CASE 2146: Application of HUMBLE for an OIL-OIL DUAL OF ITS D. H. CROCKETT WELL NO. 1, located in Unit C.

Case No.

2146

Application, Transcript,
Small Exhibits. Etc.

Humble O & Ref

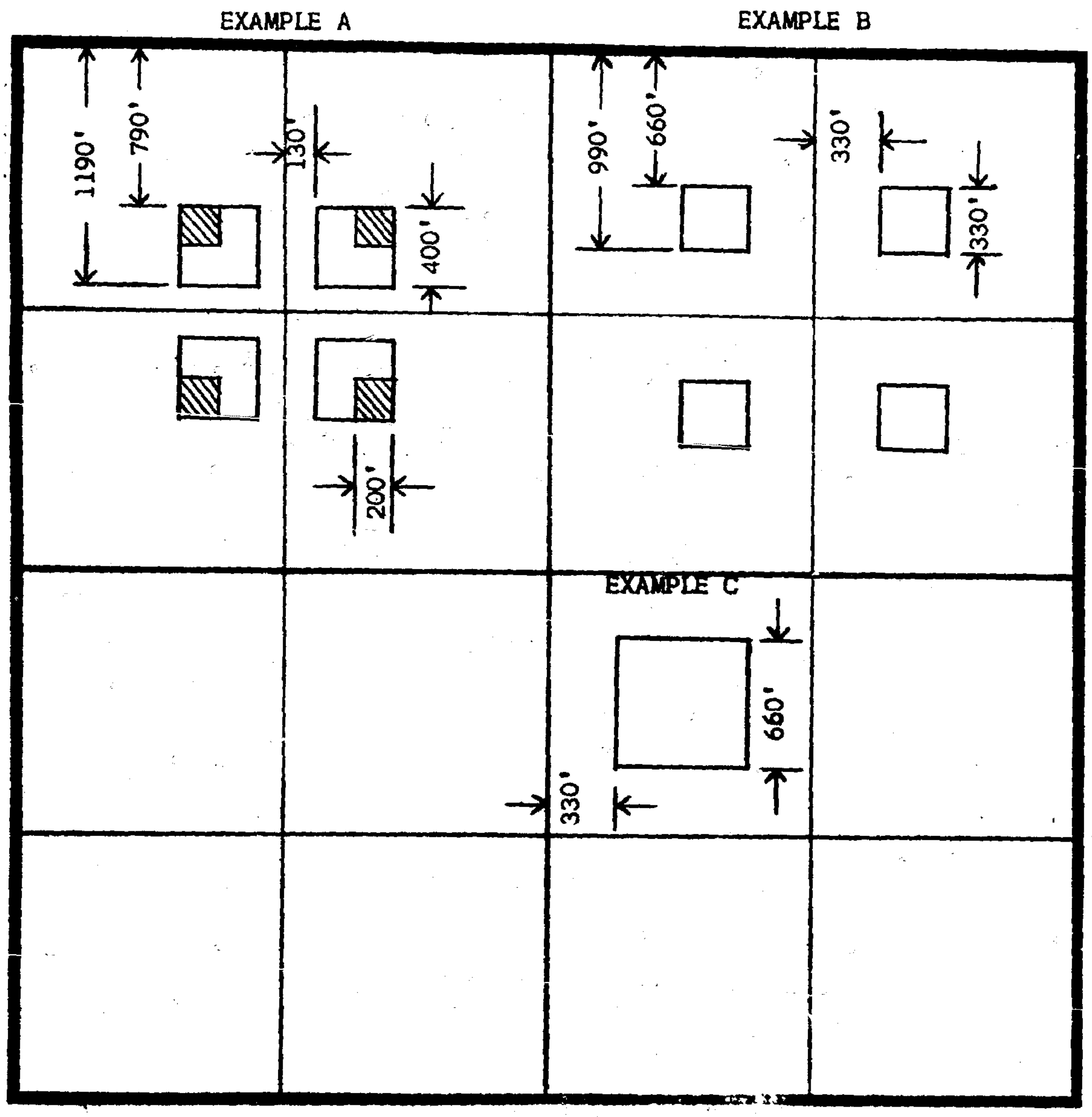
dually compl its D. H. Crockett #1

loc Unit C 21 15S 36E Lea Co.

prop to dually compl Caudill Devonian oil compl. w/ Caudill Wolfcamp oil 1 string 2 1/2 will be used inside 5 1/2 for Devonian; the Wolfcamp will be produced inside the csg-tbg annulus.

STANDARD OIL AND GAS WELL LOCATIONS IN NEW MEXICO ACCORDING TO RULE 104
OF THE GENERAL RULES AND REGULATIONS

Sec ______________ Township No. ______________ of Range No. ______________

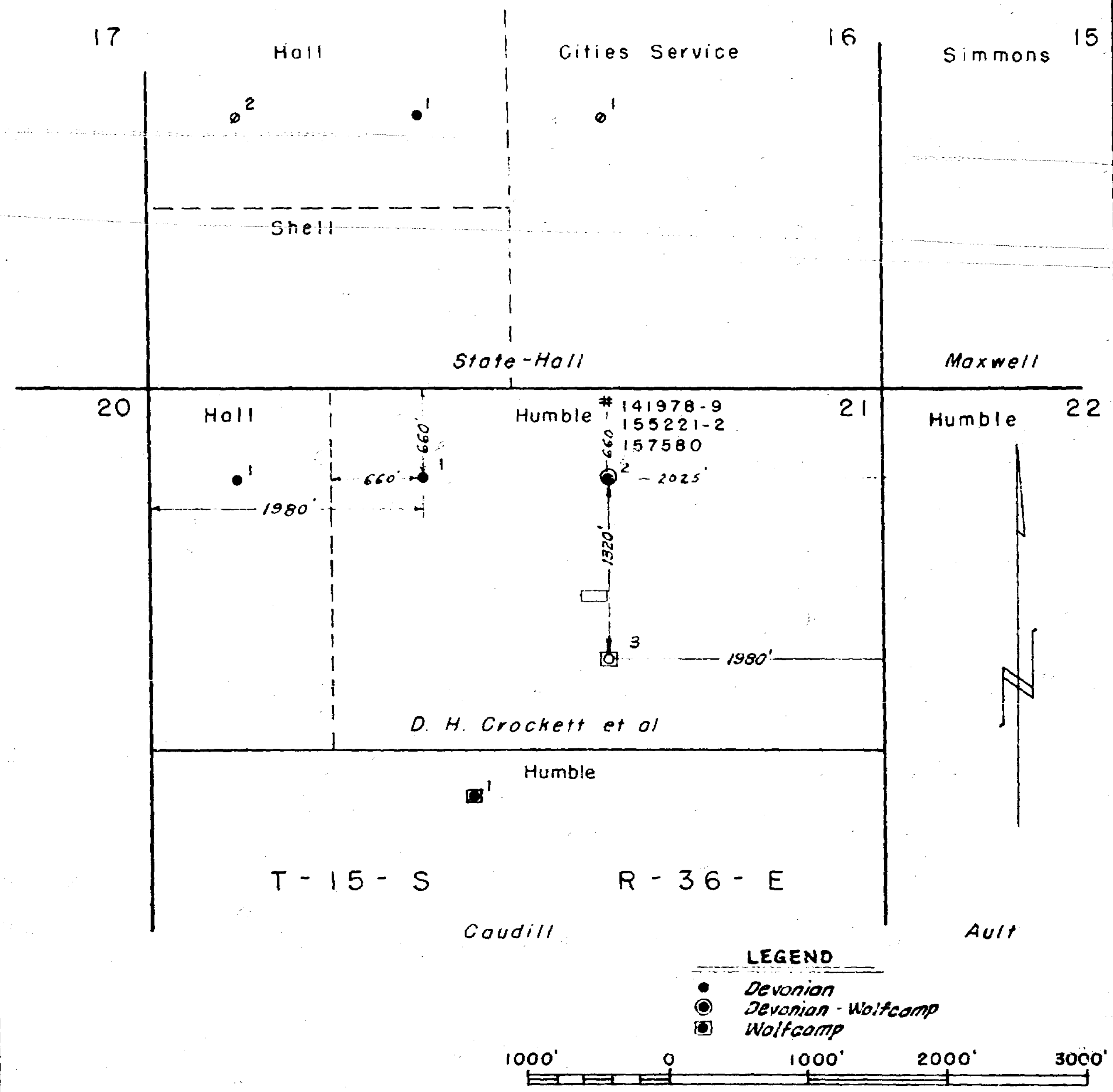


EXAMPLE A - Shows Standard Gas Well location in San Juan, Rio Arriba and Sandoval Counties. 200' crosshatched square shows portion of 400' square which is a standard location for oil or gas wells. These locations may be used in any quarter section.

EXAMPLE B - Shows standard gas well location for the State, except San Juan, Rio Arriba and Sandoval Counties. These locations may be used in any quarter section.

EXAMPLE C - Shows Standard Oil Well location for the State. This location may be used for a wildcat oil or gas well except in San Juan, Rio Arriba and Sandoval Counties. This location may be used in any quarter quarter section.

11/19/56



THIS APPLICATION FOR WELL NO. ______

D. H. CROCKETT ET AL. LSE.# 141978-9 155221-2 157580
SEC. 21, T-15-S R-36-E
LEA CO., NEW MEXICO

HUMBLE OIL & REFINING COMPANY
CIVIL ENGINEERING DIVISION
MIDLAND, TEXAS

DRAWN D. L. MCKIBBIN	SCALE 1" = 1000	FILE NO.
CHECKED E. T. [signature]	DATE 1-26-55	WT-A 1815
APPR. ______	REVISED ______	

4 MILES NORTH LOVINGTON CAUDILL DEVONIAN FIELD

NEW MEXICO OIL CONSERVATION COMMISSION

SANTA FE, NEW MEXICO

7-3-58

APPLICATION FOR DUAL COMPLETION

Field Name	County	Date
Caudill	Lea	November 17, 1960

Operator	Lease	Well No.
Humble Oil & Refining Co.	D. H. Crockett	1

Location of Well	Unit	Section	Township	Range
	C	21	15-S	36-E

1. Has the New Mexico Oil Conservation Commission heretofore authorized the dual completion of a well in these same pools or in the same zones within one mile of the subject well? YES ____ NO X

2. If answer is yes, identify one such instance: Order No. ____________; Operator, Lease, and Well No.:

3. The following facts are submitted:	Upper Zone	Lower Zone
a. Name of reservoir	Wolfcamp	Devonian
b. Top and Bottom of Pay Section (Perforations)	10542-46) 10553-68) Proposed 10576-80)	13592-13648
c. Type of production (Oil or Gas)	Oil	Oil
d. Method of Production (Flowing or Artificial Lift)	Flow	Pump

4. The following are attached. (Please mark YES or NO)

X a. Diagrammatic Sketch of the Dual Completion, showing all casing strings, including size and setting, top of cement, perforated intervals, tubing strings, including diameters and setting depth, location and type of packers and side door chokes, and such other information as may be pertinent.

____ b. Plat showing the location of all wells on applicant's lease, all offset wells on offset leases, and the names and addresses of operators of all leases offsetting applicant's lease.

____ c. Waivers consenting to such dual completion from each offset operator, or in lieu thereof, evidence that said offset operators have been furnished copies of the application.*

____ d. Electrical log of the well or other acceptable log with tops and bottoms of producing zones and intervals of perforation indicated thereon. (If such log is not available at the time application is filed, it shall be submitted as provided by Rule 112-A.)

5. List all offset operators to the lease on which this well is located together with their correct mailing address.

Columbian Carbon Company	1266 Butternut St.,	Abilene, Texas
Shell Oil Company	Box 845,	Roswell, New Mexico
Cities Service Oil Company	Box 97,	Hobbs, New Mexico

6. Were all operators listed in Item 5 above notified and furnished a copy of this application? YES ____ NO X. If answer is yes, give date of such notification ______________.

CERTIFICATE: I, the undersigned, state that I am the Agent of the Humble Oil and Refining Company (company), and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

R. G. Jonkin
Signature

* Should waivers from all offset operators not accompany an application for administrative approval, the New Mexico Oil Conservation Commission will hold the application for a period of twenty (20) days from date of receipt by the Commission's Santa Fe office. If, after said twenty-day period, no protest nor request for hearing is received by the Santa Fe office, the application will then be processed.

NOTE: If the proposed dual completion will result in an unorthodox well location and/or a non-standard proration unit in either or both of the producing zones, then separate application for approval of the same should be filed simultaneously with this application.

BKB/mcb

Case 2146

LAW OFFICES
HERVEY, DOW & HINKLE
HINKLE BUILDING
ROSWELL, NEW MEXICO

J. M. HERVEY 1874-1953
HIRAM M. DOW
CLARENCE E. HINKLE
W. E. BONDURANT, JR.
GEORGE H. HUNKER, JR.
HOWARD C. BRATTON
S. B. CHRISTY IV
LEWIS C. COX, JR.
PAUL W. EATON, JR.
CONRAD E. COFFIELD

TELEPHONE MAIN 2-6510
POST OFFICE BOX 547

November 23, 1960

New Mexico Oil Conservation Commission
P. O. Box 871
Santa Fe, New Mexico

Gentlemen:

It is requested that a hearing be scheduled to permit the dual completion of Humble's D. H. Crockett No. 1 Well located in the NE¼NW¼ of Section 21, T. 15 S., R. 36 E., Lea County, New Mexico. It is proposed to dual the existing Caudill-Devonian oil completion with a Caudill-Wolfcamp oil completion. One string of 2-1/2 inch tubing will be used inside the 5-1/2 inch casing so that the lower zone (Devonian) can be produced through the tubing and the upper zone (Wolfcamp) through the casing-tubing annulus. Exception to Statewide Rule 112-A is required since it is needed in order to dually complete the well, and administrative approval is not possible since only one string of tubing will be utilized.

Attached are the necessary Commission forms "Application for Dual Completion" and an exhibit showing all wells on offset leases.

It is requested that this matter be scheduled for hearing at the Examiner hearing of December 12. We appreciate your consideration in running a special advertisement so that this matter may be heard this year.

Very truly yours,

HUMBLE OIL & REFINING COMPANY

By [signature]
Hervey, Dow & Hinkle
P. O. Box 547
Roswell, New Mexico

HCB:db

Docket Mailed
12-5-60

GAS CORROSION ANALYSIS

Caudill Wolfcamp (D. H. Crockett No. 2 Separator Gas 12-1-60)
(60° F. and 14.696 psia)

CO_2	-	1.1949%	
H_2S	-	0.0051%	3.25 grains/100 S.C.F.
Total Acid Gas	-	1.2000%	

BEFORE EXAMINER UTZ
Humble 6
CASE NO. 2146

MULTIPLE COMPLETIONS

The term "Multiple Completion" refers to the technique which permits two or more reservoirs to be produced simultaneously but separately through the same well bore. Although most multiple completions are used only for production, many wells of this type serve as multiple injection wells for pressure maintenance or secondary recovery projects, and others are used for the injection of fluid into one or more reservoirs while maintaining production from others.

Technical reports are available on dual completions made during the late 1930's; (10);however, there was no significant application of the technique prior to World War II. The wartime demand for petroleum products and the critical shortage of steel for tubular goods prompted increased utilization of dual completions during the 1940's (11), (Fig. 12). Early dual completions were limited essentially to flowing wells selected to present no problems such as sand production or high pressure. Tools and equipment designed for use in single completions did not perform satisfactorily when subjected to the more severe loading imposed by dual completions; however, in wells where conditions were ideal, the dual completion proved to be a successful tool, offering savings of about 45 percent in steel consumption and approximately 40 percent in drilling costs as compared to the drilling of two single wells. (12). Because general experience with dual completions during this period was not entirely satisfactory, a decline in use of the technique occurred during the period 1946 to 1949.

The increasing cost of drilling wells and the relatively low additional cost of the second completion revived interest in the dual completion in the early 1950's. Equipment and techniques were rapidly improved, and widespread acceptance of dual completions followed (Fig. 12). (13). The success and economic advantages experienced with dual completions since 1950 have resulted more recently in development of equipment and techniques for triple and quadruple completions. Multiple completion techniques have permitted production of many reservoirs which otherwise could not have been profitably developed.

Dual Completions

Many different combinations of tubing strings and packers for dual completions may be utilized, and all equipment required is now commercially available. Selection of a particular installation depends upon economics as influenced by many considerations including installation cost, artificial-lift requirements, corrosion, sand production, and workover requirements. To aid in selecting the optimum-type installation, discussion of dual completion equipment and techniques is given with specific comments on application of the various type installations. (14).

Single-Tubing, Single-Packer Dual

One of the oldest types of dual completions involves setting a production packer on tubing between reservoirs and producing the lower interval through the tubing and the upper interval through the tubing-casing annulus (Fig. 13). This type completion is still popular because of simplicity and low initial cost. It is applicable where the upper interval is a long-life flowing completion which does not present problems of sand production, severe corrosion, or abnormal pressure.

It is common practice to install full-open packers and tubing equipment in order that through-tubing techniques may be utilized for workover of the lower interval. A wireline-operated circulating valve is usually placed above the packer for initiating flow from the upper zone through the tubing. The circulating valve is closed for normal production. Single tubing dual completions are commonly made with 5-1/2-inch casing and 2-inch tubing.

Workover of an upper zone requires use of a rig and removal of the tubing from the well. Concentric tubing can be used for low-pressure, squeeze-cementing of the lower zone or through-tubing dump bailers can be employed for plugback to avoid pulling tubing. Use of the tubing extension for workover of the lower zone is hazardous because the casing-tubing annulus must be used for circulation, exposing the upper zone to workover fluids and to squeeze pressures.

Single-Tubing, Two-Packer Dual

One of the main reasons for using two packers and only one tubing string in a dual installation is to achieve the flexibility of producing either zone selectively through the tubing. This type dual completion utilizes a packer between the reservoirs and a second packer with selective crossover flow equipment above the upper reservoir (Figs. 14A and 14B). Straight and crossover flow are distinguished by the flow paths of upper and lower zone production; lower zone production through the tubing is considered straight flow while upper zone production through the tubing is defined as crossover flow. The weaker zone, which may not flow through the casing-tubing annulus, can be diverted to the tubing, and production from the stronger zone can be taken through the annulus with this type installation. Similarly, if the pressure of one reservoir is abnormally high, production from this zone can be directed through the tubing with the lower-pressure reservoir being produced through the annulus.

Workover of the upper zone of a single-tubing, two-packer dual requires that the tubing and packers be removed from the well. The lower reservoir may be reworked by either the concentric tubing, dump bailer plugback, or wireline permanent completion method. Wireline workover of the lower zone can be performed by retrieving the straight or crossover flow choke by wireline and installing a tubing extension assembly of the required length (Fig. 14C). A concentric bypass assembly is installed below the extension hanger to seal the ports in the crossover flow assembly, thus isolating the interval between packers from the circulating system. With the exception of the bypass tool, wireline equipment and techniques for workover of the lower completion in this type dual well are the same as for reworking a single completion containing a packer.

Parallel-Tubing, Single-Packer Dual

Parallel-tubing strings are used in a single-packer dual installation primarily to permit independent artificial lift of both completions (Fig. 15A). A common dual completion of this type is two strings of

2-inch tubing installed independently in 7-inch casing. Wireline tubing extension of concentric tubing can be employed to wash sand from the upper zone, but both tubing strings must be removed for squeeze-cementing of this interval. Workover of the lower zone is accomplished in the same manner as previously described for the single-tubing, single-packer dual completion.

Parallel-Tubing, Two-Packer Dual

The basic reasons for utilizing two packers in a parallel-tubing dual completion are (1) to avoid exposing the casing annulus to sand-laden or corrosive well fluids or to abnormal pressures, (2) to provide a means of gas-lifting both zones from a common gas source in the annulus, and (3) to permit wireline workover of intervals below the lower packer without exposing upper intervals to circulating fluids and squeeze pressures (Fig. 15B). In addition, this type installation affords a means of independent artificial lift of both intervals by rod pumps or subsurface hydraulic pumps.

To squeeze-cement the upper zone of a parallel-tubing, two-packer dual completion, it is necessary that the tubing and packer be pulled from the well. However, a tubing extension can be utilized on the upper interval for washing sand or for placement of acids or other chemicals to stimulate the formation. The lower interval can be reworked with wireline permanent completion methods in a manner identical to a single completion containing a packer because the casing-tubing annulus is completely isolated from the upper reservoir. Similarly, other through-tubing workover methods can be employed as in a single completion.

REFERENCES

(Noted in text by underlined numbers).

10. Turner, Marshall C.: "Dual Completion Equipment and Practices", API Mid-Continent District Spring Meeting, Oklahoma City, Oklahoma, March 17-19, 1954.

11. Miller, E. B., Jr.: "A Survey of Dual Completions", API 27th Annual Meeting, Chicago, Illinois, November 11, 1947.

12. Alcorn, I. W., and Alexander, W. A.: "A Review of Multiple-Zone Well Completions", API 23rd Annual Meeting, Chicago, Illinois, November 10, 1942.

13. Prutzman, F. G.: "Economics Fosters Dual Completions", API Southwestern District Spring Meeting, Fort Worth, Texas, March 21-23, 1956.

14. Tausch, G. H., and Kenneday, John W.: "Permanent-Type Dual Completions", API Southern District Spring Meeting, San Antonio, Texas, March 7 - 9, 1956.

TEXAS DUAL COMPLETIONS

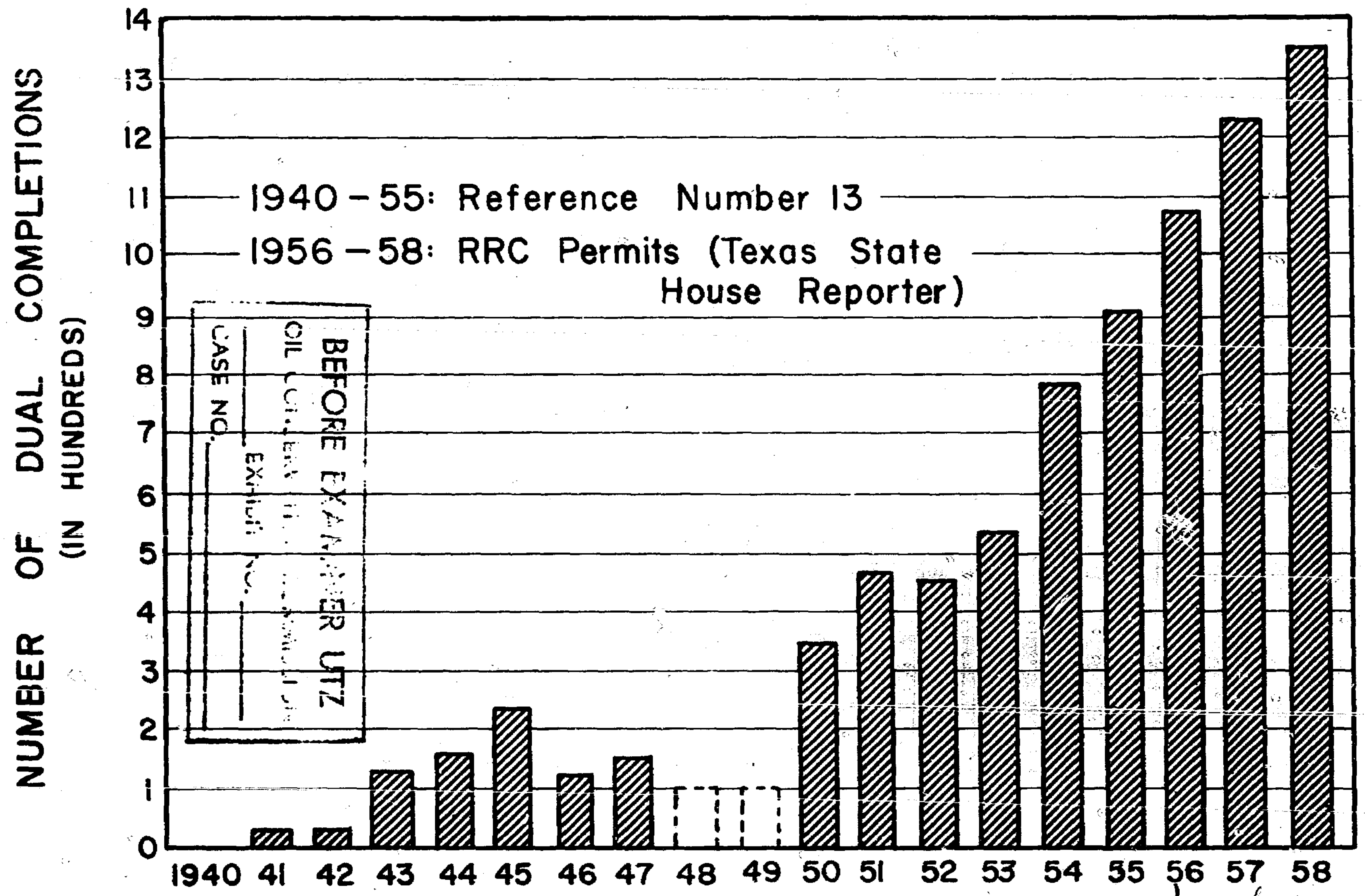


FIGURE 12

SINGLE TUBING SINGLE PACKER DUAL

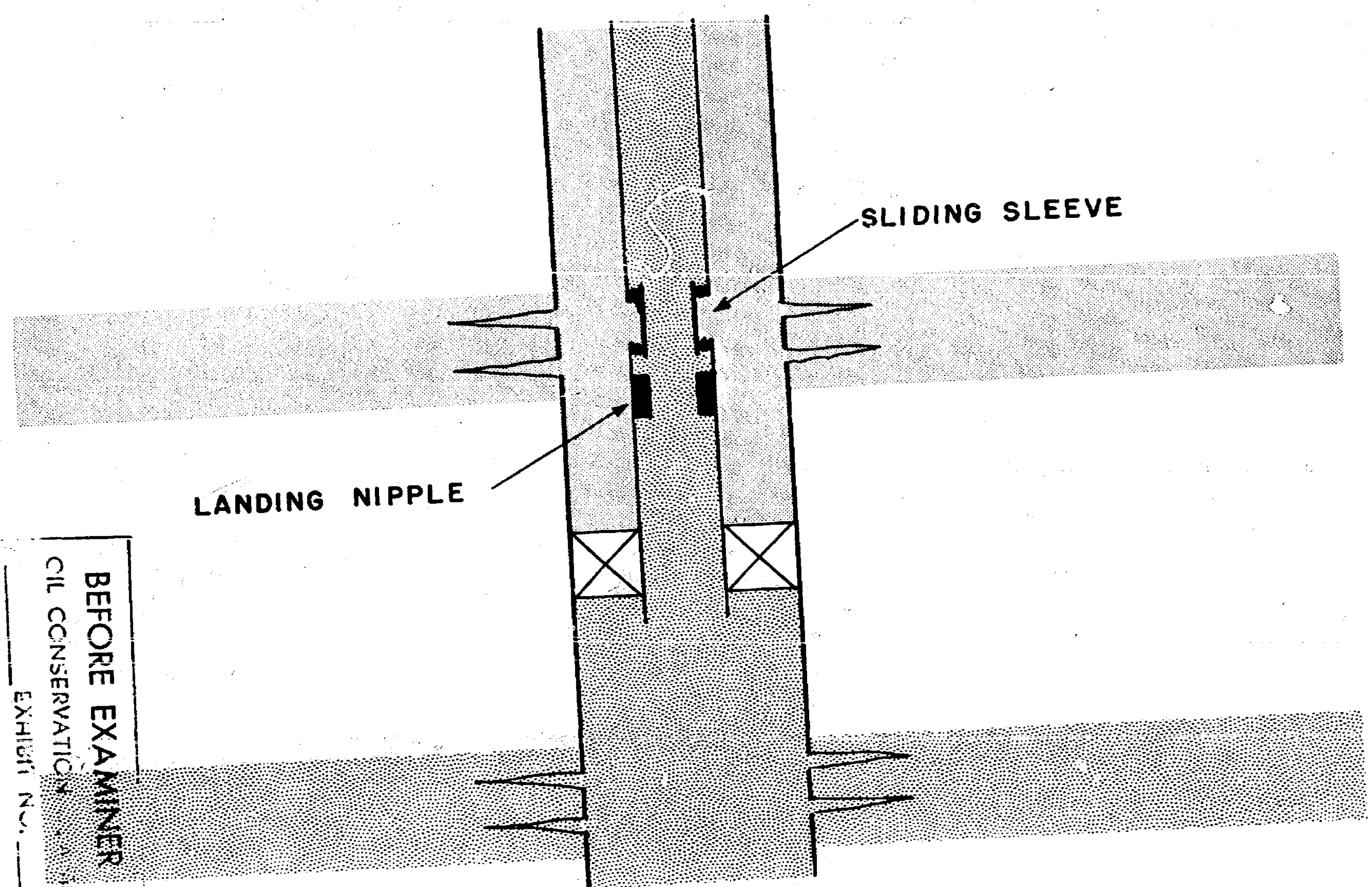


FIGURE 13

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
EXHIBIT NO.
CASE NO.

SINGLE TUBING TWO PACKER DUAL

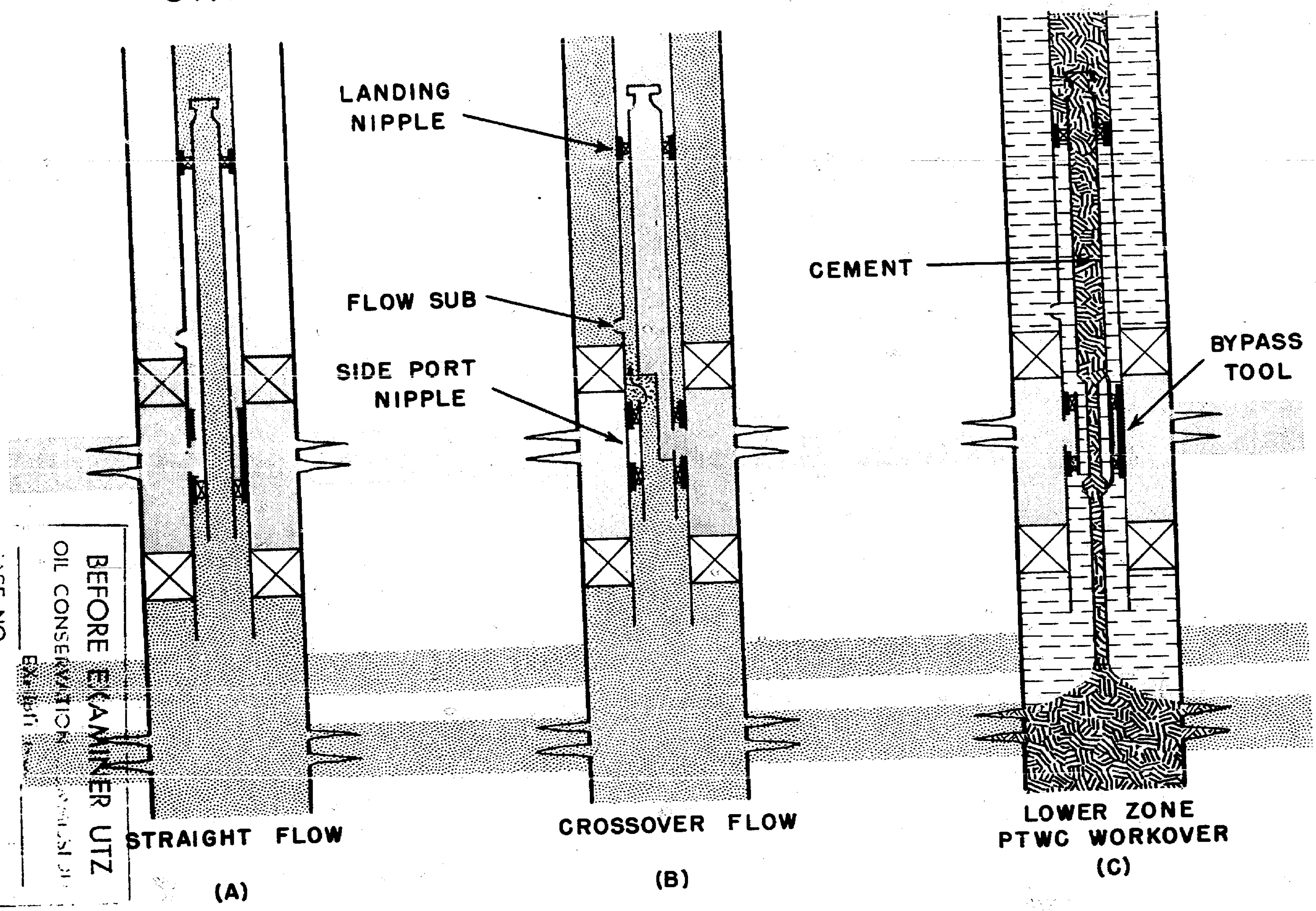
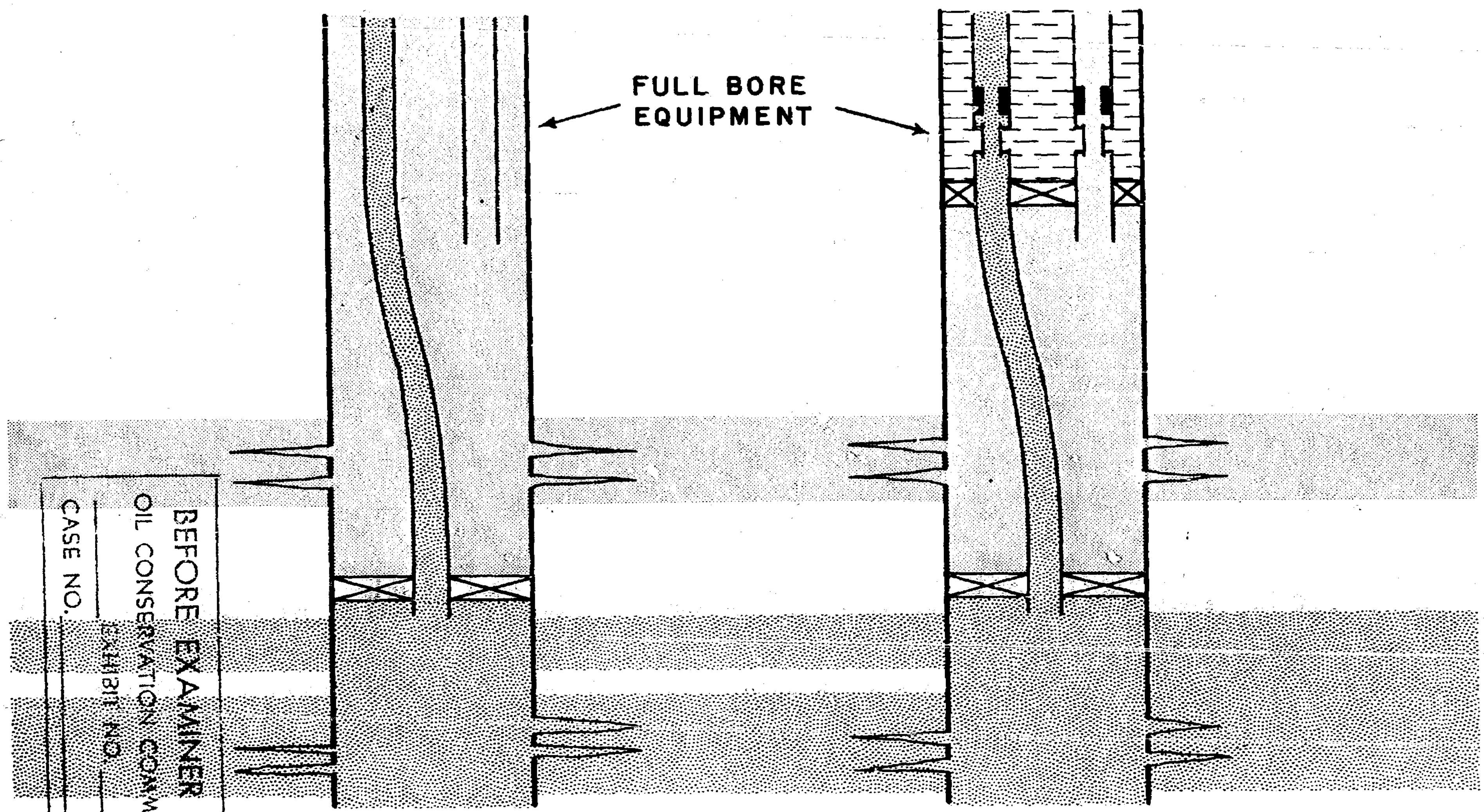


FIGURE 14

PARALLEL TUBING DUALS



SINGLE PACKER DUAL
(A)

TWO PACKER DUAL
(B)

FIGURE 15

RECENT WELL TESTS OF DEVONIAN RESERVOIR

D. H. CROCKETT 1, CAUDILL FIELD

Date	Method of Production	Barrels Per Day Salt Water	Oil	Total Fluid
10-16-58	Pump	352	235	587
11-26-59	Pump	512	70	582
1-2-60	Pump	511	90	601
10-12-60	Pump	439	60	499

Top allowable for the Devonian Reservoir - 272 Barrels per Day.

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
Humble EXHIBIT NO. 4
CASE NO. 2146

ARTIFICIAL LIFT CAPACITY

Tubing Size -Inches	Pumping Fluid Level - Feet	Method	Capacity Bbls./Day
2-1/2	10,650	Rod*	260*
2-1/2	10,650	Subsurface Hydraulic	336
1-1/2	10,650	Rod*	80*
2-1/2	5,000	Rod	602
2-1/2	5,000	Subsurface Hydraulic	550
1-1/2	5,000	Rod	210

* - Special High Tensile Rods

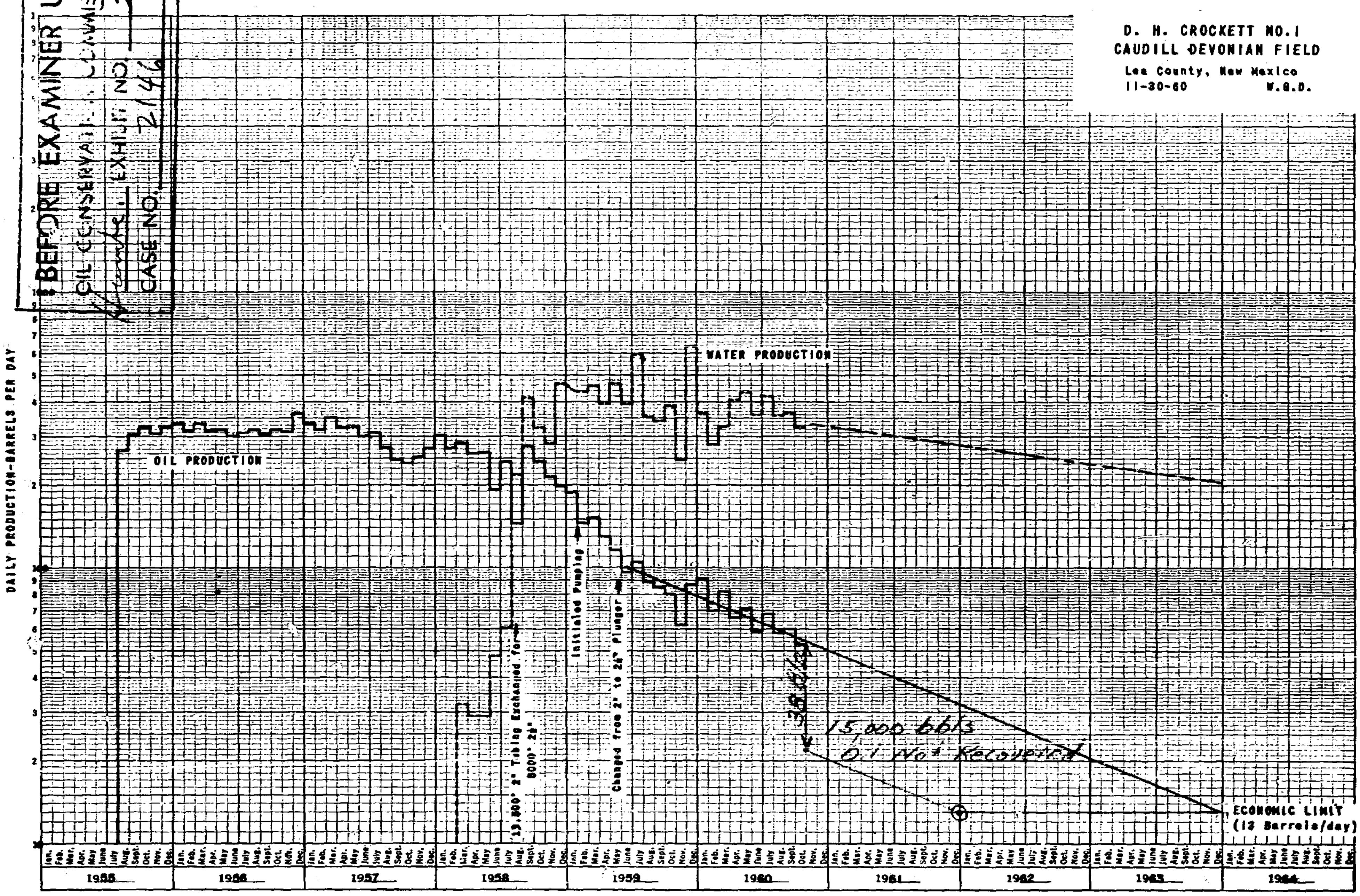
Note: All capacities were determined using a volumetric efficiency of 80 percent.

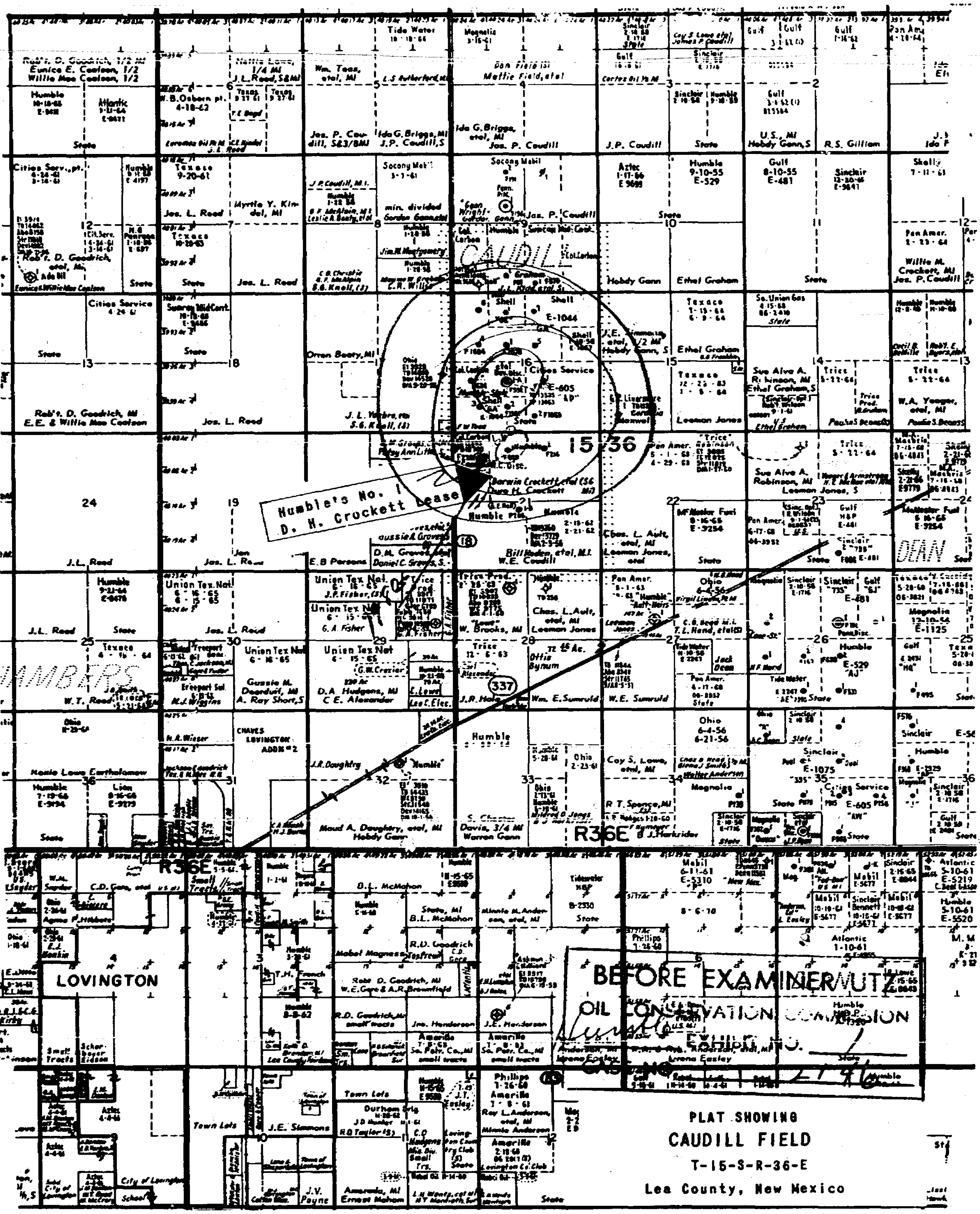
2 - 1½ Hydril $2 4,000 more

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
EXHIBIT NO. 4
CASE NO. ____

Page 2.

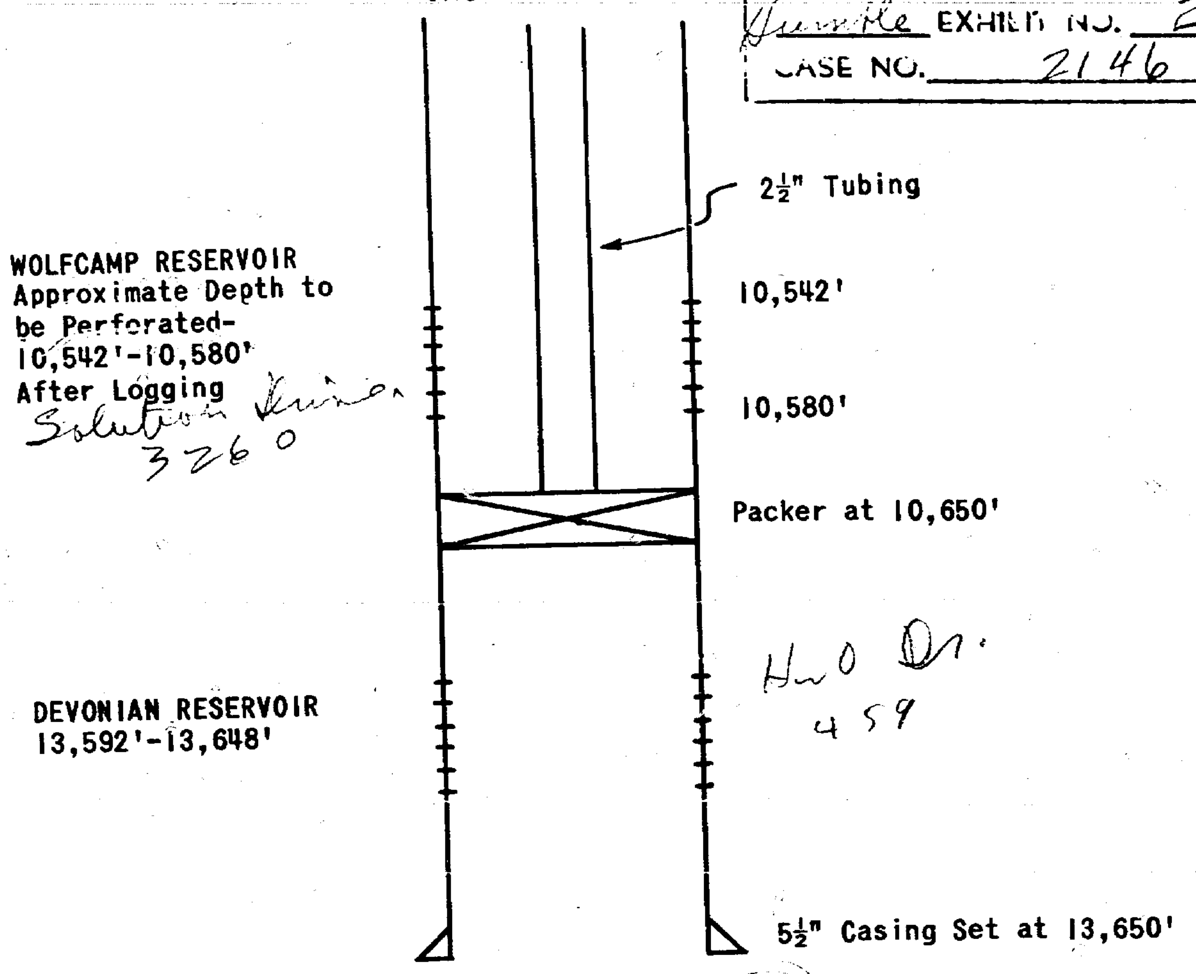
BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
EXHIBIT NO. 3
CASE NO. 2146




Humble's No. 1
D. H. Crockett Lease
CAUDILL
15/36
R36E
LOVINGTON
DEAN
BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
EXHIBIT NO.
PLAT SHOWING
CAUDILL FIELD
T-15-S-R-36-E
Lea County, New Mexico

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
Humble EXHIBIT NO. 2
CASE NO. 2146

D. H. CROCKETT I
CAUDILL FIELD



TOP OF CEMENT - 3700 FT.

PROCEDURE

1. After Logging, perforate indicated pay from approximately 10,542-80'.
2. Set non-retrievable packer at 10,650'.
3. Run 2½" tubing with a seating nipple and sliding sleeve valve two joints above the packer.
4. Set a blank off plug in the seating nipple, open the sleeve and acidize the Wolfcamp Reservoir.
5. Swab the Wolfcamp until flow is initiated, close the sliding sleeve valve and produce through the annulus.
6. Run rods and return the Devonian to production.

DRAFT

RSM/esr
December 19

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE No. 2146
Order No. R- 1848

APPLICATION OF HUMBLE OIL & REFINING COMPANY FOR AN OIL-OIL DUAL COMPLETION IN THE CAUDILL-WOLFCAMP POOL AND IN THE CAUDILL-DEVONIAN POOL, LEA COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on December 12, 1960, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this ________ day of December, 1960, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Humble Oil & Refining Company, proposes to dually complete its D. H. Crockett Well No. 1, located in Unit C, Section 21, Township 15 South, Range 36 East, NMPM, Lea County, New Mexico, in such a manner as to permit the production of oil from the Caudill-Wolfcamp Pool and the production of oil from the Caudill-Devonian Pool through the annulus between strings of 5 1/2-inch casing and 2 1/2-inch tubing and through 2 1/2-inch tubing, respectively.

(3) That inasmuch as ~~this type of dual completion is not in~~ the best interests of conservation would not be as adequately served by the proposed method of dual completion as ~~and inasmuch as there are~~ by other, safer methods of dually completing the subject well, the subject application should be denied.

IT IT THEREFORE ORDERED:

That the subject application be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

RECENT WELL TESTS OF DEVONIAN RESERVOIR

D. H. CROCKETT 1, CAUDILL FIELD

Date	Method of Production	Barrels Per Day Salt Water	Oil	Total Fluid
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ARTIFICIAL LIFT CAPACITY

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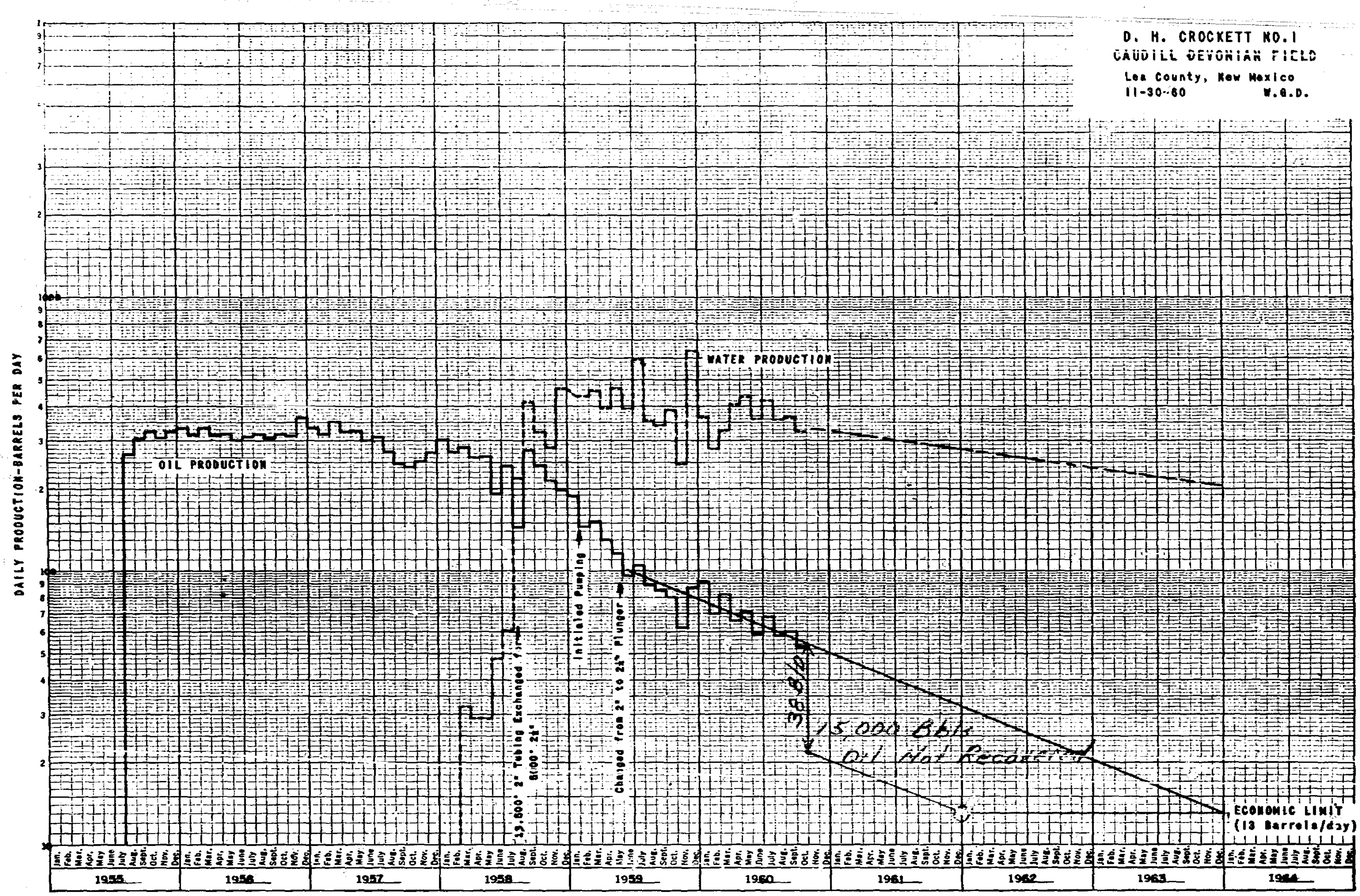


D. H. CROCKETT NO. 1
CAUDILL DEVONIAN FIELD
Lea County, New Mexico
11-30-60 W.G.D.
DAILY PRODUCTION-BARRELS PER DAY
WATER PRODUCTION
OIL PRODUCTION
Initiated Pumping
Changed from 2" to 2½" Plunger
38 B/D
15,000 Bbls
Oil Not Recovered
ECONOMIC LIMIT
(13 Barrels/day)
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964

KONTOL

PETROLITE CORPORATION

TRETOLITE COMPANY

DIVISIONS

corrosion inhibitors for petroleum producers

Saint Louis 19, Missouri
Brea, California

D Pony rods and tubing subs

Another method of surveying corrosion rate involves the use of short sections of rods (pony rods) or short sections of tubing (subs) which are sandblasted and weighed. These may be placed at any desired location in the rod or tubing string. They are normally left in the well for approximately 3 months, after which they are removed, cleaned and weighed to determine the amount of metal lost.

While pony rods or tubing subs give an accurate evaluation of corrosion rate at any desired location in the string, they are costly to install and remove, and the time between examinations is long.

E Caliper surveys

Another method used for determining corrosion rate of internal surfaces of tubing is through the use of the tubing caliper.

This tool is lowered by means of a wire line to the bottom of the well. As the tool is retrieved, actuated feelers follow the surface of the tubing, reveal any irregularity and literally feel for corroded areas and indications of pitting. A stylus records all such irregularities as a permanent record as the tool moves up through the tubing.

This method has the advantage of inspection without removal of tubing from the well. It is somewhat expensive, however, and cannot be used if there are any obstructions in the tubing string.

REPLACEMENT RECORDS

The methods of corrosion rate evaluation described above indicate various means by which the degree of protection derived from the use of corrosion inhibitors can be determined. The keeping of accurate and detailed records of parts requiring replacement because of corrosion damage provides another valuable method of determining the degree of protection.

Such replacement records will, over a period of time, often show the development of a pattern of failure. By following such data, it usually is a simple matter to make changes in the system and, by so doing, improve protection.

In any program of corrosion mitigation the keeping of accurate replacement records will prove extremely valuable.

CORROSION RATE SURVEY

The Tretolite Company offers a corrosion rate survey service to any producer who is interested in determining the rate of corrosion before, or during, treatment. In general, the testing of every well in a field is not necessary, since corrosion rates are usually very similar in adjacent wells. It is, therefore, suggested that 2 or 3 representative wells from each lease or field be chosen for testing.

When this corrosion rate survey service is requested, the Tretolite Company will:

1. Supply weighed steel test coupons for insertion in the flow stream at the well head or flow line.
2. Evaluate and report the results of the tests with coupons.
3. Analyze well brine for iron, dissolved salts, chlorides, and pH.

For information on the best methods for surveying the corrosion on your lease, call the Tretolite Field Engineer in your production area, or write or call the nearest Tretolite Company office.

ADVANTAGES OF KONTOL CORROSION INHIBITORS

Dependability KONTOL Corrosion Inhibitors are effective in all types of internal corrosion problems. Their use has enabled oil producers to prevent many costly losses.

Economy KONTOL Corrosion Inhibitors protect both carbon and alloy steels. The protection provided by KONTOL often permits the use of carbon steel instead of more costly alloys. Even when plastic or cement-coated pipe is used, the use of KONTOL protects against coating failures. The cost of KONTOL protection is nominal in comparison to the cost of steel and other expenses which would be incurred through corrosion-caused failures in the absence of protection.

Flexibility KONTOL protects against all classes of corrosive attack. The usual corrosion caused by brines, sour crudes, etc., is prevented, as are also hydrogen embrittlement and hydrogen blistering. KONTOL Corrosion Inhibitors are available in water-soluble, oil-soluble-and-water-dispersible, and oil-soluble-and-water-insoluble formulations. They are effective in pumping, flowing, gas, gas-condensate, water-flood, and water-disposal systems.

Ease of Application KONTOL Corrosion Inhibitors are available in liquid, stick, pellet, and granular forms. They are easily applied by pumping, dumping, or lubricating in the liquid form, or by simply dropping the sticks, pellets or granules down the well.

Safety KONTOL is safe to handle, store and apply. It is non-poisonous, non-explosive, and non-flammable under all normal conditions. No goggles, masks, aprons, gloves, or similar protective equipment are required for handling.

PETROLITE CORPORATION

TRETOLITE COMPANY

CANADA: Petrolite Corporation of Canada, Limited, Edmonton, Alberta
ENGLAND: Petrolite Limited, 20 Savile Row, London W.1
VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Avenida Rio Branco 57-s/1410-11, Rio de Janeiro
COLOMBIA: W. F. Faulkner, Calle 19, No. 7-30, Office 807, Bogota
GERMANY: H. Costenoble, Guiollettstrasse 47, Frankfo.t, a.M.
ITALY: NYMCO S.p.A. 9, Lungctevere A. da Brescia, Rome
JAPAN: Maruwa Bussan KK, No. 3, 2-Chome, Kyobashi, Chuo-Ku, Tokyo
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico, D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
PERU: Oilfield Import, S. A., Apartado 71, Talara
TRINIDAD: Neal and Massy, Ltd., P.O. Box 544, Port of Spain

460-AC-5M-5953

Printed In U.S.A.

CASE 2145: Application of Oil Development Company of Texas for off-lease storage of oil. Applicant, in the above-styled cause, seeks an order authorizing it to store the East Crossroads-Devonian production from its Santa Fe Pacific Railroad Lease (S/2 SW/4 of Section 19, Township 9 South, Range 37 East) in a separate tank battery to be located on its Santa Fe Pacific Railroad Lease, Crossroads-Devonian Pool (NE/4 of Section 26, Township 9 South, Range 36 East) both in Lea County, New Mexico.

CASE 2146: Application of Humble Oil & Refining Company for an oil-oil dual completion. Applicant, in the above-styled cause, seeks an order authorizing the dual completion of its D. H. Crockett Well #1, located in Unit C, Section 21, Township 15 South, Range 36 East, Lea County, New Mexico, in such a manner as to permit the production of oil from the Caudill-Wolfcamp Pool and the production of oil from the Caudill-Devonian Pool through the annulus between strings of 5½-inch casing and 2½-inch tubing and through 2½-inch tubing, respectively.

No. 3[illegible]-60

DOCKET: EXAMINER HEARING, MONDAY, DECEMBER 12, 1960

Oil Conservation Commission - 9 a.m., STATE LAND OFFICE BUILDING, SANTA FE, NM

The following cases will be heard before Elvis A. Utz, Examiner, or Oliver E. Payne, attorney, as alternate examiner:

CASE 2136: Application of Byard Bennett for a non-standard gas proration unit and for an unorthodox gas well location. Applicant, in the above-styled cause, seeks the establishment of an 80-acre non-standard gas proration unit in the Jalmat Gas Pool consisting of the E/2 NW/4 of Section 24, Township 25 South, Range 36 East, Lea County, New Mexico, said unit to be dedicated to the Ascarte-Federal Well No. 1, located at an unorthodox location at a point 330 feet from the North line and 2310 feet from the West line of said Section 24.

CASE 2137: Application of Caulkins Oil Company for a non-standard gas proration unit. Applicant, in the above-styled cause, seeks the establishment of a 320-acre non-standard gas proration unit in the Basin-Dakota Pool, San Juan and Rio Arriba Counties, New Mexico, comprising the SE/4, S/2 NE/4 and S/2 SW/4 of Section 16, Township 26 North, Range 6 West. Said unit is to be dedicated to the D-268 well located in the SE/4 NE/4 of said Section 16.

CASE 2138: Application of Skelly Oil Company for permission to commingle the production from two separate pools. Applicant, in the above-styled cause, seeks permission to commingle without separately measuring the production from the Penrose Skelly and Drinkard Pools from all wells presently completed on its Baker "B" Lease consisting of the SW/4 and the W/2 SE/4 of Section 10, Township 22 South, Range 37 East, Lea County, New Mexico.

CASE 2139: Application of Cosden Petroleum Corporation for the promulgation of special rules and regulations governing the South Prairie-Pennsylvanian Pool, Roosevelt County, New Mexico, including a provision for 80-acre oil proration units.

CASE 2140: Application of Humble Oil & Refining Company for approval of the North Kirtland Unit Agreement. Applicant, in the above-styled cause, seeks approval of the North Kirtland Unit Agreement, which unit embraces 11,478 acres of Federal and State land in Township 30 North, Range 14 West, San Juan, New Mexico.

CASE 2141: Application of Honolulu Oil Corporation for approval of a unit agreement. Applicant, in the above-styled cause, seeks approval of its McKittrick Canyon Unit Agreement, which unit is to embrace 6708 acres of Federal, State and fee lands in Township 22 South, Ranges 25 and 26 East, Eddy County, New Mexico.

HUMBLE OIL & REFINING COMPANY
HUMBLE DIVISION
P. O. BOX 1600
MIDLAND, TEXAS

PRODUCTION DEPARTMENT
WESTERN AREA
R. R. McCARTY
MANAGER
J. S. BOLDRICK
OPERATIONS SUPERINTENDENT
H. L. HENSLEY
H. E. MEADOWS
ENGINEERING COORDINATOR
A. J. BEDFORD
ADMINISTRATIVE COORDINATOR

December 14, 1960

Re: Dual Completion;
Application for
Humble Oil & Refining Co.
Case No. 2146

Mr. Elvis A. Utz
Examiner, New Mexico Oil Conservation Commission
Santa Fe, New Mexico

Dear Mr. Utz:

In response to questions by Mr. Dan Nutter at the December 12,1960 hearing for a single string dual completion application (Case No. 2146) the following additional information is presented for the Caudil-Devonian producer in D. H. Crockett Well No. 1:

1. Sucker rod size - 1-inch (56 joints + 24 feet of subs),
   7/8-inch (64 joints)
   3/4-inch (78 joints)

2. Average pumping speed is 12 strokes per minute which is considered the maximum rate for safe operation.

3. Length of stroke - 108 inches with a 320-D pumping unit.

4. Size of pump plunger - 2-1/4 inches.

A review of well development costs for the Caudill-Wolfcamp pool indicates that a single string well would cost $200,000; however, as stated in the hearing, it would be difficult to economically justify this expenditure due to limited reserves anticipated from the reservoir.

Yours very truly,

HUMBLE OIL & REFINING COMPANY

R. R. McCARTY

BY: HENRY E. MEADOWS

JEW/rs
cc: Mr. Dan Nutter
Mr. Howard Bratton
Mr. W. S. Davis

Case 2146
Heard 12-12-60
Rec. 12-19-60

1. I recommend that Humble's case for oil-oil Dual with 2½ Tubing and 2½ x 5½ annular flow be denied.

2. There are other compromises using Hydril Tubing that could be used to recover both zones at the same time.

[signature]

3. It is not in the interest of conservation to allow this type of Dual.

[initials]

GOVERNOR
JOHN BURROUGHS
CHAIRMAN

State of New Mexico
Oil Conservation Commission

LAND COMMISSIONER
MURRAY E. MORGAN
MEMBER

STATE GEOLOGIST
A. L. PORTER, JR.
SECRETARY DIRECTOR

P. O. BOX 871
SANTA FE

December 21, 1960

Re: Case No. 2146
Order No. R-1848
Applicant:
Humble Oil & Refining Co.

Mr. Howard Bratton
Hervey, Dow & Hinkle
Box 547
Roswell, New Mexico

Dear Sir:

Enclosed herewith are two copies of the above-referenced Commission order recently entered in the subject case.

Very truly yours,

A. L. PORTER, Jr.,
Secretary-Director

ir/

Carbon copy of order also sent to:

Hobbs OCC x
Artesia OCC ____
Aztec OCC ____
Other ____

File Case
2146

Memo

From

To Crockett # 2 B
Wolfcamp.

	BPM	MCF/M	GOR
		7126	1530
June	4653	6735	1402
July	4801 BPM	5767	1200
Aug	4817	7221	1545
Sept.	4668	8253	1704
Oct	4851		

Can you [illegible] WC

$5\frac{1}{2}$" $23^{\#}$ ID = 4.67

$2\frac{7}{8}$ cs jt OD (collar) = 3.22

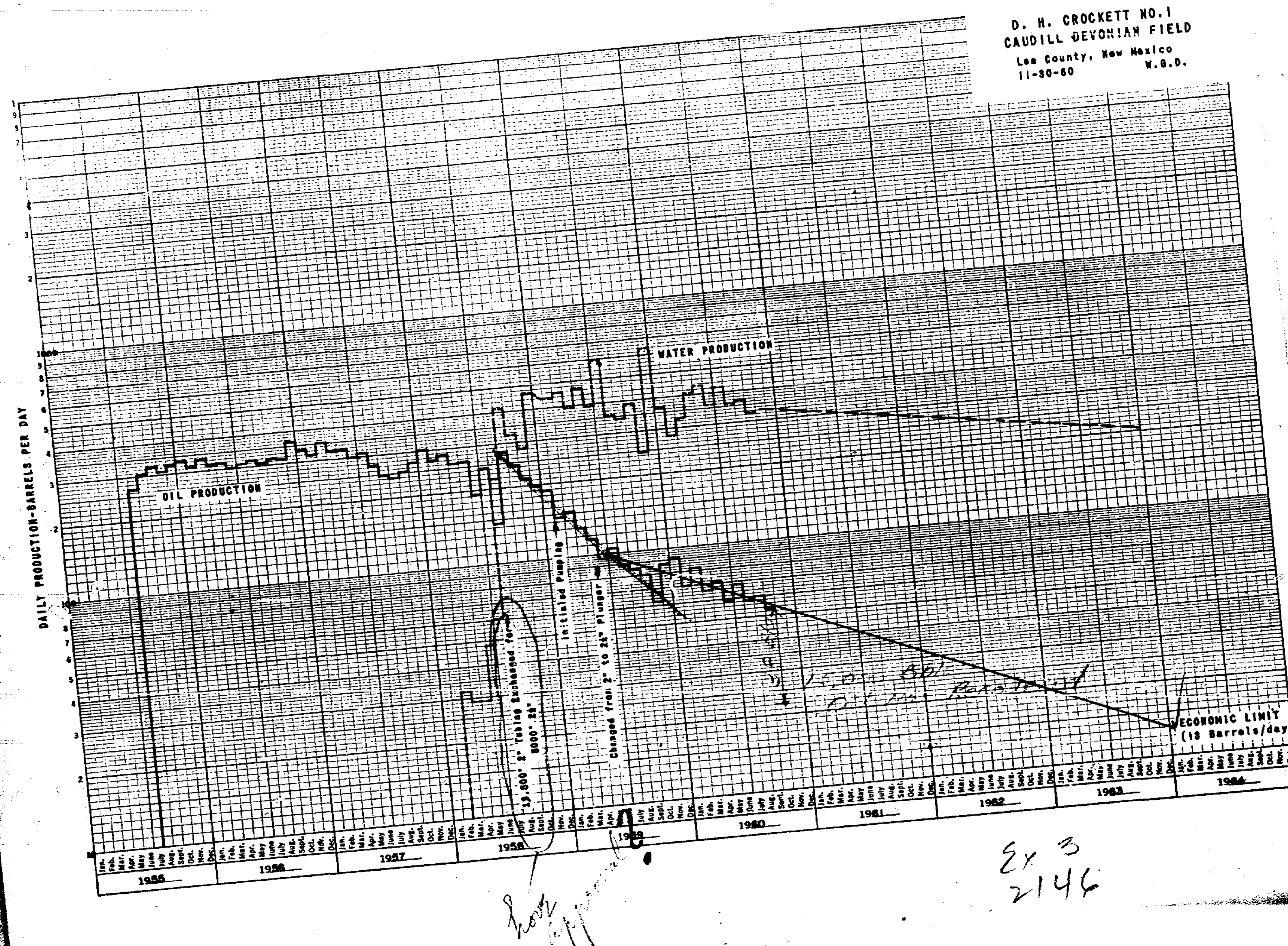
Hyd rad annular space =

$$\frac{D_1 - D_2}{4} = \frac{4.67 - 3.22}{4} = \frac{1.45}{4} = .36$$

Hyd rad circ pipe =

$$\frac{D}{4}$$

∴ hydraulic radius of annular flow above (.36) would be equal to hydraulic radius of circ pipe of $\frac{1.45}{4} = .36$ or 1.45" ID


D. H. CROCKETT NO. 1
CAUDILL DEVONIAN FIELD
Lea County, New Mexico
11-30-60 W.G.D.
DAILY PRODUCTION-BARRELS PER DAY
OIL PRODUCTION
WATER PRODUCTION
13,500' 2" Tubing Exchanged for 8000' 2½"
Initiated Pumping
Changed from 2" to 2½" Plunger
ECONOMIC LIMIT
(13 Barrels/day)
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964

Ex 3
2146

GAS CORROSION ANALYSIS

Caudill Wolfcamp (D. H. Crockett No. 2 Separator Gas 12-1-60)
(60^{o} F. and 14.696 psia)

CO_2	-	1.1949%	
H_2S	-	0.0051%	3.25 grains/100 S.C.F.
Total Acid Gas	-	1.2000%	

Ex 6
2146

RECENT WELL TESTS OF DEVONIAN RESERVOIR

D. H. CROCKETT 1, CAUDILL FIELD

Date	Method of Production	Barrels Per Day Salt Water	Oil	Total Fluid
10-16-58	Pump	352	235	587
11-26-59	Pump	512	70	582
1-2-60	Pump	511	90	601
10-12-60	Pump	439	60	499

Top allowable for the Devonian Reservoir - 272 Barrels per Day.

Ex 4
2146

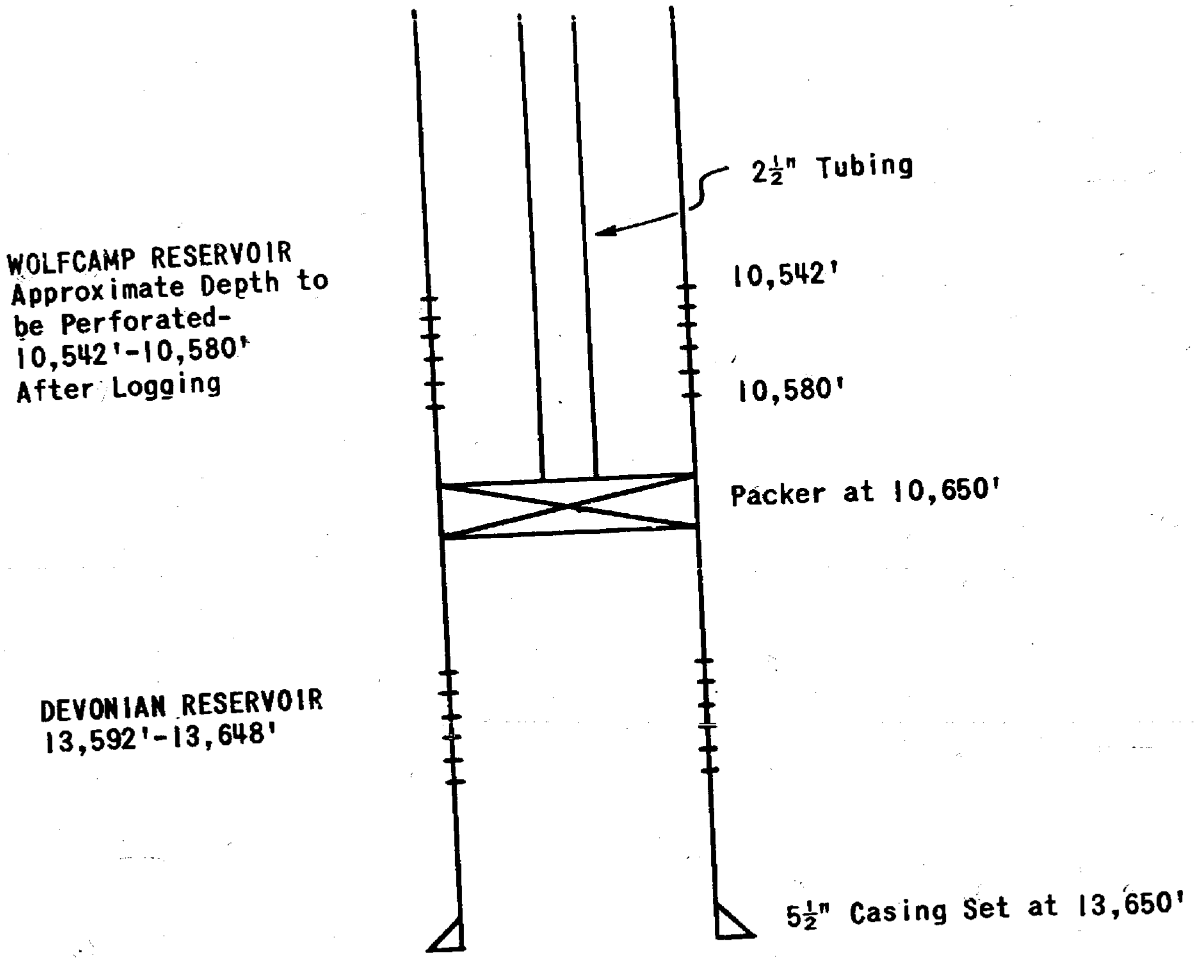
ARTIFICIAL LIFT CAPACITY

Tubing Size -Inches	Pumping Fluid Level - Feet	Method	Capacity Bbls./Day
2-1/2	10,650	Rod*	260*
2-1/2	10,650	Subsurface Hydraulic	336
1-1/2	10,650	Rod*	80*
2-1/2	5,000	Rod	602
2-1/2	5,000	Subsurface Hydraulic	550
1-1/2	5,000	Rod	210

* - Special High Tensile Rods

Note: All capacities were determined using a volumetric efficiency of 80 percent.

D. H. CROCKETT 1
CAUDILL FIELD

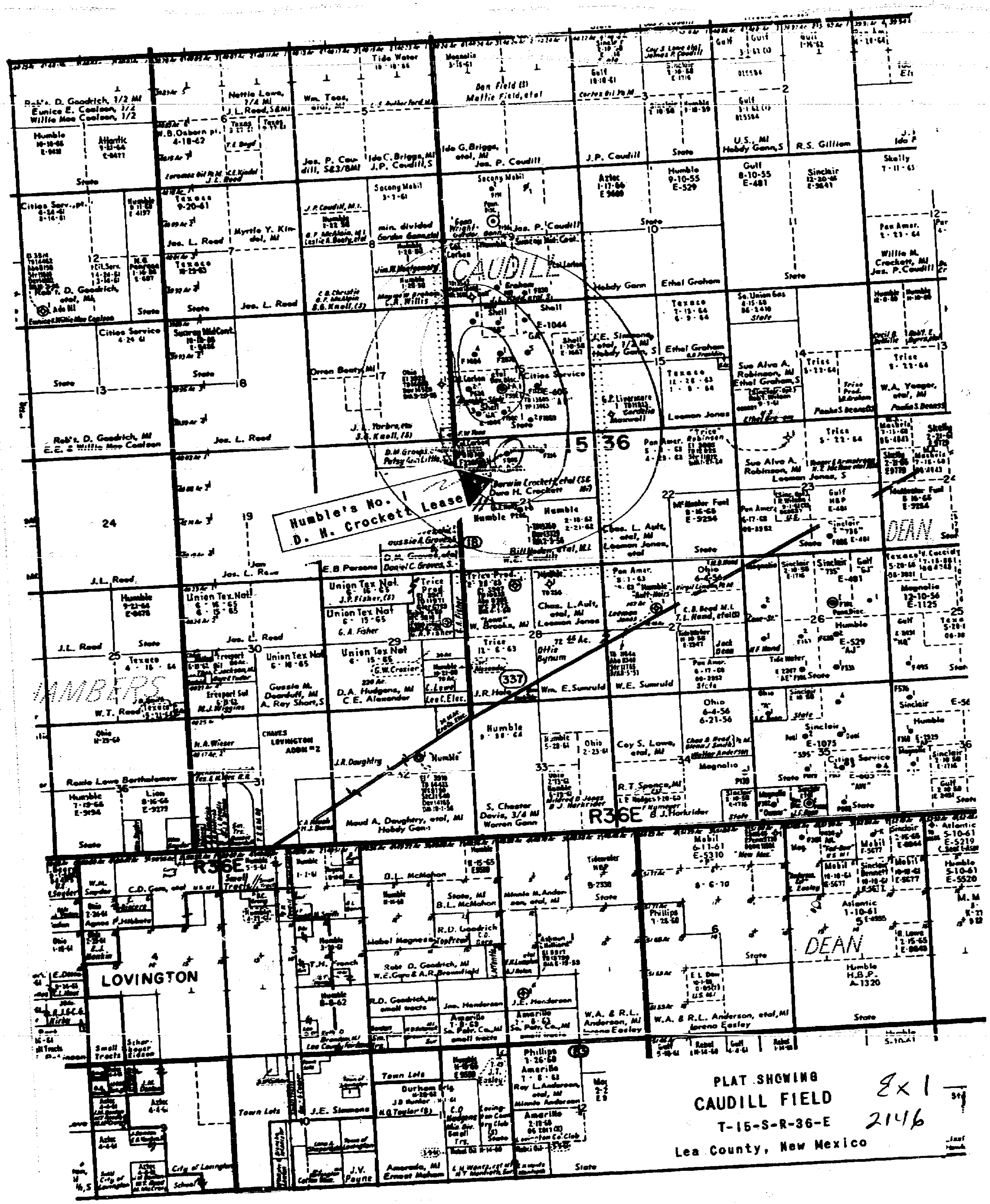


TOP OF CEMENT - 3700 FT.

PROCEDURE

1. After Logging, perforate indicated pay from approximately 10,542-80'.
2. Set non-retrievable packer at 10,650'.
3. Run 2½" tubing with a seating nipple and sliding sleeve valve two joints above the packer.
4. Set a blank off plug in the seating nipple, open the sleeve and acidize the Wolfcamp Reservoir.
5. Swab the Wolfcamp until flow is initiated, close the sliding sleeve valve and produce through the annulus.
6. Run rods and return the Devonian to production.

Ex 2
2146



PLAT SHOWING
CAUDILL FIELD
T-15-S-R-36-E
Lea County, New Mexico

Ex 1
2146

MULTIPLE COMPLETIONS

The term "Multiple Completion" refers to the technique which permits two or more reservoirs to be produced simultaneously but separately through the same well bore. Although most multiple completions are used only for production, many wells of this type serve as multiple injection wells for pressure maintenance or secondary recovery projects, and others are used for the injection of fluid into one or more reservoirs while maintaining production from others.

Technical reports are available on dual completions made during the late 1930's; (10);however, there was no significant application of the technique prior to World War II. The wartime demand for petroleum products and the critical shortage of steel for tubular goods prompted increased utilization of dual completions during the 1940's (11), (Fig. 12). Early dual completions were limited essentially to flowing wells selected to present no problems such as sand production or high pressure. Tools and equipment designed for use in single completions did not perform satisfactorily when subjected to the more severe loading imposed by dual completions; however, in wells where conditions were ideal, the dual completion proved to be a successful tool, offering savings of about 45 percent in steel consumption and approximately 40 percent in drilling costs as compared to the drilling of two single wells. (12). Because general experience with dual completions during this period was not entirely satisfactory, a decline in use of the technique occurred during the period 1946 to 1949.

The increasing cost of drilling wells and the relatively low additional cost of the second completion revived interest in the dual completion in the early 1950's. Equipment and techniques were rapidly improved, and widespread acceptance of dual completions followed (Fig. 12). (13). The success and economic advantages experienced with dual completions since 1950 have resulted more recently in development of equipment and techniques for triple and quadruple completions. Multiple completion techniques have permitted production of many reservoirs which otherwise could not have been profitably developed.

Dual Completions

Many different combinations of tubing strings and packers for dual completions may be utilized, and all equipment required is now commercially available. Selection of a particular installation depends upon economics as influenced by many considerations including installation cost, artificial-lift requirements, corrosion, sand production, and workover requirements. To aid in selecting the optimum-type installation, discussion of dual completion equipment and techniques is given with specific comments on application of the various type installations. (14).

Single-Tubing, Single-Packer Dual

One of the oldest types of dual completions involves setting a production packer on tubing between reservoirs and producing the lower interval through the tubing and the upper interval through the tubing-casing annulus (Fig. 13). This type completion is still popular because of simplicity and low initial cost. It is applicable where the upper interval is a long-life flowing completion which does not present problems of sand production, severe corrosion, or abnormal pressure.

Ex 5 2746

It is common practice to install full-open packers and tubing equipment in order that through-tubing techniques may be utilized for workover of the lower interval. A wireline-operated circulating valve is usually placed above the packer for initiating flow from the upper zone through the tubing. The circulating valve is closed for normal production. Single tubing dual completions are commonly made with 5-1/2-inch casing and 2-inch tubing.

Workover of an upper zone requires use of a rig and removal of the tubing from the well. Concentric tubing can be used for low-pressure, squeeze-cementing of the lower zone or through-tubing dump bailers can be employed for plugback to avoid pulling tubing. Use of the tubing extension for workover of the lower zone is hazardous because the casing-tubing annulus must be used for circulation, exposing the upper zone to workover fluids and to squeeze pressures.

Single-Tubing, Two-Packer Dual

One of the main reasons for using two packers and only one tubing string in a dual installation is to achieve the flexibility of producing either zone selectively through the tubing. This type dual completion utilizes a packer between the reservoirs and a second packer with selective crossover flow equipment above the upper reservoir (Figs. 14A and 14B). Straight and crossover flow are distinguished by the flow paths of upper and lower zone production; lower zone production through the tubing is considered straight flow while upper zone production through the tubing is defined as crossover flow. The weaker zone, which may not flow through the casing-tubing annulus, can be diverted to the tubing, and production from the stronger zone can be taken through the annulus with this type installation. Similarly, if the pressure of one reservoir is abnormally high, production from this zone can be directed through the tubing with the lower-pressure reservoir being produced through the annulus.

Workover of the upper zone of a single-tubing, two-packer dual requires that the tubing and packers be removed from the well. The lower reservoir may be reworked by either the concentric tubing, dump bailer plugback, or wireline permanent completion method. Wireline workover of the lower zone can be performed by retrieving the straight or crossover flow choke by wireline and installing a tubing extension assembly of the required length (Fig. 14C). A concentric bypass assembly is installed below the extension hanger to seal the ports in the crossover flow assembly, thus isolating the interval between packers from the circulating system. With the exception of the bypass tool, wireline equipment and techniques for workover of the lower completion in this type dual well are the same as for reworking a single completion containing a packer.

Parallel-Tubing, Single-Packer Dual

Parallel-tubing strings are used in a single-packer dual installation primarily to permit independent artificial lift of both completions (Fig. 15A). A common dual completion of this type is two strings of

2-inch tubing installed independently in 7-inch casing. Wireline tubing extension of concentric tubing can be employed to wash sand from the upper zone, but both tubing strings must be removed for squeeze-cementing of this interval. Workover of the lower zone is accomplished in the same manner as previously described for the single-tubing, single-packer dual completion.

Parallel-Tubing, Two-Packer Dual

The basic reasons for utilizing two packers in a parallel-tubing dual completion are (1) to avoid exposing the casing annulus to sand-laden or corrosive well fluids or to abnormal pressures, (2) to provide a means of gas-lifting both zones from a common gas source in the annulus, and (3) to permit wireline workover of intervals below the lower packer without exposing upper intervals to circulating fluids and squeeze pressures (Fig. 15B). In addition, this type installation affords a means of independent artificial lift of both intervals by rod pumps or subsurface hydraulic pumps.

To squeeze-cement the upper zone of a parallel-tubing, two-packer dual completion, it is necessary that the tubing and packer be pulled from the well. However, a tubing extension can be utilized on the upper interval for washing sand or for placement of acids or other chemicals to stimulate the formation. The lower interval can be reworked with wireline permanent completion methods in a manner identical to a single completion containing a packer because the casing-tubing annulus is completely isolated from the upper reservoir. Similarly, other through-tubing workover methods can be employed as in a single completion.

REFERENCES

(Noted in text by underlined numbers).

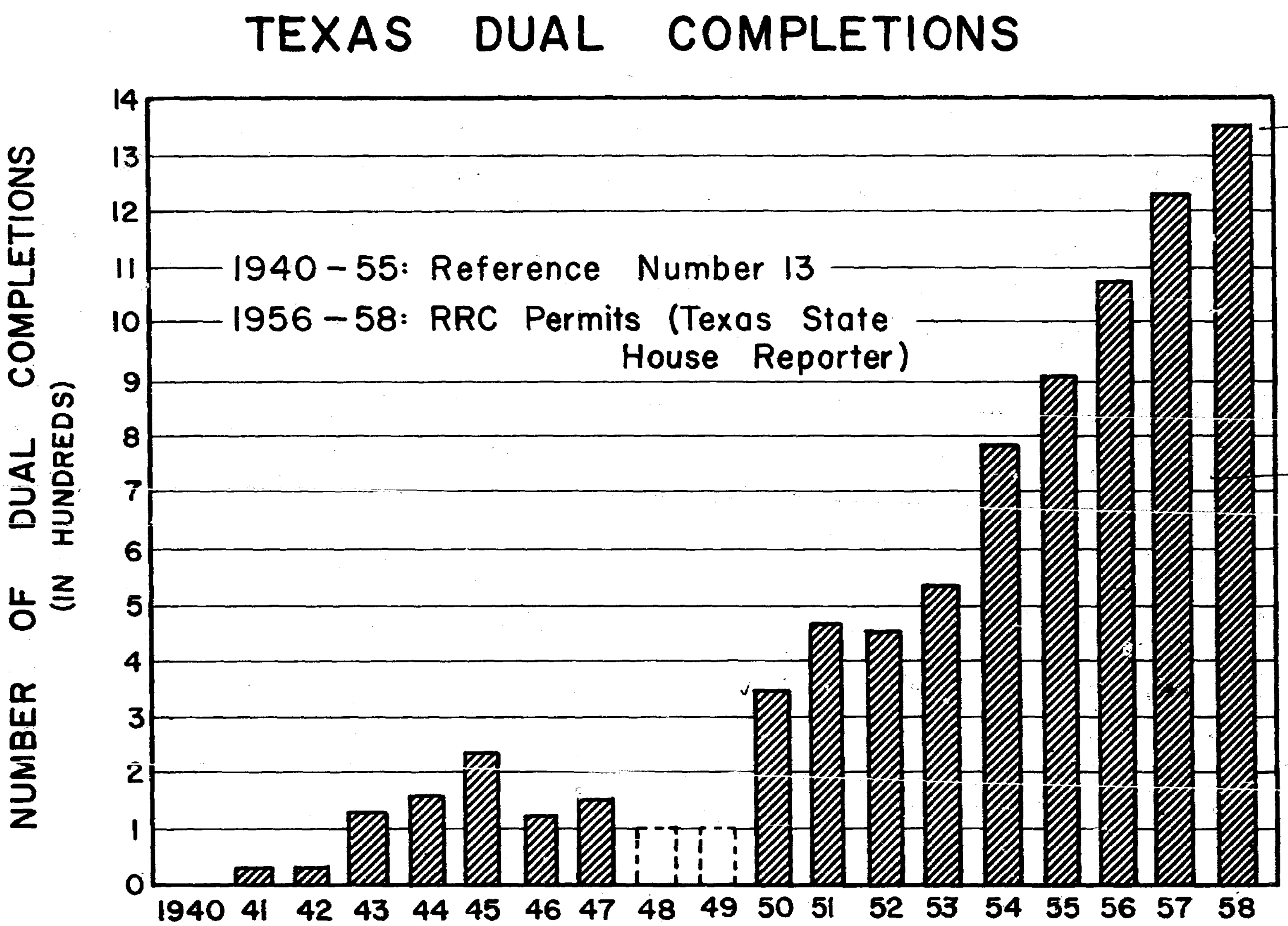
10. Turner, Marshall C.: "Dual Completion Equipment and Practices", API Mid-Continent District Spring Meeting, Oklahoma City, Oklahoma, March 17-19, 1954.

11. Miller, E. B., Jr.: "A Survey of Dual Completions", API 27th Annual Meeting, Chicago, Illinois, November 11, 1947.

12. Alcorn, I. W., and Alexander, W. A.: "A Review of Multiple-Zone Well Completions", API 23rd Annual Meeting, Chicago, Illinois, November 10, 1942.

13. Prutzman, F. G.: "Economics Fosters Dual Completions", API Southwestern District Spring Meeting, Fort Worth, Texas, March 21-23, 1956.

14. Tausch, G. H., and Kenneday, John W.: "Permanent-Type Dual Completions", API Southern District Spring Meeting, San Antonio, Texas, March 7 - 9, 1956.



TEXAS DUAL COMPLETIONS
NUMBER OF DUAL COMPLETIONS
(IN HUNDREDS)
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1940 – 55: Reference Number 13
1956 – 58: RRC Permits (Texas State House Reporter)
1940 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58

FIGURE 12

SINGLE TUBING SINGLE PACKER DUAL

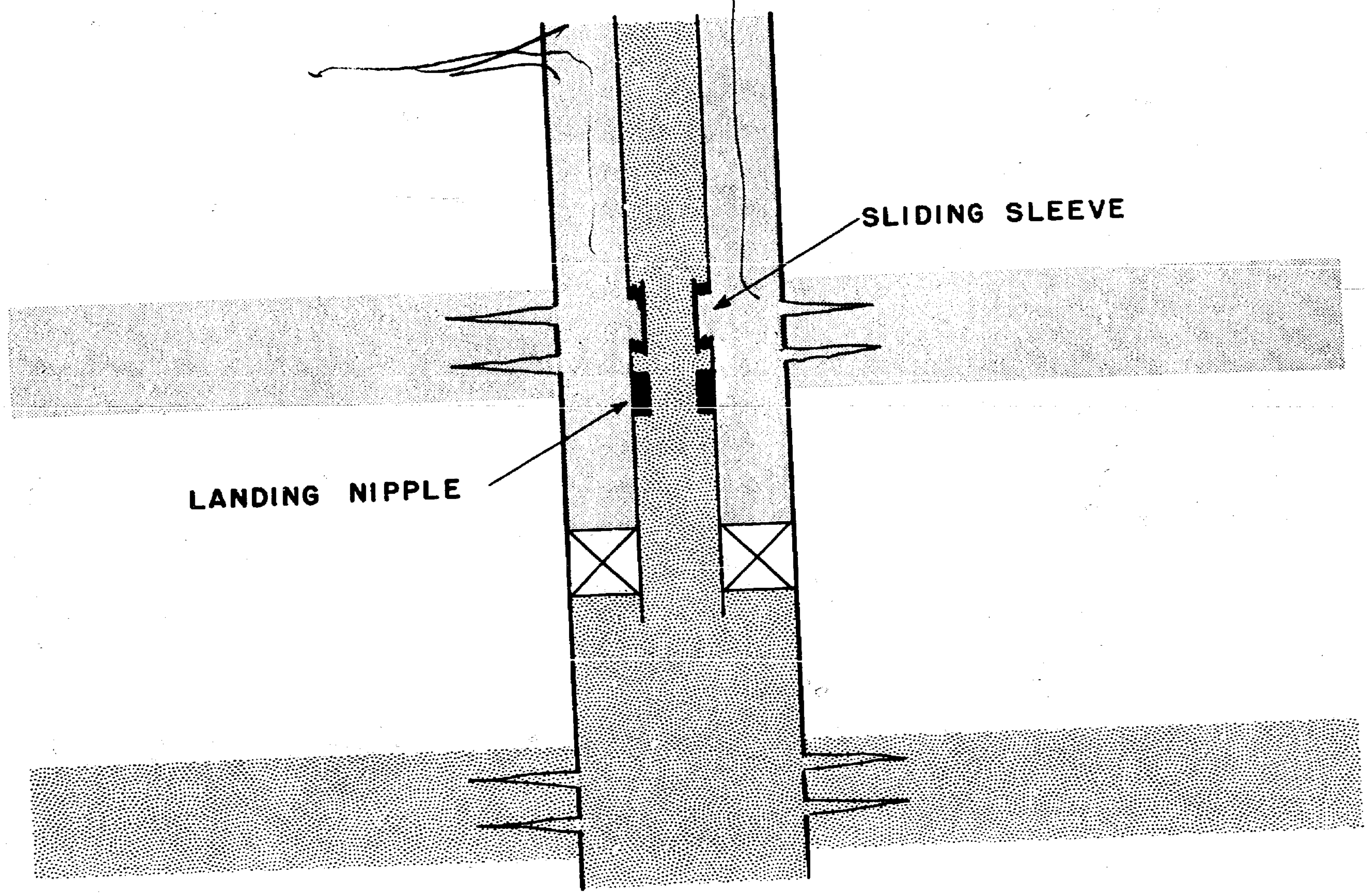


FIGURE 13

SINGLE TUBING TWO PACKER DUAL

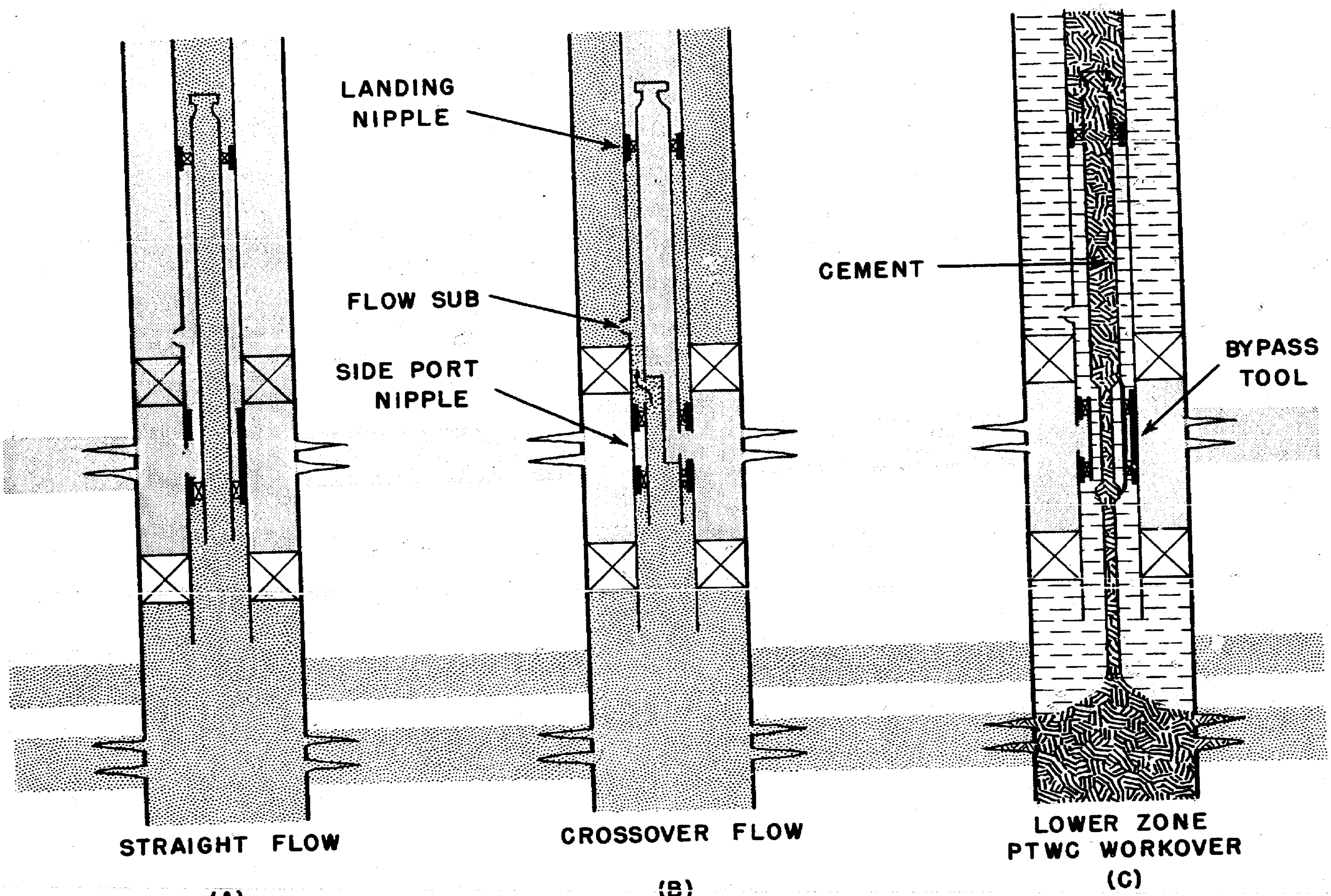


FIGURE 14

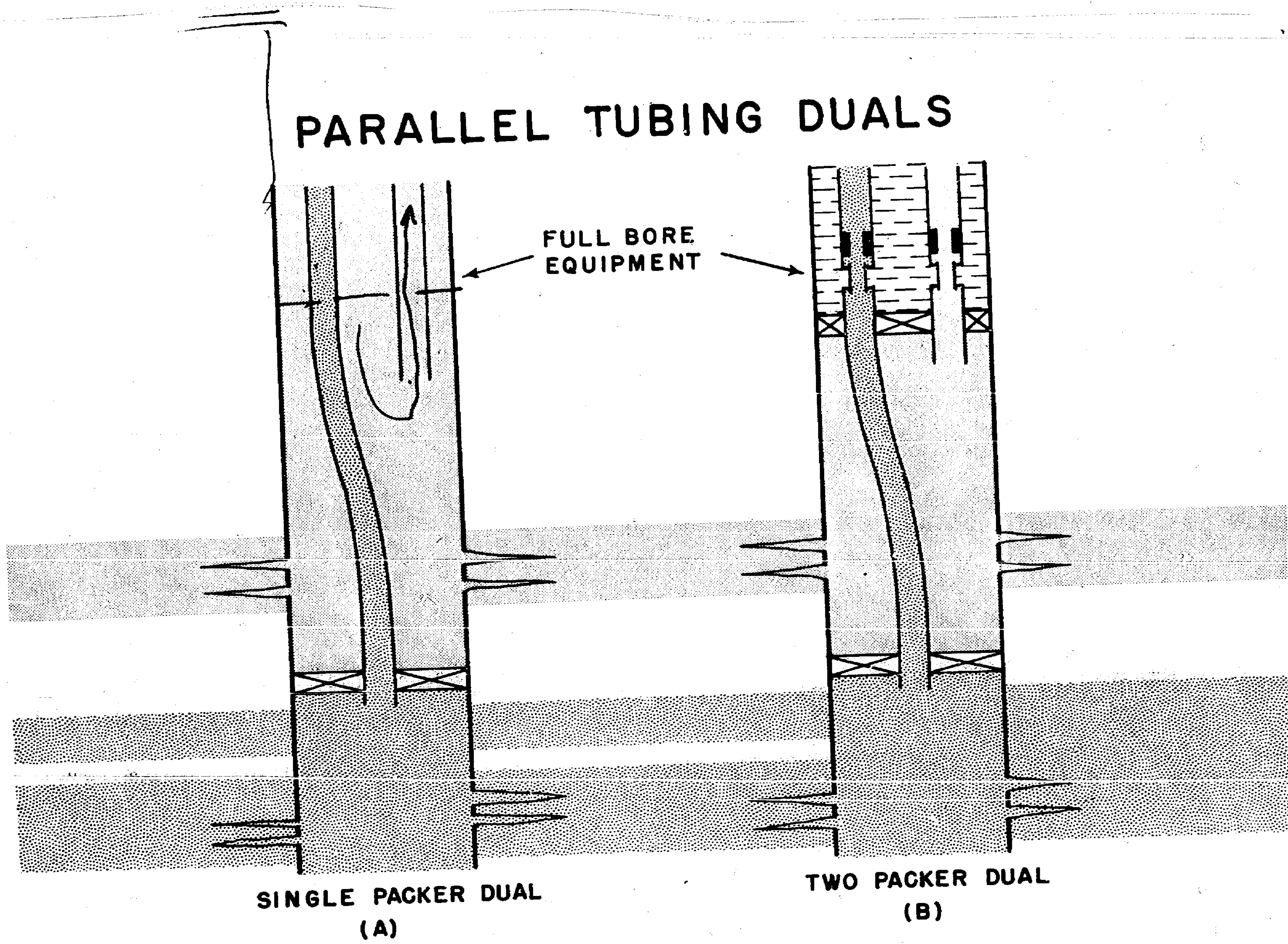

PARALLEL TUBING DUALS
FULL BORE
EQUIPMENT
SINGLE PACKER DUAL
(A)
TWO PACKER DUAL
(B)

FIGURE 15

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 2146
Order No. R-1848

APPLICATION OF HUMBLE OIL & REFINING
COMPANY FOR AN OIL-OIL DUAL COMPLETION
IN THE CAUDILL-WOLFCAMP POOL AND IN
THE CAUDILL-DEVONIAN POOL, LEA COUNTY,
NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on December 12, 1960, at Santa Fe, New Mexico, before Elvis A. Utz, Examiner duly appointed by the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission," in accordance with Rule 1214 of the Commission Rules and Regulations.

NOW, on this 21st day of December, 1960, the Commission, a quorum being present, having considered the application, the evidence adduced, and the recommendations of the Examiner, Elvis A. Utz, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Humble Oil & Refining Company, proposes to dually complete its D. H. Crockett Well No. 1, located in Unit C, Section 21, Township 15 South, Range 36 East, NMPM, Lea County, New Mexico, in such a manner as to permit the production of oil from the Caudill-Wolfcamp Pool and the production of oil from the Caudill-Devonian Pool through the annulus between strings of 5 1/2-inch casing and 2 1/2-inch tubing and through 2 1/2-inch tubing, respectively.

(3) That inasmuch as the best interests of conservation would not be as adequately served by the proposed method of dual completion as by other, safer methods of dually completing the subject well, the subject application should be denied.

CASE No. 2146
Order No. R-1848

IT IS THEREFORE ORDERED:

That the subject application be and the same is hereby denied.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

A. L. PORTER, Jr., Member & Secretary

esr/

P 591 Gas Engr's Handbook.

Flow thru conduits of square or annular cross section can be calculated by means of the curves and equations given in Figs. 23, 2 , 25, 26. (pp 582 585)

The value of D used both in the equations themselves and in the determination of the friction factor should be the diameter of a circular pipe having the same hydraulic radius (m) as the given conduit.

$$\text{Hydraulic radius} = \frac{\text{area of cross section}}{\text{"wetted" perimeter}}$$

$$= D/4 \text{ for a circular pipe}$$

$$= \frac{D_1 - D_2}{4} \text{ for an annular space}$$

$$= X/4 \text{ for a square conduit}$$

where D = inside diameter of circular pipe
D_1 = inside diameter of outer pipe (annular)
D_2 = outside diameter of inner shell (annular)
X = width of side of conduit of sq. x-section

$$\frac{D}{4} = \frac{D_1 - D_2}{4}$$

5½" 20# ID = 4.778
2" 4.7# tbg OD = 2.375

$$\frac{D}{4} = \frac{D_1 - D_2}{4} = \frac{4.778 - 2.375}{4} = \frac{2.403}{4} = 0.6008$$

$$\frac{D}{4} = .6008 \quad D = 4(.6008)\ 2.403$$

Diameter of circ. pipe having a hyd rad of .6008 = 4(m) = 2.403

circular pipe   hydraulic radius = m = $\frac{\text{area of x section}}{\text{wetted perimeter}}$

$m = \frac{D}{4}$ $m = \frac{\pi r^2}{\pi D} = \frac{r^2}{D} = $ ~~$\left(\frac{D}{2}\right)^2$~~

$r = \frac{D}{2}$ $A = \pi r^2 = \pi \frac{D^2}{4}$ $m = \pi \frac{D^2}{4} \div \pi D$

$m = \frac{\pi D^2}{4} \times \frac{1}{\pi D} = \frac{D}{4}$

Jackson

annular flow:

$m = \frac{\text{area of X section}}{\text{wetted perimeter}}$ D_1 = outer pipe diam.
D_2 = inner pipe diam.

$= \frac{A}{P} = \frac{\frac{\pi D_1^2}{4} - \frac{\pi D_2^2}{4}}{\pi D_1 + \pi D_2} = \frac{\frac{\pi}{4}(D_1^2 - D_2^2)}{\pi(D_1 + D_2)}$

$= \frac{\pi}{4}(D_1^2 - D_2^2) \times \frac{1}{\pi(D_1 + D_2)} = \frac{D_1^2 - D_2^2}{4(D_1 + D_2)}$

$m = \frac{\text{area of cross section}}{\text{wetted perimeter}}$

area of cross section $= \frac{\pi D_1^2}{4} - \frac{\pi D_2^2}{4} = \frac{\pi}{4}(D_1^2 - D_2^2)$

$a+b$
$a-b$
$-ab-b^2$
$a^2 + ab$
$a^2 - b^2$

wetted perimeter $= \pi D_1 + \pi D_2 = \pi(D_1 + D_2)$

$m = \frac{\pi}{4}(D_1 - D_2)(D_1 + D_2) \div \pi(D_1 + D_2)$

$= \frac{\pi}{4}(D_1 - D_2)(D_1 + D_2) \times \frac{1}{\pi(D_1 + D_2)} = \frac{D_1 - D_2}{4}$

$m = \frac{D_1 - D_2}{4}$ hydraulic radius for annular flow must equal equivalent hydraulic radius for circular flow

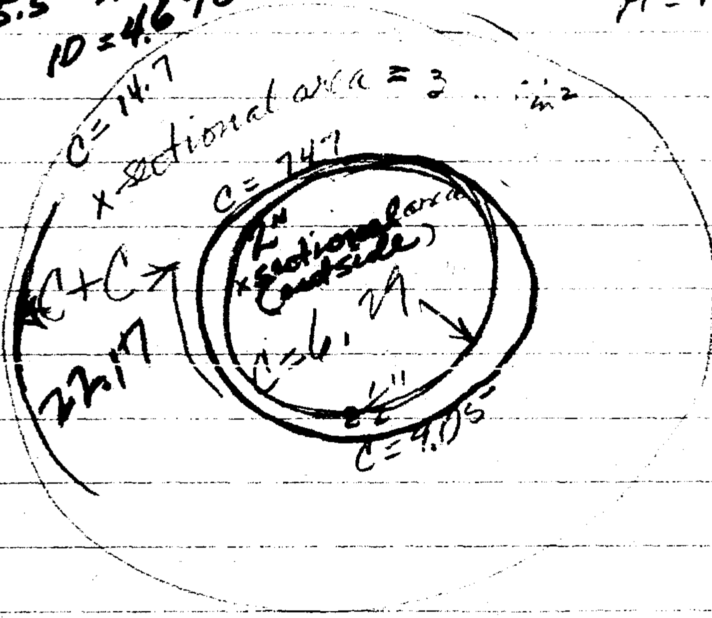
		ID
5 1/2"	17#	4.9
	20#	4.8
	23#	

$A = \pi \frac{d^2}{2}$

$A = \pi r^2$

$A = .7854\, d^2$

5.5" 23# csg
ID = 4.670



$C = \pi D$

5½" 23# csg, ID = 4.670

C = 14.7"

2" OD = 2.375 C = 7.47

2½" OD = 2.875 C = 9.05

14.7
7.47
22.17

with 5½" 23# csg and 2" tbg the area of pipe enclosing the annular space is 22.17" the cross-sectional area would be

	OD	ID	OUTSIDE AREA
2" tbg	2.375	2.041	4.43
	2.375	1.995	4.43
2½" tbg	2.875	2.441	6.48

		OD	ID	INSIDE AREA
5½" csg	17#	5.5	4.892	
	20#	5.5	4.778	
	23#	5.5	4.670	17.12

17.12
4.43
12.69 in²

17.12
6.48
10.64

x-sectional area of annulus:

			area of pipe exposed to annular space
5½" 23# csg	w/ 2" tbg	12.69 in²	22.17 in²/in
	w/ 2½ tbg	10.64 in²	23.75 in²/in

14.7
7.47
22.17

14.7
9.05
23.75

x-sectional area of 2" tbg
3.13 in² — tbg area

4.05 more area

tubing wall area 6.29 in²/in

Dual completion hearing Feb 15
Order R-799 Apr 27

C.S. State AW #2
5½" pipe run + cmtd 5-22 to 5-24

Appd 1-26-56
FTP 175
13626-650
4-11

Slippage governed largely by flow velocity, size of tubing GOR and density + pressure of the gases

It becomes x sive at low velocities and with high GORS

(more gas reqd to remove a given amt of oil)
less pronounced in small tubes than those with large diam.

more drag of the oil on the walls
more internal friction of the fluid masses
more couplings (tbg + csg)

Csg cmt 5-23-56

date of DST (obtain dates)
4008 BHP
-3589 Sat press
2334 to Sol gas

the particles moving against each other.

order R-799 4-27-56

(1) Can you run a bomb thru the Otis side door, choke + landing nipple
anticipate pumping. how.

46

(2) type of drive? ~~gas~~ lot of ~~???~~ lot of gas in solution.

dolg at 13800

do you know of any such duals in N.M.

when did you decide this was the most practical

restrictive order ??

for 2.403" **ID** pipe:

$$a = \frac{\pi d^2}{4} = \frac{\pi (2.403)^2}{4} = \frac{\pi (5.774)}{4} = \pi(1.444) = 4.536$$

for annular space (4.778 and 2.375)

$$a = \frac{\pi d_1^2}{4} - \frac{\pi d_2^2}{4} = \frac{\pi}{4}(d_1^2 - d_2^2) = \frac{\pi}{4}(22.829 - 5.641)$$

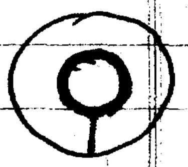
$$a = \frac{\pi}{4}(17.188) = 13.499 = 13.50$$

relative areas of annular space to the circular space

annular = 2.976 times the circular area for the same hydraulic radius.

$$\frac{D_1 - D_2}{4} = D_1 - D_2 = D$$

$D_1 - D_2 = D_{annular}$, circ



for determining friction loss factors

$5\frac{1}{2}$" 23# casing drift ID = 4.55" D_1
$2\frac{7}{8}$" cs jt hydril OD = 3.22" D_2

1.33

Hydraulic radius = $\frac{D_1 - D_2}{4} = \frac{1.33}{4} = .332$

Hydraulic radius of circular pipe = $\frac{D}{4} = .332$

for the annular flow hyd rad to be equivalent to the circ pipe hyd rad (.332 = .332) the circ pipe would have to have an ID of 4(.332) = 1.33

friction loss factor the same then as

take BHP both zones.
(calculated)

What drive of dr is WC

Expect considerable gas, especially later.

Propelling agent to lift oil
(gas coming out of soln)
in the pipe?

will some gas slip?

is amt of slippage governed
by flow velocity

is velocity governed by tbg diam

would GOR have bearing on slippage

compare size of annulus w/
tubing size being used in
#2 well

BHP 3590 WC [illegible]
BHP 3260 D[illegible] Wtr drive

special [illegible]

Drained — which res

Ex 3 38 B/D drop in prod not function of capac of tbg to prod but one of pump capac and based on p. 2 where 1½" tbg will yield 210 BPD total fluid?

24,000 more for 2 1½" cs strings than 1 string 2⅞

300,000

150 duals 20 flds ideal
sand
corrosion

comp # 13 w/ 15-A on corrosion
fluid level.

loss of oil thru csg flow not thru tbg

has observed
no diff tbg flow and annulus flow, would you see
[illegible] complete wells w/o tbg.

Kirkpatrick's chart
Constant use of energy — gas lift while intermittent is constant, reservoirs do not produce w/ constant flow up thru tbg.

to compare ann flow w/ tbg flow you would have to have 2 identical wells comp at identical times.

several factors which render this type undes
how Com know in adv if cond present?

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
DECEMBER 12, 1960

IN THE MATTER OF:

CASE 2146 Application of Humble Oil & Refining Company for an oil-oil dual completion. Applicant, in the above-styled cause, seeks an order authorizing the dual completion of its D. H. Crockett Well #1, located in Unit C, Section 21, Township 15 South, Range 36 East, Lea County, New Mexico, in such a manner as to permit the production of oil from the Caudill-Wolfcamp Pool and the production of oil from the Caudill-Devonian Pool through the annulus between strings of 5½-inch casing and 2½-inch tubing and through 2½-inch tubing, respectively.

BEFORE:

Elvis A. Utz, Examiner.

TRANSCRIPT OF PROCEEDINGS

MR. UTZ: Case 2146.

MR. MOORE: Case 2146. Application of Humble Oil & Refining Company for an oil-oil dual completion.

MR. BRATTON: Howard Bratton, appearing on behalf of Humble Oil & Refining Company. We have one witness. I ask that he be sworn.

(Witness sworn)

J. E. WILLINGHAM,

called as a witness, having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. BRATTON:

Q Will you state your name, address and occupation?

A I am J. E. Willingham. I am a Senior Superintendent Engineer of Humble Oil & Refining Company. I live in Midland, Texas.

Q Have you previously qualified before this Commission as an expert witness and had your qualifications made a matter of record?

A Yes, sir.

Q Are you familiar with the application in the instant case and the subject well?

A Yes, sir, I am.

MR. BRATTON: Are the witness' qualifications acceptable?

MR. UTZ: Yes, sir, they are.

Q (By Mr. Bratton) Will you explain, Mr. Willingham, what Humble is applying for in this case and the cause of the application?

A We are applying for an oil-oil dual completion, and it is single string dual. I wanted to introduce this in this way. We have deliberated in calling this hearing. We did not call it casually, and we recognized that many similar requests in the past have been requested and have been denied by the Commission, and we are not saying that our request is something that should be universal because we ourselves limit this type of installation to selective wells. What we are hoping to demonstrate is the fact that there are special cases which do require this type of installation in order to have an efficient operational system. I am going to show in this hearing six major points: First, that the new developments in our work on techniques make this type of installation, that is, single string dual, very attractive. Two, that new development in corrosion preventions are suited to this type of installation in that you can inhibit corrosion in the annulus. Three, that due to the fact we have 5½-inch 23 casing, we would suffer a severe loss of productive capacity if we used parallel strings instead of single string. Four, due to our structural position, if we don't get the oil we will be drained. Five, that the efficiency of oil production in the tubing casing annulus is actually better than it is in the single string, for example, in 2½-inch tubing. And six, that if we are forced to make a parallel tubing dual well, actually, it will result in us leaving commercial oil production in the reservoir. In that sense, it would be waste. And I realize that this is a big bit to chew off in a hearing. I am going to try to summarize it and keep to the major points, and I realize that some of the things I am going to be telling you, in all probability, you might have read about them, they have probably not been proceeded in the hearing before where they requested a single string dual. That is my introduction.

(Whereupon, Applicant's Exhibit No. 1 was marked for identification.)

Q Will you refer to your Exhibit No. 1, Mr. Willingham, and explain what it is?

A Exhibit No. 1 is a map showing the position of the well. It is located in red. And I have drawn on this and I want to point out these have rough contours. We had not verified the contours, we did not want to use those in the exhibit. What it does illustrate, this is the contour of the Devonian, that is our wells circled in red, it's low at the structure, and I want to emphasize that in the Devonian, if we do not get the oil now, since this is an oil drive reservoir, this oil will be swept out of the way and we will lose it.

Q What is the location of this well, Mr. Willingham?

A It is 660 feet from the North line and 1980 feet from the West line of Section 21, Township 15 South, Range 36 East in Lea County, New Mexico.

Q What formation are we talking about now?

A We are talking about the Devonian and Wolfcamp.

Q This is the Caudill-Devonian or Caudill-Wolfcamp?

A Yes, it is the Caudill Field.

Q There is no question but what the Humble well is downdip?

A That is true.

(Whereupon, Applicant's Exhibit No. 2 was marked for identification.)

Q Turn to your Exhibit No. 2, Mr. Willingham, explain what it is.

A This is just a schematic sketch of our dual completion installation. As you will see, it's a single packer which we are setting. The packer we have perforated at intervals with 2½-inch tubing. Without going into detail, you will notice that the top of our cement is 3700 feet, which is well above the perforated intervals, and we will have a seating nipple with the sliding sleeve mandril you have above that so we can go in and plug it off, and so we can swab it off at 2½, and we will go back in and close our sliding sleeve. I don't believe I will go into any more detail, it's self-explanatory.

Q What kind of reservoirs with regard to the kind of mechanisms?

A The Wolfcamp is dissolved gas drive, and on the Devonian is water drive.

Q What are the bottom hole pressures of the two reservoirs?

A The Wolfcamp was, on last measurement, was 3590, and the Devonian was 3260 pounds per square inch.

Q Do you have 5½-inch casing in the well?

A Yes, sir.

(Whereupon, Applicant's Exhibit No. 3 was marked for identification.)

Q Turn, then, to your Exhibit No. 3, Mr. Willingham, and explain what it is and what it shows.

A This is a history of our well showing the decline in oil production, increase in water production, and the reason this is being presented, it illustrates the fact that first of all we have taken the well just like it is producing in the Devonian. It is now pumping through 2½-inch tubing, and you will notice we predict that well will reach the economic limit over on the right-hand side, lower side, at 13 barrels per day in early 1964, the beginning of 1964. And I have done some calculations, and you can't make a detailed engineering calculation, you've got to assume your declines, but what this indicates is if we have to go to inch and a half tubing, we will suffer a 38 barrel drop in our oil production, which will reduce our life of our well by two years and will result in us leaving approximately 15,000 barrels of oil in the reservoir.

(Whereupon, Applicant's Exhibit No. 4 was marked for identification.)

Q Turn, then, to your Exhibit No. 4, Mr. Willingham, and explain it.

A This Exhibit is in two parts, the first part shows Crockett No. 1, which is the offsetting well in the Caudill Field, and it shows several well tests, the most recent being in October, 1960. We are pumping 439 barrels of salt water and 60 barrels of oil for total fluid of 499 barrels per day. The second page illustrates two different pumping levels. We think our pumping level is going to stay around 5,000 feet. We have calculated producing pumping volumes for 10,000 just for the sake of illustration. But looking at the 5,000 for the pumping level, if you will notice with 2½-inch tubing we can rod pump 602 barrels per day. If we have to go to inch and a half tubing our production will drop to 210 barrels per day. Now, this is fluid and if you will notice, since we are producing now 499 barrels a day, we will take a very substantial drop in our productive capacity.

Q This, then, referring to your previous Exhibit, explains why 2½-inch tubing is required to pump the Devonian in order to protect your correlative rights and prevents the leaving of this 15,000 barrels in the reservoir?

A Yes, sir, that is true.

Q Then, the Devonian is a water drive, and this is down structure?

A That's right.

Q Anything else you would care to point out in connection with Exhibit No. 4?

A I might point out that if we run parallel inch and a half hydrill we will have to spend $24,000 more for tubular gas than we will for the present installation, and another consideration, you can drill another well, but another well would cost us approximately $300,000 and would be extremely difficult to justify the drilling of it from an economic standpoint.

MR. NUTTER: You said it would cost twenty-four for the hydrill. What size hydrill?

A Inch and a half.

MR. NUTTER: To both strings?

A Yes, sir. In other words, that is two strings of inch and a half as compared to one string of 2½.

Q (By Mr. Bratton) Is that all you have in connection with Exhibit No. 4?

A Yes, sir.

(Whereupon, Applicant's Exhibit No. 5 was marked for identification.)

Q Turn, then, to your Exhibit No. 5, Mr. Willingham, and briefly explain it, if you can.

A Exhibit No. 5 is more or less the history of multiple completions and as far as duals are concerned, and the main reason I am giving you this, it's something to talk from. We've got several different sketches in the back part of it. If you are interested, it does have the history of the development of dual completions. Turning back to Figure 12, now, I know that you are not affected by what happened in Texas. The reason I am using this Exhibit, this is where I have had my experience and where, when I talk about my experience, I am going to talk about it in Texas, but actually, we don't have anything in New Mexico to compare it to. This shows the number of dual completions if it were made in Texas, oh, from 1940 to 1958, and you will notice, starting in 1950 is when they really became popular, that in '48 and '49 the reason there weren't very many made was because when they first started, if they didn't have adequate packers, they had a lot of operation problems. I remember it wasn't until 1950 that the industry had the equipment to really dually complete its wells. From 1950 to '56, you will notice that there were, in '53, were three hundred fifty wells completed in this nature during the year, and by 1956 this had grown to better than one thousand wells per year.

Following this, in 1957 and '58, and from then on the parallel string tubing came into being and part of these are parallel string duals from 1956 on. And I wanted to state to the Examiner that I have had personal experience with approximately 150 wells of this nature in twenty different fields, and I can say with real sincerity I think that is an installation that provides the industry with a tool that will help itself to produce some kinds of wells. I am not saying we should have it in all kinds of conditions within the abnormal pressure. If we had sand surrounding the formation, we would not want this type of dual completion.

The next figure is Figure 13, and this is the type of installation we are talking about. This is a single string, single packer dual with sliding sleeve mandril, and below this is a landing nipple. And the reason for this, we can block off the Devonian which is the lower completion and swab the Wolfcamp and the upper and then close our sliding sleeve and pull the plug and we've got our zones separated, with this type of installation with the $5\frac{1}{2}$. If we had one and a half tubing, we couldn't do many of the things we will be able to do with this installation. For instance, we can go through this with a small tubing string and do workover work we can squeeze with the perforation through this tubing string. We can go in and wash sand through this tubing string.

Turning to Figure 14, this is another type of single string dual in which you use two packers. The advantages of this installation is you can cross over from one zone to another and as shown in "C," you can do wire line work overwork with this tool without moving the workover rig on it. That is, you can squeeze cement, you can wash sand, and you can do several different types of installations.

Figure 15 is the type "F," is a parallel string dual, and you will notice that we have two different types here. We have the single packer and the dual packer type. I wanted to point out one thing while I am here, if we had the type installation shown in "A" and we were producing this well and we were not a prudent operator, we could have corrosion in this installation as well as we could, turning back to Figure 12, because we've got this exposed for the corrosion. With the dual parallel we've also got this one exposed to corrosion, and I'm not saying that the type "A" parallel string dual isn't a good one because it is, because you need to vent gas and circulate hot air and paraffin control and many other things I think it's a good installation, but what I'm pointing out is some of the problems of this type of dual are similar to the one we have in our other type. That, briefly, is all of this, Mr. Bratton. I thought we might come back to this.

(Whereupon, Applicant's Exhibit No. 6 was marked for identification.)

Q Let's turn to Exhibit No. 6, Mr. Willingham.

A Exhibit No. 6 we had our, in Crockett 2 we have a Wolfcamp producer, and we felt that one of the Commissioner's concerns is, naturally, corrosion. So we had this gas analyzed to see how corrosive it was, and, as you will notice, the CO^2 is a little larger than one percent better than volume on 024. The hydronsil of it is very minor. I'm not saying this gas isn't corrosive. I will say that generally with this type of material in the gas you would not expect severe corrosion at all, and you would expect this could be very easy to handle.

Q What if you do have corrosion, Mr. Willingham? Is there any technique for controlling it?

A Yes, sir, there are several. I wanted, if we could, to turn back to Figure 12 on the Exhibit we just passed, and I want to illustrate this is one thing we can do. Excuse me, Figure 13 -- I beg your pardon. We could get a back plug in your landing nipple, open our sliding sleeve mandril and pump oil with a corrosion inhibitor out into the formation, for I am sure that you have been hearing more and more about this type of corrosion inhibitor. This is one step that we can take. Another step we can take is instead of forcing it into the formation, we can even circulate this inhibitor. Now, we don't feel on this particular well we are going to do this, but we can do it. Another thing I wanted to show when, for unexpected severe corrosion, another thing we can do, the industry now has wire line tools in which when you can have a side pocket mandril and put a tool like this into it, and you can pump, it has a check valce, and you can go in and regularly pump in an inhibitor in the formation by setting your backing plug and use this approach rather than your sliding sleeve mandril if you wanted to. Another approach, you can take -- these were on my desk, and my supervisors accused me of having taken tranquilizer pills -- I wanted to show you some of these. It doesn't hurt to handle them. This is what you call a pellet type inhibitor. This is a new thing to the industry, and you can get these in various sizes, you can get them granular if you want to. In other words, you can get them of this nature (indicating). This is a new thing and hasn't been on the market very long. But we have known for several years they have used string inhibitors when we drop strings down the tubing, and they're very good in inhibiting corrosion, and you can take the same approach with the pellets or granular material. You have a lubricator and take your lubricator put these pellets into it, put some oil into it and pull it into the annulus and then having this drop and shutting your well in for several hours.

Q Mr. Willingham, recognizing that the Commission, of course, is very concerned about the question of corrosion, how would you detect corrosion, how could you detect it before any damage is done?

A There are several ways you can do this. For one thing, you can inspect the choke on the well and your flow line, where it enters the flow line, you can locate your wellhead equipment. A better way would be putting a coupon in and your well produced, say, after a month or two or three months, you can take this coupon out, and it would be put in with a designated weight. You can weigh it, then when it, for example, after you got through, weigh it again and see how much metal you lose and by that way you would know you were suffering corrosion.

Q If the Commission should so designate, would you be willing to put in these coupons and report the results of periodic inspection of them?

A Yes, sir, we would be glad to, if the Commission took that approach. I want to emphasize I really feel with the test the range is we are not going to have corrosion. I can understand the Commission's concern of getting someone that isn't a prudent operator with this type of installation and let it go on and not pay any attention to it. If the Commission decided to, we would be glad to put the coupon in.

Q For my information, Mr. Willingham, would you intend starting to use your pellet inhibitor immediately, or would you intend putting your coupon in and evaluating the BGS of the gas?

A We would, first of all, we wouldn't inhibit until we saw we were having corrosion, and then we would put the inhibitor in and study the effects of the coupon to see how often we had to

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PHONE CH 3-6691

treat the well to retard the corrosion.

Q You would be willing to do this at such periodic intervals as the Commission might desire to detect whether you are getting into corrosion problems, and if you find that you are, how would your method of inhibiting it work?

A Yes, sir, we would be glad to. Mr. Bratton, we also have some literature on these pellets. As you notice, I have just -- they got them in various different sizes, and this is some literature on it. There is more than one company that has these on the market. I will leave this, I wasn't going to leave it as an Exhibit, because it's advertizing literature. I thought you might be interested in knowing these are on the market as a commercial product, it's not something we have gotten up to treat a special well.

Q You believe, Mr. Willingham, that there is small likelihood of severe corrosion in this well from production through the annulus, and if there is, with these methods now available, you can inhibit it?

A Yes.

Q And with the methods of detection, that you could detect it early enough to prevent damage to the reservoir --

A Yes, sir.

Q -- or loss of oil through a break in the casing?

A Yes.

Q Is this corrosion treatment problem, if there is one, in your proposed installation, similar to the problem you would have in a parallel string dual completion such as in Figure 15, example A?

A Yes, sir, in fashion, and if you treat that well with this type of corrosion inhibitor. Commonly, though, what we use in there is a string of this material, about this large and about that long (indicating), and drop these strings down so you would have to follow putting these in separately. It's easier to put it in one long string.

Q Is there anything else you would care to state about the question of corrosion, Mr. Willingham?

A I believe I have covered it .

Q Now, recognizing that there might be a question in the Commissioner's mind as to the efficiency of it producing -- of it producing through the casing tubing annulus, have you looked into the question of whether you will lose the efficiency of your producing mechanism by producing it into the annulus?

A Yes, sir. I'll have to explain what I did. I went to the literature and found that it's very limited in this nature. Now, as I say, I know from field experience and I am confident I looked at many well tests, I never noticed any difference between flowing wells in the tubing and wells flowing in the annulus in this size installation. But what I had to do finally, I had to go to Dr. Kirkpatrick at Texas University and use some material he had for gas lift. And I can leave this for an exhibit if the

Commission would like. I did an article on a list of people in Houston whereby I marked that portion that refers to the efficiency.

Q If you would please mark it as Exhibit No. 7, Mr. Willingham.

A All right, sir.

(Whereupon, Applicant's Exhibit No. 7 was marked for identification.)

Essentially, what we do -- Before I discuss this graph, I want to explain Table 2 which precedes this. I might talk where two of us can see it. We took a well as completed in the Wolfcamp and assumed it was producing in the tubing. This well was producing 165 barrles per day with the GOR of 3150. What we did, we assumed that we were going to operate at 10,000 feet, just as an illustration, and we went to the curves on the Kirkpatrick which showed that with a constant use of energy, in other words, using the 3100 tube, 11 foot per day barrel, you can produce 215 in the 2 7/8 5½-inch annulus. In other words, if you have less friction, you can actually produce more fluid.

Looking at it the other way, though, what it would mean to you in ratio, you can use the curve to show that theoretically the ratio would drop from 3150 to 2300. We all know gas breaks out, you cannot begin to be able to reduce this ratio. What this illustrates is that is an official mechanism. I want to point this out, we state this, that in your letters we don't know and the industry doesn't know it because the study has never been made, and you get larger in your annulus. In other words, if you went to 95 and the string of 2-inch, it's conceivable you would have slippage in your oil, and water would begin to drop through your gas, and you wouldn't produce it out of the hole. But we know from experience that with this size installation we have been able to produce it without having this problem. Now, this curving, without going into details on it, at the bottom we have our lifting depth, and on the left-hand column we have the least relative producing rate. For example, if you will follow the 2½-inch curve, that is this curve right here, down to the 10,000 foot level, you will notice this has a relative rate of .77, whereas your 2½ and 5½ installation, that is this one right above it, has a relative producing rate of 1, which means that if you take one over .77 times 165 barrels of oil it is producing, you will end up with 215 barrels per day. And this is very complicated, I do know,as the curves have been verified with field results. I want to mention this one thing to the Commission; this is something to think about. There is one way of really telling on your efficiency, in other words, if we were granted permission to make a 2½-inch by 5½-inch annulus producing after its GOR was higher than the other two wells in the same reservoir, we've got two offsetting wells, if that ratio was higher we would know this was inefficient. I am confident we will find, though, that the ratio will be the same, and that concludes my point on that.

I would like, if it's permissible, to leave this one copy. I got this Air Mail Special over at the office, and this is the only other copy I have.

Q Now, Mr. Willingham, summarizing on the two problems that undoubtedly concern the Commission with respect to this type of installation, as to the corrosion problem, you are confident that you could detect, by means of these coupons, corrosion prior to the time it has done any material damage in the well?

A Yes, sir, we could.

Q And you would be willing to put in these coupons and submit the results of the periodic inspection to the Commission office there in Hobbs --

A Yes, sir.

Q -- or in Santa Fe, as desired?

A Yes, sir.

Q You are confident by means of improved techniques in corrosion inhibition that if there does develop corrosion, you could inhibit it?

A Yes, sir, that is true.

Q And you would be willing to demonstrate to the Commission or show to the Commission the results of tests to show the effectiveness of the corrosion inhibition methods which you propose to adopt --

A Yes, sir.

Q -- if corrosion should occur?

A If the Commission desires, we will certainly do it.

Q Too, as to the question of dissipating the reservoir energy, you are confident that this installation in this size hole will not dissipate the reservoir energy in the Wolfcamp?

A Yes, sir, I am.

Q And also as a result of comparing the GOR in this well with the adjoining wells, you are confident that you can detect if by some chance there is a dissipation of the reservoir energy?

A Yes, sir, we could. In other words, we will have to be testing the wells anyway, and it will be very simple to compare the erosion.

Q If the Commission should permit this installation, would you be willing for the Commission to provide in its order that it is keeping the case open for such further orders as the Commission might make depending upon the results of the development in the well?

A Yes, sir. I can certainly understand the Commission's attitude because of the industry implication of this thing.

Q Now, also, Mr. Willingham, you do not recommend this type of installation as a general rule, and you do not believe that the Commission is granting it under this circumstance would be any precedent for widespread adoption of this type of installation?

A No, sir. I will say Humble itself would not want this type of installation in many different types of wells and to re-emphasize it, would not want a well making sand, or that you fraced, or a well making formation sand, or a well you fraced with a lot of sand, and dissipate sand problems. I do think you object to a pressure will nor a well that showed from test it had quite a considerable hydrogen sulfate or CO^2 in it.

Q Do you believe in this well this type of installation is essential to protect Humble's correlative rights in the two reservoirs?

A Yes, I do.

Q In your opinion, the granting of this would be in the interest of conservation?

A Yes, sir.

Q Do you have anything else you would care to state in connection with this application, Mr. Willingham?

A No, sir. I believe I've covered all I wish to say.

Q Were Humble's Exhibits 1 through 6 prepared by you or under your direction?

A Yes, sir.

Q And Humble's Exhibit No. 7 is a reproduction of a letter directed to you?

A Yes, it is a letter that was sent to me.

MR. BRATTON: We would offer Humble's Exhibits 1 through 7 in evidence.

MR. UTZ: Without objection, the Exhibits 1 through 7 will be entered into the record.

(Whereupon, Humble's Exhibits Nos. 1 through 7 were received in evidence.)

CROSS EXAMINATION

BY MR. UTZ:

Q What has your second point on the type of completion or type of well, as you would not want to use this installation in, to do with pressure?

A Abnormal pressures.

MR. NUTTER: By that, I suppose you mean extremely high pressures?

A I believe with 3,000 or 4,000 or greater pressure, this particular well would have 2300 casing, which is quite strong, but I think even with that, I think if you were getting up in pressure over 4,000, you would not be prudent, you would stand a chance of having a blowout if you did develop a leak.

BY MR. NUTTER:

Q Mr. Willingham, you stated if this application were not approved that Humble would be drained and be deprived on its fair share of the oil in place. Which reservoir were you referring to?

A The Denonian.

Q How about the Wolfcamp? Are you being drained in the Wolfcamp at the present time?

A I feel we could be, I don't believe we are being drained at the present time, however.

Q As a matter of fact, how many wells are completed in the

Wolfcamp?

A We have two.

Q Does anyone else have any wells?

A Mr. Nutter, I can't answer that. I don't know. I feel sure, though, that there will be some completions made in it because there are many wells in that area, and they should have the Wolfcamp in them.

Q I see. Now, here on Exhibit 3, Mr. Willingham, where you have drawn these red lines in here on this production decline curve, you show a drop of 38 barrels per day.

A Yes, sir.

Q In the amount of oil you would be recovering, is that -- what is that drop of 38 barrels per day based on?

A It's based on the well tests that I showed in Exhibit 4.

Q In Exhibit 4?

A Yes, sir.

Q Where at the present the latest test indicates you are making about 60 barrels of oil and more than 400 barrels of water per day?

A Yes, sir.

Q Well, now, over on Page 2 (f) Exhibit 4, you show that by the installation of 1½-inch tubing pumping fluid from 5,000 feet you would recover 210 barrels per day maximum capacity. Is that the figure that you were using to show this 38 barrel per day loss?

A Yes, sir. I have the calculations with me, as a matter of fact.

Q Well, I was just interested in what tubing size you were referring to.

A Inch and a half.

Q In other words, the red figures here indicate the production that you would obtain using $1\frac{1}{2}$-inch tubing?

A Yes, sir. Mr. Nutter, I want to say this, you can't make a real accurate estimate of this, I mean you can make a general estimate. As you well know, your fluid levels and you have well changes, and your amount of water changes, and, but with the data we had I made the best estimate that I could.

Q Water production is actually going down here at the present time, too, is it not --

A Yes, that is correct.

Q -- by the curve on Exhibit 3?

A Yes, sir.

Q Mr. Willingham, you stated that, in your opinion -- first of all, do you know when the parallel type of tubing string dual completion was first used in Texas?

A I asked that question because I felt someone might bring it up. I was told in Houston that they went back and looked and they said they felt they got started in 1956, and it gradually grew in popularity to where it has displaced many of the single string duals.

Q Do you know that you showed 1958 as being the greatest year here, and some 1350 dual completions authorized that year? Are all these oil-oil dual completions?

A No, sir.

Q Some have gas completions?

A Yes, sir, and no way to tell from the records, we had to take what we could, no way to tell from the records which are which.

Q So if a man had a gas-oil dual completion, it would be reflected on this chart here?

A Yes, sir, all is parallel string there, that is why I had -- I said 1956 backs the single string duals.

Q Well, now, when you were comparing the efficiency of the installation on Page -- Figure 13, with the efficiency of Figure A, as far as corrosion resistence was concerned --

A Yes, sir.

Q -- you were attributing the corrosion on the gas that would be in the casing, I presume. Now, would the liquids have a corrosive effect also?

A Definitely, I think you would be more worried by the gas than you would by the oil.

Q If you had the installation shown in Figure 13, would you have -- would you be producing oil up through the annulus?

A Yes, sir.

Q And if you did have corrosion, and you got a leak, you would have an opportunity for oil to escape from the annulus into some porous formation, would you not?

A Yes.

Q Would you have that condition in Figure 15?

A Yes, sir, you would.

Q Supposing your tubing fluid levels were standing just above the bottom of the tubing there in 15, and you would have gas in the annulus on up above, you would have your fluid production coming on up through the tubing, wouldn't you?

A Yes, sir, that is true.

Q So if you did develop a leak on up here, the most you would lose would be some gas into the porous formation?

A That is true, that is reasonably true, that is right. You will notice in one Exhibit we showed cement up to 3700 feet, and there is one thing, if you did develop a casing leak above 3700 feet, you would be able to detect it, in between your protective string and your oil string you would develop pressure there.

Q Does the intermediate bottom go below 3700 on this well?

A I think I can tell, I don't know that offhand.

Q Our files would reflect that, I am sure.

A Yes, sir. Within our hard rock country, even if it does not, I am sure, I am confident it does go below 3700 feet for that deep a wildcat because it was 14,000 feet even if it did I feel that pressure would work up between the oil string too, and the protective string, and you would find gas bleeding, or you would have a pressure gas gauge for protective measure.

Q Now, you stated, Mr. Willingham, you observe 1550 duals in twenty fields. Were all of those duals, this type of completion?

A Approximately -- I am estimating here, I would say approximately two-thirds of them were oil-oil duals.

Q And you never saw one that you thought was less efficient than tubing flow?

A No, sir, I never did.

Q Have you ever made any recommendations to Humble they complete a well without tubing in it --

A Yes, sir.

Q -- with large diameter casing?

A Not with large diameter casing because there, I don't deny there is going to be a point of where you are going to have slippage, and as a rule the Commission in Texas will not allow you to run a well with tubing in it above where it is $4\frac{1}{2}$ inches or larger.

Q I thought we might get to the slippage in a minute, Mr. Willingham. Now, that Exhibit that shows Mr. Kirkpatrick's graph --

A Yes, sir.

Q -- now, you stated that was based on constant source of energy, is that correct?

A One of the calculations was, yes, sir.

Q And that chart was derived for the purpose of making gas lift calculation primarily, especially where in the gas limit you have a pressure gas gauge for protective measure.

Q Now, you stated, Mr. Willingham, you observe 1550 duals in twenty fields. Were all of those duals, this type of completion?

A Approximately -- I am estimating here, I would say approximately two-thirds of them were oil-oil duals.

Q And you never saw one that you thought was less efficient than tubing flow?

A No, sir, I never did.

Q Have you ever made any recommendations to Humble they complete a well without tubing in it --

A Yes, sir.

Q -- with large diameter casing?

A Not with large diameter casing because there,I don't deny there is going to be a point of where you are going to have slippage, and as a rule the Commission in Texas will not allow you to run a well with tubing in it above where it is 4½ inches or larger.

Q I thought we might get to the slippage in a minute, Mr. Willingham. Now, that Exhibit that shows Mr. Kirkpatrick's graph --

A Yes, sir.

Q -- now, you stated that was based on constant source of energy, is that correct?

A One of the calculations was,yes, sir.

Q And that chart was derived for the purpose of making gas lift calculation primarily, especially where in the gas limit you do have a constant source of energy, is this correct?

A When in a continuous flow, you would.

Q At the most, it would be intermittent on the regular schedule, is that correct?

A Yes, sir. In other words, if this was based on continuous flow, you assume we had a constant amount of gas going in all the time.

Q You stated this was a solution gas drive reservoir here. In your experience, Mr. Willingham, have you not had solution gas drive reservoirs that did not flow in a regular manner but flowed in such a way it appeared there -- that either the energy was coming into the well bore intermittently or breaking out in the well bore and the well was flowing in solution?

A Yes, I have known wells --

Q Do you think a chart like this would be applicable in a place where the well is flowing in solution?

A Well, Mr. Nutter, to be quite frank, I am very desirous of having better data than we had. Unfortunately, this was all that was available.

Q As a matter of fact, the actual data that is available for multi-phase flow through vertical tabulation is rather scanty, is it not?

A That is true.

Q So it's almost impossible to determine that annular flow is as efficient as tubing flow?

A The only way that I think we can tell is to measure our gas-oil ratio after we make the installations. That ought to show up readily if we are having slippage, and the oil is dropping back throughout.

Q Mr. Willingham, to compare annular flow with tubing through there, a gauge size string of tubing, you would have to have two identical wells completed in the given pool at identical times, would you not?

A True.

Q Now, is there any other well in this pool that could be put on Wolfcamp production at the same time this one would be?

A No, sir, I don't think we could, but I will say this, though, that some of it, in fact, both of the Wolfcamp completions are fairly recent, and we should have, after the well was produced for a month or two, they should have relatively the same conditions, but I understand what you are saying is that if we have, say, Caudel 1 and Crockett 2 has pulled down, they could very easily have a gas breaking out at a higher ratio which could indicate it could give you a false assumption.

Q As a matter of fact, Mr. Willingham, from the Commission's records, it appears that the producing GOR on the Crockett No. 2 which is the other Wolfcamp well --

A Yes, sir, I have those there.

Q -- has gone up from 1200 in the month of August -- producing GOR, gone up from 1200 for the month of August to 1545 approximately in September and October over 1700 in October, this is characteristic of solution gas type for the GOR?

A The gas breaks out, then you have a gradual rise in GOR until it peaks out, and then it declines.

Q Then, it would fall?

A Yes.

Q Well, now, all of your calculations for the amount of production you can get from the Devonian pool were based on inch and a half tubing?

A Nominal inch and a half.

Q Is it possible to equip this well with any size of tubing larger than inch and a half, and then run another size of tubing to the Wolfcamp?

A You could get a special, get 2 and 6/8-inch tubing and one and a half string and produce the Wolfcamp through the 2 and 6/8, which would give you a little more capacity. You use inch and a half because it was common through -- further, if you would turn to Exhibit 3, this rather illustrates the point. We changed out in 1958 our 2-inch tubing to 2½, and you will notice what a rise we had in our bottom hole -- our oil production and our water production. Later, the well was put on pump.

Q You undoubtedly changed the size of the pump also at that time, didn't you?

A Yes, sir. It shows in 1959 we increased the size of the plunger and again we had a small increase in oil and water production.

Q Well, now, would it be possible to put in a,take a string of something like 2½-inch hydrill tubing and install this well and then put a small diameter macaroni string into the Wolfcamp?

A The problem would be that your small string would be so small that you would have extreme difficulty in swabbing the well in, you would have considerable friction losses, when we get into this tiny string, and you've got a very limber string, if it ever broke off, you would really be in a mess with your well.

Q You could put a sliding door collector in your large diameter to swab the upper zone in, couldn't you, the way you do here on this installation?

A You could, yes, sir, but you would not be able to. Say you could cut paraffin, it turned out you had paraffin, the problem is that you are limited to very tiny tools, which is very much of a problem. The trouble with the 5½-inch, this is such a deep well even such heavy 5½-inch our take is very much reduced, we don't have very much room.

Q Now, can you pump the Wolfcamp formation with your proposed installation?

A No, sir, you cannot unless you abandoned the Devonian. You can set a plug in your seating nipple and open the sliding sleeve and pull through the piping string.

Q What would you do if you had to pump Devonian,Wolfcamp prior to the time of this economic limit on the Devonian?

A You would have to make the decision at that time whether you wanted to prematurely abandon the Devonian or Wolfcamp because you wouldn't be able to produce both at the same time. Now, there are some dual zone pumps that you can run that will produce both of them at the same time, but that is, they have to, in order to use dual zone pumps, you've got to have wells of a certain type that the dual zone pump is suited for, and, unfortunately, this isn't the type. One of them is producing great volumes of fluid, then the others would not be; and as a result you would have an installation that would be very difficult to make operate properly.

Q Now, you've got a two and one-quarter inch plunger in this pump at the present time?

A Yes, sir.

Q How many strokes is this unit operating?

A I'm not prepared to say, I don't know offhand.

Q Would you furnish us with that information?

A Yes, sir, I certainly would.

Q Could you also furnish us with the length of the stroke?

A The length.

Q I would also like to know what size sucker rods you have in this well.

A All right. Size sucker rods, number of strokes per minute, and the length of the stroke.

Q I presume you have a two-quarter inch plunger?

A I will verify the plunger size.

Q One further question, Mr. Willingham. You listed a number of conditions under which you stated you wouldn't recommend this type of installation be made, is this correct?

A Yes, sir.

Q How is the Commission to know in advance, when an applicant comes in and requests an annulus tubing dual completion, whether those conditions are going to be encountered or not?

A Well, the only way that I know is to ask those three questions. Do you anticipate formation sand, production or sand problems when you frac? Do you anticipate abnormal pressure is going to be present, and also have a test of their gas as we present it.

Q Well, now, supposing they don't know or they say they don't anticipate they will have these problems, and then the problems arise, what would you recommend that the Commission do then?

A I would think they would have to tell you whether these conditions existed before they could make that type of installation.

Q They might not anticipate is the point I mean, but then the conditions did arise, what should the Commission do in a case like that, then? The man is going to come in, "Well, I spent my money, I got this dual completion made, and I've got these conditions. Now what do I do?"

A Well, you would have quite a problem. If you had the corrosion, of course, you can inhibit it with the technique that I have. Then when this is abnormal pressure, if he found a pressure like that, he just -- if a prudent operator, he should not make the installation.

Q Then, supposing on the third factor he went ahead and made the installation and then encountered sanding of the well?

A Mr. Nutter, there is one thing an operator could do if he didn't know the conditions that he was going to get in, he would make a double packer dual which would allow him to put his bad zone in the tubing.

Q Even if it were the upper zone through a crossover?

A Yes, sir. In other words, if it's unknown, then he doesn't know. The Commission could insist on the two-packer dual, so that he would know if he did get adverse conditions in one reservoir he could put it in the tubing and that is illustrated on this sketch. I think that is a good point on Figure 14. He could make this type of installation.

Q "B" on 14?

A Yes, sir. Actually, "A," "B" and "C" are the same installation with just different types of tools.

MR. NUTTER: I believe that is all. Thank you.

BY MR. UTZ:

Q Mr. Willingham, do you believe that a test of the Wolfcamp, say, flowing thirty days through the 2p-inch tubing, the next thirty days through the annulus would prove flow efficiency or a reasonable accurate test to determine such --

A Yes, that would be one way of determining it in which you would know it would meet the statement Mr. Nutter mentioned, that you would have a similar condition, you would know that your well shouldn't change too much.

Q But would Humble be willing to make such a test?

A It would result in some expense on our part in order to do this, and it would mean our other side, of course, we would lose the oil production from it. Certainly, we wouldn't, well, we wouldn't be able to put the Devonian in the annulus, anyway, we would not put the Devonian in the annulus because there is no way to pump it.

Q What is the capacity of your Devonian, would it be able to make up lost allowable?

A No, sir, I don't feel that it would because of the extreme amount of water production. Now, it's possible we could, but I am not certain on that. I fear we would actually lose some oil production because of the high water volumes. Of course, now there is one thing that we could do, when we first complete this well, we are going to have to swab the well in in the tubing anyway to get it started flowing, and we could test the well at that time and then when we closed our valve we would have that test as a guide.

Q Do you feel that the prpduction will be stabilized enough so that the test would be meaningful?

A I think if we observed it and watched it to make sure it was, I think if we produced it for a couple of days and then tested it, I feel that it would be providing, of course, we would observe if we weren't getting any mud or any kind of contaminant.

MR. UTZ: Are there other questions?

MR. NUTTER: Just one.

BY MR. NUTTER:

Q Mr. Willingham, you stated that it cost three hundred thousand dollars to drill a well in here. Did you mean a Devonian well or Wolfcamp?

A Wolfcamp well.

Q Wolfcamp well?

A Yes, sir.

Q Which is approximately what depth, 10,000 feet?

A Let's see. I've got it on one of these prints. Your Wolfcamp is 10,542 to 10,580.

Q Is this a normal cost for drilling a well of this depth in Lea County?

A Yes, sir. I have, in fact, in case that came up, I brought some cost data which I wouldn't want to put this in as an exhibit, but I do have it to verify the cost.

Q That would be for a wildcat or development?

A Development well. In fact, if you would like to look, I've got it right here.

BY MR. PAYNE:

Q Mr. Willingham, you anticipate the Wolfcamp completion would be capable of making considerable in excess of top unit allowable. What about your other Wolfcamp wells in the area?

A I think initially it would probably make more than its allowable, yes, sir.

Q So that if we are going to take the type of test Mr. Utz mentioned, might be one way of determining flow efficiency. We would have to allow the well to flow at capacity for both thirty-day tests, would we not, because it might make its allowable flowing under either condition through tubing or through the annulus, and yet in actuality, one method might or might not be more efficient than the other?

A That is true. Actually, Mr. Payne, the reservoir I am worried about would be the Devonian. I don't feel you would lose any oil from the Wolfcamp, only from the Devonian.

Q I see. Thank you.

MR. UTZ: Other questions?

BY MR. MORRIS:

Q Mr. Willingham, I have been looking through this pamphlet you handed us, and I note in here that the use of these coupons to detect corrosion or measure the corrosion rate they point out here are indicative only of the corrosion rate at the point where the coupon is inserted in the line.

A That is true.

Q And that would indicate to me that it might be useful only for measuring corrosion in the surface facilities rather than the corrosion rate, deep in the well, for instance.

A Yes, sir. However, I don't think you can run a coupon at any place and say, "Well, I had corrosion, I lost a tenth of my coupon, therefore, I know any corrosion is such a rate." In other words, this is a qualitative measure and not a quantitative measure. Whether this coupon would show you after you put the inhibitor in you stopped the corrosion you could be confident it was stopped as far as your pellets would drop and since these pellets would not melt, they have to stand in the well for a few hours before they will melt.

Q It also points out here your coupon is not effective if you have any paraffin problems in your well because your coupon will become coated. Do you anticipate any paraffin problems in this well?

A That is a penetrating question. I don't know that we can say the problem is trouble with paraffin. I can have a field that was not a paraffin field, and there isn't severe paraffin problems which we don't ever anticipate. We have isolated wells even in fields that do have paraffin problems. I would be telling an untruth if I said possibly we would have the paraffin.

Q Do you use these coupons on any installation that you presently have to detect corrosion?

A To a limited extent.

Q It just seemed to me that it might, the use of the coupon might only be effective for determining surface corrosion rather than in the well corrosion, and they do have other methods here, it seemed, that are better suited to measuring in the well corrosion of such problems.

A The only problem in using some of the others, you would have expense in getting it down in the well, and that would be your problem. You certainly have a point there. I think the thing about this situation is that if you will turn back to the Exhibit that I gave you on the gas analysis, that is, Exhibit 6, you will notice I calculated the grains there as 3.5 for hydrogen sulfate, and the well normally is considered getting into the corrosive problems when you get over twenty grains, so you can see that we are well below what is considered your getting into the corrosion problems.

BY MR. PAYNE:

Q How expensive are these pellets and how many does it take?

A Mr. Payne, your corrosion treatment cost can vary from one hundred dollars to two or three hundred dollars per year, and you can't say how many it will take. In other words, generally, what you do is you are going to have to use coupons to judge whether or not you handle your corrosion in the past and the experience I have, I had two sticks of this sperm which are about this long that normally would protect you for about three weeks in some of the wells that we had.

MR. PAYNE: Thank you.

A One other thing I might mention here. He talked about corrosion. I am sure that you are aware that gas is a much more corrosive material than oil, and we are allowing that to be produced in the annulus, but we've got inhibitors that will control gas corrosion. We've got some very excellent corrosion inhibitors and some of them are quite similar to these.

BY MR. PAYNE:

Q Isn't it true, Mr. Willingham, in very recent years, at least, we have only allowed the annular flow of gas in the dual completions when there were no severe corrosion problems?

A Yes, sir, but in gas, any gas is corrosive, if you've got the pressure and the producing volume. In other words, if you had a well with less than two thousand pounds pressure, was producing less than a million cubic feet a day, you wouldn't anticipate corrosion. When you start getting over a million feet per day above two thousand pounds, I know if I could run water sample tests, we know when we need to treat, we are very active in that because it's good business to watch your corrosion.

MR. UTZ: Any other questions?

MR. BRATTON: Mr. Willingham, Mr. Nutter was inquiring as to what the Commission might do in instances where an operator requests this type of installation and where he might not anticipate some of it to encounter some of the situations where you believe this installation should not be used, and under those conditions, do you not believe the Commission could either refuse to grant the application, if the conditions appear to exist, or might grant the application and retain the case under its jurisdiction to see what does actually happen, and if any of these conditions develop, wouldn't that be a feasible way of handling that type of situation?

A Yes, sir, they could.

Q And you do not believe, do you, that by granting this application, if the Commission should, and by placing such restrictions in the order as the Commission might see fit, if it should grant it, that it would be recruiting any widespread precedent for this type of installation?

A No, sir, I don't believe that it would. I think the seriousness with which the Commission has asked these questions is certainly deterrent on any one wanting to make this type of installation. I think they are certainly going to get all the facts before they grant it.

MR. UTZ: Any other questions? The witness may be excused.

(Witness excused)

MR. UTZ: Any statements in this case? The case will be taken under advisement. The hearing is adjourned.

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STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, LLEWELYN NELSON, Court Reporter, in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me in machine shorthand and reduced to typewritten transcript under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this, the 20th day of January, 1961, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Llewelyn Nelson
NOTARY PUBLIC

My Commission expires:
June 14, 1964

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 2146, heard by me on [illegible], 1960.

[signature], Examiner
New Mexico Oil Conservation Commission

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
________ EXHIBIT NO. ________
CASE NO. ________

Houston, Texas

December 8, 1960

Fluid Production Calculations
For Proposed Dual Completion
In New Mexico

4-0

Mr. R. R. McCarty
Midland, Texas

Attention: Mr. J. W. Graybeal

This is to confirm our telephone conversations of November 18 and December 6, 1960, with Mr. J. S. Willingham, regarding the fluid production from a proposed dual completion in New Mexico. Artificial lift calculations are summarized in the attached Table I and were made to determine the maximum fluid that could be produced in a well equipped with 5-1/2-inch casing and (1) a rod pump in 2-7/8-inch tubing; (2) a rod pump in 1-1/2-inch tubing, or, (3) subsurface hydraulic lift with 2-7/8-inch tubing and 1-1/4-inch concentric power oil string. As no gas vent is provided in this completion, the volumetric efficiency of the pumping equipment may be greatly reduced if the GOR of the produced fluid is greater than 50 cubic feet per barrel.

In regard to the question concerning efficiency of energy consumption in flowing one zone of the proposed well on a 2-7/8- x 5-1/2-inch annulus as compared to flow through 2-7/8-inch tubing, we offer the information shown in the attached Table II. The information submitted in the table uses flow in 2-7/8-inch tubing as a base and assumes such to be satisfactory. Numbers used in the lefthand column are from production data from an existing adjacent well using 2-7/8-inch tubing as the flow path. The gas requirement indicated in annular flow is that necessary to produce this same amount of fluid produced in tubing flow. Also shown is the maximum fluid production that could be expected from producing in the annulus if the same amount of gas used in the existing well were expended in annulus-type flow. The relationship between flow characteristics of 2-7/8-inch tubing as compared to the 2-7/8- x 5-1/2-inch annulus used in these calculations are indicated on the attached Figure 1. As far as we are able to ascertain, a study has not been made in the Industry to determine the optimum size tubing or annulus that would make maximum use of energy from a given amount of reservoir gas - that is to prevent slippage and gas breakthrough. However, field experience shows that production can be satisfactorily obtained by producing through the annulus.

If we can be of further aid, please advise.

T. A. Huber

By
R. S. Rugeley
Subsurface Engineering
Practices Section

RSR:ag
Attchs.
cc: Mr. Douglas Ragland, w/attch.
Mr. J. R. Willingham, w/attch.

TABLE I

COMPARISON OF PUMPING METHODS IN A PROPOSED NEW MEXICO WELL

Method	Limiting Factor	Rod Size - In.	Plunger Size - In.	Length Of Stroke - In.	SPM	Unit Size Req'd.	Vol. Eff. (%)	Prod. B/D
Rod Pumping in 1-1/2-In. Tbg.								
From 10,650 ft.	Rod Stress	5/8, 1/2, Hi-Tensile	3/4	144	1[illegible]	3[illegible]-D	80	79.5
From 5,000 ft.	Rod Stress	5/8, 1/2, Hi-Tensile	1-1/4	144	1[illegible]	3[illegible]0-D	80	210
Rod Pumping in 2-7/8-In. Tbg.								
From 10,650 ft.	Rod Stress	1, 7/8, 3/4 Std.	1-1/16	144	[illegible]	456-D	80	[illegible]5.5
From 10,650 ft.	Rod Stress	1, 7/8, 3/4 Hi-Tensile	1-1/4	144	11	91[illegible]-D	80	260
From 5,000 ft.		1, 7/8, Std.	2	144	1[illegible]	64[illegible]-D	80	602
Subsurface Hydraulic in 2-7/8-In. With 1-1/4 Power Oil Tbg.	Sur.Press. 5,000 psi	-	-	-	60		[illegible]	336

Note: **Tubing Anchored in All Cases.**
No gas vent provided - volumetric efficiency may be less.

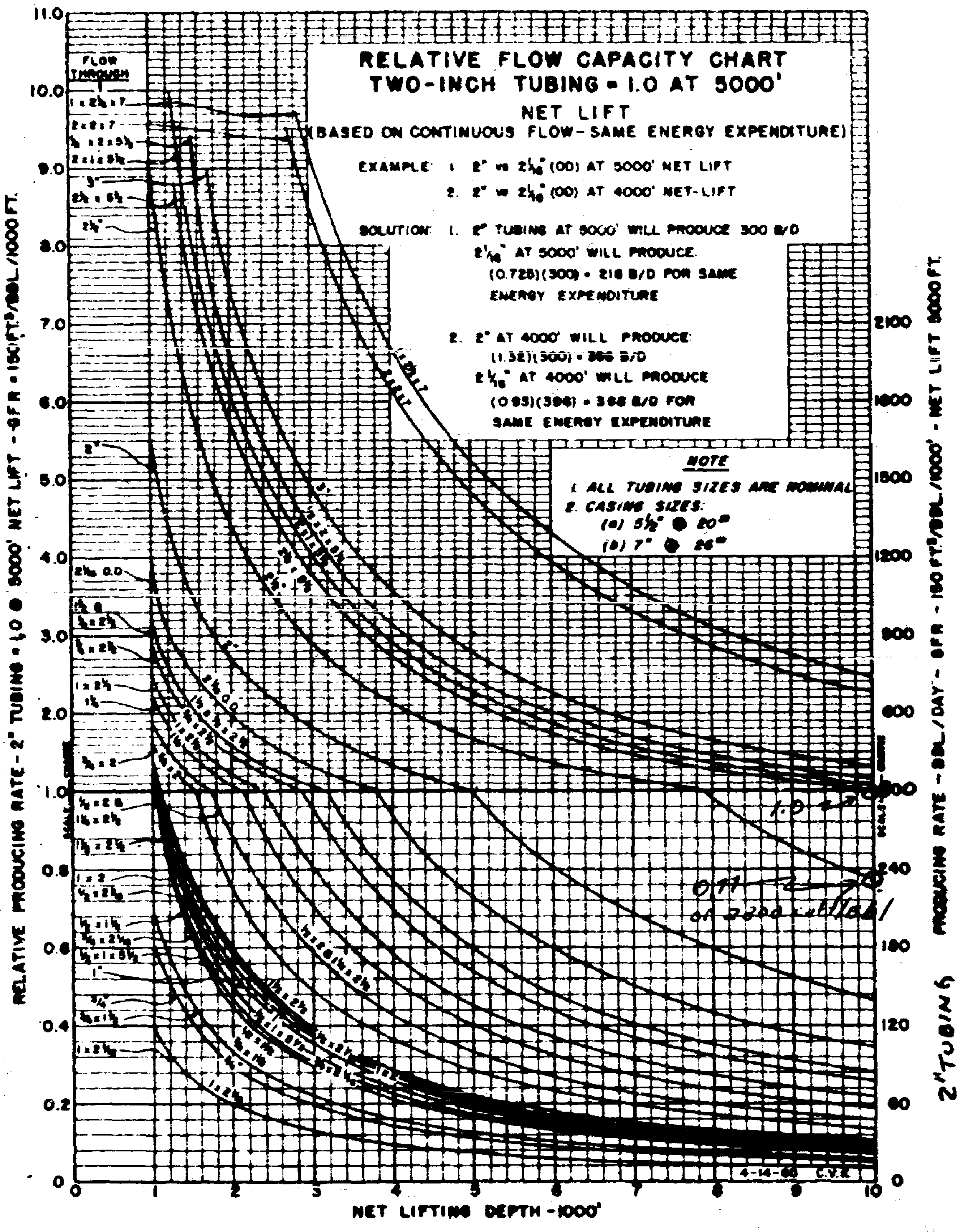
Petroleum Eng. Div.
Subsurface Eng. Pract. Section
[illegible]:ng 1[illegible]-6-60

TABLE II

EFFECT OF FLOW PATH ON ENERGY CONSUMPTION
(2-7/8-In. Tubing vs. 2-1/2- x 5-1/2-In. Annulus)

	Existing Well	Proposed Well
Flow Path	2-7/8-In. Tbg.	2-7/8- x 5-1/2-Inch Annulus
Fluid Production	165 B/D	165 B/D
Water Content	6%	6%
Gas Rate Required	3,150 Cu.Ft./Bbl.	2,300 Cu.Ft./Bbl
Total Gas Per Day	520 MCFD	380 MCFD
With Energy Constant (3,150 Cu.Ft./Bbl) Production	165 B/D	215 B/D
Producing Depth	10,000 feet	10,000 feet

Petroleum Engineering Division
Subsurface Eng. Pract. Section
RSR:ng 12-8-60



$$\frac{1.0}{0.77} \times 165 \text{ B/D} = 215 \text{ B/D}$$

Houston, Texas

BEFORE EXAMINER UTZ
OIL CONSERVATION COMMISSION
EXHIBIT NO. 7
CASE NO. 2146

December 8, 1960

Fluid Production Calculations
For Proposed Dual Completion
In New Mexico

4-0

Mr. R. R. McCarty
Midland, Texas

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Attchs.
cc: Mr. Douglas Ragland, w/attch.
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TABLE I

COMPARISON OF PUMPING METHODS IN A PROPOSED NEW MEXICO WELL

Method	Limiting Factor	Rod Size - In.	Plunger Size - In.	Length Of Stroke - In.	SPM	Unit Size Req'd.	Vol. Eff. (%)	Prod. B/D
Rod Pumping in 1-1/2-In. Tbg.								
From 10,650 ft.	Rod Stress	5/8, 1/2, Hi-Tensile	3/4	144	12	320-D	80	79.5
From 5,000 ft.	Rod Stress	5/8, 1/2, Hi-Tensile	1-1/4	144	12	320-D	80	210
Rod Pumping in 2-7/8-In. Tbg.								
From 10,650 ft.	Rod Stress	1, 7/8, 3/4 Std.	1-1/16	144	7	456-D	80	95.5
From 10,650 ft.	Rod Stress	1, 7/8, 3/4 Hi-Tensile	1-1/4	144	11	912-D	80	260
From 5,000 ft.		1, 7/8, Std.	2	144	12	640-D	80	602
Subsurface Hydraulic in 2-7/8-In. With 1-1/4 Power Oil Tbg.	Sur.Press. 5,000 psi	-	-	-	60		80	336

Note: Tubing Anchored in All Cases.
No gas vent provided - volumetric efficiency may be less.

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TABLF II

EFFECT OF FLOW PATH ON ENERGY CONSUMPTION
(2-7/8-In. Tubing vs. 2-1/2- x 5-1/2-In. Annulus)

	Existing Well	Proposed Well
Flow Path	2-7/8-In. Tbg.	2-7/8- x 5-1/2-Inch Annulus
Fluid Production	165 B/D	165 B/D
Wate. Content	6%	6%
Gas Rate Required	3,150 Cu.Ft./Bbl.	2,300 Cu.Ft./Bbl
Total Gas Per Day	520 MCFD	380 MCFD
With Energy Constant (3,150 Cu.Ft./Bbl) Production	165 B/D	215 B/D
Producing Depth	10,000 feet	10,000 feet

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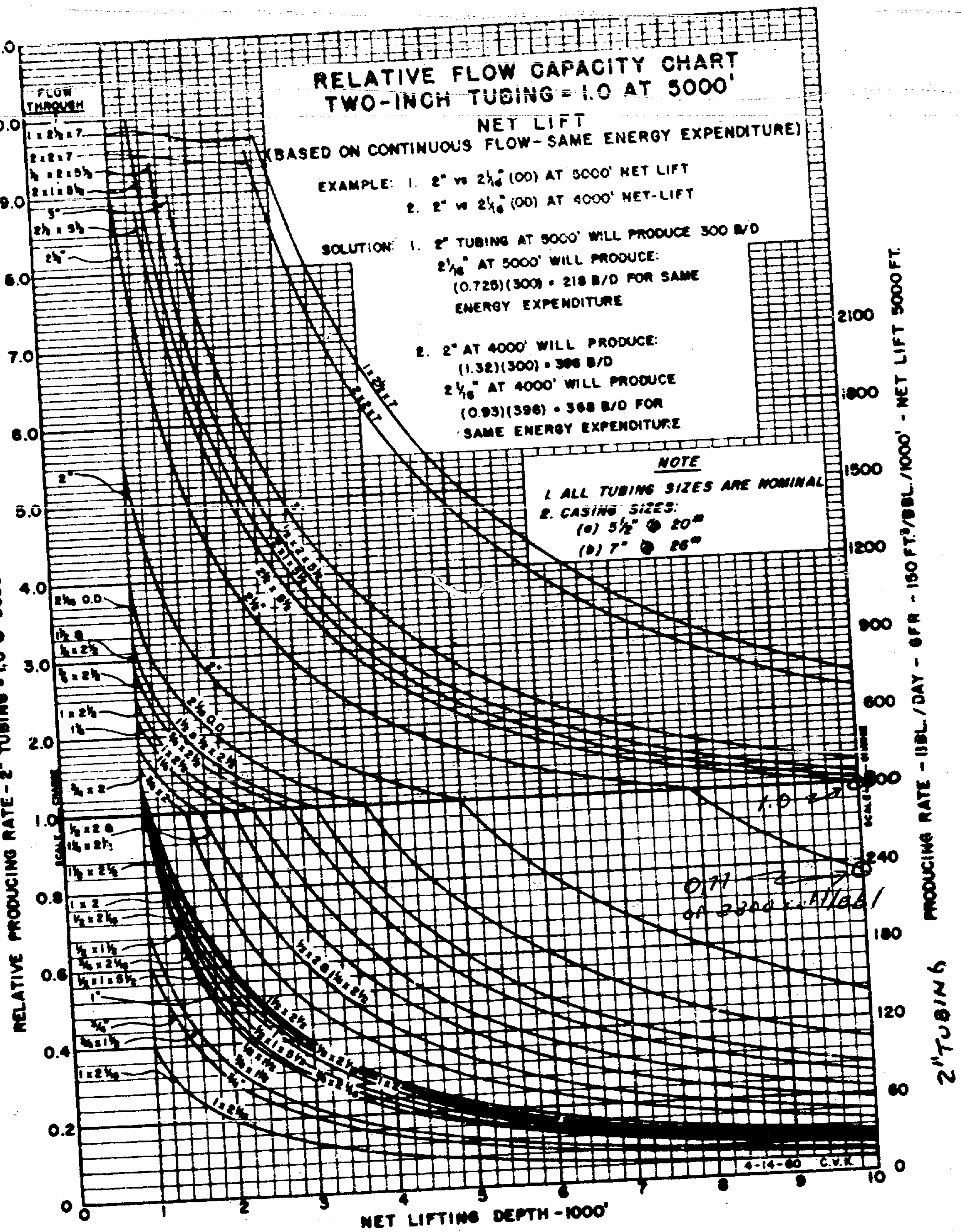

$$\frac{1.0}{0.77} \times 165\ B/D = 215\ B/D$$