STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION TO AMEND ORDER NO. R-8170, AS AMENDED.

CASE NO. 9050
Order No. R-8170-B

ORDER OF THE DIVISION

BY THE DIVISION:

This cause came on for hearing at 8:15 a.m. on December 3, 1986, at Santa Fe, New Mexico, before Examiner Michael E. Stogner.

NOW, on this 23rd day of December, 1986, the Division Director, having considered the record and the recommendations of the Examiner, and being fully advised in the premises,

FINDS THAT:

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

(2) RULE 9(b) under part "B", Nominations and Proration Schedule, of the General Rules for the Prorated Gas Pools of New Mexico as promulgated by Division Order No. R-8170, dated March 28, 1986, and issued in Commission Case No. 8749, provides for a change of the deliverability assigned to a well only after that well has experienced an increase in production due to recompletion or workover operations.

(3) There is a need to expand this rule to include provisions for assigning a revised deliverability to a well for allowable purposes when such well has experienced an increase in production for reasons other than recompletion or workover.

(4) Said RULE 9(b) should be amended to include a provision whereby a change in a well's deliverability due to retest after any activity, other than routine maintenance, would become effective either the date of redelivery after such activity, (such date to be shown on the sundry notice, if required, and on the remarks portion of the Form C-122-A) or 90 days prior to the receipt date of the appropriate deliverability test form (as is presently provided for in Rule 9(b)(2)).

(5) To amend said rule in the aforesaid manner is in the interest of conservation, may prevent waste, and will protect rather than impair correlative rights.

IT IS THEREFORE ORDERED THAT:

(1) RULE 9(b) under part "B", Nominations and Proration Schedule, of the General Rules of the Prorated Gas Pools of New Mexico as promulgated by Division Order No. R-8170, dated March 28, 1986, and issued in Commission Case No. 8749, is hereby amended to read in its entirety as follows:

> "RULE 9(b) DELIVERABILITY RETESTS: A change in a well's deliverability following a retest after any activity, other than routine maintenance, shall become effective the later of:
>
> (1) the date of redelivery after such activity, such date to be indicated on the sundry notice (if a sundry notice is required) and on the remarks portion of the Form C-122-A; or,
>
> (2) 90 days prior to the date of receipt of the appropriate deliverability test report form at the appropriate Division district office.
>
> A change in a well's deliverability due to any other reason shall become effective on the first day of the month following the month during which the retest is approved in the appropriate Division district office."

(2) Jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

R. L. STAMETS,
Director

S E A L

GAS WELL TESTING MANUAL FOR SAN JUAN BASIN, NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in the San Juan Basin, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the

August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this

testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow

period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in

pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven

and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60°F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60° F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a

correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \frac{(P_c^2 - P_d^2)^n}{(P_c^2 - P_w^2)}$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for San Juan Basin.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations	0.85
For formations deeper than Pictured Cliffs	0.75

(Note: Special Rules for Any Specific Pool or Formation May Supersede The Above Values. Check Special Rules If In Doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed

a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the San Juan Basin Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III <u>INFORMATIONAL TESTS</u>

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be

taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV Type of Tests Required for Wells Completed in Non-Prorated Pools

SECTION 1: Initial Shut-in Pressure Tests for newly Completed Wells.

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-in Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of shut-in Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

END OF THIS PROPOSED MANUAL FOR TESTING IN SJB 11/10/86

GAS WELL TESTING MANUAL FOR ~~SAN JUAN BASIN~~ Northwest New Mexico

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in ~~the San Juan Basin,~~ Northwest New Mexico a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the

August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this

testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow

period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in

pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven

and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60°F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60° F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a

correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \frac{(P_c^2 - P_d^2)^n}{(P_c^2 - P_w^2)}$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for San Juan Basin.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations	0.85
For formations deeper than Pictured Cliffs	0.75

(Note: Special Rules for Any Specific Pool or Formation May Supersede The Above Values. Check Special Rules If In Doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed

a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the San Juan Basin Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be

taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV Type of Tests Required for Wells Completed in Non-Prorated Pools

SECTION 1: Initial Shut-in Pressure Tests for newly Completed Wells.

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-in Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of shut-in Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

END OF THIS PROPOSED MANUAL FOR TESTING IN SJB 11/10/86

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in northwest New Mexico, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60^{o}F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^{o} F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \frac{(P_c^2 - P_d^2)^n}{(P_c^2 - P_w^2)}$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for northwest New Mexico.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations	0.85
For formations deeper than Pictured Cliffs	0.75

(Note: Special rules for any specific pool or formation may supersede the above values. Check special rules if in doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the northwest New Mexico Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec

office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN NON-PRORATED POOLS

SECTION 1: Initial Shut-In Pressure Tests for Newly Completed Wells

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-In Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of Shut-In Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

Exhibit A
Case No. 8586
Order No. R-333-I

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in northwest New Mexico, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the

unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not

have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14

consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the

meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded

and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60°F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^{o} F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of

comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \left[\frac{(P_c^2 - P_d^2)}{(P_c^2 - P_w^2)} \right]^n$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for northwest New Mexico.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations 0.85

For formations deeper than Pictured Cliffs 0.75

(Note: Special rules for any specific pool or formation may supersede the above values. Check special rules if in doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field

test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the northwest New Mexico Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown

in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN NON-PRORATED POOLS

SECTION 1: Initial Shut-In Pressure Tests for Newly Completed Wells

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-In Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of

these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in

pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of Shut-In Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

Exhibit A
Case No. 8586
Order No. R-333-I

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in northwest New Mexico, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the

unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not

have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14

consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the

meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded

and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60^{o}F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^{o} F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of

comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \left[\frac{(P_c^2 - P_d^2)}{(P_c^2 - P_w^2)} \right]^n$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for northwest New Mexico.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations 0.85

For formations deeper than Pictured Cliffs 0.75

(Note: Special rules for any specific pool or formation may supersede the above values. Check special rules if in doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field

test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the northwest New Mexico Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown

in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN NON-PRORATED POOLS

SECTION 1: Initial Shut-In Pressure Tests for Newly Completed Wells

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-In Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of

these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in

pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of Shut-In Pressure Data

The results of this test will be filed in triplicate on Form C-125 showing the pressure in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

The results of this test shall be filed with the Aztec District Office of the Division on Form C-125

The results of this test shall be reported on the last column of Division Form C-125 showing the pressure in psia and shall be filed in triplicate with the Aztec District Office of the Division.

that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. The filing of shut-in pressures for "exempt" wells is not required.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that

Form C-122A - "Well Deliverability Test Report"

This test is the basis by which gas wells are prorated in the San Juan Basin. This form is to be used for both initial and annual tests conducted in accordance with Order R-333-F-2 as amended, and filed in triplicate with the Aztec office.

Instructions for completing C-122A

A. Test Year

The test year runs from March 1 to the last day of February of the following year. Therefore, annual tests run between January 1 and March 1 cannot be accepted for the current year, except that wells first delivered January 1 or later and tested before March 1 may use the initial test to satisfy the first annual test requirement of the current year.

Initial tests: Initial tests are for the calendar year of first delivery.

B. Enter the name of the pool as separate from the formation.

C. Enter the pool slope as determined by Order R-333-F-2 and subsequent memos.

D. Enter the full formation name.

E. Enter the county in which the well is located.

F. Show complete operator name, well name, well number, and well location.

G. Enter the name of the pipeline that is transporting the gas.

H. Enter mechanical completion information.

I. Enter top and bottom perf. for cased completions, and depth of casing shoe and TD for open holes.

J. Check the appropriate flow stream.

K. Enter gas gravity for latest test. (This information is usually obtained from the pipeline.)

L. Enter the product of (K) and either the top casing perf, or casing shoe depth, or top tubing perf as appropriate.

M. Enter the appropriate test dates. (Note: These dates must correspond to the scheduled test dates. Also, the year in which the test was run might not be the year for which the test is valid.)

N. Enter the instantaneous pressures, corrected to PSIA, measured at the well during the flow and shut-in periods.

O. Calculate meter error and friction loss as shown.

P. Enter average pressure. (Usually supplied by pipeline)

Q. Calculate corrected meter pressure and average wellhead pressure as shown. If the ratio of wellhead pressure to meter pressure is 0.57 or less, critical flow will be considered to exist and the measured wellhead pressure shall be used as the average wellhead pressure and a notation made in the "Remarks" section, unless an intermediate pressure interest in item (n) disproves critical flow.

R. Select highest shut-in pressure and multiply it by appropriate percentage (from R-333-F-2, and subsequent memos) to find Pd.

S. Enter the integrated average daily volume produced during the test and correct for meter error as shown.

T. Calculate working pressure using tables and equations from "Method of Calculating Pressure Loss Due to Friction in Gas Well Strings". (If $R^2 \leq P_t$ friction loss is neglible and $Pw = P_t$.)

U. Calculate "D" as shown.

V. Use remarks section for the following:

1. Critical flow notations
2. Commingled well allocations
3. Delinquent test
4. Initial Test
5. Other information which is pertinent

W. Enter summary of data.

X. Show company doing the testing and person(s) responsible.

OIL CONSERVATION DIVISION

P. O. BOX 2088

SANTA FE, NEW MEXICO 87501

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

Form C-122-A
Revised 10-1-78

WELL DELIVERABILITY TEST REPORT FOR 19 ____

POOL NAME	POOL CODE	FORMATION	COUNTY
	n =		

COMPANY			WELL NAME AND NUMBER		
UNIT LETTER	SECTION	TOWNSHIP	RANGE	PURCHASING PIPELINE	
CASING O.D. - INCHES	CASING I.D. - INCHES	SET AT DEPTH - FEET	TUBING O.D. - INCHES	TUBING I.D. - INCHES	TBP - TUBING PERF. - FEET
GAS PAY ZONE: FROM	TO	CASING	PRODUCING THRU: TUBING	GAS GRAVITY	GRAVITY & DEGREE
DATE OF FLOW TEST: FROM	TO		DATE SHUT-IN PRESSURE MEASURED		

PRESSURE DATA — ALL PRESSURES IN PSIA

(a) Flowing Casing Pressure (DWt)	(b) Flowing Tubing Pressure (DWt)	(c) Flowing Meter Pressure (DWt)	(d) Flow Chart Static Reading	(e) Meter Error (Item c − Item d)	(f) Friction Loss (a − c) or (b − c)	(g) Average Meter Pressure (Integ.)
(h) Corrected Meter Pressure (g + e)	(i) Avg. Wellhead Press. P_t = (b + f)	(j) Shut-in Casing Pressure (DWt)	(k) Shut-in Tubing Pressure (DWt)	(l) P_c = higher value of (j) or (k)	(m) Del. Pressure P_d = ____ %P_c	(n) Separator or Dehydrator Pr. (DWt) for natural flow only

FLOW RATE CORRECTION (METER ERROR)

Integrated Volume — MCF/D	Quotient of $\frac{\text{Item e}}{\text{Item d}}$	$\sqrt{\frac{\text{Item e}}{\text{Item d}}}$	Corrected Volume
			Q = MCF/D

WORKING PRESSURE CALCULATION

$(1-e^{-s})$	$(F_c Q_m)^2$ (1000)	$R^2 = (1-e^{-s})(F_c Q_m)^2(1000)$	P_s^2	$P_w^2 = P_t^2 + R^2$	$P_w = \sqrt{P_w^2}$

DELIVERABILITY CALCULATION

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = ____ \left[\left(\quad\right)^n \left(\quad\right)^n = ____\right] = ____ \text{ MCF/D}$$

REMARKS:

SUMMARY

Item h	Psia	Company
P_c	Psia	By
Q	MCF/D	Title
P_w	Psia	Witnessed By
P_d	Psia	Company
D	MCF/D	

GAS WELL TESTING MANUAL FOR SAN JUAN BASIN, NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in the San Juan Basin, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the

August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this

testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow

period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to

"HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60°F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^0 F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells

in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \frac{(P_c^2 - P_d^2)^n}{(P_c^2 - P_w^2)}$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for San Juan Basin.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations	0.85
For formations deeper than Pictured Cliffs	0.75

(Note: Special Rules for Any Specific Pool or Formation May Supersede The Above Values. Check Special Rules If In Doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and

deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the San Juan Basin Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV Type of Tests Required for Wells Completed in Non-Prorated Pools

SECTION 1: Initial Shut-in Pressure Tests for newly Completed Wells.

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-in Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of shut-in Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

END OF THIS PROPOSED MANUAL FOR TESTING IN SJB 6/14/85

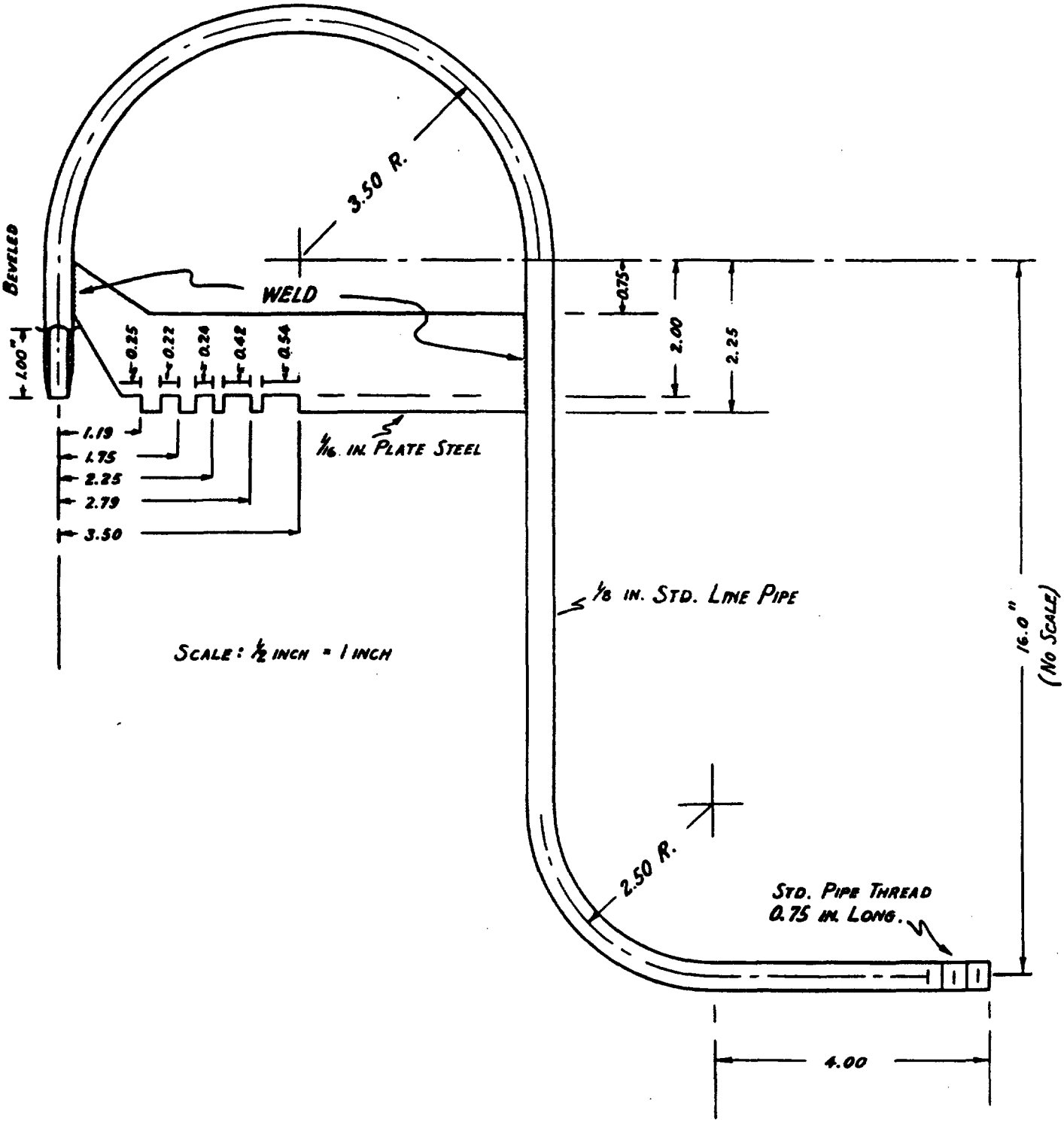


PLATE I

STANDARD PITOT TUBE

APPROVED BY NEW MEXICO OIL CONSERVATION COMMISSION

TABLE I

VOLUMES FOR PITOT TUBES

(Based on Ried's Formulas, M.C.F./24 hrs.)
Bases: 15.025 psia; 60°F; .65 sp. Gravity, Bar. pressure at wellhead 12.0 psia.

IMPACT PRESSURE			DIAMETER OF PIPE, IN. I.D.					
Inches of Water	Inches of Mercury	Lbs. per Sq. In.	1.0"	2.0"	3.0"	4.0"	5.0"	6.0"
.1			9.3	37.2	83.7	148.8	232.5	334.8
.2			13.1	52.4	117.9	209.6	327.5	471.6
.3			16.1	64.4	144.9	257.6	402.5	579.6
.4			18.6	74.4	167.4	297.6	465.0	669.6
.5			20.8	83.2	187.2	332.8	520.0	748.8
.6			22.8	91.2	205.2	364.8	570.0	820.8
.7			24.6	98.4	221.4	393.6	615.0	885.6
.8			26.3	105.2	236.7	420.3	657.5	946.8
.9			27.9	111.6	251.1	446.4	697.5	1004.4
1.0			29.4	117.6	264.6	470.4	735.0	1058.4
1.1			30.9	123.6	278.1	494.4	772.5	1112.4
1.2			32.3	129.2	290.7	516.8	807.5	1162.8
1.3			33.5	134.0	301.5	536.0	837.5	1206.0
1.4			34.8	139.2	313.2	556.8	870.0	1252.8
1.5			36.0	144.0	324.0	576.0	900.0	1296.0
1.6	.12		37.2	148.8	334.8	595.2	930.0	1339.2
1.7			38.4	153.6	345.6	614.4	960.0	1382.4
1.8	.13		39.5	158.0	355.5	632.0	987.5	1422.0
1.9			40.6	162.4	365.4	649.6	1015.0	1461.6
2.0	.15		41.7	166.8	375.3	667.2	1042.5	1501.2
2.2	.16		43.7	174.8	393.3	699.2	1092.5	1573.2
2.4	.18		45.6	182.4	410.4	729.6	1140.0	1641.6
2.6			47.5	190.0	427.5	760.0	1187.5	1710.0
2.8			49.3	197.2	443.7	788.8	1232.5	1774.8
3.0	.22		51.0	204.0	459.0	816.0	1275.0	1836.0
3.2	.24		53.6	214.4	482.4	857.6	1340.0	1929.6
3.4			54.3	217.2	488.7	868.8	1357.5	1954.8
3.6			55.9	223.6	503.1	894.4	1397.5	[illegible]
3.8	.28		57.4	229.6	516.6	918.4	1435.0	2066.4
4.0	.30		58.9	235.6	530.1	942.4	1472.5	2120.4
4.2			60.3	241.2	542.7	964.8	1507.5	2170.3
4.4			61.8	247.2	556.2	988.8	1545.0	2224.8
4.6			62.4	249.6	561.6	998.4	1560.0	2246.4
4.8	.36		63.2	252.8	568.8	1011.2	1580.0	2275.2
5.0			65.9	263.6	593.1	1054.4	1647.5	2372.4
5.5			68.4	273.6	615.6	1094.4	1710.0	2462.4
6.0	.44		71.4	285.6	642.6	1142.4	1785.0	2570.4
6.5			74.4	297.6	669.6	1190.4	1860.0	2678.4
7.0	.51		77.2	308.8	694.8	1235.2	1930.0	2779.2
7.5			80.7	322.8	726.3	1291.2	2017.5	2905.2
8.0	.58		82.8	331.2	745.2	1324.8	2070.0	2980.8
8.5			85.9	343.6	773.1	1374.4	2147.5	3092.4
9.0	.66		88.4	353.6	795.6	1414.4	2210.0	3182.4
9.5			90.7	362.8	816.3	1451.2	2267.5	3265.2
10.0	.74		93.1	372.4	837.9	1489.6	2327.5	3351.6

TABLE I (Continued)

VOLUMES FOR PITOT TUBES

IMPACT PRESSURE Inches of Water	Inches of Mercury	Lbs. per Sq. In.	DIAMETER OF PIPE, IN. I.D. 1.0"	2.0"	3.0"	4.0"	5.0"	6.0"
10.5			95.4	381.6	858.6	1526.4	2385.0	3434.4
11.0			97.8	391.2	880.2	1564.8	2445.0	3520.8
11.5	.85		99.7	398.8	897.3	1595.2	2492.5	3589.2
12.0	.88		101.0	404.0	909.0	1616.0	2525.0	3636.0
12.5			104.3	417.2	938.7	1668.8	2607.5	3754.8
13.0			106.6	426.4	959.4	1705.6	2665.0	3837.6
13.5			107.1	428.4	963.9	1713.6	2677.5	3855.6
13.59	1.0	.5	108.4	433.6	975.6	1734.4	2710.0	3902.4
14.0			110.1	440.4	990.9	1761.6	2752.5	3963.6
14.5			112.0	448.0	1008.0	1792.0	2800.0	4032.0
15.0			114.0	456.0	1026.0	1824.0	2850.0	4104.0
15.5			116.0	464.0	1044.0	1856.0	2900.0	4176.0
16.0			117.8	471.2	1060.2	1884.8	2945.0	4240.8
16.3	1.2		118.9	475.6	1070.1	1902.4	2972.5	4280.4
16.5			119.5	478.0	1075.5	1912.0	2987.5	4302.0
17.0			121.5	486.0	1093.5	1944.0	3037.5	4374.0
17.5			123.1	492.4	1107.9	1969.6	3077.5	4431.6
18.0			124.8	499.2	1123.2	1996.8	3120.0	4492.8
18.5			126.6	506.4	1139.4	2025.6	3163.0	4557.6
19.0			128.4	513.6	1155.6	2054.4	3210.0	4622.4
19.2	1.4		128.9	515.6	1160.1	2062.4	3222.5	4640.4
19.5			130.1	520.4	1170.9	2081.6	3252.5	4683.6
20.0			131.6	526.4	1184.4	2105.6	3290.0	4737.6
21.0			134.8	539.2	1213.2	2156.8	3370.0	4852.8
21.7			137.2	548.8	1234.8	2195.2	3430.0	4939.2
22.0			138.1	552.4	1242.9	2209.6	3452.5	4971.6
23.0			141.3	565.2	1271.7	2260.8	3532.5	5086.8
24.0			144.3	577.2	1298.7	2308.8	3607.5	5194.8
24.46	1.8		145.4	581.6	1308.6	2326.4	3635.0	5234.4
25.0			147.2	588.8	1324.8	2355.2	3680.0	5299.2
26.0			150.1	600.4	1350.9	2401.6	3752.5	5403.6
27.0			153.1	612.4	1377.9	2449.6	3827.5	5511.6
27.18	2.0	1.00	153.7	614.8	1383.2	2459.2	3842.5	5533.2
28.0			155.8	623.2	1402.2	2492.8	3895.0	5608.8
29.0			158.4	633.6	1425.6	2534.4	3960.0	5702.4
29.89	2.2		160.8	643.2	1447.2	2572.8	4020.0	5788.8
30.			161.4	645.6	1452.6	2582.4	4035.0	5810.4
32.0			166.7	666.8	1500.3	2667.2	4167.5	6001.2
32.6	2.4		168.2	672.8	1513.8	2691.2	4205.0	6055.2
34.0			171.7	686.8	1545.3	2747.2	4292.5	6181.2
35.33	2.6		174.9	699.6	1574.1	2798.4	4272.5	6296.4
36.0			176.7	706.8	1590.3	2827.2	4417.5	6361.2
38.0	2.8		181.4	725.6	1632.6	2902.4	4535.0	6530.4
40.0			186.3	745.2	1676.7	2980.8	4657.5	6706.8
40.77	3.0	1.5	187.9	751.6	1691.1	3006.4	4697.5	6764.4
42.0			190.8	763.2	1717.2	3052.8	4770.0	6868.8
43.48	3.2		194.1	776.4	1746.9	3105.6	4852.5	6987.6

TABLE IV

MULTIPLIERS FOR SPECIFIC GRAVITY

.65 Base

SPECIFIC GRAVITY	FACTOR	SPECIFIC GRAVITY	FACTOR
0.500	1.1400	0.665	.9885
0.505	1.1344	0.670	.9849
0.510	1.1289	0.675	.9811
0.515	1.1234	0.680	.9776
0.520	1.1180	0.685	.9740
0.525	1.1126	0.690	.9705
0.530	1.1074	0.695	.9671
0.535	1.1022	0.700	.9636
0.540	1.0971	0.705	.9601
0.545	1.0920	0.710	.9568
0.550	1.0871	0.715	.9535
0.555	1.0822	0.720	.9501
0.560	1.0773	0.725	.9463
0.565	1.0724	0.730	.9436
0.570	1.0678	0.735	.9403
0.575	1.0631	0.740	.9372
0.580	1.0585	0.745	.9340
0.585	1.0540	0.750	.9308
0.590	1.0495	0.755	.9277
0.595	1.0450	0.760	.9247
0.600	1.0408	0.765	.9217
0.605	1.0364	0.770	.9187
0.610	1.0322	0.775	.9151
0.615	1.0279	0.780	.9128
0.620	1.0238	0.785	.9099
0.625	1.0197	0.790	.9070
0.630	1.0157	0.795	.9041
0.635	1.0117	0.800	.9013
0.640	1.0077	0.805	.8987
0.645	1.0030	0.810	.8958
0.650	1.0000	0.815	.8930
0.655	.9961	0.820	.8903
0.660	.9924	0.825	.8875

TEST EXAMPLE NO. 7

CALCULATION OF SUBSURFACE PRESSURE P_f (sandface) WHERE THE WELLHEAD SHUT-IN PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE

When the height of a liquid column in the wellbore and the specific gravity of the liquid are known, the reservoir pressure may be calculated by making the normal static column calculations to determine the pressure at the gas-liquid interface and adding the pressure exerted by the liquid column above the desired datum plane.

Using the results obtained in this example, an equivalent wellhead pressure may be calculated in accordance with the procedures in example 5 or 6.

In this example, the depth "H" and "L" and pressure "P_f" will refer to the gas-liquid interface rather than at the datum plane. This pressure may be calculated by either the average temperature and compressibility factor method or the stepwise procedure.

The additional pressure to be added to the calculated pressure at the gas-liquid interface "P_f" is determined as follows:

Height of liquid column (ft.) x Sp. gr. (water = 1.00) x .433 = pressure psi.

A. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE
(Using Average Temperature and Compressibility Factors)

Given: Shut-in wellhead pressure of 1878 psia, H = 8130 ft., L = 8130 ft., L/H = 1.00, gas gravity = 0.641, CO_2 = 2.0%, N_2 = 3.0%, wellhead temperature = 74 F, and 1000 ft. of liquid having a specific gravity of 0.74.

STEP 1. Begin calculation of pressure at the gas-liquid interface.

a. Enter well information as shown at top of Form C-122-G.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for carbon dioxide = 2.0 percent, and nitrogen = 3.0 percent from Table X.
Correct P_{cr} and T_{cr} as follows:
$P_{cr} = 670 + 8 - 5 = 673$
$T_{cr} = 372 - 3 - 9 = 360$
(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Determine H for the well and calculate L/H. In most gas wells L/H is unity as H is equal to L. However, L/H is greater than unity for directionally drilled wells. In this example, both L and H are 8130 ft., and L/H is 1.000.

d. GH = 0.641 x 8130 = 5211.

STEP 2.

a. Enter "0" rate of flow on Line 1. (Line references are indicated in parenthesis following each step.)

b. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 2).
T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 3).
The bottom-hole temperature should be measured or estimated from reliable data on other wells in the area.

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ R (Line 4).

STEP 3. (First Trial)
Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 5).

STEP 4.

a. $TZ = 575 \times 0.860 = 495$ (Line 6).

b. $GH/TZ = 5211/(495) = 10.527$ (Line 7).

c. For GH/TZ = 10.527 read e^s in Table XIV. $e^s = 1.484$ (Line 8).

STEP 5.

a. Enter wellhead shut-in pressure (P_c) = 1878 (Line 10).

b. $P_c^2 = (1878)^2/1000 = 3526.9$ (Line 11).

c. $e^s P_c^2 = (1.484)\ (3526.9) = 5233.9$ (Line 18).

STEP 6.
Lines 12 through 17 are not used in the static column calculation.

STEP 7.

a. $P_f = e^s P_c^2 = 5233.9\ (1000) = 2288$ (Line 19).

b. $P = (P_c + P_f)/2 = (1878 + 2288)/2 = 2083$ (Line 20).

c. $P_r = P/P_{cr} = 2083/673 = 3.10$ (Line 21).

d. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 22).

STEP 8.
Enter in Line 23 the compressibility factor from Table XI corresponding to a P_r of 3.10 and a T_r of 1.60. In this example, Z = 0.822 (Line 23).

STEP 9.

Since Z (Line 23) is not equal to Z (Line 5), enter Z = 0.822 on Line 5, 2nd Trial, and repeat Steps 4 through 8.

STEP 10.

Since the final value of Z (Line 23, 2nd Trial) is equal to the assumed value of Z (Line 5, 2nd Trial), the value of $e^s P_c^2 = P_f^2 = 5332.7$ and $P_f = 2309$.

STEP 11.

Now calculate the pressure exerted by the liquid column.

a. 1000' x 0.74 x 0.433 = 320.4 psi.

STEP 12.

Calculate pressure at datum by adding 2309 psia (P_f) and 320.4 psi (pressure of liquid column).

a. 2309 + 320.4 = 2629.4 psia at the sandface. This is the P_f which should be used in calculating a wellhead pressure in accordance with the procedures in example 5 or 6.

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE H. I. Test WELL NO. 2 DATE 10-1-64

L 8130 H 8130 L/H 1.00 G 0.641 % CO_2 2.0% % N_2 3.0% % H_2S --

d _____ F_r _____ GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		Trial 1	Trial 2								
1	Q_m	0	0								
2	T_w (W.H. °R)	534									
3	T_s (BH °R)	615 R									
4	$T = (\frac{T_w + T_s}{2})$	575 R									
5	Z (Est.)	0.860	0.822								
6	TZ	495	473								
7	GH/TZ	10.527	11.017								
8	e^s (Table XIV)	1.484	1.512								
9	$1 - e^{-s}$ (Table XIV)										
10	P_c	1878	1878								
11	P_c^2	3526.9	3526.9								
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$	5233.9	5332.7								
19	P_f	2288	2309								
20	$P = (\frac{P_c + P_f}{2})$	2083	2094								
21	$F_r = \frac{P}{P_{cr}}$	3.10	3.11								
22	$T_r = \frac{T}{T_{cr}}$	1.60	1.60								
23	Z (Table XI)	0.822	0.822								

One copy to be filed in District Office (Work acceptable)

TEST EXAMPLE NO. 5

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE
(Using Average Temperature and Pressure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing cases (P_w). Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	N_2	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\, G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_l = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B, page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

G = 0.641

STEP 2.

a. Enter well information at the top of Form C-122-D.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Calculate L/H, the length of the flow string divided by the vertical depth.

$$L/H = 1.000$$

d. GH = 0.641 x 8130 = 5211

STEP 3.

a. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 1)

b. T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 2)

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ (Line 3)

STEP 4.

Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 4)

STEP 5.

a. TZ = 575 x 0.860 = 495 (Line 5)

b. GH/TZ = 5211/495 = 10.527 (Line 6)

c. For GH/TZ = 10.527 read e^s in Table XIV. e^s = 1.484 (Line 7)

STEP 6.

a. Enter reservoir pressure (P_f) = 2309 (Line 8)

b. $P_f^2 = (2309)^2/1000 = 5331.5$ (Line 9)

c. $P_c^2 = P_f^2/e^s = 5331.5/1.484 = 3592.7$ (Line 10)

d. $P_c = \sqrt{3592.7} = 1895$ (Line 11)

STEP 7.

a. $P = (P_c + P_f)/2 = (1895 + 2309)/2 = 2102$ (Line 12)

b. $P_r = 2102/673 = 3.12$ (Line 13)

c. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 14)

STEP 8.

Enter in Line 15 the compressibility factor from Table XI corresponding to a P_r of 3.12 and a T_r of 1.60. In this example, Z = 0.822 (Line 15).

STEP 9.

Since Z (Line 15) is not equal to Z (Line 4), enter Z = 0.822 on Line 4, 2nd Trial and repeat Steps 5 through 8.

STEP 10.

Since the final value of Z (Line 15, 2nd Trial) is equal to the assumed value of Z (Line 4, 2nd Trial), the value of P_c = 1878 (Line 11, 2nd Trial) is used in the back-pressure computations.

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or ~~P_w~~)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or ~~P_s~~)

Form C-122F
Adopted 9-1-65

COMPANY Test Example 5 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S -

GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		1st Trial 1	2nd Trial 2	3	4	5	6	7	8
1	T_w(W.H. °R)	534	534						
2	T_s(B.H. °R)	615	615						
3	$T=(\frac{T_w + T_s}{2})$	575	575						
4	Z (Est.)	0.860	0.822						
5	TZ	495	473						
6	GH/TZ	10.527	11.017						
7	e^s(Table XIV)	1.484	1.512						
8	P_f or P_s	2309	2309						
9	P_f^2 or ~~P_s^2~~	5331.5	5331.5						
10	$P_c^2 = P_f^2/e^s$ or ~~$P_w^2 = P_s^2/e^s$~~	3592.7	3526.1						
11	P_c or ~~P_w~~	1895	1878						
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$	2102	2094						
13	$P_r = (P/P_{cr})$	3.12	3.11						
14	$T_r = (T/T_{cr})$	1.60	1.60						
15	Z (Table XI)	0.822	0.822						

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or P_s)

Form C-122F
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

GH _____ P_{ct} _____ (TABLE IX & X) T_{ct} _____ (TABLE IX & X)

LINE		1	2	3	4	5	6	7	8
1	T_w(W.H. °R)								
2	T_s(B.H. °R)								
3	$T=(\frac{T_w + T_s}{2})$								
4	Z (Est.)								
5	TZ								
6	GH/TZ								
7	e^s(Table XIV)								
8	P_f or P_s								
9	P_f^2 or P_s^2								
10	$P_c^2 = P_f^2/e^s$ or $P_w^2 = P_s^2/e^s$								
11	P_c or P_w								
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$								
13	$P_r = (P/P_{cr})$								
14	$T_r = (T/T_{cr})$								
15	Z (Table XI)								

One copy to be filed in District Office (Work copy acceptable)

WORKSHEET FOR CALCULATION OF STATIC _UMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE											
1	Q_m										
2	T_w (W.H. °R)										
3	T_s (BH °R)										
4	$T = (\frac{T_w + T_s}{2})$										
5	Z (Est.)										
6	TZ										
7	GH/TZ										
8	e^s (Table XIV)										
9	$1 - e^{-s}$ (Table XIV)										
10	P_c										
11	P_c^2										
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_t^2 = e^s P_c^2$										
19	P_t										
20	$P = (\frac{P_c + P_t}{2})$										
21	$P_r = \frac{P}{P_{cr}}$										
22	$T_r = \frac{1}{T_{cr}}$										
23	Z (Table XI)										

One copy to be filed in District Office (Work copy acceptable)

STATE OF NEW MEXICO

ENERGY AND MINERALS DEPARTMENT

NEW MEXICO OIL CONSERVATION DIVISION

GAS WELL TEST MANUAL

SAN JUAN BASIN AREA

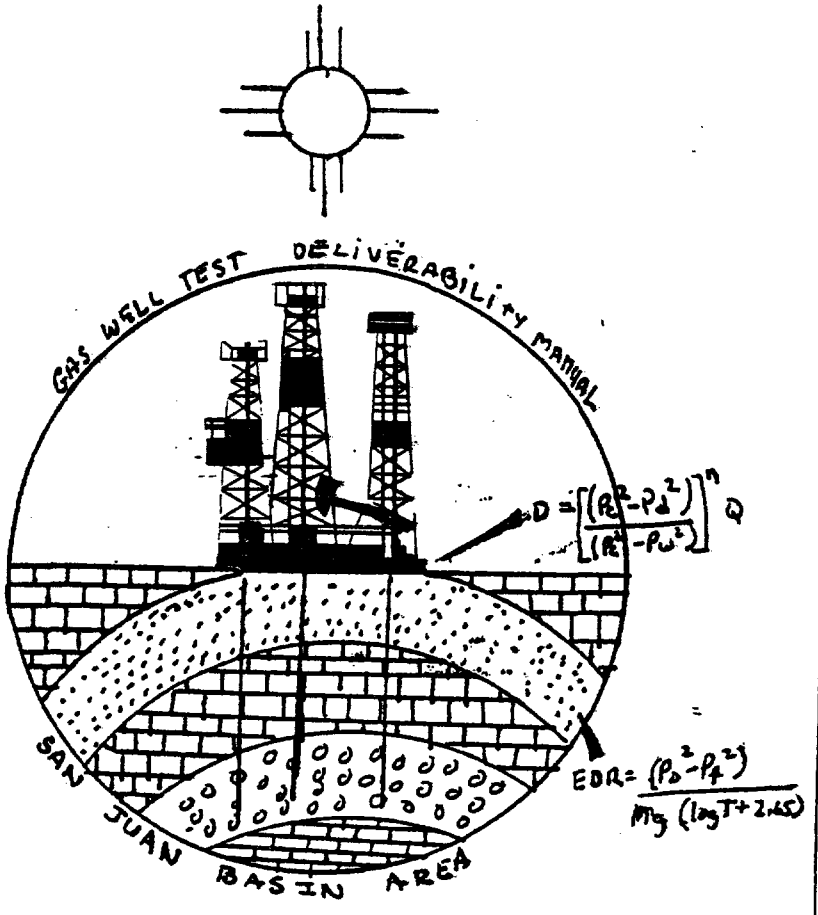
R. L. STAMETS, DIVISION DIRECTOR

AUGUST, 1985

STATE OF NEW MEXICO

Energy And Minerals Department

New Mexico Oil and Conservation Division



AUGUST, 1986

R. L. STAMENTS

GAS WELL TESTING MANUAL FOR SAN JUAN BASIN, NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in the San Juan Basin, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the

August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. "Exempt" wells do not require the filing of a shut-in pressure.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost prorated completion of well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this

testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow

period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and write "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to

"HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60^{o}F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' \{h_w P_f\}^{1/2}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^0 F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells

in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \frac{(P_c^2 - P_d^2)^n}{(P_c^2 - P_w^2)}$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for San Juan Basin.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations	0.85
For formations deeper than Pictured Cliffs	0.75

(Note: Special Rules for Any Specific Pool or Formation May Supersede The Above Values. Check Special Rules If In Doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and

deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the San Juan Basin Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV Type of Tests Required for Wells Completed in Non-Prorated Pools

SECTION 1: Initial Shut-in Pressure Tests for newly Completed Wells.

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-in Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of shut-in Pressure Data

The results of this test will be filed in triplicate on Form C-125-B showing the pressures in psia in column labeled "S. I. PRESSURE PSIA (DWT)" with the Aztec District Office.

END OF THIS PROPOSED MANUAL FOR TESTING IN SJB 6/14/85

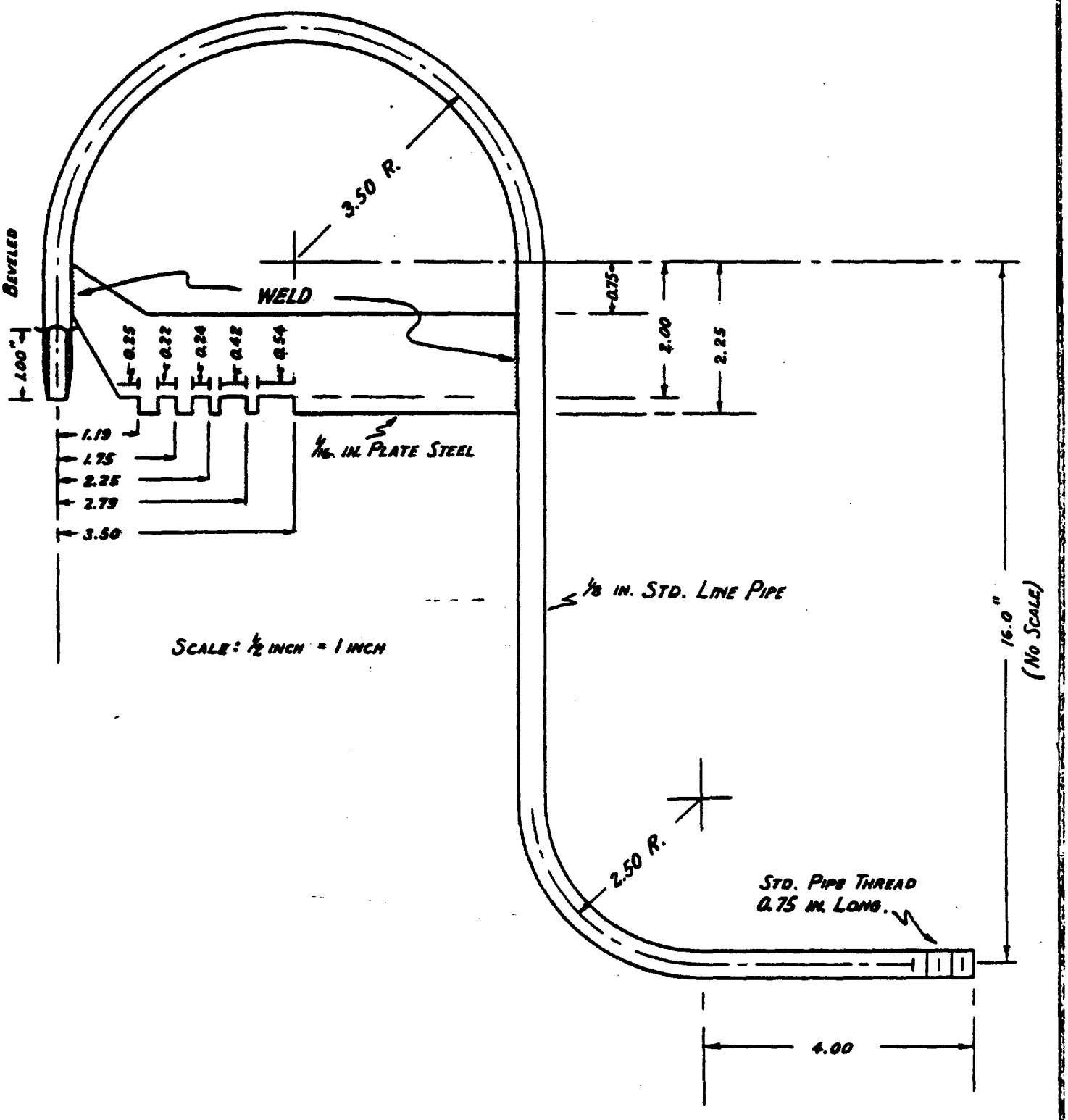


PLATE I

STANDARD PITOT TUBE

APPROVED BY NEW MEXICO OIL CONSERVATION COMMISSION

TABLE I

VOLUMES FOR PITOT TUBES

(Based on Ried's Formulas, M.C.F./24 hrs.)

Bases: 15.025 psia; 60°F; .65 sp. Gravity, Bar. pressure at wellhead 12.0 psia.

IMPACT PRESSURE			DIAMETER OF PIPE, IN. I.D.					
Inches of Water	Inches of Mercury	Lbs. per Sq. In.	1.0"	2.0"	3.0"	4.0"	5.0"	6.0"
.1			9.3	37.2	83.7	148.8	232.5	334.8
.2			13.1	52.4	117.9	209.6	327.5	471.6
.3			16.1	64.4	144.9	257.6	402.5	579.6
.4			18.6	74.4	167.4	297.6	465.0	669.6
.5			20.8	83.2	187.2	332.8	520.0	748.8
.6			22.8	91.2	205.2	364.8	570.0	820.8
.7			24.6	98.4	221.4	393.6	615.0	885.6
.8			26.3	105.2	236.7	420.3	657.5	946.8
.9			27.9	111.6	251.1	446.4	697.5	1004.4
1.0			29.4	117.6	264.6	470.4	735.0	1058.4
1.1			30.9	123.6	278.1	494.4	772.5	1112.4
1.2			32.3	129.2	290.7	516.8	807.5	1162.8
1.3			33.5	134.0	301.5	536.0	837.5	1206.0
1.4			34.8	139.2	313.2	556.8	870.0	1252.8
1.5			36.0	144.0	324.0	576.0	900.0	1296.0
1.6	.12		37.2	148.8	334.8	595.2	930.0	1339.2
1.7			38.4	153.6	345.6	614.4	960.0	1382.4
1.8	.13		39.5	158.0	355.5	632.0	987.5	1422.0
1.9			40.6	162.4	365.4	649.6	1015.0	1461.6
2.0	.15		41.7	166.8	375.3	667.2	1042.5	1501.2
2.2	.16		43.7	174.8	393.3	699.2	1092.5	1573.2
2.4	.18		45.6	182.4	410.4	729.6	1140.0	1641.6
2.6			47.5	190.0	427.5	760.0	1187.5	1710.0
2.8			49.3	197.2	443.7	788.8	1232.5	1774.8
3.0	.22		51.0	204.0	459.0	816.0	1275.0	1836.0
3.2	.24		53.6	214.4	482.4	857.6	1340.0	1929.6
3.4			54.3	217.2	488.7	868.8	1357.5	1954.8
3.6			55.9	223.6	503.1	894.4	1397.5	2012.6 ?
3.8	.28		57.4	229.6	516.6	918.4	1435.0	2066.4
4.0	.30		58.9	235.6	530.1	942.4	1472.5	2120.4
4.2			60.3	241.2	542.7	964.8	1507.5	2170.3
4.4			61.8	247.2	556.2	988.8	1545.0	2224.8
4.6			62.4	249.6	561.6	998.4	1560.0	2246.4
4.8	.36		63.2	252.8	568.8	1011.2	1580.0	2275.2
5.0			65.9	263.6	593.1	1054.4	1647.5	2372.4
5.5			68.4	273.6	615.6	1094.4	1710.0	2462.4
6.0	.44		71.4	285.6	642.6	1142.4	1785.0	2570.4
6.5			74.4	297.6	669.6	1190.4	1860.0	2678.4
7.0	.51		77.2	308.8	694.8	1235.2	1930.0	2779.2
7.5			80.7	322.8	726.3	1291.2	2017.5	2905.2
8.0	.58		82.8	331.2	745.2	1324.8	2070.0	2980.8
8.5			85.9	343.6	773.1	1374.4	2147.5	3092.4
9.0	.66		88.4	353.6	795.6	1414.4	2210.0	3182.4
9.5			90.7	362.8	816.3	1451.2	2267.5	3265.2
10.0	.74		93.1	372.4	837.9	1489.6	2327.5	3351.6

TABLE I (Continued)

VOLUMES FOR PITOT TUBES

IMPACT PRESSURE			DIAMETER OF PIPE, IN. I.D.					
Inches of Water	Inches of Mercury	Lbs. per Sq. In.	1.0"	2.0"	3.0"	4.0"	5.0"	6.0"
10.5			95.4	381.6	858.6	1526.4	2385.0	3434.4
11.0			97.8	391.2	880.2	1564.8	2445.0	3520.8
11.5	.85		99.7	398.8	897.3	1595.2	2492.5	3589.2
12.0	.88		101.0	404.0	909.0	1616.0	2525.0	3636.0
12.5			104.3	417.2	938.7	1668.8	2607.5	3754.8
13.0			106.6	426.4	959.4	1705.6	2665.0	3837.6
13.5			107.1	428.4	963.9	1713.6	2677.5	3855.6
13.59	1.0	.5	108.4	433.6	975.6	1734.4	2710.0	3902.4
14.0			110.1	440.4	990.9	1761.6	2752.5	3963.6
14.5			112.0	448.0	1008.0	1792.0	2800.0	4032.0
15.0			114.0	456.0	1026.0	1824.0	2850.0	4104.0
15.5			116.0	464.0	1044.0	1856.0	2900.0	4176.0
16.0			117.8	471.2	1060.2	1884.8	2945.0	4240.8
16.3	1.2		118.9	475.6	1070.1	1902.4	2972.5	4280.4
16.5			119.5	478.0	1075.5	1912.0	2987.5	4302.0
17.0			121.5	486.0	1093.5	1944.0	3037.5	4374.0
17.5			123.1	492.4	1107.9	1969.6	3077.5	4431.6
18.0			124.8	499.2	1123.2	1996.8	3120.0	4492.8
18.5			126.6	506.4	1139.4	2025.6	3163.0	4557.6
19.0			128.4	513.6	1155.6	2054.4	3210.0	4622.4
19.2	1.4		128.9	515.6	1160.1	2062.4	3222.5	4640.4
19.5			130.1	520.4	1170.9	2081.6	3252.5	4683.6
20.0			131.6	526.4	1184.4	2105.6	3290.0	4737.6
21.0			134.8	539.2	1213.2	2156.8	3370.0	4852.8
21.7			137.2	548.8	1234.8	2195.2	3430.0	4939.2
22.0			138.1	552.4	1242.9	2209.6	3452.5	4971.6
23.0			141.3	565.2	1271.7	2260.8	3532.5	5086.8
24.0			144.3	577.2	1298.7	2308.8	3607.5	5194.8
24.46	1.8		145.4	581.6	1308.6	2326.4	3635.0	5234.4
25.0			147.2	588.8	1324.8	2355.2	3680.0	5299.2
26.0			150.1	600.4	1350.9	2401.6	3752.5	5403.6
27.0			153.1	612.4	1377.9	2449.6	3827.5	5511.6
27.18	2.0	1.00	153.7	614.8	1383.2	2459.2	3842.5	5533.2
28.0			155.8	623.2	1402.2	2492.8	3895.0	5608.8
29.0			158.4	633.6	1425.6	2534.4	3960.0	5702.4
29.89	2.2		160.8	643.2	1447.2	2572.8	4020.0	5788.8
30.			161.4	645.6	1452.6	2582.4	4035.0	5810.4
32.0			166.7	666.8	1500.3	2667.2	4167.5	6001.2
32.6	2.4		168.2	672.8	1513.8	2691.2	4205.0	6055.2
34.0			171.7	686.8	1545.3	2747.2	4292.5	6181.2
35.33	2.6		174.9	699.6	1574.1	2798.4	4272.5	6296.4
36.0			176.7	706.8	1590.3	2827.2	4417.5	6361.2
38.0	2.8		181.4	725.6	1632.6	2902.4	4535.0	6530.4
40.0			186.3	745.2	1676.7	2980.8	4657.5	6706.8
40.77	3.0	1.5	187.9	751.6	1691.1	3006.4	4697.5	6764.4
42.0			190.8	763.2	1717.2	3052.8	4770.0	6868.8
43.48	3.2		194.1	776.4	1746.9	3105.6	4852.5	6987.6

TABLE IV

MULTIPLIERS FOR SPECIFIC GRAVITY

.65 Base

SPECIFIC GRAVITY	FACTOR	SPECIFIC GRAVITY	FACTOR
0.500	1.1400	0.665	.9885
0.505	1.1344	0.670	.9849
0.510	1.1289	0.675	.9811
0.515	1.1234	0.680	.9776
0.520	1.1180	0.685	.9740
0.525	1.1126	0.690	.9705
0.530	1.1074	0.695	.9671
0.535	1.1022	0.700	.9636
0.540	1.0971	0.705	.9601
0.545	1.0920	0.710	.9568
0.550	1.0871	0.715	.9535
0.555	1.0822	0.720	.9501
0.560	1.0773	0.725	.9463
0.565	1.0724	0.730	.9436
0.570	1.0678	0.735	.9403
0.575	1.0631	0.740	.9372
0.580	1.0585	0.745	.9340
0.585	1.0540	0.750	.9308
0.590	1.0495	0.755	.9277
0.595	1.0450	0.760	.9247
0.600	1.0408	0.765	.9217
0.605	1.0364	0.770	.9187
0.610	1.0322	0.775	.9151
0.615	1.0279	0.780	.9128
0.620	1.0238	0.785	.9099
0.625	1.0197	0.790	.9070
0.630	1.0157	0.795	.9041
0.635	1.0117	0.800	.9013
0.640	1.0077	0.805	.8987
0.645	1.0030	0.810	.8958
0.650	1.0000	0.815	.8930
0.655	.9961	0.820	.8903
0.660	.9924	0.825	.8875

TEST EXAMPLE NO. 7

CALCULATION OF SUBSURFACE PRESSURE P_f (sandface) WHERE THE WELLHEAD SHUT-IN PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE

When the height of a liquid column in the wellbore and the specific gravity of the liquid are known, the reservoir pressure may be calculated by making the normal static column calculations to determine the pressure at the gas-liquid interface and adding the pressure exerted by the liquid column above the desired datum plane.

Using the results obtained in this example, an equivalent wellhead pressure may be calculated in accordance with the procedures in example 5 or 6.

In this example, the depth "H" and "L" and pressure "P_f" will refer to the gas-liquid interface rather than at the datum plane. This pressure may be calculated by either the average temperature and compressibility factor method or the stepwise procedure.

The additional pressure to be added to the calculated pressure at the gas-liquid interface "P_f" is determined as follows:

Height of liquid column (ft.) x Sp. gr. (water = 1.00) x .433 = pressure psi.

A. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE
(Using Average Temperature and Compressibility Factors)

Given: Shut-in wellhead pressure of 1878 psia, H = 8130 ft., L = 8130 ft., L/H = 1.00, gas gravity = 0.641, CO_2 = 2.0%, N_2 = 3.0%, wellhead temperature = 74 F, and 1000 ft. of liquid having a specific gravity of 0.74.

STEP 1. Begin calculation of pressure at the gas-liquid interface.

a. Enter well information as shown at top of Form C-122-G.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for carbon dioxide = 2.0 percent, and nitrogen = 3.0 percent from Table X.
Correct P_{cr} and T_{cr} as follows:

$P_{cr} = 670 + 8 - 5 = 673$

$T_{cr} = 372 - 3 - 9 = 360$

(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Determine H for the well and calculate L/H. In most gas wells L/H is unity as H is equal to L. However, L/H is greater than unity for directionally drilled wells. In this example, both L and H are 8130 ft., and L/H is 1.000.

d. GH = 0.641 x 8130 = 5211.

STEP 2.

a. Enter "0" rate of flow on Line 1. (Line references are indicated in parenthesis following each step.)

b. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 2).
T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 3).
The bottom-hole temperature should be measured or estimated from reliable data on other wells in the area.

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ R (Line 4).

STEP 3. (First Trial)
Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 5).

STEP 4.

a. $TZ = 575 \times 0.860 = 495$ (Line 6).

b. $GH/TZ = 5211/(495) = 10.527$ (Line 7).

c. For $GH/TZ = 10.527$ read e^s in Table XIV. $e^s = 1.484$ (Line 8).

STEP 5.

a. Enter wellhead shut-in pressure (P_c) = 1878 (Line 10).

b. $P_c^2 = (1878)^2/1000 = 3526.9$ (Line 11).

c. $e^s P_c^2 = (1.484)\ (3526.9) = 5233.9$ (Line 18).

STEP 6.
Lines 12 through 17 are not used in the static column calculation.

STEP 7.

a. $P_f = e^s P_c^2 = 5233.9\ (1000) = 2288$ (Line 19).

b. $P = (P_c + P_f)/2 = (1878 + 2288)/2 = 2083$ (Line 20).

c. $P_r = P/P_{cr} = 2083/673 = 3.10$ (Line 21).

d. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 22).

STEP 8.
Enter in Line 23 the compressibility factor from Table XI corresponding to a P_r of 3.10 and a T_r of 1.60. In this example, Z = 0.822 (Line 23).

STEP 9.

Since Z (Line 23) is not equal to Z (Line 5), enter Z = 0.822 on Line 5, 2nd Trial, and repeat Steps 4 through 8.

STEP 10.

Since the final value of Z (Line 23, 2nd Trial) is equal to the assumed value of Z (Line 5, 2nd Trial), the value of $e^s P_c^2 = P_f^2 = 5332.7$ and $P_f = 2309$.

STEP 11.

Now calculate the pressure exerted by the liquid column.

a. 1000' x 0.74 x 0.433 = 320.4 psi.

STEP 12.

Calculate pressure at datum by adding 2309 psia (P_f) and 320.4 psi (pressure of liquid column).

a. 2309 + 320.4 = 2629.4 psia at the sandface. This is the P_f which should be used in calculating a wellhead pressure in accordance with the procedures in example 5 or 6.

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE H. I. Test WELL NO. 2 DATE 10-1-64

L 8130 H 8130 L/H 1.00 G 0.641 % CO_2 2.0% % N_2 3.0% % H_2S --

d _____ F_r _____ GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		Trial 1	Trial 2								
1	Q_m	0	0								
2	T_w (W.H. °R)	534									
3	T_s (BH °R)	615 R									
4	$T = (\frac{T_w + T_s}{2})$	575 R									
5	Z (Est.)	0.860	0.822								
6	TZ	495	473								
7	GH/TZ	10.527	11.017								
8	e^s (Table XIV)	1.484	1.512								
9	$1 - e^{-s}$ (Table XIV)										
10	P_c	1878	1878								
11	P_c^2	3526.9	3526.9								
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$	5233.9	5332.7								
19	P_f	2288	2309								
20	$P = (\frac{P_c + P_f}{2})$	2083	2094								
21	$F_r = \frac{P}{P_{cr}}$	3.10	3.11								
22	$T_r = \frac{T}{T_{cr}}$	1.60	1.60								
23	Z (Table XI)	0.822	0.822								

VI-46

One copy to be filed in District Office (Work acceptable)

TEST EXAMPLE NO. 5

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE
(Using Average Temperature and Pressure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing cases (P_w). Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	$\bar{N}_2$	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\ G_1}{GOR}}{1 + \frac{V_1}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_1 = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_1 = 721 (Appendix B, page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

$$G = 0.641$$

STEP 2.

a. Enter well information at the top of Form C-122-D.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Calculate L/H, the length of the flow string divided by the vertical depth.

$$L/H = 1.000$$

d. GH = 0.641 x 8130 = 5211

STEP 3.

a. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 1)

b. T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 2)

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ (Line 3)

STEP 4.

Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 4)

STEP 5.

a. TZ = 575 x 0.860 = 495 (Line 5)

b. GH/TZ = 5211/495 = 10.527 (Line 6)

c. For GH/TZ = 10.527 read e^S in Table XIV. e^S = 1.484 (Line 7)

STEP 6.

a. Enter reservoir pressure (P_f) = 2309 (Line 8)

b. $P_f^2 = (2309)^2/1000 = 5331.5$ (Line 9)

c. $P_c^2 = P_f^2/e^S = 5331.5/1.484 = 3592.7$ (Line 10)

d. $P_c = \sqrt{3592.7} = 1895$ (Line 11)

STEP 7.

a. $P = (P_c + P_f)/2 = (1895 + 2309)/2 = 2102$ (Line 12)

b. $P_r = 2102/673 = 3.12$ (Line 13)

c. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 14)

STEP 8.

Enter in Line 15 the compressibility factor from Table XI corresponding to a P_r of 3.12 and a T_r of 1.60. In this example, $Z = 0.822$ (Line 15).

STEP 9.

Since Z (Line 15) is not equal to Z (Line 4), enter $Z = 0.822$ on Line 4, 2nd Trial and repeat Steps 5 through 8.

STEP 10.

Since the final value of Z (Line 15, 2nd Trial) is equal to the assumed value of Z (Line 4, 2nd Trial), the value of $P_c = 1878$ (Line 11, 2nd Trial) is used in the back-pressure computations.

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or ~~P_w~~)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or ~~P_s~~)

Form C-122F
Adopted 9-1-65

COMPANY Test Example 5 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S -

GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		1st Trial 1	2nd Trial 2	3	4	5	6	7	8
1	T_w(W.H. °R)	534	534						
2	T_s(B.H. °R)	615	615						
3	$T=(\frac{T_w + T_s}{2})$	575	575						
4	Z (Est.)	0.860	0.822						
5	TZ	495	473						
6	GH/TZ	10.527	11.017						
7	e^s(Table XIV)	1.484	1.512						
8	P_f or P_s	2309	2309						
9	P_f^2 or ~~P_s^2~~	5331.5	5331.5						
10	$P_c^2 = P_f^2/e^s$ or ~~$P_w^2 = P_s^2/e^s$~~	3592.7	3526.1						
11	P_c or ~~P_w~~	1895	1878						
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$	2102	2094						
13	$P_r = (P/P_{cr})$	3.12	3.11						
14	$T_r = (T/T_{cr})$	1.60	1.60						
15	Z (Table XI)	0.822	0.822						

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WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or P_s)

Form C-122F
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

GH _____ P_{CT} _____ (TABLE IX & X) T_{CT} _____ (TABLE IX & X)

LINE		1	2	3	4	5	6	7	8
1	T_w(W.H. °R)								
2	T_s(B.H. °R)								
3	$T=(\frac{T_w + T_s}{2})$								
4	Z (Est.)								
5	TZ								
6	GH/TZ								
7	e^s(Table XIV)								
8	P_f or P_s								
9	P_f^2 or P_s^2								
10	$P_c^2 = P_f^2/e^s$ or $P_w^2 = P_s^2/e^s$								
11	P_c or P_w								
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$								
13	$P_r = (P/P_{cr})$								
14	$T_r = (T/T_{cr})$								
15	Z (Table XI)								

WORKSHEET FOR CALCULATION OF STATIC _UMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

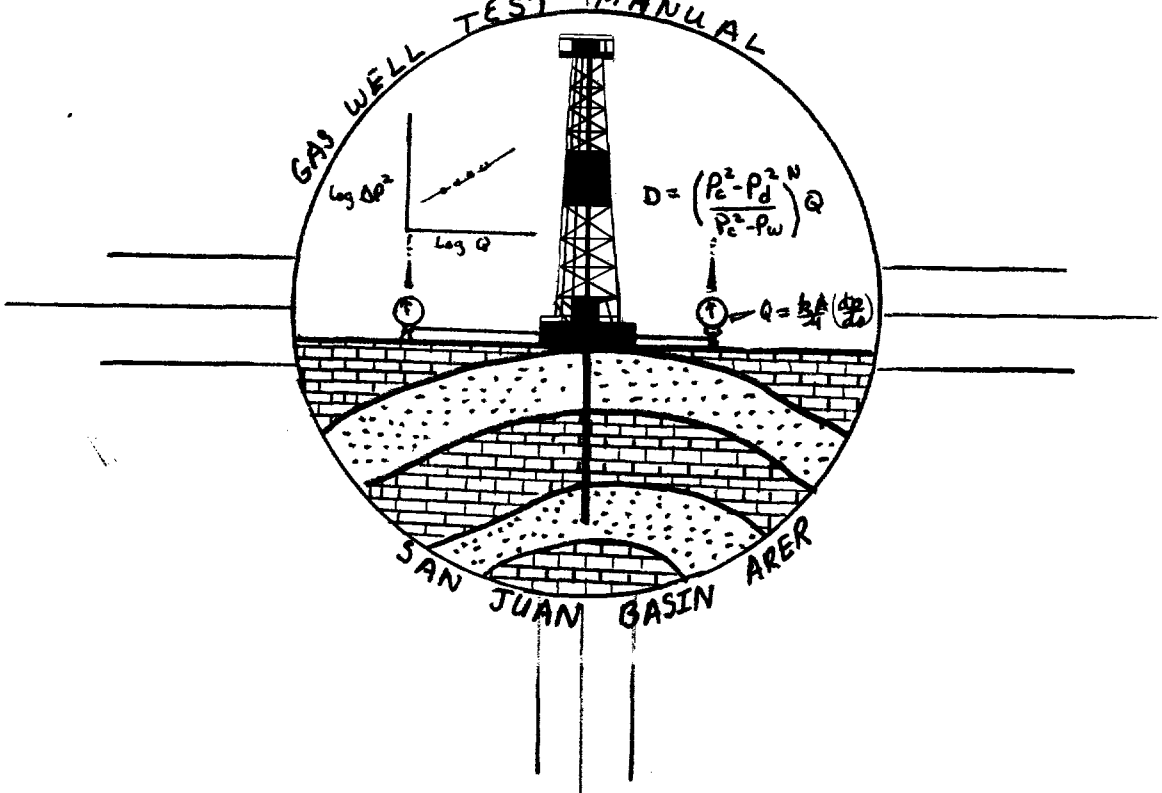
LINE											
1	Q_m										
2	T_w (W.H. °R)										
3	T_s (BH °R)										
4	$T = (\frac{T_w + T_s}{2})$										
5	Z (Est.)										
6	TZ										
7	GH/TZ										
8	e^s (Table XIV)										
9	$1 - e^{-s}$ (Table XIV)										
10	P_c										
11	P_c^2										
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_t^2 = e^s P_c^2$										
19	P_t										
20	$P = (\frac{P_c + P_t}{2})$										
21	$F_r = \frac{P}{P_{cr}}$										
22	$T_r = \frac{T}{T_{cr}}$										
23	Z (Table XI)										

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STATE OF NEW MEXICO

ENERGY AND MINERALS DEPARTMENT

NEW MEXICO OIL CONSERVATION DIVISION



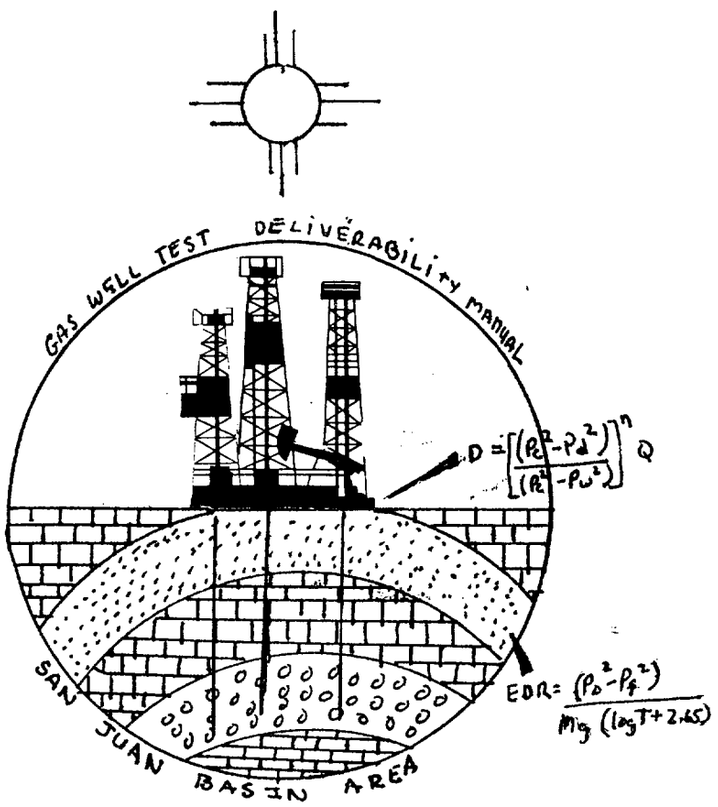
AUGUST, 1985

R.L. STAMENTS, DIVISION DIRECTOR

STATE OF NEW MEXICO

Energy And Minerals
Department

New Mexico Oil and Conservation
Division



AUGUST, 1986

R.L. STAMENTS

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION
P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-125
Revised 3-2-84

GAS WELL SHUT-IN PRESSURE REPORT

Operator	Address	Pool	County

LEASE	WELL NO.	LOCATION				DATE PRESS. RUN	TIME S.I. HRS./MIN.	S.I. PRESSURE PSIG (DWT)		
		UNIT	SEC.	TWP.	RGE.					

I hereby certify that the above information is true and complete to the best of my knowledge and belief. SEE RULE 402

Signature _____ Title _____ Date _____

STATE
OF
NEW MEXICO

OIL CONSERVATION
DIVISION



GAS WELL TESTING MANUAL
FOR
NORTHWEST NEW MEXICO

GAS WELL

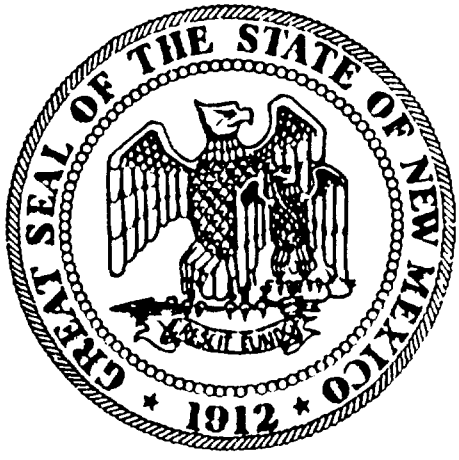
TESTING MANUAL

FOR

NORTHWEST NEW MEXICO

Prepared by an Industry Committee
appointed by the
Oil Conservation Division

H.L. Kendrick
Committee Chairman



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WILLIAM J. LeMay, Director

PREFACE

An industry committee met during 1985 - 1986 to revise deliverability testing procedures in San Juan Basin wells. In the course of the meetings it was decided a testing manual should be developed to replace Order R-333, as amended, and to incorporate all necessary procedures and tables.

This manual was prepared to meet with the committee's decision. Sincere appreciation is extended to all the members of the committee, listed below, and particularly to H. L. Kendrick of El Paso Natural Gas Company who chaired the committee and coordinated the preparation of this manual.

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SECTION I

INTRODUCTION

INTRODUCTION

Analysis of the performance of gas wells is an important part of the Petroleum Industry's operations. Gas well tests are used in regulatory work, various types of reservoir analyses, and in determining deliverability, or the capacity of a well to produce against a particular back-pressure. Historically, the capacity of gas wells to produce has been described in terms of the "open-flow" delivery rate or the "potential" of the well and the "shut-in pressure at the wellhead" or, less frequently, by some related quantity such as the "deliverability" at specified wellhead pressures. The open-flow capacity of a gas well is used for company operations, legal instruments such as contracts to buy or sell gas and governmental regulatory work. In the early days of the petroleum industry, the open-flow capacity of a gas well was measured directly. As this is a wasteful and hazardous practice, methods of calculating open-flow capacity from well tests made at reasonable and controlled rates of flow have been devised.

The first step toward calculating the open-flow potential or capacity of a gas well was made in the classic report of Rawlins and Schellhardt (1) which described, proposed, and explained the back-pressure method of determining the capacity of the gas well to produce under various conditions of back-pressure. This report was a milestone in the history of petroleum engineering and in the conservation of petroleum. These investigators analyzed data from 582 gas wells located throughout the United States. Specifically, they demonstrated that for the normal gas well, a plot of volume-rate-of-flow versus the difference between the square of the static reservoir pressure and the square of the corresponding flowing bottom-hole pressure on log-log paper is a straight line. Although the term "absolute open-flow potential" as used by Rawlins and Schellhardt represented the capacity of a well to produce against atmospheric pressure at the bottom of the well, the absolute open-flow will not be changed whether measured against atmospheric back-pressure or zero psia, because for most wells atmospheric pressure is negligible as compared to the shut-in sand face pressure. Rawlins and Schellhardt also devised a method of calculating the capacity of a well to produce against atmospheric pressure at the surface, i.e., the open-flow capacity, by taking into account the weight of the column of gas and the pressure drop due to frictional resistance in the flow string. In shallow wells producing through large-diameter flow strings, the absolute open-flow capacity and open-flow capacity are nearly equal because the pressure loss due to friction and the weight of the column of gas in the flow string is small or trivial in comparison to reservoir pressure. Since that time, the term absolute open-flow potential has been used and will be used in this manual to mean the rate of flow that would be obtained if the bottom-hole pressure opposite the sand face were reduced to zero psia; consequently, the absolute open-flow potential is independent of well equipment and represents the maximum productivity of the reservoir rock adjacent to a particular well.

(1) Rawlins, E. L., and Schellhardt, M. A., Back-Pressure Data on Natural Gas Wells and Their Application to Production Practice. U. S. Bureau of Mines, Monograph 7, 1935.

From a theoretical standpoint, the validity of Rawlins' and Schellhardt's findings can be supported by a consideration of the radial flow equation for gas. This equation, which represents the isothermal flow of gas in the steady state to a well bore in a symmetrical reservoir, can be stated as:

$$Q = \frac{C \pi K H (P_f^2 - P_s^2) T_b}{\mu P_b \ln \left[\frac{r_e}{r_w}\right] T_f Z} \qquad \text{I-1}$$

Where

- Q = flow to well, Mcf per day
- C = numerical constant to adjust units
- K = permeability of reservoir
- H = thickness of reservoir
- P_b = pressure base
- P_f = shut-in reservoir pressure
- P_s = flowing pressure at sand face
- T_f = formation temperature
- Z = average compressibility
- μ = average viscosity of the flowing gas
- ln = natural logarithm, i.e. logarithm to the base "e"
- r_e = drainage radius of well
- r_w = well-bore radius
- T_b = temperature base

For a particular well, the terms C, K, H, T_b, μ, P_b, ln r_e/r_w, T_f, and Z may be considered constant and thus can be combined into a single well constant, "C", which reduces the flow equation to: $Q = C (P_f^2 - P_s^2)$. This equation assumes isothermal steady state streamline flow and requires an average compressibility factor. As neither of these assumptions holds absolutely true in a gas reservoir, an exponent, "n", must be introduced to match actual field conditions. The formula then becomes: $Q = C (P_f^2 - P_s^2)^n$. This is the formula developed by Rawlins and Schellhardt. (For a "perfect" gas under isothermal steady state streamline flow, n = 1.) For a specific well and reservoir, "n" must be determined by measuring Q, P_f, and P_s under several different conditions and then solving for "n". By writing the equation as: $\log Q = \log C + n \log (P_f^2 - P_s^2)$ it can be seen that Q plotted versus $P_f^2 - P_s^2$ on log-log paper is a straight line with a slope of "n". To determine the absolute open-flow potential of a well, the measured points are plotted on log-log paper and the straight line is extrapolated to a point where $P_f^2 - P_s^2 = P_f^2$ (in other words $P_s = 0$). "Q" read at this point is the absolute open-flow potential. The flow rate at other conditions of back pressure can also be determined by calculating $P_f^2 - P_s^2$, using the desired P_s and reading Q at the corresponding point.

Rawlins and Schellhardt considered the coefficient "C" and the exponent "n" to be constants for a particular well. This is apparently true for a well operating under stabilized conditions; however, later studies indicate that for wells producing from low permeability reservoirs, the coefficient "C" is a variable related to time and can be considered as a constant only with respect to a particular time.

In general, the exponent "n" varies for individual wells between the limits of 0.5 and 1.0 and it is generally accepted that back-pressure curves with exponents below 0.5 or above 1.0 are erroneous. From a theoretical standpoint, the variation of the exponent "n" between different wells has not been satisfactorily explained; however, many investigators under both laboratory and actual field conditions have demonstrated the reliability of the back-pressure equation.

The basic equation for calculating the absolute open-flow potential of a gas well uses bottom-hole pressures, whereas surface pressures are more frequently and easily obtained. The theory of calculating subsurface pressures from surface pressures is simple, namely that the closed-in static bottom-hole pressure is equal to the closed-in wellhead pressure plus the weight of the column of fluid and that the flowing bottom-hole pressure is equal to the flowing wellhead pressure plus the weight of the column of fluid plus the pressure differential required to overcome frictional resistance to the flow of the gas in the particular flow string.

Several methods of calculating subsurface pressures in gas wells have been developed. Rawlins and Schellhardt used Weymouth's formula for calculating the pressure drop due to frictional resistance. As no corrections were made for compressibility and as an average temperature of flow of 80° F was taken, this method, generally termed the U. S. Bureau of Mines method, is applicable only to shallow, low-pressure gas wells. The technique of computation for this method was improved and simplified by Ferguson (2) (3). As the use of the method was extended to deep, high-pressure gas wells, the earlier simplifying assumptions had to be modified. Vitter (4) adapted the method to condensate wells. The calculation techniques described in this manual are based in principle on this early work but incorporate recent modifications to obtain a procedure that is as simple as possible, consistent with accuracy.

Throughout this manual the pressure base is taken as 15.025 psia, and the temperature base is 60° F. All gas volumes are referred to these base conditions which are sometimes designated as standard volumes or standard conditions. If maximum accuracy is to be obtained, all flow data gathered for back-pressure tests

(2) Ferguson, J. William, Calculation of Back-Pressure Tests on Natural Gas Wells; Oil and Gas Journal, January 19, 1939. pp. 47-53.
(3) Ferguson, J. William, Calculation of Back-Pressure Tests; Oil and Gas Journal, May 7, 1942. p. 52.
(4) Vitter, A. L., Jr., Back-Pressure Tests on Gas-Condensate Wells; A. P. I. Drilling and Production Practice, 1942. pp. 79-87.

must be measured under stabilized conditions. With reference to the production of gas wells, the term "stabilized" is generally used in a manner to infer that at a constant flow rate the flowing conditions within the well bore have become constant and are thus unchanging with time. This condition, of course, can never be attained when a well is producing at a constant rate because the mass content of the reservoir is being continually reduced. Associated with the reduction in mass content must be a continual decrease in the pressure level throughout the reservoir. In view of this, the term "stabilized" when applied to well conditions associated with gas well production tests will be used to denote that further changes in pressure, gas-oil ratio, and rate of flow will be negligible and can be ignored for the purpose of calculating a back-pressure test.

The calculation techniques described in this manual can be divided into three categories: (1) stabilized multipoint back-pressure tests, (2) nonstabilized multipoint tests, and (3) surface tests. The stabilized multipoint back-pressure test procedure can be used in wells in which stabilized flowing conditions can be reached within a reasonable period of time. Prior to testing, the well should be flowed at sufficient rate and for a sufficient period of time to clear the well of accumulated liquids that might result in erroneous pressure data. After the well has been cleaned, it should be shut-in for a period long enough to permit the measurement of an accurate stabilized shut-in pressure. Normally, pressures are measured at four stabilized rates of flow for use in the equation: $Q = C (P_f^2 - P_s^2)^n$. In taking the flowing pressures, the flow rates should be sufficient to prevent the accumulation of liquids in the well bore. A wide variation in flow rates is desirable to achieve a good spread in data points and thus permit accurate extrapolation of the back-pressure curve.

Accurate wellhead temperatures are required in the calculation of subsurface pressures. Flowing temperatures can usually be measured accurately at the wellhead for each rate of flow; however, at low flow rates the observed wellhead temperature may be distorted by atmospheric conditions. When this situation exists, the mean annual temperature should be used as an approximation of the actual wellhead temperature. The static wellhead temperature usually cannot be measured accurately and in lieu thereof the mean annual temperature appropriate to the locality is sufficiently accurate for the computation.

The rates of flow during the tests should be accurately measured with acceptable metering devices; and the gas-liquid ratios, gas and liquid gravites, and other pertinent information should be obtained. It is good practice to plot the data points as they are obtained or, at least, plot the difference of the squares of the surface pressures to check for alignment and make sure the data are satisfactory and the well properly cleaned. This procedure often will indicate the condition of the test equipment and the well and make it possible to make adjustments immediately that could eliminate the necessity for a re-test. After the field data have been obtained, the results can be plotted on log-log paper, with Q shown on the abscissa and $P_f^2 - P_s^2$ on the ordinate. These points should fall in a straight

line, the slope of which represents the reciprocal of "n". The absolute open-flow potential can then be determined by extrapolating the straight line graphically or by use of the back-pressure equation for which the numerical values of "n" and "C" are easily found.

Whenever stabilization cannot be reached within a reasonable period of time because of reservoir conditions, or when flow rates of sufficient duration to reach stabilized conditions are impractical, the slope of the back-pressure curve can be obtained by using one of two different procedures; namely, the constant-time multipoint test or the isochronal multipoint test. The constant-time multipoint test is identical to the stabilized test except that the duration shall be the same for each flow rate. The four points determined from the constant-duration flow tests can be used to determine the slope of the back-pressure curve. A line of this slope can then be drawn through the point determined from an extended flow test approximating stabilized conditions. The absolute open-flow capacity of the well is determined from this line. The precautions to be observed and the method of plotting the data are also identical to the stabilized test.

The isochronal multipoint test can also be used where it is not possible to obtain stabilized flow conditions. This procedure is based on the work of Cullender (5) which showed that the slope of the back-pressure curve can be obtained from data points taken prior to stabilization, providing that each flow rate is of the same duration and that each flow period starts from stabilized shut-in conditions. In making this test, the well is first cleaned and a shut-in pressure obtained in the same manner as would be done under stabilized conditions. Each flow rate following the shut-in pressure should be of the same duration; but, after each flowing pressure is observed, the well should be shut in until a reasonable constancy in pressure is achieved. In plotting the points, the shut-in pressure preceding each flow rate should be used in conjunction with the flowing pressure corresponding to that rate used in the calculation of $P_f^2 - P_s^2$. The points so calculated will determine the slope of the back-pressure curve. An extended flow test to obtain a flowing pressure approximating a "stabilized condition" is required to locate the position of the back-pressure curve. The curve is completed by drawing a line of the slope determined from the four constant-time points through the point plotted from the extended ("stabilized condition") test. The absolute open-flow capacity of the well is obtained from this line.

Redetermination of the absolute open-flow potential can be made by the "one-point" test procedure once the slope of the back-pressure curve has been established. This method assumes that the slope of the back-pressure curve does not change with time. Accordingly, a one-point test requires only that a shut-in pressure and one stabilized flow rate be obtained. The new value of

(5) Cullender, M. H., The Isochronal Performance Method of Determining the Flow Characteristics of Gas Wells; AIME Trans., V 204, pp. 137-142, 1955.

absolute open flow is determined by drawing the back-pressure curve through this point using the known slope. This determination can also be made by using the following equation:

$$AOF = Q\left[\frac{P_f^2}{P_f^2 - P_s^2}\right]^n \qquad \text{I-2}$$

These procedures require that the subsurface pressures be either measured or calculated. In shallow wells with large flow strings the differences between surface and subsurface pressures are usually small, and surface pressures can be used with little error. If the error introduced by using the surface pressures does not warrant the use of subsurface pressures, then the static column wellhead pressures can be substituted for the bottom-hole pressures. Surface pressures are used in determining the deliverability of a well or capacity of the formation to produce gas into the wellbore against a specified surface pressure. The deliverability is calculated by solving for "D" in the following equation:

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n \qquad \text{I-3}$$

Where

D = deliverability of well at back pressure, P_d
Q = rate of flow at a pressure of P_w, during test
P_c = shut-in wellhead pressure

The ability of a well to produce into a gathering system can be determined for various wellhead pressures of the flow string corresponding to a specified line pressure after establishing a curve by first plotting Q versus $P_c^2 - P_t^2$ for several rates of flow in the same manner as is done for Q versus $P_f^2 - P_s^2$ in the standard back-pressure plot. Then the producing capacity of the well at a given back pressure can be read from the curve using the appropriate values of $P_c^2 - P_t^2$ or by replacing P_d and P_w in the deliverability equation with the corresponding pressures of the flow string and utilizing the exponent "n" established by the plot of Q versus $P_c^2 - P_t^2$. The plotted line may not be exactly straight but by restricting its use to those situations which require little extrapolation, the producing capacity can be determined with reasonable accuracy.

SECTION II

TABLE OF NOMENCLATURE

TABLE OF NOMENCLATURE

AOF = absolute open flow, Mcfd

C = coefficient of the particular back-pressure equation

D = deliverability of well at back pressure, P_d, Mcfd

F_b = basic orifice factor, Mcfd/$\sqrt{h_w P_m}$

F_c = combined friction, temperature, and compressibility factor, $F_r TZ$

F_d = meter factor for direct reading L-10 chart = $0.01\sqrt{R_h R_P}$

F_e = energy loss factor = $(F_r Q_m)^2$

F_g = specific gravity factor, dimensionless

F_p = basic critical flow prover or positive nonadjustable choke factor, Mcfd/psia

F_{pv} = supercompressibility factor = $\sqrt{1/Z}$, dimensionless

F_r = friction factor, $\left[\frac{2.6665\, f}{d^5}\right]^{0.5}$

F_s = pressure loss factor = $(L/H)\ (F_c Q_m)^2(e^s - 1) = P_s^2 - e^s P_t^2$

F_t = flowing temperature factor, dimensionless

F_w = pressure loss factor = $(L/H)\ (F_c Q_m)^2(1 - e^{-s}) = P_w^2 - P_t^2$

G = specific gravity of flowing fluid (air = 1.000), dimensionless

G_g = specific gravity of separator gas (air = 1.000), dimensionless

G_l = specific gravity of separator liquid (water = 1.000), dimensionless

GOR = gas-liquid ratio, cu ft of gas (15.025 psia and 60F) per barrel of hydrocarbon liquid (60F)

H = vertical depth corresponding to L, feet

I_n = value of the right hand member of the flow equation corresponding to P_n

I_{n-1} = value of the right hand member of the flow equation corresponding to P_{n-1}

L = length of flow channel, feet (See General Instructions)

M = computational aid

Mcfd = thousand cubic feet per day (15.025 psia and 60F)

M^2cfd = million cubic feet per day (15.025 psia and 60F)

N = computational aid

P = pressure, psia

P^2 = $(psia)^2/1000$

P_L = static pressure reading, L-10 chart

P_a = field barometric pressure, psia

P_b = pressure at base conditions, psia

P_c = shut-in wellhead pressure, psia

P_{cr} = pseudocritical pressure, psia

P_d = designated deliverability pressure, psia

P_f = shut-in pressure at vertical depth H, psia

P_m = static pressure at point of gas measurement, psia

P_n = pressure in the flow channel at a given point, psia

P_{n-1} = pressure in the flow channel at the preceding point, psia

P_r = reduced pressure, dimensionless

P_s = flowing pressure at vertical depth H, psia

P_t = flowing wellhead pressure, psia

P_w = static column wellhead pressure corresponding to P_t, psia

Q = rate of flow, Mcfd (15.025 psia and 60F)

Q_m = rate of flow, M^2cfd (15.025 psia and 60F)

R_h = meter differential range, inches of water

R_p = meter pressure range, psia

R_t = meter temperature range, F

T = absolute temperature, R

T_b = absolute temperature at base conditions, R

T_{cr} = absolute pseudocritical temperature, R

T_m = absolute temperature of fluid at point of gas measurement, R

T_r = reduced temperature, dimensionless

T_s = absolute temperature at vertical depth H, R

T_w = absolute temperature of fluid at wellhead, R

V_l = cu ft of vapor (15.025 psia and 60F) equivalent to 1 barrel of hydrocarbon liquid (60F)

Z = compressibility factor, dimensionless

d = inside diameter, inches

d_e = effective diameter, inches

d_o = outside pipe diameter, inches

e = natural logarithm base = 2.71828+

e^s = weight of column factor, dimensionless

f = coefficient of friction, dimensionless

h_d = differential reading, L-10 chart

h_w = meter differential pressure, inches of water

n = exponent of the particular back-pressure equation, dimensionless

psia = pounds per square inch absolute

psig = pounds per square inch gauge

s = 0.0375 GH/TZ

t_d = temperature reading, L-10 chart

NOTE: "F" as used in this Table of Nomenclature and throughout this manual is the symbol for degrees Fahrenheit.

"R" as used in this Table of Nomenclature and throughout this manual is the symbol for degrees Rankine (degrees Fahrenheit absolute).

SECTION III

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

DIVISION ORDER NO. R-333-I ..... III-i

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STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

CASE NO: 8586
ORDER NO: R-333-I

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION FOR RESCISSION OF DIVISION ORDER No. R-333, AS AMENDED, AND FOR RECODIFICATION AND REISSUANCE OF GAS WELL TESTING PROCEDURES FOR NORTHWEST NEW MEXICO. APPLICANT FURTHER SEEKS AN EXTENSION OF THE 1986 TESTING PERIOD AND SUSPENSION OF THE 1987 TESTING PERIOD. MCKINLEY, RIO ARRIBA, SANDOVAL, AND SAN JUAN COUNTIES, NEW MEXICO.

BY THE DIVISION:

This cause came on for hearing at 8:00 a.m. on May 8, 1985, and at 8:15 a.m. on December 3, 1986, in Santa Fe, New Mexico, before Examiners Gilbert P. Quintana and Michael E. Stogner, respectively.

NOW, on this 2nd day of October, 1987, the Division Director, having considered the testimony, the record, and the recommendations of the Examiners, and being fully advised in the premises,

FINDS THAT:

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

(2) The applicant in the instant case seeks to rescind Division Order No. R-333, as amended, and to recodify and amend the Special Rules and Regulations for the testing of gas wells in Northwest New Mexico contained therein.

(3) Special rules and regulations for the testing of gas wells in McKinley, Rio Arriba, Sandoval, and San Juan Counties, New Mexico, (Northwest New Mexico) have been adopted and amended by the Division and are embodied in Division Order No. R-333, as amended.

(4) These existing rules and regulations relating to gas well testing procedures in Northwest New Mexico have been adopted over many years and are collected in numerous orders, therefore, making reference to them somewhat difficult.

(5) In addition some of the gas well testing procedures are out-dated and in need of revision.

(6) Because of the need to review these rules relating to gas well testing in Northwest New Mexico, the Division Director at that time appointed a committee to study the existing rules and to recommend changes.

(7) Harold L. Kendrick, Chairman of the Deliverability Test Committee, appeared on its behalf at the May 8, 1985 (at which time it was taken under advisement, however no order was issued) and December 3, 1987 examiner hearings and made the following recommendations regarding gas well testing procedures in Northwest New Mexico:

(a) to recodify the rules and issuing them as the "Gas Well Testing Manual for Northwest New Mexico";

(b) to require deliverability testing in prorated gas pools on a biennial (every two years) basis;

(c) to require biennial shut-in pressures in non-prorated gas pools with no deliverability testing;

(d) to make the deliverability test year be the same as the calendar year;

(e) to make exemption from deliverability testing in the Blanco-Mesaverde and Basin-Dakota Pools based upon the combined producibility of all wells on a gas proration unit;

(f) to permit wells shut-in for overproduction to be produced for deliverability test purposes after the operator notifies the Division Aztec District office;

(g) to relax restriction on flow interruptions during the conditioning period slightly;

(h) to permit the 7-day shut in pressure to be measured at a time during the current testing season other than immediately following the test flow period;

(i) to set deliverability pressure (Pd) assigned as a percentage of the 7-day shut-in pressure in each pool to more nearly approximate the pool average operating conditions;

(j) the 7-day shut-in pressure for wells in non-prorated gas pools should be filed with the Division and reported on Form C-125 or any other form designated by the Division; and

(k) to include in the manual all required tables.

(8) All of the above proposals are embodied in Exhibit "A" attached hereto and made a part thereof.

(9) A manual for well testing as set out in said supplemental exhibit should be adopted.

(10) The existing Division Order No. R-333, as amended, should be rescinded, in its entirety, and a new order designated R-333-I should be promulgated.

(11) It is further sought in this Case to extend the deadline for completing and filing 1986 deliverability tests to March 31, 1987, and for a one year suspension of biennial deliverability testing whereby the deliverability test cycle will begin again in 1988 with those pools which would have been tested in 1987.

(12) No testimony was received in opposition to this request.

(13) Approval of this application is in the best interest of conservation and will prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED THAT:

(1) Effective September 1, 1987, the Special Rules and Regulations governing gas well testing in Northwest New Mexico, which includes McKinley, Rio Arriba, Sandoval and San Juan Counties, New Mexico, as set forth in Exhibit "A" attached hereto and made a part hereof, are hereby promulgated and adopted as an exception to Rules 401 and 402 of the general statewide rules and regulations of this Division relating to gas well testing procedures, superseding the rules and regulations contained in their entirety in Division Order No. R-333, as amended.

(2) The deadline for completing and filing 1986 deliverability tests is hereby extended to March 31, 1987.

(3) The required biennial deliverability testing of wells is hereby suspended for a one year period whereby the deliverability test cycle will begin again in 1988 with those pools which would have been tested in 1987.

(4) Jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

WILLIAM J. LEMAY
Director

S E A L

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in northwest New Mexico, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. The filing of shut-in pressures for "exempt" wells is not required.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of the lowermost prorated completion of the well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

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B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

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SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and identified as "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60^{o}F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' (h_w P_f)^{.5}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^{o} F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \left[\frac{(P_c^2 - P_d^2)}{(P_c^2 - P_w^2)} \right]^n$$

Where:

D = Deliverability Mcf/d at the delivcrability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for northwest New Mexico.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations 0.85

For formations deeper than Pictured Cliffs 0.75

(Note: Special rules for any specific pool or formation may supersede the above values. Check special rules if in doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the northwest New Mexico Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec

office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN NON-PRORATED POOLS

SECTION 1: Initial Shut-In Pressure Tests for Newly Completed Wells

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-In Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of Shut-In Pressure Data

The result of this test shall be reported in the last column of Division Form C-125 showing the pressure in psia and shall be filed in triplicate with the Aztec District Office of the Division.

SECTION IV

FORMS

SUGGESTED FIELD DATA SHEET

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL (Form C-122)

GAS WELL TEST DATA SHEET - SAN JUAN BASIN (Form C-122-A)

INITIAL POTENTIAL TEST DATA SHEET (Form C-122-B)

DELIVERABILITY TEST REPORT (Form C-122-C)

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w) (Form C-122-D)

WORKSHEET FOR STEPWISE CALCULATION OF (SURFACE) (SUBSURFACE) PRESSURE (P_c & P_w) (P_f & P_s) (Form C-122-E)

WORKSHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w) FROM KNOWN BOTTOMHOLE PRESSURE (P_f or P_s) (Form C-122-F)

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE (Form C-122-G)

GAS WELL SHUT-IN PRESSURE TESTS (Form C-125)

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test ☐ Initial ☐ Annual ☐ Special — Test Date	Lease No. or Serial No.
Company — Connection	Allottee
Field — Reservoir — Location	Unit
Completion Date — Total Depth — Plug Back TD — Elevation	Farm or Lease Name
Csg. Size — Wt. — d — Set At — Perforations: From — To	Well No.
Tbg. Size — Wt. — d — Set At — Perforations: From — To	Sec. — Twp.-Blk. — Rge.-Sur.
Type Completion (Describe) — Packer Set At	County or Parish
Producing Thru — Reservoir Temp. F — Mean Annual Temp. F — Baro. Press. – P_a	State
L — H — G_g — % CO_2 — % N_2 — % H_2S	Prover — Meter Run — Taps

DATE	ELAP. TIME	Wellhead Working Pressure			METER OR PROVER				REMARKS
Time of Reading	Hrs.	Tbg. Psig.	Csg. Psig.	Temp. F	Pressure Psig.	Diff.	Temp. F	Orifice	(Include liquid production data: Type—A.P.I. Gravity—Amount)
		NOT REQUIRED TO BE FILED							

Page _____ of _____ . Data By _____

OIL CONSERVATION DIVISION

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122
Revised 10-1-78

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Type Test ☐ Initial ☐ Annual ☐ Special				Test Date	
Company		Connection			
Pool		Formation		Unit	
Completion Date	Total Depth	Plug Back TD	Elevation	Farm or Lease Name	
Csg. Size / Wt. / d / Set At		Perforations: From To		Well No.	
Tbg. Size / Wt. / d / Set At		Perforations: From To		Unit Sec. Twp. Rge.	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple		Packer Set At		County	
Producing Thru	Reservoir Temp. °F	Mean Annual Temp. °F	Baro. Press. – P_a	State	
L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI									
1.									
2.									
3.									
4.									
5.									

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1							
2.							
3.							
4.							
5.							

NO.	P_t	Temp. °R	T_r	Z
1.				
2.				
3.				
4.				
5.				

Gas Liquid Hydrocarbon Ratio _____ Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons _____ Deg.
Specific Gravity Separator Gas _____ XXXXXXXXXX
Specific Gravity Flowing Fluid XXXXX _____
Critical Pressure _____ P.S.I.A. _____ P.S.I.A.
Critical Temperature _____ R _____ R

P_c _____ P_c^2 _____

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1				
2				
3				
4				
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} =$ _____ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n =$ _____

AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n =$ _____

Absolute Open Flow _____ Mcfd @ 15.025 | Angle of Slope θ _____ | Slope, n _____

Remarks: _____

Approved By Division	Conducted By:	Calculated By:	Checked By:

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION
P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122-A
Revised 10-1-78

WELL DELIVERABILITY TEST REPORT FOR 19____

POOL NAME	POOL SLOPE	FORMATION	COUNTY
	n=		

COMPANY			WELL NAME AND NUMBER		
UNIT LETTER	SECTION	TOWNSHIP	RANGE	PURCHASING PIPELINE	
CASING O.D. – INCHES	CASING I.D. – INCHES	SET AT DEPTH – FEET	TUBING O.D. – INCHES	TUBING I.D. – INCHES	TOP – TUBING PERF. – FEET
GAS PAY ZONE FROM TO		WELL PRODUCING THRU CASING TUBING		GAS GRAVITY	GRAVITY X LENGTH
DATE OF FLOW TEST FROM TO			DATE SHUT-IN PRESSURE MEASURED		

PRESSURE DATA – ALL PRESSURES IN PSIA

(a) Flowing Casing Pressure (DWt)	(b) Flowing Tubing Pressure (DWt)	(c) Flowing Meter Pressure (DWt)	(d) Flow Chart Static Reading	(e) Meter Error (Item c – Item d)	(f) Friction Loss (a – c) or (b – c)	(g) Average Meter Pressure (Integr.)
(h) Corrected Meter Pressure (g + e)	(i) Avg. Wellhead Press. P_t = (h + f)	(j) Shut-in Casing Pressure (DWt)	(k) Shut-in Tubing Pressure (DWt)	(l) P_c = higher value of (j) or (k)	(m) Del. Pressure P_d = _____ %P_c	(n) Separator or Dehydrator Pr. (DWt) for critical flow only

FLOW RATE CORRECTION (METER ERROR)

Integrated Volume – MCF/D	Quotient of $\frac{\text{Item c}}{\text{Item d}}$	$\sqrt{\frac{\text{Item c}}{\text{Item d}}}$	Corrected Volume Q = MCF/D

WORKING PRESSURE CALCULATION

$(1-e^{-s})$	$(F_c\ Q_m)^2\ (1000)$	$R^2 = (1-e^{-s})\ (F_c\ Q_m)^2 (1000)$	P_t^2	$P_w^2 = P_t^2 + R^2$	$P_w = \sqrt{P_w^2}$

DELIVERABILITY CALCULATION

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = _____\left[\left(_____\right)^n \left(_____\right)^n = _____ = _____\right] = _____ \text{MCF/D}$$

REMARKS:

SUMMARY

Item b _____ Psia
P_c _____ Psia
Q _____ MCF/D
P_w _____ Psia
P_d _____ Psia
D _____ MCF/D

Company _____
By _____
Title _____
Witnessed By _____
Company _____

NEW MEXICO OIL CONSERVATION COMMISSION

INITIAL POTENTIAL TEST DATA SHEET

Form C-122-B

This form must be used for reporting all pitot tube tests made in the State. It is particularly important that it be used for reporting Initial Potential Tests in the San Juan Basin as prescribed by Order No. R-333 and by the New Mexico Oil Conservation Commission Manual of Tables and Procedure for Initial Potential (Pitot Tube) Tests.

Pool _____ Formation _____

County _____ Date Well Tested _____

Operator _____ Lease _____ Well No. _____

Unit Letter _____ Section _____ Township _____ Range _____

Casing O.D. _____ Wt. _____ Set At _____ Tubing O.D. _____ Wt. _____ Set At _____

Pay Zone: From _____ To _____ Gas Gravity: Meas. _____ Est. _____

Tested Through: Casing _____ Tubing _____

Test Nipple _____ I.D. Type of Gauge Used: Spring ☐ Monometer ☐

OBSERVED DATA

Shut-In Pressure: Casing _____ Tubing _____ S.I. Period _____

Time Well Opened _____ Time Well Gauged _____ Impact Pressure _____

Volume (Table I) _____ (a)

Multiplier For Pipe or Casing (Table II) _____ (b)

Multiplier For Flowing Temperature (Table III) _____ (c)

Multiplier For Sp. Gravity (Table IV) _____ (d)

Avg. Barometer Pressure at Wellhead (Table V) _____

Multiplier For Barometric Pressure (Table VI) _____ (e)

Initial Potential, MCF/24 Hrs. (a) x (b) x (c) x (d) x (e) = _____

Witnessed By: _____ Tested By _____

Company: _____ Company _____

Title: _____ Title _____

NEW MEXICO OIL CONSERVATION COMMISSION

DELIVERABILITY TEST REPORT

Form C-122-C
Revised 9-1-65

Type Test ☐ Initial ☐ Annual ☐ Special						Test Date		
Company				Connection				
Pool				Formation			Unit	
Completion		Total Depth		Plug Back TD		Elevation	Farm or Lease Name	
Csg. Size	Wt.	d	Set At	Perforations: From	To		Well No.	
Tbg. Size	Wt.	d	Set At	Perforations: From	To		Unit Sec. Twp. Rge.	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple				Packer Set At			County	
Producing Thru	Reservoir Temp. °F @		Mean Annual Temp. °F	Baro. Press. – P_a			State	
L	H	Gg.	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size X Choke Orifice Size	Press. p.s.i.g.	Diff. hw	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI									
1.									

NO.	Coefficient (24-Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft	Gravity Factor Fg	Super Compress. Factor Fpv	Rate of Flow Q, Mcfd
1.							

NO.	P_r	Temp. R.	T_r	Z

P_d _____

P_d^2 _____

P_c _____ P_c^2 _____

Gas Liquid Hydrocarbon Ratio _____ Mcf/bbl.

A.P.I. Gravity of Liquid Hydrocarbons _____ Deg.

Specific Gravity Separator Gas _____ XXXXXXXXXX

Specific Gravity Flowing Fluid XXXXX _____

Critical Pressure _____ p.s.i.a. _____ p.s.i.a.

Critical Temperature _____ R _____ R

Pf _____ P_f^2 _____

NO.	P_t	P_t^2	$P_c^2 - P_t^2$	P_w	P_w^2	$P_c^2 - P_w^2$	P_s	P_s^2	$P_f^2 - P_s^2$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = \left[\quad\right] = _____$$

$$\text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = _____$$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = _____$$

$$n\ \text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = _____$$

$$\text{Deliv.} = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n$$

Deliv. _____ Mcfd

n _____

(Source of n)

Commission _____

Company _____

Others _____

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w)

Form C-122D
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE										
1 Q_m										
2 T_w (W.H. °R)										
3 T_s (B.H. °R)										
4 $T = (\frac{T_w + T_s}{2})$										
5 Z (Est.)										
6 TZ										
7 GH/TZ										
8 e^s (Table XIV)										
9 $1-e^{-s}$ (Table XIV)										
10 P_t										
11 $P_t{}^2/1000$										
12 F_r (Table XV)										
13 $F_c = F_r$ TZ										
14 $F_c Q_m$										
15 $L/H (F_c Q_m)^2$										
16 $F_w = L/H (F_c Q_m)^2 (1-e^{-s})$										
17 $P_w{}^2 = P_t{}^2 + F_w$										
18 $P_s{}^2 = e^s P_w{}^2$										
19 P_s										
20 $P = (\frac{P_t + P_s}{2})$										
21 $P_r = (P/P_{cr})$										
22 $T_r = (T/T_{cr})$										
23 Z (Table XI)										

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) (SURFACE) PRESSURE (P_f & P_s) (P_c & P_w)

Form C–122–E
Adopted 9–1–65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ Q_m _____ M^2cfd $(L/H)(F_rQ_m)^2$ _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H											
2	GH											
3	37.5GH											
4	P_c or P_n											
5	P_r											
6	T											
7	T_r											
8	Z											
9	P/Z P/Z	$\overline{4} \div \overline{8}$										
10	P/TZ	$\overline{9} \div \overline{6}$										
11	$(P/TZ)^2/1000$	$(\overline{10})^2/1000$										
12	$L/H(F_rQ_m)^2$											
13		$\overline{11} + \overline{12}$										
14	I_n	$\overline{10} \div \overline{13}$										
15	$M=P_n-P_{n-1}$											
16	$N=I_n + I_{n-1}$											
17	M x N	$\overline{15} \times \overline{16}$										
18	Σ(M x N)	$\Sigma\overline{17}$										

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or P_s)

Form C-122F
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE		1	2	3	4	5	6	7	8
1	T_w(W.H. °R)								
2	T_s(B.H. °R)								
3	$T=(\frac{T_w + T_s}{2})$								
4	Z (Est.)								
5	TZ								
6	GH/TZ								
7	e^s(Table XIV)								
8	P_f or P_s								
9	P_f^2 or P_s^2								
10	$P_c^2 = P_f^2/e^s$ or $P_w^2 = P_s^2/e^s$								
11	P_c or P_w								
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$								
13	$P_r = (P/P_{cr})$								
14	$T_r = (T/T_{cr})$								
15	Z (Table XI)								

One copy to be filed in District Office (Work copy acceptable)

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE											
1	Q_m										
2	T_w (W.H. °R)										
3	T_s (BH °R)										
4	$T = (\frac{T_w + T_s}{2})$										
5	Z (Est.)										
6	TZ										
7	GH/TZ										
8	e^s (Table XIV)										
9	$1 - e^{-s}$ (Table XIV)										
10	P_c										
11	P_c^2										
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$										
19	P_f										
20	$P = (\frac{P_c + P_f}{2})$										
21	$P_r = \frac{P}{P_{cr}}$										
22	$T_r = \frac{T}{T_{cr}}$										
23	Z (Table XI)										

One copy to be filed in District Office (Work copy acceptable)

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-125
Revised 3-2-84

GAS WELL SHUT-IN PRESSURE REPORT

Operator	Address	Pool	County

LEASE	WELL NO.	LOCATION				DATE PRESS. RUN	TIME S.I. HRS./MIN.	S.I. PRESSURE PSIG (DWT)		
		UNIT	SEC.	TWP.	RGE.					

I hereby certify that the above information is true and complete to the best of my knowledge and belief. SEE RULE 402

Signature _____ Title _____ Date _____

SECTION V

BASIC CALCULATIONS

Determination of Compressibility Factor, Z, and Supercompressibility Factor, F_{pv} . . . . . V - 1

Calculation of the Rate of Flow, Using Orifice Meter Data. . . . . V - 1

Calculation of the Rate of Flow, Using Critical Flow Prover Data . . . . . V - 2

Calculation of the Rate of Flow, Using Positive Choke Data. . . . . V - 2

Determination of the Exponent "n" of the Back-Pressure Equation . . . . . V - 3

BASIC CALCULATIONS

Number 1.

Determination of compressibility factor (Z) and supercompressibility factor (F_{pv}):

Using the data from the Field Data Sheet, Test Example 1.

G_g	=	0.625
Carbon dioxide	=	2%
Nitrogen	=	3%

From Table IX determine P_{cr} and T_{cr} and make appropriate corrections for carbon dioxide and nitrogen content as determined from Table X, thus:

$$P_{cr} = 671 + 8 - 5 = 674$$
$$T_{cr} = 365 - 3 - 9 = 353$$

Using the 3-hour data obtained from the first flow,

$$P_r = P_m/P_{cr} = 734.2/674 = 1.09$$
$$T_r = T_m/T_{cr} = 526/353 = 1.49$$

From Table XI for $P_r = 1.09$ and $T_r = 1.49$,

$$Z = 0.891$$

From Table XII for $Z = 0.891$,

$$F_{pv} = 1.059$$

Number 2.

Calculation of the rate of flow using meter data:

$$Q = F_b \times \sqrt{(h_w)(P_m)} \times F_t \times F_g \times F_{pv}$$

Using the 3-hour data obtained from the first flow,

$$Q = (16.80)\sqrt{(8.3)(734.2)}\ (0.9943)(1.265)(1.059)$$

$$= (16.80)\ (78.05)\ (0.9943)\ (1.265)\ (1.059)$$

$$= 1747 \text{ Mcfd}$$

Number 2. (Continued)

Source of factors:

F_b = 16.80 (from Table II for 4-inch meter run and 1.750 inch orifice)

Note: Use Table I for flange tap meters.

$\sqrt{(8.3)(734.2)} = (2.881)(27.09)$ (from Table III)
$= 78.05$

F_t = 0.9943 (from Table VII for temperature of 66 F)

F_g = 1.265 (from Table VIII for G_g = 0.625)

F_{pv} = 1.059 (from Basic Calculation Number 1, page V-1)

Number 3.

Calculation of the rate of flow using critical flow prover data:

$$Q = F_p \times P_m \times F_t \times F_g \times F_{pv}$$

Source of factors:

F_p (from Table V for appropriate prover size and orifice diameter)

P_m (prover pressure, psia)

Note: Other factors are determined in the same manner as in Basic Calculation Number 2.

Number 4.

Calculation of the rate of flow using positive choke data:

$$Q = F_p \times P_m \times F_t \times F_g \times F_{pv}$$

Source of factors:

F_p (from Table VI for appropriate choke size and type)

P_m (choke pressure, psia)

Note: Other factors are determined in the same manner as in Basic Calculation Number 2.

Number 5.

Determination of the exponent "n" of the back-pressure equation:

The exponent of the back-pressure equation, "n", may be determined as follows:

$$n = \frac{\log Q_2 - \log Q_1}{\log (P_c^2 - P_w^2)_2 - \log (P_c^2 - P_w^2)_1}$$

If $(P_c^2 - P_w^2)_2$ is selected from the back-pressure curve at a point one cycle greater than $(P_c^2 - P_w^2)_1$, then

$$n = \log Q_2 - \log Q_1, \text{ or}$$

$$n = \log Q_2/Q_1$$

Using the back-pressure curve in Test Example 1

at $(P_c^2 - P_w^2)_1 = 2,250$,

$Q_1 = 9,400$ and $\log Q_1 = 3.9731$

and

at $(P_c^2 - P_w^2)_2 = 225$,

$Q_2 = 1,590$ and $\log Q_2 = \underline{3.2014}$

0.7717

and

$n = 0.772$

When the back-pressure curve is plotted on equal cycle log-log paper, the exponent "n" is equal to the tangent of the angle formed with the $(P_c^2 - P_w^2)$ - axis or the cotangent of the angle formed with the "Q"-axis.

The exponent "n" may also be determined by the use of curve fitting methods such as that of least squares.

SECTION VI

TEST EXAMPLES

TEST EXAMPLE NO. 1 ..... VI- 1

A. Calculation of Absolute Open Flow on a Gas Well Where P_w Cannot be Measured (Using Average Temperature and Compressibility Factor, Step 6)..... VI- 1

B. Alternate Method of Calculation P_w Corresponding to Flowing Wellhead Pressure, P_t (Using Stepwise Procedure, Step 6-A)..... VI-10

TEST EXAMPLE NO. 2 - Calculation of Absolute Open Flow on a Gas Well Where P_w Can be Measured..... VI-19

TEST EXAMPLE NO. 3 - Calculation of Absolute Open Flow Using the One-Point Back-Pressure Test..... VI-25

TEST EXAMPLE NO. 4 - Calculation of Deliverability (D) Using the One-Point Back Pressure Test..... VI-30

TEST EXAMPLE NO. 5 - Calculation of Wellhead Pressure P_c or P_w Where the Observed Wellhead Pressure is Affected by Liquids in the Wellbore (Using Average Temperature and Pressure)..... VI-34

TEST EXAMPLE NO. 6 - Calculation of Wellhead Pressure P_c or P_w Where the Observed Wellhead Pressure is Affected by Liquids in the Wellbore (Using Stepwise Procedure)..... VI-38

TEST EXAMPLE NO. 7 - Calculation of Subsurface Pressure P_f (sandface) Where the Wellhead Shut-in Pressure is Affected by Liquids in the Wellbore..... VI-43

A. Calculation of Subsurface Pressure at the Sandface (Using Average Temperature and Compressibility Factors)..... VI-43

B. Calculation of Subsurface Pressure at the Sandface (Using Stepwise Procedure)..... VI-47

TEST EXAMPLE NO. 8 - Well Deliverability Test as Required for Prorated Gas Pools in Northwest New Mexico..... VI-52

A. CALCULATION OF ABSOLUTE OPEN FLOW ON A GAS WELL WHERE P_w CANNOT BE MEASURED

NOTE: If liquids are known to exist in the wellbore under shut-in conditions, refer to Test Example 5 or 6 for calculation of effective wellhead shut-in pressure P_c.

ALL SQUARED PRESSURES IN THOUSANDS

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate the compressibility Factor, Z, and supercompressibility Factor, F_{pv}, for flow rate calculations as follows:

Obtain P_{cr} and T_{cr} from Table IX for a gas gravity of 0.625; obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X. Correct P_{cr} and T_{cr} as follows:

$P_{cr} = 671 + 8 - 5 = 674$
$T_{cr} = 365 - 3 - 9 = 353$
$P_m = 721 + 13.2 = 734.2$ psia
$T_m = 66 + 460 = 526$ R
$P_r = P_m/P_{cr} = \frac{734.2}{674} = 1.09$

$T_r = T_m/T_{cr} = \frac{526}{353} = 1.49$

From Table XI, for $P_r = 1.09$ and $T_r = 1.49$, $Z = 0.891$
From Table XII for $Z = 0.891$, $F_{pv} = 1.059$

STEP 3.

Calculate the flow rates as follows and record on C-122

$$Q = F_b \sqrt{h_w \times P_m \times F_t \times F_g \times F_{pv}}$$

a. Rate #1
$F_b = 16.80$ Table II
$F_t = .9943$ Table VII
$F_g = 1.265$ Table VIII
$F_{pv} = 1.059$ Determined in Step 2

$Q_1 = 16.80 \sqrt{8.3 \times 734.2 \times 0.9943 \times 1.265 \times 1.059}$
$= 1747$ Mcfd

b. In like manner, the other three flow rates are calculated to be
Rate #2 - 2590 Mcfd
Rate #3 - 3398 Mcfd
Rate #4 - 4082 Mcfd

Record on Form C-122

STEP 4.

Since the well produces liquids with the gas, it is necessary to calculate the specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595 \quad G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

4595 = Constant
G_g = 0.625 (air = 1.000)
G_l = 0.7787 (water = 1.000) Table XIII - API = 50.2°
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

$G = 0.641$

STEP 5.

a. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X. Correct P_{cr} and T_{cr} as follows:

$P_{cr} = 670 + 8 - 5 = 673$
$T_{cr} = 372 - 3 - 9 = 360$

(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D)

b. Calculate L/H, the length of the flow string divided by the vertical depth.
L/H = 1.000

c. GH = 0.641 x 8130 = 5211

STEP 6.

Calculate P_w for the 1st flow rate using Average Temperature and Compressibility factors. (For greater accuracy, in wells with shut-in pressure in excess of 2000 psig, the Stepwise Procedure should be used to calculate P_w. The Stepwise Procedure is described starting on page VI - 10, Step 6-A.)

a. Enter Q_m = 1.747 on Form C-122-D Line 1, 1st Trial

STEP 6. (Cont'd)

b. $T_w = 74 + 460 = 534$ (Line 2)
$T_s = 155 + 460 = 615$ (Line 3)
$T = (T_w + T_s)/2 = (534 + 615)/2 = 574.5$ (Line 4)

STEP 7.

Estimate compressibility factor, Z. In this case Z is estimated to be 0.825.

STEP 8.

a. $TZ = 574.5 \times 0.825 = 474.0$ (Line 6)
$GH/TZ = 5211/474.0 = 10.994$ (Line 7)

STEP 9.

For GH/TZ = 10.994, read e^s and $1 - e^{-s}$ from Table XIV

$e^s = 1.510$

$1 - e^{-s} = 0.338$

STEP 10.

a. P_t = flowing wellhead pressure = 1785.2 psia (Line 10)

b. $P_t^2 = (1785.2)^2 = 3186.9$ (Line 11)

STEP 11.

For flow string with d = 1.995", F_r from Table XV is 0.018231

STEP 12.

a. $F_c = F_r\ TZ = (0.018231)\ (474.0) = 8.641$ (Line 13)

b. $F_c\ Q_m = (8.641)\ (1.747) = 15.10$ (Line 14)

c. $L/H\ (F_c\ Q_m)^2 = 1.000\ (15.10)^2 = 228.0$ (Line 15)

d. $F_w = L/H\ (F_c\ Q_m)^2\ (1 - e^{-s}) = (228.0)\ (.338) = 77.06$ (Line 16)

e. $P_w^2 = P_t^2 + F_w = 3186.9 + 77.06 = 3264.0$ (Line 17)

STEP 13.

a. $P_s^2 = e^s\ P_w^2 = (1.510)\ (3264.0) = 4928.6$ (Line 18)

b. $P_s = \sqrt{P_s^2} = \sqrt{4928.6} = 2220.1$ psia (Line 19)

c. $P = (P_t + P_s)/2 = (1785.2 + 2220.1)/2 = 2002.7$ (Line 20)

STEP 13. (Cont'd.)

d. $P_r = \frac{P}{P_{cr}} = \frac{2002.7}{673} = 2.98$ (Line 21)

e. $T_r = \frac{T}{T_{cr}} = \frac{574.5}{360} = 1.60$ (Line 22)

STEP 14.

Enter on Line 23 the compressibility factor, Z, from Table XI corresponding to a P_r of 2.98 and a T_r of 1.60. In this example Z = 0.826.

STEP 15.

Since Z in line 23 is not equal to Z in line 5, the estimation of Z in line 5 and subsequent calculations of P_w^2 are in error. Enter Z from line 23, 1st Trial, on line 5, 2nd Trial, and repeat calculations, Line 4 through Line 23. When Z in Line 5 is equal to Z in Line 23, the calculated value of P_w^2 is correct for the first flow rate.

STEP 16.

Repeat procedure for other flow rates and record the results on Form C-122.

STEP 17.

Determination of Absolute Open Flow.

Calculated data points from Form C-122 are to be plotted upon log-log paper of at least three inches per cycle to establish the absolute open flow and exponent "n." Q shall be plotted on the horizontal axis and the difference of the squared pressures, $P_c^2 - P_w^2$, on the vertical axis. (SQUARED PRESSURES IN THOUSANDS)

	Q Mcfd	$P_c^2 - P_w^2$
1.	1747	259.8
2.	2590	425.8
3.	3396	601.4
4.	4083	770.5

Absolute open flow is defined as the calculated 24-hour rate of flow against atmospheric pressure. The rate of flow shall be expressed at New Mexico Oil Conservation Commission base conditions of 15.025 psia and 60 F.

The error caused in the value of the absolute open flow, when atmospheric pressure is ignored, is insignificant when the shut-in pressure is above 100 psia. Because of this fact, atmospheric pressure will not be considered in this example.

The absolute open flow shall be read on the Q axis directly under the point where the value of P_c^2 intersects the back-pressure curve. In this example, $P_c^2 = 3523.9$. When plotted on the back-pressure curve the absolute open flow is 13, 250 Mcfd, see attached curve.

STEP 18.

Determination of exponent, n, of the back-pressure curve.

STEP 18. (Cont'd.)

The numerical value of the exponent, n, is the cotangent of the angle formed by the back pressure curve and the horizontal axis of the log-log plot.

The most accurate method to determine "n" is to find the difference of the logrithms of two values of Q which are exactly one vertical cycle apart. Exponent "n" is found as follows:

Q_1 (where $P_c^2 - P_w^2$ is 2250) = 9400 Mcfd

Q_2 (where $P_c^2 - P_w^2$ is 225) = 1590 Mcfd

Log 9400 (Q_1) = 3.97313

Log 1590 (Q_2) = 3.20140

n = 0.77173

n = 0.772

STEP 19.

The value of absolute open flow should be checked by substituting test data into the following formula. If a test data point does not fall on the curve as drawn, then any convenient value of Q and ($P_c^2 - P_w^2$) from the curve should be used.

$$AOF = Q\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n$$

where:

AOF = absolute open flow.
Q = rate of flow from test data point or from back-pressure curve.
P_c = wellhead shut in pressure.
P_w = static column wellhead pressure.
n = exponent of back-pressure curve.

NOTE: Where Q is taken from the back-pressure curve, ($P_c^2 - P_w^2$) is read directly from the curve.

Substituting values in the equation (2nd flow rate)

$$AOF = 2590 \text{ Mcfd} \left[\frac{3523.9}{3523.9 - 3098.1}\right]^{.772}$$

$AOF = 2590 (8.276)^{.772}$
$AOF = 2590 (5.112)$
$AOF = 13,240$ Mcfd

AOF from back-pressure curve is 13, 250 Mcfd which is in good agreement. Although the figure 13, 250 Mcfd as read from the curve cannot be used, it is a good method for checking the calculations.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special	Test Date: 11/10/64			Lease No. or Serial No.
Company: Test Example No. 1		Connection: Blowe Gas Company		Allottee
Field: Monument	Reservoir: McKee	Location		Unit
Completion Date: 2-4-58	Total Depth: 8293	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test
Csg. Size: 7"	Wt.: 23.#	d: 6.366	Set At: 8293	Perforations: From: 8112 To: 8138 — Well No.: 1
Tbg. Size: 2-3/8"	Wt.: 4.7#	d: 1.995	Set At: 8130	Perforations: From: Open Ended To — Unit: D Sec.: 30 Twp.: 19-S Rge.: 36-E
Type Completion (Describe): Single			Packer Set At: 8100	County or Parish: Lea
Producing Thru: Tbg.	Reservoir Temp. F: 155 @ 8130'	Mean Annual Temp. F: 60	Baro. Press. – P_a: 13.2	State: New Mexico
L: 8130	H: 8130	G_g: 0.625	% CO_2: 2.0	% N_2: 3.0 — % H_2S: 0 — Prover: — Meter Run: 4" — Taps: Pipe

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure: Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER: Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type–A.P.I. Gravity–Amount)
11-10-64									St Tk 3' - 7 1/8" 60F
7:45A		1864.0	Packer						72 hour Shut-in Pressure
8:00A									Start 1st Flow
8:30A		1809.0		74	718.0	7.0	60	1.75	
9:00A		1793.0		74	720.0	8.0	59		
9:30A		1772.0		74	721.0	8.4	64		
10:00A		1772.0		74	721.0	8.3	66		St Tk 3' - 7 1/2" 60F
		NOT REQUIRED TO BE FILED							
10:00A									Increased Rate for 2nd Flow
10:30A		1765.0		74	719.0	15.0	54	1.75	
11:00A		1742.0		74	719.0	15.0	54		
11:30A		1698.0		74	722.0	15.7	55		
12:00N		1698.0		74	729.0	17.5	56		St Tk 3' - 8 1/4" 60F
12:00N									Increased Rate for 3rd Flow
12:30P		1705.0		74	739.0	24.0	43	1.75	
1:00P		1672.0		74	740.0	25.5	46		
1:30P		1608.0		74	742.0	27.5	50		
2:00P		1608.0		74	744.0	29.3	54		St Tk 3' - 9 1/8" 60F
2:00P									Increased Rate for 4th Flow
2:30P		1630.0		74	745.0	38.0	44	1.75	
3:00P		1587.0		74	746.0	39.3	46		
3:30P		1512.0		74	749.0	41.5	52		
4:00P		1512.0		74	759.0	41.5	55		St Tk 3' - 10 1/4" 60F
									API - 50.2 at 60F
									Tank Size - 12' Diameter
									1.68 Barrels/inch

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 11-10-64	
Company: Test Example No. 1		Connection: Blowe Gas Co.			
Pool: Monument		Formation: McKee		Unit:	
Completion Date: 2-4-58	Total Depth: 8293	Plug Back TD:	Elevation:	Farm or Lease Name: H. I. Test	
Csg. Size: 7" / Wt.: 23 / d: 6.366 / Set At: 8293		Perforations: From 8112 To 8148		Well No.: 1	
Tbg. Size: 2-3/8" / Wt.: 4.7 / d: 1.995 / Set At: 8130		Perforations: From Open To Ended		Unit: D / Sec.: 30 / Twp.: 19-S / Rge.: 36-E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: 8100		County: Lea	
Producing Thru: Tbg.	Reservoir Temp. °F: 155 @ 8130'	Mean Annual Temp. °F: 60	Baro. Press. – P_a: 13.2	State: New Mexico	

L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps
8130	8130	0.625	2.0	3.0	0.0		4"	Pipe

NO.	FLOW DATA: Prover Line Size X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	TUBING DATA: Press. p.s.i.g.	Temp. °F	CASING DATA: Press. p.s.i.g.	Temp. °F	Duration of Flow
SI					1864.0		Pkr		72
1.	4x1.75	721.0	8.3	66	1772.0	74			2
2.	4x1.75	729.0	17.5	56	1698.0	74			2
3.	4x1.75	744.0	29.3	54	1608.0	74			2
4.	4x1.75	759.0	41.5	55	1512.0	74			2
5.									

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	16.80	78.06	734.2	.9943	1.265	1.059	1747
2	16.80	114.0	742.2	1.004	1.265	1.065	2590
3	16.80	149.0	757.2	1.006	1.265	1.066	3396
4	16.80	179.0	772.2	1.005	1.265	1.068	4083
5							

NO.	P_t	Temp. °R	T_r	Z
1	1.09	526	1.49	0.891
2	1.10	516	1.46	0.882
3	1.12	514	1.46	0.880
4	1.15	515	1.46	0.877
5				

Gas Liquid Hydrocarbon Ratio: 193 Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: 50.2 Deg.
Specific Gravity Separator Gas: 0.625 XXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX 0.641
Critical Pressure: 674 P.S.I.A. 673 P.S.I.A.
Critical Temperature: 353 R 360 R

P_c 1877.2 P_c^2 3523.9

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1	3186.9		3264.1	259.8
2	2928.2		3098.1	425.8
3	2628.3		2922.5	601.4
4	2326.2		2753.4	770.5
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 8.276$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 5.112$

AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 13,240$

Absolute Open Flow: 13,240 Mcfd @ 15.025 Angle of Slope θ: Slope, n: .772

Remarks:

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w)

Form C-122D
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11/10/64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

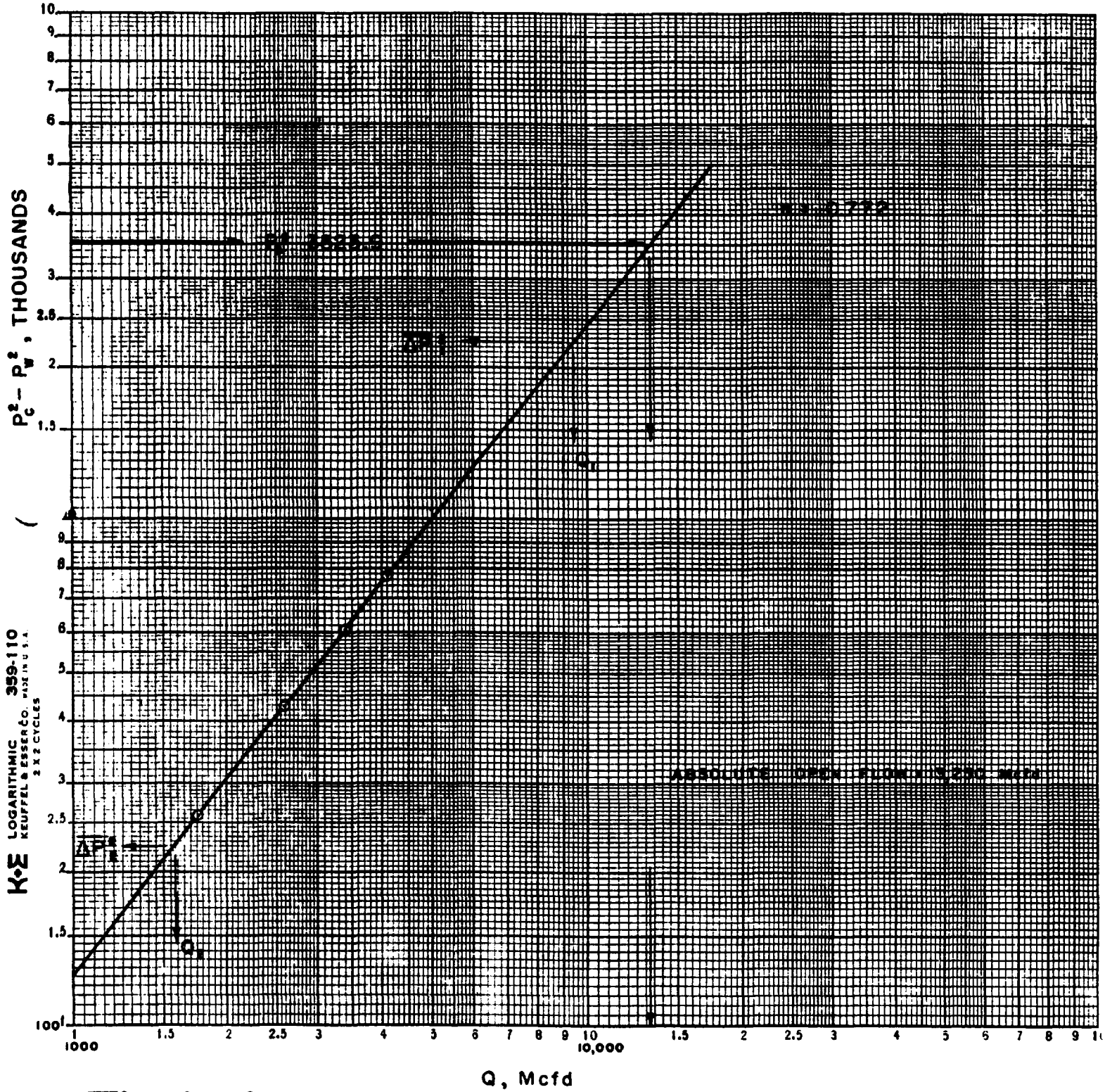
L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .018231 GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	1st Rate		2nd Rate		3rd Rate		4th Rate			
	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial		
1 Q_m	1.747	1.747	2.590	2.590	3.396	3.396	4.083	4.083		
2 T_w (W.H. °R)	534	534	534	534	534	534	534	534		
3 T_s (B.H. °R)	615	615	615	615	615	615	615	615		
4 $T = (\frac{T_w + T_s}{2})$	574.5	574.5	574.5	574.5	574.5	574.5	574.5	574.5		
5 Z (Est.)	0.825	0.826	0.833	0.829	0.833	0.832	0.833	0.835		
6 TZ	474.0	474.5	478.6	476.3	478.6	478.0	478.6	479.7		
7 GH/TZ	10.994	10.982	10.888	10.941	10.888	10.902	10.888	10.863		
8 e^s (Table XIV)	1.510	1.510	1.504	1.507	1.504	1.505	1.504	1.503		
9 $1-e^{-s}$ (Table XIV)	0.338	0.338	0.335	0.336	0.335	0.336	0.335	0.335		
10 P_t	1785.2	1785.2	1711.2	1711.2	1621.2	1621.2	1525.2	1525.2		
11 $P_t^2/1000$	3186.9	3186.9	2928.2	2928.2	2628.3	2628.3	2326.2	2326.2		
12 F_f (Table XV)	.018231	.018231	.018231	.018231	.018231	.018231	.018231	.018231		
13 $F_c = F_f$ TZ	8.641	8.651	8.725	8.683	8.725	8.714	8.725	8.745		
14 $F_c Q_m$	15.10	15.11	22.60	22.49	29.63	29.59	35.62	35.71		
15 $L/H (F_c Q_m)^2$	228.0	228.3	510.8	505.8	877.9	875.6	1268.8	1275.2		
16 $F_w = L/H(F_c Q_m)^2(1-e^{-s})$	77.06	77.17	171.1	169.9	294.1	294.2	425.0	427.2		
17 $P_w^2 = P_t^2 + F_w$	3264.0	3264.1	3099.3	3098.1	2922.4	2922.5	2751.2	2753.4		
18 $P_s^2 = e^s P_w^2$	4928.6	4928.8	4661.3	4668.8	4395.3	4398.4	4137.8	4138.4		
19 P_s	2220.1	2220.1	2159.0	2160.7	2096.5	2097.2	2034.2	2034.3		
20 $P = (\frac{P_t + P_s}{2})$	2002.7	2002.7	1935.1	1936.0	1858.9	1859.2	1779.7	1779.8		
21 $P_r = (P/P_{cr})$	2.98	2.98	2.88	2.88	2.76	2.76	2.64	2.64		
22 $T_r = (T/T_{cr})$	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60		
23 Z (Table XI)	0.826	0.826	0.829	0.829	0.832	0.832	0.835	0.835		

One copy to be filed in District Office (Work ... acceptable)

Company	Test Example No. 1
Well	H. I. Test No. 1
Location	D, 30-20S-36E
County	Lea
Date	11-10-64



$\overline{\Delta P_1^2}$ $P_c^2 - P_w^2$ = 2250

$\overline{\Delta P_2^2}$ $P_c^2 - P_w^2$ = 225

Q_1 = 9400 Mcfd

Q_2 = 1590 Mcfd

LOG Q_1 = 3.97313

LOG Q_2 = 3.20140

n = .77173 = 0.772

B. ALTERNATE METHOD OF CALCULATION P_w CORRESPONDING TO FLOWING WELLHEAD PRESSURE, P_t

(This method is based on Stepwise Procedure rather than using average temperature and compressibility factors.)

NOTE: This method of calculation is to be used when shut-in wellhead pressures exceed 2000 psi. However, in order to be consistent in the use of basic data, this example uses a shut-in wellhead pressure of 1864 psig.

STEP 6-A.

a. Fill in the required information at the top of Form C-122-E.

b. Obtain the inside diameter of the flow string and corresponding F_r value.

Enter at the top of Form C-122-E.

$d = 1.995"$
$F_r = 0.018231$ Table XV

c. Calculate (L/H) $(F_r\ Q_m)^2$ and enter on Form C-122-E
$(1.000)\ (0.018231 \times 1.747)^2 = 0.001014$

STEP 7-A.

Determine the flowing temperature at the surface, mid-point of the flow string, and at the bottom of the hole for use in the pressure calculations.

$T @ H = 0 = 74 + 460 = 534$ R
$T @ H = 8130/2 = (74 + 155)/2 + 460 = 574.5$ R
$T @ H = 8130 = 155 + 460 = 615$ R

STEP 8-A.

Enter H = 0 on Line 1, Column 1. Form C-122-E. (Line references are indicated in parenthesis following each step; column references remain unchanged unless indicated.)

a. Lines 1, 2, and 3 in Column 1 are zero.

b. $P_t = 1785.2$ psia (measured wellhead pressure) (Line 4)

c. $P_r = \frac{P_t}{P_{cr}} = \frac{1785.2}{673} = 2.65$ (Line 5)

d. T = wellhead temperature, 534 R (Line 6)

e. $T_r = \frac{T}{T_{cr}} = \frac{534}{360} = 1.48$ (Line 7)

f. Z = 0.777 Table XI (Line 8)

STEP 8-A. (Cont'd.)

g. $P/Z = (1785.2)/.777 = 2297.6$ (Line 9)

h. $P/TZ = 2297.6/534 = 4.3026$ (Line 10)

i. $(P/TZ)^2/1000 = (4.3026)^2/1000 = 0.018512$ (Line 11)

j. $(L/H)\ (F_r\ Q_m)^2 = 0.001014$ (previously calculated) (Line 12)

k. Add (Line 11) and (Line 12);
$0.018512 + 0.001014 = 0.019526$ (Line 13)

l. I_t = (Line 10)/(Line 13) = $4.3026/0.019526 = 220.352$ (Line 14)

STEP 9-A.

Make first trial calculation for the pressure at the midway point, H = 8130/2 = 4065'. (Line 1, Column 2)

a. Compute GH and 37.5 GH
GH = $0.641 \times 4065 = 2605.67$ (Line 2)
$37.5\ GH = 37.5 \times 2605.67 = 97,713$ (Line 3)

b. Estimate value of M as follows:
$(37.5\ GH/2I_t = 97,713/2\ (220.352) = 222$ (Line 15, Column 2)

c. Add M to P_t, $222 + 1785.2 = 2007.2$ (Line 4)

d. Compute P_r and T_r using the estimated pressure and temperature at H = 4065, and obtain Z from Table XI.

$P_r = \frac{2007.2}{673} = 2.98$ (Line 5)

T = 574.5 R (Line 6)

$T_r = \frac{574.5}{360} = 1.60$ (Line 7)

Z = 0.826 (Line 8)

e. Compute P/Z, P/TZ, and $(P/TZ)^2/1000$ and enter appropriate values in Lines 9, 10, and 11, respectively.

f. Since L/H = 1.000 and neither F_r or Q_m have changed, $L/H\ (F_r\ Q_m)^2$ is still equal to the previously calculated value of 0.001014 (Line 12)

g. (Line 11) plus (Line 12) = $0.017891 + 0.001014 = 0.018905$ (Line 13)

h. I_1 = (Line 10)/(Line 13) = 223.740 (Line 14)

i. $N = I_t$ + Trial $I_1 = 220.352 + 223.740 = 444.092$ (Line 16)

STEP 9-A. (Cont'd.)

j. Calculate M by dividing 37.5 GH by N, 97, 713/444.092 = 220 (Line 15, Column 3)

k. When M has been estimated correctly, the value determined under item (j) will equal M under item (b).

l. Enter 220 under M (Line 15, Column 3) and repeat items (c) through (j) until the correct M is estimated.

m. By repeating the calculations, the correct value of M is determined to be 220.

n. Multiply final values of M and N
(220) (444.284) = 97, 742 (Line 17)

o. Enter the value of M x N under $\sum$ (M x N) (Line 18)

STEP 10-A.

Make first trial calculation for the pressure at H = 8130'. (Line 1, Column 4)

a. Compute GH and 37.5 GH and enter on the appropriate line.
GH = 0.641 x 8130 = 5211.33 (Line 2)
37.5 GH = 37.5 x 5211.33 = 195, 425 (Line 3)

b. Estimate value of M by dividing N (Line 16, Column 3) into the difference between 37.5 GH (Line 3, Column 4) and M x N (Line 17, Column 3)
M = (195, 425 - 97, 742)/444.284 = 220 (Line 15, Column 4)

c. $P_2 = M + P_1 = 220 + 2005.2 = 2225.2$

d. Compute P_r and T_r at H = 8130; obtain appropriate Z. Compute P/Z, P/TZ, and $(P/TZ)^2/1000$. Enter all these values on the appropriate Lines 5 through 11.

e. $L/H\ (F_r\ Q_m)^2 = 0.001014$ (Line 12)

f. (Line 11) + (Line 12) = 0.018632 (Line 13)

g. I_2 = (Line 10)/(Line 13) = 4.1974/.018632 = 225.279 (Line 14)

h. $N = I_1 + \text{Trial } I_2 = 223.932 + 225.279 = 449.211$ (Line 16)

i. Compute M by dividing N (Line 16) into the difference, 37.5 GH (Line 3) minus (M x N) (Line 17, Column 3) thus
M = (195, 425 - 97, 742)/449.473 = 217 (Line 15, Column 5)

j. When M has been estimated correctly, the value determined under item (i) is equal to that determined under item (b).

STEP 10-A. (Cont'd.)

k. Enter M = 217 on Line 15, Column 5, and repeat items (c) through (i) until the correct value of M is determined.

l. By repeating the calculations, the correct M is determined to be 217.

m. Multiply final values of M and N
217 x 449.473 = 97,536 (Line 17)

n. Add M x N (Line 17) to $\sum$ (M x N) (Line 18, Column 3) and enter on Line 18, Column 5. $\sum$ (M x N) = 97,742 + 97,536 = 195,278

STEP 11-A.

Using the following equations, compute the flowing pressure (P_s) at H = 8130 feet.

$$\triangle P = \frac{3(37.5\ GH)}{I_t + 4I_1 + I_2}$$

$$P_s = P_t + \triangle P$$

where:

$G = 0.641$
$H = 8130'$
$I_t = 220.352$ (Line 14, Column 1)
$I_1 = 223.932$ (Line 14, Column 3)
$I_2 = 225.541$ (Line 14, Column 5)
$P_t = 1785.2$ (Line 4, Column 1)

$$\triangle P = \frac{3(195,425)}{220.352 + 4(223.932) + 225.541}$$

$$\triangle P = \frac{586,275}{1341.621} = 437.0$$

$P_s = 1785.2 + 437.0$
$P_s = 2222.2$ psia at H = 8130'
P_s is to be used in the next major step in the calculations, which is to convert P_s to a static column pressure at the wellhead, P_w.

STEP 12-A.

Transfer the following from the last column on page 1, Form C-122-E, to Column 1, Page 2: H = 8130', GH = 5211.33, 37.5 GH = 195,425, $P_n = 2222.2$, $P_r = 3.30$, T = 615, $T_r = 1.71$, Z = 0.862, P/Z = 2578.0, and P/TZ = 4.1919.

a. Lines 11, 12, and 13 can be omitted in the static column case where Q_m is zero. Where $Q_m = 0$, L/H $(F_r\ Q_m)^2$ must necessarily = 0. Therefore, I_n resolves.

$$I_n = \frac{P/TZ}{(P/TZ)^2/1000 + L/H(F_r\ Q_m)^2} = \frac{P/TZ}{(P/TZ)^2/1000 + 0}$$

$$I_n = \frac{1000}{P/TZ}$$

$I_s = (1000)/4.1919 = 238.555$ (Line 14)

STEP 12-A. (Cont'd.)

b. Enter value of 37.5 GH = 195, 425 from Line 3 to 18.

STEP 13-A.

Make first trial calculation for the pressure at H/2 = 8130/2 = 4065 (Line 1, Column 2)

a. H = 4065 (Line 1)

b. GH = 2605.67 (Line 2)

c. 37.5 GH = 97, 713 (Line 3)

d. Estimate value of M by dividing $2I_s$ (Line 14, Column 1) into the difference between $\sum$ (M x N) (Line 18, Column 1) and 37.5 GH (Line 3, Column 2)
M = (195, 425 - 97, 713)/2 (238.555) = 205 (Line 18, Column 2)

e. $P_1 = P_n - M = 2222.2 - 205 = 2017.2$ (Line 4)

f. $P_r = 2017.2/673 = 3.00$ (Line 5)

g. T = estimated temperature at 4065' = (74 + 155)/2 + 460 = 574.5 (Line 6)

(Since the temperature of a static column will approach the temperature of the adjoining flowing column, the temperatures used in the calculations of pressure at H = 4065 and H = 0 should be the temperatures of the flowing column.)

h. $T_r = 574.5/360 = 1.60$ (Line 7)

i. Z = 0.825 (Line 8)

j. P/Z = 2017.2/0.825 = 2445.1 (Line 9)

k. P/TZ = 2445.1/574.5 = 4.2560 (Line 10)

l. $I_1 = 1000/(P/TZ) = 1000/4.2560 = 234.962$ (Line 14)

m. N = I_s (Column 1) + Trial I_1 (Column 2) = 238.555 + 234.962 = 473.517 (Line 16)

n. M = 37.5 GH/N = 97, 713/473.517 = 206. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

o. Enter M = 206 (Line 15, Column 3)

p. P_1 is then P_n - M = 2222.2 - 206 = 2016.2 (Line 4, Column 3)

q. Repeat Steps (f) through (n) until the correct value of M is determined. M = 206

STEP 13-A. (Cont'd.)

r. Multiply final values of M x N
206 x 473.628 = 97,567 (Line 17)

s. Subtract M x N (Line 17) from $\sum$ (M x N) (Line 18, Column 1)
195,425 - 97,567 = 97,858 (Line 18)

STEP 14-A.

Make first trial calculation for the pressure at H = 0 (Line 1, Column 4)

a. GH = 0

b. 37.5 GH = 0

c. Estimate M by dividing N (Line 16, Column 3) into $\sum$ (M x N) (Line 18, Column 3)
M = 97,858/473.628 = 207 (Line 15, Column 4)

d. Subtract M from P_1 (H = 4065)
2016.2 - 207 = 1809.2 (Line 4)

e. P_r = 1809.2/673 = 2.69 (Line 5)

f. T = 74 + 460 = 534 (Line 6)

g. T_r = 534/360 = 1.48 (Line 7)

h. Z = 0.775 (Line 8)

i. P/Z = 2334.5 (Line 9)

j. P/TZ = 4.3717 (Line 10)

k. I_c = 1000/4.3717 = 228.744 (Line 14)

l. N = 235.078 + 228.744 = 463.822 (Line 16)

m. Compute M by dividing $\sum$ (M x N) (Line 18, Column 3) by N (Line 16, Column 4)
M = 97,858/463.822 = 211
When M has been estimated correctly, the value determined under this item will be equal to that determined under item (c).

n. Enter M = 211 on Line 15, Column 5 and repeat the calculations (d) through (m).
M = 210

o. Multiply final values of M and N
210 x 465.053 = 97,661 (Line 17)

STEP 15-A.

Using the following equations calculate the static column wellhead pressure P_w.

$$\triangle P = \frac{3(37.5\ GH)}{I_w + 4I_1 + I_2}$$

$$P_w = P_s - \triangle P$$

where:

$G = 0.641$

$H = 8130$

$I_w = 229.975$ (Line 14, Column 6)

$I_1 = 235.073$ (Line 14, Columr 3)

$I_2 = 238.555$ (Line 14, Column 1)

$P_s = 2222.2$ (Line 4, Column 1)

$$\triangle P = \frac{3(37.5)\ (.641)\ (8130)}{229.975 + 4\ (235.073) + 238.555} = \frac{586,275}{1408.822} = 416.1$$

$$P_w = 2222.2 - 416.1 = 1806.1$$

STEP 16-A.

Using the same procedure as outlined, the other three pressure points are then calculated. After calculating P_w for all flow rates, refer to Steps 17, 18, and 19 on pages VI-4 and VI-5 for the procedure to be followed in determining the absolute open flow.

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) ~~(SURFACE)~~ PRESSURE (P_f & P_s) ~~(P_c & P_w)~~

Form C-122E
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11-10-64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .01823 Q_m 1.747 M^2cfd (L/H) $(F_rQ_m)^2$ 0.001014 P_{CT} 673 (TABLE IX & X) T_{CT} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		0	4065		8130						
2	GH		0	2605.67		5211.33						
3	37.5GH		0	97,713		195,425						
4	P_c or P_n		1785.2	2007.2	2005.2	2225.2	2222.2					
5	P_r		2.65	2.98	2.98	3.31	3.30					
6	T		534	574.5	574.5	615	615					
7	T_r		1.48	1.60	1.60	1.71	1.71					
8	Z		.777	0.826	0.826	0.862	0.862					
9	P/Z P/Z	4÷8	2297.6	2430.0	2427.6	2581.4	2578.0					
10	P/TZ	9÷6	4.3026	4.2298	4.2256	4.1974	4.1919					
11	$(P/TZ)^2/1000$	$(10)^2/1000$	0.018512	0.017891	0.017856	0.017618	.017572					
12	$L/H(F_rQ_m)^2$		0.001014	.001014	0.001014	0.001014	0.001014					
13		11 + 12	0.019526	0.018905	0.018870	0.018632	0.018586					
14	I_n	10÷13	220.352	223.740	223.932	225.279	225.541					
15	$M=P_n-P_{n-1}$			222	220	220	217					
16	$N=I_n+I_{n-1}$			444.092	444.284	449.211	449.473					
17	M x N	15x16			97, 742		97, 536					
18	Σ(M x N)	Σ17			97, 742		195, 278					

VI-17

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) (SURFACE) PRESSURE (P_f & P_s) (P_c & P_w)

Form C-122E
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11-10-64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

L 8130 H 8130 L/H 1.000 G .641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .018231 Q_m 0 M^2cfd (L/H) $(F_rQ_m)^2$ 0 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		8130	4065		0						
2	GH		5211.33	2605.67		0						
3	37.5GH		195,425	97,713		0						
4	P_c or P_n		2222.2	2017.2	2016.2	1809.2	1805.2	1804.2				
5	P_r		3.30	3.00	3.00	2.69	2.68	2.68				
6	T		615	574.5	574.5	534	534	534				
7	T_r		1.71	1.60	1.60	1.48	1.48	1.48				
8	Z		0.862	0.825	0.825	0.775	0.777	0.777				
9	P/Z P/Z	$\bar{4}\div\bar{8}$	2578.0	2445.1	2443.9	2334.5	2323.3	2322.0				
10	P/TZ	$\bar{9}\div\bar{6}$	4.1919	4.2560	4.2540	4.3717	4.3507	4.3483				
11	$(P/TZ)^2/1000$	$(\bar{10})^2/1000$										
12	$L/H(F_rQ_m)^2$											
13		$\bar{11}+\bar{12}$										
14	I_n	$\bar{10}+\bar{13}$	238.555	234.962	235.073	228.744	229.848	229.975				
15	$M=P_n-P_{n-1}$			205	206	207	211	210				
16	$N=I_n+I_{n-1}$			473.517	473.628	463.822	464.926	465.053				
17	M x N	$\bar{15}\times\bar{16}$			97,567			97,661				
18	Σ(M x N)	$\Sigma\bar{17}$	195,425		97,858							

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 2

CALCULATION OF ABSOLUTE OPEN FLOW ON A GAS WELL WHERE P_w CAN BE MEASURED

Producing through tubing with casing pressures available.

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate Flow rates as follows, and record on C-122:

$$Q = F_b \sqrt{h_w \times P_m} \times F_t \times F_g \times F_{pv}$$

a. Rate #1

P_{cr} = 669 Table IX
T_{cr} = 382 Table IX
P_m = 754 + 13.2 = 767.2
T_m = 74 + 460 = 534
P_r = $\frac{767.2}{669}$ = 1.15
T_r = $\frac{534}{382}$ = 1.40
Z = .856 Table XI
F_{pv} = 1.081 Table XII
F_b = 10.84 Table I
F_t = .9868 Table VII
F_g = 1.217 Table VIII
Q = 10.84 x 95.94 x .9868 x 1.217 x 1.081 = 1350 Mcfd

b. In like manner, the other three flow rates are found to be (see Form C-122):

Rate #2 Q_2 = 1839 Mcfd
Rate #3 Q_3 = 2032 Mcfd
Rate #4 Q_4 = 2432 Mcfd

STEP 3.

Pressure calculations -

Since the static wellhead working pressures (P_w) are measured, the pressure loss due to friction calculations are not necessary.

Data for plotting back pressure curve:

Q vs. $(P_c^2 - P_w^2)$

where:

Q = rate of flow, Mcfd @ 15.025 psia & 60 F.
P_c = wellhead shut-in pressure, casing or tubing whichever is higher.
P_w = static wellhead working pressure at the termination of each flow period. (Casing if flowing through tubing, tubing if flowing through casing.)

ALL SQUARED PRESSURES IN THOUSANDS

Values of P_c and P_w are calculated by adding 13.2 (Northwest New Mexico use 12.2) to the casing pressures recorded on Suggested Field Data Sheet.

Rate	Q (Mcfd)	P_c (Psia)	P_c^2 (Thsnds)	P_w (Psia)	P_w^2 (Thsnds)	$P_c^2-P_w^2$ (Thsnds)
1	1350	999.2	998.4	855.2	731.4	267.0
2	1839	999.2	998.4	795.2	632.3	366.1
3	2032	999.2	998.4	767.2	588.6	409.8
4	2432	999.2	998.4	711.2	505.8	492.6

STEP 4.

The above data shall then be plotted on log-log paper of at least three inch cycles in accordance with rule 5a of the Stabilized Multipoint Test instructions. Q shall be plotted on the horizontal axis and (P_c^2 - P_w^2) on the vertical axis as shown at the end of this example.
Enter values of Pc, Pc^2, P_w, P_w^2, and (P_c^2 - P_w^2) on Form C-122.

STEP 5.

Determining the value of the exponent "n" of the back-pressure curve. The numerical value of "n" is the cotangent of the angle formed by the back-pressure curve and the horizontal axis of the log-log plot.

However, a more convenient and accurate method may be used to determine the value of "n." The difference of the logarithm of two values of Q which are exactly one vertical cycle apart shall be determined in the following manner: (see attached curve)

Value of Q where curve intersects the (P_c^2 - P_w^2) scale exactly one cycle higher than the (P_c^2 - P_w^2) value used for Q_1. In this example, this value is 2000 (thousands).

Q_2 = 8910; Log Q_2 = 3.949878

Value of Q where curve intersects the lowest convenient value of (P_c^2 - P_w^2). In this example this value is 200 (thousands)

Q_1 = 1045; Log Q_1 = 3.019116

n = .930762

Rounded off to three decimals, "n" is then 0.931. This value shall be entered on Form C-122.

STEP 6.

Determining Absolute Open Flow.
Absolute open flow is defined as the calculated 24-hour rate of flow against atmospheric pressure. The rate of flow shall be expressed at New Mexico Oil Conservation Commission base conditions of 15.025 psia and 60 F.

The error caused in the value of the absolute open flow, when atmospheric pressure is ignored, is insignificant when shut-in pressure is above 100 psia. Because of this fact, atmospheric pressure will not be considered in this example.

The absolute open flow shall be determined by plotting the value of (P_c^2 - P_w^2) on the back-pressure curve when P_w equals zero. The absolute open flow is

STEP 6. (Cont'd.)

read on the Q or horizontal scale of the log-log plot directly under the plotted point where the $(P_c^2 - P_w^2)$ value intersects the back-pressure curve.

In this example P_c^2 equals 998.4 (thousands). When plotted on the back-pressure curve, the value of the absolute open flow is 4670 Mcfd. Record this value on Form C-122.

The value of AOF should be checked by substituting test data in the following formula. If a data point does not fall on the curve as drawn, then any convenient value of Q and $(P_c^2 - P_w^2)$ from the curve should be used.

$$AOF = Q \left[\frac{P_c^2}{(P_c^2 - P_w^2)} \right]^n$$

where:

AOF = absolute open flow
Q = rate of flow from test data point, or from back-pressure curve
P_c = wellhead shut-in pressure psia
P_w = static column wellhead pressure
n = exponent of back-pressure curve

Note: Where Q is taken from the back-pressure curve, $(P_c^2 - P_w^2)$ is read directly from the curve.

Substituting values in equation (4th flow rate):

$$AOF = 2432 \left[\frac{998.4}{(998.4 - 505.8)} \right]^{0.931}$$

$$AOF = 2432\ (2.027)^{.931}$$
$$AOF = 2432\ (1.931)$$
$$AOF = 4696 \text{ Mcfd}$$

The calculation checks the value of 4670 Mcfd as read from the back-pressure curve and is correct.

Although the figure 4670 as read from the curve cannot be used, it is a good method for checking the calculations.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special	Test Date: 11-10-64			Lease No. or Serial No.
Company: Test Example No. 2	Connection: Blowe Gas Co.			Allottee
Field: Eumont	Reservoir: Queen	Location		Unit
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test
Csg. Size: 5-1/2 / Wt.: 15.5 / d: 4.950	Set At: 3593	Perforations: From: 3550	To: 3560	Well No.: 6
Tbg. Size: 2-3/8 / Wt.: 4.7 / d: 1.995	Set At: 3573	Perforations: From	To: Open End	Unit: A / Sec.: 36 / Twp.: 22-S / Rge.: 35-E
Type Completion (Describe): Single		Packer Set At: None		County or Parish: Lea
Producing Thru: Tbg.	Reservoir Temp. F: @ 130° F	Mean Annual Temp. F	Baro. Press. – P_a: 13.2	State: New Mexico
L: 3573 / H: 3573	G_g: 0.675	% CO_2	% N_2	% H_2S	Prover	Meter Run: 4" Flange	Taps

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure: Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER: Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type–A.P.I. Gravity–Amount)
11-10-64									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press
11-11-64									
7:00A	24	754	842	75	754	12.0"	74	1.5"	1st Flow rate
		NOT REQUIRED TO BE FILED							
11-12-64									
7:00A	24	652	782	75	652	26.0"	71	1.5"	2nd Flow rate
11-13-64									
7:00A	24	598	754	75	598	35.0"	71	1.5"	3rd Flow rate
11-14-64									
7:00A	24	401	698	75	401	77.0"	71	1.5"	4th Flow rate

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 11-10-64	
Company: Test Example No. 2			Connection: Blowe Gas Company		
Pool: Eumont			Formation: Queen		Unit:
Completion Date: 6-4-50	Total Depth: 3593		Plug Back TD:	Elevation:	Farm or Lease Name: H. I. Test
Csg. Size: 5-1/2 / Wt.: 15.5 / d: 4.950 / Set At: 3593			Perforations: From 3550 To 3560		Well No.: 6
Tbg. Size: 2-3/8 / Wt.: 4.7 / d: 1.995 / Set At: 3573			Perforations: From Open To Ended		Unit: A / Sec.: 36 / Twp.: 22-S / Rge.: 35-E
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single			Packer Set At: None		County: Lea
Producing Thru: Tbg.	Reservoir Temp. °F: 130	Mean Annual Temp. °F:	Baro. Press. – P_a: 13.2		State: New Mexico
L: 3573	H: 3573	Gg: 0.675	% CO_2:	% N_2:	% H_2S:
Prover:	Meter Run: 4"	Taps: Flange			

	FLOW DATA					TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI	4"	1.5"				986	75	984	75	SI 72 hr.
1.	4"	"	754	12.0"	74	754	"	842	"	24
2.	4"	"	652	26.0	71	652	"	782	"	24
3.	4"	"	598	35.0	71	598	"	754	"	24
4.	4"	"	401	77.0	71	401	"	698	"	24
5.										

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	10.84	95.95	767.2	.9868	1.217	1.081	1350
2	10.84	131.51	665.2	.9896	1.217	1.071	1839
3	10.84	146.26	611.2	.9896	1.217	1.064	2032
4	10.84	178.59	414.2	.9896	1.217	1.043	2432
5							

NO.	P_t	Temp. °R	T_r	Z
1	1.15	534	1.40	.856
2.	.99	531	1.39	.872
3.	.91	531	1.39	.883
4.	.62	531	1.39	.919
5				

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.
Specific Gravity Separator Gas: .675 XXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX Dry Gas
Critical Pressure: 669 P.S.I.A. ____ P.S.I.A.
Critical Temperature: 382 R ____ R

P_c 999.2 P_c^2 998.4

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1		855.2	731.4	267.0
2		795.2	632.3	366.1
3		767.2	588.6	409.8
4		711.2	505.8	492.6
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 2.027$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 1.931$

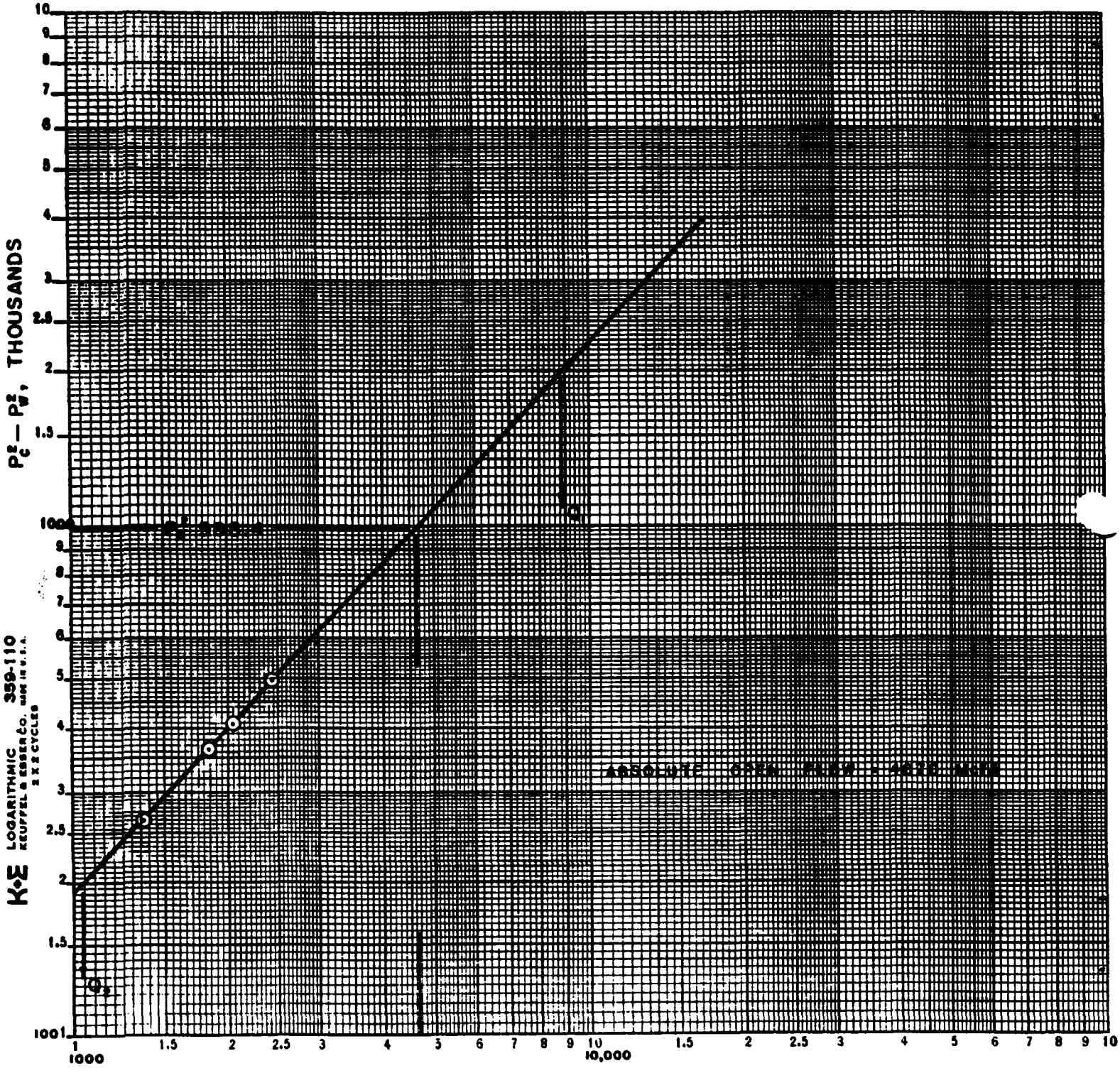
AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 4696$

Absolute Open Flow: 4696 Mcfd @ 15.025 | Angle of Slope θ: | Slope, n: .931

Remarks:

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

Company	Test Example No. 2
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64



Q_1 = 8910 Mcfd, LOG Q_1 = 3.949878

Q_2 = 1045 Mcfd, LOG Q_2 = 3.019116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 3

CALCULATION OF ABSOLUTE OPEN FLOW USING THE ONE-POINT BACK-PRESSURE TEST

This example assumes that casing pressures can be measured. If P_w cannot be measured, the point can be calculated using the procedure used in Example No. 1.

NOTE: **A copy of the back-pressure curve used to establish the value of "n" must be submitted with Form C-122. (Refer to Testing Procedure, page III-12.)**

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate flow rate as follows and record on C-122.

$$Q = F_b \sqrt{h_w \times P_m} \times F_t \times F_g \times F_{pv}$$

$G = 0.675$

$P_{cr} = 669$ Table IX

$T_{cr} = 382$ Table IX

$P_m = 754 + 13.2 = 767.2$

$T_m = 74 + 460 = 534$

$P_r = \frac{767.2}{669} = 1.15$

$T_r = \frac{534}{382} = 1.40$

$Z = 0.856$ Table XI

$F_{pv} = 1.081$ Table XII

$F_b = 10.84$ Table I

$F_t = 0.9868$ Table VII

$F_g = 1.217$ Table VIII

$Q = 10.84 \times 95.94 \times 0.9868 \times 1.217 \times 1.081 = 1350$ Mcfd

ALL SQUARED PRESSURES IN THOUSANDS

STEP 3.

The absolute open flow may be calculated from the one-point back-pressure test by use of the following equation:

$$AOF = Q \left[\frac{P_c^2}{P_c^2 - P_w^2} \right]^n$$

where:

AOF = absolute open flow

Q = rate of flow from test data point

P_c = wellhead shut-in pressure, psia

STEP 3. (Cont'd.)

P_w = static column wellhead pressure (casing if flowing through tubing, tubing if flowing through casing); since P_w is measured, the pressure loss due to friction calculations are not necessary.

n = exponent of back-pressure curve (0.931 as determined from the latest back-pressure test)

$$AOF = 1350 \left[\frac{998.4}{998.4 - 731.4} \right]^{.931}$$

$$AOF = 1350 (3.739)^{.931}$$
$$AOF = 1350 (3.414)$$
$$AOF = 4609 \text{ Mcfd}$$

Enter 4609 Mcfd on C-122.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 1-15-65	Lease No. or Serial No.
Company: Test Example No. 3			Connection: Blowe Gas Co.		Allottee
Field: Eumont	Reservoir: Queen		Location		Unit
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation		Farm or Lease Name: H. I. Test
Csg. Size: 5.50	Wt.: 15.5	d: 4.950	Set At: 3593	Perforations: From 3550 To 3560	Well No.: 6
Tbg. Size: 2.375	Wt.: 4.7	d: 1.995	Set At: 3573	Perforations: From — To Open Ended	Unit: A Sec.: 36 Twp.: 22-S Rge.: 35-E
Type Completion (Describe): Single				Packer Set At: None	County or Parish: Lea
Producing Thru: Tubing	Reservoir Temp. F: 130 @ 3573	Mean Annual Temp. F	Baro. Press. — P_a: 13.2		State: New Mexico
L: 3573	H: 3573	G_g: .675	% CO_2	% N_2	% H_2S	Prover	Meter Run: 4"	Taps: Flange

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure: Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER: Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type—A.P.I. Gravity—Amount)
1-15-65									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press.
1-16-65									
7:00A	24	754	842	75	754	12.0	74	1.5	

NOT REQUIRED

TO BE FILED

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☐ Annual ☐ Special				Test Date: 1-15-65	
Company: Test Example No. 3		Connection: Blowe Gas Co.			
Pool: Eumont		Formation: Queen		Unit	
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test	
Csg. Size: 5.50 / Wt.: 15.5 / d: 4.95 / Set At: 3593		Perforations: From 3550 To 3560		Well No.: 6	
Tbg. Size: 2.375 / Wt.: 4.7 / d: 1.995 / Set At: 3573		Perforations: From None To		Unit: A / Sec.: 36 / Twp.: 22-S / Rge.: 35-E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: None		County: Lea	
Producing Thru: Tubing	Reservoir Temp. °F: 130 @ 3573	Mean Annual Temp. °F	Baro. Press. – P_a: 13.2	State: New Mexico	

L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps
3573	3573	.675	--	--	--		4"	Flange

	FLOW DATA					TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI			--	--	--	986		984	75	72
1.	4"	1.5	754	12.0	74	754	75	842	75	24
2.										
3.										
4.										
5.										

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	10.84	95.95	767.2	0.9868	1.217	1.081	1350
2							
3							
4							
5							

NO.	P_t	Temp. °R	T_r	Z
1	1.15	534	1.40	0.856
2.				
3.				
4.				
5				

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.
Specific Gravity Separator Gas: .675 XXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX
Critical Pressure: 669 P.S.I.A. ____ P.S.I.A.
Critical Temperature: 382 R ____ R

P_c 999.2 P_c^2 998.4

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1		855.2	731.4	267
2				
3				
4				
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 3.739$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 3.414$

AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 4609$

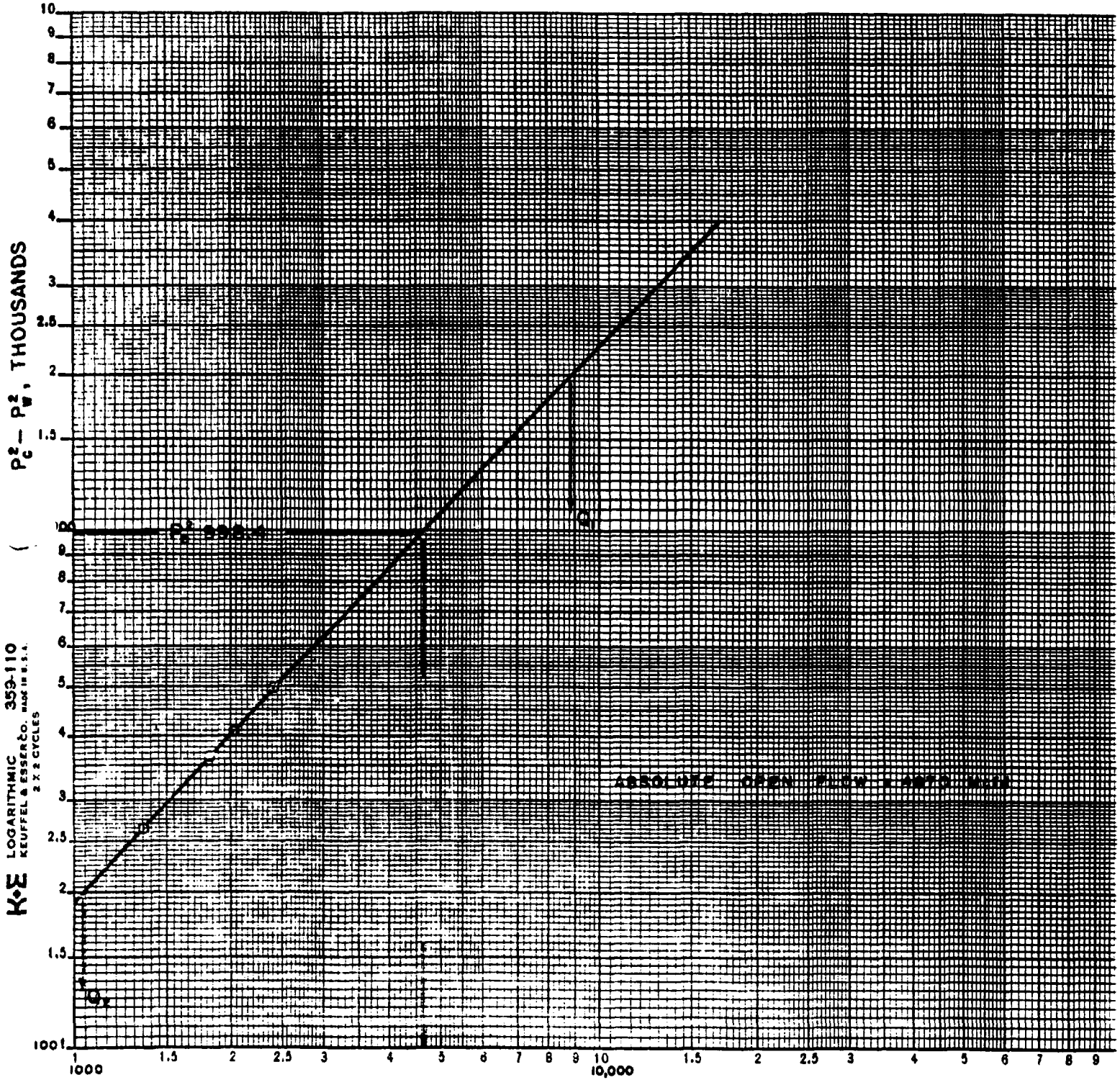
Absolute Open Flow: 4609 Mcfd @ 15.025 | Angle of Slope θ: ____ | Slope, n: 0.931*

Remarks: * Previous Back Pressure Test

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

Company	Test Example No. 3
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64

(Curve from Latest Previous Test)



Q_1 = 8910 Mcfd; LOG Q_1 = 3.949878

Q_2 = 1045 Mcfd; LOG Q_2 = 3.019116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 4

CALCULATION OF DELIVERABILITY (D) USING THE ONE-POINT BACK-PRESSURE TEST
(Refer to Testing Procedure, page III-14)

The calculations for Deliverability are the same as for the absolute open flow except that a deliverability pressure, P_d, is used instead of atmospheric pressure. The deliverability pressure is defined by the New Mexico Oil Conservation Commission as a percent of the shut-in wellhead pressure. The exact percent is determined at the time deliverability is adopted in a field's special pool rules and is not a calculated value. For this example, P_d is used as 80% of P_c.

NOTE: A copy of the latest back-pressure curve must be submitted with Form C-122-C. The data in this example is the same as in Example 3 and Steps 1 and 2 are also the same.

STEP 3.

Calculate the deliverability using the following equation:

$$D = Q \left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2} \right]^n$$

where:

- D = deliverability of the well at back-pressure P_d
- Q = rate of flow from test data point (1350 Mcfd)
- P_c = wellhead shut-in pressure (999.2 psia)
- P_d = deliverability pressure (80% of P_c)
- P_w = static column wellhead pressure (casing if flowing through tubing, tubing if flowing through casing)
- n = exponent of back-pressure curve (0.931 as determined from the latest back-pressure test)

ALL SQUARED PRESSURE IN THOUSANDS

$$D = 1350 \left[\frac{(999.2)^2 - (.80 \times 999.2)^2}{(999.2)^2 - (855.2)^2} \right]^{0.931}$$

$$D = 1350\ (1.346)^{.931}$$

$$D = 1350\ (1.319)$$

$$D = 1781 \text{ Mcfd}$$

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special — Test Date: 1-15-65 — Lease No. or Serial No.:

Company: Test Example No. 4 — Connection: Blowe Gas Co. — Allottee:

Field: Eumont — Reservoir: Queen — Location: — Unit:

Completion Date: 6-4-50 — Total Depth: 3593 — Plug Back TD: — Elevation: — Farm or Lease Name: H. I. Test

Csg. Size: 5.50 — Wt.: 15.5 — d: 4.950 — Set At: 3593 — Perforations: From 3550 To 3560 — Well No.: 6

Tbg. Size: 2.375 — Wt.: 4.7 — d: 1.995 — Set At: 3573 — Perforations: From — To: Open Ended — Unit: A — Sec.: 36 — Twp.: 22-S — Rge.: 35-E

Type Completion (Describe): Single — Packer Set At: None — County or Parish: Lea

Producing Thru: Tubing — Reservoir Temp. F: 130 @ 3573 — Mean Annual Temp. F: — Baro. Press. — P_a: 13.2 — State: New Mexico

L: 3573 — H: 3573 — G_g: .675 — % CO_2: -- — % N_2: -- — % H_2S: -- — Prover: — Meter Run: 4" — Taps: Flange

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type–A.P.I. Gravity–Amount)
1-15-65									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press.
1-16-65									
7:00A	24	754	842	75	754	12.0	74	1.5"	

NOT REQUIRED

TO BE FILED

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMISSION

DELIVERABILITY TEST REPORT

Form C-122-C
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 1-15-65	
Company: Test Example No. 4		Connection: Blowe Gas Co.			
Pool: Eumont		Formation: Queen		Unit	
Completion: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test	
Csg. Size: 5.50 / Wt.: 15.5 / d: 4.95 / Set At: 3593		Perforations: From 3550 To 3560		Well No.: 6	
Tbg. Size: 2.375 / Wt.: 4.7 / d: 1.995 / Set At: 3573		Perforations: From Open To Ended		Unit: A / Sec.: 36 / Twp.: T-22S / Rge.: R-35E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: None		County: Lea	
Producing Thru: Tubing	Reservoir Temp. °F: 130 @ 3573	Mean Annual Temp. °F	Baro. Press. – P_a: 13.2	State: New Mexico	
L: 3573 / H: 3573	Gg.: .675	% CO_2: --	% N_2: --	% H_2S: --	Prover	Meter Run: 4"	Taps: Flange

	FLOW DATA					TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Choke Orifice Size	Press. p.s.i.g.	Diff. hw	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI						986		984	75	72
1.	4"	1.5	754	12.0	74	754	75	842	75	24

NO.	Coefficient (24-Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft	Gravity Factor Fg	Super Compress. Factor Fpv	Rate of Flow Q, Mcfd
1.	10.84	95.94	767.2	0.9868	1.217	1.081	1350

NO.	P_r	Temp. R.	T_r	Z
1.	1.15	534	1.40	0.856

P_d 0.8 (999.2) = 799.4

P_d^2 639.0

P_c 999.2 P_c^2 998.4

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.

A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.

Specific Gravity Separator Gas: XXXXXXXXXX

Specific Gravity Flowing Fluid: XXXXX

Critical Pressure: 669 p.s.i.a. p.s.i.a.

Critical Temperature: 382 R R

Pf Pf²

NO.	P_t	P_t^2	$P_c^2 - P_t^2$	P_w	P_w^2	$P_c^2 - P_w^2$	P_s	P_s^2	$P_f^2 - P_s^2$
1.				855.2	731.4	267.0			

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = \left[\frac{359.4}{267}\right] = 1.346$$

$$\text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = 0.129045$$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = 1.319$$

$$n\ \text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = 0.120141$$

$$\text{Deliv.} = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = (1.350)\ (1.319)$$

Deliv. 1781 Mcfd

n 0.931

Previous back-pressure test
(Source of n)

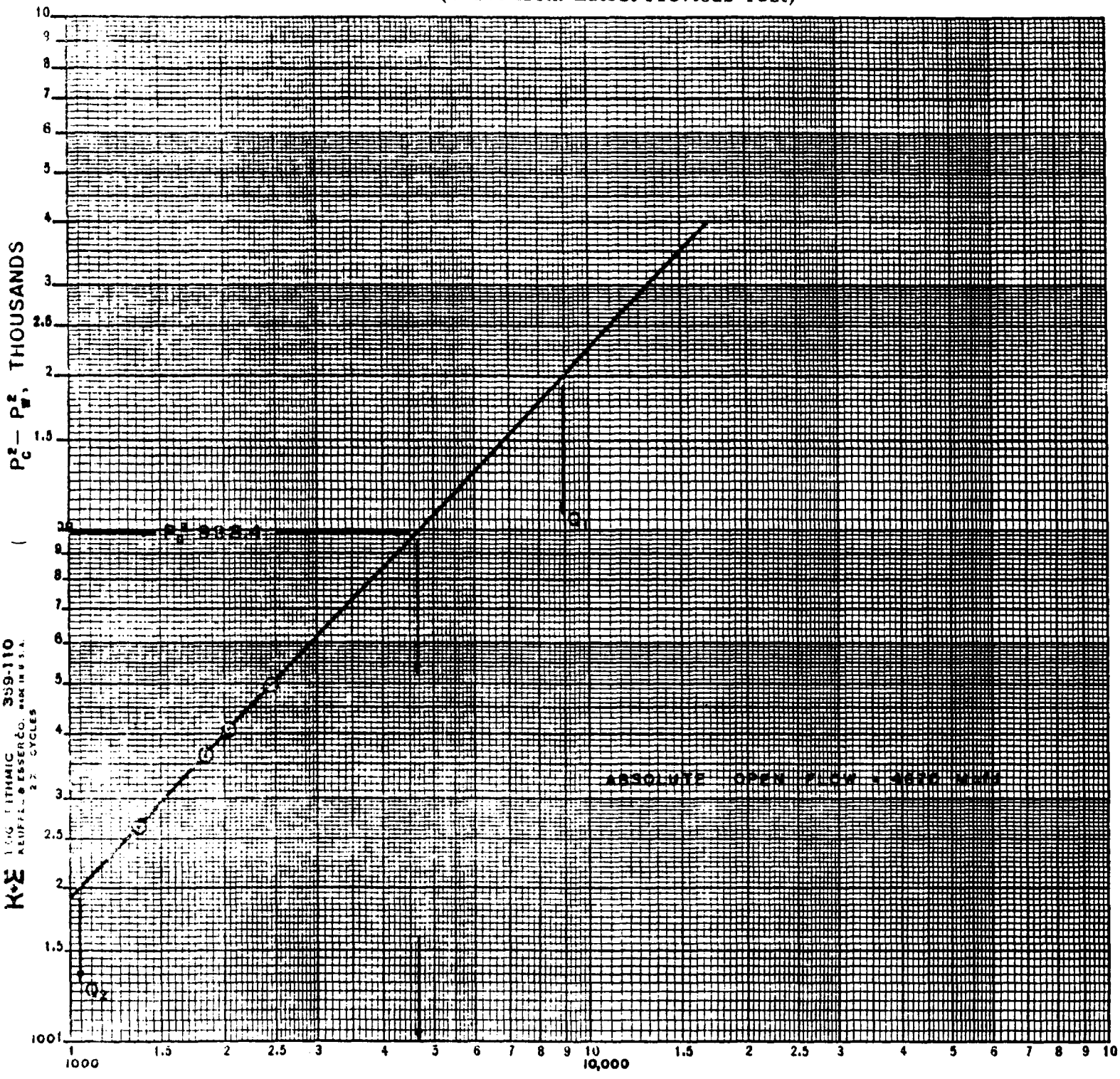
Commission

Company

Others

Company	Test Example No. 4
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64

(Curve from Latest Previous Test)



Q_1 = 8910 Mcfd; LOG Q_1 = 3.949878

Q_2 = 1045 Mcfd; LOG Q_2 = 3.019116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 5

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE
(Using Average Temperature and Pressure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing cases (P_w). Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	N_2	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\ G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_l = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B, page B-1)

$$= \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

G = 0.641

STEP 2.

a. Enter well information at the top of Form C-122-D.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Calculate L/H, the length of the flow string divided by the vertical depth.

$$L/H = 1.000$$

d. GH = 0.641 x 8130 = 5211

STEP 3.

a. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 1)

b. T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 2)

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ (Line 3)

STEP 4.

Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 4)

STEP 5.

a. TZ = 575 x 0.860 = 495 (Line 5)

b. GH/TZ = 5211/495 = 10.527 (Line 6)

c. For GH/TZ = 10.527 read e^S in Table XIV. e^S = 1.484 (Line 7)

STEP 6.

a. Enter reservoir pressure (P_f) = 2309 (Line 8)

b. $P_f^2 = (2309)^2/1000 = 5331.5$ (Line 9)

c. $P_c^2 = P_f^2/e^S = 5331.5/1.484 = 3592.7$ (Line 10)

d. $P_c = \sqrt{3592.7} = 1895$ (Line 11)

STEP 7.

a. $P = (P_c + P_f)/2 = (1895 + 2309)/2 = 2102$ (Line 12)

b. $P_r = 2102/673 = 3.12$ (Line 13)

c. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 14)

STEP 8.

Enter in Line 15 the compressibility factor from Table XI corresponding to a P_r of 3.12 and a T_r of 1.60. In this example, Z = 0.822 (Line 15).

STEP 9.

Since Z (Line 15) is not equal to Z (Line 4), enter Z = 0.822 on Line 4, 2nd Trial and repeat Steps 5 through 8.

STEP 10.

Since the final value of Z (Line 15, 2nd Trial) is equal to the assumed value of Z (Line 4, 2nd Trial), the value of P_c = 1878 (Line 11, 2nd Trial) is used in the back-pressure computations.

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or ~~P_w~~)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or ~~P_s~~)

Form C-122F
Adopted 9-1-65

COMPANY Test Example 5 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S -

GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		1st Trial 1	2nd Trial 2	3	4	5	6	7	8
1	T_w(W.H. °R)	534	534						
2	T_s(B.H. °R)	615	615						
3	$T=(\frac{T_w + T_s}{2})$	575	575						
4	Z (Est.)	0.860	0.822						
5	TZ	495	473						
6	GH/TZ	10.527	11.017						
7	e^s(Table XIV)	1.484	1.512						
8	P_f or P_s	2309	2309						
9	P_f^2 or ~~P_s^2~~	5331.5	5331.5						
10	$P_c^2 = P_f^2/e^s$ or ~~$P_w^2 = P_s^2/e^s$~~	3592.7	3526.1						
11	P_c or ~~P_w~~	1895	1878						
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$	2102	2094						
13	$P_r = (P/P_{cr})$	3.12	3.11						
14	$T_r = (T/T_{cr})$	1.60	1.60						
15	Z (Table XI)	0.822	0.822						

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 6

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE
(Using Stepwise Procedure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with the pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing (P_w) cases. Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	N_2	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\ G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_l = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B, page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

$$G = 0.641$$

STEP 2.

a. Enter well information at the top of Form C-122-E.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Enter H = 8130 on Line 1, Column 1. (Line references are indicated following each step. Column references remain unchanged unless indicated.)

d. GH = 0.641 x 8130 = 5211 (Line 2)

e. 37.5 GH = 37.5 x 5211 = 195,413 (Line 3 and Line 18)

STEP 3.

a. Enter P_n = 2309 on Line 4

b. $P_r = P_n/P_{cr}$ = 2309/673 = 3.43 (Line 5)

c. Enter T = 155 + 460 = 615 R (Line 6)

d. $T_r = T/T_{cr}$ = 615/360 = 1.71 (Line 7)

e. Z = 0.861 from Table XI (Line 8)

f. P/Z = 2309/0.861 = 2682 (Line 9)

g. P/TZ = 2682/615 = 4.3610 (Line 10)

h. Lines 11, 12, and 13 may be omitted in the static column case. Where $Q_m = 0$, $L/H\ (F_r\ Q_m)^2$ must necessarily = 0; therefore, I_n resolves to:

$$I_n = (P/TZ)/\left[(P/TZ)^2/1000 + L/H\ (F_r\ Q_m)^2\right] = 1000/(P/TZ) + 0$$

$$I_n = 1000/(P/TZ) = 229.305 \quad \text{(Line 14)}$$

STEP 4.

Make first trial calculation for the pressure at H/2 = 8130/2 = 4065 (Line 1, Column 2) as follows:

a. H = 4065 (Line 1)

b. GH = 0.641 x 4065 = 2606 (Line 2)

STEP 4. (Cont'd.)

c. 37.5 GH = 37.5 x 2606 = 97, 725

d. Estimate value of M by dividing $2I_n$ (Line 14, Column 1) into the difference between $\sum$(M x N) (Line 18, Column 1) and 37.5 GH (Line 3, Column 2). (195, 413 - 97, 725)/2 x 229.305 = 213 (Line 15), then $P_1 = P_f$ - M = 2309 - 213 = 2096 (Line 4).

e. P_r = 2096/673 = 3.11 (Line 5)

f. T = estimated temperature at 4065 ft. = (74 + 155)/2 + 460 = 575 R (Line 6)

g. T_r = 575/360 = 1.60 (Line 7)

h. Z = compressibility factor of a gas at a P_r of 3.11 and a T_r of 1.60 = 0.822 (Line 8)

i. P/Z = 2096/0.822 = 2550 (Line 9)

j. P/TZ = 2550/575 = 4.4348 (Line 10)

k. I_1 = 1000/(P/TZ) = 225.489 (Line 14)

l. N = I_2 (Column 1) + I_1 (Column 2) = 229.305 + 225.489 = 454.794 (Line 16)

m. M = 37.5 GH/N = 97, 725/454.794 = 215. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

n. Enter M = 215 (Line 15, Column 3). P_1 (Line 4, Column 3) is then P_f - M = 2309 - 215 = 2094.

o. Repeat steps (e) through (m) until the correct value of M is determined (Line 15, Column 4).

p. Multiply final values of M and N. 215 x 455.059 = 97838 (Line 17, Column 3).

q. Subtract (M x N) (Line 17, Column 3) from $\sum$(M x N) (Line 18, Column 1). 195, 413 - 97, 838 = 97, 575 (Line 18, Column 3).

STEP 5.

Make first trial calculation for the pressure at H = 0 (Line 1, Column 5)

a. GH = 0 (Line 2)

b. 37.5 GH = 0 (Line 3)

c. Estimate M by dividing N (Line 16, Column 3) into Line 18, Column 3 = 97, 575/455.059 = 214 (Line 15, Column 5)

STEP 5. (Cont'd.)

d. Subtract M from P_n value found at H = 4065. 2094 - 214 = 1880 (Line 4, Column 5)

e. P_r = 1880/673 = 2.79 (Line 5)

f. T = 74 + 460 = 534 R (Line 6)

g. T_r = 534/360 = 1.48 (Line 7)

h. Z = compressibility factor of gas at a P_r of 2.79 and a T_r of 1.48 = 0.771 (Line 8)

i. P/Z= 1880/0.771 = 2438 (Line 9)

j. P/TZ = 2438/534 = 4.5655 (Line 10)

k. I_c = 1000/4.5655 = 219.034 (Line 14)

l. N = 225.754 + 219.034 = 444.788 (Line 16)

m. Divide $\sum$ (M x N) (Line 18, Column 3) by N (Line 16, Column 5) = 97,575/444.788 = 219. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

n. Enter M = 219 (Line 15, Column 6). P_1 (Line 4, Column 6) is then P_1 - M = 2094 - 219 = 1875 (Line 4, Column 6).

o. Repeat steps (e) through (m) until the correct value of M is determined.

p. Multiply final values of M and N. 219 x 445.327 = 97,527 (Line 17, Column 6).

q. Subtract Line 17, Column 6 from Line 18, Column 3. 97,575 - 97,527 = 48 (Line 18, Column 6).

STEP 6.

Using the equation $\triangle P = 3\,(37.5\,GH)/(I_c + 4I_1 + I_2)$, calculate $\triangle P$ by substituting 219.573 (Line 14, Column 6) for I_c, 225.754 (Line 14, Column 3) for I_1, and 229.305 (Line 14, Column 1) for I_2 as indicated by calculations near the bottom of Form C-122-E. The result is $\triangle P$ = 434. By use of the equation $P_f = P_c + \triangle P$, P_c = 2309 - 434 = 1875.

WORK SHEET FOR STEPWISE CALCULATION ~~(SUBSURFACE)~~ (SURFACE) PRESSURE ~~(P_t & P_s)~~ (P_c & ~~P_w~~)

Form C-1220
Adopted 1-1-65

COMPANY Test Example No. 6 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0.0

d 1.995" F_r _____ Q_m 0 M^2cfd (L/H) $(F_rQ_m)^2$ 0 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H	Given	8130	4065	4065		0	0				
2	GH	Given	5211	2606	2606		0	0				
3	37.5GH	37.5X2	195.413	97.725	97.725		0	0				
4	P_c or P_n	Given	2309	2096	2094		1880	1875				
5	P_r	4÷P_{cr}	3.43	3.11	3.11		2.79	2.79				
6	T	Given	.615	575	575		534	534				
7	T_r	6÷T_{cr}	1.71	1.60	1.60		1.48	1.48				
8	Z	Table XI	0.861	0.822	0.822		0.771	0.771				
9	P/Z P/Z	4÷8	2682	2550	2547		2438	2432				
10	P/TZ	9÷6	4.3610	4.4348	4.4296		4.5655	4.5543				
11	$(P/TZ)^2/1000$	$(10)^2/1000$	XX	XX	XX		XX	XX				
12	$L/H(F_rQ_m)^2$	XX	XX	XX	XX		XX	XX				
13		11 + 12	XX	XX	XX		XX	XX				
14	I_n	10÷13	229.305	225.489	225.754		219.034	219.573				
15	$M=P_n-P_{n-1}$			213	215	215	214	219	219			
16	$N=I_n+I_{n-1}$			454.794	455.059		444.788	445.327				
17	M x N	15x16			97,838			97,527				
18	Σ(M×N)	Σ17	195,413		97,575			48				

$$\Delta P = \frac{3\,(37.5)\,(GH)}{I\quad {}^{1}I_1 + I_2} = \frac{3 \times 195,413}{219.573 + 4\,(225.754) + 229.305} = 434$$

$P_c = P_f - \Delta P = 2309 - 434 = 1875$ psia

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 7

CALCULATION OF SUBSURFACE PRESSURE P_f (sandface) WHERE THE WELLHEAD SHUT-IN PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE

When the height of a liquid column in the wellbore and the specific gravity of the liquid are known, the reservoir pressure may be calculated by making the normal static column calculations to determine the pressure at the gas-liquid interface and adding the pressure exerted by the liquid column above the desired datum plane.

Using the results obtained in this example, an equivalent wellhead pressure may be calculated in accordance with the procedures in example 5 or 6.

In this example, the depth "H" and "L" and pressure "P_f" will refer to the gas-liquid interface rather than at the datum plane. This pressure may be calculated by either the average temperature and compressibility factor method or the stepwise procedure.

The additional pressure to be added to the calculated pressure at the gas-liquid interface "P_f" is determined as follows:

Height of liquid column (ft.) x Sp. gr. (water = 1.00) x .433 = pressure psi.

A. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE (Using Average Temperature and Compressibility Factors)

Given: Shut-in wellhead pressure of 1878 psia, H = 8130 ft., L = 8130 ft., L/H = 1.00, gas gravity = 0.641, CO_2 = 2.0%, N_2 = 3.0%, wellhead temperature = 74 F, and 1000 ft. of liquid having a specific gravity of 0.74.

STEP 1. Begin calculation of pressure at the gas-liquid interface.

a. Enter well information as shown at top of Form C-122-G.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for carbon dioxide = 2.0 percent, and nitrogen = 3.0 percent from Table X.
Correct P_{cr} and T_{cr} as follows:
$P_{cr} = 670 + 8 - 5 = 673$
$T_{cr} = 372 - 3 - 9 = 360$
(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Determine H for the well and calculate L/H. In most gas wells L/H is unity as H is equal to L. However, L/H is greater than unity for directionally drilled wells. In this example, both L and H are 8130 ft., and L/H is 1.000.

d. GH = 0.641 x 8130 = 5211.

STEP 2.

a. Enter "0" rate of flow on Line 1. (Line references are indicated in parenthesis following each step.)

b. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 2).
T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 3).
The bottom-hole temperature should be measured or estimated from reliable data on other wells in the area.

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ R (Line 4).

STEP 3. (First Trial)
Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 5).

STEP 4.

a. $TZ = 575 \times 0.860 = 495$ (Line 6).

b. $GH/TZ = 5211/(495) = 10.527$ (Line 7).

c. For $GH/TZ = 10.527$ read e^s in Table XIV. $e^s = 1.484$ (Line 8).

STEP 5.

a. Enter wellhead shut-in pressure (P_c) = 1878 (Line 10).

b. $P_c^2 = (1878)^2/1000 = 3526.9$ (Line 11).

c. $e^s P_c^2 = (1.484)\ (3526.9) = 5233.9$ (Line 18).

STEP 6.
Lines 12 through 17 are not used in the static column calculation.

STEP 7.

a. $P_f = e^s P_c^2 = 5233.9\ (1000) = 2288$ (Line 19).

b. $P = (P_c + P_f)/2 = (1878 + 2288)/2 = 2083$ (Line 20).

c. $P_r = P/P_{cr} = 2083/673 = 3.10$ (Line 21).

d. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 22).

STEP 8.
Enter in Line 23 the compressibility factor from Table XI corresponding to a P_r of 3.10 and a T_r of 1.60. In this example, $Z = 0.822$ (Line 23).

STEP 9.

Since Z (Line 23) is not equal to Z (Line 5), enter Z = 0.822 on Line 5, 2nd Trial, and repeat Steps 4 through 8.

STEP 10.

Since the final value of Z (Line 23, 2nd Trial) is equal to the assumed value of Z (Line 5, 2nd Trial), the value of $e^s P_c^2 = P_f^2 = 5332.7$ and $P_f = 2309$.

STEP 11.

Now calculate the pressure exerted by the liquid column.

a. 1000' x 0.74 x 0.433 = 320.4 psi.

STEP 12.

Calculate pressure at datum by adding 2309 psia (P_f) and 320.4 psi (pressure of liquid column).

a. 2309 + 320.4 = 2629.4 psia at the sandface. This is the P_f which should be used in calculating a wellhead pressure in accordance with the procedures in example 5 or 6.

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE H. I. Test WELL NO. 2 DATE 10-1-64

L 8130 H 8130 L/H 1.00 G 0.641 % CO_2 2.0% % N_2 3.0% % H_2S --

d _____ F_r _____ GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		Trial 1	Trial 2								
1	Q_m	0	0								
2	T_w (W.H. °R)	534									
3	T_s (BH °R)	615 R									
4	$T = (\frac{T_w + T_s}{2})$	575 R									
5	Z (Est.)	0.860	0.822								
6	TZ	495	473								
7	GH/TZ	10.527	11.017								
8	e^s (Table XIV)	1.484	1.512								
9	$1 - e^{-s}$ (Table XIV)										
10	P_c	1878	1878								
11	P_c^2	3526.9	3526.9								
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2(1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$	5233.9	5332.7								
19	P_f	2288	2309								
20	$P = (\frac{P_c + P_f}{2})$	2083	2094								
21	$F_r = \frac{P}{P_{cr}}$	3.10	3.11								
22	$T_r = \frac{T}{T_{cr}}$	1.60	1.60								
23	Z (Table XI)	0.822	0.822								

One copy to be filed in District Office (Work (acceptable)

B. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE
(Using Stepwise Procedure)

Given: Shut-in wellhead pressure = 3573 psig, gas gravity = 0.865, P_{cr} = 664, T_{cr} = 444, H = 14,998 feet, wellhead temperature = 74 F, temperature at 14,998 feet = 238 F (therefore, the temperature at 7499 feet = 156 F or the arithmetic average of wellhead and bottom-hole temperature), and 1000 feet of liquid having a specific gravity of 0.74.

STEP 1.

Begin calculation of bottom-hole shut-in pressure, P_f.

a. Enter H = 0 on Line 1, Column 1, Form C-122-E (Line references are indicated in parentheses following each step; column references remain unchanged unless indicated.)

b. GH = 0 (Line 2)

c. 37.5 GH = 0 (Line 3)

d. P_c = 3573 + 13.2 = 3586.2 (Line 4)

e. P_r = P_c/P_{cr} = 3586.2/664 = 5.40 (Line 5)

f. T = 534 R (Line 6)

g. T_r = T/T_{cr} = 534/444 = 1.20 (Line 7)

h. Z = 0.731 Table XI (Line 8)

i. P/Z = 3586.2/.733 = 4905.9 (Line 9)

j. P/TZ = 4905.9/534 = 9.1871 (Line 10)

k. Since this calculation deals with shut-in conditions and Q = 0, Lines 11, 12, and 13 may be omitted.
Where Q_m = 0, $L/H\ (F_r\ Q_m)^2$ must = 0. Therefore, I_n resolves to:

$$I_n = \frac{P/TZ}{(P/TZ)^2/1000 + L/H\ (F_r\ Q_m)^2} = \frac{P/TZ}{(P/TZ)^2/1000}$$

$$I_n = \frac{1000}{P/TZ}$$

I_t = 1000/(P/TZ) = 1000/9.1871 = 108.848 (Line 14)

STEP 2.

Make first trial calculation for the pressure at the midway point, H = 14,998/2 = 7499. (Line 1, Column 2).

a. Compute GH and 37.5 GH
GH = 0.865 x 7499 = 6486.64 (Line 2)
37.5 GH = 37.5 x 6486.64 = 243,249 (Line 3)

b. Estimate value of M as follows:
$M = 37.5\ GH/2I_t = 243,249/2\ (108.848) = 1117.4$ (Line 15)

c. Add M to P_c for estimate of P_1
$P_1 = 1117.4 + 3586.2 = 4703.6$ (Line 4)

d. Compute P_r and T_r for H = 7499
$P_r = P_1/P_{cr} = 4703.6/664 = 7.08$ (Line 5)
T = 616 R (Line 6)
$T_r = T/T_{cr} = 616/444 = 1.39$ (Line 7)

e. Z = 0.907 Table XI (Line 8)

f. P/Z = 4703.6/0.907 = 5185.9 (Line 9)

g. P/TZ = 5185.9/616 = 8.4187 (Line 10)

h. $I_1 = 1000/(P/TZ) = 1000/8.4187 = 118.783$ (Line 14)

i. $N = I_t + \text{Trial } I_1 = 108.848 + 118.783 = 227.631$ (Line 16)

j. Calculate M as follows:
M = 37.5 GH/N = 243,249/227.631 = 1069

k. When M has been estimated correctly, the value determined under Item (j) will equal M under item (b). Since the values of M are different, enter M = 1070 on Line 15, Column 3 and repeat items (c) through (j) until the correct value of M is determined.

l. By repeating the calculation, the correct value of M is determined to be 1066.

m. Multiply final values of M and N.
1066 x 228.284 = 243,351 (Line 17)

n. Enter the value of M x N under $\sum$ (M x N) (Line 18)

STEP 3.

Make first trial calculation for the pressure at H = 14,998. (Line 1, Column 5).

a. Compute GH and 37.5 GH
GH = 0.865 x 14,998 = 12,973.27 (Line 2, Column 5)
37.5 GH = 37.5 x 12,973.27 = 486,498 (Line 3)

STEP 3. (Cont'd.)

b. Estimate value of M as follows:
$M = (37.5\ GH) - \sum (M \times N)/N$ (Line 16, Column 5)
$M = (486,498 - 243,351)/228.284 = 1065$ (Line 15)

c. $P_2 = M + P_1 = 1065 + 4652.2 = 5717.2$ (Line 4)

d. Compute P_r and T_r at H = 14,998. Obtain appropriate Z from Table XI. Compute P/Z and P/TZ. Enter all these values on the appropriate lines 5 through 10.

e. $I_2 = 1000/(P/TZ) = 1000/7.8940 = 126.678$ (Line 14)

f. $N = I_1 + \text{Trial } I_2 = 119.436 + 126.678 = 246.114$ (Line 16)

g. Compute M as follows:
$M = (37.5\ GH) - \sum (M \times N)/N$
$M = (486,498 - 243,351)/246.114 = 987.9$

h. When M has been estimated correctly, the value determined under item (g) will be equal to M as estimated under item (b). Since the values of M are not the same, enter M = 987.9 on Line 15, Column 6, and repeat items (c) through (g).

i. By repeating the calculations, the correct value of M is determined to be 985.1.

j. Multiply final values of M and N
$M \times N = 985.1 \times 246.831 = 243,153$ (Line 17)

k. $\sum (M \times N) = 243,153 + 243,351 = 486,504$ (Line 18)

STEP 4.

Using the following equations, compute the bottom-hole shut-in pressure, P_f, at H = 14,998.

$$\Delta P = \frac{3\ (37.5\ GH)}{I_t + 4I_1 + I_2}$$

$$P_f = P_c + \Delta P$$

where:

$G = 0.865$
$H = 14,998$
$I_t = 108.848$ (Line 14, Column 1)
$I_1 = 119.436$ (Line 14, Column 4)
$I_2 = 127.395$ (Line 14, Column 7)

STEP 4. (Cont'd.)

$$P_c = 3586.2 \text{ (Line 4, Column 1)}$$

$$\triangle P = \frac{3(37.5 \times .865 \times 14,998)}{108.845 + 4(119.436) + 127.395}$$

$$\triangle P = 2044.2$$

$$P_f = 3586.2 + 2044.2 = \underline{5630.4 \text{ psia}}$$

STEP 5.

Now calculate pressure exerted by liquid column.

a. $1000 \times 0.74 \times 0.4333 = 320.6$

STEP 6.

Add pressure at the gas-liquid interface and pressure exerted by the liquid column to get pressure at sandface.

a. $5630.4 + 320.6 = \underline{5951 \text{ psia}}$

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) ~~(SURFACE)~~ PRESSURE (P_f & ~~P_s~~) (P_c & P_w)

Form C-122D
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 14,998 H 14,998 L/H 1.000 G 0.865 % CO_2 _____ % N_2 _____ % H_2S _____

d 1.995 F_1 01823 Q_m 0 M^2cfd $(L/H)(F_rQ_m)^2$ 0 P_{cr} 664 (TABLE IX & X) T_{cr} 444 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		0	7,499			14,998					
2	GH		0	6486.64			12,973.27					
3	37.5GH		0	243,249			486,498					
4	~~P_s~~ or P_n		3586.2	4703.6	4655.2	4652.2	5717.2	5640.1	5637.5	5637.3		
5	P_r		5.40	7.08	7.01	7.01	8.61	8.49	8.49	8.49		
6	T		534	616	616	616	698	698	698	698		
7	T_r		1.20	1.39	1.39	1.39	1.57	1.57	1.57	1.57		
8	Z		0.731	0.907	0.902	0.902	1.0376	1.0289	1.0289	1.0289		
9	P/Z P/Z	$\bar{4}\div\bar{8}$	4905.9	5185.9	5161.0	5157.6	5510.0	5481.7	5479.2	5479.0		
10	P/TZ	$\bar{9}\div\bar{6}$	9.1871	8.4187	8.3782	8.3727	7.8940	7.8534	7.8499	7.8496		
11	$(P/TZ)^2/1000$	$(\bar{10})^2/1000$										
12	$L/H(F_rQ_m)^2$											
13		$\bar{11}+\bar{12}$										
14	I_n	$\bar{10}\div\bar{13}$	108.848	118.783	119.357	119.436	126.678	127.333	127.390	127.395		
15	$M=P_n-P_{n-1}$			1117.4	1069	1066	1065	987.9	985.3	985.1		
16	$N=I_n+I_{n-1}$			227.631	228.205	228.284	246.114	246.769	246.826	246.831		
17	M x N	$\bar{15}\times\bar{16}$				243,351				243,153		
18	Σ(M x N)	$\Sigma\bar{17}$				243,351				486,504		

$\triangle P = \frac{1,459,493}{713.984} = 2044.2$ $P_f = 3586.2 + 2044.2 = 5630.4$

One copy to be filed in District Office (Work copy acceptable)

VT-51

TEST EXAMPLE NO. 8

WELL DELIVERABILITY TEST AS REQUIRED FOR PRORATED GAS POOLS IN NORTHWEST NEW MEXICO

This test is a part of the basis upon which gas wells are prorated in the northwest. Division Form C-122-A is to be used for reporting both the initial, annual, and biennial test results as required by Division Order No. R-333-I and filed in triplicate with the Aztec District Office of the Division.

I. LINE-BY-LINE INSTRUCTIONS FOR ENTERING INFORMATION AND DATA TO PROPERLY COMPLETE FORM C-122-A.

A. The calendar year for which the annual or biennial test is required. For initial tests, enter the calendar year of first delivery.

B. The name of the pool as separate from the formation.

C. The pool slope as determined by Order No. R-333-I or any Special Pool Rules superseding same.

D. The full formation name.

E. County in which the well is located.

F. Complete operator name, well name and number, and well location (unit, section, township, and range).

G. Name of pipeline that is transporting the gas.

H. Well completion information.

I. Top and bottommost perforations for cased wells and the depths of the casing shoe and TD for open holes.

J. Indicate type of flow stream.

K. Gas gravity for latest test (this data is usually obtained from the transporter).

L. The product of (K) times the depth in feet of the uppermost casing perforation, casing shoe depth, or uppermost tubing perforation, which ever is applicable.

M. The appropriate test dates.

N. Pressure data corrected to PSIA.

O. Calculate meter error and friction loss as shown.

P. Average meter pressure (usually supplied by the transporter).

Q. Calculate corrected meter pressure and average wellhead pressures as shown. If the ratio of average wellhead pressure to corrected meter pressure is 0.57 or less, critical flow will be considered to exist and the (measured) average wellhead pressure as shown in item (b) of this form shall be used as the average wellhead pressure. A notation of such shall be made in the "Remarks" section of the form, unless an intermediate pressure entry in item (n) of the form disproves critical flow.

R. Select the highest shut-in pressure, casing or tubing, and multiply it by the appropriate percentage, pursuant to Order No. R-333-I, to find the deliverability pressure, P_d.

S. The integrated average daily volume produced during the test corrected for meter error as shown ($S_1 \times S_3$).

T. Calculate working pressure using tables and equations from "Method of Calculating Pressure Loss Due To Friction In Gas Well Strings". Note: If R^2 is greater than or equal to P_t then friction loss is negligible, therefore $P_w = P_t$.

U. Calculate for deliverability "D" as shown.

V. Use "Remarks" section for the following:

1. Critical flow notations
2. Commingled well allocations
3. Delinquent test
4. Initial test
5. Other information which is pertinent

W. Summary of data.

X. Show company doing the testing and person(s) responsible.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122-A
Revised 10-1-78

WELL DELIVERABILITY TEST REPORT FOR 19 A.

POOL NAME	POOL SLOPE	FORMATION	COUNTY
B.	n= C.	D.	E.

COMPANY			WELL NAME AND NUMBER		
F.			F.		
UNIT LETTER	SECTION	TOWNSHIP	RANGE	PURCHASING PIPELINE	
F.	F.	F.	F.	G.	
CASING O.D. – INCHES	CASING I.D. – INCHES	SET AT DEPTH – FEET	TUBING O.D. – INCHES	TUBING I.D. – INCHES	TOP – TUBING PERF. – FEET
H.	H.	H.	H.	H.	H.
GAS PAY ZONE FROM TO I.		WELL PRODUCING THRU CASING TUBING J.		GAS GRAVITY K.	GRAVITY X LENGTH L.
DATE OF FLOW TEST FROM TO M.			DATE SHUT-IN PRESSURE MEASURED M.		

PRESSURE DATA – ALL PRESSURES IN PSIA

(a) Flowing Casing Pressure (DWt)	(b) Flowing Tubing Pressure (DWt)	(c) Flowing Meter Pressure (DWt)	(d) Flow Chart Static Reading	(e) Meter Error (Item c – Item d)	(f) Friction Loss (a – c) or (b – c)	(g) Average Meter Pressure (Integr.)
N.	N.	N.	N.	O.	O.	P.
(h) Corrected Meter Pressure (g + e)	**(i) Avg. Wellhead Press. P_t = (h + f)**	**(j) Shut-in Casing Pressure (DWt)**	**(k) Shut-in Tubing Pressure (DWt)**	**(l) P_c = higher value of (j) or (k)**	**(m) Del. Pressure P_d = _____ %P_c**	**(n) Separator or Dehydrator Pr. (DWt) for critical flow only**
Q.	Q.	N.	N.	R.	R.	

FLOW RATE CORRECTION (METER ERROR)

Integrated Volume – MCF/D	Quotient of $\frac{\text{Item c}}{\text{Item d}}$	$\sqrt{\frac{\text{Item c}}{\text{Item d}}}$	Corrected Volume
S_1.	S_2.	S_3.	Q = S_4. MCF/D

WORKING PRESSURE CALCULATION

$(1-e^{-s})$	$(F_c Q_m)^2 (1000)$	$R^2 = (1-e^{-s})(F_c Q_m)^2(1000)$	P_t^2	$P_w^2 = P_t^2 + R^2$	$P_w = \sqrt{P_w^2}$
T.	T.	T.	T.	T.	T.

DELIVERABILITY CALCULATION

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = \text{U.} \quad \left[\left(\quad\right)^n = \quad = \quad\right] = \quad \text{MCF/D}$$

REMARKS:

V.

SUMMARY

W.

Item b		Psia
P_c		Psia
Q		MCF/D
P_w		Psia
P_d		Psia
D		MCF/D

X.

Company _____
By _____
Title _____
Witnessed By _____
Company _____

SECTION VII

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TABLE I

BASIC ORIFICE FACTORS – FLANGE TAPS – $Mcfd/\sqrt{h_w P_m} = F_b$

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

Nom. Diameter, Inches	2			3				4	
ASA Schedule	160	80	40	xxHvy	160	80	40	xxHvy	160
Inside Diameter, Inches	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438
Orifice Diameter Inches			*				*		
0.250	0.2987	0.2990	0.2991	0.2991	0.2991	0.2990	0.2989	0.2989	0.2987
0.375	0.6700	0.6691	0.6689	0.6685	0.6681	0.6678	0.6677	0.6676	0.6674
0.500	1.195	1.190	1.189	1.187	1.185	1.184	1.183	1.183	1.183
0.625	1.884	1.871	1.866	1.860	1.854	1.851	1.850	1.849	1.848
0.750	2.755	2.720	2.709	2.695	2.682	2.675	2.672	2.671	2.667
0.875	3.834	3.754	3.729	3.697	3.670	3.657	3.650	3.648	3.640
1.000	5.171	4.999	4.946	4.881	4.828	4.801	4.789	4.784	4.770
1.125	6.847	6.499	6.393	6.267	6.165	6.116	6.095	6.086	6.062
1.250	9.077	8,319	8.120	7.885	7.703	7.615	7.577	7.561	7.520
1.375	---	10.55	10.20	9.782	9.463	9.313	9.249	9.223	9.153
1.500	---	----	12.76	12.02	11.48	11.23	11.13	11.09	10.97
1.625	---	----	----	14.68	13.81	13.40	13.24	13.17	13.00
1.750	---	----	----	----	16.50	15.87	15.61	15.50	15.24
1.875	---	----	----	----	19.64	18.68	18.29	18.13	17.72
2.000	---	----	----	----	----	21.90	21.32	21.08	20.48
2.125	---	----	----	----	----	25.67	24.76	24.43	23.56
2.250	---	----	----	----	----	----	28.78	28.23	27.00
2.375	---	----	----	----	----	----	----	----	30.86
2.500	---	----	----	----	----	----	----	----	35.26

Adapted from American Gas Association Gas Measurement Committee Report No. 3

* Use this column if only the nominal diameter is known.

TABLE 1, Continued

BASIC ORIFICE FACTORS — FLANGE TAPS — Mcfd/$\sqrt{h_w P_m}$ — F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

4		6				8			Nom. Diameter, Inches
80	40	xxHvy	160	80	40	80	40	30	ASA Schedule
3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071	Inside Diameter, Inches
	*				*				Orifice Diameter Inches
0.2985	0.2984	----	----	----	----	----	----	----	0.250
0.6671	0.6670	----	----	----	----	----	----	----	0.375
1.182	1.182	1.181	1.181	1.181	1.181	----	----	----	0.500
1.846	1.845	1.843	1.843	1.842	1.842	----	----	----	0.625
2.662	2.661	2.656	2.655	2.653	2.652	----	----	----	0.750
3.633	3.630	3.621	3.618	3.615	3.613	3.608	3.607	3.607	0.875
4.758	4.753	4.737	4.734	4.728	4.726	4.717	4.715	4.715	1.000
6.040	6.031	6.007	6.002	5.993	5.989	5.976	5.974	5.973	1.125
7.483	7.469	7.431	7.423	7.410	7.405	7.386	7.383	7.382	1.250
9.093	9.071	9.011	8.999	8.981	8.973	8.947	8.942	8.941	1.375
10.88	10.84	10.75	10.73	10.71	10.70	10.66	10.65	10.65	1.500
12.84	12.79	12.65	12.63	12.59	12.57	12.52	12.52	12.51	1.625
15.01	14.93	14.72	14.68	14.63	14.61	14.54	14.53	14.53	1.750
17.38	17.26	16.96	16.91	16.83	16.80	16.71	16.70	16.70	1.875
19.99	19.81	19.39	19.31	19.20	19.16	19.04	19.02	19.02	2.000
22.85	22.60	22.00	21.89	21.74	21.69	21.52	21.50	21.50	2.125
25.99	25.64	24.81	24.66	24.46	24.38	24.17	24.14	24.13	2.250
29.46	28.98	27.83	27.63	27.35	27.25	26.97	26.93	26.92	2.375
33.29	32.64	31.08	30.81	30.44	30.31	29.94	29.89	29.88	2.500
37.54	36.66	34.57	34.21	33.73	33.55	33.07	33.01	32.99	2.625
42.28	41.10	38.33	37.85	37.22	36.99	36.37	36.29	36.28	2.750
----	46.01	42.38	41.75	40.94	40.65	39.84	39.75	39.73	2.875
----	51.64	46.74	45.94	44.89	44.51	43.50	43.38	43.35	3.000
----	----	51.46	50.43	49.09	48.61	47.33	47.18	47.15	3.125
----	----	56.57	55.26	53.56	52.96	51.35	51.17	51.13	3.250
----	----	62.10	60.46	58.33	57.57	55.57	55.34	55.29	3.375
----	----	68.13	66.07	63.41	62.47	59.99	59.71	59.65	3.500
----	----	74.84	72.12	68.84	67.67	64.62	64.28	64.20	3.625
----	----	----	78.72	74.64	73.20	69.47	69.05	68.96	3.750
----	----	----	86.06	80.84	79.09	74.55	74.04	73.93	3.875
----	----	----	----	87.48	85.37	79.86	79.26	79.12	4.000
----	----	----	----	102.5	99.21	91.28	90.40	90.21	4.250
----	----	----	----	----	115.3	103.8	102.6	102.3	4.500
----	----	----	----	----	----	117.7	116.0	115.6	4.750
----	----	----	----	----	----	132.9	130.6	130.1	5.000
----	----	----	----	----	----	149.9	146.7	146.1	5.250
----	----	----	----	----	----	168.7	164.5	163.6	5.500
----	----	----	----	----	----	----	184.2	183.0	5.750
----	----	----	----	----	----	----	----	204.9	6.000

TABLE II

BASIC ORIFICE FACTORS — PIPE TAPS — Mcfd/ $\sqrt{h_w P_m}$ — F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

Nom. Diameter, Inches	2			3				4	
ASA Schedule	160	80	40	xxHvy	160	80	40	xxHvy	160
Inside Diameter, Inches	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438
Orifice Diameter Inches			*				*		
0.250	0.3023	0.3015	0.3012	0.3007	0.3003	0.3001	0.2999	0.2999	0.2997
0.375	0.6908	0.6846	0.6825	0.6796	0.6769	0.6755	0.6749	0.6745	0.6737
0.500	1.264	1.243	1.235	1.224	1.214	1.208	1.206	1.205	1.201
0.625	2.052	1.998	1.978	1.951	1.925	1.909	1.902	1.899	1.890
0.750	3.111	2.985	2.941	2.881	2.825	2.792	2.776	2.769	2.750
0.875	4.535	4.259	4.166	4.045	3.935	3.872	3.842	3.830	3.792
1.000	6.481	5.908	5.724	5.489	5.284	5.171	5.118	5.095	5.030
1.125	9.222	8.070	7.717	7.281	6.913	6.717	6.627	6.589	6.480
1.250	---	10.96	10.31	9.518	8.879	8.551	8.403	8.340	8.165
1.375	---	----	13.74	12.35	11.26	10.72	10.49	10.39	10.11
1.500	---	----	----	15.98	14.17	13.31	12.94	12.78	12.36
1.625	---	----	----	----	17.77	16.41	15.83	15.60	14.96
1.750	---	----	----	----	22.28	20.15	19.27	18.91	17.96
1.875	---	----	----	----	----	24.71	23.39	22.85	21.46
2.000	---	----	----	----	----	30.37	28.37	27.57	25.54
2.125	---	----	----	----	----	----	34.47	33.29	30.35
2.250	---	----	----	----	----	----	----	----	36.05
2.375	---	----	----	----	----	----	----	----	42.89

Adapted from American Gas Association Gas Measurement Committee Report No. 3

* Use this column if only the nominal diameter is known.

TABLE II, Continued

BASIC ORIFICE FACTORS — PIPE TAPS — Mcfd/ $\sqrt{h_w P_m}$ — F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

4		6				8			Nom. Diameter, Inches
80	40	xxHvy	160	80	40	80	40	30	ASA Schedule
3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071	Inside Diameter, Inches
	*				*			*	Orifice Diameter Inches
0.2995	0.2993	----	----	----	----	----	----	----	0.250
0.6729	0.6725	----	----	----	----	----	----	----	0.375
1.198	1.197	1.194	1.193	1.192	1.191	----	----	----	0.500
1.882	1.878	1.869	1.867	1.864	1.863	----	----	----	0.625
2.731	2.723	2.701	2.697	2.690	2.687	----	----	----	0.750
3.754	3.740	3.697	3.687	3.674	3.668	3.649	3.647	3.646	0.875
4.965	4.939	4.862	4.845	4.820	4.810	4.776	4.772	4.770	1.000
6.374	6.332	6.205	6.177	6.134	6.117	6.061	6.053	6.052	1.125
7.997	7.930	7.735	7.690	7.624	7.597	7.508	7.495	7.493	1.250
9.854	9.753	9.460	9.395	9.296	9.255	9.120	9.101	9.097	1.375
11.97	11.82	11.39	11.30	11.16	11.10	10.90	10.87	10.87	1.500
14.38	14.16	13.55	13.41	13.22	13.13	12.86	12.82	12.81	1.625
17.12	16.80	15.94	15.76	15.48	15.37	15.00	14.95	14.93	1.750
20.24	19.79	18.59	18.34	17.97	17.82	17.33	17.25	17.24	1.875
23.80	23.18	21.52	21.18	20.69	20.49	19.84	19.75	19.73	2.000
27.89	27.02	24.76	24.31	23.66	23.40	22.56	22.44	22.41	2.125
32.60	31.40	28.35	27.75	26.90	26.56	25.48	25.33	25.29	2.250
38.05	36.41	32.31	31.53	30.43	29.99	28.62	28.42	28.38	2.375
44.41	42.17	36.72	35.70	34.27	33.71	31.98	31.74	31.68	2.500
51.90	48.84	41.61	40.29	38.45	37.75	35.58	35.27	35.21	2.625
----	56.63	47.05	45.35	43.02	42.12	39.42	39.05	38.97	2.750
----	----	53.14	50.96	48.00	46.87	43.53	43.07	42.97	2.875
----	----	59.97	57.18	53.44	52.04	47.90	47.36	47.23	3.000
----	----	67.65	64.10	59.39	57.65	52.58	51.91	51.76	3.125
----	----	76.35	71.83	65.92	63.76	57.56	56.76	56.58	3.250
----	----	86.25	80.49	73.10	70.43	62.88	61.92	61.70	3.375
----	----	----	90.25	81.01	77.72	68.56	67.40	67.14	3.500
----	----	----	101.3	89.75	85.70	74.61	73.24	72.93	3.625
----	----	----	----	99.44	94.46	81.08	79.45	79.08	3.750
----	----	----	----	110.2	104.1	88.00	86.06	85.63	3.875
----	----	----	----	122.3	114.8	95.39	93.10	92.59	4.000
----	----	----	----	----	----	111.8	108.6	107.9	4.250
----	----	----	----	----	----	130.7	126.3	125.4	4.500
----	----	----	----	----	----	152.6	146.6	145.3	4.750
----	----	----	----	----	----	178.1	170.0	168.2	5.000
----	----	----	----	----	----	208.2	197.1	194.7	5.250
----	----	----	----	----	----	----	228.8	225.5	5.500

TABLE III
SQUARE ROOTS

N	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.317	0.447	0.548	0.632	0.707	0.775	0.837	0.894	0.949
1	1.000	1.049	1.095	1.140	1.183	1.225	1.265	1.304	1.342	1.378
2	1.414	1.449	1.483	1.517	1.549	1.581	1.612	1.643	1.673	1.703
3	1.732	1.761	1.789	1.817	1.844	1.871	1.897	1.923	1.949	1.975
4	2.000	2.025	2.049	2.074	2.098	2.121	2.145	2.168	2.191	2.214
5	2.236	2.258	2.280	2.302	2.324	2.345	2.366	2.387	2.408	2.429
6	2.449	2.470	2.490	2.501	2.530	2.550	2.569	2.588	2.608	2.627
7	2.646	2.665	2.683	2.702	2.720	2.739	2.757	2.775	2.793	2.811
8	2.828	2.846	2.864	2.881	2.898	2.915	2.933	2.950	2.966	2.983
9	3.000	3.017	3.033	3.050	3.066	3.082	3.098	3.114	3.130	3.146
10	3.162	3.178	3.194	3.209	3.225	3.240	3.256	3.271	3.286	3.303
11	3.317	3.332	3.347	3.362	3.376	3.391	3.406	3.421	3.435	3.450
12	3.464	3.479	3.493	3.507	3.521	3.536	3.550	3.564	3.578	3.592
13	3.606	3.619	3.633	3.647	3.661	3.674	3.688	3.701	3.715	3.728
14	3.742	3.755	3.768	3.782	3.795	3.808	3.821	3.834	3.847	3.860
15	3.873	3.886	3.899	3.912	3.924	3.937	3.950	3.962	3.975	3.987
16	4.000	4.012	4.025	4.037	4.050	4.062	4.074	4.087	4.099	4.111
17	4.123	4.135	4.147	4.159	4.171	4.183	4.195	4.207	4.219	4.231
18	4.243	4.254	4.266	4.278	4.290	4.301	4.313	4.324	4.336	4.347
19	4.359	4.370	4.382	4.393	4.405	4.416	4.427	4.438	4.450	4.461
20	4.472	4.483	4.494	4.506	4.517	4.528	4.539	4.550	4.561	4.572
21	4.583	4.593	4.604	4.615	4.626	4.637	4.648	4.658	4.669	4.680
22	4.690	4.701	4.712	4.722	4.733	4.743	4.754	4.764	4.775	4.785
23	4.796	4.806	4.817	4.827	4.337	4.848	4.858	4.868	4.879	4.889
24	4.899	4.909	4.919	4.930	4.940	4.950	4.960	4.970	4.980	4.990
25	5.000	5.010	5.020	5.030	5.040	5.050	5.060	5.070	5.079	5.089
26	5.099	5.109	5.119	5.128	5.138	5.148	5.158	5.167	5.177	5.187
27	5.196	5.206	5.215	5.225	5.235	5.244	5.254	5.263	5.273	5.282
28	5.292	5.301	5.310	5.320	5.329	5.339	5.348	5.357	5.367	5.376
29	5.385	5.394	5.404	5.413	5.422	5.431	5.441	5.450	5.459	5.468
30	5.477	5.486	5.495	5.505	5.514	5.523	5.532	5.541	5.550	5.559
31	5.568	5.577	5.586	5.595	5.604	5.612	5.621	5.630	5.639	5.648
32	5.657	5.666	5.675	5.683	5.692	5.701	5.710	5.718	5.727	5.736
33	5.745	5.753	5.762	5.771	5.779	5.788	5.797	5.805	5.814	5.822
34	5.831	5.840	5.848	5.857	5.865	5.874	5.882	5.891	5.899	5.908
35	5.916	5.925	5.933	5.941	5.950	5.958	5.967	5.975	5.983	5.992
36	6.000	6.008	6.017	6.025	6.033	6.042	6.050	6.058	6.066	6.075
37	6.083	6.091	6.099	6.107	6.116	6.124	6.132	6.140	6.148	6.156
38	6.164	6.173	6.181	6.189	6.197	6.205	6.213	6.221	6.229	6.237
39	6.245	6.253	6.261	6.269	6.277	6.285	6.293	6.301	6.309	6.317
40	6.325	6.332	6.340	6.348	6.356	6.364	6.372	6.380	6.387	6.395
41	6.403	6.411	6.419	6.427	6.434	6.442	6.450	6.458	6.465	6.473
42	6.481	6.488	6.496	6.504	6.512	6.519	6.527	6.535	6.542	6.550
43	6.557	6.565	6.573	6.580	6.588	6.595	6.603	6.611	6.618	6.626
44	6.633	6.641	6.648	6.656	6.663	6.671	6.678	6.686	6.693	6.701
45	6.708	6.716	6.723	6.731	6.738	6.745	6.753	6.760	6.768	6.775
46	6.782	6.790	6.797	6.804	6.812	6.819	6.826	6.834	6.841	6.848
47	6.856	6.863	6.870	6.877	6.885	6.892	6.899	6.907	6.914	6.921
48	6.928	6.935	6.943	6.950	6.957	6.964	6.971	6.979	6.986	6.993
49	7.000	7.007	7.014	7.021	7.029	7.036	7.043	7.050	7.057	7.064

TABLE III, Continued

N	0	1	2	3	4	5	6	7	8	9
50	7.071	7.141	7.211	7.280	7.348	7.416	7.483	7.550	7.616	7.681
60	7.746	7.810	7.874	7.937	8.000	8.062	8.124	8.185	8.246	8.307
70	8.367	8.426	8.485	8.544	8.602	8.660	8.718	8.775	8.832	8.888
80	8.944	9.000	9.055	9.110	9.165	9.220	9.274	9.327	9.381	9.434
90	9.487	9.539	9.592	9.644	9.695	9.747	9.798	9.849	9.899	9.950
100	10.00	10.05	10.10	10.15	10.20	10.25	10.30	10.34	10.39	10.44
110	10.49	10.54	10.58	10.63	10.68	10.72	10.77	10.82	10.86	10.91
120	10.95	11.00	11.05	11.09	11.14	11.18	11.22	11.27	11.31	11.36
130	11.40	11.45	11.49	11.53	11.58	11.62	11.66	11.70	11.75	11.79
140	11.83	11.87	11.92	11.96	12.00	12.04	12.08	12.12	12.17	12.21
150	12.25	12.29	12.33	12.37	12.41	12.45	12.49	12.53	12.57	12.61
160	12.65	12.69	12.73	12.77	12.81	12.85	12.88	12.92	12.96	13.00
170	13.04	13.08	13.11	13.15	13.19	13.23	13.27	13.30	13.34	13.38
180	13.42	13.45	13.49	13.53	13.56	13.60	13.64	13.67	13.71	13.75
190	13.78	13.82	13.86	13.89	13.93	13.96	14.00	14.04	14.07	14.11
200	14.14	14.18	14.21	14.25	14.28	14.32	14.35	14.39	14.42	14.46
210	14.49	14.53	14.56	14.59	14.63	14.66	14.70	14.73	14.76	14.80
220	14.83	14.87	14.90	14.93	14.97	15.00	15.03	15.07	15.10	15.13
230	15.17	15.20	15.23	15.26	15.30	15.33	15.36	15.39	15.43	15.46
240	15.49	15.52	15.56	15.59	15.62	15.65	15.68	15.72	15.75	15.78
250	15.81	15.84	15.87	15.91	15.94	15.97	16.00	16.03	16.06	16.09
260	16.12	16.16	16.19	16.22	16.25	16.28	16.31	16.34	16.37	16.40
270	16.43	16.46	16.49	16.52	16.55	16.58	16.61	16.64	16.67	16.70
280	16.73	16.76	16.79	16.82	16.85	16.88	16.91	16.94	16.97	17.00
290	17.03	17.06	17.09	17.12	17.15	17.18	17.20	17.23	17.26	17.29
300	17.32	17.35	17.38	17.41	17.44	17.46	17.49	17.52	17.55	17.58
310	17.61	17.64	17.66	17.69	17.72	17.75	17.78	17.80	17.83	17.86
320	17.89	17.92	17.94	17.97	18.00	18.03	18.06	18.08	18.11	18.14
330	18.17	18.19	18.22	18.25	18.28	18.30	18.33	18.36	18.38	18.41
340	18.44	18.47	18.49	18.52	18.55	18.57	18.60	18.63	18.65	18.68
350	18.71	18.73	18.76	18.79	18.81	18.84	18.87	18.89	18.92	18.95
360	18.97	19.00	19.03	19.05	19.08	19.10	19.13	19.16	19.18	19.21
370	19.24	19.26	19.29	19.31	19.34	19.36	19.39	19.42	19.44	19.47
380	19.49	19.52	19.54	19.57	19.60	19.62	19.65	19.67	19.70	19.72
390	19.74	19.77	19.80	19.82	19.85	19.87	19.90	19.92	19.95	19.97
400	20.00	20.02	20.05	20.07	20.10	20.12	20.15	20.17	20.20	20.22
410	20.25	20.27	20.30	20.32	20.35	20.37	20.40	20.42	20.45	20.47
420	20.49	20.52	20.54	20.57	20.59	20.62	20.64	20.66	20.69	20.71
430	20.74	20.76	20.78	20.81	20.83	20.86	20.88	20.90	20.93	20.95
440	20.98	21.00	21.02	21.05	21.07	21.10	21.12	21.14	21.17	21.19
450	21.21	21.24	21.26	21.28	21.31	21.33	21.35	21.38	21.40	21.42
460	21.45	21.47	21.49	21.52	21.54	21.56	21.59	21.61	21.63	21.66
470	21.68	21.70	21.73	21.75	21.77	21.79	21.82	21.84	21.86	21.89
480	21.91	21.93	21.95	21.98	22.00	22.02	22.05	22.07	22.09	22.11
490	22.14	22.16	22.18	22.20	22.23	22.25	22.27	22.29	22.32	22.34
500	22.36	22.38	22.41	22.43	22.45	22.47	22.49	22.52	22.54	22.56
510	22.58	22.61	22.63	22.65	22.67	22.69	22.72	22.74	22.76	22.78
520	22.80	22.83	22.85	22.87	22.89	22.91	22.93	22.96	22.98	23.00
530	23.02	23.04	23.07	23.09	23.11	23.13	23.15	23.17	23.19	23.22
540	23.24	23.26	23.28	23.30	23.32	23.35	23.37	23.39	23.41	23.43

TABLE III, Continued

N	0	1	2	3	4	5	6	7	8	9
550	23.45	23.47	23.49	23.52	23.54	23.56	23.58	23.60	23.62	23.64
560	23.66	23.69	23.71	23.73	23.75	23.77	23.79	23.81	23.83	23.85
570	23.87	23.90	23.92	23.94	23.96	23.98	24.00	24.02	24.04	24.06
580	24.08	24.10	24.12	24.15	24.17	24.19	24.21	24.23	24.25	24.27
590	24.29	24.31	24.33	24.35	24.37	24.39	24.41	24.43	24.45	24.47
600	24.49	24.52	24.54	24.56	24.58	24.60	24.62	24.64	24.66	24.68
610	24.70	24.72	24.74	24.76	24.78	24.80	24.82	24.84	24.86	24.88
620	24.90	24.92	24.94	24.96	24.98	25.00	25.02	25.04	25.06	25.08
630	25.10	25.12	25.14	25.16	25.18	25.20	25.22	25.24	25.26	25.28
640	25.30	25.32	25.34	25.36	25.38	25.40	25.42	25.44	25.46	25.48
650	25.50	25.51	25.53	25.55	25.57	25.59	25.61	25.63	25.65	25.67
660	25.69	25.71	25.73	25.75	25.77	25.79	25.81	25.83	25.85	25.87
670	25.88	25.90	25.92	25.94	25.96	25.98	26.00	26.02	26.04	26.06
680	26.08	26.10	26.12	26.13	26.15	26.17	26.19	26.21	26.23	26.25
690	26.27	26.29	26.31	26.32	26.34	26.36	26.38	26.40	26.42	26.44
700	26.46	26.48	26.50	26.51	26.53	26.55	26.57	26.59	26.61	26.63
710	26.65	26.66	26.68	26.70	26.72	26.74	26.76	26.78	26.80	26.81
720	26.83	26.85	26.87	26.89	26.91	26.93	26.94	26.96	26.98	27.00
730	27.02	27.04	27.06	27.07	27.09	27.11	27.13	27.15	27.17	27.18
740	27.20	27.22	26.24	27.26	27.28	27.29	27.31	27.33	27.35	27.37
750	27.39	27.40	27.42	27.44	27.46	27.48	27.50	27.51	27.53	27.55
760	27.57	27.59	27.60	27.62	27.64	27.66	27.68	27.69	27.71	27.73
770	27.75	27.77	27.78	27.80	27.82	27.84	27.86	27.87	27.89	27.91
780	27.93	27.95	27.96	27.98	28.00	28.02	28.04	28.05	28.07	28.09
790	28.11	28.12	28.14	28.16	28.18	28.20	28.21	28.23	28.25	28.27
800	28.28	28.30	28.32	28.34	28.35	28.37	28.39	28.41	28.43	28.44
810	28.46	28.48	28.50	28.51	28.53	28.55	28.57	28.58	28.60	28.62
820	28.64	28.65	28.67	28.69	28.71	28.72	28.74	28.76	28.77	28.79
830	28.81	28.83	28.84	28.86	28.88	28.90	28.91	28.93	28.95	28.97
840	28.98	29.00	29.02	29.03	29.05	29.07	29.09	29.10	29.12	29.14
850	29.15	29.17	29.19	29.21	29.22	29.24	29.26	29.27	29.29	29.31
860	29.33	29.34	29.36	29.38	29.39	29.41	29.43	29.44	29.46	29.48
870	29.50	29.51	29.53	29.55	29.56	29.58	29.60	29.61	29.63	29.65
880	29.66	29.68	29.70	29.72	29.73	29.75	29.77	29.78	29.80	29.82
890	29.83	29.85	29.87	29.88	29.90	29.92	29.93	29.95	29.97	29.98
900	30.00	30.02	30.03	30.05	30.07	30.08	30.10	30.12	30.13	30.15
910	30.17	30.18	30.20	30.22	30.23	30.25	30.27	30.28	30.30	30.32
920	30.33	30.35	30.36	30.38	30.40	30.41	30.43	30.45	30.46	30.48
930	30.50	30.51	30.53	30.55	30.56	30.58	30.59	30.61	30.63	30.64
940	30.66	30.68	30.69	30.71	30.72	30.74	30.76	30.77	30.79	30.81
950	30.82	30.84	30.85	30.87	30.89	30.90	30.92	30.94	30.95	30.97
960	30.98	31.00	31.02	31.03	31.05	31.06	31.08	31.10	31.11	31.13
970	31.14	31.16	31.18	31.19	31.21	31.22	31.24	31.26	31.27	31.29
980	31.30	31.32	31.34	31.35	31.37	31.38	31.40	31.42	31.43	31.45
990	31.46	31.48	31.50	31.51	31.53	31.54	31.56	31.58	31.59	31.61

TABLE IV

METER FACTORS FOR L-10 (SQUARE ROOT) CHARTS - F_d

$$F_d = 0.01 \sqrt{R_h \cdot R_p}$$

Meter Pressure Range psia - R_p	Meter Differential Range, Inches - R_h				
	10	20	50	100	200
24.7	0.1572	0.2223	0.3514	-	-
50.0	0.2236	0.3162	0.5000	0.7071	1.000
100.0	0.3162	0.4472	0.7071	1.000	1.414
150.0	-	0.5477	0.8660	1.22	1.732
250.0	-	0.7071	1.118	1.581	2.236
300.0	-	0.7746	1.225	1.732	2.449
350.0	-	0.8367	1.323	1.871	2.646
500.0	-	1.000	1.581	2.236	3.162
750.0	-	-	1.936	2.739	3.873
1000.0	-	-	2.236	3.162	4.472
1500.0	-	-	2.739	3.873	5.477
2000.0	-	-	3.162	4.472	6.325
2500.0	-	-	-	5.000	7.071
3000.0	-	-	-	5.477	7.746
4000.0	-	-	-	6.325	8.944
5000.0	-	-	-	7.071	10.00
6000.0	-	-	-	7.746	10.95
10000.0	-	-	-	10.00	14.14

TABLE V

BASIC CRITICAL FLOW PROVER FACTORS - Mcfd/psia - F_p

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

Two-Inch Prover		Four-Inch Prover	
Orifice Diameter, Inches	F_p	Orifice Diameter, Inches	F_p
1/16	0.06405	1/4	1.047
3/32	0.1410	3/8	2.354
1/8	0.2648	1/2	4.211
3/16	0.6082	5/8	6.561
7/32	0.8393	3/4	9.402
1/4	1.087	7/8	12.79
5/16	1.672	1	16.66
3/8	2.378	1 1/8	20.98
7/16	3.408	1 1/4	25.91
1/2	4.279	1 3/8	31.19
5/8	6.473	1 1/2	37.17
3/4	9.453	1 3/4	50.77
7/8	13.00	2	67.08
1	17.09	2 1/4	85.99
1 1/8	21.89	2 1/2	107.8
1 1/4	27.63	2 3/4	133.5
1 3/8	33.95	3	164.1
1 1/2	42.11		

Based on data from USBM Monograph 7, Tables 26 and 27, pages 122 and 123.

TABLE VI

BASIC POSITIVE CHOKE FACTORS - Mcfd/psia - F_p

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

Nominal Choke Size, Inches	Inside Diameter Inches	Factor - F_p	
		Six-Inch (1) Choke Nipple	Thornhill-Carver (2) Positive Choke
1/8	0.1250	0.2618	0.2416
9/64	0.1406	0.3346	0.3105
5/32	0.1563	0.4173	0.3885
11/64	0.1719	0.5090	0.4758
3/16	0.1875	0.6101	0.5725
13/64	0.2031	0.7208	0.6778
7/32	0.2188	0.8419	0.7924
15/64	0.2344	0.9720	0.9165
1/4	0.2500	1.112	1.050
17/64	0.2656	1.262	1.187
9/32	0.2813	1.422	1.331
19/64	0.2969	1.592	1.484
5/16	0.3125	1.771	1.645
21/64	0.3281	1.961	1.817
11/32	0.3438	2.162	1.999
23/64	0.3594	2.371	2.189
3/8	0.3750	2.591	2.388
25/64	0.3906	2.821	2.587
13/32	0.4063	3.063	2.794
27/64	0.4219	3.313	3.009
7/16	0.4375	3.574	3.231
29/64	0.4531	3.845	3.460
15/32	0.4688	4.128	3.697
31/64	0.4844	4.420	3.942
1/2	0.5000	4.722	4.194
9/16	0.5625	6.038	5.290
5/8	0.6250	7.522	6.510
11/16	0.6875	9.177	7.978
3/4	0.7500	11.00	9.604

(1) Based on data published on page 294 of Diehl's Natural Gas Handbook.

(2) Based on data published in 1946 on page 15 of the "Report on the Calibration of Positive Flow Beans" by the Texas College of Arts and Industries, Kingsville, Texas.

TABLE VII

FLOWING TEMPERATURE FACTORS — F_t

$$F_t = \sqrt{\frac{520}{T_m}}$$

Observed Temperature °F	0	1	2	3	4	5	6	7	8	9
0	1.063	1.062	1.061	1.060	1.059	1.057	1.056	1.055	1.054	1.053
10	1.052	1.051	1.050	1.049	1.047	1.046	1.045	1.044	1.043	1.042
20	1.041	1.040	1.039	1.038	1.037	1.035	1.034	1.033	1.032	1.031
30	1.030	1.029	1.028	1.027	1.026	1.025	1.024	1.023	1.022	1.021
40	1.020	1.019	1.018	1.017	1.016	1.015	1.014	1.013	1.012	1.011
50	1.010	1.009	1.008	1.007	1.006	1.005	1.004	1.003	1.002	1.001
60	1.000	0.9990	0.9981	0.9971	0.9962	0.9952	0.9943	0.9933	0.9924	0.9915
70	0.9905	0.9896	0.9887	0.9877	0.9868	0.9859	0.9850	0.9840	0.9831	0.9822
80	0.9813	0.9804	0.9795	0.9786	0.9777	0.9768	0.9759	0.9750	0.9741	0.9732
90	0.9723	0.9715	0.9706	0.9697	0.9688	0.9680	0.9671	0.9662	0.9653	0.9645
100	0.9636	0.9628	0.9619	0.9610	0.9602	0.9594	0.9585	0.9577	0.9568	0.9560
110	0.9551	0.9543	0.9535	0.9526	0.9518	0.9510	0.9501	0.9493	0.9485	0.9477
120	0.9469	0.9460	0.9452	0.9444	0.9436	0.9428	0.9420	0.9412	0.9404	0.9396
130	0.9388	0.9380	0.9372	0.9364	0.9356	0.9349	0.9341	0.9333	0.9325	0.9317
140	0.9309	0.9302	0.9294	0.9286	0.9279	0.9271	0.9263	0.9256	0.9248	0.9240
150	0.9233	0.9225	0.9217	0.9210	0.9202	0.9195	0.9187	0.9180	0.9173	0.9165
160	0.9158	0.9150	0.9143	0.9135	0.9128	0.9121	0.9114	0.9106	0.9099	0.9092
170	0.9085	0.9077	0.9071	0.9063	0.9055	0.9048	0.9042	0.9035	0.9028	0.9020
180	0.9014	0.9007	0.9000	0.8992	0.8985	0.8979	0.8972	0.8965	0.8958	0.8951
190	0.8944	0.8937	0.8931	0.8923	0.8916	0.8910	0.8903	0.8896	0.8889	0.8882
200	0.8876	0.8870	0.8863	0.8856	0.8849	0.8843	0.8836	0.8830	0.8823	0.8816
210	0.8810	0.8803	0.8797	0.8790	0.8784	0.8777	0.8770	0.8764	0.8758	0.8751
220	0.8745	0.8738	0.8732	0.8725	0.8719	0.8713	0.8706	0.8700	0.8694	0.8687
230	0.8681	0.8675	0.8668	0.8662	0.8656	0.8650	0.8644	0.8637	0.8631	0.8625
240	0.8619	0.8613	0.8606	0.8600	0.8594	0.8588	0.8582	0.8576	0.8570	0.8564

TABLE VIII

SPECIFIC GRAVITY FACTORS — F_g

$$F_g = \sqrt{\frac{1}{G}}$$

Specific Gravity G	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
0.550	1.348	1.347	1.346	1.345	1.344	1.342	1.341	1.340	1.339	1.338
0.560	1.336	1.335	1.334	1.333	1.332	1.330	1.329	1.328	1.327	1.326
0.570	1.325	1.323	1.322	1.321	1.320	1.319	1.318	1.316	1.315	1.314
0.580	1.313	1.312	1.311	1.310	1.309	1.307	1.306	1.305	1.304	1.303
0.590	1.302	1.301	1.300	1.299	1.298	1.296	1.295	1.294	1.293	1.292
0.600	1.291	1.290	1.289	1.288	1.287	1.286	1.285	1.284	1.282	1.281
0.610	1.280	1.279	1.278	1.277	1.276	1.275	1.274	1.273	1.272	1.271
0.620	1.270	1.269	1.268	1.267	1.266	1.265	1.264	1.263	1.262	1.261
0.630	1.260	1.259	1.258	1.257	1.256	1.255	1.254	1.253	1.252	1.251
0.640	1.250	1.249	1.248	1.247	1.246	1.245	1.244	1.243	1.242	1.241
0.650	1.240	1.239	1.238	1.237	1.237	1.236	1.235	1.234	1.233	1.232
0.660	1.231	1.230	1.229	1.228	[illegible]27	1.226	1.225	1.224	1.224	1.223
0.670	1.222	1.221	1.220	1.219	[illegible]8	1.217	1.216	1.215	1.214	1.214
0.680	1.213	1.212	1.211	1.210	1.[illegible]09	1.208	1.207	1.206	1.206	1.205
0.690	1.204	1.203	1.202	1.201	1.200	1.200	1.199	1.198	1.197	1.196
0.700	1.195	1.194	1.194	1.193	1.192	1.191	1.190	1.189	1.188	1.188
0.710	1.187	1.186	1.185	1.184	1.183	1.183	1.182	1.181	1.180	1.179
0.720	1.179	1.178	1.177	1.176	1.175	1.174	1.174	1.173	1.172	1.171
0.730	1.170	1.170	1.169	1.168	1.167	1.166	1.166	1.165	1.164	1.163
0.740	1.162	1.162	1.161	1.160	1.159	1.159	1.158	1.157	1.156	1.155
0.750	1.155	1.154	1.153	1.152	1.152	1.151	1.150	1.149	1.149	1.148
0.760	1.147	1.146	1.146	1.145	1.144	1.143	1.143	1.142	1.141	1.140
0.770	1.140	1.139	1.138	1.137	1.137	1.136	1.135	1.134	1.134	1.133
0.780	1.132	1.132	1.131	1.130	1.129	1.129	1.128	1.127	1.127	1.126
0.790	1.125	1.124	1.124	1.123	1.122	1.122	1.121	1.120	1.119	1.119
0.800	1.118	1.117	1.117	1.116	1.115	1.115	1.114	1.113	1.112	1.112
0.810	1.111	1.110	1.110	1.109	1.108	1.108	1.107	1.106	1.106	1.105
0.820	1.104	1.104	1.103	1.102	1.102	1.101	1.100	1.100	1.099	1.098
0.830	1.098	1.097	1.096	1.096	1.095	1.094	1.094	1.093	1.092	1.092
0.840	1.091	1.090	1.090	1.089	1.089	1.088	1.087	1.087	1.086	1.085
0.850	1.085	1.084	1.083	1.083	1.082	1.081	1.081	1.080	1.080	1.079
0.860	1.078	1.078	1.077	1.076	1.076	1.075	1.075	1.074	1.073	1.073
0.870	1.072	1.072	1.071	1.070	1.070	1.069	1.068	1.068	1.067	1.067
0.880	1.066	1.065	1.065	1.064	1.064	1.063	1.062	1.062	1.061	1.061
0.890	1.060	1.059	1.059	1.058	1.058	1.057	1.056	1.056	1.055	1.055
0.900	1.054	1.054	1.053	1.052	1.052	1.051	1.051	1.050	1.049	1.049
0.910	1.048	1.048	1.047	1.047	1.046	1.045	1.045	1.044	1.044	1.043
0.920	1.043	1.042	1.041	1.041	1.040	1.040	1.039	1.039	1.038	1.038
0.930	1.037	1.036	1.036	1.035	1.035	1.034	1.034	1.033	1.033	1.032
0.940	1.031	1.031	1.030	1.030	1.029	1.029	1.028	1.028	1.027	1.027
0.950	1.026	1.025	1.025	1.024	1.024	1.023	1.023	1.022	1.022	1.021
0.960	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.016
0.970	1.015	1.015	1.014	1.014	1.013	1.013	1.012	1.012	1.011	1.011
0.980	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.006	1.006
0.990	1.005	1.005	1.004	1.004	1.003	1.003	1.002	1.002	1.001	1.001

TABLE IX

PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES — P_{cr} and T_{cr}

G	P_{cr}	T_{cr}	G	P_{cr}	T_{cr}
0.55	673	336	0.85	664	441
0.56	673	341	0.86	664	444
0.57	672	346	0.87	663	448
0.58	672	350	0.88	663	451
0.59	672	354	0.89	662	454
0.60	671	358	0.90	662	457
0.61	671	362	0.91	662	461
0.62	671	365	0.92	662	464
0.63	670	368	0.93	661	467
0.64	670	372	0.94	661	471
0.65	670	375	0.95	660	474
0.66	670	378	0.96	660	477
0.67	669	382	0.97	659	481
0.68	669	385	0.98	659	484
0.69	669	388	0.99	659	487
0.70	668	392	1.00	658	491
0.71	668	395	1.01	658	494
0.72	668	398	1.02	657	497
0.73	668	401	1.03	656	500
0.74	667	405	1.04	656	504
0.75	667	408	1.05	655	507
0.76	667	411	1.06	655	510
0.77	666	415	1.07	654	514
0.78	666	418	1.08	654	517
0.79	666	421	1.09	653	520
0.80	665	424	1.10	652	524
0.81	665	428	1.11	652	527
0.82	665	431	1.12	651	530
0.83	665	434	1.13	651	534
0.84	664	438	1.14	650	537

Do not interpolate, values are inclusive to the next higher value.

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TABLE X

CORRECTION TO PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES FOR CARBON DIOXIDE AND NITROGEN

Values given below are to be added if positive, or subtracted if negative, from values taken from Table IX, Pseudocritical Properties of Hydrocarbon Gases.

Volume Percent of CO_2 or N_2 in Gas	Carbon Dioxide, CO_2		Nitrogen, N_2	
	P_{cr}	T_{cr}	P_{cr}	T_{cr}
1	+ 4	- 1	- 1	- 3
2	+ 8	- 3	- 3	- 6
3	+ 12	- 5	- 5	- 9
4	+ 17	- 7	- 7	- 11
5	+ 21	- 9	- 9	- 14
6	+ 25	- 11	- 11	- 17
7	+ 30	- 12	- 12	- 20
8	+ 34	- 14	- 14	- 22
9	+ 39	- 16	- 16	- 25
10	+ 44	- 17	- 17	- 28
11	+ 48	- 19	- 19	- 30
12	+ 53	- 21	- 21	- 33
13	+ 57	- 22	- 22	- 36
14	+ 61	- 24	- 24	- 39
15	+ 66	- 26	- 26	- 42
16	+ 70	- 27	- 27	- 44
17	+ 74	- 29	- 29	- 47
18	+ 79	- 31	- 31	- 50
19	+ 83	- 32	- 32	- 52
20	+ 87	- 34	- 34	- 55
21	+ 92	- 36	- 36	- 58
22	+ 96	- 37	- 37	- 60
23	+ 100	- 39	- 39	- 63
24	+ 104	- 41	- 41	- 66
25	+ 109	- 42	- 42	- 68
26	+ 113	- 44	- 44	- 71
27	+ 117	- 46	- 46	- 74
28	+ 122	- 47	- 47	- 77
29	+ 126	- 49	- 49	- 79
30	+ 130	- 51	- 51	- 82
31	+ 134	- 52	- 52	- 85
32	+ 139	- 54	- 54	- 87
33	+ 143	- 56	- 56	- 90
34	+ 147	- 57	- 57	- 93
35	+ 152	- 59	- 59	- 95
36	+ 156	- 61	- 61	- 98

Based on data from the California Natural Gasoline Association Bulletin No. TS-461.

TABLE XI

COMPRESSIBILITY FACTORS

FOR NATURAL GAS

- -

Expanded from Tables of Compressibility Factors and Integral Functions for Natural Gas as a function of pseudo-reduced pressure and temperature, Table 3, The Multiphase Flow of Gas, Oil, and Water Through Vertical Flow Strings with Application to the Design of Gas-lift Installations; F. H. Poettmann and P. G. Carpenter; Drilling and Production Practice, pages 279-291, 1952, American Petroleum Institute.

Interpolation between T_r values required.

(Values of P_r and T_r shall be calculated to four significant figures and rounded off to two significant figures following the decimal point before determining the Z value from Table XI.)

P_r and T_r in this table are pseudo-reduced pressure and pseudo-reduced temperature.

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.20	0.938	0.948	0.953	0.959	0.964	0.969	0.971	0.973	0.978	0.979
0.21	0.935	0.945	0.951	0.957	0.962	0.967	0.970	0.972	0.977	0.978
0.22	0.932	0.942	0.948	0.955	0.960	0.965	0.968	0.971	0.976	0.977
0.23	0.928	0.940	0.946	0.853	0.959	0.964	0.967	0.970	0.974	0.976
0.24	0.925	0.937	0.943	0.951	0.957	0.962	0.965	0.969	0.973	0.975
0.25	0.922	0.934	0.941	0.949	0.955	0.960	0.964	0.968	0.972	0.974
0.26	0.919	0.931	0.938	0.947	0.953	0.958	0.962	0.967	0.971	0.973
0.27	0.915	0.928	0.936	0.945	0.951	0.956	0.961	0.966	0.969	0.972
0.28	0.912	0.926	0.933	0.942	0.950	0.955	0.959	0.964	0.968	0.971
0.29	0.908	0.923	0.931	0.940	0.948	0.953	0.958	0.963	0.966	0.970
0.30	0.905	0.920	0.928	0.938	0.946	0.951	0.956	0.962	0.965	0.969
0.31	0.901	0.917	0.925	0.936	0.944	0.949	0.955	0.961	0.964	0.968
0.32	0.898	0.914	0.922	0.934	0.942	0.948	0.953	0.960	0.963	0.967
0.33	0.894	0.911	0.920	0.931	0.941	0.946	0.952	0.958	0.961	0.966
0.34	0.891	0.908	0.917	0.929	0.939	0.945	0.950	0.957	0.960	0.965
0.35	0.887	0.905	0.914	0.927	0.937	0.943	0.949	0.956	0.959	0.964
0.36	0.883	0.902	0.911	0.925	0.935	0.941	0.948	0.955	0.958	0.963
0.37	0.879	0.899	0.908	0.923	0.933	0.939	0.946	0.953	0.957	0.962
0.38	0.876	0.895	0.906	0.920	0.932	0.938	0.945	0.952	0.955	0.961
0.39	0.872	0.892	0.903	0.918	0.930	0.936	0.943	0.950	0.954	0.960
0.40	0.868	0.889	0.900	0.916	0.928	0.934	0.942	0.949	0.953	0.959
0.41	0.864	0.886	0.897	0.914	0.926	0.932	0.940	0.948	0.952	0.958
0.42	0.860	0.882	0.895	0.912	0.924	0.931	0.939	0.947	0.951	0.957
0.43	0.857	0.879	0.892	0.909	0.923	0.929	0.937	0.945	0.950	0.956
0.44	0.853	0.875	0.890	0.907	0.921	0.928	0.936	0.944	0.949	0.955
0.45	0.849	0.872	0.887	0.905	0.919	0.926	0.934	0.943	0.948	0.954
0.46	0.845	0.869	0.884	0.903	0.917	0.924	0.932	0.942	0.947	0.953
0.47	0.841	0.865	0.882	0.901	0.915	0.923	0.931	0.941	0.946	0.952
0.48	0.837	0.862	0.879	0.898	0.913	0.921	0.929	0.939	0.944	0.951
0.49	0.833	0.858	0.877	0.896	0.911	0.920	0.928	0.938	0.943	0.950
0.50	0.829	0.855	0.874	0.894	0.909	0.918	0.926	0.937	0.942	0.949
0.51	0.825	0.852	0.872	0.892	0.907	0.916	0.925	0.936	0.941	0.948
0.52	0.821	0.849	0.869	0.890	0.905	0.913	0.923	0.934	0.940	0.947
0.53	0.818	0.845	0.867	0.887	0.904	0.912	0.922	0.933	0.939	0.946
0.54	0.814	0.842	0.864	0.885	0.902	0.911	0.920	0.931	0.938	0.945
0.55	0.810	0.839	0.862	0.883	0.900	0.909	0.919	0.930	0.937	0.944
0.56	0.806	0.836	0.859	0.881	0.898	0.907	0.918	0.929	0.936	0.943
0.57	0.802	0.832	0.857	0.879	0.896	0.905	0.916	0.927	0.935	0.942
0.58	0.798	0.829	0.854	0.876	0.894	0.904	0.915	0.926	0.933	0.941
0.59	0.794	0.825	0.852	0.874	0.892	0.902	0.913	0.924	0.932	0.940
0.60	0.790	0.822	0.849	0.872	0.890	0.900	0.912	0.923	0.931	0.939
0.61	0.786	0.818	0.846	0.870	0.888	0.899	0.911	0.922	0.930	0.938
0.62	0.782	0.815	0.843	0.868	0.886	0.897	0.909	0.921	0.929	0.937
0.63	0.777	0.811	0.841	0.865	0.885	0.896	0.908	0.919	0.928	0.937
0.64	0.773	0.808	0.838	0.863	0.883	0.894	0.906	0.918	0.927	0.936

T_r										P_r 0.20 - 0.64
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.984	0.987	0.990	0.991	0.993	0.995	0.998	0.999	1.000	1.001	0.20
0.983	0.986	0.990	0.991	0.993	0.995	0.998	0.999	1.000	1.001	0.21
0.982	0.986	0.989	0.990	0.993	0.995	0.998	0.999	1.000	1.001	0.22
0.982	0.985	0.989	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.23
0.981	0.985	0.988	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.24
0.980	0.984	0.988	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.25
0.979	0.983	0.987	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.26
0.978	0.983	0.987	0.989	0.991	0.995	0.998	0.999	1.000	1.001	0.27
0.978	0.982	0.986	0.989	0.991	0.994	0.997	0.999	1.000	1.001	0.28
0.977	0.982	0.986	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.29
0.976	0.981	0.985	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.30
0.975	0.980	0.985	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.31
0.974	0.980	0.984	0.987	0.990	0.994	0.997	0.999	1.000	1.001	0.32
0.974	0.979	0.984	0.987	0.989	0.994	0.997	0.999	1.000	1.001	0.33
0.973	0.979	0.983	0.986	0.989	0.994	0.997	0.999	1.000	1.001	0.34
0.972	0.978	0.983	0.986	0.989	0.994	0.997	0.999	1.000	1.001	0.35
0.971	0.977	0.982	0.985	0.989	0.994	0.997	0.999	1.000	1.001	0.36
0.970	0.977	0.982	0.985	0.988	0.993	0.997	0.999	1.000	1.001	0.37
0.970	0.976	0.981	0.984	0.988	0.993	0.996	0.998	1.000	1.002	0.38
0.969	0.976	0.981	0.984	0.987	0.992	0.996	0.998	1.000	1.002	0.39
0.968	0.975	0.980	0.983	0.987	0.992	0.996	0.998	1.000	1.002	0.40
0.967	0.974	0.980	0.983	0.987	0.992	0.996	0.998	1.000	1.002	0.41
0.966	0.974	0.979	0.982	0.986	0.992	0.996	0.998	1.000	1.002	0.42
0.966	0.973	0.979	0.982	0.986	0.991	0.995	0.998	1.000	1.002	0.43
0.965	0.973	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.44
0.964	0.972	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.45
0.963	0.971	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.46
0.962	0.971	0.977	0.980	0.984	0.991	0.995	0.998	1.000	1.002	1.47
0.962	0.970	0.977	0.980	0.984	0.990	0.994	0.998	1.000	1.002	0.48
0.961	0.970	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.49
0.960	0.969	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.50
0.959	0.968	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.51
0.958	0.968	0.975	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.52
0.958	0.967	0.975	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.53
0.957	0.967	0.974	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.54
0.956	0.966	0.974	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.55
0.955	0.965	0.973	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.56
0.954	0.965	0.973	0.977	0.982	0.989	0.994	0.998	1.000	1.002	0.57
0.954	0.965	0.972	0.977	0.981	0.988	0.993	0.997	1.000	1.003	0.58
0.953	0.964	0.972	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.59
0.952	0.963	0.971	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.60
0.951	0.963	0.971	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.61
0.951	0.962	0.970	0.975	0.981	0.988	0.993	0.997	1.000	1.003	0.62
0.950	0.962	0.970	0.975	0.980	0.987	0.993	0.997	1.000	1.003	0.63
0.950	0.961	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.64

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.65	0.769	0.804	0.835	0.861	0.881	0.893	0.905	0.917	0.926	0.935
0.66	0.765	0.800	0.832	0.859	0.879	0.891	0.904	0.916	0.925	0.934
0.67	0.760	0.796	0.829	0.857	0.877	0.890	0.902	0.915	0.924	0.933
0.68	0.756	0.793	0.826	0.854	0.875	0.888	0.901	0.913	0.923	0.932
0.69	0.751	0.789	0.823	0.852	0.873	0.887	0.899	0.912	0.922	0.931
0.70	0.747	0.785	0.820	0.850	0.871	0.885	0.898	0.911	0.921	0.930
0.71	0.742	0.781	0.817	0.848	0.869	0.884	0.896	0.910	0.920	0.929
0.72	0.737	0.778	0.814	0.846	0.867	0.882	0.895	0.909	0.919	0.928
0.73	0.732	0.774	0.812	0.843	0.865	0.881	0.893	0.907	0.918	0.927
0.74	0.727	0.771	0.809	0.841	0.863	0.879	0.892	0.906	0.917	0.926
0.75	0.722	0.767	0.806	0.839	0.861	0.878	0.890	0.905	0.916	0.925
0.76	0.717	0.763	0.803	0.837	0.859	0.876	0.889	0.904	0.915	0.924
0.77	0.712	0.759	0.800	0.834	0.857	0.875	0.887	0.903	0.914	0.923
0.78	0.708	0.756	0.797	0.832	0.855	0.873	0.886	0.901	0.912	0.922
0.79	0.703	0.752	0.794	0.829	0.853	0.872	0.884	0.900	0.911	0.921
0.80	0.698	0.748	0.791	0.827	0.851	0.870	0.883	0.899	0.910	0.920
0.81	0.693	0.744	0.788	0.825	0.849	0.868	0.882	0.898	0.909	0.919
0.82	0.688	0.740	0.785	0.822	0.847	0.866	0.880	0.897	0.908	0.918
0.83	0.682	0.737	0.782	0.820	0.846	0.865	0.879	0.895	0.907	0.918
0.84	0.677	0.733	0.779	0.817	0.844	0.863	0.877	0.894	0.906	0.917
0.85	0.672	0.729	0.776	0.815	0.842	0.861	0.876	0.893	0.905	0.916
0.86	0.667	0.725	0.773	0.812	0.840	0.859	0.875	0.892	0.904	0.915
0.87	0.661	0.721	0.770	0.810	0.838	0.857	0.874	0.891	0.903	0.914
0.88	0.656	0.718	0.767	0.807	0.836	0.856	0.872	0.889	0.901	0.913
0.89	0.650	0.714	0.764	0.805	0.834	0.854	0.871	0.888	0.900	0.912
0.90	0.645	0.710	0.761	0.802	0.832	0.852	0.870	0.887	0.899	0.911
0.91	0.640	0.706	0.758	0.800	0.830	0.851	0.869	0.886	0.898	0.910
0.92	0.634	0.702	0.756	0.798	0.828	0.849	0.867	0.885	0.897	0.909
0.93	0.629	0.698	0.753	0.795	0.827	0.848	0.866	0.883	0.897	0.908
0.94	0.623	0.694	0.751	0.793	0.825	0.846	0.864	0.882	0.896	0.907
0.95	0.618	0.690	0.748	0.791	0.823	0.845	0.863	0.881	0.895	0.906
0.96	0.612	0.686	0.745	0.789	0.821	0.844	0.862	0.880	0.894	0.905
0.97	0.607	0.682	0.742	0.787	0.819	0.842	0.860	0.879	0.893	0.904
0.98	0.601	0.678	0.740	0.784	0.817	0.841	0.859	0.877	0.892	0.903
0.99	0.596	0.674	0.737	0.782	0.815	0.839	0.857	0.876	0.891	0.902
1.00	0.590	0.670	0.734	0.780	0.813	0.838	0.856	0.875	0.890	0.901
1.01	0.583	0.665	0.731	0.778	0.811	0.836	0.855	0.874	0.889	0.900
1.02	0.576	0.661	0.728	0.775	0.809	0.834	0.853	0.873	0.888	0.899
1.03	0.569	0.656	0.725	0.773	0.807	0.833	0.852	0.871	0.887	0.899
1.04	0.562	0.652	0.722	0.770	0.805	0.831	0.850	0.870	0.886	0.898
1.05	0.555	0.647	0.719	0.768	0.803	0.829	0.849	0.869	0.885	0.897
1.06	0.548	0.642	0.716	0.765	0.801	0.827	0.848	0.868	0.884	0.896
1.07	0.541	0.638	0.713	0.763	0.799	0.825	0.846	0.866	0.883	0.895
1.08	0.534	0.633	0.709	0.760	0.797	0.824	0.845	0.865	0.881	0.895
1.09	0.527	0.629	0.706	0.758	0.795	0.822	0.843	0.863	0.880	0.894

T_r										P_r 0.65 - 1.09
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.949	0.961	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.65
0.948	0.960	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.66
0.947	0.960	0.968	0.973	0.979	0.987	0.993	0.997	1.000	1.003	0.67
0.947	0.959	0.968	0.973	0.979	0.986	0.992	0.997	1.001	1.004	0.68
0.946	0.959	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.69
0.945	0.958	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.70
0.944	0.957	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.71
0.944	0.957	0.966	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.72
0.943	0.956	0.966	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.73
0.943	0.956	0.965	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.74
0.942	0.955	0.965	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.75
0.941	0.954	0.964	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.76
0.940	0.954	0.964	0.970	0.976	0.985	0.992	0.997	1.001	1.004	0.77
0.940	0.953	0.963	0.970	0.976	0.984	0.991	0.997	1.001	1.005	0.78
0.939	0.953	0.963	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.79
0.938	0.952	0.962	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.80
0.937	0.952	0.962	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.81
0.937	0.951	0.961	0.968	0.975	0.984	0.991	0.997	1.001	1.005	0.82
0.936	0.951	0.961	0.968	0.974	0.983	0.991	0.997	1.001	1.005	0.83
0.936	0.950	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.84
0.935	0.950	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.85
0.934	0.949	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.86
0.933	0.949	0.959	0.966	0.973	0.983	0.991	0.997	1.001	1.005	0.87
0.933	0.948	0.959	0.966	0.973	0.983	0.990	0.996	1.001	1.006	0.88
0.932	0.948	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.89
0.931	0.947	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.90
0.930	0.946	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.91
0.929	0.946	0.957	0.964	0.972	0.983	0.990	0.996	1.001	1.006	0.92
0.929	0.945	0.957	0.964	0.971	0.982	0.990	0.996	1.001	1.006	0.93
0.928	0.945	0.956	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.94
0.927	0.944	0.956	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.95
0.926	0.943	0.955	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.96
0.925	0.943	0.955	0.962	0.971	0.982	0.990	0.996	1.001	1.006	0.97
0.925	0.942	0.954	0.962	0.970	0.981	0.989	0.996	1.001	1.007	0.98
0.924	0.942	0.954	0.961	0.970	0.981	0.989	0.996	1.001	1.007	0.99
0.923	0.941	0.953	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.00
0.922	0.941	0.953	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.01
0.922	0.940	0.952	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.02
0.921	0.940	0.952	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.03
0.921	0.939	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.04
0.920	0.939	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.05
0.919	0.938	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.06
0.919	0.938	0.950	0.959	0.968	0.980	0.989	0.996	1.001	1.007	1.07
0.918	0.937	0.950	0.959	0.968	0.979	0.988	0.996	1.002	1.008	1.08
0.918	0.937	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.09

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
1.10	0.520	0.624	0.703	0.755	0.793	0.820	0.842	0.862	0.879	0.893
1.11	0.512	0.620	0.700	0.753	0.791	0.818	0.841	0.861	0.878	0.892
1.12	0.505	0.615	0.697	0.750	0.789	0.817	0.840	0.860	0.877	0.891
1.13	0.497	0.611	0.694	0.748	0.787	0.815	0.838	0.858	0.876	0.891
1.14	0.490	0.606	0.691	0.745	0.785	0.814	0.837	8.857	0.875	0.890
1.15	0.482	0.602	0.688	0.743	0.783	0.812	0.836	0.856	0.874	0.889
1.16	0.474	0.598	0.685	0.741	0.781	0.810	0.835	0.855	0.873	0.888
1.17	0.467	0.593	0.682	0.738	0.779	0.809	0.833	0.854	0.872	0.887
1.18	0.459	0.589	0.678	0.736	0.777	0.807	0.832	0.852	0.871	0.886
1.19	0.452	0.584	0.675	0.733	0.775	0.806	0.830	0.851	0.870	0.885
1.20	0.444	0.580	0.672	0.731	0.773	0.804	0.829	0.850	0.869	0.884
1.21	0.435	0.575	0.669	0.729	0.771	0.803	0.828	0.849	0.868	0.883
1.22	0.426	0.570	0.666	0.726	0.769	0.801	0.827	0.848	0.867	0.882
1.23	0.416	0.565	0.662	0.724	0.767	0.800	0.825	0.847	0.866	0.882
1.24	0.407	0.560	0.659	0.721	0.765	0.798	0.824	0.846	0.865	0.881
1.25	0.398	0.555	0.656	0.719	0.763	0.797	0.823	0.845	0.864	0.880
1.26	0.389	0.550	0.653	0.717	0.761	0.795	0.822	0.844	0.863	0.879
1.27	0.379	0.545	0.650	0.714	0.759	0.794	0.821	0.843	0.862	0.878
1.28	0.370	0.540	0.646	0.712	0.757	0.792	0.819	0.841	0.861	0.878
1.29	0.360	0.535	0.643	0.709	0.755	0.791	0.818	0.840	0.860	0.877
1.30	0.351	0.530	0.640	0.707	0.753	0.789	0.817	0.839	0.859	0.876
1.31	0.342	0.525	0.637	0.705	0.751	0.787	0.816	0.838	0.859	0.875
1.32	0.333	0.520	0.633	0.702	0.749	0.786	0.814	0.837	0.857	0.874
1.33	0.325	0.515	0.630	0.700	0.747	0.784	0.813	0.836	0.857	0.874
1.34	0.316	0.510	0.626	0.697	0.745	0.783	0.811	0.835	0.856	0.873
1.35	0.307	0.505	0.623	0.695	0.743	0.781	0.810	0.834	0.855	0.872
1.36	0.298	0.500	0.619	0.692	0.741	0.779	0.809	0.833	0.854	0.871
1.37	0.289	0.495	0.616	0.690	0.739	0.777	0.807	0.832	0.853	0.870
1.38	0.281	0.490	0.612	0.687	0.736	0.776	0.806	0.830	0.852	0.870
1.39	0.272	0.485	0.609	0.685	0.734	0.774	0.804	0.829	0.851	0.869
1.40	0.263	0.480	0.605	0.682	0.732	0.772	0.803	0.828	0.850	0.868
1.41	0.262	0.475	0.602	0.680	0.730	0.771	0.802	0.827	0.849	0.867
1.42	0.261	0.469	0.598	0.677	0.728	0.769	0.801	0.826	0.848	0.866
1.43	0.261	0.464	0.595	0.675	0.725	0.768	0.790	0.826	0.848	0.866
1.44	0.260	0.458	0.591	0.672	0.723	0.766	0.798	0.825	0.847	0.865
1.45	0.259	0.453	0.588	0.670	0.721	0.765	0.797	0.824	0.846	0.864
1.46	0.258	0.447	0.584	0.667	0.719	0.763	0.796	0.823	0.845	0.863
1.47	0.257	0.442	0.581	0.665	0.717	0.762	0.795	0.821	0.844	0.862
1.48	0.256	0.436	0.577	0.662	0.714	0.760	0.793	0.820	0.843	0.861
1.49	0.255	0.431	0.574	0.660	0.712	0.759	0.792	0.818	0.842	0.860
1.50	0.254	0.425	0.570	0.657	0.710	0.757	0.791	0.817	0,841	0.859
1.51	0.254	0.422	0.567	0.655	0.708	0.756	0.790	0.816	0.840	0.858
1.52	0.254	0.419	0.564	0.653	0.706	0.754	0.789	0.815	0.839	0.857
1.53	0.253	0.415	0.562	0.650	0.705	0.753	0.787	0.813	0.839	0.857
1.54	0.253	0.412	0.559	0.648	0.703	0.751	0.786	0.812	0.838	0.856

				T_r						P_r 1.10 - 1.54
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.917	0.936	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.10
0.916	0.935	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.11
0.915	0.935	0.948	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.12
0.915	0.934	0.948	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.13
0.914	0.934	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.14
0.913	0.933	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.15
0.912	0.932	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.16
0.911	0.932	0.946	0.956	0.965	0.979	0.988	0.996	1.002	1.008	1.17
0.911	0.931	0.946	0.956	0.965	0.978	0.987	0.996	1.002	1.008	1.18
0.910	0.931	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.19
0.909	0.930	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.20
0.908	0.930	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.21
0.907	0.929	0.944	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.22
0.907	0.929	0.944	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.23
0.906	0.928	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.24
0.905	0.928	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.25
0.904	0.927	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.26
0.903	0.927	0.942	0.953	0.963	0.978	0.987	0.996	1.002	1.008	1.27
0.903	0.926	0.942	0.953	0.962	0.977	0.987	0.996	1.002	1.009	1.28
0.902	0.926	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.29
0.901	0.925	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.30
0.900	0.925	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.31
0.900	0.924	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.32
0.899	0.924	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.33
0.899	0.923	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.34
0.898	0.923	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.35
0.897	0.922	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.36
0.897	0.922	0.939	0.950	0.961	0.976	0.986	0.996	1.002	1.009	1.37
0.896	0.921	0.939	0.950	0.960	0.975	0.986	0.996	1.002	1.010	1.38
0.896	0.921	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.39
0.895	0.920	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.40
0.894	0.920	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.41
0.894	0.919	0.937	0.948	0.960	0.975	0.986	0.996	1.002	1.010	1.42
0.893	0.919	0.937	0.948	0.959	0.975	0.986	0.996	1.002	1.010	1.43
0.893	0.918	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.44
0.892	0.918	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.45
0.891	0.917	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.46
0.891	0.917	0.935	0.947	0.958	0.975	0.986	0.996	1.002	1.010	1.47
0.890	0.916	0.935	0.946	0.958	0.974	0.985	0.995	1.003	1.010	1.48
0.890	0.916	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.49
0.889	0.915	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.50
0.888	0.915	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.51
0.888	0.914	0.933	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.52
0.887	0.914	0.933	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.53
0.887	0.913	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.54

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
1.55	0.253	0.409	0.556	0.646	0.701	0.750	0.785	0.811	0.837	0.855
1.56	0.253	0.406	0.553	0.644	0.699	0.748	0.784	0.810	0.836	0.854
1.57	0.252	0.403	0.550	0.641	0.697	0.747	0.783	0.809	0.835	0.853
1.58	0.252	0.399	0.547	0.639	0.695	0.745	0.781	0.807	0.834	0.853
1.59	0.251	0.396	0.544	0.636	0.693	0.744	0.780	0.806	0.833	0.852
1.60	0.251	0.393	0.541	0.634	0.691	0.742	0.779	0.805	0.832	0.851
1.61	0.251	0.392	0.539	0.632	0.689	0.741	0.778	0.804	0.831	0.850
1.62	0.251	0.390	0.536	0.630	0.687	0.739	0.777	0.803	0.830	0.849
1.63	0.251	0.389	0.534	0.627	0.686	0.738	0.775	0.802	0.830	0.849
1.64	0.251	0.387	0.531	0.625	0.684	0.736	0.774	0.801	0.829	0.848
1.65	0.251	0.386	0.529	0.623	0.682	0.735	0.773	0.800	0.828	0.847
1.66	0.251	0.384	0.527	0.621	0.680	0.734	0.772	0.799	0.827	0.846
1.67	0.251	0.383	0.524	0.619	0.678	0.732	0.771	0.798	0.826	0.845
1.68	0.252	0.381	0.522	0.616	0.676	0.731	0.769	0.797	0.825	0.845
1.69	0.252	0.380	0.519	0.614	0.674	0.729	0.768	0.796	0.824	0.844
1.70	0.252	0.378	0.517	0.612	0.672	0.728	0.767	0.795	0.823	0.843
1.71	0.253	0.377	0.515	0.610	0.670	0.726	0.766	0.794	0.822	0.842
1.72	0.254	0.376	0.513	0.608	0.669	0.725	0.765	0.793	0.821	0.842
1.73	0.254	0.376	0.511	0.606	0.667	0.723	0.763	0.792	0.821	0.841
1.74	0.255	0.375	0.509	0.604	0.666	0.722	0.762	0.791	0.820	0.841
1.75	0.256	0.374	0.507	0.602	0.664	0.720	0.761	0.790	0.819	0.840
1.76	0.257	0.373	0.505	0.600	0.662	0.718	0.760	0.789	0.818	0.839
1.77	0.258	0.372	0.503	0.598	0.661	0.717	0.759	0.788	0.817	0.839
1.78	0.258	0.372	0.501	0.596	0.659	0.716	0.757	0.786	0.817	0.838
1.79	0.259	0.371	0.499	0.594	0.658	0.714	0.756	0.785	0.816	0.838
1.80	0.260	0.370	0.497	0.592	0.656	0.712	0.755	0.784	0.815	0.837
1.81	0.261	0.370	0.495	0.590	0.654	0.711	0.754	0.783	0.814	0.836
1.82	0.262	0.370	0.494	0.588	0.653	0.710	0.753	0.782	0.813	0.836
1.83	0.263	0.370	0.492	0.586	0.651	0.708	0.752	0.781	0.813	0.835
1.84	0.264	0.370	0.491	0.584	0.650	0.707	0.751	0.780	0.812	0.835
1.85	0.265	0.370	0.489	0.582	0.648	0.706	0.750	0.779	0.811	0.834
1.86	0.266	0.370	0.487	0.580	0.646	0.705	0.749	0.778	0.810	0.833
1.87	0.267	0.370	0.485	0.578	0.645	0.703	0.748	0.777	0.809	0.832
1.88	0.268	0.369	0.484	0.576	0.643	0.702	0.746	0.776	0.808	0.832
1.89	0.269	0.369	0.482	0.574	0.642	0.700	0.745	0.775	0.807	0.831
1.90	0.270	0.369	0.480	0.572	0.640	0.699	0.744	0.774	0.806	0.830
1.91	0.271	0.369	0.479	0.570	0.639	0.698	0.743	0.773	0.805	0.829
1.92	0.272	0.369	0.478	0.569	0.638	0.697	0.742	0.773	0.805	0.829
1.93	0.273	0.369	0.476	0.567	0.636	0.695	0.740	0.772	0.804	0.828
1.94	0.274	0.369	0.475	0.566	0.635	0.694	0.739	0.772	0.804	0.828
1.95	0.275	0.369	0.474	0.564	0.634	0.693	0.738	0.771	0.803	0.827
1.96	0.276	0.369	0.473	0.562	0.633	0.692	0.737	0.770	0.802	0.826
1.97	0.277	0.369	0.471	0.560	0.631	0.691	0.736	0.769	0.801	0.826
1.98	0.278	0.370	0.470	0.559	0.630	0.689	0.734	0.769	0.801	0.825
1.99	0.279	0.370	0.468	0.557	0.628	0.688	0.733	0.768	0.800	0.825

T_r										P_r 1.55 - 1.99
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.886	0.913	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.55
0.885	0.912	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.56
0.884	0.912	0.931	0.944	0.955	0.973	0.985	0.995	1.003	1.010	1.57
0.884	0.911	0.931	0.944	0.955	0.972	0.984	0.995	1.003	1.011	1.58
0.883	0.911	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.59
0.882	0.910	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.60
0.882	0.910	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.61
0.881	0.909	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.62
0.881	0.909	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.63
0.880	0.908	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.64
0.880	0.908	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.65
0.879	0.907	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.66
0.879	0.907	0.928	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.67
0.878	0.906	0.928	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.68
0.878	0.906	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.69
0.877	0.905	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.70
0.876	0.905	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.71
0.876	0.904	0.926	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.72
0.875	0.904	0.926	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.73
0.875	0.903	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.74
0.874	0.903	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.75
0.873	0.902	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.76
0.873	0.902	0.924	0.939	0.951	0.971	0.983	0.995	1.004	1.012	1.77
0.872	0.901	0.924	0.939	0.950	0.970	0.983	0.995	1.004	1.012	1.78
0.872	0.901	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.79
0.871	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.80
0.871	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.81
0.870	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.82
0.870	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.83
0.869	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.84
0.869	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.85
0.868	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.86
0.868	0.898	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.87
0.867	0.898	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.88
0.867	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.89
0.866	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.90
0.866	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.91
0.865	0.896	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.92
0.865	0.896	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.93
0.864	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.94
0.864	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.95
0.863	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.96
0.863	0.894	0.919	0.934	0.948	0.969	0.982	0.995	1.005	1.013	1.97
0.862	0.894	0.919	0.934	0.947	0.968	0.982	0.995	1.006	1.014	1.98
0.862	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	1.99

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.00	0.280	0.370	0.467	0.555	0.627	0.687	0.732	0.767	0.799	0.824
2.01	0.281	0.370	0.466	0.553	0.626	0.686	0.731	0.766	0.798	0.823
2.02	0.282	0.370	0.465	0.552	0.624	0.685	0.730	0.765	0.797	0.823
2.03	0.284	0.371	0.464	0.550	0.623	0.683	0.729	0.764	0.797	0.822
2.04	0.285	0.371	0.463	0.549	0.621	0.682	0.728	0.763	0.796	0.822
2.05	0.286	0.371	0.462	0.547	0.620	0.681	0.727	0.762	0.795	0.821
2.06	0.287	0.371	0.461	0.545	0.618	0.680	0.726	0.761	0.794	0.820
2.07	0.288	0.371	0.460	0.544	0.617	0.678	0.725	0.760	0.793	0.820
2.08	0.290	0.372	0.459	0.542	0.615	0.677	0.723	0.759	0.793	0.819
2.09	0.291	0.372	0.458	0.541	0.614	0.675	0.722	0.758	0.792	0.819
2.10	0.292	0.372	0.457	0.539	0.612	0.674	0.721	0.757	0.791	0.818
2.11	0.293	0.372	0.456	0.538	0.611	0.673	0.720	0.756	0.790	0.817
2.12	0.294	0.373	0.456	0.537	0.610	0.672	0.719	0.755	0.790	0.817
2.13	0.296	0.373	0.455	0.536	0.609	0.671	0.718	0.755	0.789	0.816
2.14	0.297	0.374	0.455	0.535	0.608	0.670	0.717	0.754	0.789	0.816
2.15	0.298	0.374	0.454	0.534	0.607	0.669	0.716	0.753	0.788	0.815
2.16	0.299	0.374	0.453	0.533	0.606	0.668	0.715	0.752	0.787	0.814
2.17	0.301	0.375	0.452	0.532	0.605	0.667	0.714	0.751	0.786	0.813
2.18	0.302	0.375	0.452	0.530	0.604	0.665	0.713	0.750	0.786	0.813
2.19	0.304	0.376	0.451	0.529	0.603	0.664	0.712	0.749	0.785	0.812
2.20	0.305	0.376	0.450	0.528	0.602	0.663	0.711	0.748	0.784	0.811
2.21	0.306	0.376	0.450	0.527	0.601	0.662	0.710	0.747	0.783	0.810
2.22	0.307	0.377	0.450	0.527	0.600	0.661	0.709	0.747	0.783	0.810
2.23	0.309	0.377	0.449	0.526	0.600	0.660	0.709	0.746	0.782	0.809
2.24	0.310	0.378	0.449	0.526	0.599	0.659	0.708	0.746	0.782	0.809
2.25	0.311	0.378	0.449	0.525	0.598	0.658	0.707	0.745	0.781	0.808
2.26	0.312	0.378	0.449	0.524	0.597	0.657	0.706	0.744	0.780	0.807
2.27	0.314	0.379	0.449	0.524	0.596	0.656	0.705	0.743	0.780	0.807
2.28	0.315	0.379	0.448	0.523	0.595	0.654	0.704	0.743	0.779	0.806
2.29	0.317	0.380	0.448	0.523	0.594	0.653	0.703	0.742	0.779	0.806
2.30	0.318	0.380	0.448	0.522	0.593	0.652	0.702	0.741	0.778	0.805
2.31	0.319	0.381	0.448	0.522	0.592	0.651	0.701	0.740	0.777	0.805
2.32	0.320	0.381	0.448	0.522	0.592	0.651	0.701	0.739	0.777	0.804
2.33	0.322	0.382	0.448	0.521	0.591	0.650	0.700	0.739	0.776	0.804
2.34	0.323	0.382	0.448	0.521	0.591	0.650	0.700	0.738	0.776	0.803
2.35	0.324	0.383	0.448	0.521	0.590	0.649	0.699	0.737	0.775	0.803
2.36	0.325	0.384	0.448	0.521	0.589	0.648	0.698	0.736	0.774	0.802
2.37	0.326	0.385	0.448	0.521	0.588	0.647	0.697	0.735	0.773	0.802
2.38	0.328	0.385	0.449	0.520	0.588	0.647	0.697	0.735	0.773	0.801
2.39	0.329	0.386	0.449	0.520	0.587	0.646	0.696	0.734	0.772	0.801
2.40	0.330	0.387	0.449	0.520	0.586	0.645	0.695	0.733	0.771	0.800
2.41	0.331	0.388	0.449	0.520	0.585	0.644	0.694	0.733	0.770	0.800
2.42	0.332	0.388	0.449	0.520	0.585	0.644	0.694	0.732	0.770	0.799
2.43	0.334	0.389	0.450	0.520	0.584	0.643	0.693	0.732	0.769	0.799
2.44	0.335	0.389	0.450	0.520	0.584	0.643	0.693	0.731	0.769	0.798

				T_r						P_r 2.00 - 2.44
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.861	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.00
0.861	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.01
0.860	0.892	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.02
0.860	0.892	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.03
0.859	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.04
0.859	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.05
0.858	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.06
0.858	0.890	0.916	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.07
0.857	0.890	0.916	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.08
0.857	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.09
0.856	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.10
0.856	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.11
0.855	0.888	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.12
0.855	0.888	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.13
0.854	0.887	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.14
0.854	0.877	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.15
0.853	0.887	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.16
0.853	0.886	0.913	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.17
0.852	0.886	0.913	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.18
0.852	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.19
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.20
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.21
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.22
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.23
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.24
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.25
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.26
0.849	0.883	0.910	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.27
0.849	0.883	0.910	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.28
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.29
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.30
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.31
0.847	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.32
0.847	0.881	0.908	0.827	0.942	0.965	0.980	0.995	1.008	1.017	2.33
0.846	0.881	0.908	0.827	0.942	0.965	0.980	0.995	1.008	1.017	2.34
0.846	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.35
0.845	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.36
0.845	0.880	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.37
0.844	0.880	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.38
0.844	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.39
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.40
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.41
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.42
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.43
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.44

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.45	0.336	0.390	0.450	0.520	0.583	0.642	0.692	0.731	0.768	0.798
2.46	0.337	0.391	0.450	0.520	0.583	0.641	0.691	0.730	0.767	0.798
2.47	0.339	0.392	0.450	0.520	0.582	0.640	0.690	0.730	0.767	0.797
2.48	0.340	0.392	0.451	0.519	0.582	0.640	0.690	0.729	0.767	0.797
2.49	0.342	0.393	0.451	0.519	0.581	0.639	0.689	0.729	0.767	0.796
2.50	0.343	0.394	0.451	0.519	0.581	0.638	0.688	0.728	0.765	0.796
2.51	0.344	0.395	0.452	0.519	0.581	0.638	0.687	0.727	0.765	0.795
2.52	0.345	0.396	0.452	0.519	0.581	0.637	0.687	0.727	0.764	0.795
2.53	0.347	0.396	0.453	0.519	0.581	0.637	0.686	0.726	0.764	0.794
2.54	0.348	0.397	0.453	0.519	0.581	0.636	0.686	0.726	0.763	0.794
2.55	0.349	0.398	0.454	0.519	0.581	0.636	0.685	0.725	0.763	0.793
2.56	0.350	0.399	0.455	0.519	0.581	0.635	0.684	0.724	0.762	0.793
2.57	0.352	0.400	0.456	0.519	0.581	0.635	0.684	0.724	0.762	0.792
2.58	0.353	0.400	0.456	0.520	0.580	0.634	0.683	0.723	0.761	0.792
2.59	0.355	0.401	0.457	0.520	0.580	0.634	0.683	0.723	0.761	0.791
2.60	0.356	0.402	0.458	0.520	0.580	0.633	0.682	0.722	0.760	0.791
2.61	0.357	0.403	0.458	0.520	0.580	0.633	0.682	0.722	0.760	0.791
2.62	0.358	0.404	0.459	0.520	0.580	0.632	0.681	0.721	0.759	0.790
2.63	0.360	0.404	0.459	0.521	0.580	0.632	0.681	0.721	0.759	0.790
2.64	0.361	0.405	0.460	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.65	0.362	0.406	0.460	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.66	0.363	0.407	0.461	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.67	0.365	0.408	0.461	0.521	0.580	0.630	0.679	0.719	0.757	0.788
2.68	0.366	0.408	0.462	0.522	0.579	0.630	0.679	0.719	0.757	0.788
2.69	0.368	0.409	0.462	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.70	0.369	0.410	0.463	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.71	0.370	0.411	0.464	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.72	0.371	0.412	0.465	0.523	0.579	0.629	0.677	0.717	0.755	0.786
2.73	0.373	0.412	0.465	0.523	0.579	0.628	0.677	0.717	0.755	0.786
2.74	0.374	0.413	0.466	0.524	0.579	0.628	0.676	0.716	0.754	0.785
2.75	0.375	0.414	0.467	0.524	0.579	0.628	0.676	0.716	0.754	0.785
2.76	0.376	0.415	0.468	0.524	0.579	0.628	0.675	0.715	0.754	0.785
2.77	0.377	0.416	0.469	0.525	0.579	0.628	0.675	0.715	0.753	0.784
2.78	0.379	0.417	0.470	0.525	0.579	0.627	0.674	0.714	0.753	0.784
2.79	0.380	0.418	0.471	0.526	0.579	0.627	0.674	0.714	0.752	0.783
2.80	0.381	0.419	0.472	0.526	0.579	0.627	0.673	0.713	0.752	0.783
2.81	0.382	0.420	0.473	0.526	0.579	0.627	0.673	0.713	0.752	0.783
2.82	0.383	0.421	0.474	0.527	0.579	0.627	0.673	0.713	0.751	0.782
2.83	0.385	0.422	0.474	0.527	0.579	0.626	0.672	0.712	0.751	0.782
2.84	0.386	0.423	0.475	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.85	0.387	0.424	0.476	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.86	0.388	0.425	0.477	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.87	0.390	0.426	0.478	0.529	0.579	0.626	0.671	0.711	0.749	0.780
2.88	0.391	0.427	0.479	0.529	0.580	0.625	0.671	0.711	0.749	0.780
2.89	0.393	0.428	0.480	0.530	0.580	0.625	0.670	0.710	0.748	0.779

				T_r						P_r 2.45 - 2.89
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.45
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.46
0.841	0.877	0.905	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.47
0.841	0.877	0.905	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.48
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.49
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.50
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.51
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.52
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.53
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.54
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.55
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.56
0.838	0.874	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.57
0.838	0.874	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.58
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.59
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.60
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.61
0.836	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.62
0.836	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.63
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.64
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.65
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.66
0.834	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.67
0.834	0.871	0.900	0.921	0 939	0.962	0.980	0.996	1.010	1.021	2.68
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.69
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.70
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.71
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.72
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.73
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.74
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.75
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.76
0.831	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.77
0.831	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.78
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.79
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.80
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.81
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.82
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.83
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.84
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.85
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.86
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.87
0.829	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.88
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.89

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.90	0.394	0.429	0.481	0.530	0.580	0.625	0.670	0.710	0.748	0.779
2.91	0.395	0.430	0.482	0.530	0.580	0.625	0.670	0.710	0.748	0.779
2.92	0.397	0.431	0.483	0.531	0.580	0.625	0.670	0.710	0.748	0.779
2.93	0.398	0.432	0.483	0.531	0.580	0.625	0.670	0.709	0.747	0.778
2.94	0.400	0.433	0.484	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.95	0.401	0.434	0.485	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.96	0.402	0.435	0.486	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.97	0.403	0.436	0.487	0.533	0.580	0.625	0.670	0.708	0.746	0.778
2.98	0.405	0.438	0.487	0.533	0.581	0.624	0.669	0.708	0.746	0.777
2.99	0.406	0.439	0.488	0.534	0.581	0.624	0.669	0.707	0.745	0.777
3.00	0.407	0.440	0.489	0.534	0.581	0.624	0.669	0.707	0.745	0.777
3.01	0.408	0.441	0.490	0.535	0.581	0.624	0.669	0.707	0.745	0.777
3.02	0.409	0.442	0.491	0.535	0.581	0.624	0.669	0.707	0.745	0.777
3.03	0.411	0.444	0.492	0.536	0.582	0.624	0.669	0.706	0.744	0.776
3.04	0.412	0.445	0.493	0.536	0.582	0.624	0.669	0.706	0.744	0.776
3.05	0.413	0.446	0.494	0.537	0.582	0.624	0.669	0.706	0.744	0.776
3.06	0.414	0.447	0.495	0.538	0.582	0.624	0.669	0.706	0.744	0.776
3.07	0.416	0.448	0.496	0.538	0.583	0.624	0.669	0.706	0.743	0.776
3.08	0.417	0.450	0.497	0.539	0.583	0.625	0.668	0.705	0.743	0.775
3.09	0.419	0.451	0.498	0.539	0.584	0.625	0.668	0.705	0.742	0.775
3.10	0.420	0.452	0.499	0.540	0.584	0.625	0.668	0.705	0.742	0.775
3.11	0.421	0.453	0.500	0.541	0.584	0.625	0.668	0.705	0.742	0.775
3.12	0.422	0.454	0.501	0.541	0.585	0.625	0.668	0.705	0.742	0.775
3.13	0.424	0.455	0.501	0.542	0.585	0.625	0.668	0.704	0.742	0.774
3.14	0.425	0.456	0.502	0.542	0.586	0.625	0.668	0.704	0.742	0.774
3.15	0.426	0.457	0.503	0.543	0.586	0.625	0.668	0.704	0.742	0.774
3.16	0.427	0.458	0.504	0.544	0.586	0.625	0.668	0.704	0.742	0.774
3.17	0.428	0.459	0.505	0.544	0.587	0.625	0.668	0.704	0.742	0.774
3.18	0.430	0.461	0.505	0.545	0.587	0.626	0.668	0.703	0.741	0.773
3.19	0.431	0.462	0.506	0.545	0.588	0.626	0.668	0.703	0.741	0.773
3.20	0.432	0.463	0.507	0.546	0.588	0.626	0.668	0.703	0.741	0.773
3.21	0.433	0.464	0.508	0.546	0.588	0.626	0.668	0.703	0.741	0.773
3.22	0.434	0.465	0.509	0.547	0.589	0.626	0.668	0.702	0.741	0.773
3.23	0.436	0.467	0.509	0.547	0.589	0.627	0.668	0.702	0.741	0.773
3.24	0.437	0.468	0.510	0.548	0.590	0.627	0.668	0.701	0.741	0.773
3.25	0.438	0.469	0.511	0.548	0.590	0.627	0.668	0.701	0.741	0.773
3.26	0.439	0.470	0.512	0.549	0.590	0.627	0.668	0.701	0.741	0.773
3.27	0.441	0.471	0.513	0.549	0.591	0.627	0.668	0.701	0.741	0.773
3.28	0.442	0.473	0.514	0.550	0.591	0.628	0.668	0.702	0.740	0.772
3.29	0.444	0.474	0.515	0.550	0.592	0.628	0.669	0.702	0.740	0.772
3.30	0.445	0.475	0.516	0.551	0.592	0.628	0.669	0.702	0.740	0.772
3.31	0.446	0.476	0.517	0.552	0.592	0.628	0.669	0.702	0.740	0.772
3.32	0.447	0.477	0.518	0.553	0.593	0.628	0.669	0.702	0.740	0.772
3.33	0.449	0.479	0.518	0.553	0.593	0.629	0.669	0.702	0.740	0.772
3.34	0.450	0.480	0.519	0.554	0.594	0.629	0.669	0.702	0.740	0.772

					T_r					P_r 2.90 - 3.34
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.90
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.91
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.92
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.93
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.94
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.95
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.96
0.826	0.865	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.97
0.826	0.865	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	2.98
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	2.99
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.00
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.01
0.824	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.02
0.824	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.03
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.04
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.05
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.06
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.07
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.08
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.09
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.10
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.11
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.12
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.13
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.14
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.15
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.16
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.17
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.18
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.19
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.20
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.21
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.22
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.23
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.24
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.25
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.26
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.27
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.28
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.29
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.30
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.31
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.32
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.33
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.34

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
3.35	0.451	0.481	0.520	0.555	0.594	0.629	0.669	0.702	0.740	0.772
3.36	0.452	0.482	0.521	0.556	0.595	0.629	0.669	0.702	0.740	0.772
3.37	0.454	0.484	0.522	0.557	0.595	0.630	0.669	0.702	0.740	0.772
3.38	0.455	0.485	0.523	0.557	0.596	0.630	0.670	0.703	0.739	0.771
3.39	0.457	0.487	0.524	0.558	0.596	0.631	0.670	0.703	0.739	0.771
3.40	0.458	0.488	0.525	0.559	0.597	0.631	0.670	0.703	0.739	0.771
3.41	0.459	0.489	0.526	0.560	0.597	0.631	0.670	0.703	0.739	0.771
3.42	0.460	0.490	0.527	0.560	0.598	0.631	0.670	0.703	0.739	0.771
3.43	0.462	0.492	0.528	0.561	0.598	0.632	0.670	0.703	0.739	0.771
3.44	0.463	0.493	0.529	0.561	0.599	0.632	0.670	0.703	0.739	0.771
3.45	0.464	0.494	0.530	0.562	0.599	0.632	0.670	0.703	0.739	0.771
3.46	0.465	0.495	0.531	0.563	0.600	0.632	0.670	0.703	0.739	0.771
3.47	0.467	0.496	0.532	0.564	0.600	0.632	0.670	0.703	0.739	0.771
3.48	0.468	0.498	0.533	0.564	0.601	0.633	0.670	0.704	0.739	0.771
3.49	0.470	0.499	0.534	0.565	0.601	0.633	0.670	0.704	0.739	0.771
3.50	0.471	0.500	0.535	0.566	0.602	0.633	0.670	0.704	0.739	0.771
3.51	0.472	0.501	0.536	0.567	0.603	0.633	0.670	0.704	0.739	0.771
3.52	0.473	0.502	0.537	0.567	0.603	0.634	0.671	0.704	0.739	0.771
3.53	0.475	0.503	0.537	0.568	0.604	0.634	0.671	0.705	0.739	0.771
3.54	0.476	0.504	0.538	0.568	0.604	0.635	0.672	0.705	0.739	0.771
3.55	0.477	0.505	0.539	0.569	0.605	0.635	0.672	0.705	0.739	0.771
3.56	0.478	0.506	0.540	0.570	0.606	0.635	0.672	0.705	0.739	0.771
3.57	0.479	0.507	0.541	0.570	0.606	0.636	0.672	0.705	0.739	0.771
3.58	0.481	0.509	0.542	0.571	0.607	0.636	0.673	0.706	0.740	0.771
3.59	0.482	0.510	0.543	0.571	0.607	0.637	0.673	0.706	0.740	0.771
3.60	0.483	0.511	0.544	0.572	0.608	0.637	0.673	0.706	0.740	0.771
3.61	0.484	0.512	0.545	0.573	0.609	0.637	0.673	0.706	0.740	0.771
3.62	0.486	0.513	0.546	0.574	0.609	0.638	0.674	0.706	0.740	0.771
3.63	0.487	0.515	0.546	0.575	0.610	0.638	0.674	0.707	0.740	0.771
3.64	0.489	0.516	0.547	0.576	0.610	0.639	0.675	0.707	0.740	0.771
3.65	0.490	0.517	0.548	0.577	0.611	0.639	0.675	0.707	0.740	0.771
3.66	0.491	0.518	0.549	0.578	0.612	0.639	0.675	0.707	0.740	0.771
3.67	0.493	0.519	0.550	0.579	0.612	0.640	0.676	0.707	0.740	0.771
3.68	0.494	0.521	0.551	0.580	0.613	0.640	0.676	0.708	0.741	0.772
3.69	0.496	0.522	0.552	0.581	0.613	0.641	0.677	0.708	0.741	0.772
3.70	0.497	0.523	0.553	0.582	0.614	0.641	0.677	0.708	0.741	0.772
3.71	0.498	0.524	0.554	0.583	0.615	0.641	0.677	0.708	0.741	0.772
3.72	0.499	0.525	0.555	0.583	0.615	0.641	0.677	0.708	0.741	0.772
3.73	0.501	0.527	0.556	0.584	0.616	0.642	0.678	0.709	0.741	0.772
3.74	0.502	0.528	0.557	0.585	0.616	0.642	0.678	0.709	0.741	0.772
3.75	0.503	0.529	0.558	0.586	0.617	0.642	0.678	0.709	0.741	0.772
3.76	0.504	0.530	0.559	0.587	0.618	0.642	0.678	0.709	0.741	0.772
3.77	0.505	0.531	0.560	0.588	0.618	0.643	0.679	0.709	0.741	0.772
3.78	0.507	0.533	0.561	0.588	0.619	0.643	0.679	0.710	0.742	0.773
3.79	0.508	0.534	0.562	0.589	0.619	0.644	0.680	0.710	0.742	0.773

1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.35
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.36
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.37
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.38
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.39
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.40
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.41
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.42
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.43
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.44
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.45
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.46
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.47
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.48
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.49
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.50
0.817	0.858	0.891	0.916	0.937	0.963	0.984	1.000	1.017	1.030	3.51
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.52
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.53
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.54
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.55
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.56
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.57
0.816	0 857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.58
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.59
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.60
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.61
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.62
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.63
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.64
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.65
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.66
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.67
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.68
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.69
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.70
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.71
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.72
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.73
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.74
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.75
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.76
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.77
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.78
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.79

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
3.80	0.509	0.535	0.563	0.590	0.620	0.644	0.680	0.710	0.742	0.773
3.81	0.510	0.536	0.564	0.591	0.621	0.644	0.680	0.710	0.742	0.773
3.82	0.511	0.537	0.565	0.592	0.621	0.645	0.680	0.710	0.742	0.773
3.83	0.513	0.539	0.566	0.592	0.622	0.645	0.681	0.711	0.742	0.773
3.84	0.514	0.540	0.567	0.593	0.622	0.646	0.681	0.711	0.742	0.773
3.85	0.515	0.541	0.568	0.594	0.623	0.646	0.681	0.711	0.742	0.773
3.86	0.516	0.542	0.569	0.595	0.624	0.647	0.681	0.711	0.742	0.773
3.87	0.518	0.543	0.570	0.596	0.625	0.647	0.682	0.712	0.742	0.773
3.88	0.519	0.545	0.571	0.597	0.625	0.648	0.682	0.712	0.743	0.774
3.89	0.521	0.546	0.572	0.598	0.626	0.648	0.683	0.713	0.743	0.774
3.90	0.522	0.547	0.573	0.599	0.627	0.649	0.683	0.713	0.743	0.774
3.91	0.523	0.548	0.574	0.600	0.628	0.649	0.683	0.713	0.743	0.774
3.92	0.524	0.549	0.575	0.601	0.628	0.650	0.684	0.713	0.743	0.774
3.93	0.526	0.550	0.575	0.601	0.629	0.650	0.684	0.714	0.744	0.775
3.94	0.527	0.551	0.576	0.602	0.629	0.651	0.685	0.714	0.744	0.775
3.95	0.528	0.552	0.577	0.603	0.630	0.651	0.685	0.714	0.744	0.775
3.96	0.529	0.553	0.578	0.604	0.631	0.651	0.685	0.714	0.744	0.775
3.97	0.530	0.554	0.579	0.605	0.631	0.652	0.686	0.715	0.745	0.775
3.98	0.532	0.556	0.580	0.606	0.632	0.652	0.686	0.715	0.745	0.776
3.99	0.533	0.557	0.581	0.607	0.632	0.653	0.687	0.716	0.746	0.776
4.00	0.534	0.558	0.582	0.608	0.633	0.653	0.687	0.716	0.746	0.776
4.01	0.535	0.559	0.583	0.609	0.634	0.654	0.687	0.716	0.746	0.776
4.02	0.536	0.560	0.584	0.610	0.634	0.654	0.688	0.716	0.746	0.776
4.03	0.538	0.562	0.585	0.610	0.635	0.655	0.688	0.717	0.747	0.777
4.04	0.539	0.563	0.586	0.611	0.635	0.655	0.689	0.717	0.747	0.777
4.05	0.540	0.564	0.587	0.612	0.636	0.656	0.689	0.717	0.747	0.777
4.06	0.541	0.565	0.588	0.613	0.637	0.657	0.690	0.717	0.747	0.777
4.07	0.543	0.566	0.589	0.614	0.638	0.657	0.690	0.718	0.748	0.778
4.08	0.544	0.568	0.590	0.614	0.638	0.658	0.691	0.718	0.748	0.778
4.09	0.546	0.569	0.591	0.615	0.639	0.658	0.691	0.719	0.749	0.779
4.10	0.547	0.570	0.592	0.616	0.640	0.659	0.692	0.719	0.749	0.779
4.11	0.548	0.571	0.593	0.617	0.641	0.660	0.693	0.719	0.749	0.779
4.12	0.549	0.572	0.594	0.618	0.642	0.660	0.693	0.719	0,749	0.779
4.13	0.551	0.573	0.594	0.618	0.642	0.661	0.694	0.720	0.750	0.780
4.14	0.552	0.574	0.595	0.619	0.643	0.661	0.694	0.720	0.750	0.780
4.15	0.553	0.575	0.596	0.620	0.644	0.662	0.694	0.720	0.750	0.780
4.16	0.554	0.576	0.597	0.621	0.645	0.663	0.695	0.720	0.750	0.780
4.17	0.556	0.577	0.598	0.622	0.646	0.663	0.696	0.721	0.751	0.780
4.18	0.557	0.579	0.599	0.622	0.646	0.664	0.696	0.721	0.751	0.781
4.19	0.559	0.580	0.600	0.623	0.647	0.664	0.697	0.722	0.752	0.781
4.20	0.560	0.581	0.601	0.624	0.648	0.665	0.697	0.722	0.752	0.781
4.21	0.561	0.582	0.602	0.625	0.649	0.666	0.697	0.722	0.752	0.781
4.22	0.562	0.583	0.603	0.626	0.649	0.666	0.698	0.723	0.752	0.781
4.23	0.564	0.585	0.604	0.626	0.650	0.667	0.698	0.723	0.753	0.782
4.24	0.565	0.586	0.605	0.627	0.650	0.667	0.699	0.724	0.753	0.782

T_r										P_r 3.80 - 4.24
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.80
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.81
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.82
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.83
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.84
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.85
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.86
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.87
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.88
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.89
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.90
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.91
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.92
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.93
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.94
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.95
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.96
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.97
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	3.98
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	3.99
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.00
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.01
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.02
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.03
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.04
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.05
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.06
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.07
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.08
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.09
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.10
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.11
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.12
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.13
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.14
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.15
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.16
0.821	0.858	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.17
0.822	0.858	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.18
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.19
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.20
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.21
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.22
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.23
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.24

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
4.25	0.566	0.587	0.606	0.628	0.651	0.668	0.699	0.724	0.753	0.782
4.26	0.567	0.588	0.607	0.629	0.652	0.669	0.699	0.724	0.753	0.782
4.27	0.568	0.589	0.608	0.630	0.653	0.669	0.700	0.725	0.754	0.783
4.28	0.570	0.591	0.609	0.630	0.653	0.670	0.700	0.725	0.754	0.783
4.29	0.571	0.592	0.610	0.631	0.654	0.670	0.701	0.726	0.755	0.784
4.30	0.572	0.593	0.611	0.632	0.655	0.671	0.701	0.726	0.755	0.784
4.31	0.573	0.594	0.612	0.633	0.656	0.672	0.701	0.726	0.755	0.784
4.32	0.575	0.595	0.613	0.634	0.656	0.672	0.702	0.727	0.756	0.784
4.33	0.576	0.596	0.614	0.634	0.657	0.673	0.702	0.727	0.756	0.785
4.34	0.578	0.597	0.615	0.635	0.657	0.673	0.703	0.728	0.757	0.785
4.35	0.579	0.598	0.616	0.636	0.658	0.674	0.703	0.728	0.757	0.785
4.36	0.580	0.599	0.617	0.637	0.659	0.675	0.704	0.728	0.757	0.785
4.37	0.582	0.600	0.618	0.638	0.660	0.676	0.704	0.729	0.758	0.786
4.38	0.583	0.602	0.619	0.639	0.660	0.676	0.705	0.729	0.758	0.786
4.39	0.585	0.603	0.620	0.640	0.661	0.677	0.705	0.730	0.759	0.787
4.40	0.586	0.604	0.621	0.641	0.662	0.678	0.706	0.730	0.759	0.787
4.41	0.587	0.605	0.622	0.642	0.663	0.678	0.707	0.730	0.759	0.787
4.42	0.588	0.606	0.623	0.643	0.664	0.679	0.707	0.731	0.760	0.787
4.43	0.590	0.608	0.624	0.643	0.664	0.679	0.708	0.731	0.760	0.788
4.44	0.591	0.609	0.625	0.644	0.665	0.680	0.708	0.732	0.761	0.788
4.45	0.592	0.610	0.626	0.645	0.666	0.680	0.709	0.732	0.761	0.788
4.46	0.593	0.611	0.627	0.646	0.667	0.681	0.710	0.732	0.761	0.788
4.47	0.595	0.612	0.628	0.647	0.668	0.681	0.710	0.733	0.762	0.789
4.48	0.596	0.614	0.629	0.648	0.668	0.682	0.711	0.734	0.762	0.789
4.49	0.598	0.615	0.630	0.649	0.669	0.682	0.711	0.734	0.763	0.790
4.50	0.599	0.616	0.631	0.650	0.670	0.683	0.712	0.734	0.763	0.790
4.51	0.600	0.617	0.632	0.651	0.671	0.684	0.713	0.734	0.763	0.790
4.52	0.601	0.618	0.633	0.652	0.671	0.685	0.713	0.735	0.764	0.791
4.53	0.603	0.619	0.634	0.652	0.672	0.685	0.714	0.735	0.764	0.791
4.54	0.604	0.620	0.635	0.653	0.672	0.686	0.714	0.735	0.764	0.791
4.55	0.605	0.621	0.636	0.654	0.673	0.687	0.715	0.736	0.765	0.792
4.56	0.606	0.622	0.637	0.655	0.674	0.688	0.716	0.737	0.766	0.792
4.57	0.608	0.623	0.638	0.656	0.675	0.689	0.716	0.737	0.766	0.793
4.58	0.609	0.625	0.639	0.657	0.675	0.689	0.717	0.738	0.767	0.793
4.59	0.611	0.626	0.640	0.658	0.676	0.690	0.717	0.738	0.767	0.794
4.60	0.612	0.627	0.641	0.659	0.677	0.691	0.718	0.739	0.768	0.794
4.61	0.613	0.628	0.642	0.660	0.678	0.692	0.718	0.739	0.768	0.794
4.62	0.614	0.629	0.643	0.661	0.679	0.692	0.719	0.740	0.769	0.795
4.63	0.615	0.631	0.644	0.661	0.679	0.693	0.719	0.740	0.769	0.795
4.64	0.616	0.632	0.645	0.662	0.680	0.693	0.720	0.741	0.770	0.796
4.65	0.617	0.633	0.646	0.663	0.681	0.694	0.720	0.741	0.770	0.796
4.66	0.618	0.634	0.647	0.664	0.682	0.695	0.721	0.741	0.770	0.796
4.67	0.619	0.635	0.648	0.665	0.683	0.696	0.721	0.742	0.771	0.797
4.68	0.621	0.637	0.649	0.666	0.683	0.696	0.722	0.742	0.771	0.797
4.69	0.622	0.638	0.650	0.667	0.684	0.697	0.722	0.743	0.772	0.798

T_r										P_r 4.25 - 4.69
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.25
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.26
0.823	0.860	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.27
0.824	0.860	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.28
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.29
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.30
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.31
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.32
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.33
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.34
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.35
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.36
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.37
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.38
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.39
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.40
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.41
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.42
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.43
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.44
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.45
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.46
0.828	0.863	0.899	0.922	0.943	0.976	0.999	1.015	1.029	1.040	4.47
0.828	0.863	0.900	0.923	0.944	0.976	1.000	1.016	1.030	1.041	4.48
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.49
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.50
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.51
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.52
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.53
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.54
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.55
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.56
0.831	0.866	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.57
0.831	0.866	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.58
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.59
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.60
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.61
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.62
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.63
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.64
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.65
0.833	0.869	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.66
0.834	0.869	0.903	0.926	0.947	0.980	1.003	1.019	1.033	1.043	4.67
0.834	0.869	0.904	0.927	0.948	0.980	1.004	1.020	1.034	1.044	4.68
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.69

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
4.70	0.623	0.639	0.651	0.668	0.685	0.698	0.723	0.743	0.772	0.798
4.71	0.624	0.640	0.652	0.669	0.686	0.699	0.724	0.744	0.772	0.798
4.72	0.626	0.641	0.653	0.670	0.687	0.699	0.724	0.744	0.773	0.799
4.73	0.627	0.642	0.653	0.670	0.687	0.700	0.725	0.745	0.773	0.799
4.74	0.629	0.643	0.654	0.671	0.688	0.700	0.725	0.745	0.774	0.800
4.75	0.630	0.644	0.655	0.672	0.689	0.701	0.726	0.746	0.774	0.800
4.76	0.631	0.645	0.656	0.673	0.690	0.702	0.727	0.747	0.775	0.800
4.77	0.633	0.646	0.658	0.674	0.691	0.703	0.727	0.747	0.775	0.801
4.78	0.634	0.648	0.659	0.675	0.691	0.703	0.728	0.748	0.776	0.801
4.79	0.636	0.649	0.661	0.676	0.692	0.704	0.728	0.748	0.776	0.802
4.80	0.637	0.650	0.662	0.677	0.693	0.705	0.729	0.749	0.777	0.802
4.81	0.638	0.651	0.663	0.678	0.694	0.706	0.730	0.749	0.777	0.802
4.82	0.639	0.652	0.664	0.679	0.695	0.706	0.730	0.750	0.778	0.803
4.83	0.641	0.653	0.665	0.679	0.695	0.707	0.731	0.750	0.778	0.803
4.84	0.642	0.654	0.666	0.680	0.696	0.707	0.731	0.751	0.779	0.804
4.85	0.643	0.655	0.667	0.681	0.697	0.708	0.732	0.751	0.779	0.804
4.86	0.644	0.656	0.668	0.682	0.698	0.709	0.733	0.751	0.780	0.804
4.87	0.646	0.657	0.669	0.683	0.699	0.710	0.734	0.752	0.780	0.805
4.88	0.647	0.659	0.670	0.684	0.699	0.710	0.734	0.752	0.781	0.805
4.89	0.649	0.660	0.671	0.685	0.700	0.711	0.735	0.753	0.781	0.806
4.90	0.650	0.661	0.672	0.686	0.701	0.712	0.736	0.753	0.782	0.806
4.91	0.651	0.662	0.673	0.687	0.702	0.713	0.737	0.754	0.782	0.806
4.92	0.652	0.663	0.674	0.688	0.703	0.714	0.737	0.754	0.783	0.807
4.93	0.654	0.664	0.675	0.688	0.703	0.714	0.738	0.755	0.783	0.807
4.94	0.655	0.665	0.676	0.689	0.704	0.715	0.738	0.755	0.784	0.808
4.95	0.656	0.666	0.677	0.690	0.705	0.716	0.739	0.756	0.784	0.808
4.96	0.657	0.667	0.678	0.691	0.706	0.717	0.740	0.757	0.785	0.808
4.97	0.659	0.668	0.679	0.692	0.707	0.718	0.740	0.758	0.785	0.809
4.98	0.660	0.670	0.681	0.692	0.707	0.718	0.741	0.758	0.786	0.809
4.99	0.662	0.671	0.682	0.693	0.708	0.719	0.741	0.759	0.786	0.810
5.00	0.663	0.672	0.683	0.694	0.709	0.720	0.742	0.760	0.787	0.810
5.01	0.664	0.673	0.684	0.695	0.710	0.721	0.743	0.761	0.787	0.810
5.02	0.665	0.674	0.685	0.696	0.711	0.721	0.743	0.761	0.788	0.811
5.03	0.667	0.675	0.686	0.696	0.711	0.722	0.744	0.762	0.788	0.811
5.04	0.668	0.676	0.687	0.697	0.712	0.722	0.744	0.762	0.789	0.812
5.05	0.669	0.677	0.688	0.698	0.713	0.723	0.745	0.763	0.789	0.812
5.06	0.670	0.678	0.689	0.699	0.714	0.724	0.746	0.764	0.790	0.812
5.07	0.671	0.679	0.690	0.700	0.715	0.725	0.747	0.764	0.790	0.813
5.08	0.673	0.681	0.691	0.701	0.715	0.725	0.747	0.765	0.791	0.813
5.09	0.674	0.682	0.692	0.702	0.716	0.726	0.748	0.765	0.791	0.814
5.10	0.675	0.683	0.693	0.703	0.717	0.727	0.749	0.766	0.792	0.814
5.11	0.676	0.684	0.694	0.704	0.718	0.728	0.750	0.767	0.793	0.815
5.12	0.677	0.685	0.695	0.705	0.719	0.729	0.750	0.767	0.793	0.815
5.13	0.679	0.687	0.696	0.706	0.719	0.729	0.751	0.768	0.794	0.816
5.14	0.680	0.688	0.697	0.707	0.720	0.730	0.751	0.768	0.794	0.816

T_r										P_r 4.70 - 5.14
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.70
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.71
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.72
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.73
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.74
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.75
0.836	0.870	0.905	0.928	0.949	0.982	1.006	1.021	1.035	1.045	4.76
0.837	0.871	0.906	0.928	0.950	0.983	1.006	1.022	1.036	1.046	4.77
0.837	0.871	0.906	0.929	0.950	0.983	1.006	1.022	1.036	1.046	4.78
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.79
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.80
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.81
0.839	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.82
0.839	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.83
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.84
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.85
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.86
0.841	0.874	0.909	0.931	0.951	0.984	1.008	1.023	1.037	1.047	4.87
0.841	0.874	0.909	0.931	0.951	0.984	1.009	1.024	1.038	1.048	4.88
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.89
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.90
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.91
0.843	0.876	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.92
0.843	0.876	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.93
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.94
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.95
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.96
0.845	0.878	0.911	0.933	0.953	0.987	1.010	1.026	1.038	1.048	4.97
0.845	0.878	0.912	0.934	0.954	0.987	1.011	1.026	1.039	1.049	4.98
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	4.99
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.00
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.01
0.847	0.879	0.913	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.02
0.847	0.880	0.913	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.03
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.04
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.05
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.06
0.849	0.881	0.915	0.936	0.956	0.989	1.012	1.028	1.040	1.050	5.07
0.849	0.881	0.915	0.936	0.956	0.990	1.013	1.029	1.041	1.050	5.08
0.850	0.882	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.09
0.850	0.882	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.10
0.850	0.882	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.11
0.850	0.883	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.12
0.851	0.883	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.13
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.14

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
5.15	0.681	0.689	0.698	0.708	0.721	0.731	0.752	0.769	0.795	0.817
5.16	0.682	0.690	0.699	0.709	0.722	0.732	0.753	0.770	0.796	0.818
5.17	0.684	0.691	0.700	0.710	0.723	0.733	0.753	0.770	0.796	0.818
5.18	0.685	0.693	0.701	0.711	0.723	0.733	0.754	0.771	0.797	0.819
5.19	0.687	0.694	0.702	0.712	0.724	0.734	0.754	0.771	0.797	0.819
5.20	0.688	0.695	0.703	0.713	0.725	0.735	0.755	0.772	0.798	0.820
5.21	0.689	0.696	0.704	0.714	0.726	0.736	0.756	0.773	0.798	0.820
5.22	0.690	0.697	0.705	0.715	0.727	0.737	0.756	0.773	0.799	0.821
5.23	0.692	0.698	0.706	0.715	0.727	0.737	0.757	0.774	0.799	0.821
5.24	0.693	0.699	0.707	0.716	0.728	0.738	0.757	0.774	0.800	0.822
5.25	0.694	0.700	0.708	0.717	0.729	0.739	0.758	0.775	0.800	0.822
5.26	0.695	0.701	0.709	0.718	0.730	0.740	0.759	0.776	0.801	0.823
5.27	0.697	0.702	0.710	0.719	0.731	0.741	0.760	0.776	0.801	0.823
5.28	0.698	0.704	0.711	0.720	0.732	0.741	0.760	0.777	0.802	0.824
5.29	0.700	0.705	0.712	0.721	0.733	0.742	0.761	0.777	0.802	0.824
5.30	0.701	0.706	0.713	0.722	0.734	0.743	0.762	0.778	0.803	0.825
5.31	0.702	0.707	0.714	0.723	0.735	0.744	0.763	0.779	0.804	0.825
5.32	0.703	0.708	0.715	0.724	0.736	0.745	0.763	0.779	0.804	0.826
5.33	0.705	0.710	0.716	0.724	0.736	0.745	0.764	0.780	0.805	0.826
5.34	0.706	0.711	0.717	0.725	0.737	0.746	0.764	0.780	0.805	0.827
5.35	0.707	0.712	0.718	0.726	0.738	0.747	0.765	0.781	0.806	0.827
5.36	0.708	0.713	0.719	0.727	0.739	0.748	0.766	0.782	0.807	0.828
5.37	0.709	0.714	0.720	0.728	0.740	0.749	0.767	0.783	0.807	0.828
5.38	0.711	0.716	0.721	0.729	0.740	0.749	0.767	0.783	0.808	0.829
5.39	0.712	0.717	0.722	0.730	0.741	0.750	0.768	0.784	0.808	0.829
5.40	0.713	0.718	0.723	0.731	0.742	0.751	0.769	0.785	0.809	0.830
5.41	0.714	0.719	0.724	0.732	0.743	0.752	0.770	0.786	0.810	0.830
5.42	0.716	0.720	0.725	0.733	0.744	0.753	0.770	0.786	0.810	0.831
5.43	0.717	0.721	0.726	0.733	0.744	0.753	0.771	0.787	0.811	0.831
5.44	0.719	0.722	0.727	0.734	0.745	0.754	0.771	0.787	0.811	0.832
5.45	0.720	0.723	0.728	0.735	0.746	0.755	0.772	0.788	0.812	0.832
5.46	0.721	0.724	0.729	0.736	0.747	0.756	0.773	0.789	0.813	0.833
5.47	0.723	0.725	0.730	0.737	0.748	9.757	0.774	C.790	0.813	0.833
5.48	0.724	0.727	0.731	0.738	0.749	0.757	0.774	0.790	0.814	0.834
5.49	0.726	0.728	0.732	0.739	0.750	0.758	0.775	0.791	0.814	0.834
5.50	0.727	0.729	0.733	0.740	0.751	0.759	0.776	0.792	0.815	0.835
5.51	0.728	0.730	0.734	0.741	0.752	0.760	0.777	0.793	0.816	0.836
5.52	0.729	0.731	0.735	0.742	0.753	0.761	0.777	0.793	0.816	0.837
5.53	0.731	0.732	0.736	0.743	0.753	0.761	0.778	0.794	0.817	0.837
5.54	0.732	0.733	0.737	0.744	0.754	0.762	0.778	0.794	0.817	0.838
5.55	0.733	0.734	0.738	0.745	0.755	0.763	0.779	0.795	0.818	0.837
5.56	0.734	0.735	0.739	0.746	0.756	0.764	0.780	0.796	0.819	0.838
5.57	0.735	0.736	0.740	0.747	0.757	0.765	0.781	0.797	0.819	0.838
5.58	0.737	0.738	0.742	0.748	0.758	0.766	0.781	0.797	0.820	0.839
5.59	0.738	0.739	0.743	0.749	0.759	0.767	0.782	0.798	0.820	0.839

					T_r					P_r 5.15 - 5.59
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.15
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.16
0.852	0.885	0.918	0.939	0.959	0.991	1.015	1.030	1.042	1.051	5.17
0.852	0.885	0.918	0.939	0.959	0.992	1.015	1.031	1.043	1.052	5.18
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.19
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.20
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.21
0.854	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.22
0.854	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.23
0.855	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.24
0.855	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.25
0.856	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.26
0.856	0.888	0.920	0.942	0.962	0.994	1.017	1.032	1.044	1.052	5.27
0.857	0.888	0.921	0.942	0.962	0.994	1.018	1.033	1.045	1.053	5.28
0.857	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.29
0.858	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.30
0.858	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.31
0.859	0.890	0.922	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.32
0.859	0.890	0.922	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.33
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.34
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.35
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.36
0.861	0.892	0.924	0.945	0.965	0.997	1.020	1.034	1.046	1.054	5.37
0.861	0.892	0.924	0.945	0.965	0.997	1.020	1.035	1.047	1.054	5.38
0.862	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.39
0.862	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.40
0.863	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.41
0.863	0.894	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.42
0.864	0.894	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.43
0.864	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.44
0.865	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.45
0.866	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.46
0.866	0.896	0.927	0.948	0.968	0.999	1.022	1.037	1.048	1.056	5.47
0.867	0.896	0.927	0.948	0.968	1.000	1.023	1.037	1.049	1.057	5.48
0.867	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.49
0.868	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.50
0.868	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.51
0.869	0.898	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.52
0.869	0.898	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.53
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.54
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.55
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.56
0.871	0.899	0.930	0.951	0.971	1.002	1.025	1.039	1.050	1.058	5.57
0.871	0.900	0.930	0.951	0.971	1.002	1.025	1.040	1.051	1.058	5.58
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.59

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
5.60	0.739	0.740	0.744	0.750	0.760	0.768	0.783	0.799	0.821	0.840
5.61	0.740	0.741	0.745	0.751	0.761	0.769	0.784	0.800	0.822	0.841
5.62	0.741	0.742	0.746	0.752	0.762	0.770	0.785	0.800	0.822	0.841
5.63	0.743	0.743	0.747	0.753	0.762	0.770	0.785	0.801	0.823	0.842
5.64	0.744	0.744	0.748	0.754	0.763	0.771	0.786	0.801	0.823	0.842
5.65	0.745	0.745	0.749	0.755	0.764	0.772	0.787	0.802	0.824	0.843
5.66	0.746	0.746	0.750	0.756	0.765	0.773	0.788	0.803	0.825	0.844
5.67	0.747	0.747	0.751	0.757	0.766	0.774	0.789	0.804	0.825	0.844
5.68	0.749	0.749	0.752	0.758	0.767	0.775	0.789	0.804	0.826	0.845
5.69	0.750	0.750	0.753	0.759	0.768	0.776	0.790	0.805	0.826	0.845
5.70	0.751	0.751	0.754	0.760	0.769	0.777	0.791	0.806	0.827	0.846
5.71	0.752	0.752	0.755	0.761	0.770	0.778	0.792	0.807	0.828	0.846
5.72	0.753	0.753	0.756	0.762	0.771	0.779	0.793	0.807	0.828	0.847
5.73	0.755	0.754	0.757	0.762	0.771	0.779	0.793	0.808	0.829	0.847
5.74	0.756	0.755	0.758	0.763	0.772	0.780	0.794	0.808	0.829	0.848
5.75	0.757	0.756	0.759	0.764	0.773	0.781	0.795	0.809	0.830	0.848
5.76	0.758	0.757	0.760	0.765	0.774	0.782	0.796	0.810	0.831	0.849
5.77	0.759	0.758	0.761	0.766	0.775	0.783	0.797	0.811	0.831	0.849
5.78	0.761	0.760	0.762	0.767	0.776	0.783	0.797	0.811	0.832	0.850
5.79	0.762	0.761	0.763	0.768	0.777	0.784	0.798	0.812	0.832	0.850
5.80	0.763	0.762	0.764	0.769	0.778	0.785	0.799	0.813	0.833	0.851
5.81	0.764	0.763	0.765	0.770	0.779	0.786	0.800	0.814	0.834	0.852
5.82	0.765	0.764	0.766	0.771	0.780	0.787	0.801	0.815	0.834	0.852
5.83	0.767	0.766	0.768	0.772	0.780	0.787	0.801	0.815	0.835	0.853
5.84	0.768	0.767	0.769	0.773	0.781	0.788	0.802	0.816	0.835	0.853
5.85	0.769	0.768	0.770	0.774	0.782	0.789	0.803	0.817	0.836	0.854
5.86	0.770	0.769	0.771	0.775	0.783	0.790	0.804	0.818	0.837	0.855
5.87	0.771	0.770	0.773	0.776	0.784	0.791	0.805	0.819	0.837	0.855
5.88	0.773	0.772	0.774	0.777	0.785	0.792	0.805	0.819	0.838	0.856
5.89	0.774	0.773	0.776	0.778	0.786	0.793	0.806	0.820	0.838	0.856
5.90	0.775	0.774	0.777	0.779	0.787	0.794	0.807	0.821	0.839	0.857
5.91	0.776	0.775	0.778	0.780	0.788	0.795	0.808	0.822	0.840	0.858
5.92	0.777	0.776	0.779	0.781	0.789	0.796	0.808	0.822	0.840	0.858
5.93	0.779	0.777	0.780	0.782	0.790	0.796	0.809	0.823	0.841	0.859
5.94	0.780	0.778	0.781	0.783	0.791	0.797	0.809	0.823	0.841	0.859
5.95	0.781	0.779	0.782	0.784	0.792	0.798	0.810	0.824	0.842	0.860
5.96	0.782	0.780	0.783	0.785	0.793	0.799	0.811	0.825	0.843	0.861
5.97	0.784	0.781	0.784	0.786	0.794	0.800	0.812	0.826	0.843	0.861
5.98	0.785	0.783	0.785	0.788	0.795	0.801	0.812	0.826	0.844	0.862
5.99	0.787	0.784	0.786	0.789	0.796	0.802	0.813	0.827	0.844	0.862
6.00	0.788	0.785	0.787	0.790	0.797	0.803	0.814	0.828	0.845	0.863
6.01	0.789	0.786	0.788	0.791	0.798	0.804	0.815	0.829	0.846	0.864
6.02	0.790	0.787	0.789	0.792	0.799	0.805	0.816	0.829	0.846	0.864
6.03	0.792	0.788	0.790	0.793	0.799	0.805	0.816	0.830	0.847	0.865
6.04	0.793	0.789	0.791	0.794	0.800	0.806	0.817	0.830	0.847	0.865

				T_r						P_r 5.60 - 6.04
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.60
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.61
0.873	0.901	0.932	0.952	0.973	1.003	1.026	1.040	1.051	1.058	5.62
0.873	0.901	0.932	0.953	0.973	1.004	1.027	1.041	1.052	1.059	5.63
0.874	0.902	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.64
0.874	0.902	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.65
0.875	0.903	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.66
0.875	0.903	0.934	0.954	0.975	1.005	1.027	1.041	1.052	1.059	5.67
0.876	0.904	0.934	0.954	0.975	1.005	1.028	1.042	1.053	1.060	5.68
0.876	0.904	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.69
0.877	0.905	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.70
0.877	0.905	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.71
0.878	0.906	0.936	0.956	0.976	1.006	1.028	1.042	1.053	1.060	5.72
0.878	0.906	0.936	0.956	0.977	1.007	1.029	1.043	1.054	1.061	5.73
0.879	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.74
0.879	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.75
0.880	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.76
0.880	0.908	0.938	0.958	0.978	1.007	1.030	1.044	1.054	1.061	5.77
0.881	0.908	0.938	0.958	0.978	1.008	1.030	1.044	1.055	1.062	5.78
0.881	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5.79
0.882	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5
0.882	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5.
0.883	0.910	0.939	0.960	0.979	1.008	1.031	1.045	1.055	1.062	5.82
0.883	0.910	0.940	0.960	0.980	1.009	1.032	1.046	1.056	1.063	5.83
0.884	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.84
0.884	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.85
0.885	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.86
0.885	0.912	0.941	0.962	0.981	1.010	1.032	1.047	1.056	1.063	5.87
0.886	0.912	0.941	0.962	0.981	1.010	1.033	1.047	1.057	1.064	5.88
0.886	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.89
0.887	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.90
0.887	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.91
0.888	0.914	0.943	0.964	0.983	1.011	1.033	1.048	1.057	1.064	5.92
0.888	0.914	0.943	0.964	0.983	1.012	1.034	1.049	1.058	1.065	5.93
0.889	0.915	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.94
0.889	0.915	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.95
0.890	0.916	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.96
0.890	0.916	0.945	0.966	0.985	1.012	1.035	1.049	1.058	1.065	5.97
0.891	0.917	0.945	0.966	0.985	1.013	1.035	1.050	1.059	1.066	5.98
0.891	0.917	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	5.99
0.892	0.918	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	6.00
0.892	0.918	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	6.01
0.893	0.919	0.947	0.967	0.986	1.014	1.036	1.050	1.059	1.066	6.02
0.893	0.919	0.947	0.968	0.987	1.014	1.037	1.051	1.060	1.067	6.03
0.894	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.04

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.05	0.794	0.790	0.792	0.795	0.801	0.807	0.818	0.831	0.848	0.865
6.06	0.795	0.791	0.793	0.796	0.802	0.808	0.819	0.832	0.849	0.866
6.07	0.796	0.792	0.794	0.797	0.803	0.809	0.820	0.833	0.850	0.866
6.08	0.798	0.794	0.795	0.798	0.803	0.810	0.820	0.833	0.850	0.867
6.09	0.799	0.795	0.796	0.799	0.804	0.811	0.821	0.834	0.851	0.867
6.10	0.800	0.796	0.797	0.800	0.805	0.812	0.822	0.835	0.852	0.868
6.11	0.801	0.797	0.798	0.801	0.806	0.813	0.823	0.836	0.853	0.868
6.12	0.802	0.798	0.799	0.802	0.807	0.814	0.824	0.836	0.853	0.869
6.13	0.803	0.799	0.800	0.803	0.807	0.814	0.824	0.837	0.854	0.869
6.14	0.804	0.800	0.801	0.804	0.808	0.815	0.825	0.837	0.854	0.870
6.15	0.805	0.801	0.802	0.805	0.809	0.816	0.826	0.838	0.855	0.870
6.16	0.806	0.802	0.803	0.806	0.810	0.817	0.827	0.839	0.856	0.871
6.17	0.807	0.803	0.804	0.807	0.811	0.818	0.828	0.840	0.856	0.871
6.18	0.809	0.805	0.806	0.808	0.812	0.818	0.828	0.840	0.857	0.872
6.19	0.810	0.806	0.807	0.809	0.813	0.819	0.829	0.841	0.857	0.872
6.20	0.811	0.807	0.808	0.810	0.814	0.820	0.830	0.842	0.858	0.873
6.21	0.812	0.808	0.809	0.811	0.815	0.821	0.831	0.843	0.859	0.874
6.22	0.813	0.809	0.810	0.812	0.816	0.822	0.832	0.844	0.859	0.874
6.23	0.814	0.810	0.811	0.813	0.816	0.822	0.832	0.844	0.860	0.875
6.24	0.815	0.811	0.812	0.814	0.817	0.823	0.833	0.845	0.860	0.875
6.25	0.816	0.812	0.813	0.815	0.818	0.824	0.834	0.846	0.861	0.876
6.26	0.817	0.813	0.814	0.816	0.819	0.825	0.835	0.847	0.862	0.877
6.27	0.818	0.814	0.815	0.817	0.820	0.826	0.836	0.848	0.862	0.878
6.28	0.820	0.816	0.816	0.818	0.821	0.827	0.837	0.848	0.863	0.878
6.29	0.821	0.817	0.817	0.819	0.822	0.828	0.838	0.849	0.863	0.879
6.30	0.822	0.818	0.818	0.820	0.823	0.829	0.839	0.850	0.864	0.880
6.31	0.823	0.819	0.819	0.821	0.824	0.830	0.840	0.851	0.865	0.881
6.32	0.825	0.820	0.820	0.822	0.825	0.831	0.841	0.851	0.865	0.881
6.33	0.826	0.822	0.821	0.823	0.826	0.831	0.841	0.852	0.866	0.882
6.34	0.828	0.823	0.822	0.824	0.827	0.832	0.842	0.852	0.866	0.882
6.35	0.829	0.824	0.823	0.825	0.828	0.833	0.843	0.853	0.867	0.883
6.36	0.830	0.825	0.824	0.826	0.829	0.834	0.844	0.854	0.868	0.884
6.37	0.831	0.826	0.825	0.827	0.830	0.835	0.845	0.855	0.869	0.884
6.38	0.833	0.828	0.827	0.828	0.831	0.836	0.846	0.855	0.869	0.885
6.39	0.834	0.829	0.828	0.829	0.832	0.837	0.847	0.856	0.870	0.885
6.40	0.835	0.830	0.829	0.830	0.833	0.838	0.848	0.857	0.871	0.886
6.41	0.836	0.831	0.830	0.831	0.834	0.839	0.849	0.858	0.872	0.887
6.42	0.837	0.832	0.831	0.832	0.835	0.840	0.850	0.859	0.872	0.887
6.43	0.839	0.833	0.832	0.833	0.835	0.840	0.850	0.859	0.873	0.888
6.44	0.840	0.834	0.833	0.834	0.836	0.841	0.851	0.860	0.873	0.888
6.45	0.841	0.835	0.834	0.835	0.837	0.842	0.852	0.861	0.874	0.889
6.46	0.842	0.836	0.835	0.836	0.838	0.843	0.853	0.862	0.875	0.890
6.47	0.844	0.837	0.836	0.837	0.839	0.844	0.854	0.863	0.876	0.890
6.48	0.845	0.839	0.837	0.838	0.840	0.845	0.854	0.863	0.876	0.891
6.49	0.847	0.840	0.838	0.839	0.841	0.846	0.855	0.864	0.877	0.891

T_r										P_r 6.05 - 6.49
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.894	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.05
0.895	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.06
0.895	0.921	0.949	0.969	0.988	1.016	1.037	1.051	1.060	1.067	6.07
0.896	0.921	0.949	0.969	0.988	1.016	1.038	1.052	1.061	1.068	6.08
0.896	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.09
0.897	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.10
0.897	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.11
0.898	0.923	0.951	0.970	0.990	1.017	1.038	1.052	1.061	1.068	6.12
0.898	0.923	0.951	0.971	0.990	1.018	1.039	1.052	1.062	1.069	6.13
0.899	0.924	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.14
0.899	0.924	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.15
0.900	0.925	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.16
0.900	0.925	0.953	0.972	0.992	1.018	1.040	1.054	1.062	1.069	6.17
0.901	0.926	0.953	0.972	0.992	1.019	1.040	1.054	1.063	1.070	6.18
0.901	0.926	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.19
0.902	0.927	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.20
0.902	0.928	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.21
0.903	0.928	0.955	0.974	0.994	1.019	1.041	1.055	1.063	1.070	6.22
0.903	0.929	0.955	0.974	0.994	1.020	1.042	1.056	1.064	1.071	6.23
0.904	0.929	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.24
0.904	0.930	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.25
0.905	0.930	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.26
0.905	0.930	0.957	0.976	0.996	1.021	1.042	1.056	1.064	1.071	6.27
0.906	0.931	0.957	0.976	0.996	1.022	1.043	1.057	1.065	1.072	6.28
0.906	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.29
0.907	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.30
0.907	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.31
0.908	0.931	0.959	0.978	0.997	1.022	1.044	1.057	1.065	1.072	6.32
0.908	0.932	0.959	0.978	0.998	1.023	1.044	1.058	1.066	1.072	6.33
0.909	0.932	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.072	6.34
0.909	0.932	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.077	6.35
0.910	0.933	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.072	6.36
0.910	0.934	0.961	0.980	0.999	1.024	1.046	1.058	1.066	1.072	6.37
0.911	0.934	0.961	0.980	0.999	1.024	1.046	1.059	1.067	1.073	6.38
0.911	0.935	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.39
0.912	0.936	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.40
0.913	0.936	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.41
0.913	0.937	0.963	0.982	1.000	1.025	1.047	1.059	1.067	1.073	6.42
0.914	0.937	0.963	0.982	1.001	1.026	1.048	1.060	1.068	1.074	6.43
0.914	0.938	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.44
0.915	0.938	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.45
0.916	0.939	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.46
0.916	0.939	0.965	0.984	1.002	1.027	1.048	1.061	1.068	1.074	6.47
0.917	0.940	0.965	0.984	1.002	1.027	1.049	1.061	1.069	1.075	6.48
0.917	0.940	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.49

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.50	0.848	0.841	0.839	0.840	0.842	0.847	0.856	0.865	0.878	0.892
6.51	0.849	0.842	0.840	0.841	0.843	0.848	0.857	0.866	0.879	0.893
6.52	0.850	0.843	0.841	0.842	0.844	0.849	0.858	0.866	0.879	0.893
6.53	0.851	0.844	0.842	0.843	0.844	0.849	0.858	0.867	0.880	0.894
6.54	0.852	0.845	0.843	0.844	0.845	0.850	0.859	0.867	0.880	0.894
6.55	0.853	0.846	0.844	0.845	0.846	0.851	0.860	0.868	0.881	0.895
6.56	0.854	0.847	0.845	0.846	0.847	0.852	0.861	0.869	0.882	0.896
6.57	0.855	0.848	0.846	0.847	0.848	0.853	0.862	0.869	0.882	0.896
6.58	0.856	0.850	0.848	0.849	0.849	0.853	0.862	0.870	0.883	0.897
6.59	0.857	0.851	0.849	0.850	0.850	0.854	0.863	0.870	0.883	0.897
6.60	0.858	0.852	0.850	0.851	0.851	0.855	0.864	0.871	0.884	0.898
6.61	0.859	0.853	0.851	0.852	0.852	0.856	0.865	0.872	0.885	0.898
6.62	0.860	0.854	0.852	0.853	0.853	0.857	0.866	0.873	0.886	0.899
6.63	0.862	0.855	0.853	0.854	0.854	0.857	0.866	0.873	0.886	0.899
6.64	0.863	0.856	0.854	0.855	0.855	0.858	0.867	0.874	0.887	0.890
6.65	0.864	0.857	0.855	0.856	0.856	0.859	0.868	0.875	0.888	0.900
6.66	0.865	0.858	0.856	0.857	0.857	0.860	0.869	0.876	0.889	0.901
6.67	0.866	0.859	0.857	0.858	0.858	0.861	0.870	0.877	0.890	0.901
6.68	0.868	0.861	0.858	0.859	0.859	0.861	0.870	0.878	0.890	0.902
6.69	0.869	0.862	0.859	0.860	0.860	0.862	0.871	0.879	0.891	0.902
6.70	0.870	0.863	0.860	0.861	0.861	0.863	0.872	0.880	0.892	0.903
6.71	0.871	0.864	0.861	0.862	0.862	0.864	0.873	0.881	0.893	0.904
6.72	0.872	0.865	0.862	0.863	0.863	0.865	0.874	0.882	0.893	0.904
6.73	0.873	0.866	0.863	0.864	0.863	0.865	0.874	0.882	0.894	0.905
6.74	0.874	0.867	0.864	0.865	0.864	0.866	0.875	0.883	0.894	0.905
6.75	0.875	0.868	0.865	0.866	0.865	0.867	0.876	0.884	0.895	0.906
6.76	0.876	0.869	0.866	0.867	0.866	0.868	0.877	0.885	0.896	0.907
6.77	0.877	0.870	0.867	0.868	0.867	0.869	0.878	0.886	0.897	0.908
6.78	0.879	0.872	0.869	0.870	0.868	0.870	0.878	0.886	0.897	0.908
6.79	0.880	0.873	0.870	0.871	0.869	0.871	0.879	0.887	0.898	0.909
6.80	0.881	0.874	0.871	0.872	0.870	0.872	0.880	0.888	0.899	0.910
6.81	0.882	0.875	0.872	0.873	0.871	0.873	0.881	0.889	0.900	0.911
6.82	0.883	0.876	0.873	0.874	0.872	0.874	0.882	0.889	0.900	0.911
6.83	0.884	0.877	0.874	0.875	0.873	0.875	0.882	0.890	0.901	0.912
6.84	0.885	0.878	0.875	0.876	0.874	0.876	0.883	0.890	0.901	0.912
6.85	0.886	0.879	0.876	0.877	0.875	0.877	0.884	0.891	0.902	0.913
6.86	0.887	0.880	0.877	0.878	0.876	0.878	0.885	0.892	0.903	0.914
6.87	0.888	0.881	0.878	0.879	0.877	0.879	0.886	0.893	0.904	0.915
6.88	0.890	0.883	0.879	0.879	0.879	0.879	0.886	0.893	0.904	0.915
6.89	0.891	0.884	0.880	0.880	0.880	0.880	0.887	0.894	0.905	0.916
6.90	0.892	0.885	0.881	0.881	0.881	0.881	0.888	0.895	0.906	0.917
6.91	0.893	0.886	0.882	0.882	0.882	0.882	0.889	0.896	0.907	0.917
6.92	0.894	0.887	0.883	0.883	0.883	0.883	0.890	0.896	0.907	0.918
6.93	0.895	0.888	0.884	0.883	0.883	0.883	0.890	0.897	0.908	0.918
6.94	0.896	0.889	0.885	0.884	0.884	0.884	0.891	0.897	0.909	0.919

				T_r						P_r 6.50 - 6.94
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.918	0.941	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.50
0.918	0.941	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.51
0.919	0.942	0.967	0.986	1.004	1.028	1.049	1.062	1.069	1.075	6.52
0.919	0.942	0.967	0.986	1.004	1.029	1.050	1.063	1.070	1.076	6.53
0.920	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.54
0.920	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.55
0.921	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.56
0.921	0.944	0.969	0.988	1.006	1.030	1.051	1.063	1.071	1.076	6.57
0.922	0.944	0.969	0.988	1.006	1.030	1.051	1.064	1.071	1.077	6.58
0.922	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.59
0.923	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.60
0.923	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.61
0.924	0.946	0.971	0.990	1.007	1.031	1.052	1.064	1.072	1.077	6.62
0.924	0.946	0.971	0.990	1.008	1.032	1.053	1.065	1.073	1.078	6.63
0.925	0.947	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.64
0.925	0.947	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.65
0.926	0.948	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.66
0.926	0.948	0.973	0.992	1.009	1.033	1.053	1.066	1.073	1.079	6.67
0.927	0.949	0.973	0.992	1.009	1.033	1.054	1.066	1.074	1.079	6.68
0.927	0.949	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.69
0.928	0.950	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.70
0.928	0.950	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.71
0.929	0.951	0.975	0.994	1.010	1.035	1.054	1.067	1.074	1.080	6.72
0.929	0.951	0.975	0.994	1.011	1.035	1.055	1.068	1.075	1.081	6.73
0.930	0.952	0.976	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.74
0.930	0.952	0.976	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.75
0.931	0.953	0.977	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.76
0.931	0.953	0.977	0.996	1.012	1.037	1.056	1.068	1.076	1.081	6.77
0.932	0.954	0.978	0.996	1.012	1.037	1.056	1.069	1.076	1.082	6.78
0.932	0.954	0.978	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.79
0.933	0.955	0.979	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.80
0.934	0.955	0.979	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.81
0.934	0.956	0.980	0.997	1.014	1.039	1.057	1.069	1.077	1.082	6.82
0.935	0.956	0.980	0.998	1.014	1.039	1.058	1.070	1.078	1.083	6.83
0.935	0.957	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.84
0.936	0.957	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.85
0.937	0.958	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.86
0.937	0.958	0.982	0.999	1.016	1.040	1.058	1.070	1.078	1.083	6.87
0.938	0.959	0.982	0.999	1.016	1.041	1.059	1.071	1.079	1.084	6.88
0.938	0.959	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.89
0.939	0.960	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.90
0.939	0.960	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.91
0.940	0.961	0.984	1.001	1.017	1.041	1.059	1.071	1.079	1.084	6.92
0.940	0.961	0.984	1.001	1.018	1.042	1.060	1.072	1.080	1.085	6.93
0.941	0.962	0.985	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.94

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.95	0.897	0.890	0.886	0.885	0.885	0.885	0.892	0.898	0.909	0.919
6.96	0.898	0.891	0.887	0.886	0.886	0.886	0.893	0.899	0.910	0.920
6.97	0.899	0.892	0.888	0.887	0.887	0.887	0.894	0.900	0.911	0.920
6.98	0.901	0.894	0.890	0.888	0.888	0.888	0.894	0.900	0.911	0.921
6.99	0.902	0.895	0.891	0.889	0.889	0.889	0.895	0.901	0.911	0.921
7.00	0.903	0.896	0.892	0.890	0.890	0.890	0.896	0.902	0.913	0.922
7.01	0.904	0.897	0.893	0.891	0.891	0.891	0.897	0.903	0.914	0.923
7.02	0.905	0.898	0.894	0.892	0.892	0.892	0.897	0.904	0.914	0.923
7.03	0.907	0.899	0.895	0.893	0.892	0.892	0.898	0.904	0.915	0.924
7.04	0.908	0.900	0.896	0.894	0.893	0.893	0.898	0.905	0.915	0.924
7.05	0.909	0.901	0.897	0.895	0.894	0.894	0.899	0.906	0.916	0.925
7.06	0.910	0.902	0.898	0.896	0.895	0.895	0.900	0.907	0.917	0.926
7.07	0.911	0.903	0.899	0.897	0.896	0.896	0.901	0.908	0.918	0.927
7.08	0.913	0.905	0.901	0.898	0.897	0.897	0.901	0.908	0.918	0.927
7.09	0.914	0.906	0.902	0.899	0.898	0.898	0.902	0.909	0.919	0.928
7.10	0.915	0.907	0.903	0.900	0.899	0.899	0.903	0.910	0.920	0.929
7.11	0.916	0.908	0.904	0.901	0.900	0.900	0.904	0.911	0.921	0.930
7.12	0.917	0.909	0.905	0.902	0.901	0.901	0.905	0.912	0.921	0.930
7.13	0.919	0.910	0.906	0.903	0.901	0.901	0.905	0.912	0.922	0.931
7.14	0.920	0.911	0.907	0.904	0.902	0.902	0.906	0.913	0.922	0.931
7.15	0.921	0.912	0.908	0.905	0.903	0.903	0.907	0.914	0.923	0.932
7.16	0.922	0.913	0.909	0.906	0.904	0.904	0.908	0.915	0.924	0.933
7.17	0.924	0.914	0.910	0.907	0.905	0.905	0.909	0.916	0.925	0.933
7.18	0.925	0.916	0.911	0.908	0.906	0.905	0.909	0.916	0.925	0.934
7.19	0.927	0.917	0.912	0.909	0.907	0.906	0.910	0.917	0.926	0.934
7.20	0.928	0.918	0.913	0.910	0.908	0.907	0.911	0.918	0.927	0.935
7.21	0.929	0.919	0.914	0.911	0.909	0.908	0.912	0.919	0.928	0.936
7.22	0.930	0.920	0.915	0.912	0.910	0.908	0.913	0.919	0.928	0.936
7.23	0.931	0.921	0.916	0.913	0.910	0.909	0.913	0.920	0.929	0.937
7.24	0.932	0.922	0.917	0.914	0.911	0.909	0.914	0.920	0.929	0.937
7.25	0.933	0.923	0.918	0.915	0.912	0.910	0.915	0.921	0.930	0.938
7.26	0.934	0.924	0.919	0.916	0.913	0.911	0.916	0.922	0.931	0.939
7.27	0.935	0.925	0.920	0.917	0.914	0.912	0.917	0.923	0.932	0.939
7.28	0.936	0.927	0.921	0.918	0.915	0.912	0.917	0.923	0.932	0.940
7.29	0.937	0.928	0.922	0.919	0.916	0.913	0.918	0.924	0.933	0.940
7.30	0.938	0.929	0.923	0.920	0.917	0.914	0.919	0.925	0.934	0.942
7.31	0.939	0.930	0.924	0.921	0.918	0.915	0.920	0.926	0.935	0.943
7.32	0.940	0.931	0.925	0.922	0.919	0.916	0.921	0.926	0.935	0.944
7.33	0.941	0.932	0.926	0.922	0.919	0.916	0.921	0.927	0.936	0.944
7.34	0.942	0.933	0.927	0.923	0.920	0.917	0.922	0.927	0.936	0.945
7.35	0.943	0.934	0.928	0.924	0.921	0.918	0.923	0.928	0.937	0.946
7.36	0.944	0.935	0.929	0.925	0.922	0.919	0.924	0.929	0.938	0.947
7.37	0.945	0.936	0.930	0.926	0.923	0.920	0.925	0.930	0.939	0.948
7.38	0.947	0.938	0.931	0.927	0.924	0.921	0.925	0.930	0.939	0.948
7.39	0.948	0.939	0.932	0.928	0.925	0.922	0.926	0.931	0.940	0.949

				T_r						P_r 6.95 - 7.39
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.941	0.962	0.985	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.95
0.942	0.963	0.986	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.96
0.942	0.963	0.986	1.003	1.019	1.043	1.061	1.072	1.080	1.085	6.97
0.943	0.964	0.987	1.003	1.019	1.043	1.061	1.073	1.081	1.086	6.98
0.943	0.964	0.987	1.004	1.020	1.044	1.062	1.073	1.081	1.086	6.99
0.944	0.965	0.988	1.004	1.020	1.044	1.062	1.073	1.081	1.086	7.00
0.945	0.965	0.988	1.004	1.020	1.044	1.062	1.073	1.081	1.086	7.01
0.945	0.966	0.989	1.005	1.021	1.044	1.062	1.074	1.081	1.086	7.02
0.946	0.966	0.989	1.005	1.021	1.045	1.063	1.074	1.082	1.087	7.03
0.946	0.967	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.04
0.947	0.967	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.05
0.948	0.968	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.06
0.948	0.968	0.991	1.007	1.023	1.046	1.064	1.076	1.082	1.087	7.07
0.949	0.969	0.991	1.007	1.023	1.046	1.064	1.076	1.083	1.088	7.08
0.949	0.969	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.09
0.950	0.970	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.10
0.951	0.970	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.11
0.951	0.971	0.993	1.009	1.025	1.047	1.065	1.077	1.083	1.088	7.12
0.952	0.971	0.993	1.009	1.025	1.048	1.066	1.078	1.084	1.089	7.13
0.952	0.972	0.994	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.14
0.953	0.972	0.994	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.15
0.954	0.973	0.995	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.16
0.954	0.973	0.995	1.011	1.027	1.049	1.066	1.078	1.085	1.090	7.17
0.955	0.974	0.996	1.011	1.027	1.049	1.067	1.079	1.085	1.090	7.18
0.955	0.974	0.996	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.19
0.956	0.975	0.997	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.20
0.957	0.975	0.997	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.21
0.957	0.976	0.998	1.013	1.028	1.050	1.067	1.079	1.086	1.091	7.22
0.958	0.976	0.998	1.013	1.029	1.051	1.068	1.080	1.087	1.092	7.23
0.958	0.977	0.999	1.014	1.029	1.051	1.068	1.080	1.087	1.092	7.24
0.959	0.977	0.999	1.014	1.029	1.051	1.068	1.080	1.087	1.092	7.25
0.960	0.978	0.999	1.015	1.029	1.051	1.068	1.080	1.087	1.092	7.26
0.960	0.978	1.000	1.015	1.030	1.052	1.069	1.080	1.087	1.092	7.27
0.961	0.979	1.000	1.016	1.030	1.052	1.069	1.081	1.088	1.093	7.28
0.961	0.979	1.001	1.016	1.031	1.053	1.070	1.081	1.088	1.093	7.29
0.962	0.980	1.001	1.017	1.031	1.053	1.070	1.081	1.088	1.093	7.30
0.963	0.980	1.001	1.017	1.031	1.053	1.070	1.081	1.088	1.093	7.31
0.963	0.981	1.002	1.018	1.032	1.054	1.070	1.081	1.088	1.093	7.32
0.964	0.981	1.002	1.018	1.032	1.054	1.071	1.082	1.089	1.094	7.33
0.964	0.982	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.34
0.965	0.982	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.35
0.966	0.983	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.36
0.966	0.983	1.004	1.020	1.034	1.056	1.072	1.083	1.090	1.094	7.37
0.967	0.984	1.004	1.020	1.034	1.056	1.072	1.083	1.090	1.095	7.38
0.967	0.984	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.39

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
7.40	0.949	0.940	0.933	0.929	0.926	0.923	0.927	0.932	0.941	0.950
7.41	0.950	0.941	0.934	0.930	0.927	0.924	0.928	0.933	0.942	0.951
7.42	0.951	0.942	0.935	0.931	0.928	0.925	0.929	0.934	0.942	0.951
7.43	0.953	0.943	0.936	0.932	0.928	0.925	0.929	0.934	0.943	0.952
7.44	0.954	0.944	0.937	0.933	0.929	0.926	0.930	0.935	0.943	0.952
7.45	0.955	0.945	0.938	0.934	0.930	0.927	0.931	0.936	0.944	0.953
7.46	0.956	0.946	0.939	0.935	0.931	0.928	0.932	0.937	0.945	0.954
7.47	0.957	0.947	0.940	0.936	0.932	0.929	0.933	0.938	0.946	0.954
7.48	0.959	0.949	0.941	0.937	0.933	0.930	0.933	0.938	0.946	0.955
7.49	0.960	0.950	0.942	0.938	0.934	0.931	0.934	0.939	0.947	0.955
7.50	0.961	0.951	0.943	0.939	0.935	0.932	0.935	0.940	0.948	0.956
7.51	0.962	0.952	0.944	0.940	0.936	0.933	0.936	0.941	0.949	0.957
7.52	0.963	0.953	0.945	0.941	0.937	0.934	0.937	0.942	0.949	0.957
7.53	0.964	0.954	0.946	0.942	0.937	0.934	0.937	0.942	0.950	0.958
7.54	0.965	0.955	0.947	0.943	0.938	0.935	0.938	0.943	0.950	0.958
7.55	0.966	0.956	0.948	0.944	0.939	0.936	0.939	0.944	0.951	0.959
7.56	0.967	0.957	0.949	0.945	0.940	0.937	0.940	0.945	0.952	0.960
7.57	0.968	0.958	0.950	0.946	0.941	0.938	0.941	0.946	0.953	0.960
7.58	0.970	0.959	0.951	0.947	0.942	0.939	0.941	0.947	0.953	0.961
7.59	0.971	0.960	0.952	0.948	0.943	0.940	0.942	0.948	0.954	0.961
7.60	0.972	0.961	0.953	0.949	0.944	0.941	0.943	0.949	0.955	0.962
7.61	0.973	0.962	0.954	0.950	0.945	0.942	0.944	0.950	0.956	0.963
7.62	0.974	0.963	0.955	0.951	0.946	0.943	0.945	0.950	0.956	0.963
7.63	0.975	0.964	0.956	0.952	0.947	0.943	0.945	0.951	0.957	0.964
7.64	0.976	0.965	0.957	0.953	0.948	0.944	0.946	0.951	0.957	0.964
7.65	0.977	0.966	0.958	0.954	0.949	0.945	0.947	0.952	0.958	0.965
7.66	0.978	0.967	0.959	0.955	0.950	0.946	0.948	0.953	0.959	0.966
7.67	0.979	0.968	0.960	0.956	0.951	0.947	0.949	0.954	0.960	0.967
7.68	0.981	0.970	0.961	0.957	0.952	0.948	0.950	0.954	0.960	0.967
7.69	0.982	0.971	0.962	0.958	0.953	0.949	0.951	0.955	0.961	0.968
7.70	0.983	0.972	0.963	0.959	0.954	0.950	0.952	0.956	0.962	0.969
7.71	0.984	0.973	0.964	0.960	0.955	0.951	0.953	0.957	0.963	0.970
7.72	0.985	0.974	0.965	0.961	0.956	0.952	0.954	0.957	0.963	0.970
7.73	0.987	0.975	0.966	0.961	0.956	0.952	0.954	0.958	0.964	0.971
7.74	0.988	0.976	0.967	0.962	0.957	0.953	0.955	0.958	0.964	0.971
7.75	0.989	0.977	0.968	0.963	0.958	0.954	0.956	0.959	0.965	0.972
7.76	0.990	0.978	0.969	0.964	0.959	0.955	0.957	0.960	0.966	0.973
7.77	0.991	0.979	0.970	0.965	0.960	0.956	0.958	0.961	0.967	0.974
7.78	0.993	0.981	0.971	0.966	0.960	0.957	0.958	0.961	0.967	0.974
7.79	0.994	0.982	0.972	0.967	0.961	0.958	0.959	0.962	0.968	0.975
7.80	0.995	0.983	0.973	0.968	0.962	0.959	0.960	0.963	0.969	0.976
7.81	0.996	0.984	0.974	0.969	0.962	0.960	0.961	0.964	0.970	0.977
7.82	0.997	0.985	0.975	0.970	0.963	0.961	0.962	0.965	0.971	0.977
7.83	0.998	0.986	0.976	0.971	0.963	0.961	0.962	0.965	0.971	0.978
7.84	0.999	0.987	0.977	0.972	0.964	0.962	0.963	0.966	0.972	0.978

				T_r						P_r 7.40 - 7.84
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.968	0.985	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.40
0.968	0.986	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.41
0.969	0.986	1.006	1.022	1.036	1.057	1.073	1.084	1.091	1.095	7.42
0.969	0.987	1.006	1.022	1.036	1.058	1.074	1.085	1.092	1.096	7.43
0.970	0.987	1.007	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.44
0.970	0.988	1.007	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.45
0.971	0.989	1.008	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.46
0.971	0.989	1.008	1.024	1.038	1.059	1.075	1.086	1.092	1.097	7.47
0.972	0.990	1.009	1.024	1.038	1.059	1.075	1.086	1.093	1.097	7.48
0.972	0.990	1.009	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.49
0.973	0.991	1.010	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.50
0.974	0.991	1.010	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.51
0.974	1.992	1.011	1.026	1.040	1.060	1.076	1.087	1.093	1.098	7.52
0.975	0.992	1.011	1.026	1.040	1.061	1.077	1.088	1.094	1.099	7.53
0.975	0.993	1.012	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.54
0.976	0.993	1.012	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.55
0.977	0.994	1.013	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.56
0.977	0.994	1.013	1.028	1.042	1.062	1.078	1.088	1.095	1.099	7.57
0.978	0.995	1.014	1.028	1.042	1.062	1.078	1.089	1.095	1.100	7.58
0.978	0.995	1.014	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.59
0.979	0.996	1.015	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.60
0.979	0.996	1.015	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.61
0.980	0.997	1.016	1.030	1.044	1.064	1.079	1.089	1.096	1.100	7.62
0.980	0.997	1.016	1.030	1.044	1.064	1.080	1.090	1.097	1.101	7.63
0.981	0.998	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.64
0.981	0.998	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.65
0.982	0.999	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.66
0.982	0.999	1.018	1.032	1.046	1.066	1.081	1.091	1.097	1.101	7.67
0.983	1.000	1.018	1.032	1.046	1.066	1.081	1.091	1.098	1.102	7.68
0.983	1.000	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.69
0.984	1.001	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.70
0.985	1.001	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.71
0.985	1.002	1.020	1.034	1.048	1.067	1.082	1.092	1.098	1.102	7.72
0.986	1.002	1.020	1.034	1.048	1.068	1.083	1.093	1.099	1.103	7.73
0.986	1.003	1.021	1.035	1.049	1.068	1.083	1.093	1.099	1.103	7.74
0.987	1.003	1.021	1.035	1.049	1.068	1.083	1.093	1.099	1.103	7.75
0.988	1.004	1.022	1.036	1.049	1.068	1.083	1.093	1.099	1.103	7.76
0.988	1.004	1.022	1.036	1.050	1.069	1.083	1.094	1.099	1.103	7.77
0.989	1.005	1.023	1.037	1.050	1.069	1.084	1.094	1.100	1.104	7.78
0.989	1.005	1.023	1.037	1.051	1.070	1.084	1.095	1.100	1.104	7.79
0.990	1.006	1.024	1.038	1.051	1.070	1.084	1.095	1.100	1.104	7.80
0.991	1.007	1.024	1.038	1.051	1.070	1.084	1.095	1.100	1.104	7.81
0.991	1.007	1.025	1.039	1.052	1.070	1.084	1.095	1.100	1.104	7.82
0.992	1.008	1.025	1.039	1.052	1.071	1.085	1.096	1.101	1.105	7.83
0.992	1.008	1.026	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.84

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
7.85	1.000	0.988	0.978	0.973	0.966	0.963	0.964	0.967	0.973	0.979
7.86	1.001	0.989	0.979	0.974	0.967	0.964	0.965	0.968	0.974	0.980
7.87	1.002	0.990	0.980	0.975	0.968	0.965	0.966	0.969	0.975	0.980
7.88	1.003	0.991	0.982	0.976	0.968	0.966	0.966	0.970	0.975	0.981
7.89	1.004	0.992	0.983	0.977	0.969	0.967	0.967	0.971	0.976	0.981
7.90	1.005	0.993	0.984	0.978	0.970	0.968	0.968	0.972	0.977	0.982
7.91	1.006	0.994	0.985	0.979	0.971	0.969	0.969	0.973	0.978	0.983
7.92	1.007	0.994	0.986	0.980	0.972	0.970	0.970	0.974	0.978	0.984
7.93	1.009	0.997	0.987	0.981	0.972	0.970	0.970	0.974	0.979	0.984
7.94	1.010	0.998	0.988	0.982	0.973	0.971	0.971	0.975	0.979	0.985
7.95	1.011	0.999	0.989	0.983	0.974	0.972	0.972	0.976	0.980	0.986
7.96	1.012	1.000	0.990	0.984	0.975	0.973	0.973	0.977	0.981	0.987
7.97	1.013	1.001	0.991	0.985	0.976	0.974	0.974	0.978	0.982	0.988
7.98	1.015	1.003	0.993	0.986	0.977	0.975	0.974	0.978	0.982	0.988
7.99	1.016	1.004	0.994	0.987	0.978	0.976	0.975	0.979	0.983	0.989
8.00	1.017	1.005	0.995	0.988	0.979	0.977	0.976	0.980	0.984	0.990
8.01	1.018	1.006	0.996	0.989	0.980	0.978	0.977	0.981	0.985	0.991
8.02	1.019	1.007	0.997	0.990	0.981	0.979	0.978	0.982	0.986	0.992
8.03	1.020	1.008	0.998	0.991	0.981	0.980	0.978	0.982	0.986	0.992
8.04	1.021	1.009	0.999	0.992	0.982	0.981	0.979	0.983	0.987	0.993
8.05	1.022	1.010	1.000	0.993	0.983	0.982	0.980	0.984	0.988	0.994
8.06	1.023	1.011	1.001	0.994	0.984	0.983	0.981	0.985	0.989	0.995
8.07	1.024	1.012	1.002	0.995	0.985	0.984	0.982	0.986	0.990	0.996
8.08	1.025	1.014	1.004	0.996	0.985	0.985	0.982	0.987	0.990	0.996
8.09	1.026	1.015	1.005	0.997	0.986	0.986	0.983	0.988	0.991	0.997
8.10	1.027	1.016	1.006	0.998	0.987	0.987	0.984	0.989	0.992	0.998
8.11	1.028	1.017	1.007	0.999	0.988	0.988	0.985	0.990	0.993	0.998
8.12	1.029	1.018	1.008	1.000	0.989	0.989	0.986	0.990	0.994	0.999
8.13	1.030	1.019	1.009	1.000	0.989	0.989	0.986	0.991	0.994	0.999
8.14	1.031	1.020	1.010	1.001	0.990	0.990	0.987	0.991	0.995	1.000
8.15	1.032	1.021	1.011	1.002	0.991	0.991	0.988	0.992	0.996	1.000
8.16	1.033	1.022	1.012	1.003	0.992	0.992	0.989	0.993	0.997	1.001
8.17	1.034	1.023	1.013	1.004	0.993	0.993	0.990	0.994	0.998	1.001
8.18	1.036	1.024	1.014	1.005	0.994	0.994	0.990	0.994	0.998	1.002
8.19	1.037	1.025	1.015	1.006	0.995	0.995	0.991	0.995	0.999	1.002
8.20	1.038	1.026	1.016	1.007	0.996	0.996	0.992	0.996	1.000	1.003
8.21	1.039	1.027	1.017	1.008	0.997	0.997	0.993	0.997	1.001	1.004
8.22	1.040	1.028	1.018	1.009	0.998	0.998	0.994	0.997	1.002	1.005
8.23	1.042	1.029	1.019	1.010	0.998	0.998	0.994	0.998	1.002	1.005
8.24	1.043	1.030	1.020	1.011	0.999	0.999	0.995	0.998	1.003	1.006
8.25	1.044	1.031	1.021	1.012	1.000	1.000	0.996	0.999	1.004	1.007
8.26	1.045	1.032	1.022	1.013	1.001	1.001	0.997	1.000	1.005	1.008
8.27	1.046	1.033	1.023	1.014	1.002	1.002	0.998	1.001	1.006	1.009
8.28	1.048	1.035	1.024	1.015	1.003	1.002	0.999	1.001	1.006	1.009
8.29	1.049	1.036	1.025	1.016	1.004	1.003	1.000	1.002	1.007	1.010

				T_r						P_r 7.85 - 8.29
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.993	1.009	1.026	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.85
0.994	1.010	1.027	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.86
0.995	1.010	1.027	1.041	1.054	1.072	1.086	1.097	1.102	1.106	7.87
0.995	1.011	1.028	1.041	1.054	1.072	1.086	1.097	1.102	1.106	7.88
0.996	1.011	1.028	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.89
0.997	1.012	1.029	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.90
0.997	1.013	1.029	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.91
0.998	1.013	1.030	1.043	1.056	1.074	1.087	1.098	1.103	1.107	7.92
0.998	1.014	1.030	1.043	1.056	1.074	1.088	1.099	1.104	1.108	7.93
0.999	1.014	1.031	1.044	1.057	1.075	1.088	1.099	1.104	1.108	7.94
0.999	1.015	1.031	1.044	1.057	1.075	1.088	1.099	1.104	1.108	7.95
0.999	1.016	1.031	1.045	1.057	1.076	1.088	1.099	1.104	1.108	7.96
1.000	1.016	1.032	1.045	1.058	1.076	1.089	1.099	1.105	1.109	7.97
1.000	1.017	1.032	1.046	1.058	1.077	1.089	1.100	1.105	1.109	7.98
1.001	1.017	1.033	1.046	1.059	1.077	1.090	1.100	1.106	1.110	7.99
1.001	1.018	1.033	1.047	1.059	1.078	1.090	1.100	1.106	1.110	8.00
1.002	1.018	1.033	1.047	1.059	1.078	1.090	1.100	1.106	1.110	8.01
1.002	1.019	1.034	1.048	1.059	1.078	1.090	1.100	1.106	1.110	8.02
1.003	1.019	1.034	1.048	1.060	1.078	1.091	1.101	1.107	1.111	8.03
1.003	1.020	1.035	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.04
1.004	1.020	1.035	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.05
1.005	1.020	1.036	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.06
1.006	1.021	1.036	1.050	1.061	1.080	1.092	1.101	1.108	1.111	8.07
1.006	1.021	1.037	1.050	1.061	1.080	1.092	1.102	1.108	1.112	8.08
1.007	1.022	1.037	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.09
1.008	1.022	1.038	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.10
1.009	1.023	1.038	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.11
1.009	1.023	1.039	1.052	1.063	1.081	1.094	1.102	1.109	1.112	8.12
1.010	1.024	1.039	1.052	1.063	1.082	1.094	1.103	1.110	1.113	8.13
1.010	1.024	1.040	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.14
1.011	1.025	1.040	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.15
1.012	1.026	1.041	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.16
1.012	1.026	1.041	1.054	1.065	1.083	1.096	1.104	1.110	1.114	8.17
1.013	1.027	1.042	1.054	1.065	1.083	1.096	1.104	1.111	1.114	8.18
1.013	1.027	1.042	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.19
1.014	1.028	1.043	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.20
1.015	1.028	1.043	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.21
1.015	1.029	1.044	1.056	1.067	1.085	1.097	1.105	1.111	1.115	8.22
1.016	1.029	1.044	1.056	1.067	1.085	1.098	1.106	1.112	1.116	8.23
1.016	1.030	1.045	1.057	1.068	1.086	1.098	1.106	1.112	1.116	8.24
1.017	1.030	1.045	1.057	1.068	1.086	1.098	1.106	1.112	1.116	8.25
1.018	1.031	1.046	1.058	1.068	1.086	1.098	1.106	1.112	1.116	8.26
1.019	1.031	1.046	1.058	1.069	1.087	1.099	1.107	1.112	1.117	8.27
1.019	1.032	1.047	1.059	1.069	1.087	1.099	1.107	1.113	1.117	8.28
1.020	1.032	1.047	1.059	1.070	1.088	1.100	1.108	1.113	1.118	8.29

ILLEGIBLE

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
8.30	1.050	1.037	1.026	1.017	1.005	1.004	1.001	1.003	1.008	1.011
8.31	1.051	1.038	1.027	1.018	1.006	1.005	1.002	1.004	1.009	1.012
8.32	1.052	1.039	1.028	1.019	1.007	1.006	1.003	1.005	1.009	1.012
8.33	1.053	1.040	1.029	1.019	1.008	1.006	1.003	1.005	1.010	1.013
8.34	1.054	1.041	1.030	1.020	1.009	1.007	1.004	1.006	1.010	1.013
8.35	1.055	1.042	1.031	1.021	1.010	1.008	1.005	1.007	1.011	1.014
8.36	1.056	1.043	1.032	1.022	1.011	1.009	1.006	1.008	1.012	1.015
8.37	1.057	1.044	1.033	1.023	1.012	1.010	1.007	1.009	1.013	1.016
8.38	1.058	1.046	1.034	1.024	1.013	1.010	1.008	1.010	1.013	1.016
8.39	1.059	1.047	1.035	1.025	1.014	1.011	1.009	1.011	1.014	1.017
8.40	1.060	1.048	1.036	1.026	1.015	1.012	1.010	1.012	1.015	1.018
8.41	1.061	1.049	1.037	1.027	1.016	1.013	1.011	1.013	1.016	1.019
8.42	1.062	1.050	1.038	1.028	1.017	1.014	1.012	1.014	1.017	1.019
8.43	1.063	1.051	1.039	1.028	1.017	1.014	1.012	1.014	1.017	1.020
8.44	1.064	1.052	1.040	1.029	1.018	1.015	1.013	1.015	1.018	1.020
8.45	1.065	1.053	1.041	1.030	1.019	1.016	1.014	1.016	1.019	1.021
8.46	1.066	1.054	1.042	1.031	1.020	1.017	1.015	1.017	1.020	1.022
8.47	1.067	1.055	1.043	1.032	1.021	1.018	1.016	1.018	1.021	1.023
8.48	1.068	1.056	1.044	1.033	1.022	1.019	1.017	1.018	1.021	1.023
8.49	1.069	1.057	1.045	1.034	1.023	1.020	1.018	1.019	1.022	1.024
8.50	1.070	1.058	1.046	1.035	1.024	1.021	1.019	1.020	1.023	1.025
8.51	1.071	1.059	1.047	1.036	1.025	1.022	1.020	1.021	1.024	1.026
8.52	1.072	1.060	1.048	1.037	1.026	1.023	1.021	1.022	1.024	1.026
8.53	1.073	1.061	1.049	1.038	1.027	1.023	1.021	1.022	1.025	1.027
8.54	1.074	1.062	1.050	1.039	1.028	1.024	1.022	1.023	1.025	1.027
8.55	1.075	1.063	1.051	1.040	1.029	1.025	1.023	1.024	1.026	1.028
8.56	1.076	1.064	1.052	1.041	1.030	1.026	1.024	1.025	1.027	1.029
8.57	1.077	1.065	1.053	1.042	1.031	1.027	1.025	1.026	1.028	1.029
8.58	1.079	1.066	1.054	1.043	1.032	1.028	1.026	1.026	1.028	1.030
8.59	1.080	1.067	1.055	1.044	1.033	1.029	1.027	1.027	1.029	1.030
8.60	1.081	1.068	1.056	1.045	1.034	1.030	1.028	1.028	1.030	1.031
8.61	1.082	1.069	1.057	1.046	1.035	1.031	1.029	1.029	1.031	1.032
8.62	1.083	1.070	1.058	1.047	1.036	1.032	1.030	1.030	1.032	1.033
8.63	1.084	1.071	1.059	1.047	1.037	1.032	1.030	1.030	1.032	1.033
8.64	1.085	1.072	1.060	1.048	1.038	1.033	1.031	1.031	1.033	1.034
8.65	1.086	1.073	1.061	1.049	1.039	1.034	1.032	1.032	1.034	1.035
8.66	1.087	1.074	1.062	1.050	1.040	1.035	1.033	1.033	1.035	1.036
8.67	1.088	1.075	1.063	1.051	1.041	1.036	1.034	1.034	1.036	1.037
8.68	1.090	1.076	1.064	1.052	1.042	1.037	1.035	1.034	1.036	1.037
8.69	1.091	1.077	1.065	1.053	1.043	1.038	1.036	1.035	1.037	1.038
8.70	1.092	1.078	1.066	1.054	1.044	1.039	1.037	1.036	1.038	1.039
8.71	1.093	1.079	1.067	1.055	1.045	1.040	1.038	1.037	1.039	1.040
8.72	1.094	1.080	1.068	1.056	1.046	1.041	1.039	1.038	1.039	1.041
8.73	1.095	1.081	1.068	1.056	1.047	1.041	1.039	1.038	1.040	1.041
8.74	1.096	1.082	1.069	1.057	1.048	1.042	1.040	1.039	1.040	1.042

				T_r						P_r 8.30 - 8.74
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.021	1.033	1.048	1.060	1.070	1.088	1.100	1.108	1.113	1.118	8.30
1.022	1.034	1.048	1.060	1.070	1.088	1.100	1.108	1.113	1.118	8.31
1.022	1.034	1.049	1.061	1.071	1.088	1.100	1 108	1.114	1.118	8.32
1.023	1.035	1.049	1.061	1.071	1.089	1.101	1.109	1.114	1.119	8.33
1.023	1.035	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.34
1.024	1.036	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.35
1.025	1.037	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.36
1.025	1.037	1.051	1.063	1.073	1.090	1.101	1.110	1.116	1.119	8.37
1.026	1.038	1.051	1.063	1.073	1.090	1.102	1.110	1.116	1.120	8.38
1.026	1.038	1.052	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.39
1.027	1.039	1.052	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.40
1.027	1.039	1.053	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.41
1.028	1.040	1.053	1.065	1.075	1.091	1.102	1.111	1.117	1.120	8.42
1.028	1.040	1.054	1.065	1.075	1.092	1.103	1.112	1.118	1.121	8.43
1.029	1.041	1.054	1.066	1.076	1.092	1.103	1.112	1.118	1.121	8.44
1.029	1.041	1.055	1.066	1.076	1.092	1.103	1.112	1.118	1.121	8.45
1.030	1.042	1.056	1.067	1.076	1.092	1.103	1.112	1.118	1.121	8.46
1.030	1.042	1.056	1.067	1.077	1.093	1.104	1.112	1.118	1.122	8.47
1.031	1.043	1.057	1.068	1.077	1.093	1.104	1.113	1.119	1.122	8.48
1.031	1.043	1.057	1.068	1.078	1.094	1.105	1.113	1.119	1.123	8.49
1.032	1.044	1.058	1.069	1.078	1.094	1.105	1.113	1.119	1.123	8.50
1.033	1.045	1.058	1.069	1.078	1.094	1.105	1.113	1.119	1.123	8.51
1.033	1.045	1.059	1.070	1.079	1.095	1.106	1.114	1.119	1.123	8.52
1.034	1.046	1.059	1.070	1.079	1.095	1.106	1.114	1.120	1.124	8.53
1.034	1.046	1.060	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.54
1.035	1.047	1.060	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.55
1.036	1.048	1.061	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.56
1.037	1.048	1.061	1.072	1.081	1.097	1.108	1.116	1.121	1.125	8.57
1.037	1.049	1.062	1.072	1.081	1.097	1.108	1.116	1.121	1.125	8.58
1.038	1.049	1.062	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.59
1.039	1.050	1.063	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.60
1.040	1.050	1.063	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.61
1.040	1.051	1.064	1.074	1.083	1.098	1.109	1.117	1.122	1.126	8.62
1.041	1.051	1.064	1.074	1.083	1.099	1.110	1.118	1.123	1.127	8.63
1.041	1.052	1.065	1.075	1.084	1.099	1.110	1.118	1.123	1.127	8.64
1.042	1.052	1.065	1.075	1.084	1.099	1.110	1.118	1.123	1.127	8.65
1.043	1.053	1.066	1.076	1.085	1.099	1.110	1.118	1.123	1.127	8.66
1.044	1.053	1.066	1.076	1.085	1.100	1.111	1.119	1.124	1.128	8.67
1.044	1.054	1.067	1.077	1.086	1.100	1.111	1.119	1.124	1.128	8.68
1.045	1.054	1.067	1.077	1.086	1.101	1.112	1.120	1.125	1.129	8.69
1.046	1.055	1.068	1.078	1.087	1.101	1.112	1.120	1.125	1.129	8.70
1.046	1.056	1.068	1.078	1.087	1.101	1.112	1.120	1.125	1.129	8.71
1.047	1.056	1.069	1.079	1.088	1.102	1.112	1.120	1.125	1.129	8.72
1.047	1.057	1.069	1.079	1.088	1.102	1.113	1.121	1.126	1.130	8.73
1.048	1.057	1.070	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.74

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
8.75	1.097	1.083	1.070	1.058	1.049	1.043	1.041	1.040	1.041	1.043
8.76	1.098	1.084	1.071	1.059	1.050	1.044	1.042	1.041	1.042	1.044
8.77	1.099	1.085	1.072	1.060	1.051	1.045	1.043	1.042	1.043	1.045
8.78	1.100	1.086	1.073	1.061	1.052	1.046	1.043	1.042	1.043	1.045
8.79	1.101	1.087	1.074	1.062	1.053	1.047	1.044	1.043	1.044	1.046
8.80	1.102	1.088	1.075	1.063	1.054	1.048	1.045	1.044	1.045	1.047
8.81	1.103	1.089	1.076	1.064	1.055	1.049	1.046	1.045	1.046	1.047
8.82	1.104	1.090	1.077	1.065	1.056	1.050	1.047	1.046	1.046	1.048
8.83	1.106	1.092	1.078	1.066	1.056	1.050	1.047	1.046	1.047	1.048
8.84	1.107	1.093	1.079	1.067	1.057	1.051	1.048	1.047	1.047	1.049
8.85	1.108	1.094	1.080	1.068	1.058	1.052	1.049	1.048	1.048	1.049
8.86	1.109	1.095	1.081	1.069	1.059	1.053	1.050	1.049	1.049	1.050
8.87	1.110	1.096	1.082	1.070	1.060	1.054	1.051	1.050	1.050	1.050
8.88	1.111	1.097	1.083	1.071	1.061	1.054	1.051	1.050	1.050	1.051
8.89	1.112	1.098	1.084	1.072	1.062	1.055	1.052	1.051	1.051	1.051
8.90	1.113	1.099	1.085	1.073	1.063	1.056	1.053	1.052	1.052	1.052
8.91	1.114	1.100	1.086	1.074	1.064	1.057	1.054	1.053	1.053	1.053
8.92	1.115	1.101	1.087	1.075	1.065	1.058	1.055	1.053	1.054	1.054
8.93	1.116	1.101	1.088	1.075	1.065	1.058	1.055	1.054	1.054	1.054
8.94	1.117	1.102	1.089	1.076	1.066	1.059	1.056	1.055	1.055	1.055
8.95	1.118	1.103	1.090	1.077	1.067	1.060	1.057	1.056	1.056	1.056
8.96	1.119	1.104	1.091	1.078	1.068	1.061	1.058	1.057	1.057	1.057
8.97	1.120	1.105	1.092	1.079	1.069	1.062	1.059	1.058	1.058	1.058
8.98	1.122	1.106	1.093	1.080	1.070	1.062	1.059	1.058	1.058	1.058
8.99	1.123	1.107	1.094	1.081	1.071	1.063	1.060	1.059	1.059	1.059
9.00	1.124	1.108	1.095	1.082	1.072	1.064	1.061	1.060	1.060	1.060
9.01	1.125	1.109	1.096	1.083	1.073	1.065	1.062	1.061	1.061	1.061
9.02	1.126	1.110	1.097	1.084	1.074	1.066	1.063	1.062	1.062	1.062
9.03	1.127	1.111	1.098	1.084	1.074	1.066	1.063	1.062	1.062	1.062
9.04	1.128	1.112	1.099	1.085	1.075	1.067	1.064	1.063	1.063	1.063
9.05	1.129	1.113	1.100	1.086	1.076	1.068	1.065	1.064	1.064	1.064
9.06	1.130	1.114	1.101	1.087	1.077	1.069	1.066	1.065	1.065	1.065
9.07	1.131	1.115	1.102	1.088	1.078	1.070	1.067	1.066	1.066	1.066
9.08	1.133	1.116	1.103	1.089	1.079	1.071	1.067	1.066	1.066	1.066
9.09	1.134	1.117	1.104	1.090	1.080	1.072	1.068	1.067	1.067	1.067
9.10	1.135	1.118	1.105	1.091	1.081	1.073	1.069	1.068	1.068	1.068
9.11	1.136	1.119	1.106	1.092	1.082	1.074	1.070	1.069	1.069	1.069
9.12	1.137	1.120	1.107	1.093	1.083	1.075	1.071	1.069	1.069	1.069
9.13	1.138	1.121	1.107	1.094	1.083	1.075	1.071	1.070	1.070	1.070
9.14	1.139	1.122	1.108	1.095	1.084	1.076	1.072	1.070	1.070	1.070
9.15	1.140	1.123	1.109	1.096	1.085	1.077	1.073	1.071	1.071	1.071
9.16	1.141	1.124	1.110	1.097	1.086	1.078	1.074	1.072	1.072	1.072
9.17	1.142	1.125	1.111	1.098	1.087	1.079	1.075	1.073	1.072	1.072
9.18	1.144	1.126	1.112	1.099	1.088	1.080	1.076	1.073	1.073	1.073
9.19	1.145	1.127	1.113	1.100	1.089	1.081	1.077	1.074	1.073	1.073

1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.048	1.058	1.070	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.75
1.049	1.059	1.071	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.76
1.049	1.059	1.071	1.081	1.090	1.104	1.114	1.121	1.126	1.131	8.77
1.050	1.060	1.072	1.081	1.090	1.104	1.114	1.122	1.127	1.131	8.78
1.050	1.060	1.072	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.79
1.051	1.061	1.073	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.80
1.052	1.062	1.073	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.81
1.053	1.062	1.074	1.083	1.092	1.106	1.115	1.123	1.128	1.132	8.82
1.053	1.063	1.074	1.083	1.092	1.106	1.116	1.123	1.128	1.133	8.83
1.054	1.063	1.075	1.084	1.093	1.107	1.116	1.124	1.129	1.133	8.84
1.055	1.064	1.075	1.084	1.093	1.107	1.116	1.124	1.129	1.133	8.85
1.056	1.065	1.076	1.085	1.093	1.107	1.116	1.124	1.129	1.133	8.86
1.056	1.065	1.076	1.085	1.094	1.108	1.117	1.125	1.130	1.134	8.87
1.057	1.066	1.077	1.086	1.094	1.108	1.117	1.125	1.130	1.134	8.88
1.057	1.066	1.077	1.086	1.095	1.109	1.118	1.126	1.131	1.135	8.89
1.058	1.067	1.078	1.087	1.095	1.109	1.118	1.126	1.131	1.135	8.90
1.059	1.067	1.078	1.087	1.095	1.109	1.118	1.126	1.131	1.135	8.91
1.059	1.068	1.079	1.088	1.096	1.110	1.119	1.126	1.131	1.135	8.92
1.060	1.068	1.079	1.088	1.096	1.110	1.119	1.127	1.132	1.136	8.93
1.060	1.069	1.080	1.089	1.097	1.111	1.120	1.127	1.132	1.136	8.94
1.061	1.069	1.080	1.089	1.097	1.111	1.120	1.127	1.132	1.136	8.95
1.062	1.070	1.081	1.090	1.098	1.111	1.120	1.127	1.132	1.136	8.96
1.062	1.070	1.081	1.090	1.098	1.112	1.121	1.128	1.133	1.137	8.97
1.063	1.071	1.082	1.091	1.099	1.112	1.121	1.128	1.133	1.137	8.98
1.063	1.071	1.082	1.091	1.099	1.113	1.122	1.129	1.134	1.138	8.99
1.064	1.072	1.083	1.092	1.100	1.113	1.122	1.129	1.134	1.138	9.00
1.065	1.073	1.083	1.092	1.100	1.113	1.122	1.129	1.134	1.138	9.01
1.065	1.073	1.084	1.093	1.101	1.114	1.123	1.129	1.134	1.138	9.02
1.066	1.074	1.084	1.093	1.101	1.114	1.123	1.130	1.135	1.139	9.03
1.066	1.074	1.085	1.094	1.102	1.115	1.124	1.130	1.135	1.139	9.04
1.067	1.075	1.085	1.094	1.102	1.115	1.124	1.130	1.135	1.139	9.05
1.068	1.076	1.086	1.095	1.102	1.115	1.124	1.130	1.135	1.139	9.06
1.068	1.076	1.086	1.095	1.103	1.116	1.125	1.131	1.136	1.139	9.07
1.069	1.077	1.087	1.096	1.103	1.116	1.125	1.131	1.136	1.140	9.08
1.069	1.077	1.087	1.096	1.104	1.117	1.126	1.132	1.137	1.140	9.09
1.070	1.078	1.088	1.097	1.104	1.117	1.126	1.132	1.137	1.140	9.10
1.071	1.079	1.089	1.097	1.104	1.117	1.126	1.132	1.137	1.140	9.11
1.072	1.079	1.089	1.098	1.105	1.118	1.127	1.132	1.137	1.140	9.12
1.072	1.080	1.090	1.098	1.105	1.118	1.127	1.133	1.138	1.141	9.13
1.073	1.080	1.090	1.099	1.106	1.119	1.128	1.133	1.138	1.141	9.14
1.074	1.081	1.091	1.099	1.106	1.119	1.128	1.133	1.138	1.141	9.15
1.075	1.082	1.092	1.100	1.106	1.120	1.128	1.133	1.138	1.141	9.16
1.076	1.082	1.092	1.100	1.107	1.120	1.129	1.134	1.139	1.142	9.17
1.076	1.083	1.093	1.101	1.107	1.121	1.129	1.134	1.139	1.142	9.18
1.077	1.083	1.093	1.101	1.108	1.121	1.130	1.135	1.140	1.143	9.19

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
9.20	1.146	1.128	1.114	1.101	1.090	1.082	1.078	1.075	1.074	1.074
9.21	1.147	1.129	1.115	1.102	1.091	1.083	1.079	1.076	1.075	1.075
9.22	1.148	1.130	1.116	1.103	1.092	1.084	1.080	1.077	1.076	1.075
9.23	1.149	1.131	1.117	1.103	1.092	1.084	1.080	1.077	1.076	1.076
9.24	1.150	1.132	1.118	1.104	1.093	1.085	1.081	1.078	1.077	1.076
9.25	1.151	1.133	1.119	1.105	1.094	1.086	1.082	1.079	1.078	1.077
9.26	1.152	1.134	1.120	1.106	1.095	1.087	1.083	1.080	1.079	1.078
9.27	1.153	1.135	1.121	1.107	1.096	1.088	1.084	1.081	1.080	1.078
9.28	1.155	1.136	1.122	1.108	1.097	1.089	1.084	1.081	1.080	1.079
9.29	1.156	1.137	1.123	1.109	1.098	1.090	1.085	1.082	1.081	1.079
9.30	1.157	1.138	1.124	1.110	1.099	1.091	1.086	1.083	1.082	1.081
9.31	1.158	1.139	1.125	1.111	1.100	1.092	1.087	1.084	1.083	1.082
9.32	1.159	1.140	1.126	1.112	1.101	1.093	1.088	1.085	1.084	1.082
9.33	1.160	1.141	1.127	1.113	1.102	1.093	1.088	1.085	1.084	1.083
9.34	1.161	1.142	1.128	1.114	1.103	1.094	1.089	1.086	1.085	1.083
9.35	1.162	1.143	1.129	1.115	1.104	1.095	1.090	1.087	1.086	1.084
9.36	1.163	1.144	1.130	1.116	1.105	1.096	1.091	1.088	1.087	1.085
9.37	1.164	1.145	1.131	1.117	1.106	1.097	1.092	1.089	1.088	1.086
9.38	1.165	1.146	1.132	1.118	1.107	1.098	1.093	1.090	1.088	1.086
9.39	1.166	1.147	1.133	1.119	1.108	1.099	1.094	1.091	1.089	1.087
9.40	1.167	1.148	1.134	1.120	1.109	1.100	1.095	1.092	1.090	1.088
9.41	1.168	1.149	1.135	1.121	1.110	1.101	1.096	1.093	1.091	1.089
9.42	1.169	1.150	1.136	1.122	1.111	1.102	1.097	1.094	1.092	1.090
9.43	1.170	1.151	1.137	1.122	1.111	1.102	1.097	1.094	1.092	1.090
9.44	1.171	1.152	1.138	1.123	1.112	1.103	1.098	1.095	1.093	1.091
9.45	1.172	1.153	1.139	1.124	1.113	1.104	1.099	1.096	1.094	1.092
9.46	1.172	1.154	1.140	1.125	1.114	1.105	1.100	1.097	1.095	1.093
9.47	1.173	1.155	1.141	1.126	1.115	1.106	1.101	1.098	1.096	1.094
9.48	1.175	1.157	1.142	1.127	1.116	1.107	1.101	1.098	1.096	1.094
0.49	1.176	1.158	1.143	1.128	1.117	1.108	1.102	1.099	1.097	1.095
9.50	1.178	1.159	1.144	1.129	1.118	1.109	1.103	1.100	1.098	1.096
9.51	1.179	1.160	1.145	1.130	1.119	1.110	1.104	1.101	1.099	1.097
9.52	1.180	1.161	1.146	1.131	1.120	1.111	1.105	1.102	1.099	1.097
9.53	1.180	1.162	1.147	1.132	1.120	1.111	1.105	1.102	1.100	1.098
9.54	1.181	1.163	1.148	1.133	1.121	1.112	1.106	1.103	1.100	1.098
9.55	1.182	1.164	1.149	1.134	1.122	1.113	1.107	1.104	1.101	1.099
9.56	1.183	1.165	1.150	1.135	1.123	1.114	1.108	1.105	1.102	1.100
9.57	1.185	1.166	1.151	1.136	1.124	1.115	1.109	1.106	1.102	1.100
9.58	1.186	1.167	1.152	1.137	1.125	1.116	1.109	1.106	1.103	1.101
9.59	1.188	1.168	1.153	1.138	1.126	1.117	1.110	1.107	1.103	1.101
9.60	1.189	1.169	1.154	1.139	1.127	1.118	1.111	1.108	1.104	1.102
9.61	1.190	1.170	1.155	1.140	1.128	1.119	1.112	1.109	1.105	1.103
9.62	1.191	1.171	1.156	1.141	1.129	1.120	1.113	1.110	1.106	1.103
9.63	1.192	1.172	1.156	1.141	1.130	1.120	1.113	1.110	1.106	1.104
9.64	1.193	1.173	1.157	1.142	1.131	1.121	1.114	1.111	1.107	1.104

1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.078	1.084	1.094	1.102	1.108	1.122	1.130	1.135	1.140	1.143	9.20
1.079	1.084	1.094	1.102	1.108	1.122	1.130	1.135	1.140	1.143	9.21
1.079	1.085	1.095	1.103	1.109	1.123	1.131	1.135	1.140	1.144	9.22
1.080	1.085	1.095	1.103	1.109	1.123	1.131	1.136	1.141	1.144	9.23
1.080	1.086	1.096	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.24
1.081	1.086	1.096	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.25
1.082	1.087	1.097	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.26
1.082	1.087	1.097	1.105	1.111	1.125	1.133	1.137	1.142	1.146	9.27
1.083	1.088	1.098	1.105	1.111	1.125	1.133	1.137	1.142	1.146	9.28
1.083	1.088	1.098	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.29
1.084	1.089	1.099	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.30
1.085	1.090	1.099	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.31
1.085	1.090	1.100	1.107	1.113	1.127	1.135	1.139	1.144	1.147	9.32
1.086	1.091	1.100	1.107	1.113	1.127	1.135	1.139	1.144	1.148	9.33
1.086	1.091	1.101	1.108	1.114	1.128	1.136	1.140	1.145	1.148	9.34
1.087	1.092	1.101	1.108	1.114	1.128	1.136	1.140	1.145	1.148	9.35
1.088	1.093	1.102	1.109	1.115	1.128	1.136	1.140	1.145	1.148	9.36
1.088	1.093	1.102	1.109	1.115	1.129	1.137	1.141	1.146	1.148	9.37
1.189	1.094	1.103	1.110	1.116	1.129	1.137	1.141	1.146	1.149	9.38
1.089	1.094	1.103	1.110	1.116	1.130	1.138	1.142	1.147	1.149	9.39
1.090	1.095	1.104	1.111	1.117	1.130	1.138	1.142	1.147	1.149	9.40
1.091	1.096	1.104	1.111	1.117	1.130	1.138	1.142	1.147	1.149	9.41
1.091	1.096	1.105	1.112	1.118	1.131	1.139	1.142	1.147	1.149	9.42
1.092	1.097	1.105	1.112	1.118	1.131	1.139	1.143	1.148	1.150	9.43
1.092	1.097	1.106	1.113	1.119	1.132	1.140	1.143	1.148	1.150	9.44
1.093	1.098	1.106	1.113	1.119	1.132	1.140	1.143	1.148	1.150	9.45
1.094	1.099	1.107	1.114	1.120	1.132	1.140	1.143	1.148	1.150	9.46
1.095	1.100	1.107	1.114	1.120	1.133	1.141	1.144	1.149	1.151	9.47
1.095	1.100	1.108	1.115	1.121	1.133	1.141	1.144	1.149	1.151	9.48
1.096	1.101	1.108	1.115	1.121	1.134	1.142	1.145	1.150	1.152	9.49
1.097	1.102	1.109	1.116	1.122	1.134	1.142	1.145	1.150	1.152	9.50
1.098	1.102	1.109	1.116	1.122	1.134	1.142	1.145	1.150	1.152	9.51
1.098	1.103	1.110	1.117	1.123	1.135	1.142	1.146	1.150	1.152	9.52
1.099	1.103	1.110	1.117	1.123	1.135	1.143	1.146	1.151	1.153	9.53
1.099	1.104	1.111	1.118	1.124	1.136	1.143	1.147	1.151	1.153	9.54
1.100	1.104	1.111	1.118	1.124	1.136	1.143	1.147	1.151	1.153	9.55
1.101	1.105	1.112	1.119	1.124	1.137	1.143	1.147	1.151	1.153	9.56
1.101	1.105	1.112	1.119	1.125	1.137	1.144	1.148	1.152	1.154	9.57
1.102	1.106	1.113	1.120	1.125	1.138	1.144	1.148	1.152	1.154	9.58
1.102	1.106	1.113	1.120	1.126	1.138	1.145	1.149	1.153	1.155	9.59
1.103	1.107	1.114	1.121	1.126	1.139	1.145	1.149	1.153	1.155	9.60
1.104	1.108	1.115	1.121	1.126	1.139	1.145	1.149	1.153	1.155	9.61
1.104	1.108	1.115	1.122	1.127	1.140	1.146	1.149	1.153	1.155	9.62
1.105	1.109	1.116	1.122	1.127	1.140	1.146	1.150	1.154	1.156	9.63
1.105	1.109	1.116	1.123	1.128	1.141	1.147	1.150	1.154	1.156	9.64

ILLEGIBLE

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
9.65	1.194	1.174	1.158	1.143	1.132	1.122	1.115	1.112	1.108	1.105
9.66	1.195	1.175	1.159	1.144	1.133	1.123	1.116	1.113	1.109	1.106
9.67	1.196	1.176	1.160	1.145	1.134	1.124	1.117	1.114	1.110	1.107
9.68	1.198	1.177	1.161	1.146	1.135	1.125	1.118	1.114	1.110	1.107
9.69	1.199	1.178	1.162	1.147	1.136	1.126	1.119	1.115	1.111	1.108
9.70	1.200	1.179	1.163	1.148	1.137	1.127	1.120	1.116	1.112	1.109
9.71	1.201	1.180	1.164	1.149	1.138	1.128	1.121	1.117	1.113	1.110
9.72	1.202	1.181	1.165	1.150	1.139	1.129	1.122	1.118	1.113	1.111
9.73	1.203	1.182	1.166	1.151	1.139	1.129	1.122	1.118	1.114	1.111
9.74	1.204	1.183	1.167	1.152	1.140	1.130	1.123	1.119	1.114	1.112
9.75	1.205	1.184	1.168	1.153	1.141	1.131	1.124	1.120	1.115	1.113
9.76	1.206	1.185	1.169	1.154	1.142	1.132	1.125	1.121	1.116	1.114
9.77	1.207	1.186	1.170	1.155	1.143	1.133	1.126	1.122	1.117	1.115
9.78	1.208	1.187	1.171	1.156	1.144	1.133	1.126	1.122	1.117	1.115
9.79	1.209	1.188	1.172	1.157	1.145	1.134	1.127	1.123	1.118	1.116
9.80	1.210	1.189	1.173	1.158	1.146	1.135	1.128	1.124	1.119	1.117
9.81	1.211	1.190	1.174	1.159	1.147	1.136	1.129	1.125	1.120	1.118
9.82	1.212	1.191	1.175	1.160	1.148	1.137	1.130	1.126	1.121	1.118
9.83	1.213	1.192	1.176	1.160	1.148	1.137	1.130	1.126	1.121	1.119
9.84	1.214	1.193	1.177	1.161	1.149	1.138	1.131	1.127	1.122	1.119
9.85	1.215	1.194	1.178	1.162	1.150	1.139	1.132	1.128	1.123	1.120
9.86	1.216	1.195	1.179	1.163	1.151	1.140	1.133	1.129	1.124	1.121
9.87	1.217	1.196	1.180	1.164	1.152	1.141	1.134	1.130	1.125	1.122
9.88	1.219	1.198	1.181	1.165	1.153	1.141	1.135	1.130	1.125	1.123
9.89	1.220	1.199	1.182	1.166	1.154	1.142	1.136	1.131	1.126	1.123
9.90	1.221	1.200	1.183	1.167	1.155	1.143	1.137	1.132	1.127	1.123
9.91	1.222	1.201	1.184	1.168	1.156	1.144	1.138	1.133	1.128	1.124
9.92	1.223	1.202	1.185	1.169	1.157	1.145	1.139	1.134	1.128	1.124
9.93	1.224	1.203	1.185	1.169	1.157	1.145	1.139	1.134	1.129	1.125
9.94	1.225	1.204	1.186	1.170	1.158	1.146	1.140	1.135	1.129	1.125
9.95	1.226	1.205	1.187	1.171	1.159	1.147	1.141	1.136	1.130	1.126
9.96	1.227	1.206	1.188	1.172	1.160	1.148	1.142	1.137	1.131	1.127
9.97	1.228	1.207	1.189	1.173	1.161	1.149	1.143	1.138	1.132	1.128
9.98	1.229	1.208	1.190	1.174	1.162	1.150	1.143	1.138	1.132	1.128
9.99	1.230	1.209	1.191	1.175	1.163	1.151	1.144	1.139	1.133	1.129
10.00	1.231	1.210	1.192	1.176	1.164	1.152	1.145	1.140	1.134	1.130
10.01	1.232	1.211	1.193	1.177	1.165	1.153	1.146	1.141	1.135	1.131
10.02	1.233	1.212	1.194	1.178	1.166	1.154	1.147	1.142	1.136	1.132
10.03	1.234	1.213	1.195	1.178	1.166	1.154	1.147	1.142	1.136	1.132
10.04	1.235	1.214	1.196	1.179	1.167	1.155	1.148	1.143	1.137	1.133
10.05	1.236	1.215	1.197	1.180	1.168	1.156	1.149	1.144	1.138	1.134
10.06	1.237	1.216	1.198	1.181	1.169	1.157	1.150	1.145	1.139	1.135
10.07	1.238	1.217	1.199	1.182	1.170	1.158	1.151	1.146	1.140	1.136
10.08	1.240	1.218	1.200	1.183	1.171	1.158	1.151	1.146	1.140	1.136
10.09	1.241	1.219	1.201	1.184	1.172	1.159	1.152	1.147	1.141	1.137

				T_r						P_r 9.65 - 10.09
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.106	1.110	1.117	1.123	1.128	1.141	1.147	1.150	1.154	1.156	9.65
1.107	1.111	1.118	1.124	1.129	1.141	1.147	1.150	1.154	1.156	9.66
1.107	1.111	1.118	1.124	1.129	1.142	1.148	1.151	1.155	1.157	9.67
1.108	1.112	1.119	1.125	1.130	1.142	1.148	1.151	1.155	1.157	9.68
1.108	1.112	1.119	1.125	1.130	1.143	1.149	1.152	1.156	1.158	9.69
1.109	1.113	1.120	1.126	1.131	1.143	1.149	1.152	1.156	1.158	9.70
1.110	1.114	1.120	1.126	1.131	1.143	1.149	1.152	1.156	1.158	9.71
1.111	1.114	1.121	1.127	1.132	1.144	1.149	1.153	1.156	1.158	9.72
1.111	1.115	1.121	1.127	1.132	1.144	1.150	1.153	1.157	1.159	9.73
1.112	1.115	1.122	1.128	1.133	1.145	1.150	1.154	1.157	1.159	9.74
1.113	1.116	1.112	1.128	1.133	1.145	1.150	1.154	1.157	1.159	9.75
1.114	1.117	1.123	1.129	1.134	1.146	1.150	1.154	1.157	1.159	9.76
1.115	1.117	1.123	1.129	1.134	1.146	1.151	1.155	1.158	1.160	9.77
1.115	1.118	1.124	1.130	1.135	1.147	1.151	1.155	1.158	1.160	9.78
1.116	1.118	1.124	1.130	1.135	1.147	1.152	1.156	1.159	1.161	9.79
1.117	1.119	1.125	1.131	1.136	1.148	1.152	1.156	1.159	1.161	9.80
1.118	1.120	1.125	1.131	1.136	1.148	1.152	1.156	1.159	1.161	9.81
1.118	1.120	1.126	1.132	1.137	1.149	1.153	1.156	1.159	1.161	9.82
1.119	1.121	1.126	1.132	1.137	1.149	1.153	1.157	1.160	1.162	9.83
1.119	1.121	1.127	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.84
1.120	1.122	1.127	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.85
1.121	1.123	1.128	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.86
1.121	1.124	1.128	1.134	1.139	1.151	1.155	1.158	1.161	1.163	9.87
1.122	1.124	1.129	1.134	1.139	1.151	1.155	1.158	1.161	1.163	9.88
1.122	1.125	1.129	1.135	1.140	1.152	1.156	1.159	1.162	1.164	9.89
1.123	1.126	1.130	1.135	1.140	1.152	1.156	1.159	1.162	1.164	9.90
1.124	1.127	1.131	1.136	1.140	1.152	1.156	1.159	1.162	1.164	9.91
1.124	1.127	1.131	1.136	1.141	1.153	1.157	1.160	1.162	1.164	9.92
1.125	1.128	1.132	1.137	1.141	1.153	1.157	1.160	1.163	1.165	9.93
1.125	1.128	1.132	1.137	1.142	1.154	1.158	1.161	1.163	1.165	9.94
1.126	1.129	1.133	1.138	1.142	1.154	1.158	1.161	1.163	1.165	9.95
1.127	1.130	1.134	1.139	1.142	1.154	1.158	1.161	1.163	1.165	9.96
1.128	1.130	1.134	1.139	1.143	1.155	1.159	1.162	1.164	1.166	9.97
1.128	1.131	1.135	1.140	1.143	1.155	1.159	1.162	1.164	1.166	9.98
1.129	1.131	1.135	1.140	1.144	1.156	1.160	1.163	1.165	1.167	9.99
1.130	1.132	1.136	1.141	1.144	1.156	1.160	1.163	1.165	1.167	10.00
1.131	1.133	1.137	1.141	1.144	1.156	1.160	1.163	1.165	1.167	10.01
1.131	1.133	1.137	1.142	1.145	1.157	1.161	1.163	1.165	1.167	10.02
1.132	1.134	1.138	1.142	1.145	1.157	1.161	1.164	1.166	1.168	10.03
1.132	1.134	1.138	1.143	1.146	1.158	1.162	1.164	1.166	1.168	10.04
1.133	1.135	1.139	1.143	1.146	1.158	1.162	1.164	1.166	1.168	10.05
1.134	1.136	1.139	1.143	1.147	1.158	1.162	1.164	1.166	1.168	10.06
1.135	1.136	1.140	1.144	1.147	1.159	1.163	1.165	1.167	1.169	10.07
1.135	1.137	1.140	1.144	1.148	1.159	1.163	1.165	1.167	1.169	10.08
1.136	1.137	1.141	1.145	1.148	1.160	1.164	1.166	1.168	1.170	10.09

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
10.10	1.242	1.220	1.202	1.185	1.173	1.160	1.153	1.148	1.142	1.138
10.11	1.243	1.221	1.203	1.186	1.174	1.161	1.154	1.149	1.143	1.139
10.12	1.244	1.222	1.204	1.187	1.175	1.162	1.155	1.150	1.143	1.139
10.13	1.245	1.223	1.204	1.188	1.175	1.162	1.155	1.150	1.144	1.140
10.14	1.246	1.224	1.205	1.189	1.176	1.163	1.156	1.151	1.144	1.140
10.15	1.247	1.225	1.206	1.190	1.177	1.164	1.157	1.152	1.145	1.141
10.16	1.248	1.226	1.207	1.191	1.178	1.165	1.158	1.153	1.146	1.142
10.17	1.249	1.227	1.208	1.192	1.179	1.166	1.159	1.153	1.147	1.143
10.18	1.250	1.228	1.209	1.193	1.179	1.167	1.160	1.154	1.148	1.143
10.19	1.251	1.229	1.210	1.194	1.180	1.168	1.161	1.154	1.149	1.144
10.20	1.252	1.230	1.211	1.195	1.181	1.169	1.162	1.155	1.149	1.145
10.21	1.253	1.231	1.212	1.196	1.182	1.170	1.163	1.156	1.150	1.146
10.22	1.254	1.232	1.213	1.197	1.183	1.171	1.164	1.157	1.151	1.146
10.23	1.255	1.233	1.214	1.197	1.183	1.172	1.164	1.157	1.151	1.147
10.24	1.256	1.234	1.215	1.198	1.184	1.173	1.165	1.158	1.152	1.147
10.25	1.257	1.235	1.216	1.199	1.185	1.174	1.166	1.159	1.153	1.148
10.26	1.258	1.236	1.217	1.200	1.186	1.175	1.167	1.160	1.154	1.149
10.27	1.259	1.237	1.218	1.201	1.187	1.176	1.168	1.161	1.155	1.150
10.28	1.261	1.238	1.219	1.202	1.188	1.177	1.168	1.161	1.155	1.150
10.29	1.262	1.239	1.220	1.203	1.189	1.178	1.169	1.162	1.156	1.151
10.30	1.263	1.240	1.221	1.204	1.190	1.179	1.170	1.163	1.157	1.152
10.31	1.264	1.241	1.222	1.205	1.191	1.180	1.171	1.164	1.158	1.153
10.32	1.265	1.242	1.223	1.206	1.192	1.181	1.172	1.165	1.158	1.154
10.33	1.266	1.243	1.224	1.206	1.192	1.181	1.172	1.165	1.159	1.154
10.34	1.267	1.244	1.225	1.207	1.193	1.182	1.173	1.166	1.159	1.155
10.35	1.268	1.245	1.226	1.208	1.194	1.183	1.174	1.167	1.160	1.156
10.36	1.269	1.246	1.227	1.209	1.195	1.184	1.175	1.168	1.161	1.157
10.37	1.270	1.247	1.228	1.210	1.196	1.185	1.176	1.169	1.162	1.158
10.38	1.272	1.248	1.229	1.211	1.197	1.186	1.176	1.169	1.162	1.158
10.39	1.273	1.249	1.230	1.212	1.198	1.187	1.177	1.170	1.163	1.159
10.40	1.274	1.250	1.231	1.213	1.199	1.188	1.178	1.171	1.164	1.160
10.41	1.275	1.251	1.232	1.214	1.200	1.189	1.179	1.172	1.165	1.161
10.42	1.276	1.252	1.233	1.215	1.201	1.190	1.180	1.173	1.166	1.162
10.43	1.277	1.253	1.234	1.216	1.201	1.190	1.180	1.173	1.166	1.162
10.44	1.278	1.254	1.235	1.217	1.202	1.191	1.181	1.174	1.167	1.163
10.45	1.279	1.255	1.236	1.218	1.203	1.192	1.182	1.175	1.168	1.164
10.46	1.280	1.256	1.237	1.219	1.204	1.193	1.183	1.176	1.169	1.165
10.47	1.281	1.257	1.238	1.220	1.205	1.194	1.184	1.177	1.170	1.166
10.48	1.283	1.258	1.239	1.221	1.206	1.194	1.184	1.177	1.170	1.166
10.49	1.284	1.259	1.240	1.222	1.207	1.195	1.185	1.178	1.171	1.167
10.50	1.285	1.260	1.241	1.223	1.208	1.196	1.186	1.179	1.172	1.168
10.51	1.286	1.261	1.242	1.224	1.209	1.197	1.187	1.180	1.173	1.169
10.52	1.287	1.262	1.243	1.225	1.210	1.198	1.188	1.181	1.174	1.169
10.53	1.288	1.263	1.244	1.225	1.210	1.198	1.188	1.181	1.174	1.170
10.54	1.289	1.264	1.245	1.226	1.211	1.199	1.189	1.182	1.175	1.170

					T_r					P_r 10.10 - 10.54
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.137	1.138	1.141	1.145	1.149	1.160	1.164	1.166	1.168	1.170	10.10
1.138	1.139	1.142	1.145	1.149	1.160	1.164	1.166	1.168	1.170	10.11
1.138	1.139	1.142	1.146	1.150	1.161	1.164	1.166	1.168	1.170	10.12
1.139	1.140	1.143	1.146	1.150	1.161	1.165	1.167	1.169	1.171	10.13
1.139	1.140	1.143	1.147	1.151	1.162	1.165	1.167	1.169	1.171	10.14
1.140	1.141	1.144	1.147	1.151	1.162	1.165	1.167	1.169	1.171	10.15
1.141	1.142	1.145	1.148	1.152	1.162	1.165	1.167	1.169	1.171	10.16
1.141	1.142	1.145	1.148	1.152	1.163	1.166	1.168	1.170	1.172	10.17
1.142	1.143	1.146	1.149	1.153	1.163	1.166	1.168	1.170	1.172	10.18
1.142	1.143	1.146	1.149	1.153	1.164	1.167	1.169	1.171	1.173	10.19
1.143	1.144	1.147	1.150	1.154	1.164	1.167	1.169	1.171	1.173	10.20
1.144	1.145	1.147	1.150	1.154	1.164	1.167	1.169	1.171	1.173	10.21
1.144	1.145	1.148	1.151	1.155	1.165	1.168	1.170	1.172	1.174	10.22
1.145	1.146	1.148	1.151	1.155	1.165	1.168	1.170	1.172	1.174	10.23
1.145	1.146	1.149	1.152	1.156	1.166	1.169	1.171	1.173	1.175	10.24
1.146	1.147	1.149	1.152	1.156	1.166	1.169	1.171	1.173	1.175	10.25
1.147	1.148	1.150	1.153	1.157	1.166	1.169	1.171	1.173	1.175	10.26
1.147	1.148	1.150	1.153	1.157	1.167	1.170	1.172	1.174	1.176	10.27
1.148	1.149	1.151	1.154	1.158	1.167	1.170	1.172	1.174	1.176	10.28
1.148	1.149	1.151	1.154	1.158	1.168	1.171	1.173	1.175	1.177	10.29
1.149	1.150	1.152	1.155	1.159	1.168	1.171	1.173	1.175	1.177	10.30
1.150	1.151	1.153	1.155	1.159	1.168	1.171	1.173	1.175	1.177	10.31
1.150	1.151	1.153	1.156	1.160	1.169	1.172	1.173	1.175	1.177	10.32
1.151	1.152	1.154	1.156	1.160	1.169	1.172	1.174	1.176	1.178	10.33
1.151	1.152	1.154	1.157	1.161	1.170	1.173	1.174	1.176	1.178	10.34
1.152	1.153	1.155	1.157	1.161	1.170	1.173	1.174	1.176	1.178	10.35
1.153	1.154	1.156	1.158	1.162	1.170	1.173	1.174	1.176	1.178	10.36
1.154	1.154	1.156	1.158	1.162	1.171	1.174	1.175	1.177	1.179	10.37
1.154	1.155	1.157	1.159	1.163	1.171	1.174	1.175	1.177	1.179	10.38
1.155	1.155	1.157	1.159	1.163	1.172	1.175	1.176	1.178	1.180	10.39
1.156	1.156	1.158	1.160	1.164	1.172	1.175	1.176	1.178	1.180	10.40
1.157	1.157	1.158	1.160	1.164	1.172	1.175	1.176	1.178	1.180	10.41
1.157	1.157	1.159	1.161	1.165	1.173	1.176	1.176	1.178	1.180	10.42
1.158	1.158	1.159	1.161	1.165	1.173	1.176	1.177	1.179	1.181	10.43
1.158	1.158	1.160	1.162	1.166	1.174	1.177	1.177	1.179	1.181	10.44
1.159	1.159	1.160	1.162	1.166	1.174	1.177	1.177	1.179	1.181	10.45
1.160	1.160	1.160	1.163	1.167	1.174	1.177	1.177	1.179	1.181	10.46
1.160	1.160	1.161	1.163	1.167	1.175	1.178	1.178	1.180	1.182	10.47
1.161	1.161	1.161	1.164	1.168	1.175	1.178	1.178	1.180	1.182	10.48
1.161	1.161	1.162	1.164	1.168	1.176	1.179	1.179	1.181	1.183	10.49
1.162	1.162	1.162	1.165	1.169	1.176	1.179	1.179	1.181	1.183	10.50
1.163	1.163	1.163	1.166	1.169	1.176	1.179	1.179	1.181	1.183	10.51
1.163	1.163	1.163	1.166	1.170	1.177	1.180	1.180	1.181	1.183	10.52
1.164	1.164	1.164	1.167	1.170	1.177	1.180	1.180	1.182	1.184	10.53
1.164	1.164	1.164	1.167	1.171	1.178	1.181	1.181	1.182	1.184	10.54

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
10.55	1.290	1.265	1.246	1.227	1.212	1.200	1.190	1.183	1.176	1.171
10.56	1.291	1.266	1.247	1.228	1.213	1.201	1.191	1.184	1.177	1.172
10.57	1.292	1.267	1.248	1.229	1.214	1.202	1.192	1.185	1.178	1.172
10.58	1.294	1.268	1.249	1.230	1.215	1.202	1.193	1.185	1.178	1.173
10.59	1.295	1.269	1.250	1.231	1.216	1.203	1.194	1.186	1.179	1.173
10.60	1.296	1.270	1.251	1.232	1.217	1.204	1.195	1.187	1.180	1.174
10.61	1.297	1.271	1.252	1.233	1.218	1.205	1.196	1.188	1.181	1.175
10.62	1.298	1.272	1.253	1.234	1.219	1.206	1.197	1.189	1.181	1.175
10.63	1.299	1.273	1.254	1.234	1.219	1.206	1.197	1.189	1.182	1.176
10.64	1.300	1.274	1.255	1.235	1.220	1.207	1.198	1.190	1.182	1.176
10.65	1.301	1.275	1.256	1.236	1.221	1.208	1.199	1.191	1.183	1.177
10.66	1.302	1.276	1.257	1.237	1.222	1.209	1.200	1.192	1.184	1.178
10.67	1.303	1.277	1.258	1.238	1.223	1.210	1.201	1.193	1.185	1.179
10.68	1.305	1.278	1.259	1.239	1.224	1.211	1.201	1.193	1.185	1.179
10.69	1.306	1.279	1.260	1.240	1.225	1.212	1.202	1.194	1.186	1.180
10.70	1.307	1.280	1.261	1.241	1.226	1.213	1.203	1.195	1.187	1.181
10.71	1.308	1.281	1.262	1.242	1.227	1.214	1.204	1.196	1.188	1.182
10.72	1.309	1.282	1.263	1.243	1.228	1.215	1.205	1.196	1.189	1.183
10.73	1.310	1.283	1.263	1.244	1.229	1.215	1.205	1.197	1.189	1.183
10.74	1.311	1.284	1.264	1.245	1.230	1.216	1.206	1.197	1.190	1.184
10.75	1.312	1.285	1.265	1.246	1.231	1.217	1.207	1.198	1.191	1.185
10.76	1.313	1.286	1.266	1.247	1.232	1.218	1.208	1.199	1.192	1.186
10.77	1.314	1.287	1.267	1.248	1.233	1.219	1.209	1.200	1.193	1.187
10.78	1.316	1.289	1.268	1.249	1.234	1.220	1.209	1.200	1.193	1.187
10.79	1.317	1.290	1.269	1.250	1.235	1.221	1.210	1.201	1.194	1.188
10.80	1.318	1.291	1.270	1.251	1.236	1.222	1.211	1.202	1.195	1.189
10.81	1.319	1.292	1.271	1.252	1.237	1.223	1.212	1.203	1.196	1.190
10.82	1.320	1.293	1.272	1.253	1.238	1.224	1.213	1.204	1.196	1.191
10.83	1.321	1.294	1.273	1.253	1.238	1.224	1.213	1.204	1.197	1.191
10.84	1.322	1.295	1.274	1.254	1.239	1.225	1.214	1.205	1.197	1.192
10.85	1.323	1.296	1.275	1.255	1.240	1.226	1.215	1.206	1.198	1.193
10.86	1.324	1.297	1.276	1.256	1.241	1.227	1.216	1.207	1.199	1.194
10.87	1.325	1.298	1.277	1.257	1.242	1.228	1.217	1.208	1.200	1.195
10.88	1.327	1.299	1.278	1.258	1.243	1.228	1.217	1.208	1.200	1.195
10.89	1.328	1.300	1.279	1.259	1.244	1.229	1.218	1.209	1.201	1.196
10.90	1.329	1.301	1.280	1.260	1.245	1.230	1.219	1.210	1.202	1.197
10.91	1.330	1.302	1.281	1.261	1.246	1.231	1.220	1.211	1.203	1.198
10.92	1.331	1.303	1.282	1.262	1.247	1.232	1.221	1.212	1.204	1.198
10.93	1.332	1.304	1.282	1.263	1.247	1.233	1.221	1.212	1.204	1.199
10.94	1.333	1.305	1.283	1.264	1.248	1.234	1.222	1.213	1.205	1.199
10.95	1.334	1.306	1.284	1.265	1.249	1.235	1.223	1.214	1.206	1.200
10.96	1.335	1.307	1.285	1.266	1.250	1.236	1.224	1.215	1.207	1.201
10.97	1.336	1.308	1.286	1.267	1.251	1.237	1.225	1.216	1.208	1.202
10.98	1.337	1.309	1.287	1.268	1.252	1.238	1.226	1.216	1.208	1.202
10.99	1.338	1.310	1.288	1.269	1.253	1.239	1.227	1.217	1.209	1.203

T_r										P_r 10.55 - 10.99
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.165	1.165	1.165	1.168	1.171	1.178	1.181	1.181	1.182	1.184	10.55
1.166	1.166	1.166	1.169	1.172	1.179	1.181	1.181	1.182	1.184	10.56
1.167	1.166	1.166	1.169	1.172	1.179	1.182	1.182	1.183	1.185	10.57
1.167	1.167	1.167	1.170	1.173	1.180	1.182	1.182	1.183	1.185	10.58
1.168	1.167	1.167	1.170	1.173	1.180	1.183	1.183	1.184	1.186	10.59
1.169	1.168	1.168	1.171	1.174	1.181	1.183	1.183	1.184	1.186	10.60
1.170	1.168	1.169	1.172	1.174	1.181	1.183	1.183	1.184	1.186	10.61
1.170	1.169	1.169	1.172	1.175	1.182	1.183	1.183	1.184	1.186	10.62
1.171	1.169	1.170	1.173	1.175	1.182	1.184	1.184	1.185	1.187	10.63
1.171	1.170	1.170	1.173	1.176	1.183	1.184	1.184	1.185	1.187	10.64
1.172	1.170	1.171	1.174	1.176	1.183	1.184	1.184	1.185	1.187	10.65
1.173	1.171	1.172	1.175	1.177	1.183	1.184	1.184	1.185	1.187	10.66
1.174	1.171	1.172	1.175	1.177	1.184	1.185	1.185	1.186	1.188	10.67
1.174	1.172	1.173	1.176	1.178	1.184	1.185	1.185	1.186	1.188	10.68
1.175	1.172	1.173	1.176	1.178	1.185	1.186	1.186	1.187	1.189	10.69
1.176	1.173	1.174	1.177	1.179	1.185	1.186	1.186	1.187	1.189	10.70
1.177	1.174	1.174	1.177	1.180	1.185	1.186	1.186	1.187	1.189	10.71
1.177	1.174	1.175	1.178	1.180	1.186	1.186	1.187	1.188	1.189	10.72
1.178	1.175	1.175	1.178	1.181	1.186	1.187	1.187	1.188	1.190	10.73
1.178	1.175	1.176	1.179	1.181	1.187	1.187	1.188	1.189	1.190	10.74
1.179	1.176	1.176	1.179	1.182	1.187	1.187	1.188	1.189	1.190	10.75
1.180	1.177	1.177	1.180	1.183	1.187	1.187	1.188	1.189	1.190	10.76
1.180	1.177	1.177	1.180	1.183	1.188	1.188	1.189	1.190	1.191	10.77
1.181	1.178	1.178	1.181	1.184	1.188	1.188	1.189	1.190	1.191	10.78
1.181	1.178	1.178	1.181	1.184	1.189	1.189	1.190	1.191	1.192	10.79
1.182	1.179	1.179	1.182	1.185	1.189	1.189	1.190	1.191	1.192	10.80
1.183	1.180	1.180	1.183	1.185	1.189	1.189	1.190	1.191	1.192	10.81
1.184	1.180	1.180	1.183	1.186	1.190	1.190	1.191	1.191	1.192	10.82
1.184	1.181	1.181	1.184	1.186	1.190	1.190	1.191	1.192	1.193	10.83
1.185	1.181	1.181	1.184	1.187	1.191	1.191	1.192	1.192	1.193	10.84
1.186	1.182	1.182	1.185	1.187	1.191	1.191	1.192	1.192	1.193	10.85
1.187	1.183	1.183	1.186	1.188	1.191	1.191	1.192	1.192	1.193	10.86
1.188	1.184	1.184	1.186	1.188	1.192	1.192	1.193	1.193	1.194	10.87
1.188	1.184	1.184	1.187	1.189	1.192	1.192	1.193	1.193	1.194	10.88
1.189	1.185	1.185	1.187	1.189	1.193	1.193	1.194	1.194	1.195	10.89
1.190	1.186	1.186	1.188	1.190	1.193	1.193	1.194	1.194	1.195	10.90
1.191	1.187	1.187	1.189	1.190	1.193	1.193	1.194	1.194	1.195	10.91
1.191	1.187	1.187	1.189	1.191	1.194	1.194	1.195	1.195	1.196	10.92
1.192	1.188	1.188	1.190	1.191	1.194	1.194	1.195	1.195	1.196	10.93
1.192	1.188	1.188	1.190	1.192	1.195	1.195	1.196	1.196	1.197	10.94
1.193	1.189	1.189	1.191	1.192	1.195	1.195	1.196	1.196	1.197	10.95
1.194	1.190	1.190	1.192	1.193	1.195	1.195	1.196	1.196	1.197	10.96
1.194	1.191	1.191	1.192	1.193	1.196	1.196	1.197	1.197	1.198	10.97
1.195	1.191	1.191	1.193	1.194	1.196	1.196	1.197	1.197	1.198	10.98
1.195	1.192	1.191	1.193	1.194	1.197	1.197	1.198	1.198	1.199	10.99

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.00	1.339	1.311	1.289	1.270	1.254	1.240	1.228	1.218	1.210	1.204
11.01	1.340	1.312	1.290	1.271	1.255	1.241	1.229	1.219	1.211	1.205
11.02	1.341	1.313	1.291	1.272	1.256	1.242	1.230	1.219	1.211	1.206
11.03	1.342	1.314	1.292	1.273	1.256	1.242	1.230	1.220	1.212	1.206
11.04	1.343	1.315	1.293	1.274	1.257	1.243	1.231	1.220	1.212	1.207
11.05	1.344	1.316	1.294	1.275	1.258	1.244	1.232	1.221	1.213	1.208
11.06	1.345	1.317	1.295	1.276	1.259	1.245	1.233	1.222	1.214	1.209
11.07	1.346	1.318	1.296	1.277	1.260	1.246	1.234	1.223	1.215	1.209
11.08	1.348	1.319	1.297	1.278	1.261	1.247	1.234	1.223	1.215	1.210
11.09	1.349	1.320	1.298	1.279	1.262	1.248	1.235	1.224	1.216	1.210
11.10	1.350	1.321	1.299	1.280	1.263	1.249	1.236	1.225	1.217	1.211
11.11	1.351	1.322	1.300	1.281	1.264	1.250	1.237	1.226	1.218	1.212
11.12	1.352	1.323	1.301	1.282	1.265	1.251	1.238	1.227	1.219	1.212
11.13	1.353	1.324	1.301	1.282	1.266	1.251	1.238	1.227	1.219	1.213
11.14	1.354	1.325	1.302	1.283	1.267	1.252	1.239	1.228	1.220	1.213
11.15	1.355	1.326	1.303	1.284	1.268	1.253	1.240	1.229	1.221	1.214
11.16	1.356	1.327	1.304	1.285	1.269	1.254	1.241	1.230	1.222	1.215
11.17	1.357	1.328	1.305	1.286	1.270	1.255	1.242	1.231	1.223	1.216
11.18	1.358	1.329	1.306	1.287	1.271	1.255	1.243	1.231	1.223	1.216
11.19	1.359	1.330	1.307	1.288	1.272	1.256	1.244	1.232	1.224	1.217
11.20	1.360	1.331	1.308	1.289	1.273	1.257	1.245	1.233	1.225	1.218
11.21	1.361	1.332	1.309	1.290	1.274	1.258	1.246	1.234	1.226	1.219
11.22	1.362	1.333	1.310	1.291	1.275	1.259	1.247	1.235	1.226	1.219
11.23	1.363	1.334	1.311	1.292	1.275	1.259	1.247	1.235	1.227	1.220
11.24	1.364	1.335	1.312	1.293	1.276	1.260	1.248	1.236	1.227	1.220
11.25	1.365	1.336	1.313	1.294	1.277	1.261	1.249	1.237	1.228	1.221
11.26	1.366	1.337	1.314	1.295	1.278	1.262	1.250	1.238	1.229	1.222
11.27	1.367	1.338	1.315	1.296	1.279	1.263	1.251	1.239	1.230	1.223
11.28	1.368	1.339	1.316	1.297	1.280	1.263	1.251	1.239	1.230	1.223
11.29	1.369	1.340	1.317	1.298	1.281	1.264	1.252	1.240	1.231	1.224
11.30	1.370	1.341	1.318	1.299	1.282	1.265	1.253	1.241	1.232	1.225
11.31	1.371	1.342	1.319	1.300	1.283	1.266	1.254	1.242	1.233	1.226
11.32	1.372	1.343	1.320	1.301	1.284	1.267	1.255	1.243	1.234	1.226
11.33	1.373	1.344	1.321	1.301	1.284	1.267	1.255	1.243	1.234	1.227
11.34	1.374	1.345	1.322	1.302	1.285	1.268	1.256	1.244	1.235	1.227
11.35	1.375	1.346	1.323	1.303	1.286	1.269	1.257	1.245	1.236	1.228
11.36	1.376	1.347	1.324	1.304	1.287	1.270	1.258	1.246	1.237	1.229
11.37	1.377	1.348	1.325	1.305	1.288	1.271	1.259	1.247	1.238	1.230
11.38	1.379	1.249	1.326	1.306	1.289	1.271	1.259	1.247	1.238	1.230.
11.39	1.380	1.350	1.327	1.307	1.290	1.272	1.260	1.248	1.239	1.231
11.40	1.381	1.351	1.328	1.308	1.291	1.273	1.261	1.249	1.240	1.232
11.41	1.382	1.352	1.329	1.309	1.292	1.274	1.262	1.250	1.241	1.233
11.42	1.383	1.353	1.330	1.310	1.293	1.275	1.263	1.251	1.241	1.234
11.43	1.384	1.354	1.331	1.311	1.293	1.275	1.263	1.251	1.242	1.234
11.44	1.385	1.355	1.332	1.312	1.294	1.276	1.264	1.252	1.242	1.235

T_r										P_r 11.00 - 11.44
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.196	1.193	1.192	1.194	1.195	1.197	1.197	1.198	1.198	1.199	11.00
1.197	1.194	1.192	1.194	1.195	1.197	1.197	1.198	1.198	1.199	11.01
1.197	1.194	1.193	1.195	1.196	1.198	1.198	1.198	1.198	1.199	11.02
1.198	1.195	1.193	1.195	1.196	1.198	1.198	1.199	1.199	1.200	11.03
1.198	1.195	1.194	1.196	1.197	1.199	1.199	1.199	1.199	1.200	11.04
1.199	1.196	1.194	1.196	1.197	1.199	1.199	1.199	1.199	1.200	11.05
1.200	1.197	1.194	1.197	1.198	1.199	1.199	1.199	1.199	1.200	11.06
1.200	1.197	1.195	1.197	1.198	1.200	1.200	1.200	1.200	1.201	11.07
1.201	1.198	1.194	1.198	1.199	1.200	1.200	1.200	1.200	1.201	11.08
1.201	1.198	1.196	1.198	1.199	1.201	1.201	1.201	1.201	1.202	11.09
1.202	1.199	1.196	1.199	1.200	1.201	1.201	1.201	1.201	1.202	11.10
1.203	1.200	1.197	1.199	1.200	1.201	1.201	1.201	1.201	1.202	11.11
1.204	1.200	1.197	1.200	1.201	1.202	1.202	1.202	1.202	1.202	11.12
1.204	1.201	1.198	1.200	1.201	1.202	1.202	1.202	1.202	1.202	11.13
1.205	1.201	1.198	1.201	1.202	1.203	1.203	1.203	1.203	1.203	11.14
1.206	1.202	1.199	1.201	1.202	1.203	1.203	1.203	1.203	1.203	11.15
1.207	1.203	1.200	1.202	1.202	1.204	1.203	1.203	1.203	1.203	11.16
1.208	1.203	1.200	1.202	1.203	1.204	1.204	1.204	1.204	1.204	11.17
1.208	1.204	1.201	1.203	1.203	1.205	1.204	1.204	1.204	1.204	11.18
1.209	1.204	1.201	1.203	1.204	1.205	1.205	1.205	1.205	1.205	11.19
1.210	1.205	1.202	1.204	1.204	1.205	1.205	1.205	1.205	1.205	11.20
1.211	1.206	1.203	1.204	1.204	1.205	1.205	1.205	1.205	1.205	11.21
1.211	1.206	1.203	1.205	1.205	1.206	1.206	1.206	1.206	1.206	11.22
1.212	1.207	1.204	1.025	1.205	1.206	1.206	1.206	1.206	1.206	11.23
1.212	1.207	1.204	1.206	1.206	1.207	1.207	1.207	1.207	1.207	11.24
1.213	1.208	1.205	1.206	1.206	1.207	1.207	1.207	1.207	1.207	11.25
1.214	1.209	1.206	1.207	1.207	1.207	1.207	1.207	1.207	1.207	11.26
1.215	1.209	1.206	1.207	1.207	1.208	1.208	1.208	1.208	1.208	11.27
1.215	1.210	21.07	1.208	1.208	1.208	1.208	1.208	1.208	1.208	11.28
1.216	1.210	12.07	1.208	1.208	1.209	1.209	1.209	1.209	1.209	11.29
1.217	1.211	1.208	1.209	1.209	1.209	1.209	1.209	1.209	1.209	11.30
1.218	1.212	1.209	1.209	1.209	1.209	1.209	1.209	1.209	1.209	11.31
1.218	1.212	1.209	1.210	1.210	1.210	1.210	1.210	1.209	1.209	11.32
1.219	1.213	1.210	1.210	1.210	1.210	1.210	1.210	1.210	1.210	11.33
1.219	1.213	1.210	1.211	1.211	1.211	1.211	1.211	1.210	1.210	11.34
1.220	1.214	1.211	1.211	1.211	1.211	1.211	1.211	1.210	1.210	11.35
1.221	1.215	1.212	1.212	1.212	1.212	1.212	1.211	1.210	1.210	11.36
1.222	1.215	1.212	1.212	1.212	1.212	1.212	1.212	1.211	1.211	11.37
1.222	1.216	1.213	1.213	1.213	1.213	1.213	1.212	1.211	1.211	11.38
1.223	1.216	1.213	1.213	1.213	1.213	1.213	1.213	1.212	1.212	11.39
1.224	1.217	1.214	1.214	1.214	1.214	1.214	1.213	1.212	1.212	11.40
1.225	1.218	1.214	1.214	1.214	1.214	1.214	1.213	1.212	1.212	11.41
1.225	1.218	1.215	1.215	1.215	1.215	1.215	1.214	1.213	1.212	11.42
1.226	1.219	1.216	1.215	1.215	1.215	1.215	1.214	1.213	1.213	11.43
1.226	1.219	1.216	1.216	1.216	1.216	1.216	1.215	1.214	1.213	11.44

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.45	1.386	1.356	1.333	1.313	1.295	1.277	1.265	1.253	1.243	1.236
11.46	1.387	1.357	1.334	1.314	1.296	1.278	1.266	1.253	1.244	1.237
11.47	1.388	1.358	1.335	1.315	1.297	1.279	1.267	1.254	1.245	1.238
11.48	1.389	1.360	1.336	1.316	1.298	1.280	1.267	1.254	1.245	1.238
11.49	1.390	1.361	1.337	1.317	1.299	1.281	1.268	1.255	1.246	1.239
11.50	1.391	1.362	1.338	1.318	1.300	1.282	1.269	1.257	1.247	1.240
11.51	1.392	1.363	1.339	1.319	1.301	1.283	1.270	1.258	1.248	1.241
11.52	1.393	1.364	1.340	1.320	1.302	1.284	1.271	1.258	1.249	1.242
11.53	1.394	1.365	1.341	1.320	1.302	1.284	1.271	1.259	1.249	1.242
11.54	1.395	1.366	1.342	1.321	1.303	1.285	1.272	1.259	1.250	1.243
11.55	1.396	1.367	1.343	1.322	1.304	1.286	1.273	1.260	1.251	1.244
11.56	1.397	1.368	1.344	1.323	1.305	1.287	1.274	1.261	1.252	1.245
11.57	1.398	1.369	1.345	1.324	1.306	1.288	1.275	1.262	1.253	1.246
11.58	1.400	1.370	1.346	1.325	1.307	1.289	1.275	1.262	1.253	1.246
11.59	1.401	1.371	1.347	1.326	1.308	1.290	1.276	1.263	1.254	1.247
11.60	1.402	1.372	1.348	1.327	1.309	1.291	1.277	1.264	1.255	1.248
11.61	1.403	1.373	1.349	1.328	1.310	1.292	1.278	1.265	1.256	1.249
11.62	1.404	1.374	1.350	1.329	1.311	1.293	1.279	1.266	1.256	1.249
11.63	1.405	1.375	1.351	1.329	1.311	1.293	1.279	1.267	1.257	1.250
11.64	1.406	1.376	1.352	1.330	1.312	1.294	1.280	1.267	1.257	1.250
11.65	1.407	1.377	1.353	1.331	1.313	1.295	1.281	1.268	1.258	1.251
11.66	1.408	1.378	1.354	1.332	1.314	1.296	1.282	1.269	1.259	1.252
11.67	1.409	1.379	1.355	1.333	1.315	1.297	1.283	1.270	1.260	1.253
11.68	1.410	1.380	1.356	1.334	1.315	1.298	1.284	1.270	1.260	1.253
11.69	1.411	1.381	1.357	1.335	1.316	1.299	1.285	1.271	1.261	1.254
11.70	1.412	1.382	1.358	1.336	1.317	1.300	1.286	1.272	1.262	1.255
11.71	1.413	1.383	1.359	1.337	1.318	1.301	1.287	1.273	1.263	1.256
11.72	1.414	1.384	1.360	1.338	1.319	1.302	1.288	1.274	1.263	1.257
11.73	1.415	1.385	1.361	1.338	1.319	1.303	1.288	1.274	1.264	1.257
11.74	1.416	1.386	1.362	1.339	1.320	1.304	1.289	1.275	1.264	1.258
11.75	1.417	1.387	1.363	1.340	1.321	1.305	1.290	1.276	1.265	1.259
11.76	1.418	1.388	1.364	1.341	1.322	1.306	1.291	1.277	1.266	1.260
11.77	1.419	1.389	1.365	1.342	1.323	1.307	1.292	1.278	1.267	1.260
11.78	1.421	1.390	1.366	1.343	1.324	1.307	1.292	1.278	1.267	1.261
11.79	1.422	1.391	1.367	1.344	1.325	1.308	1.293	1.279	1.268	1.261
11.80	1.423	1.392	1.268	1.345	1.326	1.309	1.294	1.280	1.269	1.262
11.81	1.424	1.393	1.369	1.346	1.327	1.310	1.295	1.281	1.270	1.263
11.82	1.425	1.394	1.370	1.347	1.328	1.311	1.296	1.282	1.271	1.264
11.83	1.426	1.395	1.371	1.348	1.328	1.311	1.296	1.282	1.271	1.264
11.84	1.427	1.396	1.372	1.349	1.329	1.312	1.297	1.283	1.272	1.265
11.85	1.428	1.397	1.373	1.350	1.330	1.313	1.298	1.284	1.273	1.266
11.86	1.429	1.398	1.374	1.351	1.331	1.314	1.299	1.285	1.274	1.267
11.87	1.430	1.399	1.375	1.352	1.332	1.315	1.300	1.286	1.274	1.268
11.88	1.431	1.400	1.376	1.353	1.333	1.316	1.300	1.286	1.275	1.268
11.89	1.432	1.401	1.377	1.354	1.334	1.317	1.301	1.287	1.276	1.269

					T_r					P_r 11.45 - 11.89
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.227	1.220	1.217	1.216	1.216	1.216	1.216	1.215	1.214	1.213	11.45
1.228	1.221	1.218	1.217	1.217	1.217	1.216	1.215	1.214	1.213	11.46
1.229	1.222	1.218	1.217	1.217	1.217	1.217	1.216	1.215	1.214	11.47
1.229	1.222	1.219	1.218	1.218	1.218	1.217	1.216	1.215	1.214	11.48
1.230	1.223	1.219	1.218	1.218	1.218	1.218	1.217	1.216	1.215	11.49
1.231	1.224	1.220	1.219	1.219	1.219	1.218	1.217	1.216	1.215	11.50
1.232	1.225	1.221	1.220	1.219	1.219	1.218	1.217	1.216	1.215	11.51
1.232	1.225	1.221	1.220	1.220	1.220	1.219	1.218	1.217	1.216	11.52
1.233	1.226	1.222	1.221	1.220	1.220	1.219	1.218	1.217	1.216	11.53
1.233	1.226	1.222	1.221	1.221	1.221	1.220	1.219	1.218	1.217	11.54
1.234	1.227	1.223	1.222	1.221	1.221	1.220	1.219	1.218	1.217	11.55
1.235	1.228	1.224	1.223	1.222	1.221	1.220	1.219	1.218	1.217	11.56
1.236	1.228	1.224	1.223	1.222	1.222	1.221	1.220	1.219	1.218	11.57
1.236	1.229	1.225	1.224	1.223	1.222	1.221	1.220	1.219	1.218	11.58
1.237	1.229	1.225	1.224	1.223	1.223	1.222	1.221	1.220	1.219	11.59
1.238	1.230	1.226	1.225	1.224	1.223	1.222	1.221	1.220	1.219	11.60
1.239	1.231	1.227	1.225	1.224	1.223	1.222	1.221	1.220	1.219	11.61
1.239	1.231	1.227	1.226	1.225	1.224	1.222	1.221	1.220	1.219	11.62
1.240	1.232	1.228	1.226	1.225	1.224	1.223	1.222	1.221	1.220	11.63
1.240	1.232	1.228	1.227	1.226	1.225	1.223	1.222	1.221	1.220	11.64
1.241	1.233	1.229	1.227	1.226	1.225	1.223	1.222	1.221	1.220	11.65
1.242	1.234	1.230	1.228	1.227	1.225	1.223	1.222	1.221	1.220	11.66
1.243	1.234	1.230	1.228	1.227	1.226	1.224	1.223	1.222	1.221	11.67
1.243	1.235	1.231	1.229	1.228	1.226	1.224	1.223	1.222	1.221	11.68
1.244	1.235	1.231	1.229	1.228	1.227	1.225	1.224	1.223	1.222	11.69
1.245	1.236	1.232	1.230	1.229	1.227	1.225	1.224	1.223	1.222	11.70
1.246	1.237	1.233	1.231	1.230	1.227	1.225	1.224	1.223	1.222	11.71
1.246	1.237	1.233	1.231	1.230	1.228	1.226	1.225	1.223	1.223	11.72
1.247	1.238	1.234	1.232	1.231	1.228	1.226	1.224	1.224	1.223	11.73
1.247	1.238	1.234	1.232	1.231	1.229	1.227	1.226	1.225	1.224	11.74
1.248	1.239	1.235	1.233	1.232	1.229	1.227	1.226	1.225	1.224	11.75
1.249	1.240	1.236	1.234	1.232	1.229	1.227	1.226	1.225	1.224	11.76
1.250	1.241	1.236	1.234	1.233	1.230	1.228	1.227	1.226	1.225	11.77
1.250	1.241	1.237	1.235	1.233	1.230	1.228	1.227	1.226	1.225	11.78
1.251	1.242	1.237	1.235	1.234	1.231	1.229	1.228	1.227	1.226	11.79
1.252	1.243	1.238	1.236	1.234	1.231	1.229	1.228	1.227	1.226	11.80
1.253	1.244	1.238	1.236	1.234	1.231	1.229	1.228	1.227	1.226	11.81
1.253	1.244	1.239	1.237	1.235	1.232	1.230	1.228	1.227	1.226	11.82
1.254	1.245	1.239	1.237	1.235	1.232	1.230	1.229	1.227	1.226	11.83
1.254	1.245	1.240	1.238	1.236	1.233	1.231	1.229	1.228	1.227	11.84
1.255	1.246	1.240	1.238	1.236	1.233	1.231	1.229	1.228	1.227	11.85
1.256	1.247	1.241	1.239	1.237	1.234	1.231	1.229	1.228	1.227	11.86
1.257	1.248	1.241	1.239	1.237	1.234	1.232	1.230	1.229	1.228	11.87
1.257	1.248	1.242	1.240	1.238	1.235	1.232	1.230	1.229	1.228	11.88
1.258	1.249	1.242	1.240	1.238	1.235	1.233	1.231	1.230	1.229	11.89

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.90	1.433	1.402	1.378	1.355	1.335	1.318	1.302	1.288	1.277	1.270
11.91	1.434	1.403	1.379	1.356	1.336	1.319	1.303	1.289	1.278	1.271
11.92	1.435	1.404	1.380	1.357	1.337	1.320	1.304	1.290	1.278	1.272
11.93	1.436	1.405	1.381	1.357	1.337	1.320	1.304	1.290	1.279	1.272
11.94	1.437	1.406	1.382	1.358	1.338	1.321	1.305	1.291	1.279	1.273
11.95	1.438	1.407	1.383	1.359	1.339	1.322	1.306	1.292	1.280	1.274
11.96	1.439	1.408	1.384	1.360	1.340	1.323	1.307	1.293	1.281	1.275
11.97	1.440	1.409	1.385	1.361	1.341	1.324	1.308	1.294	1.282	1.276
11.98	1.442	1.411	1.386	1.362	1.342	1.325	1.308	1.294	1.282	1.276
11.99	1.443	1.412	1.387	1.363	1.343	1.326	1.309	1.295	1.283	1.277
12.00	1.444	1.413	1.388	1.364	1.344	1.327	1.310	1.296	1.284	1.278
12.01	1.445	1.414	1.389	1.365	1.345	1.328	1.311	1.297	1.285	1.279
12.02	1.446	1.415	1.390	1.366	1.346	1.329	1.312	1.297	1.286	1.279
12.03	1.447	1.416	1.391	1.366	1.346	1.329	1.312	1.298	1.286	1.280
12.04	1.448	1.417	1.392	1.367	1.347	1.330	1.313	1.298	1.287	1.280
12.05	1.449	1.418	1.393	1.368	1.348	1.331	1.314	1.299	1.288	1.281
12.06	1.450	1.419	1.394	1.369	1.349	1.332	1.315	1.300	1.289	1.282
12.07	1.451	1.420	1.395	1.370	1.350	1.333	1.316	1.301	1.290	1.283
12.08	1.452	1.421	1.396	1.371	1.351	1.333	1.316	1.301	1.290	1.283
12.09	1.453	1.422	1.397	1.372	1.352	1.334	1.317	1.302	1.291	1.284
12.10	1.454	1.423	1.398	1.373	1.353	1.335	1.318	1.303	1.292	1.285
12.11	1.455	1.424	1.399	1.374	1.354	1.336	1.319	1.304	1.293	1.286
12.12	1.456	1.425	1.400	1.375	1.355	1.337	1.320	1.305	1.294	1.286
12.13	1.457	1.426	1.401	1.376	1.355	1.337	1.320	1.305	1.294	1.287
12.14	1.458	1.427	1.402	1.377	1.356	1.338	1.321	1.306	1.295	1.287
12.15	1.459	1.428	1.403	1.378	1.357	1.339	1.322	1.307	1.296	1.288
12.16	1.460	1.429	1.404	1.379	1.358	1.340	1.323	1.308	1.297	1.289
12.17	1.461	1.430	1.405	1.380	1.359	1.341	1.324	1.309	1.298	1.290
12.18	1.463	1.431	1.406	1.381	1.360	1.342	1.324	1.309	1.298	1.290
12.19	1.464	1.432	1.407	1.382	1.361	1.343	1.325	1.310	1.299	1.291
12.20	1.465	1.433	1.408	1.383	1.362	1.344	1.326	1.311	1.300	1.292
12.21	1.466	1.434	1.409	1.384	1.363	1.345	1.327	1.312	1.301	1.293
12.22	1.467	1.435	1.410	1.385	1.364	1.346	1.328	1.313	1.302	1.293
12.23	1.468	1.436	1.411	1.386	1.364	1.346	1.328	1.313	1.302	1.294
12.24	1.469	1.437	1.412	1.387	1.365	1.347	1.329	1.314	1.303	1.294
12.25	1.470	1.438	1.413	1.388	1.366	1.348	1.330	1.315	1.304	1.295
12.26	1.471	1.439	1.414	1.389	1.567	1.349	1.331	1.316	1.305	1.296
12.27	1.472	1.440	1.415	1.390	1.368	1.350	1.332	1.317	1.305	1.297
12.28	1.473	1.441	1.416	1.390	1.369	1.351	1.332	1.317	1.306	1.297
12.29	1.474	1.442	1.417	1.391	1.370	1.352	1.333	1.318	1.306	1.298
12.30	1.475	1.443	1.318	1.392	1.371	1.353	1.334	1.319	1.307	1.299
12.31	1.476	1.444	1.419	1.393	1.372	1.354	1.335	1.320	1.308	1.300
12.32	1.477	1.445	1.420	1.394	1.373	1.355	1.336	1.321	1.309	1.301
12.33	1.478	1.446	1.421	1.395	1.373	1.355	1.336	1.321	1.309	1.301
12.34	1.479	1.447	1.422	1.396	1.374	1.356	1.337	1.322	1.310	1.302

				T_r						P_r 11.90 - 12.34
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.259	1.250	1.243	1.241	1.239	1.236	1.233	1.231	1.230	1.229	11.90
1.260	1.251	1.244	1.242	1.239	1.236	1.233	1.231	1.230	1.229	11.91
1.260	1.251	1.244	1.242	1.240	1.237	1.234	1.232	1.230	1.229	11.92
1.261	1.252	1.245	1.243	1.240	1.237	1.234	1.232	1.231	1.230	11.93
1.261	1.252	1.245	1.243	1.241	1.238	1.235	1.233	1.231	1.230	11.94
1.262	1.253	1.246	1.244	1.241	1.238	1.235	1.233	1.231	1.230	11.95
1.263	1.254	1.247	1.245	1.242	1.238	1.235	1.233	1.231	1.230	11.96
1.264	1.254	1.247	1.245	1.242	1.239	1.236	1.234	1.232	1.231	11.97
1.264	1.255	1.248	1.246	1.243	1.239	1.236	1.234	1.232	1.231	11.98
1.265	1.255	1.248	1.246	1.243	1.240	1.237	1.235	1.233	1.232	11.99
1.266	1.256	1.249	1.247	1.244	1.240	1.237	1.235	1.233	1.232	12.00
1.267	1.257	1.250	1.247	1.244	1.240	1.237	1.235	1.233	1.232	12.01
1.267	1.257	1.250	1.248	1.245	1.241	1.237	1.235	1.234	1.233	12.02
1.268	1.258	1.251	1.248	1.245	1.241	1.238	1.236	1.234	1.233	12.03
1.268	1.258	1.251	1.249	1.246	1.242	1.238	1.236	1.235	1.234	12.04
1.269	1.259	1.252	1.249	1.246	1.242	1.238	1.236	1.235	1.234	12.05
1.270	1.260	1.253	1.249	1.247	1.242	1.238	1.236	1.235	1.234	12.06
1.270	1.260	1.253	1.250	1.247	1.243	1.239	1.237	1.236	1.235	12.07
1.271	1.261	1.254	1.250	1.248	1.243	1.239	1.237	1.236	1.235	12.08
1.271	1.262	1.254	1.251	1.248	1.244	1.240	1.238	1.237	1.236	12.09
1.272	1.262	1.255	1.251	1.249	1.244	1.240	1.238	1.237	1.236	12.10
1.273	1.263	1.256	1.252	1.249	1.244	1.240	1.238	1.237	1.236	12.11
1.273	1.263	1.256	1.252	1.250	1.245	1.241	1.239	1.237	1.236	12.12
1.274	1.264	1.257	1.253	1.250	1.245	1.241	1.239	1.238	1.237	12.13
1.274	1.264	1.257	1.253	1.251	1.246	1.242	1.240	1.238	1.237	12.14
1.275	1.265	1.258	1.254	1.251	1.246	1.242	1.240	1.238	1.237	12.15
1.276	1.266	1.259	1.255	1.252	1.246	1.242	1.240	1.238	1.237	12.16
1.277	1.266	1.259	1.255	1.252	1.247	1.243	1.241	1.239	1.238	12.17
1.277	1.267	1.260	1.256	1.253	1.247	1.243	1.241	1.239	1.238	12.18
1.278	1.267	1.260	1.256	1.253	1.248	1.244	1.242	1.240	1.239	12.19
1.279	1.268	1.261	1.257	1.254	1.248	1.244	1.242	1.240	1.239	12.20
1.280	1.269	1.262	1.257	1.254	1.248	1.244	1.242	1.240	1.239	12.21
1.281	1.269	1.262	1.258	1.255	1.249	1.245	1.243	1.241	1.240	12.22
1.281	1.270	1.263	1.258	1.255	1.259	1.245	1.243	1.241	1.240	12.23
1.282	1.270	1.263	1.259	1.256	1.250	1.246	1.244	1.242	1.241	12.24
1.283	1.271	1.264	1.259	1.256	1.250	1.246	1.244	1.242	1.241	12.25
1.284	1.272	1.265	1.260	1.257	1.250	1.246	1.244	1.242	1.241	12.26
1.285	1.272	1.265	1.260	1.257	1.251	1.247	1.245	1.243	1.242	12.27
1.285	1.273	1.266	1.261	1.258	1.251	1.247	1.245	1.243	1.242	12.28
1.286	1.273	1.266	1.261	1.258	1.252	1.248	1.246	1.244	1.243	12.29
1.287	1.274	1.267	1.262	1.259	1.252	1.248	1.246	1.244	1.243	12.30
1.288	1.275	1.268	1.263	1.259	1.252	1.248	1.246	1.244	1.243	12.31
1.288	1.275	1.268	1.263	1.260	1.253	1.249	1.246	1.245	1.244	12.32
1.289	1.276	1.269	1.264	1.260	1.253	1.249	1.247	1.245	1.244	12.33
1.289	1.276	1.269	1.264	1.261	1.254	1.250	1.247	1.246	1.245	12.34

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
12.35	1.480	1.448	1.423	1.397	1.375	1.357	1.338	1.323	1.311	1.303
12.36	1.481	1.449	1.424	1.398	1.376	1.358	1.339	1.324	1.312	1.304
12.37	1.482	1.450	1.425	1.399	1.377	1.359	1.340	1.325	1.313	1.305
12.38	1.484	1.451	1.426	1.400	1.378	1.360	1.340	1.325	1.313	1.305
12.39	1.485	1.452	1.427	1.401	1.379	1.361	1.341	1.326	1.314	1.306
12.40	1.486	1.453	1.428	1.402	1.380	1.362	1.342	1.327	1.315	1.307
12.41	1.487	1.454	1.429	1.403	1.381	1.363	1.343	1.328	1.316	1.308
12.42	1.488	1.455	1.430	1.404	1.382	1.364	1.344	1.328	1.317	1.308
12.43	1.489	1.456	1.431	1.405	1.382	1.364	1.344	1.329	1.317	1.309
12.44	1.490	1.457	1.432	1.406	1.383	1.365	1.345	1.329	1.318	1.309
12.45	1.491	1.458	1.433	1.407	1.384	1.366	1.346	1.330	1.319	1.310
12.46	1.492	1.459	1.434	1.408	1.385	1.367	1.347	1.331	1.320	1.311
12.47	1.493	1.460	1.435	1.409	1.386	1.368	1.348	1.332	1.321	1.311
12.48	1.494	1.462	1.436	1.409	1.387	1.368	1.348	1.332	1.321	1.312
12.49	1.495	1.463	1.437	1.410	1.388	1.369	1.349	1.333	1.322	1.312
12.50	1.496	1.464	1.438	1.411	1.389	1.370	1.350	1.334	1.323	1.313
12.51	1.497	1.465	1.439	1.412	1.390	1.371	1.351	1.335	1.324	1.314
12.52	1.498	1.466	1.440	1.413	1.391	1.372	1.352	1.336	1.324	1.315
12.53	1.499	1.467	1.441	1.414	1.392	1.372	1.352	1.336	1.325	1.315
12.54	1.500	1.468	1.442	1.415	1.393	1.373	1.353	1.337	1.325	1.316
12.55	1.501	1.469	1.443	1.416	1.394	1.374	1.354	1.338	1.326	1.317
12.56	1.502	1.470	1.444	1.417	1.395	1.375	1.355	1.339	1.327	1.318
12.57	1.503	1.471	1.445	1.418	1.396	1.376	1.356	1.340	1.328	1.319
12.58	1.505	1.472	1.446	1.418	1.397	1.377	1.356	1.340	1.328	1.319
12.59	1.506	1.473	1.447	1.419	1.398	1.378	1.357	1.341	1.329	1.320
12.60	1.507	1.474	1.448	1.420	1.399	1.379	1.358	1.342	1.330	1.321
12.61	1.508	1.475	1.449	1.421	1.400	1.380	1.359	1.343	1.331	1.322
12.62	1.509	1.476	1.450	1.422	1.401	1.381	1.360	1.344	1.332	1.323
12.63	1.510	1.477	1.451	1.423	1.402	1.381	1.360	1.344	1.332	1.323
12.64	1.511	1.478	1.452	1.424	1.403	1.382	1.361	1.345	1.333	1.324
12.65	1.512	1.479	1.453	1.425	1.404	1.383	1.362	1.346	1.334	1.325
12.66	1.513	1.480	1.454	1.426	1.405	1.384	1.363	1.347	1.335	1.326
12.67	1.514	1.481	1.455	1.427	1.406	1.385	1.364	1.348	1.335	1.327
12.68	1.515	1.482	1.456	1.428	1.407	1.386	1.365	1.348	1.336	1.327
12.69	1.516	1.483	1.457	1.429	1.408	1.387	1.366	1.349	1.336	1.328
12.70	1.517	1.484	1.458	1.430	1.409	1.388	1.367	1.350	1.337	1.329
12.71	1.518	1.485	1.459	1.431	1.410	1.389	1.368	1.351	1.338	1.330
12.72	1.519	1.486	1.460	1.432	1.411	1.390	1.369	1.352	1.339	1.330
12.73	1.520	1.487	1.461	1.433	1.411	1.390	1.369	1.352	1.339	1.331
12.74	1.521	1.488	1.462	1.434	1.412	1.391	1.370	1.353	1.340	1.331
12.75	1.522	1.489	1.463	1.435	1.413	1.392	1.371	1.354	1.341	1.332
12.76	1.523	1.490	1.464	1.436	1.414	1.393	1.372	1.355	1.342	1.333
12.77	1.524	1.491	1.465	1.437	1.415	1.394	1.373	1.356	1.343	1.334
12.78	1.525	1.492	1.466	1.437	1.416	1.395	1.373	1.356	1.343	1.334
12.79	1.526	1.494	1.467	1.438	1.417	1.396	1.374	1.357	1.344	1.335

				T_r						P_r 12.35 - 12.79
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.290	1.277	1.270	1.265	1.261	1.254	1.250	1.247	1.246	1.245	12.35
1.291	1.278	1.271	1.266	1.262	1.254	1.250	1.247	1.246	1.245	12.36
1.291	1.279	1.271	1.266	1.262	1.255	1.251	1.248	1.247	1.246	12.37
1.292	1.279	1.272	1.267	1.263	1.255	1.251	1.248	1.247	1.246	12.38
1.292	1.280	1.272	1.267	1.263	1.256	1.252	1.249	1.248	1.247	12.39
1.293	1.281	1.273	1.268	1.264	1.256	1.252	1.249	1.248	1.247	12.40
1.294	1.282	1.274	1.268	1.264	1.256	1.252	1.249	1.248	1.247	12.41
1.294	1.282	1.274	1.269	1.265	1.257	1.253	1.249	1.248	1.247	12.42
1.295	1.283	1.275	1.269	1.265	1.257	1.253	1.250	1.249	1.248	12.43
1.295	1.283	1.275	1.270	1.266	1.258	1.254	1.250	1.249	1.248	12.44
1.296	1.284	1.276	1.270	1.266	1.258	1.254	1.250	1.249	1.248	12.45
1.297	1.285	1.277	1.271	1.267	1.259	1.254	1.250	1.249	1.248	12.46
1.298	1.286	1.277	1.271	1.267	1.259	1.255	1.251	1.250	1.249	12.47
1.298	1.286	1.278	1.272	1.268	1.260	1.255	1.251	1.250	1.249	12.48
1.299	1.287	1.278	1.272	1.268	1.260	1.256	1.252	1.251	1.250	12.49
1.300	1.288	1.279	1.273	1.269	1.261	1.256	1.252	1.251	1.250	12.50
1.301	1.288	1.280	1.273	1.269	1.261	1.256	1.252	1.251	1.250	12.51
1.301	1.289	1.280	1.274	1.270	1.262	1.257	1.253	1.251	1.250	12.52
1.302	1.289	1.281	1.274	1.270	1.262	1.257	1.253	1.252	1.251	12.53
1.302	1.290	1.281	1.275	1.271	1.263	1.258	1.254	1.252	1.251	12.54
1.303	1.290	1.282	1.275	1.271	1.263	1.258	1.254	1.252	1.251	12.55
1.304	1.291	1.283	1.276	1.271	1.263	1.258	1.254	1.252	1.251	12.56
1.305	1.291	1.283	1.276	1.272	1.264	1.259	1.255	1.253	1.252	12.57
1.305	1.292	1.284	1.277	1.272	1.264	1.259	1.255	1.253	1.252	12.58
1.306	1.292	1.284	1.277	1.273	1.265	1.260	1.256	1.254	1.253	12.59
1.307	1.293	1.285	1.278	1.273	1.265	1.260	1.256	1.254	1.253	12.60
1.308	1.294	1.286	1.278	1.274	1.265	1.260	1.256	1.254	1.253	12.61
1.308	1.295	1.286	1.279	1.274	1.266	1.260	1.256	1.255	1.254	12.62
1.309	1.295	1.287	1.279	1.275	1.266	1.261	1.257	1.255	1.254	12.63
1.309	1.296	1.287	1.280	1.275	1.267	1.261	1.257	1.256	1.255	12.64
1.310	1.297	1.288	1.280	1.276	1.267	1.261	1.257	1.256	1.255	12.65
1.311	1.298	1.289	1.281	1.277	1.267	1.261	1.257	1.256	1.255	12.66
1.312	1.298	1.289	1.281	1.277	1.268	1.262	1.258	1.257	1.256	12.67
1.312	1.299	1.290	1.282	1.278	1.268	1.262	1.258	1.257	1.256	12.68
1.313	1.299	1.290	1.282	1.278	1.269	1.263	1.259	1.258	1.257	12.69
1.314	1.300	1.291	1.283	1.279	1.269	1.263	1.259	1.258	1.257	12.70
1.315	1.301	1.292	1.284	1.279	1.269	1.263	1.259	1.258	1.257	12.71
1.315	1.301	1.292	1.284	1.280	1.270	1.264	1.260	1.258	1.257	12.72
1.316	1.302	1.293	1.285	1.280	1.270	1.264	1.260	1.259	1.258	12.73
1.316	1.302	1.293	1.285	1.281	1.271	1.265	1.261	1.259	1.258	12.74
1.317	1.303	1.294	1.286	1.281	1.271	1.265	1.261	1.259	1.258	12.75
1.318	1.304	1.295	1.287	1.281	1.271	1.265	1.261	1.259	1.258	12.76
1.319	1.304	1.295	1.287	1.282	1.272	1.266	1.262	1.260	1.259	12.77
1.319	1.305	1.296	1.288	1.282	1.272	1.266	1.262	1.260	1.259	12.78
1.320	1.305	1.296	1.288	1.283	1.273	1.267	1.263	1.261	1.260	12.79

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
12.80	1.527	1.495	1.468	1.439	1.418	1.397	1.375	1.358	1.345	1.336
12.81	1.528	1.496	1.469	1.440	1.419	1.398	1.376	1.359	1.346	1.337
12.82	1.529	1.497	1.470	1.441	1.420	1.399	1.377	1.360	1.346	1.337
12.83	1.530	1.498	1.471	1.442	1.420	1.399	1.377	1.360	1.347	1.338
12.84	1.531	1.499	1.472	1.443	1.421	1.400	1.378	1.361	1.347	1.338
12.85	1.532	1.500	1.473	1.444	1.422	1.401	1.379	1.362	1.348	1.339
12.86	1.533	1.501	1.474	1.445	1.423	1.402	1.380	1.363	1.349	1.340
12.87	1.534	1.502	1.475	1.446	1.424	1.403	1.381	1.363	1.350	1.340
12.88	1.535	1.503	1.475	1.447	1.425	1.403	1.381	1.364	1.350	1.341
12.89	1.536	1.504	1.476	1.448	1.426	1.404	1.382	1.364	1.351	1.341
12.90	1.537	1.505	1.477	1.449	1.427	1.405	1.383	1.365	1.352	1.342
12.91	1.538	1.506	1.478	1.450	1.428	1.406	1.384	1.366	1.353	1.343
12.92	1.539	1.507	1.479	1.451	1.429	1.407	1.385	1.367	1.354	1.344
12.93	1.540	1.508	1.480	1.452	1.429	1.407	1.385	1.367	1.354	1.344
12.94	1.541	1.509	1.481	1.453	1.430	1.308	1.386	1.368	1.355	1.345
12.95	1.542	1.510	1.482	1.454	1.431	1.409	1.387	1.369	1.356	1.346
12.96	1.543	1.511	1.483	1.455	1.432	1.410	1.388	1.370	1.357	1.347
12.97	1.544	1.512	1.484	1.456	1.433	1.411	1.389	1.371	1.358	1.348
12.98	1.546	1.513	1.485	1.456	1.434	1.412	1.389	1.372	1.358	1.348
12.99	1.547	1.514	1.486	1.457	1.435	1.413	1.390	1.373	1.359	1.349
13.00	1.548	1.515	1.487	1.458	1.436	1.414	1.391	1.374	1.360	1.350
13.01	1.549	1.516	1.488	1.459	1.437	1.415	1.392	1.375	1.361	1.351
13.02	1.550	1.517	1.489	1.460	1.438	1.416	1.393	1.376	1.362	1.352
13.03	1.551	1.518	1.490	1.461	1.438	1.416	1.393	1.376	1.362	1.352
13.04	1.552	1.519	1.491	1.462	1.439	1.417	1.394	1.377	1.363	1.353
13.05	1.553	1.520	1.492	1.463	1.440	1.418	1.395	1.378	1.364	1.354
13.06	1.554	1.521	1.493	1.464	1.441	1.419	1.396	1.379	1.365	1.355
13.07	1.555	1.522	1.494	1.465	1.442	1.420	1.397	1.379	1.365	1.356
13.08	1.556	1.523	1.495	1.466	1.443	1.420	1.397	1.380	1.366	1.356
13.09	1.557	1.524	1.496	1.467	1.444	1.421	1.398	1.380	1.366	1.357
13.10	1.558	1.525	1.497	1.468	1.445	1.422	1.399	1.381	1.367	1.358
13.11	1.559	1.526	1.498	1.469	1.446	1.423	1.400	1.382	1.368	1.359
13.12	1.560	1.527	1.499	1.470	1.447	1.424	1.401	1.383	1.369	1.359
13.13	1.561	1.528	1.500	1.471	1.447	1.424	1.401	1.383	1.369	1.360
13.14	1.562	1.529	1.501	1.472	1.448	1.425	1.402	1.384	1.370	1.360
13.15	1.563	1.530	1.502	1.473	1.449	1.426	1.403	1.385	1.371	1.361
13.16	1.564	1.531	1.503	1.474	1.450	1.427	1.404	1.386	1.372	1.362
13.17	1.565	1.532	1.504	1.475	1.451	1.428	1.405	1.387	1.372	1.362
13.18	1.566	1.533	1.505	1.475	1.451	1.429	1.406	1.387	1.373	1.363
13.19	1.567	1.534	1.506	1.476	1.452	1.430	1.407	1.388	1.373	1.363
13.20	1.568	1.535	1.507	1.477	1.453	1.431	1.408	1.389	1.374	1.364
13.21	1.569	1.536	1.508	1.478	1.454	1.432	1.409	1.390	1.375	1.365
13.22	1.570	1.537	1.509	1.479	1.455	1.433	1.410	1.391	1.376	1.366
13.23	1.571	1.538	1.510	1.480	1.456	1.433	1.410	1.391	1.376	1.366
13.24	1.572	1.539	1.511	1.481	1.457	1.434	1.411	1.392	1.377	1.367

					T_r					P_r 12.80 - 13.24
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.321	1.306	1.297	1.289	1.283	1.273	1.267	1.263	1.261	1.260	12.80
1.322	1.307	1.297	1.289	1.284	1.273	1.267	1.263	1.261	1.260	12.81
1.322	1.307	1.298	1.290	1.284	1.274	1.268	1.264	1.262	1.260	12.82
1.323	1.308	1.298	1.290	1.285	1.274	1.268	1.264	1.262	1.261	12.83
1.323	1.308	1.299	1.291	1.285	1.275	1.269	1.265	1.263	1.261	12.84
1.324	1.309	1.299	1.291	1.286	1.275	1.269	1.265	1.263	1.261	12.85
1.325	1.310	1.300	1.292	1.287	1.275	1.269	1.265	1.263	1.262	12.86
1.326	1.310	1.300	1.292	1.287	1.276	1.270	1.266	1.264	1.262	12.87
1.326	1.311	1.301	1.293	1.288	1.276	1.270	1.266	1.264	1.262	12.88
1.327	1.311	1.301	1.293	1.288	1.277	1.271	1.267	1.265	1.263	12.89
1.328	1.312	1.302	1.294	1.289	1.277	1.271	1.267	1.265	1.263	12.90
1.329	1.313	1.303	1.295	1.289	1.277	1.271	1.267	1.265	1.263	12.91
1.329	1.313	1.303	1.295	1.290	1.278	1.271	1.267	1.265	1.264	12.92
1.330	1.314	1.304	1.296	1.290	1.278	1.272	1.268	1.266	1.264	12.93
1.330	1.314	1.304	1.296	1.291	1.279	1.272	1.268	1.266	1.265	12.94
1.331	1.315	1.305	1.297	1.291	1.279	1.272	1.268	1.266	1.265	12.95
1.332	1.316	1.306	1.298	1.291	1.279	1.272	1.268	1.266	1.265	12.96
1.333	1.317	1.306	1.298	1.292	1.280	1.273	1.269	1.267	1.266	12.97
1.333	1.317	1.307	1.299	1.292	1.280	1.273	1.269	1.267	1.266	12.98
1.334	1.318	1.307	1.299	1.293	1.281	1.274	1.270	1.268	1.267	12.99
1.335	1.319	1.308	1.300	1.293	1.281	1.274	1.270	1.268	1.267	13.00
1.336	1.319	1.308	1.300	1.293	1.281	1.274	1.270	1.268	1.267	13.01
1.336	1.320	1.309	1.301	1.294	1.282	1.275	1.270	1.268	1.267	13.02
1.337	1.320	1.309	1.301	1.294	1.282	1.275	1.271	1.269	1.268	13.03
1.337	1.321	1.310	1.302	1.295	1.283	1.276	1.271	1.269	1.268	13.04
1.338	1.321	1.310	1.302	1.295	1.283	1.276	1.271	1.269	1.268	13.05
1.339	1.322	1.311	1.302	1.296	1.284	1.276	1.271	1.269	1.268	13.06
1.339	1.322	1.311	1.303	1.296	1.284	1.277	1.272	1.270	1.269	13.07
1.340	1.323	1.312	1.303	1.297	1.285	1.277	1.272	1.270	1.269	13.08
1.340	1.323	1.312	1.304	1.297	1.285	1.278	1.273	1.271	1.270	13.09
1.341	1.324	1.313	1.304	1.298	1.286	1.278	1.273	1.271	1.270	13.10
1.342	1.325	1.314	1.305	1.298	1.286	1.278	1.273	1.271	1.270	13.11
1.343	1.325	1.314	1.305	1.299	1.287	1.279	1.274	1.272	1.270	13.12
1.343	1.326	1.315	1.306	1.299	1.287	1.279	1.274	1.272	1.271	13.13
1.344	1.326	1.315	1.306	1.300	1.288	1.280	1.275	1.273	1.271	13.14
1.345	1.327	1.316	1.307	1.300	1.288	1.280	1.275	1.273	1.271	13.15
1.346	1.328	1.317	1.308	1.301	1.288	1.280	1.275	1.273	1.271	13.16
1.347	1.329	1.318	1.308	1.301	1.289	1.281	1.276	1.274	1.272	13.17
1.347	1.329	1.318	1.309	1.302	1.289	1.281	1.276	1.274	1.272	13.18
1.348	1.330	1.319	1.309	1.302	1.290	1.282	1.277	1.275	1.273	13.19
1.349	1.331	1.320	1.310	1.303	1.290	1.282	1.277	1.275	1.273	13.20
1.350	1.332	1.320	1.311	1.303	1.290	1.282	1.277	1.275	1.273	13.21
1.350	1.332	1.321	1.311	1.304	1.291	1.283	1.277	1.275	1.274	13.22
1.351	1.333	1.321	1.312	1.304	1.291	1.283	1.278	1.276	1.274	13.23
1.351	1.333	1.322	1.312	1.305	1.292	1.284	1.278	1.276	1.275	13.24

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
13.25	1.573	1.540	1.512	1.482	1.458	1.435	1.412	1.393	1.378	1.368
13.26	1.574	1.541	1.513	1.483	1.459	1.436	1.413	1.394	1.379	1.369
13.27	1.575	1.542	1.514	1.484	1.460	1.437	1.414	1.395	1.380	1.370
13.28	1.576	1.544	1.515	1.484	1.461	1.438	1.414	1.396	1.380	1.370
13.29	1.577	1.545	1.516	1.485	1.462	1.439	1.415	1.397	1.381	1.371
13.30	1.578	1.546	1.517	1.486	1.463	1.440	1.416	1.398	1.382	1.372
13.31	1.579	1.547	1.518	1.487	1.464	1.441	1.417	1.399	1.383	1.373
13.32	1.580	1.548	1.519	1.488	1.465	1.442	1.418	1.399	1.383	1.373
13.33	1.581	1.549	1.519	1.489	1.465	1.442	1.418	1.400	1.384	1.374
13.34	1.582	1.550	1.520	1.490	1.466	1.443	1.419	1.400	1.384	1.374
13.35	1.583	1.551	1.521	1.491	1.467	1.444	1.420	1.401	1.385	1.375
13.36	1.584	1.552	1.522	1.492	1.468	1.445	1.421	1.402	1.386	1.376
13.37	1.585	1.553	1.523	1.493	1.469	1.446	1.422	1.402	1.387	1.377
13.38	1.587	1.554	1.524	1.493	1.470	1.447	1.422	1.403	1.387	1.377
13.39	1.588	1.556	1.525	1.494	1.471	1.448	1.423	1.403	1.388	1.378
13.40	1.589	1.556	1.526	1.495	1.472	1.449	1.424	1.404	1.389	1.379
13.41	1.590	1.557	1.527	1.496	1.473	1.450	1.425	1.405	1.390	1.380
13.42	1.591	1.558	1.528	1.497	1.474	1.451	1.426	1.406	1.391	1.380
13.43	1.592	1.559	1.529	1.498	1.474	1.451	1.426	1.406	1.391	1.381
13.44	1.593	1.560	1.530	1.499	1.475	1.452	1.427	1.407	1.392	1.381
13.45	1.594	1.561	1.531	1.500	1.476	1.453	1.428	1.408	1.393	1.382
13.46	1.595	1.562	1.532	1.501	1.477	1.454	1.429	1.409	1.394	1.383
13.47	1.596	1.563	1.533	1.502	1.478	1.455	1.430	1.410	1.395	1.384
13.48	1.597	1.564	1.534	1.502	1.478	1.455	1.430	1.410	1.395	1.384
13.49	1.598	1.565	1.535	1.503	1.480	1.456	1.431	1.411	1.396	1.385
13.50	1.599	1.566	1.536	1.504	1.481	1.457	1.432	1.412	1.397	1.386
13.51	1.600	1.567	1.537	1.505	1.482	1.458	1.433	1.413	1.398	1.387
13.52	1.601	1.568	1.538	1.506	1.483	1.459	1.434	1.414	1.398	1.387
13.53	1.602	1.569	1.539	1.507	1.483	1.459	1.434	1.414	1.399	1.388
13.54	1.603	1.570	1.540	1.508	1.484	1.460	1.435	1.415	1.399	1.388
13.55	1.604	1.571	1.541	1.509	1.485	1.461	1.436	1.416	1.400	1.389
13.56	1.605	1.572	1.542	1.510	1.486	1.462	1.437	1.417	1.401	1.390
13.57	1.606	1.573	1.543	1.511	1.487	1.463	1.438	1.418	1.402	1.391
13.58	1.607	1.575	1.544	1.512	1.488	1.464	1.438	1.418	1.402	1.391
13.59	1.608	1.576	1.545	1.513	1.489	1.465	1.439	1.419	1.403	1.392
13.60	1.609	1.577	1.546	1.514	1.490	1.466	1.440	1.420	1.404	1.393
13.61	1.610	1.578	1.547	1.515	1.491	1.467	1.441	1.421	1.405	1.394
13.62	1.611	1.579	1.548	1.516	1.492	1.468	1.442	1.422	1.406	1.394
13.63	1.612	1.580	1.549	1.516	1.492	1.468	1.442	1.422	1.406	1.395
13.64	1.613	1.581	1.550	1.517	1.493	1.469	1.443	1.423	1.407	1.395
13.65	1.614	1.582	1.551	1.518	1.494	1.470	1.444	1.424	1.408	1.396
13.66	1.615	1.583	1.552	1.519	1.495	1.471	1.445	1.425	1.409	1.397
13.67	1.616	1.584	1.553	1.520	1.496	1.472	1.446	1.426	1.410	1.398
13.68	1.617	1.585	1.554	1.521	1.497	1.473	1.446	1.426	1.410	1.398
13.69	1.618	1.586	1.555	1.522	1.498	1.474	1.447	1.427	1.411	1.399

T_r										P_r 13.25 - 13.69
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.352	1.334	1.322	1.313	1.305	1.292	1.284	1.278	1.276	1.275	13.25
1.353	1.335	1.323	1.314	1.306	1.292	1.284	1.278	1.276	1.275	13.26
1.353	1.335	1.323	1.314	1.306	1.293	1.285	1.279	1.277	1.276	13.27
1.354	1.336	1.324	1.315	1.307	1.293	1.285	1.279	1.277	1.276	13.28
1.354	1.336	1.324	1.315	1.307	1.294	1.286	1.280	1.278	1.277	13.29
1.355	1.337	1.325	1.316	1.308	1.294	1.286	1.280	1.278	1.277	13.30
1.356	1.338	1.326	1.316	1.308	1.294	1.286	1.280	1.278	1.277	13.31
1.356	1.338	1.326	1.317	1.309	1.295	1.286	1.280	1.278	1.277	13.32
1.357	1.339	1.327	1.317	1.309	1.295	1.287	1.281	1.279	1.278	13.33
1.357	1.339	1.327	1.318	1.310	1.296	1.287	1.281	1.279	1.278	13.34
1.358	1.340	1.328	1.318	1.310	1.296	1.287	1.281	1.279	1.278	13.35
1.359	1.341	1.329	1.319	1.311	1.296	1.287	1.281	1.279	1.278	13.36
1.360	1.341	1.329	1.319	1.311	1.297	1.388	1.282	1.280	1.279	13.37
1.360	1.342	1.330	1.320	1.312	1.297	1.288	1.282	1.280	1.279	13.38
1.361	1.342	1.330	1.320	1.312	1.298	1.289	1.283	1.281	1.280	13.39
1.362	1.343	1.331	1.321	1.313	1.298	1.289	1.283	1.281	1.280	13.40
1.363	1.344	1.332	1.321	1.313	1.298	1.289	1.283	1.281	1.280	13.41
1.363	1.344	1.332	1.322	1.314	1.299	1.290	1.284	1.282	1.280	13.42
1.364	1.345	1.333	1.322	1.314	1.299	1.290	1.284	1.282	1.281	13.43
1.364	1.345	1.333	1.323	1.315	1.300	1.291	1.285	1.283	1.281	13.44
1.365	1.346	1.334	1.323	1.315	1.300	1.291	1.285	1.283	1.281	13.45
1.366	1.347	1.335	1.324	1.315	1.300	1.291	1.285	1.283	1.281	13.46
1.367	1.347	1.335	1.324	1.316	1.301	1.292	1.286	1.284	1.282	13.47
1.367	1.348	1.336	1.325	1.316	1.301	1.292	1.286	1.284	1.282	13.48
1.368	1.348	1.336	1.325	1.317	1.302	1.293	1.287	1.285	1.283	13.49
1.369	1.337	1.337	1.326	1.317	1.302	1.293	1.287	1.285	1.283	13.50
1.370	1.338	1.338	1.326	1.317	1.302	1.293	1.287	1.285	1.283	13.51
1.370	1.350	1.338	1.327	1.318	1.303	1.294	1.288	1.286	1.284	13.52
1.371	1.351	1.339	1.327	1.318	1.303	1.294	1.288	1.286	1.284	13.53
1.371	1.351	1.339	1.328	1.319	1.304	1.295	1.289	1.287	1.284	13.54
1.372	1.352	1.340	1.328	1.319	1.304	1.295	1.289	1.287	1.285	13.55
1.373	1.353	1.341	1.329	1.320	1.304	1.295	1.289	1.287	1.285	13.56
1.374	1.353	1.341	1.329	1.320	1.305	1.296	1.290	1.288	1.286	13.57
1.374	1.354	1.342	1.330	1.321	1.305	1.296	1.290	1.288	1.286	13.58
1.375	1.354	1.342	1.330	1.321	1.306	1.297	1.291	1.289	1.287	13.59
1.376	1.355	1.343	1.331	1.322	1.306	1.297	1.291	1.289	1.287	13.60
1.377	1.356	1.344	1.332	1.322	1.306	1.297	1.291	1.289	1.287	13.61
1.377	1.356	1.344	1.332	1.323	1.307	1.297	1.291	1.289	1.288	13.62
1.378	1.357	1.345	1.333	1.323	1.307	1.298	1.292	1.290	1.288	13.63
1.378	1.357	1.345	1.333	1.324	1.308	1.298	1.292	1.290	1.288	13.64
1.379	1.358	1.346	1.334	1.324	1.308	1.298	1.292	1.290	1.288	13.65
1.380	1.359	1.347	1.335	1.325	1.308	1.298	1.292	1.290	1.288	13.66
1.380	1.359	1.347	1.335	1.325	1.309	1.299	1.293	1.291	1.289	13.67
1.381	1.360	1.348	1.336	1.326	1.309	1.299	1.293	1.291	1.289	13.68
1.381	1.360	1.348	1.336	1.326	1.310	1.300	1.294	1.292	1.290	13.69

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
13.70	1.619	1.587	1.556	1.523	1.499	1.475	1.448	1.428	1.412	1.400
13.71	1.620	1.588	1.557	1.524	1.500	1.476	1.449	1.429	1.413	1.401
13.72	1.621	1.589	1.558	1.525	1.501	1.477	1.450	1.430	1.414	1.402
13.73	1.622	1.590	1.559	1.525	1.501	1.477	1.450	1.430	1.414	1.402
13.74	1.623	1.591	1.560	1.526	1.502	1.478	1.451	1.431	1.415	1.403
13.75	1.624	1.592	1.561	1.527	1.503	1.479	1.452	1.532	1.416	1.404
13.76	1.625	1.593	1.562	1.528	1.504	1.480	1.453	1.433	1.417	1.405
13.77	1.626	1.594	1.563	1.529	1.505	1.481	1.454	1.434	1.417	1.406
13.78	1.628	1.595	1.564	1.530	1.506	1.481	1.454	1.434	1.418	1.406
13.79	1.629	1.596	1.565	1.531	1.507	1.482	1.455	1.435	1.418	1.407
13.80	1.630	1.597	1.566	1.532	1.508	1.483	1.456	1.436	1.419	1.408
13.81	1.631	1.598	1.567	1.533	1.509	1.484	1.457	1.437	1.420	1.409
13.82	1.632	1.599	1.568	1.534	1.510	1.485	1.458	1.437	1.421	1.409
13.83	1.633	1.600	1.569	1.535	1.511	1.485	1.458	1.438	1.421	1.410
13.84	1.634	1.601	1.570	1.536	1.512	1.486	1.459	1.438	1.422	1.410
13.85	1.635	1.602	1.571	1.537	1.513	1.487	1.460	1.439	1.423	1.411
13.86	1.636	1.603	1.572	1.538	1.514	1.488	1.461	1.440	1.424	1.412
13.87	1.637	1.604	1.573	1.539	1.515	1.489	1.462	1.441	1.424	1.413
13.88	1.638	1.606	1.573	1.540	1.515	1.490	1.463	1.441	1.425	1.413
13.89	1.639	1.607	1.574	1.541	1.516	1.491	1.464	1.442	1.425	1.413
13.90	1.640	1.608	1.574	1.542	1.517	1.492	1.465	1.443	1.426	1.414
13.91	1.641	1.609	1.576	1.543	1.518	1.493	1.466	1.444	1.427	1.415
13.92	1.642	1.610	1.577	1.544	1.519	1.494	1.467	1.445	1.428	1.416
13.93	1.643	1.611	1.578	1.544	1.520	1.494	1.467	1.445	1.428	1.416
13.94	1.644	1.612		1.545	1.521	1.495	1.468	1.446	1.429	1.417
13.95	1.645	1.613	1.580	1.546	1.522	1.496	1.469	1.447	1.430	1.417
13.96	1.646	1.614	1.581	1.547	1.523	1.497	1.470	1.448	1.431	1.418
13.97	1.647	1.615	1.582	1.548	1.524	1.498	1.471	1.449	1.432	1.419
13.98	1.648	1.616	1.583	1.548	1.524	1.498	1.471	1.449	1.432	1.419
13.99	1.649	1.617	1.584	1.549	1.525	1.499	1.472	1.450	1.433	1.420
14.00	1.650	1.618	1.585	1.550	1.526	1.500	1.473	1.451	1.434	1.421
14.01	1.651	1.619	1.586	1.551	1.527	1.501	1.474	1.452	1.435	1.422
14.02	1.652	1.620	1.587	1.552	1.528	1.502	1.475	1.453	1.435	1.423
14.03	1.653	1.621	1.588	1.553	1.529	1.502	1.476	1.453	1.436	1.423
14.04	1.654	1.622	1.589	1.554	1.530	1.503	1.477	1.454	1.436	1.424
14.05	1.655	1.623	1.590	1.555	1.531	1.504	1.478	1.455	1.437	1.425
14.06	1.656	1.624	1.591	1.555	1.532	1.505	1.479	1.456	1.438	1.426
14.07	1.657	1.625	1.592	1.557	1.533	1.506	1.480	1.457	1.439	1.427
14.08	1.659	1.626	1.593	1.558	1.533	1.507	1.480	1.457	1.439	1.427
14.09	1.660	1.627	1.594	1.559	1.534	1.508	1.481	1.458	1.440	1.428
14.10	1.661	1.628	1.595	1.560	1.535	1.509	1.482	1.459	1.441	1.429
14.11	1.662	1.629	1.596	1.561	1.536	1.510	1.483	1.460	1.442	1.430
14.12	1.663	1.630	1.597	1.562	1.537	1.511	1.484	1.461	1.443	1.430
14.13	1.664	1.631	1.598	1.563	1.537	1.511	1.484	1.461	1.443	1.431
14.14	1.665	1.632	1.599	1.564	1.538	1.512	1.485	1.462	1.444	1.431

T_r										P_r
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.382	1.361	1.349	1.337	1.327	1.310	1.300	1.294	1.292	1.290	13.70
1.383	1.362	1.349	1.337	1.327	1.310	1.300	1.294	1.292	1.390	13.71
1.383	1.362	1.350	1.338	1.328	1.311	1.300	1.295	1.292	1.290	13.72
1.384	1.363	1.350	1.338	1.328	1.311	1.301	1.295	1.293	1.291	13.73
1.384	1.363	1.351	1.339	1.329	1.312	1.301	1.296	1.293	1.291	13.74
1.385	1.364	1.351	1.339	1.329	1.312	1.301	1.296	1.293	1.291	13.75
1.386	1.365	1.352	1.340	1.330	1.312	1.301	1.296	1.293	1.291	13.76
1.387	1.366	1.352	1.340	1.330	1.313	1.302	1.297	1.294	1.292	13.77
1.387	1.366	1.353	1.341	1.331	1.313	1.302	1.297	1.294	1.292	13.78
1.388	1.367	1.353	1.341	1.331	1.314	1.303	1.298	1.295	1.293	13.79
1.389	1.368	1.354	1.342	1.332	1.314	1.303	1.298	1.295	1.293	13.80
1.390	1.369	1.355	1.343	1.332	1.314	1.303	1.298	1.295	1.293	13.81
1.391	1.369	1.355	1.343	1.333	1.315	1.304	1.299	1.296	1.294	13.82
1.391	1.370	1.356	1.344	1.333	1.315	1.304	1.299	1.296	1.294	13.83
1.392	1.370	1.356	1.344	1.334	1.316	1.305	1.300	1.297	1.295	13.84
1.393	1.371	1.357	1.345	1.334	1.316	1.305	1.300	1.297	1.295	13.85
1.394	1.372	1.358	1.346	1.335	1.316	1.305	1.300	1.297	1.295	13.86
1.395	1.372	1.358	1.346	1.335	1.317	1.306	1.300	1.298	1.296	13.87
1.395	1.373	1.359	1.347	1.336	1.317	1.306	1.301	1.298	1.296	13.88
1.396	1.373	1.359	1.347	1.336	1.318	1.307	1.301	1.299	1.297	13.89
1.397	1.374	1.360	1.348	1.337	1.318	1.307	1.301	1.299	1.297	13.90
1.397	1.375	1.361	1.348	1.337	1.318	1.307	1.301	1.299	1.297	13.91
1.398	1.375	1.361	1.349	1.338	1.319	1.308	1.301	1.299	1.297	13.92
1.398	1.376	1.362	1.349	1.338	1.319	1.308	1.302	1.300	1.298	13.93
1.399	1.376	1.362	1.350	1.339	1.320	1.309	1.302	1.300	1.298	13.94
1.399	1.377	1.363	1.350	1.339	1.320	1.309	1.302	1.300	1.298	13.95
1.400	1.378	1.364	1.351	1.339	1.320	1.309	1.302	1.300	1.298	13.96
1.400	1.378	1.364	1.351	1.340	1.321	1.310	1.303	1.301	1.299	13.97
1.401	1.379	1.365	1.352	1.340	1.321	1.310	1.303	1.301	1.299	13.98
1.401	1.379	1.365	1.352	1.341	1.321	1.311	1.304	1.302	1.300	13.99
1.402	1.380	1.366	1.353	1.341	1.322	1.311	1.304	1.302	1.300	14.00
1.403	1.381	1.367	1.354	1.341	1.322	1.311	1.304	1.302	1.300	14.01
1.403	1.381	1.367	1.354	1.342	1.323	1.312	1.305	1.302	1.300	14.02
1.404	1.382	1.368	1.355	1.342	1.323	1.312	1.305	1.303	1.301	14.03
1.404	1.382	1.368	1.355	1.343	1.324	1.313	1.306	1.303	1.301	14.04
1.405	1.383	1.369	1.356	1.343	1.324	1.313	1.306	1.303	1.301	14.05
1.406	1.384	1.370	1.356	1.344	1.324	1.313	1.306	1.303	1.301	14.06
1.407	1.384	1.370	1.357	1.344	1.325	1.314	1.307	1.304	1.302	14.07
1.407	1.385	1.371	1.357	1.345	1.325	1.314	1.307	1.304	1.302	14.08
1.408	1.385	1.371	1.358	1.345	1.326	1.315	1.308	1.305	1.303	14.09
1.409	1.386	1.372	1.358	1.346	1.326	1.315	1.308	1.305	1.303	14.10
1.410	1.387	1.373	1.358	1.346	1.326	1.315	1.308	1.305	1.303	14.11
1.410	1.387	1.373	1.359	1.347	1.327	1.316	1.308	1.306	1.304	14.12
1.411	1.388	1.374	1.359	1.347	1.327	1.316	1.309	1.306	1.304	14.13
1.411	1.388	1.374	1.360	1.348	1.328	1.317	1.309	1.307	1.305	14.14

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
14.15	1.666	1.633	1.600	1.565	1.539	1.513	1.486	1.463	1.445	1.432
14.16	1.667	1.634	1.601	1.566	1.540	1.514	1.487	1.464	1.446	1.433
14.17	1.668	1.635	1.602	1.567	1.541	1.515	1.488	1.465	1.447	1.434
14.18	1.669	1.637	1.603	1.568	1.542	1.516	1.488	1.465	1.447	1.434
14.19	1.670	1.638	1.604	1.569	1.543	1.517	1.489	1.466	1.448	1.435
14.20	1.671	1.639	1.605	1.570	1.544	1.518	1.490	1.467	1.449	1.436
14.21	1.672	1.640	1.606	1.571	1.545	1.519	1.491	1.468	1.450	1.437
14.22	1.673	1.641	1.607	1.572	1.546	1.520	1.492	1.469	1.450	1.437
14.23	1.674	1.642	1.607	1.573	1.546	1.520	1.492	1.469	1.451	1.438
14.24	1.675	1.643	1.608	1.574	1.547	1.521	1.493	1.470	1.452	1.438
14.25	1.676	1.644	1.609	1.575	1.548	1.522	1.494	1.471	1.452	1.439
14.26	1.677	1.645	1.610	1.576	1.549	1.523	1.495	1.472	1.453	1.440
14.27	1.678	1.646	1.611	1.577	1.550	1.524	1.496	1.473	1.454	1.441
14.28	1.679	1.647	1.612	1.578	1.551	1.525	1.496	1.473	1.454	1.441
14.29	1.680	1.648	1.613	1.579	1.552	1.526	1.497	1.474	1.455	1.442
14.30	1.681	1.649	1.614	1.580	1.553	1.527	1.498	1.475	1.456	1.443
14.31	1.682	1.650	1.615	1.581	1.554	1.528	1.499	1.476	1.457	1.444
14.32	1.683	1.651	1.616	1.582	1.555	1.529	1.500	1.476	1.458	1.444
14.33	1.684	1.652	1.617	1.582	1.555	1.529	1.500	1.477	1.458	1.445
14.34	1.685	1.653	1.618	1.583	1.556	1.530	1.501	1.477	1.459	1.445
14.35	1.686	1.654	1.619	1.584	1.557	1.531	1.502	1.478	1.460	1.446
14.36	1.687	1.655	1.620	1.585	1.558	1.532	1.503	1.479	1.461	1.447
14.37	1.688	1.656	1.621	1.586	1.559	1.533	1.504	1.480	1.462	1.448
14.38	1.690	1.657	1.622	1.587	1.559	1.534	1.504	1.480	1.462	1.448
14.39	1.691	1.658	1.623	1.588	1.560	1.535	1.505	1.481	1.463	1.449
14.40	1.692	1.659	1.624	1.589	1.561	1.536	1.506	1.482	1.464	1.450
14.41	1.693	1.660	1.625	1.590	1.562	1.537	1.507	1.483	1.465	1.451
14.42	1.694	1.661	1.626	1.591	1.563	1.538	1.508	1.484	1.466	1.452
14.43	1.695	1.662	1.627	1.592	1.563	1.538	1.508	1.484	1.466	1.452
14.44	1.696	1.663	1.628	1.593	1.564	1.539	1.509	1.485	1.467	1.453
14.45	1.697	1.664	1.629	1.594	1.565	1.540	1.510	1.486	1.468	1.454
14.46	1.698	1.665	1.630	1.595	1.566	1.541	1.511	1.487	1.469	1.455
14.47	1.699	1.666	1.631	1.596	1.567	1.542	1.512	1.488	1.470	1.456
14.48	1.700	1.667	1.632	1.596	1.568	1.542	1.513	1.488	1.470	1.456
14.49	1.701	1.668	1.633	1.597	1.569	1.543	1.514	1.489	1.471	1.457
14.50	1.702	1.669	1.634	1.598	1.570	1.544	1.515	1.490	1.472	1.458
14.51	1.703	1.670	1.635	1.599	1.571	1.545	1.516	1.491	1.473	1.459
14.52	1.704	1.671	1.636	1.600	1.572	1.546	1.517	1.492	1.474	1.459
14.53	1.705	1.672	1.637	1.601	1.573	1.546	1.518	1.492	1.474	1.460
14.54	1.706	1.673	1.638	1.602	1.574	1.547	1.519	1.493	1.475	1.460
14.55	1.707	1.674	1.639	1.603	1.575	1.548	1.520	1.494	1.476	1.461
14.56	1.708	1.675	1.640	1.604	1.576	1.549	1.521	1.495	1.477	1.462
14.57	1.709	1.676	1.641	1.605	1.577	1.550	1.522	1.496	1.478	1.463
14.58	1.710	1.677	1.641	1.606	1.578	1.550	1.522	1.496	1.478	1.463
14.59	1.711	1.678	1.642	1.607	1.579	1.551	1.523	1.497	1.479	1.464

T_r										P_r 14.15 - 14.59
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.412	1.389	1.375	1.360	1.348	1.328	1.317	1.309	1.307	1.305	14.15
1.413	1.390	1.376	1.361	1.349	1.328	1.317	1.309	1.307	1.305	14.16
1.414	1.390	1.376	1.361	1.349	1.329	1.318	1.310	1.308	1.306	14.17
1.414	1.391	1.377	1.362	1.350	1.329	1.318	1.310	1.308	1.306	14.18
1.415	1.391	1.377	1.362	1.350	1.330	1.319	1.311	1.309	1.307	14.19
1.416	1.392	1.378	1.363	1.351	1.330	1.319	1.311	1.309	1.307	14.20
1.417	1.393	1.379	1.364	1.351	1.330	1.319	1.311	1.309	1.307	14.21
1.417	1.393	1.379	1.364	1.352	1.331	1.319	1.312	1.309	1.307	14.22
1.418	1.394	1.380	1.365	1.352	1.331	1.320	1.312	1.310	1.308	14.23
1.418	1.394	1.380	1.365	1.353	1.332	1.320	1.313	1.310	1.308	14.24
1.419	1.395	1.381	1.366	1.353	1.332	1.320	1.313	1.310	1.308	14.25
1.420	1.396	1.382	1.367	1.354	1.332	1.320	1.313	1.310	1.308	14.26
1.421	1.396	1.382	1.367	1.354	1.333	1.321	1.314	1.311	1.309	14.27
1.421	1.397	1.383	1.368	1.355	1.333	1.321	1.314	1.311	1.309	14.28
1.422	1.397	1.383	1.368	1.355	1.334	1.322	1.315	1.312	1.310	14.29
1.423	1.398	1.384	1.369	1.356	1.334	1.322	1.315	1.312	1.310	14.30
1.424	1.399	1.385	1.369	1.356	1.334	1.322	1.315	1.312	1.310	14.31
1.424	1.399	1.385	1.370	1.357	1.335	1.322	1.315	1.312	1.310	14.32
1.425	1.400	1.386	1.370	1.357	1.335	1.323	1.316	1.313	1.311	14.33
1.425	1.400	1.386	1.371	1.358	1.336	1.323	1.316	1.313	1.311	14.34
1.426	1.401	1.387	1.371	1.358	1.336	1.323	1.316	1.313	1.311	14.35
1.427	1.402	1.388	1.372	1.358	1.336	1.323	1.316	1.313	1.311	14.36
1.428	1.402	1.388	1.372	1.359	1.337	1.324	1.317	1.314	1.312	14.37
1.428	1.403	1.389	1.373	1.359	1.337	1.324	1.317	1.314	1.312	14.38
1.429	1.403	1.389	1.373	1.360	1.338	1.325	1.318	1.315	1.313	14.39
1.430	1.404	1.390	1.374	1.360	1.338	1.325	1.318	1.315	1.313	14.40
1.431	1.405	1.391	1.374	1.360	1.338	1.325	1.318	1.315	1.313	14.41
1.431	1.405	1.391	1.375	1.361	1.339	1.326	1.319	1.316	1.314	14.42
1.432	1.406	1.392	1.375	1.361	1.339	1.326	1.319	1.316	1.314	14.43
1.432	1.406	1.392	1.376	1.362	1.340	1.327	1.320	1.317	1.315	14.44
1.433	1.407	1.393	1.376	1.362	1.340	1.327	1.320	1.317	1.315	14.45
1.434	1.408	1.394	1.376	1.363	1.340	1.327	1.320	1.317	1.315	14.46
1.435	1.409	1.394	1.377	1.363	1.341	1.328	1.321	1.318	1.316	14.47
1.435	1.409	1.395	1.377	1.364	1.341	1.328	1.321	1.318	1.316	14.48
1.436	1.410	1.395	1.378	1.364	1.342	1.329	1.322	1.319	1.317	14.49
1.437	1.411	1.396	1.379	1.365	1.342	1.329	1.322	1.319	1.317	14.50
1.438	1.412	1.396	1.380	1.365	1.342	1.329	1.322	1.319	1.317	14.51
1.438	1.412	1.397	1.380	1.366	1.343	1.330	1.323	1.320	1.317	14.52
1.439	1.413	1.397	1.381	1.366	1.343	1.330	1.323	1.320	1.318	14.53
1.439	1.413	1.398	1.381	1.367	1.344	1.331	1.324	1.321	1.318	14.54
1.440	1.414	1.398	1.382	1.367	1.344	1.331	1.324	1.321	1.318	14.55
1.441	1.415	1.398	1.383	1.368	1.344	1.331	1.324	1.321	1.218	14.56
1.441	1.415	1.399	1.383	1.368	1.345	1.332	1.325	1.322	1.319	14.57
1.442	1.416	1.399	1.384	1.369	1.345	1.332	1.325	1.322	1.319	14.58
1.442	1.416	1.400	1.384	1.369	1.346	1.333	1.326	1.323	1.320	14.59

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
14.60	1.712	1.679	1.643	1.608	1.580	1.552	1.524	1.498	1.480	1.465
14.61	1.713	1.680	1.644	1.609	1.581	1.553	1.525	1.499	1.481	1.466
14.62	1.714	1.681	1.645	1.610	1.582	1.554	1.526	1.500	1.482	1.466
14.63	1.715	1.682	1.646	1.611	1.582	1.554	1.526	1.500	1.482	1.467
14.64	1.716	1.683	1.647	1.612	1.583	1.555	1.527	1.501	1.483	1.467
14.65	1.717	1.684	1.648	1.613	1.584	1.556	1.528	1.502	1.484	1.468
14.66	1.718	1.685	1.649	1.614	1.585	1.557	1.529	1.503	1.485	1.469
14.67	1.719	1.686	1.650	1.615	1.586	1.558	1.530	1.503	1.486	1.470
14.68	1.720	1.688	1.651	1.615	1.587	1.559	1.530	1.504	1.486	1.470
14.69	1.721	1.689	1.652	1.616	1.588	1.560	1.531	1.504	1.487	1.471
14.70	1.722	1.690	1.653	1.617	1.589	1.561	1.532	1.505	1.488	1.472
14.71	1.723	1.691	1.654	1.618	1.590	1.562	1.533	1.506	1.489	1.473
14.72	1.724	1.692	1.655	1.619	1.591	1.563	1.534	1.507	1.489	1.473
14.73	1.725	1.693	1.656	1.620	1.592	1.563	1.534	1.507	1.490	1.474
14.74	1.726	1.694	1.657	1.621	1.593	1.564	1.535	1.508	1.490	1.474
14.75	1.727	1.695	1.658	1.622	1.594	1.565	1.536	1.509	1.491	1.475
14.76	1.728	1.696	1.659	1.623	1.595	1.566	1.537	1.510	1.492	1.476
14.77	1.729	1.697	1.660	1.624	1.596	1.567	1.538	1.511	1.493	1.477
14.78	1.731	1.698	1.661	1.625	1.596	1.568	1.538	1.511	1.493	1.477
14.79	1.732	1.699	1.662	1.626	1.597	1.569	1.539	1.512	1.494	1.478
14.80	1.733	1.700	1.663	1.627	1.598	1.570	1.540	1.513	1.495	1.479
14.81	1.734	1.701	1.664	1.628	1.599	1.571	1.541	1.514	1.496	1.480
14.82	1.735	1.702	1.665	1.629	1.600	1.572	1.542	1.515	1.496	1.481
14.83	1.736	1.703	1.666	1.630	1.601	1.572	1.542	1.515	1.497	1.481
14.84	1.737	1.704	1.667	1.631	1.602	1.573	1.543	1.516	1.497	1.482
14.85	1.738	1.705	1.668	1.632	1.603	1.574	1.544	1.517	1.498	1.483
14.86	1.739	1.706	1.669	1.633	1.604	1.575	1.545	1.518	1.499	1.484
14.87	1.740	1.707	1.670	1.634	1.605	1.576	1.546	1.519	1.500	1.485
14.88	1.741	1.708	1.671	1.634	1.605	1.577	1.547	1.519	1.500	1.485
14.89	1.742	1.709	1.672	1.635	1.606	1.578	1.548	1.520	1.501	1.486
14.90	1.743	1.710	1.673	1.636	1.607	1.579	1.549	1.521	1.502	1.487
14.91	1.744	1.711	1.674	1.637	1.608	1.580	1.550	1.522	1.503	1.488
14.92	1.745	1.712	1.675	1.638	1.609	1.581	1.551	1.523	1.503	1.488
14.93	1.746	1.713	1.676	1.639	1.610	1.581	1.551	1.523	1.504	1.489
14.94	1.747	1.714	1.677	1.640	1.611	1.582	1.552	1.524	1.504	1.489
14.95	1.748	1.715	1.678	1.641	1.612	1.583	1.553	1.525	1.505	1.490
14.96	1.749	1.716	1.679	1.642	1.613	1.584	1.554	1.526	1.506	1.491
14.97	1.750	1.717	1.680	1.643	1.614	1.585	1.555	1.527	1.506	1.491
14.98	1.751	1.718	1.680	1.643	1.614	1.586	1.556	1.527	1.507	1.492
14.99	1.752	1.719	1.681	1.644	1.615	1.587	1.557	1.528	1.507	1.492
15.00	1.753	1.720	1.682	1.645	1.616	1.588	1.558	1.529	1.508	1.493

T_r										P_r 14.60 - 15.00
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.443	1.417	1.400	1.385	1.370	1.346	1.333	1.326	1.323	1.320	14.60
1.444	1.418	1.401	1.385	1.370	1.346	1.333	1.326	1.323	1.320	14.61
.444	1.418	1.401	1.386	1.371	1.347	1.333	1.326	1.323	1.320	14.62
1.445	1.419	1.402	1.386	1.371	1.347	1.334	1.327	1.324	1.321	14.63
1.445	1.419	1.402	1.387	1.372	1.348	1.334	1.327	1.324	1.321	14.64
1.446	1.420	1.403	1.387	1.372	1.348	1.334	1.327	1.324	1.321	14.65
1.447	1.421	1.404	1.388	1.373	1.348	1.334	1.327	1.324	1.321	14.66
1.448	1.421	1.405	1.388	1.373	1.349	1.335	1.328	1.325	1.322	14.67
1.448	1.422	1.405	1.389	1.374	1.349	1.335	1.328	1.325	1.322	14.68
1.449	1.422	1.406	1.389	1.374	1.350	1.336	1.329	1.326	1.323	14.69
1.450	1.423	1.407	1.390	1.375	1.350	1.336	1.329	1.326	1.323	14.70
1.451	1.424	1.408	1.390	1.375	1.350	1.336	1.329	1.326	1.323	14.71
1.451	1.424	1.408	1.391	1.376	1.351	1.337	1.329	1.326	1.324	14.72
1.452	1.425	1.409	1.391	1.376	1.351	1.337	1.330	1.327	1.324	14.73
1.452	1.425	1.409	1.392	1.377	1.352	1.338	1.330	1.327	1.325	14.74
1.453	1.426	1.410	1.392	1.377	1.352	1.338	1.330	1.327	1.325	14.75
1.454	1.427	1.411	1.393	1.378	1.352	1.338	1.330	1.327	1.325	14.76
1.455	1.427	1.411	1.393	1.378	1.353	1.339	1.331	1.328	1.326	14.77
1.455	1.428	1.412	1.394	1.379	1.353	1.339	1.331	1.328	1.326	14.78
1.456	1.428	1.412	1.394	1.379	1.354	1.340	1.332	1.329	1.327	14.79
1.457	1.429	1.413	1.395	1.380	1.354	1.340	1.332	1.329	1.327	14.80
1.458	1.430	1.414	1.396	1.380	1.354	1.340	1.332	1.329	1.327	14.81
1.458	1.430	1.414	1.396	1.381	1.355	1.340	1.333	1.330	1.327	14.82
1.459	1.431	1.415	1.397	1.381	1.355	1.341	1.333	1.330	1.328	14.83
1.459	1.431	1.415	1.397	1.382	1.356	1.341	1.334	1.331	1.328	14.84
1.460	1.432	1.416	1.398	1.382	1.356	1.341	1.334	1.331	1.328	14.85
1.461	1.433	1.417	1.399	1.383	1.356	1.341	1.334	1.331	1.328	14.86
1.461	1.434	1.417	1.399	1.383	1.357	1.342	1.335	1.332	1.329	14.87
1.462	1.434	1.418	1.400	1.384	1.357	1.342	1.335	1.332	1.329	14.88
1.462	1.435	1.418	1.400	1.384	1.358	1.343	1.336	1.333	1.330	14.89
1.463	1.436	1.419	1.401	1.385	1.358	1.343	1.336	1.333	1.330	14.90
1.464	1.437	1.419	1.401	1.385	1.358	1.343	1.336	1.333	1.330	14.91
1.464	1.437	1.420	1.402	1.386	1.359	1.344	1.337	1.333	1.330	14.92
1.465	1.438	1.420	1.402	1.386	1.359	1.344	1.337	1.334	1.331	14.93
1.465	1.438	1.421	1.403	1.387	1.360	1.345	1.338	1.334	1.331	14.94
1.466	1.439	1.421	1.403	1.387	1.360	1.345	1.338	1.334	1.331	14.95
1.467	1.440	1.422	1.404	1.388	1.360	1.345	1.338	1.334	1.331	14.96
1.468	1.440	1.422	1.404	1.388	1.361	1.346	1.339	1.335	1.332	14.97
1.468	1.441	1.423	1.405	1.389	1.361	1.346	1.339	1.335	1.332	14.98
1.469	1.441	1.423	1.406	1.389	1.362	1.347	1.340	1.336	1.333	14.99
1.470	1.442	1.424	1.406	1.390	1.362	1.347	1.340	1.336	1.333	15.00

TABLE XII

CONVERSION FACTORS FROM COMPRESSIBILITY (Z) TO SUPERCOMPRESSIBILITY - F_{pv}

$$F_{pv} = \sqrt{\frac{1}{Z}}$$

Z	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
					F_{pv}					
0.250	2.000	1.996	1.992	1.988	1.984	1.980	1.976	1.973	1.969	1.965
0.260	1.961	1.957	1.954	1.950	1.946	1.943	1.939	1.935	1.932	1.928
0.270	1.925	1.921	1.917	1.914	1.910	1.907	1.903	1.900	1.897	1.893
0.280	1.890	1.886	1.883	1.880	1.876	1.873	1.870	1.867	1.863	1.860
0.290	1.857	1.854	1.851	1.847	1.844	1.841	1.838	1.835	1.832	1.829
0.300	1.826	1.823	1.820	1.817	1.814	1.811	1.808	1.805	1.802	1.799
0.310	1.796	1.793	1.790	1.787	1.785	1.782	1.779	1.776	1.773	1.771
0.320	1.768	1.765	1.762	1.760	1.757	1.754	1.751	1.749	1.746	1.743
0.330	1.741	1.738	1.736	1.733	1.730	1.728	1.725	1.723	1.720	1.718
0.340	1.715	1.712	1.710	1.707	1.705	1.703	1.700	1.698	1.695	1.693
0.350	1.690	1.688	1.685	1.683	1.681	1.678	1.676	1.674	1.671	1.669
0.360	1.667	1.664	1.662	1.660	1.657	1.655	1.653	1.651	1.648	1.646
0.370	1.664	1.642	1.640	1.637	1.635	1.633	1.631	1.629	1.627	1.624
0.380	1.622	1.620	1.618	1.616	1.614	1.612	1.610	1.607	1.605	1.603
0.390	1.601	1.599	1.597	1.595	1.593	1.591	1.589	1.587	1.585	1.583
0.400	1.581	1.579	1.577	1.575	1.573	1.571	1.569	1.567	1.566	1.564
0.410	1.562	1.560	1.558	1.556	1.554	1.552	1.550	1.549	1.547	1.545
0.420	1.543	1.541	1.539	1.538	1.536	1.534	1.532	1.530	1.529	1.527
0.430	1.525	1.523	1.521	1.520	1.518	1.516	1.514	1.513	1.511	1.509
0.440	1.508	1.506	1.504	1.502	1.501	1.499	1.497	1.496	1.494	1.492
0.450	1.491	1.489	1.487	1.486	1.484	1.482	1.481	1.479	1.478	1.476
0.460	1.474	1.473	1.471	1.470	1.468	1.466	1.465	1.463	1.462	1.460
0.470	1.459	1.457	1.456	1.454	1.452	1.451	1.449	1.448	1.446	1.445
0.480	1.443	1.442	1.440	1.439	1.437	1.436	1.434	1.433	1.431	1.430
0.490	1.429	1.427	1.426	1.424	1.423	1.421	1.420	1.418	1.417	1.416
0.500	1.414	1.413	1.411	1.410	1.409	1.407	1.406	1.404	1.403	1.402
0.510	1.400	1.399	1.398	1.396	1.395	1.393	1.392	1.391	1.389	1.388
0.520	1.387	1.385	1.384	1.383	1.381	1.380	1.379	1.378	1.376	1.375
0.530	1.374	1.372	1.371	1.370	1.368	1.367	1.366	1.365	1.363	1.362
0.540	1.361	1.360	1.358	1.357	1.356	1.355	1.353	1.352	1.351	1.350
0.550	1.348	1.347	1.346	1.345	1.344	1.342	1.341	1.340	1.339	1.338
0.560	1.336	1.335	1.334	1.333	1.332	1.330	1.329	1.328	1.327	1.326
0.570	1.325	1.323	1.322	1.321	1.320	1.319	1.318	1.316	1.315	1.314
0.580	1.313	1.312	1.311	1.310	1.309	1.307	1.306	1.305	1.304	1.303
0.590	1.302	1.301	1.300	1.299	1.297	1.296	1.295	1.294	1.293	1.292

TABLE XII, Continued

Z	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
					F_{pv}					
0.600	1.291	1.290	1.289	1.288	1.287	1.286	1.285	1.284	1.282	1.281
0.610	1.280	1.279	1.278	1.277	1.276	1.275	1.274	1.273	1.272	1.271
0.620	1.270	1.269	1.268	1.267	1.266	1.265	1.264	1.263	1.262	1.261
0.630	1.260	1.259	1.258	1.257	1.256	1.255	1.254	1.253	1.252	1.251
0.640	1.250	1.249	1.248	1.247	1.246	1.245	1.244	1.243	1.242	1.241
0.650	1.240	1.239	1.238	1.237	1.237	1.236	1.235	1.234	1.233	1.232
0.660	1.231	1.230	1.229	1.228	1.227	1.226	1.225	1.224	1.224	1.223
0.670	1.222	1.221	1.220	1.219	1.218	1.217	1.216	1.215	1.214	1.214
0.680	1.213	1.212	1.211	1.210	1.209	1.208	1.207	1.206	1.206	1.205
0.690	1.204	1.203	1.202	1.201	1.200	1.200	1.199	1.198	1.197	1.196
0.700	1.195	1.194	1.194	1.193	1.192	1.191	1.190	1.189	1.188	1.188
0.710	1.187	1.186	1.185	1.184	1.183	1.183	1.182	1.181	1.180	1.179
0.720	1.179	1.178	1.177	1.176	1.175	1.174	1.174	1.173	1.172	1.171
0.730	1.170	1.170	1.169	1.168	1.167	1.166	1.166	1.165	1.164	1.163
0.740	1.162	1.162	1.161	1.160	1.159	1.159	1.158	1.157	1.156	1.155
0.750	1.155	1.154	1.153	1.152	1.152	1.151	1.150	1.149	1.149	1.148
0.760	1.147	1.146	1.146	1.145	1.144	1.143	1.143	1.142	1.141	1.140
0.770	1.140	1.139	1.138	1.137	1.137	1.136	1.135	1.134	1.134	1.1
0.780	1.132	1.132	1.131	1.130	1.129	1.129	1.128	1.127	1.127	1.126
0.790	1.125	1.124	1.124	1.123	1.122	1.122	1.121	1.120	1.119	1.119
0.800	1.118	1.117	1.117	1.116	1.115	1.115	1.114	1.113	1.112	1.112
0.810	1.111	1.110	1.110	1.109	1.108	1.108	1.107	1.106	1.106	1.105
0.820	1.104	1.104	1.103	1.102	1.102	1.101	1.100	1.100	1.099	1.098
0.830	1.098	1.097	1.096	1.096	1.095	1.094	1.094	1.093	1.092	1.092
0.840	1.091	1.090	1.090	1.089	1.089	1.088	1.087	1.087	1.086	1.085
0.850	1.085	1.084	1.083	1.083	1.082	1.081	1.081	1.080	1.080	1.079
0.860	1.078	1.078	1.077	1.076	1.076	1.075	1.075	1.074	1.073	1.073
0.870	1.072	1.071	1.071	1.070	1.070	1.069	1.068	1.068	1.067	1.067
0.880	1.066	1.065	1.065	1.064	1.064	1.063	1.062	1.062	1.061	1.061
0.890	1.060	1.059	1.059	1.058	1.058	1.057	1.056	1.056	1.055	1.055
0.900	1.054	1.054	1.053	1.052	1.052	1.051	1.051	1.050	1.049	1.049
0.910	1.048	1.048	1.047	1.047	1.046	1.045	1.045	1.044	1.044	1.043
0.920	1.043	1.042	1.041	1.041	1.040	1.040	1.139	1.039	1.038	1.038
0.930	1.037	1.036	1.036	1.035	1.035	1.034	1.034	1.033	1.033	1.032
0.940	1.031	1.031	1.030	1.030	1.029	1.029	1.028	1.028	1.027	1.027
0.950	1.026	1.025	1.025	1.024	1.024	1.023	1.023	1.022	1.022	1.0
0.960	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.0
0.970	1.015	1.015	1.014	1.014	1.013	1.013	1.012	1.012	1.011	1.011
0.980	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.006	1.006
0.990	1.005	1.005	1.004	1.004	1.003	1.003	1.002	1.002	1.001	1.001

TABLE XIII

CONVERSION OF API GRAVITY TO SPECIFIC GRAVITY - G_1

$$G_1 = \frac{141.5}{131.5 + API}$$

API Gravity at 60F	Specific Gravity	API Gravity at 60F	Specific Gravity	API Gravity at 60F	Specific Gravity
10	1.000	35	0.8498	60	0.7389
11	0.9930	36	0.8448	61	0.7351
12	0.9861	37	0.8398	62	0.7313
13	0.9792	38	0.8348	63	0.7275
14	0.9725	39	0.8299	64	0.7238
15	0.9659	40	0.8251	65	0.7201
16	0.9593	41	0.8203	66	0.7165
17	0.9529	42	0.8155	67	0.7128
18	0.9465	43	0.8109	68	0.7093
19	0.9402	44	0.8063	69	0.7057
20	0.9340	45	0.8017	70	0.7022
21	0.9279	46	0.7972	71	0.6988
22	0.9218	47	0.7927	72	0.6953
23	0.9159	48	0.7883	73	0.6919
24	0.9100	49	0.7839	74	0.6886
25	0.9042	50	0.7796	75	0.6852
26	0.8984	51	0.7753	76	0.6819
27	0.8927	52	0.7711	77	0.6787
28	0.8871	53	0.7669	78	0.6754
29	0.8816	54	0.7628	79	0.6722
30	0.8762	55	0.7587	80	0.6690
31	0.8708	56	0.7547	81	0.6659
32	0.8654	57	0.7507	82	0.6628
33	0.8602	58	0.7467	83	0.6597
34	0.8550	59	0.7428	84	0.6566

For conversion from other temperature to 60F see Table XVII, page VII - 97.

TABLE XIV

Values of $1-e^{-S}$ for Various Values of GL

VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$
598	611	.043	1,320	1,334	.092	2,083	2,098	.141
612	625	.044	1,335	1,349	.093	2,099	2,114	.142
626	640	.045	1,350	1,365	.094	2,115	2,130	.143
641	654	.046	1,366	1,380	.095	2,131	2,146	.144
655	669	.047	1,381	1,395	.096	2,147	2,162	.145
670	683	.048	1,396	1,410	.097	2,163	2,178	.146
684	698	.049	1,411	1,426	.098	2,179	2,194	.147
699	712	.050	1,427	1,441	.099	2,195	2,210	.148
713	727	.051	1,442	1,456	.100	2,211	2,226	.149
728	741	.052	1,457	1,471	.101	2,227	2,243	.150
742	756	.053	1,472	1,487	.102	2,244	2,259	.151
757	770	.054	1,488	1,502	.103	2,260	2,275	.152
771	785	.055	1,503	1,517	.104	2,276	2,291	.153
786	799	.056	1,518	1,533	.105	2,292	2,307	.154
800	814	.057	1,534	1,548	.106	2,308	2,324	.155
815	828	.058	1,549	1,563	.107	2,325	2,340	.156
829	843	.059	1,564	1,579	.108	2,341	2,356	.157
844	858	.060	1,580	1,594	.109	2,357	2,373	.158
859	872	.061	1,595	1,610	.110	2,374	2,389	.159
873	887	.062	1,611	1,625	.111	2,390	2,405	.160
888	902	.063	1,626	1,641	.112	2,406	2,422	.161
903	916	.064	1,642	1,656	.113	2,423	2,438	.162
917	931	.065	1,657	1,672	.114	2,439	2,455	.163
932	946	.066	1,673	1,687	.115	2,456	2,471	.164
947	961	.067	1,688	1,703	.116	2,472	2,488	.165
962	975	.068	1,704	1,718	.117	2,489	2,504	.166
976	990	.069	1,719	1,734	.118	2,505	2,521	.167
991	1,005	.070	1,735	1,750	.119	2,522	2,537	.168
1,006	1,020	.071	1,751	1,765	.120	2,538	2,554	.169
1,021	1,035	.072	1,766	1,781	.121	2,555	2,570	.170
1,036	1,049	.073	1,782	1,797	.122	2,571	2,587	.171
1,050	1,064	.074	1,798	1,812	.123	2,588	2,603	.172
1,065	1,079	.075	1,813	1,828	.124	2,604	2,620	.173
1,080	1,094	.076	1,829	1,844	.125	2,621	2,637	.174
1,095	1,109	.077	1,845	1,859	.126	2,638	2,653	.175
1,110	1,124	.078	1,860	1,875	.127	2,654	2,670	.176
1,125	1,139	.079	1,876	1,891	.128	2,671	2,687	.177
1,140	1,154	.080	1,892	1,907	.129	2,688	2,703	.178
1,155	1,169	.081	1,908	1,923	.130	2,704	2,720	.179
1,170	1,184	.082	1,924	1,938	.131	2,721	2,737	.180
1,185	1,199	.083	1,939	1,954	.132	2,738	2,754	.181
1,200	1,214	.084	1,955	1,970	.133	2,755	2,771	.182
1,215	1,229	.085	1,971	1,986	.134	2,772	2,787	.183
1,230	1,244	.086	1,987	2,002	.135	2,788	2,804	.184
1,245	1,259	.087	2,003	2,018	.136	2,805	2,821	.185
1,260	1,274	.088	2,019	2,034	.137	2,822	2,838	.186
1,275	1,289	.089	2,035	2,050	.138	2,839	2,855	.187
1,290	1,304	.090	2,051	2,066	.139	2,856	2,872	.188
1,305	1,319	.091	2,067	2,082	.140	2,873	2,889	.189

TABLE XIV, Continued

VALUES FROM	OF GL TO	$1-e^{x}-S$		VALUES FROM	OF GL TO	$1-e^{x}-S$		VALUES FROM	OF GL TO	$1-e^{x}-S$
2,890	2,906	.190		3,747	3,765	.239		4,662	4,680	.288
2,907	2,923	.191		3,766	3,783	.240		4,681	4,700	.289
2,924	2,940	.192		3,784	3,801	.241		4,701	4,719	.290
2,941	2,957	.193		3,802	3,819	.242		4,720	4,739	.291
2,958	2,974	.194		3,820	3,837	.243		4,740	4,758	.292
2,975	2,991	.195		3,838	3,855	.244		4,759	4,777	.293
2,992	3,008	.196		3,856	3,873	.245		4,778	4,816	.294
3,009	3,025	.197		3,874	3,892	.246		4,798	4,816	.295
3,026	3,042	.198		3,893	3,910	.247		4,817	4,836	.296
3,043	3,060	.199		3,911	3,928	.248		4,837	4,855	.297
3,061	3,077	.200		3,929	3,947	.249		4,856	4,875	.298
3,078	3,094	.201		3,948	3,965	.250		4,876	4,895	.299
3,095	3,111	.202		3,966	3,983	.251		4,896	4,914	.300
3,112	3,128	.203		3,984	4,002	.252		4,915	4,934	.301
3,129	3,146	.204		4,003	4,020	.253		4,935	4,954	.302
3,147	3,163	.205		4,021	4,038	.254		4,955	4,973	.303
3,164	3,180	.206		4,039	4,057	.255		4,974	4,993	.304
3,181	3,198	.207		4,058	4,075	.256		4,994	5,013	.305
3,199	3,215	.208		4,076	4,094	.257		5,014	5,033	.306
3,216	3,232	.209		4,095	4,112	.258		5,034	5,053	.307
3,233	3,250	.210		4,113	4,131	.259		5,054	5,072	.308
3,251	3,267	.211		4,132	4,150	.260		5,073	5,092	.309
3,268	3,285	.212		4,151	4,168	.261		5,093	5,112	.310
3,286	3,302	.213		4,169	4,187	.262		5,113	5,132	.311
3,303	3,320	.214		4,188	4,205	.263		5,133	5,152	.312
3,321	3,337	.215		4,206	4,224	.264		5,153	5,172	.313
3,338	3,355	.216		4,225	4,243	.265		5,173	5,192	.314
3,356	3,372	.217		4,244	4,262	.266		5,193	5,212	.315
3,373	3,390	.218		4,263	4,280	.267		5,213	5,233	.316
3,391	3,408	.219		4,281	4,299	.268		5,234	5,253	.317
3,409	3,425	.220		4,300	4,318	.269		5,254	5,273	.318
3,426	3,443	.221		4,319	4,337	.270		5,274	5,293	.319
3,444	3,460	.222		4,338	4,356	.271		5,294	5,313	.320
3,461	3,478	.223		4,357	4,375	.272		5,314	5,333	.321
3,479	3,496	.224		4,376	4,393	.273		5,334	5,354	.322
3,497	3,514	.225		4,394	4,412	.274		5,355	5,374	.323
3,515	3,531	.226		4,413	4,431	.275		5,375	5,394	.324
3,532	3,549	.227		4,432	4,450	.276		5,395	5,415	.325
3,550	3,567	.228		4,451	4,469	.277		5,416	5,435	.326
3,568	3,585	.229		4,470	4,488	.278		5,436	5,456	.327
3,586	3,603	.230		4,489	4,508	.279		5,457	5,476	.328
3,604	3,621	.231		4,509	4,527	.280		5,477	5,497	.329
3,622	3,639	.232		4,528	4,546	.281		5,498	5,517	.330
3,640	3,656	.233		4,547	4,565	.282		5,518	5,538	.331
3,657	3,674	.234		4,566	4,584	.283		5,539	5,558	.332
3,675	3,692	.235		4,585	4,603	.284		5,559	5,579	.333
3,693	3,710	.236		4,604	4,623	.285		5,580	5,600	.334
3,711	3,728	.237		4,624	4,642	.286		5,601	5,620	.335
3,729	3,746	.238		4,643	4,661	.287		5,621	5,641	.336

TABLE XIV, Continued

VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$
5,642	5,662	.337	6,697	6,718	.386	7,840	7,863	.435
5,663	5,682	.338	6,719	6,741	.387	7,864	7,887	.436
5,683	5,703	.339	6,742	6,763	.388	7,888	7,912	.437
5,704	5,724	.340	6,764	6,786	.389	7,913	7,936	.438
5,725	5,745	.341	6,787	6,808	.390	7,937	7,961	.439
5,746	5,766	.342	6,809	6,831	.391	7,962	7,985	.440
5,767	5,787	.343	6,832	6,854	.392	7,986	8,010	.441
5,788	5,808	.344	6,855	6,876	.393	8,011	8,035	.442
5,809	5,829	.345	6,877	6,899	.394	8,036	8,059	.443
5,830	5,850	.346	6,900	6,922	.395	8,060	8,084	.444
5,851	5,871	.347	6,923	6,944	.396	8,085	8,109	.445
5,872	5,892	.348	6,945	6,967	.397	8,110	8,134	.446
5,893	5,913	.349	6,968	6,990	.398	8,135	8,159	.447
5,914	5,934	.350	6,991	7,013	.399	8,160	8,183	.448
5,935	5,955	.351	7,014	7,036	.400	8,184	8,208	.449
5,956	5,977	.352	7,037	7,059	.401	8,209	8,233	.450
5,978	5,998	.353	7,060	7,082	.402	8,234	8,258	.451
5,999	6,019	.354	7,083	7,105	.403	8,259	8,284	.452
6,020	6,040	.355	7,106	7,128	.404	8,285	8,309	.453
6,041	6,062	.356	7,129	7,151	.405	8,310	8,334	.454
6,063	6,083	.357	7,152	7,174	.406	8,335	8,359	.455
6,084	6,105	.358	7,175	7,197	.407	8,360	8,384	.456
6,106	6,126	.359	7,198	7,221	.408	8,385	8,410	.457
6,127	6,148	.360	7,222	7,244	.409	8,411	8,435	.458
6,149	6,169	.361	7,245	7,267	.410	8,436	8,461	.459
6,170	6,191	.362	7,268	7,290	.411	8,462	8,486	.460
6,192	6,212	.363	7,291	7,314	.412	8,487	8,512	.461
6,213	6,234	.364	7,315	7,337	.413	8,513	8,537	.462
6,235	6,256	.365	7,338	7,361	.414	8,538	8,563	.463
6,257	6,277	.366	7,362	7,384	.415	8,564	8,588	.464
6,278	6,299	.367	7,385	7,408	.416	8,589	8,614	.465
6,300	6,321	.368	7,409	7,431	.417	8,615	8,640	.466
6,322	6,342	.369	7,432	7,455	.418	8,641	8,666	.467
6,343	6,364	.370	7,456	7,479	.419	8,667	8,691	.468
6,365	6,386	.371	7,480	7,502	.420	8,692	8,717	.469
6,387	6,408	.372	7,503	7,526	.421	8,718	8,743	.470
6,409	6,430	.373	7,527	7,550	.422	8,744	8,769	.471
6,431	6,452	.374	7,551	7,574	.423	8,770	8,795	.472
6,453	6,474	.375	7,575	7,598	.424	8,796	8,821	.473
6,475	6,496	.376	7,599	7,622	.425	8,822	8,848	.474
6,497	6,518	.377	7,623	7,646	.426	8,849	8,874	.475
6,519	6,540	.378	7,647	7,670	.427	8,875	8,900	.476
6,541	6,562	.379	7,671	7,694	.428	8,901	8,926	.477
6,563	6,585	.380	7,695	7,718	.429	8,927	8,953	.478
6,586	6,607	.381	7,719	7,742	.430	8,954	8,979	.479
6,608	6,629	.382	7,743	7,766	.431	8,980	9,005	.480
6,630	6,651	.383	7,767	7,790	.432	9,006	9,032	.481
6,652	6,674	.384	7,791	7,814	.433	9,033	9,059	.482
6,675	6,696	.385	7,815	7,839	.434	9,060	9,085	.483

TABLE XIV, Continued

VALUE FROM	OF GL TO	1-e^-S		VALUE FROM	OF GL TO	1-e^-S		VALUE FROM	OF GL TO	1-e^-S
9,086	9,112	.484		9,657	9,684	.505		10,253	10,281	.526
9,113	9,138	.485		9,685	9,712	.506		10,282	10,310	.527
9,139	9,165	.486		9,713	9,739	.507		10,311	10,339	.528
9,166	9,192	.487		9,740	9,767	.508		10,340	10,368	.529
9,193	9,219	.488		9,768	9,795	.509		10,369	10,397	.530
9,220	9,246	.489		9,796	9,824	.510		10,398	10,427	.531
9,247	9,273	.490		9,825	9,852	.511		10,428	10,456	.532
9,274	9,300	.491		9,853	9,880	.512		10,457	10,485	.533
9,301	9,327	.492		9,881	9,908	.513		10,486	10,515	.534
9,328	9,354	.493		9,909	9,936	.514		10,516	10,544	.535
9,355	9,381	.494		9,937	9,965	.515		10,545	10,574	.536
9,382	9,408	.495		9,966	9,993	.516		10,575	10,604	.537
9,409	9,436	.496		9,994	10,022	.517		10,605	10,634	.538
9,437	9,463	.497		10,023	10,050	.518		10,635	10,663	.539
9,464	9,490	.498		10,051	10,079	.519		10,664	10,693	.540
9,491	9,518	.499		10,080	10,107	.520		10,694	10,723	.541
9,519	9,545	.500		10,108	10,136	.521		10,724	10,753	.542
9,546	9,573	.501		10,137	10,165	.522		10,754	10,783	.543
9,574	9,601	.502		10,166	10,194	.523		10,784	10,814	.544
9,602	9,628	.503		10,195	10,223	.524		10,815	10,844	.545
9,629	9,656	.504		10,224	10,252	.525		10,845		.546

TABLE XV

Friction Factors for Various Flow Strings (F_r), Tubing

FRICTION FACTORS (Fc) FOR SMALL DIAMETER FLOW STRINGS				
NOMINAL PIPE SIZE INCHES	OUTSIDE DIAMETER INCHES	WEIGHT POUNDS PER FT	INSIDE DIAMETER INCHES	FRICTION FACTOR Fc
TUBING				
3/4	1.050	1.20	.824	94.68
1	1.315	1.80	1.049	50.40
1 1/4	1.660	2.40	1.380	24.62
1 1/4	1.600	2.10	1.410	23.28
1 1/2	1.900	2.90	1.610	16.46
1 1/2	1.900	2.40	1.650	15.44
2 1/16	2.062	3.25	1.867	11.18
2 3/8	2.375	5.95	1.867	11.18
2 3/8	2.375	4.70	1.995	9.402
2 7/8	2.875	8.70	2.259	6.796
2 7/8	2.875	6.50	2.441	5.551
3 1/2	3.500	12.95	2.750	4.066
3 1/2	3.500	10.20	2.922	3.470
3 1/2	3.500	9.30	2.992	3.262
3 1/2	3.500	7.70	3.068	3.055
4	4.000	11.00	3.476	2.205
4	4.000	9.50	3.548	2.090
4 1/2	4.500	12.75	3.958	1.571
CASING				
4 1/2	4.500	15.10	3.826	1.716
4 1/2	4.500	13.50	3.920	1.611
4 1/2	4.500	12.75	3.958	1.571
4 1/2	4.500	11.60	4.000	1.528
4 1/2	4.500	10.50	4.052	1.477
4 1/2	4.500	9.50	4.090	1.442
5	5.000	24.10	4.000	1.528
5	5.000	21.40	4.126	1.409
5	5.000	21.00	4.154	1.384
5	5.000	18.00	4.276	1.284

TABLE XV, Continued (Casing)

FRICTION FACTORS (Fc) FOR LARGE DIAMETER FLOW STRINGS							
CASING NOMINAL SIZE INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES	FRICTION FACTOR Fc	CASING NOMINAL SIZE INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES	FRICTION FACTOR Fc
5.000	15.00	4.408	1.187	7.625	47.10	6.375	.4577
5.000	13.00	4.494	1.129	7.625	45.00	6.445	.4450
5.000	11.50	4.560	1.087	7.625	42.80	6.501	.4352
				7.625	39.00	6.625	.4144
				7.625	33.70	6.765	.3927
5.500	25.00	4.580	1.075	7.625	29.70	6.875	.3766
5.500	23.00	4.670	1.022	7.625	26.40	6.969	.3637
5.500	20.00	4.778	.9637	7.625	24.00	7.025	.3562
5.500	17.00	4.892	.9068				
5.500	15.50	4.950	.8796				
5.500	15.00	4.976	.8678	8.625	49.00	7.511	.2997
5.500	14.00	5.012	.8518	8.625	44.00	7.651	.2858
5.500	13.00	5.044	.8379	8.625	43.00	7.625	.2883
				8.625	40.00	7.725	.2787
				8.625	38.00	7.775	.2741
6.000	26.00	5.140	.7981	8.625	36.00	7.825	.2696
6.000	23.00	5.240	.7594	8.625	32.00	7.907	.2625
6.000	20.00	5.352	.7190	8.625	32.00	7.921	.2613
6.000	18.00	5.424	.6946	8.625	28.00	8.003	.2544
6.000	17.00	5.450	.6861	8.625	28.00	8.017	.2533
6.000	15.00	5.524	.6626	8.625	24.00	8.097	.2469
				8.625	20.00	8.191	.2396
				8.625	17.50	8.249	.2353
6.625	34.00	5.595	.6411				
6.625	32.00	5.675	.6181				
6.625	28.00	5.791	.5866	9.625	58.00	8.435	.2221
6.625	26.00	5.855	.5702	9.625	53.50	8.535	.2155
6.625	24.00	5.921	.5539	9.625	47.00	8.681	.2062
6.625	22.00	5.989	.5378	9.625	43.50	8.755	.2018
6.625	20.00	6.049	.5242	9.625	40.00	8.835	.1971
				9.625	36.00	8.921	.1922
				9.625	32.30	9.001	.1878
7.000	40.00	5.836	.5750				
7.000	38.00	5.920	.5542				
7.000	35.00	6.004	.5344				
7.000	32.00	6.094	.5142				
7.000	30.00	6.154	.5014				
7.000	29.00	6.184	.4951				
7.000	28.00	6.214	.4890				
7.000	26.00	6.276	.4766				
7.000	24.00	6.336	.4650				
7.000	23.00	6.366	.4594				
7.000	22.00	6.398	.4535				
7.000	20.00	6.456	.4430				
7.000	17.00	6.538	.4288				

TABLE XVI Friction Factors for Various Annuli (F_r)

FRICTION	FACTORS	(Fc)	FOR	ANNUL	AR FLO	W IN	GAS	WELL	FLOW	STRINGS
CASING	CASING	CASING				TUBING		SIZES		
OUTSIDE	WEIGHT	INSIDE			OUTSIDE		DIAMETE	R	INCHES	
DIAMETER	POUNDS	DIAMETER								
INCHES	PER FT.	INCHES		1.050	1.315	1.660	1.900	2.0625	2.375	2.875
2.375	5.95	1.867		27.12	46.77	205.1				
2.375	4.70	1.995		20.54	32.13	91.08	651.7			
2.375	4.00	2.041		18.75	28.51	73.10	340.8			
2.875	8.70	2.259		12.71	17.53	33.29	71.59	182.0		
2.875	6.50	2.441		9.609	12.56	20.74	35.41	60.71	948.2	
3.500	12.95	2.750		6.389	7.848	11.27	15.96	21.71	54.16	
3.500	9.30	2.992		4.846	5.762	7.733	10.13	12.71	23.17	309.3
3.500	7.70	3.068		4.472	5.271	6.957	8.949	11.03	18.95	136.3
4.000	11.60	3.428		3.156	3.605	4.479	5.411	6.295	9.055	23.54
4.000	11.00	3.476		3.024	3.442	4.250	5.102	5.902	8.358	20.43
4.000	10.40	3.500		2.960	3.364	4.141	4.957	5.719	8.039	19.11
4.000	*9.50	3.548		2.839	3.216	3.936	4.685	5.378	7.455	16.83
4.500	15.10	3.826		2.259	2.518	2.995	3.467	3.886	5.054	9.241
4.500	13.50	3.920		2.100	2.331	2.749	3.159	3.518	4.499	7.828
4.500	12.75	3.958		2.040	2.260	2.658	3.045	3.383	4.300	7.349
4.500	11.60	4.000		1.977	2.186	2.563	2.927	3.243	4.095	6.870
4.500	10.50	4.052		1.903	2.099	2.451	2.789	3.081	3.861	6.339
4.500	9.50	4.090		1.851	2.039	2.374	2.694	2.970	3.702	5.990
5.000	24.10	4.000		1.977	2.186	2.563	2.927	3.243	4.095	6.870
5.000	21.40	4.126		1.803	1.984	2.304	2.609	2.870	3.561	5.685
5.000	21.00	4.154		1.768	1.942	2.251	2.545	2.796	3.456	5.464
5.000	18.00	4.276		1.623	1.775	2.042	2.291	2.503	3.048	4.637
5.000	15.00	4.408		1.485	1.616	1.845	2.056	2.233	2.682	3.938
5.000	13.00	4.494		1.403	1.524	1.731	1.921	2.080	2.478	3.564
5.000	11.50	4.560		1.345	1.457	1.650	1.826	1.972	2.336	3.312
5.500	25.00	4.580		1.328	1.438	1.627	1.799	1.941	2.295	3.241
5.500	23.00	4.670		1.249	1.356	1.527	1.682	1.809	2.124	2.948
5.500	20.00	4.778		1.170	1.258	1.418	1.556	1.668	1.943	2.645
5.500	17.00	4.892		1.094	1.173	1.315	1.437	1.536	1.775	2.373
5.500	15.50	4.950		1.058	1.133	1.257	1.381	1.474	1.697	2.250
5.500	15.00	4.976		1.043	1.115	1.237	1.357	1.447	1.664	2.198
5.500	14.00	5.012		1.022	1.092	1.209	1.325	1.412	1.619	2.129
5.500	13.00	5.044		1.003	1.072	1.185	1.298	1.381	1.581	2.070

TABLE XVI, Continued

FRICTION	FACTORS	(Fo)	FOR	ANNUL	AR FLO	W IN	GAS	WELL	FLOW	STRINGS
CASING	CASING	CASING				TUBING		SIZES		
OUTSIDE	WEIGHT	INSIDE			OUTSIDE		DIAMETE	R	INCHES	
DIAMETER	POUNDS	DIAMETER								
INCHES	PER FT.	INCHES		1.050	1.315	1.660	1.900	2.0625	2.375	2.875
6.000	26.00	5.140		.9513	1.014	1.118	1.209	1.295	1.475	1.907
6.000	23.00	5.240		.9011	.9588	1.054	1.136	1.202	1.374	1.757
6.000	20.00	5.352		.8492	.9017	.9875	1.062	1.121	1.260	1.609
6.000	18.00	5.424		.8179	.8674	.9480	1.018	1.073	1.202	1.523
6.000	17.00	5.450		.8071	.8555	.9343	1.002	1.056	1.182	1.493
6.000	15.00	5.524		.7772	.8229	.8968	.9605	1.011	1.127	1.414
6.625	34.00	5.595		.7500	.7931	.8628	.9226	.9697	1.079	1.344
6.625	32.00	5.675		.7209	.7614	.8267	.8825	.9262	1.027	1.254
6.625	28.00	5.791		.6814	.7185	.7780	.8285	.8680	.9588	1.161
6.625	26.00	5.855		.6609	.6963	.7528	.8008	.8381	.9238	1.113
6.625	24.00	5.921		.6407	.6744	.7280	.7735	.8088	.8896	1.067
6.625	22.00	5.989		.6208	.6528	.7037	.7467	.7801	.8563	1.023
6.625	20.00	6.049		.6039	.6345	.6832	.7242	.7560	.8283	.9855
7.000	40.00	5.836		.6669	.7028	.7601	.8089	.8469	.9340	1.127
7.000	38.00	5.920		.6410	.6747	.7284	.7739	.8093	.8901	1.068
7.000	35.00	6.004		.6165	.6481	.6985	.7410	.7740	.8492	1.013
7.000	32.00	6.094		.5916	.6213	.6684	.7080	.7386	.8082	.9590
7.000	30.00	6.154		.5758	.6043	.6493	.6871	.7163	.7825	.9252
7.000	29.00	6.184		.5681	.5960	.6400	.6769	.7055	.7700	.9089
7.000	28.00	6.214		.5606	.5879	.6310	.6670	.6949	.7579	.8931
7.000	26.00	6.276		.5455	.5716	.6128	.6472	.6737	.7336	.8616
7.000	24.00	6.336		.5313	.5564	.5959	.6288	.6541	.7112	.8326
7.000	23.00	6.366		.5245	.5490	.5877	.6199	.6446	.7003	.8187
7.000	22.00	6.398		.5173	.5413	.5791	.6105	.6347	.6890	.8041
7.000	20.00	6.456		.5046	.5277	.5640	.5941	.6173	.6692	.7768
7.000	17.00	6.538		.4874	.5093	.5436	.5720	.5938	.6425	.7448
7.625	47.10	6.375		.5224	.5469	.5852	.6172	.6418	.6971	.8145
7.625	45.00	6.445		.5070	.5303	.5668	.5972	.6205	.6729	.7835
7.625	42.80	6.501		.4951	.5175	.5527	.5818	.6042	.6543	.7599
7.625	39.00	6.625		.4700	.4907	.5230	.5498	.5702	.6158	.7111
7.625	33.70	6.765		.4439	.4628	.4922	.5165	.5349	.5760	.6613
7.625	29.70	6.875		.4247	.4424	.4698	.4923	.5094	.5473	.6256
7.625	26.40	6.969		.4092	.4259	.4517	.4728	.4889	.5244	.5973
7.625	24.00	7.025		.4004	.4165	.4414	.4618	.4772	.5114	.5813

TABLE XVI, Continued

FRICTION	FACTORS	(Fc)	FOR	ANNUL	AR FLO	W IN	GAS	WELL	FLOW	STRINGS
CASING	CASING	CASING				TUBING		SIZES		
OUTSIDE	WEIGHT	INSIDE			OUTSIDE		DIAMETE	R	INCHES	
DIAMETER	POUNDS	DIAMETER								
INCHES	PER FT.	INCHES		1.050	1.315	1.660	1.900	2.0625	2.375	2.875
8.625	49.00	7.511		.3337	.3458	.3644	.3794	.3908	.4155	.4650
8.625	44.00	7.651		.3174	.3285	.3458	.3596	.3700	.3926	.4377
8.625	43.00	7.625		.3203	.3317	.3491	.3632	.3737	.3967	.4426
8.625	40.00	7.725		.3092	.3200	.3364	.3497	.3596	.3812	.4242
8.625	38.00	7.775		.3038	.3144	.3303	.3432	.3528	.3738	.4155
8.625	36.00	7.825		.2986	.3088	.3244	.3369	.3463	.3666	.4069
8.625	32.00	7.907		.2903	.3001	.3149	.3269	.3358	.3552	.3935
8.625	32.00	7.921		.2889	.2986	.3134	.3252	.3341	.3533	.3912
8.625	28.00	8.003		.2810	.2903	.3044	.3157	.3241	.3424	.3785
8.625	28.00	8.017		.2796	.2889	.3029	.3141	.3225	.3406	.3764
8.625	24.00	8.097		.2722	.2811	.2945	.3053	.3133	.3306	.3646
8.625	20.00	8.191		.2639	.2723	.2851	.2953	.3029	.3193	.3515
8.625	17.50	8.249		.2589	.2671	.2795	.2894	.2967	.3126	.3437
9.625	58.00	8.435		.2438	.2513	.2625	.2715	.2781	.2925	.3203
9.625	53.50	8.535		.2362	.2433	.2540	.2625	.2688	.2824	.3087
9.625	47.00	8.681		.2256	.2323	.2422	.2501	.2560	.2685	.2928
9.625	43.50	8.755		.2205	.2269	.2365	.2441	.2498	.2618	.2851
9.625	40.00	8.835		.2152	.2214	.2306	.2379	.2433	.2549	.2772
9.625	36.00	8.921		.2097	.2156	.2245	.2315	.2367	.2477	.2690
9.625	32.30	9.001		.2047	.2104	.2190	.2257	.2307	.2413	.2617

TABLE XVII

CORRECTIONS TO OBSERVED A. P. I. GRAVITY TAKEN AT VARIOUS TEMPERATURES, TO OBTAIN A. P. I. GRAVITY AT 60F

Observed Temperature F	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0
	Add to observed A. P. I. reading							
30	1.7	2.0	2.4	3.0	3.7	4.3	5.0	5.7
32	1.6	1.9	2.3	2.8	3.4	4.0	4.7	5.3
34	1.5	1.8	2.1	2.6	3.1	3.7	4.3	4.9
36	1.4	1.6	2.0	2.4	2.9	3.4	4.0	4.6
38	1.3	1.5	1.8	2.2	2.6	3.1	3.6	4.2
40	1.2	1.4	1.6	2.0	2.4	2.8	3.2	3.8
42	1.1	1.2	1.5	1.8	2.2	2.5	2.9	3.4
44	0.9	1.1	1.3	1.6	2.0	2.2	2.6	3.0
46	0.8	0.9	1.1	1.4	1.7	1.9	2.3	2.7
48	0.7	0.8	0.9	1.2	1.4	1.6	2.0	2.3
50	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9
52	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5
54	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1
56	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
58	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.4
	Subtract from observed A. P. I. reading							
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
64	0.2	0.3	0.3	0.4	0.4	0.6	0.6	0.7
66	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
68	0.5	0.6	0.6	0.7	0.9	1.1	1.3	1.4
70	0.6	0.7	0.8	0.9	1.1	1.4	1.6	1.7
72	0.7	0.8	0.9	1.1	1.3	1.6	1.9	2.1
74	0.8	0.9	1.1	1.3	1.6	1.8	2.2	2.5
76	0.9	1.1	1.3	1.5	1.8	2.1	2.5	2.8
78	1.0	1.2	1.4	1.7	2.0	2.4	2.8	3.1
80	1.1	1.3	1.5	1.8	2.2	2.6	3.1	3.5
82	1.2	1.4	1.7	2.0	2.5	2.9	3.4	3.9
84	1.3	1.5	1.8	2.2	2.7	3.2	3.7	4.3
86	1.4	1.7	2.0	2.4	2.9	3.4	4.0	4.6
88	1.6	1.8	2.1	2.6	3.1	3.7	4.2	4.9
90	1.7	2.0	2.3	2.7	3.3	3.9	4.5	5.2
92	1.8	2.1	2.4	2.9	3.5	4.2	4.8	5.6
94	1.9	2.2	2.6	3.1	3.8	4.4	5.1	5.9
96	2.0	2.3	2.7	3.3	4.0	4.6	5.4	6.3
98	2.1	2.4	2.9	3.4	4.2	4.9	5.7	6.6
100	2.2	2.6	3.0	3.6	4.4	5.1	6.0	6.9
102	2.3	2.7	3.2	3.8	4.6	5.4	6.3	7.2
104	2.4	2.9	3.3	4.0	4.8	5.7	6.6	7.5
106	2.5	3.0	3.5	4.2	5.0	5.9	6.9	7.9
108	2.7	3.1	3.6	4.3	5.2	6.2	7.2	8.2
110	2.8	3.2	3.7	4.4	5.4	6.4	7.5	8.5
112	2.9	3.3	3.9	4.6	5.6	6.7	7.7	8.8
114	3.0	3.4	4.0	4.7	5.8	6.9	7.9	9.1
116	3.1	3.6	4.1	4.9	6.0	7.1	8.2	9.4
118	3.2	3.7	4.3	5.1	6.2	7.3	8.5	9.8
120	3.3	3.8	4.4	5.3	6.4	7.5	8.8	10.0

Based on data from U. S. Bureau of Standards Technical Paper 77.

APPENDICES

APPENDIX A, L 10 (Square Root) Chart Conversion Factors..... A-1

APPENDIX B, Calculation of Specific Gravity of the Well Fluid (G) B-1

APPENDIX C, The Flow Equation and Friction Factor (F_r)..... C-1

APPENDIX D, Correction for Deviation from Ideal Gas Laws..... D-1

APPENDIX A

L-10 (SQUARE ROOT) CHART CONVERSION FACTORS

Square Root Chart Reading	Differential, h_w $R_h = 100$	Static Pressure, P_m $R_p = 100$	Temperature, F. $R_t = 150$
0.0	0.0	0.0	0.0
1.0	1.00	1.00	1.5
1.5	2.25	2.25	3.4
2.0	4.00	4.00	6.0
2.2	4.84	4.84	7.3
2.4	5.76	5.76	8.6
2.6	6.76	6.76	10.1
2.8	7.84	7.84	11.8
3.0	9.00	9.00	13.5
3.2	10.24	10.24	15.4
3.4	11.56	11.56	17.3
3.6	12.96	12.96	19.4
3.8	14.44	14.44	21.7
4.0	16.00	16.00	24.0
4.1	16.81	16.81	25.2
4.2	17.64	17.64	26.5
4.3	18.49	18.49	27.7
4.4	19.36	19.36	29.0
4.5	20.25	20.25	30.4
4.6	21.16	21.16	31.7
4.7	22.09	22.09	33.1
4.8	23.04	23.04	34.6
4.9	24.01	24.01	36.0
5.0	25.00	25.00	37.5
5.1	26.01	26.01	39.0
5.2	27.04	27.04	40.6
5.3	28.09	28.09	42.1
5.4	29.16	29.16	43.7
5.5	30.25	30.25	45.4
5.6	31.36	31.36	47.0
5.7	32.49	32.49	48.7
5.8	33.64	33.64	50.5
5.9	34.81	34.81	52.
6.0	36.00	36.00	54.
6.1	37.21	37.21	55.8
6.2	38.44	38.44	57.7

Square Root Chart Reading	Differential, h_w $R_h = 100$	Static Pressure, P_m $R_p = 100$	Temperature, F. $R_t = 150$
6.3	39.69	39.69	59.5
6.4	40.96	40.96	61.4
6.5	42.25	42.25	63.5
6.6	43.56	43.56	65.3
6.7	44.89	44.89	67.3
6.8	46.24	46.24	69.4
6.9	47.61	47.61	71.4
7.0	49.00	49.00	73.5
7.1	50.41	50.41	75.6
7.2	51.84	51.84	77.8
7.3	53.29	53.29	79.9
7.4	54.76	54.76	82.1
7.5	56.25	56.25	84.4
7.6	57.76	57.76	86.6
7.7	59.29	59.29	88.9
7.8	60.84	60.84	91.3
7.9	62.41	62.41	93.6
8.0	64.00	64.00	96.0
8.1	65.61	65.61	98.4
8.2	67.24	67.24	100.9
8.3	68.89	68.89	103.3
8.4	70.56	70.56	105.8
8.5	72.25	72.25	108.4
8.6	73.96	73.96	110.9
8.7	75.69	75.69	113.5
8.8	77.44	77.44	116.2
8.9	79.21	79.21	118.8
9.0	81.00	81.00	121.5
9.1	82.82	82.82	124.2
9.2	84.64	84.64	127.0
9.3	86.49	86.49	129.7
9.4	88.36	88.36	132.5
9.5	90.25	90.25	135.4
9.6	92.16	92.16	138.2
9.7	94.09	94.09	141.1
9.8	96.04	96.04	144.1
9.9	98.01	98.01	147.0
10.0	100.00	100.0	150.0

Note: Subtract the actual atmospheric pressure from the static pressure to obtain gauge (dead weight) pressure.

Should the meter ranges differ from the ranges reflected in the above table, values corresponding to the proper range shall be determined by use of the following formula:

$$\text{Value at Range of Meter} = \frac{\text{Range of Meter}}{\text{Range of Table}} \times \text{Value in Table}$$

APPENDIX B
Calculation of the Specific Gravity of the Well Fluid (G)

When the specific gravity of the well fluid is not known, but the specific gravity of the separator gas "G_g," the API gravity of the separator liquid, and the gas-liquid hydrocarbon ratio are known, the well fluid gravity can be calculated from the following equation:

$$G = \frac{G_g + \frac{4595\ G_l}{GOR}}{1 + \frac{V_l}{GOR}} \qquad \text{B-1}$$

The approximate vapor volume equivalent, V_l (cu. ft. per bbl.), corresponding to the applicable API gravity is obtained through use of the following equation or table:

$$V_l = 369 + 5\ (\text{API gravity}) + 0.04\ (\text{API gravity})^2 \qquad \text{B-2}$$

Equation derived from Table 13.9, page 708, Volume II, U. S. Bureau of Mines Monograph 10.

Vapor Volume Equivalent, V_l, Corresponding to API Gravity

API Gravity	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
40.0	633	634	635	635	636	637	638	639	640	640
41.0	641	642	643	644	645	645	646	647	648	649
42.0	650	650	651	652	653	654	655	655	656	657
43.0	658	659	660	660	661	662	663	664	665	666
44.0	666	667	668	669	670	671	672	672	673	674
45.0	675	676	677	678	678	679	680	681	682	683
46.0	684	685	685	686	687	688	689	690	691	691
47.0	692	693	694	695	696	697	698	699	699	700
48.0	701	702	703	704	705	706	706	707	708	709
49.0	710	711	712	713	714	715	715	716	717	718
50.0	719	720	721	722	723	724	724	725	726	727
51.0	728	729	730	731	732	733	734	734	735	736
52.0	737	738	739	740	741	742	743	744	745	745
53.0	746	747	748	749	750	751	752	753	754	755
54.0	756	757	758	758	759	760	761	762	763	764
55.0	765	766	767	768	769	770	771	772	773	773
56.0	774	775	776	777	778	779	780	781	782	783
57.0	784	785	786	787	788	789	790	791	792	793
58.0	794	795	795	796	797	798	799	800	801	802
59.0	803	804	805	806	807	808	809	810	811	812
60.0	813	814	815	816	817	818	819	820	821	822
61.0	823	824	825	826	827	828	829	830	831	832
62.0	833	834	835	836	837	838	839	840	841	842
63.0	843	844	845	846	847	848	849	850	851	852
64.0	853	854	855	856	857	858	859	860	861	862
65.0	863	864	865	866	867	868	869	870	871	872
66.0	873	874	875	876	877	878	879	880	881	883
67.0	884	885	886	887	888	889	890	891	892	893
68.0	894	895	896	897	898	899	900	901	902	903
69.0	904	905	907	908	909	910	911	912	913	914
70.0	915	916	917	918	919	920	921	922	924	925
71.0	926	927	928	929	930	931	932	933	934	935
72.0	936	937	939	940	941	942	943	944	945	946
73.0	947	948	949	950	952	953	954	955	956	957
74.0	958	959	960	961	962	964	965	966	967	968

APPENDIX C

The Flow Equations and the Friction Factor (F_r)

The general flow equation may be expressed as follows: (1)

$$\frac{1000\ GL}{53.33} = \int_{P_2}^{P_1} \frac{P/TZ\ d(P)}{\frac{2.6665 f Q_m^2}{d^5} + H/L(P/TZ)^2} \qquad C\text{-}1$$

In order to utilize equation C-1, the coefficient of friction "f" must be evaluated. It may be obtained from various correlations; however, for the purpose of this report the coefficient of friction "f" as determined from the "complete turbulence" portion of Moody's (2) curves has been adopted. Moody's curves were calculated by means of the Colebrook (3) equation and are equivalent to the Nikuradse (4) equation where the coefficient of friction is independent of the Reynolds Number and depends only on the relative roughness. These values for various sizes of pipe are shown below:

d in.	Relative Roughness(*)	Moody f(**)	f(**)
0.6	0.001	0.0196	0.004900
0.75	0.0008	0.0187	0.004675
1.00	0.0006	0.0175	0.004375
1.50	0.0004	0.0159	0.003975
3.00	0.0002	0.0137	0.003425
6.00	0.0001	0.0120	0.003000
12.00	0.00005	0.0106	0.002650
60.00	0.00001	0.0082	0.002050

(*) Based on an absolute roughness of 0.0006 inches. (For roughness other than 0.0006 inches, see page C-5)

(**) The numerical value of the coefficient of friction "f" as used in this report is equal to 1/4 of the numerical value of the term "f" as used by Moody.

1 Cullender, M. H. and Smith, R. V.: "Practical Solution of Gas-Flow Equations for Wells and Pipelines with Large Temperature Gradients, "AIME Trans. v 207, p 281, 1956.

2 Moody, L. F.: "Friction Factors for Pipe Flow, " ASME Trans. v 66, p 671, 1944.

3 Colebrook, C. F.: "Turbulent Flow in Pipes, with Particular Reference to the Transition Region between the Smooth and Rough Pipe Laws, " J. Inst. Civil Engr. (London) v 11, p 133, 1938 - 1939.

4 Nikuradse, J.: "Stromungsgesetze in Rauhen Rohren, " V. D. I. Forschungsheft 361 (Aug., 1933), Translation, Pet. Engr. (March, May, June, July, Aug., 1940), v 11.

The log-log plot of the coefficient of friction "f" versus the corresponding internal diameter "d" for the values shown above indicates a straight line relationship for pipe diameters less than 4.277 inches and a different straight line relationship for pipe diameters greater than 4.277 inches. These straight lines may be expressed by the form $f = ad^b$, where "a" and "b" are constants.

Application of the method of least squares to the above data results in the following expressions for the coefficient of friction "f, "

$$f = \frac{4.372 \times 10^{-3}}{d^{0.224}} \qquad \text{C-2}$$

for internal diameters less than 4.277 inches, and

$$f = \frac{4.007 \times 10^{-3}}{d^{0.164}} \qquad \text{C-3}$$

for internal diameters greater than 4.277 inches.

For convenience, it is desirable to introduce two new terms F_r and F_e where:

$$(F_r Q_m)^2 = F_e = \frac{2.6665 f Q_m^2}{d^5} \qquad \text{C-4}$$

Substitution of the right hand term of Eq. C-2 and Eq. C-3 for "f" in Eq. C-4 results in

$$F_r = \frac{0.10797}{d^{2.612}} \qquad \text{C-5}$$

for internal diameters less than 4.277 inches, and

$$F_r = \frac{0.10337}{d^{2.582}} \qquad \text{C-6}$$

A table of values of F_r for various sizes of pipe is shown in Table XV.

For non-circular cross-sections, it is necessary to determine an effective value of the internal diameter "d" for substitution in Eq. C-5 and Eq. C-6.

The term d^5 in the general flow equation is from the expression

$$d_e^5 = \frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \qquad \text{C-7}$$

The terms $d^{0.224}$ in Eq. C-2 and $d^{0.164}$ in Eq. C-3 are a result of an empirical relationship and are from the equivalent diameter formula:

$$d_e = \frac{4 \text{ area}}{\text{perimeter}} \qquad \text{C-8}$$

Thus the effective diameter "d" for noncircular cross-sections for use with equation C-5 above is

$$d_e^{2.612} = \left[\frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \times \left(\frac{4 \text{ area}}{\text{perimeter}}\right)^{0.224} \right]^{1/2} \qquad \text{C-9}$$

and for use with Eq. C-6 above is

$$d_e^{2.582} = \left[\frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \times \left(\frac{4 \text{ area}}{\text{perimeter}}\right)^{0.164} \right]^{1/2} \qquad \text{C-10}$$

The term perimeter, as used in equations C-7 through C-10, refers to the total wetted perimeter in contact with the fluid, that is, for annular flow the wetted perimeter would be the sum of the internal perimeter of the larger flow string and external perimeter of the smaller. Thus,

$$d_e^{2.612} = (d - d_o)^{1.612} \ (d + d_o) \qquad \text{C-11}$$

and

$$d_e^{2.582} = (d - d_o)^{1.582} \ (d + d_o) \qquad \text{C-12}$$

for flow through an annular space.

For inclined static column or flow calculations, Eq. C-1 may be simplified as follows:

$$18.75 \ GH = \int_{P_t}^{P_s} \frac{P/TZ \ d(P)}{L/H \ F_e + (P/TZ)^2} \qquad \text{C-13}$$

It should be noted that the term "L/H" in Eq. C-13 is positive when the flow is upward as in a producing gas well and is negative when the flow is downward as in a gas injection well.

Equation C-13 does not lend itself to mathematical integration unless conditions are such that it can be assumed that the temperature "T" and compressibility factor "Z" are constant. In many cases this assumption does not introduce appreciable error and Eq. C-13 may be simplified with the result that

$$P_f^2 = e^s P_c^2 \qquad \text{C-14}$$

for the static column, and

$$P_s^2 = e^s P_t^2 + L/H \left[F_r Q_m TZ\right]^2 \ (e^s - 1) \qquad \text{C-15}$$

where

$$s = 0.0375 \ GH/Tz.$$

Often it is desired to convert the flowing pressure "P_t" to a corresponding static column pressure "P_w." In this case Eq. C-15 becomes

$$P_w^2 = P_t^2 + L/H \left[F_r Q_m TZ\right]^2 \quad (1 - e^{-s}) \qquad \text{C-16}$$

It should be noted that the additional assumption has been made that the temperature "T" and the compressibility factor "Z" are not only constant but that they are the same in both flowing and static columns.

In those cases (usually in deep high-pressure gas wells) when the assumption of constant temperature "T" and compressibility factor "Z" introduces appreciable error, Eq. C-13 may be evaluated by means of a numerical stepwise procedure. The equation for stepwise calculation of subsurface pressures in shut-in gas wells is:

$$37.5\ GH = \left[(P_1 - P_c)\ (I_1 + I_c) + (P_2 - P_1)\ (I_2 + I_1)\right] \qquad \text{C-17}$$

Where the subscripts "c," "1," and "2" indicate conditions at the wellhead, at "H/2," and at "H," respectively.

The final evaluation of the shut-in pressure "P_f" at a vertical depth of "H" in the well computed by:

$$P_f = P_c + \triangle P \qquad \text{C-18}$$

Where

$$\triangle P = \frac{3(37.5\ GH)}{I_c + 4I_1 + I_2} \qquad \text{C-19}$$

The equation for stepwise calculation of subsurface pressures in flowing gas wells is:

$$37.5\ GH = (P_1 - P_t)\ (I_1 + I_t) + (P_2 - P_1)\ (I_2 + I_1) \qquad \text{C-20}$$

Where the subscripts "t," "1," and "2" indicate conditions at the wellhead, at"H/2" and at "H," respectively.

The final evaluation of the flowing pressure "P_s" at a vertical depth of "H" in the well is computed by:

$$P_s = P_t + \triangle P \qquad \text{C-21}$$

and

$$\triangle P = \frac{3(37.5\ GH)}{I_t + 4I_1 + I_2} \qquad \text{C-22}$$

If the Nikuradse (4) equation relating relative roughness with pipe diameter were used instead of Moody's relationship, F_r for an absolute roughness of 0.0006 inches can be expressed as a function of pipe diameter as follows:

$$F_r = \frac{1.63294}{(15.1603 + 4 \log d)\ d^{5/2}} \qquad \text{C-23}$$

In using F_r values based on an absolute roughness of 0.0006 inches, a few wells will be found where flowing bottom-hole pressures are calculated to be more than the shut-in pressure. This is probably caused by the extremely smooth condition of the tubing or a combination of physical conditions which caused the tubing to act as a completely smooth pipe with a resultant low pressure drop due to friction. In those rare instances where there is evidence that the tubing is smoother than normal, the use of F_r values based on an absolute roughness of 0.0001 inches is suggested. F_r values based on an absolute roughness of 0.0001 inches may be calculated as follows:

$$F_r = \frac{1.63294}{(18.2728 + 4 \log d)\ d^{5/2}} \qquad \text{C-24}$$

APPENDIX D

Corrections for Deviations from Ideal Gas Laws

As a part of the problem of determining the characteristics and capacity of a gas well to produce, the volume of gas flowing and its flowing density must be computed.

The volume of gas flowing must be calculated to base conditions from flowing conditions at the point of metering, and the density of the gas in the flowing column must be calculated from atmospheric conditions to those existing in the flowing string. This is done by the use of the Ideal Gas Law: (1)

$$PV = nRT \qquad \text{D-1*}$$

At relatively low pressure or high temperature the deviation of natural gas from this relation is small, but at high pressures or low temperatures this deviation may be considerable. With pure gaseous elements corrections can be made with relatively small error by use of an equation of state. However, with gaseous compounds and mixtures of these gaseous compounds, these equations of state for the mixture become extremely complicated and difficult to handle mathematically. By using the "Law of Corresponding States," calculations of volumes and densities can be made with relatively small error at any pressure and temperature. This is: "That the ratio of the value of any intensive properties to the value of that property at the critical state is related to the ratios of the prevailing absolute temperature and pressure to the critical temperature and pressure by the same function for all similar substances." (2)

The reduced volume $V_r = \frac{V}{V_{cr}}$

The reduced pressure $P_r = \frac{P}{P_{cr}}$

The reduced temperature $T_r = \frac{T}{T_{cr}}$

These relations, developed for pure elements and compounds, have been extended to apply to mixtures by a method devised by Kay (3). In this method, the molal average critical pressure and molal average critical temperature are used rather than the true critical pressure and true critical temperature. The molal average critical pressure and molal average critical temperature are called pseudocritical pressure and pseudocritical temperature to distinguish them from the true critical pressure and true critical temperature. The pseudocritical pressure and pseudocritical temperature are used to compute the pseudo-reduced pressure and pseudo-reduced temperature for mixtures.

By using the pseudo-reduced pressure and pseudo-reduced temperature, the desired compressibility factor can be obtained from Table XI or from a compressibility chart.

The conventional compressibility chart is a plot of Z versus P_r at constant T_r obtained from the equation:

$$Z = \frac{PV}{nRT} = \frac{P_r V_r}{nRT_r} \qquad \text{D-2}$$

*See the following page for Special Nomenclature.

Thus, Z is the factor necessary to correct for the deviation from the Ideal Gas Law of the gas under investigation.

The chart shown (Figure 1) was prepared for hydrocarbons in natural gas. It is possible to utilize this chart satisfactorily by using values of the critical temperature and critical pressure adjusted for other material found in natural gases.

Table A lists the critical properties, molecular weights, and gas gravities of gases common to natural gases. The pseudocritical property of a mixture can be computed by multiplying the value given in this table (use underlined property where more than one is given) by the volume fraction of that constituent in the mixture. The sum of these products is equal to the pseudocritical property of the mixture. This is the preferred method of determining the pseudocritical property.

When no analysis of the gas is available, the pseudocritical properties can be estimated from the gas gravity. In general, carbon dioxide, nitrogen, and hydrogen sulphide will materially affect the pseudocritical properties.

These affects can be approximated by use of Table X. When the quantities of CO_2 or N_2 are beyond the range of Table X, or when appreciable quantities of H_2S are present, the compressibility factors should be determined experimentally.

Table IX is a tabulation of the values for hydrocarbon gases free from carbon dioxide, nitrogen, and hydrogen sulphide.

Table X is a tabulation of corrections of these values for various amounts of carbon dioxide and nitrogen.

Figure 2 shows pseudocritical properties versus gas gravity for miscellaneous natural gases and condensate well fluids. This chart should not be used when a gas analysis is available.

The relationship of pseudocritical properties also can be computed from the following equations devised by A. E. Sweeney, Jr.:

$$P_{cr} = 693 - 35.0G + 432.9X_c - 167.3X_n + 654\,X_{H_2S} \qquad \text{D-(3)}$$

$$T_{cr} = 158 + 33.0G - 167.3X_c - 279.9X_n + 127\,X_{H_2S} \qquad \text{D-(4)}$$

References

(1) Brown, G. G., Katz, D. L., Oberfell, G. C., and Alden, R. C., Natural Gasoline and The Volatile Hydrocarbons, Natural Gasoline Association of America, Tulsa, 1948.

(2) Sage, B. H. and Lacey, W. N., Volumetric and Phase Behavior of Hydrocarbons, Stanford University Press, 1939.

(3) Kay, W. B., Industrial and Engineering Chemistry, v 28, pp 1014, 1936.

Special Nomenclature

P = pressure, lbs./sq. in., absolute $\qquad$ P_{cr} = critical pressure

V = volume, cu. ft. at standard conditions
n = number of moles
R = gas constant, 10.73 per pound mole
T = temperature, degrees Rankine
G = gas gravity, air = 1.000

T_{cr} = critical temperature
V_{cr} = critical volume
X_c = fractional volume of carbon dioxide
X_n = fractional volume of nitrogen
X_{H_2S} = fractional volume of hydrogen sulphide

TABLE A

Component	Molecular Weights M.W.*	Gravity G_g @	Critical T_{cr}*	Temperature T_{cr} #	Critical P_{cr}*	Pressure
Air **	28.95	1.000	238.74		546.69	
N_2 **	28.016	.968	227.22	204.0	492.32	
CO_2 **	44.01	1.52	547.98	496.0	1,072.81	
H_2O **	18.016	.622	1,165.20		3,199.61	
H_2S **	34.082	1.177	672.72		1,306.47	
CH_4	16.042	.554	343.3	336.0	673.1	
C_2H_6	30.068	1.039	549.77		708.3	
C_3H_8	44.094	1.523	665.95		617.4	
nC_4H_{10}	58.120	2.008	765.31		550.7	
nC_5H_{12}	72.146	2.493	845.60		489.5	
nC_6H_{14}	86.172	2.977	914.1		439.7	
nC_7H_{16}	100.198	3.461	972.31		396.9	
Iso-C_4H_{10}	58.120	2.008	734.65		529.1	
Iso-C_5H_{12}	72.146	2.493	829.8		483.0	
Neo-C_5H_{12}	72.146	2.493	780.77		464.0	
C_6H_{14}						
2-Methylpentane	86.172	2.977	896.5		440.1	
3-Methylpentane	86.172	2.977	907.8		453.1	
2-2-Dimethylbutane	86.172	2.977	880.9		450.5	
2-3-Dimethylbutane	86.172	2.977	900.5		455.4	
C_7H_{16}						
2-Methylhexane	100.198	3.461	955.9		400.0	
3-Methylhexane	100.198	3.461	964.0		413.0	
3-Ethylpentane	100.198	3.461	973.4		420.0	
2-2-Dimethylpentane	100.198	3.461	937.6		417.0	
2-3-Dimethylpentane	100.198	3.461	968.0		429.0	
2-4-Dimethylpentane	100.198	3.461	936.5		403.0	
3-3-Dimethylpentane	100.198	3.461	965.0		440.0	
2-2-3-Trimethylbutane	100.198	3.461	956.6		437.2	

* Values from SELECTED VALUES OF PHYSICAL THERMODYNAMIC PROPERTIES OF HYDROCARBONS AND RELATED COMPOUNDS; F. D. Rosini, K. S. Pitzer, R. L. Arnet, R. M. Braun and G. C. Pimentel; American Petroleum Institute, 1953.

** Values from INTERNATIONAL CRITICAL TABLES; McGraw-Hill Publishing Co.

@ Calculated, Air = 1.000.

\# Values from California Natural Gasoline Association Bulletin No. TS 461.

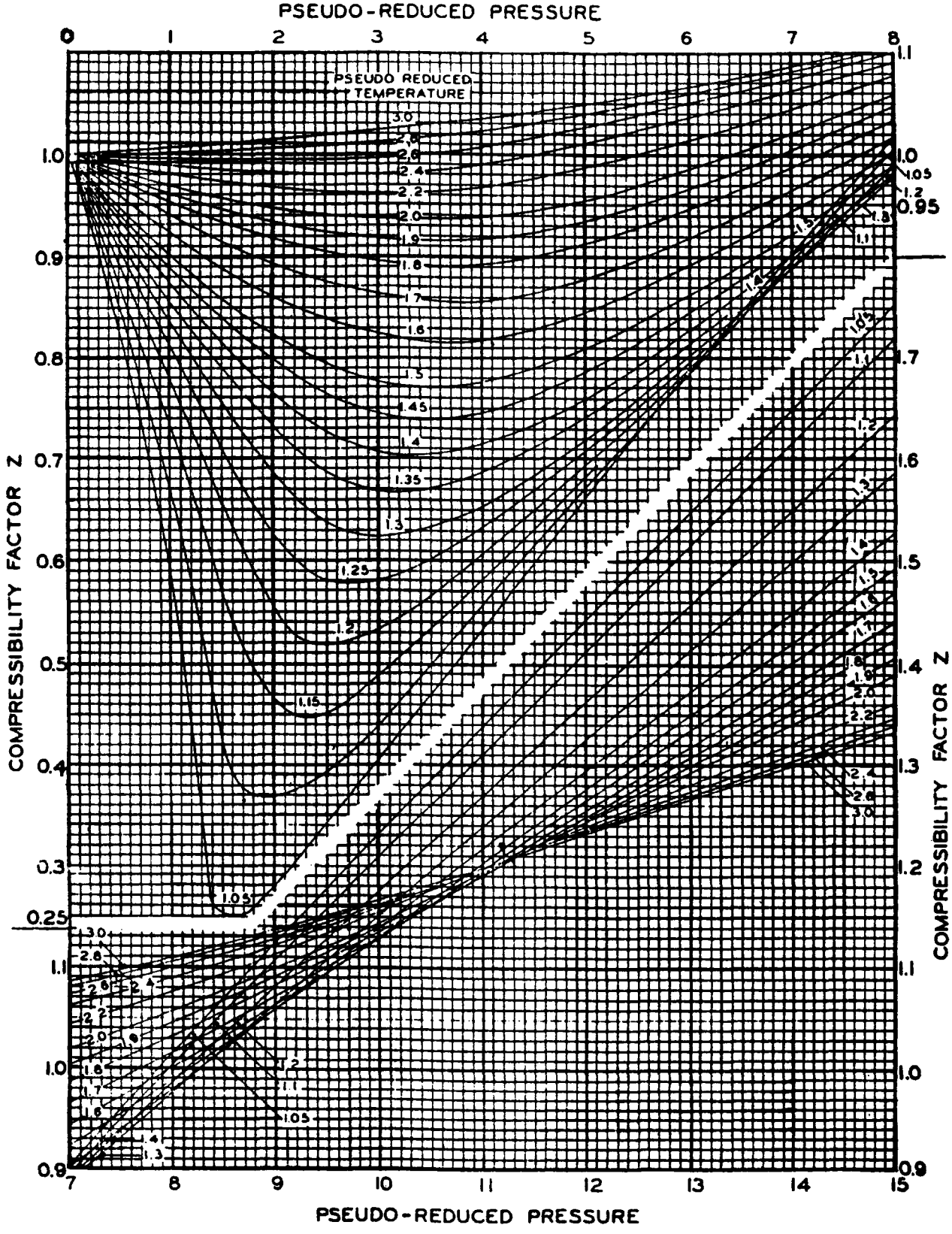
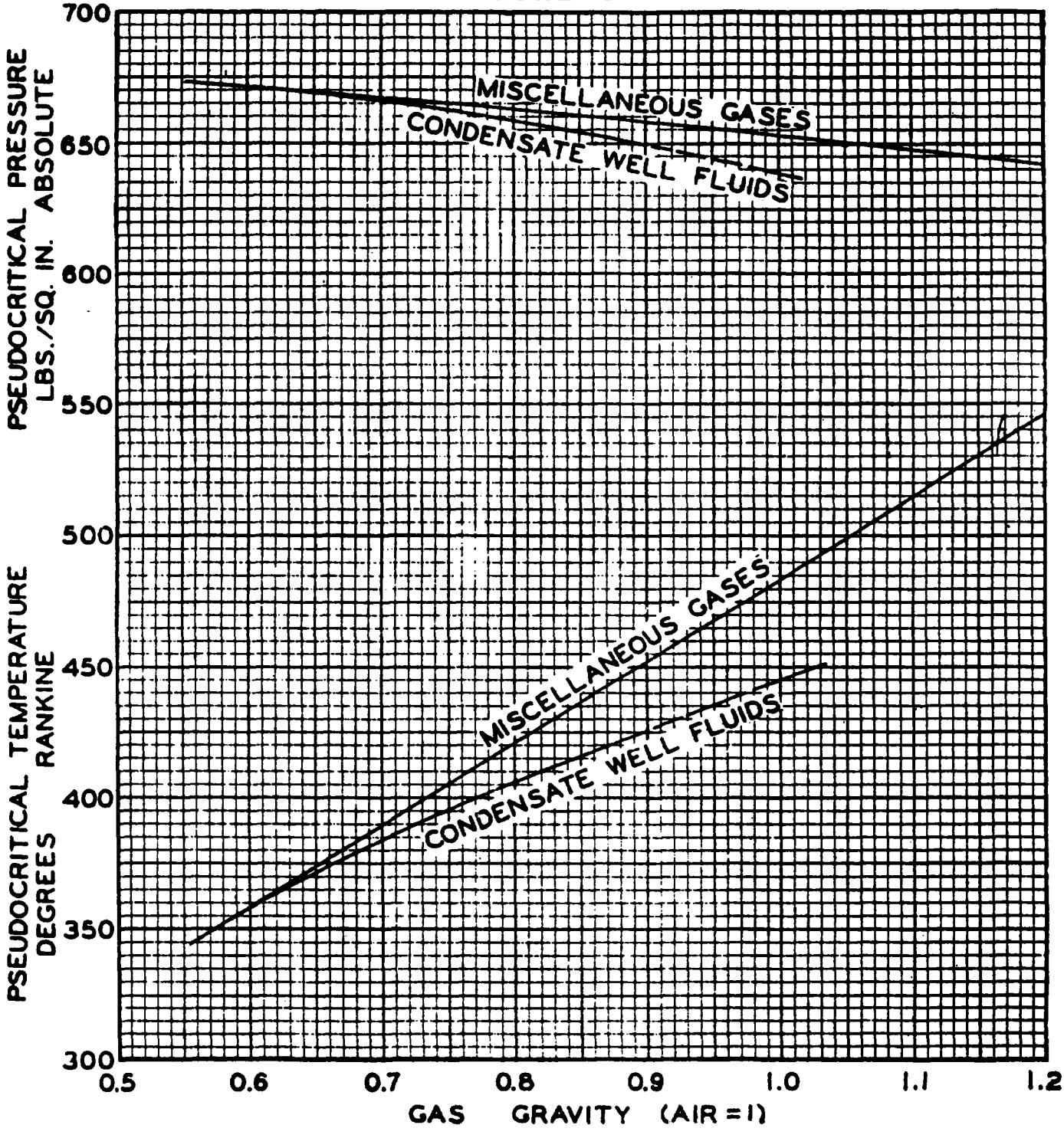

PSEUDO-REDUCED PRESSURE
PSEUDO REDUCED TEMPERATURE
COMPRESSIBILITY FACTOR Z
COMPRESSIBILITY FACTOR Z
PSEUDO-REDUCED PRESSURE

FIGURE 2


PSEUDOCRITICAL PRESSURE
LBS./SQ. IN. ABSOLUTE
700
650
600
550
500
450
400
350
300
MISCELLANEOUS GASES
CONDENSATE WELL FLUIDS
PSEUDOCRITICAL TEMPERATURE
DEGREES RANKINE
MISCELLANEOUS GASES
CONDENSATE WELL FLUIDS
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
GAS GRAVITY (AIR = 1)

GAS WELL TESTING MANUAL

FOR

NORTHWEST NEW MEXICO

STATE
OF
NEW MEXICO

OIL CONSERVATION
DIVISION



GAS WELL TESTING MANUAL
FOR
NORTHWEST NEW MEXICO

GAS WELL

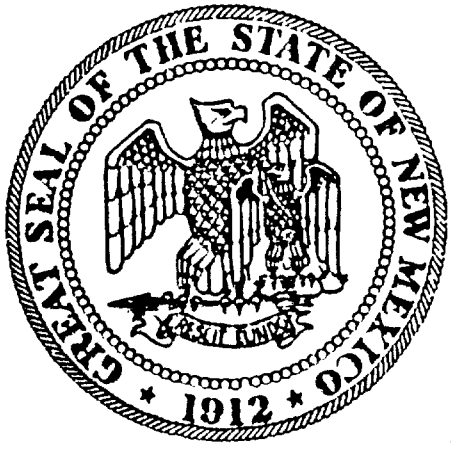
TESTING MANUAL

FOR

NORTHWEST NEW MEXICO

Prepared by an Industry Committee
appointed by the
Oil Conservation Division

H.L. Kendrick
Committee Chairman



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WILLIAM J. LeMay, Director

T A B L E O F C O N T E N T S

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PREFACE

An industry committee met during 1985 - 1986 to revise deliverability testing procedures in San Juan Basin wells. In the course of the meetings it was decided a testing manual should be developed to replace Order R-333, as amended, and to incorporate all necessary procedures and tables.

This manual was prepared to meet with the committee's decision. Sincere appreciation is extended to all the members of the committee, listed below, and particularly to H. L. Kendrick of El Paso Natural Gas Company who chaired the committee and coordinated the preparation of this manual.

SECTION I

INTRODUCTION

INTRODUCTION

Analysis of the performance of gas wells is an important part of the Petroleum Industry's operations. Gas well tests are used in regulatory work, various types of reservoir analyses, and in determining deliverability, or the capacity of a well to produce against a particular back-pressure. Historically, the capacity of gas wells to produce has been described in terms of the "open-flow" delivery rate or the "potential" of the well and the "shut-in pressure at the wellhead" or, less frequently, by some related quantity such as the "deliverability" at specified wellhead pressures. The open-flow capacity of a gas well is used for company operations, legal instruments such as contracts to buy or sell gas and governmental regulatory work. In the early days of the petroleum industry, the open-flow capacity of a gas well was measured directly. As this is a wasteful and hazardous practice, methods of calculating open-flow capacity from well tests made at reasonable and controlled rates of flow have been devised.

The first step toward calculating the open-flow potential or capacity of a gas well was made in the classic report of Rawlins and Schellhardt (1) which described, proposed, and explained the back-pressure method of determining the capacity of the gas well to produce under various conditions of back-pressure. This report was a milestone in the history of petroleum engineering and in the conservation of petroleum. These investigators analyzed data from 582 gas wells located throughout the United States. Specifically, they demonstrated that for the normal gas well, a plot of volume-rate-of-flow versus the difference between the square of the static reservoir pressure and the square of the corresponding flowing bottom-hole pressure on log-log paper is a straight line. Although the term "absolute open-flow potential" as used by Rawlins and Schellhardt represented the capacity of a well to produce against atmospheric pressure at the bottom of the well, the absolute open-flow will not be changed whether measured against atmospheric back-pressure or zero psia, because for most wells atmospheric pressure is negligible as compared to the shut-in sand face pressure. Rawlins and Schellhardt also devised a method of calculating the capacity of a well to produce against atmospheric pressure at the surface, i.e., the open-flow capacity, by taking into account the weight of the column of gas and the pressure drop due to frictional resistance in the flow string. In shallow wells producing through large-diameter flow strings, the absolute open-flow capacity and open-flow capacity are nearly equal because the pressure loss due to friction and the weight of the column of gas in the flow string is small or trivial in comparison to reservoir pressure. Since that time, the term absolute open-flow potential has been used and will be used in this manual to mean the rate of flow that would be obtained if the bottom-hole pressure opposite the sand face were reduced to zero psia; consequently, the absolute open-flow potential is independent of well equipment and represents the maximum productivity of the reservoir rock adjacent to a particular well.

(1) Rawlins, E. L., and Schellhardt, M. A., Back-Pressure Data on Natural Gas Wells and Their Application to Production Practice. U. S. Bureau of Mines, Monograph 7, 1935.

From a theoretical standpoint, the validity of Rawlins' and Schellhardt's findings can be supported by a consideration of the radial flow equation for gas. This equation, which represents the isothermal flow of gas in the steady state to a well bore in a symmetrical reservoir, can be stated as:

$$Q = \frac{C \pi K H (P_f^2 - P_s^2) T_b}{\mu P_b \ln \left[\frac{r_e}{r_w}\right] T_f Z} \qquad \text{I-1}$$

Where

- Q = flow to well, Mcf per day
- C = numerical constant to adjust units
- K = permeability of reservoir
- H = thickness of reservoir
- P_b = pressure base
- P_f = shut-in reservoir pressure
- P_s = flowing pressure at sand face
- T_f = formation temperature
- Z = average compressibility
- μ = average viscosity of the flowing gas
- ln = natural logarithm, i. e. logarithm to the base "e"
- r_e = drainage radius of well
- r_w = well-bore radius
- T_b = temperature base

For a particular well, the terms C, K, H, T_b, μ, P_b, ln r_e/r_w, T_f, and Z may be considered constant and thus can be combined into a single well constant, "C", which reduces the flow equation to: $Q = C (P_f^2 - P_s^2)$. This equation assumes isothermal steady state streamline flow and requires an average compressibility factor. As neither of these assumptions holds absolutely true in a gas reservoir, an exponent, "n", must be introduced to match actual field conditions. The formula then becomes: $Q = C (P_f^2 - P_s^2)^n$. This is the formula developed by Rawlins and Schellhardt. (For a "perfect" gas under isothermal steady state streamline flow, n = 1.) For a specific well and reservoir, "n" must be determined by measuring Q, P_f, and P_s under several different conditions and then solving for "n". By writing the equation as: $\log Q = \log C + n \log (P_f^2 - P_s^2)$ it can be seen that Q plotted versus $P_f^2 - P_s^2$ on log-log paper is a straight line with a slope of "n". To determine the absolute open-flow potential of a well, the measured points are plotted on log-log paper and the straight line is extrapolated to a point where $P_f^2 - P_s^2 = P_f^2$ (in other words $P_s = 0$). "Q" read at this point is the absolute open-flow potential. The flow rate at other conditions of back pressure can also be determined by calculating $P_f^2 - P_s^2$, using the desired P_s and reading Q at the corresponding point.

Rawlins and Schellhardt considered the coefficient "C" and the exponent "n" to be constants for a particular well. This is apparently true for a well operating under stabilized conditions; however, later studies indicate that for wells producing from low permeability reservoirs, the coefficient "C" is a variable related to time and can be considered as a constant only with respect to a particular time.

In general, the exponent "n" varies for individual wells between the limits of 0.5 and 1.0 and it is generally accepted that back-pressure curves with exponents below 0.5 or above 1.0 are erroneous. From a theoretical standpoint, the variation of the exponent "n" between different wells has not been satisfactorily explained; however, many investigators under both laboratory and actual field conditions have demonstrated the reliability of the back-pressure equation.

The basic equation for calculating the absolute open-flow potential of a gas well uses bottom-hole pressures, whereas surface pressures are more frequently and easily obtained. The theory of calculating subsurface pressures from surface pressures is simple, namely that the closed-in static bottom-hole pressure is equal to the closed-in wellhead pressure plus the weight of the column of fluid and that the flowing bottom-hole pressure is equal to the flowing wellhead pressure plus the weight of the column of fluid plus the pressure differential required to overcome frictional resistance to the flow of the gas in the particular flow string.

Several methods of calculating subsurface pressures in gas wells have been developed. Rawlins and Schellhardt used Weymouth's formula for calculating the pressure drop due to frictional resistance. As no corrections were made for compressibility and as an average temperature of flow of 80° F was taken, this method, generally termed the U. S. Bureau of Mines method, is applicable only to shallow, low-pressure gas wells. The technique of computation for this method was improved and simplified by Ferguson (2) (3). As the use of the method was extended to deep, high-pressure gas wells, the earlier simplifying assumptions had to be modified. Vitter (4) adapted the method to condensate wells. The calculation techniques described in this manual are based in principle on this early work but incorporate recent modifications to obtain a procedure that is as simple as possible, consistent with accuracy.

Throughout this manual the pressure base is taken as 15.025 psia, and the temperature base is 60° F. All gas volumes are referred to these base conditions which are sometimes designated as standard volumes or standard conditions. If maximum accuracy is to be obtained, all flow data gathered for back-pressure tests

(2) Ferguson, J. William, Calculation of Back-Pressure Tests on Natural Gas Wells; Oil and Gas Journal, January 19, 1939. pp. 47-53.
(3) Ferguson, J. William, Calculation of Back-Pressure Tests; Oil and Gas Journal, May 7, 1942. p. 52.
(4) Vitter, A. L., Jr., Back-Pressure Tests on Gas-Condensate Wells; A. P. I. Drilling and Production Practice, 1942. pp. 79-87.

must be measured under stabilized conditions. With reference to the production of gas wells, the term "stabilized" is generally used in a manner to infer that at a constant flow rate the flowing conditions within the well bore have become constant and are thus unchanging with time. This condition, of course, can never be attained when a well is producing at a constant rate because the mass content of the reservoir is being continually reduced. Associated with the reduction in mass content must be a continual decrease in the pressure level throughout the reservoir. In view of this, the term "stabilized" when applied to well conditions associated with gas well production tests will be used to denote that further changes in pressure, gas-oil ratio, and rate of flow will be negligible and can be ignored for the purpose of calculating a back-pressure test.

The calculation techniques described in this manual can be divided into three categories: (1) stabilized multipoint back-pressure tests, (2) nonstabilized multipoint tests, and (3) surface tests. The stabilized multipoint back-pressure test procedure can be used in wells in which stabilized flowing conditions can be reached within a reasonable period of time. Prior to testing, the well should be flowed at sufficient rate and for a sufficient period of time to clear the well of accumulated liquids that might result in erroneous pressure data. After the well has been cleaned, it should be shut-in for a period long enough to permit the measurement of an accurate stabilized shut-in pressure. Normally, pressures are measured at four stabilized rates of flow for use in the equation: $Q = C (P_f^2 - P_s^2)^n$. In taking the flowing pressures, the flow rates should be sufficient to prevent the accumulation of liquids in the well bore. A wide variation in flow rates is desirable to achieve a good spread in data points and thus permit accurate extrapolation of the back-pressure curve.

Accurate wellhead temperatures are required in the calculation of subsurface pressures. Flowing temperatures can usually be measured accurately at the wellhead for each rate of flow; however, at low flow rates the observed wellhead temperature may be distorted by atmospheric conditions. When this situation exists, the mean annual temperature should be used as an approximation of the actual wellhead temperature. The static wellhead temperature usually cannot be measured accurately and in lieu thereof the mean annual temperature appropriate to the locality is sufficiently accurate for the computation.

The rates of flow during the tests should be accurately measured with acceptable metering devices; and the gas-liquid ratios, gas and liquid gravites, and other pertinent information should be obtained. It is good practice to plot the data points as they are obtained or, at least, plot the difference of the squares of the surface pressures to check for alignment and make sure the data are satisfactory and the well properly cleaned. This procedure often will indicate the condition of the test equipment and the well and make it possible to make adjustments immediately that could eliminate the necessity for a re-test. After the field data have been obtained, the results can be plotted on log-log paper, with Q shown on the abscissa and $P_f^2 - P_s^2$ on the ordinate. These points should fall in a straight

line, the slope of which represents the reciprocal of "n". The absolute open-flow potential can then be determined by extrapolating the straight line graphically or by use of the back-pressure equation for which the numerical values of "n" and "C" are easily found.

Whenever stabilization cannot be reached within a reasonable period of time because of reservoir conditions, or when flow rates of sufficient duration to reach stabilized conditions are impractical, the slope of the back-pressure curve can be obtained by using one of two different procedures; namely, the constant-time multipoint test or the isochronal multipoint test. The constant-time multipoint test is identical to the stabilized test except that the duration shall be the same for each flow rate. The four points determined from the constant-duration flow tests can be used to determine the slope of the back-pressure curve. A line of this slope can then be drawn through the point determined from an extended flow test approximating stabilized conditions. The absolute open-flow capacity of the well is determined from this line. The precautions to be observed and the method of plotting the data are also identical to the stabilized test.

The isochronal multipoint test can also be used where it is not possible to obtain stabilized flow conditions. This procedure is based on the work of Cullender (5) which showed that the slope of the back-pressure curve can be obtained from data points taken prior to stabilization, providing that each flow rate is of the same duration and that each flow period starts from stabilized shut-in conditions. In making this test, the well is first cleaned and a shut-in pressure obtained in the same manner as would be done under stabilized conditions. Each flow rate following the shut-in pressure should be of the same duration; but, after each flowing pressure is observed, the well should be shut in until a reasonable constancy in pressure is achieved. In plotting the points, the shut-in pressure preceding each flow rate should be used in conjunction with the flowing pressure corresponding to that rate used in the calculation of $P_f^2 - P_s^2$. The points so calculated will determine the slope of the back-pressure curve. An extended flow test to obtain a flowing pressure approximating a "stabilized condition" is required to locate the position of the back-pressure curve. The curve is completed by drawing a line of the slope determined from the four constant-time points through the point plotted from the extended ("stabilized condition") test. The absolute open-flow capacity of the well is obtained from this line.

Redetermination of the absolute open-flow potential can be made by the "one-point" test procedure once the slope of the back-pressure curve has been established. This method assumes that the slope of the back-pressure curve does not change with time. Accordingly, a one-point test requires only that a shut-in pressure and one stabilized flow rate be obtained. The new value of

(5) Cullender, M. H., The Isochronal Performance Method of Determining the Flow Characteristics of Gas Wells; AIME Trans., V 204, pp. 137-142, 1955.

absolute open flow is determined by drawing the back-pressure curve through this point using the known slope. This determination can also be made by using the following equation:

$$AOF = Q \left[\frac{P_f^2}{P_f^2 - P_s^2} \right]^n \qquad \text{I-2}$$

These procedures require that the subsurface pressures be either measured or calculated. In shallow wells with large flow strings the differences between surface and subsurface pressures are usually small, and surface pressures can be used with little error. If the error introduced by using the surface pressures does not warrant the use of subsurface pressures, then the static column wellhead pressures can be substituted for the bottom-hole pressures. Surface pressures are used in determining the deliverability of a well or capacity of the formation to produce gas into the well bore against a specified surface pressure. The deliverability is calculated by solving for "D" in the following equation:

$$D = Q \left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2} \right]^n \qquad \text{I-3}$$

Where

D = deliverability of well at back pressure, P_d
Q = rate of flow at a pressure of P_w, during test
P_c = shut-in wellhead pressure

The ability of a well to produce into a gathering system can be determined for various wellhead pressures of the flow string corresponding to a specified line pressure after establishing a curve by first plotting Q versus $P_c^2 - P_t^2$ for several rates of flow in the same manner as is done for Q versus $P_f^2 - P_s^2$ in the standard back-pressure plot. Then the producing capacity of the well at a given back pressure can be read from the curve using the appropriate values of $P_c^2 - P_t^2$ or by replacing P_d and P_w in the deliverability equation with the corresponding pressures of the flow string and utilizing the exponent "n" established by the plot of Q versus $P_c^2 - P_t^2$. The plotted line may not be exactly straight but by restricting its use to those situations which require little extrapolation, the producing capacity can be determined with reasonable accuracy.

SECTION II

TABLE OF NOMENCLATURE

TABLE OF NOMENCLATURE

AOF = absolute open flow, Mcfd

C = coefficient of the particular back-pressure equation

D = deliverability of well at back pressure, P_d, Mcfd

F_b = basic orifice factor, Mcfd/$\sqrt{h_w P_m}$

F_c = combined friction, temperature, and compressibility factor, $F_r TZ$

F_d = meter factor for direct reading L-10 chart = $0.01\sqrt{R_h R_p}$

F_e = energy loss factor = $(F_r Q_m)^2$

F_g = specific gravity factor, dimensionless

F_p = basic critical flow prover or positive nonadjustable choke factor, Mcfd/psia

F_{pv} = supercompressibility factor = $\sqrt{1/Z}$, dimensionless

F_r = friction factor, $\left[\frac{2.6665\ f}{d^5}\right]^{0.5}$

F_s = pressure loss factor = $(L/H)\ (F_c Q_m)^2(e^s - 1) = P_s^2 - e^s P_t^2$

F_t = flowing temperature factor, dimensionless

F_w = pressure loss factor = $(L/H)\ (F_c Q_m)^2(1 - e^{-s}) = P_w^2 - P_t^2$

G = specific gravity of flowing fluid (air = 1.000), dimensionless

G_g = specific gravity of separator gas (air = 1.000), dimensionless

G_l = specific gravity of separator liquid (water = 1.000), dimensionless

GOR = gas-liquid ratio, cu ft of gas (15.025 psia and 60F) per barrel of hydrocarbon liquid (60F)

H = vertical depth corresponding to L, feet

I_n = value of the right hand member of the flow equation corresponding to P_n

I_{n-1} = value of the right hand member of the flow equation corresponding to P_{n-1}

L = length of flow channel, feet (See General Instructions)

M = computational aid

Mcfd = thousand cubic feet per day (15.025 psia and 60F)

M^2cfd = million cubic feet per day (15.025 psia and 60F)

N = computational aid

P = pressure, psia

P^2 = $(psia)^2/1000$

P_L = static pressure reading, L-10 chart

P_a = field barometric pressure, psia

P_b = pressure at base conditions, psia

P_c = shut-in wellhead pressure, psia

P_{cr} = pseudocritical pressure, psia

P_d = designated deliverability pressure, psia

P_f = shut-in pressure at vertical depth H, psia

P_m = static pressure at point of gas measurement, psia

P_n = pressure in the flow channel at a given point, psia

P_{n-1} = pressure in the flow channel at the preceding point, psia

P_r = reduced pressure, dimensionless

P_s = flowing pressure at vertical depth H, psia

P_t = flowing wellhead pressure, psia

P_w = static column wellhead pressure corresponding to P_t, psia

Q = rate of flow, Mcfd (15.025 psia and 60F)

Q_m = rate of flow, M^2cfd (15.025 psia and 60F)

R_h = meter differential range, inches of water

R_p = meter pressure range, psia

R_t = meter temperature range, F

T = absolute temperature, R

T_b = absolute temperature at base conditions, R

T_{cr} = absolute pseudocritical temperature, R

T_m = absolute temperature of fluid at point of gas measurement, R

T_r = reduced temperature, dimensionless

T_s = absolute temperature at vertical depth H, R

T_w = absolute temperature of fluid at wellhead, R

V_l = cu ft of vapor (15.025 psia and 60F) equivalent to 1 barrel of hydrocarbon liquid (60F)

Z = compressibility factor, dimensionless

d = inside diameter, inches

d_e = effective diameter, inches

d_o = outside pipe diameter, inches

e = natural logarithm base = 2.71828+

e^s = weight of column factor, dimensionless

f = coefficient of friction, dimensionless

h_d = differential reading, L-10 chart

h_w = meter differential pressure, inches of water

n = exponent of the particular back-pressure equation, dimensionless

psia = pounds per square inch absolute

psig = pounds per square inch gauge

s = 0.0375 GH/TZ

t_d = temperature reading, L-10 chart

NOTE: "F" as used in this Table of Nomenclature and throughout this manual is the symbol for degrees Fahrenheit.

"R" as used in this Table of Nomenclature and throughout this manual is the symbol for degrees Rankine (degrees Fahrenheit absolute).

SECTION III

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

DIVISION ORDER NO. R-333-I ..... III-i

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STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

CASE NO: 8586
ORDER NO: R-333-I

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION ON ITS OWN MOTION FOR RESCISSION OF DIVISION ORDER No. R-333, AS AMENDED, AND FOR RECODIFICATION AND REISSUANCE OF GAS WELL TESTING PROCEDURES FOR NORTHWEST NEW MEXICO. APPLICANT FURTHER SEEKS AN EXTENSION OF THE 1986 TESTING PERIOD AND SUSPENSION OF THE 1987 TESTING PERIOD. MCKINLEY, RIO ARRIBA, SANDOVAL, AND SAN JUAN COUNTIES, NEW MEXICO.

BY THE DIVISION:

This cause came on for hearing at 8:00 a.m. on May 8, 1985, and at 8:15 a.m. on December 3, 1986, in Santa Fe, New Mexico, before Examiners Gilbert P. Quintana and Michael E. Stogner, respectively.

NOW, on this 2nd day of October, 1987, the Division Director, having considered the testimony, the record, and the recommendations of the Examiners, and being fully advised in the premises,

FINDS THAT:

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

(2) The applicant in the instant case seeks to rescind Division Order No. R-333, as amended, and to recodify and amend the Special Rules and Regulations for the testing of gas wells in Northwest New Mexico contained therein.

(3) Special rules and regulations for the testing of gas wells in McKinley, Rio Arriba, Sandoval, and San Juan Counties, New Mexico, (Northwest New Mexico) have been adopted and amended by the Division and are embodied in Division Order No. R-333, as amended.

(4) These existing rules and regulations relating to gas well testing procedures in Northwest New Mexico have been adopted over many years and are collected in numerous orders, therefore, making reference to them somewhat difficult.

(5) In addition some of the gas well testing procedures are out-dated and in need of revision.

(6) Because of the need to review these rules relating to gas well testing in Northwest New Mexico, the Division Director at that time appointed a committee to study the existing rules and to recommend changes.

(7) Harold L. Kendrick, Chairman of the Deliverability Test Committee, appeared on its behalf at the May 8, 1985 (at which time it was taken under advisement, however no order was issued) and December 3, 1987 examiner hearings and made the following recommendations regarding gas well testing procedures in Northwest New Mexico:

(a) to recodify the rules and issuing them as the "Gas Well Testing Manual for Northwest New Mexico";

(b) to require deliverability testing in prorated gas pools on a biennial (every two years) basis;

(c) to require biennial shut-in pressures in non-prorated gas pools with no deliverability testing;

(d) to make the deliverability test year be the same as the calendar year;

(e) to make exemption from deliverability testing in the Blanco-Mesaverde and Basin-Dakota Pools based upon the combined producibility of all wells on a gas proration unit;

(f) to permit wells shut-in for overproduction to be produced for deliverability test purposes after the operator notifies the Division Aztec District office;

(g) to relax restriction on flow interruptions during the conditioning period slightly;

(h) to permit the 7-day shut in pressure to be measured at a time during the current testing season other than immediately following the test flow period;

(i) to set deliverability pressure (Pd) assigned as a percentage of the 7-day shut-in pressure in each pool to more nearly approximate the pool average operating conditions;

(j) the 7-day shut-in pressure for wells in non-prorated gas pools should be filed with the Division and reported on Form C-125 or any other form designated by the Division; and

(k) to include in the manual all required tables.

(8) All of the above proposals are embodied in Exhibit "A" attached hereto and made a part thereof.

(9) A manual for well testing as set out in said supplemental exhibit should be adopted.

(10) The existing Division Order No. R-333, as amended, should be rescinded, in its entirety, and a new order designated R-333-I should be promulgated.

(11) It is further sought in this Case to extend the deadline for completing and filing 1986 deliverability tests to March 31, 1987, and for a one year suspension of biennial deliverability testing whereby the deliverability test cycle will begin again in 1988 with those pools which would have been tested in 1987.

(12) No testimony was received in opposition to this request.

(13) Approval of this application is in the best interest of conservation and will prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED THAT:

(1) Effective September 1, 1987, the Special Rules and Regulations governing gas well testing in Northwest New Mexico, which includes McKinley, Rio Arriba, Sandoval and San Juan Counties, New Mexico, as set forth in Exhibit "A" attached hereto and made a part hereof, are hereby promulgated and adopted as an exception to Rules 401 and 402 of the general statewide rules and regulations of this Division relating to gas well testing procedures, superseding the rules and regulations contained in their entirety in Division Order No. R-333, as amended.

(2) The deadline for completing and filing 1986 deliverability tests is hereby extended to March 31, 1987.

(3) The required biennial deliverability testing of wells is hereby suspended for a one year period whereby the deliverability test cycle will begin again in 1988 with those pools which would have been tested in 1987.

(4) Jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

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

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

WILLIAM J. LEMAY
Director

S E A L

RULES OF PROCEDURE FOR NORTHWEST NEW MEXICO

CHAPTER I TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN PRORATED GAS POOLS

SECTION 1: Initial Deliverability and Shut-In Pressure Tests for Newly Completed Well

A. Immediately upon completion of each gas well in northwest New Mexico, a shut-in pressure test of at least seven days duration shall be made. This initial shut-in pressure shall be filed with the Division's Aztec Office on either Form C-122 or C-104.

B. Within 90 days after a well first delivers gas to a gas transportation facility, the well shall have been tested in accordance with Section 1 of Chapter II of these rules, "Initial Deliverability and Shut-In Pressure Test Procedures", and the results of the test filed in triplicate with the Division's Aztec office and one copy filed with the gas transportation facility to which the well is connected. This test is to be filed on Form C-122-A. Failure to file said test within the above-prescribed 90-day period will subject the well to the loss of one day's allowable for each day the test is late.

1. If the newly first delivered well is an infill well on a proration unit, the old well on the unit is not required to be tested provided it has a valid test on file for the current proration year. Testing of the old well follows the regularly assigned test year for the pool in which the wells are located. The new well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

2. If the newly first delivered well is an infill well on a proration unit and the old well on the unit is "exempt", the old well is to be tested along with the new well for the Initial and Annual Deliverability and Shut-In Pressure Test. The old well will lose its "exempt" classification and must be tested biennially along with other wells in that pool. The new infill well is required to be tested annually until at least three annual tests are on file and then the well is to be tested biennially with other wells in that pool.

C. The requirements for Initial Tests and Annual or Biennial Deliverability and Shut-In Pressure Tests and the notification requirements and scheduling of such tests which apply to newly completed wells shall also apply to recompleted wells.

D. Any tests taken for informational purposes prior to pipeline connection shall not be recognized as official tests for the assignment of allowables.

SECTION 2. Annual and Biennial Deliverability and Shut-In Pressure Tests

A. Annual or Biennial Deliverability and Shut-In Pressure Tests shall be made on all gas wells during the period from January 1 through December 31 of that year except as follows:

1. A newly completed well or a recompleted well shall be tested on an annual basis until a minimum of three annual tests have been taken, after which the well shall be tested biennially as is required for other wells in the pool in which the well is located.

2. Wells classified as "exempt" shall not be subject to the requirements of annual or biennial deliverability tests.

   Classification of wells into or out of the "exempt" status shall be done once each year immediately following the reporting of June production and shall be effective for the succeeding annual test period.

   Gas wells completed in the Pictured Cliffs or any shallower formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 250 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

   Gas wells completed in any formation deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the well failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the well is classified as marginal in the August Gas Proration Schedule.

Gas wells on multiple well Gas Proration Units will not be classified "exempt" unless the Gas Proration Unit is classified as marginal. Any or all wells on a marginal multiple well Gas Proration Unit may be classified as "exempt" provided each Gas Proration Unit so classified meets the qualification for "exempt" status. Gas Proration Units for wells producing from formations deeper than the Pictured Cliffs formation shall be classified "exempt" if at least three months of production history is available and the Gas Proration Unit failed to produce, and is incapable of producing, an average of 2000 MCF or more per month during the months produced within the preceding 12-month period, and the Gas Proration Unit is classified as marginal in the August Gas Proration Schedule. Gas Proration Units are to be classified as "exempt" because of their low producing ability.

The District Supervisor of the Division's Aztec Office may classify a well or Gas Proration Unit as "exempt" at any time if the operator presents sufficient evidence to the District Supervisor indicating that the well or Gas Proration Unit is incapable of producing gas at a higher rate than that rate required for "exempt" classification for wells or Gas Proration Units in that pool.

Once a well or Gas Proration Unit has been declared "exempt" for the following test year, it shall remain classified "exempt" for that test year.

3. If a test is filed on any well on a gas proration unit, the test requirement for the gas proration unit has been met. The deliverability of the unit is taken only as the resulting sum of all wells tested.

4. A shut-in pressure must be filed on Form C-122-A even if no gas is measured during the production phase of the test. The filing of shut-in pressures for "exempt" wells is not required.

B. All Annual and Biennial Deliverability and Shut-In Pressure Tests required by these rules must be filed with the Division's Aztec office and with the appropriate gas transportation facility within 90 days following the completion of each test. Provided however, that any test completed between October 31 of the test year and January 31 of the following year are due no later than January 31. No extension of time for filing tests beyond January 31 will be granted except after notice and hearing.

Failure to file any test within the above-prescribed times will subject the well to the loss of one day's allowable for each day the test is late. A well classified as marginal shall be shut-in one day for each day the test is late.

SECTION 3: Scheduling of Tests

A. Notification of Pools to be Tested

By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells and a list of wells that do not have a minimum of three Annual Deliverability and Shut-In Pressure Tests on file.

Any well scheduled for testing during its test year may have the conditioning period, test flow period, and some of the seven day shut-in period conducted in December of the previous year provided that if the 7 day shut-in period immediately follows the test flow period the 7 day shut-in pressure would be measured in January of the test year. The earliest date that a well could be scheduled for Annual or Biennial Deliverability and Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of the lowermost prorated completion of the well.

B. Annual and Biennial Deliverability Tests

By November 1 of each year, each gas transportation facility shall, in cooperation with the operators involved, prepare and submit a schedule of the wells to which it is connected which are to begin testing in December and January. Said schedule shall be entitled, "Annual and Biennial Deliverability and Shut-In Pressure Test Schedule", and one copy shall be submitted to the Division's Aztec office and to each operator concerned. The schedule shall indicate the date of tests, pool, operator, lease, well number, and location of each well.

At least 30 days prior to the beginning of each succeeding 2-month testing interval, a similar schedule shall be prepared and filed in accordance with the above.

The gas transportation facility and the Aztec District Office of the Division shall be notified immediately by any operator unable to conduct any test as scheduled.

In the event a well is not tested in accordance with the existing test schedule, the well shall be re-scheduled by the gas transportation facility, and the Division and the operator of the well so notified in writing. Every effort should be made to notify the Division of the new schedule prior to the conclusion of the newly assigned 14-day conditioning period.

Notice to the Division of Shut-In Pressure Tests which are scheduled at a time other than immediately following the flow test must be received prior to the time that the well is shut-in.

It shall be the responsibility of each operator to determine that all of its wells are properly scheduled for testing by the gas transportation facility to which they are connected, in order that all annual and biennial tests may be completed during the testing season.

In the event a well is shut-in by the state for over production, the operator may produce the well for a period of time to secure a test after notification to the Division. All gas produced during this testing period will be used in determining the over/under produced status of the well.

C. Deliverability Re-Tests

An operator may, in cooperation with the gas transportation facility, schedule a well for a deliverability re-test upon notification to the Division's Aztec office at least ten days before the test is to be commenced. Such re-test shall be for good and substantial reason and shall be subject to the approval of the Division. Re-tests shall in all ways be conducted in conformance with the Annual and Biennial Deliverability Test Procedures of these rules. The Division, at its discretion, may require the re-testing of any well by notification to the operator to schedule such re-test. These tests as filed on Form C-122-A should be identified as "RETEST" in the remarks column.

SECTION 4: Witnessing of Tests

Any Initial Annual or Biennial Deliverability and Shut-In Pressure Test may be witnessed by any or all of the following: an agent of the Division, an offset operator, a representative of the gas transportation facility connected to the well under test, or a representative of the gas transportation facility taking gas from an offset operator.

CHAPTER II PROCEDURE FOR TESTING

SECTION 1: Initial Deliverability and Shut-In Pressure Test Procedure

A. Within 90 days after a newly completed well is first delivered to a gas transportation facility, the operator shall complete a deliverability and shut-in pressure test of the well in conformance with the "Annual and Biennial Deliverability and Shut-In Pressure Test Procedures", prescribed in Section 2 of this chapter. Results of the test shall be filed as required by Section 1 of Chapter I of these rules.

B. In the event it is impractical to test a newly completed well in conformance with Paragraph A above, the operator may conduct the deliverability and shut-in pressure test in the following manner (provided, however, that any test so conducted will not be accepted as the first annual deliverability and shut-in pressure test as described in Paragraph A-1 of Section 2, Chapter I):

1. A 7-day or 8-day production chart may be used as the basis for determining the well's deliverability, providing the chart so used is preceded by at least 14 days continuous production. The well shall produce through either the casing or tubing, but not both, into a pipeline during these periods. The production valve and the choke settings shall not be changed during either the conditioning or flow period with the exception of the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment.

2. A shut-in pressure of at least seven days duration shall be taken. This shall be the shut-in test required in Paragraph A, Section 1 of Chapter I of these rules.

3. The average daily static meter pressure shall be determined in accordance with Section 2 of Chapter II of these rules. This pressure shall be used as P_t in calculating P_w for the Deliverability Calculation.

4. The daily average rate of flow shall be determined in accordance with Section 2 of Chapter II.

5. The static wellhead working pressure (P_w) shall be determined in accordance with Section 2 of Chapter II.

6. The deliverability of the well shall be determined by using the data determined in Paragraphs 1 through 5 above in the deliverability formula in accordance with Section 2 of Chapter II.

7. The data and calculations for Paragraphs 1 through 6 above shall be reported as required in Section 1 of Chapter I of these rules, upon the blue-colored Form C-122-A or on white Form C-122-A and identified as "INITIAL TEST ONLY" in remarks.

SECTION 2: Annual and Biennial Deliverability and Shut-In Pressure Test Procedure

This test shall begin by producing a well in the normal operating manner into the pipeline through either the casing or tubing, but not both, for a period of fourteen consecutive days. This shall be known as the conditioning period. The production valve and choke settings shall not be changed during either the conditioning or flow periods except during the first ten (10) days of the conditioning period when maximum production would over-range the meter chart or location production equipment. The first ten (10) days of said conditioning period shall not have more than forty eight (48) hours of cumulative interruptions of flow. The eleventh to fourteenth days, inclusive, of said conditioning period shall have no interruptions of flow whatsoever. Any interruption of flow that occurs as normal operation of the well as stop-cock flow, intermittent flow, or well blow down will not be counted as shut-in time in either the conditioning or flow period.

The daily flowing rate shall be determined from an average of seven or eight consecutive producing days, following a minimum conditioning period of 14 consecutive days of production. This shall be known as the flow period.

Instantaneous pressures shall be measured by deadweight gauge or other method approved by the Division during the 7-day or 8-day flow period at the casinghead, tubinghead, and orifice meter, and shall be recorded along with instantaneous meter-chart static pressure reading.

If a well is producing through a compressor that is located between the wellhead and the meter run, the meter run pressure and the wellhead casing pressure and the wellhead tubing pressure are to be reported on Form C-122-A. (Neither the suction pressure nor the discharge pressure of the compressor is considered wellhead pressure.) A note shall be entered in the remarks portion on Form C-122-A stating "This well produces through a compressor".

When it is necessary to restrict the flow of gas between the wellhead and orifice meter, the ratio of the downstream pressure, psia, to the upstream pressure, psia shall be determined. When this ratio is 0.57, or less, critical flow conditions shall be considered to exist across the restriction.

When more than one restriction between the wellhead and orifice meter causes the pressures to reflect critical flow between the wellhead and orifice meter, the pressures across each of these restrictions shall be measured to determine whether critical flow exists at any restriction. When critical flow does not exist at any restriction, the pressures taken to disprove critical flow shall be reported to the Division on Form C-122-A in item (n) of the form. When critical flow conditions exist, the instantaneous flowing pressures required hereinabove shall be measured during the last 48 hours of the 7-day or 8-day flow period.

When critical flow exists between the wellhead and orifice meter, the measured wellhead flowing pressure of the string through which the well flowed during test shall be used as P_t when calculating the static wellhead working pressure (P_w) using the method established below.

When critical flow does not exist at any restriction, P_t shall be the corrected average static pressure from the meter chart plus friction loss from the wellhead to the orifice meter.

The static wellhead working pressure (P_w) of any well under test shall be the calculated 7-day or 8-day average static tubing pressure if the well is flowing through the casing; it shall be the calculated 7-day or 8-day average static casing pressure if the well is flowing through the tubing. The static wellhead working pressure (P_w) shall be calculated by applying the tables and procedures set out in this manual.

To obtain the shut-in pressure of a well under test, the well shall be shut in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The 7-day shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be used as P_c in the deliverability calculation. When any such shut-in pressure is determined by the Division to be abnormally low or the well can not be shut-in due to "HARDSHIP" classification, the shut-in pressure to be used as P_c shall be determined by one of the following methods:

1. A Division-designated value.

2. An average shut-in pressure of all offset wells completed in the same zone. Offset wells include the four side and four corner wells, if available.

3. A calculated surface pressure based on a calculated bottom-hole pressure. Such calculation shall be made in accordance with the examples in this manual.

All Wellhead pressures as well as the flowing meter pressure tests which are to be taken during the 7-day or 8-day deliverability test period as required hereinabove shall be taken with a deadweight gauge or other method approved by the Division. The pressure readings and the date and time according to the chart shall be recorded and maintained in the operator's records with the test information.

Orifice meter charts shall be changed and so arranged as to reflect upon a single chart the flow data for the gas from each well for the full 7-day or 8-day deliverability test period; however, no tests shall be voided if satisfactory explanation is made as to the necessity for using test volumes through two chart periods. Corrections shall be made for pressure base, measured flowing temperature, specific gravity, and supercompressibility; provided however, if the specific gravity of the gas from any well under test is not available, an estimated specific gravity may be assumed therefor, based upon that of gas from near-by wells, the specific gravity of which has been actually determined by measurement.

The average flowing meter pressure for the 7-day or 8-day flow period and the corrected integrated volume shall be determined by the purchasing company that integrates the flow charts and furnished to the operator or testing agency.

The 7-day or 8-day flow period volume shall be calculated from the integrated readings as determined from the flow period orifice meter chart. The volume so calculated shall be divided by the number of testing days on the chart to determine the average daily rate of flow during said flow period. The flow period shall have a minimum of seven and a maximum of eight legibly recorded flowing days to be acceptable for test purposes. The volume used in this calculation shall be corrected to New Mexico Oil Conservation Division standard conditions of 15.025 psia pressure base, 60°F. temperature base and 0.60 specific gravity base.

The daily volume of flow as determined from the flow period chart readings shall be calculated by applying the Basic Orifice Meter Formula or other acceptable industry standard practices.

$$Q = C' (h_w P_f)^{.5}$$

Where:

Q = Metered volume of flow Mcf/d @ 15.025 psia, 60^0 F., and 0.60 specific gravity.

C' = The 24-hour basic orifice meter flow factor corrected for flowing temperature, gravity, and supercompressibility.

h_w = Daily average differential meter pressure from flow period chart.

P_f = Daily average flowing meter pressure from flow period chart.

The basic orifice meter flow factors, flowing temperature factor, and specific gravity factor shall be determined from the tables in this manual.

The daily flow period average corrected flowing meter pressure, psig, shall be used to determine the supercompressibility factor. Supercompressibility Tables may be obtained from the New Mexico Oil Conservation Division.

When supercompressibility correction is made for a gas containing either nitrogen or carbon dioxide in excess of two percent, the supercompressibility factors of such gas shall be determined by the use of Table V of the C.N.G.A. Bulletin TS-402 for pressures 100-500 psig, or Table II, TS-461 for pressures in excess of 500 psig.

The use of tables for calculating rates of flow from integrator readings which do not specifically conform to the New Mexico Oil Conservation Division "Back Pressure Test Manual", or this manual, may be approved for determining the daily flow period rates of flow upon a showing that such tables are appropriate and necessary.

The daily average integrated rate of flow for the 7-day or 8-day flow period shall be corrected for meter error by multiplication by a correction factor. Said correction factor shall be determined by dividing the square root of the deadweight flowing meter pressure, psia, by the square root of the chart flowing meter pressure, psia.

Deliverability pressure, as used herein, is a defined pressure applied to each well and used in the process of comparing the abilities of wells in a pool to produce at static wellhead working pressures equal to a percentage of the 7-day shut-in pressure of the respective individual wells. Such percentage shall be determined and announced periodically by the Division based on the relationship of the average static wellhead working pressures (P_w) divided by the average 7-day shut-in pressure (P_c) of the pool.

The deliverability of gas at the "deliverability pressure" of any well under test shall be calculated from the test data derived from the tests hereinabove required by use of the following deliverability formula:

$$D = Q \left[\frac{(P_c^2 - P_d^2)}{(P_c^2 - P_w^2)} \right]^n$$

Where:

D = Deliverability Mcf/d at the deliverability pressure, (P_d), (at Standard Conditions of 15.025 psia, 60°F and 0.60 sp. gr.).

Q = Daily flow rate in Mcf/d, at wellhead pressure (P_w).

P_c = 7-day shut-in Wellhead pressure, psia, determined in accordance with Section 2 of Chapter II.

P_d = Deliverability pressure, psia, as defined above.

P_w = Average static wellhead working pressure, as determined from 7-day or 8-day flow period, psia, and calculated from tables in this manual entitled "Pressure Loss Due to Friction" Tables for northwest New Mexico.

n = Average pool slope of back pressure curves as follows:

For Pictured Cliffs and shallower formations 0.85

For formations deeper than Pictured Cliffs 0.75

(Note: Special rules for any specific pool or formation may supersede the above values. Check special rules if in doubt.)

The value of the multiplier in the above formula (ratio factor after the application of the pool slope) by which Q is multiplied shall not exceed a limiting value to be determined and announced periodically by the Division. Such determination shall be made after a study of the test data of the pool obtained during the previous testing season.

Downhole commingled wells are to be tested in year for pool of lowermost prorated completion of well and shall use pool slope (n), and deliverability pressure of lowermost pool. The total flow rate from the downhole commingled well will be used to calculate a value of deliverability. For each prorated gas zone of a downhole commingled well, a Form C-122-A is required to be filed and in the Summary portion of that form, all zones will indicate the same data for line h, P_c, Q, P_w, and P_d. The value shown for Deliverability (D) will be that percentage of the total deliverability of the well that is applicable to this zone. A note shall be placed in the remarks column that indicates the percentage of deliverability to be allocated to this zone of the well.

Any test prescribed herein will be considered acceptable if the average flow rate for the final 7-day or 8-day deliverability test is not more than ten percent in excess of any consecutive 7-day or 8-day average of the preceding two weeks. A deliverability test not meeting this requirement may be declared invalid, requiring the well to be re-tested.

All charts relative to initial, annual, or biennial deliverability tests or copies thereof shall be made available to the Division upon its request.

All testing agencies, whether individuals, companies, pipeline companies, or operators, shall maintain a log of all tests accomplished by them, including all field test data. The operator shall maintain the above data for a period of not less than two (2) years plus the current test year.

All forms heretofore mentioned are hereby adopted for use in the northwest New Mexico Area in open form subject to such modification as experience may indicate desirable or necessary.

Initial and Annual or Biennial Deliverability and Shut-In Pressure Tests for gas wells in all formations shall be conducted and reported in accordance with these rules and procedures. Provided however, these rules shall be subject to any specific modification or change contained in Special Pool Rules adopted for any pool after notice and hearing.

CHAPTER III INFORMATIONAL TESTS

A. A one-point back pressure test may be taken on newly completed wells before their connection or reconnection to a gas transportation facility. This test shall not be a required official test but may be taken for informational purposes at the option of the operator. When taken, this test must be taken and reported as prescribed below:

ONE-POINT BACK PRESSURE POTENTIAL TEST PROCEDURE

1. This test shall be accomplished after a minimum shut-in of seven days. The shut-in pressure shall be measured with a deadweight gauge or other method approved by the Division.

2. The flow rate shall be that rate in Mcf/d measured at the end of a three hour test flow period. The flow from the well shall be for three hours through a positive choke, which has a 3/4-inch orifice.

3. A 2-inch nipple which provides a mechanical means of accurately measuring the pressure and temperature of the flowing gas shall be installed immediately upstream from the positive choke.

4. The absolute open flow shall be calculated using the conventional back pressure formula as shown in this manual or the New Mexico Oil Conservation Division "Back Pressure Test Manual."

5. The observed data and flow calculations shall be reported in duplicate on Form C-122, "Multi-Point Back Pressure Test for Gas Wells."

6. Non-critical flow shall be considered to exist when the choke pressure is 13 psig or less. When this condition exists the flow rate shall be measured with a pitot tube and nipple as specified in this manual or in the Division's Manual of "Tables and Procedure for Pitot Tests." The pitot test nipple shall be installed immediately downstream from the 3/4-inch positive choke.

7. Any well completed with 2-inch nominal size tubing (1.995-inch ID) or larger shall be tested through the tubing.

B. Other tests for informational purposes may be conducted prior to obtaining a pipeline connection for a newly completed well upon receiving specific approval therefor from the Division's Aztec

office. Approval of these tests shall be based primarily upon the volume of gas to be vented.

CHAPTER IV TYPE OF TESTS REQUIRED FOR WELLS COMPLETED IN NON-PRORATED POOLS

SECTION 1: Initial Shut-In Pressure Tests for Newly Completed Wells

A. (Same as Chapter I, Section 1, A)

SECTION 2: Biennial Shut-In Pressure Tests

A. Non-prorated wells will be tested biennially as required by the District Office except as follows:

1. Wells which meet the "exempt" qualification as shown in Chapter I, Section 2, paragraph A-2 of these rules shall also be exempt from shut-in test requirements.

2. Wells classified as "hardship" wells during the test year shall also be exempt from shut-in test requirements.

B. All shut-in tests required by these rules must be filed with the Division's Aztec office by January 31 of the following year. Failure to file the test will subject the well to being shut-in one day for each day the test is late.

SECTION 3: Scheduling Tests

A. By September 1 of each year, the District Supervisor of the Aztec District Office of the Division shall by memorandum notify each gas transportation facility and each operator of the pools which are to be scheduled for biennial shut-in pressure testing during the following testing period from January 1 through the last day of December of that test year. The District Supervisor will also provide a list of "exempt" wells.

Any well scheduled for testing during its test year may have the test flow period, and some of the seven day shut-in period conducted in December of the previous year. The earliest date that a well could be scheduled for Biennial Shut-In Pressure Test would be such that the Test Flow Period would end on December 25 of the previous year.

Downhole commingled wells are to be scheduled for tests on dates for pool of lowermost completion of well.

SECTION 4: Test Procedure

A. To obtain the shut-in pressure of a well under test, the well shall be shut-in some time during the current testing season for a period of seven to fourteen consecutive days, which have been preceded by a minimum of seven days of uninterrupted production. Such shut-in pressure shall be measured by deadweight gauge or other method approved by the Division on the seventh to fourteenth day of shut-in of the well. The shut-in pressure shall be measured on both the tubing and the casing when communication exists between the two strings. The higher of such pressures shall be reported as the shut-in pressure of the well.

SECTION 5: Filing of Shut-In Pressure Data

The result of this test shall be reported in the last column of Division Form C-125 showing the pressure in psia and shall be filed in triplicate with the Aztec District Office of the Division.

SECTION IV

FORMS

SUGGESTED FIELD DATA SHEET

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL (Form C-122)

GAS WELL TEST DATA SHEET - SAN JUAN BASIN (Form C-122-A)

INITIAL POTENTIAL TEST DATA SHEET (Form C-122-B)

DELIVERABILITY TEST REPORT (Form C-122-C)

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w) (Form C-122-D)

WORKSHEET FOR STEPWISE CALCULATION OF (SURFACE) (SUBSURFACE) PRESSURE (P_c & P_w) (P_f & P_s) (Form C-122-E)

WORKSHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w) FROM KNOWN BOTTOMHOLE PRESSURE (P_f or P_s) (Form C-122-F)

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE (Form C-122-G)

GAS WELL SHUT-IN PRESSURE TESTS (Form C-125)

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test ☐ Initial ☐ Annual ☐ Special — Test Date	Lease No. or Serial No.
Company — Connection	Allottee
Field — Reservoir — Location	Unit
Completion Date — Total Depth — Plug Back TD — Elevation	Farm or Lease Name
Csg. Size — Wt. — d — Set At — Perforations: From — To	Well No.
Tbg. Size — Wt. — d — Set At — Perforations: From — To	Sec. — Twp.-Blk. — Rge.-Sur.
Type Completion (Describe) — Packer Set At	County or Parish
Producing Thru — Reservoir Temp. F — Mean Annual Temp. F — Baro. Press. — P_a	State
L — H — G_g — % CO_2 — % N_2 — % H_2S	Prover — Meter Run — Taps

DATE	ELAP. TIME	Wellhead Working Pressure			METER OR PROVER				REMARKS
Time of Reading	Hrs.	Tbg. Psig.	Csg. Psig.	Temp. F	Pressure Psig.	Diff.	Temp. F	Orifice	(Include liquid production data: Type—A.P.I. Gravity—Amount)
		NOT REQUIRED TO BE FILED							

Page _____ of _____ Data By _____

OIL CONSERVATION DIVISION

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122
Revised 10-1-78

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Type Test ☐ Initial ☐ Annual ☐ Special				Test Date	
Company		Connection			
Pool		Formation		Unit	
Completion Date	Total Depth	Plug Back TD	Elevation	Farm or Lease Name	
Csg. Size / Wt. / d / Set At		Perforations: From To		Well No.	
Tbg. Size / Wt. / d / Set At		Perforations: From To		Unit Sec. Twp. Rge.	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple		Packer Set At		County	
Producing Thru	Reservoir Temp. °F	Mean Annual Temp. °F	Baro. Press. – P_a	State	
L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps

FLOW DATA					TUBING DATA		CASING DATA		
NO.	Prover Line Size X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI									
1.									
2.									
3.									
4.									
5.									

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1							
2.							
3.							
4.							
5.							

NO.	P_r	Temp. °R	T_r	Z
1.				
2.				
3.				
4.				
5.				

Gas Liquid Hydrocarbon Ratio _____ Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons _____ Deg.
Specific Gravity Separator Gas _____ XXXXXXXXXX
Specific Gravity Flowing Fluid XXXXX _____
Critical Pressure _____ P.S.I.A. _____ P.S.I.A.
Critical Temperature _____ R _____ R

P_c _____ P_c^2 _____

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1				
2				
3				
4				
5				

(1) $\dfrac{P_c^2}{P_c^2 - P_w^2} =$ _____ (2) $\left[\dfrac{P_c^2}{P_c^2 - P_w^2}\right]^n =$ _____

$AOF = Q \left[\dfrac{P_c^2}{P_c^2 - P_w^2}\right]^n =$ _____

Absolute Open Flow _____ Mcfd @ 15.025 | Angle of Slope θ _____ | Slope, n _____

Remarks: _____

Approved By Division	Conducted By:	Calculated By:	Checked By:

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122-A
Revised 10-1-78

WELL DELIVERABILITY TEST REPORT FOR 19____

POOL NAME	POOL SLOPE	FORMATION	COUNTY
	n=		

COMPANY			WELL NAME AND NUMBER		
UNIT LETTER	SECTION	TOWNSHIP	RANGE	PURCHASING PIPELINE	
CASING O.D. – INCHES	CASING I.D. – INCHES	SET AT DEPTH – FEET	TUBING O.D. – INCHES	TUBING I.D. – INCHES	TOP – TUBING PERF. – FEET
GAS PAY ZONE FROM TO		WELL PRODUCING THRU CASING TUBING		GAS GRAVITY	GRAVITY X LENGTH
DATE OF FLOW TEST FROM TO			DATE SHUT-IN PRESSURE MEASURED		

PRESSURE DATA – ALL PRESSURES IN PSIA

(a) Flowing Casing Pressure (DWt)	(b) Flowing Tubing Pressure (DWt)	(c) Flowing Meter Pressure (DWt)	(d) Flow Chart Static Reading	(e) Meter Error (Item c – Item d)	(f) Friction Loss (a – c) or (b – c)	(g) Average Meter Pressure (Integr.)
(h) Corrected Meter Pressure (g + e)	(i) Avg. Wellhead Press. P_t = (h + f)	(j) Shut-in Casing Pressure (DWt)	(k) Shut-in Tubing Pressure (DWt)	(l) P_c = higher value of (j) or (k)	(m) Del. Pressure P_d = _____ %P_c	(n) Separator or Dehydrator Pr. (DWt) for critical flow only

FLOW RATE CORRECTION (METER ERROR)

Integrated Volume – MCF/D	Quotient of $\frac{\text{Item c}}{\text{Item d}}$	$\sqrt{\frac{\text{Item c}}{\text{Item d}}}$	Corrected Volume Q = MCF/D

WORKING PRESSURE CALCULATION

$(1-e^{-s})$	$(F_c\,Q_m)^2\,(1000)$	$R^2 = (1-e^{-s})\,(F_c\,Q_m)^2(1000)$	P_t^2	$P_w^2 = P_t^2 + R^2$	$P_w = \sqrt{P_w^2}$

DELIVERABILITY CALCULATION

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = _____\left[\left(_____\right)^n\left(_____\right)^n = _____ = _____\right] = _____ \text{ MCF/D}$$

REMARKS:

SUMMARY

Item b _____ Psia
P_c _____ Psia
Q _____ MCF/D
P_w _____ Psia
P_d _____ Psia
D _____ MCF/D

Company _____
By _____
Title _____
Witnessed By _____
Company _____

NEW MEXICO OIL CONSERVATION COMMISSION

INITIAL POTENTIAL TEST DATA SHEET

Form C-122-B

This form must be used for reporting all pitot tube tests made in the State. It is particularly important that it be used for reporting Initial Potential Tests in the San Juan Basin as prescribed by Order No. R-333 and by the New Mexico Oil Conservation Commission Manual of Tables and Procedure for Initial Potential (Pitot Tube) Tests.

Pool _____ Formation _____

County _____ Date Well Tested _____

Operator _____ Lease _____ Well No. _____

Unit Letter _____ Section _____ Township _____ Range _____

Casing O.D. _____ Wt. _____ Set At _____ Tubing O.D. _____ Wt. _____ Set At _____

Pay Zone: From _____ To _____ Gas Gravity: Meas. _____ Est. _____

Tested Through: Casing _____ Tubing _____

Test Nipple _____ I.D. Type of Gauge Used: Spring ☐ Monometer ☐

OBSERVED DATA

Shut-In Pressure: Casing _____ Tubing _____ S.I. Period _____

Time Well Opened _____ Time Well Gauged _____ Impact Pressure _____

Volume (Table I) _____ (a)

Multiplier For Pipe or Casing (Table II) _____ (b)

Multiplier For Flowing Temperature (Table III) _____ (c)

Multiplier For Sp. Gravity (Table IV) _____ (d)

Avg. Barometer Pressure at Wellhead (Table V) _____

Multiplier For Barometric Pressure (Table VI) _____ (e)

Initial Potential, MCF/24 Hrs. (a) x (b) x (c) x (d) x (e) = _____

Witnessed By: _____ Tested By _____

Company: _____ Company _____

Title: _____ Title _____

NEW MEXICO OIL CONSERVATION COMMISSION

DELIVERABILITY TEST REPORT

Form C-122-C
Revised 9-1-65

Type Test ☐ Initial ☐ Annual ☐ Special				Test Date	
Company		Connection			
Pool		Formation		Unit	
Completion	Total Depth		Plug Back TD	Elevation	Farm or Lease Name
Csg. Size / Wt. / d / Set At			Perforations: From To		Well No.
Tbg. Size / Wt. / d / Set At			Perforations: From To		Unit Sec. Twp. Rge.
Type Well – Single – Bradenhead – G.G. or G.O. Multiple			Packer Set At		County
Producing Thru	Reservoir Temp. °F	Mean Annual Temp. °F	Baro. Press. – P_a		State
L / H	Gg.	% CO_2	% N_2	% H_2S	Prover / Meter Run / Taps

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size X Choke Orifice Size	Press. p.s.i.g.	Diff. hw	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI									
1.									

NO.	Coefficient (24-Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft	Gravity Factor Fg	Super Compress. Factor Fpv	Rate of Flow Q, Mcfd
1.							

NO.	P_r	Temp. R.	T_r	Z

P_d _____
P_d^2 _____
P_c _____ P_c^2 _____

Gas Liquid Hydrocarbon Ratio _____ Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons _____ Deg.
Specific Gravity Separator Gas _____ XXXXXXXXXX
Specific Gravity Flowing Fluid XXXXX _____
Critical Pressure _____ p.s.i.a. _____ p.s.i.a.
Critical Temperature _____ R _____ R
Pf _____ Pf^2 _____

NO.	P_t	P_t^2	$P_c^2 - P_t^2$	P_w	P_w^2	$P_c^2 - P_w^2$	P_s	P_s^2	$P_t^2 - P_s^2$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = \left[\quad\right] = _____$$

$$\text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = _____$$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = _____$$

$$n\ \text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = _____$$

$$\text{Deliv.} = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n$$

Deliv. _____ Mcfd
n _____
_____
(Source of n)

Commission _____
Company _____
Others _____

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w)

Form C-122D
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE										
1 Q_m										
2 T_w (W.H. °R)										
3 T_s (B.H. °R)										
4 $T = (\frac{T_w + T_s}{2})$										
5 Z (Est.)										
6 TZ										
7 GH/TZ										
8 e^s (Table XIV)										
9 $1-e^{-s}$ (Table XIV)										
10 P_t										
11 $P_t^2/1000$										
12 F_r (Table XV)										
13 $F_c = F_r$ TZ										
14 F_c Q_m										
15 L/H $(F_c Q_m)^2$										
16 $F_w = L/H (F_c Q_m)^2 (1-e^{-s})$										
17 $P_w^2 = P_t^2 + F_w$										
18 $P_s^2 = e^s P_w^2$										
19 P_s										
20 $P = (\frac{P_t + P_s}{2})$										
21 $P_r = (P/P_{cr})$										
22 $T_r = (T/T_{cr})$										
23 Z (Table XI)										

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) (SURFACE) PRESSURE (P_f & P_s) (P_c & P_w)

Form C–122–E
Adopted 9–1–65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ Q_m _____ M^2cfd (L/H) $(F_rQ_m)^2$ _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H											
2	GH											
3	37.5GH											
4	P_c or P_n											
5	P_r											
6	T											
7	T_r											
8	Z											
9	P/Z P/Z	$\overline{4} \div \overline{8}$										
10	P/TZ	$\overline{9} \div \overline{6}$										
11	$(P/TZ)^2/1000$	$(\overline{10})^2/1000$										
12	$L/H(F_rQ_m)^2$											
13		$\overline{11} + \overline{12}$										
14	I_n	$\overline{10} \div \overline{13}$										
15	$M=P_n-P_{n-1}$											
16	$N=I_n + I_{n-1}$											
17	M x N	$\overline{15} \times \overline{16}$										
18	Σ(M x N)	$\Sigma\overline{17}$										

One copy to be filed in District Office (Work copy acceptable)

Form C-122F
Adopted 9-1-65

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or P_w) FROM KNOWN BOTTOM HOLE PRESSURE (P_f or P_s)

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE		1	2	3	4	5	6	7	8
1	T_w(W.H. °R)								
2	T_s(B.H. °R)								
3	$T=(\frac{T_w + T_s}{2})$								
4	Z (Est.)								
5	TZ								
6	GH/TZ								
7	e^s(Table XIV)								
8	P_f or P_s								
9	P_f^2 or P_s^2								
10	$P_c^2 = P_f^2/e^s$ or $P_w^2 = P_s^2/e^s$								
11	P_c or P_w								
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$								
13	$P_r = (P/P_{cr})$								
14	$T_r = (T/T_{cr})$								
15	Z (Table XI)								

One copy to be filed in District Office (Work copy acceptable)

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY _____ LEASE _____ WELL NO. _____ DATE _____

L _____ H _____ L/H _____ G _____ % CO_2 _____ % N_2 _____ % H_2S _____

d _____ F_r _____ GH _____ P_{cr} _____ (TABLE IX & X) T_{cr} _____ (TABLE IX & X)

LINE											
1	Q_m										
2	T_w (W.H. °R)										
3	T_s (BH °R)										
4	$T = (\frac{T_w + T_s}{2})$										
5	Z (Est.)										
6	TZ										
7	GH/TZ										
8	e^s (Table XIV)										
9	$1 - e^{-s}$ (Table XIV)										
10	P_c										
11	P_c^2										
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H\ (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2(1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$										
19	P_f										
20	$P = (\frac{P_c + P_f}{2})$										
21	$P_r = \frac{P}{P_{cr}}$										
22	$T_r = \frac{T}{T_{cr}}$										
23	Z (Table XI)										

One copy to be filed in District Office (Work copy acceptable)

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION
P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-125
Revised 3-2-84

GAS WELL SHUT-IN PRESSURE REPORT

Operator	Address	Pool	County

LEASE	WELL NO.	LOCATION				DATE PRESS. RUN	TIME S.I. HRS./MIN.	S.I. PRESSURE PSIG (DWT)		
		UNIT	SEC.	TWP.	RGE.					

I hereby certify that the above information is true and complete to the best of my knowledge and belief. SEE RULE 402

Signature _____ Title _____ Date _____

SECTION V

BASIC CALCULATIONS

Determination of Compressibility Factor, Z, and Supercompressibility Factor, F_{pv} . . . . . V - 1

Calculation of the Rate of Flow, Using Orifice Meter Data. . . . . V - 1

Calculation of the Rate of Flow, Using Critical Flow Prover Data. . . . . V - 2

Calculation of the Rate of Flow, Using Positive Choke Data. . . . . V - 2

Determination of the Exponent "n" of the Back-Pressure Equation . . . . . V - 3

BASIC CALCULATIONS

Number 1.

Determination of compressibility factor (Z) and supercompressibility factor (F_{pv}):

Using the data from the Field Data Sheet, Test Example 1.

G_g	=	0.625
Carbon dioxide	=	2%
Nitrogen	=	3%

From Table IX determine P_{cr} and T_{cr} and make appropriate corrections for carbon dioxide and nitrogen content as determined from Table X, thus:

$$P_{cr} = 671 + 8 - 5 = 674$$
$$T_{cr} = 365 - 3 - 9 = 353$$

Using the 3-hour data obtained from the first flow,

$$P_r = P_m/P_{cr} = 734.2/674 = 1.09$$
$$T_r = T_m/T_{cr} = 526/353 = 1.49$$

From Table XI for $P_r = 1.09$ and $T_r = 1.49$,

$$Z = 0.891$$

From Table XII for $Z = 0.891$,

$$F_{pv} = 1.059$$

Number 2.

Calculation of the rate of flow using meter data:

$$Q = F_b \times \sqrt{(h_w)(P_m)} \times F_t \times F_g \times F_{pv}$$

Using the 3-hour data obtained from the first flow,

$$Q = (16.80)\sqrt{(8.3)(734.2)}\ (0.9943)(1.265)(1.059)$$

$$= (16.80)(78.05)(0.9943)(1.265)(1.059)$$

$$= 1747 \text{ Mcfd}$$

Number 2. (Continued)

Source of factors:

F_b = 16.80 (from Table II for 4-inch meter run and 1.750 inch orifice)

Note: Use Table I for flange tap meters.

$\sqrt{(8.3)(734.2)} = (2.881)(27.09)$ (from Table III)
$= 78.05$

F_t = 0.9943 (from Table VII for temperature of 66 F)

F_g = 1.265 (from Table VIII for G_g = 0.625)

F_{pv} = 1.059 (from Basic Calculation Number 1, page V-1)

Number 3.

Calculation of the rate of flow using critical flow prover data:

$$Q = F_p \times P_m \times F_t \times F_g \times F_{pv}$$

Source of factors:

F_p (from Table V for appropriate prover size and orifice diameter)

P_m (prover pressure, psia)

Note: Other factors are determined in the same manner as in Basic Calculation Number 2.

Number 4.

Calculation of the rate of flow using positive choke data:

$$Q = F_p \times P_m \times F_t \times F_g \times F_{pv}$$

Source of factors:

F_p (from Table VI for appropriate choke size and type)

P_m (choke pressure, psia)

Note: Other factors are determined in the same manner as in Basic Calculation Number 2.

Number 5.

Determination of the exponent "n" of the back-pressure equation:

The exponent of the back-pressure equation, "n", may be determined as follows:

$$n = \frac{\log Q_2 - \log Q_1}{\log (P_c^2 - P_w^2)_2 - \log (P_c^2 - P_w^2)_1}$$

If $(P_c^2 - P_w^2)_2$ is selected from the back-pressure curve at a point one cycle greater than $(P_c^2 - P_w^2)_1$, then

$$n = \log Q_2 - \log Q_1, \text{ or}$$

$$n = \log Q_2/Q_1$$

Using the back-pressure curve in Test Example 1

at $(P_c^2 - P_w^2)_1 = 2,250$,

$Q_1 = 9,400$ and $\log Q_1 = 3.9731$

and

at $(P_c^2 - P_w^2)_2 = 225$,

$Q_2 = 1,590$ and $\log Q_2 = \underline{3.2014}$

0.7717

and

$n = 0.772$

When the back-pressure curve is plotted on equal cycle log-log paper, the exponent "n" is equal to the tangent of the angle formed with the $(P_c^2 - P_w^2)$ - axis or the cotangent of the angle formed with the "Q"-axis.

The exponent "n" may also be determined by the use of curve fitting methods such as that of least squares.

SECTION VI

TEST EXAMPLES

TEST EXAMPLE NO. 1 ..... VI- 1

A. Calculation of Absolute Open Flow on a Gas Well Where P_w Cannot be Measured (Using Average Temperature and Compressibility Factor, Step 6)..... VI- 1

B. Alternate Method of Calculation P_w Corresponding to Flowing Wellhead Pressure, P_t (Using Stepwise Procedure, Step 6-A)..... VI-10

TEST EXAMPLE NO. 2 - Calculation of Absolute Open Flow on a Gas Well Where P_w Can be Measured..... VI-19

TEST EXAMPLE NO. 3 - Calculation of Absolute Open Flow Using the One-Point Back-Pressure Test..... VI-25

TEST EXAMPLE NO. 4 - Calculation of Deliverability (D) Using the One-Point Back Pressure Test..... VI-30

TEST EXAMPLE NO. 5 - Calculation of Wellhead Pressure P_c or P_w Where the Observed Wellhead Pressure is Affected by Liquids in the Wellbore (Using Average Temperature and Pressure)..... VI-34

TEST EXAMPLE NO. 6 - Calculation of Wellhead Pressure P_c or P_w Where the Observed Wellhead Pressure is Affected by Liquids in the Wellbore (Using Stepwise Procedure)..... VI-38

TEST EXAMPLE NO. 7 - Calculation of Subsurface Pressure P_f (sandface) Where the Wellhead Shut-in Pressure is Affected by Liquids in the Wellbore..... VI-43

A. Calculation of Subsurface Pressure at the Sandface (Using Average Temperature and Compressibility Factors)..... VI-43

B. Calculation of Subsurface Pressure at the Sandface (Using Stepwise Procedure)..... VI-47

TEST EXAMPLE NO. 8 - Well Deliverability Test as Required for Prorated Gas Pools in Northwest New Mexico..... VI-52

TEST EXAMPLE NO. 1

A. CALCULATION OF ABSOLUTE OPEN FLOW ON A GAS WELL WHERE P_w CANNOT BE MEASURED

NOTE: If liquids are known to exist in the wellbore under shut-in conditions, refer to Test Example 5 or 6 for calculation of effective wellhead shut-in pressure P_c.

ALL SQUARED PRESSURES IN THOUSANDS

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate the compressibility Factor, Z, and supercompressibility Factor, F_{pv}, for flow rate calculations as follows:

Obtain P_{cr} and T_{cr} from Table IX for a gas gravity of 0.625; obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X. Correct P_{cr} and T_{cr} as follows:

$P_{cr} = 671 + 8 - 5 = 674$
$T_{cr} = 365 - 3 - 9 = 353$
$P_m = 721 + 13.2 = 734.2$ psia
$T_m = 66 + 460 = 526$ R
$P_r = P_m/P_{cr} = \frac{734.2}{674} = 1.09$

$T_r = T_m/T_{cr} = \frac{526}{353} = 1.49$

From Table XI, for $P_r = 1.09$ and $T_r = 1.49$, $Z = 0.891$
From Table XII for $Z = 0.891$, $F_{pv} = 1.059$

STEP 3.

Calculate the flow rates as follows and record on C-122

$$Q = F_b \sqrt{h_w \times P_m} \times F_t \times F_g \times F_{pv}$$

a. Rate #1
$F_b = 16.80$ Table II
$F_t = .9943$ Table VII
$F_g = 1.265$ Table VIII
$F_{pv} = 1.059$ Determined in Step 2

$Q_1 = 16.80 \sqrt{8.3 \times 734.2} \times 0.9943 \times 1.265 \times 1.059$
$= 1747$ Mcfd

b. In like manner, the other three flow rates are calculated to be
Rate #2 - 2590 Mcfd
Rate #3 - 3398 Mcfd
Rate #4 - 4082 Mcfd

Record on Form C-122

STEP 4.

Since the well produces liquids with the gas, it is necessary to calculate the specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595 \quad G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

4595 = Constant
G_g = 0.625 (air = 1.000)
G_l = 0.7787 (water = 1.000) Table XIII - API = 50.2°
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

$G = 0.641$

STEP 5.

a. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X. Correct P_{cr} and T_{cr} as follows:

$P_{cr} = 670 + 8 - 5 = 673$
$T_{cr} = 372 - 3 - 9 = 360$

(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D)

b. Calculate L/H, the length of the flow string divided by the vertical depth.
L/H = 1.000

c. GH = 0.641 x 8130 = 5211

STEP 6.

Calculate P_w for the 1st flow rate using Average Temperature and Compressibility factors. (For greater accuracy, in wells with shut-in pressure in excess of 2000 psig, the Stepwise Procedure should be used to calculate P_w. The Stepwise Procedure is described starting on page VI - 10, Step 6-A.)

a. Enter Q_m = 1.747 on Form C-122-D Line 1, 1st Trial

STEP 6. (Cont'd)

b. $T_w = 74 + 460 = 534$ (Line 2)
$T_s = 155 + 460 = 615$ (Line 3)
$T = (T_w + T_s)/2 = (534 + 615)/2 = 574.5$ (Line 4)

STEP 7.

Estimate compressibility factor, Z. In this case Z is estimated to be 0.825.

STEP 8.

a. $TZ = 574.5 \times 0.825 = 474.0$ (Line 6)
$GH/TZ = 5211/474.0 = 10.994$ (Line 7)

STEP 9.

For GH/TZ = 10.994, read e^s and $1 - e^{-s}$ from Table XIV

$e^s = 1.510$

$1 - e^{-s} = 0.338$

STEP 10.

a. P_t = flowing wellhead pressure = 1785.2 psia (Line 10)

b. $P_t^2 = (1785.2)^2 = 3186.9$ (Line 11)

STEP 11.

For flow string with d = 1.995", F_r from Table XV is 0.018231

STEP 12.

a. $F_c = F_r\ TZ = (0.018231)\ (474.0) = 8.641$ (Line 13)

b. $F_c\ Q_m = (8.641)\ (1.747) = 15.10$ (Line 14)

c. $L/H\ (F_c\ Q_m)^2 = 1.000\ (15.10)^2 = 228.0$ (Line 15)

d. $F_w = L/H\ (F_c\ Q_m)^2\ (1 - e^{-s}) = (228.0)\ (.338) = 77.06$ (Line 16)

e. $P_w^2 = P_t^2 + F_w = 3186.9 + 77.06 = 3264.0$ (Line 17)

STEP 13.

a. $P_s^2 = e^s\ P_w^2 = (1.510)\ (3264.0) = 4928.6$ (Line 18)

b. $P_s = \sqrt{P_s^2} = \sqrt{4928.6} = 2220.1$ psia (Line 19)

c. $P = (P_t + P_s)/2 = (1785.2 + 2220.1)/2 = 2002.7$ (Line 20)

STEP 13. (Cont'd.)

d. $P_r = \frac{P}{P_{cr}} = \frac{2002.7}{673} = 2.98$ (Line 21)

e. $T_r = \frac{T}{T_{cr}} = \frac{574.5}{360} = 1.60$ (Line 22)

STEP 14.

Enter on Line 23 the compressibility factor, Z, from Table XI corresponding to a P_r of 2.98 and a T_r of 1.60. In this example Z = 0.826.

STEP 15.

Since Z in line 23 is not equal to Z in line 5, the estimation of Z in line 5 and subsequent calculations of P_w^2 are in error. Enter Z from line 23, 1st Trial, on line 5, 2nd Trial, and repeat calculations, Line 4 through Line 23. When Z in Line 5 is equal to Z in Line 23, the calculated value of P_w^2 is correct for the first flow rate.

STEP 16.

Repeat procedure for other flow rates and record the results on Form C-122.

STEP 17.

Determination of Absolute Open Flow.

Calculated data points from Form C-122 are to be plotted upon log-log paper of at least three inches per cycle to establish the absolute open flow and exponent "n." Q shall be plotted on the horizontal axis and the difference of the squared pressures, $P_c^2 - P_w^2$, on the vertical axis. (SQUARED PRESSURES IN THOUSANDS)

	Q Mcfd	$P_c^2 - P_w^2$
1.	1747	259.8
2.	2590	425.8
3.	3396	601.4
4.	4083	770.5

Absolute open flow is defined as the calculated 24-hour rate of flow against atmospheric pressure. The rate of flow shall be expressed at New Mexico Oil Conservation Commission base conditions of 15.025 psia and 60 F.

The error caused in the value of the absolute open flow, when atmospheric pressure is ignored, is insignificant when the shut-in pressure is above 100 psia. Because of this fact, atmospheric pressure will not be considered in this example.

The absolute open flow shall be read on the Q axis directly under the point where the value of P_c^2 intersects the back-pressure curve. In this example, $P_c^2 = 3523.9$. When plotted on the back-pressure curve the absolute open flow is 13, 250 Mcfd, see attached curve.

STEP 18.

Determination of exponent, n, of the back-pressure curve.

STEP 18. (Cont'd.)

The numerical value of the exponent, n, is the cotangent of the angle formed by the back pressure curve and the horizontal axis of the log-log plot.

The most accurate method to determine "n" is to find the difference of the logrithms of two values of Q which are exactly one vertical cycle apart. Exponent "n" is found as follows:

Q_1 (where $P_c^2 - P_w^2$ is 2250) = 9400 Mcfd

Q_2 (where $P_c^2 - P_w^2$ is 225) = 1590 Mcfd

Log 9400 (Q_1) = 3.97313

Log 1590 (Q_2) = 3.20140

n = 0.77173

n = 0.772

STEP 19.

The value of absolute open flow should be checked by substituting test data into the following formula. If a test data point does not fall on the curve as drawn, then any convenient value of Q and ($P_c^2 - P_w^2$) from the curve should be used.

$$AOF = Q\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n$$

where:

AOF = absolute open flow.
Q = rate of flow from test data point or from back-pressure curve.
P_c = wellhead shut in pressure.
P_w = static column wellhead pressure.
n = exponent of back-pressure curve.

NOTE: Where Q is taken from the back-pressure curve, ($P_c^2 - P_w^2$) is read directly from the curve.

Substituting values in the equation (2nd flow rate)

$$AOF = 2590 \text{ Mcfd} \left[\frac{3523.9}{3523.9 - 3098.1}\right]^{.772}$$

$AOF = 2590 (8.276)^{.772}$

$AOF = 2590 (5.112)$

AOF = 13,240 Mcfd

AOF from back-pressure curve is 13, 250 Mcfd which is in good agreement. Although the figure 13, 250 Mcfd as read from the curve cannot be used, it is a good method for checking the calculations.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special	Test Date: 11/10/64		Lease No. or Serial No.
Company: Test Example No. 1	Connection: Blowe Gas Company		Allottee
Field: Monument	Reservoir: McKee	Location	Unit
Completion Date: 2-4-58	Total Depth: 8293	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test
Csg. Size: 7" Wt.: 23.# d: 6.366	Set At: 8293	Perforations: From 8112 To 8138	Well No.: 1
Tbg. Size: 2-3/8" Wt.: 4.7# d: 1.995	Set At: 8130	Perforations: From Open Ended To	Unit: D Sec.: 30 Twp.: 19-S Rge.: 36-E
Type Completion (Describe): Single		Packer Set At: 8100	County or Parish: Lea
Producing Thru: Tbg.	Reservoir Temp. F: 155 @ 8130'	Mean Annual Temp. F: 60	Baro. Press., P_a: 13.2	State: New Mexico
L: 8130 H: 8130	G_g: 0.625	% CO_2: 2.0 % N_2: 3.0 % H_2S: 0	Prover: 4" Meter Run: Pipe Taps

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type—A.P.I. Gravity—Amount)
11-10-64									St Tk 3' - 7 1/8" 60F
7:45A		1864.0	Packer						72 hour Shut-in Pressure
8:00A									Start 1st Flow
8:30A		1809.0		74	718.0	7.0	60	1.75	
9:00A		1793.0		74	720.0	8.0	59		
9:30A		1772.0		74	721.0	8.4	64		
10:00A		1772.0		74	721.0	8.3	66		St Tk 3' - 7 1/2" 60F
		NOT REQUIRED TO BE FILED							
10:00A									Increased Rate for 2nd Flow
10:30A		1765.0		74	719.0	15.0	54	1.75	
11:00A		1742.0		74	719.0	15.0	54		
11:30A		1698.0		74	722.0	15.7	55		
12:00N		1698.0		74	729.0	17.5	56		St Tk 3' - 8 1/4" 60F
12:00N									Increased Rate for 3rd Flow
12:30P		1705.0		74	739.0	24.0	43	1.75	
1:00P		1672.0		74	740.0	25.5	46		
1:30P		1608.0		74	742.0	27.5	50		
2:00P		1608.0		74	744.0	29.3	54		St Tk 3' - 9 1/8" 60F
2:00P									Increased Rate for 4th Flow
2:30P		1630.0		74	745.0	38.0	44	1.75	
3:00P		1587.0		74	746.0	39.3	46		
3:30P		1512.0		74	749.0	41.5	52		
4:00P		1512.0		74	759.0	41.5	55		St Tk 3' - 10 1/4" 60F
									API - 50.2 at 60F
									Tank Size - 12' Diameter
									1.68 Barrels/inch

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 11-10-64	
Company: Test Example No. 1		Connection: Blowe Gas Co.			
Pool: Monument		Formation: McKee		Unit:	
Completion Date: 2-4-58	Total Depth: 8293	Plug Back TD:	Elevation:	Farm or Lease Name: H. I. Test	
Csg. Size: 7" / Wt.: 23 / d: 6.366 / Set At: 8293		Perforations: From 8112 To 8148		Well No.: 1	
Tbg. Size: 2-3/8" / Wt.: 4.7 / d: 1.995 / Set At: 8130		Perforations: From Open To Ended		Unit: D / Sec.: 30 / Twp.: 19-S / Rge.: 36-E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: 8100		County: Lea	
Producing Thru: Tbg.	Reservoir Temp. °F: 155 @ 8130'	Mean Annual Temp. °F: 60	Baro. Press. – P_a: 13.2	State: New Mexico	

L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps
8130	8130	0.625	2.0	3.0	0.0		4"	Pipe

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI						1864.0		Pkr		72
1.	4x1.75		721.0	8.3	66	1772.0	74			2
2.	4x1.75		729.0	17.5	56	1698.0	74			2
3.	4x1.75		744.0	29.3	54	1608.0	74			2
4.	4x1.75		759.0	41.5	55	1512.0	74			2
5.										

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	16.80	78.06	734.2	.9943	1.265	1.059	1747
2	16.80	114.0	742.2	1.004	1.265	1.065	2590
3	16.80	149.0	757.2	1.006	1.265	1.066	3396
4	16.80	179.0	772.2	1.005	1.265	1.068	4083
5							

NO.	P_t	Temp. °R	T_f	Z
1	1.09	526	1.49	0.891
2.	1.10	516	1.46	0.882
3.	1.12	514	1.46	0.880
4	1.15	515	1.46	0.877
5				

Gas Liquid Hydrocarbon Ratio: 193 Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: 50.2 Deg.
Specific Gravity Separator Gas: 0.625 / XXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX / 0.641
Critical Pressure: 674 P.S.I.A. / 673 P.S.I.A.
Critical Temperature: 353 R / 360 R

P_c 1877.2 P_c^2 3523.9

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1	3186.9		3264.1	259.8
2	2928.2		3098.1	425.8
3	2628.3		2922.5	601.4
4	2326.2		2753.4	770.5
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 8.276$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 5.112$

AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 13,240$

Absolute Open Flow: 13,240 Mcfd @ 15.025 | Angle of Slope θ: | Slope, n: .772

Remarks:

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

WORKSHEET FOR CALCULATION OF STATIC COLUMN WELLHEAD PRESSURE (P_w)

Form C-122D
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11/10/64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

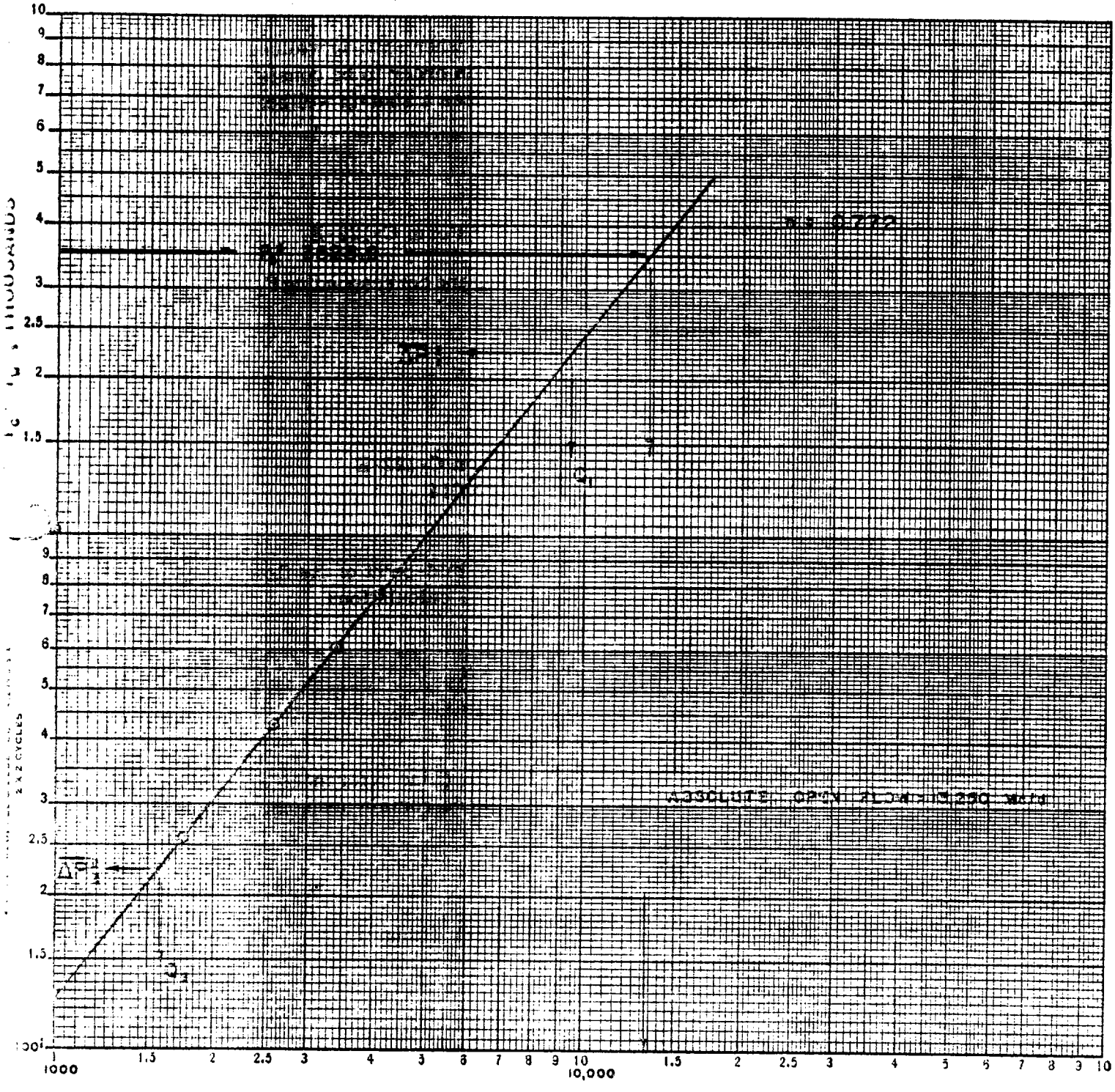
L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .018231 GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	1st Rate		2nd Rate		3rd Rate		4th Rate			
	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial		
1 Q_m	1.747	1.747	2.590	2.590	3.396	3.396	4.083	4.083		
2 T_w (W.H. °R)	534	534	534	534	534	534	534	534		
3 T_s (B.H. °R)	615	615	615	615	615	615	615	615		
4 $T = (\frac{T_w + T_s}{2})$	574.5	574.5	574.5	574.5	574.5	574.5	574.5	574.5		
5 Z (Est.)	0.825	0.826	0.833	0.829	0.833	0.832	0.833	0.835		
6 TZ	474.0	474.5	478.6	476.3	478.6	478.0	478.6	479.7		
7 GH/TZ	10.994	10.982	10.888	10.941	10.888	10.902	10.888	10.863		
8 e^S (Table XIV)	1.510	1.510	1.504	1.507	1.504	1.505	1.504	1.503		
9 $1-e^{-S}$ (Table XIV)	0.338	0.338	0.335	0.336	0.335	0.336	0.335	0.335		
10 P_t	1785.2	1785.2	1711.2	1711.2	1621.2	1621.2	1525.2	1525.2		
11 $P_t{}^2/1000$	3186.9	3186.9	2928.2	2928.2	2628.3	2628.3	2326.2	2326.2		
12 F_I (Table XV)	.018231	.018231	.018231	.018231	.018231	.018231	.018231	.018231		
13 $F_c = F_I$ TZ	8.641	8.651	8.725	8.683	8.725	8.714	8.725	8.745		
14 $F_c Q_m$	15.10	15.11	22.60	22.49	29.63	29.59	35.62	35.71		
15 $L/H (F_c Q_m)^2$	228.0	228.3	510.8	505.8	877.9	875.6	1268.8	1275.2		
16 $F_w = L/H (F_c Q_m)^2 (1-e^{-S})$	77.06	77.17	171.1	169.9	294.1	294.2	425.0	427.2		
17 $P_w{}^2 = P_t{}^2 + F_w$	3264.0	3264.1	3099.3	3098.1	2922.4	2922.5	2751.2	2753.4		
18 $P_s{}^2 = e^S P_w{}^2$	4928.6	4928.8	4661.3	4668.8	4395.3	4398.4	4137.8	4138.4		
19 P_s	2220.1	2220.1	2159.0	2160.7	2096.5	2097.2	2034.2	2034.3		
20 $P = (\frac{P_t + P_s}{2})$	2002.7	2002.7	1935.1	1936.0	1858.9	1859.2	1779.7	1779.8		
21 $P_r = (P/P_{cr})$	2.98	2.98	2.88	2.88	2.76	2.76	2.64	2.64		
22 $T_r = (T/T_{cr})$	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60		
23 Z (Table XI)	0.826	0.826	0.829	0.829	0.832	0.832	0.835	0.835		

One copy to be filed in District Office (Work [illegible] acceptable)

Company	Test Example No. 1
Well	H. I. Test No. 1
Location	D, 30-20S-36E
County	Lea
Date	11-10-64



$\overline{\Delta P}_1^2$ $P_c^2 - P_w^2$ = 2250

$\overline{\Delta P}_2^2$ $P_c^2 - P_w^2$ = 225

Q_1 = 9400 Mcfd

Q_2 = 1590 Mcfd

LOG Q_1 = 3.97313

LOG Q_2 = 3.20140

n = .77173 = 0.772

B. ALTERNATE METHOD OF CALCULATION P_w CORRESPONDING TO FLOWING WELLHEAD PRESSURE, P_t

(This method is based on Stepwise Procedure rather than using average temperature and compressibility factors.)

NOTE: This method of calculation is to be used when shut-in wellhead pressures exceed 2000 psi. However, in order to be consistent in the use of basic data, this example uses a shut-in wellhead pressure of 1864 psig.

STEP 6-A.

a. Fill in the required information at the top of Form C-122-E.

b. Obtain the inside diameter of the flow string and corresponding F_r value.

Enter at the top of Form C-122-E.

$d = 1.995"$
$F_r = 0.018231$ Table XV

c. Calculate (L/H) $(F_r\ Q_m)^2$ and enter on Form C-122-E
$(1.000)\ (0.018231 \times 1.747)^2 = 0.001014$

STEP 7-A.

Determine the flowing temperature at the surface, mid-point of the flow string, and at the bottom of the hole for use in the pressure calculations.

$T @ H = 0 = 74 + 460 = 534$ R
$T @ H = 8130/2 = (74 + 155)/2 + 460 = 574.5$ R
$T @ H = 8130 = 155 + 460 = 615$ R

STEP 8-A.

Enter H = 0 on Line 1, Column 1. Form C-122-E. (Line references are indicated in parenthesis following each step; column references remain unchanged unless indicated.)

a. Lines 1, 2, and 3 in Column 1 are zero.

b. $P_t = 1785.2$ psia (measured wellhead pressure) (Line 4)

c. $P_r = \frac{P_t}{P_{cr}} = \frac{1785.2}{673} = 2.65$ (Line 5)

d. T = wellhead temperature, 534 R (Line 6)

e. $T_r = \frac{T}{T_{cr}} = \frac{534}{360} = 1.48$ (Line 7)

f. $Z = 0.777$ Table XI (Line 8)

STEP 8-A. (Cont'd.)

g. $P/Z = (1785.2)/.777 = 2297.6$ (Line 9)

h. $P/TZ = 2297.6/534 = 4.3026$ (Line 10)

i. $(P/TZ)^2/1000 = (4.3026)^2/1000 = 0.018512$ (Line 11)

j. $(L/H)\ (F_r\ Q_m)^2 = 0.001014$ (previously calculated) (Line 12)

k. Add (Line 11) and (Line 12);
$0.018512 + 0.001014 = 0.019526$ (Line 13)

l. I_t = (Line 10)/(Line 13) = $4.3026/0.019526 = 220.352$ (Line 14)

STEP 9-A.

Make first trial calculation for the pressure at the midway point, H = 8130/2 = 4065'. (Line 1, Column 2)

a. Compute GH and 37.5 GH
GH = $0.641 \times 4065 = 2605.67$ (Line 2)
37.5 GH = $37.5 \times 2605.67 = 97,713$ (Line 3)

b. Estimate value of M as follows:
$(37.5\ GH/2I_t = 97,713/2\ (220.352) = 222$ (Line 15, Column 2)

c. Add M to P_t, $222 + 1785.2 = 2007.2$ (Line 4)

d. Compute P_r and T_r using the estimated pressure and temperature at H = 4065, and obtain Z from Table XI.

$P_r = \frac{2007.2}{673} = 2.98$ (Line 5)

T = 574.5 R (Line 6)

$T_r = \frac{574.5}{360} = 1.60$ (Line 7)

Z = 0.826 (Line 8)

e. Compute P/Z, P/TZ, and $(P/TZ)^2/1000$ and enter appropriate values in Lines 9, 10, and 11, respectively.

f. Since L/H = 1.000 and neither F_r or Q_m have changed, $L/H\ (F_r\ Q_m)^2$ is still equal to the previously calculated value of 0.001014 (Line 12)

g. (Line 11) plus (Line 12) = $0.017391 + 0.001014 = 0.018905$ (Line 13)

h. I_1 = (Line 10)/(Line 13) = 223.740 (Line 14)

i. $N = I_t$ + Trial $I_1 = 220.352 + 223.740 = 444.092$ (Line 16)

STEP 9-A. (Cont'd.)

j. Calculate M by dividing 37.5 GH by N, 97,713/444.092 = 220 (Line 15, Column 3)

k. When M has been estimated correctly, the value determined under item (j) will equal M under item (b).

l. Enter 220 under M (Line 15, Column 3) and repeat items (c) through (j) until the correct M is estimated.

m. By repeating the calculations, the correct value of M is determined to be 220.

n. Multiply final values of M and N
(220) (444.284) = 97,742 (Line 17)

o. Enter the value of M x N under $\sum$ (M x N) (Line 18)

STEP 10-A.

Make first trial calculation for the pressure at H = 8130'. (Line 1, Column 4)

a. Compute GH and 37.5 GH and enter on the appropriate line.
GH = 0.641 x 8130 = 5211.33 (Line 2)
37.5 GH = 37.5 x 5211.33 = 195,425 (Line 3)

b. Estimate value of M by dividing N (Line 16, Column 3) into the difference between 37.5 GH (Line 3, Column 4) and M x N (Line 17, Column 3)
M = (195,425 - 97,742)/444.284 = 220 (Line 15, Column 4)

c. $P_2 = M + P_1 = 220 + 2005.2 = 2225.2$

d. Compute P_r and T_r at H = 8130; obtain appropriate Z. Compute P/Z, P/TZ, and $(P/TZ)^2/1000$. Enter all these values on the appropriate Lines 5 through 11.

e. $L/H\ (F_r\ Q_m)^2 = 0.001014$ (Line 12)

f. (Line 11) + (Line 12) = 0.018632 (Line 13)

g. I_2 = (Line 10)/(Line 13) = 4.1974/.018632 = 225.279 (Line 14)

h. $N = I_1 + \text{Trial } I_2 = 223.932 + 225.279 = 449.211$ (Line 16)

i. Compute M by dividing N (Line 16) into the difference, 37.5 GH (Line 3) minus (M x N) (Line 17, Column 3) thus
M = (195,425 - 97,742)/449.473 = 217 (Line 15, Column 5)

j. When M has been estimated correctly, the value determined under item (i) is equal to that determined under item (b).

STEP 10-A. (Cont'd.)

k. Enter M = 217 on Line 15, Column 5, and repeat items (c) through (i) until the correct value of M is determined.

l. By repeating the calculations, the correct M is determined to be 217.

m. Multiply final values of M and N
217 x 449.473 = 97, 536 (Line 17)

n. Add M x N (Line 17) to $\sum$ (M x N) (Line 18, Column 3) and enter on Line 18, Column 5. $\sum$ (M x N) = 97, 742 + 97, 536 = 195, 278

STEP 11-A.

Using the following equations, compute the flowing pressure (P_s) at H = 8130 feet.

$$\triangle P = \frac{3(37.5\ GH)}{I_t + 4I_1 + I_2}$$

$$P_s = P_t + \triangle P$$

where:

$G = 0.641$
$H = 8130'$
$I_t = 220.352$ (Line 14, Column 1)
$I_1 = 223.932$ (Line 14, Column 3)
$I_2 = 225.541$ (Line 14, Column 5)
$P_t = 1785.2$ (Line 4, Column 1)

$$\triangle P = \frac{3(195,425)}{220.352 + 4(223.932) + 225.541}$$

$$\triangle P = \frac{586,275}{1341.621} = 437.0$$

$P_s = 1785.2 + 437.0$
$P_s = 2222.2$ psia at H = 8130'
P_s is to be used in the next major step in the calculations, which is to convert P_s to a static column pressure at the wellhead, P_w.

STEP 12-A.

Transfer the following from the last column on page 1, Form C-122-E, to Column 1, Page 2: H = 8130', GH = 5211.33, 37.5 GH = 195, 425, P_n = 2222.2, P_r = 3.30, T = 615, T_r = 1.71, Z = 0.862, P/Z = 2578.0, and P/TZ = 4.1919.

a. Lines 11, 12, and 13 can be omitted in the static column case where Q_m is zero. Where $Q_m = 0$, $L/H\ (F_r\ Q_m)^2$ must necessarily = 0. Therefore, I_n resolves.

$$I_n = \frac{P/TZ}{(P/TZ)^2/1000 + L/H(F_r\ Q_m)^2} = \frac{P/TZ}{(P/TZ)^2/1000 + 0}$$

$$I_n = \frac{1000}{P/TZ}$$

$I_s = (1000)/4.1919 = 238.555$ (Line 14)

STEP 12-A. (Cont'd.)

b. Enter value of 37.5 GH = 195, 425 from Line 3 to 18.

STEP 13-A.

Make first trial calculation for the pressure at H/2 = 8130/2 = 4065 (Line 1, Column 2)

a. H = 4065 (Line 1)

b. GH = 2605.67 (Line 2)

c. 37.5 GH = 97, 713 (Line 3)

d. Estimate value of M by dividing $2I_s$ (Line 14, Column 1) into the difference between $\sum$ (M x N) (Line 18, Column 1) and 37.5 GH (Line 3, Column 2)
M = (195, 425 - 97, 713)/2 (238.555) = 205 (Line 18, Column 2)

e. $P_1 = P_n - M = 2222.2 - 205 = 2017.2$ (Line 4)

f. $P_r = 2017.2/673 = 3.00$ (Line 5)

g. T = estimated temperature at 4065' = (74 + 155)/2 + 460 = 574.5 (Line 6)

(Since the temperature of a static column will approach the temperature of the adjoining flowing column, the temperatures used in the calculations of pressure at H = 4065 and H = 0 should be the temperatures of the flowing column.)

h. $T_r = 574.5/360 = 1.60$ (Line 7)

i. Z = 0.825 (Line 8)

j. P/Z = 2017.2/0.825 = 2445.1 (Line 9)

k. P/TZ = 2445.1/574.5 = 4.2560 (Line 10)

l. $I_1 = 1000/(P/TZ) = 1000/4.2560 = 234.962$ (Line 14)

m. N = I_S (Column 1) + Trial I_1 (Column 2) = 238.555 + 234.962 = 473.517 (Line 16)

n. M = 37.5 GH/N = 97, 713/473.517 = 206. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

o. Enter M = 206 (Line 15, Column 3)

p. P_1 is then P_n - M = 2222.2 - 206 = 2016.2 (Line 4, Column 3)

q. Repeat Steps (f) through (n) until the correct value of M is determined. M = 206

STEP 13-A. (Cont'd.)

r. Multiply final values of M x N
206 x 473.628 = 97,567 (Line 17)

s. Subtract M x N (Line 17) from $\sum$ (M x N) (Line 18, Column 1)
195,425 - 97,567 = 97,858 (Line 18)

STEP 14-A.

Make first trial calculation for the pressure at H = 0 (Line 1, Column 4)

a. GH = 0

b. 37.5 GH = 0

c. Estimate M by dividing N (Line 16, Column 3) into $\sum$ (M x N) (Line 18, Column 3)
M = 97,858/473.628 = 207 (Line 15, Column 4)

d. Subtract M from P_1 (H = 4065)
2016.2 - 207 = 1809.2 (Line 4)

e. P_r = 1809.2/673 = 2.69 (Line 5)

f. T = 74 + 460 = 534 (Line 6)

g. T_r = 534/360 = 1.48 (Line 7)

h. Z = 0.775 (Line 8)

i. P/Z = 2334.5 (Line 9)

j. P/TZ = 4.3717 (Line 10)

k. I_c = 1000/4.3717 = 228.744 (Line 14)

l. N = 235.078 + 228.744 = 463.822 (Line 16)

m. Compute M by dividing $\sum$ (M x N) (Line 18, Column 3) by N (Line 16, Column 4)
M = 97,858/463.822 = 211
When M has been estimated correctly, the value determined under this item will be equal to that determined under item (c).

n. Enter M = 211 on Line 15, Column 5 and repeat the calculations (d) through (m).
M = 210

o. Multiply final values of M and N
210 x 465.053 = 97,661 (Line 17)

STEP 15-A.

Using the following equations calculate the static column wellhead pressure P_w.

$$\triangle P = \frac{3(37.5\ GH)}{I_w + 4I_1 + I_2}$$

$$P_w = P_s - \triangle P$$

where:

$G = 0.641$

$H = 8130$

$I_w = 229.975$ (Line 14, Column 6)

$I_1 = 235.073$ (Line 14, Columr 3)

$I_2 = 238.555$ (Line 14, Column 1)

$P_s = 2222.2$ (Line 4, Column 1)

$$\triangle P = \frac{3(37.5)\ (.641)\ (8130)}{229.975 + 4\ (235.073) + 238.555} = \frac{586,275}{1408.822} = 416.1$$

$$P_w = 2222.2 - 416.1 = 1806.1$$

STEP 16-A.

Using the same procedure as outlined, the other three pressure points are then calculated. After calculating P_w for all flow rates, refer to Steps 17, 18, and 19 on pages VI-4 and VI-5 for the procedure to be followed in determining the absolute open flow.

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) ~~(SURFACE)~~ PRESSURE (P_f & P_s) ~~(P_c & P_w)~~

Form C-122E
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11-10-64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

L 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .01823 Q_m 1.747 M^2cfd $(L/H)(F_rQ_m)^2$ 0.001014 P_{CT} 673 (TABLE IX & X) T_{CT} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		0	4065		8130						
2	GH		0	2605.67		5211.33						
3	37.5GH		0	97,713		195,425						
4	P_c or P_n		1785.2	2007.2	2005.2	2225.2	2222.2					
5	P_f		2.65	2.98	2.98	3.31	3.30					
6	T		534	574.5	574.5	615	615					
7	T_r		1.48	1.60	1.60	1.71	1.71					
8	Z		.777	0.826	0.826	0.862	0.862					
9	P/Z P/Z	$\bar{4}\div\bar{8}$	2297.6	2430.0	2427.6	2581.4	2578.0					
10	P/TZ	$\bar{9}\div\bar{6}$	4.3026	4.2298	4.2256	4.1974	4.1919					
11	$(P/TZ)^2/1000$	$(\bar{10})^2/1000$	0.018512	0.017891	0.017856	0.017618	.017572					
12	$L/H(F_rQ_m)^2$		0.001014	.001014	0.001014	0.001014	0.001014					
13		$\bar{11} + \bar{12}$	0.019526	0.018905	0.018870	0.018632	0.018586					
14	I_n	$\bar{10}\div\bar{13}$	220.352	223.740	223.932	225.279	225.541					
15	$M=P_n-P_{n-1}$			222	220	220	217					
16	$N=I_n + I_{n-1}$			444.092	444.284	449.211	449.473					
17	M x N	$\bar{15}\times\bar{16}$			97,742		97,536					
18	Σ(M x N)	$\Sigma\bar{17}$			97,742		195,278					

VI-17

One copy to be filed in District Office (Work copy acceptable)

WORK SHEET FOR STEPWISE CALCULATION (SURFACE) PRESSURE (SUBSURFACE) (P_f & P_s) (P_c & P_w)

Form C-122E
Adopted 9-1-65

COMPANY Test Example No. 1 LEASE H. I. Test WELL NO. 1 DATE 11-10-64

LOCATION: Unit D Section 30 Township 19-S Range 36-E

L 8130 H 8130 L/H 1.000 G .641 % CO_2 2.0 % N_2 3.0 % H_2S 0

d 1.995 F_r .01823 Q_m 0 M^2cfd (L/H) $(F_rQ_m)^2$ 0 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		8130	4065		0						
2	GH		5211.33	2605.67		0						
3	37.5GH		195,425	97,713		0						
4	P_c or P_n		2222.2	2017.2	2016.2	1809.2	1805.2	1804.2				
5	P_r		3.30	3.00	3.00	2.69	2.68	2.68				
6	T		615	574.5	574.5	534	534	534				
7	T_r		1.71	1.60	1.60	1.48	1.48	1.48				
8	Z		0.862	0.825	0.825	0.775	0.777	0.777				
9	P/Z P/Z	$\bar{4}\div\bar{8}$	2578.0	2445.1	2443.9	2334.5	2323.3	2322.0				
10	P/TZ	$\bar{9}\div\bar{6}$	4.1919	4.2560	4.2540	4.3717	4.3507	4.3483				
11	$(P/TZ)^2/1000$	$(\bar{10})^2/1000$										
12	$L/H(F_rQ_m)^2$											
13		$\bar{11}+\bar{12}$										
14	I_n	$\bar{10}\div\bar{13}$	238.555	234.962	235.073	228.744	229.848	229.975				
15	$M=P_n-P_{n-1}$			205	206	207	211	210				
16	$N=I_n+I_{n-1}$			473.517	473.628	463.822	464.926	465.053				
17	M x N	$\bar{15}\times\bar{16}$			97,567			97,661				
18	Σ(M x N)	$\Sigma\bar{17}$	195,425		97,858							

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 2

CALCULATION OF ABSOLUTE OPEN FLOW ON A GAS WELL WHERE P_w CAN BE MEASURED

Producing through tubing with casing pressures available.

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate Flow rates as follows, and record on C-122:

$$Q = F_b \sqrt{h_w \times P_m \times F_t \times F_g \times F_{pv}}$$

a. Rate #1

$P_{cr} = 669$ Table IX
$T_{cr} = 382$ Table IX
$P_m = 754 + 13.2 = 767.2$
$T_m = 74 + 460 = 534$
$P_r = \frac{767.2}{669} = 1.15$
$T_r = \frac{534}{382} = 1.40$
$Z = .856$ Table XI
$F_{pv} = 1.081$ Table XII
$F_b = 10.84$ Table I
$F_t = .9868$ Table VII
$F_g = 1.217$ Table VIII
$Q = 10.84 \times 95.94 \times .9868 \times 1.217 \times 1.081 = 1350$ Mcfd

b. In like manner, the other three flow rates are found to be (see Form C-122):

Rate #2 $Q_2 = 1839$ Mcfd
Rate #3 $Q_3 = 2032$ Mcfd
Rate #4 $Q_4 = 2432$ Mcfd

STEP 3.

Pressure calculations -

Since the static wellhead working pressures (P_w) are measured, the pressure loss due to friction calculations are not necessary.

Data for plotting back pressure curve:

Q vs. $(P_c^2 - P_w^2)$

where:

Q = rate of flow, Mcfd @ 15.025 psia & 60 F.
P_c = wellhead shut-in pressure, casing or tubing whichever is higher.
P_w = static wellhead working pressure at the termination of each flow period. (Casing if flowing through tubing, tubing if flowing through casing.)

ALL SQUARED PRESSURES IN THOUSANDS

Values of P_c and P_w are calculated by adding 13.2 (Northwest New Mexico use 12.2) to the casing pressures recorded on Suggested Field Data Sheet.

Rate	Q (Mcfd)	P_c (Psia)	P_c^2 (Thsnds)	P_w (Psia)	P_w^2 (Thsnds)	$P_c^2-P_w^2$ (Thsnds)
1	1350	999.2	998.4	855.2	731.4	267.0
2	1839	999.2	998.4	795.2	632.3	366.1
3	2032	999.2	998.4	767.2	588.6	409.8
4	2432	999.2	998.4	711.2	505.8	492.6

STEP 4.

The above data shall then be plotted on log-log paper of at least three inch cycles in accordance with rule 5a of the Stabilized Multipoint Test instructions. Q shall be plotted on the horizontal axis and ($P_c^2 - P_w^2$) on the vertical axis as shown at the end of this example.
Enter values of Pc, Pc^2, P_w, P_w^2, and ($P_c^2 - P_w^2$) on Form C-122.

STEP 5.

Determining the value of the exponent "n" of the back-pressure curve. The numerical value of "n" is the cotangent of the angle formed by the back-pressure curve and the horizontal axis of the log-log plot.

However, a more convenient and accurate method may be used to determine the value of "n." The difference of the logarithm of two values of Q which are exactly one vertical cycle apart shall be determined in the following manner: (see attached curve)

Value of Q where curve intersects the ($P_c^2 - P_w^2$) scale exactly one cycle higher than the ($P_c^2 - P_w^2$) value used for Q_1. In this example, this value is 2000 (thousands).

$Q_2 = 8910$; Log $Q_2 = 3.949878$

Value of Q where curve intersects the lowest convenient value of ($P_c^2 - P_w^2$). In this example this value is 200 (thousands)

$Q_1 = 1045$; Log $Q_1 = 3.019116$

$n = .930762$

Rounded off to three decimals, "n" is then 0.931. This value shall be entered on Form C-122.

STEP 6.

Determining Absolute Open Flow.
Absolute open flow is defined as the calculated 24-hour rate of flow against atmospheric pressure. The rate of flow shall be expressed at New Mexico Oil Conservation Commission base conditions of 15.025 psia and 60 F.

The error caused in the value of the absolute open flow, when atmospheric pressure is ignored, is insignificant when shut-in pressure is above 100 psia. Because of this fact, atmospheric pressure will not be considered in this example.

The absolute open flow shall be determined by plotting the value of ($P_c^2 - P_w^2$) on the back-pressure curve when P_w equals zero. The absolute open flow is

STEP 6. (Cont'd.)

read on the Q or horizontal scale of the log-log plot directly under the plotted point where the $(P_c^2 - P_w^2)$ value intersects the back-pressure curve.

In this example P_c^2 equals 998.4 (thousands). When plotted on the back-pressure curve, the value of the absolute open flow is 4670 Mcfd. Record this value on Form C-122.

The value of AOF should be checked by substituting test data in the following formula. If a data point does not fall on the curve as drawn, then any convenient value of Q and $(P_c^2 - P_w^2)$ from the curve should be used.

$$AOF = Q \left[\frac{P_c^2}{(P_c^2 - P_w^2)} \right]^n$$

where:

AOF = absolute open flow
Q = rate of flow from test data point, or from back-pressure curve
P_c = wellhead shut-in pressure psia
P_w = static column wellhead pressure
n = exponent of back-pressure curve

Note: Where Q is taken from the back-pressure curve, $(P_c^2 - P_w^2)$ is read directly from the curve.

Substituting values in equation (4th flow rate):

$$AOF = 2432 \left[\frac{998.4}{(998.4 - 505.8)} \right]^{0.931}$$

$$AOF = 2432\ (2.027)^{.931}$$

$$AOF = 2432\ (1.931)$$

$$AOF = 4696 \text{ Mcfd}$$

The calculation checks the value of 4670 Mcfd as read from the back-pressure curve and is correct.

Although the figure 4670 as read from the curve cannot be used, it is a good method for checking the calculations.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special	Test Date: 11-10-64		Lease No. or Serial No.
Company: Test Example No. 2	Connection: Blowe Gas Co.		Allottee
Field: Eumont	Reservoir: Queen	Location	Unit
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test
Csg. Size: 5-1/2	Wt.: 15.5	d: 4.950	Set At: 3593	Perforations: From 3550 To 3560	Well No.: 6
Tbg. Size: 2-3/8	Wt.: 4.7	d: 1.995	Set At: 3573	Perforations: From Open End To	Unit: A Sec.: 36 Twp.: 22-S Rge.: 35-E
Type Completion (Describe): Single			Packer Set At: None	County or Parish: Lea
Producing Thru: Tbg.	Reservoir Temp. F: @ 130° F	Mean Annual Temp. F	Baro. Press. – P_a: 13.2	State: New Mexico
L: 3573	H: 3573	G_g: 0.675	% CO_2	% N_2	% H_2S	Prover	Meter Run: 4" Flange	Taps

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure: Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER: Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type—A.P.I. Gravity—Amount)
11-10-64									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press
11-11-64									
7:00A	24	754	842	75	754	12.0"	74	1.5"	1st Flow rate
		NOT REQUIRED TO BE FILED							
11-12-64									
7:00A	24	652	782	75	652	26.0"	71	1.5"	2nd Flow rate
11-13-64									
7:00A	24	598	754	75	598	35.0"	71	1.5"	3rd Flow rate
11-14-64									
7:00A	24	401	698	75	401	77.0"	71	1.5"	4th Flow rate

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 11-10-64	
Company: Test Example No. 2		Connection: Blowe Gas Company			
Pool: Eumont		Formation: Queen		Unit:	
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD:	Elevation:	Farm or Lease Name: H. I. Test	
Csg. Size: 5-1/2 / Wt.: 15.5 / d: 4.950 / Set At: 3593		Perforations: From 3550 To 3560		Well No.: 6	
Tbg. Size: 2-3/8 / Wt.: 4.7 / d: 1.995 / Set At: 3573		Perforations: From Open To Ended		Unit: A / Sec.: 36 / Twp.: 22-S / Rge.: 35-E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: None		County: Lea	
Producing Thru: Tbg.	Reservoir Temp. °F: 130	Mean Annual Temp. °F:	Baro. Press. – P_a: 13.2	State: New Mexico	
L: 3573 / H: 3573	Gg: 0.675	% CO_2:	% N_2:	% H_2S:	Prover: / Meter Run: 4" / Taps: Flange

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI	4"	1.5"				986	75	984	75	SI 72 hr.
1.	4"	"	754	12.0"	74	754	"	842	"	24
2.	4"	"	652	26.0	71	652	"	782	"	24
3.	4"	"	598	35.0	71	598	"	754	"	24
4.	4"	"	401	77.0	71	401	"	698	"	24
5.										

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	10.84	95.95	767.2	.9868	1.217	1.081	1350
2	10.84	131.51	665.2	.9896	1.217	1.071	1839
3	10.84	146.26	611.2	.9896	1.217	1.064	2032
4	10.84	178.59	414.2	.9896	1.217	1.043	2432
5							

NO	P_t	Temp. °R	T_f	Z
1	1.15	534	1.40	.856
2.	.99	531	1.39	.872
3.	.91	531	1.39	.883
4.	.62	531	1.39	.919
5				

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.
Specific Gravity Separator Gas: .675 XXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX Dry Gas
Critical Pressure: 669 P.S.I.A. ____ P.S.I.A.
Critical Temperature: 382 R ____ R

P_c 999.2 P_c^2 998.4

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1		355.2	731.4	267.0
2		795.2	632.3	366.1
3		767.2	588.6	409.3
4		711.2	505.8	492.6
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 2.027$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 1.931$

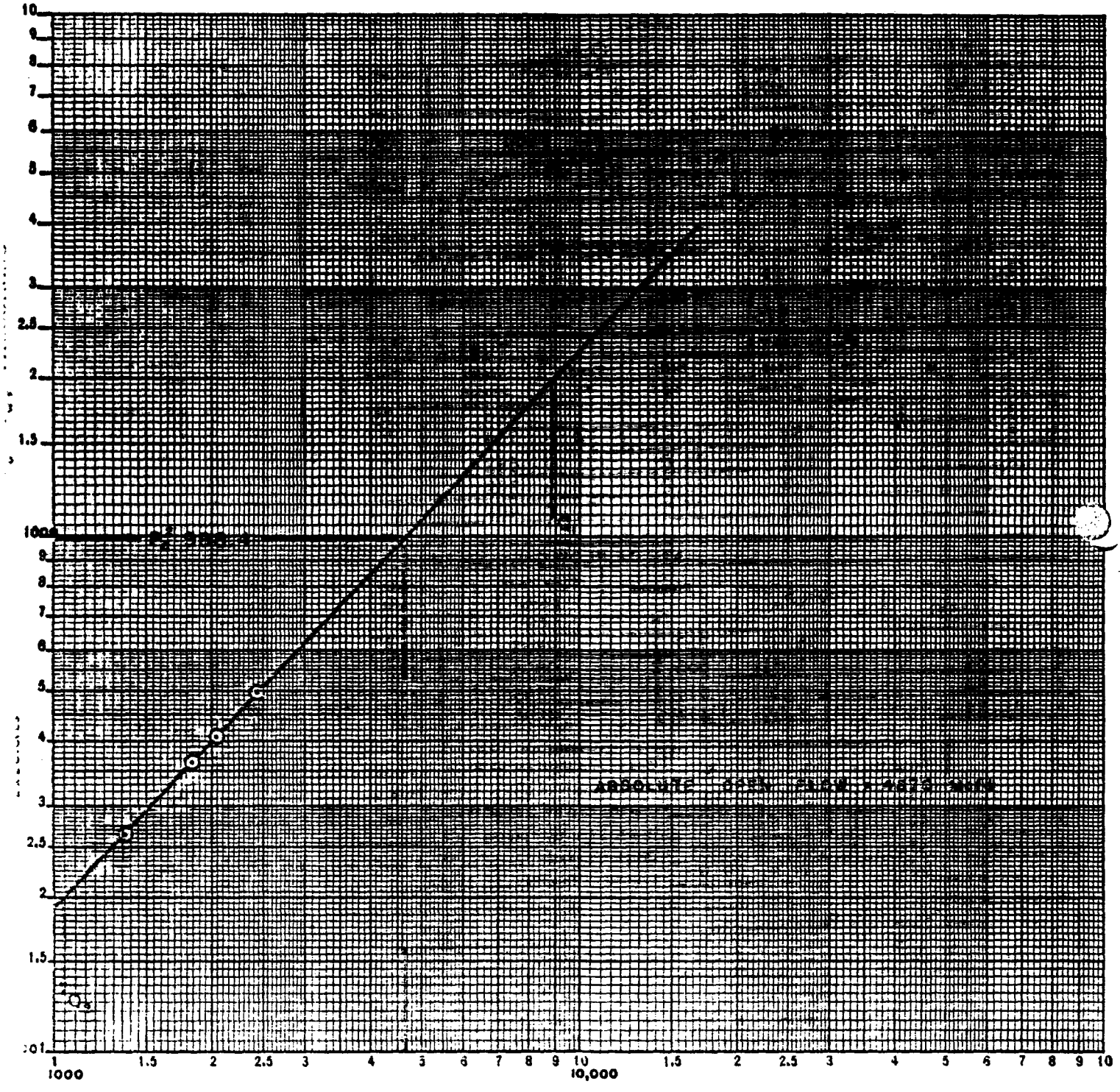
AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 4696$

Absolute Open Flow: 4696 Mcfd @ 15.025 | Angle of Slope θ: | Slope, n: .931

Remarks:

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

Company	Test Example No. 2
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64



Q, Mcfd

Q_1 = 8910 Mcfd, LOG Q_1 = 3.949878

Q_2 = 1045 Mcfd, LOG Q_2 = 3.019116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 3

CALCULATION OF ABSOLUTE OPEN FLOW USING THE ONE-POINT BACK-PRESSURE TEST

This example assumes that casing pressures can be measured. If P_w cannot be measured, the point can be calculated using the procedure used in Example No. 1.

NOTE: **A copy of the back-pressure curve used to establish the value of "n" must be submitted with Form C-122. (Refer to Testing Procedure, page III-12.)**

STEP 1.

Using general data on suggested Field Data Sheet, fill in C-122 where applicable.

STEP 2.

Calculate flow rate as follows and record on C-122.

$$Q = F_b \sqrt{h_w \times P_m} \times F_t \times F_g \times F_{pv}$$

$G = 0.675$

$P_{cr} = 669$ Table IX

$T_{cr} = 382$ Table IX

$P_m = 754 + 13.2 = 767.2$

$T_m = 74 + 460 = 534$

$P_r = \frac{767.2}{669} = 1.15$

$T_r = \frac{534}{382} = 1.40$

$Z = 0.856$ Table XI

$F_{pv} = 1.081$ Table XII

$F_b = 10.84$ Table I

$F_t = 0.9868$ Table VII

$F_g = 1.217$ Table VIII

$Q = 10.84 \times 95.94 \times 0.9868 \times 1.217 \times 1.081 = 1350$ Mcfd

ALL SQUARED PRESSURES IN THOUSANDS

STEP 3.

The absolute open flow may be calculated from the one-point back-pressure test by use of the following equation:

$$AOF = Q \left[\frac{P_c^2}{P_c^2 - P_w^2} \right]^n$$

where:

AOF = absolute open flow

Q = rate of flow from test data point

P_c = wellhead shut-in pressure, psia

STEP 3. (Cont'd.)

P_w = static column wellhead pressure (casing if flowing through tubing, tubing if flowing through casing); since P_w is measured, the pressure loss due to friction calculations are not necessary.

n = exponent of back-pressure curve (0.931 as determined from the latest back-pressure test)

$$AOF = 1350 \left[\frac{998.4}{998.4 - 731.4} \right]^{.931}$$

$$AOF = 1350 (3.739)^{.931}$$
$$AOF = 1350 (3.414)$$
$$AOF = 4609 \text{ Mcfd}$$

Enter 4609 Mcfd on C-122.

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special	Test Date: 1-15-65			Lease No. or Serial No.
Company: Test Example No. 3	Connection: Blowe Gas Co.			Allottee
Field: Eumont	Reservoir: Queen	Location		Unit
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test
Csg. Size: 5.50	Wt.: 15.5	d: 4.950	Set At: 3593	Perforations: From 3550 To 3560 — Well No.: 6
Tbg. Size: 2.375	Wt.: 4.7	d: 1.995	Set At: 3573	Perforations: From — To: Open Ended — Unit: A, Sec.: 36, Twp.: 22-S, Rge.: 35-E
Type Completion (Describe): Single			Packer Set At: None	County or Parish: Lea
Producing Thru: Tubing	Reservoir Temp. F: 130 @ 3573	Mean Annual Temp. F	Baro. Press. – P_a: 13.2	State: New Mexico
L: 3573	H: 3573	G_g: .675	% CO_2 — % N_2 — % H_2S	Prover — Meter Run: 4" — Taps: Flange

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure: Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER: Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type—A.P.I. Gravity—Amount)
1-15-65									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press.
1-16-65									
7:00A	24	754	842	75	754	12.0	74	1.5	

NOT REQUIRED

TO BE FILED

Page _____ of _____ Data By _____

NEW MEXICO OIL CONSERVATION COMMSSION

MULTIPOINT AND ONE POINT BACK PRESSURE TEST FOR GAS WELL

Form C-122
Revised 9-1-65

Type Test: ☐ Initial ☐ Annual ☐ Special				Test Date: 1-15-65	
Company: Test Example No. 3		Connection: Blowe Gas Co.			
Pool: Eumont		Formation: Queen		Unit	
Completion Date: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test	
Csg. Size: 5.50 / Wt.: 15.5 / d: 4.95 / Set At: 3593		Perforations: From 3550 To 3560		Well No.: 6	
Tbg. Size: 2.375 / Wt.: 4.7 / d: 1.995 / Set At: 3573		Perforations: From None To		Unit: A / Sec.: 36 / Twp.: 22-S / Rge.: 35-E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: None		County: Lea	
Producing Thru: Tubing	Reservoir Temp. °F: 130 @ 3573	Mean Annual Temp. °F	Baro. Press. – P_a: 13.2	State: New Mexico	

L	H	Gg	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps
3573	3573	.675	--	--	--		4"	Flange

NO.	FLOW DATA: Prover Line Size	x Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	TUBING DATA: Press. p.s.i.g.	Temp. °F	CASING DATA: Press. p.s.i.g.	Temp. °F	Duration of Flow
SI			--	--	--	986		984	75	72
1.	4"	1.5	754	12.0	74	754	75	842	75	24
2.										
3.										
4.										
5.										

RATE OF FLOW CALCULATIONS

NO.	Coefficient (24 Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft.	Gravity Factor Fg	Super Compress. Factor, Fpv	Rate of Flow Q, Mcfd
1	10.84	95.95	767.2	0.9868	1.217	1.081	1350
2							
3							
4.							
5							

NO.	P_t	Temp. °R	T_r	Z
1	1.15	534	1.40	0.856
2.				
3.				
4.				
5				

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.
Specific Gravity Separator Gas: .675 XXXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX
Critical Pressure: 669 P.S.I.A. ____ P.S.I.A.
Critical Temperature: 382 R ____ R

P_c 999.2 P_c^2 998.4

NO	P_t^2	P_w	P_w^2	$P_c^2 - P_w^2$
1		855.2	731.4	267
2				
3				
4				
5				

(1) $\frac{P_c^2}{P_c^2 - P_w^2} = 3.739$ (2) $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 3.414$

AOF = Q $\left[\frac{P_c^2}{P_c^2 - P_w^2}\right]^n = 4609$

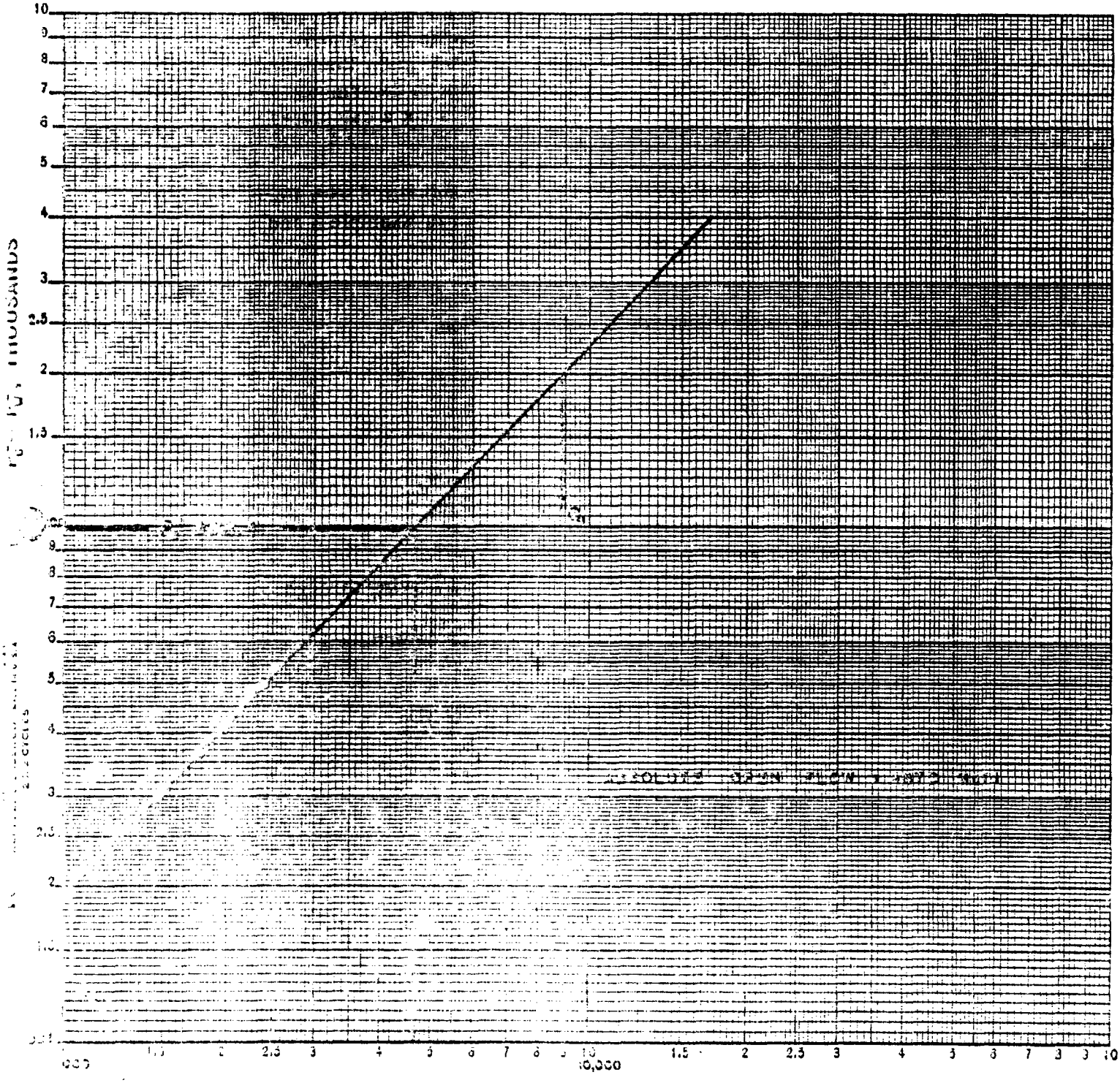
Absolute Open Flow: 4609 Mcfd @ 15.025 | Angle of Slope θ: ____ | Slope, n: 0.931*

Remarks: * Previous Back Pressure Test

Approved By Commission:	Conducted By:	Calculated By:	Checked By:

Company	Test Example No. 3
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64

(Curve from Latest Previous Test)



Q, Mcfd

Q_1 = 98.0 Mcfd; LOG Q_1 = 3.949878

Q_2 = 1043 Mcfd; LOG Q_2 = 3.018116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 4

CALCULATION OF DELIVERABILITY (D) USING THE ONE-POINT BACK-PRESSURE TEST
(Refer to Testing Procedure, page III-14)

The calculations for Deliverability are the same as for the absolute open flow except that a deliverability pressure, P_d, is used instead of atmospheric pressure. The deliverability pressure is defined by the New Mexico Oil Conservation Commission as a percent of the shut-in wellhead pressure. The exact percent is determined at the time deliverability is adopted in a field's special pool rules and is not a calculated value. For this example, P_d is used as 80% of P_c.

NOTE: A copy of the latest back-pressure curve must be submitted with Form C-122-C. The data in this example is the same as in Example 3 and Steps 1 and 2 are also the same.

STEP 3.

Calculate the deliverability using the following equation:

$$D = Q \left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2} \right]^n$$

where:

- D = deliverability of the well at back-pressure P_d
- Q = rate of flow from test data point (1350 Mcfd)
- P_c = wellhead shut-in pressure (999.2 psia)
- P_d = deliverability pressure (80% of P_c)
- P_w = static column wellhead pressure (casing if flowing through tubing, tubing if flowing through casing)
- n = exponent of back-pressure curve (0.931 as determined from the latest back-pressure test)

ALL SQUARED PRESSURE IN THOUSANDS

$$D = 1350 \left[\frac{(999.2)^2 - (.80 \times 999.2)^2}{(999.2)^2 - (855.2)^2} \right]^{0.931}$$

$$D = 1350\ (1.346)^{.931}$$

$$D = 1350\ (1.319)$$

$$D = 1781 \text{ Mcfd}$$

SUGGESTED FIELD DATA SHEET (Not Required To File)

Type Test: ☐ Initial ☒ Annual ☐ Special — Test Date: 1-15-65 — Lease No. or Serial No.:

Company: Test Example No. 4 — Connection: Blowe Gas Co. — Allottee:

Field: Eumont — Reservoir: Queen — Location: — Unit:

Completion Date: 6-4-50 — Total Depth: 3593 — Plug Back TD: — Elevation: — Farm or Lease Name: H. I. Test

Csg. Size: 5.50 — Wt.: 15.5 — d: 4.950 — Set At: 3593 — Perforations: From 3550 To 3560 — Well No.: 6

Tbg. Size: 2.375 — Wt.: 4.7 — d: 1.995 — Set At: 3573 — Perforations: From — To: Open Ended — Unit: A — Sec.: 36 — Twp.: 22-S — Rge.: 35-E

Type Completion (Describe): Single — Packer Set At: None — County or Parish: Lea

Producing Thru: Tubing — Reservoir Temp. F: 130 @ 3573 — Mean Annual Temp. F: — Baro. Press. – P_a: 13.2 — State: New Mexico

L: 3573 — H: 3573 — G_g: .675 — % CO_2: -- — % N_2: -- — % H_2S: -- — Prover — Meter Run: 4" — Taps: Flange

DATE Time of Reading	ELAP. TIME Hrs.	Wellhead Working Pressure Tbg. Psig.	Csg. Psig.	Temp. F	METER OR PROVER Pressure Psig.	Diff.	Temp. F	Orifice	REMARKS (Include liquid production data: Type–A.P.I. Gravity–Amount)
1-15-65									
7:00A	72	986	984	75	-	-	-	-	72 hr. S. I. Press.
1-16-65									
7:00A	24	754	842	75	754	12.0	74	1.5"	

NOT REQUIRED

TO BE FILED

Page ____ of ____ Data By ____

NEW MEXICO OIL CONSERVATION COMMISSION

DELIVERABILITY TEST REPORT

Form C-122-C
Revised 9-1-65

Type Test: ☐ Initial ☒ Annual ☐ Special				Test Date: 1-15-65	
Company: Test Example No. 4		Connection: Blowe Gas Co.			
Pool: Eumont		Formation: Queen		Unit	
Completion: 6-4-50	Total Depth: 3593	Plug Back TD	Elevation	Farm or Lease Name: H. I. Test	
Csg. Size: 5.50 / Wt.: 15.5 / d: 4.95 / Set At: 3593		Perforations: From 3550 To 3560		Well No.: 6	
Tbg. Size: 2.375 / Wt.: 4.7 / d: 1.995 / Set At: 3573		Perforations: From Open To Ended		Unit: A / Sec.: 36 / Twp.: T-22S / Rge.: R-35E	
Type Well – Single – Bradenhead – G.G. or G.O. Multiple: Single		Packer Set At: None		County: Lea	
Producing Thru: Tubing	Reservoir Temp. °F: 130 @ 3573	Mean Annual Temp. °F	Baro. Press. – P_a: 13.2	State: New Mexico	

L	H	Gg.	% CO_2	% N_2	% H_2S	Prover	Meter Run	Taps
3573	3573	.675	--	--	--		4"	Flange

	FLOW DATA				TUBING DATA		CASING DATA		
NO.	Prover Line Size	X Choke Orifice Size	Press. p.s.i.g.	Diff. h_w	Temp. °F	Press. p.s.i.g.	Temp. °F	Press. p.s.i.g.	Temp. °F	Duration of Flow
SI						986		984	75	72
1.	4"	1.5	754	12.0	74	754	75	842	75	24

NO.	Coefficient (24-Hour)	$\sqrt{h_w P_m}$	Pressure P_m	Flow Temp. Factor Ft	Gravity Factor Fg	Super Compress. Factor Fpv	Rate of Flow Q, Mcfd
1.	10.84	95.94	767.2	0.9868	1.217	1.081	1350

NO.	P_r	Temp. R.	T_r	Z
1.	1.15	534	1.40	0.856

Gas Liquid Hydrocarbon Ratio: Dry Gas Mcf/bbl.
A.P.I. Gravity of Liquid Hydrocarbons: Dry Deg.
Specific Gravity Separator Gas: XXXXXXXXXX
Specific Gravity Flowing Fluid: XXXXX
Critical Pressure: 669 p.s.i.a. ____ p.s.i.a.
Critical Temperature: 382 R ____ R
Pf ____ P_f^2 ____

P_d = 0.8 (999.2) = 799.4
P_d^2 = 639.0
P_c = 999.2 P_c^2 = 998.4

NO.	P_t	P_t^2	$P_c^2 - P_t^2$	P_w	P_w^2	$P_c^2 - P_w^2$	P_s	P_s^2	$P_f^2 - P_s^2$
				855.2	731.4	267.0			

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = \left[\frac{359.4}{267}\right] = 1.346 \qquad \text{Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = 0.129045$$

$$\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = 1.319 \qquad n \text{ Log}\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right] = 0.120141$$

Calculated Abs. Open Flow = Q $\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n$ = (1.350) (1.319)

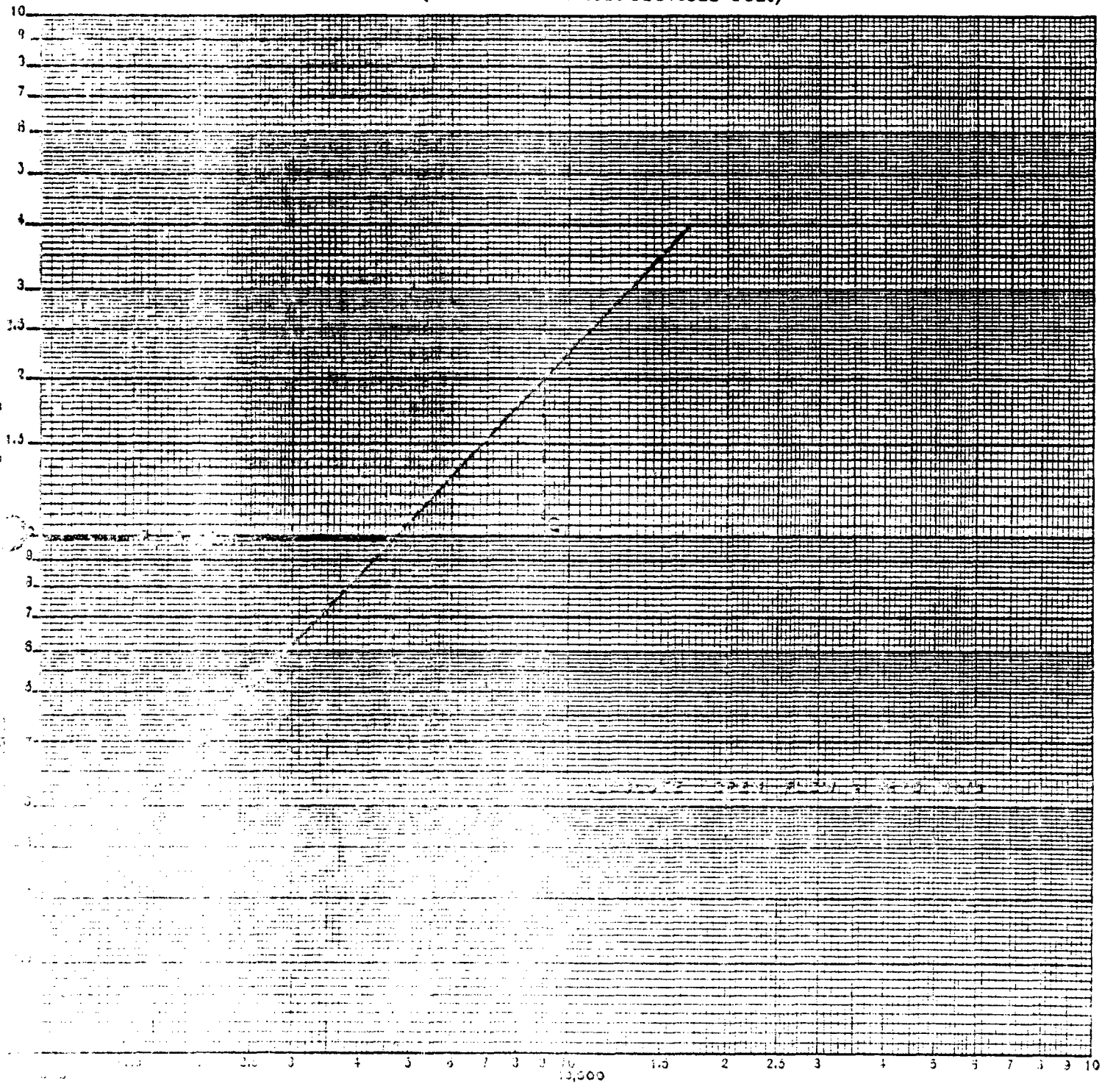
Calculated Abs. Open Flow: 1781 Mcfd

n: 1.351
(Source of n): Previous back-pressure test

Commission ____
Company ____
Others ____

Company	Test Example No. 4
Well	H. I. Test No. 6
Location	A, 36-22S-35E
County	Lea
Date	11-10-64

(Curve from Latest Previous Test)



Q, Mcfd

Q_1 = 8810 Mcfd; LOG Q_1 = 3.949678

Q_2 = 1043 Mcfd; LOG Q_2 = 3.018116

n = 0.930762 = 0.931

TEST EXAMPLE NO. 5

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE
(Using Average Temperature and Pressure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing cases (P_w). Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	N_2	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\ G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_l = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B, page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

G = 0.641

STEP 2.

a. Enter well information at the top of Form C-122-D.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Calculate L/H, the length of the flow string divided by the vertical depth.

$$L/H = 1.000$$

d. GH = 0.641 x 8130 = 5211

STEP 3.

a. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 1)

b. T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 2)

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ (Line 3)

STEP 4.

Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 4)

STEP 5.

a. TZ = 575 x 0.860 = 495 (Line 5)

b. GH/TZ = 5211/495 = 10.527 (Line 6)

c. For GH/TZ = 10.527 read e^S in Table XIV. $e^S = 1.484$ (Line 7)

STEP 6.

a. Enter reservoir pressure (P_f) = 2309 (Line 8)

b. $P_f^2 = (2309)^2/1000 = 5331.5$ (Line 9)

c. $P_c^2 = P_f^2/e^S = 5331.5/1.484 = 3592.7$ (Line 10)

d. $P_c = \sqrt{3592.7} = 1895$ (Line 11)

STEP 7.

a. $P = (P_c + P_f)/2 = (1895 + 2309)/2 = 2102$ (Line 12)

b. $P_r = 2102/673 = 3.12$ (Line 13)

c. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 14)

STEP 8.

Enter in Line 15 the compressibility factor from Table XI corresponding to a P_r of 3.12 and a T_r of 1.60. In this example, Z = 0.822 (Line 15).

STEP 9.

Since Z (Line 15) is not equal to Z (Line 4), enter Z = 0.822 on Line 4, 2nd Trial and repeat Steps 5 through 8.

STEP 10.

Since the final value of Z (Line 15, 2nd Trial) is equal to the assumed value of Z (Line 4, 2nd Trial), the value of P_c = 1878 (Line 11, 2nd Trial) is used in the back-pressure computations.

WORK SHEET FOR CALCULATION OF WELLHEAD PRESSURES (P_c or ~~P_w~~)

FROM KNOWN BOTTOM HOLE PRESSURE (P_f or ~~P_s~~)

Form C-122F
Adopted 9-1-65

COMPANY Test Example 5 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

I. 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S -

GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		1st Trial 1	2nd Trial 2	3	4	5	6	7	8
1	T_w(W.H. °R)	534	534						
2	T_s(B.H. °R)	615	615						
3	$T=(\frac{T_w + T_s}{2})$	575	575						
4	Z (Est.)	0.860	0.822						
5	TZ	495	473						
6	GH/TZ	10.527	11.017						
7	e^s(Table XIV)	1.484	1.512						
8	P_f or P_s	2309	2309						
9	P_f^2 or ~~P_s^2~~	5331.5	5331.5						
10	$P_c^2 = P_f^2/e^s$ or ~~$P_w^2 = P_s^2/e^s$~~	3592.7	3526.1						
11	P_c or ~~P_w~~	1895	1878						
12	$P=(\frac{P_w + P_s}{2})$ or $(\frac{P_c + P_f}{2})$	2102	2094						
13	$P_r = (P/P_{cr})$	3.12	3.11						
14	$T_r = (T/T_{cr})$	1.60	1.60						
15	Z (Table XI)	0.822	0.822						

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 6

CALCULATION OF WELLHEAD PRESSURE P_c OR P_w WHERE THE OBSERVED WELLHEAD PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE (Using Stepwise Procedure)

The general instructions, page III-1, provide that the stepwise procedure shall be used for wells with SIWHP in excess of 2000 psig. However, for purposes of comparison of results, Test Examples 5 and 6 are calculated using the same data.

In some cases it may be necessary to calculate the wellhead pressure which would have existed had there been no liquid accumulation in the wellbore. This calculation depends upon a known reservoir pressure which has been determined by the use of a bottom-hole pressure gauge or calculated as in Example 7.

With the known reservoir pressure, the adjusted wellhead pressure is determined by carrying out the normal static column calculations in reverse, i.e., by starting with the pressure at the sandface and calculating the wellhead pressure. Since the calculations of P_c and P_w from measured bottom-hole pressures are based on conditions of "no flow," the procedure set out in this example will apply to either shut-in (P_c) or flowing (P_w) cases. Data from a shut-in case will be used in this example.

Using the information given below, the calculations would be carried out as shown below.

Given:

H	= 8130	N_2	= 3.0%
L	= 8130	T_s	= 155 F
G_{gas}	= 0.625	T_w	= 74 F
Oil Gravity	= 50.2° API	P_f	= 2309 psia
CO_2	= 2.0%	GOR	= 193 Mcf/bbl.

STEP 1.

Since the well produces liquids with the gas, it is necessary to calculate the average specific gravity (G) of the flowing fluid (air = 1.000) for use in the pressure calculations.

$$G = \frac{G_g + \frac{4595\ G_l}{GOR}}{1 + \frac{V_l}{GOR}}$$

where:

G_g = 0.625 (air = 1.000)
4595 = Constant
G_l = 0.7787 (water = 1.000) Table XIII
GOR = 193 Mcf/bbl.
V_l = 721 (Appendix B, page B-1)

$$G = \frac{0.625 + \frac{(4595)\ (0.7787)}{193,000}}{1 + \frac{721}{193,000}}$$

G = 0.641

STEP 2.

a. Enter well information at the top of Form C-122-E.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a gravity of 0.641. Obtain corrections for CO_2 = 2.0% and N_2 = 3.0% from Table X and correct P_{cr} and T_{cr} as follows:

$$P_{cr} = 670 + 8 - 5 = 673$$
$$T_{cr} = 372 - 3 - 9 = 360$$

(If composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Enter H = 8130 on Line 1, Column 1. (Line references are indicated following each step. Column references remain unchanged unless indicated.)

d. GH = 0.641 x 8130 = 5211 (Line 2)

e. 37.5 GH = 37.5 x 5211 = 195,413 (Line 3 and Line 18)

STEP 3.

a. Enter P_n = 2309 on Line 4

b. $P_r = P_n/P_{cr} = 2309/673 = 3.43$ (Line 5)

c. Enter T = 155 + 460 = 615 R (Line 6)

d. $T_r = T/T_{cr} = 615/360 = 1.71$ (Line 7)

e. Z = 0.861 from Table XI (Line 8)

f. P/Z = 2309/0.861 = 2682 (Line 9)

g. P/TZ = 2682/615 = 4.3610 (Line 10)

h. Lines 11, 12, and 13 may be omitted in the static column case. Where $Q_m = 0$, $L/H\ (F_r\ Q_m)^2$ must necessarily = 0; therefore, I_n resolves to:

$$I_n = (P/TZ)/\left[(P/TZ)^2/1000 + L/H\ (F_r\ Q_m)^2\right] = 1000/(P/TZ) + 0$$

$$I_n = 1000/(P/TZ) = 229.305 \quad \text{(Line 14)}$$

STEP 4.

Make first trial calculation for the pressure at H/2 = 8130/2 = 4065 (Line 1, Column 2) as follows:

a. H = 4065 (Line 1)

b. GH = 0.641 x 4065 = 2606 (Line 2)

STEP 4. (Cont'd.)

c. 37.5 GH = 37.5 x 2606 = 97, 725

d. Estimate value of M by dividing $2I_n$ (Line 14, Column 1) into the difference between $\sum$(M x N) (Line 18, Column 1) and 37.5 GH (Line 3, Column 2). (195, 413 - 97, 725)/2 x 229.305 = 213 (Line 15), then $P_1 = P_f - M$ = 2309 - 213 = 2096 (Line 4).

e. P_r = 2096/673 = 3.11 (Line 5)

f. T = estimated temperature at 4065 ft. = (74 + 155)/2 + 460 = 575 R (Line 6)

g. T_r = 575/360 = 1.60 (Line 7)

h. Z = compressibility factor of a gas at a P_r of 3.11 and a T_r of 1.60 = 0.822 (Line 8)

i. P/Z = 2096/0.822 = 2550 (Line 9)

j. P/TZ = 2550/575 = 4.4348 (Line 10)

k. I_1 = 1000/(P/TZ) = 225.489 (Line 14)

l. N = I_2 (Column 1) + I_1 (Column 2) = 229.305 + 225.489 = 454.794 (Line 16)

m. M = 37.5 GH/N = 97, 725/454.794 = 215. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

n. Enter M = 215 (Line 15, Column 3). P_1 (Line 4, Column 3) is then $P_f - M$ = 2309 - 215 = 2094.

o. Repeat steps (e) through (m) until the correct value of M is determined (Line 15, Column 4).

p. Multiply final values of M and N. 215 x 455.059 = 97838 (Line 17, Column 3).

q. Subtract (M x N) (Line 17, Column 3) from $\sum$(M x N) (Line 18, Column 1). 195, 413 - 97, 838 = 97, 575 (Line 18, Column 3).

STEP 5.

Make first trial calculation for the pressure at H = 0 (Line 1, Column 5)

a. GH = 0 (Line 2)

b. 37.5 GH = 0 (Line 3)

c. Estimate M by dividing N (Line 16, Column 3) into Line 18, Column 3 = 97, 575/455.059 = 214 (Line 15, Column 5)

STEP 5. (Cont'd.)

d. Subtract M from P_n value found at H = 4065. 2094 - 214 = 1880 (Line 4, Column 5)

e. P_r = 1880/673 = 2.79 (Line 5)

f. T = 74 + 460 = 534 R (Line 6)

g. T_r = 534/360 = 1.48 (Line 7)

h. Z = compressibility factor of gas at a P_r of 2.79 and a T_r of 1.48 = 0.771 (Line 8)

i. P/Z= 1880/0.771 = 2438 (Line 9)

j. P/TZ = 2438/534 = 4.5655 (Line 10)

k. I_c = 1000/4.5655 = 219.034 (Line 14)

l. N = 225.754 + 219.034 = 444.788 (Line 16)

m. Divide $\sum$ (M x N) (Line 18, Column 3) by N (Line 16, Column 5) = 97,575/444.788 = 219. When M has been estimated correctly, the value determined under this step will be equal to M as estimated under (d).

n. Enter M = 219 (Line 15, Column 6). P_1 (Line 4, Column 6) is then P_1 - M = 2094 - 219 = 1875 (Line 4, Column 6).

o. Repeat steps (e) through (m) until the correct value of M is determined.

p. Multiply final values of M and N. 219 x 445.327 = 97,527 (Line 17, Column 6).

q. Subtract Line 17, Column 6 from Line 18, Column 3. 97,575 - 97,527 = 48 (Line 18, Column 6).

STEP 6.

Using the equation $\triangle P = 3\,(37.5\ GH)/(I_c + 4I_1 + I_2)$, calculate $\triangle P$ by substituting 219.573 (Line 14, Column 6) for I_c, 225.754 (Line 14, Column 3) for I_1, and 229.305 (Line 14, Column 1) for I_2 as indicated by calculations near the bottom of Form C-122-E. The result is $\triangle P$ = 434. By use of the equation $P_f = P_c + \triangle P$, P_c = 2309 - 434 = 1875.

WORK SHEET FOR STEP-RISE CALCULATION (SURFACE) PRESSURE (P_c & P_w)

Form C-122[illegible]
Adopted 4-1-65

COMPANY Ex. Example No. 6 LEASE _____ WELL NO. _____ DATE _____

LOCATION Unit _____ Section _____ Township _____ Range _____

H 8130 H 8130 L/H 1.000 G 0.641 % CO_2 2.0 % N_2 3.0 % H_2S 0.0

F_t 1.995 Q_m 0 M^2cfd $(L/H)(F_tQ_m)^2$ 0 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H	Given	8130	4065	4065		0	0				
2	GH	Given	5211	2606	2606		0	0				
3	37.5GH	37.5X2	195.413	97.725	97.725		0	0				
4	P_f or P_n	Given	2309	2096	2094		1880	1875				
5	P_f	4÷P_{cr}	3.43	3.11	3.11		2.79	2.79				
6	T	Given	.615	575	575		534	534				
7	T_r	6÷T_{cr}	1.71	1.60	1.60		1.48	1.48				
8	--	Table XI	0.861	0.822	0.822		0.771	0.771				
9	P_f/Z	4÷8	2682	2550	2547		2438	2432				
10	$P_f TZ$	9÷6	4.3610	4.4348	4.4296		4.5655	4.5543				
11	$(P_f TZ)^2 \cdot 1000$	$(10)^2/100$	XX	XX	XX		XX	XX				
12	$L/H(F_tQ_m)^2$	XX	XX	XX	XX		XX	XX				
13		11 + 12	XX	XX	XX		XX	XX				
14	I_n	10÷13	229.305	225.489	225.754		219.034	219.573				
15	$M=P_n-P_{n-1}$			213	215	215	214	219	219			
16	$N=I_n+I_{n-1}$			454.794	455.059		444.788	445.327				
17	M x N	15 x 16			97,838			97,527				
18	$\sum$(M*N)	$\sum$17	195,413		97,575			48				

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$$\triangle P = \frac{3\,(37.5)\,(GH)}{I} = \frac{3 \times 195,413}{219.573 + 4\,(225.754) + 229.305} = 434 \qquad P_c = P_f - \triangle P = 2309 - 434 = 1875 \text{ psia}$$

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 7

CALCULATION OF SUBSURFACE PRESSURE P_f (sandface) WHERE THE WELLHEAD SHUT-IN PRESSURE IS AFFECTED BY LIQUIDS IN THE WELLBORE

When the height of a liquid column in the wellbore and the specific gravity of the liquid are known, the reservoir pressure may be calculated by making the normal static column calculations to determine the pressure at the gas-liquid interface and adding the pressure exerted by the liquid column above the desired datum plane.

Using the results obtained in this example, an equivalent wellhead pressure may be calculated in accordance with the procedures in example 5 or 6.

In this example, the depth "H" and "L" and pressure "P_f" will refer to the gas-liquid interface rather than at the datum plane. This pressure may be calculated by either the average temperature and compressibility factor method or the stepwise procedure.

The additional pressure to be added to the calculated pressure at the gas-liquid interface "P_f" is determined as follows:

Height of liquid column (ft.) x Sp. gr. (water = 1.00) x .433 = pressure psi.

A. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE (Using Average Temperature and Compressibility Factors)

Given: Shut-in wellhead pressure of 1878 psia, H = 8130 ft., L = 8130 ft., L/H = 1.00, gas gravity = 0.641, CO_2 = 2.0%, N_2 = 3.0%, wellhead temperature = 74 F, and 1000 ft. of liquid having a specific gravity of 0.74.

STEP 1. Begin calculation of pressure at the gas-liquid interface.

a. Enter well information as shown at top of Form C-122-G.

b. Obtain P_{cr} and T_{cr} from Table IX for a gas with a specific gravity of 0.641; obtain corrections for carbon dioxide = 2.0 percent, and nitrogen = 3.0 percent from Table X.
Correct P_{cr} and T_{cr} as follows:

P_{cr} = 670 + 8 - 5 = 673

T_{cr} = 372 - 3 - 9 = 360

(If the composition of the gas is known, P_{cr} and T_{cr} may be calculated directly from critical pressure and temperature data, Table A, Appendix D.)

c. Determine H for the well and calculate L/H. In most gas wells L/H is unity as H is equal to L. However, L/H is greater than unity for directionally drilled wells. In this example, both L and H are 8130 ft., and L/H is 1.000.

d. GH = 0.641 x 8130 = 5211.

STEP 2.

a. Enter "0" rate of flow on Line 1. (Line references are indicated in parenthesis following each step.)

b. T_w = Wellhead temperature, R = 74 + 460 = 534 R (Line 2).
T_s = Bottom-hole temperature, R = 155 + 460 = 615 R (Line 3).
The bottom-hole temperature should be measured or estimated from reliable data on other wells in the area.

c. $T = (T_w + T_s)/2 = (534 + 615)/2 = 575$ R (Line 4).

STEP 3. (First Trial)
Estimate effective compressibility factor. In this example Z was estimated to be 0.860 (Line 5).

STEP 4.

a. $TZ = 575 \times 0.860 = 495$ (Line 6).

b. $GH/TZ = 5211/(495) = 10.527$ (Line 7).

c. For $GH/TZ = 10.527$ read e^s in Table XIV. $e^s = 1.484$ (Line 8).

STEP 5.

a. Enter wellhead shut-in pressure (P_c) = 1878 (Line 10).

b. $P_c^2 = (1878)^2/1000 = 3526.9$ (Line 11).

c. $e^s P_c^2 = (1.484)\ (3526.9) = 5233.9$ (Line 18).

STEP 6.
Lines 12 through 17 are not used in the static column calculation.

STEP 7.

a. $P_f = e^s P_c^2 = 5233.9\ (1000) = 2288$ (Line 19).

b. $P = (P_c + P_f)/2 = (1878 + 2288)/2 = 2083$ (Line 20).

c. $P_r = P/P_{cr} = 2083/673 = 3.10$ (Line 21).

d. $T_r = T/T_{cr} = 575/360 = 1.60$ (Line 22).

STEP 8.
Enter in Line 23 the compressibility factor from Table XI corresponding to a P_r of 3.10 and a T_r of 1.60. In this example, $Z = 0.822$ (Line 23).

STEP 9.

Since Z (Line 23) is not equal to Z (Line 5), enter Z = 0.822 on Line 5, 2nd Trial, and repeat Steps 4 through 8.

STEP 10.

Since the final value of Z (Line 23, 2nd Trial) is equal to the assumed value of Z (Line 5, 2nd Trial), the value of $e^s P_c^2 = P_f^2 = 5332.7$ and $P_f = 2309$.

STEP 11.

Now calculate the pressure exerted by the liquid column.

a. 1000' x 0.74 x 0.433 = 320.4 psi.

STEP 12.

Calculate pressure at datum by adding 2309 psia (P_f) and 320.4 psi (pressure of liquid column).

a. 2309 + 320.4 = 2629.4 psia at the sandface. This is the P_f which should be used in calculating a wellhead pressure in accordance with the procedures in example 5 or 6.

WORKSHEET FOR CALCULATION OF STATIC COLUMN PRESSURE AT GAS LIQUID INTERFACE

Form C-122G
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE H. I. Test WELL NO. 2 DATE 10-1-64

L 8130 H 8130 L/H 1.00 G 0.641 % CO_2 2.0% % N_2 3.0% % H_2S --

d _____ F_r _____ GH 5211 P_{cr} 673 (TABLE IX & X) T_{cr} 360 (TABLE IX & X)

LINE		Trial 1	Trial 2								
1	Q_m	0	0								
2	T_w (W.H. °R)	534									
3	T_s (BH °R)	615 R									
4	$T = (\frac{T_w + T_s}{2})$	575 R									
5	Z (Est.)	0.860	0.822								
6	TZ	495	473								
7	GH/TZ	10.527	11.017								
8	e^s (Table XIV)	1.484	1.512								
9	$1 - e^{-s}$ (Table XIV)										
10	P_c	1878	1878								
11	P_c^2	3526.9	3526.9								
12	F_r (Table XV)										
13	$F_c = F_r TZ$										
14	$F_c Q_m$										
15	$L/H (F_c Q_m)^2$										
16	$F_w = L/H(F_c Q_m)^2 (1-e^{-s})$										
17	$P_w^2 = P_t^2 + F_w$										
18	$P_f^2 = e^s P_c^2$	5233.9	5332.7								
19	P_f	2288	2309								
20	$P = (\frac{P_c + P_f}{2})$	2083	2094								
21	$F_r = \frac{P}{P_{cr}}$	3.10	3.11								
22	$T_r = \frac{T}{T_{cr}}$	1.60	1.60								
23	Z (Table XI)	0.822	0.822								

One copy to be filed in District Office (Work (acceptable)

B. CALCULATION OF SUBSURFACE PRESSURE AT THE SANDFACE (Using Stepwise Procedure)

Given: Shut-in wellhead pressure = 3573 psig, gas gravity = 0.865, P_{cr} = 664, T_{cr} = 444, H = 14,998 feet, wellhead temperature = 74 F, temperature at 14,998 feet = 238 F (therefore, the temperature at 7499 feet = 156 F or the arithmetic average of wellhead and bottom-hole temperature), and 1000 feet of liquid having a specific gravity of 0.74.

STEP 1.

Begin calculation of bottom-hole shut-in pressure, P_f.

a. Enter H = 0 on Line 1, Column 1, Form C-122-E (Line references are indicated in parentheses following each step; column references remain unchanged unless indicated.)

b. GH = 0 (Line 2)

c. 37.5 GH = 0 (Line 3)

d. P_c = 3573 + 13.2 = 3586.2 (Line 4)

e. $P_r = P_c/P_{cr}$ = 3586.2/664 = 5.40 (Line 5)

f. T = 534 R (Line 6)

g. $T_r = T/T_{cr}$ = 534/444 = 1.20 (Line 7)

h. Z = 0.731 Table XI (Line 8)

i. P/Z = 3586.2/.733 = 4905.9 (Line 9)

j. P/TZ = 4905.9/534 = 9.1871 (Line 10)

k. Since this calculation deals with shut-in conditions and Q = 0, Lines 11, 12, and 13 may be omitted.
Where Q_m = 0, L/H $(F_r\ Q_m)^2$ must = 0. Therefore, I_n resolves to:

$$I_n = \frac{P/TZ}{(P/TZ)^2/1000 + L/H\ (F_r\ Q_m)^2} = \frac{P/TZ}{(P/TZ)^2/1000}$$

$$I_n = \frac{1000}{P/TZ}$$

I_t = 1000/(P/TZ) = 1000/9.1871 = 108.848 (Line 14)

STEP 2.

Make first trial calculation for the pressure at the midway point, H = 14,998/2 = 7499. (Line 1, Column 2).

a. Compute GH and 37.5 GH
GH = 0.865 x 7499 = 6486.64 (Line 2)
37.5 GH = 37.5 x 6486.64 = 243,249 (Line 3)

b. Estimate value of M as follows:
$M = 37.5\ GH/2I_t = 243,249/2\ (108.848) = 1117.4$ (Line 15)

c. Add M to P_c for estimate of P_1
$P_1 = 1117.4 + 3586.2 = 4703.6$ (Line 4)

d. Compute P_r and T_r for H = 7499
$P_r = P_1/P_{cr} = 4703.6/664 = 7.08$ (Line 5)
$T = 616$ R (Line 6)
$T_r = T/T_{cr} = 616/444 = 1.39$ (Line 7)

e. $Z = 0.907$ Table XI (Line 8)

f. $P/Z = 4703.6/0.907 = 5185.9$ (Line 9)

g. $P/TZ = 5185.9/616 = 8.4187$ (Line 10)

h. $I_1 = 1000/(P/TZ) = 1000/8.4187 = 118.783$ (Line 14)

i. $N = I_t + \text{Trial } I_1 = 108.848 + 118.783 = 227.631$ (Line 16)

j. Calculate M as follows:
$M = 37.5\ GH/N = 243,249/227.631 = 1069$

k. When M has been estimated correctly, the value determined under Item (j) will equal M under item (b). Since the values of M are different, enter M = 1070 on Line 15, Column 3 and repeat items (c) through (j) until the correct value of M is determined.

l. By repeating the calculation, the correct value of M is determined to be 1066.

m. Multiply final values of M and N.
1066 x 228.284 = 243,351 (Line 17)

n. Enter the value of M x N under $\sum$ (M x N) (Line 18)

STEP 3.

Make first trial calculation for the pressure at H = 14,998. (Line 1, Column 5).

a. Compute GH and 37.5 GH
GH = 0.865 x 14,998 = 12,973.27 (Line 2, Column 5)
37.5 GH = 37.5 x 12,973.27 = 486,498 (Line 3)

STEP 3. (Cont'd.)

b. Estimate value of M as follows:
$M = (37.5\ GH) - \sum (M \times N)/N$ (Line 16, Column 5)
$M = (486,498 - 243,351)/228.284 = 1065$ (Line 15)

c. $P_2 = M + P_1 = 1065 + 4652.2 = 5717.2$ (Line 4)

d. Compute P_r and T_r at H = 14,998. Obtain appropriate Z from Table XI. Compute P/Z and P/TZ. Enter all these values on the appropriate lines 5 through 10.

e. $I_2 = 1000/(P/TZ) = 1000/7.8940 = 126.678$ (Line 14)

f. $N = I_1 + \text{Trial } I_2 = 119.436 + 126.678 = 246.114$ (Line 16)

g. Compute M as follows:
$M = (37.5\ GH) - \sum (M \times N)/N$
$M = (486,498 - 243,351)/246.114 = 987.9$

h. When M has been estimated correctly, the value determined under item (g) will be equal to M as estimated under item (b). Since the values of M are not the same, enter M = 987.9 on Line 15, Column 6, and repeat items (c) through (g).

i. By repeating the calculations, the correct value of M is determined to be 985.1.

j. Multiply final values of M and N
$M \times N = 985.1 \times 246.831 = 243,153$ (Line 17)

k. $\sum (M \times N) = 243,153 + 243,351 = 486,504$ (Line 18)

STEP 4.

Using the following equations, compute the bottom-hole shut-in pressure, P_f, at H = 14,998.

$$\triangle P = \frac{3\ (37.5\ GH)}{I_t + 4I_1 + I_2}$$

$$P_f = P_c + \triangle P$$

where:

G = 0.865
H = 14,998
I_t = 108.848 (Line 14, Column 5)
I_1 = 119.436 (Line 14, Column 6)
I_2 = 127.395 (Line 14, Column 7)

STEP 4. (Cont'd.)

$$P_c = 3586.2 \text{ (Line 4, Column 1)}$$

$$\triangle P = \frac{3(37.5 \times .865 \times 14,998)}{108.845 + 4(119.436) + 127.395}$$

$$\triangle P = 2044.2$$

$$P_f = 3586.2 + 2044.2 = \underline{5630.4 \text{ psia}}$$

STEP 5.

Now calculate pressure exerted by liquid column.

a. $1000 \times 0.74 \times 0.4333 = 320.6$

STEP 6.

Add pressure at the gas-liquid interface and pressure exerted by the liquid column to get pressure at sandface.

a. $5630.4 + 320.6 = \underline{5951 \text{ psia}}$

WORK SHEET FOR STEPWISE CALCULATION (SUBSURFACE) ~~(SURFACE)~~ PRESSURE (P_f & ~~P_s~~) (~~P_c & P_w~~)

Form C-122E
Adopted 9-1-65

COMPANY Test Example No. 7 LEASE _____ WELL NO. _____ DATE _____

LOCATION: Unit _____ Section _____ Township _____ Range _____

L 14,998 H 14,998 L/H 1.000 G 0.865 % CO_2 _____ % N_2 _____ % H_2S _____

d 1.995 F_1 018231 Q_m 0 M^2cfd (L/H) $(F_1Q_m)^2$ 0 P_{cr} 664 (TABLE IX & X) T_{cr} 444 (TABLE IX & X)

LINE	ITEM	SOURCE	1	2	3	4	5	6	7	8	9	10
1	H		0	7,499			14,998					
2	GH		0	6486.64			12,973.27					
3	37.5GH		0	243,249			486,498					
4	[illegible]		3586.2	4703.6	4655.2	4652.2	5717.2	5640.1	5637.5	5637.3		
5	[illegible]		5.40	7.08	7.01	7.01	8.61	8.49	8.49	8.49		
6	[illegible]		534	616	616	616	698	698	698	698		
7	I_1		1.20	1.39	1.39	1.39	1.57	1.57	1.57	1.57		
8	[illegible]		0.731	0.907	0.902	0.902	1.0376	1.0289	1.0289	1.0289		
9	[illegible] P/Z	$\bar{4}\div\bar{8}$	4905.9	5185.9	5161.0	5157.6	5510.0	5481.7	5479.2	5479.0		
10	P/TZ	$\bar{9}\div\bar{6}$	9.1871	8.4187	8.3782	8.3727	7.8940	7.8534	7.8499	7.8496		
11	$(P/TZ)^2/1000$	$(\bar{10})^2/1000$										
12	$L/H(F_1Q_m)^2$											
13		$\bar{11}+\bar{12}$										
14	I_n	$\bar{10}\div\bar{13}$	108.848	118.783	119.357	119.436	126.678	127.333	127.390	127.395		
15	$M=P_n-P_{n-1}$			1117.4	1069	1066	1065	987.9	985.3	985.1		
16	$N=I_n+I_{n-1}$			227.631	228.205	228.284	246.114	246.769	246.826	246.831		
17	M x N	$\bar{15}\times\bar{16}$				243,351				243,153		
18	$\sum$(M x N)	$\sum\bar{17}$				243,351				486,504		

$$\triangle P = \frac{1,459,493}{713.984} = 2044.2 \qquad P_f = 3586.2 + 2044.2 = 5630.4$$

One copy to be filed in District Office (Work copy acceptable)

TEST EXAMPLE NO. 8

WELL DELIVERABILITY TEST AS REQUIRED FOR PRORATED GAS POOLS IN NORTHWEST NEW MEXICO

This test is a part of the basis upon which gas wells are prorated in the northwest. Division Form C-122-A is to be used for reporting both the initial, annual, and biennial test results as required by Division Order No. R-333-I and filed in triplicate with the Aztec District Office of the Division.

I. LINE-BY-LINE INSTRUCTIONS FOR ENTERING INFORMATION AND DATA TO PROPERLY COMPLETE FORM C-122-A.

A. The calendar year for which the annual or biennial test is required. For initial tests, enter the calendar year of first delivery.

B. The name of the pool as separate from the formation.

C. The pool slope as determined by Order No. R-333-I or any Special Pool Rules superseding same.

D. The full formation name.

E. County in which the well is located.

F. Complete operator name, well name and number, and well location (unit, section, township, and range).

G. Name of pipeline that is transporting the gas.

H. Well completion information.

I. Top and bottommost perforations for cased wells and the depths of the casing shoe and TD for open holes.

J. Indicate type of flow stream.

K. Gas gravity for latest test (this data is usually obtained from the transporter).

L. The product of (K) times the depth in feet of the uppermost casing perforation, casing shoe depth, or uppermost tubing perforation, which ever is applicable.

M. The appropriate test dates.

N. Pressure data corrected to PSIA.

O. Calculate meter error and friction loss as shown.

P. Average meter pressure (usually supplied by the transporter).

Q. Calculate corrected meter pressure and average wellhead pressures as shown. If the ratio of average wellhead pressure to corrected meter pressure is 0.57 or less, critical flow will be considered to exist and the (measured) average wellhead pressure as shown in item (b) of this form shall be used as the average wellhead pressure. A notation of such shall be made in the "Remarks" section of the form, unless an intermediate pressure entry in item (n) of the form disproves critical flow.

R. Select the highest shut-in pressure, casing or tubing, and multiply it by the appropriate percentage, pursuant to Order No. R-333-I, to find the deliverability pressure, P_d.

S. The integrated average daily volume produced during the test corrected for meter error as shown ($S_1 \times S_3$).

T. Calculate working pressure using tables and equations from "Method of Calculating Pressure Loss Due To Friction In Gas Well Strings". Note: If R^2 is greater than or equal to P_t then friction loss is negligible, therefore $P_w = P_t$.

U. Calculate for deliverability "D" as shown.

V. Use "Remarks" section for the following:

1. Critical flow notations
2. Commingled well allocations
3. Delinquent test
4. Initial test
5. Other information which is pertinent

W. Summary of data.

X. Show company doing the testing and person(s) responsible.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-122-A
Revised 10-1-78

WELL DELIVERABILITY TEST REPORT FOR 19 A.

POOL NAME	POOL SLOPE	FORMATION	COUNTY
B.	n= C.	D.	E.

COMPANY			WELL NAME AND NUMBER		
F.			F.		
UNIT LETTER	SECTION	TOWNSHIP	RANGE	PURCHASING PIPELINE	
F.	F.	F.	F.	G.	
CASING O.D. – INCHES	CASING I.D. – INCHES	SET AT DEPTH – FEET	TUBING O.D. – INCHES	TUBING I.D. – INCHES	TOP – TUBING PERF. – FEET
H.	H.	H.	H.	H.	H.
GAS PAY ZONE FROM TO I.		WELL PRODUCING THRU CASING TUBING J.		GAS GRAVITY K.	GRAVITY X LENGTH L.
DATE OF FLOW TEST FROM TO M.			DATE SHUT-IN PRESSURE MEASURED M.		

PRESSURE DATA – ALL PRESSURES IN PSIA

(a) Flowing Casing Pressure (DWt)	(b) Flowing Tubing Pressure (DWt)	(c) Flowing Meter Pressure (DWt)	(d) Flow Chart Static Reading	(e) Meter Error (Item c – Item d)	(f) Friction Loss (a – c) or (b – c)	(g) Average Meter Pressure (Integr.)
N.	N.	N.	N.	O.	O.	P.
(h) Corrected Meter Pressure (g + e)	(i) Avg. Wellhead Press. P_t = (h + f)	(j) Shut-in Casing Pressure (DWt)	(k) Shut-in Tubing Pressure (DWt)	(l) P_c = higher value of (j) or (k)	(m) Del. Pressure P_d = _____ %P_c	(n) Separator or Dehydrator Pr. (DWt) for critical flow only
Q.	Q.	N.	N.	R.	R.	

FLOW RATE CORRECTION (METER ERROR)

Integrated Volume – MCF/D	Quotient of $\frac{\text{Item c}}{\text{Item d}}$	$\sqrt{\frac{\text{Item c}}{\text{Item d}}}$	Corrected Volume
S_1.	S_2.	S_3.	Q = S_4. MCF/D

WORKING PRESSURE CALCULATION

$(1-e^{-s})$	$(F_c Q_m)^2 (1000)$	$R^2 = (1-e^{-s})(F_c Q_m)^2(1000)$	P_t^2	$P_w^2 = P_t^2 + R^2$	$P_w = \sqrt{P_w^2}$
T.	T_1	T.	T.	T.	T.

DELIVERABILITY CALCULATION

$$D = Q\left[\frac{P_c^2 - P_d^2}{P_c^2 - P_w^2}\right]^n = \text{_____}\left[\left(\text{_____}\right)^n \left(\text{_____}\right)^n = \text{_____} = \text{_____}\right] = \text{_____ MCF/D}$$

U.

REMARKS:

V.

SUMMARY

W.
- Item h _____ Psia
- P_c _____ Psia
- Q _____ MCF/D
- P_w _____ Psia
- P_d _____ Psia
- D _____ MCF/D

X.
- Company _____
- By _____
- Title _____
- Witnessed By _____
- Company _____

SECTION VII

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TABLE I

BASIC ORIFICE FACTORS – FLANGE TAPS – $Mcfd/\sqrt{h_w P_m} = F_b$

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

Nom. Diameter, Inches	2			3				4	
ASA Schedule	160	80	40	xxHvy	160	80	40	xxHvy	160
Inside Diameter, Inches	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438
Orifice Diameter Inches			*				*		
0.250	0.2987	0.2990	0.2991	0.2991	0.2991	0.2990	0.2989	0.2989	0.2987
0.375	0.6700	0.6691	0.6689	0.6685	0.6681	0.6678	0.6677	0.6676	0.6674
0.500	1.195	1.190	1.189	1.187	1.185	1.184	1.183	1.183	1.183
0.625	1.884	1.871	1.866	1.860	1.854	1.851	1.850	1.849	1.848
0.750	2.755	2.720	2.709	2.695	2.682	2.675	2.672	2.671	2.667
0.875	3.834	3.754	3.729	3.697	3.670	3.657	3.650	3.648	3.640
1.000	5.171	4.999	4.946	4.881	4.828	4.801	4.789	4.784	4.770
1.125	6.847	6.499	6.393	6.267	6.165	6.116	6.095	6.086	6.062
1.250	9.077	8.319	8.120	7.885	7.703	7.615	7.577	7.561	7.520
1.375	---	10.55	10.20	9.782	9.463	9.313	9.249	9.223	9.153
1.500	---	----	12.76	12.02	11.48	11.23	11.13	11.09	10.97
1.625	---	----	----	14.68	13.81	13.40	13.24	13.17	13.00
1.750	---	----	----	----	16.50	15.87	15.61	15.50	15.24
1.875	---	----	----	----	19.64	18.68	18.29	18.13	17.72
2.000	---	----	----	----	----	21.90	21.32	21.08	20.48
2.125	---	----	----	----	----	25.67	24.76	24.43	23.56
2.250	---	----	----	----	----	----	28.78	28.23	27.00
2.375	---	----	----	----	----	----	----	----	30.86
2.500	---	----	----	----	----	----	----	----	35.26

Adapted from American Gas Association Gas Measurement Committee Report No. 3

* Use this column if only the nominal diameter is known.

TABLE I, Continued

BASIC ORIFICE FACTORS — FLANGE TAPS — $Mcfd/\sqrt{h_w P_m}$ — F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

4		6				8			Nom. Diameter, Inches
80	40	xxHyy	160	80	40	80	40	30	ASA Schedule
3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071	Inside Diameter, Inches
	*				*				Orifice Diameter Inches
0.2985	0.2984	----	----	----	----	----	----	----	0.250
0.6671	0.6670	----	----	----	----	----	----	----	0.375
1.182	1.182	1.181	1.181	1.181	1.181	----	----	----	0.500
1.846	1.845	1.843	1.843	1.842	1.842	----	----	----	0.625
2.662	2.661	2.656	2.655	2.653	2.652	----	----	----	0.750
3.633	3.630	3.621	3.618	3.615	3.613	3.608	3.607	3.607	0.875
4.758	4.753	4.737	4.734	4.728	4.726	4.717	4.715	4.715	1.000
6.040	6.031	6.007	6.002	5.993	5.989	5.976	5.974	5.973	1.125
7.483	7.469	7.431	7.423	7.410	7.405	7.386	7.383	7.382	1.250
9.093	9.071	9.011	8.999	8.981	8.973	8.947	8.942	8.941	1.375
10.88	10.84	10.75	10.73	10.71	10.70	10.66	10.65	10.65	1.500
12.84	12.79	12.65	12.63	12.59	12.57	12.52	12.52	12.51	1.625
15.01	14.93	14.72	14.68	14.63	14.61	14.54	14.53	14.53	1.750
17.38	17.26	16.96	16.91	16.83	16.80	16.71	16.70	16.70	1.875
19.99	19.81	19.39	19.31	19.20	19.16	19.04	19.02	19.02	2.000
22.85	22.60	22.00	21.89	21.74	21.69	21.52	21.50	21.50	2.125
25.99	25.64	24.81	24.66	24.46	24.38	24.17	24.14	24.13	2.250
29.46	28.98	27.83	27.63	27.35	27.25	26.97	26.93	26.92	2.375
33.29	32.64	31.08	30.81	30.44	30.31	29.94	29.89	29.88	2.500
37.54	36.66	34.57	34.21	33.73	33.55	33.07	33.01	32.99	2.625
42.28	41.10	38.33	37.85	37.22	36.99	36.37	36.29	36.28	2.750
----	46.01	42.38	41.75	40.94	40.65	39.84	39.75	39.73	2.875
----	51.64	46.74	45.94	44.89	44.51	43.50	43.38	43.35	3.000
----	----	51.46	50.43	49.09	48.61	47.33	47.18	47.15	3.125
----	----	56.57	55.26	53.56	52.96	51.35	51.17	51.13	3.250
----	----	62.10	60.46	58.33	57.57	55.57	55.34	55.29	3.375
----	----	68.13	66.07	63.41	62.47	59.99	59.71	59.65	3.500
----	----	74.84	72.12	68.84	67.67	64.62	64.28	64.20	3.625
----	----	----	78.72	74.64	73.20	69.47	69.05	68.96	3.750
----	----	----	86.06	80.84	79.09	74.55	74.04	73.93	3.375
----	----	----	----	87.48	85.37	79.36	79.26	79.12	4.000
----	----	----	----	102.5	99.21	91.28	90.40	90.21	4.250
----	----	----	----	----	115.3	103.3	102.6	102.3	4.500
----	----	----	----	----	----	117.7	116.0	115.6	4.750
----	----	----	----	----	----	132.9	130.6	130.1	5.000
----	----	----	----	----	----	149.9	146.7	146.1	5.250
----	----	----	----	----	----	168.7	164.5	163.6	5.500
----	----	----	----	----	----	----	184.2	183.0	5.750
----	----	----	----	----	----	----	----	204.9	6.000

TABLE II

BASIC ORIFICE FACTORS – PIPE TAPS – Mcfd/ $\sqrt{h_w P_m}$ – F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

Nom. Diameter, Inches	2			3				4	
ASA Schedule	160	80	40	xxHvy	160	80	40	xxHvy	160
Inside Diameter, Inches	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438
Orifice Diameter Inches			*				*		
0.250	0.3023	0.3015	0.3012	0.3007	0.3003	0.3001	0.2999	0.2999	0.2997
0.375	0.6908	0.6846	0.6825	0.6796	0.6769	0.6755	0.6749	0.6745	0.6737
0.500	1.264	1.243	1.235	1.224	1.214	1.208	1.206	1.205	1.201
0.625	2.052	1.998	1.978	1.951	1.925	1.909	1.902	1.899	1.890
0.750	3.111	2.985	2.941	2.881	2.825	2.792	2.776	2.769	2.750
0.875	4.535	4.259	4.166	4.045	3.935	3.872	3.842	3.830	3.792
1.000	6.481	5.908	5.724	5.489	5.284	5.171	5.118	5.095	5.030
1.125	9.222	8.070	7.717	7.281	6.913	6.717	6.627	6.589	6.480
1.250	---	10.96	10.31	9.518	8.879	8.551	8.403	8.340	8.165
1.375	---	----	13.74	12.35	11.26	10.72	10.49	10.39	10.11
1.500	---	----	----	15.98	14.17	13.31	12.94	12.78	12.36
1.625	---	----	----	----	17.77	16.41	15.83	15.60	14.96
1.750	---	----	----	----	22.28	20.15	19.27	18.91	17.96
1.875	---	----	----	----	----	24.71	23.39	22.85	21.46
2.000	---	----	----	----	----	30.37	28.37	27.57	25.54
2.125	---	----	----	----	----	----	34.47	33.29	30.35
2.250	---	----	----	----	----	----	----	----	36.05
2.375	---	----	----	----	----	----	----	----	42.89

Adapted from American Gas Association Gas Measurement Committee Report No. 3

* Use this column if only the nominal diameter is known.

TABLE II, Continued

BASIC ORIFICE FACTORS — PIPE TAPS — Mcfd/ $\sqrt{h_w P_m}$ — F_b

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

All other factors = 1.000

4		6				8			Nom. Diameter, Inches
80	40	xxHvy	160	80	40	80	40	30	ASA Schedule
3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071	Inside Diameter, Inches
	*				*			*	Orifice Diameter Inches
0.2995	0.2993	----	----	----	----	----	----	----	0.250
0.6729	0.6725	----	----	----	----	----	----	----	0.375
1.198	1.197	1.194	1.193	1.192	1.191	----	----	----	0.500
1.882	1.878	1.869	1.867	1.864	1.863	----	----	----	0.625
2.731	2.723	2.701	2.697	2.690	2.687	----	----	----	0.750
3.754	3.740	3.697	3.687	3.674	3.668	3.649	3.647	3.646	0.875
4.965	4.939	4.862	4.845	4.820	4.810	4.776	4.772	4.770	1.000
6.374	6.332	6.205	6.177	6.134	6.117	6.061	6.053	6.052	1.125
7.997	7.930	7.735	7.690	7.624	7.597	7.508	7.495	7.493	1.250
9.854	9.753	9.460	9.395	9.296	9.255	9.120	9.101	9.097	1.375
11.97	11.82	11.39	11.30	11.16	11.10	10.90	10.87	10.87	1.500
14.38	14.16	13.55	13.41	13.22	13.13	12.86	12.82	12.81	1.625
17.12	16.80	15.94	15.76	15.48	15.37	15.00	14.95	14.93	1.750
20.24	19.79	18.59	18.34	17.97	17.82	17.33	17.25	17.24	1.875
23.80	23.18	21.52	21.18	20.69	20.49	19.84	19.75	19.73	2.000
27.89	27.02	24.76	24.31	23.66	23.40	22.56	22.44	22.41	2.125
32.60	31.40	28.35	27.75	26.90	26.56	25.48	25.33	25.29	2.250
38.05	36.41	32.31	31.53	30.43	29.99	28.62	28.42	28.38	2.375
44.41	42.17	36.72	35.70	34.27	33.71	31.98	31.74	31.68	2.500
51.90	48.84	41.61	40.29	38.45	37.75	35.58	35.27	35.21	2.625
----	56.63	47.05	45.35	43.02	42.12	39.42	39.05	38.97	2.750
----	----	53.14	50.96	48.00	46.87	43.53	43.07	42.97	2.875
----	----	59.97	57.18	53.44	52.04	47.90	47.36	47.23	3.000
----	----	67.65	64.10	59.39	57.65	52.58	51.91	51.76	3.125
----	----	76.35	71.83	65.92	63.76	57.56	56.76	56.58	3.250
----	----	86.25	80.49	73.10	70.43	62.88	61.92	61.70	3.375
----	----	----	90.25	81.01	77.72	68.56	67.40	67.14	3.500
----	----	----	101.3	89.75	85.70	74.61	73.24	72.93	3.625
----	----	----	----	99.44	94.46	81.08	79.45	79.08	3.750
----	----	----	----	110.2	104.1	88.00	86.06	85.63	3.875
----	----	----	----	122.3	114.8	95.39	93.10	92.59	4.000
----	----	----	----	----	----	111.8	108.6	107.9	4.250
----	----	----	----	----	----	130.7	126.3	125.4	4.500
----	----	----	----	----	----	152.6	146.6	145.3	4.750
----	----	----	----	----	----	178.1	170.0	168.2	5.000
----	----	----	----	----	----	208.2	197.1	194.7	5.250
----	----	----	----	----	----	----	228.8	225.5	5.500

TABLE III
SQUARE ROOTS

N	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.000	0.317	0.447	0.548	0.632	0.707	0.775	0.837	0.894	0.949
1	1.000	1.049	1.095	1.140	1.183	1.225	1.265	1.304	1.342	1.378
2	1.414	1.449	1.483	1.517	1.549	1.581	1.612	1.643	1.673	1.703
3	1.732	1.761	1.789	1.817	1.844	1.871	1.897	1.923	1.949	1.975
4	2.000	2.025	2.049	2.074	2.098	2.121	2.145	2.168	2.191	2.214
5	2.236	2.258	2.280	2.302	2.324	2.345	2.366	2.387	2.408	2.429
6	2.449	2.470	2.490	2.501	2.530	2.550	2.569	2.588	2.608	2.627
7	2.645	2.665	2.683	2.702	2.720	2.739	2.757	2.775	2.793	2.811
8	2.828	2.846	2.864	2.881	2.898	2.915	2.933	2.950	2.966	2.983
9	3.000	3.017	3.033	3.050	3.066	3.082	3.098	3.114	3.130	3.146
10	3.162	3.178	3.194	3.209	3.225	3.240	3.256	3.271	3.286	3.303
11	3.317	3.332	3.347	3.362	3.376	3.391	3.406	3.421	3.435	3.450
12	3.464	3.479	3.493	3.507	3.521	3.536	3.550	3.564	3.578	3.592
13	3.606	3.619	3.633	3.647	3.661	3.674	3.688	3.701	3.715	3.728
14	3.742	3.755	3.768	3.782	3.795	3.808	3.821	3.834	3.847	3.860
15	3.873	3.886	3.899	3.912	3.924	3.937	3.950	3.962	3.975	3.987
16	4.000	4.012	4.025	4.037	4.050	4.062	4.074	4.087	4.099	4.111
17	4.123	4.135	4.147	4.159	4.171	4.183	4.195	4.207	4.219	4.231
18	4.243	4.254	4.266	4.278	4.290	4.301	4.313	4.324	4.336	4.347
19	4.359	4.370	4.382	4.393	4.405	4.416	4.427	4.438	4.450	4.461
20	4.472	4.483	4.494	4.506	4.517	4.528	4.539	4.550	4.561	4.572
21	4.583	4.593	4.604	4.615	4.626	4.637	4.648	4.658	4.669	4.680
22	4.690	4.701	4.712	4.722	4.733	4.743	4.754	4.764	4.775	4.785
23	4.796	4.806	4.817	4.827	4.337	4.848	4.858	4.868	4.879	4.889
24	4.899	4.909	4.919	4.930	4.940	4.950	4.960	4.970	4.980	4.990
25	5.000	5.010	5.020	5.030	5.040	5.050	5.060	5.070	5.079	5.089
26	5.099	5.109	5.119	5.128	5.138	5.148	5.158	5.167	5.177	5.187
27	5.196	5.206	5.215	5.225	5.235	5.244	5.254	5.263	5.273	5.282
28	5.292	5.301	5.310	5.320	5.329	5.339	5.348	5.357	5.367	5.376
29	5.385	5.394	5.404	5.413	5.422	5.431	5.441	5.450	5.459	5.468
30	5.477	5.486	5.495	5.505	5.514	5.523	5.532	5.541	5.550	5.559
31	5.568	5.577	5.586	5.595	5.604	5.612	5.621	5.630	5.639	5.648
32	5.657	5.666	5.675	5.683	5.692	5.701	5.710	5.718	5.727	5.736
33	5.745	5.753	5.762	5.771	5.779	5.788	5.797	5.805	5.814	5.822
34	5.831	5.840	5.848	5.857	5.865	5.874	5.882	5.891	5.899	5.908
35	5.916	5.925	5.933	5.941	5.950	5.958	5.967	5.975	5.983	5.992
36	6.000	6.008	6.017	6.025	6.033	6.042	6.050	6.058	6.066	6.075
37	6.083	6.091	6.099	6.107	6.116	6.124	6.132	6.140	6.148	6.156
38	6.164	6.173	6.181	6.189	6.197	6.205	6.213	6.221	6.229	6.237
39	6.245	6.253	6.261	6.269	6.277	6.285	6.293	6.301	6.309	6.317
40	6.325	6.332	6.340	6.348	6.356	6.364	6.372	6.380	6.387	6.395
41	6.403	6.411	6.419	6.427	6.434	6.442	6.450	6.458	6.465	6.473
42	6.481	6.488	6.496	6.504	6.512	6.519	6.527	6.535	6.542	6.550
43	6.557	6.565	6.573	6.580	6.588	6.595	6.603	6.611	6.618	6.626
44	6.633	6.641	6.648	6.656	6.663	6.671	6.678	6.686	6.693	6.701
45	6.708	6.716	6.723	6.731	6.738	6.745	6.753	6.760	6.768	6.775
46	6.782	6.790	6.797	6.804	6.812	6.819	6.826	6.834	6.841	6.848
47	6.856	6.863	6.870	6.877	6.885	6.892	6.899	6.907	6.914	6.921
48	6.928	6.935	6.943	6.950	6.957	6.964	6.971	6.979	6.986	6.993
49	7.000	7.007	7.014	7.021	7.029	7.036	7.043	7.050	7.057	7.064

TABLE III, Continued

N	0	1	2	3	4	5	6	7	8	9
50	7.071	7.141	7.211	7.280	7.348	7.416	7.483	7.550	7.616	7.681
60	7.746	7.810	7.874	7.937	8.000	8.062	8.124	8.185	8.246	8.307
70	8.367	8.426	8.485	8.544	8.602	8.660	8.718	8.775	8.832	8.888
80	8.944	9.000	9.055	9.110	9.165	9.220	9.274	9.327	9.381	9.434
90	9.487	9.539	9.592	9.644	9.695	9.747	9.798	9.849	9.899	9.950
100	10.00	10.05	10.10	10.15	10.20	10.25	10.30	10.34	10.39	10.44
110	10.49	10.54	10.58	10.63	10.68	10.72	10.77	10.82	10.86	10.91
120	10.95	11.00	11.05	11.09	11.14	11.18	11.22	11.27	11.31	11.36
130	11.40	11.45	11.49	11.53	11.58	11.62	11.66	11.70	11.75	11.79
140	11.83	11.87	11.92	11.96	12.00	12.04	12.08	12.12	12.17	12.21
150	12.25	12.29	12.33	12.37	12.41	12.45	12.49	12.53	12.57	12.61
160	12.65	12.69	12.73	12.77	12.81	12.85	12.88	12.92	12.96	13.00
170	13.04	13.08	13.11	13.15	13.19	13.23	13.27	13.30	13.34	13.38
180	13.42	13.45	13.49	13.53	13.56	13.60	13.64	13.67	13.71	13.75
190	13.78	13.82	13.86	13.89	13.93	13.96	14.00	14.04	14.07	14.11
200	14.14	14.18	14.21	14.25	14.28	14.32	14.35	14.39	14.42	14.46
210	14.49	14.53	14.56	14.59	14.63	14.66	14.70	14.73	14.76	14.80
220	14.83	14.87	14.90	14.93	14.97	15.00	15.03	15.07	15.10	15.13
230	15.17	15.20	15.23	15.26	15.30	15.33	15.36	15.39	15.43	15.46
240	15.49	15.52	15.56	15.59	15.62	15.65	15.68	15.72	15.75	15.78
250	15.81	15.84	15.87	15.91	15.94	15.97	16.00	16.03	16.06	16.09
260	16.12	16.16	16.19	16.22	16.25	16.28	16.31	16.34	16.37	16.40
270	16.43	16.46	16.49	16.52	16.55	16.58	16.61	16.64	16.67	16.70
280	16.73	16.76	16.79	16.82	16.85	16.88	16.91	16.94	16.97	17.00
290	17.03	17.06	17.09	17.12	17.15	17.18	17.20	17.23	17.26	17.29
300	17.32	17.35	17.38	17.41	17.44	17.46	17.49	17.52	17.55	17.58
310	17.61	17.64	17.66	17.69	17.72	17.75	17.78	17.80	17.83	17.86
320	17.89	17.92	17.94	17.97	18.00	18.03	18.06	18.08	18.11	18.14
330	18.17	18.19	18.22	18.25	18.28	18.30	18.33	18.36	18.38	18.41
340	18.44	18.47	18.49	18.52	18.55	18.57	18.60	18.63	18.65	18.68
350	18.71	18.73	18.76	18.79	18.81	18.84	18.87	18.89	18.92	18.95
360	18.97	19.00	19.03	19.05	19.08	19.10	19.13	19.16	19.18	19.21
370	19.24	19.26	19.29	19.31	19.34	19.36	19.39	19.42	19.44	19.47
380	19.49	19.52	19.54	19.57	19.60	19.62	19.65	19.67	19.70	19.72
390	19.74	19.77	19.80	19.82	19.85	19.87	19.90	19.92	19.95	19.97
400	20.00	20.02	20.05	20.07	20.10	20.12	20.15	20.17	20.20	20.22
410	20.25	20.27	20.30	20.32	20.35	20.37	20.40	20.42	20.45	20.47
420	20.49	20.52	20.54	20.57	20.59	20.62	20.64	20.66	20.69	20.71
430	20.74	20.76	20.78	20.81	20.83	20.86	20.88	20.90	20.93	20.95
440	20.98	21.00	21.02	21.05	21.07	21.10	21.12	21.14	21.17	21.19
450	21.21	21.24	21.26	21.28	21.31	21.33	21.35	21.38	21.40	21.42
460	21.45	21.47	21.49	21.52	21.54	21.56	21.59	21.61	21.63	21.66
470	21.68	21.70	21.73	21.75	21.77	21.79	21.82	21.84	21.86	21.89
480	21.91	21.93	21.95	21.98	22.00	22.02	22.05	22.07	22.09	22.11
490	22.14	22.16	22.18	22.20	22.23	22.25	22.27	22.29	22.32	22.34
500	22.36	22.38	22.41	22.43	22.45	22.47	22.49	22.52	22.54	22.56
510	22.58	22.61	22.63	22.65	22.67	22.69	22.72	22.74	22.76	22.78
520	22.80	22.83	22.85	22.87	22.89	22.91	22.93	22.96	22.98	23.00
530	23.02	23.04	23.07	23.09	23.11	23.13	23.15	23.17	23.19	23.22
540	23.24	23.26	23.28	23.30	23.32	23.35	23.37	23.39	23.41	23.43

TABLE III, Continued

N	0	1	2	3	4	5	6	7	8	9
550	23.45	23.47	23.49	23.52	23.54	23.56	23.58	23.60	23.62	23.64
560	23.66	23.69	23.71	23.73	23.75	23.77	23.79	23.81	23.83	23.85
570	23.87	23.90	23.92	23.94	23.96	23.98	24.00	24.02	24.04	24.06
580	24.08	24.10	24.12	24.15	24.17	24.19	24.21	24.23	24.25	24.27
590	24.29	24.31	24.33	24.35	24.37	24.39	24.41	24.43	24.45	24.47
600	24.49	24.52	24.54	24.56	24.58	24.60	24.62	24.64	24.66	24.68
610	24.70	24.72	24.74	24.76	24.78	24.80	24.82	24.84	24.86	24.88
620	24.90	24.92	24.94	24.96	24.98	25.00	25.02	25.04	25.06	25.08
630	25.10	25.12	25.14	25.16	25.18	25.20	25.22	25.24	25.26	25.28
640	25.30	25.32	25.34	25.36	25.38	25.40	25.42	25.44	25.46	25.48
650	25.50	25.51	25.53	25.55	25.57	25.59	25.61	25.63	25.65	25.67
660	25.69	25.71	25.73	25.75	25.77	25.79	25.81	25.83	25.85	25.87
670	25.88	25.90	25.92	25.94	25.96	25.98	26.00	26.02	26.04	26.06
680	26.08	26.10	26.12	26.13	26.15	26.17	26.19	26.21	26.23	26.25
690	26.27	26.29	26.31	26.32	26.34	26.36	26.38	26.40	26.42	26.44
700	26.46	26.48	26.50	26.51	26.53	26.55	26.57	26.59	26.61	26.63
710	26.65	26.66	26.68	26.70	26.72	26.74	26.76	26.78	26.80	26.81
720	26.83	26.85	26.87	26.89	26.91	26.93	26.94	26.96	26.98	27.00
730	27.02	27.04	27.06	27.07	27.09	27.11	27.13	27.15	27.17	27.18
740	27.20	27.22	26.24	27.26	27.28	27.29	27.31	27.33	27.35	27.37
750	27.39	27.40	27.42	27.44	27.46	27.48	27.50	27.51	27.53	27.55
760	27.57	27.59	27.60	27.62	27.64	27.66	27.68	27.69	27.71	27.73
770	27.75	27.77	27.78	27.80	27.82	27.84	27.86	27.87	27.89	27.91
780	27.93	27.95	27.96	27.98	28.00	28.02	28.04	28.05	28.07	28.09
790	28.11	28.12	28.14	28.16	28.18	28.20	28.21	28.23	28.25	28.27
800	28.28	28.30	28.32	28.34	28.35	28.37	28.39	28.41	28.43	28.44
810	28.46	28.48	28.50	28.51	28.53	28.55	28.57	28.58	28.60	28.62
820	28.64	28.65	28.67	28.69	28.71	28.72	28.74	28.76	28.77	28.79
830	28.81	28.83	28.84	28.86	28.88	28.90	28.91	28.93	28.95	28.97
840	28.98	29.00	29.02	29.03	29.05	29.07	29.09	29.10	29.12	29.14
850	29.15	29.17	29.19	29.21	29.22	29.24	29.26	29.27	29.29	29.31
860	29.33	29.34	29.36	29.38	29.39	29.41	29.43	29.44	29.46	29.48
870	29.50	29.51	29.53	29.55	29.56	29.58	29.60	29.61	29.63	29.65
880	29.66	29.68	29.70	29.72	29.73	29.75	29.77	29.78	29.80	29.82
890	29.83	29.85	29.87	29.88	29.90	29.92	29.93	29.95	29.97	29.98
900	30.00	30.02	30.03	30.05	30.07	30.08	30.10	30.12	30.13	30.15
910	30.17	30.18	30.20	30.22	30.23	30.25	30.27	30.28	30.30	30.32
920	30.33	30.35	30.36	30.38	30.40	30.41	30.43	30.45	30.46	30.48
930	30.50	30.51	30.53	30.55	30.56	30.58	30.59	30.61	30.63	30.64
940	30.66	30.68	30.69	30.71	30.72	30.74	30.76	30.77	30.79	30.81
950	30.82	30.84	30.85	30.87	30.89	30.90	30.92	30.94	30.95	30.97
960	30.98	31.00	31.02	31.03	31.05	31.06	31.08	31.10	31.11	31.13
970	31.14	31.16	31.18	31.19	31.21	31.22	31.24	31.26	31.27	31.29
980	31.30	31.32	31.34	31.35	31.37	31.38	31.40	31.42	31.43	31.45
990	31.46	31.48	31.50	31.51	31.53	31.54	31.56	31.58	31.59	31.61

TABLE IV

METER FACTORS FOR L-10 (SQUARE ROOT) CHARTS - F_d

$$F_d = 0.01 \sqrt{R_h \cdot R_p}$$

Meter Pressure Range psia - R_p	Meter Differential Range, Inches - R_h				
	10	20	50	100	200
24.7	0.1572	0.2223	0.3514	-	-
50.0	0.2236	0.3162	0.5000	0.7071	1.000
100.0	0.3162	0.4472	0.7071	1.000	1.414
150.0	-	0.5477	0.8660	1.22	1.732
250.0	-	0.7071	1.118	1.581	2.236
300.0	-	0.7746	1.225	1.732	2.449
350.0	-	0.8367	1.323	1.871	2.646
500.0	-	1.000	1.581	2.236	3.162
750.0	-	-	1.936	2.739	3.873
1000.0	-	-	2.236	3.162	4.472
1500.0	-	-	2.739	3.873	5.477
2000.0	-	-	3.162	4.472	6.325
2500.0	-	-	-	5.000	7.071
3000.0	-	-	-	5.477	7.746
4000.0	-	-	-	6.325	8.944
5000.0	-	-	-	7.071	10.00
6000.0	-	-	-	7.746	10.95
10000.0	-	-	-	10.00	14.14

TABLE V

BASIC CRITICAL FLOW PROVER FACTORS - Mcfd/psia - F_p

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

Two-Inch Prover		Four-Inch Prover	
Orifice Diameter, Inches	F_p	Orifice Diameter, Inches	F_p
1/16	0.06405	1/4	1.047
3/32	0.1410	3/8	2.354
1/8	0.2648	1/2	4.211
3/16	0.6082	5/8	6.561
7/32	0.8393	3/4	9.402
1/4	1.087	7/8	12.79
5/16	1.672	1	16.66
3/8	2.378	1 1/8	20.98
7/16	3.408	1 1/4	25.91
1/2	4.279	1 3/8	31.19
5/8	6.473	1 1/2	37.17
3/4	9.453	1 3/4	50.77
7/8	13.00	2	67.08
1	17.09	2 1/4	85.99
1 1/8	21.89	2 1/2	107.8
1 1/4	27.63	2 3/4	133.5
1 3/8	33.95	3	164.1
1 1/2	42.11		

Based on data from USBM Monograph 7, Tables 26 and 27, pages 122 and 123.

TABLE VI

BASIC POSITIVE CHOKE FACTORS - Mcfd/psia - F_p

T_b = 520R (60F) T_m = 520R (60F)

P_b = 15.025 psia G = 1.000

Nominal Choke Size, Inches	Inside Diameter Inches	Factor - F_p	
		Six-Inch (1) Choke Nipple	Thornhill-Carver (2) Positive Choke
1/8	0.1250	0.2618	0.2416
9/64	0.1406	0.3346	0.3105
5/32	0.1563	0.4173	0.3885
11/64	0.1719	0.5090	0.4758
3/16	0.1875	0.6101	0.5725
13/64	0.2031	0.7208	0.6778
7/32	0.2188	0.8419	0.7924
15/64	0.2344	0.9720	0.9165
1/4	0.2500	1.112	1.050
17/64	0.2656	1.262	1.187
9/32	0.2813	1.422	1.331
19/64	0.2969	1.592	1.484
5/16	0.3125	1.771	1.645
21/64	0.3281	1.961	1.817
11/32	0.3438	2.162	1.999
23/64	0.3594	2.371	2.189
3/8	0.3750	2.591	2.388
25/64	0.3906	2.821	2.587
13/32	0.4063	3.063	2.794
27/64	0.4219	3.313	3.009
7/16	0.4375	3.574	3.231
29/64	0.4531	3.845	3.460
15/32	0.4688	4.128	3.697
31/64	0.4844	4.420	3.942
1/2	0.5000	4.722	4.194
9/16	0.5625	6.038	5.290
5/8	0.6250	7.522	6.510
11/16	0.6875	9.177	7.978
3/4	0.7500	11.00	9.604

(1) Based on data published on page 294 of Diehl's Natural Gas Handbook.

(2) Based on data published in 1946 on page 15 of the "Report on the Calibration of Positive Flow Beans" by the Texas College of Arts and Industries, Kingsville, Texas.

TABLE VII

FLOWING TEMPERATURE FACTORS — F_t

$$F_t = \sqrt{\frac{520}{T_m}}$$

Observed Temperature °F	0	1	2	3	4	5	6	7	8	9
0	1.063	1.062	1.061	1.060	1.059	1.057	1.056	1.055	1.054	1.053
10	1.052	1.051	1.050	1.049	1.047	1.046	1.045	1.044	1.043	1.042
20	1.041	1.040	1.039	1.038	1.037	1.035	1.034	1.033	1.032	1.031
30	1.030	1.029	1.028	1.027	1.026	1.025	1.024	1.023	1.022	1.021
40	1.020	1.019	1.018	1.017	1.016	1.015	1.014	1.013	1.012	1.011
50	1.010	1.009	1.008	1.007	1.006	1.005	1.004	1.003	1.002	1.001
60	1.000	0.9990	0.9981	0.9971	0.9962	0.9952	0.9943	0.9933	0.9924	0.9915
70	0.9905	0.9896	0.9887	0.9877	0.9868	0.9859	0.9850	0.9840	0.9831	0.9822
80	0.9813	0.9804	0.9795	0.9786	0.9777	0.9768	0.9759	0.9750	0.9741	0.9732
90	0.9723	0.9715	0.9706	0.9697	0.9688	0.9680	0.9671	0.9662	0.9653	0.9645
100	0.9636	0.9628	0.9619	0.9610	0.9602	0.9594	0.9585	0.9577	0.9568	0.9560
110	0.9551	0.9543	0.9535	0.9526	0.9518	0.9510	0.9501	0.9493	0.9485	0.9477
120	0.9469	0.9460	0.9452	0.9444	0.9436	0.9428	0.9420	0.9412	0.9404	0.9396
130	0.9388	0.9380	0.9372	0.9364	0.9356	0.9349	0.9341	0.9333	0.9325	0.9317
140	0.9309	0.9302	0.9294	0.9286	0.9279	0.9271	0.9263	0.9256	0.9248	0.9240
150	0.9233	0.9225	0.9217	0.9210	0.9202	0.9195	0.9187	0.9180	0.9173	0.9165
160	0.9158	0.9150	0.9143	0.9135	0.9128	0.9121	0.9114	0.9106	0.9099	0.9092
170	0.9085	0.9077	0.9071	0.9063	0.9055	0.9048	0.9042	0.9035	0.9028	0.9020
180	0.9014	0.9007	0.9000	0.8992	0.8985	0.8979	0.8972	0.8965	0.8958	0.8951
190	0.8944	0.8937	0.8931	0.8923	0.8916	0.8910	0.8903	0.8896	0.8889	0.8882
200	0.8876	0.8870	0.8863	0.8856	0.8849	0.8843	0.8836	0.8830	0.8823	0.8816
210	0.8810	0.8803	0.8797	0.8790	0.8784	0.8777	0.8770	0.8764	0.8758	0.8751
220	0.8745	0.8738	0.8732	0.8725	0.8719	0.8713	0.8706	0.8700	0.8694	0.8687
230	0.8681	0.8675	0.8668	0.8662	0.8656	0.8650	0.8644	0.8637	0.8631	0.8625
240	0.8619	0.8613	0.8606	0.8600	0.8594	0.8588	0.8582	0.8576	0.8570	0.8564

TABLE VIII

SPECIFIC GRAVITY FACTORS — F_g

$$F_g = \sqrt{\frac{I}{G}}$$

Specific Gravity G	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
0.550	1.348	1.347	1.346	1.345	1.344	1.342	1.341	1.340	1.339	1.338
0.560	1.336	1.335	1.334	1.333	1.332	1.330	1.329	1.328	1.327	1.326
0.570	1.325	1.323	1.322	1.321	1.320	1.319	1.318	1.316	1.315	1.314
0.580	1.313	1.312	1.311	1.310	1.309	1.307	1.306	1.305	1.304	1.303
0.590	1.302	1.301	1.300	1.299	1.298	1.296	1.295	1.294	1.293	1.292
0.600	1.291	1.290	1.289	1.288	1.287	1.286	1.285	1.284	1.282	1.281
0.610	1.280	1.279	1.278	1.277	1.276	1.275	1.274	1.273	1.272	1.271
0.620	1.270	1.269	1.268	1.267	1.266	1.265	1.264	1.263	1.262	1.261
0.630	1.260	1.259	1.258	1.257	1.256	1.255	1.254	1.253	1.252	1.251
0.640	1.250	1.249	1.248	1.247	1.246	1.245	1.244	1.243	1.242	1.241
0.650	1.240	1.239	1.238	1.237	1.237	1.236	1.235	1.234	1.233	1.232
0.660	1.231	1.230	1.229	1.228	1.227	1.226	1.225	1.224	1.224	1.223
0.670	1.222	1.221	1.220	1.219	1.218	1.217	1.216	1.215	1.214	1.214
0.680	1.213	1.212	1.211	1.210	1.209	1.208	1.207	1.206	1.206	1.205
0.690	1.204	1.203	1.202	1.201	1.200	1.200	1.199	1.198	1.197	1.196
0.700	1.195	1.194	1.194	1.193	1.192	1.191	1.190	1.189	1.188	1.188
0.710	1.187	1.186	1.185	1.184	1.183	1.183	1.182	1.181	1.180	1.179
0.720	1.179	1.178	1.177	1.176	1.175	1.174	1.174	1.173	1.172	1.171
0.730	1.170	1.170	1.169	1.168	1.167	1.166	1.166	1.165	1.164	1.163
0.740	1.162	1.162	1.161	1.160	1.159	1.159	1.158	1.157	1.156	1.155
0.750	1.155	1.154	1.153	1.152	1.152	1.151	1.150	1.149	1.149	1.148
0.760	1.147	1.146	1.146	1.145	1.144	1.143	1.143	1.142	1.141	1.140
0.770	1.140	1.139	1.138	1.137	1.137	1.136	1.135	1.134	1.134	1.133
0.780	1.132	1.132	1.131	1.130	1.129	1.129	1.128	1.127	1.127	1.126
0.790	1.125	1.124	1.124	1.123	1.122	1.122	1.121	1.120	1.119	1.119
0.800	1.118	1.117	1.117	1.116	1.115	1.115	1.114	1.113	1.112	1.112
0.810	1.111	1.110	1.110	1.109	1.108	1.108	1.107	1.106	1.106	1.105
0.820	1.104	1.104	1.103	1.102	1.102	1.101	1.100	1.100	1.099	1.098
0.830	1.098	1.097	1.096	1.096	1.095	1.094	1.094	1.093	1.092	1.092
0.840	1.091	1.090	1.090	1.089	1.089	1.088	1.087	1.087	1.086	1.085
0.850	1.085	1.084	1.083	1.083	1.082	1.081	1.081	1.080	1.080	1.079
0.860	1.078	1.078	1.077	1.076	1.076	1.075	1.075	1.074	1.073	1.073
0.870	1.072	1.072	1.071	1.070	1.070	1.069	1.068	1.068	1.067	1.067
0.880	1.066	1.065	1.065	1.064	1.064	1.063	1.062	1.062	1.061	1.061
0.890	1.060	1.059	1.059	1.058	1.058	1.057	1.056	1.056	1.055	1.055
0.900	1.054	1.054	1.053	1.052	1.052	1.051	1.051	1.050	1.049	1.049
0.910	1.048	1.048	1.047	1.047	1.046	1.045	1.045	1.044	1.044	1.043
0.920	1.043	1.042	1.041	1.041	1.040	1.040	1.039	1.039	1.038	1.038
0.930	1.037	1.036	1.036	1.035	1.035	1.034	1.034	1.033	1.033	1.032
0.940	1.031	1.031	1.030	1.030	1.029	1.029	1.028	1.028	1.027	1.027
0.950	1.026	1.025	1.025	1.024	1.024	1.023	1.023	1.022	1.022	1.021
0.960	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.016
0.970	1.015	1.015	1.014	1.014	1.013	1.013	1.012	1.012	1.011	1.011
0.980	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.006	1.006
0.990	1.005	1.005	1.004	1.004	1.003	1.003	1.002	1.002	1.001	1.001

TABLE IX

PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES — P_{cr} and T_{cr}

G	P_{cr}	T_{cr}	G	P_{cr}	T_{cr}
0.55	673	336	0.85	664	441
0.56	673	341	0.86	664	444
0.57	672	346	0.87	663	448
0.58	672	350	0.88	663	451
0.59	672	354	0.89	662	454
0.60	671	358	0.90	662	457
0.61	671	362	0.91	662	461
0.62	671	365	0.92	662	464
0.63	670	368	0.93	661	467
0.64	670	372	0.94	661	471
0.65	670	375	0.95	660	474
0.66	670	378	0.96	660	477
0.67	669	382	0.97	659	481
0.68	669	385	0.98	659	484
0.69	669	388	0.99	659	487
0.70	668	392	1.00	658	491
0.71	668	395	1.01	658	494
0.72	668	398	1.02	657	497
0.73	668	401	1.03	656	500
0.74	667	405	1.04	656	504
0.75	667	408	1.05	655	507
0.76	667	411	1.06	655	510
0.77	666	415	1.07	654	514
0.78	666	418	1.08	654	517
0.79	666	421	1.09	653	520
0.80	665	424	1.10	652	524
0.81	665	428	1.11	652	527
0.82	665	431	1.12	651	530
0.83	665	434	1.13	651	534
0.84	664	438	1.14	650	537

Do not interpolate, values are inclusive to the next higher value.

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TABLE X

CORRECTION TO PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES FOR CARBON DIOXIDE AND NITROGEN

Values given below are to be added if positive, or subtracted if negative, from values taken from Table IX, Pseudocritical Properties of Hydrocarbon Gases.

Volume Percent of CO_2 or N_2 in Gas	Carbon Dioxide, CO_2		Nitrogen, N_2	
	P_{cr}	T_{cr}	P_{cr}	T_{cr}
1	+ 4	- 1	- 1	- 3
2	+ 8	- 3	- 3	- 6
3	+ 12	- 5	- 5	- 9
4	+ 17	- 7	- 7	- 11
5	+ 21	- 9	- 9	- 14
6	+ 25	- 11	- 11	- 17
7	+ 30	- 12	- 12	- 20
8	+ 34	- 14	- 14	- 22
9	+ 39	- 16	- 16	- 25
10	+ 44	- 17	- 17	- 28
11	+ 48	- 19	- 19	- 30
12	+ 53	- 21	- 21	- 33
13	+ 57	- 22	- 22	- 36
14	+ 61	- 24	- 24	- 39
15	+ 66	- 26	- 26	- 42
16	+ 70	- 27	- 27	- 44
17	+ 74	- 29	- 29	- 47
18	+ 79	- 31	- 31	- 50
19	+ 83	- 32	- 32	- 52
20	+ 87	- 34	- 34	- 55
21	+ 92	- 36	- 36	- 58
22	+ 96	- 37	- 37	- 60
23	+ 100	- 39	- 39	- 63
24	+ 104	- 41	- 41	- 66
25	+ 109	- 42	- 42	- 68
26	+ 113	- 44	- 44	- 71
27	+ 117	- 46	- 46	- 74
28	+ 122	- 47	- 47	- 77
29	+ 126	- 49	- 49	- 79
30	+ 130	- 51	- 51	- 82
31	+ 134	- 52	- 52	- 85
32	+ 139	- 54	- 54	- 87
33	+ 143	- 56	- 56	- 90
34	+ 147	- 57	- 57	- 93
35	+ 152	- 59	- 59	- 95
36	+ 156	- 61	- 61	- 98

Based on data from the California Natural Gasoline Association Bulletin No. TS-461.

TABLE XI

COMPRESSIBILITY FACTORS

FOR NATURAL GAS

- -

Expanded from Tables of Compressibility Factors and Integral Functions for Natural Gas as a function of pseudo-reduced pressure and temperature, Table 3, The Multiphase Flow of Gas, Oil, and Water Through Vertical Flow Strings with Application to the Design of Gas-lift Installations; F. H. Poettmann and P. G. Carpenter; Drilling and Production Practice, pages 279-291, 1952, American Petroleum Institute.

Interpolation between T_r values required.

(Values of P_r and T_r shall be calculated to four significant figures and rounded off to two significant figures following the decimal point before determining the Z value from Table XI.)

P_r and T_r in this table are pseudo-reduced pressure and pseudo-reduced temperature.

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.20	0.938	0.948	0.953	0.959	0.964	0.969	0.971	0.973	0.978	0.979
0.21	0.935	0.945	0.951	0.957	0.962	0.967	0.970	0.972	0.977	0.978
0.22	0.932	0.942	0.948	0.955	0.960	0.965	0.968	0.971	0.976	0.977
0.23	0.928	0.940	0.946	0.853	0.959	0.964	0.967	0.970	0.974	0.976
0.24	0.925	0.937	0.943	0.951	0.957	0.962	0.965	0.969	0.973	0.975
0.25	0.922	0.934	0.941	0.949	0.955	0.960	0.964	0.968	0.972	0.974
0.26	0.919	0.931	0.938	0.947	0.953	0.958	0.962	0.967	0.971	0.973
0.27	0.915	0.928	0.936	0.945	0.951	0.956	0.961	0.966	0.969	0.972
0.28	0.912	0.926	0.933	0.942	0.950	0.955	0.959	0.964	0.968	0.971
0.29	0.908	0.923	0.931	0.940	0.948	0.953	0.958	0.963	0.966	0.970
0.30	0.905	0.920	0.928	0.938	0.946	0.951	0.956	0.962	0.965	0.969
0.31	0.901	0.917	0.925	0.936	0.944	0.949	0.955	0.961	0.964	0.968
0.32	0.898	0.914	0.922	0.934	0.942	0.948	0.953	0.960	0.963	0.967
0.33	0.894	0.911	0.920	0.931	0.941	0.946	0.952	0.958	0.961	0.966
0.34	0.891	0.908	0.917	0.929	0.939	0.945	0.950	0.957	0.960	0.965
0.35	0.887	0.905	0.914	0.927	0.937	0.943	0.949	0.956	0.959	0.964
0.36	0.883	0.902	0.911	0.925	0.935	0.941	0.948	0.955	0.958	0.963
0.37	0.879	0.899	0.908	0.923	0.933	0.939	0.946	0.953	0.957	0.962
0.38	0.876	0.895	0.906	0.920	0.932	0.938	0.945	0.952	0.955	0.961
0.39	0.872	0.892	0.903	0.918	0.930	0.936	0.943	0.950	0.954	0.960
0.40	0.868	0.889	0.900	0.916	0.928	0.934	0.942	0.949	0.953	0.959
0.41	0.864	0.886	0.897	0.914	0.926	0.932	0.940	0.948	0.952	0.958
0.42	0.860	0.882	0.895	0.912	0.924	0.931	0.939	0.947	0.951	0.957
0.43	0.857	0.879	0.892	0.909	0.923	0.929	0.937	0.945	0.950	0.956
0.44	0.853	0.875	0.890	0.907	0.921	0.928	0.936	0.944	0.949	0.955
0.45	0.849	0.872	0.887	0.905	0.919	0.926	0.934	0.943	0.948	0.954
0.46	0.845	0.869	0.884	0.903	0.917	0.924	0.932	0.942	0.947	0.953
0.47	0.841	0.865	0.882	0.901	0.915	0.923	0.931	0.941	0.946	0.952
0.48	0.837	0.862	0.879	0.898	0.913	0.921	0.929	0.939	0.944	0.951
0.49	0.833	0.858	0.877	0.896	0.911	0.920	0.928	0.938	0.943	0.950
0.50	0.829	0.855	0.874	0.894	0.909	0.918	0.926	0.937	0.942	0.949
0.51	0.825	0.852	0.872	0.892	0.907	0.916	0.925	0.936	0.941	0.948
0.52	0.821	0.849	0.869	0.890	0.905	0.913	0.923	0.934	0.940	0.947
0.53	0.818	0.845	0.867	0.887	0.904	0.912	0.922	0.933	0.939	0.946
0.54	0.814	0.842	0.864	0.885	0.902	0.911	0.920	0.931	0.938	0.945
0.55	0.810	0.839	0.862	0.883	0.900	0.909	0.919	0.930	0.937	0.944
0.56	0.806	0.836	0.859	0.881	0.898	0.907	0.918	0.929	0.936	0.943
0.57	0.802	0.832	0.857	0.879	0.896	0.905	0.916	0.927	0.935	0.942
0.58	0.798	0.829	0.854	0.876	0.894	0.904	0.915	0.926	0.933	0.941
0.59	0.794	0.825	0.852	0.874	0.892	0.902	0.913	0.924	0.932	0.940
0.60	0.790	0.822	0.849	0.872	0.890	0.900	0.912	0.923	0.931	0.939
0.61	0.786	0.818	0.846	0.870	0.888	0.899	0.911	0.922	0.930	0.938
0.62	0.782	0.815	0.843	0.868	0.886	0.897	0.909	0.921	0.929	0.937
0.63	0.777	0.811	0.841	0.865	0.885	0.896	0.908	0.919	0.928	0.937
0.64	0.773	0.808	0.838	0.863	0.883	0.894	0.906	0.918	0.927	0.936

T_r										P_r 0.20 - 0.64
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.984	0.987	0.990	0.991	0.993	0.995	0.998	0.999	1.000	1.001	0.20
0.983	0.986	0.990	0.991	0.993	0.995	0.998	0.999	1.000	1.001	0.21
0.982	0.986	0.989	0.990	0.993	0.995	0.998	0.999	1.000	1.001	0.22
0.982	0.985	0.989	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.23
0.981	0.985	0.988	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.24
0.980	0.984	0.988	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.25
0.979	0.983	0.987	0.990	0.992	0.995	0.998	0.999	1.000	1.001	0.26
0.978	0.983	0.987	0.989	0.991	0.995	0.998	0.999	1.000	1.001	0.27
0.978	0.982	0.986	0.989	0.991	0.994	0.997	0.999	1.000	1.001	0.28
0.977	0.982	0.986	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.29
0.976	0.981	0.985	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.30
0.975	0.980	0.985	0.988	0.990	0.994	0.997	0.999	1.000	1.001	0.31
0.974	0.980	0.984	0.987	0.990	0.994	0.997	0.999	1.000	1.001	0.32
0.974	0.979	0.984	0.987	0.989	0.994	0.997	0.999	1.000	1.001	0.33
0.973	0.979	0.983	0.986	0.989	0.994	0.997	0.999	1.000	1.001	0.34
0.972	0.978	0.983	0.986	0.989	0.994	0.997	0.999	1.000	1.001	0.35
0.971	0.977	0.982	0.985	0.989	0.994	0.997	0.999	1.000	1.001	0.36
0.970	0.977	0.982	0.985	0.988	0.993	0.997	0.999	1.000	1.001	0.37
0.970	0.976	0.981	0.984	0.988	0.993	0.996	0.998	1.000	1.002	0.38
0.969	0.976	0.981	0.984	0.987	0.992	0.996	0.998	1.000	1.002	0.39
0.968	0.975	0.980	0.983	0.987	0.992	0.996	0.998	1.000	1.002	0.40
0.967	0.974	0.980	0.983	0.987	0.992	0.996	0.998	1.000	1.002	0.41
0.966	0.974	0.979	0.982	0.986	0.992	0.996	0.998	1.000	1.002	0.42
0.966	0.973	0.979	0.982	0.986	0.991	0.995	0.998	1.000	1.002	0.43
0.965	0.973	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.44
0.964	0.972	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.45
0.963	0.971	0.978	0.981	0.985	0.991	0.995	0.998	1.000	1.002	0.46
0.962	0.971	0.977	0.980	0.984	0.991	0.995	0.998	1.000	1.002	1.47
0.962	0.970	0.977	0.980	0.984	0.990	0.994	0.998	1.000	1.002	0.48
0.961	0.970	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.49
0.960	0.969	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.50
0.959	0.968	0.976	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.51
0.958	0.968	0.975	0.979	0.983	0.990	0.994	0.998	1.000	1.002	0.52
0.958	0.967	0.975	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.53
0.957	0.967	0.974	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.54
0.956	0.966	0.974	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.55
0.955	0.965	0.973	0.978	0.982	0.989	0.994	0.998	1.000	1.002	0.56
0.954	0.965	0.973	0.977	0.982	0.989	0.994	0.998	1.000	1.002	0.57
0.954	0.965	0.972	0.977	0.981	0.988	0.993	0.997	1.000	1.003	0.58
0.953	0.964	0.972	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.59
0.952	0.963	0.971	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.60
0.951	0.963	0.971	0.976	0.981	0.988	0.993	0.997	1.000	1.003	0.61
0.951	0.962	0.970	0.975	0.981	0.988	0.993	0.997	1.000	1.003	0.62
0.950	0.962	0.970	0.975	0.980	0.987	0.993	0.997	1.000	1.003	0.63
0.950	0.961	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.64

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.65	0.769	0.804	0.835	0.861	0.881	0.893	0.905	0.917	0.926	0.935
0.66	0.765	0.800	0.832	0.859	0.879	0.891	0.904	0.916	0.925	0.934
0.67	0.760	0.796	0.829	0.857	0.877	0.890	0.902	0.915	0.924	0.933
0.68	0.756	0.793	0.826	0.854	0.875	0.888	0.901	0.913	0.923	0.932
0.69	0.751	0.789	0.823	0.852	0.873	0.887	0.899	0.912	0.922	0.931
0.70	0.747	0.785	0.820	0.850	0.871	0.885	0.898	0.911	0.921	0.930
0.71	0.742	0.781	0.817	0.848	0.869	0.884	0.896	0.910	0.920	0.929
0.72	0.737	0.778	0.814	0.846	0.867	0.882	0.895	0.909	0.919	0.928
0.73	0.732	0.774	0.812	0.843	0.865	0.881	0.893	0.907	0.918	0.927
0.74	0.727	0.771	0.809	0.841	0.863	0.879	0.892	0.906	0.917	0.926
0.75	0.722	0.767	0.806	0.839	0.861	0.878	0.890	0.905	0.916	0.925
0.76	0.717	0.763	0.803	0.837	0.859	0.876	0.889	0.904	0.915	0.924
0.77	0.712	0.759	0.800	0.834	0.857	0.875	0.887	0.903	0.914	0.923
0.78	0.708	0.756	0.797	0.832	0.855	0.873	0.886	0.901	0.912	0.922
0.79	0.703	0.752	0.794	0.829	0.853	0.872	0.884	0.900	0.911	0.921
0.80	0.698	0.748	0.791	0.827	0.851	0.870	0.883	0.899	0.910	0.920
0.81	0.693	0.744	0.788	0.825	0.849	0.868	0.882	0.898	0.909	0.919
0.82	0.688	0.740	0.785	0.822	0.847	0.866	0.880	0.897	0.908	0.918
0.83	0.682	0.737	0.782	0.820	0.846	0.865	0.879	0.895	0.907	0.918
0.84	0.677	0.733	0.779	0.817	0.844	0.863	0.877	0.894	0.906	0.917
0.85	0.672	0.729	0.776	0.815	0.842	0.861	0.876	0.893	0.905	0.916
0.86	0.667	0.725	0.773	0.812	0.840	0.859	0.875	0.892	0.904	0.915
0.87	0.661	0.721	0.770	0.810	0.838	0.857	0.874	0.891	0.903	0.914
0.88	0.656	0.718	0.767	0.807	0.836	0.856	0.872	0.889	0.901	0.913
0.89	0.650	0.714	0.764	0.805	0.834	0.854	0.871	0.888	0.900	0.912
0.90	0.645	0.710	0.761	0.802	0.832	0.852	0.870	0.887	0.899	0.911
0.91	0.640	0.706	0.758	0.800	0.830	0.851	0.869	0.886	0.898	0.910
0.92	0.634	0.702	0.756	0.798	0.828	0.849	0.867	0.885	0.897	0.909
0.93	0.629	0.698	0.753	0.795	0.827	0.848	0.866	0.883	0.897	0.908
0.94	0.623	0.694	0.751	0.793	0.825	0.846	0.864	0.882	0.896	0.907
0.95	0.618	0.690	0.748	0.791	0.823	0.845	0.863	0.881	0.895	0.906
0.96	0.612	0.686	0.745	0.789	0.821	0.844	0.862	0.880	0.894	0.905
0.97	0.607	0.682	0.742	0.787	0.819	0.842	0.860	0.879	0.893	0.904
0.98	0.601	0.678	0.740	0.784	0.817	0.841	0.859	0.877	0.892	0.903
0.99	0.596	0.674	0.737	0.782	0.815	0.839	0.857	0.876	0.891	0.902
1.00	0.590	0.670	0.734	0.780	0.813	0.838	0.856	0.875	0.890	0.901
1.01	0.583	0.665	0.731	0.778	0.811	0.836	0.855	0.874	0.889	0.900
1.02	0.576	0.661	0.728	0.775	0.809	0.834	0.853	0.873	0.888	0.899
1.03	0.569	0.656	0.725	0.773	0.807	0.833	0.852	0.871	0.887	0.899
1.04	0.562	0.652	0.722	0.770	0.805	0.831	0.850	0.870	0.886	0.898
1.05	0.555	0.647	0.719	0.768	0.803	0.829	0.849	0.869	0.885	0.897
1.06	0.548	0.642	0.716	0.765	0.801	0.827	0.848	0.868	0.884	0.896
1.07	0.541	0.638	0.713	0.763	0.799	0.825	0.846	0.866	0.883	0.895
1.08	0.534	0.633	0.709	0.760	0.797	0.824	0.845	0.865	0.881	0.895
1.09	0.527	0.629	0.706	0.758	0.795	0.822	0.843	0.863	0.880	0.894

					T_r					P_r 0.65 - 1.09
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.949	0.961	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.65
0.948	0.960	0.969	0.974	0.980	0.987	0.993	0.997	1.000	1.003	0.66
0.947	0.960	0.968	0.973	0.979	0.987	0.993	0.997	1.000	1.003	0.67
0.947	0.959	0.968	0.973	0.979	0.986	0.992	0.997	1.001	1.004	0.68
0.946	0.959	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.69
0.945	0.958	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.70
0.944	0.957	0.967	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.71
0.944	0.957	0.966	0.972	0.978	0.986	0.992	0.997	1.001	1.004	0.72
0.943	0.956	0.966	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.73
0.943	0.956	0.965	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.74
0.942	0.955	0.965	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.75
0.941	0.954	0.964	0.971	0.977	0.985	0.992	0.997	1.001	1.004	0.76
0.940	0.954	0.964	0.970	0.976	0.985	0.992	0.997	1.001	1.004	0.77
0.940	0.953	0.963	0.970	0.976	0.984	0.991	0.997	1.001	1.005	0.78
0.939	0.953	0.963	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.79
0.938	0.952	0.962	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.80
0.937	0.952	0.962	0.969	0.975	0.984	0.991	0.997	1.001	1.005	0.81
0.937	0.951	0.961	0.968	0.975	0.984	0.991	0.997	1.001	1.005	0.82
0.936	0.951	0.961	0.968	0.974	0.983	0.991	0.997	1.001	1.005	0.83
0.936	0.950	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.84
0.935	0.950	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.85
0.934	0.949	0.960	0.967	0.974	0.983	0.991	0.997	1.001	1.005	0.86
0.933	0.949	0.959	0.966	0.973	0.983	0.991	0.997	1.001	1.005	0.87
0.933	0.948	0.959	0.966	0.973	0.983	0.990	0.996	1.001	1.006	0.88
0.932	0.948	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.89
0.931	0.947	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.90
0.930	0.946	0.958	0.965	0.972	0.983	0.990	0.996	1.001	1.006	0.91
0.929	0.946	0.957	0.964	0.972	0.983	0.990	0.996	1.001	1.006	0.92
0.929	0.945	0.957	0.964	0.971	0.982	0.990	0.996	1.001	1.006	0.93
0.928	0.945	0.956	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.94
0.927	0.944	0.956	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.95
0.926	0.943	0.955	0.963	0.971	0.982	0.990	0.996	1.001	1.006	0.96
0.925	0.943	0.955	0.962	0.971	0.982	0.990	0.996	1.001	1.006	0.97
0.925	0.942	0.954	0.962	0.970	0.981	0.989	0.996	1.001	1.007	0.98
0.924	0.942	0.954	0.961	0.970	0.981	0.989	0.996	1.001	1.007	0.99
0.923	0.941	0.953	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.00
0.922	0.941	0.953	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.01
0.922	0.940	0.952	0.961	0.970	0.981	0.989	0.996	1.001	1.007	1.02
0.921	0.940	0.952	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.03
0.921	0.939	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.04
0.920	0.939	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.05
0.919	0.938	0.951	0.960	0.969	0.980	0.989	0.996	1.001	1.007	1.06
0.919	0.938	0.950	0.959	0.968	0.980	0.989	0.996	1.001	1.007	1.07
0.918	0.937	0.950	0.959	0.968	0.979	0.988	0.996	1.002	1.008	1.08
0.918	0.937	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.09

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
1.10	0.520	0.624	0.703	0.755	0.793	0.820	0.842	0.862	0.879	0.893
1.11	0.512	0.620	0.700	0.753	0.791	0.818	0.841	0.861	0.878	0.892
1.12	0.505	0.615	0.697	0.750	0.789	0.817	0.840	0.860	0.877	0.891
1.13	0.497	0.611	0.694	0.748	0.787	0.815	0.838	0.858	0.876	0.891
1.14	0.490	0.606	0.691	0.745	0.785	0.814	0.837	8.857	0.875	0.890
1.15	0.482	0.602	0.688	0.743	0.783	0.812	0.836	0.856	0.874	0.889
1.16	0.474	0.598	0.685	0.741	0.781	0.810	0.835	0.855	0.873	0.888
1.17	0.467	0.593	0.682	0.738	0.779	0.809	0.833	0.854	0.872	0.887
1.18	0.459	0.589	0.678	0.736	0.777	0.807	0.832	0.852	0.871	0.886
1.19	0.452	0.584	0.675	0.733	0.775	0.806	0.830	0.851	0.870	0.885
1.20	0.444	0.580	0.672	0.731	0.773	0.804	0.829	0.850	0.869	0.884
1.21	0.435	0.575	0.669	0.729	0.771	0.803	0.828	0.849	0.868	0.883
1.22	0.426	0.570	0.666	0.726	0.769	0.801	0.827	0.848	0.867	0.882
1.23	0.416	0.565	0.662	0.724	0.767	0.800	0.825	0.847	0.866	0.882
1.24	0.407	0.560	0.659	0.721	0.765	0.798	0.824	0.846	0.865	0.881
1.25	0.398	0.555	0.656	0.719	0.763	0.797	0.823	0.845	0.864	0.880
1.26	0.389	0.550	0.653	0.717	0.761	0.795	0.822	0.844	0.863	0.879
1.27	0.379	0.545	0.650	0.714	0.759	0.794	0.821	0.843	0.862	0.878
1.28	0.370	0.540	0.646	0.712	0.757	0.792	0.819	0.841	0.861	0.878
1.29	0.360	0.535	0.643	0.709	0.755	0.791	0.818	0.840	0.860	0.877
1.30	0.351	0.530	0.640	0.707	0.753	0.789	0.817	0.839	0.859	0.876
1.31	0.342	0.525	0.637	0.705	0.751	0.787	0.816	0.838	0.859	0.875
1.32	0.333	0.520	0.633	0.702	0.749	0.786	0.814	0.837	0.857	0.874
1.33	0.325	0.515	0.630	0.700	0.747	0.784	0.813	0.836	0.857	0.874
1.34	0.316	0.510	0.626	0.697	0.745	0.783	0.811	0.835	0.856	0.873
1.35	0.307	0.505	0.623	0.695	0.743	0.781	0.810	0.834	0.855	0.872
1.36	0.298	0.500	0.619	0.692	0.741	0.779	0.809	0.833	0.854	0.871
1.37	0.289	0.495	0.616	0.690	0.739	0.777	0.807	0.832	0.853	0.870
1.38	0.281	0.490	0.612	0.687	0.736	0.776	0.806	0.830	0.852	0.870
1.39	0.272	0.485	0.609	0.685	0.734	0.774	0.804	0.829	0.851	0.869
1.40	0.263	0.480	0.605	0.682	0.732	0.772	0.803	0.828	0.850	0.868
1.41	0.262	0.475	0.602	0.680	0.730	0.771	0.802	0.827	0.849	0.867
1.42	0.261	0.469	0.598	0.677	0.728	0.769	0.801	0.826	0.848	0.866
1.43	0.261	0.464	0.595	0.675	0.725	0.768	0.790	0.826	0.848	0.866
1.44	0.260	0.458	0.591	0.672	0.723	0.766	0.798	0.825	0.847	0.865
1.45	0.259	0.453	0.588	0.670	0.721	0.765	0.797	0.824	0.846	0.864
1.46	0.258	0.447	0.584	0.667	0.719	0.763	0.796	0.823	0.845	0.863
1.47	0.257	0.442	0.581	0.665	0.717	0.762	0.795	0.821	0.844	0.862
1.48	0.256	0.436	0.577	0.662	0.714	0.760	0.793	0.820	0.843	0.861
1.49	0.255	0.431	0.574	0.660	0.712	0.759	0.792	0.818	0.842	0.860
1.50	0.254	0.425	0.570	0.657	0.710	0.757	0.791	0.817	0.841	0.859
1.51	0.254	0.422	0.567	0.655	0.708	0.756	0.790	0.816	0.840	0.858
1.52	0.254	0.419	0.564	0.653	0.706	0.754	0.789	0.815	0.839	0.857
1.53	0.253	0.415	0.562	0.650	0.705	0.753	0.787	0.813	0.839	0.857
1.54	0.253	0.412	0.559	0.648	0.703	0.751	0.786	0.812	0.838	0.856

T_r										P_r 1.10 - 1.54
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.917	0.936	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.10
0.916	0.935	0.949	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.11
0.915	0.935	0.948	0.958	0.967	0.979	0.988	0.996	1.002	1.008	1.12
0.915	0.934	0.948	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.13
0.914	0.934	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.14
0.913	0.933	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.15
0.912	0.932	0.947	0.957	0.966	0.979	0.988	0.996	1.002	1.008	1.16
0.911	0.932	0.946	0.956	0.965	0.979	0.988	0.996	1.002	1.008	1.17
0.911	0.931	0.946	0.956	0.965	0.978	0.987	0.996	1.002	1.008	1.18
0.910	0.931	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.19
0.909	0.930	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.20
0.908	0.930	0.945	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.21
0.907	0.929	0.944	0.955	0.964	0.978	0.987	0.996	1.002	1.008	1.22
0.907	0.929	0.944	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.23
0.906	0.928	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.24
0.905	0.928	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.25
0.904	0.927	0.943	0.954	0.963	0.978	0.987	0.996	1.002	1.008	1.26
0.903	0.927	0.942	0.953	0.963	0.978	0.987	0.996	1.002	1.008	1.27
0.903	0.926	0.942	0.953	0.962	0.977	0.987	0.996	1.002	1.009	1.28
0.902	0.926	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.29
0.901	0.925	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.30
0.900	0.925	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.31
0.900	0.924	0.941	0.952	0.962	0.977	0.987	0.996	1.002	1.009	1.32
0.899	0.924	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.33
0.899	0.923	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.34
0.898	0.923	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.35
0.897	0.922	0.940	0.951	0.961	0.976	0.986	0.996	1.002	1.009	1.36
0.897	0.922	0.939	0.950	0.961	0.976	0.986	0.996	1.002	1.009	1.37
0.896	0.921	0.939	0.950	0.960	0.975	0.986	0.996	1.002	1.010	1.38
0.896	0.921	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.39
0.895	0.920	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.40
0.894	0.920	0.938	0.949	0.960	0.975	0.986	0.996	1.002	1.010	1.41
0.894	0.919	0.937	0.948	0.960	0.975	0.986	0.996	1.002	1.010	1.42
0.893	0.919	0.937	0.948	0.959	0.975	0.986	0.996	1.002	1.010	1.43
0.893	0.918	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.44
0.892	0.918	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.45
0.891	0.917	0.936	0.947	0.959	0.975	0.986	0.996	1.002	1.010	1.46
0.891	0.917	0.935	0.947	0.958	0.975	0.986	0.996	1.002	1.010	1.47
0.890	0.916	0.935	0.946	0.958	0.974	0.985	0.995	1.003	1.010	1.48
0.890	0.916	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.49
0.889	0.915	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.50
0.888	0.915	0.934	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.51
0.888	0.914	0.933	0.946	0.957	0.974	0.985	0.995	1.003	1.010	1.52
0.887	0.914	0.933	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.53
0.887	0.913	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.54

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
1.55	0.253	0.409	0.556	0.646	0.701	0.750	0.785	0.811	0.837	0.855
1.56	0.253	0.406	0.553	0.644	0.699	0.748	0.784	0.810	0.836	0.854
1.57	0.252	0.403	0.550	0.641	0.697	0.747	0.783	0.809	0.835	0.853
1.58	0.252	0.399	0.547	0.639	0.695	0.745	0.781	0.807	0.834	0.853
1.59	0.251	0.396	0.544	0.636	0.693	0.744	0.780	0.806	0.833	0.852
1.60	0.251	0.393	0.541	0.634	0.691	0.742	0.779	0.805	0.832	0.851
1.61	0.251	0.392	0.539	0.632	0.689	0.741	0.778	0.804	0.831	0.850
1.62	0.251	0.390	0.536	0.630	0.687	0.739	0.777	0.803	0.830	0.849
1.63	0.251	0.389	0.534	0.627	0.686	0.738	0.775	0.802	0.830	0.849
1.64	0.251	0.387	0.531	0.625	0.684	0.736	0.774	0.801	0.829	0.848
1.65	0.251	0.386	0.529	0.623	0.682	0.735	0.773	0.800	0.828	0.847
1.66	0.251	0.384	0.527	0.621	0.680	0.734	0.772	0.799	0.827	0.846
1.67	0.251	0.383	0.524	0.619	0.678	0.732	0.771	0.798	0.826	0.845
1.68	0.252	0.381	0.522	0.616	0.676	0.731	0.769	0.797	0.825	0.845
1.69	0.252	0.380	0.519	0.614	0.674	0.729	0.768	0.796	0.824	0.844
1.70	0.252	0.378	0.517	0.612	0.672	0.728	0.767	0.795	0.823	0.843
1.71	0.253	0.377	0.515	0.610	0.670	0.726	0.766	0.794	0.822	0.842
1.72	0.254	0.376	0.513	0.608	0.669	0.725	0.765	0.793	0.821	0.842
1.73	0.254	0.376	0.511	0.606	0.667	0.723	0.763	0.792	0.821	0.841
1.74	0.255	0.375	0.509	0.604	0.666	0.722	0.762	0.791	0.820	0.841
1.75	0.256	0.374	0.507	0.602	0.664	0.720	0.761	0.790	0.819	0.840
1.76	0.257	0.373	0.505	0.600	0.662	0.718	0.760	0.789	0.818	0.839
1.77	0.258	0.372	0.503	0.598	0.661	0.717	0.759	0.788	0.817	0.839
1.78	0.258	0.372	0.501	0.596	0.659	0.716	0.757	0.786	0.817	0.838
1.79	0.259	0.371	0.499	0.594	0.658	0.714	0.756	0.785	0.816	0.838
1.80	0.260	0.370	0.497	0.592	0.656	0.712	0.755	0.784	0.815	0.837
1.81	0.261	0.370	0.495	0.590	0.654	0.711	0.754	0.783	0.814	0.836
1.82	0.262	0.370	0.494	0.588	0.653	0.710	0.753	0.782	0.813	0.836
1.83	0.263	0.370	0.492	0.586	0.651	0.708	0.752	0.781	0.813	0.835
1.84	0.264	0.370	0.491	0.584	0.650	0.707	0.751	0.780	0.812	0.835
1.85	0.265	0.370	0.489	0.582	0.648	0.706	0.750	0.779	0.811	0.834
1.86	0.266	0.370	0.487	0.580	0.646	0.705	0.749	0.778	0.810	0.833
1.87	0.267	0.370	0.485	0.578	0.645	0.703	0.748	0.777	0.809	0.832
1.88	0.268	0.369	0.484	0.576	0.643	0.702	0.746	0.776	0.808	0.832
1.89	0.269	0.369	0.482	0.574	0.642	0.700	0.745	0.775	0.807	0.831
1.90	0.270	0.369	0.480	0.572	0.640	0.699	0.744	0.774	0.806	0.830
1.91	0.271	0.369	0.479	0.570	0.639	0.698	0.743	0.773	0.805	0.829
1.92	0.272	0.369	0.478	0.569	0.638	0.697	0.742	0.773	0.805	0.829
1.93	0.273	0.369	0.476	0.567	0.636	0.695	0.740	0.772	0.804	0.828
1.94	0.274	0.369	0.475	0.566	0.635	0.694	0.739	0.772	0.804	0.828
1.95	0.275	0.369	0.474	0.564	0.634	0.693	0.738	0.771	0.803	0.827
1.96	0.276	0.369	0.473	0.562	0.633	0.692	0.737	0.770	0.802	0.826
1.97	0.277	0.369	0.471	0.560	0.631	0.691	0.736	0.769	0.801	0.826
1.98	0.278	0.370	0.470	0.559	0.630	0.689	0.734	0.769	0.801	0.825
1.99	0.279	0.370	0.468	0.557	0.628	0.688	0.733	0.768	0.800	0.825

T_r										P_r 1.55 - 1.99
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.886	0.913	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.55
0.885	0.912	0.932	0.945	0.956	0.973	0.985	0.995	1.003	1.010	1.56
0.884	0.912	0.931	0.944	0.955	0.973	0.985	0.995	1.003	1.010	1.57
0.884	0.911	0.931	0.944	0.955	0.972	0.984	0.995	1.003	1.011	1.58
0.883	0.911	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.59
0.882	0.910	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.60
0.882	0.910	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.61
0.881	0.909	0.930	0.943	0.954	0.972	0.984	0.995	1.003	1.011	1.62
0.881	0.909	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.63
0.880	0.908	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.64
0.880	0.908	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.65
0.879	0.907	0.929	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.66
0.879	0.907	0.928	0.942	0.953	0.972	0.984	0.995	1.003	1.011	1.67
0.878	0.906	0.928	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.68
0.878	0.906	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.69
0.877	0.905	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.70
0.876	0.905	0.927	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.71
0.876	0.904	0.926	0.941	0.952	0.971	0.983	0.995	1.004	1.012	1.72
0.875	0.904	0.926	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.73
0.875	0.903	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.74
0.874	0.903	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.75
0.873	0.902	0.925	0.940	0.951	0.971	0.983	0.995	1.004	1.012	1.76
0.873	0.902	0.924	0.939	0.951	0.971	0.983	0.995	1.004	1.012	1.77
0.872	0.901	0.924	0.939	0.950	0.970	0.983	0.995	1.004	1.012	1.78
0.872	0.901	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.79
0.871	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.80
0.871	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.81
0.870	0.900	0.923	0.938	0.950	0.970	0.983	0.995	1.004	1.012	1.82
0.870	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.83
0.869	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.84
0.869	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.85
0.868	0.899	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.86
0.868	0.898	0.922	0.937	0.949	0.970	0.983	0.995	1.004	1.012	1.87
0.867	0.898	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.88
0.867	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.89
0.866	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.90
0.866	0.897	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.91
0.865	0.896	0.921	0.936	0.948	0.969	0.982	0.995	1.005	1.013	1.92
0.865	0.896	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.93
0.864	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.94
0.864	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.95
0.863	0.895	0.920	0.935	0.948	0.969	0.982	0.995	1.005	1.013	1.96
0.863	0.894	0.919	0.934	0.947	0.969	0.982	0.995	1.005	1.013	1.97
0.862	0.894	0.919	0.934	0.947	0.968	0.982	0.995	1.006	1.014	1.98
0.862	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	1.99

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.00	0.280	0.370	0.467	0.555	0.627	0.687	0.732	0.767	0.799	0.824
2.01	0.281	0.370	0.466	0.553	0.626	0.686	0.731	0.766	0.798	0.823
2.02	0.282	0.370	0.465	0.552	0.624	0.685	0.730	0.765	0.797	0.823
2.03	0.284	0.371	0.464	0.550	0.623	0.683	0.729	0.764	0.797	0.822
2.04	0.285	0.371	0.463	0.549	0.621	0.682	0.728	0.763	0.796	0.822
2.05	0.286	0.371	0.462	0.547	0.620	0.681	0.727	0.762	0.795	0.821
2.06	0.287	0.371	0.461	0.545	0.618	0.680	0.726	0.761	0.794	0.820
2.07	0.288	0.371	0.460	0.544	0.617	0.678	0.725	0.760	0.793	0.820
2.08	0.290	0.372	0.459	0.542	0.615	0.677	0.723	0.759	0.793	0.819
2.09	0.291	0.372	0.458	0.541	0.614	0.675	0.722	0.758	0.792	0.819
2.10	0.292	0.372	0.457	0.539	0.612	0.674	0.721	0.757	0.791	0.818
2.11	0.293	0.372	0.456	0.538	0.611	0.673	0.720	0.756	0.790	0.817
2.12	0.294	0.373	0.456	0.537	0.610	0.672	0.719	0.755	0.790	0.817
2.13	0.296	0.373	0.455	0.536	0.609	0.671	0.718	0.755	0.789	0.816
2.14	0.297	0.374	0.455	0.535	0.608	0.670	0.717	0.754	0.789	0.816
2.15	0.298	0.374	0.454	0.534	0.607	0.669	0.716	0.753	0.788	0.815
2.16	0.299	0.374	0.453	0.533	0.606	0.668	0.715	0.752	0.787	0.814
2.17	0.301	0.375	0.452	0.532	0.605	0.667	0.714	0.751	0.786	0.813
2.18	0.302	0.375	0.452	0.530	0.604	0.665	0.713	0.750	0.786	0.813
2.19	0.304	0.376	0.451	0.529	0.603	0.664	0.712	0.749	0.785	0.812
2.20	0.305	0.376	0.450	0.528	0.602	0.663	0.711	0.748	0.784	0.811
2.21	0.306	0.376	0.450	0.527	0.601	0.662	0.710	0.747	0.783	0.810
2.22	0.307	0.377	0.450	0.527	0.600	0.661	0.709	0.747	0.783	0.810
2.23	0.309	0.377	0.449	0.526	0.600	0.660	0.709	0.746	0.782	0.809
2.24	0.310	0.378	0.449	0.526	0.599	0.659	0.708	0.746	0.782	0.809
2.25	0.311	0.378	0.449	0.525	0.598	0.658	0.707	0.745	0.781	0.808
2.26	0.312	0.378	0.449	0.524	0.597	0.657	0.706	0.744	0.780	0.807
2.27	0.314	0.379	0.449	0.524	0.596	0.656	0.705	0.743	0.780	0.807
2.28	0.315	0.379	0.448	0.523	0.595	0.654	0.704	0.743	0.779	0.806
2.29	0.317	0.380	0.448	0.523	0.594	0.653	0.703	0.742	0.779	0.806
2.30	0.318	0.380	0.448	0.522	0.593	0.652	0.702	0.741	0.778	0.805
2.31	0.319	0.381	0.448	0.522	0.592	0.651	0.701	0.740	0.777	0.805
2.32	0.320	0.381	0.448	0.522	0.592	0.651	0.701	0.739	0.777	0.804
2.33	0.322	0.382	0.448	0.521	0.591	0.650	0.700	0.739	0.776	0.804
2.34	0.323	0.382	0.448	0.521	0.591	0.650	0.700	0.738	0.776	0.803
2.35	0.324	0.383	0.448	0.521	0.590	0.649	0.699	0.737	0.775	0.803
2.36	0.325	0.384	0.448	0.521	0.589	0.648	0.698	0.736	0.774	0.802
2.37	0.326	0.385	0.448	0.521	0.588	0.647	0.697	0.735	0.773	0.802
2.38	0.328	0.385	0.449	0.520	0.588	0.647	0.697	0.735	0.773	0.801
2.39	0.329	0.386	0.449	0.520	0.587	0.646	0.696	0.734	0.772	0.801
2.40	0.330	0.387	0.449	0.520	0.586	0.645	0.695	0.733	0.771	0.800
2.41	0.331	0.388	0.449	0.520	0.585	0.644	0.694	0.733	0.770	0.800
2.42	0.332	0.388	0.449	0.520	0.585	0.644	0.694	0.732	0.770	0.799
2.43	0.334	0.389	0.450	0.520	0.584	0.643	0.693	0.732	0.769	0.799
2.44	0.335	0.389	0.450	0.520	0.584	0.643	0.693	0.731	0.769	0.798

T_r										P_r 2.00 - 2.44
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.861	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.00
0.861	0.893	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.01
0.860	0.892	0.918	0.933	0.947	0.968	0.982	0.995	1.006	1.014	2.02
0.860	0.892	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.03
0.859	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.04
0.859	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.05
0.858	0.891	0.917	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.06
0.858	0.890	0.916	0.932	0.946	0.968	0.982	0.995	1.006	1.014	2.07
0.857	0.890	0.916	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.08
0.857	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.09
0.856	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.10
0.856	0.889	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.11
0.855	0.888	0.915	0.931	0.945	0.967	0.981	0.995	1.007	1.015	2.12
0.855	0.888	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.13
0.854	0.887	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.14
0.854	0.877	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.15
0.853	0.887	0.914	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.16
0.853	0.886	0.913	0.930	0.945	0.967	0.981	0.995	1.007	1.015	2.17
0.852	0.886	0.913	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.18
0.852	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.19
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.20
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.21
0.851	0.885	0.912	0.929	0.944	0.966	0.981	0.995	1.007	1.016	2.22
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.23
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.24
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.25
0.850	0.884	0.911	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.26
0.849	0.883	0.910	0.928	0.943	0.966	0.981	0.995	1.007	1.016	2.27
0.849	0.883	0.910	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.28
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.29
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.30
0.848	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.31
0.847	0.882	0.909	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.32
0.847	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.33
0.846	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.34
0.846	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.35
0.845	0.881	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.36
0.845	0.880	0.908	0.927	0.942	0.965	0.980	0.995	1.008	1.017	2.37
0.844	0.880	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.38
0.844	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.39
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.40
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.41
0.843	0.879	0.907	0.926	0.941	0.964	0.980	0.995	1.008	1.018	2.42
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.43
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.44

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.45	0.336	0.390	0.450	0.520	0.583	0.642	0.692	0.731	0.768	0.798
2.46	0.337	0.391	0.450	0.520	0.583	0.641	0.691	0.730	0.767	0.798
2.47	0.339	0.392	0.450	0.520	0.582	0.640	0.690	0.730	0.767	0.797
2.48	0.340	0.392	0.451	0.519	0.582	0.640	0.690	0.729	0.767	0.797
2.49	0.342	0.393	0.451	0.519	0.581	0.639	0.689	0.729	0.767	0.796
2.50	0.343	0.394	0.451	0.519	0.581	0.638	0.688	0.728	0.765	0.796
2.51	0.344	0.395	0.452	0.519	0.581	0.638	0.687	0.727	0.765	0.795
2.52	0.345	0.396	0.452	0.519	0.581	0.637	0.687	0.727	0.764	0.795
2.53	0.347	0.396	0.453	0.519	0.581	0.637	0.686	0.726	0.764	0.794
2.54	0.348	0.397	0.453	0.519	0.581	0.636	0.686	0.726	0.763	0.794
2.55	0.349	0.398	0.454	0.519	0.581	0.636	0.685	0.725	0.763	0.793
2.56	0.350	0.399	0.455	0.519	0.581	0.635	0.684	0.724	0.762	0.793
2.57	0.352	0.400	0.456	0.519	0.581	0.635	0.684	0.724	0.762	0.792
2.58	0.353	0.400	0.456	0.520	0.580	0.634	0.683	0.723	0.761	0.792
2.59	0.355	0.401	0.457	0.520	0.580	0.634	0.683	0.723	0.761	0.791
2.60	0.356	0.402	0.458	0.520	0.580	0.633	0.682	0.722	0.760	0.791
2.61	0.357	0.403	0.458	0.520	0.580	0.633	0.682	0.722	0.760	0.791
2.62	0.358	0.404	0.459	0.520	0.580	0.632	0.681	0.721	0.759	0.790
2.63	0.360	0.404	0.459	0.521	0.580	0.632	0.681	0.721	0.759	0.790
2.64	0.361	0.405	0.460	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.65	0.362	0.406	0.460	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.66	0.363	0.407	0.461	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.67	0.365	0.408	0.461	0.521	0.580	0.630	0.679	0.719	0.757	0.788
2.68	0.366	0.408	0.462	0.522	0.579	0.630	0.679	0.719	0.757	0.788
2.69	0.368	0.409	0.462	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.70	0.369	0.410	0.463	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.71	0.370	0.411	0.464	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.72	0.371	0.412	0.465	0.523	0.579	0.629	0.677	0.717	0.755	0.786
2.73	0.373	0.412	0.465	0.523	0.579	0.628	0.677	0.717	0.755	0.786
2.74	0.374	0.413	0.466	0.524	0.579	0.628	0.676	0.716	0.754	0.785
2.75	0.375	0.414	0.467	0.524	0.579	0.628	0.676	0.716	0.754	0.785
2.76	0.376	0.415	0.468	0.524	0.579	0.628	0.675	0.715	0.754	0.785
2.77	0.377	0.416	0.469	0.525	0.579	0.628	0.675	0.715	0.753	0.784
2.78	0.379	0.417	0.470	0.525	0.579	0.627	0.674	0.714	0.753	0.784
2.79	0.380	0.418	0.471	0.526	0.579	0.627	0.674	0.714	0.752	0.783
2.80	0.381	0.419	0.472	0.526	0.579	0.627	0.673	0.713	0.752	0.783
2.81	0.382	0.420	0.473	0.526	0.579	0.627	0.673	0.713	0.752	0.783
2.82	0.383	0.421	0.474	0.527	0.579	0.627	0.673	0.713	0.751	0.782
2.83	0.385	0.422	0.474	0.527	0.579	0.626	0.672	0.712	0.751	0.782
2.84	0.386	0.423	0.475	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.85	0.387	0.424	0.476	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.86	0.388	0.425	0.477	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.87	0.390	0.426	0.478	0.529	0.579	0.626	0.671	0.711	0.749	0.780
2.88	0.391	0.427	0.479	0.529	0.580	0.625	0.671	0.711	0.749	0.780
2.89	0.393	0.428	0.480	0.530	0.580	0.625	0.670	0.710	0.748	0.779

T_r										P_r 2.45 - 2.89
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.45
0.842	0.878	0.906	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.46
0.841	0.877	0.905	0.925	0.941	0.964	0.980	0.995	1.008	1.018	2.47
0.841	0.877	0.905	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.48
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.49
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.50
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.51
0.840	0.876	0.904	0.924	0.941	0.963	0.980	0.995	1.009	1.019	2.52
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.53
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.54
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.55
0.839	0.875	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.56
0.838	0.874	0.903	0.923	0.941	0.963	0.980	0.995	1.009	1.019	2.57
0.838	0.874	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.58
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.59
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.60
0.837	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.61
0.836	0.873	0.902	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.62
0.836	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.63
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.64
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.65
0.835	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.66
0.834	0.872	0.901	0.922	0.940	0.963	0.980	0.995	1.009	1.020	2.67
0.834	0.871	0.900	0.921	0 939	0.962	0.980	0.996	1.010	1.021	2.68
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.69
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.70
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.71
0.833	0.871	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.72
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.73
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.74
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.75
0.832	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.76
0.831	0.870	0.900	0.921	0.939	0.962	0.980	0.996	1.010	1.021	2.77
0.831	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.78
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.79
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.80
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.81
0.830	0.869	0.899	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.82
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.83
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.84
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.85
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.86
0.829	0.868	0.898	0.920	0.938	0.962	0.980	0.996	1.010	1.022	2.87
0.829	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.88
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.89

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
2.90	0.394	0.429	0.481	0.530	0.580	0.625	0.670	0.710	0.748	0.779
2.91	0.395	0.430	0.482	0.530	0.580	0.625	0.670	0.710	0.748	0.779
2.92	0.397	0.431	0.483	0.531	0.580	0.625	0.670	0.710	0.748	0.779
2.93	0.398	0.432	0.483	0.531	0.580	0.625	0.670	0.709	0.747	0.778
2.94	0.400	0.433	0.484	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.95	0.401	0.434	0.485	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.96	0.402	0.435	0.486	0.532	0.580	0.625	0.670	0.709	0.747	0.778
2.97	0.403	0.436	0.487	0.533	0.580	0.625	0.670	0.708	0.746	0.778
2.98	0.405	0.438	0.487	0.533	0.581	0.624	0.669	0.708	0.746	0.777
2.99	0.406	0.439	0.488	0.534	0.581	0.624	0.669	0.707	0.745	0.777
3.00	0.407	0.440	0.489	0.534	0.581	0.624	0.669	0.707	0.745	0.777
3.01	0.408	0.441	0.490	0.535	0.581	0.624	0.669	0.707	0.745	0.777
3.02	0.409	0.442	0.491	0.535	0.581	0.624	0.669	0.707	0.745	0.777
3.03	0.411	0.444	0.492	0.536	0.582	0.624	0.669	0.706	0.744	0.776
3.04	0.412	0.445	0.493	0.536	0.582	0.624	0.669	0.706	0.744	0.776
3.05	0.413	0.446	0.494	0.537	0.582	0.624	0.669	0.706	0.744	0.776
3.06	0.414	0.447	0.495	0.538	0.582	0.624	0.669	0.706	0.744	0.776
3.07	0.416	0.448	0.496	0.538	0.583	0.624	0.669	0.706	0.743	0.776
3.08	0.417	0.450	0.497	0.539	0.583	0.625	0.668	0.705	0.743	0.775
3.09	0.419	0.451	0.498	0.539	0.584	0.625	0.668	0.705	0.742	0.775
3.10	0.420	0.452	0.499	0.540	0.584	0.625	0.668	0.705	0.742	0.775
3.11	0.421	0.453	0.500	0.541	0.584	0.625	0.668	0.705	0.742	0.775
3.12	0.422	0.454	0.501	0.541	0.585	0.625	0.668	0.705	0.742	0.775
3.13	0.424	0.455	0.501	0.542	0.585	0.625	0.668	0.704	0.742	0.774
3.14	0.425	0.456	0.502	0.542	0.586	0.625	0.668	0.704	0.742	0.774
3.15	0.426	0.457	0.503	0.543	0.586	0.625	0.668	0.704	0.742	0.774
3.16	0.427	0.458	0.504	0.544	0.586	0.625	0.668	0.704	0.742	0.774
3.17	0.428	0.459	0.505	0.544	0.587	0.625	0.668	0.704	0.742	0.774
3.18	0.430	0.461	0.505	0.545	0.587	0.626	0.668	0.703	0.741	0.773
3.19	0.431	0.462	0.506	0.545	0.588	0.626	0.668	0.703	0.741	0.773
3.20	0.432	0.463	0.507	0.546	0.588	0.626	0.668	0.703	0.741	0.773
3.21	0.433	0.464	0.508	0.546	0.588	0.626	0.668	0.703	0.741	0.773
3.22	0.434	0.465	0.509	0.547	0.589	0.626	0.668	0.702	0.741	0.773
3.23	0.436	0.467	0.509	0.547	0.589	0.627	0.668	0.702	0.741	0.773
3.24	0.437	0.468	0.510	0.548	0.590	0.627	0.668	0.701	0.741	0.773
3.25	0.438	0.469	0.511	0.548	0.590	0.627	0.668	0.701	0.741	0.773
3.26	0.439	0.470	0.512	0.549	0.590	0.627	0.668	0.701	0.741	0.773
3.27	0.441	0.471	0.513	0.549	0.591	0.627	0.668	0.701	0.741	0.773
3.28	0.442	0.473	0.514	0.550	0.591	0.628	0.668	0.702	0.740	0.772
3.29	0.444	0.474	0.515	0.550	0.592	0.628	0.669	0.702	0.740	0.772
3.30	0.445	0.475	0.516	0.551	0.592	0.628	0.669	0.702	0.740	0.772
3.31	0.446	0.476	0.517	0.552	0.592	0.628	0.669	0.702	0.740	0.772
3.32	0.447	0.477	0.518	0.553	0.593	0.628	0.669	0.702	0.740	0.772
3.33	0.449	0.479	0.518	0.553	0.593	0.629	0.669	0.702	0.740	0.772
3.34	0.450	0.480	0.519	0.554	0.594	0.629	0.669	0.702	0.740	0.772

T_r										P_r 2.90 - 3.34
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.90
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.91
0.828	0.867	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.92
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.93
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.94
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.95
0.827	0.866	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.96
0.826	0.865	0.897	0.919	0.938	0.962	0.980	0.997	1.011	1.023	2.97
0.826	0.865	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	2.98
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	2.99
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.00
0.825	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.01
0.824	0.864	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.02
0.824	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.03
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.04
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.05
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.06
0.823	0.863	0.896	0.918	0.938	0.962	0.981	0.997	1.012	1.024	3.07
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.08
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.09
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.10
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.11
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.12
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.13
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.14
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.15
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.16
0.822	0.862	0.895	0.917	0.937	0.962	0.981	0.998	1.013	1.025	3.17
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.18
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.19
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.20
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.21
0.821	0.861	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.22
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.23
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.24
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.25
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.26
0.820	0.860	0.894	0.917	0.937	0.962	0.982	0.998	1.014	1.026	3.27
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.28
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.29
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.30
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.31
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.32
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.33
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.34

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
3.35	0.451	0.481	0.520	0.555	0.594	0.629	0.669	0.702	0.740	0.772
3.36	0.452	0.482	0.521	0.556	0.595	0.629	0.669	0.702	0.740	0.772
3.37	0.454	0.484	0.522	0.557	0.595	0.630	0.669	0.702	0.740	0.772
3.38	0.455	0.485	0.523	0.557	0.596	0.630	0.670	0.703	0.739	0.771
3.39	0.457	0.487	0.524	0.558	0.596	0.631	0.670	0.703	0.739	0.771
3.40	0.458	0.488	0.525	0.559	0.597	0.631	0.670	0.703	0.739	0.771
3.41	0.459	0.489	0.526	0.560	0.597	0.631	0.670	0.703	0.739	0.771
3.42	0.460	0.490	0.527	0.560	0.598	0.631	0.670	0.703	0.739	0.771
3.43	0.462	0.492	0.528	0.561	0.598	0.632	0.670	0.703	0.739	0.771
3.44	0.463	0.493	0.529	0.561	0.599	0.632	0.670	0.703	0.739	0.771
3.45	0.464	0.494	0.530	0.562	0.599	0.632	0.670	0.703	0.739	0.771
3.46	0.465	0.495	0.531	0.563	0.600	0.632	0.670	0.703	0.739	0.771
3.47	0.467	0.496	0.532	0.564	0.600	0.632	0.670	0.703	0.739	0.771
3.48	0.468	0.498	0.533	0.564	0.601	0.633	0.670	0.704	0.739	0.771
3.49	0.470	0.499	0.534	0.565	0.601	0.633	0.670	0.704	0.739	0.771
3.50	0.471	0.500	0.535	0.566	0.602	0.633	0.670	0.704	0.739	0.771
3.51	0.472	0.501	0.536	0.567	0.603	0.633	0.670	0.704	0.739	0.771
3.52	0.473	0.502	0.537	0.567	0.603	0.634	0.671	0.704	0.739	0.771
3.53	0.475	0.503	0.537	0.568	0.604	0.634	0.671	0.705	0.739	0.771
3.54	0.476	0.504	0.538	0.568	0.604	0.635	0.672	0.705	0.739	0.771
3.55	0.477	0.505	0.539	0.569	0.605	0.635	0.672	0.705	0.739	0.771
3.56	0.478	0.506	0.540	0.570	0.606	0.635	0.672	0.705	0.739	0.771
3.57	0.479	0.507	0.541	0.570	0.606	0.636	0.672	0.705	0.739	0.771
3.58	0.481	0.509	0.542	0.571	0.607	0.636	0.673	0.706	0.740	0.771
3.59	0.482	0.510	0.543	0.571	0.607	0.637	0.673	0.706	0.740	0.771
3.60	0.483	0.511	0.544	0.572	0.608	0.637	0.673	0.706	0.740	0.771
3.61	0.484	0.512	0.545	0.573	0.609	0.637	0.673	0.706	0.740	0.771
3.62	0.486	0.513	0.546	0.574	0.609	0.638	0.674	0.706	0.740	0.771
3.63	0.487	0.515	0.546	0.575	0.610	0.638	0.674	0.707	0.740	0.771
3.64	0.489	0.516	0.547	0.576	0.610	0.639	0.675	0.707	0.740	0.771
3.65	0.490	0.517	0.548	0.577	0.611	0.639	0.675	0.707	0.740	0.771
3.66	0.491	0.518	0.549	0.578	0.612	0.639	0.675	0.707	0.740	0.771
3.67	0.493	0.519	0.550	0.579	0.612	0.640	0.676	0.707	0.740	0.771
3.68	0.494	0.521	0.551	0.580	0.613	0.640	0.676	0.708	0.741	0.772
3.69	0.496	0.522	0.552	0.581	0.613	0.641	0.677	0.708	0.741	0.772
3.70	0.497	0.523	0.553	0.582	0.614	0.641	0.677	0.708	0.741	0.772
3.71	0.498	0.524	0.554	0.583	0.615	0.641	0.677	0.708	0.741	0.772
3.72	0.499	0.525	0.555	0.583	0.615	0.641	0.677	0.708	0.741	0.772
3.73	0.501	0.527	0.556	0.584	0.616	0.642	0.678	0.709	0.741	0.772
3.74	0.502	0.528	0.557	0.585	0.616	0.642	0.678	0.709	0.741	0.772
3.75	0.503	0.529	0.558	0.586	0.617	0.642	0.678	0.709	0.741	0.772
3.76	0.504	0.530	0.559	0.587	0.618	0.642	0.678	0.709	0.741	0.772
3.77	0.505	0.531	0.560	0.588	0.618	0.643	0.679	0.709	0.741	0.772
3.78	0.507	0.533	0.561	0.588	0.619	0.643	0.679	0.710	0.742	0.773
3.79	0.508	0.534	0.562	0.589	0.619	0.644	0.680	0.710	0.742	0.773

			T_r						P_r 3.35 - 3.79
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.35
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.36
0.819	0.859	0.893	0.916	0.937	0.962	0.982	0.999	1.015	1.027	3.37
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.38
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.39
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.40
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.41
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.028	3.42
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.43
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.44
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.45
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.46
0.818	0.858	0.892	0.916	0.937	0.963	0.983	1.000	1.016	1.029	3.47
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.48
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.49
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.50
0.817	0.858	0.891	0.916	0.937	0.963	0.984	1.000	1.017	1.030	3.51
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.52
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.53
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.54
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.55
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.56
0.817	0.858	0.891	0.915	0.937	0.963	0.984	1.000	1.017	1.030	3.57
0.816	0 857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.58
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.59
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.60
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.61
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.018	1.031	3.62
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.63
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.64
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.65
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.66
0.816	0.857	0.890	0.915	0.937	0.964	0.985	1.001	1.019	1.031	3.67
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.68
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.69
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.70
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.71
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.72
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.73
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.74
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.75
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.76
0.816	0.856	0.890	0.916	0.937	0.965	0.986	1.002	1.019	1.032	3.77
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.78
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.79

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
3.80	0.509	0.535	0.563	0.590	0.620	0.644	0.680	0.710	0.742	0.773
3.81	0.510	0.536	0.564	0.591	0.621	0.644	0.680	0.710	0.742	0.773
3.82	0.511	0.537	0.565	0.592	0.621	0.645	0.680	0.710	0.742	0.773
3.83	0.513	0.539	0.566	0.592	0.622	0.645	0.681	0.711	0.742	0.773
3.84	0.514	0.540	0.567	0.593	0.622	0.646	0.681	0.711	0.742	0.773
3.85	0.515	0.541	0.568	0.594	0.623	0.646	0.681	0.711	0.742	0.773
3.86	0.516	0.542	0.569	0.595	0.624	0.647	0.681	0.711	0.742	0.773
3.87	0.518	0.543	0.570	0.596	0.625	0.647	0.682	0.712	0.742	0.773
3.88	0.519	0.545	0.571	0.597	0.625	0.648	0.682	0.712	0.743	0.774
3.89	0.521	0.546	0.572	0.598	0.626	0.648	0.683	0.713	0.743	0.774
3.90	0.522	0.547	0.573	0.599	0.627	0.649	0.683	0.713	0.743	0.774
3.91	0.523	0.548	0.574	0.600	0.628	0.649	0.683	0.713	0.743	0.774
3.92	0.524	0.549	0.575	0.601	0.628	0.650	0.684	0.713	0.743	0.774
3.93	0.526	0.550	0.575	0.601	0.629	0.650	0.684	0.714	0.744	0.775
3.94	0.527	0.551	0.576	0.602	0.629	0.651	0.685	0.714	0.744	0.775
3.95	0.528	0.552	0.577	0.603	0.630	0.651	0.685	0.714	0.744	0.775
3.96	0.529	0.553	0.578	0.604	0.631	0.651	0.685	0.714	0.744	0.775
3.97	0.530	0.554	0.579	0.605	0.631	0.652	0.686	0.715	0.745	0.775
3.98	0.532	0.556	0.580	0.606	0.632	0.652	0.686	0.715	0.745	0.776
3.99	0.533	0.557	0.581	0.607	0.632	0.653	0.687	0.716	0.746	0.776
4.00	0.534	0.558	0.582	0.608	0.633	0.653	0.687	0.716	0.746	0.776
4.01	0.535	0.559	0.583	0.609	0.634	0.654	0.687	0.716	0.746	0.776
4.02	0.536	0.560	0.584	0.610	0.634	0.654	0.688	0.716	0.746	0.776
4.03	0.538	0.562	0.585	0.610	0.635	0.655	0.688	0.717	0.747	0.777
4.04	0.539	0.563	0.586	0.611	0.635	0.655	0.689	0.717	0.747	0.777
4.05	0.540	0.564	0.587	0.612	0.636	0.656	0.689	0.717	0.747	0.777
4.06	0.541	0.565	0.588	0.613	0.637	0.657	0.690	0.717	0.747	0.777
4.07	0.543	0.566	0.589	0.614	0.638	0.657	0.690	0.718	0.748	0.778
4.08	0.544	0.568	0.590	0.614	0.638	0.658	0.691	0.718	0.748	0.778
4.09	0.546	0.569	0.591	0.615	0.639	0.658	0.691	0.719	0.749	0.779
4.10	0.547	0.570	0.592	0.616	0.640	0.659	0.692	0.719	0.749	0.779
4.11	0.548	0.571	0.593	0.617	0.641	0.660	0.693	0.719	0.749	0.779
4.12	0.549	0.572	0.594	0.618	0.642	0.660	0.693	0.719	0,749	0.779
4.13	0.551	0.573	0.594	0.618	0.642	0.661	0.694	0.720	0.750	0.780
4.14	0.552	0.574	0.595	0.619	0.643	0.661	0.694	0.720	0.750	0.780
4.15	0.553	0.575	0.596	0.620	0.644	0.662	0.694	0.720	0.750	0.780
4.16	0.554	0.576	0.597	0.621	0.645	0.663	0.695	0.720	0.750	0.780
4.17	0.556	0.577	0.598	0.622	0.646	0.663	0.696	0.721	0.751	0.780
4.18	0.557	0.579	0.599	0.622	0.646	0.664	0.696	0.721	0.751	0.781
4.19	0.559	0.580	0.600	0.623	0.647	0.664	0.697	0.722	0.752	0.781
4.20	0.560	0.581	0.601	0.624	0.648	0.665	0.697	0.722	0.752	0.781
4.21	0.561	0.582	0.602	0.625	0.649	0.666	0.697	0.722	0.752	0.781
4.22	0.562	0.583	0.603	0.626	0.649	0.666	0.698	0.723	0.752	0.781
4.23	0.564	0.585	0.604	0.626	0.650	0.667	0.698	0.723	0.753	0.782
4.24	0.565	0.586	0.605	0.627	0.650	0.667	0.699	0.724	0.753	0.782

T_r										P_r 3.80 - 4.24
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.80
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.81
0.816	0.855	0.891	0.916	0.937	0.966	0.987	1.003	1.020	1.033	3.82
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.83
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.84
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.85
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.86
0.816	0.855	0.891	0.916	0.937	0.966	0.988	1.004	1.021	1.033	3.87
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.88
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.89
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.90
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.91
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.005	1.022	1.034	3.92
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.93
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.94
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.95
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.96
0.817	0.855	0.891	0.917	0.938	0.967	0.989	1.006	1.022	1.034	3.97
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	3.98
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	3.99
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.00
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.01
0.818	0.856	0.892	0.917	0.939	0.968	0.990	1.007	1.023	1.035	4.02
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.03
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.04
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.05
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.06
0.819	0.856	0.892	0.917	0.939	0.968	0.991	1.008	1.023	1.035	4.07
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.08
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.09
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.10
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.11
0.820	0.857	0.893	0.918	0.940	0.969	0.992	1.009	1.024	1.036	4.12
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.13
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.14
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.15
0.821	0.857	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.16
0.821	0.858	0.894	0.918	0.940	0.970	0.993	1.010	1.025	1.036	4.17
0.822	0.858	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.18
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.19
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.20
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.21
0.822	0.859	0.895	0.919	0.941	0.971	0.994	1.011	1.026	1.037	4.22
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.23
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.24

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
4.25	0.566	0.587	0.606	0.628	0.651	0.668	0.699	0.724	0.753	0.782
4.26	0.567	0.588	0.607	0.629	0.652	0.669	0.699	0.724	0.753	0.782
4.27	0.568	0.589	0.608	0.630	0.653	0.669	0.700	0.725	0.754	0.783
4.28	0.570	0.591	0.609	0.630	0.653	0.670	0.700	0.725	0.754	0.783
4.29	0.571	0.592	0.610	0.631	0.654	0.670	0.701	0.726	0.755	0.784
4.30	0.572	0.593	0.611	0.632	0.655	0.671	0.701	0.726	0.755	0.784
4.31	0.573	0.594	0.612	0.633	0.656	0.672	0.701	0.726	0.755	0.784
4.32	0.575	0.595	0.613	0.634	0.656	0.672	0.702	0.727	0.756	0.784
4.33	0.576	0.596	0.614	0.634	0.657	0.673	0.702	0.727	0.756	0.785
4.34	0.578	0.597	0.615	0.635	0.657	0.673	0.703	0.728	0.757	0.785
4.35	0.579	0.598	0.616	0.636	0.658	0.674	0.703	0.728	0.757	0.785
4.36	0.580	0.599	0.617	0.637	0.659	0.675	0.704	0.728	0.757	0.785
4.37	0.582	0.600	0.618	0.638	0.660	0.676	0.704	0.729	0.758	0.786
4.38	0.583	0.602	0.619	0.639	0.660	0.676	0.705	0.729	0.758	0.786
4.39	0.585	0.603	0.620	0.640	0.661	0.677	0.705	0.730	0.759	0.787
4.40	0.586	0.604	0.621	0.641	0.662	0.678	0.706	0.730	0.759	0.787
4.41	0.587	0.605	0.622	0.642	0.663	0.678	0.707	0.730	0.759	0.787
4.42	0.588	0.606	0.623	0.643	0.664	0.679	0.707	0.731	0.760	0.787
4.43	0.590	0.608	0.624	0.643	0.664	0.679	0.708	0.731	0.760	0.788
4.44	0.591	0.609	0.625	0.644	0.665	0.680	0.708	0.732	0.761	0.788
4.45	0.592	0.610	0.626	0.645	0.666	0.680	0.709	0.732	0.761	0.788
4.46	0.593	0.611	0.627	0.646	0.667	0.681	0.710	0.732	0.761	0.788
4.47	0.595	0.612	0.628	0.647	0.668	0.681	0.710	0.733	0.762	0.789
4.48	0.596	0.614	0.629	0.648	0.668	0.682	0.711	0.734	0.762	0.789
4.49	0.598	0.615	0.630	0.649	0.669	0.682	0.711	0.734	0.763	0.790
4.50	0.599	0.616	0.631	0.650	0.670	0.683	0.712	0.734	0.763	0.790
4.51	0.600	0.617	0.632	0.651	0.671	0.684	0.713	0.734	0.763	0.790
4.52	0.601	0.618	0.633	0.652	0.671	0.685	0.713	0.735	0.764	0.791
4.53	0.603	0.619	0.634	0.652	0.672	0.685	0.714	0.735	0.764	0.791
4.54	0.604	0.620	0.635	0.653	0.672	0.686	0.714	0.735	0.764	0.791
4.55	0.605	0.621	0.636	0.654	0.673	0.687	0.715	0.736	0.765	0.792
4.56	0.606	0.622	0.637	0.655	0.674	0.688	0.716	0.737	0.766	0.792
4.57	0.608	0.623	0.638	0.656	0.675	0.689	0.716	0.737	0.766	0.793
4.58	0.609	0.625	0.639	0.657	0.675	0.689	0.717	0.738	0.767	0.793
4.59	0.611	0.626	0.640	0.658	0.676	0.690	0.717	0.738	0.767	0.794
4.60	0.612	0.627	0.641	0.659	0.677	0.691	0.718	0.739	0.768	0.794
4.61	0.613	0.628	0.642	0.660	0.678	0.692	0.718	0.739	0.768	0.794
4.62	0.614	0.629	0.643	0.661	0.679	0.692	0.719	0.740	0.769	0.795
4.63	0.615	0.631	0.644	0.661	0.679	0.693	0.719	0.740	0.769	0.795
4.64	0.616	0.632	0.645	0.662	0.680	0.693	0.720	0.741	0.770	0.796
4.65	0.617	0.633	0.646	0.663	0.681	0.694	0.720	0.741	0.770	0.796
4.66	0.618	0.634	0.647	0.664	0.682	0.695	0.721	0.741	0.770	0.796
4.67	0.619	0.635	0.648	0.665	0.683	0.696	0.721	0.742	0.771	0.797
4.68	0.621	0.637	0.649	0.666	0.683	0.696	0.722	0.742	0.771	0.797
4.69	0.622	0.638	0.650	0.667	0.684	0.697	0.722	0.743	0.772	0.798

T_r										P_r 4.25 - 4.69
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.25
0.823	0.859	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.26
0.823	0.860	0.896	0.919	0.941	0.972	0.995	1.012	1.026	1.037	4.27
0.824	0.860	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.28
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.29
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.30
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.31
0.824	0.861	0.897	0.920	0.942	0.973	0.996	1.013	1.027	1.038	4.32
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.33
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.34
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.35
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.36
0.825	0.861	0.897	0.921	0.942	0.973	0.997	1.013	1.028	1.039	4.37
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.38
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.39
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.40
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.41
0.826	0.862	0.898	0.922	0.943	0.974	0.998	1.014	1.029	1.040	4.42
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.43
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.44
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.45
0.827	0.862	0.899	0.922	0.943	0.975	0.999	1.015	1.029	1.040	4.46
0.828	0.863	0.899	0.922	0.943	0.976	0.999	1.015	1.029	1.040	4.47
0.828	0.863	0.900	0.923	0.944	0.976	1.000	1.016	1.030	1.041	4.48
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.49
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.50
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.51
0.829	0.864	0.900	0.923	0.944	0.977	1.000	1.016	1.030	1.041	4.52
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.53
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.54
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.55
0.830	0.865	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.56
0.831	0.866	0.901	0.924	0.945	0.977	1.001	1.017	1.031	1.042	4.57
0.831	0.866	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.58
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.59
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.60
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.61
0.832	0.867	0.902	0.925	0.946	0.978	1.002	1.018	1.032	1.043	4.62
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.63
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.64
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.65
0.833	0.868	0.903	0.926	0.947	0.979	1.003	1.019	1.033	1.043	4.66
0.834	0.868	0.903	0.926	0.947	0.980	1.003	1.019	1.033	1.043	4.67
0.834	0.869	0.904	0.927	0.948	0.980	1.004	1.020	1.034	1.044	4.68
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.69

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
4.70	0.623	0.639	0.651	0.668	0.685	0.698	0.723	0.743	0.772	0.798
4.71	0.624	0.640	0.652	0.669	0.686	0.699	0.724	0.744	0.772	0.798
4.72	0.626	0.641	0.653	0.670	0.687	0.699	0.724	0.744	0.773	0.799
4.73	0.627	0.642	0.653	0.670	0.687	0.700	0.725	0.745	0.773	0.799
4.74	0.629	0.643	0.654	0.671	0.688	0.700	0.725	0.745	0.774	0.800
4.75	0.630	0.644	0.655	0.672	0.689	0.701	0.726	0.746	0.774	0.800
4.76	0.631	0.645	0.656	0.673	0.690	0.702	0.727	0.747	0.775	0.800
4.77	0.633	0.646	0.658	0.674	0.691	0.703	0.727	0.747	0.775	0.801
4.78	0.634	0.648	0.659	0.675	0.691	0.703	0.728	0.748	0.776	0.801
4.79	0.636	0.649	0.661	0.676	0.692	0.704	0.728	0.748	0.776	0.802
4.80	0.637	0.650	0.662	0.677	0.693	0.705	0.729	0.749	0.777	0.802
4.81	0.638	0.651	0.663	0.678	0.694	0.706	0.730	0.749	0.777	0.802
4.82	0.639	0.652	0.664	0.679	0.695	0.706	0.730	0.750	0.778	0.803
4.83	0.641	0.653	0.665	0.679	0.695	0.707	0.731	0.750	0.778	0.803
4.84	0.642	0.654	0.666	0.680	0.696	0.707	0.731	0.751	0.779	0.804
4.85	0.643	0.655	0.667	0.681	0.697	0.708	0.732	0.751	0.779	0.804
4.86	0.644	0.656	0.668	0.682	0.698	0.709	0.733	0.751	0.780	0.804
4.87	0.646	0.657	0.669	0.683	0.699	0.710	0.734	0.752	0.780	0.805
4.88	0.647	0.659	0.670	0.684	0.699	0.710	0.734	0.752	0.781	0.805
4.89	0.649	0.660	0.671	0.685	0.700	0.711	0.735	0.753	0.781	0.806
4.90	0.650	0.661	0.672	0.686	0.701	0.712	0.736	0.753	0.782	0.806
4.91	0.651	0.662	0.673	0.687	0.702	0.713	0.737	0.754	0.782	0.806
4.92	0.652	0.663	0.674	0.688	0.703	0.714	0.737	0.754	0.783	0.807
4.93	0.654	0.664	0.675	0.688	0.703	0.714	0.738	0.755	0.783	0.807
4.94	0.655	0.665	0.676	0.689	0.704	0.715	0.738	0.755	0.784	0.808
4.95	0.656	0.666	0.677	0.690	0.705	0.716	0.739	0.756	0.784	0.808
4.96	0.657	0.667	0.678	0.691	0.706	0.717	0.740	0.757	0.785	0.808
4.97	0.659	0.668	0.679	0.692	0.707	0.718	0.740	0.758	0.785	0.809
4.98	0.660	0.670	0.681	0.692	0.707	0.718	0.741	0.758	0.786	0.809
4.99	0.662	0.671	0.682	0.693	0.708	0.719	0.741	0.759	0.786	0.810
5.00	0.663	0.672	0.683	0.694	0.709	0.720	0.742	0.760	0.787	0.810
5.01	0.664	0.673	0.684	0.695	0.710	0.721	0.743	0.761	0.787	0.810
5.02	0.665	0.674	0.685	0.696	0.711	0.721	0.743	0.761	0.788	0.811
5.03	0.667	0.675	0.686	0.696	0.711	0.722	0.744	0.762	0.788	0.811
5.04	0.668	0.676	0.687	0.697	0.712	0.722	0.744	0.762	0.789	0.812
5.05	0.669	0.677	0.688	0.698	0.713	0.723	0.745	0.763	0.789	0.812
5.06	0.670	0.678	0.689	0.699	0.714	0.724	0.746	0.764	0.790	0.812
5.07	0.671	0.679	0.690	0.700	0.715	0.725	0.747	0.764	0.790	0.813
5.08	0.673	0.681	0.691	0.701	0.715	0.725	0.747	0.765	0.791	0.813
5.09	0.674	0.682	0.692	0.702	0.716	0.726	0.748	0.765	0.791	0.814
5.10	0.675	0.683	0.693	0.703	0.717	0.727	0.749	0.766	0.792	0.814
5.11	0.676	0.684	0.694	0.704	0.718	0.728	0.750	0.767	0.793	0.815
5.12	0.677	0.685	0.695	0.705	0.719	0.729	0.750	0.767	0.793	0.815
5.13	0.679	0.687	0.696	0.706	0.719	0.729	0.751	0.768	0.794	0.816
5.14	0.680	0.688	0.697	0.707	0.720	0.730	0.751	0.768	0.794	0.816

T_r										P_r 4.70 - 5.14
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.70
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.71
0.835	0.869	0.904	0.927	0.948	0.981	1.004	1.020	1.034	1.044	4.72
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.73
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.74
0.836	0.870	0.905	0.928	0.949	0.982	1.005	1.021	1.035	1.045	4.75
0.836	0.870	0.905	0.928	0.949	0.982	1.006	1.021	1.035	1.045	4.76
0.837	0.871	0.906	0.928	0.950	0.983	1.006	1.022	1.036	1.046	4.77
0.837	0.871	0.906	0.929	0.950	0.983	1.006	1.022	1.036	1.046	4.78
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.79
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.80
0.838	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.81
0.839	0.872	0.907	0.929	0.950	0.983	1.007	1.022	1.036	1.046	4.82
0.839	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.83
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.84
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.85
0.840	0.873	0.908	0.930	0.951	0.984	1.008	1.023	1.037	1.047	4.86
0.841	0.874	0.909	0.931	0.951	0.984	1.008	1.023	1.037	1.047	4.87
0.841	0.874	0.909	0.931	0.951	0.984	1.009	1.024	1.038	1.048	4.88
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.89
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.90
0.842	0.875	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.91
0.843	0.876	0.910	0.932	0.952	0.985	1.009	1.024	1.038	1.048	4.92
0.843	0.876	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.93
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.94
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.95
0.844	0.877	0.911	0.933	0.953	0.986	1.010	1.025	1.038	1.048	4.96
0.845	0.878	0.911	0.933	0.953	0.987	1.010	1.026	1.038	1.048	4.97
0.845	0.878	0.912	0.934	0.954	0.987	1.011	1.026	1.039	1.049	4.98
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	4.99
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.00
0.846	0.879	0.912	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.01
0.847	0.879	0.913	0.934	0.954	0.988	1.011	1.027	1.039	1.049	5.02
0.847	0.880	0.913	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.03
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.04
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.05
0.848	0.880	0.914	0.935	0.955	0.989	1.012	1.028	1.040	1.050	5.06
0.849	0.881	0.915	0.936	0.956	0.989	1.012	1.028	1.040	1.050	5.07
0.849	0.881	0.915	0.936	0.956	0.990	1.013	1.029	1.041	1.050	5.08
0.850	0.882	0.915	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.09
0.850	0.882	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.10
0.850	0.882	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.11
0.850	0.883	0.916	0.937	0.957	0.990	1.013	1.029	1.041	1.051	5.12
0.851	0.883	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.13
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.14

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
5.15	0.681	0.689	0.698	0.708	0.721	0.731	0.752	0.769	0.795	0.817
5.16	0.682	0.690	0.699	0.709	0.722	0.732	0.753	0.770	0.796	0.818
5.17	0.684	0.691	0.700	0.710	0.723	0.733	0.753	0.770	0.796	0.818
5.18	0.685	0.693	0.701	0.711	0.723	0.733	0.754	0.771	0.797	0.819
5.19	0.687	0.694	0.702	0.712	0.724	0.734	0.754	0.771	0.797	0.819
5.20	0.688	0.695	0.703	0.713	0.725	0.735	0.755	0.772	0.798	0.820
5.21	0.689	0.696	0.704	0.714	0.726	0.736	0.756	0.773	0.798	0.820
5.22	0.690	0.697	0.705	0.715	0.727	0.737	0.756	0.773	0.799	0.821
5.23	0.692	0.698	0.706	0.715	0.727	0.737	0.757	0.774	0.799	0.821
5.24	0.693	0.699	0.707	0.716	0.728	0.738	0.757	0.774	0.800	0.822
5.25	0.694	0.700	0.708	0.717	0.729	0.739	0.758	0.775	0.800	0.822
5.26	0.695	0.701	0.709	0.718	0.730	0.740	0.759	0.776	0.801	0.823
5.27	0.697	0.702	0.710	0.719	0.731	0.741	0.760	0.776	0.801	0.823
5.28	0.698	0.704	0.711	0.720	0.732	0.741	0.760	0.777	0.802	0.824
5.29	0.700	0.705	0.712	0.721	0.733	0.742	0.761	0.777	0.802	0.824
5.30	0.701	0.706	0.713	0.722	0.734	0.743	0.762	0.778	0.803	0.825
5.31	0.702	0.707	0.714	0.723	0.735	0.744	0.763	0.779	0.804	0.825
5.32	0.703	0.708	0.715	0.724	0.736	0.745	0.763	0.779	0.804	0.826
5.33	0.705	0.710	0.716	0.724	0.736	0.745	0.764	0.780	0.805	0.826
5.34	0.706	0.711	0.717	0.725	0.737	0.746	0.764	0.780	0.805	0.827
5.35	0.707	0.712	0.718	0.726	0.738	0.747	0.765	0.781	0.806	0.827
5.36	0.708	0.713	0.719	0.727	0.739	0.748	0.766	0.782	0.807	0.828
5.37	0.709	0.714	0.720	0.728	0.740	0.749	0.767	0.783	0.807	0.828
5.38	0.711	0.716	0.721	0.729	0.740	0.749	0.767	0.783	0.808	0.829
5.39	0.712	0.717	0.722	0.730	0.741	0.750	0.768	0.784	0.808	0.829
5.40	0.713	0.718	0.723	0.731	0.742	0.751	0.769	0.785	0.809	0.830
5.41	0.714	0.719	0.724	0.732	0.743	0.752	0.770	0.786	0.810	0.830
5.42	0.716	0.720	0.725	0.733	0.744	0.753	0.770	0.786	0.810	0.831
5.43	0.717	0.721	0.726	0.733	0.744	0.753	0.771	0.787	0.811	0.831
5.44	0.719	0.722	0.727	0.734	0.745	0.754	0.771	0.787	0.811	0.832
5.45	0.720	0.723	0.728	0.735	0.746	0.755	0.772	0.788	0.812	0.832
5.46	0.721	0.724	0.729	0.736	0.747	0.756	0.773	0.789	0.813	0.333
5.47	0.723	0.725	0.730	0.737	0.748	9.757	0.774	0.790	0.813	0.833
5.48	0.724	0.727	0.731	0.738	0.749	0.757	0.774	0.790	0.814	0.834
5.49	0.726	0.728	0.732	0.739	0.750	0.758	0.775	0.791	0.814	0.834
5.50	0.727	0.729	0.733	0.740	0.751	0.759	0.776	0.792	0.815	0.835
5.51	0.728	0.730	0.734	0.741	0.752	0.760	0.777	0.793	0.816	0.836
5.52	0.729	0.731	0.735	0.742	0.753	0.761	0.777	0.793	0.816	0.837
5.53	0.731	0.732	0.736	0.743	0.753	0.761	0.778	0.794	0.817	0.837
5.54	0.732	0.733	0.737	0.744	0.754	0.762	0.778	0.794	0.817	0.838
5.55	0.733	0.734	0.738	0.745	0.755	0.763	0.779	0.795	0.818	0.837
5.56	0.734	0.735	0.739	0.746	0.756	0.764	0.780	0.796	0.819	0.838
5.57	0.735	0.736	0.740	0.747	0.757	0.765	0.781	0.797	0.819	0.838
5.58	0.737	0.738	0.742	0.748	0.758	0.766	0.781	0.797	0.820	0.839
5.59	0.738	0.739	0.743	0.749	0.759	0.767	0.782	0.798	0.820	0.839

T_r										P_r 5.15 - 5.59
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.15
0.851	0.884	0.917	0.938	0.958	0.991	1.014	1.030	1.042	1.051	5.16
0.852	0.885	0.918	0.939	0.959	0.991	1.015	1.030	1.042	1.051	5.17
0.852	0.885	0.918	0.939	0.959	0.992	1.015	1.031	1.043	1.052	5.18
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.19
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.20
0.853	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.21
0.854	0.886	0.919	0.940	0.960	0.992	1.016	1.031	1.043	1.052	5.22
0.854	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.23
0.855	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.24
0.855	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.25
0.856	0.887	0.920	0.941	0.961	0.993	1.017	1.032	1.044	1.052	5.26
0.856	0.888	0.920	0.942	0.962	0.994	1.017	1.032	1.044	1.052	5.27
0.857	0.888	0.921	0.942	0.962	0.994	1.018	1.033	1.045	1.053	5.28
0.857	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.29
0.858	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.30
0.858	0.889	0.921	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.31
0.859	0.890	0.922	0.943	0.963	0.995	1.018	1.033	1.045	1.053	5.32
0.859	0.890	0.922	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.33
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.34
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.35
0.860	0.891	0.923	0.944	0.964	0.996	1.019	1.034	1.046	1.053	5.36
0.861	0.892	0.924	0.945	0.965	0.997	1.020	1.034	1.046	1.054	5.37
0.861	0.892	0.924	0.945	0.965	0.997	1.020	1.035	1.047	1.054	5.38
0.862	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.39
0.862	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.40
0.863	0.893	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.41
0.863	0.894	0.925	0.946	0.966	0.998	1.021	1.035	1.047	1.055	5.42
0.864	0.894	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.43
0.864	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.44
0.865	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.45
0.866	0.895	0.926	0.947	0.967	0.999	1.022	1.036	1.048	1.056	5.46
0.866	0.896	0.927	0.948	0.968	0.999	1.022	1.037	1.048	1.056	5.47
0.867	0.896	0.927	0.948	0.968	1.000	1.023	1.037	1.049	1.057	5.48
0.867	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.49
0.868	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.50
0.868	0.897	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.51
0.869	0.898	0.928	0.949	0.969	1.000	1.023	1.038	1.049	1.057	5.52
0.869	0.898	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.53
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.54
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.55
0.870	0.899	0.929	0.950	0.970	1.001	1.024	1.039	1.050	1.058	5.56
0.871	0.899	0.930	0.951	0.971	1.002	1.025	1.039	1.050	1.058	5.57
0.871	0.900	0.930	0.951	0.971	1.002	1.025	1.040	1.051	1.058	5.58
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.59

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
5.60	0.739	0.740	0.744	0.750	0.760	0.768	0.783	0.799	0.821	0.840
5.61	0.740	0.741	0.745	0.751	0.761	0.769	0.784	0.800	0.822	0.841
5.62	0.741	0.742	0.746	0.752	0.762	0.770	0.785	0.800	0.822	0.841
5.63	0.743	0.743	0.747	0.753	0.762	0.770	0.785	0.801	0.823	0.842
5.64	0.744	0.744	0.748	0.754	0.763	0.771	0.786	0.801	0.823	0.842
5.65	0.745	0.745	0.749	0.755	0.764	0.772	0.787	0.802	0.824	0.843
5.66	0.746	0.746	0.750	0.756	0.765	0.773	0.788	0.803	0.825	0.844
5.67	0.747	0.747	0.751	0.757	0.766	0.774	0.789	0.804	0.825	0.844
5.68	0.749	0.749	0.752	0.758	0.767	0.775	0.789	0.804	0.826	0.845
5.69	0.750	0.750	0.753	0.759	0.768	0.776	0.790	0.805	0.826	0.845
5.70	0.751	0.751	0.754	0.760	0.769	0.777	0.791	0.806	0.827	0.846
5.71	0.752	0.752	0.755	0.761	0.770	0.778	0.792	0.807	0.828	0.846
5.72	0.753	0.753	0.756	0.762	0.771	0.779	0.793	0.807	0.828	0.847
5.73	0.755	0.754	0.757	0.762	0.771	0.779	0.793	0.808	0.829	0.847
5.74	0.756	0.755	0.758	0.763	0.772	0.780	0.794	0.808	0.829	0.848
5.75	0.757	0.756	0.759	0.764	0.773	0.781	0.795	0.809	0.830	0.848
5.76	0.758	0.757	0.760	0.765	0.774	0.782	0.796	0.810	0.831	0.849
5.77	0.759	0.758	0.761	0.766	0.775	0.783	0.797	0.811	0.831	0.849
5.78	0.761	0.760	0.762	0.767	0.776	0.783	0.797	0.811	0.832	0.850
5.79	0.762	0.761	0.763	0.768	0.777	0.784	0.798	0.812	0.832	0.850
5.80	0.763	0.762	0.764	0.769	0.778	0.785	0.799	0.813	0.833	0.851
5.81	0.764	0.763	0.765	0.770	0.779	0.786	0.800	0.814	0.834	0.852
5.82	0.765	0.764	0.766	0.771	0.780	0.787	0.801	0.815	0.834	0.852
5.83	0.767	0.766	0.768	0.772	0.780	0.787	0.801	0.815	0.835	0.853
5.84	0.768	0.767	0.769	0.773	0.781	0.788	0.802	0.816	0.835	0.853
5.85	0.769	0.768	0.770	0.774	0.782	0.789	0.803	0.817	0.836	0.854
5.86	0.770	0.769	0.771	0.775	0.783	0.790	0.804	0.818	0.837	0.855
5.87	0.771	0.770	0.773	0.776	0.784	0.791	0.805	0.819	0.837	0.855
5.88	0.773	0.772	0.774	0.777	0.785	0.792	0.805	0.819	0.838	0.856
5.89	0.774	0.773	0.776	0.778	0.786	0.793	0.806	0.820	0.838	0.856
5.90	0.775	0.774	0.777	0.779	0.787	0.794	0.807	0.821	0.839	0.857
5.91	0.776	0.775	0.778	0.780	0.788	0.795	0.808	0.822	0.840	0.858
5.92	0.777	0.776	0.779	0.781	0.789	0.796	0.808	0.822	0.840	0.858
5.93	0.779	0.777	0.780	0.782	0.790	0.796	0.809	0.823	0.841	0.859
5.94	0.780	0.778	0.781	0.783	0.791	0.797	0.809	0.823	0.841	0.859
5.95	0.781	0.779	0.782	0.784	0.792	0.798	0.810	0.824	0.842	0.860
5.96	0.782	0.780	0.783	0.785	0.793	0.799	0.811	0.825	0.843	0.861
5.97	0.784	0.781	0.784	0.786	0.794	0.800	0.812	0.826	0.843	0.861
5.98	0.785	0.783	0.785	0.788	0.795	0.801	0.812	0.826	0.844	0.862
5.99	0.787	0.784	0.786	0.789	0.796	0.802	0.813	0.827	0.844	0.862
6.00	0.788	0.785	0.787	0.790	0.797	0.803	0.814	0.828	0.845	0.863
6.01	0.789	0.786	0.788	0.791	0.798	0.804	0.815	0.829	0.846	0.864
6.02	0.790	0.787	0.789	0.792	0.799	0.805	0.816	0.829	0.846	0.864
6.03	0.792	0.788	0.790	0.793	0.799	0.805	0.816	0.830	0.847	0.865
6.04	0.793	0.789	0.791	0.794	0.800	0.806	0.817	0.830	0.847	0.865

T_r										P_r 5.60 - 6.04
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.60
0.872	0.900	0.931	0.952	0.972	1.003	1.026	1.040	1.051	1.058	5.61
0.873	0.901	0.932	0.952	0.973	1.003	1.026	1.040	1.051	1.058	5.62
0.873	0.901	0.932	0.953	0.973	1.004	1.027	1.041	1.052	1.059	5.63
0.874	0.902	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.64
0.874	0.902	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.65
0.875	0.903	0.933	0.953	0.974	1.004	1.027	1.041	1.052	1.059	5.66
0.875	0.903	0.934	0.954	0.975	1.005	1.027	1.041	1.052	1.059	5.67
0.876	0.904	0.934	0.954	0.975	1.005	1.028	1.042	1.053	1.060	5.68
0.876	0.904	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.69
0.877	0.905	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.70
0.877	0.905	0.935	0.955	0.976	1.006	1.028	1.042	1.053	1.060	5.71
0.878	0.906	0.936	0.956	0.976	1.006	1.028	1.042	1.053	1.060	5.72
0.878	0.906	0.936	0.956	0.977	1.007	1.029	1.043	1.054	1.061	5.73
0.879	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.74
0.879	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.75
0.880	0.907	0.937	0.957	0.977	1.007	1.029	1.043	1.054	1.061	5.76
0.880	0.908	0.938	0.958	0.978	1.007	1.030	1.044	1.054	1.061	5.77
0.881	0.908	0.938	0.958	0.978	1.008	1.030	1.044	1.055	1.062	5.78
0.881	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5.79
0.882	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5.80
0.882	0.909	0.939	0.959	0.979	1.008	1.031	1.045	1.055	1.062	5.81
0.883	0.910	0.939	0.960	0.979	1.008	1.031	1.045	1.055	1.062	5.82
0.883	0.910	0.940	0.960	0.980	1.009	1.032	1.046	1.056	1.063	5.83
0.884	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.84
0.884	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.85
0.885	0.911	0.940	0.961	0.980	1.009	1.032	1.046	1.056	1.063	5.86
0.885	0.912	0.941	0.962	0.981	1.010	1.032	1.047	1.056	1.063	5.87
0.886	0.912	0.941	0.962	0.981	1.010	1.033	1.047	1.057	1.064	5.88
0.886	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.89
0.887	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.90
0.887	0.913	0.942	0.963	0.982	1.011	1.033	1.048	1.057	1.064	5.91
0.888	0.914	0.943	0.964	0.983	1.011	1.033	1.048	1.057	1.064	5.92
0.888	0.914	0.943	0.964	0.983	1.012	1.034	1.049	1.058	1.065	5.93
0.889	0.915	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.94
0.889	0.915	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.95
0.890	0.916	0.944	0.965	0.984	1.012	1.034	1.049	1.058	1.065	5.96
0.890	0.916	0.945	0.966	0.985	1.012	1.035	1.049	1.058	1.065	5.97
0.891	0.917	0.945	0.966	0.985	1.013	1.035	1.050	1.059	1.066	5.98
0.891	0.917	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	5.99
0.892	0.918	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	6.00
0.892	0.918	0.946	0.967	0.986	1.013	1.036	1.050	1.059	1.066	6.01
0.893	0.919	0.947	0.967	0.986	1.014	1.036	1.050	1.059	1.066	6.02
0.893	0.919	0.947	0.968	0.987	1.014	1.037	1.051	1.060	1.067	6.03
0.894	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.04

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.05	0.794	0.790	0.792	0.795	0.801	0.807	0.818	0.831	0.848	0.865
6.06	0.795	0.791	0.793	0.796	0.802	0.808	0.819	0.832	0.849	0.866
6.07	0.796	0.792	0.794	0.797	0.803	0.809	0.820	0.833	0.850	0.866
6.08	0.798	0.794	0.795	0.798	0.803	0.810	0.820	0.833	0.850	0.867
6.09	0.799	0.795	0.796	0.799	0.804	0.811	0.821	0.834	0.851	0.867
6.10	0.800	0.796	0.797	0.800	0.805	0.812	0.822	0.835	0.852	0.868
6.11	0.801	0.797	0.798	0.801	0.806	0.813	0.823	0.836	0.853	0.868
6.12	0.802	0.798	0.799	0.802	0.807	0.814	0.824	0.836	0.853	0.869
6.13	0.803	0.799	0.800	0.803	0.807	0.814	0.824	0.837	0.854	0.869
6.14	0.804	0.800	0.801	0.804	0.808	0.815	0.825	0.837	0.854	0.870
6.15	0.805	0.801	0.802	0.805	0.809	0.816	0.826	0.838	0.855	0.870
6.16	0.806	0.802	0.803	0.806	0.810	0.817	0.827	0.839	0.856	0.871
6.17	0.807	0.803	0.804	0.807	0.811	0.818	0.828	0.840	0.856	0.871
6.18	0.809	0.805	0.806	0.808	0.812	0.818	0.828	0.840	0.857	0.872
6.19	0.810	0.806	0.807	0.809	0.813	0.819	0.829	0.841	0.857	0.872
6.20	0.811	0.807	0.808	0.810	0.814	0.820	0.830	0.842	0.858	0.873
6.21	0.812	0.808	0.809	0.811	0.815	0.821	0.831	0.843	0.859	0.874
6.22	0.813	0.809	0.810	0.812	0.816	0.822	0.832	0.844	0.859	0.874
6.23	0.814	0.810	0.811	0.813	0.816	0.822	0.832	0.844	0.860	0.875
6.24	0.815	0.811	0.812	0.814	0.817	0.823	0.833	0.845	0.860	0.875
6.25	0.816	0.812	0.813	0.815	0.818	0.824	0.834	0.846	0.861	0.876
6.26	0.817	0.813	0.814	0.816	0.819	0.825	0.835	0.847	0.862	0.877
6.27	0.818	0.814	0.815	0.817	0.820	0.826	0.836	0.848	0.862	0.878
6.28	0.820	0.816	0.816	0.818	0.821	0.827	0.837	0.848	0.863	0.878
6.29	0.821	0.817	0.817	0.819	0.822	0.828	0.838	0.849	0.863	0.879
6.30	0.822	0.818	0.818	0.820	0.823	0.829	0.839	0.850	0.864	0.880
6.31	0.823	0.819	0.819	0.821	0.824	0.830	0.840	0.851	0.865	0.881
6.32	0.825	0.820	0.820	0.822	0.825	0.831	0.841	0.851	0.865	0.881
6.33	0.826	0.822	0.821	0.823	0.826	0.831	0.841	0.852	0.866	0.882
6.34	0.828	0.823	0.822	0.824	0.827	0.832	0.842	0.852	0.866	0.882
6.35	0.829	0.824	0.823	0.825	0.828	0.833	0.843	0.853	0.867	0.883
6.36	0.830	0.825	0.824	0.826	0.829	0.834	0.844	0.854	0.868	0.884
6.37	0.831	0.826	0.825	0.827	0.830	0.835	0.845	0.855	0.869	0.884
6.38	0.833	0.828	0.827	0.828	0.831	0.836	0.846	0.855	0.869	0.885
6.39	0.834	0.829	0.828	0.829	0.832	0.837	0.847	0.856	0.870	0.885
6.40	0.835	0.830	0.829	0.830	0.833	0.838	0.848	0.857	0.871	0.886
6.41	0.836	0.831	0.830	0.831	0.834	0.839	0.849	0.858	0.872	0.887
6.42	0.837	0.832	0.831	0.832	0.835	0.840	0.850	0.859	0.872	0.887
6.43	0.839	0.833	0.832	0.833	0.835	0.840	0.850	0.859	0.873	0.888
6.44	0.840	0.834	0.833	0.834	0.836	0.841	0.851	0.860	0.873	0.888
6.45	0.841	0.835	0.834	0.835	0.837	0.842	0.852	0.861	0.874	0.889
6.46	0.842	0.836	0.835	0.836	0.838	0.843	0.853	0.862	0.875	0.890
6.47	0.844	0.837	0.836	0.837	0.839	0.844	0.854	0.863	0.876	0.890
6.48	0.845	0.839	0.837	0.838	0.840	0.845	0.854	0.863	0.876	0.891
6.49	0.847	0.840	0.838	0.839	0.841	0.846	0.855	0.864	0.877	0.891

T_r | P_r 6.05 - 6.49

1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.894	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.05
0.895	0.920	0.948	0.968	0.987	1.015	1.037	1.051	1.060	1.067	6.06
0.895	0.921	0.949	0.969	0.988	1.016	1.037	1.051	1.060	1.067	6.07
0.896	0.921	0.949	0.969	0.988	1.016	1.038	1.052	1.061	1.068	6.08
0.896	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.09
0.897	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.10
0.897	0.922	0.950	0.970	0.989	1.017	1.038	1.052	1.061	1.068	6.11
0.898	0.923	0.951	0.970	0.990	1.017	1.038	1.052	1.061	1.068	6.12
0.898	0.923	0.951	0.971	0.990	1.018	1.039	1.052	1.062	1.069	6.13
0.899	0.924	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.14
0.899	0.924	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.15
0.900	0.925	0.952	0.971	0.991	1.018	1.039	1.053	1.062	1.069	6.16
0.900	0.925	0.953	0.972	0.992	1.018	1.040	1.054	1.062	1.069	6.17
0.901	0.926	0.953	0.972	0.992	1.019	1.040	1.054	1.063	1.070	6.18
0.901	0.926	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.19
0.902	0.927	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.20
0.902	0.928	0.954	0.973	0.993	1.019	1.041	1.055	1.063	1.070	6.21
0.903	0.928	0.955	0.974	0.994	1.019	1.041	1.055	1.063	1.070	6.22
0.903	0.929	0.955	0.974	0.994	1.020	1.042	1.056	1.064	1.071	6.23
0.904	0.929	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.24
0.904	0.930	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.25
0.905	0.930	0.956	0.975	0.995	1.020	1.042	1.056	1.064	1.071	6.26
0.905	0.930	0.957	0.976	0.996	1.021	1.042	1.056	1.064	1.071	6.27
0.906	0.931	0.957	0.976	0.996	1.022	1.043	1.057	1.065	1.072	6.28
0.906	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.29
0.907	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.30
0.907	0.931	0.958	0.977	0.997	1.022	1.043	1.057	1.065	1.072	6.31
0.908	0.931	0.959	0.978	0.997	1.022	1.044	1.057	1.065	1.072	6.32
0.908	0.932	0.959	0.978	0.998	1.023	1.044	1.058	1.066	1.072	6.33
0.909	0.932	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.072	6.34
0.909	0.932	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.077	6.35
0.910	0.933	0.960	0.979	0.998	1.023	1.045	1.058	1.066	1.072	6.36
0.910	0.934	0.961	0.980	0.999	1.024	1.046	1.058	1.066	1.072	6.37
0.911	0.934	0.961	0.980	0.999	1.024	1.046	1.059	1.067	1.073	6.38
0.911	0.935	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.39
0.912	0.936	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.40
0.913	0.936	0.962	0.981	1.000	1.025	1.047	1.059	1.067	1.073	6.41
0.913	0.937	0.963	0.982	1.000	1.025	1.047	1.059	1.067	1.073	6.42
0.914	0.937	0.963	0.982	1.001	1.026	1.048	1.060	1.068	1.074	6.43
0.914	0.938	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.44
0.915	0.938	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.45
0.916	0.939	0.964	0.983	1.001	1.026	1.048	1.060	1.068	1.074	6.46
0.916	0.939	0.965	0.984	1.002	1.027	1.048	1.061	1.068	1.074	6.47
0.917	0.940	0.965	0.984	1.002	1.027	1.049	1.061	1.069	1.075	6.48
0.917	0.940	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.49

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.50	0.848	0.841	0.839	0.840	0.842	0.847	0.856	0.865	0.878	0.892
6.51	0.849	0.842	0.840	0.841	0.843	0.848	0.857	0.866	0.879	0.893
6.52	0.850	0.843	0.841	0.842	0.844	0.849	0.858	0.866	0.879	0.893
6.53	0.851	0.844	0.842	0.843	0.844	0.849	0.858	0.867	0.880	0.894
6.54	0.852	0.845	0.843	0.844	0.845	0.850	0.859	0.867	0.880	0.894
6.55	0.853	0.846	0.844	0.845	0.846	0.851	0.860	0.868	0.881	0.895
6.56	0.854	0.847	0.845	0.846	0.847	0.852	0.861	0.869	0.882	0.896
6.57	0.855	0.848	0.846	0.847	0.848	0.853	0.862	0.869	0.882	0.896
6.58	0.856	0.850	0.848	0.849	0.849	0.853	0.862	0.870	0.883	0.897
6.59	0.857	0.851	0.849	0.850	0.850	0.854	0.863	0.870	0.883	0.897
6.60	0.858	0.852	0.850	0.851	0.851	0.855	0.864	0.871	0.884	0.898
6.61	0.859	0.853	0.851	0.852	0.852	0.856	0.865	0.872	0.885	0.898
6.62	0.860	0.854	0.852	0.853	0.853	0.857	0.866	0.873	0.886	0.899
6.63	0.862	0.855	0.853	0.854	0.854	0.857	0.866	0.873	0.886	0.899
6.64	0.863	0.856	0.854	0.855	0.855	0.858	0.867	0.874	0.887	0.890
6.65	0.864	0.857	0.855	0.856	0.856	0.859	0.868	0.875	0.888	0.900
6.66	0.865	0.858	0.856	0.857	0.857	0.860	0.869	0.876	0.889	0.901
6.67	0.866	0.859	0.857	0.858	0.858	0.861	0.870	0.877	0.890	0.901
6.68	0.868	0.861	0.858	0.859	0.859	0.861	0.870	0.878	0.890	0.902
6.69	0.869	0.862	0.859	0.860	0.860	0.862	0.871	0.879	0.891	0.902
6.70	0.870	0.863	0.860	0.861	0.861	0.863	0.872	0.880	0.892	0.903
6.71	0.871	0.864	0.861	0.862	0.862	0.864	0.873	0.881	0.893	0.904
6.72	0.872	0.865	0.862	0.863	0.863	0.865	0.874	0.882	0.893	0.904
6.73	0.873	0.866	0.863	0.864	0.863	0.865	0.874	0.882	0.894	0.905
6.74	0.874	0.867	0.864	0.865	0.864	0.866	0.875	0.883	0.894	0.905
6.75	0.875	0.868	0.865	0.866	0.865	0.867	0.876	0.884	0.895	0.906
6.76	0.876	0.869	0.866	0.867	0.866	0.868	0.877	0.885	0.896	0.907
6.77	0.877	0.870	0.867	0.868	0.867	0.869	0.878	0.886	0.897	0.908
6.78	0.879	0.872	0.869	0.870	0.868	0.870	0.878	0.886	0.897	0.908
6.79	0.880	0.873	0.870	0.871	0.869	0.871	0.879	0.887	0.898	0.909
6.80	0.881	0.874	0.871	0.872	0.870	0.872	0.880	0.888	0.899	0.910
6.81	0.882	0.875	0.872	0.873	0.871	0.873	0.881	0.889	0.900	0.911
6.82	0.883	0.876	0.873	0.874	0.872	0.874	0.882	0.889	0.900	0.911
6.83	0.884	0.877	0.874	0.875	0.873	0.875	0.882	0.890	0.901	0.912
6.84	0.885	0.878	0.875	0.876	0.874	0.876	0.883	0.890	0.901	0.912
6.85	0.886	0.879	0.876	0.877	0.875	0.877	0.884	0.891	0.902	0.913
6.86	0.887	0.880	0.877	0.878	0.876	0.878	0.885	0.892	0.903	0.914
6.87	0.888	0.881	0.878	0.879	0.877	0.879	0.886	0.893	0.904	0.915
6.88	0.890	0.883	0.879	0.879	0.879	0.879	0.886	0.893	0.904	0.915
6.89	0.891	0.884	0.880	0.880	0.880	0.880	0.887	0.894	0.905	0.916
6.90	0.892	0.885	0.881	0.881	0.881	0.881	0.888	0.895	0.906	0.917
6.91	0.893	0.886	0.882	0.882	0.882	0.882	0.889	0.896	0.907	0.917
6.92	0.894	0.887	0.883	0.883	0.883	0.883	0.890	0.896	0.907	0.918
6.93	0.895	0.888	0.884	0.883	0.883	0.883	0.890	0.897	0.908	0.918
6.94	0.896	0.889	0.885	0.884	0.884	0.884	0.891	0.897	0.909	0.919

				T_r						P_r 6.50 - 6.94
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.918	0.941	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.50
0.918	0.941	0.966	0.985	1.003	1.028	1.049	1.062	1.069	1.075	6.51
0.919	0.942	0.967	0.986	1.004	1.028	1.049	1.062	1.069	1.075	6.52
0.919	0.942	0.967	0.986	1.004	1.029	1.050	1.063	1.070	1.076	6.53
0.920	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.54
0.920	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.55
0.921	0.943	0.968	0.987	1.005	1.029	1.050	1.063	1.070	1.076	6.56
0.921	0.944	0.969	0.988	1.006	1.030	1.051	1.063	1.071	1.076	6.57
0.922	0.944	0.969	0.988	1.006	1.030	1.051	1.064	1.071	1.077	6.58
0.922	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.59
0.923	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.60
0.923	0.945	0.970	0.989	1.007	1.031	1.052	1.064	1.072	1.077	6.61
0.924	0.946	0.971	0.990	1.007	1.031	1.052	1.064	1.072	1.077	6.62
0.924	0.946	0.971	0.990	1.008	1.032	1.053	1.065	1.073	1.078	6.63
0.925	0.947	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.64
0.925	0.947	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.65
0.926	0.948	0.972	0.991	1.008	1.032	1.053	1.065	1.073	1.078	6.66
0.926	0.948	0.973	0.992	1.009	1.033	1.053	1.066	1.073	1.079	6.67
0.927	0.949	0.973	0.992	1.009	1.033	1.054	1.066	1.074	1.079	6.68
0.927	0.949	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.69
0.928	0.950	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.70
0.928	0.950	0.974	0.993	1.010	1.034	1.054	1.067	1.074	1.080	6.71
0.929	0.951	0.975	0.994	1.010	1.035	1.054	1.067	1.074	1.080	6.72
0.929	0.951	0.975	0.994	1.011	1.035	1.055	1.068	1.075	1.081	6.73
0.930	0.952	0.976	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.74
0.930	0.952	0.976	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.75
0.931	0.953	0.977	0.995	1.011	1.036	1.055	1.068	1.075	1.081	6.76
0.931	0.953	0.977	0.996	1.012	1.037	1.056	1.068	1.076	1.081	6.77
0.932	0.954	0.978	0.996	1.012	1.037	1.056	1.069	1.076	1.082	6.78
0.932	0.954	0.978	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.79
0.933	0.955	0.979	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.80
0.934	0.955	0.979	0.997	1.013	1.038	1.057	1.069	1.077	1.082	6.81
0.934	0.956	0.980	0.997	1.014	1.039	1.057	1.069	1.077	1.082	6.82
0.935	0.956	0.980	0.998	1.014	1.039	1.058	1.070	1.078	1.083	6.83
0.935	0.957	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.84
0.936	0.957	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.85
0.937	0.958	0.981	0.998	1.015	1.040	1.058	1.070	1.078	1.083	6.86
0.937	0.958	0.982	0.999	1.016	1.040	1.058	1.070	1.078	1.083	6.87
0.938	0.959	0.982	0.999	1.016	1.041	1.059	1.071	1.079	1.084	6.88
0.938	0.959	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.89
0.939	0.960	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.90
0.939	0.960	0.983	1.000	1.017	1.041	1.059	1.071	1.079	1.084	6.91
0.940	0.961	0.984	1.001	1.017	1.041	1.059	1.071	1.079	1.084	6.92
0.940	0.961	0.984	1.001	1.018	1.042	1.060	1.072	1.080	1.085	6.93
0.941	0.962	0.985	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.94

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
6.95	0.897	0.890	0.886	0.885	0.885	0.885	0.892	0.898	0.909	0.919
6.96	0.898	0.891	0.887	0.886	0.886	0.886	0.893	0.899	0.910	0.920
6.97	0.899	0.892	0.888	0.887	0.887	0.887	0.894	0.900	0.911	0.920
6.98	0.901	0.894	0.890	0.888	0.888	0.888	0.894	0.900	0.911	0.921
6.99	0.902	0.895	0.891	0.889	0.889	0.889	0.895	0.901	0.911	0.921
7.00	0.903	0.896	0.892	0.890	0.890	0.890	0.896	0.902	0.913	0.922
7.01	0.904	0.897	0.893	0.891	0.891	0.891	0.897	0.903	0.914	0.923
7.02	0.905	0.898	0.894	0.892	0.892	0.892	0.897	0.904	0.914	0.923
7.03	0.907	0.899	0.895	0.893	0.892	0.892	0.898	0.904	0.915	0.924
7.04	0.908	0.900	0.896	0.894	0.893	0.893	0.898	0.905	0.915	0.924
7.05	0.909	0.901	0.897	0.895	0.894	0.894	0.899	0.906	0.916	0.925
7.06	0.910	0.902	0.898	0.896	0.895	0.895	0.900	0.907	0.917	0.926
7.07	0.911	0.903	0.899	0.897	0.896	0.896	0.901	0.908	0.918	0.927
7.08	0.913	0.905	0.901	0.898	0.897	0.897	0.901	0.908	0.918	0.927
7.09	0.914	0.906	0.902	0.899	0.898	0.898	0.902	0.909	0.919	0.928
7.10	0.915	0.907	0.903	0.900	0.899	0.899	0.903	0.910	0.920	0.929
7.11	0.916	0.908	0.904	0.901	0.900	0.900	0.904	0.911	0.921	0.930
7.12	0.917	0.909	0.905	0.902	0.901	0.901	0.905	0.912	0.921	0.930
7.13	0.919	0.910	0.906	0.903	0.901	0.901	0.905	0.912	0.922	0.931
7.14	0.920	0.911	0.907	0.904	0.902	0.902	0.906	0.913	0.922	0.931
7.15	0.921	0.912	0.908	0.905	0.903	0.903	0.907	0.914	0.923	0.932
7.16	0.922	0.913	0.909	0.906	0.904	0.904	0.908	0.915	0.924	0.933
7.17	0.924	0.914	0.910	0.907	0.905	0.905	0.909	0.916	0.925	0.933
7.18	0.925	0.916	0.911	0.908	0.906	0.905	0.909	0.916	0.925	0.934
7.19	0.927	0.917	0.912	0.909	0.907	0.906	0.910	0.917	0.926	0.934
7.20	0.928	0.918	0.913	0.910	0.908	0.907	0.911	0.918	0.927	0.935
7.21	0.929	0.919	0.914	0.911	0.909	0.908	0.912	0.919	0.928	0.936
7.22	0.930	0.920	0.915	0.912	0.910	0.908	0.913	0.919	0.928	0.936
7.23	0.931	0.921	0.916	0.913	0.910	0.909	0.913	0.920	0.929	0.937
7.24	0.932	0.922	0.917	0.914	0.911	0.909	0.914	0.920	0.929	0.937
7.25	0.933	0.923	0.918	0.915	0.912	0.910	0.915	0.921	0.930	0.938
7.26	0.934	0.924	0.919	0.916	0.913	0.911	0.916	0.922	0.931	0.939
7.27	0.935	0.925	0.920	0.917	0.914	0.912	0.917	0.923	0.932	0.939
7.28	0.936	0.927	0.921	0.918	0.915	0.912	0.917	0.923	0.932	0.940
7.29	0.937	0.928	0.922	0.919	0.916	0.913	0.918	0.924	0.933	0.940
7.30	0.938	0.929	0.923	0.920	0.917	0.914	0.919	0.925	0.934	0.942
7.31	0.939	0.930	0.924	0.921	0.918	0.915	0.920	0.926	0.935	0.943
7.32	0.940	0.931	0.925	0.922	0.919	0.916	0.921	0.926	0.935	0.944
7.33	0.941	0.932	0.926	0.922	0.919	0.916	0.921	0.927	0.936	0.944
7.34	0.942	0.933	0.927	0.923	0.920	0.917	0.922	0.927	0.936	0.945
7.35	0.943	0.934	0.928	0.924	0.921	0.918	0.923	0.928	0.937	0.946
7.36	0.944	0.935	0.929	0.925	0.922	0.919	0.924	0.929	0.938	0.947
7.37	0.945	0.936	0.930	0.926	0.923	0.920	0.925	0.930	0.939	0.948
7.38	0.947	0.938	0.931	0.927	0.924	0.921	0.925	0.930	0.939	0.948
7.39	0.948	0.939	0.932	0.928	0.925	0.922	0.926	0.931	0.940	0.949

T_r										P_r 6.95 - 7.39
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.941	0.962	0.985	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.95
0.942	0.963	0.986	1.002	1.018	1.042	1.060	1.072	1.080	1.085	6.96
0.942	0.963	0.986	1.003	1.019	1.043	1.061	1.072	1.080	1.085	6.97
0.943	0.964	0.987	1.003	1.019	1.043	1.061	1.073	1.081	1.086	6.98
0.943	0.964	0.987	1.004	1.020	1.044	1.062	1.073	1.081	1.086	6.99
0.944	0.965	0.988	1.004	1.020	1.044	1.062	1.073	1.081	1.086	7.00
0.945	0.965	0.988	1.004	1.020	1.044	1.062	1.073	1.081	1.086	7.01
0.945	0.966	0.989	1.005	1.021	1.044	1.062	1.074	1.081	1.086	7.02
0.946	0.966	0.989	1.005	1.021	1.045	1.063	1.074	1.082	1.087	7.03
0.946	0.967	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.04
0.947	0.967	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.05
0.948	0.968	0.990	1.006	1.022	1.045	1.063	1.075	1.082	1.087	7.06
0.948	0.968	0.991	1.007	1.023	1.046	1.064	1.076	1.082	1.087	7.07
0.949	0.969	0.991	1.007	1.023	1.046	1.064	1.076	1.083	1.088	7.08
0.949	0.969	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.09
0.950	0.970	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.10
0.951	0.970	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088	7.11
0.951	0.971	0.993	1.009	1.025	1.047	1.065	1.077	1.083	1.088	7.12
0.952	0.971	0.993	1.009	1.025	1.048	1.066	1.078	1.084	1.089	7.13
0.952	0.972	0.994	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.14
0.953	0.972	0.994	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.15
0.954	0.973	0.995	1.010	1.026	1.048	1.066	1.078	1.084	1.089	7.16
0.954	0.973	0.995	1.011	1.027	1.049	1.066	1.078	1.085	1.090	7.17
0.955	0.974	0.996	1.011	1.027	1.049	1.067	1.079	1.085	1.090	7.18
0.955	0.974	0.996	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.19
0.956	0.975	0.997	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.20
0.957	0.975	0.997	1.012	1.028	1.050	1.067	1.079	1.086	1.091	7.21
0.957	0.976	0.998	1.013	1.028	1.050	1.067	1.079	1.086	1.091	7.22
0.958	0.976	0.998	1.013	1.029	1.051	1.068	1.080	1.087	1.092	7.23
0.958	0.977	0.999	1.014	1.029	1.051	1.068	1.080	1.087	1.092	7.24
0.959	0.977	0.999	1.014	1.029	1.051	1.068	1.080	1.087	1.092	7.25
0.960	0.978	0.999	1.015	1.029	1.051	1.068	1.080	1.087	1.092	7.26
0.960	0.978	1.000	1.015	1.030	1.052	1.069	1.080	1.087	1.092	7.27
0.961	0.979	1.000	1.016	1.030	1.052	1.069	1.081	1.088	1.093	7.28
0.961	0.979	1.001	1.016	1.031	1.053	1.070	1.081	1.088	1.093	7.29
0.962	0.980	1.001	1.017	1.031	1.053	1.070	1.081	1.088	1.093	7.30
0.963	0.980	1.001	1.017	1.031	1.053	1.070	1.081	1.088	1.093	7.31
0.963	0.981	1.002	1.018	1.032	1.054	1.070	1.081	1.088	1.093	7.32
0.964	0.981	1.002	1.018	1.032	1.054	1.071	1.082	1.089	1.094	7.33
0.964	0.982	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.34
0.965	0.982	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.35
0.966	0.983	1.003	1.019	1.033	1.055	1.071	1.082	1.089	1.094	7.36
0.966	0.983	1.004	1.020	1.034	1.056	1.072	1.083	1.090	1.094	7.37
0.967	0.984	1.004	1.020	1.034	1.056	1.072	1.083	1.090	1.095	7.38
0.967	0.984	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.39

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
7.40	0.949	0.940	0.933	0.929	0.926	0.923	0.927	0.932	0.941	0.950
7.41	0.950	0.941	0.934	0.930	0.927	0.924	0.928	0.933	0.942	0.951
7.42	0.951	0.942	0.935	0.931	0.928	0.925	0.929	0.934	0.942	0.951
7.43	0.953	0.943	0.936	0.932	0.928	0.925	0.929	0.934	0.943	0.952
7.44	0.954	0.944	0.937	0.933	0.929	0.926	0.930	0.935	0.943	0.952
7.45	0.955	0.945	0.938	0.934	0.930	0.927	0.931	0.936	0.944	0.953
7.46	0.956	0.946	0.939	0.935	0.931	0.928	0.932	0.937	0.945	0.954
7.47	0.957	0.947	0.940	0.936	0.932	0.929	0.933	0.938	0.946	0.954
7.48	0.959	0.949	0.941	0.937	0.933	0.930	0.933	0.938	0.946	0.955
7.49	0.960	0.950	0.942	0.938	0.934	0.931	0.934	0.939	0.947	0.955
7.50	0.961	0.951	0.943	0.939	0.935	0.932	0.935	0.940	0.948	0.956
7.51	0.962	0.952	0.944	0.940	0.936	0.933	0.936	0.941	0.949	0.957
7.52	0.963	0.953	0.945	0.941	0.937	0.934	0.937	0.942	0.949	0.957
7.53	0.964	0.954	0.946	0.942	0.937	0.934	0.937	0.942	0.950	0.958
7.54	0.965	0.955	0.947	0.943	0.938	0.935	0.938	0.943	0.950	0.958
7.55	0.966	0.956	0.948	0.944	0.939	0.936	0.939	0.944	0.951	0.959
7.56	0.967	0.957	0.949	0.945	0.940	0.937	0.940	0.945	0.952	0.960
7.57	0.968	0.958	0.950	0.946	0.941	0.938	0.941	0.946	0.953	0.960
7.58	0.970	0.959	0.951	0.947	0.942	0.939	0.941	0.947	0.953	0.961
7.59	0.971	0.960	0.952	0.948	0.943	0.940	0.942	0.948	0.954	0.961
7.60	0.972	0.961	0.953	0.949	0.944	0.941	0.943	0.949	0.955	0.962
7.61	0.973	0.962	0.954	0.950	0.945	0.942	0.944	0.950	0.956	0.963
7.62	0.974	0.963	0.955	0.951	0.946	0.943	0.945	0.950	0.956	0.963
7.63	0.975	0.964	0.956	0.952	0.947	0.943	0.945	0.951	0.957	0.964
7.64	0.976	0.965	0.957	0.953	0.948	0.944	0.946	0.951	0.957	0.964
7.65	0.977	0.966	0.958	0.954	0.949	0.945	0.947	0.952	0.958	0.965
7.66	0.978	0.967	0.959	0.955	0.950	0.946	0.948	0.953	0.959	0.966
7.67	0.979	0.968	0.960	0.956	0.951	0.947	0.949	0.954	0.960	0.967
7.68	0.981	0.970	0.961	0.957	0.952	0.948	0.950	0.954	0.960	0.967
7.69	0.982	0.971	0.962	0.958	0.953	0.949	0.951	0.955	0.961	0.968
7.70	0.983	0.972	0.963	0.959	0.954	0.950	0.952	0.956	0.962	0.969
7.71	0.984	0.973	0.964	0.960	0.955	0.951	0.953	0.957	0.963	0.970
7.72	0.985	0.974	0.965	0.961	0.956	0.952	0.954	0.957	0.963	0.970
7.73	0.987	0.975	0.966	0.961	0.956	0.952	0.954	0.958	0.964	0.971
7.74	0.988	0.976	0.967	0.962	0.957	0.953	0.955	0.958	0.964	0.971
7.75	0.989	0.977	0.968	0.963	0.958	0.954	0.956	0.959	0.965	0.972
7.76	0.990	0.978	0.969	0.964	0.959	0.955	0.957	0.960	0.966	0.973
7.77	0.991	0.979	0.970	0.965	0.960	0.956	0.958	0.961	0.967	0.974
7.78	0.993	0.981	0.971	0.966	0.960	0.957	0.958	0.961	0.967	0.974
7.79	0.994	0.982	0.972	0.967	0.961	0.958	0.959	0.962	0.968	0.975
7.80	0.995	0.983	0.973	0.968	0.962	0.959	0.960	0.963	0.969	0.976
7.81	0.996	0.984	0.974	0.969	0.962	0.960	0.961	0.964	0.970	0.977
7.82	0.997	0.985	0.975	0.970	0.963	0.961	0.962	0.965	0.971	0.977
7.83	0.998	0.986	0.976	0.971	0.963	0.961	0.962	0.965	0.971	0.978
7.84	0.999	0.987	0.977	0.972	0.964	0.962	0.963	0.966	0.972	0.978

T_r										P_r 7.40 - 7.84
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.968	0.985	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.40
0.968	0.986	1.005	1.021	1.035	1.057	1.073	1.084	1.091	1.095	7.41
0.969	0.986	1.006	1.022	1.036	1.057	1.073	1.084	1.091	1.095	7.42
0.969	0.987	1.006	1.022	1.036	1.058	1.074	1.085	1.092	1.096	7.43
0.970	0.987	1.007	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.44
0.970	0.988	1.007	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.45
0.971	0.989	1.008	1.023	1.037	1.058	1.074	1.085	1.092	1.096	7.46
0.971	0.989	1.008	1.024	1.038	1.059	1.075	1.086	1.092	1.097	7.47
0.972	0.990	1.009	1.024	1.038	1.059	1.075	1.086	1.093	1.097	7.48
0.972	0.990	1.009	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.49
0.973	0.991	1.010	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.50
0.974	0.991	1.010	1.025	1.039	1.060	1.076	1.087	1.093	1.098	7.51
0.974	1.992	1.011	1.026	1.040	1.060	1.076	1.087	1.093	1.098	7.52
0.975	0.992	1.011	1.026	1.040	1.061	1.077	1.088	1.094	1.099	7.53
0.975	0.993	1.012	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.54
0.976	0.993	1.012	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.55
0.977	0.994	1.013	1.027	1.041	1.061	1.077	1.088	1.094	1.099	7.56
0.977	0.994	1.013	1.028	1.042	1.062	1.078	1.088	1.095	1.099	7.57
0.978	0.995	1.014	1.028	1.042	1.062	1.078	1.089	1.095	1.100	7.58
0.978	0.995	1.014	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.59
0.979	0.996	1.015	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.60
0.979	0.996	1.015	1.029	1.043	1.063	1.079	1.089	1.096	1.100	7.61
0.980	0.997	1.016	1.030	1.044	1.064	1.079	1.089	1.096	1.100	7.62
0.980	0.997	1.016	1.030	1.044	1.064	1.080	1.090	1.097	1.101	7.63
0.981	0.998	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.64
0.981	0.998	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.65
0.982	0.999	1.017	1.031	1.045	1.065	1.080	1.090	1.097	1.101	7.66
0.982	0.999	1.018	1.032	1.046	1.066	1.081	1.091	1.097	1.101	7.67
0.983	1.000	1.018	1.032	1.046	1.066	1.081	1.091	1.098	1.102	7.68
0.983	1.000	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.69
0.984	1.001	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.70
0.985	1.001	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102	7.71
0.985	1.002	1.020	1.034	1.048	1.067	1.082	1.092	1.098	1.102	7.72
0.986	1.002	1.020	1.034	1.048	1.068	1.083	1.093	1.099	1.103	7.73
0.986	1.003	1.021	1.035	1.049	1.068	1.083	1.093	1.099	1.103	7.74
0.987	1.003	1.021	1.035	1.049	1.068	1.083	1.093	1.099	1.103	7.75
0.988	1.004	1.022	1.036	1.049	1.068	1.083	1.093	1.099	1.103	7.76
0.988	1.004	1.022	1.036	1.050	1.069	1.083	1.094	1.099	1.103	7.77
0.989	1.005	1.023	1.037	1.050	1.069	1.084	1.094	1.100	1.104	7.78
0.989	1.005	1.023	1.037	1.051	1.070	1.084	1.095	1.100	1.104	7.79
0.990	1.006	1.024	1.038	1.051	1.070	1.084	1.095	1.100	1.104	7.80
0.991	1.007	1.024	1.038	1.051	1.070	1.084	1.095	1.100	1.104	7.81
0.991	1.007	1.025	1.039	1.052	1.070	1.084	1.095	1.100	1.104	7.82
0.992	1.008	1.025	1.039	1.052	1.071	1.085	1.096	1.101	1.105	7.83
0.992	1.008	1.026	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.84

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
7.85	1.000	0.988	0.978	0.973	0.966	0.963	0.964	0.967	0.973	0.979
7.86	1.001	0.989	0.979	0.974	0.967	0.964	0.965	0.968	0.974	0.980
7.87	1.002	0.990	0.980	0.975	0.968	0.965	0.966	0.969	0.975	0.980
7.88	1.003	0.991	0.982	0.976	0.968	0.966	0.966	0.970	0.975	0.981
7.89	1.004	0.992	0.983	0.977	0.969	0.967	0.967	0.971	0.976	0.981
7.90	1.005	0.993	0.984	0.978	0.970	0.968	0.968	0.972	0.977	0.982
7.91	1.006	0.994	0.985	0.979	0.971	0.969	0.969	0.973	0.978	0.983
7.92	1.007	0.994	0.986	0.980	0.972	0.970	0.970	0.974	0.978	0.984
7.93	1.009	0.997	0.987	0.981	0.972	0.970	0.970	0.974	0.979	0.984
7.94	1.010	0.998	0.988	0.982	0.973	0.971	0.971	0.975	0.979	0.985
7.95	1.011	0.999	0.989	0.983	0.974	0.972	0.972	0.976	0.980	0.986
7.96	1.012	1.000	0.990	0.984	0.975	0.973	0.973	0.977	0.981	0.987
7.97	1.013	1.001	0.991	0.985	0.976	0.974	0.974	0.978	0.982	0.988
7.98	1.015	1.003	0.993	0.986	0.977	0.975	0.974	0.978	0.982	0.988
7.99	1.016	1.004	0.994	0.987	0.978	0.976	0.975	0.979	0.983	0.989
8.00	1.017	1.005	0.995	0.988	0.979	0.977	0.976	0.980	0.984	0.990
8.01	1.018	1.006	0.996	0.989	0.980	0.978	0.977	0.981	0.985	0.991
8.02	1.019	1.007	0.997	0.990	0.981	0.979	0.978	0.982	0.986	0.992
8.03	1.020	1.008	0.998	0.991	0.981	0.980	0.978	0.982	0.986	0.992
8.04	1.021	1.009	0.999	0.992	0.982	0.981	0.979	0.983	0.987	0.993
8.05	1.022	1.010	1.000	0.993	0.983	0.982	0.980	0.984	0.988	0.994
8.06	1.023	1.011	1.001	0.994	0.984	0.983	0.981	0.985	0.989	0.995
8.07	1.024	1.012	1.002	0.995	0.985	0.984	0.982	0.986	0.990	0.996
8.08	1.025	1.014	1.004	0.996	0.985	0.985	0.982	0.987	0.990	0.996
8.09	1.026	1.015	1.005	0.997	0.986	0.986	0.983	0.988	0.991	0.997
8.10	1.027	1.016	1.006	0.998	0.987	0.987	0.984	0.989	0.992	0.998
8.11	1.028	1.017	1.007	0.999	0.988	0.988	0.985	0.990	0.993	0.998
8.12	1.029	1.018	1.008	1.000	0.989	0.989	0.986	0.990	0.994	0.999
8.13	1.030	1.019	1.009	1.000	0.989	0.989	0.986	0.991	0.994	0.999
8.14	1.031	1.020	1.010	1.001	0.990	0.990	0.987	0.991	0.995	1.000
8.15	1.032	1.021	1.011	1.002	0.991	0.991	0.988	0.992	0.996	1.000
8.16	1.033	1.022	1.012	1.003	0.992	0.992	0.989	0.993	0.997	1.001
8.17	1.034	1.023	1.013	1.004	0.993	0.993	0.990	0.994	0.998	1.001
8.18	1.036	1.024	1.014	1.005	0.994	0.994	0.990	0.994	0.998	1.002
8.19	1.037	1.025	1.015	1.006	0.995	0.995	0.991	0.995	0.999	1.002
8.20	1.038	1.026	1.016	1.007	0.996	0.996	0.992	0.996	1.000	1.003
8.21	1.039	1.027	1.017	1.008	0.997	0.997	0.993	0.997	1.001	1.004
8.22	1.040	1.028	1.018	1.009	0.998	0.998	0.994	0.997	1.002	1.005
8.23	1.042	1.029	1.019	1.010	0.998	0.998	0.994	0.998	1.002	1.005
8.24	1.043	1.030	1.020	1.011	0.999	0.999	0.995	0.998	1.003	1.006
8.25	1.044	1.031	1.021	1.012	1.000	1.000	0.996	0.999	1.004	1.007
8.26	1.045	1.032	1.022	1.013	1.001	1.001	0.997	1.000	1.005	1.008
8.27	1.046	1.033	1.023	1.014	1.002	1.002	0.998	1.001	1.006	1.009
8.28	1.048	1.035	1.024	1.015	1.003	1.002	0.999	1.001	1.006	1.009
8.29	1.049	1.036	1.025	1.016	1.004	1.003	1.000	1.002	1.007	1.010

T_r										P_r 7.85 - 8.29
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
0.993	1.009	1.026	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.85
0.994	1.010	1.027	1.040	1.053	1.071	1.085	1.096	1.101	1.105	7.86
0.995	1.010	1.027	1.041	1.054	1.072	1.086	1.097	1.102	1.106	7.87
0.995	1.011	1.028	1.041	1.054	1.072	1.086	1.097	1.102	1.106	7.88
0.996	1.011	1.028	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.89
0.997	1.012	1.029	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.90
0.997	1.013	1.029	1.042	1.055	1.073	1.087	1.098	1.103	1.107	7.91
0.998	1.013	1.030	1.043	1.056	1.074	1.087	1.098	1.103	1.107	7.92
0.998	1.014	1.030	1.043	1.056	1.074	1.088	1.099	1.104	1.108	7.93
0.999	1.014	1.031	1.044	1.057	1.075	1.088	1.099	1.104	1.108	7.94
0.999	1.015	1.031	1.044	1.057	1.075	1.088	1.099	1.104	1.108	7.95
0.999	1.016	1.031	1.045	1.057	1.076	1.088	1.099	1.104	1.108	7.96
1.000	1.016	1.032	1.045	1.058	1.076	1.089	1.099	1.105	1.109	7.97
1.000	1.017	1.032	1.046	1.058	1.077	1.089	1.100	1.105	1.109	7.98
1.001	1.017	1.033	1.046	1.059	1.077	1.090	1.100	1.106	1.110	7.99
1.001	1.018	1.033	1.047	1.059	1.078	1.090	1.100	1.106	1.110	8.00
1.002	1.018	1.033	1.047	1.059	1.078	1.090	1.100	1.106	1.110	8.01
1.002	1.019	1.034	1.048	1.059	1.078	1.090	1.100	1.106	1.110	8.02
1.003	1.019	1.034	1.048	1.060	1.078	1.091	1.101	1.107	1.111	8.03
1.003	1.020	1.035	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.04
1.004	1.020	1.035	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.05
1.005	1.020	1.036	1.049	1.060	1.079	1.091	1.101	1.107	1.111	8.06
1.006	1.021	1.036	1.050	1.061	1.080	1.092	1.101	1.108	1.111	8.07
1.006	1.021	1.037	1.050	1.061	1.080	1.092	1.102	1.108	1.112	8.08
1.007	1.022	1.037	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.09
1.008	1.022	1.038	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.10
1.009	1.023	1.038	1.051	1.062	1.081	1.093	1.102	1.109	1.112	8.11
1.009	1.023	1.039	1.052	1.063	1.081	1.094	1.102	1.109	1.112	8.12
1.010	1.024	1.039	1.052	1.063	1.082	1.094	1.103	1.110	1.113	8.13
1.010	1.024	1.040	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.14
1.011	1.025	1.040	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.15
1.012	1.026	1.041	1.053	1.064	1.082	1.095	1.103	1.110	1.113	8.16
1.012	1.026	1.041	1.054	1.065	1.083	1.096	1.104	1.110	1.114	8.17
1.013	1.027	1.042	1.054	1.065	1.083	1.096	1.104	1.111	1.114	8.18
1.013	1.027	1.042	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.19
1.014	1.028	1.043	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.20
1.015	1.028	1.043	1.055	1.066	1.084	1.097	1.105	1.111	1.115	8.21
1.015	1.029	1.044	1.056	1.067	1.085	1.097	1.105	1.111	1.115	8.22
1.016	1.029	1.044	1.056	1.067	1.085	1.098	1.106	1.112	1.116	8.23
1.016	1.030	1.045	1.057	1.068	1.086	1.098	1.106	1.112	1.116	8.24
1.017	1.030	1.045	1.057	1.068	1.086	1.098	1.106	1.112	1.116	8.25
1.018	1.031	1.046	1.058	1.068	1.086	1.098	1.106	1.112	1.116	8.26
1.019	1.031	1.046	1.058	1.069	1.087	1.099	1.107	1.112	1.117	8.27
1.019	1.032	1.047	1.059	1.069	1.087	1.099	1.107	1.113	1.117	8.28
1.020	1.032	1.047	1.059	1.070	1.088	1.100	1.108	1.113	1.118	8.29

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
8.30	1.050	1.037	1.026	1.017	1.005	1.004	1.001	1.003	1.008	1.011
8.31	1.051	1.038	1.027	1.018	1.006	1.005	1.002	1.004	1.009	1.012
8.32	1.052	1.039	1.028	1.019	1.007	1.006	1.003	1.005	1.009	1.012
8.33	1.053	1.040	1.029	1.019	1.008	1.006	1.003	1.005	1.010	1.013
8.34	1.054	1.041	1.030	1.020	1.009	1.007	1.004	1.006	1.010	1.013
8.35	1.055	1.042	1.031	1.021	1.010	1.008	1.005	1.007	1.011	1.014
8.36	1.056	1.043	1.032	1.022	1.011	1.009	1.006	1.008	1.012	1.015
8.37	1.057	1.044	1.033	1.023	1.012	1.010	1.007	1.009	1.013	1.016
8.38	1.058	1.046	1.034	1.024	1.013	1.010	1.008	1.010	1.013	1.016
8.39	1.059	1.047	1.035	1.025	1.014	1.011	1.009	1.011	1.014	1.017
8.40	1.060	1.048	1.036	1.026	1.015	1.012	1.010	1.012	1.015	1.018
8.41	1.061	1.049	1.037	1.027	1.016	1.013	1.011	1.013	1.016	1.019
8.42	1.062	1.050	1.038	1.028	1.017	1.014	1.012	1.014	1.017	1.019
8.43	1.063	1.051	1.039	1.028	1.017	1.014	1.012	1.014	1.017	1.020
8.44	1.064	1.052	1.040	1.029	1.018	1.015	1.013	1.015	1.018	1.020
8.45	1.065	1.053	1.041	1.030	1.019	1.016	1.014	1.016	1.019	1.021
8.46	1.066	1.054	1.042	1.031	1.020	1.017	1.015	1.017	1.020	1.022
8.47	1.067	1.055	1.043	1.032	1.021	1.018	1.016	1.018	1.021	1.023
8.48	1.068	1.056	1.044	1.033	1.022	1.019	1.017	1.018	1.021	1.023
8.49	1.069	1.057	1.045	1.034	1.023	1.020	1.018	1.019	1.022	1.024
8.50	1.070	1.058	1.046	1.035	1.024	1.021	1.019	1.020	1.023	1.025
8.51	1.071	1.059	1.047	1.036	1.025	1.022	1.020	1.021	1.024	1.026
8.52	1.072	1.060	1.048	1.037	1.026	1.023	1.021	1.022	1.024	1.026
8.53	1.073	1.061	1.049	1.038	1.027	1.023	1.021	1.022	1.025	1.027
8.54	1.074	1.062	1.050	1.039	1.028	1.024	1.022	1.023	1.025	1.027
8.55	1.075	1.063	1.051	1.040	1.029	1.025	1.023	1.024	1.026	1.028
8.56	1.076	1.064	1.052	1.041	1.030	1.026	1.024	1.025	1.027	1.029
8.57	1.077	1.065	1.053	1.042	1.031	1.027	1.025	1.026	1.028	1.029
8.58	1.079	1.066	1.054	1.043	1.032	1.028	1.026	1.026	1.028	1.030
8.59	1.080	1.067	1.055	1.044	1.033	1.029	1.027	1.027	1.029	1.030
8.60	1.081	1.068	1.056	1.045	1.034	1.030	1.028	1.028	1.030	1.031
8.61	1.082	1.069	1.057	1.046	1.035	1.031	1.029	1.029	1.031	1.032
8.62	1.083	1.070	1.058	1.047	1.036	1.032	1.030	1.030	1.032	1.033
8.63	1.084	1.071	1.059	1.047	1.037	1.032	1.030	1.030	1.032	1.033
8.64	1.085	1.072	1.060	1.048	1.038	1.033	1.031	1.031	1.033	1.034
8.65	1.086	1.073	1.061	1.049	1.039	1.034	1.032	1.032	1.034	1.035
8.66	1.087	1.074	1.062	1.050	1.040	1.035	1.033	1.033	1.035	1.036
8.67	1.088	1.075	1.063	1.051	1.041	1.036	1.034	1.034	1.036	1.037
8.68	1.090	1.076	1.064	1.052	1.042	1.037	1.035	1.034	1.036	1.037
8.69	1.091	1.077	1.065	1.053	1.043	1.038	1.036	1.035	1.037	1.038
8.70	1.092	1.078	1.066	1.054	1.044	1.039	1.037	1.036	1.038	1.039
8.71	1.093	1.079	1.067	1.055	1.045	1.040	1.038	1.037	1.039	1.040
8.72	1.094	1.080	1.068	1.056	1.046	1.041	1.039	1.038	1.039	1.041
8.73	1.095	1.081	1.068	1.056	1.047	1.041	1.039	1.038	1.040	1.041
8.74	1.096	1.082	1.069	1.057	1.048	1.042	1.040	1.039	1.040	1.042

T_r										P_r 8.30 - 8.74
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.021	1.033	1.048	1.060	1.070	1.088	1.100	1.108	1.113	1.118	8.30
1.022	1.034	1.048	1.060	1.070	1.088	1.100	1.108	1.113	1.118	8.31
1.022	1.034	1.049	1.061	1.071	1.088	1.100	1 108	1.114	1.118	8.32
1.023	1.035	1.049	1.061	1.071	1.089	1.101	1.109	1.114	1.119	8.33
1.023	1.035	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.34
1.024	1.036	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.35
1.025	1.037	1.050	1.062	1.072	1.089	1.101	1.109	1.115	1.119	8.36
1.025	1.037	1.051	1.063	1.073	1.090	1.101	1.110	1.116	1.119	8.37
1.026	1.038	1.051	1.063	1.073	1.090	1.102	1.110	1.116	1.120	8.38
1.026	1.038	1.052	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.39
1.027	1.039	1.052	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.40
1.027	1.039	1.053	1.064	1.074	1.091	1.102	1.111	1.117	1.120	8.41
1.028	1.040	1.053	1.065	1.075	1.091	1.102	1.111	1.117	1.120	8.42
1.028	1.040	1.054	1.065	1.075	1.092	1.103	1.112	1.118	1.121	8.43
1.029	1.041	1.054	1.066	1.076	1.092	1.103	1.112	1.118	1.121	8.44
1.029	1.041	1.055	1.066	1.076	1.092	1.103	1.112	1.118	1.121	8.45
1.030	1.042	1.056	1.067	1.076	1.092	1.103	1.112	1.118	1.121	8.46
1.030	1.042	1.056	1.067	1.077	1.093	1.104	1.112	1.118	1.122	8.47
1.031	1.043	1.057	1.068	1.077	1.093	1.104	1.113	1.119	1.122	8.48
1.031	1.043	1.057	1.068	1.078	1.094	1.105	1.113	1.119	1.123	8.49
1.032	1.044	1.058	1.069	1.078	1.094	1.105	1.113	1.119	1.123	8.50
1.033	1.045	1.058	1.069	1.078	1.094	1.105	1.113	1.119	1.123	8.51
1.033	1.045	1.059	1.070	1.079	1.095	1.106	1.114	1.119	1.123	8.52
1.034	1.046	1.059	1.070	1.079	1.095	1.106	1.114	1.120	1.124	8.53
1.034	1.046	1.060	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.54
1.035	1.047	1.060	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.55
1.036	1.048	1.061	1.071	1.080	1.096	1.107	1.115	1.120	1.124	8.56
1.037	1.048	1.061	1.072	1.081	1.097	1.108	1.116	1.121	1.125	8.57
1.037	1.049	1.062	1.072	1.081	1.097	1.108	1.116	1.121	1.125	8.58
1.038	1.049	1.062	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.59
1.039	1.050	1.063	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.60
1.040	1.050	1.063	1.073	1.082	1.098	1.109	1.117	1.122	1.126	8.61
1.040	1.051	1.064	1.074	1.083	1.098	1.109	1.117	1.122	1.126	8.62
1.041	1.051	1.064	1.074	1.083	1.099	1.110	1.118	1.123	1.127	8.63
1.041	1.052	1.065	1.075	1.084	1.099	1.110	1.118	1.123	1.127	8.64
1.042	1.052	1.065	1.075	1.084	1.099	1.110	1.118	1.123	1.127	8.65
1.043	1.053	1.066	1.076	1.085	1.099	1.110	1.118	1.123	1.127	8.66
1.044	1.053	1.066	1.076	1.085	1.100	1.111	1.119	1.124	1.128	8.67
1.044	1.054	1.067	1.077	1.086	1.100	1.111	1.119	1.124	1.128	8.68
1.045	1.054	1.067	1.077	1.086	1.101	1.112	1.120	1.125	1.129	8.69
1.046	1.055	1.068	1.078	1.087	1.101	1.112	1.120	1.125	1.129	8.70
1.046	1.055	1.068	1.078	1.087	1.101	1.112	1.120	1.125	1.129	8.71
1.047	1.056	1.069	1.079	1.088	1.102	1.112	1.120	1.125	1.129	8.72
1.047	1.057	1.069	1.079	1.088	1.102	1.113	1.121	1.126	1.130	8.73
1.048	1.057	1.070	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.74

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
8.75	1.097	1.083	1.070	1.058	1.049	1.043	1.041	1.040	1.041	1.043
8.76	1.098	1.084	1.071	1.059	1.050	1.044	1.042	1.041	1.042	1.044
8.77	1.099	1.085	1.072	1.060	1.051	1.045	1.043	1.042	1.043	1.045
8.78	1.100	1.086	1.073	1.061	1.052	1.046	1.043	1.042	1.043	1.045
8.79	1.101	1.087	1.074	1.062	1.053	1.047	1.044	1.043	1.044	1.046
8.80	1.102	1.088	1.075	1.063	1.054	1.048	1.045	1.044	1.045	1.047
8.81	1.103	1.089	1.076	1.064	1.055	1.049	1.046	1.045	1.046	1.047
8.82	1.104	1.090	1.077	1.065	1.056	1.050	1.047	1.046	1.046	1.048
8.83	1.106	1.092	1.078	1.066	1.056	1.050	1.047	1.046	1.047	1.048
8.84	1.107	1.093	1.079	1.067	1.057	1.051	1.048	1.047	1.047	1.049
8.85	1.108	1.094	1.080	1.068	1.058	1.052	1.049	1.048	1.048	1.049
8.86	1.109	1.095	1.081	1.069	1.059	1.053	1.050	1.049	1.049	1.050
8.87	1.110	1.096	1.082	1.070	1.060	1.054	1.051	1.050	1.050	1.050
8.88	1.111	1.097	1.083	1.071	1.061	1.054	1.051	1.050	1.050	1.051
8.89	1.112	1.098	1.084	1.072	1.062	1.055	1.052	1.051	1.051	1.051
8.90	1.113	1.099	1.085	1.073	1.063	1.056	1.053	1.052	1.052	1.052
8.91	1.114	1.100	1.086	1.074	1.064	1.057	1.054	1.053	1.053	1.053
8.92	1.115	1.101	1.087	1.075	1.065	1.058	1.055	1.053	1.054	1.054
8.93	1.116	1.101	1.088	1.075	1.065	1.058	1.055	1.054	1.054	1.054
8.94	1.117	1.102	1.089	1.076	1.066	1.059	1.056	1.055	1.055	1.055
8.95	1.118	1.103	1.090	1.077	1.067	1.060	1.057	1.056	1.056	1.056
8.96	1.119	1.104	1.091	1.078	1.068	1.061	1.058	1.057	1.057	1.057
8.97	1.120	1.105	1.092	1.079	1.069	1.062	1.059	1.058	1.058	1.058
8.98	1.122	1.106	1.093	1.080	1.070	1.062	1.059	1.058	1.058	1.058
8.99	1.123	1.107	1.094	1.081	1.071	1.063	1.060	1.059	1.059	1.059
9.00	1.124	1.108	1.095	1.082	1.072	1.064	1.061	1.060	1.060	1.060
9.01	1.125	1.109	1.096	1.083	1.073	1.065	1.062	1.061	1.061	1.061
9.02	1.126	1.110	1.097	1.084	1.074	1.066	1.063	1.062	1.062	1.062
9.03	1.127	1.111	1.098	1.084	1.074	1.066	1.063	1.062	1.062	1.062
9.04	1.128	1.112	1.099	1.085	1.075	1.067	1.064	1.063	1.063	1.063
9.05	1.129	1.113	1.100	1.086	1.076	1.068	1.065	1.064	1.064	1.064
9.06	1.130	1.114	1.101	1.087	1.077	1.069	1.066	1.065	1.065	1.065
9.07	1.131	1.115	1.102	1.088	1.078	1.070	1.067	1.066	1.066	1.066
9.08	1.133	1.116	1.103	1.089	1.079	1.071	1.067	1.066	1.066	1.066
9.09	1.134	1.117	1.104	1.090	1.080	1.072	1.068	1.067	1.067	1.067
9.10	1.135	1.118	1.105	1.091	1.081	1.073	1.069	1.068	1.068	1.068
9.11	1.136	1.119	1.106	1.092	1.082	1.074	1.070	1.069	1.069	1.069
9.12	1.137	1.120	1.107	1.093	1.083	1.075	1.071	1.069	1.069	1.069
9.13	1.138	1.121	1.107	1.094	1.083	1.075	1.071	1.070	1.070	1.070
9.14	1.139	1.122	1.108	1.095	1.084	1.076	1.072	1.070	1.070	1.070
9.15	1.140	1.123	1.109	1.096	1.085	1.077	1.073	1.071	1.071	1.071
9.16	1.141	1.124	1.110	1.097	1.086	1.078	1.074	1.072	1.072	1.072
9.17	1.142	1.125	1.111	1.098	1.087	1.079	1.075	1.073	1.072	1.072
9.18	1.144	1.126	1.112	1.099	1.088	1.080	1.076	1.073	1.073	1.073
9.19	1.145	1.127	1.113	1.100	1.089	1.081	1.077	1.074	1.073	1.073

				T_r						P_r 8.75 - 9.19
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.048	1.058	1.070	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.75
1.049	1.059	1.071	1.080	1.089	1.103	1.113	1.121	1.126	1.130	8.76
1.049	1.059	1.071	1.081	1.090	1.104	1.114	1.121	1.126	1.131	8.77
1.050	1.060	1.072	1.081	1.090	1.104	1.114	1.122	1.127	1.131	8.78
1.050	1.060	1.072	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.79
1.051	1.061	1.073	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.80
1.052	1.062	1.073	1.082	1.091	1.105	1.115	1.122	1.127	1.132	8.81
1.053	1.062	1.074	1.083	1.092	1.106	1.115	1.123	1.128	1.132	8.82
1.053	1.063	1.074	1.083	1.092	1.106	1.116	1.123	1.128	1.133	8.83
1.054	1.063	1.075	1.084	1.093	1.107	1.116	1.124	1.129	1.133	8.84
1.055	1.064	1.075	1.084	1.093	1.107	1.116	1.124	1.129	1.133	8.85
1.056	1.065	1.076	1.085	1.093	1.107	1.116	1.124	1.129	1.133	8.86
1.056	1.065	1.076	1.085	1.094	1.108	1.117	1.125	1.130	1.134	8.87
1.057	1.066	1.077	1.086	1.094	1.108	1.117	1.125	1.130	1.134	8.88
1.057	1.066	1.077	1.086	1.095	1.109	1.118	1.126	1.131	1.135	8.89
1.058	1.067	1.078	1.087	1.095	1.109	1.118	1.126	1.131	1.135	8.90
1.059	1.067	1.078	1.087	1.095	1.109	1.118	1.126	1.131	1.135	8.91
1.059	1.068	1.079	1.088	1.096	1.110	1.119	1.126	1.131	1.135	8.92
1.060	1.068	1.079	1.088	1.096	1.110	1.119	1.127	1.132	1.136	8.93
1.060	1.069	1.080	1.089	1.097	1.111	1.120	1.127	1.132	1.136	8.94
1.061	1.069	1.080	1.089	1.097	1.111	1.120	1.127	1.132	1.136	8.95
1.062	1.070	1.081	1.090	1.098	1.111	1.120	1.127	1.132	1.136	8.96
1.062	1.070	1.081	1.090	1.098	1.112	1.121	1.128	1.133	1.137	8.97
1.063	1.071	1.082	1.091	1.099	1.112	1.121	1.128	1.133	1.137	8.98
1.063	1.071	1.082	1.091	1.099	1.113	1.122	1.129	1.134	1.138	8.99
1.064	1.072	1.083	1.092	1.100	1.113	1.122	1.129	1.134	1.138	9.00
1.065	1.073	1.083	1.092	1.100	1.113	1.122	1.129	1.134	1.138	9.01
1.065	1.073	1.084	1.093	1.101	1.114	1.123	1.129	1.134	1.138	9.02
1.066	1.074	1.084	1.093	1.101	1.114	1.123	1.130	1.135	1.139	9.03
1.066	1.074	1.085	1.094	1.102	1.115	1.124	1.130	1.135	1.139	9.04
1.067	1.075	1.085	1.094	1.102	1.115	1.124	1.130	1.135	1.139	9.05
1.068	1.076	1.086	1.095	1.102	1.115	1.124	1.130	1.135	1.139	9.06
1.068	1.076	1.086	1.095	1.103	1.116	1.125	1.131	1.136	1.139	9.07
1.069	1.077	1.087	1.096	1.103	1.116	1.125	1.131	1.136	1.140	9.08
1.069	1.077	1.087	1.096	1.104	1.117	1.126	1.132	1.137	1.140	9.09
1.070	1.078	1.088	1.097	1.104	1.117	1.126	1.132	1.137	1.140	9.10
1.071	1.079	1.089	1.097	1.104	1.117	1.126	1.132	1.137	1.140	9.11
1.072	1.079	1.089	1.098	1.105	1.118	1.127	1.132	1.137	1.140	9.12
1.072	1.080	1.090	1.098	1.105	1.118	1.127	1.133	1.138	1.141	9.13
1.073	1.080	1.090	1.099	1.106	1.119	1.128	1.133	1.138	1.141	9.14
1.074	1.081	1.091	1.099	1.106	1.119	1.128	1.133	1.138	1.141	9.15
1.075	1.082	1.092	1.100	1.106	1.120	1.128	1.133	1.138	1.141	9.16
1.076	1.082	1.092	1.100	1.107	1.120	1.129	1.134	1.139	1.142	9.17
1.076	1.083	1.093	1.101	1.107	1.121	1.129	1.134	1.139	1.142	9.18
1.077	1.083	1.093	1.101	1.108	1.121	1.130	1.135	1.140	1.143	9.19

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
9.20	1.146	1.128	1.114	1.101	1.090	1.082	1.078	1.075	1.074	1.074
9.21	1.147	1.129	1.115	1.102	1.091	1.083	1.079	1.076	1.075	1.075
9.22	1.148	1.130	1.116	1.103	1.092	1.084	1.080	1.077	1.076	1.075
9.23	1.149	1.131	1.117	1.103	1.092	1.084	1.080	1.077	1.076	1.076
9.24	1.150	1.132	1.118	1.104	1.093	1.085	1.081	1.078	1.077	1.076
9.25	1.151	1.133	1.119	1.105	1.094	1.086	1.082	1.079	1.078	1.077
9.26	1.152	1.134	1.120	1.106	1.095	1.087	1.083	1.080	1.079	1.078
9.27	1.153	1.135	1.121	1.107	1.096	1.088	1.084	1.081	1.080	1.078
9.28	1.155	1.136	1.122	1.108	1.097	1.089	1.084	1.081	1.080	1.079
9.29	1.156	1.137	1.123	1.109	1.098	1.090	1.085	1.082	1.081	1.079
9.30	1.157	1.138	1.124	1.110	1.099	1.091	1.086	1.083	1.082	1.081
9.31	1.158	1.139	1.125	1.111	1.100	1.092	1.087	1.084	1.083	1.082
9.32	1.159	1.140	1.126	1.112	1.101	1.093	1.088	1.085	1.084	1.082
9.33	1.160	1.141	1.127	1.113	1.102	1.093	1.088	1.085	1.084	1.083
9.34	1.161	1.142	1.128	1.114	1.103	1.094	1.089	1.086	1.085	1.083
9.35	1.162	1.143	1.129	1.115	1.104	1.095	1.090	1.087	1.086	1.084
9.36	1.163	1.144	1.130	1.116	1.105	1.096	1.091	1.088	1.087	1.085
9.37	1.164	1.145	1.131	1.117	1.106	1.097	1.092	1.089	1.088	1.086
9.38	1.165	1.146	1.132	1.118	1.107	1.098	1.093	1.090	1.088	1.086
9.39	1.166	1.147	1.133	1.119	1.108	1.099	1.094	1.091	1.089	1.087
9.40	1.167	1.148	1.134	1.120	1.109	1.100	1.095	1.092	1.090	1.088
9.41	1.168	1.149	1.135	1.121	1.110	1.101	1.096	1.093	1.091	1.089
9.42	1.169	1.150	1.136	1.122	1.111	1.102	1.097	1.094	1.092	1.090
9.43	1.170	1.151	1.137	1.122	1.111	1.102	1.097	1.094	1.092	1.090
9.44	1.171	1.152	1.138	1.123	1.112	1.103	1.098	1.095	1.093	1.091
9.45	1.172	1.153	1.139	1.124	1.113	1.104	1.099	1.096	1.094	1.092
9.46	1.172	1.154	1.140	1.125	1.114	1.105	1.100	1.097	1.095	1.093
9.47	1.173	1.155	1.141	1.126	1.115	1.106	1.101	1.098	1.096	1.094
9.48	1.175	1.157	1.142	1.127	1.116	1.107	1.101	1.098	1.096	1.094
0.49	1.176	1.158	1.143	1.128	1.117	1.108	1.102	1.099	1.097	1.095
9.50	1.178	1.159	1.144	1.129	1.118	1.109	1.103	1.100	1.098	1.096
9.51	1.179	1.160	1.145	1.130	1.119	1.110	1.104	1.101	1.099	1.097
9.52	1.180	1.161	1.146	1.131	1.120	1.111	1.105	1.102	1.099	1.097
9.53	1.180	1.162	1.147	1.132	1.120	1.111	1.105	1.102	1.100	1.098
9.54	1.181	1.163	1.148	1.133	1.121	1.112	1.106	1.103	1.100	1.098
9.55	1.182	1.164	1.149	1.134	1.122	1.113	1.107	1.104	1.101	1.099
9.56	1.183	1.165	1.150	1.135	1.123	1.114	1.108	1.105	1.102	1.100
9.57	1.185	1.166	1.151	1.136	1.124	1.115	1.109	1.106	1.102	1.100
9.58	1.186	1.167	1.152	1.137	1.125	1.116	1.109	1.106	1.103	1.101
9.59	1.188	1.168	1.153	1.138	1.126	1.117	1.110	1.107	1.103	1.101
9.60	1.189	1.169	1.154	1.139	1.127	1.118	1.111	1.108	1.104	1.102
9.61	1.190	1.170	1.155	1.140	1.128	1.119	1.112	1.109	1.105	1.103
9.62	1.191	1.171	1.156	1.141	1.129	1.120	1.113	1.110	1.106	1.103
9.63	1.192	1.172	1.156	1.141	1.130	1.120	1.113	1.110	1.106	1.104
9.64	1.193	1.173	1.157	1.142	1.131	1.121	1.114	1.111	1.107	1.104

T_r										P_r
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	
1.078	1.084	1.094	1.102	1.108	1.122	1.130	1.135	1.140	1.143	9.20
1.079	1.084	1.094	1.102	1.108	1.122	1.130	1.135	1.140	1.143	9.21
1.079	1.085	1.095	1.103	1.109	1.123	1.131	1.135	1.140	1.144	9.22
1.080	1.085	1.095	1.103	1.109	1.123	1.131	1.136	1.141	1.144	9.23
1.080	1.086	1.096	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.24
1.081	1.086	1.096	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.25
1.082	1.087	1.097	1.104	1.110	1.124	1.132	1.136	1.141	1.145	9.26
1.082	1.087	1.097	1.105	1.111	1.125	1.133	1.137	1.142	1.146	9.27
1.083	1.088	1.098	1.105	1.111	1.125	1.133	1.137	1.142	1.146	9.28
1.083	1.088	1.098	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.29
1.084	1.089	1.099	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.30
1.085	1.090	1.099	1.106	1.112	1.126	1.134	1.138	1.143	1.147	9.31
1.085	1.090	1.100	1.107	1.113	1.127	1.135	1.139	1.144	1.147	9.32
1.086	1.091	1.100	1.107	1.113	1.127	1.135	1.139	1.144	1.148	9.33
1.086	1.091	1.101	1.108	1.114	1.128	1.136	1.140	1.145	1.148	9.34
1.087	1.092	1.101	1.108	1.114	1.128	1.136	1.140	1.145	1.148	9.35
1.088	1.093	1.102	1.109	1.115	1.128	1.136	1.140	1.145	1.148	9.36
1.088	1.093	1.102	1.109	1.115	1.129	1.137	1.141	1.146	1.148	9.37
1.189	1.094	1.103	1.110	1.116	1.129	1.137	1.141	1.146	1.149	9.38
1.089	1.094	1.103	1.110	1.116	1.130	1.138	1.142	1.147	1.149	9.39
1.090	1.095	1.104	1.111	1.117	1.130	1.138	1.142	1.147	1.149	9.40
1.091	1.096	1.104	1.111	1.117	1.130	1.138	1.142	1.147	1.149	9.41
1.091	1.096	1.105	1.112	1.118	1.131	1.139	1.142	1.147	1.149	9.42
1.092	1.097	1.105	1.112	1.118	1.131	1.139	1.143	1.148	1.150	9.43
1.092	1.097	1.106	1.113	1.119	1.132	1.140	1.143	1.148	1.150	9.44
1.093	1.098	1.106	1.113	1.119	1.132	1.140	1.143	1.148	1.150	9.45
1.094	1.099	1.107	1.114	1.120	1.132	1.140	1.143	1.148	1.150	9.46
1.095	1.100	1.107	1.114	1.120	1.133	1.141	1.144	1.149	1.151	9.47
1.095	1.100	1.108	1.115	1.121	1.133	1.141	1.144	1.149	1.151	9.48
1.096	1.101	1.108	1.115	1.121	1.134	1.142	1.145	1.150	1.152	9.49
1.097	1.102	1.109	1.116	1.122	1.134	1.142	1.145	1.150	1.152	9.50
1.098	1.102	1.109	1.116	1.122	1.134	1.142	1.145	1.150	1.152	9.51
1.098	1.103	1.110	1.117	1.123	1.135	1.142	1.146	1.150	1.152	9.52
1.099	1.103	1.110	1.117	1.123	1.135	1.143	1.146	1.151	1.153	9.53
1.099	1.104	1.111	1.118	1.124	1.136	1.143	1.147	1.151	1.153	9.54
1.100	1.104	1.111	1.118	1.124	1.136	1.143	1.147	1.151	1.153	9.55
1.101	1.105	1.112	1.119	1.124	1.137	1.143	1.147	1.151	1.153	9.56
1.101	1.105	1.112	1.119	1.125	1.137	1.144	1.148	1.152	1.154	9.57
1.102	1.106	1.113	1.120	1.125	1.138	1.144	1.148	1.152	1.154	9.58
1.102	1.106	1.113	1.120	1.126	1.138	1.145	1.149	1.153	1.155	9.59
1.103	1.107	1.114	1.121	1.126	1.139	1.145	1.149	1.153	1.155	9.60
1.104	1.108	1.115	1.121	1.126	1.139	1.145	1.149	1.153	1.155	9.61
1.104	1.108	1.115	1.122	1.127	1.140	1.146	1.149	1.153	1.155	9.62
1.105	1.109	1.116	1.122	1.127	1.140	1.146	1.150	1.154	1.156	9.63
1.105	1.109	1.116	1.123	1.128	1.141	1.147	1.150	1.154	1.156	9.64

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
9.65	1.194	1.174	1.158	1.143	1.132	1.122	1.115	1.112	1.108	1.105
9.66	1.195	1.175	1.159	1.144	1.133	1.123	1.116	1.113	1.109	1.106
9.67	1.196	1.176	1.160	1.145	1.134	1.124	1.117	1.114	1.110	1.107
9.68	1.198	1.177	1.161	1.146	1.135	1.125	1.118	1.114	1.110	1.107
9.69	1.199	1.178	1.162	1.147	1.136	1.126	1.119	1.115	1.111	1.108
9.70	1.200	1.179	1.163	1.148	1.137	1.127	1.120	1.116	1.112	1.109
9.71	1.201	1.180	1.164	1.149	1.138	1.128	1.121	1.117	1.113	1.110
9.72	1.202	1.181	1.165	1.150	1.139	1.129	1.122	1.118	1.113	1.111
9.73	1.203	1.182	1.166	1.151	1.139	1.129	1.122	1.118	1.114	1.111
9.74	1.204	1.183	1.167	1.152	1.140	1.130	1.123	1.119	1.114	1.112
9.75	1.205	1.184	1.168	1.153	1.141	1.131	1.124	1.120	1.115	1.113
9.76	1.206	1.185	1.169	1.154	1.142	1.132	1.125	1.121	1.116	1.114
9.77	1.207	1.186	1.170	1.155	1.143	1.133	1.126	1.122	1.117	1.115
9.78	1.208	1.187	1.171	1.156	1.144	1.133	1.126	1.122	1.117	1.115
9.79	1.209	1.188	1.172	1.157	1.145	1.134	1.127	1.123	1.118	1.116
9.80	1.210	1.189	1.173	1.158	1.146	1.135	1.128	1.124	1.119	1.117
9.81	1.211	1.190	1.174	1.159	1.147	1.136	1.129	1.125	1.120	1.118
9.82	1.212	1.191	1.175	1.160	1.148	1.137	1.130	1.126	1.121	1.118
9.83	1.213	1.192	1.176	1.160	1.148	1.137	1.130	1.126	1.121	1.119
9.84	1.214	1.193	1.177	1.161	1.149	1.138	1.131	1.127	1.122	1.119
9.85	1.215	1.194	1.178	1.162	1.150	1.139	1.132	1.128	1.123	1.120
9.86	1.216	1.195	1.179	1.163	1.151	1.140	1.133	1.129	1.124	1.121
9.87	1.217	1.196	1.180	1.164	1.152	1.141	1.134	1.130	1.125	1.122
9.88	1.219	1.198	1.181	1.165	1.153	1.141	1.135	1.130	1.125	1.123
9.89	1.220	1.199	1.182	1.166	1.154	1.142	1.136	1.131	1.126	1.123
9.90	1.221	1.200	1.183	1.167	1.155	1.143	1.137	1.132	1.127	1.123
9.91	1.222	1.201	1.184	1.168	1.156	1.144	1.138	1.133	1.128	1.124
9.92	1.223	1.202	1.185	1.169	1.157	1.145	1.139	1.134	1.128	1.124
9.93	1.224	1.203	1.185	1.169	1.157	1.145	1.139	1.134	1.129	1.125
9.94	1.225	1.204	1.186	1.170	1.158	1.146	1.140	1.135	1.129	1.125
9.95	1.226	1.205	1.187	1.171	1.159	1.147	1.141	1.136	1.130	1.126
9.96	1.227	1.206	1.188	1.172	1.160	1.148	1.142	1.137	1.131	1.127
9.97	1.228	1.207	1.189	1.173	1.161	1.149	1.143	1.138	1.132	1.128
9.98	1.229	1.208	1.190	1.174	1.162	1.150	1.143	1.138	1.132	1.128
9.99	1.230	1.209	1.191	1.175	1.163	1.151	1.144	1.139	1.133	1.129
10.00	1.231	1.210	1.192	1.176	1.164	1.152	1.145	1.140	1.134	1.130
10.01	1.232	1.211	1.193	1.177	1.165	1.153	1.146	1.141	1.135	1.131
10.02	1.233	1.212	1.194	1.178	1.166	1.154	1.147	1.142	1.136	1.132
10.03	1.234	1.213	1.195	1.178	1.166	1.154	1.147	1.142	1.136	1.132
10.04	1.235	1.214	1.196	1.179	1.167	1.155	1.148	1.143	1.137	1.133
10.05	1.236	1.215	1.197	1.180	1.168	1.156	1.149	1.144	1.138	1.134
10.06	1.237	1.216	1.198	1.181	1.169	1.157	1.150	1.145	1.139	1.135
10.07	1.238	1.217	1.199	1.182	1.170	1.158	1.151	1.146	1.140	1.136
10.08	1.240	1.218	1.200	1.183	1.171	1.158	1.151	1.146	1.140	1.136
10.09	1.241	1.219	1.201	1.184	1.172	1.159	1.152	1.147	1.141	1.137

T_r										P_r 9.65 - 10.09
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.106	1.110	1.117	1.123	1.128	1.141	1.147	1.150	1.154	1.156	9.65
1.107	1.111	1.118	1.124	1.129	1.141	1.147	1.150	1.154	1.156	9.66
1.107	1.111	1.118	1.124	1.129	1.142	1.148	1.151	1.155	1.157	9.67
1.108	1.112	1.119	1.125	1.130	1.142	1.148	1.151	1.155	1.157	9.68
1.108	1.112	1.119	1.125	1.130	1.143	1.149	1.152	1.156	1.158	9.69
1.109	1.113	1.120	1.126	1.131	1.143	1.149	1.152	1.156	1.158	9.70
1.110	1.114	1.120	1.126	1.131	1.143	1.149	1.152	1.156	1.158	9.71
1.111	1.114	1.121	1.127	1.132	1.144	1.149	1.153	1.156	1.158	9.72
1.111	1.115	1.121	1.127	1.132	1.144	1.150	1.153	1.157	1.159	9.73
1.112	1.115	1.122	1.128	1.133	1.145	1.150	1.154	1.157	1.159	9.74
1.113	1.116	1.112	1.128	1.133	1.145	1.150	1.154	1.157	1.159	9.75
1.114	1.117	1.123	1.129	1.134	1.146	1.150	1.154	1.157	1.159	9.76
1.115	1.117	1.123	1.129	1.134	1.146	1.151	1.155	1.158	1.160	9.77
1.115	1.118	1.124	1.130	1.135	1.147	1.151	1.155	1.158	1.160	9.78
1.116	1.118	1.124	1.130	1.135	1.147	1.152	1.156	1.159	1.161	9.79
1.117	1.119	1.125	1.131	1.136	1.148	1.152	1.156	1.159	1.161	9.80
1.118	1.120	1.125	1.131	1.136	1.148	1.152	1.156	1.159	1.161	9.81
1.118	1.120	1.126	1.132	1.137	1.149	1.153	1.156	1.159	1.161	9.82
1.119	1.121	1.126	1.132	1.137	1.149	1.153	1.157	1.160	1.162	9.83
1.119	1.121	1.127	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.84
1.120	1.122	1.127	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.85
1.121	1.123	1.128	1.133	1.138	1.150	1.154	1.157	1.160	1.162	9.86
1.121	1.124	1.128	1.134	1.139	1.151	1.155	1.158	1.161	1.163	9.87
1.122	1.124	1.129	1.134	1.139	1.151	1.155	1.158	1.161	1.163	9.88
1.122	1.125	1.129	1.135	1.140	1.152	1.156	1.159	1.162	1.164	9.89
1.123	1.126	1.130	1.135	1.140	1.152	1.156	1.159	1.162	1.164	9.90
1.124	1.127	1.131	1.136	1.140	1.152	1.156	1.159	1.162	1.164	9.91
1.124	1.127	1.131	1.136	1.141	1.153	1.157	1.160	1.162	1.164	9.92
1.125	1.128	1.132	1.137	1.141	1.153	1.157	1.160	1.163	1.165	9.93
1.125	1.128	1.132	1.137	1.142	1.154	1.158	1.161	1.163	1.165	9.94
1.126	1.129	1.133	1.138	1.142	1.154	1.158	1.161	1.163	1.165	9.95
1.127	1.130	1.134	1.139	1.142	1.154	1.158	1.161	1.163	1.165	9.96
1.128	1.130	1.134	1.139	1.143	1.155	1.159	1.162	1.164	1.166	9.97
1.128	1.131	1.135	1.140	1.143	1.155	1.159	1.162	1.164	1.166	9.98
1.129	1.131	1.135	1.140	1.144	1.156	1.160	1.163	1.165	1.167	9.99
1.130	1.132	1.136	1.141	1.144	1.156	1.160	1.163	1.165	1.167	10.00
1.131	1.133	1.137	1.141	1.144	1.156	1.160	1.163	1.165	1.167	10.01
1.131	1.133	1.137	1.142	1.145	1.157	1.161	1.163	1.165	1.167	10.02
1.132	1.134	1.138	1.142	1.145	1.157	1.161	1.164	1.166	1.168	10.03
1.132	1.134	1.138	1.143	1.146	1.158	1.162	1.164	1.166	1.168	10.04
1.133	1.135	1.139	1.143	1.146	1.158	1.162	1.164	1.166	1.168	10.05
1.134	1.136	1.139	1.143	1.147	1.158	1.162	1.164	1.166	1.168	10.06
1.135	1.136	1.140	1.144	1.147	1.159	1.163	1.165	1.167	1.169	10.07
1.135	1.137	1.140	1.144	1.148	1.159	1.163	1.165	1.167	1.169	10.08
1.136	1.137	1.141	1.145	1.148	1.160	1.164	1.166	1.168	1.170	10.09

P_r	T_r = 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
10.10	1.242	1.220	1.202	1.185	1.173	1.160	1.153	1.148	1.142	1.138
10.11	1.243	1.221	1.203	1.186	1.174	1.161	1.154	1.149	1.143	1.139
10.12	1.244	1.222	1.204	1.187	1.175	1.162	1.155	1.150	1.143	1.139
10.13	1.245	1.223	1.204	1.188	1.175	1.162	1.155	1.150	1.144	1.140
10.14	1.246	1.224	1.205	1.189	1.176	1.163	1.156	1.151	1.144	1.140
10.15	1.247	1.225	1.206	1.190	1.177	1.164	1.157	1.152	1.145	1.141
10.16	1.248	1.226	1.207	1.191	1.178	1.165	1.158	1.153	1.146	1.142
10.17	1.249	1.227	1.208	1.192	1.179	1.166	1.159	1.153	1.147	1.143
10.18	1.250	1.228	1.209	1.193	1.179	1.167	1.160	1.154	1.148	1.143
10.19	1.251	1.229	1.210	1.194	1.180	1.168	1.161	1.154	1.149	1.144
10.20	1.252	1.230	1.211	1.195	1.181	1.169	1.162	1.155	1.149	1.145
10.21	1.253	1.231	1.212	1.196	1.182	1.170	1.163	1.156	1.150	1.146
10.22	1.254	1.232	1.213	1.197	1.183	1.171	1.164	1.157	1.151	1.146
10.23	1.255	1.233	1.214	1.197	1.183	1.172	1.164	1.157	1.151	1.147
10.24	1.256	1.234	1.215	1.198	1.184	1.173	1.165	1.158	1.152	1.147
10.25	1.257	1.235	1.216	1.199	1.185	1.174	1.166	1.159	1.153	1.148
10.26	1.258	1.236	1.217	1.200	1.186	1.175	1.167	1.160	1.154	1.149
10.27	1.259	1.237	1.218	1.201	1.187	1.176	1.168	1.161	1.155	1.150
10.28	1.261	1.238	1.219	1.202	1.188	1.177	1.168	1.161	1.155	1.150
10.29	1.262	1.239	1.220	1.203	1.189	1.178	1.169	1.162	1.156	1.151
10.30	1.263	1.240	1.221	1.204	1.190	1.179	1.170	1.163	1.157	1.152
10.31	1.264	1.241	1.222	1.205	1.191	1.180	1.171	1.164	1.158	1.153
10.32	1.265	1.242	1.223	1.206	1.192	1.181	1.172	1.165	1.158	1.154
10.33	1.266	1.243	1.224	1.206	1.192	1.181	1.172	1.165	1.159	1.154
10.34	1.267	1.244	1.225	1.207	1.193	1.182	1.173	1.166	1.159	1.155
10.35	1.268	1.245	1.226	1.208	1.194	1.183	1.174	1.167	1.160	1.156
10.36	1.269	1.246	1.227	1.209	1.195	1.184	1.175	1.168	1.161	1.157
10.37	1.270	1.247	1.228	1.210	1.196	1.185	1.176	1.169	1.162	1.158
10.38	1.272	1.248	1.229	1.211	1.197	1.186	1.176	1.169	1.162	1.158
10.39	1.273	1.249	1.230	1.212	1.198	1.187	1.177	1.170	1.163	1.159
10.40	1.274	1.250	1.231	1.213	1.199	1.188	1.178	1.171	1.164	1.160
10.41	1.275	1.251	1.232	1.214	1.200	1.189	1.179	1.172	1.165	1.161
10.42	1.276	1.252	1.233	1.215	1.201	1.190	1.180	1.173	1.166	1.162
10.43	1.277	1.253	1.234	1.216	1.201	1.190	1.180	1.173	1.166	1.162
10.44	1.278	1.254	1.235	1.217	1.202	1.191	1.181	1.174	1.167	1.163
10.45	1.279	1.255	1.236	1.218	1.203	1.192	1.182	1.175	1.168	1.164
10.46	1.280	1.256	1.237	1.219	1.204	1.193	1.183	1.176	1.169	1.165
10.47	1.281	1.257	1.238	1.220	1.205	1.194	1.184	1.177	1.170	1.166
10.48	1.283	1.258	1.239	1.221	1.206	1.194	1.184	1.177	1.170	1.166
10.49	1.284	1.259	1.240	1.222	1.207	1.195	1.185	1.178	1.171	1.167
10.50	1.285	1.260	1.241	1.223	1.208	1.196	1.186	1.179	1.172	1.168
10.51	1.286	1.261	1.242	1.224	1.209	1.197	1.187	1.180	1.173	1.169
10.52	1.287	1.262	1.243	1.225	1.210	1.198	1.188	1.181	1.174	1.169
10.53	1.288	1.263	1.244	1.225	1.210	1.198	1.188	1.181	1.174	1.170
10.54	1.289	1.264	1.245	1.226	1.211	1.199	1.189	1.182	1.175	1.170

T_r										P_r 10.10 - 10.54
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.137	1.138	1.141	1.145	1.149	1.160	1.164	1.166	1.168	1.170	10.10
1.138	1.139	1.142	1.145	1.149	1.160	1.164	1.166	1.168	1.170	10.11
1.138	1.139	1.142	1.146	1.150	1.161	1.164	1.166	1.168	1.170	10.12
1.139	1.140	1.143	1.146	1.150	1.161	1.165	1.167	1.169	1.171	10.13
1.139	1.140	1.143	1.147	1.151	1.162	1.165	1.167	1.169	1.171	10.14
1.140	1.141	1.144	1.147	1.151	1.162	1.165	1.167	1.169	1.171	10.15
1.141	1.142	1.145	1.148	1.152	1.162	1.165	1.167	1.169	1.171	10.16
1.141	1.142	1.145	1.148	1.152	1.163	1.166	1.168	1.170	1.172	10.17
1.142	1.143	1.146	1.149	1.153	1.163	1.166	1.168	1.170	1.172	10.18
1.142	1.143	1.146	1.149	1.153	1.164	1.167	1.169	1.171	1.173	10.19
1.143	1.144	1.147	1.150	1.154	1.164	1.167	1.169	1.171	1.173	10.20
1.144	1.145	1.147	1.150	1.154	1.164	1.167	1.169	1.171	1.173	10.21
1.144	1.145	1.148	1.151	1.155	1.165	1.168	1.170	1.172	1.174	10.22
1.145	1.146	1.148	1.151	1.155	1.165	1.168	1.170	1.172	1.174	10.23
1.145	1.146	1.149	1.152	1.156	1.166	1.169	1.171	1.173	1.175	10.24
1.146	1.147	1.149	1.152	1.156	1.166	1.169	1.171	1.173	1.175	10.25
1.147	1.148	1.150	1.153	1.157	1.166	1.169	1.171	1.173	1.175	10.26
1.147	1.148	1.150	1.153	1.157	1.167	1.170	1.172	1.174	1.176	10.27
1.148	1.149	1.151	1.154	1.158	1.167	1.170	1.172	1.174	1.176	10.28
1.148	1.149	1.151	1.154	1.158	1.168	1.171	1.173	1.175	1.177	10.29
1.149	1.150	1.152	1.155	1.159	1.168	1.171	1.173	1.175	1.177	10.30
1.150	1.151	1.153	1.155	1.159	1.168	1.171	1.173	1.175	1.177	10.31
1.150	1.151	1.153	1.156	1.160	1.169	1.172	1.173	1.175	1.177	10.32
1.151	1.152	1.154	1.156	1.160	1.169	1.172	1.174	1.176	1.178	10.33
1.151	1.152	1.154	1.157	1.161	1.170	1.173	1.174	1.176	1.178	10.34
1.152	1.153	1.155	1.157	1.161	1.170	1.173	1.174	1.176	1.178	10.35
1.153	1.154	1.156	1.158	1.162	1.170	1.173	1.174	1.176	1.178	10.36
1.154	1.154	1.156	1.158	1.162	1.171	1.174	1.175	1.177	1.179	10.37
1.154	1.155	1.157	1.159	1.163	1.171	1.174	1.175	1.177	1.179	10.38
1.155	1.155	1.157	1.159	1.163	1.172	1.175	1.176	1.178	1.180	10.39
1.156	1.156	1.158	1.160	1.164	1.172	1.175	1.176	1.178	1.180	10.40
1.157	1.157	1.158	1.160	1.164	1.172	1.175	1.176	1.178	1.180	10.41
1.157	1.157	1.159	1.161	1.165	1.173	1.176	1.176	1.178	1.180	10.42
1.158	1.158	1.159	1.161	1.165	1.173	1.176	1.177	1.179	1.181	10.43
1.158	1.158	1.160	1.162	1.166	1.174	1.177	1.177	1.179	1.181	10.44
1.159	1.159	1.160	1.162	1.166	1.174	1.177	1.177	1.179	1.181	10.45
1.160	1.160	1.160	1.163	1.167	1.174	1.177	1.177	1.179	1.181	10.46
1.160	1.160	1.161	1.163	1.167	1.175	1.178	1.178	1.180	1.182	10.47
1.161	1.161	1.161	1.164	1.168	1.175	1.178	1.178	1.180	1.182	10.48
1.161	1.161	1.162	1.164	1.168	1.176	1.179	1.179	1.181	1.183	10.49
1.162	1.162	1.162	1.165	1.169	1.176	1.179	1.179	1.181	1.183	10.50
1.163	1.163	1.163	1.166	1.169	1.176	1.179	1.179	1.181	1.183	10.51
1.163	1.163	1.163	1.166	1.170	1.177	1.180	1.180	1.181	1.183	10.52
1.164	1.164	1.164	1.167	1.170	1.177	1.180	1.180	1.182	1.184	10.53
1.164	1.164	1.164	1.167	1.171	1.178	1.181	1.181	1.182	1.184	10.54

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
10.55	1.290	1.265	1.246	1.227	1.212	1.200	1.190	1.183	1.176	1.171
10.56	1.291	1.266	1.247	1.228	1.213	1.201	1.191	1.184	1.177	1.172
10.57	1.292	1.267	1.248	1.229	1.214	1.202	1.192	1.185	1.178	1.172
10.58	1.294	1.268	1.249	1.230	1.215	1.202	1.193	1.185	1.178	1.173
10.59	1.295	1.269	1.250	1.231	1.216	1.203	1.194	1.186	1.179	1.173
10.60	1.296	1.270	1.251	1.232	1.217	1.204	1.195	1.187	1.180	1.174
10.61	1.297	1.271	1.252	1.233	1.218	1.205	1.196	1.188	1.181	1.175
10.62	1.298	1.272	1.253	1.234	1.219	1.206	1.197	1.189	1.181	1.175
10.63	1.299	1.273	1.254	1.234	1.219	1.206	1.197	1.189	1.182	1.176
10.64	1.300	1.274	1.255	1.235	1.220	1.207	1.198	1.190	1.182	1.176
10.65	1.301	1.275	1.256	1.236	1.221	1.208	1.199	1.191	1.183	1.177
10.66	1.302	1.276	1.257	1.237	1.222	1.209	1.200	1.192	1.184	1.178
10.67	1.303	1.277	1.258	1.238	1.223	1.210	1.201	1.193	1.185	1.179
10.68	1.305	1.278	1.259	1.239	1.224	1.211	1.201	1.193	1.185	1.179
10.69	1.306	1.279	1.260	1.240	1.225	1.212	1.202	1.194	1.186	1.180
10.70	1.307	1.280	1.261	1.241	1.226	1.213	1.203	1.195	1.187	1.181
10.71	1.308	1.281	1.262	1.242	1.227	1.214	1.204	1.196	1.188	1.182
10.72	1.309	1.282	1.263	1.243	1.228	1.215	1.205	1.196	1.189	1.183
10.73	1.310	1.283	1.263	1.244	1.229	1.215	1.205	1.197	1.189	1.183
10.74	1.311	1.284	1.264	1.245	1.230	1.216	1.206	1.197	1.190	1.184
10.75	1.312	1.285	1.265	1.246	1.231	1.217	1.207	1.198	1.191	1.185
10.76	1.313	1.286	1.266	1.247	1.232	1.218	1.208	1.199	1.192	1.186
10.77	1.314	1.287	1.267	1.248	1.233	1.219	1.209	1.200	1.193	1.187
10.78	1.316	1.289	1.268	1.249	1.234	1.220	1.209	1.200	1.193	1.187
10.79	1.317	1.290	1.269	1.250	1.235	1.221	1.210	1.201	1.194	1.188
10.80	1.318	1.291	1.270	1.251	1.236	1.222	1.211	1.202	1.195	1.189
10.81	1.319	1.292	1.271	1.252	1.237	1.223	1.212	1.203	1.196	1.190
10.82	1.320	1.293	1.272	1.253	1.238	1.224	1.213	1.204	1.196	1.191
10.83	1.321	1.294	1.273	1.253	1.238	1.224	1.213	1.204	1.197	1.191
10.84	1.322	1.295	1.274	1.254	1.239	1.225	1.214	1.205	1.197	1.192
10.85	1.323	1.296	1.275	1.255	1.240	1.226	1.215	1.206	1.198	1.193
10.86	1.324	1.297	1.276	1.256	1.241	1.227	1.216	1.207	1.199	1.194
10.87	1.325	1.298	1.277	1.257	1.242	1.228	1.217	1.208	1.200	1.195
10.88	1.327	1.299	1.278	1.258	1.243	1.228	1.217	1.208	1.200	1.195
10.89	1.328	1.300	1.279	1.259	1.244	1.229	1.218	1.209	1.201	1.196
10.90	1.329	1.301	1.280	1.260	1.245	1.230	1.219	1.210	1.202	1.197
10.91	1.330	1.302	1.281	1.261	1.246	1.231	1.220	1.211	1.203	1.198
10.92	1.331	1.303	1.282	1.262	1.247	1.232	1.221	1.212	1.204	1.198
10.93	1.332	1.304	1.282	1.263	1.247	1.233	1.221	1.212	1.204	1.199
10.94	1.333	1.305	1.283	1.264	1.248	1.234	1.222	1.213	1.205	1.199
10.95	1.334	1.306	1.284	1.265	1.249	1.235	1.223	1.214	1.206	1.200
10.96	1.335	1.307	1.285	1.266	1.250	1.236	1.224	1.215	1.207	1.201
10.97	1.336	1.308	1.286	1.267	1.251	1.237	1.225	1.216	1.208	1.202
10.98	1.337	1.309	1.287	1.268	1.252	1.238	1.226	1.216	1.208	1.202
10.99	1.338	1.310	1.288	1.269	1.253	1.239	1.227	1.217	1.209	1.203

T_r										P_r 10.55 - 10.99
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.165	1.165	1.165	1.168	1.171	1.178	1.181	1.181	1.182	1.184	10.55
1.166	1.166	1.166	1.169	1.172	1.179	1.181	1.181	1.182	1.184	10.56
1.167	1.166	1.166	1.169	1.172	1.179	1.182	1.182	1.183	1.185	10.57
1.167	1.167	1.167	1.170	1.173	1.180	1.182	1.182	1.183	1.185	10.58
1.168	1.167	1.167	1.170	1.173	1.180	1.183	1.183	1.184	1.186	10.59
1.169	1.168	1.168	1.171	1.174	1.181	1.183	1.183	1.184	1.186	10.60
1.170	1.168	1.169	1.172	1.174	1.181	1.183	1.183	1.184	1.186	10.61
1.170	1.169	1.169	1.172	1.175	1.182	1.183	1.183	1.184	1.186	10.62
1.171	1.169	1.170	1.173	1.175	1.182	1.184	1.184	1.185	1.187	10.63
1.171	1.170	1.170	1.173	1.176	1.183	1.184	1.184	1.185	1.187	10.64
1.172	1.170	1.171	1.174	1.176	1.183	1.184	1.184	1.185	1.187	10.65
1.173	1.171	1.172	1.175	1.177	1.183	1.184	1.184	1.185	1.187	10.66
1.174	1.171	1.172	1.175	1.177	1.184	1.185	1.185	1.186	1.188	10.67
1.174	1.172	1.173	1.176	1.178	1.184	1.185	1.185	1.186	1.188	10.68
1.175	1.172	1.173	1.176	1.178	1.185	1.186	1.186	1.187	1.189	10.69
1.176	1.173	1.174	1.177	1.179	1.185	1.186	1.186	1.187	1.189	10.70
1.177	1.174	1.174	1.177	1.180	1.185	1.186	1.186	1.187	1.189	10.71
1.177	1.174	1.175	1.178	1.180	1.186	1.186	1.187	1.188	1.189	10.72
1.178	1.175	1.175	1.178	1.181	1.186	1.187	1.187	1.188	1.190	10.73
1.178	1.175	1.176	1.179	1.181	1.187	1.187	1.188	1.189	1.190	10.74
1.179	1.176	1.176	1.179	1.182	1.187	1.187	1.188	1.189	1.190	10.75
1.180	1.177	1.177	1.180	1.183	1.187	1.187	1.188	1.189	1.190	10.76
1.180	1.177	1.177	1.180	1.183	1.188	1.188	1.189	1.190	1.191	10.77
1.181	1.178	1.178	1.181	1.184	1.188	1.188	1.189	1.190	1.191	10.78
1.181	1.178	1.178	1.181	1.184	1.189	1.189	1.190	1.191	1.192	10.79
1.182	1.179	1.179	1.182	1.185	1.189	1.189	1.190	1.191	1.192	10.80
1.183	1.180	1.180	1.183	1.185	1.189	1.189	1.190	1.191	1.192	10.81
1.184	1.180	1.180	1.183	1.186	1.190	1.190	1.191	1.191	1.192	10.82
1.184	1.181	1.181	1.184	1.186	1.190	1.190	1.191	1.192	1.193	10.83
1.185	1.181	1.181	1.184	1.187	1.191	1.191	1.192	1.192	1.193	10.84
1.186	1.182	1.182	1.185	1.187	1.191	1.191	1.192	1.192	1.193	10.85
1.187	1.183	1.183	1.186	1.188	1.191	1.191	1.192	1.192	1.193	10.86
1.188	1.184	1.184	1.186	1.188	1.192	1.192	1.193	1.193	1.194	10.87
1.188	1.184	1.184	1.187	1.189	1.192	1.192	1.193	1.193	1.194	10.88
1.189	1.185	1.185	1.187	1.189	1.193	1.193	1.194	1.194	1.195	10.89
1.190	1.186	1.186	1.188	1.190	1.193	1.193	1.194	1.194	1.195	10.90
1.191	1.187	1.187	1.189	1.190	1.193	1.193	1.194	1.194	1.195	10.91
1.191	1.187	1.187	1.189	1.191	1.194	1.194	1.195	1.195	1.196	10.92
1.192	1.188	1.188	1.190	1.191	1.194	1.194	1.195	1.195	1.196	10.93
1.192	1.188	1.188	1.190	1.192	1.195	1.195	1.196	1.196	1.197	10.94
1.193	1.189	1.189	1.191	1.192	1.195	1.195	1.196	1.196	1.197	10.95
1.194	1.190	1.190	1.192	1.193	1.195	1.195	1.196	1.196	1.197	10.96
1.194	1.191	1.191	1.192	1.193	1.196	1.196	1.197	1.197	1.198	10.97
1.195	1.191	1.191	1.193	1.194	1.196	1.196	1.197	1.197	1.198	10.98
1.195	1.192	1.191	1.193	1.194	1.197	1.197	1.198	1.198	1.199	10.99

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.00	1.339	1.311	1.289	1.270	1.254	1.240	1.228	1.218	1.210	1.204
11.01	1.340	1.312	1.290	1.271	1.255	1.241	1.229	1.219	1.211	1.205
11.02	1.341	1.313	1.291	1.272	1.256	1.242	1.230	1.219	1.211	1.206
11.03	1.342	1.314	1.292	1.273	1.256	1.242	1.230	1.220	1.212	1.206
11.04	1.343	1.315	1.293	1.274	1.257	1.243	1.231	1.220	1.212	1.207
11.05	1.344	1.316	1.294	1.275	1.258	1.244	1.232	1.221	1.213	1.208
11.06	1.345	1.317	1.295	1.276	1.259	1.245	1.233	1.222	1.214	1.209
11.07	1.346	1.318	1.296	1.277	1.260	1.246	1.234	1.223	1.215	1.209
11.08	1.348	1.319	1.297	1.278	1.261	1.247	1.234	1.223	1.215	1.210
11.09	1.349	1.320	1.298	1.279	1.262	1.248	1.235	1.224	1.216	1.210
11.10	1.350	1.321	1.299	1.280	1.263	1.249	1.236	1.225	1.217	1.211
11.11	1.351	1.322	1.300	1.281	1.264	1.250	1.237	1.226	1.218	1.212
11.12	1.352	1.323	1.301	1.282	1.265	1.251	1.238	1.227	1.219	1.212
11.13	1.353	1.324	1.301	1.282	1.266	1.251	1.238	1.227	1.219	1.213
11.14	1.354	1.325	1.302	1.283	1.267	1.252	1.239	1.228	1.220	1.213
11.15	1.355	1.326	1.303	1.284	1.268	1.253	1.240	1.229	1.221	1.214
11.16	1.356	1.327	1.304	1.285	1.269	1.254	1.241	1.230	1.222	1.215
11.17	1.357	1.328	1.305	1.286	1.270	1.255	1.242	1.231	1.223	1.216
11.18	1.358	1.329	1.306	1.287	1.271	1.255	1.243	1.231	1.223	1.216
11.19	1.359	1.330	1.307	1.288	1.272	1.256	1.244	1.232	1.224	1.217
11.20	1.360	1.331	1.308	1.289	1.273	1.257	1.245	1.233	1.225	1.218
11.21	1.361	1.332	1.309	1.290	1.274	1.258	1.246	1.234	1.226	1.219
11.22	1.362	1.333	1.310	1.291	1.275	1.259	1.247	1.235	1.226	1.219
11.23	1.363	1.334	1.311	1.292	1.275	1.259	1.247	1.235	1.227	1.220
11.24	1.364	1.335	1.312	1.293	1.276	1.260	1.248	1.236	1.227	1.220
11.25	1.365	1.336	1.313	1.294	1.277	1.261	1.249	1.237	1.228	1.221
11.26	1.366	1.337	1.314	1.295	1.278	1.262	1.250	1.238	1.229	1.222
11.27	1.367	1.338	1.315	1.296	1.279	1.263	1.251	1.239	1.230	1.223
11.28	1.368	1.339	1.316	1.297	1.280	1.263	1.251	1.239	1.230	1.223
11.29	1.369	1.340	1.317	1.298	1.281	1.264	1.252	1.240	1.231	1.224
11.30	1.370	1.341	1.318	1.299	1.282	1.265	1.253	1.241	1.232	1.225
11.31	1.371	1.342	1.319	1.300	1.283	1.266	1.254	1.242	1.233	1.226
11.32	1.372	1.343	1.320	1.301	1.284	1.267	1.255	1.243	1.234	1.226
11.33	1.373	1.344	1.321	1.301	1.284	1.267	1.255	1.243	1.234	1.227
11.34	1.374	1.345	1.322	1.302	1.285	1.268	1.256	1.244	1.235	1.227
11.35	1.375	1.346	1.323	1.303	1.286	1.269	1.257	1.245	1.236	1.228
11.36	1.376	1.347	1.324	1.304	1.287	1.270	1.258	1.246	1.237	1.229
11.37	1.377	1.348	1.325	1.305	1.288	1.271	1.259	1.247	1.238	1.230
11.38	1.379	1.249	1.326	1.306	1.289	1.271	1.259	1.247	1.238	1.230.
11.39	1.380	1.350	1.327	1.307	1.290	1.272	1.260	1.248	1.239	1.231
11.40	1.381	1.351	1.328	1.308	1.291	1.273	1.261	1.249	1.240	1.232
11.41	1.382	1.352	1.329	1.309	1.292	1.274	1.262	1.250	1.241	1.233
11.42	1.383	1.353	1.330	1.310	1.293	1.275	1.263	1.251	1.241	1.234
11.43	1.384	1.354	1.331	1.311	1.293	1.275	1.263	1.251	1.242	1.234
11.44	1.385	1.355	1.332	1.312	1.294	1.276	1.264	1.252	1.242	1.235

T_r										P_r 11.00 - 11.44
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.196	1.193	1.192	1.194	1.195	1.197	1.197	1.198	1.198	1.199	11.00
1.197	1.194	1.192	1.194	1.195	1.197	1.197	1.198	1.198	1.199	11.01
1.197	1.194	1.193	1.195	1.196	1.198	1.198	1.198	1.198	1.199	11.02
1.198	1.195	1.193	1.195	1.196	1.198	1.198	1.199	1.199	1.200	11.03
1.198	1.195	1.194	1.196	1.197	1.199	1.199	1.199	1.199	1.200	11.04
1.199	1.196	1.194	1.196	1.197	1.199	1.199	1.199	1.199	1.200	11.05
1.200	1.197	1.194	1.197	1.198	1.199	1.199	1.199	1.199	1.200	11.06
1.200	1.197	1.195	1.197	1.198	1.200	1.200	1.200	1.200	1.201	11.07
1.201	1.198	1.194	1.198	1.199	1.200	1.200	1.200	1.200	1.201	11.08
1.201	1.198	1.196	1.198	1.199	1.201	1.201	1.201	1.201	1.202	11.09
1.202	1.199	1.196	1.199	1.200	1.201	1.201	1.201	1.201	1.202	11.10
1.203	1.200	1.197	1.199	1.200	1.201	1.201	1.201	1.201	1.202	11.11
1.204	1.200	1.197	1.200	1.201	1.202	1.202	1.202	1.202	1.202	11.12
1.204	1.201	1.198	1.200	1.201	1.202	1.202	1.202	1.202	1.202	11.13
1.205	1.201	1.198	1.201	1.202	1.203	1.203	1.203	1.203	1.203	11.14
1.206	1.202	1.199	1.201	1.202	1.203	1.203	1.203	1.203	1.203	11.15
1.207	1.203	1.200	1.202	1.202	1.204	1.203	1.203	1.203	1.203	11.16
1.208	1.203	1.200	1.202	1.203	1.204	1.204	1.204	1.204	1.204	11.17
1.208	1.204	1.201	1.203	1.203	1.205	1.204	1.204	1.204	1.204	11.18
1.209	1.204	1.201	1.203	1.204	1.205	1.205	1.205	1.205	1.205	11.19
1.210	1.205	1.202	1.204	1.204	1.205	1.205	1.205	1.205	1.205	11.20
1.211	1.206	1.203	1.204	1.204	1.205	1.205	1.205	1.205	1.205	11.21
1.211	1.206	1.203	1.205	1.205	1.206	1.206	1.206	1.206	1.206	11.22
1.212	1.207	1.204	1.025	1.205	1.206	1.206	1.206	1.206	1.206	11.23
1.212	1.207	1.204	1.206	1.206	1.207	1.207	1.207	1.207	1.207	11.24
1.213	1.208	1.205	1.206	1.206	1.207	1.207	1.207	1.207	1.207	11.25
1.214	1.209	1.206	1.207	1.207	1.207	1.207	1.207	1.207	1.207	11.26
1.215	1.209	1.206	1.207	1.207	1.208	1.208	1.208	1.208	1.208	11.27
1.215	1.210	21.07	1.208	1.208	1.208	1.208	1.208	1.208	1.208	11.28
1.216	1.210	12.07	1.208	1.208	1.209	1.209	1.209	1.209	1.209	11.29
1.217	1.211	1.208	1.209	1.209	1.209	1.209	1.209	1.209	1.209	11.30
1.218	1.212	1.209	1.209	1.209	1.209	1.209	1.209	1.209	1.209	11.31
1.218	1.212	1.209	1.210	1.210	1.210	1.210	1.210	1.209	1.209	11.32
1.219	1.213	1.210	1.210	1.210	1.210	1.210	1.210	1.210	1.210	11.33
1.219	1.213	1.210	1.211	1.211	1.211	1.211	1.211	1.210	1.210	11.34
1.220	1.214	1.211	1.211	1.211	1.211	1.211	1.211	1.210	1.210	11.35
1.221	1.215	1.212	1.212	1.212	1.212	1.212	1.211	1.210	1.210	11.36
1.222	1.215	1.212	1.212	1.212	1.212	1.212	1.212	1.211	1.211	11.37
1.222	1.216	1.213	1.213	1.213	1.213	1.213	1.212	1.211	1.211	11.38
1.223	1.216	1.213	1.213	1.213	1.213	1.213	1.213	1.212	1.212	11.39
1.224	1.217	1.214	1.214	1.214	1.214	1.214	1.213	1.212	1.212	11.40
1.225	1.218	1.214	1.214	1.214	1.214	1.214	1.213	1.212	1.212	11.41
1.225	1.218	1.215	1.215	1.215	1.215	1.215	1.214	1.213	1.212	11.42
1.226	1.219	1.216	1.215	1.215	1.215	1.215	1.214	1.213	1.213	11.43
1.226	1.219	1.216	1.216	1.216	1.216	1.216	1.215	1.214	1.213	11.44

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.45	1.386	1.356	1.333	1.313	1.295	1.277	1.265	1.253	1.243	1.236
11.46	1.387	1.357	1.334	1.314	1.296	1.278	1.266	1.253	1.244	1.237
11.47	1.388	1.358	1.335	1.315	1.297	1.279	1.267	1.254	1.245	1.238
11.48	1.389	1.360	1.336	1.316	1.298	1.280	1.267	1.254	1.245	1.238
11.49	1.390	1.361	1.337	1.317	1.299	1.281	1.268	1.255	1.246	1.239
11.50	1.391	1.362	1.338	1.318	1.300	1.282	1.269	1.257	1.247	1.240
11.51	1.392	1.363	1.339	1.319	1.301	1.283	1.270	1.258	1.248	1.241
11.52	1.393	1.364	1.340	1.320	1.302	1.284	1.271	1.258	1.249	1.242
11.53	1.394	1.365	1.341	1.320	1.302	1.284	1.271	1.259	1.249	1.242
11.54	1.395	1.366	1.342	1.321	1.303	1.285	1.272	1.259	1.250	1.243
11.55	1.396	1.367	1.343	1.322	1.304	1.286	1.273	1.260	1.251	1.244
11.56	1.397	1.368	1.344	1.323	1.305	1.287	1.274	1.261	1.252	1.245
11.57	1.398	1.369	1.345	1.324	1.306	1.288	1.275	1.262	1.253	1.246
11.58	1.400	1.370	1.346	1.325	1.307	1.289	1.275	1.262	1.253	1.246
11.59	1.401	1.371	1.347	1.326	1.308	1.290	1.276	1.263	1.254	1.247
11.60	1.402	1.372	1.348	1.327	1.309	1.291	1.277	1.264	1.255	1.248
11.61	1.403	1.373	1.349	1.328	1.310	1.292	1.278	1.265	1.256	1.249
11.62	1.404	1.374	1.350	1.329	1.311	1.293	1.279	1.266	1.256	1.249
11.63	1.405	1.375	1.351	1.329	1.311	1.293	1.279	1.267	1.257	1.250
11.64	1.406	1.376	1.352	1.330	1.312	1.294	1.280	1.267	1.257	1.250
11.65	1.407	1.377	1.353	1.331	1.313	1.295	1.281	1.268	1.258	1.251
11.66	1.408	1.378	1.354	1.332	1.314	1.296	1.282	1.269	1.259	1.252
11.67	1.409	1.379	1.355	1.333	1.315	1.297	1.283	1.270	1.260	1.253
11.68	1.410	1.380	1.356	1.334	1.315	1.298	1.284	1.270	1.260	1.253
11.69	1.411	1.381	1.357	1.335	1.316	1.299	1.285	1.271	1.261	1.254
11.70	1.412	1.382	1.358	1.336	1.317	1.300	1.286	1.272	1.262	1.255
11.71	1.413	1.383	1.359	1.337	1.318	1.301	1.287	1.273	1.263	1.256
11.72	1.414	1.384	1.360	1.338	1.319	1.302	1.288	1.274	1.263	1.257
11.73	1.415	1.385	1.361	1.338	1.319	1.303	1.288	1.274	1.264	1.257
11.74	1.416	1.386	1.362	1.339	1.320	1.304	1.289	1.275	1.264	1.258
11.75	1.417	1.387	1.363	1.340	1.321	1.305	1.290	1.276	1.265	1.259
11.76	1.418	1.388	1.364	1.341	1.322	1.306	1.291	1.277	1.266	1.260
11.77	1.419	1.389	1.365	1.342	1.323	1.307	1.292	1.278	1.267	1.260
11.78	1.421	1.390	1.366	1.343	1.324	1.307	1.292	1.278	1.267	1.261
11.79	1.422	1.391	1.367	1.344	1.325	1.308	1.293	1.279	1.268	1.261
11.80	1.423	1.392	1.268	1.345	1.326	1.309	1.294	1.280	1.269	1.262
11.81	1.424	1.393	1.369	1.346	1.327	1.310	1.295	1.281	1.270	1.263
11.82	1.425	1.394	1.370	1.347	1.328	1.311	1.296	1.282	1.271	1.264
11.83	1.426	1.395	1.371	1.348	1.328	1.311	1.296	1.282	1.271	1.264
11.84	1.427	1.396	1.372	1.349	1.329	1.312	1.297	1.283	1.272	1.265
11.85	1.428	1.397	1.373	1.350	1.330	1.313	1.298	1.284	1.273	1.266
11.86	1.429	1.398	1.374	1.351	1.331	1.314	1.299	1.285	1.274	1.267
11.87	1.430	1.399	1.375	1.352	1.332	1.315	1.300	1.286	1.274	1.268
11.88	1.431	1.400	1.376	1.353	1.333	1.316	1.300	1.286	1.275	1.268
11.89	1.432	1.401	1.377	1.354	1.334	1.317	1.301	1.287	1.276	1.269

T_r										P_r 11.45 - 11.89
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.227	1.220	1.217	1.216	1.216	1.216	1.216	1.215	1.214	1.213	11.45
1.228	1.221	1.218	1.217	1.217	1.217	1.216	1.215	1.214	1.213	11.46
1.229	1.222	1.218	1.217	1.217	1.217	1.217	1.216	1.215	1.214	11.47
1.229	1.222	1.219	1.218	1.218	1.218	1.217	1.216	1.215	1.214	11.48
1.230	1.223	1.219	1.218	1.218	1.218	1.218	1.217	1.216	1.215	11.49
1.231	1.224	1.220	1.219	1.219	1.219	1.218	1.217	1.216	1.215	11.50
1.232	1.225	1.221	1.220	1.219	1.219	1.218	1.217	1.216	1.215	11.51
1.232	1.225	1.221	1.220	1.220	1.220	1.219	1.218	1.217	1.216	11.52
1.233	1.226	1.222	1.221	1.220	1.220	1.219	1.218	1.217	1.216	11.53
1.233	1.226	1.222	1.221	1.221	1.221	1.220	1.219	1.218	1.217	11.54
1.234	1.227	1.223	1.222	1.221	1.221	1.220	1.219	1.218	1.217	11.55
1.235	1.228	1.224	1.223	1.222	1.221	1.220	1.219	1.218	1.217	11.56
1.236	1.228	1.224	1.223	1.222	1.222	1.221	1.220	1.219	1.218	11.57
1.236	1.229	1.225	1.224	1.223	1.222	1.221	1.220	1.219	1.218	11.58
1.237	1.229	1.225	1.224	1.223	1.223	1.222	1.221	1.220	1.219	11.59
1.238	1.230	1.226	1.225	1.224	1.223	1.222	1.221	1.220	1.219	11.60
1.239	1.231	1.227	1.225	1.224	1.223	1.222	1.221	1.220	1.219	11.61
1.239	1.231	1.227	1.226	1.225	1.224	1.222	1.221	1.220	1.219	11.62
1.240	1.232	1.228	1.226	1.225	1.224	1.223	1.222	1.221	1.220	11.63
1.240	1.232	1.228	1.227	1.226	1.225	1.223	1.222	1.221	1.220	11.64
1.241	1.233	1.229	1.227	1.226	1.225	1.223	1.222	1.221	1.220	11.65
1.242	1.234	1.230	1.228	1.227	1.225	1.223	1.222	1.221	1.220	11.66
1.243	1.234	1.230	1.228	1.227	1.226	1.224	1.223	1.222	1.221	11.67
1.243	1.235	1.231	1.229	1.228	1.226	1.224	1.223	1.222	1.221	11.68
1.244	1.235	1.231	1.229	1.228	1.227	1.225	1.224	1.223	1.222	11.69
1.245	1.236	1.232	1.230	1.229	1.227	1.225	1.224	1.223	1.222	11.70
1.246	1.237	1.233	1.231	1.230	1.227	1.225	1.224	1.223	1.222	11.71
1.246	1.237	1.233	1.231	1.230	1.228	1.226	1.225	1.223	1.223	11.72
1.247	1.238	1.234	1.232	1.231	1.228	1.226	1.224	1.224	1.223	11.73
1.247	1.238	1.234	1.232	1.231	1.229	1.227	1.226	1.225	1.224	11.74
1.248	1.239	1.235	1.233	1.232	1.229	1.227	1.226	1.225	1.224	11.75
1.249	1.240	1.236	1.234	1.232	1.229	1.227	1.226	1.225	1.224	11.76
1.250	1.241	1.236	1.234	1.233	1.230	1.228	1.227	1.226	1.225	11.77
1.250	1.241	1.237	1.235	1.233	1.230	1.228	1.227	1.226	1.225	11.78
1.251	1.242	1.237	1.235	1.234	1.231	1.229	1.228	1.227	1.226	11.79
1.252	1.243	1.238	1.236	1.234	1.231	1.229	1.228	1.227	1.226	11.80
1.253	1.244	1.238	1.236	1.234	1.231	1.229	1.228	1.227	1.226	11.81
1.253	1.244	1.239	1.237	1.235	1.232	1.230	1.228	1.227	1.226	11.82
1.254	1.245	1.239	1.237	1.235	1.232	1.230	1.229	1.227	1.226	11.83
1.254	1.245	1.240	1.238	1.236	1.233	1.231	1.229	1.228	1.227	11.84
1.255	1.246	1.240	1.238	1.236	1.233	1.231	1.229	1.228	1.227	11.85
1.256	1.247	1.241	1.239	1.237	1.234	1.231	1.229	1.228	1.227	11.86
1.257	1.248	1.241	1.239	1.237	1.234	1.232	1.230	1.229	1.228	11.87
1.257	1.248	1.242	1.240	1.238	1.235	1.232	1.230	1.229	1.228	11.88
1.258	1.249	1.242	1.240	1.238	1.235	1.233	1.231	1.230	1.229	11.89

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.90	1.433	1.402	1.378	1.355	1.335	1.318	1.302	1.288	1.277	1.270
11.91	1.434	1.403	1.379	1.356	1.336	1.319	1.303	1.289	1.278	1.271
11.92	1.435	1.404	1.380	1.357	1.337	1.320	1.304	1.290	1.278	1.272
11.93	1.436	1.405	1.381	1.357	1.337	1.320	1.304	1.290	1.279	1.272
11.94	1.437	1.406	1.382	1.358	1.338	1.321	1.305	1.291	1.279	1.273
11.95	1.438	1.407	1.383	1.359	1.339	1.322	1.306	1.292	1.280	1.274
11.96	1.439	1.408	1.384	1.360	1.340	1.323	1.307	1.293	1.281	1.275
11.97	1.440	1.409	1.385	1.361	1.341	1.324	1.308	1.294	1.282	1.276
11.98	1.442	1.411	1.386	1.362	1.342	1.325	1.308	1.294	1.282	1.276
11.99	1.443	1.412	1.387	1.363	1.343	1.326	1.309	1.295	1.283	1.277
12.00	1.444	1.413	1.388	1.364	1.344	1.327	1.310	1.296	1.284	1.278
12.01	1.445	1.414	1.389	1.365	1.345	1.328	1.311	1.297	1.285	1.279
12.02	1.446	1.415	1.390	1.366	1.346	1.329	1.312	1.297	1.286	1.279
12.03	1.447	1.416	1.391	1.366	1.346	1.329	1.312	1.298	1.286	1.280
12.04	1.448	1.417	1.392	1.367	1.347	1.330	1.313	1.298	1.287	1.280
12.05	1.449	1.418	1.393	1.368	1.348	1.331	1.314	1.299	1.288	1.281
12.06	1.450	1.419	1.394	1.369	1.349	1.332	1.315	1.300	1.289	1.282
12.07	1.451	1.420	1.395	1.370	1.350	1.333	1.316	1.301	1.290	1.283
12.08	1.452	1.421	1.396	1.371	1.351	1.333	1.316	1.301	1.290	1.283
12.09	1.453	1.422	1.397	1.372	1.352	1.334	1.317	1.302	1.291	1.284
12.10	1.454	1.423	1.398	1.373	1.353	1.335	1.318	1.303	1.292	1.285
12.11	1.455	1.424	1.399	1.374	1.354	1.336	1.319	1.304	1.293	1.286
12.12	1.456	1.425	1.400	1.375	1.355	1.337	1.320	1.305	1.294	1.286
12.13	1.457	1.426	1.401	1.376	1.355	1.337	1.320	1.305	1.294	1.287
12.14	1.458	1.427	1.402	1.377	1.356	1.338	1.321	1.306	1.295	1.287
12.15	1.459	1.428	1.403	1.378	1.357	1.339	1.322	1.307	1.296	1.288
12.16	1.460	1.429	1.404	1.379	1.358	1.340	1.323	1.308	1.297	1.289
12.17	1.461	1.430	1.405	1.380	1.359	1.341	1.324	1.309	1.298	1.290
12.18	1.463	1.431	1.406	1.381	1.360	1.342	1.324	1.309	1.298	1.290
12.19	1.464	1.432	1.407	1.382	1.361	1.343	1.325	1.310	1.299	1.291
12.20	1.465	1.433	1.408	1.383	1.362	1.344	1.326	1.311	1.300	1.292
12.21	1.466	1.434	1.409	1.384	1.363	1.345	1.327	1.312	1.301	1.293
12.22	1.467	1.435	1.410	1.385	1.364	1.346	1.328	1.313	1.302	1.293
12.23	1.468	1.435	1.411	1.386	1.364	1.346	1.328	1.313	1.302	1.294
12.24	1.469	1.437	1.412	1.387	1.365	1.347	1.329	1.314	1.303	1.294
12.25	1.470	1.438	1.413	1.388	1.366	1.348	1.330	1.315	1.304	1.295
12.26	1.471	1.439	1.414	1.389	1.567	1.349	1.331	1.316	1.305	1.296
12.27	1.472	1.440	1.415	1.390	1.368	1.350	1.332	1.317	1.305	1.297
12.28	1.473	1.441	1.416	1.390	1.369	1.351	1.332	1.317	1.306	1.297
12.29	1.474	1.442	1.417	1.391	1.370	1.352	1.333	1.318	1.306	1.298
12.30	1.475	1.443	1.318	1.392	1.371	1.353	1.334	1.319	1.307	1.299
12.31	1.476	1.444	1.419	1.393	1.372	1.354	1.335	1.320	1.308	1.300
12.32	1.477	1.445	1.420	1.394	1.373	1.355	1.336	1.321	1.309	1.301
12.33	1.478	1.446	1.421	1.395	1.373	1.355	1.336	1.321	1.309	1.301
12.34	1.479	1.447	1.422	1.396	1.374	1.356	1.337	1.322	1.310	1.302

				T_r						P_r 11.90 - 12.34
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.259	1.250	1.243	1.241	1.239	1.236	1.233	1.231	1.230	1.229	11.90
1.260	1.251	1.244	1.242	1.239	1.236	1.233	1.231	1.230	1.229	11.91
1.260	1.251	1.244	1.242	1.240	1.237	1.234	1.232	1.230	1.229	11.92
1.261	1.252	1.245	1.243	1.240	1.237	1.234	1.232	1.231	1.230	11.93
1.261	1.252	1.245	1.243	1.241	1.238	1.235	1.233	1.231	1.230	11.94
1.262	1.253	1.246	1.244	1.241	1.238	1.235	1.233	1.231	1.230	11.95
1.263	1.254	1.247	1.245	1.242	1.238	1.235	1.233	1.231	1.230	11.96
1.264	1.254	1.247	1.245	1.242	1.239	1.236	1.234	1.232	1.231	11.97
1.264	1.255	1.248	1.246	1.243	1.239	1.236	1.234	1.232	1.231	11.98
1.265	1.255	1.248	1.246	1.243	1.240	1.237	1.235	1.233	1.232	11.99
1.266	1.256	1.249	1.247	1.244	1.240	1.237	1.235	1.233	1.232	12.00
1.267	1.257	1.250	1.247	1.244	1.240	1.237	1.235	1.233	1.232	12.01
1.267	1.257	1.250	1.248	1.245	1.241	1.237	1.235	1.234	1.233	12.02
1.268	1.258	1.251	1.248	1.245	1.241	1.238	1.236	1.234	1.233	12.03
1.268	1.258	1.251	1.249	1.246	1.242	1.238	1.236	1.235	1.234	12.04
1.269	1.259	1.252	1.249	1.246	1.242	1.238	1.236	1.235	1.234	12.05
1.270	1.260	1.253	1.249	1.247	1.242	1.238	1.236	1.235	1.234	12.06
1.270	1.260	1.253	1.250	1.247	1.243	1.239	1.237	1.236	1.235	12.07
1.271	1.261	1.254	1.250	1.248	1.243	1.239	1.237	1.236	1.235	12.08
1.271	1.262	1.254	1.251	1.248	1.244	1.240	1.238	1.237	1.236	12.09
1.272	1.262	1.255	1.251	1.249	1.244	1.240	1.238	1.237	1.236	12.10
1.273	1.263	1.256	1.252	1.249	1.244	1.240	1.238	1.237	1.236	12.11
1.273	1.263	1.256	1.252	1.250	1.245	1.241	1.239	1.237	1.236	12.12
1.274	1.264	1.257	1.253	1.250	1.245	1.241	1.239	1.238	1.237	12.13
1.274	1.264	1.257	1.253	1.251	1.246	1.242	1.240	1.238	1.237	12.14
1.275	1.265	1.258	1.254	1.251	1.246	1.242	1.240	1.238	1.237	12.15
1.276	1.266	1.259	1.255	1.252	1.246	1.242	1.240	1.238	1.237	12.16
1.277	1.266	1.259	1.255	1.252	1.247	1.243	1.241	1.239	1.238	12.17
1.277	1.267	1.260	1.256	1.253	1.247	1.243	1.241	1.239	1.238	12.18
1.278	1.267	1.260	1.256	1.253	1.248	1.244	1.242	1.240	1.239	12.19
1.279	1.268	1.261	1.257	1.254	1.248	1.244	1.242	1.240	1.239	12.20
1.280	1.269	1.262	1.257	1.254	1.248	1.244	1.242	1.240	1.239	12.21
1.281	1.269	1.262	1.258	1.255	1.249	1.245	1.243	1.241	1.240	12.22
1.281	1.270	1.263	1.258	1.255	1.259	1.245	1.243	1.241	1.240	12.23
1.282	1.270	1.263	1.259	1.256	1.250	1.246	1.244	1.242	1.241	12.24
1.283	1.271	1.264	1.259	1.256	1.250	1.246	1.244	1.242	1.241	12.25
1.284	1.272	1.265	1.260	1.257	1.250	1.246	1.244	1.242	1.241	12.26
1.285	1.272	1.265	1.260	1.257	1.251	1.247	1.245	1.243	1.242	12.27
1.285	1.273	1.266	1.261	1.258	1.251	1.247	1.245	1.243	1.242	12.28
1.286	1.273	1.266	1.261	1.258	1.252	1.248	1.246	1.244	1.243	12.29
1.287	1.274	1.267	1.262	1.259	1.252	1.248	1.246	1.244	1.243	12.30
1.288	1.275	1.268	1.263	1.259	1.252	1.248	1.246	1.244	1.243	12.31
1.288	1.275	1.268	1.263	1.260	1.253	1.249	1.246	1.245	1.244	12.32
1.289	1.276	1.269	1.264	1.260	1.253	1.249	1.247	1.245	1.244	12.33
1.289	1.276	1.269	1.264	1.261	1.254	1.250	1.247	1.246	1.245	12.34

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
12.35	1.480	1.448	1.423	1.397	1.375	1.357	1.338	1.323	1.311	1.303
12.36	1.481	1.449	1.424	1.398	1.376	1.358	1.339	1.324	1.312	1.304
12.37	1.482	1.450	1.425	1.399	1.377	1.359	1.340	1.325	1.313	1.305
12.38	1.484	1.451	1.426	1.400	1.378	1.360	1.340	1.325	1.313	1.305
12.39	1.485	1.452	1.427	1.401	1.379	1.361	1.341	1.326	1.314	1.306
12.40	1.486	1.453	1.428	1.402	1.380	1.362	1.342	1.327	1.315	1.307
12.41	1.487	1.454	1.429	1.403	1.381	1.363	1.343	1.328	1.316	1.308
12.42	1.488	1.455	1.430	1.404	1.382	1.364	1.344	1.328	1.317	1.308
12.43	1.489	1.456	1.431	1.405	1.382	1.364	1.344	1.329	1.317	1.309
12.44	1.490	1.457	1.432	1.406	1.383	1.365	1.345	1.329	1.318	1.309
12.45	1.491	1.458	1.433	1.407	1.384	1.366	1.346	1.330	1.319	1.310
12.46	1.492	1.459	1.434	1.408	1.385	1.367	1.347	1.331	1.320	1.311
12.47	1.493	1.460	1.435	1.409	1.386	1.368	1.348	1.332	1.321	1.311
12.48	1.494	1.462	1.436	1.409	1.387	1.368	1.348	1.332	1.321	1.312
12.49	1.495	1.463	1.437	1.410	1.388	1.369	1.349	1.333	1.322	1.312
12.50	1.496	1.464	1.438	1.411	1.389	1.370	1.350	1.334	1.323	1.313
12.51	1.497	1.465	1.439	1.412	1.390	1.371	1.351	1.335	1.324	1.314
12.52	1.498	1.466	1.440	1.413	1.391	1.372	1.352	1.336	1.324	1.315
12.53	1.499	1.467	1.441	1.414	1.392	1.372	1.352	1.336	1.325	1.315
12.54	1.500	1.468	1.442	1.415	1.393	1.373	1.353	1.337	1.325	1.316
12.55	1.501	1.469	1.443	1.416	1.394	1.374	1.354	1.338	1.326	1.317
12.56	1.502	1.470	1.444	1.417	1.395	1.375	1.355	1.339	1.327	1.318
12.57	1.503	1.471	1.445	1.418	1.396	1.376	1.356	1.340	1.328	1.319
12.58	1.505	1.472	1.446	1.418	1.397	1.377	1.356	1.340	1.328	1.319
12.59	1.506	1.473	1.447	1.419	1.398	1.378	1.357	1.341	1.329	1.320
12.60	1.507	1.474	1.448	1.420	1.399	1.379	1.358	1.342	1.330	1.321
12.61	1.508	1.475	1.449	1.421	1.400	1.380	1.359	1.343	1.331	1.322
12.62	1.509	1.476	1.450	1.422	1.401	1.381	1.360	1.344	1.332	1.323
12.63	1.510	1.477	1.451	1.423	1.402	1.381	1.360	1.344	1.332	1.323
12.64	1.511	1.478	1.452	1.424	1.403	1.382	1.361	1.345	1.333	1.324
12.65	1.512	1.479	1.453	1.425	1.404	1.383	1.362	1.346	1.334	1.325
12.66	1.513	1.480	1.454	1.426	1.405	1.384	1.363	1.347	1.335	1.326
12.67	1.514	1.481	1.455	1.427	1.406	1.385	1.364	1.348	1.335	1.327
12.68	1.515	1.482	1.456	1.428	1.407	1.386	1.365	1.348	1.336	1.327
12.69	1.516	1.483	1.457	1.429	1.408	1.387	1.366	1.349	1.336	1.328
12.70	1.517	1.484	1.458	1.430	1.409	1.388	1.367	1.350	1.337	1.329
12.71	1.518	1.485	1.459	1.431	1.410	1.389	1.368	1.351	1.338	1.330
12.72	1.519	1.486	1.460	1.432	1.411	1.390	1.369	1.352	1.339	1.330
12.73	1.520	1.487	1.461	1.433	1.411	1.390	1.369	1.352	1.339	1.331
12.74	1.521	1.488	1.462	1.434	1.412	1.391	1.370	1.353	1.340	1.331
12.75	1.522	1.489	1.463	1.435	1.413	1.392	1.371	1.354	1.341	1.332
12.76	1.523	1.490	1.464	1.436	1.414	1.393	1.372	1.355	1.342	1.333
12.77	1.524	1.491	1.465	1.437	1.415	1.394	1.373	1.356	1.343	1.334
12.78	1.525	1.492	1.466	1.437	1.416	1.395	1.373	1.356	1.343	1.334
12.79	1.526	1.494	1.467	1.438	1.417	1.396	1.374	1.357	1.344	1.335

T_r									P_r 12.35 - 12.79
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.290	1.277	1.270	1.265	1.261	1.254	1.250	1.247	1.246	1.245	12.35
1.291	1.278	1.271	1.266	1.262	1.254	1.250	1.247	1.246	1.245	12.36
1.291	1.279	1.271	1.266	1.262	1.255	1.251	1.248	1.247	1.246	12.37
1.292	1.279	1.272	1.267	1.263	1.255	1.251	1.248	1.247	1.246	12.38
1.292	1.280	1.272	1.267	1.263	1.256	1.252	1.249	1.248	1.247	12.39
1.293	1.281	1.273	1.268	1.264	1.256	1.252	1.249	1.248	1.247	12.40
1.294	1.282	1.274	1.268	1.264	1.256	1.252	1.249	1.248	1.247	12.41
1.294	1.282	1.274	1.269	1.265	1.257	1.253	1.249	1.248	1.247	12.42
1.295	1.283	1.275	1.269	1.265	1.257	1.253	1.250	1.249	1.248	12.43
1.295	1.283	1.275	1.270	1.266	1.258	1.254	1.250	1.249	1.248	12.44
1.296	1.284	1.276	1.270	1.266	1.258	1.254	1.250	1.249	1.248	12.45
1.297	1.285	1.277	1.271	1.267	1.259	1.254	1.250	1.249	1.248	12.46
1.298	1.286	1.277	1.271	1.267	1.259	1.255	1.251	1.250	1.249	12.47
1.298	1.286	1.278	1.272	1.268	1.260	1.255	1.251	1.250	1.249	12.48
1.299	1.287	1.278	1.272	1.268	1.260	1.256	1.252	1.251	1.250	12.49
1.300	1.288	1.279	1.273	1.269	1.261	1.256	1.252	1.251	1.250	12.50
1.301	1.288	1.280	1.273	1.269	1.261	1.256	1.252	1.251	1.250	12.51
1.301	1.289	1.280	1.274	1.270	1.262	1.257	1.253	1.251	1.250	12.52
1.302	1.289	1.281	1.274	1.270	1.262	1.257	1.253	1.252	1.251	12.53
1.302	1.290	1.281	1.275	1.271	1.263	1.258	1.254	1.252	1.251	12.54
1.303	1.290	1.282	1.275	1.271	1.263	1.258	1.254	1.252	1.251	12.55
1.304	1.291	1.283	1.276	1.271	1.263	1.258	1.254	1.252	1.251	12.56
1.305	1.291	1.283	1.276	1.272	1.264	1.259	1.255	1.253	1.252	12.57
1.305	1.292	1.284	1.277	1.272	1.264	1.259	1.255	1.253	1.252	12.58
1.306	1.292	1.284	1.277	1.273	1.265	1.260	1.256	1.254	1.253	12.59
1.307	1.293	1.285	1.278	1.273	1.265	1.260	1.256	1.254	1.253	12.60
1.308	1.294	1.286	1.278	1.274	1.265	1.260	1.256	1.254	1.253	12.61
1.308	1.295	1.286	1.279	1.274	1.266	1.260	1.256	1.255	1.254	12.62
1.309	1.295	1.287	1.279	1.275	1.266	1.261	1.257	1.255	1.254	12.63
1.309	1.296	1.287	1.280	1.275	1.267	1.261	1.257	1.256	1.255	12.64
1.310	1.297	1.288	1.280	1.276	1.267	1.261	1.257	1.256	1.255	12.65
1.311	1.298	1.289	1.281	1.277	1.267	1.261	1.257	1.256	1.255	12.66
1.312	1.298	1.289	1.281	1.277	1.268	1.262	1.258	1.257	1.256	12.67
1.312	1.299	1.290	1.282	1.278	1.268	1.262	1.258	1.257	1.256	12.68
1.313	1.299	1.290	1.282	1.278	1.269	1.263	1.259	1.258	1.257	12.69
1.314	1.300	1.291	1.283	1.279	1.269	1.263	1.259	1.258	1.257	12.70
1.315	1.301	1.292	1.284	1.279	1.269	1.263	1.259	1.258	1.257	12.71
1.315	1.301	1.292	1.284	1.280	1.270	1.264	1.260	1.258	1.257	12.72
1.316	1.302	1.293	1.285	1.280	1.270	1.264	1.260	1.259	1.258	12.73
1.316	1.302	1.293	1.285	1.281	1.271	1.265	1.261	1.259	1.258	12.74
1.317	1.303	1.294	1.286	1.281	1.271	1.265	1.261	1.259	1.258	12.75
1.318	1.304	1.295	1.287	1.281	1.271	1.265	1.261	1.259	1.258	12.76
1.319	1.304	1.295	1.287	1.282	1.272	1.266	1.262	1.260	1.259	12.77
1.319	1.305	1.296	1.288	1.282	1.272	1.266	1.262	1.260	1.259	12.78
1.320	1.305	1.296	1.288	1.283	1.273	1.267	1.263	1.261	1.260	12.79

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
12.80	1.527	1.495	1.468	1.439	1.418	1.397	1.375	1.358	1.345	1.336
12.81	1.528	1.496	1.469	1.440	1.419	1.398	1.376	1.359	1.346	1.337
12.82	1.529	1.497	1.470	1.441	1.420	1.399	1.377	1.360	1.346	1.337
12.83	1.530	1.498	1.471	1.442	1.420	1.399	1.377	1.360	1.347	1.338
12.84	1.531	1.499	1.472	1.443	1.421	1.400	1.378	1.361	1.347	1.338
12.85	1.532	1.500	1.473	1.444	1.422	1.401	1.379	1.362	1.348	1.339
12.86	1.533	1.501	1.474	1.445	1.423	1.402	1.380	1.363	1.349	1.340
12.87	1.534	1.502	1.475	1.446	1.424	1.403	1.381	1.363	1.350	1.340
12.88	1.535	1.503	1.475	1.447	1.425	1.403	1.381	1.364	1.350	1.341
12.89	1.536	1.504	1.476	1.448	1.426	1.404	1.382	1.364	1.351	1.341
12.90	1.537	1.505	1.477	1.449	1.427	1.405	1.383	1.365	1.352	1.342
12.91	1.538	1.506	1.478	1.450	1.428	1.406	1.384	1.366	1.353	1.343
12.92	1.539	1.507	1.479	1.451	1.429	1.407	1.385	1.367	1.354	1.344
12.93	1.540	1.508	1.480	1.452	1.429	1.407	1.385	1.367	1.354	1.344
12.94	1.541	1.509	1.481	1.453	1.430	1.308	1.386	1.368	1.355	1.345
12.95	1.542	1.510	1.482	1.454	1.431	1.409	1.387	1.369	1.356	1.346
12.96	1.543	1.511	1.483	1.455	1.432	1.410	1.388	1.370	1.357	1.347
12.97	1.544	1.512	1.484	1.456	1.433	1.411	1.389	1.371	1.358	1.348
12.98	1.546	1.513	1.485	1.456	1.434	1.412	1.389	1.372	1.358	1.348
12.99	1.547	1.514	1.486	1.457	1.435	1.413	1.390	1.373	1.359	1.349
13.00	1.548	1.515	1.487	1.458	1.436	1.414	1.391	1.374	1.360	1.350
13.01	1.549	1.516	1.488	1.459	1.437	1.415	1.392	1.375	1.361	1.351
13.02	1.550	1.517	1.489	1.460	1.438	1.416	1.393	1.376	1.362	1.352
13.03	1.551	1.518	1.490	1.461	1.438	1.416	1.393	1.376	1.362	1.352
13.04	1.552	1.519	1.491	1.462	1.439	1.417	1.394	1.377	1.363	1.353
13.05	1.553	1.520	1.492	1.463	1.440	1.418	1.395	1.378	1.364	1.354
13.06	1.554	1.521	1.493	1.464	1.441	1.419	1.396	1.379	1.365	1.355
13.07	1.555	1.522	1.494	1.465	1.442	1.420	1.397	1.379	1.365	1.356
13.08	1.556	1.523	1.495	1.466	1.443	1.420	1.397	1.380	1.366	1.356
13.09	1.557	1.524	1.496	1.467	1.444	1.421	1.398	1.380	1.366	1.357
13.10	1.558	1.525	1.497	1.468	1.445	1.422	1.399	1.381	1.367	1.358
13.11	1.559	1.526	1.498	1.469	1.446	1.423	1.400	1.382	1.368	1.359
13.12	1.560	1.527	1.499	1.470	1.447	1.424	1.401	1.383	1.369	1.359
13.13	1.561	1.528	1.500	1.471	1.447	1.424	1.401	1.383	1.369	1.360
13.14	1.562	1.529	1.501	1.472	1.448	1.425	1.402	1.384	1.370	1.360
13.15	1.563	1.530	1.502	1.473	1.449	1.426	1.403	1.385	1.371	1.361
13.16	1.564	1.531	1.503	1.474	1.450	1.427	1.404	1.386	1.372	1.362
13.17	1.565	1.532	1.504	1.475	1.451	1.428	1.405	1.387	1.372	1.362
13.18	1.566	1.533	1.505	1.475	1.451	1.429	1.406	1.387	1.373	1.363
13.19	1.567	1.534	1.506	1.476	1.452	1.430	1.407	1.388	1.373	1.363
13.20	1.568	1.535	1.507	1.477	1.453	1.431	1.408	1.389	1.374	1.364
13.21	1.569	1.536	1.508	1.478	1.454	1.432	1.409	1.390	1.375	1.365
13.22	1.570	1.537	1.509	1.479	1.455	1.433	1.410	1.391	1.376	1.366
13.23	1.571	1.538	1.510	1.480	1.456	1.433	1.410	1.391	1.376	1.366
13.24	1.572	1.539	1.511	1.481	1.457	1.434	1.411	1.392	1.377	1.367

				T_r					P_r 12.80 - 13.24	
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.321	1.306	1.297	1.289	1.283	1.273	1.267	1.263	1.261	1.260	12.80
1.322	1.307	1.297	1.289	1.284	1.273	1.267	1.263	1.261	1.260	12.81
1.322	1.307	1.298	1.290	1.284	1.274	1.268	1.264	1.262	1.260	12.82
1.323	1.308	1.298	1.290	1.285	1.274	1.268	1.264	1.262	1.261	12.83
1.323	1.308	1.299	1.291	1.285	1.275	1.269	1.265	1.263	1.261	12.84
1.324	1.309	1.299	1.291	1.286	1.275	1.269	1.265	1.263	1.261	12.85
1.325	1.310	1.300	1.292	1.287	1.275	1.269	1.265	1.263	1.262	12.86
1.326	1.310	1.300	1.292	1.287	1.276	1.270	1.266	1.264	1.262	12.87
1.326	1.311	1.301	1.293	1.288	1.276	1.270	1.266	1.264	1.262	12.88
1.327	1.311	1.301	1.293	1.288	1.277	1.271	1.267	1.265	1.263	12.89
1.328	1.312	1.302	1.294	1.289	1.277	1.271	1.267	1.265	1.263	12.90
1.329	1.313	1.303	1.295	1.289	1.277	1.271	1.267	1.265	1.263	12.91
1.329	1.313	1.303	1.295	1.290	1.278	1.271	1.267	1.265	1.264	12.92
1.330	1.314	1.304	1.296	1.290	1.278	1.272	1.268	1.266	1.264	12.93
1.330	1.314	1.304	1.296	1.291	1.279	1.272	1.268	1.266	1.265	12.94
1.331	1.315	1.305	1.297	1.291	1.279	1.272	1.268	1.266	1.265	12.95
1.332	1.316	1.306	1.298	1.291	1.279	1.272	1.268	1.266	1.265	12.96
1.333	1.317	1.306	1.298	1.292	1.280	1.273	1.269	1.267	1.266	12.97
1.333	1.317	1.307	1.299	1.292	1.280	1.273	1.269	1.267	1.266	12.98
1.334	1.318	1.307	1.299	1.293	1.281	1.274	1.270	1.268	1.267	12.99
1.335	1.319	1.308	1.300	1.293	1.281	1.274	1.270	1.268	1.267	13.00
1.336	1.319	1.308	1.300	1.293	1.281	1.274	1.270	1.268	1.267	13.01
1.336	1.320	1.309	1.301	1.294	1.282	1.275	1.270	1.268	1.267	13.02
1.337	1.320	1.309	1.301	1.294	1.282	1.275	1.271	1.269	1.268	13.03
1.337	1.321	1.310	1.302	1.295	1.283	1.276	1.271	1.269	1.268	13.04
1.338	1.321	1.310	1.302	1.295	1.283	1.276	1.271	1.269	1.268	13.05
1.339	1.322	1.311	1.302	1.296	1.284	1.276	1.271	1.269	1.268	13.06
1.339	1.322	1.311	1.303	1.296	1.284	1.277	1.272	1.270	1.269	13.07
1.340	1.323	1.312	1.303	1.297	1.285	1.277	1.272	1.270	1.269	13.08
1.340	1.323	1.312	1.304	1.297	1.285	1.278	1.273	1.271	1.270	13.09
1.341	1.324	1.313	1.304	1.298	1.286	1.278	1.273	1.271	1.270	13.10
1.342	1.325	1.314	1.305	1.298	1.286	1.278	1.273	1.271	1.270	13.11
1.343	1.325	1.314	1.305	1.299	1.287	1.279	1.274	1.272	1.270	13.12
1.343	1.326	1.315	1.306	1.299	1.287	1.279	1.274	1.272	1.271	13.13
1.344	1.326	1.315	1.306	1.300	1.288	1.280	1.275	1.273	1.271	13.14
1.345	1.327	1.316	1.307	1.300	1.288	1.280	1.275	1.273	1.271	13.15
1.346	1.328	1.317	1.308	1.301	1.288	1.280	1.275	1.273	1.271	13.16
1.347	1.329	1.318	1.308	1.301	1.289	1.281	1.276	1.274	1.272	13.17
1.347	1.329	1.318	1.309	1.302	1.289	1.281	1.276	1.274	1.272	13.18
1.348	1.330	1.319	1.309	1.302	1.290	1.282	1.277	1.275	1.273	13.19
1.349	1.331	1.320	1.310	1.303	1.290	1.282	1.277	1.275	1.273	13.20
1.350	1.332	1.320	1.311	1.303	1.290	1.282	1.277	1.275	1.273	13.21
1.350	1.332	1.321	1.311	1.304	1.291	1.283	1.277	1.275	1.274	13.22
1.351	1.333	1.321	1.312	1.304	1.291	1.283	1.278	1.276	1.274	13.23
1.351	1.333	1.322	1.312	1.305	1.292	1.284	1.278	1.276	1.275	13.24

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
13.25	1.573	1.540	1.512	1.482	1.458	1.435	1.412	1.393	1.378	1.368
13.26	1.574	1.541	1.513	1.483	1.459	1.436	1.413	1.394	1.379	1.369
13.27	1.575	1.542	1.514	1.484	1.460	1.437	1.414	1.395	1.380	1.370
13.28	1.576	1.544	1.515	1.484	1.461	1.438	1.414	1.396	1.380	1.370
13.29	1.577	1.545	1.516	1.485	1.462	1.439	1.415	1.397	1.381	1.371
13.30	1.578	1.546	1.517	1.486	1.463	1.440	1.416	1.398	1.382	1.372
13.31	1.579	1.547	1.518	1.487	1.464	1.441	1.417	1.399	1.383	1.373
13.32	1.580	1.548	1.519	1.488	1.465	1.442	1.418	1.399	1.383	1.373
13.33	1.581	1.549	1.519	1.489	1.465	1.442	1.418	1.400	1.384	1.374
13.34	1.582	1.550	1.520	1.490	1.466	1.443	1.419	1.400	1.384	1.374
13.35	1.583	1.551	1.521	1.491	1.467	1.444	1.420	1.401	1.385	1.375
13.36	1.584	1.552	1.522	1.492	1.468	1.445	1.421	1.402	1.386	1.376
13.37	1.585	1.553	1.523	1.493	1.469	1.446	1.422	1.402	1.387	1.377
13.38	1.587	1.554	1.524	1.493	1.470	1.447	1.422	1.403	1.387	1.377
13.39	1.588	1.556	1.525	1.494	1.471	1.448	1.423	1.403	1.388	1.378
13.40	1.589	1.556	1.526	1.495	1.472	1.449	1.424	1.404	1.389	1.379
13.41	1.590	1.557	1.527	1.496	1.473	1.450	1.425	1.405	1.390	1.380
13.42	1.591	1.558	1.528	1.497	1.474	1.451	1.426	1.406	1.391	1.380
13.43	1.592	1.559	1.529	1.498	1.474	1.451	1.426	1.406	1.391	1.381
13.44	1.593	1.560	1.530	1.499	1.475	1.452	1.427	1.407	1.392	1.381
13.45	1.594	1.561	1.531	1.500	1.476	1.453	1.428	1.408	1.393	1.382
13.46	1.595	1.562	1.532	1.501	1.477	1.454	1.429	1.409	1.394	1.383
13.47	1.596	1.563	1.533	1.502	1.478	1.455	1.430	1.410	1.395	1.384
13.48	1.597	1.564	1.534	1.502	1.478	1.455	1.430	1.410	1.395	1.384
13.49	1.598	1.565	1.535	1.503	1.480	1.456	1.431	1.411	1.396	1.385
13.50	1.599	1.566	1.536	1.504	1.481	1.457	1.432	1.412	1.397	1.386
13.51	1.600	1.567	1.537	1.505	1.482	1.458	1.433	1.413	1.398	1.387
13.52	1.601	1.568	1.538	1.506	1.483	1.459	1.434	1.414	1.398	1.387
13.53	1.602	1.569	1.539	1.507	1.483	1.459	1.434	1.414	1.399	1.388
13.54	1.603	1.570	1.540	1.508	1.484	1.460	1.435	1.415	1.399	1.388
13.55	1.604	1.571	1.541	1.509	1.485	1.461	1.436	1.416	1.400	1.389
13.56	1.605	1.572	1.542	1.510	1.486	1.462	1.437	1.417	1.401	1.390
13.57	1.606	1.573	1.543	1.511	1.487	1.463	1.438	1.418	1.402	1.391
13.58	1.607	1.575	1.544	1.512	1.488	1.464	1.438	1.418	1.402	1.391
13.59	1.608	1.576	1.545	1.513	1.489	1.465	1.439	1.419	1.403	1.392
13.60	1.609	1.577	1.546	1.514	1.490	1.466	1.440	1.420	1.404	1.393
13.61	1.610	1.578	1.547	1.515	1.491	1.467	1.441	1.421	1.405	1.394
13.62	1.611	1.579	1.548	1.516	1.492	1.468	1.442	1.422	1.406	1.394
13.63	1.612	1.580	1.549	1.516	1.492	1.468	1.442	1.422	1.406	1.395
13.64	1.613	1.581	1.550	1.517	1.493	1.469	1.443	1.423	1.407	1.395
13.65	1.614	1.582	1.551	1.518	1.494	1.470	1.444	1.424	1.408	1.396
13.66	1.615	1.583	1.552	1.519	1.495	1.471	1.445	1.425	1.409	1.397
13.67	1.616	1.584	1.553	1.520	1.496	1.472	1.446	1.426	1.410	1.398
13.68	1.617	1.585	1.554	1.521	1.497	1.473	1.446	1.426	1.410	1.398
13.69	1.618	1.586	1.555	1.522	1.498	1.474	1.447	1.427	1.411	1.399

T_r										P_r 13.25 - 13.69
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.352	1.334	1.322	1.313	1.305	1.292	1.284	1.278	1.276	1.275	13.25
1.353	1.335	1.323	1.314	1.306	1.292	1.284	1.278	1.276	1.275	13.26
1.353	1.335	1.323	1.314	1.306	1.293	1.285	1.279	1.277	1.276	13.27
1.354	1.336	1.324	1.315	1.307	1.293	1.285	1.279	1.277	1.276	13.28
1.354	1.336	1.324	1.315	1.307	1.294	1.286	1.280	1.278	1.277	13.29
1.355	1.337	1.325	1.316	1.308	1.294	1.286	1.280	1.278	1.277	13.30
1.356	1.338	1.326	1.316	1.308	1.294	1.286	1.280	1.278	1.277	13.31
1.356	1.338	1.326	1.317	1.309	1.295	1.286	1.280	1.278	1.277	13.32
1.357	1.339	1.327	1.317	1.309	1.295	1.287	1.281	1.279	1.278	13.33
1.357	1.339	1.327	1.318	1.310	1.296	1.287	1.281	1.279	1.278	13.34
1.358	1.340	1.328	1.318	1.310	1.296	1.287	1.281	1.279	1.278	13.35
1.359	1.341	1.329	1.319	1.311	1.296	1.287	1.281	1.279	1.278	13.36
1.360	1.341	1.329	1.319	1.311	1.297	1.388	1.282	1.280	1.279	13.37
1.360	1.342	1.330	1.320	1.312	1.297	1.288	1.282	1.280	1.279	13.38
1.361	1.342	1.330	1.320	1.312	1.298	1.289	1.283	1.281	1.280	13.39
1.362	1.343	1.331	1.321	1.313	1.298	1.289	1.283	1.281	1.280	13.40
1.363	1.344	1.332	1.321	1.313	1.298	1.289	1.283	1.281	1.280	13.41
1.363	1.344	1.332	1.322	1.314	1.299	1.290	1.284	1.282	1.280	13.42
1.364	1.345	1.333	1.322	1.314	1.299	1.290	1.284	1.282	1.281	13.43
1.364	1.345	1.333	1.323	1.315	1.300	1.291	1.285	1.283	1.281	13.44
1.365	1.346	1.334	1.323	1.315	1.300	1.291	1.285	1.283	1.281	13.45
1.366	1.347	1.335	1.324	1.315	1.300	1.291	1.285	1.283	1.281	13.46
1.367	1.347	1.335	1.324	1.316	1.301	1.292	1.286	1.284	1.282	13.47
1.367	1.348	1.336	1.325	1.316	1.301	1.292	1.286	1.284	1.282	13.48
1.368	1.348	1.336	1.325	1.317	1.302	1.293	1.287	1.285	1.283	13.49
1.369	1.337	1.337	1.326	1.317	1.302	1.293	1.287	1.285	1.283	13.50
1.370	1.338	1.338	1.326	1.317	1.302	1.293	1.287	1.285	1.283	13.51
1.370	1.350	1.338	1.327	1.318	1.303	1.294	1.288	1.286	1.284	13.52
1.371	1.351	1.339	1.327	1.318	1.303	1.294	1.288	1.286	1.284	13.53
1.371	1.351	1.339	1.328	1.319	1.304	1.295	1.289	1.287	1.284	13.54
1.372	1.352	1.340	1.328	1.319	1.304	1.295	1.289	1.287	1.285	13.55
1.373	1.353	1.341	1.329	1.320	1.304	1.295	1.289	1.287	1.285	13.56
1.374	1.353	1.341	1.329	1.320	1.305	1.296	1.290	1.288	1.286	13.57
1.374	1.354	1.342	1.330	1.321	1.305	1.296	1.290	1.288	1.286	13.58
1.375	1.354	1.342	1.330	1.321	1.306	1.297	1.291	1.289	1.287	13.59
1.376	1.355	1.343	1.331	1.322	1.306	1.297	1.291	1.289	1.287	13.60
1.377	1.356	1.344	1.332	1.322	1.306	1.297	1.291	1.289	1.287	13.61
1.377	1.356	1.344	1.332	1.323	1.307	1.297	1.291	1.289	1.288	13.62
1.378	1.357	1.345	1.333	1.323	1.307	1.298	1.292	1.290	1.288	13.63
1.378	1.357	1.345	1.333	1.324	1.308	1.298	1.292	1.290	1.288	13.64
1.379	1.358	1.346	1.334	1.324	1.308	1.298	1.292	1.290	1.288	13.65
1.380	1.359	1.347	1.335	1.325	1.308	1.298	1.292	1.290	1.288	13.66
1.380	1.359	1.347	1.335	1.325	1.309	1.299	1.293	1.291	1.289	13.67
1.381	1.360	1.348	1.336	1.326	1.309	1.299	1.293	1.291	1.289	13.68
1.381	1.360	1.348	1.336	1.326	1.310	1.300	1.294	1.292	1.290	13.69

P_r	T_r 1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
13.70	1.619	1.587	1.556	1.523	1.499	1.475	1.448	1.428	1.412	1.400
13.71	1.620	1.588	1.557	1.524	1.500	1.476	1.449	1.429	1.413	1.401
13.72	1.621	1.589	1.558	1.525	1.501	1.477	1.450	1.430	1.414	1.402
13.73	1.622	1.590	1.559	1.525	1.501	1.477	1.450	1.430	1.414	1.402
13.74	1.623	1.591	1.560	1.526	1.502	1.478	1.451	1.431	1.415	1.403
13.75	1.624	1.592	1.561	1.527	1.503	1.479	1.452	1.532	1.416	1.404
13.76	1.625	1.593	1.562	1.528	1.504	1.480	1.453	1.433	1.417	1.405
13.77	1.626	1.594	1.563	1.529	1.505	1.481	1.454	1.434	1.417	1.406
13.78	1.628	1.595	1.564	1.530	1.506	1.481	1.454	1.434	1.418	1.406
13.79	1.629	1.596	1.565	1.531	1.507	1.482	1.455	1.435	1.418	1.407
13.80	1.630	1.597	1.566	1.532	1.508	1.483	1.456	1.436	1.419	1.408
13.81	1.631	1.598	1.567	1.533	1.509	1.484	1.457	1.437	1.420	1.409
13.82	1.632	1.599	1.568	1.534	1.510	1.485	1.458	1.437	1.421	1.409
13.83	1.633	1.600	1.569	1.535	1.511	1.485	1.458	1.438	1.421	1.410
13.84	1.634	1.601	1.570	1.536	1.512	1.486	1.459	1.438	1.422	1.410
13.85	1.635	1.602	1.571	1.537	1.513	1.487	1.460	1.439	1.423	1.411
13.86	1.636	1.603	1.572	1.538	1.514	1.488	1.461	1.440	1.424	1.412
13.87	1.637	1.604	1.573	1.539	1.515	1.489	1.462	1.441	1.424	1.413
13.88	1.638	1.606	1.573	1.540	1.515	1.490	1.463	1.441	1.425	1.413
13.89	1.639	1.607	1.574	1.541	1.516	1.491	1.464	1.442	1.425	1.413
13.90	1.640	1.608	1.574	1.542	1.517	1.492	1.465	1.443	1.426	1.414
13.91	1.641	1.609	1.576	1.543	1.518	1.493	1.466	1.444	1.427	1.415
13.92	1.642	1.610	1.577	1.544	1.519	1.494	1.467	1.445	1.428	1.416
13.93	1.643	1.611	1.578	1.544	1.520	1.494	1.467	1.445	1.428	1.416
13.94	1.644	1.612		1.545	1.521	1.495	1.468	1.446	1.429	1.417
13.95	1.645	1.613	1.580	1.546	1.522	1.496	1.469	1.447	1.430	1.417
13.96	1.646	1.614	1.581	1.547	1.523	1.497	1.470	1.448	1.431	1.418
13.97	1.647	1.615	1.582	1.548	1.524	1.498	1.471	1.449	1.432	1.419
13.98	1.648	1.616	1.583	1.548	1.524	1.498	1.471	1.449	1.432	1.419
13.99	1.649	1.617	1.584	1.549	1.525	1.499	1.472	1.450	1.433	1.420
14.00	1.650	1.618	1.585	1.550	1.526	1.500	1.473	1.451	1.434	1.421
14.01	1.651	1.619	1.586	1.551	1.527	1.501	1.474	1.452	1.435	1.422
14.02	1.652	1.620	1.587	1.552	1.528	1.502	1.475	1.453	1.435	1.423
14.03	1.653	1.621	1.588	1.553	1.529	1.502	1.476	1.453	1.436	1.423
14.04	1.654	1.622	1.589	1.554	1.530	1.503	1.477	1.454	1.436	1.424
14.05	1.655	1.623	1.590	1.555	1.531	1.504	1.478	1.455	1.437	1.425
14.06	1.656	1.624	1.591	1.555	1.532	1.505	1.479	1.456	1.438	1.426
14.07	1.657	1.625	1.592	1.557	1.533	1.506	1.480	1.457	1.439	1.427
14.08	1.659	1.626	1.593	1.558	1.533	1.507	1.480	1.457	1.439	1.427
14.09	1.660	1.627	1.594	1.559	1.534	1.508	1.481	1.458	1.440	1.428
14.10	1.661	1.628	1.595	1.560	1.535	1.509	1.482	1.459	1.441	1.429
14.11	1.662	1.629	1.596	1.561	1.536	1.510	1.483	1.460	1.442	1.430
14.12	1.663	1.630	1.597	1.562	1.537	1.511	1.484	1.461	1.443	1.430
14.13	1.664	1.631	1.598	1.563	1.537	1.511	1.484	1.461	1.443	1.431
14.14	1.665	1.632	1.599	1.564	1.538	1.512	1.485	1.462	1.444	1.431

1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.382	1.361	1.349	1.337	1.327	1.310	1.300	1.294	1.292	1.290	13.70
383	1.362	1.349	1.337	1.327	1.310	1.300	1.294	1.292	1.390	13.71
1.383	1.362	1.350	1.338	1.328	1.311	1.300	1.295	1.292	1.290	13.72
1.384	1.363	1.350	1 338	1.328	1.311	1.301	1.295	1.293	1.291	13.73
1.384	1.363	1.351	1.339	1.329	1.312	1.301	1.296	1.293	1.291	13.74
1.385	1.364	1.351	1.339	1.329	1.312	1.301	1.296	1.293	1.291	13.75
1.386	1.365	1.352	1.340	1.330	1.312	1.301	1.296	1.293	1.291	13.76
1.387	1.366	1.352	1.340	1.330	1.313	1.302	1.297	1.294	1.292	13.77
1.387	1.366	1.353	1.341	1.331	1.313	1.302	1.297	1.294	1.292	13.78
1.388	1.367	1.353	1.341	1.331	1.314	1.303	1.298	1.295	1.293	13.79
1.389	1.368	1.354	1.342	1.332	1.314	1.303	1.298	1.295	1.293	13.80
1.390	1.369	1.355	1.343	1.332	1.314	1.303	1.298	1.295	1.293	13.81
1.391	1.369	1.355	1.343	1.333	1.315	1.304	1.299	1.296	1.294	13.82
1.391	1.370	1.356	1.344	1.333	1.315	1.304	1.299	1.296	1.294	13.83
1.392	1.370	1.356	1.344	1.334	1.316	1.305	1.300	1.297	1.295	13.84
1.393	1.371	1.357	1.345	1.334	1.316	1.305	1.300	1.297	1.295	13.85
1.394	1.372	1.358	1.346	1.335	1.316	1.305	1.300	1.297	1.295	13.86
1.395	1.372	1.358	1.346	1.335	1.317	1.306	1.300	1.298	1.296	13.87
1.395	1.373	1.359	1.347	1.336	1.317	1.306	1.301	1.298	1.296	13.88
1.396	1.373	1.359	1.347	1.336	1.318	1.307	1.301	1.299	1.297	13.89
1.397	1.374	1.360	1.348	1.337	1.318	1.307	1.301	1.299	1.297	13.90
1.397	1.375	1.361	1.348	1.337	1.318	1.307	1.301	1.299	1.297	13.91
1.398	1.375	1.361	1.349	1.338	1.319	1.308	1.301	1.299	1.297	13.92
1.398	1.376	1.362	1.349	1.338	1.319	1.308	1.302	1.300	1.298	13.93
1.399	1.376	1.362	1.350	1.339	1.320	1.309	1.302	1.300	1.298	13.94
1.399	1.377	1.363	1.350	1.339	1.320	1.309	1.302	1.300	1.298	13.95
1.400	1.378	1.364	1.351	1.339	1.320	1.309	1.302	1.300	1.298	13.96
1.400	1.378	1.364	1.351	1.340	1.321	1.310	1.303	1.301	1.299	13.97
1.401	1.379	1.365	1.352	1.340	1.321	1.310	1.303	1.301	1.299	13.98
1.401	1.379	1.365	1.352	1.341	1.321	1.311	1.304	1.302	1.300	13.99
1.402	1.380	1.366	1.353	1.341	1.322	1.311	1.304	1.302	1.300	14.00
1.403	1.381	1.367	1.354	1.341	1.322	1.311	1.304	1.302	1.300	14.01
1.403	1.381	1.367	1.354	1.342	1.323	1.312	1.305	1.302	1.300	14.02
1.404	1.382	1.368	1.355	1.342	1.323	1.312	1.305	1.303	1.301	14.03
1.404	1.382	1.368	1.355	1.343	1.324	1.313	1.306	1.303	1.301	14.04
1.405	1.383	1.369	1.356	1.343	1.324	1.313	1.306	1.303	1.301	14.05
1.406	1.384	1.370	1.356	1.344	1.324	1.313	1.306	1.303	1.301	14.06
1.407	1.384	1.370	1.357	1.344	1.325	1.314	1.307	1.304	1.302	14.07
1.407	1.385	1.371	1.357	1.345	1.325	1.314	1.307	1.304	1.302	14.08
1.408	1.385	1.371	1.358	1.345	1.326	1.315	1.308	1.305	1.303	14.09
1.409	1.386	1.372	1.358	1.346	1.326	1.315	1.308	1.305	1.303	14.10
1.410	1.387	1.373	1.358	1.346	1.326	1.315	1.308	1.305	1.303	14.11
1.410	1.387	1.373	1.359	1.347	1.327	1.316	1.308	1.306	1.304	14.12
1.411	1.388	1.374	1.359	1.347	1.327	1.316	1.309	1.306	1.304	14.13
1.411	1.388	1.374	1.360	1.348	1.328	1.317	1.309	1.307	1.305	14.14

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
14.15	1.666	1.633	1.600	1.565	1.539	1.513	1.486	1.463	1.445	1.432
14.16	1.667	1.634	1.601	1.566	1.540	1.514	1.487	1.464	1.446	1.433
14.17	1.668	1.635	1.602	1.567	1.541	1.515	1.488	1.465	1.447	1.434
14.18	1.669	1.637	1.603	1.568	1.542	1.516	1.488	1.465	1.447	1.434
14.19	1.670	1.638	1.604	1.569	1.543	1.517	1.489	1.466	1.448	1.435
14.20	1.671	1.639	1.605	1.570	1.544	1.518	1.490	1.467	1.449	1.436
14.21	1.672	1.640	1.606	1.571	1.545	1.519	1.491	1.468	1.450	1.437
14.22	1.673	1.641	1.607	1.572	1.546	1.520	1.492	1.469	1.450	1.437
14.23	1.674	1.642	1.607	1.573	1.546	1.520	1.492	1.469	1.451	1.438
14.24	1.675	1.643	1.608	1.574	1.547	1.521	1.493	1.470	1.452	1.438
14.25	1.676	1.644	1.609	1.575	1.548	1.522	1.494	1.471	1.452	1.439
14.26	1.677	1.645	1.610	1.576	1.549	1.523	1.495	1.472	1.453	1.440
14.27	1.678	1.646	1.611	1.577	1.550	1.524	1.496	1.473	1.454	1.441
14.28	1.679	1.647	1.612	1.578	1.551	1.525	1.496	1.473	1.454	1.441
14.29	1.680	1.648	1.613	1.579	1.552	1.526	1.497	1.474	1.455	1.442
14.30	1.681	1.649	1.614	1.580	1.553	1.527	1.498	1.475	1.456	1.443
14.31	1.682	1.650	1.615	1.581	1.554	1.528	1.499	1.476	1.457	1.444
14.32	1.683	1.651	1.616	1.582	1.555	1.529	1.500	1.476	1.458	1.444
14.33	1.684	1.652	1.617	1.582	1.555	1.529	1.500	1.477	1.458	1.445
14.34	1.685	1.653	1.618	1.583	1.556	1.530	1.501	1.477	1.459	1.445
14.35	1.686	1.654	1.619	1.584	1.557	1.531	1.502	1.478	1.460	1.446
14.36	1.687	1.655	1.620	1.585	1.558	1.532	1.503	1.479	1.461	1.447
14.37	1.688	1.656	1.621	1.586	1.559	1.533	1.504	1.480	1.462	1.448
14.38	1.690	1.657	1.622	1.587	1.559	1.534	1.504	1.480	1.462	1.448
14.39	1.691	1.658	1.623	1.588	1.560	1.535	1.505	1.481	1.463	1.449
14.40	1.692	1.659	1.624	1.589	1.561	1.536	1.506	1.482	1.464	1.450
14.41	1.693	1.660	1.625	1.590	1.562	1.537	1.507	1.483	1.465	1.451
14.42	1.694	1.661	1.626	1.591	1.563	1.538	1.508	1.484	1.466	1.452
14.43	1.695	1.662	1.627	1.592	1.563	1.538	1.508	1.484	1.466	1.452
14.44	1.696	1.663	1.628	1.593	1.564	1.539	1.509	1.485	1.467	1.453
14.45	1.697	1.664	1.629	1.594	1.565	1.540	1.510	1.486	1.468	1.454
14.46	1.698	1.665	1.630	1.595	1.566	1.541	1.511	1.487	1.469	1.455
14.47	1.699	1.666	1.631	1.596	1.567	1.542	1.512	1.488	1.470	1.456
14.48	1.700	1.667	1.632	1.596	1.568	1.542	1.513	1.488	1.470	1.456
14.49	1.701	1.668	1.633	1.597	1.569	1.543	1.514	1.489	1.471	1.457
14.50	1.702	1.669	1.634	1.598	1.570	1.544	1.515	1.490	1.472	1.458
14.51	1.703	1.670	1.635	1.599	1.571	1.545	1.516	1.491	1.473	1.459
14.52	1.704	1.671	1.636	1.600	1.572	1.546	1.517	1.492	1.474	1.459
14.53	1.705	1.672	1.637	1.601	1.573	1.546	1.518	1.492	1.474	1.460
14.54	1.706	1.673	1.638	1.602	1.574	1.547	1.519	1.493	1.475	1.460
14.55	1.707	1.674	1.639	1.603	1.575	1.548	1.520	1.494	1.476	1.461
14.56	1.708	1.675	1.640	1.604	1.576	1.549	1.521	1.495	1.477	1.462
14.57	1.709	1.676	1.641	1.605	1.577	1.550	1.522	1.496	1.478	1.463
14.58	1.710	1.677	1.641	1.606	1.578	1.550	1.522	1.496	1.478	1.463
14.59	1.711	1.678	1.642	1.607	1.579	1.551	1.523	1.497	1.479	1.464

T_r										P_r 14.15 - 14.59
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.412	1.389	1.375	1.360	1.348	1.328	1.317	1.309	1.307	1.305	14.15
1.413	1.390	1.376	1.361	1.349	1.328	1.317	1.309	1.307	1.305	14.16
1.414	1.390	1.376	1.361	1.349	1.329	1.318	1.310	1.308	1.306	14.17
1.414	1.391	1.377	1.362	1.350	1.329	1.318	1.310	1.308	1.306	14.18
1.415	1.391	1.377	1.362	1.350	1.330	1.319	1.311	1.309	1.307	14.19
1.416	1.392	1.378	1.363	1.351	1.330	1.319	1.311	1.309	1.307	14.20
1.417	1.393	1.379	1.364	1.351	1.330	1.319	1.311	1.309	1.307	14.21
1.417	1.393	1.379	1.364	1.352	1.331	1.319	1.312	1.309	1.307	14.22
1.418	1.394	1.380	1.365	1.352	1.331	1.320	1.312	1.310	1.308	14.23
1.418	1.394	1.380	1.365	1.353	1.332	1.320	1.313	1.310	1.308	14.24
1.419	1.395	1.381	1.366	1.353	1.332	1.320	1.313	1.310	1.308	14.25
1.420	1.396	1.382	1.367	1.354	1.332	1.320	1.313	1.310	1.308	14.26
1.421	1.396	1.382	1.367	1.354	1.333	1.321	1.314	1.311	1.309	14.27
1.421	1.397	1.383	1.368	1.355	1.333	1.321	1.314	1.311	1.309	14.28
1.422	1.397	1.383	1.368	1.355	1.334	1.322	1.315	1.312	1.310	14.29
1.423	1.398	1.384	1.369	1.356	1.334	1.322	1.315	1.312	1.310	14.30
1.424	1.399	1.385	1.369	1.356	1.334	1.322	1.315	1.312	1.310	14.31
1.424	1.399	1.385	1.370	1.357	1.335	1.322	1.315	1.312	1.310	14.32
1.425	1.400	1.386	1.370	1.357	1.335	1.323	1.316	1.313	1.311	14.33
1.425	1.400	1.386	1.371	1.358	1.336	1.323	1.316	1.313	1.311	14.34
1.426	1.401	1.387	1.371	1.358	1.336	1.323	1.316	1.313	1.311	14.35
1.427	1.402	1.388	1.372	1.358	1.336	1.323	1.316	1.313	1.311	14.36
1.428	1.402	1.388	1.372	1.359	1.337	1.324	1.317	1.314	1.312	14.37
1.428	1.403	1.389	1.373	1.359	1.337	1.324	1.317	1.314	1.312	14.38
1.429	1.403	1.389	1.373	1.360	1.338	1.325	1.318	1.315	1.313	14.39
1.430	1.404	1.390	1.374	1.360	1.338	1.325	1.318	1.315	1.313	14.40
1.431	1.405	1.391	1.374	1.360	1.338	1.325	1.318	1.315	1.313	14.41
1.431	1.405	1.391	1.375	1.361	1.339	1.326	1.319	1.316	1.314	14.42
1.432	1.406	1.392	1.375	1.361	1.339	1.326	1.319	1.316	1.314	14.43
1.432	1.406	1.392	1.376	1.362	1.340	1.327	1.320	1.317	1.315	14.44
1.433	1.407	1.393	1.376	1.362	1.340	1.327	1.320	1.317	1.315	14.45
1.434	1.408	1.394	1.376	1.363	1.340	1.327	1.320	1.317	1.315	14.46
1.435	1.409	1.394	1.377	1.363	1.341	1.328	1.321	1.318	1.316	14.47
1.435	1.409	1.395	1.377	1.364	1.341	1.328	1.321	1.318	1.316	14.48
1.436	1.410	1.395	1.378	1.364	1.342	1.329	1.322	1.319	1.317	14.49
1.437	1.411	1.396	1.379	1.365	1.342	1.329	1.322	1.319	1.317	14.50
1.438	1.412	1.396	1.380	1.365	1.342	1.329	1.322	1.319	1.317	14.51
1.438	1.412	1.397	1.380	1.366	1.343	1.330	1.323	1.320	1.317	14.52
1.439	1.413	1.397	1.381	1.366	1.343	1.330	1.323	1.320	1.318	14.53
1.439	1.413	1.398	1.381	1.367	1.344	1.331	1.324	1.321	1.318	14.54
1.440	1.414	1.398	1.382	1.367	1.344	1.331	1.324	1.321	1.318	14.55
1.441	1.415	1.398	1.383	1.368	1.344	1.331	1.324	1.321	1.218	14.56
1.441	1.415	1.399	1.383	1.368	1.345	1.332	1.325	1.322	1.319	14.57
1.442	1.416	1.399	1.384	1.369	1.345	1.332	1.325	1.322	1.319	14.58
1.442	1.416	1.400	1.384	1.369	1.346	1.333	1.326	1.323	1.320	14.59

	T_r									
P_r	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
14.60	1.712	1.679	1.643	1.608	1.580	1.552	1.524	1.498	1.480	1.465
14.61	1.713	1.680	1.644	1.609	1.581	1.553	1.525	1.499	1.481	1.466
14.62	1.714	1.681	1.645	1.610	1.582	1.554	1.526	1.500	1.482	1.466
14.63	1.715	1.682	1.646	1.611	1.582	1.554	1.526	1.500	1.482	1.467
14.64	1.716	1.683	1.647	1.612	1.583	1.555	1.527	1.501	1.483	1.467
14.65	1.717	1.684	1.648	1.613	1.584	1.556	1.528	1.502	1.484	1.468
14.66	1.718	1.685	1.649	1.614	1.585	1.557	1.529	1.503	1.485	1.469
14.67	1.719	1.686	1.650	1.615	1.586	1.558	1.530	1.503	1.486	1.470
14.68	1.720	1.688	1.651	1.615	1.587	1.559	1.530	1.504	1.486	1.470
14.69	1.721	1.689	1.652	1.616	1.588	1.560	1.531	1.504	1.487	1.471
14.70	1.722	1.690	1.653	1.617	1.589	1.561	1.532	1.505	1.488	1.472
14.71	1.723	1.691	1.654	1.618	1.590	1.562	1.533	1.506	1.489	1.473
14.72	1.724	1.692	1.655	1.619	1.591	1.563	1.534	1.507	1.489	1.473
14.73	1.725	1.693	1.656	1.620	1.592	1.563	1.534	1.507	1.490	1.474
14.74	1.726	1.694	1.657	1.621	1.593	1.564	1.535	1.508	1.490	1.474
14.75	1.727	1.695	1.658	1.622	1.594	1.565	1.536	1.509	1.491	1.475
14.76	1.728	1.696	1.659	1.623	1.595	1.566	1.537	1.510	1.492	1.476
14.77	1.729	1.697	1.660	1.624	1.596	1.567	1.538	1.511	1.493	1.477
14.78	1.731	1.698	1.661	1.625	1.596	1.568	1.538	1.511	1.493	1.477
14.79	1.732	1.699	1.662	1.626	1.597	1.569	1.539	1.512	1.494	1.478
14.80	1.733	1.700	1.663	1.627	1.598	1.570	1.540	1.513	1.495	1.479
14.81	1.734	1.701	1.664	1.628	1.599	1.571	1.541	1.514	1.496	1.480
14.82	1.735	1.702	1.665	1.629	1.600	1.572	1.542	1.515	1.496	1.481
14.83	1.736	1.703	1.666	1.630	1.601	1.572	1.542	1.515	1.497	1.481
14.84	1.737	1.704	1.667	1.631	1.602	1.573	1.543	1.516	1.497	1.482
14.85	1.738	1.705	1.668	1.632	1.603	1.574	1.544	1.517	1.498	1.483
14.86	1.739	1.706	1.669	1.633	1.604	1.575	1.545	1.518	1.499	1.484
14.87	1.740	1.707	1.670	1.634	1.605	1.576	1.546	1.519	1.500	1.485
14.88	1.741	1.708	1.671	1.634	1.605	1.577	1.547	1.519	1.500	1.485
14.89	1.742	1.709	1.672	1.635	1.606	1.578	1.548	1.520	1.501	1.486
14.90	1.743	1.710	1.673	1.636	1.607	1.579	1.549	1.521	1.502	1.487
14.91	1.744	1.711	1.674	1.637	1.608	1.580	1.550	1.522	1.503	1.488
14.92	1.745	1.712	1.675	1.638	1.609	1.581	1.551	1.523	1.503	1.488
14.93	1.746	1.713	1.676	1.639	1.610	1.581	1.551	1.523	1.504	1.489
14.94	1.747	1.714	1.677	1.640	1.611	1.582	1.552	1.524	1.504	1.489
14.95	1.748	1.715	1.678	1.641	1.612	1.583	1.553	1.525	1.505	1.490
14.96	1.749	1.716	1.679	1.642	1.613	1.584	1.554	1.526	1.506	1.491
14.97	1.750	1.717	1.680	1.643	1.614	1.585	1.555	1.527	1.506	1.491
14.98	1.751	1.718	1.680	1.643	1.614	1.586	1.556	1.527	1.507	1.492
14.99	1.752	1.719	1.681	1.644	1.615	1.587	1.557	1.528	1.507	1.492
15.00	1.753	1.720	1.682	1.645	1.616	1.588	1.558	1.529	1.508	1.493

T_r										P_r 14.60 - 15.00
1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	P_r
1.443	1.417	1.400	1.385	1.370	1.346	1.333	1.326	1.323	1.320	14.60
1.444	1.418	1.401	1.385	1.370	1.346	1.333	1.326	1.323	1.320	14.61
.444	1.418	1.401	1.386	1.371	1.347	1.333	1.326	1.323	1.320	14.62
1.445	1.419	1.402	1.386	1.371	1.347	1.334	1.327	1.324	1.321	14.63
1.445	1.419	1.402	1.387	1.372	1.348	1.334	1.327	1.324	1.321	14.64
1.446	1.420	1.403	1.387	1.372	1.348	1.334	1.327	1.324	1.321	14.65
1.447	1.421	1.404	1.388	1.373	1.348	1.334	1.327	1.324	1.321	14.66
1.448	1.421	1.405	1.388	1.373	1.349	1.335	1.328	1.325	1.322	14.67
1.448	1.422	1.405	1.389	1.374	1.349	1.335	1.328	1.325	1.322	14.68
1.449	1.422	1.406	1.389	1.374	1.350	1.336	1.329	1.326	1.323	14.69
1.450	1.423	1.407	1.390	1.375	1.350	1.336	1.329	1.326	1.323	14.70
1.451	1.424	1.408	1.390	1.375	1.350	1.336	1.329	1.326	1.323	14.71
1.451	1.424	1.408	1.391	1.376	1.351	1.337	1.329	1.326	1.324	14.72
1.452	1.425	1.409	1.391	1.376	1.351	1.337	1.330	1.327	1.324	14.73
1.452	1.425	1.409	1.392	1.377	1.352	1.338	1.330	1.327	1.325	14.74
1.453	1.426	1.410	1.392	1.377	1.352	1.338	1.330	1.327	1.325	14.75
1.454	1.427	1.411	1.393	1.378	1.352	1.338	1.330	1.327	1.325	14.76
1.455	1.427	1.411	1.393	1.378	1.353	1.339	1.331	1.328	1.326	14.77
1.455	1.428	1.412	1.394	1.379	1.353	1.339	1.331	1.328	1.326	14.78
1.456	1.428	1.412	1.394	1.379	1.354	1.340	1.332	1.329	1.327	14.79
1.457	1.429	1.413	1.395	1.380	1.354	1.340	1.332	1.329	1.327	14.80
1.458	1.430	1.414	1.396	1.380	1.354	1.340	1.332	1.329	1.327	14.81
1.458	1.430	1.414	1.396	1.381	1.355	1.340	1.333	1.330	1.327	14.82
1.459	1.431	1.415	1.397	1.381	1.355	1.341	1.333	1.330	1.328	14.83
1.459	1.431	1.415	1.397	1.382	1.356	1.341	1.334	1.331	1.328	14.84
1.460	1.432	1.416	1.398	1.382	1.356	1.341	1.334	1.331	1.328	14.85
1.461	1.433	1.417	1.399	1.383	1.356	1.341	1.334	1.331	1.328	14.86
1.461	1.434	1.417	1.399	1.383	1.357	1.342	1.335	1.332	1.329	14.87
1.462	1.434	1.418	1.400	1.384	1.357	1.342	1.335	1.332	1.329	14.88
1.462	1.435	1.418	1.400	1.384	1.358	1.343	1.336	1.333	1.330	14.89
1.463	1.436	1.419	1.401	1.385	1.358	1.343	1.336	1.333	1.330	14.90
1.464	1.437	1.419	1.401	1.385	1.358	1.343	1.336	1.333	1.330	14.91
1.464	1.437	1.420	1.402	1.386	1.359	1.344	1.337	1.333	1.330	14.92
1.465	1.438	1.420	1.402	1.386	1.359	1.344	1.337	1.334	1.331	14.93
1.465	1.438	1.421	1.403	1.387	1.360	1.345	1.338	1.334	1.331	14.94
1.466	1.439	1.421	1.403	1.387	1.360	1.345	1.338	1.334	1.331	14.95
1.467	1.440	1.422	1.404	1.388	1.360	1.345	1.338	1.334	1.331	14.96
1.468	1.440	1.422	1.404	1.388	1.361	1.346	1.339	1.335	1.332	14.97
1.468	1.441	1.423	1.405	1.389	1.361	1.346	1.339	1.335	1.332	14.98
1.469	1.441	1.423	1.406	1.389	1.362	1.347	1.340	1.336	1.333	14.99
1.470	1.442	1.424	1.406	1.390	1.362	1.347	1.340	1.336	1.333	15.00

TABLE XII

CONVERSION FACTORS FROM COMPRESSIBILITY (Z) TO SUPERCOMPRESSIBILITY - F_{pv}

$$F_{pv} = \sqrt{\frac{1}{Z}}$$

Z	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
					F_{pv}					
0.250	2.000	1.996	1.992	1.988	1.984	1.980	1.976	1.973	1.969	1.965
0.260	1.961	1.957	1.954	1.950	1.946	1.943	1.939	1.935	1.932	1.928
0.270	1.925	1.921	1.917	1.914	1.910	1.907	1.903	1.900	1.897	1.893
0.280	1.890	1.886	1.883	1.880	1.876	1.873	1.870	1.867	1.863	1.860
0.290	1.857	1.854	1.851	1.847	1.844	1.841	1.838	1.835	1.832	1.829
0.300	1.826	1.823	1.820	1.817	1.814	1.811	1.808	1.805	1.802	1.799
0.310	1.796	1.793	1.790	1.787	1.785	1.782	1.779	1.776	1.773	1.771
0.320	1.768	1.765	1.762	1.760	1.757	1.754	1.751	1.749	1.746	1.743
0.330	1.741	1.738	1.736	1.733	1.730	1.728	1.725	1.723	1.720	1.718
0.340	1.715	1.712	1.710	1.707	1.705	1.703	1.700	1.698	1.695	1.693
0.350	1.690	1.688	1.685	1.683	1.681	1.678	1.676	1.674	1.671	1.669
0.360	1.667	1.664	1.662	1.660	1.657	1.655	1.653	1.651	1.648	1.646
0.370	1.664	1.642	1.640	1.637	1.635	1.633	1.631	1.629	1.627	1.624
0.380	1.622	1.620	1.618	1.616	1.614	1.612	1.610	1.607	1.605	1.603
0.390	1.601	1.599	1.597	1.595	1.593	1.591	1.589	1.587	1.585	1.583
0.400	1.581	1.579	1.577	1.575	1.573	1.571	1.569	1.567	1.566	1.564
0.410	1.562	1.560	1.558	1.556	1.554	1.552	1.550	1.549	1.547	1.545
0.420	1.543	1.541	1.539	1.538	1.536	1.534	1.532	1.530	1.529	1.527
0.430	1.525	1.523	1.521	1.520	1.518	1.516	1.514	1.513	1.511	1.509
0.440	1.508	1.506	1.504	1.502	1.501	1.499	1.497	1.496	1.494	1.492
0.450	1.491	1.489	1.487	1.486	1.484	1.482	1.481	1.479	1.478	1.476
0.460	1.474	1.473	1.471	1.470	1.468	1.466	1.465	1.463	1.462	1.460
0.470	1.459	1.457	1.456	1.454	1.452	1.451	1.449	1.448	1.446	1.445
0.480	1.443	1.442	1.440	1.439	1.437	1.436	1.434	1.433	1.431	1.430
0.490	1.429	1.427	1.426	1.424	1.423	1.421	1.420	1.418	1.417	1.416
0.500	1.414	1.413	1.411	1.410	1.409	1.407	1.406	1.404	1.403	1.402
0.510	1.400	1.399	1.398	1.396	1.395	1.393	1.392	1.391	1.389	1.388
0.520	1.387	1.385	1.384	1.383	1.381	1.380	1.379	1.378	1.376	1.375
0.530	1.374	1.372	1.371	1.370	1.368	1.367	1.366	1.365	1.363	1.362
0.540	1.361	1.360	1.358	1.357	1.356	1.355	1.353	1.352	1.351	1.350
0.550	1.348	1.347	1.346	1.345	1.344	1.342	1.341	1.340	1.339	1.338
0.560	1.336	1.335	1.334	1.333	1.332	1.330	1.329	1.328	1.327	1.326
0.570	1.325	1.323	1.322	1.321	1.320	1.319	1.318	1.316	1.315	1.314
0.580	1.313	1.312	1.311	1.310	1.309	1.307	1.306	1.305	1.304	1.303
0.590	1.302	1.301	1.300	1.299	1.297	1.296	1.295	1.294	1.293	1.292

TABLE XII, Continued

Z	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
					F_{pv}					
0.600	1.291	1.290	1.289	1.288	1.287	1.286	1.285	1.284	1.282	1.281
0.610	1.280	1.279	1.278	1.277	1.276	1.275	1.274	1.273	1.272	1.271
0.620	1.270	1.269	1.268	1.267	1.266	1.265	1.264	1.263	1.262	1.261
0.630	1.260	1.259	1.258	1.257	1.256	1.255	1.254	1.253	1.252	1.251
0.640	1.250	1.249	1.248	1.247	1.246	1.245	1.244	1.243	1.242	1.241
0.650	1.240	1.239	1.238	1.237	1.237	1.236	1.235	1.234	1.233	1.232
0.660	1.231	1.230	1.229	1.228	1.227	1.226	1.225	1.224	1.224	1.223
0.670	1.222	1.221	1.220	1.219	1.218	1.217	1.216	1.215	1.214	1.214
0.680	1.213	1.212	1.211	1.210	1.209	1.208	1.207	1.206	1.206	1.205
0.690	1.204	1.203	1.202	1.201	1.200	1.200	1.199	1.198	1.197	1.196
0.700	1.195	1.194	1.194	1.193	1.192	1.191	1.190	1.189	1.188	1.188
0.710	1.187	1.186	1.185	1.184	1.183	1.183	1.182	1.181	1.180	1.179
0.720	1.179	1.178	1.177	1.176	1.175	1.174	1.174	1.173	1.172	1.171
0.730	1.170	1.170	1.169	1.168	1.167	1.166	1.166	1.165	1.164	1.163
0.740	1.162	1.162	1.161	1.160	1.159	1.159	1.158	1.157	1.156	1.155
0.750	1.155	1.154	1.153	1.152	1.152	1.151	1.150	1.149	1.149	1.148
0.760	1.147	1.146	1.146	1.145	1.144	1.143	1.143	1.142	1.141	1.140
0.770	1.140	1.139	1.138	1.137	1.137	1.136	1.135	1.134	1.134	1.133
0.780	1.132	1.132	1.131	1.130	1.129	1.129	1.128	1.127	1.127	1.126
0.790	1.125	1.124	1.124	1.123	1.122	1.122	1.121	1.120	1.119	1.119
0.800	1.118	1.117	1.117	1.116	1.115	1.115	1.114	1.113	1.112	1.112
0.810	1.111	1.110	1.110	1.109	1.108	1.108	1.107	1.106	1.106	1.105
0.820	1.104	1.104	1.103	1.102	1.102	1.101	1.100	1.100	1.099	1.098
0.830	1.098	1.097	1.096	1.096	1.095	1.094	1.094	1.093	1.092	1.092
0.840	1.091	1.090	1.090	1.089	1.089	1.088	1.087	1.087	1.086	1.085
0.850	1.085	1.084	1.083	1.083	1.082	1.081	1.081	1.080	1.080	1.079
0.860	1.078	1.078	1.077	1.076	1.076	1.075	1.075	1.074	1.073	1.073
0.870	1.072	1.071	1.071	1.070	1.070	1.069	1.068	1.068	1.067	1.067
0.880	1.066	1.065	1.065	1.064	1.064	1.063	1.062	1.062	1.061	1.061
0.890	1.060	1.059	1.059	1.058	1.058	1.057	1.056	1.056	1.055	1.055
0.900	1.054	1.054	1.053	1.052	1.052	1.051	1.051	1.050	1.049	1.049
0.910	1.048	1.048	1.047	1.047	1.046	1.045	1.045	1.044	1.044	1.043
0.920	1.043	1.042	1.041	1.041	1.040	1.040	1.139	1.039	1.038	1.038
0.930	1.037	1.036	1.036	1.035	1.035	1.034	1.034	1.033	1.033	1.032
0.940	1.031	1.031	1.030	1.030	1.029	1.029	1.028	1.028	1.027	1.027
0.950	1.026	1.025	1.025	1.024	1.024	1.023	1.023	1.022	1.022	1.021
0.960	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.016
0.970	1.015	1.015	1.014	1.014	1.013	1.013	1.012	1.012	1.011	1.011
0.980	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.006	1.006
0.990	1.005	1.005	1.004	1.004	1.003	1.003	1.002	1.002	1.001	1.001

TABLE XIII

CONVERSION OF API GRAVITY TO SPECIFIC GRAVITY – G_1

$$G_1 = \frac{141.5}{131.5 + API}$$

API Gravity at 60F	Specific Gravity	API Gravity at 60F	Specific Gravity	API Gravity at 60F	Specific Gravity
10	1.000	35	0.8498	60	0.7389
11	0.9930	36	0.8448	61	0.7351
12	0.9861	37	0.8398	62	0.7313
13	0.9792	38	0.8348	63	0.7275
14	0.9725	39	0.8299	64	0.7238
15	0.9659	40	0.8251	65	0.7201
16	0.9593	41	0.8203	66	0.7165
17	0.9529	42	0.8155	67	0.7128
18	0.9465	43	0.8109	68	0.7093
19	0.9402	44	0.8063	69	0.7057
20	0.9340	45	0.8017	70	0.7022
21	0.9279	46	0.7972	71	0.6988
22	0.9218	47	0.7927	72	0.6953
23	0.9159	48	0.7883	73	0.6919
24	0.9100	49	0.7839	74	0.6886
25	0.9042	50	0.7796	75	0.6852
26	0.8984	51	0.7753	76	0.6819
27	0.8927	52	0.7711	77	0.6787
28	0.8871	53	0.7669	78	0.6754
29	0.8816	54	0.7628	79	0.6722
30	0.8762	55	0.7587	80	0.6690
31	0.8708	56	0.7547	81	0.6659
32	0.8654	57	0.7507	82	0.6628
33	0.8602	58	0.7467	83	0.6597
34	0.8550	59	0.7428	84	0.6566

For conversion from other temperature to 60F see Table XVII, page VII - 97.

TABLE XIV

Values of $1-e^{-s}$ for Various Values of GL

VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$	VALUES FROM	OF GL TO	$1-e^{-S}$
598	611	.043	1,320	1,334	.092	2,083	2,098	.141
612	625	.044	1,335	1,349	.093	2,099	2,114	.142
626	640	.045	1,350	1,365	.094	2,115	2,130	.143
641	654	.046	1,366	1,380	.095	2,131	2,146	.144
655	669	.047	1,381	1,395	.096	2,147	2,162	.145
670	683	.048	1,396	1,410	.097	2,163	2,178	.146
684	698	.049	1,411	1,426	.098	2,179	2,194	.147
699	712	.050	1,427	1,441	.099	2,195	2,210	.148
713	727	.051	1,442	1,456	.100	2,211	2,226	.149
728	741	.052	1,457	1,471	.101	2,227	2,243	.150
742	756	.053	1,472	1,487	.102	2,244	2,259	.151
757	770	.054	1,488	1,502	.103	2,260	2,275	.152
771	785	.055	1,503	1,517	.104	2,276	2,291	.153
786	799	.056	1,518	1,533	.105	2,292	2,307	.154
800	814	.057	1,534	1,548	.106	2,308	2,324	.155
815	828	.058	1,549	1,563	.107	2,325	2,340	.156
829	843	.059	1,564	1,579	.108	2,341	2,356	.157
844	858	.060	1,580	1,594	.109	2,357	2,373	.158
859	872	.061	1,595	1,610	.110	2,374	2,389	.159
873	887	.062	1,611	1,625	.111	2,390	2,405	.160
888	902	.063	1,626	1,641	.112	2,406	2,422	.161
903	916	.064	1,642	1,656	.113	2,423	2,438	.162
917	931	.065	1,657	1,672	.114	2,439	2,455	.163
932	946	.066	1,673	1,687	.115	2,456	2,471	.164
947	961	.067	1,688	1,703	.116	2,472	2,488	.165
962	975	.068	1,704	1,718	.117	2,489	2,504	.166
976	990	.069	1,719	1,734	.118	2,505	2,521	.167
991	1,005	.070	1,735	1,750	.119	2,522	2,537	.168
1,006	1,020	.071	1,751	1,765	.120	2,538	2,554	.169
1,021	1,035	.072	1,766	1,781	.121	2,555	2,570	.170
1,036	1,049	.073	1,782	1,797	.122	2,571	2,587	.171
1,050	1,064	.074	1,798	1,812	.123	2,588	2,603	.172
1,065	1,079	.075	1,813	1,828	.124	2,604	2,620	.173
1,080	1,094	.076	1,829	1,844	.125	2,621	2,637	.174
1,095	1,109	.077	1,845	1,859	.126	2,638	2,653	.175
1,110	1,124	.078	1,860	1,875	.127	2,654	2,670	.176
1,125	1,139	.079	1,876	1,891	.128	2,671	2,687	.177
1,140	1,154	.080	1,892	1,907	.129	2,688	2,703	.178
1,155	1,169	.081	1,908	1,923	.130	2,704	2,720	.179
1,170	1,184	.082	1,924	1,938	.131	2,721	2,737	.180
1,185	1,199	.083	1,939	1,954	.132	2,738	2,754	.181
1,200	1,214	.084	1,955	1,970	.133	2,755	2,771	.182
1,215	1,229	.085	1,971	1,986	.134	2,772	2,787	.183
1,230	1,244	.086	1,987	2,002	.135	2,788	2,804	.184
1,245	1,259	.087	2,003	2,018	.136	2,805	2,821	.185
1,260	1,274	.088	2,019	2,034	.137	2,822	2,838	.186
1,275	1,289	.089	2,035	2,050	.138	2,839	2,855	.187
1,290	1,304	.090	2,051	2,066	.139	2,856	2,872	.188
1,305	1,319	.091	2,067	2,082	.140	2,873	2,889	.189

TABLE XIV, Continued

VALUES FROM	OF GL TO	1-e^-S		VALUES FROM	OF GL TO	1-e^-S		VALUES FROM	OF GL TO	1-e^-S
2,890	2,906	.190		3,747	3,765	.239		4,662	4,680	.288
2,907	2,923	.191		3,766	3,783	.240		4,681	4,700	.289
2,924	2,940	.192		3,784	3,801	.241		4,701	4,719	.290
2,941	2,957	.193		3,802	3,819	.242		4,720	4,739	.291
2,958	2,974	.194		3,820	3,837	.243		4,740	4,758	.292
2,975	2,991	.195		3,838	3,855	.244		4,759	4,777	.293
2,992	3,008	.196		3,856	3,873	.245		4,778	4,816	.294
3,009	3,025	.197		3,874	3,892	.246		4,798	4,816	.295
3,026	3,042	.198		3,893	3,910	.247		4,817	4,836	.296
3,043	3,060	.199		3,911	3,928	.248		4,837	4,855	.297
3,061	3,077	.200		3,929	3,947	.249		4,856	4,875	.298
3,078	3,094	.201		3,948	3,965	.250		4,876	4,895	.299
3,095	3,111	.202		3,966	3,983	.251		4,896	4,914	.300
3,112	3,128	.203		3,984	4,002	.252		4,915	4,934	.301
3,129	3,146	.204		4,003	4,020	.253		4,935	4,954	.302
3,147	3,163	.205		4,021	4,038	.254		4,955	4,973	.303
3,164	3,180	.206		4,039	4,057	.255		4,974	4,993	.304
3,181	3,198	.207		4,058	4,075	.256		4,994	5,013	.305
3,199	3,215	.208		4,076	4,094	.257		5,014	5,033	.306
3,216	3,232	.209		4,095	4,112	.258		5,034	5,053	.307
3,233	3,250	.210		4,113	4,131	.259		5,054	5,072	.308
3,251	3,267	.211		4,132	4,150	.260		5,073	5,092	.309
3,268	3,285	.212		4,151	4,168	.261		5,093	5,112	.310
3,286	3,302	.213		4,169	4,187	.262		5,113	5,132	.311
3,303	3,320	.214		4,188	4,205	.263		5,133	5,152	.312
3,321	3,337	.215		4,206	4,224	.264		5,153	5,172	.313
3,338	3,355	.216		4,225	4,243	.265		5,173	5,192	.314
3,356	3,372	.217		4,244	4,262	.266		5,193	5,212	.315
3,373	3,390	.218		4,263	4,280	.267		5,213	5,233	.316
3,391	3,408	.219		4,281	4,299	.268		5,234	5,253	.317
3,409	3,425	.220		4,300	4,318	.269		5,254	5,273	.318
3,426	3,443	.221		4,319	4,337	.270		5,274	5,293	.319
3,444	3,460	.222		4,338	4,356	.271		5,294	5,313	.320
3,461	3,478	.223		4,357	4,375	.272		5,314	5,333	.321
3,479	3,496	.224		4,376	4,393	.273		5,334	5,354	.322
3,497	3,514	.225		4,394	4,412	.274		5,355	5,374	.323
3,515	3,531	.226		4,413	4,431	.275		5,375	5,394	.324
3,532	3,549	.227		4,432	4,450	.276		5,395	5,415	.325
3,550	3,567	.228		4,451	4,469	.277		5,416	5,435	.326
3,568	3,585	.229		4,470	4,488	.278		5,436	5,456	.327
3,586	3,603	.230		4,489	4,508	.279		5,457	5,476	.328
3,604	3,621	.231		4,509	4,527	.280		5,477	5,497	.329
3,622	3,639	.232		4,528	4,546	.281		5,498	5,517	.330
3,640	3,656	.233		4,547	4,565	.282		5,518	5,538	.331
3,657	3,674	.234		4,566	4,584	.283		5,539	5,558	.332
3,675	3,692	.235		4,585	4,603	.284		5,559	5,579	.333
3,693	3,710	.236		4,604	4,623	.285		5,580	5,600	.334
3,711	3,728	.237		4,624	4,642	.286		5,601	5,620	.335
3,729	3,746	.238		4,643	4,661	.287		5,621	5,641	.336

TABLE XIV, Continued

VALUES FROM	OF GL TO	1-e^-S	VALUES FROM	OF GL TO	1-e^-S	VALUES FROM	OF GL TO	1-e^-S
5,642	5,662	.337	6,697	6,718	.386	7,840	7,863	.435
5,663	5,682	.338	6,719	6,741	.387	7,864	7,887	.436
5,683	5,703	.339	6,742	6,763	.388	7,888	7,912	.437
5,704	5,724	.340	6,764	6,786	.389	7,913	7,936	.438
5,725	5,745	.341	6,787	6,808	.390	7,937	7,961	.439
5,746	5,766	.342	6,809	6,831	.391	7,962	7,985	.440
5,767	5,787	.343	6,832	6,854	.392	7,986	8,010	.441
5,788	5,808	.344	6,855	6,876	.393	8,011	8,035	.442
5,809	5,829	.345	6,877	6,899	.394	8,036	8,059	.443
5,830	5,850	.346	6,900	6,922	.395	8,060	8,084	.444
5,851	5,871	.347	6,923	6,944	.396	8,085	8,109	.445
5,872	5,892	.348	6,945	6,967	.397	8,110	8,134	.446
5,893	5,913	.349	6,968	6,990	.398	8,135	8,159	.447
5,914	5,934	.350	6,991	7,013	.399	8,160	8,183	.448
5,935	5,955	.351	7,014	7,036	.400	8,184	8,208	.449
5,956	5,977	.352	7,037	7,059	.401	8,209	8,233	.450
5,978	5,998	.353	7,060	7,082	.402	8,234	8,258	.451
5,999	6,019	.354	7,083	7,105	.403	8,259	8,284	.452
6,020	6,040	.355	7,106	7,128	.404	8,285	8,309	.453
6,041	6,062	.356	7,129	7,151	.405	8,310	8,334	.454
6,063	6,083	.357	7,152	7,174	.406	8,335	8,359	.455
6,084	6,105	.358	7,175	7,197	.407	8,360	8,384	.456
6,106	6,126	.359	7,198	7,221	.408	8,385	8,410	.457
6,127	6,148	.360	7,222	7,244	.409	8,411	8,435	.458
6,149	6,169	.361	7,245	7,267	.410	8,436	8,461	.459
6,170	6,191	.362	7,268	7,290	.411	8,462	8,486	.460
6,192	6,212	.363	7,291	7,314	.412	8,487	8,512	.461
6,213	6,234	.364	7,315	7,337	.413	8,513	8,537	.462
6,235	6,256	.365	7,338	7,361	.414	8,538	8,563	.463
6,257	6,277	.366	7,362	7,384	.415	8,564	8,588	.464
6,278	6,299	.367	7,385	7,408	.416	8,589	8,614	.465
6,300	6,321	.368	7,409	7,431	.417	8,615	8,640	.466
6,322	6,342	.369	7,432	7,455	.418	8,641	8,666	.467
6,343	6,364	.370	7,456	7,479	.419	8,667	8,691	.468
6,365	6,386	.371	7,480	7,502	.420	8,692	8,717	.469
6,387	6,408	.372	7,503	7,526	.421	8,718	8,743	.470
6,409	6,430	.373	7,527	7,550	.422	8,744	8,769	.471
6,431	6,452	.374	7,551	7,574	.423	8,770	8,795	.472
6,453	6,474	.375	7,575	7,598	.424	8,796	8,821	.473
6,475	6,496	.376	7,599	7,622	.425	8,822	8,848	.474
6,497	6,518	.377	7,623	7,646	.426	8,849	8,874	.475
6,519	6,540	.378	7,647	7,670	.427	8,875	8,900	.476
6,541	6,562	.379	7,671	7,694	.428	8,901	8,926	.477
6,563	6,585	.380	7,695	7,718	.429	8,927	8,953	.478
6,586	6,607	.381	7,719	7,742	.430	8,954	8,979	.479
6,608	6,629	.382	7,743	7,766	.431	8,980	9,005	.480
6,630	6,651	.383	7,767	7,790	.432	9,006	9,032	.481
6,652	6,674	.384	7,791	7,814	.433	9,033	9,059	.482
6,675	6,696	.385	7,815	7,839	.434	9,060	9,085	.483

TABLE XIV, Continued

VALUE FROM	OF GL TO	1-e^-S		VALUE FROM	OF GL TO	1-e^-S		VALUE FROM	OF GL TO	1-e^-S
9,086	9,112	.484		9,657	9,684	.505		10,253	10,281	.526
9,113	9,136	.485		9,685	9,712	.506		10,282	10,310	.527
9,139	9,165	.486		9,713	9,739	.507		10,311	10,339	.528
9,166	9,192	.487		9,740	9,767	.508		10,340	10,368	.529
9,193	9,219	.488		9,768	9,795	.509		10,369	10,397	.530
9,220	9,246	.489		9,796	9,824	.510		10,398	10,427	.531
9,247	9,273	.490		9,825	9,852	.511		10,428	10,456	.532
9,274	9,300	.491		9,853	9,880	.512		10,457	10,485	.533
9,301	9,327	.492		9,881	9,908	.513		10,486	10,515	.534
9,328	9,354	.493		9,909	9,936	.514		10,516	10,544	.535
9,355	9,381	.494		9,937	9,965	.515		10,545	10,574	.536
9,382	9,408	.495		9,966	9,993	.516		10,575	10,604	.537
9,409	9,436	.496		9,994	10,022	.517		10,605	10,634	.538
9,437	9,463	.497		10,023	10,050	.518		10,635	10,663	.539
9,464	9,490	.498		10,051	10,079	.519		10,664	10,693	.540
9,491	9,518	.499		10,080	10,107	.520		10,694	10,723	.541
9,519	9,545	.500		10,108	10,136	.521		10,724	10,753	.542
9,546	9,573	.501		10,137	10,165	.522		10,754	10,783	.543
9,574	9,601	.502		10,166	10,194	.523		10,784	10,814	.544
9,602	9,628	.503		10,195	10,223	.524		10,815	10,844	.545
9,629	9,656	.504		10,224	10,252	.525		10,845		.546

TABLE XV

Friction Factors for Various Flow Strings (F_r), Tubing

FRICTION FACTORS (Fc) FOR SMALL DIAMETER FLOW STRINGS				
NOMINAL PIPE SIZE INCHES	OUTSIDE DIAMETER INCHES	WEIGHT POUNDS PER FT	INSIDE DIAMETER INCHES	FRICTION FACTOR Fc
TUBING				
3/4	1.050	1.20	.824	94.68
1	1.315	1.80	1.049	50.40
1 1/4	1.660	2.40	1.380	24.62
1 1/4	1.600	2.10	1.410	23.28
1 1/2	1.900	2.90	1.610	16.46
1 1/2	1.900	2.40	1.650	15.44
2 1/16	2.062	3.25	1.867	11.18
2 3/8	2.375	5.95	1.867	11.18
2 3/8	2.375	4.70	1.995	9.402
2 7/8	2.875	8.70	2.259	6.796
2 7/8	2.875	6.50	2.441	5.551
3 1/2	3.500	12.95	2.750	4.066
3 1/2	3.500	10.20	2.922	3.470
3 1/2	3.500	9.30	2.992	3.262
3 1/2	3.500	7.70	3.068	3.055
4	4.000	11.00	3.476	2.205
4	4.000	9.50	3.548	2.090
4 1/2	4.500	12.75	3.958	1.571
CASING				
4 1/2	4.500	15.10	3.826	1.716
4 1/2	4.500	13.50	3.920	1.611
4 1/2	4.500	12.75	3.958	1.571
4 1/2	4.500	11.60	4.000	1.528
4 1/2	4.500	10.50	4.052	1.477
4 1/2	4.500	9.50	4.090	1.442
5	5.000	24.10	4.000	1.528
5	5.000	21.40	4.126	1.409
5	5.000	21.00	4.154	1.384
5	5.000	18.00	4.276	1.284

TABLE XV, Continued (Casing)

FRICTION FACTORS (Fc) FOR LARGE DIAMETER FLOW STRINGS							
CASING NOMINAL SIZE INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES	FRICTION FACTOR Fc	CASING NOMINAL SIZE INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES	FRICTION FACTOR Fc
5.000	15.00	4.408	1.187	7.625	47.10	6.375	.4577
5.000	13.00	4.494	1.129	7.625	45.00	6.445	.4450
5.000	11.50	4.560	1.087	7.625	42.80	6.501	.4352
				7.625	39.00	6.625	.4144
				7.625	33.70	6.765	.3927
5.500	25.00	4.580	1.075	7.625	29.70	6.875	.3766
5.500	23.00	4.670	1.022	7.625	26.40	6.969	.3637
5.500	20.00	4.778	.9637	7.625	24.00	7.025	.3562
5.500	17.00	4.892	.9068				
5.500	15.50	4.950	.8796				
5.500	15.00	4.976	.8678	8.625	49.00	7.511	.2997
5.500	14.00	5.012	.8518	8.625	44.00	7.651	.2858
5.500	13.00	5.044	.8379	8.625	43.00	7.625	.2883
				8.625	40.00	7.725	.2787
				8.625	38.00	7.775	.2741
6.000	26.00	5.140	.7981	8.625	36.00	7.825	.2696
6.000	23.00	5.240	.7594	8.625	32.00	7.907	.2625
6.000	20.00	5.352	.7190	8.625	32.00	7.921	.2613
6.000	18.00	5.424	.6946	8.625	28.00	8.003	.2544
6.000	17.00	5.450	.6861	8.625	28.00	8.017	.2533
6.000	15.00	5.524	.6626	8.625	24.00	8.097	.2469
				8.625	20.00	8.191	.2396
				8.625	17.50	8.249	.2353
6.625	34.00	5.595	.6411				
6.625	32.00	5.675	.6181				
6.625	28.00	5.791	.5866	9.625	58.00	8.435	.2221
6.625	26.00	5.855	.5702	9.625	53.50	8.535	.2155
6.625	24.00	5.921	.5539	9.625	47.00	8.681	.2062
6.625	22.00	5.989	.5378	9.625	43.50	8.755	.2018
6.625	20.00	6.049	.5242	9.625	40.00	8.835	.1971
				9.625	36.00	8.921	.1922
				9.625	32.30	9.001	.1878
7.000	40.00	5.836	.5750				
7.000	38.00	5.920	.5542				
7.000	35.00	6.004	.5344				
7.000	32.00	6.094	.5142				
7.000	30.00	6.154	.5014				
7.000	29.00	6.184	.4951				
7.000	28.00	6.214	.4890				
7.000	26.00	6.276	.4766				
7.000	24.00	6.336	.4650				
7.000	23.00	6.366	.4594				
7.000	22.00	6.398	.4535				
7.000	20.00	6.456	.4430				
7.000	17.00	6.538	.4288				

TABLE XVI Friction Factors for Various Annuli (F_r)

FRICTION FACTORS (Fc) FOR ANNULAR FLOW IN GAS WELL FLOW STRINGS										
CASING	CASING	CASING				TUBING		SIZES		
OUTSIDE	WEIGHT	INSIDE			OUTSIDE		DIAMETE	R	INCHES	
DIAMETER	POUNDS	DIAMETER								
INCHES	PER FT.	INCHES		1.050	1.315	1.660	1.900	2.0625	2.375	2.875
2.375	5.95	1.867		27.12	46.77	205.1				
2.375	4.70	1.995		20.54	32.13	91.08	651.7			
2.375	4.00	2.041		18.75	28.51	73.10	340.8			
2.875	8.70	2.259		12.71	17.53	33.29	71.59	182.0		
2.875	6.50	2.441		9.609	12.56	20.74	35.41	60.71	948.2	
3.500	12.95	2.750		6.389	7.848	11.27	15.96	21.71	54.16	
3.500	9.30	2.992		4.846	5.762	7.733	10.13	12.71	23.17	309.3
3.500	7.70	3.068		4.472	5.271	6.957	8.949	11.03	18.95	136.3
4.000	11.60	3.428		3.156	3.605	4.479	5.411	6.295	9.055	23.54
4.000	11.00	3.476		3.024	3.442	4.250	5.102	5.902	8.358	20.43
4.000	10.40	3.500		2.960	3.364	4.141	4.957	5.719	8.039	19.11
4.000	*9.50	3.548		2.839	3.216	3.936	4.685	5.378	7.455	16.83
4.500	15.10	3.826		2.259	2.518	2.995	3.467	3.886	5.054	9.241
4.500	13.50	3.920		2.100	2.331	2.749	3.159	3.518	4.499	7.828
4.500	12.75	3.958		2.040	2.260	2.658	3.045	3.383	4.300	7.349
4.500	11.60	4.000		1.977	2.186	2.563	2.927	3.243	4.095	6.870
4.500	10.50	4.052		1.903	2.099	2.451	2.789	3.081	3.861	6.339
4.500	9.50	4.090		1.851	2.039	2.374	2.694	2.970	3.702	5.990
5.000	24.10	4.000		1.977	2.186	2.563	2.927	3.243	4.095	6.870
5.000	21.40	4.126		1.803	1.984	2.304	2.609	2.870	3.561	5.685
5.000	21.00	4.154		1.768	1.942	2.251	2.545	2.796	3.456	5.464
5.000	18.00	4.276		1.623	1.775	2.042	2.291	2.503	3.048	4.637
5.000	15.00	4.408		1.485	1.616	1.845	2.056	2.233	2.682	3.938
5.000	13.00	4.494		1.403	1.524	1.731	1.921	2.080	2.478	3.564
5.000	11.50	4.560		1.345	1.457	1.650	1.826	1.972	2.336	3.312
5.500	25.00	4.580		1.328	1.438	1.627	1.799	1.941	2.295	3.241
5.500	23.00	4.670		1.249	1.356	1.527	1.682	1.809	2.124	2.948
5.500	20.00	4.778		1.170	1.258	1.418	1.556	1.668	1.943	2.645
5.500	17.00	4.892		1.094	1.173	1.315	1.437	1.536	1.775	2.373
5.500	15.50	4.950		1.058	1.133	1.257	1.381	1.474	1.697	2.250
5.500	15.00	4.976		1.043	1.115	1.237	1.357	1.447	1.664	2.198
5.500	14.00	5.012		1.022	1.092	1.209	1.325	1.412	1.619	2.129
5.500	13.00	5.044		1.003	1.072	1.185	1.298	1.381	1.581	2.070

TABLE XVI, Continued

FRICTION FACTORS (Fo) FOR ANNUL AR FLO W IN GAS WELL FLOW STRINGS										
CASING OUTSIDE DIAMETER INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES		1.050	1.315 OUTSIDE	1.660 TUBING	1.900 DIAMETE	2.0625 SIZES R	2.375 INCHES	2.875
6.000	26.00	5.140		.9513	1.014	1.118	1.209	1.295	1.475	1.907
6.000	23.00	5.240		.9011	.9588	1.054	1.136	1.202	1.374	1.757
6.000	20.00	5.352		.8492	.9017	.9875	1.062	1.121	1.260	1.609
6.000	18.00	5.424		.8179	.8674	.9480	1.018	1.073	1.202	1.523
6.000	17.00	5.450		.8071	.8555	.9343	1.002	1.056	1.182	1.493
6.000	15.00	5.524		.7772	.8229	.8968	.9605	1.011	1.127	1.414
6.625	34.00	5.595		.7500	.7931	.8628	.9226	.9697	1.079	1.344
6.625	32.00	5.675		.7209	.7614	.8267	.8825	.9262	1.027	1.254
6.625	28.00	5.791		.6814	.7185	.7780	.8285	.8680	.9588	1.161
6.625	26.00	5.855		.6609	.6963	.7528	.8008	.8381	.9238	1.113
6.625	24.00	5.921		.6407	.6744	.7280	.7735	.8088	.8896	1.067
6.625	22.00	5.989		.6208	.6528	.7037	.7467	.7801	.8563	1.023
6.625	20.00	6.049		.6039	.6345	.6832	.7242	.7560	.8283	.9855
7.000	40.00	5.836		.6669	.7028	.7601	.8089	.8469	.9340	1.127
7.000	38.00	5.920		.6410	.6747	.7284	.7739	.8093	.8901	1.068
7.000	35.00	6.004		.6165	.6481	.6985	.7410	.7740	.8492	1.013
7.000	32.00	6.094		.5916	.6213	.6684	.7080	.7386	.8082	.9590
7.000	30.00	6.154		.5758	.6043	.6493	.6871	.7163	.7825	.9252
7.000	29.00	6.184		.5681	.5960	.6400	.6769	.7055	.7700	.9089
7.000	28.00	6.214		.5606	.5879	.6310	.6670	.6949	.7579	.8931
7.000	26.00	6.276		.5455	.5716	.6128	.6472	.6737	.7336	.8616
7.000	24.00	6.336		.5313	.5564	.5959	.6288	.6541	.7112	.8326
7.000	23.00	6.366		.5245	.5490	.5877	.6199	.6446	.7003	.8187
7.000	22.00	6.398		.5173	.5413	.5791	.6105	.6347	.6890	.8041
7.000	20.00	6.456		.5046	.5277	.5640	.5941	.6173	.6692	.7788
7.000	17.00	6.538		.4874	.5093	.5436	.5720	.5938	.6425	.7448
7.625	47.10	6.375		.5224	.5469	.5852	.6172	.6418	.6971	.8145
7.625	45.00	6.445		.5070	.5303	.5668	.5972	.6205	.6729	.7835
7.625	42.80	6.501		.4951	.5175	.5527	.5818	.6042	.6543	.7599
7.625	39.00	6.625		.4700	.4907	.5230	.5498	.5702	.6158	.7111
7.625	33.70	6.765		.4439	.4628	.4922	.5165	.5349	.5760	.6613
7.625	29.70	6.875		.4247	.4424	.4698	.4923	.5094	.5473	.6256
7.625	26.40	6.969		.4092	.4259	.4517	.4728	.4889	.5244	.5973
7.625	24.00	7.025		.4004	.4165	.4414	.4618	.4772	.5114	.5813

TABLE XVI, Continued

FRICTION FACTORS (Fo) FOR ANNULAR FLOW IN GAS WELL FLOW STRINGS										
CASING OUTSIDE DIAMETER INCHES	CASING WEIGHT POUNDS PER FT.	CASING INSIDE DIAMETER INCHES		1.050 OUTSIDE	1.315	1.660 TUBING	1.900	2.0625 SIZES DIAMETER	2.375 INCHES	2.875
8.625	49.00	7.511		.3337	.3458	.3644	.3794	.3908	.4155	.4650
8.625	44.00	7.651		.3174	.3285	.3458	.3596	.3700	.3926	.4377
8.625	43.00	7.625		.3203	.3317	.3491	.3632	.3737	.3967	.4426
8.625	40.00	7.725		.3092	.3200	.3364	.3497	.3596	.3812	.4242
8.625	38.00	7.775		.3038	.3144	.3303	.3432	.3528	.3738	.4155
8.625	36.00	7.825		.2986	.3088	.3244	.3369	.3463	.3666	.4069
8.625	32.00	7.907		.2903	.3001	.3149	.3269	.3358	.3552	.3935
8.625	32.00	7.921		.2889	.2986	.3134	.3252	.3341	.3533	.3912
8.625	28.00	8.003		.2810	.2903	.3044	.3157	.3241	.3424	.3785
8.625	28.00	8.017		.2796	.2889	.3029	.3141	.3225	.3406	.3764
8.625	24.00	8.097		.2722	.2811	.2945	.3053	.3133	.3306	.3646
8.625	20.00	8.191		.2639	.2723	.2851	.2953	.3029	.3193	.3515
8.625	17.50	8.249		.2589	.2671	.2795	.2894	.2967	.3126	.3437
9.625	58.00	8.435		.2438	.2513	.2625	.2715	.2781	.2925	.3203
9.625	53.50	8.535		.2362	.2433	.2540	.2625	.2688	.2824	.3087
9.625	47.00	8.681		.2256	.2323	.2422	.2501	.2560	.2685	.2928
9.625	43.50	8.755		.2205	.2269	.2365	.2441	.2498	.2618	.2851
9.625	40.00	8.835		.2152	.2214	.2306	.2379	.2433	.2549	.2772
9.625	36.00	8.921		.2097	.2156	.2245	.2315	.2367	.2477	.2690
9.625	32.30	9.001		.2047	.2104	.2190	.2257	.2307	.2413	.2617

TABLE XVII

CORRECTIONS TO OBSERVED A. P. I. GRAVITY TAKEN AT VARIOUS TEMPERATURES, TO OBTAIN A. P. I. GRAVITY AT 60F

Observed Temperature F	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0
	Add to observed A. P. I. reading							
30	1.7	2.0	2.4	3.0	3.7	4.3	5.0	5.7
32	1.6	1.9	2.3	2.8	3.4	4.0	4.7	5.3
34	1.5	1.8	2.1	2.6	3.1	3.7	4.3	4.9
36	1.4	1.6	2.0	2.4	2.9	3.4	4.0	4.6
38	1.3	1.5	1.8	2.2	2.6	3.1	3.6	4.2
40	1.2	1.4	1.6	2.0	2.4	2.8	3.2	3.8
42	1.1	1.2	1.5	1.8	2.2	2.5	2.9	3.4
44	0.9	1.1	1.3	1.6	2.0	2.2	2.6	3.0
46	0.8	0.9	1.1	1.4	1.7	1.9	2.3	2.7
48	0.7	0.8	0.9	1.2	1.4	1.6	2.0	2.3
50	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9
52	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5
54	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1
56	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7
58	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.4
	Subtract from observed A. P. I. reading							
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
64	0.2	0.3	0.3	0.4	0.4	0.6	0.6	0.7
66	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
68	0.5	0.6	0.6	0.7	0.9	1.1	1.3	1.4
70	0.6	0.7	0.8	0.9	1.1	1.4	1.6	1.7
72	0.7	0.8	0.9	1.1	1.3	1.6	1.9	2.1
74	0.8	0.9	1.1	1.3	1.6	1.8	2.2	2.5
76	0.9	1.1	1.3	1.5	1.8	2.1	2.5	2.8
78	1.0	1.2	1.4	1.7	2.0	2.4	2.8	3.1
80	1.1	1.3	1.5	1.8	2.2	2.6	3.1	3.5
82	1.2	1.4	1.7	2.0	2.5	2.9	3.4	3.9
84	1.3	1.5	1.8	2.2	2.7	3.2	3.7	4.3
86	1.4	1.7	2.0	2.4	2.9	3.4	4.0	4.6
88	1.6	1.8	2.1	2.6	3.1	3.7	4.2	4.9
90	1.7	2.0	2.3	2.7	3.3	3.9	4.5	5.2
92	1.8	2.1	2.4	2.9	3.5	4.2	4.8	5.6
94	1.9	2.2	2.6	3.1	3.8	4.4	5.1	5.9
96	2.0	2.3	2.7	3.3	4.0	4.6	5.4	6.3
98	2.1	2.4	2.9	3.4	4.2	4.9	5.7	6.6
100	2.2	2.6	3.0	3.6	4.4	5.1	6.0	6.9
102	2.3	2.7	3.2	3.8	4.6	5.4	6.3	7.2
104	2.4	2.9	3.3	4.0	4.8	5.7	6.6	7.5
106	2.5	3.0	3.5	4.2	5.0	5.9	6.9	7.9
108	2.7	3.1	3.6	4.3	5.2	6.2	7.2	8.2
110	2.8	3.2	3.7	4.4	5.4	6.4	7.5	8.5
112	2.9	3.3	3.9	4.6	5.6	6.7	7.7	8.8
114	3.0	3.4	4.0	4.7	5.8	6.9	7.9	9.1
116	3.1	3.6	4.1	4.9	6.0	7.1	8.2	9.4
118	3.2	3.7	4.3	5.1	6.2	7.3	8.5	9.8
120	3.3	3.8	4.4	5.3	6.4	7.5	8.8	10.0

Based on data from U. S. Bureau of Standards Technical Paper 77.

APPENDICES

APPENDIX A, L 10 (Square Root) Chart Conversion Factors..... A-1

APPENDIX B, Calculation of Specific Gravity of the Well Fluid (G) B-1

APPENDIX C, The Flow Equation and Friction Factor (F_r)..... C-1

APPENDIX D, Correction for Deviation from Ideal Gas Laws..... D-1

APPENDIX A

L-10 (SQUARE ROOT) CHART CONVERSION FACTORS

Square Root Chart Reading	Differential, h_w R_h = 100	Static Pressure, P_m R_p = 100	Temperature, F. R_t = 150
0.0	0.0	0.0	0.0
1.0	1.00	1.00	1.5
1.5	2.25	2.25	3.4
2.0	4.00	4.00	6.0
2.2	4.84	4.84	7.3
2.4	5.76	5.76	8.6
2.6	6.76	6.76	10.1
2.8	7.84	7.84	11.8
3.0	9.00	9.00	13.5
3.2	10.24	10.24	15.4
3.4	11.56	11.56	17.3
3.6	12.96	12.96	19.4
3.8	14.44	14.44	21.7
4.0	16.00	16.00	24.0
4.1	16.81	16.81	25.2
4.2	17.64	17.64	26.5
4.3	18.49	18.49	27.7
4.4	19.36	19.36	29.0
4.5	20.25	20.25	30.4
4.6	21.16	21.16	31.7
4.7	22.09	22.09	33.1
4.8	23.04	23.04	34.6
4.9	24.01	24.01	36.0
5.0	25.00	25.00	37.5
5.1	26.01	26.01	39.0
5.2	27.04	27.04	40.6
5.3	28.09	28.09	42.1
5.4	29.16	29.16	43.7
5.5	30.25	30.25	45.4
5.6	31.36	31.36	47.0
5.7	32.49	32.49	48.7
5.8	33.64	33.64	50.5
5.9	34.81	34.81	52.2
6.0	36.00	36.00	54.0
6.1	37.21	37.21	55.8
6.2	38.44	38.44	57.7
6.3	39.69	39.69	59.5
6.4	40.96	40.96	61.4
6.5	42.25	42.25	63.5
6.6	43.56	43.56	65.3
6.7	44.89	44.89	67.3
6.8	46.24	46.24	69.4
6.9	47.61	47.61	71.4
7.0	49.00	49.00	73.5
7.1	50.41	50.41	75.6
7.2	51.84	51.84	77.8
7.3	53.29	53.29	79.9
7.4	54.76	54.76	82.1
7.5	56.25	56.25	84.4
7.6	57.76	57.76	86.6
7.7	59.29	59.29	88.9
7.8	60.84	60.84	91.3
7.9	62.41	62.41	93.6
8.0	64.00	64.00	96.0
8.1	65.61	65.61	98.4
8.2	67.24	67.24	100.9
8.3	68.89	68.89	103.3
8.4	70.56	70.56	105.8
8.5	72.25	72.25	108.4
8.6	73.96	73.96	110.9
8.7	75.69	75.69	113.5
8.8	77.44	77.44	116.2
8.9	79.21	79.21	118.8
9.0	81.00	81.00	121.5
9.1	82.82	82.82	124.2
9.2	84.64	84.64	127.0
9.3	86.49	86.49	129.7
9.4	88.36	88.36	132.5
9.5	90.25	90.25	135.4
9.6	92.16	92.16	138.2
9.7	94.09	94.09	141.1
9.8	96.04	96.04	144.1
9.9	98.01	98.01	147.0
10.0	100.00	100.0	150.0

Note: Subtract the actual atmospheric pressure from the static pressure to obtain gauge (dead weight) pressure.

Should the meter ranges differ from the ranges reflected in the above table, values corresponding to the proper range shall be determined by use of the following formula:

$$\text{Value at Range of Meter} = \frac{\text{Range of Meter}}{\text{Range of Table}} \times \text{Value in Table}$$

APPENDIX B

Calculation of the Specific Gravity of the Well Fluid (G)

When the specific gravity of the well fluid is not known, but the specific gravity of the separator gas "G_g" the API gravity of the separator liquid, and the gas-liquid hydrocarbon ratio are known, the well fluid gravity can be calculated from the following equation:

$$G = \frac{G_g + \frac{4595\, G_l}{GOR}}{1 + \frac{V_l}{GOR}} \qquad \text{B-1}$$

The approximate vapor volume equivalent, V_l (cu. ft. per bbl.), corresponding to the applicable API gravity is obtained through use of the following equation or table:

$$V_l = 369 + 5\,(\text{API gravity}) + 0.04\,(\text{API gravity})^2 \qquad \text{B-2}$$

Equation derived from Table 13.9, page 708, Volume II, U. S. Bureau of Mines Monograph 10.

Vapor Volume Equivalent, V_l, Corresponding to API Gravity

API Gravity	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
40.0	633	634	635	635	636	637	638	639	640	640
41.0	641	642	643	644	645	645	646	647	648	649
42.0	650	650	651	652	653	654	655	655	656	657
43.0	658	659	660	660	661	662	663	664	665	666
44.0	666	667	668	669	670	671	672	672	673	674
45.0	675	676	677	678	678	679	680	681	682	683
46.0	684	685	685	686	687	688	689	690	691	691
47.0	692	693	694	695	696	697	698	699	699	700
48.0	701	702	703	704	705	706	706	707	708	709
49.0	710	711	712	713	714	715	715	716	717	718
50.0	719	720	721	722	723	724	724	725	726	727
51.0	728	729	730	731	732	733	734	734	735	736
52.0	737	738	739	740	741	742	743	744	745	745
53.0	746	747	748	749	750	751	752	753	754	755
54.0	756	757	758	758	759	760	761	762	763	764
55.0	765	766	767	768	769	770	771	772	773	773
56.0	774	775	776	777	778	779	780	781	782	783
57.0	784	785	786	787	788	789	790	791	792	793
58.0	794	795	795	796	797	798	799	800	801	802
59.0	803	804	805	806	807	808	809	810	811	812
60.0	813	814	815	816	817	818	819	820	821	822
61.0	823	824	825	826	827	828	829	830	831	832
62.0	833	834	835	836	837	838	839	840	841	842
63.0	843	844	845	846	847	848	849	850	851	852
64.0	853	854	855	856	857	858	859	860	861	862
65.0	863	864	865	866	867	868	869	870	871	872
66.0	873	874	875	876	877	878	879	880	881	883
67.0	884	885	886	887	888	889	890	891	892	893
68.0	894	895	896	897	898	899	900	901	902	903
69.0	904	905	907	908	909	910	911	912	913	914
70.0	915	916	917	918	919	920	921	922	924	925
71.0	926	927	928	929	930	931	932	933	934	935
72.0	936	937	939	940	941	942	943	944	945	946
73.0	947	948	949	950	952	953	954	955	956	957
74.0	958	959	960	961	962	964	965	966	967	968

APPENDIX C

The Flow Equations and the Friction Factor (F_r)

The general flow equation may be expressed as follows: (1)

$$\frac{1000\ GL}{53.33} = \int_{P_2}^{P_1} \frac{P/TZ\ d(P)}{\frac{2.6665 f Q_m^2}{d^5} + H/L(P/TZ)^2} \qquad C\text{-}1$$

In order to utilize equation C-1, the coefficient of friction "f" must be evaluated. It may be obtained from various correlations; however, for the purpose of this report the coefficient of friction "f" as determined from the "complete turbulence" portion of Moody's (2) curves has been adopted. Moody's curves were calculated by means of the Colebrook (3) equation and are equivalent to the Nikuradse (4) equation where the coefficient of friction is independent of the Reynolds Number and depends only on the relative roughness. These values for various sizes of pipe are shown below:

d in.	Relative Roughness(*)	Moody f(**)	f(**)
0.6	0.001	0.0196	0.004900
0.75	0.0008	0.0187	0.004675
1.00	0.0006	0.0175	0.004375
1.50	0.0004	0.0159	0.003975
3.00	0.0002	0.0137	0.003425
6.00	0.0001	0.0120	0.003000
12.00	0.00005	0.0106	0.002650
60.00	0.00001	0.0082	0.002050

(*) Based on an absolute roughness of 0.0006 inches. (For roughness other than 0.0006 inches, see page C-5)

(**) The numerical value of the coefficient of friction "f" as used in this report is equal to 1/4 of the numerical value of the term "f" as used by Moody.

1 Cullender, M. H. and Smith, R. V.: "Practical Solution of Gas-Flow Equations for Wells and Pipelines with Large Temperature Gradients, "AIME Trans. v 207, p 281, 1956.

2 Moody, L. F.: "Friction Factors for Pipe Flow, " ASME Trans. v 66, p 671, 1944.

3 Colebrook, C. F.: "Turbulent Flow in Pipes, with Particular Reference to the Transition Region between the Smooth and Rough Pipe Laws, " J. Inst. Civil Engr. (London) v 11, p 133, 1938 - 1939.

4 Nikuradse, J.: "Stromungsgesetze in Rauhen Rohren, " V. D. I. Forschungsheft 361 (Aug., 1933), Translation, Pet. Engr. (March, May, June, July, Aug., 1940), v 11.

The log-log plot of the coefficient of friction "f" versus the corresponding internal diameter "d" for the values shown above indicates a straight line relationship for pipe diameters less than 4.277 inches and a different straight line relationship for pipe diameters greater than 4.277 inches. These straight lines may be expressed by the form $f = ad^b$, where "a" and "b" are constants.

Application of the method of least squares to the above data results in the following expressions for the coefficient of friction "f, "

$$f = \frac{4.372 \times 10^{-3}}{d^{0.224}} \qquad \text{C-2}$$

for internal diameters less than 4.277 inches, and

$$f = \frac{4.007 \times 10^{-3}}{d^{0.164}} \qquad \text{C-3}$$

for internal diameters greater than 4.277 inches.

For convenience, it is desirable to introduce two new terms F_r and F_e where:

$$(F_r Q_m)^2 = F_e = \frac{2.6665 f Q_m^2}{d^5} \qquad \text{C-4}$$

Substitution of the right hand term of Eq. C-2 and Eq. C-3 for "f" in Eq. C-4 results in

$$F_r = \frac{0.10797}{d^{2.612}} \qquad \text{C-5}$$

for internal diameters less than 4.277 inches, and

$$F_r = \frac{0.10337}{d^{2.582}} \qquad \text{C-6}$$

A table of values of F_r for various sizes of pipe is shown in Table XV.

For non-circular cross-sections, it is necessary to determine an effective value of the internal diameter "d" for substitution in Eq. C-5 and Eq. C-6.

The term d^5 in the general flow equation is from the expression

$$d_e^5 = \frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \qquad \text{C-7}$$

The terms $d^{0.224}$ in Eq. C-2 and $d^{0.164}$ in Eq. C-3 are a result of an empirical relationship and are from the equivalent diameter formula:

$$d_e = \frac{4 \text{ area}}{\text{perimeter}} \qquad \text{C-8}$$

Thus the effective diameter "d" for noncircular cross-sections for use with equation C-5 above is

$$d_e^{2.612} = \left[\frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \times \left(\frac{4 \text{ area}}{\text{perimeter}}\right)^{0.224} \right]^{1/2} \qquad \text{C-9}$$

and for use with Eq. C-6 above is

$$d_e^{2.582} = \left[\frac{\left(\frac{4 \text{ area}}{\pi}\right)^3}{\frac{\text{perimeter}}{\pi}} \times \left(\frac{4 \text{ area}}{\text{perimeter}}\right)^{0.164} \right]^{1/2} \qquad \text{C-10}$$

The term perimeter, as used in equations C-7 through C-10, refers to the total wetted perimeter in contact with the fluid, that is, for annular flow the wetted perimeter would be the sum of the internal perimeter of the larger flow string and external perimeter of the smaller. Thus,

$$d_e^{2.612} = (d - d_o)^{1.612} \ (d + d_o) \qquad \text{C-11}$$

and

$$d_e^{2.582} = (d - d_o)^{1.582} \ (d + d_o) \qquad \text{C-12}$$

for flow through an annular space.

For inclined static column or flow calculations, Eq. C-1 may be simplified as follows:

$$18.75 \ GH = \int_{P_t}^{P_s} \frac{P/TZ \ d(P)}{L/H \ F_e + (P/TZ)^2} \qquad \text{C-13}$$

It should be noted that the term "L/H" in Eq. C-13 is positive when the flow is upward as in a producing gas well and is negative when the flow is downward as in a gas injection well.

Equation C-13 does not lend itself to mathematical integration unless conditions are such that it can be assumed that the temperature "T" and compressibility factor "Z" are constant. In many cases this assumption does not introduce appreciable error and Eq. C-13 may be simplified with the result that

$$P_f^2 = e^s P_c^2 \qquad \text{C-14}$$

for the static column, and

$$P_s^2 = e^s P_t^2 + L/H \left[F_r Q_m TZ\right]^2 \ (e^s - 1) \qquad \text{C-15}$$

where

$$s = 0.0375 \ GH/Tz.$$

Often it is desired to convert the flowing pressure "P_t" to a corresponding static column pressure "P_w." In this case Eq. C-15 becomes

$$P_w^2 = P_t^2 + L/H \left[F_r Q_m TZ\right]^2 \quad (1 - e^{-s}) \qquad \text{C-16}$$

It should be noted that the additional assumption has been made that the temperature "T" and the compressibility factor "Z" are not only constant but that they are the same in both flowing and static columns.

In those cases (usually in deep high-pressure gas wells) when the assumption of constant temperature "T" and compressibility factor "Z" introduces appreciable error, Eq. C-13 may be evaluated by means of a numerical stepwise procedure. The equation for stepwise calculation of subsurface pressures in shut-in gas wells is:

$$37.5\ GH = \left[(P_1 - P_c)\ (I_1 + I_c) + (P_2 - P_1)\ (I_2 + I_1)\right] \qquad \text{C-17}$$

Where the subscripts "c," "1," and "2" indicate conditions at the wellhead, at "H/2," and at "H," respectively.

The final evaluation of the shut-in pressure "P_f" at a vertical depth of "H" in the well computed by:

$$P_f = P_c + \triangle P \qquad \text{C-18}$$

Where

$$\triangle P = \frac{3(37.5\ GH)}{I_c + 4I_1 + I_2} \qquad \text{C-19}$$

The equation for stepwise calculation of subsurface pressures in flowing gas wells is:

$$37.5\ GH = (P_1 - P_t)\ (I_1 + I_t) + (P_2 - P_1)\ (I_2 + I_1) \qquad \text{C-20}$$

Where the subscripts "t," "1," and "2" indicate conditions at the wellhead, at "H/2" and at "H," respectively.

The final evaluation of the flowing pressure "P_s" at a vertical depth of "H" in the well is computed by:

$$P_s = P_t + \triangle P \qquad \text{C-21}$$

and

$$\triangle P = \frac{3(37.5\ GH)}{I_t + 4I_1 + I_2} \qquad \text{C-22}$$

If the Nikuradse (4) equation relating relative roughness with pipe diameter were used instead of Moody's relationship, F_r for an absolute roughness of 0.0006 inches can be expressed as a function of pipe diameter as follows:

$$F_r = \frac{1.63294}{(15.1603 + 4 \log d)\ d^{5/2}} \qquad \text{C-23}$$

In using F_r values based on an absolute roughness of 0.0006 inches, a few wells will be found where flowing bottom-hole pressures are calculated to be more than the shut-in pressure. This is probably caused by the extremely smooth condition of the tubing or a combination of physical conditions which caused the tubing to act as a completely smooth pipe with a resultant low pressure drop due to friction. In those rare instances where there is evidence that the tubing is smoother than normal, the use of F_r values based on an absolute roughness of 0.0001 inches is suggested. F_r values based on an absolute roughness of 0.0001 inches may be calculated as follows:

$$F_r = \frac{1.63294}{(18.2728 + 4 \log d)\ d^{5/2}} \qquad \text{C-24}$$

APPENDIX D

Corrections for Deviations from Ideal Gas Laws

As a part of the problem of determining the characteristics and capacity of a gas well to produce, the volume of gas flowing and its flowing density must be computed.

The volume of gas flowing must be calculated to base conditions from flowing conditions at the point of metering, and the density of the gas in the flowing column must be calculated from atmospheric conditions to those existing in the flowing string. This is done by the use of the Ideal Gas Law: (1)

$$PV = nRT \qquad \text{D-1*}$$

At relatively low pressure or high temperature the deviation of natural gas from this relation is small, but at high pressures or low temperatures this deviation may be considerable. With pure gaseous elements corrections can be made with relatively small error by use of an equation of state. However, with gaseous compounds and mixtures of these gaseous compounds, these equations of state for the mixture become extremely complicated and difficult to handle mathematically. By using the "Law of Corresponding States," calculations of volumes and densities can be made with relatively small error at any pressure and temperature. This is: "That the ratio of the value of any intensive properties to the value of that property at the critical state is related to the ratios of the prevailing absolute temperature and pressure to the critical temperature and pressure by the same function for all similar substances." (2)

$$\text{The reduced volume } V_r = \frac{V}{V_{cr}}$$

$$\text{The reduced pressure } P_r = \frac{P}{P_{cr}}$$

$$\text{The reduced temperature } T_r = \frac{T}{T_{cr}}$$

These relations, developed for pure elements and compounds, have been extended to apply to mixtures by a method devised by Kay (3). In this method, the molal average critical pressure and molal average critical temperature are used rather than the true critical pressure and true critical temperature. The molal average critical pressure and molal average critical temperature are called pseudocritical pressure and pseudocritical temperature to distinguish them from the true critical pressure and true critical temperature. The pseudocritical pressure and pseudocritical temperature are used to compute the pseudo-reduced pressure and pseudo-reduced temperature for mixtures.

By using the pseudo-reduced pressure and pseudo-reduced temperature, the desired compressibility factor can be obtained from Table XI or from a compressibility chart.

The conventional compressibility chart is a plot of Z versus P_r at constant T_r obtained from the equation:

$$Z = \frac{PV}{nRT} = \frac{P_r V_r}{nRT_r} \qquad \text{D-2}$$

*See the following page for Special Nomenclature.

Thus, Z is the factor necessary to correct for the deviation from the Ideal Gas Law of the gas under investigation.

The chart shown (Figure 1) was prepared for hydrocarbons in natural gas. It is possible to utilize this chart satisfactorily by using values of the critical temperature and critical pressure adjusted for other material found in natural gases.

Table A lists the critical properties, molecular weights, and gas gravities of gases common to natural gases. The pseudocritical property of a mixture can be computed by multiplying the value given in this table (use underlined property where more than one is given) by the volume fraction of that constituent in the mixture. The sum of these products is equal to the pseudocritical property of the mixture. This is the preferred method of determining the pseudocritical property.

When no analysis of the gas is available, the pseudocritical properties can be estimated from the gas gravity. In general, carbon dioxide, nitrogen, and hydrogen sulphide will materially affect the pseudocritical properties.

These affects can be approximated by use of Table X. When the quantities of CO_2 or N_2 are beyond the range of Table X, or when appreciable quantities of H_2S are present, the compressibility factors should be determined experimentally.

Table IX is a tabulation of the values for hydrocarbon gases free from carbon dioxide, nitrogen, and hydrogen sulphide.

Table X is a tabulation of corrections of these values for various amounts of carbon dioxide and nitrogen.

Figure 2 shows pseudocritical properties versus gas gravity for miscellaneous natural gases and condensate well fluids. This chart should not be used when a gas analysis is available.

The relationship of pseudocritical properties also can be computed from the following equations devised by A. E. Sweeney, Jr.:

$$P_{cr} = 693 - 35.0G + 432.9X_c - 167.3X_n + 654\,X_{H_2S} \qquad \text{D-(3)}$$

$$T_{cr} = 158 + 33.0G - 167.3X_c - 279.9X_n + 127\,X_{H_2S} \qquad \text{D-(4)}$$

References

(1) Brown, G. G., Katz, D. L., Oberfell, G. C., and Alden, R. C., Natural Gasoline and The Volatile Hydrocarbons, Natural Gasoline Association of America, Tulsa, 1948.

(2) Sage, B. H. and Lacey, W. N., Volumetric and Phase Behavior of Hydrocarbons, Stanford University Press, 1939.

(3) Kay, W. B., Industrial and Engineering Chemistry, v 28, pp 1014, 1936.

Special Nomenclature

P = pressure, lbs./sq. in., absolute P_{cr} = critical pressure

V = volume, cu. ft. at standard conditions
n = number of moles
R = gas constant, 10.73 per pound mole
T = temperature, degrees Rankine
G = gas gravity, air = 1.000

T_{cr} = critical temperature
V_{cr} = critical volume
X_c = fractional volume of carbon dioxide
X_n = fractional volume of nitrogen
X_{H_2S} = fractional volume of hydrogen sulphide

TABLE A

Component	Molecular Weights M. W. *	Gravity G_g @	Critical T_{cr} *	Temperature T_{cr} #	Critical P_{cr} *	Pressure
Air **	28.95	1.000	238.74		546.69	
N_2 **	28.016	.968	227.22	204.0	492.32	
CO_2 **	44.01	1.52	547.98	496.0	1,072.81	
H_2O **	18.016	.622	1,165.20		3,199.61	
H_2S **	34.082	1.177	672.72		1,306.47	
CH_4	16.042	.554	343.3	336.0	673.1	
C_2H_6	30.068	1.039	549.77		708.3	
C_3H_8	44.094	1.523	665.95		617.4	
nC_4H_{10}	58.120	2.008	765.31		550.7	
nC_5H_{12}	72.146	2.493	845.60		489.5	
nC_6H_{14}	86.172	2.977	914.1		439.7	
nC_7H_{16}	100.198	3.461	972.31		396.9	
Iso-C_4H_{10}	58.120	2.008	734.65		529.1	
Iso-C_5H_{12}	72.146	2.493	829.8		483.0	
Neo-C_5H_{12}	72.146	2.493	780.77		464.0	
C_6H_{14}						
2-Methylpentane	86.172	2.977	896.5		440.1	
3-Methylpentane	86.172	2.977	907.8		453.1	
2-2-Dimethylbutane	86.172	2.977	880.9		450.5	
2-3-Dimethylbutane	86.172	2.977	900.5		455.4	
C_7H_{16}						
2-Methylhexane	100.198	3.461	955.9		400.0	
3-Methylhexane	100.198	3.461	964.0		413.0	
3-Ethylpentane	100.198	3.461	973.4		420.0	
2-2-Dimethylpentane	100.198	3.461	937.6		417.0	
2-3-Dimethylpentane	100.198	3.461	968.0		429.0	
2-4-Dimethylpentane	100.198	3.461	936.5		403.0	
3-3-Dimethylpentane	100.198	3.461	965.0		440.0	
2-2-3-Trimethylbutane	100.198	3.461	956.6		437.2	

* Values from SELECTED VALUES OF PHYSICAL THERMODYNAMIC PROPERTIES OF HYDROCARBONS AND RELATED COMPOUNDS; F. D. Rosini, K. S. Pitzer, R. L. Arnet, R. M. Braun and G. C. Pimentel; American Petroleum Institute, 1953.

** Values from INTERNATIONAL CRITICAL TABLES; McGraw-Hill Publishing Co.

@ Calculated, Air = 1.000.

\# Values from California Natural Gasoline Association Bulletin No. TS 461.

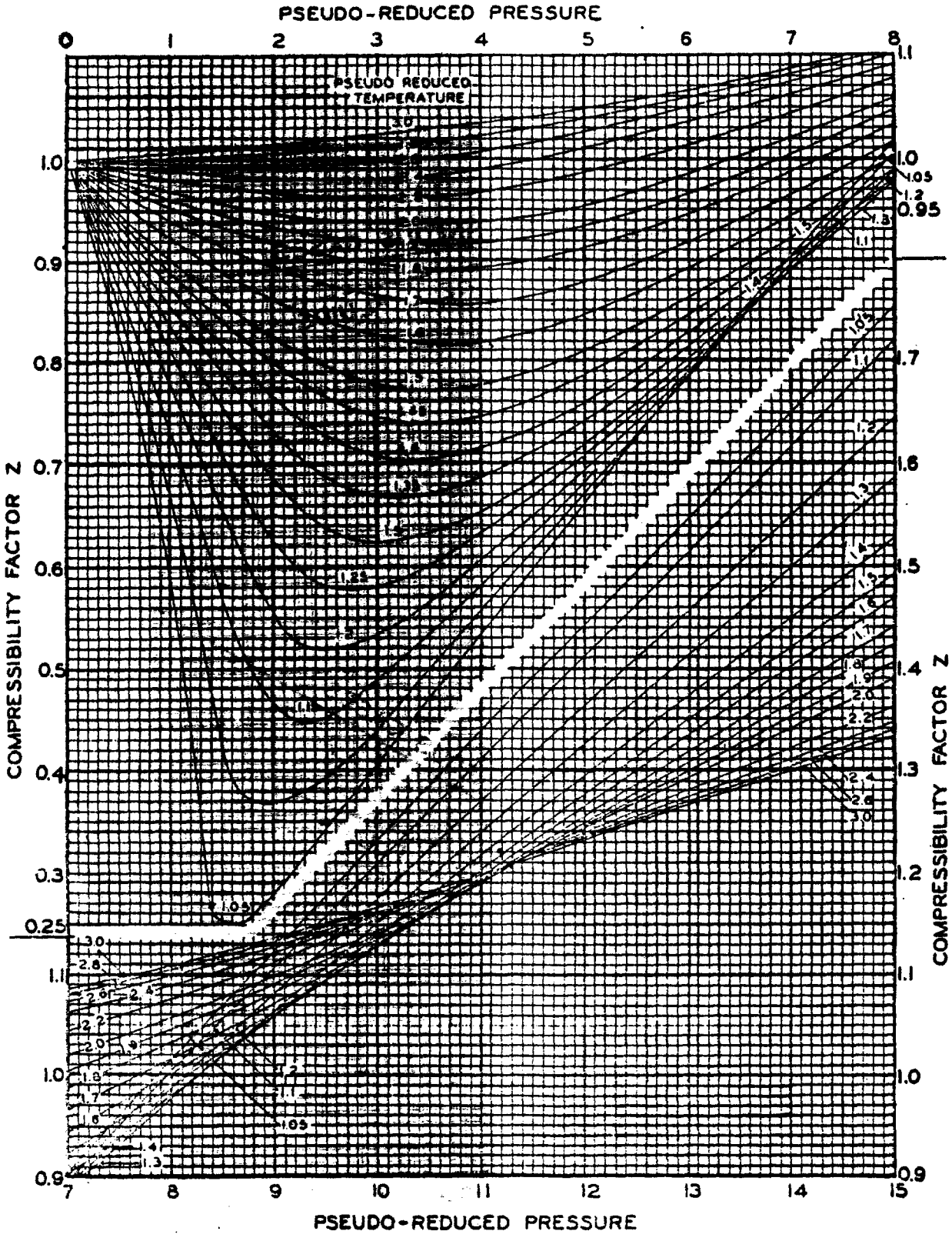
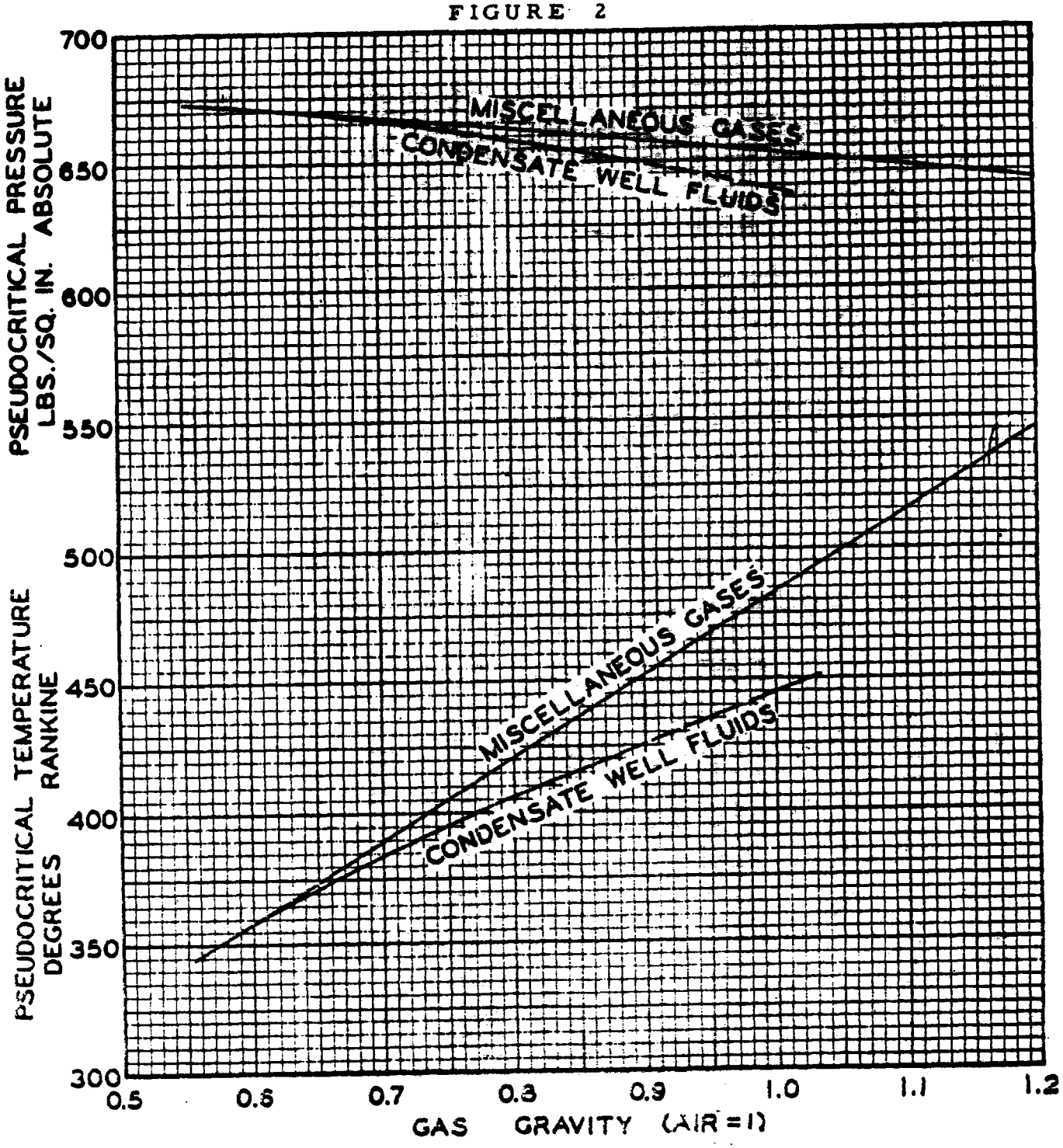

PSEUDO-REDUCED PRESSURE
0
1
2
3
4
5
6
7
8
PSEUDO REDUCED TEMPERATURE
COMPRESSIBILITY FACTOR Z
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.25
1.1
1.0
0.9
1.05
1.2
0.95
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
7
8
9
10
11
12
13
14
15
PSEUDO-REDUCED PRESSURE

FIGURE 2


PSEUDOCRITICAL PRESSURE LBS./SQ. IN. ABSOLUTE
700
650
600
550
500
450
400
350
300
MISCELLANEOUS GASES
CONDENSATE WELL FLUIDS
PSEUDOCRITICAL TEMPERATURE DEGREES RANKINE
MISCELLANEOUS GASES
CONDENSATE WELL FLUIDS
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
GAS GRAVITY (AIR = 1)