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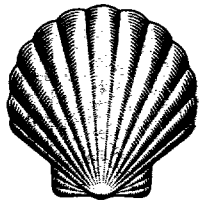
NEW MEXICO
OIL CONSERVATION COMMISSION

SUPPORTING INFORMATION
APPLICATION FOR PERMISSION TO USE
CENTRALIZED PRODUCTION TEST FACILITIES
AND AUTOMATIC CUSTODY TRANSFER EQUIPMENT

SHELL OIL COMPANY
BISTI FIELD
SAN JUAN COUNTY
NEW MEXICO





SHELL OIL COMPANY

NEW MEXICO
OIL CONSERVATION COMMISSION

# SUPPORTING INFORMATION
# APPLICATION FOR PERMISSION TO USE CENTRALIZED PRODUCTION TEST FACILITIES AND AUTOMATIC CUSTODY TRANSFER EQUIPMENT

BISTI FIELD
SAN JUAN COUNTY
NEW MEXICO

SHELL OIL COMPANY

FARMINGTON, NEW MEXICO
JUNE 1957

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## ABSTRACT

Supporting information has been assembled to supplement Shell Oil Company's application to the New Mexico Oil Conservation Commission to use centralized production test facilities and automatic transfer equipment in the Bisti field, San Juan County, New Mexico. This information should be considered along with the petition, which for convenience has been reproduced as the first section. The exceptions requested to Rule 309 of the Commission are given. The proposed oil handling system is illustrated by descriptions and drawings and its advantages to the lessors, the State of New Mexico, and the Shell Oil Company are enumerated.

# P E T I T I O N

Comes now the Shell Oil Company and petitions the Commission for an order to allow an exception to Rule 309 of the Commission, and to approve the installation and operation of a system of producing, testing and metering the wells presently located on the lands hereinafter described, and for wells to be hereafter drilled on such lands.

The Petitioner plans to establish at suitable locations on the lands hereinafter described facilities known as test stations, to which stations will be connected a number of wells. At or near each test station, separators will be provided. There will be provided one or more test separators into which by means of valves and other connections individual wells may be produced during the testing period. Production testing of the oil and gas will be effected by meters and samplers. An additional separator or separators also will be provided at each station for the common separation of gas from the production from all wells not being tested. Into this separator or separators will be run the commingled production from all wells which are served by the particular station.

The crude from the above-described test stations will then be conducted to one or more central plants where there will be located surge and weathering tankage through which the crude from the test stations will pass, and thence from such surge tanks through a positive displacement meter for transfer to the pipe line gathering system.

In the use and operation of the above-described systems and facilities, the production will not be received and measured in tanks and, further, common tankage will not be used to receive the production from eight or less units of the same basic lease as provided in Rule 309 of the New Mexico Oil Conservation Commission.

The Petitioner requests authority to commingle nonparticipating area production with participating area production in the Carson Unit and to calculate royalty payments by means of periodic production rate tests, performed at the above-described test stations; provided, however, production from nonunitized lands shall not be commingled with production from lands included within the Carson Unit.

The Petitioner requests authority to use the above-described system and facilities and requests the exception under Rule 309 to include all lands and leases which have been committed to the Carson Unit Agreement or which may hereafter be committed to such unit agreement. This unit arrangement includes the lands described in Order R-828-A of the Oil Conservation Commission and which are more particularly described as follows:

NEW MEXICO PRINCIPAL MERIDIAN

TOWNSHIP 25 NORTH, RANGE 11 WEST
All of Sections 5 to 8, inclusive;
17 to 20, inclusive; and 29 to 32,
inclusive;

TOWNSHIP 25 NORTH, RANGE 12 WEST
All Section 1; all Section 2;
all Sections 11 through 14 inclusive;
all Sections 23 through 26 inclusive;
all Section 35; all Section 36;

containing 15,366 acres, more or less.

The Petitioner further requests that authority for the installation and operation of the facilities and the system and exception to the rule above-indicated also apply to the following-described property and leases:

1. United States Oil and Gas Lease Santa Fe 078066* dated February 1, 1948, covering the following-described lands:

   Township 25 North, Range 12 West, N.M.P.M.

   Section 4: Lots 1, 2, S-1/2 NE-1/4
   Section 9: N-1/2
   Section 10: SW-1/4, E-1/2
   Section 15: All
   Section 22: N-1/2, SE-1/4
   Section 27: W-1/2

2. United States Oil and Gas Lease Santa Fe 078061* dated February 1, 1948, covering the following-described lands:

   Township 25 North, Range 11 West, N.M.P.M.

   Section 26: W-1/2
   Section 27: S-1/2
   Section 34: All

3. United States Oil and Gas Lease Santa Fe 078062* dated February 1, 1948, covering the following-described lands:

   Township 25 North, Range 11 West, N.M.P.M.

   Section 4: SW-1/4
   Section 9: W-1/2
   Section 16: All

4. United States Oil and Gas Lease Santa Fe 078065 dated February 1, 1948, covering the following-described lands:

   Township 25 North, Range 12 West, N.M.P.M.

   Section 21: All
   Section 28: All
   Section 33: All
   Section 34: All

5. United States Oil and Gas Lease Santa Fe 078228 dated February 1, 1948, covering the following-described lands:

Township 25 North, Range 11 West, N.M.P.M.

Section 9: SE-1/4
Section 15: NW-1/4

6. United States Oil and Gas Lease New Mexico 021530 dated May 1, 1956, covering the following-described lands:

Township 25 North, Range 11 West, N.M.P.M.

Section 22: NW-1/4

7. United States Oil and Gas Lease Santa Fe 078067* dated February 1, 1948, covering the following-described lands:

Township 25 North, Range 12 West, N.M.P.M.

Section 3: Lots 1, 2, 3 and 4, S-1/2 of N-1/2 and SE-1/4

*The remainder of the lands covered by these leases, which were assigned to Shell, are included within the Carson Unit.

The Petitioner further requests that this matter be set down for hearing before the Commission at its regular hearing date for July 1957.

Respectfully submitted,

SHELL OIL COMPANY

By_____
Its Attorneys

## INTRODUCTION

New Mexico will receive a new crude oil market upon completion of a large diameter pipeline now under construction to the Pacific Coast. Shell Oil Company has begun a program to fully develop the Carson Unit and their leased properties in the Bisti field to help supply the market. Although development is still continuing, sufficient wells have been drilled to enable Shell to efficiently plan the location of gathering, separating, and metering facilities.

An unusual opportunity is provided to plan and construct these facilities with the most modern equipment and techniques presently available, thus assuring that the properties can be produced in the most efficient manner. Such equipment provides a completely closed system that conserves oil vapors and maintains oil gravity. Waste of crude oil from tank cleaning is practically eliminated. By having the shipping facilities automatically controlled, thus reducing human error, waste from tank spillage is avoided. The proposed design of the oil-handling facilities for the Shell properties in the Bisti field incorporates all these conservation features.

## EXCEPTIONS REQUESTED

In order to use these modern oil-handling methods in the Bisti field, the New Mexico Oil Conservation Commission is being petitioned to allow an exception to its Rule 309 which governs the operation of central tank batteries. The specific operating procedures which are proposed and which require exception are briefly as follows:

1. More than eight units of each basic lease will be produced into a well test station for collection, measurement, and transfer to a central point for dehydration, (if necessary) and transfer to the pipeline. The test stations will be so constructed that frequent individual well tests will be made for oil and gas volumes and BS&W content.

2. Accounting of crude oil transferred to the pipeline gathering system and calculation of royalty payments will be based on measurements obtained by positive displacement meters and automatically obtained samples.

## LANDS & LEASES

This development plan involves lands and leases located in T 25 N, R 11 and 12 W, N.M.P.M., in the area commonly referred to as the Bisti field, as follows:

1. Carson Unit
2. L. M. Phillips #2
3. E. W. Mudge #1
4. E. W. Mudge #2
5. E. W. Mudge #4
6. J. R. Anderson
7. Mohr Assignment

Refer to petition for exact legal description of these properties and to Exhibit A for the map showing their relative locations. Each of the properties except the Carson Unit will be operated as a separate lease.

Under the Carson Unit agreement all lands capable of producing oil or gas in paying quantities will be included within a Participating Area. A Participating Area must be approved by the New Mexico Oil Conservation Commission, and the United States Geological Survey, and also agreed upon by the working interest owners.

The proposed first revision of the Participating Area is shown on Exhibit C together with a projection of the possible limits of the Participating Area to next year when the Four Corners pipe line is expected to be completed.

Possibly many producing wells will be completed outside of the Participating Area during the period that agreement is being secured for inclusion of the wells in the Participating Area. However, it is expected that all but a few marginal wells will be included eventually in the Participating Area.

## DESCRIPTION OF PROPOSED FACILITIES

The Bisti field facilities as proposed will consist of (1) test stations strategically located throughout the field, (2) oil gathering systems, and (3) central plants as indicated schematically on Exhibit C.

### TEST STATIONS

Using the Carson Unit as a model for the proposed installations on the other Shell Bisti field leases, it is planned to locate six test stations approximately as indicated on Exhibit C. Gas separation and well testing will be performed at the test stations, which will be shop-fabricated, skid-mounted units capable of serving a group of wells.

Referring to Exhibit D, fluid from the well in test is directed to the test separator by the three-way valve on the header manifold. Fluid from the remaining wells flows to the group separator (bypassing the test separator).

From the test separator the fluid passes through a positive displacement meter immediately upstream from the separator dump valve. The fluid then is combined with that metered from the group separator. This combined production goes through the lease gathering system to the central plant.

An automatic sampler is operated in conjunction with the test separator. The sample volume thus taken is directly proportional to the production of the particular well in test, and is used to determine the gravity and BS&W content of the test well fluid. Samples will be obtained from individual wells as often as necessary for well performance and accounting information.

The accuracy of the meters will be maintained by a routine replacement and recalibration program. In addition, frequent checks on the test meter can be made by passing a measured volume of oil from the separator through the meter. The measured volume can be obtained by filling the test separator to a high point in the sight glass, diverting the production of the well to the group separator, and then dumping the test separator to a low point in the sight glass. The known volume between points then can be compared to the volume registered by the meter.

The gas from the test separator is measured and recorded by a positive displacement or orifice meter, combined with the gas from the group separator and delivered either to the sales meter or gas gathering system.

The test station will be operated so that a 24-hour test can be obtained about once every month for each producing well. However, the equipment provides that any well can be placed into test at any time for checking.

The Carson Unit test stations will have sufficient capacity to handle both Participating Area and Non-Participating Area production. (Refer to Exhibit C.) As wells are drilled in the Non-Participating Area and determined to be commercially productive, they will be recommended periodically for inclusion in the Participating Area. The working interest owners have agreed that such wells can be produced without the need for duplicate facilities. (Refer to Exhibits E, F, G and H.) The crude oil

thus produced will be commingled, but will be accounted for separately on the basis of periodic 24-hour production tests. The non-participating interests will be charged for the use of the facilities as mutually agreeable to the working interest owners. Those wells which are later accepted for inclusion within the Participating Area will be credited with the handling charge and thereafter operated and accounted for as provided under the unit operating agreement. If the wells are not accepted in the Participating Area, the facilities will continue to handle the oil at the agreed charges.

Royalty payments for a Non-Participating Area well will be based on its allocated share of the total net production shipped from the central plant, as determined by periodic production tests. One method of accounting for the allocation is shown on Exhibit I.

Similar methods of allocating royalty payments to individual wells where oil is commingled have been approved by lessors and are in present use in at least six locations where Shell is either the operator or royalty owner. We believe that this method is fair to all parties.

FIELD GATHERING SYSTEM

The field gathering system, shown on Exhibit C, comprises a main pipeline and laterals connecting the individual test stations to the central plant.

CENTRAL PLANT

The central plant, shown on Exhibit J, provides facilities for treating the oil gathered from the various test stations to make it suitable for shipment by common carrier pipeline. It also provides for automatic custody transfer to the pipeline company.

Incoming oil first goes through a dehydration system (if required) and then through a stabilizing tank to the surge tank. A small pump continuously recirculates tank bottoms through the dehydration system, thereby minimizing tank cleaning and the attendant losses.

CUSTODY TRANSFER EQUIPMENT

The custody transfer equipment (shown on Exhibit J) receives the oil from the surge tank which is equipped with emergency, high, intermediate and low level float switches (refer to Exhibit K). As the surge tank fills to the level of the intermediate switch, the pump suction motor-operated control valve opens and the pipeline shipping pump starts. As the tank pumps out to the level of the low level switch, the pump stops and the valve closes. The emergency and high level switches are safety devices. If the oil level reaches the high level switch, the central plant inlet motor valve closes and flow into the plant stops. The emergency level switch prevents occurrence of a dangerously high level in the tank if the high level switch fails.

After leaving the surge tank the oil passes through the following equipment in succession:

1. Charging pump (if required). One of the requirements of the pipeline gathering company is that the pressure in the metering system be maintained above the vapor pressure of the

crude. In the Bisti field this should be no higher than 7 psig, according to a number of measurements made on the L. M. Phillips No. 2 lease (Refer to Exhibit L). It may be possible to maintain such pressures by strategic location of the surge tank, thus eliminating the charging pump.

2. The Sampler will be driven by electrical impulses from the meter so that a small sample for each one-half barrel of oil passing through the meter is drawn into a hermetically sealed sample container. The sampler design incorporates features that cause the pump suction motor control valve to close in the event the sampler fails to take a sample for one minute. This not only insures that all oil passing through the meter will be sampled, but also insures that the rate through the meter will not be less than 20 gpm, the lower limit of the smallest meter we plan to use.

3. The Strainer will trap any foreign objects which might accidentally get into the line.

4. The Cut Monitor, operating on a dielectric constant principle, permits only merchantable oil to pass through the meter. If the set value of 1% BS&W is exceeded for more than one minute, the monitor closes the pump suction motor control valve and stops the shipping pump. The high cut signal from the monitor also opens a bypass valve and starts a recirculating pump which diverts the non-merchartable oil to the dehydration equipment. As soon as the oil becomes acceptable to the monitor, the bypass closes and shipping resumes. If the oil does not become acceptable, the surge tank will continue to fill until the high level switch operates to shut the central plant inlet valve.

5. The Gas Eliminator will remove free air or gas if it should accidentally get into the line. Should an excessive amount of air or gas pass through the eliminator, a low level float switch will close the pump suction motor control valve.

6. The Meters will be positive displacement type with counters reading in barrels, tenths and hundredths. A discussion of the accuracy and methods of calibrating the meters follows later. Each meter is equipped with a temperature compensator to correct all measurements to a base of 60° F. The register is equipped with a ticket printer. By inserting a ticket in the printer at the beginning of a measurement period, and printing the opening reading, the ticket is automatically locked in place and cannot be removed without mutilation until the closing reading is printed.

   A lockout safety device on the meter, which requires manual reset, closes the pump suction control valve (after a short delay) in the event the counter stops functioning.

7. The Back Pressure Regulator is manually set to maintain pressure on the meter above the vapor pressure of the crude.

8. The Pump Suction Control Valve is the main operating control for the custody transfer system. The valve is opened and the pump started by a signal from the intermediate level switch in the surge tank. The valve is closed and the pump is stopped by a signal from the low level control. Other signals which act to close the valve are:

   (a) High cut from cut monitor.
   (b) Sampler failure.
   (c) High sample pressure.
   (d) Excessive gas in the eliminator.
   (e) Meter counter failure.
   (f) Low shipping pump suction pressure.
   (g) Power failure.

9. The Shipping Pump, which is the property of the pipeline gathering company, is operated automatically as noted above.

10. The Control Panel, which is enclosed in a locked and sealed weatherproof housing, contains the various relays, switches and time delays. Indicating lights, easily visible from a considerable distance, will be mounted on a nearby pole. A high intensity white or yellow light will burn continuously to signal proper functioning of the system and the power supply. A red light and horn will warn of malfunctions as follows:

    (a) High surge tank level.
    (b) Pump suction control valve failure.
    (c) Central plant inlet motor valve failure.

    Each of the above malfunctions will be identified on the control panel by a separate light in order to identify the source of trouble. Each time the meter ticket is collected the lights will be checked to assure that they are not burned out.

    Every effort has been made to design fail-safe equipment so that malfunctions cannot cause mismeasurement of oil.

Automatic custody transfer by positive displacement meters is a widely accepted industry practice. (Refer to Exhibit M for bibliography of recent publications on automatic custody transfer and metering processes.)

One pipeline company is currently transferring custody of 375,000 barrels of crude oil per day on the basis of meter measurements. These transfers involve six non-affiliated and three affiliated companies. A total of more than 140,000,000 barrels of crude oil have been measured through 60 meters in use by this company; no meter failures or meter-caused shutdowns have occurred, and accuracies are considered better than those previously obtained by tank gauging methods.

Exhibit N is a letter from the Four Corners Pipe Line Company agreeing to accept meter measurements for custody transfer in the Bisti field. Exhibits E-H show acceptance of meter measurements by the working interest owners in the Carson Unit.

Exhibits O and P are photographs of a Shell Oil Company operated automatic custody transfer system which contains most of the features outlined above. This system and a similar one in the same field have successfully metered over 1,000,000 barrels of oil with no significant trouble.

## MEASUREMENT ACCURACY

Positive displacement meters used for custody transfer measurement of crude oil must be at least as accurate as manual tank gauges, which are the standard means of measurement.

Based on Shell's experience, and that of others in the industry, we believe that meters are more accurate than manual gauges. Many more errors are possible when measurements depend on hand gauging a tank than when they depend on an accurate mechanical device. Major sources of error inherent in measurements of net oil by tank gauging are:

1. Wax and corrosion incrustations on the inside of tank walls reduce the actual tank volume. (Bisti crude oil is known to be very waxy at temperatures below 62° F. Refer to Exhibit Q.)

2. Average temperature of oil in the tank differs from observed temperature.

3. Changes in Basic Sediment deposition under the gauge hatch from opening to closing gauge.

4. Measuring liquid level to nearest 1/4 inch.

5. Use of abridged ASTM Table 7 for oil volume correction to 60° F. (The proposed meters will correct at the coefficient of expansion of the oil being shipped as determined by ASTM Table 6.)

In addition to these errors, there are a number of smaller possible errors in manual gauging. Among these are tank strapping inaccuracy, tank expansion and contraction, tank tilt and out-of-roundness, and bottom flexure from high to low gauge.

Extensive investigation by another company has shown that as a result of these errors, the volume of oil computed from tank gauging methods may differ from -1.0% to +0.15% of the true volume. Our experience is similar. Some lease tanks handling crude oil similar to Bisti Oil have had wax incrustation of up to one inch on the inside wall. This factor alone is a major source of measurement error when tanks are used.

Wax deposition in the meter case merely reduces the clearance of the moving parts and thus effects a tighter seal in the measuring chamber. Since the meter is calibrated under operating conditions, correction is made for the reduced slippage.

There are, however, some sources of error inherent in measuring oil with positive displacement meters:

1. Tolerance permitted in calibrating meter prover tank.

2. Tolerance permitted in calibrating meter.

3. Possible error in meter temperature compensating device.

4. Calibration is affected by change of meter slippage with flow rate (flow rates in this field will be stable).

5. Effect of viscosity change on meter slippage (meters will be calibrated frequently to assure correct factor for current conditions).

Based on our Bisti field tests on meters (Refer to Exhibit R) and the work of other companies, the summation of these meter errors is about ±0.15%. As the magnitude of this error is considerably less than that for tank measurement, positive displacement meters offer a more accurate means of oil measurement than manual tank gauging.

METER CALIBRATION

Meter calibration tests (meter proving) will be conducted by the pipeline company and witnessed by Shell. The frequency of calibration will be determined by experience. It is anticipated that tests will be run every two weeks initially and that this program will be revised as experience dictates.

Calibrations are made to determine a factor by which the meter reading is multiplied to derive the true volume of oil measured. Another important objective of calibration is to detect mechanical trouble before it significantly affects meter accuracy. Since a meter factor change is usually indicative of internal wear, a factor change of, say, 0.1% from one calibration to the next indicates that maintenance is required.

Meters will be proved in accordance with the API-ASME Code 1101, "Installation, Proving and Operation of Positive Displacement Meters in Liquid Hydrocarbon Service". Several alternate calibration methods are approved by this code. In the volumetric method, which will be used, a metered volume is remeasured in a container of accurately known volume. Comparison of the two measurements indicates the accuracy of the meter being checked. This container, or prover tank, will have a capacity such that the meter can flow into it for at least one minute at maximum rated flow. It will be internally coated to prevent scale and wax deposition on the walls and will be insulated to maintain constant oil temperatures during proving operations. A sketch of a prover tank with thermometers, sight gauges, calibrated seraphin neck, and other appurtenances is shown on Exhibit S.

This tank will be calibrated initially, and at reasonable intervals thereafter, by the water withdrawal method. This method determines the prover tank volume by first filling with water which is then withdrawn into measures calibrated by the National Bureau of Standards. Calibrations are repeated until two consecutive volume measurements agree within 0.02%. The average of these two measurements is taken as the prover tank volume at the pressure and temperature of the tests. Proper correction factors are applied to tank volume for temperature conditions other than calibration temperature. The prover is calibrated at its operating pressure (in this case, atmospheric pressure).

Meters at a central plant will be calibrated in place under their normal conditions of flow, pressure, temperature, and crude oil type. The meter prover tank will be trailer-mounted for ease of movement between central plants. Standard industry practice is to first fill the prover tank with the oil to wet the walls and bring it to the oil temperature. The tank is then drained, and calibration runs are made until two meter factors determinations agree within 0.05%. The average of these two values is taken as

the meter factor for the following operating period. With properly designed proving equipment and experienced personnel, usually only two or three calibration runs are needed to achieve the desired reproducibility.

Exhibit T is a reproduction of the meter proving data sheet which will be witnessed and signed by pipeline and lease operator representatives. This data sheet becomes a permanent record of both parties.

SAMPLE TESTING

The API gravity and BS&W content of the oil tendered to the pipeline company will be determined from that on the automatically-obtained composite sample whenever a run is completed. Representatives of Shell and the pipeline company will jointly witness those tests.

Throughout the oil industry, and for a number of years, large quantities of crude oil have been accounted for on the basis of automatically-obtained line samples. Both Shell Oil Company and Shell Pipe Line Corporation have conducted tests regarding the reliability and accuracy of these devices, and both have concluded that samples obtained by properly designed, installed, and maintained automatic samplers are more accurate than those taken manually. Exhibit U shows a tabulation of test data comparing results from manual and automatic sampling.

## ECONOMIC BENEFITS

Economic benefits of various sorts are expected to result from the installation of the described field facilities rather than a conventional tank battery system. These are more fully described in the following sections.

## CONSERVATION OF PETROLEUM

Crude oil is conserved because metering eliminates the exposure of crude oil to air throughout the gathering and storage systems. This maintains light petroleum fractions in the crude, retaining its volume, gravity and price. Tank cleaning is minimized along with resultant losses because it is not essential to accurate volume measurements. The automatic controls on central plant tanks prevent spillage and attendant waste.

No quantitative data are available for the Bisti field that show how much loss in gravity is prevented by a completely closed oil handling system. However, Shell has made detailed studies in other fields which show definite gravity increases when an automatic custody transfer system is installed. This closed system prevents normal losses due to hand-gauging methods which require periodic opening of tank gauge hatches.

In one field, where the oil gravity is slightly less than that at Bisti, after such a system was installed the average gravity of oil shipments increased $0.5^{\circ}$ API. It is estimated that this gravity increase corresponded to a volume increase of 0.95%. This percentage of the total oil in the Shell properties under consideration could amount to as much as 65,000 barrels. Conserving this oil will mean additional revenue to the lessors and the State of New Mexico. Moreover, if this conservation also results in maintaining the oil in a higher gravity price bracket, lessors will receive more revenue.

Besides conserving oil as it is produced and handled, ultimate recovery of oil will be greater with the proposed oil handling system. Ultimate recovery from a field is increased by pumping the wells as long as any oil is produced. However, the economic limit is reached when the cost of production equals the value of the production. Because operating cost of the Carson Unit will be materially decreased by centralization of treating and storage facilities, use of automatic equipment, elimination of hand gauging, and reduction of equipment requiring maintenance, the estimated economic life may be extended about two years. The additional expected recovery in this period is about 180,000 barrels of oil

## IMPROVED SAFETY

Safety to personnel will be improved because tank gauging, with its attendant hazards from tank vapors, climbing and fire, is eliminated.

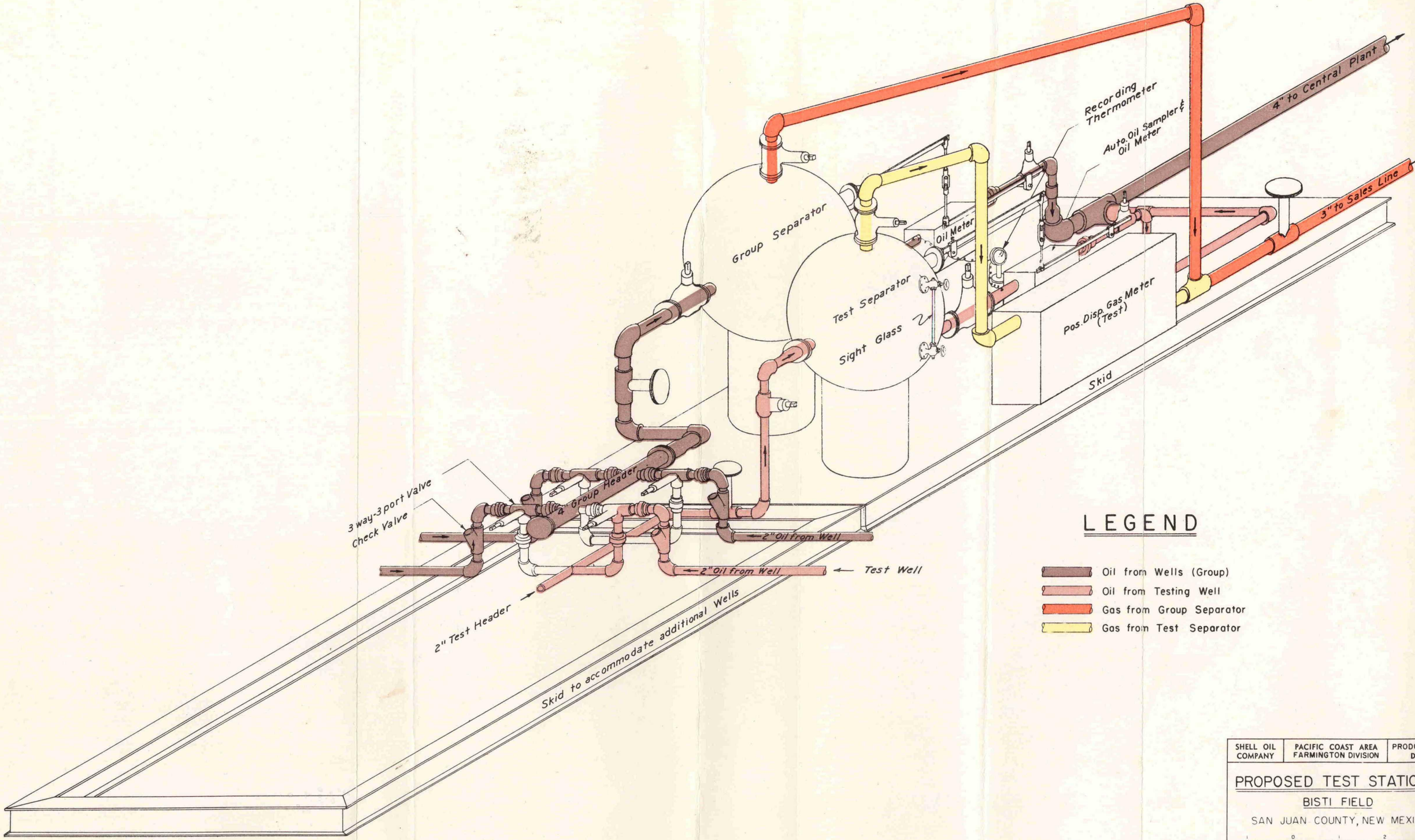
Fire hazards will be decreased, at least in proportion to the reduction in the number of oil storage tanks, and possible losses will also decrease because of the minimum above-ground storage.

## INCREASED TAXES AND ROYALTIES

The above discussion indicates that the proposed oil handling facilities will not only result in savings for the operating oil company and pipeline gathering company, but will also provide increased revenues to the state and to the lessors in the form of additional taxes and royalties.

## CONCLUSIONS

We respectfully submit that the foregoing plan of operation will result in numerous benefits to the royalty owners, the State of New Mexico, and the Shell Oil Company. It is our opinion that the design of the equipment follows sound engineering principles and that accurate metering and well testing will be achieved. One of the principle considerations in the design was the prevention of waste which was achieved by using a completely closed automatic oil handling system. As a result, light fractions of petroleum will be conserved and the volume and gravity of the produced oil will be increased. The ultimate recovery will be increased by extending the economic life of the field as a result of more efficient operation.




## LEGEND

- Oil from Wells (Group)
- Oil from Testing Well
- Gas from Group Separator
- Gas from Test Separator

| SHELL OIL COMPANY | PACIFIC COAST AREA FARMINGTON DIVISION | PRODUCTION DEPT. |
|---|---|---|

# PROPOSED TEST STATIONS

BISTI FIELD

SAN JUAN COUNTY, NEW MEXICO

APPROXIMATE 1 0 1 2 3 FT

DATE Apr 29 '57
BY L.J.S.
APPROVED

C-20-022

R-1029

EXHIBIT D CASE NO.

# HUMBLE OIL & REFINING COMPANY

MIDLAND, TEXAS

Midland, Texas
May 29, 1957

Shell Oil Company
108 North Behrend Avenue
Farmington, New Mexico

Attention of Mr. R. R. Robison

Dear Sir:

Your letter of April 29, 1957, requested approval by Humble Oil & Refining Company of the following Carson Unit Field Facilities plans:

(1) Six test stations strategically located throughout the field,
(2) An oil gathering system,
(3) A central plant, and
(4) A lease road system.

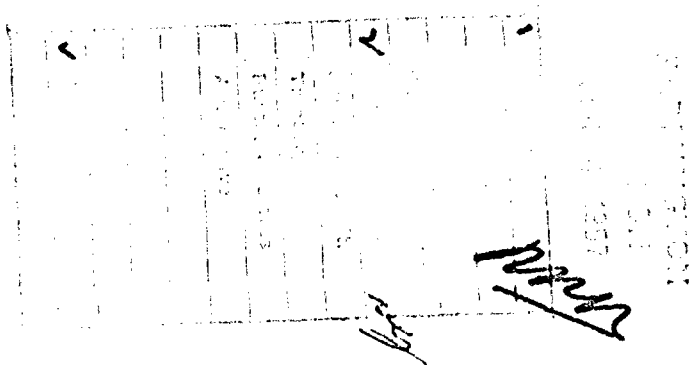
We have reviewed your request and herewith advise that we have no objection to the proposed field facilities plans.

Yours very truly,

HUMBLE OIL & REFINING COMPANY

R. R. McCARTY

WLC/rs
cc: L. H. Byrd
H. L. Hensley
H. E. Meadows
R. W. Bybee, Attn. M. L. McMillan
J. E. Zellmer
R. M. Lilly
Humble Oil & Refg. Co., 2602 Central Ave., S.E., Albuquerque, N.M.
Humble Oil & Refg. Co., Box 1287, Roswell, New Mexico



The letters from Skelly Oil Company and El Paso Natural Gas Company will be offered in evidence at the time of the hearing.

Exhibits G and H

## A CENTRAL PLANT DATA

| Total Meter Reading Bbl. | Meter(1) Factor | Cut Correction Factor | (a) Corrected Lease Production Bbl. | Water Meter Reading Bbl. | Temp.(2) Correction Factor | Meter(1) Factor | Corrected Water Production Bbl. | (b) Total Gross Fluid Bbl. | (c) Non-Part. Area Net Production Bbl. | (a-c) Participating Area Net Production Bbl. |
|---|---|---|---|---|---|---|---|---|---|---|
| 3,256.3 | 0.998 | 0.997 | 3,249.8 | 326 | 0.998 | 0.999 | 325 | 3,574.8 | 268.1 | 2,981.7 |

## B TEST STATION DATA

| Test Station No. | Group Meter Reading Bbl. | Temp.(4) Correction Factor | Meter(1) Factor | (d) Group Gross Production Bbl. | (e) Gross Test Production Bbl. | (d+e) Total Test-Sta. Gross-Prod. Bbl. | (b)/(f) Field(5) Factor | (g) Actual Test Station Gross Prod. Bbl. |
|---|---|---|---|---|---|---|---|---|
| 14(3) | 876.6 | 0.9915 | 0.997 | 866.52 | 29.88 | 896.4 | 0.997 | 893.7 |
| 24(3) | 876.6 | 0.9915 | 0.997 | 866.52 | 29.88 | 896.4 | | 893.7 |
| 18(3) | 876.6 | 0.9915 | 0.997 | 866.52 | 29.88 | 896.4 | | 893.7 |
| 20 | 876.6 | 0.9915 | 0.997 | 866.52 | 29.88 | 896.4 | | 893.7 |
| TOTAL FIELD PRODUCTION | | | | 3,466.08 | 119.52 | 3,585.6(f) | | 3,574.8 |

## C WELL TEST DATA

| Well No. | Test Meter Reading Bbl. | Temp.(4) Correction Factor | Meter(1) Factor | Gross Test Production B/D | Days Produced During Month | Well Gross Production Bbl. | (g)/(h) Test(7) Station Factor | Actual Gross Production Bbl. | Cut Correction Factor | Actual Net Production Bbl. | (c) Non-Participating Area - Net Production Bbl. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32-14 | 10.07 | 0.9915 | 0.998 | 9.96 | 30 | 298.8 | 0.997 | 297.9 | 0.90 | 268.1 | |
| 11-J | 10.07 | | | 9.96 | | 298.8 | | 297.9 | 0.90 | 268.1 | |
| 11-E(6) | 10.07 | | | 9.96 | | 298.8 | | 297.9 | 0.90 | 268.1(6) | 268.1 |
| TOTAL WELL TEST | | | | 29.88(e) | | 896.4(h) | | 893.7 | | 804.3 | 268.1 |

(1) Obtained from Meter Calibration Tests
(2) Obtained from International Critical Tables - Vol. III
(3) Test Station Handling Non-Participating Area Production
(4) Obtained from ASTM-IP, Petroleum Measurement Tables - Table 6
(5) Field Factor = $\frac{3574.8}{3585.6}$ = 0.997
(6) Non-Participating Area Well
(7) Test Station Factor = $\frac{893.7}{896.4}$ = 0.997

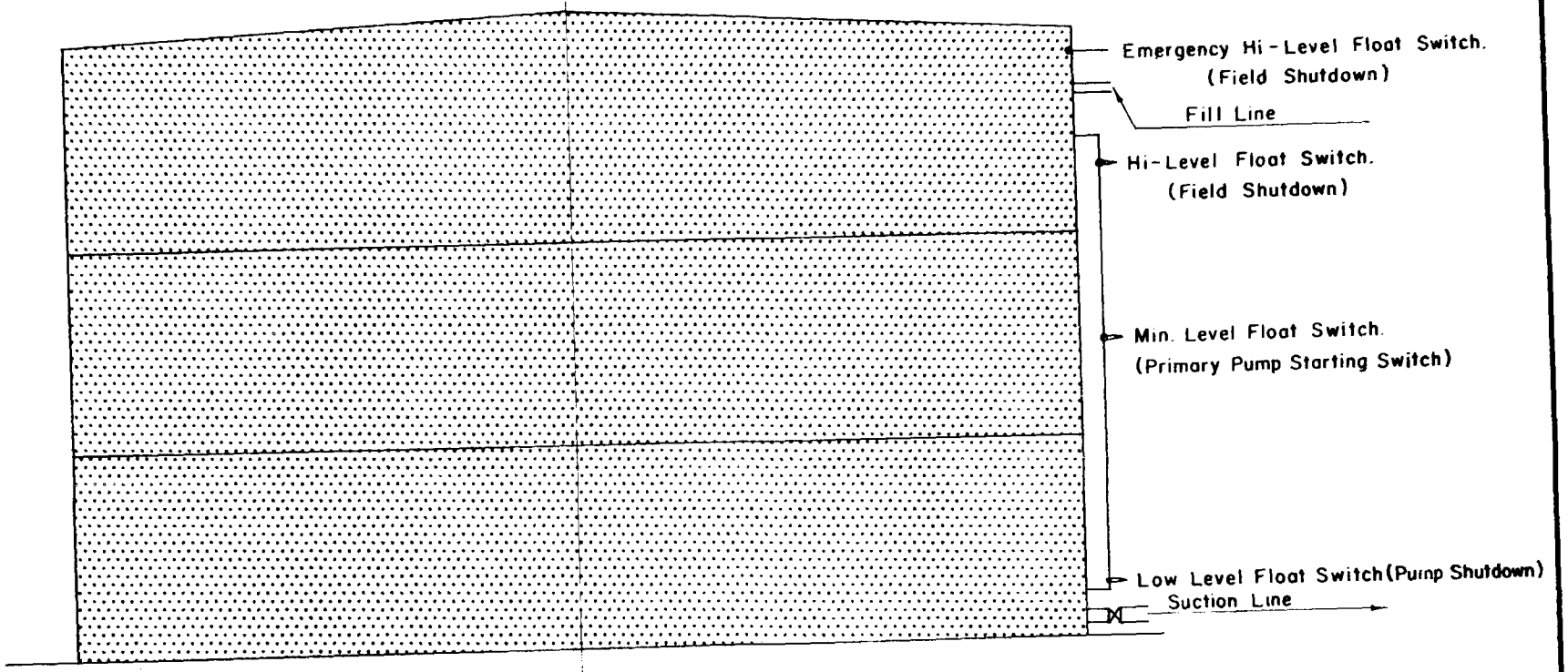
| SHELL OIL COMPANY | PACIFIC COAST AREA FARMINGTON DIV. | PRODUCTION DEPT. |
|---|---|---|

**SAMPLE PRODUCTION DATA CALCULATION SHEET**

**CARSON UNIT – BISTI FIELD**

DATE
BY
APPROVED

EXHIBIT I CASE NO ____




| SHELL OIL COMPANY | PACIFIC COAST AREA FARMINGTON DIVISION | PRODUCTION DEPT. |
|---|---|---|

PROPOSED SURGE TANK
OIL LEVEL SWITCH ARRANGEMENT

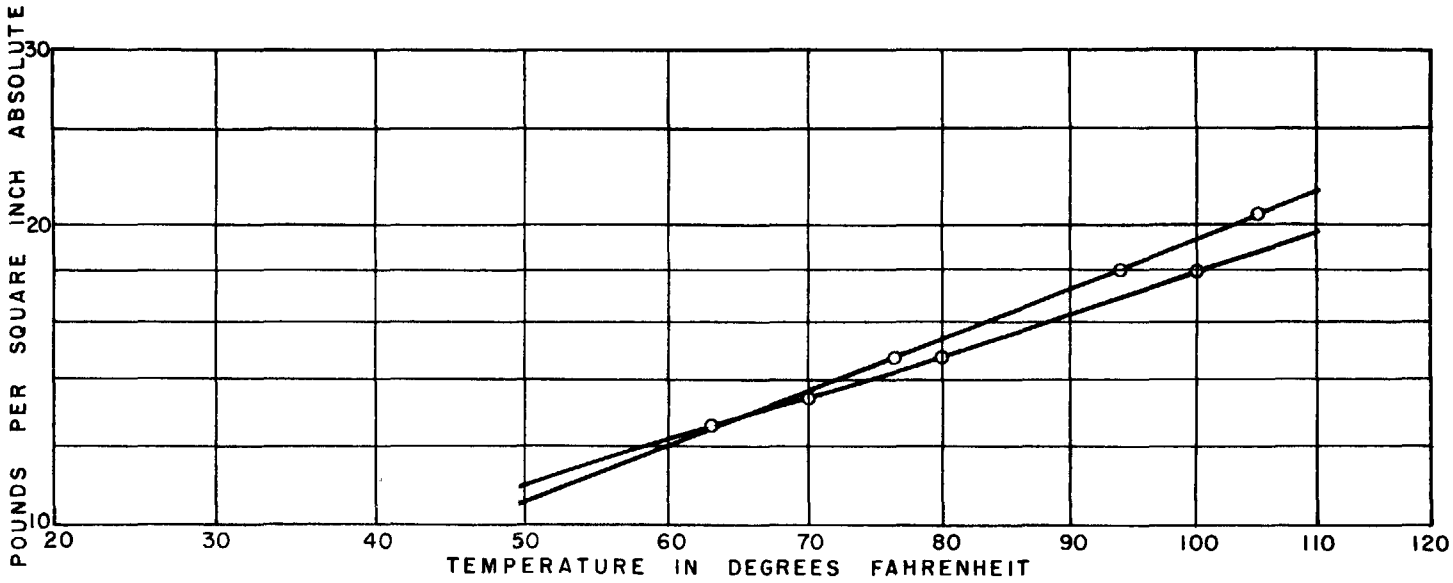
BISTI FIELD

DATE APRIL 29, 1957
BY D.G.C
APPROVED

SCALE NONE

U20-043

EXHIBIT "K" CASE NO.




NOTES: SAMPLE OF TANK 4M4
DATE SAMPLED: 5-14-57 & 5-15-57
CURVE NO. 5-57, DATE 5-20-57, BY P.R.S.
REMARKS: L.M. PHILLIPS NO. 2, WELL 12-15. SEP. PRESS. 50 PSI, SEP. TEMP. 74°-64° F., API GRAVITY 39.4 - 40.4

# TRUE VAPOR PRESSURE
## BISTI CRUDE
## L. M. PHILLIPS NO. 2 LEASE

EXHIBIT L CASE NO. ____

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Shell's trial test on lease automation pays off.
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**FOUR CORNERS PIPE LINE COMPANY**

SHELL BUILDING
P. O. BOX 2648
HOUSTON 1, TEXAS

TELEPHONE: CAPITOL 2-1181

June 19, 1957

Shell Oil Company
1008 West Sixth Street
Los Angeles 54, California

Gentlemen:

This will confirm our consent to receive lease oil from Shell Oil Company into Four Corners' lines on the basis of positive displacement meter measurements in the San Juan Basin (New Mexico) and Paradox Embayment (Utah) oil fields. We further consent that the positive displacement meters may be the volume measuring device in an automatic custody transfer facility.

These agreements are contingent upon conformance with rules and regulations of governmental regulatory bodies and with Four Corners Pipe Line's engineering and measurement standards.

Very truly yours,

FOUR CORNERS PIPE LINE COMPANY

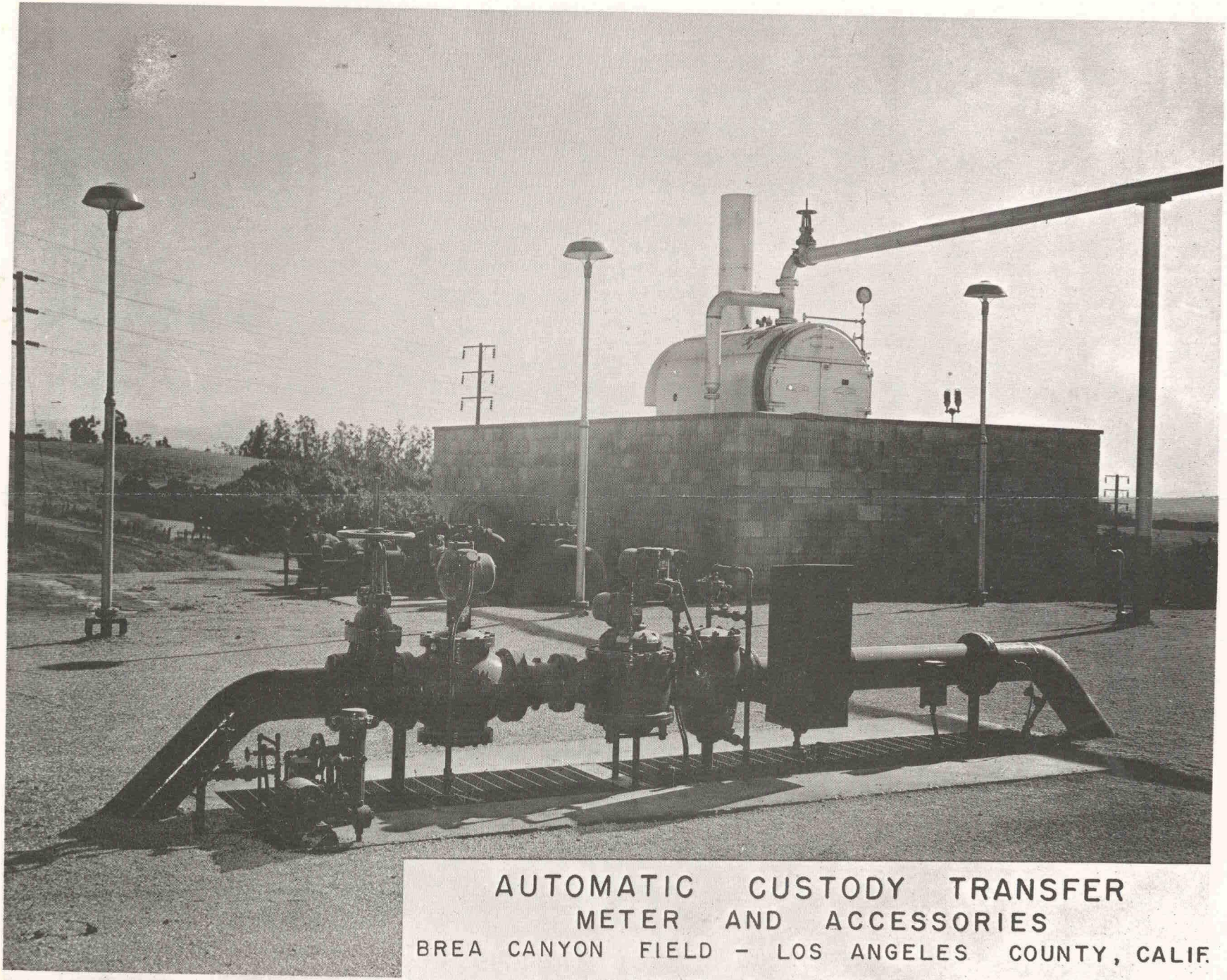
O. W. Heyden

O. W. Heyden, Chief Engineer

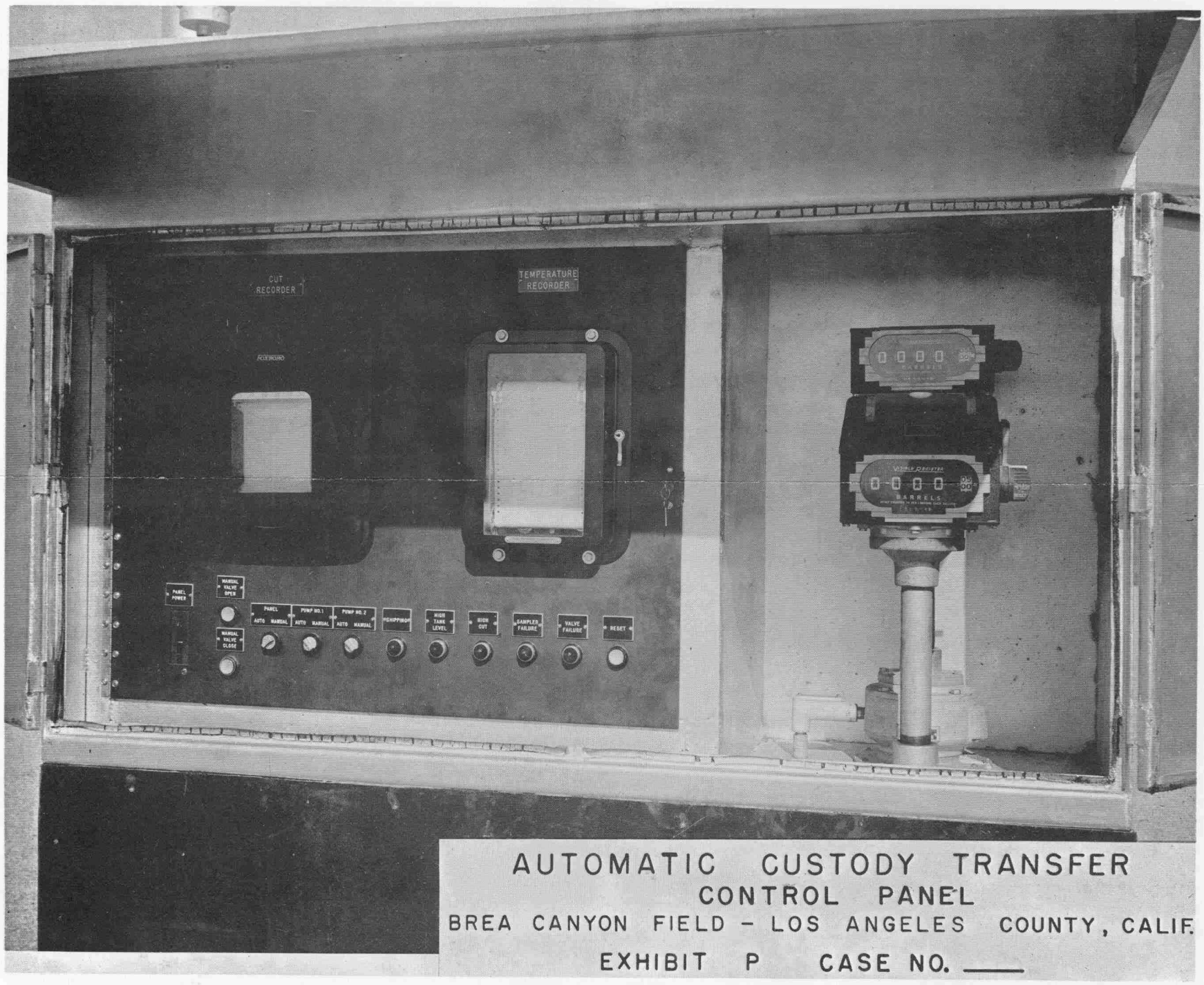
AHH:mjl

Exhibit N

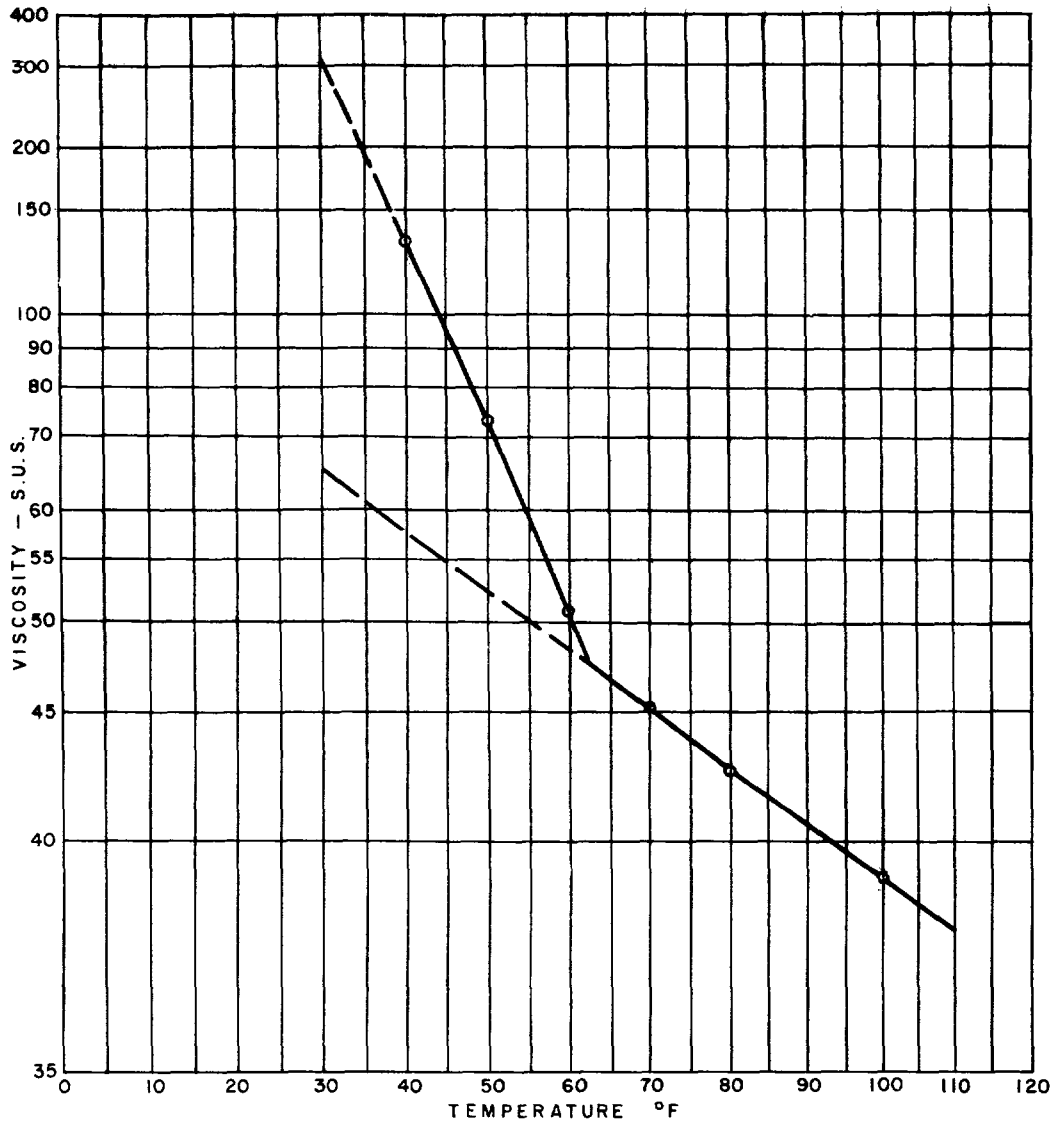
Case No. __



AUTOMATIC CUSTODY TRANSFER
METER AND ACCESSORIES
BREA CANYON FIELD - LOS ANGELES COUNTY, CALIF.
EXHIBIT O CASE NO. ___




AUTOMATIC CUSTODY TRANSFER
CONTROL PANEL
BREA CANYON FIELD - LOS ANGELES COUNTY, CALIF.
EXHIBIT P CASE NO. ____




PHYSICAL PROPERTIES

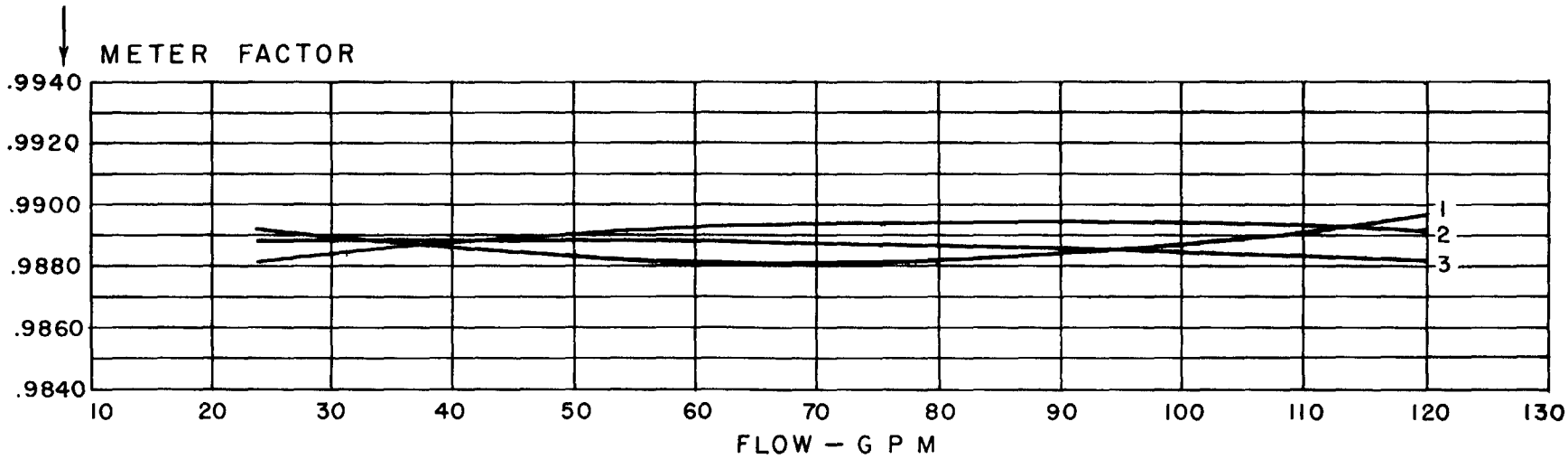
| | | | |
|---|---|---|---|
| API GRAVITY | @ | 60°F. | 38° API |
| POUR POINT | | | 40°F. |
| VIS. S.U.S. | @ | 40°F. | 130.8 |
| | | 50°F. | 73 |
| | | 60°F. | 50.8 |
| | | 70°F. | 45.1 |
| | | 80°F. | 42.4 |
| | | 100°F. | 39.0 |

SAMPLED 5-7-57

# VISCOSITY CURVE

## STABILIZED BISTI CRUDE

EXHIBIT Q CASE NO. ____



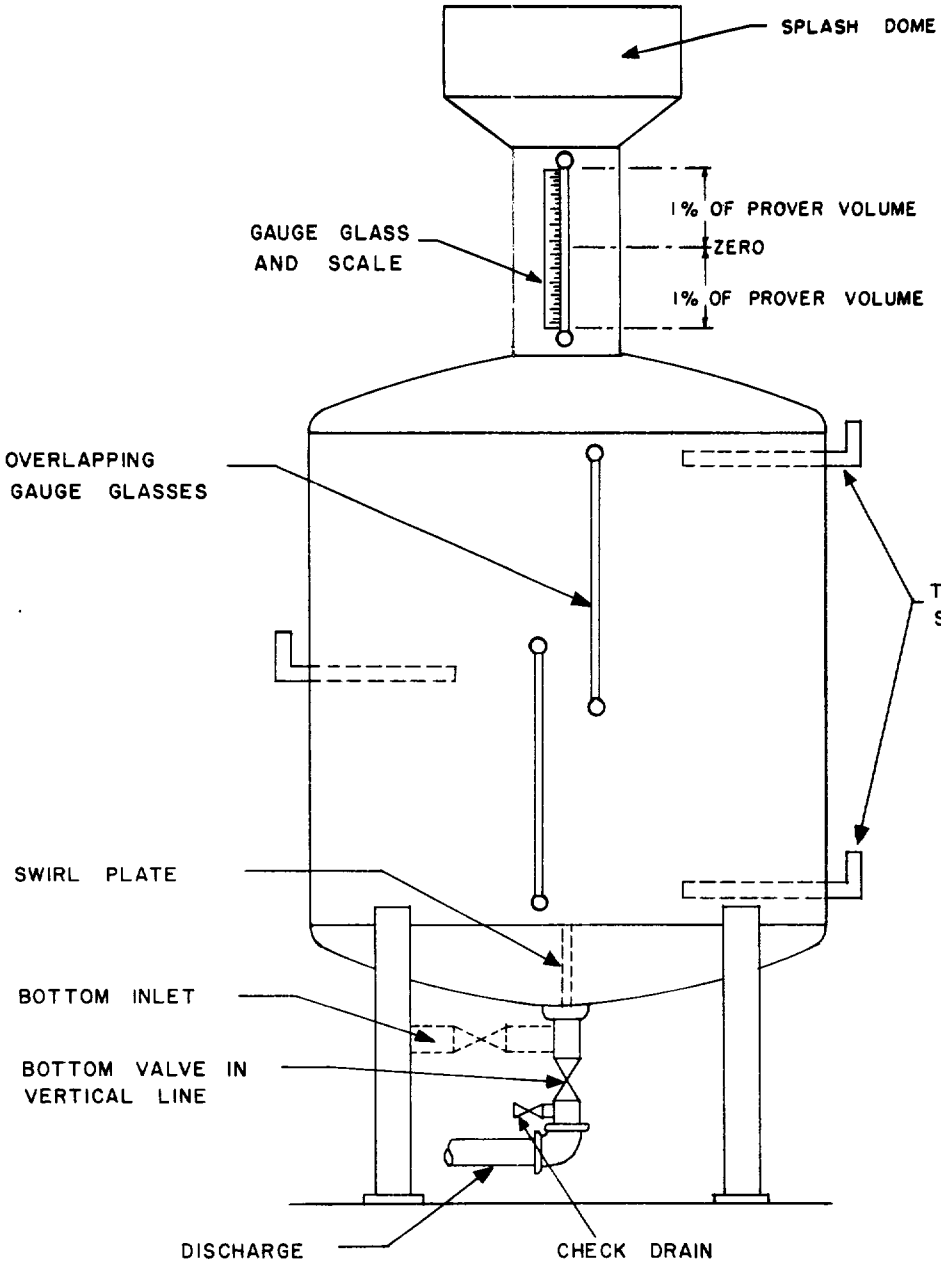

NOTE:

| Curve No. | Pump Location | Crude | Std. Deviation | Ave. Deviation |
|---|---|---|---|---|
| 1 | Downstream of meter | Weathered | 0.0013 | 0.0011 |
| 2 | Upstream of meter | Weathered | 0.0006 | 0.0005 |
| 3 | Upstream of meter | From Separator | 0.0008 | 0.0007 |

# METER FACTOR CURVES
# FOR
# THREE OPERATING CONDITIONS

## L. M. PHILLIPS NO. 2 LEASE – BISTI FIELD

EXHIBIT R , CASE No.




NOTE

TANK TO BE MOUNTED ON TRAILER

| SHELL OIL COMPANY | PACIFIC COAST AREA FARMINGTON DIVISION | PRODUCTION DEPT. |
|---|---|---|

# PROPOSED METER PROVER TANK

## BISTI FIELD

## SAN JUAN COUNTY, NEW MEXICO

DATE 17 June 57
BY J.A.M.
APPROVED

EXHIBIT S CASE NO.

# POSITIVE DISPLACEMENT METER PROVING REPORT

| Type of Liquid | | Location | | | Date | Report Number |
|---|---|---|---|---|---|---|
| Make of Meter | Serial No. | Model | Temperature Compensated ☐ No ☐ Yes → Group No. | Gravity | | Register No. |
| Prover Tank | Size | | Register No. | Pressure on Prover Tank | | |
| | | | | Previous Proving → Data | Date | Type of Liquid / Factor |

| Prover Tank Data | Run No. | Run No. | Run No. | Run No. | Run No. |
|---|---|---|---|---|---|
| TIME OF DAY | | | | | |
| DURATION OF RUN | | | | | |
| GRAVITY OF LIQUID API @ 60° F | | | | | |
| PROVER TANK TEMPERATURE °F | | | | | |
| AVERAGE PROVER TANK TEMP. °F | | | | | |
| CLOSING READING IN BARRELS | | | | | |
| OPENING READING IN BARRELS | | | | | |
| GROSS BARRELS MEASURED | | | | | |
| TEMP. CORR. FACTOR FOR TANK SHELL | | | | | |
| TEMP. CORR. FACTOR FOR LIQUID | | | | | |
| COMB. LIQUID & SHELL CORR. FACTOR | | | | | |
| MASTER METER FACTOR | | | | | |
| NET BARRELS MEASURED | | | | | |
| DATA ON METER CHECKED | | | | | |
| METER CASE PRESSURE | | | | | |
| RATE OF FLOW (B/H) | | | | | |
| TEMPERATURE OF METERED STREAM °F | | | | | |
| CLOSING METER READING IN BARRELS | | | | | |
| OPENING METER READING IN BARRELS | | | | | |
| GROSS BARRELS METERED | | | | | |
| TEMPERATURE CORRECTION FACTOR | | | | | |
| NET BARRELS METERED | | | | | |
| METER FACTOR | | | | | |

| | | | |
|---|---|---|---|
| TOTALIZER READING | | AVERAGE METER FACTOR | |
| BARRELS METERED SINCE LAST RUN | | METER FACTOR TO BE USED | |

CALIBRATOR ADJUSTMENT: ☐ NO ☐ YES → AMOUNT _____ RETARDED _____ ADVANCED _____

REMARKS (REPAIRS, ETC.): _____

| SIGNED BY: | SIGNED BY: | CALCULATIONS VERIFIED BY: |
|---|---|---|
| FOR: | FOR: | SHEET NUMBER |

Case No.

EXHIBIT T

## Comparison of Composite Sample From Automatic Sampler With Manually-Obtained Tank Samples

| Test No. | Composite Sample BS&W | Manually-Thieved Tank Sample BS&W |
|---|---|---|
| 1 | | 0.2% |
| 2 | | 0.2% |
| 3 | | 0.4% |
| 4 | | 0.2% |
| 5 | | 0.2% |
| 6 | | 0.2% |
| 7 | | 0.2% |
| 8 | | 0.2% |
| 9 | | 0.2% |
| 10 | | - |
| 11 | 0.3% (1 through 11) | 0.8% |
| 12 | | 0.4% |
| 13 | | 0.4% |
| 14 | | 0.2% |
| 15 | | 0.2% |
| 16 | | 0.4% |
| 17 | | 0.1% |
| 18 | | - |
| 19 | | 0.1% |
| 20 | | 0.3% |
| 21 | | 0.3% |
| 22 | | 0.2% |
| 23 | | 0.3% |
| 24 | 0.2% (12 through 24) | 0.1% |
| 25 | | - |
| 26 | | 0.2% |
| 27 | | 0.2% |
| 28 | | 0.2% |
| 29 | | 0.1% |
| 30 | | 0.2% |
| 31 | | 0.2% |
| 32 | 0.2% (25 through 32) | 0.2% |
| 33 | | 0.2% |
| 34 | | 0.2% |
| 35 | | 0.2% |
| 36 | | 0.2% |
| 37 | 0.2% (33 through 37) | 0.2% |
| Average | 0.23% | 0.24% |

Exhibit U

Case No. __