fishing, cement was milled to 13920 - apparent bottom of cement. Circulation produced shale cuttings.

Additional reaming was done at 13910 - 60 and two log runs failed to go below this depth. Evidently last cement job had gone out pipe at about that depth and the casing may have burst during the squeeze. The well was abandoned.

The purpose in listing the many mill runs and reaming is to show the multiple intervals of tight spots in the liner which can be attributed to spiraled intervals, and to illustrate the extended opportunities for wear. After some wear the pipe would also be susceptible to burst from internal pressures. The trouble inside the liner, the eventual pipe failure and the many squeezes were all the result of initial failure to cement the liner adequately. It is only surprising that liner failure did not occur sooner in the interval below 13700 ft. rather than 13900 ft.

The reason the seals would not enter the top of the 4 1/2 in. liner tie-back are not clear, but if the liner was not hung the top would not have been centered and this could have contributed. However, the reported liner top matches the TD less the length of pipe run indicating the top of the liner did not slide down hole. There is, of course, a possibility of failure of the metal in the liner top or of loose metal on the liner top.

W. C. Goins, Jr.
Consultant

WCG:bdn

GRUY FEDERAL, INC.

CONSULTANTS IN ENERGY SYSTEMS

APPENDIX D

April 23, 1980

2500 TANGLEWILDE, SUITE 150
HOUSTON, TEXAS 77063
713/765-9200

2001 JEFFERSON DAVIS HWY., SUITE 701
ARLINGTON, VIRGINIA 22202
703/892-2700

Mr. Ronald T. Stearns
Engineering & Energy Applications Division
DOE/Nevada Operations Office
P. O. Box 14100
Las Vegas, Nevada 89114

Re: Contract DE-AC08-77ET28460
Narrative of Events Leading to Abandonment
of Tenneco Fee "N" No. 1 Test Well
Terrebonne Parish, Louisiana

Dear Mr. Stearns:

You have requested a preliminary report on the series of operations in connection with the attempted completion of the subject well which preceded the failure of the 4-1/2 inch liner on, or shortly before, April 4, 1980.

Mr. Paul Langston has prepared the attached summary of operations which covers the period during which operations were conducted in the 4-1/2 inch liner from 13,148 feet to T.D. of 17,242 feet, and also covers the various attempts to repair the cement shut-off at the liner top. A second report by Mr. Langston provides an overall review of the operations. Mr. Langston alternated with Mr. Matula as the Gruy observer and liaison party with Tenneco on this operation.

This report is tentative. The final report on this operation will incorporate these findings and also will include all pertinent details of the original drilling of the well by Tenneco, as well as the Tenneco supervised completion attempt which had to be abandoned after 84 days.

Hopefully, the final report will contain some more definite conclusions as to the cause of the liner failure. The factors which contributed to the liner failure are believed to include one or more of the following possibilities:

1. The 4-1/2 inch liner was imperfect when installed by Tenneco.
 - a.) One or more joints possibly were bent or indented, which might have caused successive runs of the hard faced mill to remove some material on each pass through.
 - b.) The liner hanger failed on initial setting attempt, thus causing the liner to rest on bottom and to be in

compression. There is no caliper log of this section of the hole which would serve as an indication of where a liner in compression may have buckled into a washed out area of enlarged hole. The possibility that a liner joint should have failed due to this cause appears remote.

- c.) The 4-1/2 inch liner was made of "off specification" steel. This was grade N-80. Tenneco has been asked to search for inspection records, or any remnants of the lot which can be sampled. The liner was of German manufacture.
2. The possibility of milling through the liner due to a consistency in the hole deviation and inclination, but without some inherent flaw in the liner body, has been considered and ruled out.

Prior to setting the 4-1/2 inch liner, Tenneco ran a Four-Arm High Resolution Continuous Dipmeter from 13,430 feet to 17,275 feet. Deviation surveys were recorded every 100 feet. The data were processed to determine the bottom hole location at the well using the radius of curvature method and the results are attached. In the interval of interest, i.e., between 13,900 feet to 14,000 feet, the inclination of the well changes, from four degrees to four degrees and fifteen minutes. This is such a small change that the likelihood of a severe dogleg in this interval is minimal. In addition, the rectangular coordinates remain in the south-east quadrant relative to its position at 13,500 feet. This proves that the well is not "corkscrewing" back on itself through this interval. On the basis of these calculations, hole deviation was not a contributing factor to the liner failure.

3. Initially, Tenneco ran a Gamma Ray log to total depth. During the recent operations Gamma Ray (CBL) logs were run from 6500 feet to 17,219 feet. The portion of the second run which overlapped the original run, from 13,410 feet to 13,790 feet, showed a pronounced increase in radioactivity. This increase is so pronounced that it appears to have been caused by the introduction of radioactive tracers in a cement squeeze job during Tenneco's original operation. However, Tenneco states that no radioactive tracers were ever used in the well. This may be attributable to the passage of formation fluids from deeper, higher pressured reservoirs to shallower, less geopressured reservoirs. This phenomenon has been attributed to the build-up of certain radioactive deposits along the path of substantial and prolonged fluid movement. Since we now know that the liner was never effectively cemented after installation, there is a strong

possibility of substantial flow between the various geopressured reservoirs during the year's time between temporary abandonment of the well by Tenneco and the time operations were commenced to reenter the well. The effect of such postulated fluid movement on the outside of the liner is pure conjecture. Possibly, it could have caused sufficient removal of metal by galvanic action to weaken the wall of the liner and permit the liner to fail by bursting forces during the final cement squeeze job.

4. The question of seismicity in connection with the known faults in the area has been considered as a possible contributing factor. Fault movement could conceivably cause the failure of a liner joint by so called "collar jumping" or could result in a flexure in the liner which could in turn cause excessive metal removal by repeated runs of the mill which was employed to clean out the heavy mud and cement.

The attached structure map depicts the known faults in the area. Fault "A" would intersect the well at a shallow depth or not at all. Fault "B" would intersect the well at 17,734 feet, assuming an average fault dip of 45° and at 17,026 feet assuming an average fault dip of 35° . The fault has a displacement of some 3000 feet and thus would be assumed to be the most active if any of these faults are active. However, no difficulty was encountered over the area where this fault might have intersected the well bore. It is possible that it passes below the well.

Fault "C", with a throw of 1300 feet, could conceivably have effected the well bore. Only a very small adjustment, on the order of inches, could conceivably damage the liner. If the average inclination of the fault plane is 30° , and if the fault trace is correct as shown on the plat, the well would be intersected at 13,553 feet. If the average dip is 25° , the well would be cut at 13,935 feet, or at the point of the trouble. The difficulty with this exercise is that the dips of these fault planes are not uniform. They normally start out steep, say 55° to 60° and flatten at depth until they die out. Also, the position of the fault trace at the top of the mapped datum is interpretive due to limited control data.

Further, we have been unable to find any record of known seismicity in the area. It probably occurs unnoticed since the Louisiana Coast is known to be subsiding. If it has affected other wells, this is not known to Tenneco. We are attempting to learn more about the possibility of earth displacement having caused casing deformation in the area.

During the time these operations were underway, EXXON commenced a deep well several miles to the northwest. This well encountered control difficulties and had pressure on the surface casing annulus. The attempted blowout was controlled, but the well had to be junked and abandoned. Some years ago, EXXON had a serious blowout in the general area which resulted in the loss of the rig. Pennzoil also lost a hole about two miles to the west. We are attaching some information on these operations. It was known that the area contained some of the hottest, deepest, and highest pressure geopressured sands ever scheduled for testing and that was one of the reasons the location was chosen. Another reason was the willingness of Tenneco to operate and supervise the completion. We have been unable to fault Tenneco's operations, even with hindsight.

The original cause of the liner failure may never be known. It is quite obvious that the liner was penetrated by the mill, but some contributing factor also was probably operative. The over-riding fact is that operations inside the liner were carried on for too long a time with mills which contained hard facing material on the bottom (but not on the sides). The use of a rock bit rather than a mill was considered from time-to-time, but was always ruled out due to the strong probability of loosing bit cones in the hole as a result of the inherent weakness of the bearings in small bits. The whipping effect of the exceedingly limber 2-3/8 inch drill pipe may have had a contributing effect. The fact that the liner was never effectively cemented probably contributed to the failure in some as yet unexplained manner.

We have asked our own drilling people, plus some outside consultants, to study the Langston reports and the drilling records and provide an opinion for the basic cause of the failure. These will be incorporated in the final report.

This tentative report has been prepared without benefit of all the facts or all the informed opinions which may be available. For example, we intend to check on any known seismic activity and its frequency and magnitude. We may be able to find portions of the pipe lot from which the liner material was taken. (This may not be conclusive since there are cases when bad joints of pipe have been found in otherwise acceptable lots of casing.)

In summary, the operation was conducted in accordance with prudent operating methods and every possible step to avoid trouble was taken. The liner did not stand up to the normally expected drilling wear and tear. We were in the small hole for too long a time.

Please advise if you have further questions.

Very truly yours,

Richard J. Dobson
Vice President of Operations

RJD:cas
Attachments

cc: Mr. Bob Holliday, Jr.
Mr. Keith Westhusing

APPENDIX E

MEMORANDUM

April 17, 1980

TO: Mr. Richard Dobson

FROM: Paul Langston

SUBJECT: A Recap of Daily Well Reports, Tenneco Fee "N" No. 1
Test Well

This recap of daily well reports are submitted per your request. You asked for a search of the records so that we might pin-point the time when the rig supervisors knew that a leak had developed in the side of the 4-1/2 in. O. D. liner.

On March 28, 1980, when we found that cement had entered the top of the 4 1/2 in. liner, we realized that something had happened to either the side of the liner or that the bottom of the 4-1/2 was open. On April 4, 1980, when the bottom of the cement inside the 4-1/2 in. was found at 13,920 ft., we were sure that a leak had developed in the side of the 4-1/2 in. liner.

We are also sure that the bottom of the 4-1/2 in. liner, found to be open on February 13, 1980, was still open.

Paul Langston
Paul Langston

PL:bs

TENNECO FEE "N" NO. 1 TEST WELL

RECAP OF DAILY WELL REPORTS 2/12/80 - 4/8/80

All dates and hours will be the actual date and the actual hour, as shown on the AAODC (these dates may vary by one day from the report date). This will be done so that our reports are the same as Tenneco's, the same as the reports on the rig.

February 12, 1980: Finished washing out inside the 4-1/2 inch liner to 17,226 feet with 3-1/8 inch mill.

February 13, 1980: After cleaning out to the bottom of the 4-1/2 inch liner, an attempt to test the liner was made to the equivalent of 19 lbs. per gal. mud. With 17.7 ppg mud in the hole, pressure was applied by the rig pump and an attempt was made to go to 1200 psi. The pressure bled off to 700 psi drill pipe pressure which was equal to an equivalent of 18.3 ppg. The rig pump pumped in 1/2 to 1 barrel per minute at 2100 psi and the pressure slowly bled off to zero. It was concluded by the Tenneco Supervisors and the Gruy representative that the bottom of the 4-1/2 inch liner was not holding. Circulation continued and the hole was prepared for running logs. The drill pipe was pulled out of the hole.

February 14, 1980: Ran in the hole with a Schlumberger 3-3/16 inch wireline junk basket and got down to 13,690 feet; had 1700 lbs. of drag to pull free. Made several attempts to go deeper, could not and pulled out of the hole. Made attempt to go in hole with a gamma ray CBL-GRL-VDL log and it would not go past 13,145 feet, the top of the 4-1/2 inch liner. Pulled out of the hole with logging tool. Ran in the hole with 3-inch O.D. gauge ring junk basket, worked through the tieback point at 13,145 and went to 13,700 feet where it stopped. Pulled out of the hole with a 1400 lb. drag, rigged down Schlumberger, ran in the hole with a 2-3/8 inch drill pipe and a 3-5/16 inch mill.

February 15, 1980: Ran in the hole to 13,120 feet; rigged power swivel and reamed through tieback point. Went on in the hole to 13,676 feet, washed and reamed to 14,944 feet.

February 16, 1980: Continued washing and reaming to 15,531 feet. Rigged down power swivel, ran in hole to 16,648 feet. Continued on in the hole and hit bridge at 16,989 feet. Washed and reamed with power swivel to 17,226 feet which is the plug-back depth of the 4-1/2 inch liner, started pulling out of the hole.

February 17, 1980: Finished pulling out of the hole, rigged up Schlumberger and ran in the hole with a 2-1/8 inch O.D. dummy gun. Went through tieback point without weight change indication. Continued in hole to 13,740 feet and tool would not fall; had 300 to 500 lbs. pickup drag on tools. Pulled out of the hole and rigged down Schlumberger. Went in the hole with drill pipe and 3-5/16 inch mill to 13,674 feet, prepared to wash out mud at 13,700 feet.

February 18, 1980: With power swivel washed and reamed from 13,705 feet to 15,554 feet, rigged down swivel. Ran in the hole to plug back depth of 17,226 feet. Circulated a mud pill with high XP-20 content so as to leave a low gel mud inside the 4-1/2 inch liner.

February 19, 1980: Pulled out of hole, rigged up Schlumberger, ran in hole to 13,700 feet and could not get below that point. Pulled out of hole with logging tools, rigged up sinker bars and cement bond log tools, made three attempts to get past the point of 13,700 feet. Got on down to 17,226 feet and logged up to top of cement at 12,000 feet. No cement indication behind the 4-1/2 inch liner.

February 20, 1980: Finished pulling Schlumberger tools and rigged down. Picked up 3-5/16 inch mill and ran in hole freely to 13,683 feet. Had to ream 30 feet to 13,713 feet. Washed freely on down to 13,978 feet; had to start reaming again. Reamed to 13,980 feet, had too much torque and a few metal cuttings came back in the mud. 1200 to 1400 units of gas was found in the mud, no increase in volume and no increase in chlorides after five hours of circulation. This indicated to the rig supervisors that some part of the 4-1/2 inch liner had failed.

February 21, 1980: After circulating the well thoroughly, pulled out of the hole with mill, tested B.O.P. system as per routine schedule.

February 22, 1980: Ran in the hole with special 5-7/32 inch shaving mill for polished bore receptacle (PBR) at top of 5-inch casing at 12,151 feet. Dressed PBR and later got cement back to surface; started pulling out of the hole with drill pipe and polishing mill. (Cement returns a consequence of running a larger mill.)

February 23, 1980: Finished pulling out of the hole with polishing mill, ran in the hole with a TIW 5-inch seal assembly on 3-1/2 inch drill pipe. Ran slowly to 12,149 feet, stung in to PBR and went inside to 12,181 feet. Rigged up Halliburton and tested the 3-1/2 inch by 7 inch annulus to 1000 psi - O.K. Pumped in to drill pipe with HOWCO, a total of 20 barrels mud at 3 barrels per minute at 2400 psi, stopped pumping, standing drill pipe pressure equal 1200. Opened back to HOWCO tanks and slowly bled 5 barrels of mud back. Drill pipe pressure was 1100 psi. The conclusion was that the top of the 4-1/2 inch liner had broken down.

February 24, 1980: Rigged up Halliburton, opened drill pipe and found 1050 psi standing. Bled off 14 barrels of mud and pressure bled to zero. Observed the well, no flow. Referring back to the February 13 conclusion that the bottom of the 4-1/2 inch liner was not completely sealed off, the decision was made to attempt the cementation of the bottom of the 4-1/2 inch liner; 300 sacks of Class "H" cement, plus the additives, were mixed and pumped and a wiper plug was released behind the cement. The wiper plug was displaced with enough mud to displace the cement down where the cement top would be 16,990 feet. The 15-minute shut-in pressure was 850 psi WOC. This resulted in an over-displacement of cement if the cement entered the top of the 4-1/2 inch liner.

February 25, 1980: After WOC, the well was opened and a half barrel of mud was flowed back, the shut-in pressure after five minutes was 700 psi. This standing pressure of 700 psi indicated that the top of the 4-1/2 inch liner was open. The cement had been over-displaced and this accounted for the pressure.

February 26, 1980: After additional WOC time bled a half barrel from drill pipe, pressure momentarily fell from 700 psi to 300 psi and then rose again to 700 psi. Additional bleeding back and observation of the drill pipe pressure

seemed to confirm that the top of the 4-1/2 inch liner was still open. Brought out Otis wireline unit, ran in hole with slick line and sinker bars, tagged top of mushy bottom at 13,162 feet. Had to pull 800 lbs. over normal weight for tools to come out. Rigged down Otis and prepared for the sixth cement job on the top of the 4-1/2 inch liner.

February 27, 1980: Rigged up Halliburton and pumped 300 sacks of cement, plus additives, down the drill pipe. While cement was entering the 4-1/2 inch by 7 inch overlap, the pumping pressure increased from 2800 to 5000 lbs. WOC.

February 28, 1980: Observed well for flow; no return. Rigged down Halliburton, pulled out of hole with 3-1/2 inch drill pipe and TIW seal assembly. Rigged up and ran drill pipe with 3-3/4 inch mill to clean out to the top of the 4-1/2 inch liner. Ran in the hole to 12,162 feet, washed out to 12,438 feet, washed and milled to 12,510 feet, milled cement to 12,568 feet at approximate rate of 30-feet per hour.

February 29, 1980: Continued milling cement to 12,688 feet, circulated and pulled out of hole for new mill, ran in the hole with 3-3/4 inch mill on 3-1/2 inch drill pipe.

March 1, 1980: Finished running in hole with new 3-3/4 inch mill, had swivel repair problems and draw-works problems. Milled firm cement to 12,790 feet.

March 2, 1980: Milled cement to 12,923 feet, circulated and started pulling out of hole for new mill. Ran new mill back to bottom.

March 3, 1980: Had swivel repairs, milled cement from 12,923 feet to 13,067 feet.

March 4, 1980: Pulled out of hole, picked up new mill and went in hole. Drilled cement from 13,067 feet to 13,134 feet, (driller depth = 13,148 feet actual depth) which indicated that we had reached the top of the 4-1/2 inch liner. Started pulling out of the hole for new mill.

March 5, 1980: Finished pulling out of the hole, made up mill of 3-5/16 inch O.D. that would go inside of 4-1/2 inch liner and ran in the hole to 13,148 feet corrected depth. Tested top of 4-1/2 inch liner with 1500 psi for 15 minutes - O.K. Milled on cement plug at 13,148 feet and washed easily down to 13,200 feet. Laid down power swivel and ran in the hole to 13,700 feet; hit tight spot at 13,700 feet, rotated and wiped out the tight spot at 13,700 feet then continued in hole and worked through tight spots at 14,500 feet and 14,706 feet. Note that the absence of cement inside the 4-1/2 inch liner indicated that the cement had all gone outside of the 4-1/2 inch liner top and that no cement had gone down inside the 4-1/2 inch liner.

March 6, 1980: Finished running in the hole and tagged the plug-back depth at 17,242 feet, circulated and conditioned gas cut mud. Tested casing seat to 1100 psi; the seat broke down and would not hold the pressure. Mixed special pill of mud with XP-20 chemical to leave low gel mud inside 4-1/2 inch for wireline work. The assumption was made by the rig supervisors that mud was going out of the bottom of the 4-1/2 inch liner.

March 7, 1980: Displaced XP-20 pill into 4-1/2 inch liner and pulled out of hole. Rigged up GO Wireline Company and picked up 3-inch gauge ring; ran in the hole. Tool would not go past 13,146 feet, pulled out of the hole with 3-inch gauge ring. Ran in the hole with smaller gauge ring of 2.84 inch O.D., worked tool through a tight spot at 13,146 feet and tagged bottom at 13,577 feet. Started pulling out of the hole with gauge ring. The tool stuck at 13,146 feet. Jarred on the stuck tools, the wireline pulled out of the socket and the gauge ring was left on bottom. The wireline was pulled out of the hole.

March 8, 1980: Rigged down GO Wireline Services, made up fishing tools, ran in the hole and tagged fish at 13,146 feet. Chased the fish down hole, attempted to get through tight spot from 13,816 feet to 13,841 feet unsuccessfully. Pulled fishing tool out of hole with no recovery and found that overshot was packed with barite; laid down the jars and started running in hole with overshot.

March 9, 1980: Finished running in hole with overshot to 12,970 feet. Washed to 13,713 feet, (tight spots at 13,710 feet to 13,713 feet.) Washed on down to

13,782 feet, tagged hard bottom. Circulated gas cut mud 1300 units and weight cut to 16.4 ppg. No increase in chlorides and no pressure indication. Started pulling out of hole with fishing tool.

March 10, 1980: Finished pulling out of hole, recovered portion of fish (rope socket of the wireline tools.) Did routine B.O.P. tests.

March 11, 1980: Finished testing all B.O.P. equipment, picked up Tri-State friction socket and ran in hole to 12,120 feet. Washed from 12,120 feet to 12,214 feet; ran in hole freely to 13,650 feet, washed 13,650 feet to 13,773 feet. Circulated at 13,773 feet, ten feet above fish. Circulated gas cut mud 700 units, washed over fish to 13,795 feet and tagged hard bottom at 13,821 feet. Started pulling out of hole with fishing tools.

March 12, 1980: Finished pulling out of the hole, recovered part of fish. (Sinker bar, collar locator, and cross-over sub) Made up overshot fishing tool, ran in the hole, engaged fish and pulled out of the hole, laid down all of the remainder of the fish, picked up 3-5/16 inch cement mill and started running in hole. (This mill has hard surface material on the bottom and inside but not on the outside diameter).

March 13, 1980: Finished running in hole to 13,152 feet; on pickup had momentary 10,000 lb. drag at 13,152 feet. Picked up and ran through second time with no drag. Rotated and wiped tieback point with string reamer, no torque, no drag indicated. Continued running in hole to 13,742 feet and hit bridge. Rotated and washed to 13,935 feet. The last 38 feet was at rate of 5-feet-per-hour. Circulated and caught samples, found hair thin steel shavings. Started pulling out of the hole for new mill.

March 14, 1980: Finished pulling out of the hole with dull mill. Mill was worn flat on bottom and rounded on the outside. (see diagram) This was interpreted that the 3.375 inch inside diameter of the 4-1/2 inch O.D. liner had been reduced to less than 3.3125 (3-5/16th) inches. Picked up new mill and ran in hole to 13,742 feet and hit bridge. Rotated and washed through bridge from 13,742 feet to 13,746 feet and washed on to 13,865 feet. Washed and reamed to 14,005 feet.

Encountered torque at 13,870 and slow milling at 13,935 feet. Milled 10 to 12 feet per hour to 14,005 feet. Had gas cut mud in hole below 13,935-foot mill depth. Observe well for flow after gas cut mud came to surface. Mud weight was cut from 17.6 back to 16.7 lbs. Observed gain in volume of one to two barrels total. No flow after 30 minutes. Continued circulating and noted a gain of two barrels in about three hours. Noted chloride increase in mud.

March 15, 1980: Continued circulating and conditioning gas cut mud. Maximum cut was from 17.6 ppg to 16.8 ppg. Started pulling out of the hole, stopped at 15 stands, closed B.O.P.'s and did not have any pressure increase. Circulated well through choke under 800 lbs. on casing drill pipe annulus. This bled back to 210 psi. Released pressure and pumped into formation. Broke down at 1250 psi, pumped in one and one-half barrel per minute, a total of 10 barrels. Shut down and bled pressure. Well started flowing back. Closed in well and observed well while waiting on Halliburton with drill pipe at 12,566 feet. Drill pipe pressure was a constant 600 psi. This was interpreted as an indication that the top of the 4-1/2 inch liner had broken down again. Rigged up halliburton for cement job number 7. Mixed and pumped 250 sacks of type "H" cement, plus additives, and displaced enough mud to put the top of the cement at 12,950 feet.

March 16, 1980: WOC and observing well for cement set-up.

March 17, 1980: WOC bled pressure off of casing and drill pipe - O.K. Circulated and conditioned gas cut mud, maximum gas 600 units. Started pulling out of hole. Broke out all joints of 2-3/8 inch drill pipe, re-doped and re-torqued all connections.

March 18, 1980: Finished pulling out of hole, breaking all 2-3/8 inch connections, picked up new 3-11/16 inch mill and went in the hole to top of cement at 12,801 feet. Dressed off cement plug from 12,801 feet to 12,822 feet, indicating firm cement. Circulated and conditioned at 12,822 feet while waiting on orders.

March 19, 1980: Circulated at 12,822 feet; dressed off cement plug at 12,822 feet to 12,922 feet, continued circulating while waiting on orders.

March 20, 1980: Circulated at 12,922 feet and waited on orders.

March 21, 1980: Circulated at 11,984 feet and then milled cement from 12,932 feet to 13,085 feet.

March 22, 1980: Milled cement from 13,085 feet to 13,144 feet (13,148 ft. ?), the top of the 4-1/2 inch liner. Pulled out of hole and prepared to do routine field B.O.P. tests.

March 23, 1980: Repaired B.O.P.s and finished testing. Made up TIW seal assemblies on the 3-1/2 inch drill pipe and ran in the hole to the PBR at 12,191 feet. Pulled back out of PBR, closed pipe rams and applied pressure of 1570 psi. Held for 15 minutes - O.K. Bled pressure off and opened rams. Applied negative pressure test to the top of the 4-1/2 inch liner by displacing water down drill pipe to 2000 lbs. Stung into PBR and bled drill pipe pressure to zero. Waited 20 minutes, there was no flow, displaced water back out of drill pipe.

March 24, 1980: Pulled out of hole with 3-1/2 inch drill pipe and TIW seal assembly. Ran in the hole with 2-3/8 inch drill pipe, inspecting each tool joint. While pulling out of hole, a weld holding a pin from drill collar clamp failed and pin and chain fell in the hole.

March 25, 1980: Picked up Cavins hydrostatic bailer, ran in the hole to 13,134 feet and rigged up power swivel. Surged hydrostatic bailer over fish at 13,138 feet. Pulled out of hole. Cavins bailer and two subs were left in the hole. Waited on overshot, picked up overshot and started in hole.

March 26, 1980: Ran in the hole to 13,128 feet, picked up swivel and washed over fish to 13,137 feet. Pulled out of hole and made no recovery of fish. Ran back in the hole with 3-3/4 inch overshot and 2-1/2 inch grapples, rigged up, latched on to fish and started pulling out of the hole.

March 27, 1980: Finished pulling out of hole and recovered all of fish. Made up 3-5/16 inch cement mill to go inside the 4-1/2 inch liner and ran in the hole to 13,150 feet. Milled firm cement 13,150 feet to 13,165 feet. This was the first time cement was drilled inside of liner and indicated that fluid had escaped from the bottom of the liner or through some failure in the liner wall.

March 28, 1980: Drilled firm cement with occasional gaps near 13,165 feet down to 13,332 feet. Started to pull out of the hole for new mill.

March 29, 1980: Finished pulling out of hole with worn mill, changed mill and ran back into the hole and milled firm cement 13,332 feet to 13,482 feet.

March 30, 1980: Milled firm cement 13,482 feet to 13,512 feet. Pumps speeded up six strokes per minute; suspected washout in drill pipe. Pulled out of hole looking for washout and found none. Put on new mill and ran in hole; milled cement 13,512 feet to 13,600 feet.

March 31, 1980: Milled firm cement from 13,600 feet to 13,725 feet. Pulled out of hole, ran new 3-5/16 inch junk mill and drilled firm cement from 13,725 feet to 13,763 feet. Found tight spot at 13,760 feet, worked through tight spot until there was no drag.

April 1, 1980: Milled 13,760 feet to 13,763 feet and progress stopped. No excessive torque. Circulated bottoms up, pulled out of hole, found junk mill had lost all three blades. Waited on fishing tools. Rigged up Cavins hydrostatic bailer, filled 70 stands (47 barrels) of 3-1/2 with water. Ran in hole to 13,763 feet and surged hydrostatic bailer. Rigged down swivel and started pulling out of the hole.

April 2, 1980: Finished pulling out of the hole with fishing tool, recovered two blades of mill, plus miscellaneous small pieces of carbide and iron. Ran back in the hole with Cavins "junk snatcher" and attempted to surge the tool. Found that it had stuck open and would not work. Pulled out of hole and had no recovery.

April 3, 1980: Finished running in hole with mill, circulated and conditioned mud, milled on cement from 13,763 feet to 13,900 feet.

April 4, 1980: Found bottom of the cement plug at 13,920 feet. Circulated bottoms up and delivered cuttings to Core Lab in Houma, Louisiana. This was identified as shale. The recommendation to abandon this well was given at 10:00 hours on the 4th of April.

April 5, 1980: Circulated while waiting on orders. Washed 13,806 feet to 13,910 feet. Reamed 13,910 feet to 13,960 feet. Worked through real tight spot at 13,914 feet. Circulated at 13,960 feet, catching samples each 30 minutes. Maximum gas 800 units. Mud cut from 17.5 to 17.1 ppg, started building mud weight to 17.8 ppg. Continued circulating, building mud weight to 17.9 ppg.

April 6, 1980: Circulated bottoms up, started pulling out of hole. Hole did not take proper amount of mud. Ran back in hole with 15 stands, hit bridge at 13,804 feet. Reamed 13,804 feet to 13,960 feet. Washed again from 13,897 feet to 13,928 feet. Had 1500 units of gas and mud weight was cut from 18 ppg to 17.2 ppg. No indication of any cement below 13,920 feet. Washed from 13,928 feet to 13,960 feet. Started losing partial returns, pulled drill pipe up to 13,882 feet, waited on hole to heal. Pulled drill pipe to 13,424 feet, circulated slowly and built volume of mud. Ran drill pipe back to 13,954 feet indicating 6-feet of fill. Started pulling drill pipe out of hole for logging.

April 7, 1980: Pulled out of hole for logging. Rigged up GO Wireline unit. Go Wireline ran gamma-ray casing collar log and then ran GO 3-armed caliper log.

April 8, 1980: Both the logging runs of April 7th bottomed out at 13,922 feet. The 3-arm caliper failed. Sperry Sun ran gyro from 13,922 feet to 12,100 feet. Rigged down lubricator and ran in the hole with drill pipe open ended to 13,950 feet. Mr. Bob Clark gave the orders to plug the well about 11:00 a.m. on the 8th of April.

Report Concluded.

13,148 Top 4 1/2" Line
13-13,152'

13200

13300

13400

13500

13600

13700

13800

13900

2	2
2	2
2	2

- 1) 2-09-80 With 3-5/16 in. mill-tight at 13,705-13,708
- 2) 2-14-80 3-3/16 in. Schlumberger junk basket stopped at 13,690 ft. 1700 lb drag to get free-bottom marked on edge
- 3) 2-14-80 3 in. gauge ring stopped at 13,700 - 1400 lb drag to free
- 4) 2-17-80 Schlumberger dummy gun (44 ft X 2-1/8 in. OD) stopped 13,740 ft
- 5) 2-19-80 Schlumberger GR-CBL tool (w/centralizers) stopped 13,700 ft
- 6) 2-19-80 Schlumberger GR-CBL tool (w/sinker bars) stopped 13,700 ft
- 7) 2-20-80 3-5/16 in. mill stopped at 13,683 ft, reamed to 13,713 ft
- 8) 2-21-80 3-5/16 mill on bottom and 3-3/8 in. string reamer 276 ft above - milled - stopped at 13,980 ft - string reamer at 13,704 ft
- 9) 3-05-80 3-5/16 in. mill hit tight spot at 13,700 ft - milled through - RIH to 13,880 string reamer at 13,700 ft (4 hrs rotating to wipe out) - RIH tight spot 14,500 ft and 14,706 ft RIH to 17,242 ft
- 10) 3-08-80 GO ran 3 in. OD gauge ring. Stopped at 13,146 ft - Pooh - ran 2-7/8 in. gauge ring - worked through 13,146 - RIH to 13,577 ft - bottom - POOH stuck at 13,146 ft, worked free - tools in hole
- 11) 3-09-80 RIH w/3-1/8 in. overshot - chased tools to 13,816 ft (tight spot), then down to 13,841 ft. POOH - over-shot full of barite
- 12) 3-09-80 RIH w/3-1/8 in. overshot - hole tight at 13,710 - reamed to 13,712 ft. Washed down to 13,742 ft - had hard bottom at 13,782 ft
- 13) 3-13-80 RIH w/3-5/16 in. mill - had momentary drag at 13,152 ft - RIH to 13,742, washed to 13,935 ft - washing at 5 ft/hr
- 14) 3-14-80 RIH w/3-1/4 in. mill - hit bridge at 13,742 ft - reamed to 13,746 ft - washed to 14,005 ft - torqued up at 13,870 ft and 13,935 ft - gas cut mud from 13,935 to 14,005 ft
- 15) 3-31-80 While milling cement at 13,760 ft - rotary torqued up - reamed to 13,763 - P00 - left 3 blades off mill in hole
- 16) 4-05-80 After cleaning out cement to 13,920 ft - made short trip had tight spot 13,914 ft - cleaned out to 13,960 ft

TENNECO FEE "N" BOREHOLE DEVIATION

BOTTOM HOLE LOCATION CALCULATIONS USING RADIUS OF CURVATURE

COURSE LENGTH	MEASURED DEPTH	TRUE VERTICAL DEPTH	INCLINATION DEG MIN	DIRECTION DEG	RECTANGULAR COORDINATES NORTH/SOUTH	EAST/WEST	TOTAL CURVATURE TOP	BOTTOM
	13500.	13500.			0. N	0. W		
100.	13600.	13600.	3. 30.	S 1. E	-5.49 S	.19 E	.71	.73
100.	13700.	13700.	4. 18.	S 1. E	-12.29 S	.28 E	.80	.80
100.	13800.	13799.	4. 12.	S 5. E	-19.69 S	.67 E	.32	.31
100.	13900.	13899.	4. 0.	S 2. E	-26.83 S	1.10 E	.30	.29
100.	14000.	13999.	4. 15.	S 12. E	-33.96 S	1.98 E	.72	.80
100.	14100.	14098.	5. 0.	S 15. E	-41.80 S	3.86 E	.78	.80
100.	14200.	14198.	6. 30.	S 27. E	-51.13 S	7.45 E	1.75	2.15
100.	14300.	14297.	8. 0.	S 29. E	-62.27 S	13.37 E	1.51	1.53
100.	14400.	14396.	9. 0.	S 31. E	-75.07 S	20.76 E	1.03	1.05
100.	14500.	14495.	10. 30.	S 33. E	-89.44 S	29.73 E	1.53	1.55
100.	14600.	14593.	10. 40.	S 33. E	-104.84 S	39.74 E	.17	.17
100.	14700.	14691.	9. 20.	S 34. E	-119.32 S	49.32 E	1.35	1.34
100.	14800.	14790.	7. 30.	S 45. E	-130.59 S	58.62 E	2.70	2.24
100.	14900.	14890.	6. 30.	S 42. E	-139.43 S	67.00 E	1.08	1.05
100.	15000.	14989.	5. 45.	S 51. E	-146.77 S	74.74 E	1.32	1.13
100.	15100.	15089.	4. 15.	S 52. E	-152.20 S	81.56 E	1.50	1.50
100.	15200.	15188.	3. 30.	S 86. E	-154.58 S	87.77 E	2.86	2.02
100.	15300.	15288.	4. 0.	N 72. E	-153.79 S	94.23 E	1.35	1.71
100.	15400.	15388.	4. 0.	N 75. E	-151.81 S	100.91 E	.21	.21
100.	15500.	15488.	4. 40.	N 64. E	-149.17 S	107.98 E	.97	1.17
100.	15600.	15587.	5. 15.	N 64. E	-145.38 S	115.75 E	.58	.58
100.	15700.	15687.	5. 40.	N 59. E	-140.84 S	124.10 E	.61	.66
100.	15800.	15786.	5. 0.	N 65. E	-136.48 S	132.31 E	.92	.83
100.	15900.	15886.	5. 0.	N 68. E	-133.00 S	140.30 E	.26	.26
100.	16000.	15986.	5. 0.	N 90. E	-131.35 S	148.80 E	1.92	1.92
100.	16100.	16085.	5. 0.	S 71. E	-132.78 S	157.36 E	1.66	1.66
100.	16200.	16185.	5. 0.	S 75. E	-135.33 S	165.69 E	.35	.35
100.	16300.	16285.	4. 30.	S 73. E	-137.61 S	173.65 E	.53	.52
100.	16400.	16384.	4. 20.	S 89. E	-138.81 S	181.23 E	1.29	1.20

GRUY FEDERAL, INC.
HOUSTON, TEXAS

BAYOU JEAN LA CROIX AREA
TERREBONNE PARISH, LOUISIANA
STRUCTURE
TOP OF MG TEX W-2 SAND

SCALE
0 2000 4000

REPORT OF LOSS OF EXXON LA TERRE NO. 37

TERREBONNE PARISH, LA.

This well was located north 2065 feet and east 1070 feet of the southwest corner of Section 34, T-19-S, R-19-E, Terrebonne Parish, Louisiana. This is about 3-1/3 miles west of the Tenneco Fee "N" No. 1 test well.

This well was drilled by the Atlantic & Pacific Marine rig No. 4, the same contractor that drilled the Tenneco Fee "N" No. 1 well. Permit to drill for gas to a depth of 16,500 feet was requested August 9, 1979.

This well was drilled to a T.D. of 15,700 feet. A hole appeared in the 9-5/8 inch casing at 8803 feet - 8825 feet on March 11, 1980. This split was found when the well kicked and pressure was found in the 9-5/8 inch X 13-3/8 inch annulus.

The drill pipe was stuck. EXXON perforated the drill pipe and cemented the drill pipe in the hole from 12,870 feet to 12,350 feet, (they perforated the drill pipe again at 12,350 and pumped more cement down the drill pipe and into the 9-5/8 inch casing). They pumped cement down the drill pipe X 9-5/8 inch annulus to cement the hole in the 9-5/8 inch at 8803 feet to 8825 feet.

This well is temporarily abandoned and the rig is released. Additional work will be needed to secure the well or to plug and abandon.

GRUY FEDERAL, INC.

REPORT OF THE BLOW-OUT, LOSS OF TWO-R RIG NO. 8 EXXON LA TERRE NO. 30, TERREBONNE PARISH, LOUISIANA

This well was located at 1100 feet north of the southwest corner of Section 34 and 425 feet east, T-19-S, R-19-E, about 3-1/3 miles west and slightly north of the Tenneco Fee "N" No. 1 test well.

The date of the permit was July 8, 1977. They applied for a gas permit and a proposed total depth of 16,800 feet. The drilling contractor was Two-R Drilling Company with Rig No. 8.

They set 13-3/8 inch casing to 3,994 feet, followed with 9-5/8 inch to 12,699 feet. They reached a total depth of 16,500 feet with an 8-5/8 inch bit and at the time of the blowout had 17.5 ppg mud in the hole. The blowout preventor size was 10 inches. (QRC-5000 psi)

The drill pipe had stuck at 15,569 feet. They had been able to work it free with black magic mud and they had reamed the hole to 15,895 feet.

Bottom had been circulated up and gas was recorded at 40 units. Prior to the blowout, they were tripping out of the hole to log. One of the remarks here was that excessive shale was circulated out of the hole.

The blowout occurred on December 3, 1977. Personnel were safely evacuated after gas broke to the surface and shortly before an explosion which set fire to the rig. The rig and barge were in a crater within a few hours. They had been having problems prior to the blowout with differential sticking in the open hole. and they suggested in their report that it may have been related to barite contamination. In order to avoid this sticking problem they had, prior to the blowout, reduced mud weight from 17.7 ppg to 17.5 ppg at a depth of 15,533 feet.

They had reached T.D. at 16,500 feet November 27, 1977. At that time, the TPC sand section was open, which includes TP-4 which is produced in the LaTerre No. 22, the TP-4D, which is a virgin reservoir and the TP-5 which is produced in the LaTerre 29. (These are probably equivalent to the zone of the geopressured sands in the Tenneco Fee "N" No. 1 well.)

REPORT OF A TEMPORARY ABANDONMENT OF WELL - PENNZOIL LaTERRE #8

This well is located in Section 40, T-19-S, R-19-E of Terrebonne Parish, Louisiana. The well is located two miles West of the Tenneco Fee "N"-1.

The permit was issued June 15, 1979 to go to 17,500 ft. The well was drilled to 16,900 ft and the drill pipe stuck at 16,511 ft on August 31, 1979.

The well was "temporarily abandoned" on September 7, 1979.

I. R. "Bud" CHALMERS & ASSOCIATES, INC.

PETROLEUM CONSULTANTS
Box 52812 Lafayette, La. 70505
Phone 318 - 233-5082

Office: 110 Richard St.
Lafayette, La. 70506

Res.: 408 Laurence Dr.
Lafayette, La. 70503
318 - 232-3064

May 7, 1980

RECEIVED
GRUY FEDERAL, INC.
HOUSTON, TEXAS

Gruy Federal, Inc.
2500 Tanglewilde, Suite 150
Houston, Texas 77063

MAY 9 1980

Attention: Mr. Richard J. Dobson, Vice President

Reference: Liner Failure (4½")
Tenneco Fee "N" No. 1, Test Well
Terrebonne Parish, La.

Gentlemen:

The following information was provided by your office as a study base from which conclusions could be made as to the cause of the 4½" liner failure.

1. Partial Well Summary.
2. Drilling Reports.
3. Limited Hole Deviation Information.

In addition, fishing and milling operations were discussed with Tri-States Oil Tool's manager in Houma, La. We assume that Tenneco used good preventive practice and fully inspected the 4½" liner prior to running. If the pipe was then made-up under controlled conditions "over-torque" should not have occurred and trip problems would not have been caused by "crimped" pins. Reports indicate that the liner was set on a hanger and this should have eliminated "buckling" as a cause for problems.

During geopressure completion attempts we also assumed that the correct selection of bottom hole tools was made. Drilling reports indicate that a stabilizer was run 276' above a mill on one trip and it hung in a tight spot at 13,704'. A string reamer was also run with a mill on a later trip. Since these are normally open hole tools we assumed mistaken nomenclature and that actually they were swaging tools run in an effort to eliminate the tight spots in the liner.

We have concluded that the failure in the 4½" liner occurred on 3-14-80 with a mill in the hole. The break should be at a depth between 13,870' and 13,920'. On a previous trip wireline tools were fished from a depth of 13,866' with doubt as to whether the tools were on junk or a hard bottom. On the subsequent trip the mill worked 8½ hours from 13,866' to 13,935'. Final progress was 5 ft. per hour, indicating that the mill was not cutting outside the liner. We feel that it was below the failure

May 7, 1980

and still running on junk. When pulled, the mill was worn flat on bottom and the outside edge was rounded. To the writer, this indicates that the hard cutting material was lost off the bottom of the mill. This and other junk worked to the edge and jammed between the mill and inside wall of the casing. As the junk was worn away the liner was also cut out. The liner had already been exposed to approximately 55 hours of milling time between the depth of 13,700' and 13,910'. Pipe failure was confirmed on the next trip with excessive torque at 13,870' and gas-cut mud. The top of the liner was then squeezed again and, on drill-out, cement was found inside the 4½" to a depth of 13,920' with mud below that point.

Although there was a concentration of the rotating mill-hours at the ±13,700' and ±13,900' depths, we feel conditions were worsened by cumulative, one-direction hole deviation that caused the pipe wear to concentrate on the low side. This condition was more severe than indicated by the short survey and probably contributed to the back-off and backlash problems encountered. Also, varied wireline depths reached with changes in tool length indicated possible hole deviation.

Following are our comments regarding the three suppositions mentioned in your letter of transmittal:

1. The joints of 4½" liner not run could be inspected for metallurgical defects but if slugs or seams were detected it could not be assumed they were also in a joint that is in the hole. Brittleness is always a problem with "P" grade pipe. "Rockwell" hardness tests can be run on the available joints and if readings are high it may be assumed the pipe run had the same hardness. If the liner had been set on bottom, or on a bridge, compressive forces could have been applied in the releasing process and increased normal "buckling" effects.
2. With no cement behind the liner it is quite possible that salt water was communicating from the deeper sands to zones ±13,900'. Even so, this should not have caused any damage to the 4½" casing. At all times the inside of the liner was subjected to mud hydrostatic. An annular differential in the range of ±10,000 psi would have been necessary to cause collapse. Available records do not indicate any instance when this condition could have existed.
3. The power swivel, 2 3/8" drill pipe and 3 5/16" bladed mill have the combined ability to easily cut a window in the 4½" liner. In our case, if the mill continued to cut steel, progress would be -4 ft. per hour with considerable torque. Normally a small mill will drift out at a good angle and immediately cut formation. One frequent way to cause pipe failure is to mill on pieces of junk and not keep the pieces below the blades. A concave construction is usually used to keep throwing the junk toward the center of the mill as it rotates. Long body lengths are also helpful with pads machined without hard metal. In our case we feel that the mill remained inside

Gruy Federal, Inc.

Page 3

May 7, 1980

the casing while the junk cut the wall. This would be indicated by the lack of difficulty in going to 13,960' on a later trip in the hole.

4. We cannot accept seismic activity as a cause. We know of no instances on the Gulf Coast where similar failures were attributed to such activity.

For your information and files.

Yours very truly,

A handwritten signature in cursive script that reads "I. R. 'Bud' Chalmers".

I. R. "Bud" Chalmers
President

df

TENNECO FEE "N" NO. 1 TEST WELLFactors Affecting Completion of Well

1. The Rig - APMC #1, was available. It was hired despite its rough condition and looks.

The rig performed acceptably well, all considered. The down-time was within acceptable limits. Therefore, the rig was not a disturbing factor that affected the outcome of the well.

2. The Rig Crew of APMC #1 - Our evaluation of the crews of the rig was that for this period of time, they did a good job. They worked relatively safely, with only minor accidents - no major injuries. At no time did Tenneco/Gruy ask the APMC to replace any of them.

Allowing for the rain and winter cold and considering that the crew was handling more delicate drill pipe, tools and equipment than they like or are accustomed to handling, they did very well.

The only bad incident was that of dropping the D.C. clamp pin/chain in the well on March 24. This was well within the normal scope of deep well operations. Considering that we had to put the clamp on every stand of 2-3/8 D.P. that passed through the rotary table during months of operation, the record is admirable. Oftentimes drilling crews do not even report these incidents, causing even more repercussions, but this crew did report it - to their credit.

When we had unexpected flows of salt water and gas into the well bore, the crews caught them and controlled them immediately. They proved to be very good on well control procedures.

3. Tenneco Supervisors - We had three of the best Gulf Coast men assigned to us that exist. Harry, Goode and Vickers were very well prepared with background data. They persisted during the extended discouraging periods. They nursed the delicate operations and avoided many pitfalls that could have prematurely terminated the completion efforts and caused the loss of the well.

They are top flight men in B.O.P. procedures, pressure control, well technology, deep-hole completions, offshore logistics, personnel management, and rare, good common sense.

4. Service Men - Service Companies - All factors considered, all performed very well. None were dismissed during this extended operational period; this is rare.
5. Rental Tools - This operation depended heavily of the good operation and service of rental tools. Two rental companies were told that we would not rent from them again.

One company whose power swivels caused loss of rig time was warned, but their exceptional efforts to provide dependable service convinced us that the real cause was in the sizing of the swivels. The low power capacity of the swivels was necessary to protect us from twist-off of the slim hole drill pipe and to protect us from damage to the downhole tubulars. Therefore, we had to accept them as necessary safety weak links. We judged that no other equivalent equipment could have done any better.

The rental slim-hole, 2-3/8 in. drill pipe lasted far longer than we expected, no wash-outs, no fishing jobs. No other string of 2-3/8 in. drill pipe was ever located, despite repeated searches.

We can say that the rental tools performed better than average and were not a significant factor in determining the outcome of this job.

6. The top of the 7 in. original liner 12,327 ft - 13,438 ft was thought to have a leak, but this was proven wrong. Therefore, this was not a significant factor.

7. Top of 4-1/2 in. Liner, 13,148 ft

Tenneco provided Gruy with the daily reports of the liner setting/cementing problems and trouble was expected.

Tenneco worked on cementing the top of the 4-1/2 in. liner from January 11, 1979 thru January 22, 1979, eventually leaving the 7 in. liner full of cement and 657 ft of cement in the 9-5/8 in., just to be able to get away from the pressure. Three cement squeeze jobs by Tenneco failed to seal off the top of the 4-1/2 in. liner.

Since any one of these squeeze jobs would normally have served to seal this overlap, we assumed that this was not going to be very easy. It wasn't.

Any of the four squeeze jobs applied by Tenneco/Gruy from January 19, 1980 thru January 25 should have sealed this 4-1/2 in. X 7 in. overlap, but the first three obviously did not do it. The 4th squeeze held until February 20, 1980, it failed and had to be resqueezed twice.

Thus five squeeze jobs by Tenneco/Gruy were required to completely seal the top of the 4-1/2 in. liner, over and beyond the three squeeze jobs done by Tenneco. Adding the three squeeze jobs done by Tenneco before, made a total of eight jobs to seal off the 4-1/2 in. X 7 in. overlap.

We have not had a suitable explanation as to why it was so hard to cement this 4-1/2 in. x 7 in. overlap. Possibly, the overlap was short, only 290 ft. Accepted good practice is to allow about 500 ft.

The three cement squeeze jobs done by Tenneco from January 11 - January 22, 1979 and the four cement jobs by Tenneco/Gruy January 18 - January 25, 1980, plus cement job (Tenneco/Gruy) No. 7 on March 15, 1980 were pumped down through drill pipe. The drill pipe was trapped under closed BOPS and could not be pulled, a suitable packer could not be run/set to do a safe job.

On any one of the eight squeeze jobs, cement could have trapped/stuck the hanging drill pipe and a mean fishing job would have resulted.

The difficulties of plugging this overlap definitely affected the outcome of this completion, adversely, but was not the reason for abandonment of the well.

8. The Bottom of the 4-1/2 in. Liner

Tenneco's drilling record of January 10, 1978 said "plug did not leave TIW container". This "plug" is a dart designed to be pumped down through the 3-1/2 in. drill pipe behind the cement slurry. This dart latches into a rubber plug pinned into the liner setting tool. The displacing mud shears the pins, the dart/plug goes down the liner, displacing the slurry out of the bottom of the liner. The dart/plug latches into the shoe and stops the displacement. This dart/plug makes a plug on bottom of the liner to prevent over-displacement and/or back flow.

Since the dart did not leave the TIW container, the dart/plug never reached the bottom of the 4-1/2 in. liner. Over-displacement could have occurred. Tenneco's report of January 10, 1979 said that after displacement and attempted reversal of cement, the well started flowing. Part of this flow probably washed the cement slurry out of the shoe joint at the bottom of the 4-1/2 in. liner.

The bottom of the 4-1/2 in. liner was proven to be open on February 13, 1980. After running a mill to the PBD of 17,226 ft, mud pressure was applied and the pressure bled to 700 psi. This showed that the bottom was definitely open.

A try was made to set a bridge plug in the bottom of the 4-1/2 in. liner on March 7, 1980, with wireline. The 3.00 in. gauge ring stopped at 13,146 ft (overlap top). A 2.84 in. O.D. gauge ring worked past 13,146 ft and stopped at 13,577 ft. The gauge ring, locator tools, etc., were lost and a five day fishing job resulted.

The decision was made not to try to set a bridge plug in the bottom of the 4-1/2 in. liner.

Having this 4-1/2 in. liner open on bottom caused complications. The top of the 4-1/2 in. indicated that it had broken down on February 20, 1980. Gas showed up in the circulating mud. The TIW seal assembly was run-stuck into the polished-bore-receptacle at 12,181 ft. Howco pumped 20 barrels mud - 2400 psi. Standing pressure was 1200 psi.

Now, how do you pump cement into the top of the 7 in. X 4-1/2 in. over-lap if you know that the bottom of the 4-1/2 in. is open and you may fill your 4-1/2 in. completely full of cement? This was the quandary on February 23.

This is why the Genneco/Gruy well supervisors made the decision to put cement into the well in such a manner to cement the bottom of the 4-1/2 in. before trying to cement the top of the 4-1/2 in. As results showed on March 5, 1980, no cement went down into the 4-1/2 in.; both cement jobs went into the overlap.

Thus, the bottom of the 4-1/2 in. being open contributed to the high cost and difficulty of this completion effort.

9. The Tie-Back of the 4-1/2 in. X 5 in. Liners

Tenneco has allowed for a 4 in. PBR on top of the 4-1/2 in. liner. By tying in with the 7 in. X 5 in. liner, integrity would be established from surface to PBR of the 4-1/2 in. This 7 in. X 5 in. liner was run on January 31 and February 1, 1980.

All measurements were checked independently by the Tenneco supervisor, the TIW tool man, the Gruy representative and the APMC tool pusher. The seal assembly would not enter the PBR and the 7 in. X 5 in. liner had to be cemented without the mechanical seal.

This left open the possibility of a leak from the inside of the 5 in. out into the 7 in. X 4 in. overlap.

This very leak occurred on February 20.

The nature of liner tie-backs is that they are weak and unreliable. They often do not work and the industry would like not to have to depend on them. No better alternative is available. There was no surprise that this tie-back did not go together, hold a seal and seal off the 7 in. X 4-1/2 in. over-lap. We have to conclude that the outcome of this completion was adversely affected by the failure of the 4-1/2 in. X 5 in. tieback.

I will answer the question of why the 7 in. X 5 in. liner was not pulled out when the tie-in failed to make up. This 7 in. X 5 in. liner was run into the well on a calculated risk that the top of the 4-1/2 in. liner would hold long enough to get to bottom. Since no float could be run on the bottom of the 5 in., it was wide open. Had the well started to flow during running of this liner, plugs were available to try to plug the top of the 5 in. or the 7 in. This may have been futile, therefore, plans had been made to drop the portion of the liner and close the blind rams.

Pulling the 7 in. X 5 in. liner, reinspecting the threads on the shore, then rerunning the liner was simply too dangerous for the rig and crew. Therefore, no serious consideration was ever made to pull - rerun this liner.

10. The 4-1/2 in. Liner Body •

Running drill tools through a casing/liner over a long period puts wear on the inside. This is inevitable. The use of protector rubbers was excluded in this case by lack of clearance between the 3.375 in. I.D. of the 13,148 ft - 14,842 ft top interval of N-80 liner or the 3.515 ft I.D. of the 14,842 ft - 17,276 ft bottom interval of the P-110 liner.

The flush joint 2-3/8 in. O.D. Hydril drill pipe had no "hard-banding" nor tool joints to wear out the liner but some wear was inevitable.

This drill tool wear on the inside of a casing is always weighing on a drilling supervisor and he knows that as time lengthens out, the wear will inevitably weaken the casing.

Hard economics makes the techniques very strict for the running of such a string as this 4-1/2 in. liner. We are sure that Tenneco properly inspected the casing and that it was new-first class. A drift was run thru each joint as it was run. Proper torque was used in the make-up; all very proper.

However, this 4-1/2 in. liner was not quite right from the very beginning of the completion. The first time that a mill was run into the 4-1/2 in. liner, on February 9, 1980, it hit a tight spot at 13,705 ft, the mill had to be reamed thru to 13,708 ft. See attached drawing of all tight spots encountered. Most of the tight spots were concentrated in the 13,700 ft area.

Just why the liner had a reduced I.D. in this 13,700 ft area will never be known for some. When the mill encountered this tight spot at 13,705-708 on February 9 our Houston logging specialist, Lynn McCoy, made a borehole deviation computer print-out - 13,500 ft - 16,400 ft. This print out showed no abnormal deviation changes that might explain our problem. Subsequent logs on April 7 - 8, 1980 gave no indication of what might have caused these reductions of liner I.D.

We have information from the Gearhart-Owens Gamma Ray log of April 8, 1980 and the Schlumberger GR-CBL-VDL log of February 14, 1980 that the 13,438 - 13,670 interval shows an anomalous high radioactivity. A possible explanation of this high radioactivity was that salt water was flowing up the hole from a small sand at about 14,000 ft. This high radioactive area was not evident on the open hole logs run prior to setting the 4-1/2 in. liner. This flow of salt water may well have deposited salt on the 14,000 - 13,438 zone of the liner. This deposition may have caused corroded and weakened the collapse resistance of the 4-1/2 in. liner in this area.

There is no possibility that a hole was milled in the side of the 4-1/2 in. liner. Milling a long window thru the side of thick walled, hard (N-80) casing is a very hard job, downright impossible with macaroni drill pipe and a low powered rotary. Any suggestion that the mill went outside the 4-1/2 in. is ludicrous.

A hole in the 4-1/2 in. liner appeared on March 14, but it could not be verified until April 4, when the bottom of the cement inside the 4-1/2 in. was found at 13,920 ft. Until the bottom of the cement was found, there was no proof that there was a hole in the side of the 4-1/2 in. liner. On March 14, gas came out with the circulating mud, and a pit gain was noted. A standing pressure of 600 psi was found on March 15. These indications were almost identical to those of February 25, which proved that the top of the 4-1/2 in. was still open.

Hindsight is 20/20, but on March 14, there was no clear proof that the leak was not at the top of the 4-1/2 in. liner.

Keep in mind that the bottom of the 4-1/2 in. was proven again to be open on March 6. Gas cut mud was circulated out at 17,242 ft and a pressure test confirmed that the bottom was still open. When we asked T.I.W. about this gas coming into the well bore through the float valves, T.I.W. said that, yes, gas could come in - that the floats had had too much wear by then. Since the bottom was open and gas had been coming in thru the floats and fluid could flow out of the bottom, surface indications would be less dependable and even misleading.

Conclusions

We must all remember that Gruy Federal, Inc. did not have a representative on the barge when the liner was set/cemented. Gruy was brought into the project at a later date and we inherited this serious liner problem.

Gruy faced the following serious problems that contributed to the loss of this well:

1. The liner had insufficient cement outside.
2. The top of the liner was open and would have to be cemented under less than favorable conditions.
3. The bottom of the liner was open.
4. The liner had reduction of I.D.

Of the four problems, any one might have caused the loss of this well. All of them caused extra cost.

Any one of the above problems may have caused the well testing to be ruined/cancelled, after the completion was finished.

The uncemented liner caused the rig/crews to have to work 15 days with pressure under the BOPS. This is certainly excessive.

The three fishing jobs were accomplished despite the limited tool selection available for this small liner. One of the tools used, the friction socket, was made up in a shop - was not a shelf item.

Tectonic forces may have seriously damaged the liner, causing reduction of the I.D. This cannot be proven.

The work done on this well, though unsuccessful, was done properly and safely. I offer no apology for the Gruy-Tenneco-APMC men on this job.

TENNECO FEE "N" NO. 1
LOG OF ABNORMAL TIGHT SPOTS INSIDE
4-1/2 IN. LINER

13200	10 - 13,146' 13,148 Top 4 1/2" LINER 13 - 13,152'	
		1) 2-09-80 With 3-5/16 in. mill-tight at 13,705-13,708
		2) 2-14-80 3-3/16 in. Schlumberger junk basket stopped at 13,690 ft. 1700 lb drag to get free-bottom marked on edge
13300		3) 2-14-80 3 in. gauge ring stopped at 13,700 - 1400 lb drag to free
		4) 2-17-80 Schlumberger dummy gun (44 ft X 2-1/8 in. OD) stopped 13,740 ft
		5) 2-19-80 Schlumberger GR-CBL tool (w/centralizers) stopped 13,700 ft
13400	7" LINER 13,434	6) 2-19-80 Schlumberger GR-CBL tool (w/sinker bars) stopped 13,700 ft
		7) 2-20-80 3-5/16 in. mill stopped at 13,683 ft, reamed to 13,713 ft
		8) 2-21-80 3-5/16 mill on bottom and 3-3/8 in. string reamer 276 ft above - milled - stopped at 13,980 ft - string reamer at 13,704 ft
13500		9) 3-05-80 3-5/16 in. mill hit tight spot at 13,700 ft - milled through - RIH to 13,880 string reamer at 13,700 ft (4 hrs rotating to wipe out) - RIH tight spot 14,500 ft and 14,706 ft RIH to 17,242 ft
10		10) 3-08-80 GO ran 3 in. OD gauge ring. Stopped at 13,146 ft - PooH - ran 2-7/8 in. gauge ring - worked through 13,146 - RIH to 13,577 ft - bottom - POOH stuck at 13,146 ft, worked free - tools in hole
13600		11) 3-09-80 RIH w/3-1/8 in. overshot - chased tools to 13,816 ft (tight spot), then down to 13,841 ft. POOH - over-shot full of barite
		12) 3-09-80 RIH w/3-1/8 in. overshot - hole tight at 13,710 - reamed to 13,712 ft. Washed down to 13,742 ft - had hard bottom at 13,782 ft
13700	27 356,9 11	13) 3-13-80 RIH w/3-5/16 in. mill - had momentary drag at 13,152 ft - RIH to 13,742, washed to 13,935 ft - washing at 5 ft/hr
	12 4 14 15	14) 3-14-80 RIH w/3-1/4 in. mill - hit bridge at 13,742 ft - reamed to 13,746 ft - washed to 14,005 ft - torqued up at 13,870 ft and 13,935 ft - gas cut mud from 13,935 to 14,005 ft
13800	11	15) 3-31-80 While milling cement at 13,760 ft - rotary torqued up - reamed to 13,763 - P00 - left 3 blades off mill in hole
		16) 4-05-80 After cleaning out cement to 13,920 ft - made short trip had tight spot 13,914 ft - cleaned out to 13,960 ft
13900	16	