Back Pressure Test
For
Natural Gas Wells

State of Texas

RAILROAD COMMISSION
OF TEXAS

Table of Contents

Back - Pressure Test For Natural Gas Wells State of Texas

Recent papers on back-pressure testing of Natural Gas wells have pointed out that the following rules should be observed in order to arrive at a good potential test:

1. The well bore must be cleaned.
2. The well should be shut in for a period of at least 24 hours, in order to stabilize the reservoir pressure in the vicinity of the well.
3. All pressure should be measured with a dead-weight gauge.
4. The well should be produced at high back-pressure and the rate of flow determined at a minimum of four different working well-head pressures.

When the rate of flow is plotted versus the corresponding value of the difference in the square of the shut-in pressure in the formation and the square of the working pressure at the sand face on logarithmic coordinate paper, the points delineate a straight line which is expressed mathematically by the formula:

$$Q \quad C(P_f^2 - P_s^2)^n \qquad (1)$$

Where:

- Q = Rate of flow, Mcf per 24 hours.
- C = A Numerical coefficient, characteristic of the particular well.
- P_f = Shut-in formation pressure, psia.
- P_s = Working pressure at the sand face, psia.
- n = Numerical exponent, characteristic of the particular well. The value of "n" may be determined from the slope of the back-pressure curve, plotted in the conventional manner, and obviously is equal to the reciprocal of the slope.

The test procedure for establishing a back-pressure curve on a natural gas well by the use of a critical flow prover is outlined briefly below:

1. Take the stabilized dead-weight shut-in surface pressure on the well-head.
2. Install the critical flow prover on the well-head, in a vertical position, if possible.
3. Select the correctly sized plate to give the desired pressure drop for the first observation and install it in the prover.
4. Place the thermometer in the well of the prover.
5. Open the valve on the well to allow the full flow of gas to pass into the prover, restricted only by the capacity of the orifice at the operating pressure.
6. The pressure observed on the prover with the dead-weight gauge should be observed and recorded periodically, and the corresponding daily rate of flow should be computed. Whenever two consecutive pressure readings observed over a period of at least 15 minutes agree within 0.1 psig, constant conditions of flow exist and the well is "stabilized".
7. Observe and record the stabilized temperature and pressure readings on the prover at the well head.
8. Shut the well in, install a larger orifice plate in the prover, and again allow the full flow of gas to pass into the prover, and repeat steps 5, 6, 7, and 8.
9. Continue this procedure until at least four sets of stabilized readings have been obtained.

The following general rules have been accepted by the Commision as the approved method for testing natural gas wells by the back-pressure method in the State of Texas. These rules should be followed in order for tests to be accepted by the Engineering Department of the Commission and to eliminate extra work on the part of both the operators and the Commission necessitated by retesting and recalculating results when these rules are not observed.

1. If the well has a pipeline connection, it should be produced at its average daily rate of flow for 24 hours prior to the shut-in period in which the build-up pressure is to be obtained.
2. The well should be shut in for a sufficient length of time to allow a build-up to maximum pressure. The maximum pressure may be considered attained when the rate of pressure build-up does not exceed one (1) pound per thirty (30) minute period.
3. All pressure readings whether shut-in or flowing should be taken with a dead-weight gauge because spring gauge readings are not accurate enough for back-pressure tests.
4. The well should be produced at a rate which is great enough to lift whatever liquid (fluid) may be in the well bore.
5. The test can be run by beginning at either the lowest rate of flow to be employed and proceeding successively to the highest rate, or at the highest rate of flow, and proceeding to the lowest rate. The manner must be shown on the test report.
6. If possible, lower the well-head flowing pressure at least 25% below the shut-in well-head pressure. Some times it may be necessary to produce only one well at a time into a pipeline to achieve this much reduction in pressure.
7. Check the diameter of the orifice plate in the meter-run and also check the inside diameter of the run.
8. The differential pen on the meter should be zeroed.
9. Take pressure readings on the well-head every 15 minutes in order to determine if the well has stabilized.
10. Where a gas well is producing liquid, the gas-liquid ration should be arrived at from time to time to determine whether or not this ratio remains constant.
11. Under flow conditions, the pressures will be considered stabilized when they do not vary more than 0.1% of the original shut-in well-head pressure during a 15 minute interval.
12. At least 4 rates of flow and 4 corresponding stabilized pressures shall be taken on each test in order that a back-pressure curve may be drawn through at least 3 points.
13. Correct values for compressibility and friction factors should be used in determining the absolute open flow of gas wells.

14(a). A back-pressure curve with a slope of less than 1.0 will not be accepted by the Commission. Specifically this means that when the back-pressure curve is plotted in the conventional manner, the straight line drawn must be at an angle equal to or greater than 45° with the horizontal. Obviously for such conditions, "n" is equal to or less than 1.0.

(b). Upon retesting, if the points are not aligned to give a good curve, than a line with a slope of 1.0 should be drawn through the point determined by the highest rate of flow, if the general angle of the points is less than 45° with horizon, or a line with a slope of 0.500 if the general angle of the points is greater than 63.5° with the horizon, and the absolute open flow potential of the gas well should be ascertained from this curve.

15. All necessary data required for calculations of the test should be available in order that these calculations may be made in the field as the test progresses. This procedure will eliminate extra work in the event misleading or incorrect data are obtained.
16. Upon completion of the test, all calculations should be shown on Railroad Commission Form GWT-1 and shall be accompanied by a back-pressure curve neatly plotted on log-log graph paper. Two copies of data sheets together with back-pressure curves should be mailed to the Commission District Office in which the gas well is located.

Acknowledgment

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Austin, Texas
July 31, 1950

Acknowledgment is also made to the various oil and gas companies who have permitted the use of certain tables to be included in this manual.

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Back-Pressure Tests on Various Kinds of Gas Wells

Example No. 1

Back-Pressure Test On Low Pressure Shallow Dry Gas Well

General Data

Field	Panhandle
Specific Gravity (Raw Gas)	0.715
Size Casing	8-1/4 inches
Gas Pay	2910-3190 ft.
Average Length of Production Section (L)	3050 ft.
Barometer	13.2 psia
Meter Run	8 x 3-1/2 in.
Type Connection	Pipe Taps

Volume Calculations

$$Q = \frac{C\sqrt{h_w P_m} \times F_{tf} \times F_g \times F_{pv}}{1000} \qquad (2)$$

Where:

Q = Rate of flow, Mcf per 24 hours

C = Coefficient of orifice (24 hours)

h_w = Differential pressure, inches of water

P_m = Static pressure on meter, psia

F_{tf} = Flowing temperature factor

F_g = Specific gravity factor

F_{pv} = Supercompressibility factor

From Field data and Tables for the first rate of flow:

C = 89,248.04 (Table 1 - Page 33)

h_w = 10 inches of water

P_m = 262.2 psia

F_{tf} = 0.9905 (Table 4 - Page 36)

F_g = 0.9161 (Table 3 - Page 35)

F_{pv} = 1.034 (Table 13 - Page 77)

Substituting into the Formula:

$$Q1 = \frac{89{,}248.04\sqrt{(10)(262.2)}\,(.9905)\,(.9161)\,(1.034)}{1000}$$

Q1 = 4.288 Mcf per 24 hours

Q2 = 9.359

Q3 = 15.543

Q4 = 20.172

Pressure Calculations

Bottom Hole Pressures

$$K_{si} = \frac{GL}{(53.34)\,(T_{si})} \qquad (3)$$

Where:

G = The specific gravity of gas in the flow-string (air = 1)

L = The average length of the flow-string, feet

Tsi = The average shut-in well temperature,

°R = °F + 460°

Because no liquid is produced with the gas, the specific gravity of the raw gas would be used in the calculations. Also, the average shut-in temperature is the average temperature in the flow-string. Therefore:

$$T_{si} = \frac{T_{BH} + T_w}{2} \qquad (4)$$

Where:

T_{RH} = The bottom hole temperature °R

T_w = The shut-in well-head temperature °R (assumed average of 60° F)

$$T_{si} = \frac{550 + 520}{2} = 535°R$$

Then:

$$K_{si} = \frac{(0.715)(3050)}{(53.34)(535)} = \frac{2180.75}{28536.9}$$

$$K_{si} = 0.0764$$

The well-head temperatures and pressures are known, but the bottom hole pressures must be calculated. The method of calculating the bottom hole pressure is outlined as follows:

1. Assume a bottom hole pressure and temperature, provided these values are not obtained by subsurface instruments.
2. On the basis of the assumed bottom hole presure and temperature, calculate a bottom hole pressure as outlined in the calculations that follow.

If the calculated bottom hole pressure does not check within one tenth of one percent of the assumed bottom hole pressure, use the calculated value as a new assumed bottom hole pressure and calculate a new bottom hole pressure. Whenever the calculated value checks within one-tenth of one per cent of the assumed value, the calculated value may be taken as the correct value for the bottom hole pressure.

The following formula is recommended in assuming a bottom hole pressure appropriate to a particular well-head pressure.

The First Assumed BHP:

$$BHP = P_{si} + \frac{(0.01878)(P_{si})(G)(L)}{(T_{si})} \quad (5)$$

Where:

P_{si} = The well-head pressure under shut-in conditions, psia

L = The average length of the flow-string, feet

T_{si} = The average temperature of flow-string, °R

G = The specific gravity of gas in the flow-string (Air = 1)

$$0.01878 = \frac{(29)\ \text{lb/lb-mole}\ (492)\ °R}{359\ \text{ft}^3/\text{lb-mole}\ 14.7\ \text{Psia}\ 144\ \text{in}^2/\text{ft}^2}$$

$$BHP = 375.2 + \frac{(0.01878)(375.2)(.715)(3050)}{(535)}$$

$$BHP = 375.2 + 28.7 = 403.9$$

Then:

$$P_{av} = \frac{P_w + P_b}{2} \quad (6)$$

Where:

P_w = The well-head pressure, psia

P_b = The bottom hole pressure, psia

$$P_{av} = \frac{375.2 + 403.9}{2} = 389.6$$

The value of F_{pv} is found in the following manner:

The pseudo-critical pressure for a gas of 0.715 sp. gr. = 668.

The pseudo-critical temperature for a gas of 0.715 sp. gr. = 396.
(Table 11, page 46)

$$P_r = \frac{P_{av}}{P_{sc}} \text{ and } T_r = \frac{T_{si}}{T_{sc}} \quad (7)$$

Where:

P_r = Pseudo-reduced pressure of the gas

P_{av} = Average pressure in the flow string psia

P_{sc} = Pseudo-critical pressure of the gas, psia

T_r = Pseudo-reduced temperature of the gas

T_{si} = Average shut-in wellhead temperature, °R

T_{sc} = Pseudo-critical temperature of the gas, °R

Then:

$$P_r = \frac{389.6}{668} = 0.58$$

$$T_r = \frac{535}{396} = 1.35$$

From Table 12, Page 47, F_{pv} (corresponding to the above critical conditions) is 1.048.

And:

$$S = (F_{pv})^2 = \frac{1}{Z} \qquad (8)$$

and

$$S = (1.048)^2 = 1.098$$

Then:

$$KS = (.0764)(1.098) = 0.0839$$

and

$$e^{KS} = (2.718)^{0.0839} \quad 1.088$$

(Table 15, Page 103)

$$P_f = P_w \times e^{KS} \qquad (9)$$

Where:

P_f = The formation or closed-in pressure psia

P_w = The shut-in well-head pressure, psia

e^{KS} = A factor evaluated as above

Then:

$$P_f = (375.2)(1.088) = 408.2$$

The calculated BHP does not agree with the assumed BHP; therefore the calculated BHP will be used as a new assumed BHP and another calculation made.

$$P_{av} = \frac{375.2 + 408.2}{2} = 391.7$$

$$P_r = \frac{391.7}{668} = 0.59$$

$$T_r = \frac{535}{396} = 1.35$$

$$F_{pv} = 1.048$$

Then:

$$S = (1.048)^2 = 1.098$$

$$K = 0.0764$$

$$KS = (0.0764)(1.098) = 0.0839$$

$$e^{KS} = (2.718)^{0.0839}$$

$$\log e^{KS} = 0.0839 \log 2.718 = (0.0839)(0.434249)$$

$$\log e^{KS} = 0.036433$$

e^{Ks} = Anti-log of 0.036433 = 1.088

$$P_f = P_w \times e^{KS} = (375.2)(1.088) = 408.2$$

Then:

$$P_f^2 = (408.2)^2 = 166.6 \text{ (thousands)}$$

First rate of Flow

$$R = F_q \times Q \qquad (10)$$

Where:

R = A factor for evaluating the pressure drop due to frictional resistance when producing gas at a rate of Q Mcf per day

Q = The rate of flow in the flow-string, Mcf per day

F_q = A factor for evaluating $R\sqrt{\frac{GL}{C}}$ (11)

and

$$C = \frac{(1118)(D_{eff})^{8/3}}{\sqrt{Tf}} \qquad (12)$$

D_{eff} = The effective diameter of the flow string, inches

T_f = The average temperature of the flow-stream, °R

$(D_{eff})^{8/3}$, from Table 8, page 39, = 278.00

Because the changes in the flowing temperatures for different rates of flow do not materially affect the corresponding values of P, the calculation may be simplified by using an average T_f and thus obtain an average value of F_q which may be used to calculate all values of R.

Then:

$$T_f = \frac{T_{aw} + T_b}{2} \qquad (13)$$

Where:

T_{aw} = Average flowing well-head temperature, °R

T_b = Bottom hole temperature, °R

$\sqrt{T_f}$ = 23.3

Then:

$$C = \frac{(1118)(278)}{23.3} = 13339$$

and

$$Fq = \frac{\sqrt{(.715)(3050)}}{13339} = \frac{46.7}{13339}$$

$$= 0.00350$$

Therefore:

$R_l = F_q \times Ql$

$= (0.00350)(4.317)$

$= 15.1$

R_l^2 = .228 (thousands)

$$P_l = (P_w^2 + R_l^2)^{1/2} \qquad (14)$$

Where:

P_w = Well-head flowing pressure when producing at rate of Ql, psia

$P_l = (137.8 + .2)^{1/2}$

$P_l = (138{,}000)^{1/2}$

P_l = 371.5

$\frac{P_w}{P_l}$ = 0.999

F = A factor for evaluating the effect of gravity in a flowing column of gas. F is a function of $\frac{P_w}{P_l}$, and values corresponding to values of $\frac{P_w}{P_l}$, are found in Table 10, page 42.

F = 0.999

$$K_l = \frac{G\ L\ F}{(53.34)(T_{fl})} \qquad (15)$$

$$K_l = \frac{(0.715)(3050)(0.999)}{(53.34)\quad(540)}$$

K_l = 0.0756

$$P_{av} = \frac{408.2 + 371.2}{2} = 389.7$$

$$P_r = \frac{389.7}{668} = 0.58$$

$$T_a = \frac{550 + 530}{2} = 540$$

$$T_r = \frac{540}{396} = 1.36$$

F_{pv} = 1.046

Then:

S = 1.094

KS = (.0756) (1.094) 0.0827

e^{KS} = $(2.718)^{0.0827}$

log e^{KS} = 0.0827 log 2.718

log e^{KS} = (0.0827) (.434249)

log e^{KS} = 0.035912

e^{KS} = Anti-log of 0.035912 = 1.086

$P_s = P_l \times e^{KS}$

= (371.5) (1.086)

= 403.1

P_s^2 = 162.5

$$P_f^2 - P_s^2 = (166.6 - 162.5) = 4.1$$

Similar calculations for the remaining three sets of data provide a value of $(P_f^2 - P_s^2)$ for each corresponding rate of flow.

The values for $(P_f^2 - P_s^2)$ are plotted on the ordinary versus the corresponding value of Ql plotted on the abscissa and the best possible straight line is drawn through the points so obtained. A line parallel to the absicca is drawn through the value of $P_f^2 = (166.3)$ and projected to intercept the back-pressure curve. At the point of intersection a vertical line is dropped to the absicca. The point of intersection of this vertical line and the absicca is the open-flow potential of the well. Consequently the potential of the well is 58,000 Mcf per day.

Data For Plotting

Q (Mcf per day)	$P_f^2 - P_s^2$ (Mpsi)
4,228	4.1
9,265	11.4
15,552	23.3
20,177	35.1

Type or print only

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Form G-1
Rev. 4/1/83

483-047

API No. 42-

Gas Well Back Pressure Test, Completion or Recompletion Report, and Log

7. RRC District No. 10
8. RRC Gas ID No. 00111
9. Well No. 1
10. County of well site: Carson
11. Purpose of filing: Initial Potential [ ] Retest [X] Reclass [ ] Well record only (Explain in remarks) [ ]

1. FIELD NAME (as per RRC Records or Wildcat): Panhandle (West Sweet)
2. LEASE NAME: N. Young
3. OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report): ABC Gas Company
RRC Operator No.
4. ADDRESS: 1133 Oiland Gas Tower, Houston, Texas (zip code)
5. Location (Section, Block, and Survey): Sec. 12, Block 3, I. & G.W. Survey
5b. Distance and direction to nearest town in this county.
6. If operator has changed within last 60 days, name former operator: CBA Gas Co.
12. If workover or reclass, give former field (with reservoir) & Gas ID or oil lease no.

FIELD & RESERVOIR	GAS ID or OIL LEASE #	Oil—O Gas—G	WELL #

13. Pipe Line Connection: Panhandle Gas Company
14. Completion or recompletion date
15. Any condensate on hand at time of workover or recompletion? [ ] Yes [ ] No
16. Type of Electric or other Log Run: Electrical Induction

Section I — GAS MEASUREMENT DATA

Date of Test: 2-15-48

Gas Measurement Method (Check One): Orifice Meter [X] ▶ Flange Taps [ ] Pipe Taps [ ]; Positive Choke [ ]; Orifice Vent Meter [ ]; Pitot Tube [ ]; Critical-flow Prover [ ]

Gas produced during test: 2984 MCF

Run No.	Line Size	Orif. or Choke Size	24 Hr. Coeff. Orif. or Choke	Static P_m or Choke Press	Diff. h_w	Flow Temp. °F	Temp. Factor F_{tf}	Gravity Factor F_g	Compress Factor F_{pv}	Volume MCF/DAY
1	8" tap	3½	89248.04	262.2	10	70	0.9905	0.9161	1.034	4288
2	8" tap	3½	89248.04	262.2	48	73	0.9877	0.9161	1.033	9265
3	8" tap	4	123278.01	262.2	70	77	0.9840	0.9161	1.033	15552
4	8" tap	4½	167268.04	262.2	64	77	0.9840	0.9161	1.033	20177

Section II — FIELD DATA AND PRESSURE CALCULATIONS

Gravity (Dry Gas)	Gravity Liquid Hydrocarbon Deg. API	Gas-Liquid Hydro Ratio CF/Bbl	Gravity of Mixture	Avg. Shut-in Temp.	Bottom Hole Temp.
0.715	Dry Gas		G_{mix} = 0.715	75 °F	90 °F @ 3000 (Depth)

$D_{eff}^{8/3} = 278$ $\sqrt{T_f} = \sqrt{542} = 23.3$ $\sqrt{GL} = \sqrt{0.715 \times 3050} = 46.7$

$C = \frac{1118 \times (D_{eff})^{8/3}}{\sqrt{T}} = \frac{1118 \times 278}{23.3} = 13339$ $\sqrt{\frac{GL}{C}} = \frac{46.7}{13339} = 0.00350$

Run No.	Time of Run Min.	Choke Size	Wellhead Press. PSIA P_w	Wellhead Flow Temp. °F	P_w^2 (Thousands)	R	R^2 (Thousands)	P_1	P_w/P_1
Shut-In			375.2		140.8				
1	90		371.2		137.8	15.0	0.2	371.5	0.999
2	75		361.3		130.5	32.7	1.1	362.8	0.998
3	90		343.8		118.2	54.2	2.9	349.2	0.985
4	90		327.1		107.0	70.3	4.9	334.5	0.978

Run No.	F	K	$S = \frac{s}{2}$	E^{ks}	P_f and P_s	P_f^2 and P_s^2 (thousands)	$P_f^2 - P_s^2$ (thousands)
Shut—In		0.0764	1.098	1.088	408.2	166.6	
1	0.999	0.0756	1.094	1.086	403.1	162.5	4.1
2	0.998	0.0753	1.092	1.086	394.0	155.2	11.4
3	0.993	0.0746	1.084	1.084	378.5	143.3	23.3
4	0.989	0.0743	1.084	1.084	362.6	131.5	35.1

Angle of Slope
θ .... 55.5°
n 0.687
Absolute Open Flow
58,000... MCF/DAY

WELL TESTER'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I conducted or supervised this test and that data and facts shown in Sections I and II above are true, correct, and complete, to the best of my knowledge. Bottomhole temperature and the diameter and length of flow string were furnished by the operator of the well.

Signature: Well Tester Name of Company RRC Representative

OPERATOR'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that I prepared or supervised and directed this report, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature: Operator's representative Title Date Tel: A/C Number

GAS WELL
BACK PRESSURE CURVE

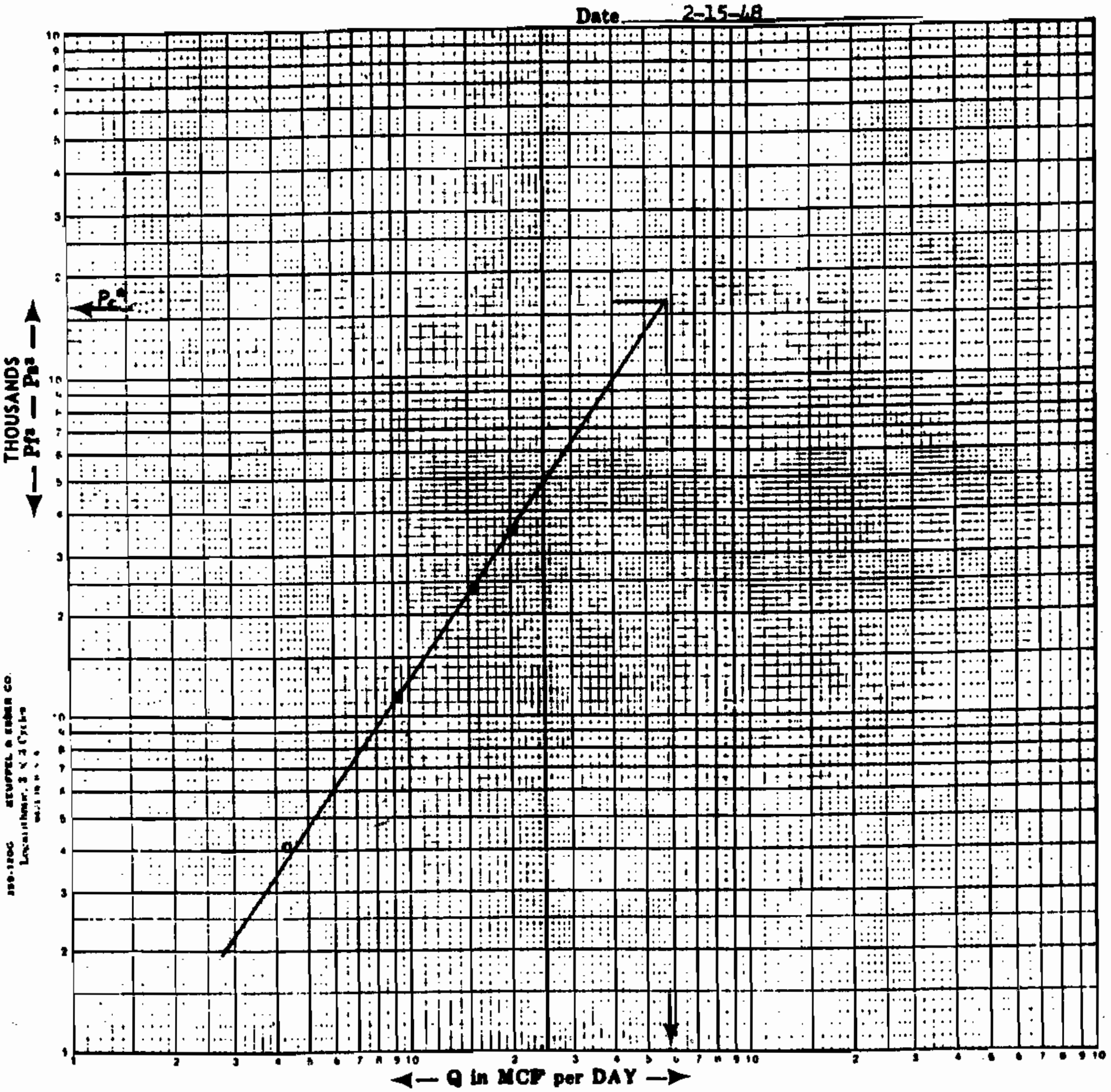
County Carson Field Panhandle

Operator A. B. C. Gas Company

Lease N. Young Well No. 1

Volume 58,000 MCF/24 hr.

Date 2-15-48



55.5° N = 0.687

Example No. 2

Back-Pressure Test on High Pressure Deep Gas Well Producing Through The Annulus

General Data

Field	Carthage
Reservoir	Upper Pettit
Specific gravity (Separator Gas)	0.700
Average Shut-in Temp.	143°F
Bottom Hole Temp.	206°F @ 6285 ft.
Size Casing	5-1/2 inches, 17 lbs. per ft.
Inside Diameter of Casing	4.892 inches
Nominal Size of Tubing	2 inches
Outside Diameter of Tubing	2.375 inches
Producing Section	6049 - 6070 ft.
Well Producing Through	Casing

Volume Calculations

$$Q = C \times P_c \times F_{tf} \times F_g \times F_{pv} \qquad (16)$$

Where:

Q = Rate of flow, Mcf per 24 hours

C = Coefficient of the choke (24 hours)

P_c = Flowing pressure on the choke, psia

F_{tf} = Flowing temperature factor

F_g = Specific gravity factor (Based on the gravity of the mixture flowing)

F_{pv} = Supercompressibility factor (Based on the gravity of the mixture flowing)

When measurement is made at the well-head or at some point between the well-head and the separator, the specific gravity factor and the supercompressibility factor must be based on the average specific gravity of the gas actually flowing through the flow-stream, and not on that of the gas after it has passed through the separator. However, if the measurement is made after the fluid has passed through the separator, the specific gravity factor and supercompressibility factor may be based on the gravity of the gas after it has passed through the separator.

In this example, measurement is made with a choke nipple at the well-head; therefore, the specific gravity of the mixture of liquid and gas is used as a basis for obtaining the specific gravity and supercompressibility factors.

Data For First Rate of Flow

C = 1.47 for 1/4" choke (Table 7, page 38)

P_c = 2628 psia — (from field Data)

F_{tf} = 0.9325 (Table 4, page 36)

The specific gravity of the mixture on which to base the gravity factor and the supercompressibility factor may be calculated in the following manner:

$$G_{mix} = \frac{G_g + \dfrac{4591\, G_c}{R_a}}{1 + \dfrac{1123}{R_a}} \qquad (17)$$

Where:

G_{mix} = Specific gravity of the mixture flowing (air = 1)

G_g = Specific gravity of the gas at the separator (air = 1)

G_c = The specific gravity of the condensate at the, separator (water = 1)

R_a = The gas-oil ratio, cubic feet per bbl.

From Field Data

(The following values of G_g, G_c and R_a were taken at the separator before starting the test with choke nipples.)

$G_c = 57.2$ A.P.I. $= 0.750$

$R_a = 86{,}880 \quad G_g = 0.70$

Then:

$$G_{mix} = \frac{0.70 + \frac{(4591)(.75)}{86{,}880}}{1 + \frac{1123}{86{,}880}}$$

$$G_{mix} = \frac{.70 + .0396}{1 + .013}$$

$G_{mix} = .730$

F_g = (for a gas of 0.730 sp. gr.) 0.9066 (Table 3, page 35)

The value of F_{pv} is found in the following manner:

The pseudo-critical pressure for a gas of 0.730 sp. gr. = 668.

The pseudo-critical temperature for a gas of 0.730 sp. gr. = 401. (Table 11, page 46)

$$P_r = \frac{P_c}{P_{sc}} \text{ and } T_r = \frac{T_c}{T_{sc}} \qquad (18)$$

Where:

P_r = Pseudo-reduced pressure of the gas

P_c = Flowing pressure at the choke, psia

P_{sc} = Pseudo-critical pressure of the gas, psia

T_r = Pseudo-reduced temperature of the gas

T_c = Flowing temperature at the choke, °R

T_{sc} = Pseudo-critical temperature of the gas, °R

Then:

$$P_r = \frac{2628}{668} = 3.93$$

$$T_r = \frac{598}{401} = 1.49$$

$F_{pv} = 1.136$ (Table 12, page 47)

Substituting these values into the flow equation:

$Q1 = (1.47)(2628)(0.9325)(0.9066)(1.136)$
$= 3710$ Mcf per day

$Q2 = (2.42)(2598)(.9066)(.9293)(1.129)$
$= 5960$

$Q3 = (3.40)(2574)(.9066)(.9217)(1.120)$
$= 8191$

$Q4 = (6.26)(2453)(.9066)(.9173)(1.119)$
$= 14{,}290$

Calculation of Pressure
Bottom Hole Pressure

$$P_s = P_1 \times e^{KS} \qquad (19)$$

Where:

P_s = Pressure at the sand face of the producing formation, psia

e^{KS} = A factor for evaluating the pressure drop due to the weight of the gas column from the well-head to the sand face.

$$P_1 = (P_w{}^2 + R^2)^{1/2} \qquad (20)$$

Where:

P_w = Well-head pressure when producing gas, psia

R = A factor for evaluating the pressure drop due to frictional resistance when producing gas

According to these definitions when Q is equal to zero, no pressure drop due to frictional resistance results, and P_1 equals P_w. Also, under shut-in conditions, when the reservoir conditions have equalized, the sand face pressure, P_s, will be equal to the formation pressure, P_f.

Therefore, under shut-in conditions:

$$P_f = P_{sl} \times e^{KS} \quad (21)$$

Where:

P_{sl} = Shut-in well-head pressure, psia

The well-head temperature and pressures are known, but the bottom hole pressure must be calculated. The method of calculating the bottom hole pressure follows:

1. Assume a bottom hole pressure and temperature, provided these values are not obtained by subsurface instruments.
2. On the basis of the assumed bottom hole pressure and temperature, calculate a bottom hole pressure as outlined in the sample calculations that follow.
3. If the calculated bottom hole pressure does not check within one-tenth of one percent of the assumed bottom hole pressure, use the calculated value as a new assumed bottom hole pressure, and calculate a new bottom hole pressure. Whenever the calculated value checks within one-tenth of one percent of the assumed value, the calculated value may be taken as the correct value for the bottom hole pressure.

To assist in the determination of the first assumed bottom hole pressure, the following formula is recommended.

$$BHP = P_{sl} \frac{(0.01878)(P_{sl})(G_{mix})(L)}{T_{sl}} \quad (22)$$

Where:

P_{sl} = Shut-in well head pressure, psia

T_{sl} = Average shut-in-temperature, °R

G_{mix} = Calculated specific gravity of the flow-stream (air = 1)

L = Average length of the producing string, ft.

From observed Field Data:

P_{sl} = 2630

T_{sl} = (460 + 143) = 603

G_{mix} = 0.730

L = 6060

Then:

$$BHP = 2630 + \frac{(0.01878)(2630)(0.730)(6060)}{603}$$

$$= 2630 + \frac{2.18 \times 10_5}{6.03 \times 10_2}$$

$$BHP = 2360 + 362 = 2992$$

The average shut-in pressure:

$$P_{av} = \frac{P_{sl} + P_b}{2}$$

$$= \frac{2630 + 2992}{2} = 2811$$

Again using the pseudo-critical pressure and pseudo-critical temperature for a gas of 0.730 specific gravity:

$$P_r = \frac{2811}{668} = 4.21$$

and

$$T_r = \frac{603}{401} = 1.50$$

F_{pv} = 1.124 (Table 12, page 47)

$S = (F_{pv})^2 = (1.124)^2 = 1.263$

Now:

$$K = \frac{(G_{mix})(L)(F)}{(53.34)(T)} \quad (23)$$

Where:

G_{mix}, L, and T are as defined previously.

F = A factor for evaluating the effect of gravity in a flowing column of gas and is a functional of $\frac{P_w}{P_l}$.

Values of F corresponding to values of $\frac{P_w}{P_l}$ are found in Table 10, page 42.

Under shut-in conditions:

$T = T_{si}$ and $F = 1$ when $P_w = P_l$

Then:

$$K_{si} = \frac{(.730)(6060)}{(53.34)(603)}$$

$$= 0.1375$$

$$KS = (1.263)(0.1375)$$

$$KS = 0.1737$$

$$e^{KS} = (2.718)^{0.1737}$$

$$\log e^{KS} = 0.1737 \log 2.718$$

$$= (0.1737)(0.434249)$$

$$= 0.075429$$

e^{KS} = Antilog of 0.075429 = 1.190 (or see Table 15, page 103).

$$P_f = P_{si} \times e^{KS}$$

$$= (2630)(1.190)$$

$$= 3130$$

This value does not agree with the assumed BHP: therefore, a new value of 3130 will be assumed and a new BHP calculated.

Then:

$$P_{av} = \frac{2630 + 3130}{2}$$

$$= 2880$$

$$P_r = \frac{2880}{668} = 4.31$$

$$T_r = \frac{603}{401} = 1.50$$

$$F_{pv} = 1.123$$

$$S = 1.261$$

$$KS = (0.1375)(1.261)$$

$$= 0.1734$$

$$e^{KS} = (2.718)^{0.1734}$$

$$\log e^{KS} = 0.1734 \log 2.718$$

$$= (0.1734)(0.434249)$$

$$= 0.075298$$

e^{KS} = Antilog of 0.075298 = 1.189

$$P_f = P_{si} \times e^{KS}$$

$$= (2630)(1.189)$$

$$= 3127$$

This value agrees within the required limits of the assumed BHP. Therefore:

$$P_f^2 = (3127)^2$$

$$= 9778 \text{ (Thousands)}$$

First Rate of Flow

$$P_s = P_l \times e^{KS} \quad (24)$$

Where:

$$P_l = (P_w^2 + R^2)^{1/2}$$

And R is evaluated in the following manner:

$$R = F_q \times Q \quad (25)$$

Where:

$$F_q = \frac{\sqrt{G_{mix} L}}{C} \quad (26)$$

and

$$C = \frac{(118)(D_{eff})^{8/3}}{\sqrt{T_f}} \quad (27)$$

Where:

D_{eff} = The effective diameter of the flow-string, inches

T_f = The average temperature of the flow-stream, °R

$D_{eff}^{8/3}$ = 36.403 (Table 9, page 40)

Because the changes in the flowing temperatures for different rates of flow do not materially affect the corresponding values of P, the calculation may be simplified by using an average T_f and thus obtain an average value of F_q which may be used to calculate all values of R.

Then:

$$T_f = \frac{T_{aw} + T_b}{2} \qquad (28)$$

Where:

T_{aw} = Average flowing well-head temperature, °R

T_b = Bottom hole temperature, °R

$$T_f = \frac{\frac{598 + 602 + 612 + 618 + 666}{4}}{2}$$

$= 637°R$

$\sqrt{T_f} = \sqrt{637} = 25.24$

Then:

$$C = \frac{(1118)(36.403)}{25.24}$$

$C = 1612$

and

$$F_q = \frac{\sqrt{(.730)(6060)}}{1612}$$

$$F_q = \frac{66.51}{1612}$$

$F_q = 0.413$

$R_l = F_q \times Ql$

$= (0.0413)(3710)$

$= 153.2$

$R_l^2 = 23.5$ (thousands)

$P_l = (P_w^2 + R^2)^{1/2}$

$= (6906 + 23.5)^{1/2}$

$= (6929.5)^{1/2}$

$= 2632$

$$\frac{P_w}{P_l} = \frac{2628}{2632} = 0.998$$

$F = 0.999$ (Table 10, page 42)

$$K_l = \frac{G_{mix}\, L\, F}{53.34\, T_{fl}}$$

$$= \frac{(0.730)(6060)(0.999)}{(53.34)\ (632)}$$

$K_l = 0.1311$

$$P_{av} = \frac{(2628) + (3127)}{2}$$

$= 2878$

$$P_r = \frac{2878}{668} = 4.31$$

$$T_r = \frac{632}{410} = 1.58$$

$F_{pv} = 1.102$

$S = 1.214$

$KS = (0.1311)(1.214)$

$KS = 0.1592$

$e^{KS} = (2.718)^{0.1592}$

$\log e^{KS} = 0.1592 \log 2.718$

$= (0.1592)(0.434249)$

$= 0.069132$

e^{KS} = Antilog of 0.0669132 = 1.173 (or see Table 15, page 103)

$P_s = P_l \times e^{KS}$

$= (2632)(1.173)$

$= 3087$

$P_s^2 = 9530$ (thousands)

$P_f^2 - P_s^2 = 9778 - 9530$

$= 248$

Similar calculations for the remaining three sets of data provide a value of ($P_f^2 - P_s^2$) for each corresponding rate of flow.

This value of ($P_f^2 - P_s^2$) is plotted versus the corresponding rate of flow on logarithmic coordinate paper. The other values of ($P_f^2 - P_s^2$) calculated in the same manner are also plotted versus the respective rates of flow, and the best straight line possible is drawn through the points.

The line is extended until it intersects a horizontal line representing P_f^2 (9778 in this example). At the intersection of these two lines a vertical line is drawn to intersect the absicca. The value read from the graph at the intersection of the vertical line and the absicca is the open-flow potential (91,000 Mcf per day in this example).

Data for Plotting

Q (Mcf per day)	$(P_f^2 - P_s^2)$ (Mpsi)
3710	248
5980	421
8191	567
14290	1123

Type or print only

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Form G-1
Rev. 4/1/83

483-047

API No. 42-

Gas Well Back Pressure Test, Completion or Recompletion Report, and Log

7. RRC District No.: 6
8. RRC Gas ID No.: 00014
9. Well No.: 1 (C)
10. County of well site: Panola
11. Purpose of filing: Initial Potential [ ] Retest [X] Reclass [ ] Well record only (Explain in remarks) [ ]

1. FIELD NAME (as per RRC Records or Wildcat): Carthage (Upper Pettit)
2. LEASE NAME: A. A. Jones
3. OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report): DEF Gas Company
RRC Operator No.:
4. ADDRESS: P. O. Box 10, Longview, Texas (zip code)
5. Location (Section, Block, and Survey): Sec. 5 Block 3 of the Brown Survey
5b. Distance and direction to nearest town in this county:
6. If operator has changed within last 60 days, name former operator:
12. If workover or reclass, give former field (with reservoir) & Gas ID or oil lease no.: FIELD & RESERVOIR / GAS ID or OIL LEASE # / OIL—O Gas—G / WELL #
13. Pipe Line Connection: Carthage Gas Company
14. Completion or recompletion date: 3/25/45
15. Any condensate on hand at time of workover or recompletion? [ ] Yes [ ] No
16. Type of Electric or other Log Run: Electric Induction

Section I

GAS MEASUREMENT DATA

Date of Test: 1/15/48

Gas Measurement Method (Check One): Orifice Meter [ ] ▶ Flange Taps [ ] Pipe Taps [ ]; Positive Choke [X]; Orifice Vent Meter [ ]; Pitot Tube [ ]; Critical-flow Prover [ ]

Gas produced during test: 4304 MCF

Run No	Line Size	Orif or Choke Size	24 Hr Coeff. Orif or Choke	Static P_m or Choke Press	Diff h_w	Flow Temp °F	Temp. Factor F_{tf}	Gravity Factor F_g	Compress Factor F_{pv}	Volume MCF/DAY
1		1/4	1.47	2628		138	0.9325	0.9066	1.136	3710
2		5/16	2.34	2598		142	0.9293	0.9066	1.129	5980
3		3/8	3.40	2574		152	0.9217	0.9066	1.120	8191
4		1/2	6.26	2453		158	0.9173	0.9066	1.119	14290

Section II

FIELD DATA AND PRESSURE CALCULATIONS

Gravity (Dry Gas)	Gravity Liquid Hydrocarbon	Gas-Liquid Hydro Ratio	Gravity of Mixture	Avg. Shut-in Temp.	Bottom Hole Temp.
0.700	57.2 Deg. API	86,800 CF/Bbl	G_{mix} = 0.730	143 °F	206 °F @ 6285 (Depth)

$D_{eff}^{8/3}$ = 36.403

$\sqrt{T_f} = \sqrt{637} = 25.24$

$\sqrt{GL} = \sqrt{(.730)\ (6060)} = 66.51$

$C = \frac{1118 \times (D_{eff})^{8/3}}{\sqrt{T}} = \frac{1118 \times 36.403}{25.24} = 1612$

$\sqrt{\frac{GL}{C}} = \frac{66.51}{1612} = 0.0413$

Run No.	Time of Run Min.	Choke Size	Wellhead Press. PSIA P_w	Wellhead Flow Temp. °F	P_w^2 (Thousands)	R	R^2 (Thousands)	P_1	P_w/P_1
Shut In			2630	80	6917				
1	180	1/4	2628	138	6906	153.2	23.5	2632	0.998
2	200	5/16	2598	142	6750	247.0	61.0	2610	0.995
3	180	3/8	2574	152	6626	338.3	114.4	2596	0.992
4	190	1/2	2453	158	6017	590.2	348.3	2523	0.972

Run No	F	X	$S = \frac{1}{Z}$	E^{ks}	P_f and P_s	P_f^2 and P_s^2 (thousands)	$P_f^2 - P_s^2$ (thousands)
Shut-In		0.1375	1.261	1.189	3127	9778	
1	0.999	0.1311	1.214	1.173	3087	9530	248
2	0.998	0.1306	1.214	1.172	3059	9357	421
3	0.996	0.1293	1.206	1.169	3035	9211	567
4	0.986	0.1274	1.203	1.166	2942	8655	1123

Angle of Slope
θ .... 49.5°
n 0.854
Absolute Open Flow
.91,000.. MCF DAY

WELL TESTER'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I conducted or supervised this test and that data and facts shown in Sections I and II above are true, correct, and complete, to the best of my knowledge. Bottomhole temperature and the diameter and length of flow string were furnished by the operator of the well.

Signature: Well Tester   Name of Company   RRC Representative

OPERATOR'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that I prepared or supervised and directed this report, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature: Operator's representative   Title   Date   Tel: A/C Number

GAS WELL
BACK PRESSURE CURVE

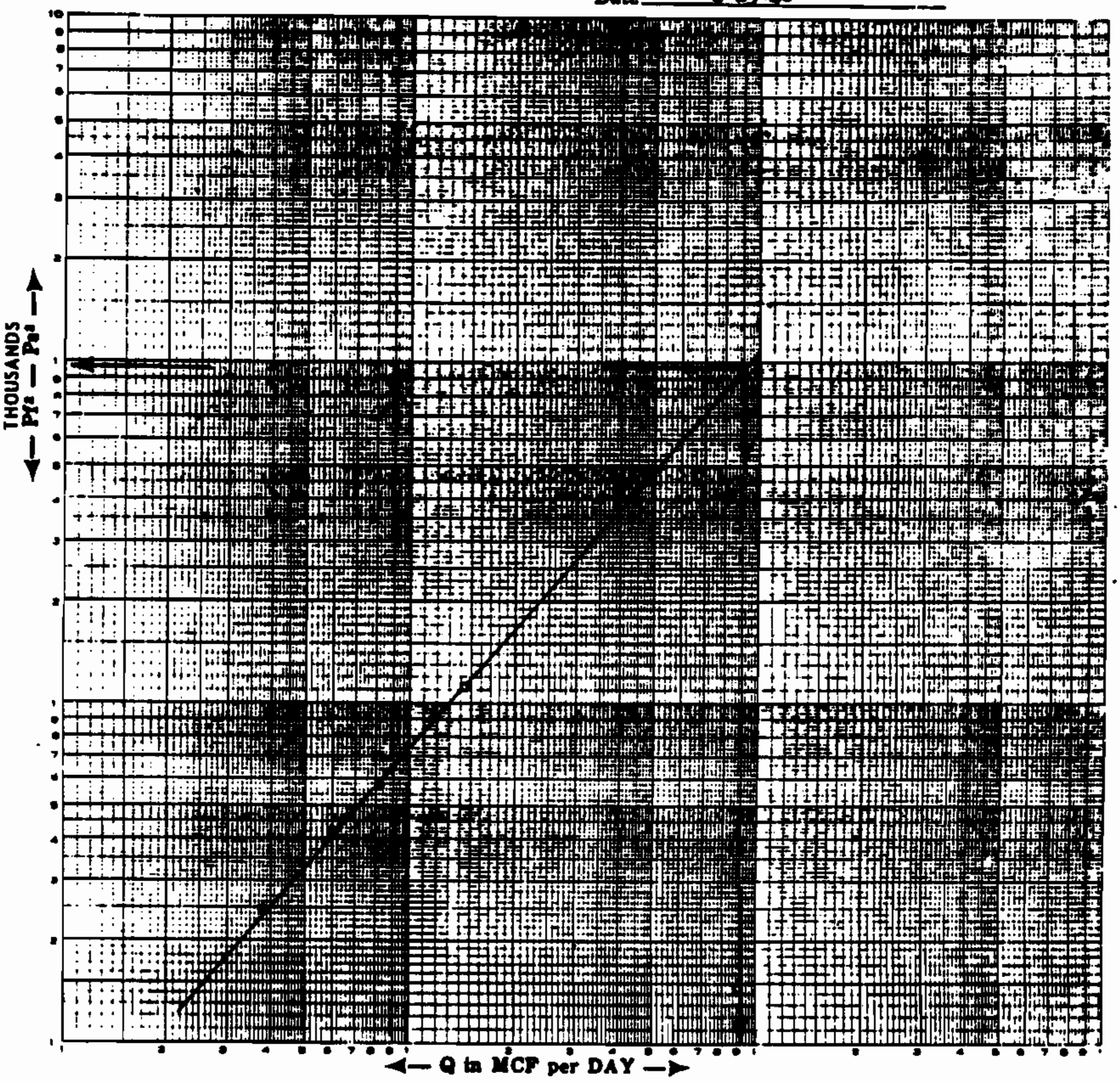
County Panola Field Cartnage

Operator DEF Gas Company

Lease A. A. Jones Well No. 1-C

Volume 91, 000 MCF/24 hr

Date 1-15-48



49.5° N = 0.854

Example No. 3

Sample Calculation Of Back Pressure Test On High Pressure Dually Completed Gas Well Producing Through The Tubing

General Data

Field	Agua Dulce
Reservoir	Yehude
Specific Gravity (Separator Gas)	0.650
Average Shut-in Temp.	145 F
Bottom Hole Temp.	210F@6826 ft.
Size Tubing	2-1/2 inches 5.9 lbs. per ft.
Inside Diameter of Tubing	2.469 inches
Size Casing	5-1/2 inches
Producing Section, feet	6818-6826
Well Producing Through	Tubing

Volume Calculation

First Rate of Flow

$$Q = C \times P_c \times F_{tf} \times F_g \times F_v \qquad (29)$$

Where:

Q = Rate of flow, MCF per 24 hours

C = Coefficient of Choke

P_c = Flowing pressure on the choke, psia

F_{tf} = Flowing temperature factor

F_q = Specific gravity factor

F_{pv} = Supercompressibility factor

When measurement is made at the wellhead or at some point between the wellhead and the separator, the gravity factor and supercompressibility factor must be based on a specific gravity of the gas equal to that of the mixture and not on the specific gravity of the gas after it has passed through the separator. However, if gas measurement is made after the fluid has passed through the separator, the gravity factor and supercompressibility factor must be based on the specific gravity of the gas after it has passed through the separator.

For a 1/8 inch choke, $C = 0.347$ (Table 7, page 38)

Choke pressure, $P_c = 2735$

F_{tf} (Table 4, page 36) = 0.9795

The specific gravity of the mixture on which to base the gravity factor and the supercompressibility factor may be calculated in the following manner:

$$G_{mix} \quad \frac{G_g + \dfrac{4591\, G_c}{R_a}}{1 + \dfrac{1123}{R_a}} \qquad (30)$$

Where:

G_{mix} = The specific gravity of the mixture (air = 1).

G_g = The specific gravity of the gas (air = 1).

G_c = The specific gravity of the condensate (water = 1).

R_a = The gas-oil ratio, cubic feet per bbl.

From Field Data:

G_g = (0.65)

G_c = 58.8° A.P.I. = 0.744 sp. gr.

R_a = 31,000 cubic feet per bbl.

Then:

$$G_{mix} = \frac{0.65 + \dfrac{(4591)(0.744)}{31{,}000}}{1 + \dfrac{1123}{31{,}000}}$$

$G_{mix} = 0.734$

F_g = (From Table 3, page 35) for a gas of 0.734 specific gravity = 0.9041

F_{pv} may be found in the following manner:

From Table 11, page 46, the pseudo-critical pressure and temperature for a gas of 0.734 specific gravity are 668 and 401 respectively.

Then:

$$P_r = \frac{P_c}{P_{sc}} \tag{31}$$

Where:

P_c = Flowing pressure at the choke, psia

P_{sc} = Pseudo-critical pressure for the gravity of gas flowing, psia.

$$P_r = \frac{2735}{668} = 4.09$$

$$T_r = \frac{T_f}{T_c}$$

Where:

T_c = Flowing temperature at the well-head, R

T_{sc} = Pseudo-critical temperature for the gravity of gas flowing, °R.

$$T_r = \frac{542}{401} = 1.35$$

F_{pv} = (From Table 12, p. 60) = 1.204

Substituting these values back into the equation:

Q1 = (0.347) (2735) (0.9795) (0.9041) (1.204)

Q1 = 1012 Mcf per day

Q2 = (0.802) (2638) (0.9777) (0.9041) (1.202)

Q2 = 2248 Mcf per day

Q3 = (1.470) (2440) (0.9759) (0.9041) (1.221)

Q3 = 3832 Mcf per day

Q4 = (2.34) (2125) (0.9741) (0.9041) (1.210)

Q4 = 5299 Mcf per day

Pressure Calculations
Bottom Hole Pressure:

$$P_s = P_l \times e^{KS} \tag{32}$$

Where:

P_s = Pressure at the sand face of the producing formation, psia

e^{KS} = A factor for evaluating the pressure drop due to the weight of the gas column for the well-head to the sand face.

$$P_l = (P_w^2 + R^2)^{1/2} \tag{33}$$

Where:

P_w = Well-head pressure when producing gas at a rate of Q Mcf per day, psia

R = A factor for evaluating the pressure drop due to frictional resistance when producing gas at a rate of Q Mcf per day.

From the above definition when Q is equal to zero, the pressure drop due to frictional resistance also is zero, and P_l will equal P_w. Also, under shut-in conditions, when the reservoir conditions have equalized, the sand face pressure P_s will be equal to the formation pressure P_f.

Then under shut-in conditions:

$$P_f = P_{sl} \times e^{KS}$$

Where:

P_{sl} = Shut-in well-head pressure, psia.

The well-head temperatures and pressures are known, but the bottom hole pressures must be calculated. The method of calculating the bottomhole pressure is outlined as follows:

1. Assume a bottom hole pressure and temperature, provided these values are not obtained by subsurface instruments.

2. On the basis of the assumed bottom hole pressure and temperature, calculate a bottom hole pressure as outlined in the calculations that follow.

3. If the calculated bottom hole pressure does not check within one-tenth of one percent of the assumed bottom hole pressure, use the calculated value as a new assumed bottom hole pressure and calculate a new bottom hole pressure. Whenever the calculated value checks within one-tenth of one per cent of the assumed value, the calculated value may be taken as the correct value for the bottom hole pressure.

The following formula is recommended in assuming a bottom hole pressure appropriate to a particular well-head pressure.

$$BHP = P_{si} = \frac{(0.01878)(P_{si})(G_{mix})(L)}{T_{si}} \quad (34)$$

Where:

P_{si} = Shut-in well-head pressure, psia

T_{si} = Average shut-in temperature, °R

G_{mix} = Calculated specific gravity of the flow stream (air = 1).

L = Average length of the producing string, ft.

From Observed Field Data:

P_{si} = 2768 psia

T_{si} = (145 + 460) = 605°R

G_{mix} = (From Volume Calculations) 0.734

L = 6822 ft.

Then:

$$BHP = 2768 = \frac{(0.01878)(2768)(0.734)(6822)}{605}$$

$$= 2768 + 430$$

$$= 3198 \text{ psia}$$

This value may be assumed for the first trial computation. The average shut-in pressure:

$$P_{av} = \frac{P_{si} + P_b}{2}$$

Then:

$$P_{av} = \frac{3198 + 2768}{2} = \frac{5966}{2}$$

$$= 2983$$

The pseudo-critical pressure and pseudo-critical temperature for a gas of 0.734 specific gravity are (Table 11, page 46) 668 and 403, respectively.

Then:

$$P_r = \frac{2983}{688} = 4.47$$

$$T_r = \frac{605}{403} = 1.50$$

F_{pv} = (Table 12, page 47) 1.121

S = $(F_{pv})^2$ = 1.257

Now

$$K = \frac{(G_{mix})(L)(F)}{53.34 \quad T} \quad (35)$$

Where:

G_{mix}, L and T are as defined previously.

F = A factor for evaluating the effect of gravity in a flowing column of gas. F is a function of $\frac{P_w}{P_l}$, and values corresponding to values of $\frac{P_w}{P_l}$, are found in Table 10, page 42.

Under shut-in conditions:

T = T_{si} and F = 1 when $P_w = P_l$

Then:

$$K_{si} = \frac{(0.734)(6822)}{(53.34)\quad(605)}$$

K_{si} = 0.1552

KS = (0.1552) (1.257)

= 0.1951

e^{KS} = $(2.718)^{0.1951}$

$\log e^{KS}$ = (0.1951) log 2.718

= (0.1951) (0.434249)

= 0.084722

e^{KS} = Antilog of 0.084722 = 1.216

(or see Table 15, page 104)

Then:

P_f = $P_{si} \times e^{KS}$

= (2768) (1.216)

= 3366

This value does not agree with the assumed BHP; therefore, a new value of 3366 will be assumed and a new BHP calculated.

Then:

$$P_{av} = \frac{3366 + 2768}{2} = \frac{6134}{2}$$

P_{av} = 3067

$$P_r = \frac{3067}{668} = 4.59$$

$$T_r = \frac{605}{403} = 1.50$$

F_{pv} = (Table 12, page 62) = 1.117

S = (F_{pv}^2) = 1.248

KS = (0.1552) (1.248)

= 0.1937

e^{KS} = $(2.718)^{0.1937}$

$\log e^{KS}$ = (0.1937) log 2.718

= (0.1937) (0.434249)

= 0.084114

e^{KS} = Antilog of 0.084114 = 1.214

P_f = $P_{si} \times e^{KS}$

= (2768) (1.214)

= 3360

This value agrees within the required limits of the assumed BHP.

Therefore:

P_f^2 = $(3360)^2$

= 11,290 (thousands)

First Rate of Flow

$$P_s = P_1 \times e^{KS} \quad (36)$$

Where:

$$P_1 = (P_w^2 + R^2)^{1/2}$$

and

R is evaluated in the following manner:

$$R = F_q \times Q \quad (37)$$

Where:

$$F_q = \frac{\sqrt{G_{mix} L}}{C}$$

and

$$C = \frac{(1118)\, D_{eff}^{8/3}}{\sqrt{T_f}} \quad (38)$$

Where:

D_{eff} = The effective diameter of the flow string

T_f = The average temperature of the flow stream, °R.

$(D_{eff})^{8/3} = (2.469)^{8/3}$

$$\log (D_{eff})^{8/3} = \frac{8 \log 2.469}{3}$$

$$= \frac{(8)(0.39252)}{3}$$

= 1.04685

$(D_{eff})^{8/3}$ = Antilog of 1.04685 = 11.139

$$T_f = \frac{T_w + T_b}{2} \quad (39)$$

Where:

T_w = Flowing well-head temperature, °R

T_b = Bottom hole temperature, °R

Because the changes in the flowing temperatures for different rates of flow do not materially affect the corresponding values of P, the calculations may be simplified by using an average T_f and thus obtain an average value for F_q which may be used to calculate all values of R.

Then:

$$T_f = \frac{\frac{542 + 544 + 546 + 548}{4} + 670}{2}$$

$$T_f = 608° R$$

$$T_f = \sqrt{608} = 24.66$$

Then:

$$C = \frac{(1118)(11.139)}{24.66}$$

$$C = 505.0$$

and

$$F_q = \frac{\sqrt{(0.734)(6822)}}{505}$$

$$= \frac{70.75}{505}$$

$$= 0.1401$$

Then:

$$R_l = F_q \times Ql$$

$$= (0.1401)(1012)$$

$$= 141.8$$

$$R_l^2 = (141.8)^2 = 20.1 \text{ (thousands)}$$

$$P_l = (P_w^2 + R^2)^{1/2}$$

$$P_l = (7480 + 20.1)^{1/2}$$

$$= (7500.1)^{1/2} = 2739$$

$$\frac{P_w}{P_l} = 0.999$$

F = Corresponding to a value of 0.999 for $\frac{P_w}{P_l}$ (Table 10, page 42)

= 0.999

$$K_l = \frac{G_{mix}\, L\, F}{53.34 \quad T_f}$$

$$K_l = \frac{(0.734)(6822)(0.999)}{(53.34)(608)}$$

$$K_l = \frac{5002.34}{32,430.7}$$

$$= 0.1542$$

$$P_{av} = \frac{2735 + 3360}{2}$$

$$= 3048$$

$$P_r = \frac{3048}{668} = 4.56$$

$$T_r = \frac{608}{403} = 1.51$$

F_{pv} = (Table 12, page 62) = 1.113

$$S = (1.113)^2 = 1.239$$

$$KS = (0.1542)(1.239)$$

$$= 0.1911$$

$$e^{KS} = (2.718)^{0.1911}$$

$$\log e^{KS} = (0.1911)(\log 2.718)$$

$$= (0.1911)(0.434249)$$

$$= 0.082985$$

e^{KS} = Antilog of 0.082985 = 1.211

Then:

$$P_s = P_l \times e^{KS}$$

$$= (2739)(1.211)$$

$$= 3317$$

$$P_s^2 = 11,002$$

$$P_f^2 - P_s^2 = 11,290 - 11,002 = 288$$

This value of $P_f^2 - P_s^2$ is plotted versus the corrsponding rate of flow on logarithmic coordinate paper. Other values of $P_f^2 - P_s^2$ calculated in the same manner are plotted versus the appropriate rate of flow and the best straight line possible is drawn through the points so obtained. This line is extended until it intersects a horizontal line representing P_f^2 (11,290 in this example). At the intersection of these two lines a vertical line is drawn to intersect the abscissa. The value read from the graph at this intersection is the open flow potential (11,000 Mcf in this example).

Data for Plotting

Q (Mcf per day)	$P_f^2 - P_s^2$ (Mpsi)
1012	228
2248	954
3832	2170
5299	3870

Explanation of R-Friction Factor PSI Using the Humble Curve

The formula used to compute the pressure drop due to friction in the producing string is computed from Weymouth's Formula and is:

$$R = \frac{Q\sqrt{GL}}{C} \qquad (40)$$

In the calculation of P_l, first use the formula $P_l = \sqrt{P_w^2 + R^2}$, but in the event the result shows a flowing subsurface pressure in excess of the static surface pressure, then use the R^2 values from the curves established by the Humble Oil and Refining Company. The curves are given on page 43. Pressure drop readings on 2 inch and 2-1/2 inch tubing in actual wells were determined and these data were correlated and plotted to establish the curves. Notice that the square of the pressure drop per mile is required to use this graph. The fraction of miles appropriate to any particular well should be multiplied by the R^2 value as read from the curve to make use of the Humble data.

Well Data:

L = 8428 ft.

G_g = 0.65

Producing string 2-1/2 inch tubing

Volume rate of flow-first run-5,000 Mcf per day

C = 501.2

P_{sl} = (shut-in) 3700 psia

P_w = (first rate of flow) 3650 psia

Then:

P_w^2 = 13,323 (thousands)

$$R = \frac{Q\sqrt{GL}}{C}$$

$$= \frac{(5000)\sqrt{(8428)(.65)}}{501.2}$$

$$R = \frac{(5000)\quad(74.01)}{501.2}$$

$$R = 738$$

and

R^2 = 545 (thousands)

Now

$$P_l = \sqrt{P_w^2 + R^2}$$

$$P_l = \sqrt{13{,}323 + 545}$$

$$P_l = 3724 \text{ psia}$$

Inasmuch as P_l is in excess of the static surface pressure, the data of the Humble Oil and Refining Company should be used, and the value of R^2 for 2-1/2 inch tubing corresponding to 5,000 Mcf per day is 225,000. The average length of the flow string is 8428 feet.

Therefore:

R^2 for 8428 ft. of tubing is

$$\frac{(8428)}{(5280)}(225{,}000) = 359{,}145$$

Substituting into the formula:

$$P_l = \sqrt{P_w^2 + R^2}$$

$$P_l = \sqrt{13{,}323 + 359 \text{ (thousands)}}$$

$$P_l = 3699 \text{ psia}$$

Therefore, the value of 3699 should be used in the determination of P_s (the pressure at the sand face in the well bore, psia) instead of the value of 3724 which was computed previously.

Type or print only

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Form G-1
Rev. 4/1/83

483-047

Gas Well Back Pressure Test, Completion or Recompletion Report, and Log

API No. 42-

7. RRC District No.	4
8. RRC Gas ID No.	00012
9. Well No.	1
10. County of well site	Nueces

1. FIELD NAME (as per RRC Records or Wildcat): Agua Dulce (Yehude)

2. LEASE NAME: A. C. Smith

3. OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report): DEF Gas Company

RRC Operator No.

4. ADDRESS: P. O. Box 10, Corpus Christi, Texas (zip code)

5. Location (Section, Block, and Survey): Sec. 12, Block 2, Tex-Mex Survey

5b. Distance and direction to nearest town in this county.

6. If operator has changed within last 60 days, name former operator

11. Purpose of filing: Initial Potential ☐ Retest ☒ Reclass ☐ Well record only (Explain in remarks) ☐

12. If workover or reclass, give former field (with reservoir) & Gas ID or oil lease no.

FIELD & RESERVOIR	GAS ID or OIL LEASE #	Oil—O Gas—G	WELL #

13. Pipe Line Connection: Jones Pipe Line Company

14. Completion or recompletion date: 12/25/45

15. Any condensate on hand at time of workover or recompletion? ☐ Yes ☐ No

16. Type of Electric or other Log Run: Electrical Induction

Section I

GAS MEASUREMENT DATA

Date of Test: 2/1/48

Gas Measurement Method (Check One): Orifice Meter ☐ ▶ Flange Taps ☐ Pipe Taps ☐ Positive Choke ☒ Orifice Vent Meter ☐ Pitot Tube ☐ Critical-flow Prover ☐

Gas produced during test: 776 MCF

Run No.	Line Size	Orif. or Choke Size	24 Hr. Coeff. Orif. or Choke	Static P_m or Choke Press	Diff. h_w	Flow Temp °F	Temp. Factor F_{tf}	Gravity Factor F_g	Compress Factor F_{pv}	Volume MCF/DAY
1		1/8	0.347	2735		82	0.9795	0.9041	1.204	1012
2		3/16	0.802	2638		84	0.9777	0.9041	1.202	2248
3		1/4	1.470	2440		86	0.9759	0.9041	1.211	3832
4		5/16	2.340	2125		88	0.9741	0.9041	1.210	5480

Section II

FIELD DATA AND PRESSURE CALCULATIONS

Gravity (Dry Gas)	Gravity Liquid Hydrocarbon	Gas Liquid Hydro Ratio	Gravity of Mixture	Avg. Shut-in Temp.	Bottom Hole Temp.
0.65	58.8 Deg. API	31,000 CF/Bbl	G_{mix} = 0.734	145 °F	210 °F @ 6826 (Depth)

$D_{eff}^{8/3} = 11.139$ $\sqrt{T_f} = \sqrt{608} = 24.66$ $\sqrt{GL} = \sqrt{(0.734)(6822)} = 70.75$

$C = \frac{1118 \times (D_{eff})^{8/3}}{\sqrt{T}} = \frac{1118 \times 11.139}{24.66} = 505.0$ $\frac{\sqrt{GL}}{C} = \frac{70.75}{505} = 0.1401$

Run No.	Time of Run Min.	Choke Size	Wellhead Press. PSIA P_w	Wellhead Flow Temp. °F	P_w^2 (Thousands)	R	R^2 (Thousands)	P_f	P_w/P_f
Shut-in			2768	80	7662				
1	60	1/8	2735	82	7480	141.8	20.1	2739	0.999
2	120	3/16	2638	84	6959	314.9	99.2	2657	0.993
3	120	1/4	2440	86	5954	536.7	288.3	2498	0.977
4	60	5/16	2125	88	4516	767.7	589.4	2259	0.941

Run No	F	K	$S = \frac{1}{z}$	E^{ks}	P_f and P_s	P_f^2 and P_s^2 (thousands)	$P_f^2 - P_s^2$ (thousands)
Shut—In		0.1552	1.248	1.214	3360	11290	
1	0.999	0.1542	1.239	1.211	3317	11002	288
2	0.996	0.1538	1.241	1.210	3215	10336	954
3	0.988	0.1525	1.245	1.209	3020	9120	2170
4	0.970	0.1498	1.254	1.206	2724	7420	3970

Angle of Slope
θ 57.5°
n 0.637
Absolute Open Flow 11,000 MCF/DAY

WELL TESTER'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I conducted or supervised this test and that data and facts shown in Sections I and II above are true, correct, and complete, to the best of my knowledge. Bottomhole temperature and the diameter and length of flow string were furnished by the operator of the well.

Signature: Well Tester ____ Name of Company ____ RRC Representative ____

OPERATOR'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that I prepared or supervised and directed this report, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature: Operator's representative ____ Title ____ Date ____ Tel: A/C ____ Number ____

GAS WELL
BACK PRESSURE CURVE

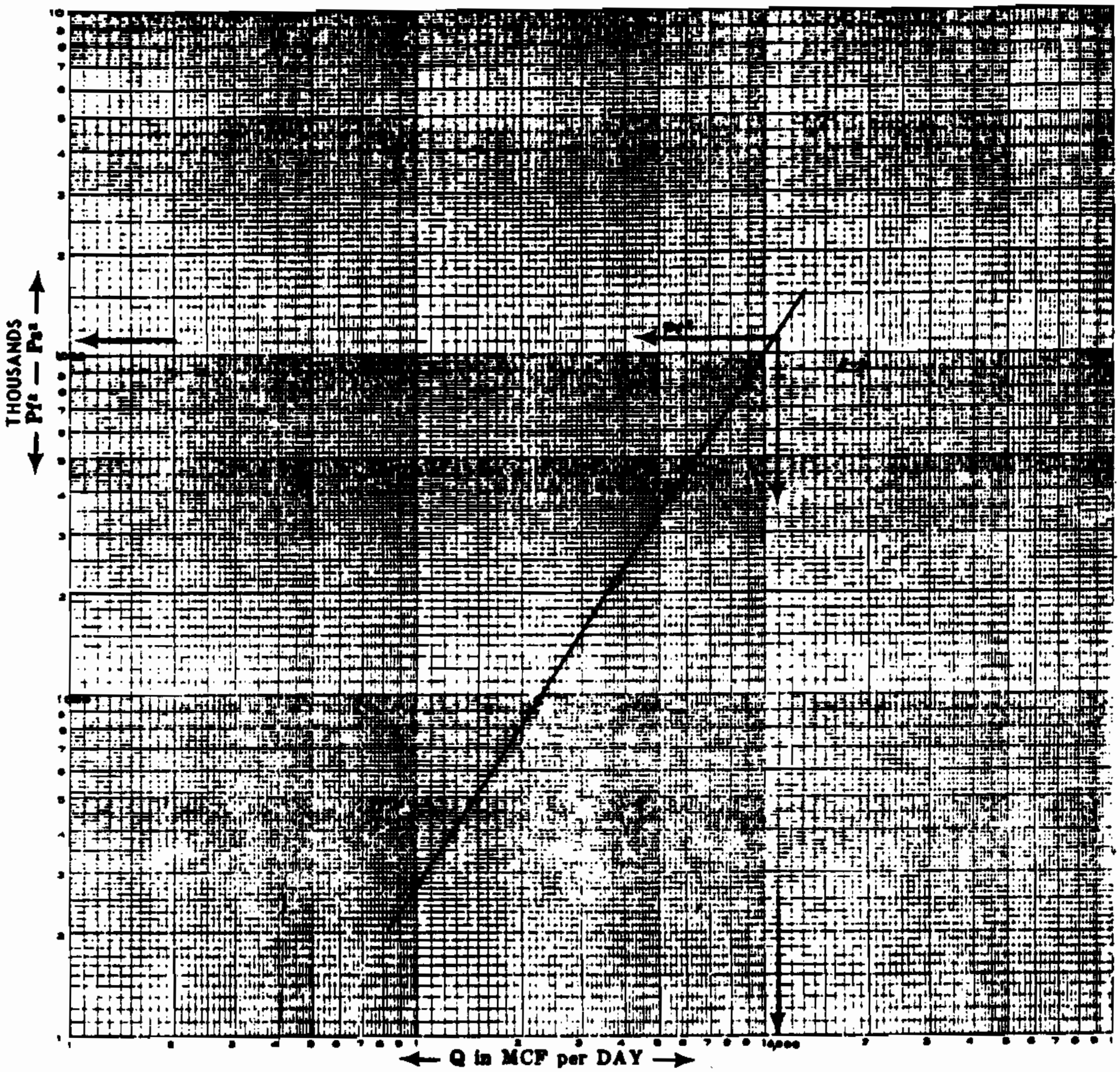
County Nueces   Field Agua Dulce

Operator DEF Gas Company

Lease A. C Smith   Well No. 1

Volume 11,000 MCF/24 hr.

Date 2-1-48



57.5° N = .637

Example No. 4

Sample Calculation of Back-Pressure Test On High Pressure Singly Completed Gas Well Producing Through The Tubing

General Data

Field	Whelan
Reservoir	Rodessa
Specific Gravity (Separator Gas)	0.630
Average Shut-in Temp.	135° F
Bottom Hole Temp.	216° F
Size Casing	7 inch
Size Tubing	2-1/2 in.
Barometer	15 psia
Meter Run	4 x 2-3/4 in.
Type Connection	Flange conn.
Production Section, ft.	6813—6823
Well Producing Through	Tubing

Volume Calculations

$$Q = \frac{C\sqrt{h_w \times P_m} \times F_{tf} \times F_g \times F_{pv}}{1000} \quad (41)$$

Where:

Q = Rate of flow, Mcf per 24 hours

C = Coefficient of orifice (24 hours)

h_w = Differential pressure across orifice, inches of water

P_m = Static pressure at orifice meter, psia

F_{tf} = Flowing temperature factor

F_g = Specific gravity factor

F_{pv} = Supercompressibility factor

For the first rate of flow, from Field Data and Tables:

C = 54417.41 (Table 2, page 34)

h_w = 13 inches of water

P_m = 995 psia

F_{tf} = 0.9697 (Table 4, page 36)

F_g = 0.9759 (Table 3, page 35)

F_{pv} is found in the following manner:

From Table 11, page 46, the pseudo-critical temperature and pseudo-critical pressure for a gas of 0.3 specific gravity are 3668 F. Abs. and 670 psia respectively.

Then:

$$P_r = \frac{P_m}{P_{sc}} \quad (42)$$

Where:

P_m = Static pressure at orifice meter, psia

P_{sc} = Pseudo-critical pressure

$$P_r = \frac{995}{670} = 1.49$$

$$T_r = \frac{T_a}{T_c}$$

Where:

T_m = Flowing temperature of the gas at the meter, R

T_{sc} = Pseudo-critical temperature, R

$$T_r = \frac{(460 + 93)}{368} = 1.50$$

From Table 12, page 47, F_{pv}, corresponding to the above values of P_r and T_r, is 1.075.

Substituting into the formula:

$$Q = \frac{54417.41\sqrt{(995)(13)}(.9697)(.9759)(1.075)}{1000}$$

$$Q = 6{,}440 \text{ Mcf}$$

Pressure Calculations

Bottom Hole Pressure:

When testing this type of condensate well, the calculation of friction in the producing string may be eliminated by taking the pressure readings with the dead-weight tester on the casing. Only the weight of the column of gas needs to be calculated and the supercompressibility factor applied to arrive at the sand face pressure.

Then:

$$K_{si} = \frac{G_{mix}\ L}{53.34\ T_{av}} \qquad (43)$$

Where:

- L = The average length of the producing string, ft.
- 53.34 = Gas constant for air
- T_{av} = The average shut-in temperature, °R
- G_{mix} = Specific gravity of the produced mixture (air = 1).

The approximate specific gravity of the mixture may be calculated by the following formula:

$$G_{mix} = \frac{G_g + \frac{(4591)(G_c)}{R_a}}{1 + \frac{1123}{R_a}} \qquad (44)$$

Where:

- G_g = Specific gravity of the separator gas, (air = 1)
- G_c = Specific gravity of the liquid, (water = 1)
- R_a = Gas-liquid ratio, cubic feet per bbl.

From well data during this test:

- G_g = 0.63
- G_c = 54.4° API @ 60° F = 0.757 specific gravity
- R_a = 119,629 cubic ft. per bbl.

Substituting these values into the formula we have:

$$G_{mix} = \frac{0.63 + \frac{(4591)(0.757)}{119{,}629}}{1 + \frac{1123}{119{,}629}}$$

$$G_{mix} = \frac{.6591}{1.0094} = 0.653$$

$$T_{av} = \frac{T_{si} + T_b}{2}$$

Where:

- T_{si} = Shut-in well-head temperature, °R
- T_b = Bottom hole temperature, °R

$$T_{av} = \frac{(460) + 53) + (460 + 216)}{2}$$

$$T_{av} = 595\ R$$

$$K_{si} = \frac{(.653)(6818)}{(53.34)(595)}$$

$$K_{si} = 0.1403$$

Calculation of bottom hole pressure for determination of compressibility:

The first BHP to be assumed may be calculated as follows:

$$BHP = P_{si} + \frac{(0.01878)(P_{si})(G_{mix})(L)}{T_{si}} \qquad (45)$$

Where:

- P_{si} = Shut-in well-head pressure, psia

The other units are as defined previously.

Then:

$$BHP = 2221 + \frac{(0.01878)(2221)(0.653)(6818)}{595}$$

$$BHP = 2221 + 312$$

$$BHP = 2533$$

Average shut-in pressure:

$$P_{av} = \frac{P_{si} + P_b}{2}$$

$$= \frac{2221 + 2533}{2}$$

$$= 2377$$

The pseudo-critical pressure and temperature corresponding to a gas gravity of 0.653 are 670 psia and 376° R respectively. (Table 11, page 46).

Then:

$$P_r = \frac{2377}{670} = 3.55$$

$$T_r = \frac{595}{376} = 1.58$$

F_{pv} = (Table 12, page 47) = 1.109

$$S = (F_{pv})^2 = 1.230$$

$$KS = (0.1403)(1.230) = 0.1726$$

Then:

$$e^{KS} = (2.718)^{.1726}$$

$$\log e^{KS} = .1726 \log 2.718$$

$$= (.1726)(.434249)$$

$$= 0.074951$$

e^{KS} = Antilog of 0.074951 = 1.188

$$P_f = P_{si} \times e^{KS}$$

$$= (2221)(1.188)$$

$$= 2639$$

Because this calculated value (2639) does not agree with the assumed value (2601) within at least one-half of one percent, a new BHP will be calculated.

Using the calculated value for the new assumed value of the BHP, we have:

$$P_{av} = \frac{2221 + 2639}{2} = 2430$$

$$P_r = \frac{2430}{670} = 3.63$$

$$T_r = \frac{595}{376} = 1.58$$

$$F_{pv} = 1.109$$

$$S = (F_{pv})^2 = 1.230$$

$$KS = (0.1403)(1.230) = .1726$$

$$e^{KS} = (2.718)^{0.1726}$$

$$\log e^{KS} = .1726 \log 2.718$$

$$= (.1726)(.434249)$$

$$= 0.074951$$

e^{KS} = Antilog of 0.074951 = 1.188

$$P_f = P_w \times e^{KS}$$

$$= (2221)(1.188) = 2639$$

$$P_f^2 = 6964$$

First Rate of Flow

$$K = \frac{G_{mix}\, L}{53.34\,(T_f)} \qquad (46)$$

Where:

T_f = Average flowing temperature, °R

To expedite calculations, an average of all flowing temperatures is used when calculating the value of K, provided the flowing well-head temperatures do not differ greatly. This value of K may be used in each calculation.

Then:

$$T_f = \frac{\frac{578 + 588 + 598 + 604}{4} + 676}{2}$$

$$T_f = 634$$

$$K = \frac{(.653)(6818)}{(53.34)(634)}$$

$$K = 0.1317$$

$$P_{av} = \frac{2175 + 2639}{2} = 2407$$

$$P_r = \frac{2407}{670} = 3.59$$

$$T_r = \frac{634}{376} = 1.69$$

F_{pv} = (Table 12, page 47) = 1.078

$S = 1.162$

$KS = 0.1530$

$e^{KS} = (2.718)^{0.1530}$

$\log e^{KS} = 0.1530 \log 2.718$

$= (0.1530)(0.434249)$

$= 0.066440$

e^{KS} = Antilog of 0.066440 = 1.165

$P_s = P_w \times e^{KS}$

$= (2175)(1.165) = 2534$

$P_s^2 = 6421$

$P_f^2 - P_s^2 = 6964 - 6421$

$= 543$

This value of $P_f^2 - P_s^2$ is plotted versus the corresponding rate of flow on logarithmic coordinate paper. Other values of $P_f^2 - P_s^2$, calculated in the same manner, are plotted versus the appropriate rate of flow and the best straight line possible is drawn through the points so obtained. The line is extended until it intersects a horizontal line representing P_f^2 (6,964 in this example). At the intersection of these two lines a vertical line is drawn to intersect the abscissa. The value read from the graph at this intersection is the open flow potential (52,000 Mcf in this example).

Data for Plotting

Q (Mcf per day)	$P_f^2 - P_s^2$ (Mpsi)
6,294	543
8,399	719
10,874	966
13,346	1,257

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Type or print only

Form G-1
Rev. 4/1/83

483-047

API No. 42-

7. RRC District No. 6

8. RRC Gas ID No. 00013

Gas Well Back Pressure Test, Completion or Recompletion Report, and Log

1. FIELD NAME (as per RRC Records or Wildcat): Whelan (Rodessa)

2. LEASE NAME: J. J. White

9. Well No.: 10

3. OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report): Wet Oil Company

RRC Operator No

10. County of well site: Harrison

4. ADDRESS: P. O. Box 100, Houston, Texas (zip code)

11. Purpose of filing: Initial Potential [X] / Retest [ ] / Reclass [ ] / Well record only (Explain in remarks) [ ]

5. Location (Section, Block, and Survey): Sec. 3, Block 2, B. Daniel Survey

5b. Distance and direction to nearest town in this county.

6. If operator has changed within last 60 days, name former operator

12. If workover or reclass, give former field (with reservoir) & Gas ID or oil lease no.

FIELD & RESERVOIR	GAS ID or OIL LEASE #	Oil—O Gas—G	WELL #

13. Pipe Line Connection: H. L. Jones

14. Completion or recompletion date: 2/22/46

15. Any condensate on hand at time of workover or recompletion? [ ] Yes [ ] No

16. Type of Electric or other Log Run: Electrical Induction

Section I

GAS MEASUREMENT DATA

Date of Test: 4/18/48

Gas Measurement Method (Check One): Orifice Meter [X] ▶ Flange Taps [ ] Pipe Taps [ ]; Positive Choke [ ]; Orifice Vent Meter [ ]; Pitot Tube [ ]; Critical-flow Prover [ ]

Gas produced during test: 4385 MCF

Run No.	Line Size	Orif. or Choke Size	24 Hr. Coeff Orif. or Choke	Static P_m or Choke Press	Diff h_w	Flow Temp. °F	Temp. Factor F_{tf}	Gravity Factor F_g	Compress Factor F_{pv}	Volume MCF/DAY
1	4	2 3/4	54417.41	995	13.0	93	0.9697	0.9759	1.075	6294
2	4	2 3/4	54417.41	1000	22.8	92	0.9706	0.9759	1.075	8399
3	4	2 3/4	54417.41	1135	35.0	109	0.9559	0.9759	1.074	10874
4	4	2 3/4	54417.41	1145	54.0	122	0.9452	0.9759	1.069	13346

Section II

FIELD DATA AND PRESSURE CALCULATIONS

Gravity (Dry Gas)	Gravity Liquid Hydrocarbon	Gas-Liquid Hydro Ratio	Gravity of Mixture	Avg. Shut-in Temp.	Bottom Hole Temp.
0.63	Deg. API	CF/Bbl	G_{mix} =	135 °F	216°F @ 6800 (Depth)

$D_{eff}^{8/3}$ = $\sqrt{T_f}$ = $\sqrt{\quad}$ = $\sqrt{GL}$ = $\sqrt{\quad}$ =

$C = \frac{1118 \times (D_{eff})^{8/3}}{\sqrt{T}}$ = = $\sqrt{\frac{GL}{C}}$ = =

Run No.	Time of Run Min.	Choke Size	Wellhead Press. PSIA P_w	Wellhead Flow Temp. °F	P_w^2 (Thousands)	R	R^2 (Thousands)	P_1	P_w/P_1
Shut-In			2221	53	4933				
1	180		2175	118	4731				
2	200		2145	128	4601				
3	150		2102	138	4418				
4	140		2051	144	4207				

Run No	F	K	$S = \frac{1}{Z}$	E^{ks}	P_f and P_s	P_f^2 and P_s^2 (thousands)	$P_f^2 - P_s^2$ (thousands)
Shut—In		0.1403	1.230	1.188	2639	6964	
1		0.1317	1.162	1.165	2534	6421	543
2		0.1317	1.162	1.165	2499	6245	719
3		0.1317	1.162	1.165	2449	5998	966
4		0.1317	1.162	1.165	2389	5707	1257

Angle of Slope: θ 45.5°; n 0.983

Absolute Open Flow: 75,000 MCF DAY

WELL TESTER'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I conducted or supervised this test and that data and facts shown in Sections I and II above are true, correct, and complete, to the best of my knowledge. Bottomhole temperature and the diameter and length of flow string were furnished by the operator of the well.

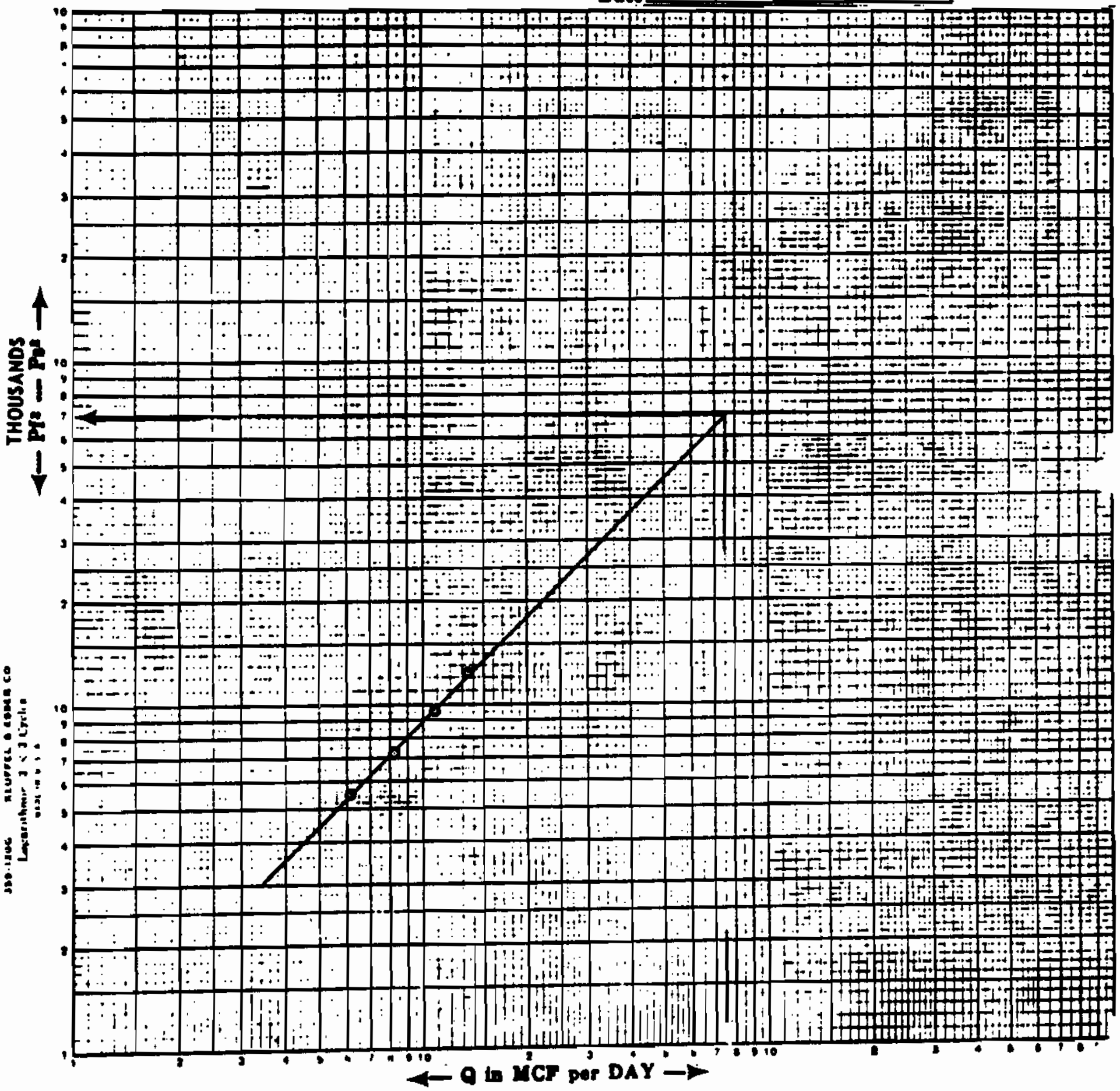
Signature: Well Tester ______ Name of Company ______ RRC Representative ______

OPERATOR'S CERTIFICATION: I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that I prepared or supervised and directed this report, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature: Operator's representative ______ Title ______ Date ______ Tel: A/C ______ Number ______

GAS WELL
BACK PRESSURE CURVE

County Harrison Field Whelan
Operator Wet Oil Company
Lease H. J. White Well No. 10
Volume 75,000 MCF/24 hr.
Date 4-18-48



θ = 45.5° N = 0.983

TABLE 1

ORIFICE COEFFICIENTS—PIPE TAPS

Base and flowing temperature – 60° F; Specific Gravity 0.600
Base Pressure – 14.65 psia. Orifice flow constant in cu. ft. per 24 hours

Pipe Sizes—Nominal and Published Inside Diameters, Inches

Orifice Diameter	2			3				4	
Inches	1.689	1.939	2.067	2.300	3.626	2.900	3.068	3.152	3.438
.250	400.33	399.18	398.78	398.22	397.69	397.31	397.16	397.06	396.81
.375	914.66	906.50	903.63	899.80	896.34	894.44	893.57	893.17	892.08
.500	1673.09	1645.45	1635.01	1620.62	1607.29	1599.87	1596.45	1594.98	1590.87
.625	2717.04	2645.60	2619.56	2583.39	2548.28	2527.93	2518.37	2514.25	2502.70
.750	4119.55	3952.25	3893.99	3814.86	3740.40	3697.09	3676.22	3666.87	3640.70
.875	6004.70	5639.57	5516.82	5356.07	5209.95	5127.39	5087.83	5070.69	5021.16
1.000	8581.48	7822.87	7578.93	7268.32	6996.03	6846.49	6776.71	6746.49	6660.50
1.125	12210.35	10685.34	10218.02	9640.11	9152.85	8893.96	8774.95	8723.86	8580.55
1.250		14517.64	13645.32	12602.58	11756.43	11321.82	11125.86	11047.68	10811.52
1.375			18192.93	16346.10	14912.99	14200.80	13886.77	13754.05	13391.10
1.500				21156.96	18768.98	17626.85	17133.06	16926.50	16368.53
1.625					23532.17	21728.02	20965.36	20649.46	19806.73
1.750					29502.92	26679.70	25517.02	25040.98	23786.71
1.875						32724.59	30966.86	30256.85	28412.20
2.000						40211.00	37559.76	36506.74	33818.11
2.125							45644.33	44083.49	40179.85
2.250									47728.56
2.375									56788.26

Orifice Diameter	4		6				8		
Inches	3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071
.250	396.50	396.35							
.375	890.95	890.52							
.500	1586.88	1585.32	1580.74	1579.68	1578.03	1577.29			
.625	2491.54	2487.21	2474.78	2472.07	2467.96	2466.25			
.750	3615.47	3605.50	3576.84	3570.61	3561.57	3557.83			
.875	4971.31	4951.68	4894.67	4882.21	4864.14	4856.66	4832.05	4828.62	4827.69
1.000	6574.52	6539.62	6437.12	6415.00	6381.67	6368.27	6324.35	6318.11	6316.56
1.125	8439.73	8383.65	8215.73	8178.34	8122.27	8099.52	8026.00	8015.41	8012.91
1.250	10588.45	10500.59	10241.39	10182.82	10094.65	10058.51	9941.37	9924.55	9920.81
1.375	13047.16	12913.82	12525.94	12439.96	12308.49	12253.96	12076.07	12050.84	12044.92
1.500	15850.12	15651.35	15084.97	14961.28	14773.42	14695.22	14436.64	14399.26	14390.85
1.625	19038.77	18748.73	17936.53	17762.38	17500.37	17391.64	17029.31	16976.66	16964.51
1.750	22666.08	22249.23	21103.38	20861.93	20502.10	20354.11	19861.25	19788.97	19772.15
1.875	26798.09	26206.78	24611.67	24281.75	23794.81	23596.04	22940.24	22843.35	22821.23
2.000	31518.92	30688.34	28492.89	28047.69	27396.57	27133.31	26273.76	26147.59	26118.30
2.125	36927.32	35777.73	32783.79	32188.74	31328.88	30983.69	29870.23	29708.22	29670.84
2.250	43161.32	41572.45	37531.72	36743.51	35615.72	35167.10	33740.23	33534.61	33487.88
2.375	50382.92	48205.22	42787.47	41753.14	40285.77	39709.41	37893.11	37634.53	37575.34
2.500	58807.07	55838.05	48616.46	47267.47	45373.29	44634.93	42345.08	42021.07	41949.42
2.625	68726.63	64673.44	55090.35	53345.70	50915.66	49981.02	47105.47	46706.69	46616.35
2.750		74988.67	62302.59	60053.24	56959.61	55775.74	52196.10	51706.98	51594.82
2.875			70362.24	67477.34	63551.89	62065.82	57632.55	57031.27	56897.30
3.000			79400.13	75711.45	70757.90	68901.10	63430.38	62704.49	62536.25
3.125			89575.17	84877.08	78643.08	76331.42	69620.76	68739.09	68536.59
3.250			101089.84	95108.19	87288.43	84425.34	76219.27	75156.90	74917.01
3.375			114199.61	106576.13	96793.64	93254.50	83260.17	81965.95	81696.21
3.500				119498.98	107264.64	102903.02	90774.61	89248.04	88905.35
3.625				134141.55	118835.39	113473.71	98793.76	96974.34	96566.22
3.750					131667.89	125078.73	107358.10	105195.99	104709.98
3.875					145955.30	137861.39	116514.39	113950.38	113377.14
4.000					161931.29	151983.68	126306.22	123278.01	122598.84
4.250							148027.07	143827.46	142892.83
4.500							173053.41	167268.04	165987.59
4.750							202045.71	194126.26	192384.72
5.000							235882.52	225068.82	222713.55
5.250							275725.89	260958.70	257771.60
5.500								302939.27	298618.15

Calculations based on American Gas Association Committee Report No. 3 —April, 1955.

TABLE 2

ORIFICE COEFFICIENT—FLANGE CONNECTION

Base and flowing temperature - 60° F; Specific Gravity 0.600
Base Pressure — 14.65 psia. Orifice flow constant in cu. ft./24 hours.

Pipe Sizes—Nominal and Published Inside Diameters, Inches

Orifice Diameter Inches	2"			3"				4"	
	1.689	1.939	2.067	2.300	2.626	2.900	3.068	3.152	3.438
.250	395.51	395.88	396.00	396.10	396.03	395.91	395.82	395.75	395.57
.375	887.09	886.00	885.66	885.13	884.57	884.22	884.04	883.94	883.66
.500	1581.93	1576.01	1573.95	1571.27	1568.81	1567.47	1566.82	1566.57	1565.76
.625	2495.16	2477.06	2470.89	2462.82	2455.53	2451.42	2449.52	2448.67	2446.34
.750	3647.87	3602.07	3587.12	3567.80	3551.29	3542.26	3537.90	3536.03	3530.73
.875	5076.61	4971.00	4937.04	4894.98	4860.09	4841.71	4833.30	4829.87	4819.90
1.000	6846.81	6619.38	6549.28	6462.67	6392.26	6356.75	6341.17	6334.63	6316.56
1.125	9065.62	8604.85	8464.65	8297.98	8164.33	8098.59	8070.24	8058.09	8026.31
1.250	12018.75	11015.58	10752.32	10440.47	10199.64	10082.50	10032.66	10012.09	9957.26
1.375		13974.93	13505.44	12952.45	12529.68	12330.92	12246.49	12211.59	12120.00
1.500			16893.79	15915.54	15202.73	14871.87	14734.79	14678.09	14530.11
1.625				19437.55	18282.03	17747.11	17526.85	17437.75	17206.89
1.750					21847.65	21011.78	20668.46	20529.51	20173.73
1.875					26010.20	24732.86	24212.59	24002.61	23464.57
2.000						28993.85	28226.21	27916.22	27122.72

Orifice Diameter Inches	4"		6"				8"		
	3.826	4.026	4.897	5.189	5.761	6.065	7.625	7.981	8.071
.250	395.26	395.13							
.375	883.32	883.17							
.500	1565.01	1564.70	1563.86	1563.67	1563.39	1563.27			
.625	2444.06	2443.16	2440.57	2440.04	2439.27	2438.99			
.750	3525.12	3522.94	3516.40	3514.84	3512.66	3511.73			
.875	4810.24	4806.19	4794.04	4790.93	4786.25	4784.07	4777.22	4776.28	4776.28
1.000	6299.42	6292.88	6272.63	6267.96	6260.79	6257.36	6245.21	6243.03	6242.72
1.125	7997.03	7985.81	7954.03	7946.87	7935.65	7930.67	7912.91	7909.79	7909.17
1.250	9908.04	9889.97	9839.50	9828.59	9812.08	9804.92	9779.68	9775.63	9774.39
1.375	12039.62	12010.34	11931.83	11915.63	11891.64	11881.36	11846.47	11840.55	11839.30
1.500	14401.75	14355.64	14235.39	14211.40	14176.19	14161.86	14113.57	14106.09	14104.23
1.625	17006.88	16935.85	16753.91	16718.70	16668.55	16648.29	16582.56	16572.59	16570.10
1.750	19871.53	19764.05	19494.25	19443.16	19371.50	19343.15	19254.05	19240.96	19237.85
1.875	23015.32	22857.37	22463.27	22390.36	22289.11	22250.17	22129.60	22112.47	22108.42
2.000	26462.87	26235.75	25670.92	25567.80	25426.05	25372.46	25210.77	25188.34	25183.36
2.125	30249.38	29923.19	29128.44	28984.51	28788.86	28715.33	28499.74	28470.77	28463.92
2.250	34416.28	33955.19	32849.21	32652.94	32385.01	32285.32	31998.70	31961.31	31951.96
2.375	39008.44	38372.89	36852.55	36581.51	36220.12	36086.16	35709.19	35662.46	35649.99
2.500	44083.49	43217.40	41151.86	40790.47	40307.58	40133.11	39637.76	39575.45	39559.87
2.625	49709.98	48544.80	45772.06	45295.40	44659.85	44426.19	43784.41	43706.52	43687.83
2.750	55987.59	54417.41	50747.42	50118.10	49289.40	48984.08	48155.37	48055.68	48033.87
2.875		60922.45	56109.10	55283.50	54208.68	53819.25	52756.88	52629.15	52601.11
3.000		68380.82	61891.35	60825.87	59436.39	58941.03	57592.05	57433.16	57395.77
3.125			68140.93	66776.37	65000.57	64368.13	62670.22	62470.83	62427.21
3.250			74901.44	73175.48	70923.02	70122.35	67997.62	67748.38	67695.42
3.375			82232.07	80060.61	77234.90	76228.62	73580.49	73275.18	73209.75
3.500			90207.60	87484.70	83964.26	82711.85	79434.40	79060.55	78976.43
3.625			99095.95	95497.62	91148.46	89600.09	85565.59	85107.62	85007.93
3.750				104227.09	98824.91	96927.61	91986.52	91431.97	91307.35
3.875				113953.49	107037.21	104725.56	98706.52	98039.82	97890.28
4.000					115838.33	113034.44	105747.42	104943.64	104769.17
4.250					135671.23	131365.69	120860.43	119704.60	119452.25
4.500						152684.66	137478.19	135848.81	135490.54
4.750							155793.87	153532.06	153036.70
5.000							176022.43	172941.26	172268.32
5.250							198431.80	194291.37	193384.78
5.500							223405.17	217831.65	216635.32
5.750								243939.05	242312.79
6.000									271258.35

Calculations based on American Gas Association Committee Report No. 3 —April, 1955.

TABLE 3

MULTIPLIERS FOR SPECIFIC GRAVITY

SPECIFIC GRAVITY	FACTOR	SPECIFIC GRAVITY	FACTOR
0.500	1.0954	0.755	0.8914
0.505	1.0900	0.760	0.8885
0.510	1.0847	0.765	0.8856
0.515	1.0794	0.770	0.8827
0.520	1.0742	0.775	0.8793
0.525	1.0690	0.780	0.8771
0.530	1.0640	0.785	0.8743
0.535	1.0590	0.790	0.8715
0.540	1.0541	0.795	0.8687
0.545	1.0492	0.800	0.8660
0.550	1.0445	0.805	0.8635
0.555	1.0398	0.810	0.8607
0.560	1.0351	0.815	0.8580
0.565	1.0304	0.820	0.8554
0.570	1.0260	0.825	0.8528
0.575	1.0215	0.830	0.8502
0.580	1.0171	0.835	0.8476
0.585	1.0127	0.840	0.8452
0.590	1.0084	0.845	0.8426
0.595	1.0041	0.850	0.8402
0.600	1.0000	0.855	0.8377
0.605	0.9958	0.860	0.8353
0.610	0.9918	0.865	0.8328
0.615	0.9877	0.870	0.8305
0.620	0.9837	0.875	0.8281
0.625	0.9798	0.880	0.8257
0.630	0.9759	0.885	0.8234
0.635	0.9721	0.890	0.8211
0.640	0.9682	0.895	0.8187
0.645	0.9645	0.900	0.8165
0.650	0.9608	0.905	0.8142
0.655	0.9571	0.910	0.8120
0.660	0.9535	0.915	0.8098
0.665	0.9498	0.920	0.8076
0.670	0.9463	0.925	0.8054
0.675	0.9427	0.930	0.8032
0.680	0.9393	0.935	0.8011
0.685	0.9359	0.940	0.7989
0.690	0.9325	0.945	0.7968
0.695	0.9292	0.950	0.7947
0.700	0.9258	0.955	0.7926
0.705	0.9225	0.960	0.7906
0.710	0.9193	0.965	0.7885
0.715	0.9161	0.970	0.7865
0.720	0.9129	0.975	0.7845
0.725	0.9092	0.980	0.7825
0.730	0.9066	0.985	0.7805
0.735	0.9035	0.990	0.7785
0.740	0.9005	0.995	0.7765
0.745	0.8974	1.000	0.7746
0.750	0.8944		

$$\text{Factor} = \sqrt{\frac{0.60}{\text{Specific Gravity}}}$$

TABLE 4

MULTIPLIERS FOR FLOWING TEMPERATURE

FLOWING TEMP. °F	FACTOR	FLOWING TEMP. °F	FACTOR	FLOWING TEMP. °F	FACTOR
50	1.0098	101	0.9627	152	0.9217
51	1.0088	102	0.9618	153	0.9210
52	1.0078	103	0.9610	154	0.9202
53	1.0068	104	0.9602	155	0.9195
54	1.0058	105	0.9592	156	0.9187
55	1.0048	106	0.9585	157	0.9180
56	1.0039	107	0.9576	158	0.9173
57	1.0029	108	0.9568	159	0.9165
58	1.0019	109	0.9559	160	0.9158
59	1.0010	110	0.9551	161	0.9150
60	1.0000	111	0.9543	162	0.9143
61	0.9990	112	0.9534	163	0.9135
62	0.9981	113	0.9526	164	0.9128
63	0.9971	114	0.9518	165	0.9121
64	0.9963	115	0.9510	166	0.9112
65	0.9952	116	0.9501	167	0.9106
66	0.9943	117	0.9493	168	0.9099
67	0.9933	118	0.9485	169	0.9092
68	0.9924	119	0.9477	170	0.9085
69	0.9915	120	0.9469	171	0.9077
70	0.9905	121	0.9460	172	0.9069
71	0.9896	122	0.9452	173	0.9063
72	0.9887	123	0.9444	174	0.9055
73	0.9877	124	0.9436	175	0.9048
74	0.9868	125	0.9428	176	0.9042
75	0.9859	126	0.9420	177	0.9035
76	0.9850	127	0.9412	178	0.9028
77	0.9840	128	0.9404	179	0.9020
78	0.9831	129	0.9396	180	0.9014
79	0.9822	130	0.9388	181	0.9007
80	0.9813	131	0.9380	182	0.9000
81	0.9804	132	0.9372	183	0.8992
82	0.9795	133	0.9364	184	0.8985
83	0.9786	134	0.9356	185	0.8979
84	0.9777	135	0.9348	186	0.8972
85	0.9768	136	0.9341	187	0.8965
86	0.9759	137	0.9333	188	0.8956
87	0.9750	138	0.9325	189	0.8951
88	0.9741	139	0.9317	190	0.8944
89	0.9732	140	0.9309	191	0.8937
90	0.9723	141	0.9301	192	0.8931
91	0.9715	142	0.9293	193	0.8923
92	0.9706	143	0.9284	194	0.8916
93	0.9697	144	0.9279	195	0.8910
94	0.9688	145	0.9271	196	0.8903
95	0.9680	146	0.9263	197	0.8896
96	0.9671	147	0.9255	198	0.8889
97	0.9662	148	0.9247	199	0.8882
98	0.9653	149	0.9240	200	0.8876
99	0.9645	150	0.9233		
100	0.9636	151	0.9225		

TABLE 5

COEFFICIENTS OF ORIFICES FOR 4-INCH CRITICAL FLOW PROVER

Base and flowing temperature – 60° F; Specific Gravity – 0.600
Base Pressure – 14.65 psia; Values are Mcf/24 hrs/lb.

SIZE OF ORIFICE INCHES	COEFFICIENT	SIZE OF ORIFICE INCHES	COEFFICIENT
1/4	1.384	1-3/8	41.210
3/8	3.110	1-1/2	49.106
1/2	5.564	1-3/4	67.082
5/8	8.668	2	88.628
3/4	12.422	2-1/4	113.617
7/8	16.893	2-1/2	142.490
1	22.007	2-3/4	176.420
1-1/8	27.721	3	216.790
1-1/4	34.229		

TABLE 6

COEFFICIENTS OF ORIFICES FOR 2-INCH CRITICAL FLOW PROVER

Base and flowing temperature – 60° F: Specific Gravity – 0.600
Base Pressure – 14.65 psia; Values are Mcf/24 hrs./lb.

SIZE OF ORIFICE INCHES	COEFFICIENT	SIZE OF ORIFICE INCHES	COEFFICIENT
1/16	0.0846	1/2	5.6530
3/32	0.1863	5/8	8.5500
1/8	0.3499	3/4	12.4900
3/16	0.8035	7/8	17.1800
7/32	1.1090	1	22.5800
1/4	1.4360	1-1/8	28.9200
5/16	2.2080	1-1/4	36.5100
3/8	3.1420	1-3/8	44.8600
7/16	4.5030	1-1/2	55.6400

TABLE 7

COEFFICIENTS FOR CHOKE NIPPLES WHEN MEASURING DELIVERY RATES UNDER CONDITIONS OF CRITICAL FLOW

Nominal Choke Size – Inches	Bore Diameter – Inches	Choke Nipple Coefficient – Mcf/Day/PSIA	Choke Number	Bore Diameter – Inches	Choke Nipple Coefficient – Mcf/Day/PSIA
1/8	0.1250	0.347	X31	0.1250	0.347
9/64	0.1406	0.444	X32	0.1319	0.388
5/32	0.1563	0.553	X33	0.1390	0.433
11/64	0.1719	0.674	X34	0.1463	0.482
3/16	0.1875	0.802	X35	0.1539	0.536
13/64	0.2031	0.956	X36	0.1618	0.595
7/32	0.2188	1.116	X37	0.1699	0.658
15/64	0.2344	1.288	X38	0.1785	0.730
1/4	0.2500	1.470	X39	0.1875	0.802
17/64	0.2656	1.667	X40	0.1968	0.895
9/32	0.2813	1.885	X41	0.2065	0.989
19/64	0.2969	2.110	X42	0.2163	1.090
5/16	0.3125	2.340	X43	0.2263	1.198
21/64	0.3281	2.601	X44	0.2380	1.330
11/32	0.3438	2.866	X45	0.2500	1.470
23/64	0.3594	3.144	X46	0.2620	1.626
3/8	0.3750	3.400	X47	0.2742	1.788
25/64	0.3906	3.740	X48	0.2867	1.962
13/32	0.4063	4.063	X49	0.2995	2.149
27/64	0.4219	4.394	X50	0.3125	2.340
7/16	0.4375	4.730	X51	0.3259	2.564
29/64	0.4531	5.101	X52	0.3402	2.804
15/32	0.4688	5.474	X53	0.3565	3.092
31/64	0.4844	5.862	X54	0.3750	3.400
1/2	0.5000	6.260	X55	0.3946	3.821
9/16	0.5625	8.010	X56	0.4154	4.254
5/8	0.6250	9.980	X57	0.4375	4.730
11/16	0.6875	12.176	X58	0.4583	5.223
3/4	0.7500	14.490	X59	0.4791	5.730
			X60	0.5000	6.260

TABLE 8

VALUES OF D_{eff} & $D^{8/3}$ FOR TUBING & CASING STRINGS

Nominal Size, In.	O. D. In.	Wt/Ft. •	I. D. In.	D_{eff} In.	$D^{8/3}$
1	1.315	1.80	1.049	1.049	1.136
1-1/4	1.660	2.40	1.380	1.380	2.361
1-1/2	1.990	2.75	1.610	1.610	3.561
2	2.375	4.70	1.995	1.995	6.310
2-1/2	2.875	6.50	2.441	2.441	10.806
3	3.500	9.30	2.992	2.992.	18.595
3-1/2	4.000	11.00	3.476	3.476	27.740
4	4.500	12.70	3.958	3.958	39.220
4-1/2	4.750	16.25	4.082	4.082	42.580
4-1/2	4.750	18.00	4.000	4.000	40.336
4-3/4	5.000	18.00	4.276	4.276	48.192
4-3/4	5.000	21.00	4.154	4.154	44.612
5-3/16	5.500	17.00	4.892	4.892	69.001
5-3/16	5.500	20.00	4.778	4.778	64.794
5-3/16	5.500	23.00	4.670	4.670	60.965
5-3/16	5.500	25.00	4.580	4.580	57.881
5-5/8	6.000	15.00	5.524	5.524	95.409
5-5/8	6.000	17.00	5.450	5.450	92.040
5-5/8	6.000	20.00	5.352	5.352	87.692
5-5/8	6.000	23.00	5.240	5.240	82.880
5-5/8	6.000	26.00	5.140	5.140	78.728
6-1/4	6.625	20.00	6.049	6.049	121.55
6-1/4	6.625	22.00	5.989	5.989	118.36
6-1/4	6.625	24.00	5.921	5.921	114.82
6-1/4	6.625	26.00	5.855	5.855	111.43
6-1/4	6.625	28.00	5.791	5.791	108.21
6-1/4	6.625	31.80	5.675	5.675	102.53
6-1/4	6.625	34.00	5.595	5.595	98.714
6-5/8	7.000	20.00	6.456	6.456	144.60
6-5/8	7.000	24.00	6.336	6.336	137.55
6-5/8	7.000	26.00	6.276	6.276	134.09
6-5/8	7.000	28.00	6.214	6.214	130.60
6-5/8	7.000	30.00	6.154	6.154	127.26
6-5/8	7.000	40.00	5.836	5.836	110.47
7-1/4	7.625	26.40	6.969	6.969	177.30
7-1/4	7.625	29.70	6.875	6.875	171.00
7-1/4	7.625	33.70	6.765	6.765	163.81
7-1/4	7.625	38.70	6.625	6.625	154.92
7-1/4	7.625	45.00	6.445	6.445	143.95
7-5/8	8.125	28.00	7.485	7.485	214.52
7-5/8	8.125	32.00	7.385	7.385	206.97
7-5/8	8.125	35.50	7.285	7.285	199.57
7-5/8	8.125	39.50	7.185	7.185	192.35
8-1/4	8.625	17.50	8.249	8.249	278.00
8-1/4	8.625	20.00	8.191	8.191	272.83
8-1/4	8.625	24.00	8.097	8.097	264.54
8-1/4	8.625	28.00	8.003	8.003	256.43
8-1/4	8.625	32.00	7.907	7.907	248.30
8-1/4	8.625	36.00	7.825	7.825	241.49
8-1/4	8.625	38.00	7.775	7.775	237.41
8-1/4	8.625	43.00	7.651	7.651	227.45
8-5/8	9.000	34.00	8.290	8.290	281.69
8-5/8	9.000	38.00	8.196	8.196	273.26
8-5/8	9.000	40.00	8.150	8.150	269.19
8-5/8	9.000	45.00	8.032	8.032	258.92
9	9.625	40.00	8.835	8.835	333.84
9	9.625	43.50	8.755	8.755	325.85
9	9.625	47.00	8.681	8.681	318.55
9	9.625	53.50	8.535	8.535	304.45
9	9.625	58.00	8.435	8.435	295.04
9-5/8	10.000	55.50	8.908	8.908	341.24
9-5/8	10.000	61.20	8.790	8.790	329.32
10	10.750	32.75	10.192	10.192	488.69
10	10.750	35.75	10.136	10.136	481.56
10	10.750	40.00	10.050	10.050	470.74
10	10.750	45.50	9.950	9.950	458.34
10	10.750	48.00	9.902	9.902	452.47
10	10.750	54.00	9.784	9.784	438.25

TABLE 9

VALUES OF D_{eff} & $D^{8/3}$ FOR ANNULAR FLOW STRINGS

CASING SIZE, IN.	Wt/Ft. •	I. D. In.	TUBING SIZE, IN.	O. D. In.	D_{eff} In.	$D^{8/3}$
4-3/4	16.00	4.000	1	1.315	3.400	26.149
			1-1/4	1.668	3.275	23.663
			1-1/2	1.990	3.123	20.846
			2	2.375	2.897	17.073
5	13.00	4.494	1	1.315	3.867	36.857
			1-1/4	1.660	3.759	34.152
			1-1/2	1.990	3.626	31.045
			2	2.375	3.434	26.852
			2-1/2	2.875	3.110	20.615
5	15.00	4.406	1	1.315	3.796	34.635
			1-1/4	1.680	3.675	32.177
			1-1/2	1.990	3.540	29.120
			2	2.375	3.342	24.974
			2-1/2	2.875	3.007	18.844
5	18.00	4.276	1	1.315	3.662	31.874
			1-1/4	1.660	3.547	29.274
			1-1/2	1.990	3.407	26.293
			2	2.375	3.200	22.245
			2-1/2	2.875	2.849	16.318
5-1/2	15.00	4.974	1	1.315	4.317	49.435
			1-1/4	1.660	4.220	46.527
			1-1/2	1.990	4.103	43.166
			2	2.375	3.933	38.559
			2-1/2	2.875	3.653	31.766
5-1/2	17.00	4.892	1	1.315	4.240	47.118
			1-1/4	1.660	4.142	44.269
			1-1/2	1.990	4.022	40.931
			2	2.375	3.949	56.403
			2-1/2	2.875	3.562	29.605
5-1/2	20.00	4.779	1	1.315	4.134	44.042
			1-1/4	1.660	4.032	41.207
			1-1/2	1.990	3.910	37.961
			2	2.375	3.731	33.501
			2-1/2	2.875	3.434	26.852
5-5/6	17.00	5.450	1	1.315	4.760	64.147
			1-1/4	1.660	4.672	61.033
			1-1/2	1.990	4.567	57.443
			2	2.375	4.415	52.465
			2-1/2	2.875	4.206	46.117
6	20.00	5.352	1-1/4	1.660	4.579	54.401
			1-1/2	1.990	4.471	54.279
			2	2.375	4.316	49.404
			2-1/2	2.975	4.063	42.053
6	23.00	5.240	1-1/4	1.660	4.473	54.344
			1-1/2	1.990	4.362	50.621
			2	2.375	4.204	46.059
			2-1/2	2.975	3.943	38.621
6	26.00	5.140	1-1/4	1.660	4.379	51.351
			1-1/2	1.990	3.995	40.202
			2	2.375	3.821	35.700
			2-1/2	2.875	3.532	28.945
6-5/8	20.00	6.049	1-1/2	1.990	5.141	76.771
			2	2.375	5.008	73.452
			2-1/2	2.975	4.790	65.231
6-5/8	22.00	5.989	1-1/2	1.990	5.084	76.463
			2	2.375	4.949	71.129
			2-1/2	2.875	4.729	63.039
6-5/9	24.00	5.921	1-1/2	1.990	5.019	73.685
			2	2.375	4.692	69.626
			2-1/2	2.575	4.659	60.548
6-5/8	26.00	5.855	1-1/2	1.990	4.955	71.397
			2	2.375	4.817	66.217
			2-1/2	2.675	4.590	59.215
6-5/9	28.00	5.791	1-1/2	1.990	4.694	69.077
			2	2.375	4.753	63.696
			2-1/2	2.875	4.524	56.012
6-5/8	34.00	5.595	1-1/2	1.990	4.706	62.223
			2	2.375	4.559	57.175
			2-1/2	2.575	4.320	49.528
7	17.00	6.538	2	2.375	5.482	93.487
			2-1/2	2.875	5.284	84.750
			3	3.500	4.970	71.975
7	20.00	6.456	2	2.375	5.403	89.937
			2-1/2	2.675	5.203	81.330
			3	3.500	4.885	68.664
7	24.00	6.336	2	2.375	5.316	86.124
			2-1/2	2.875	5.112	77.590

TABLE 9—Continued

VALUES OF D_{eff} & $D^{8/3}$ FOR ANNULAR FLOW STRINGS

CASING SIZE, IN.	Wt/Ft. #	I. D. In.	TUBING SIZE, IN.	O. D. In.	D_{eff}	$D^{8/3}$
			3	3.500	4.786	65.065
7	26.00	6.276	2	2.375	5.228	82.376
			2-1/2	2.875	5.021	73.963
			3	3.500	4.688	61.592
7	28.00	6.214	2	2.375	5.168	79.879
			2-1/2	2.875	4.956	71.514
			3	3.500	4.622	59.306
7	30.00	6.154	2	2.375	5.109	77.470
			2-1/2	2.875	4.897	69.190
			3	3.500	4.556	57.075
7	40.00	5.836	2	2.375	4.798	65.522
			2-1/2	2.875	4.571	57.577
			3	3.500	4.203	46.029
5	26.00	7.356	2	2.375	6.295	135.18
			2-1/2	2.875	6.123	125.56
			3	3.500	5.855	111.43
8-5/8	20.00	8.191	2	2.375	7.055	183.21
			2-1/2	2.875	6.903	172.87
			3	3.500	6.665	157.43
8-5/8	24.00	8.097	2	2.375	6.967	177.18
			2-1/2	2.875	6.812	166.66
			3	3.500	6.572	151.64
8-5/8	28.00	8.017	2	2.375	6.891	172.07
			2-1/2	2.875	6.736	161.94
			3	3.500	6.492	146.77
8-5/8	32.00	7.921	2	2.375	6.801	166.14
			2-1/2	2.875	6.643	156.04
			3	3.500	6.395	140.99
8-5/8	36.00	7.825	2	2.375	6.710	160.28
			2-1/2	2.875	6.550	150.29
			3	3.500	6.299	135.41
8-5/8	38.00	7.775	2	2.375	6.663	157.30
			2-1/2	2.875	6.502	147.37
			3	3.500	6.249	132.57
8-6/8	43.00	7.651	2	2.375	6.546	150.04
			2-1/2	2.875	6.381	140.17
			3	3.500	6.124	125.61
9	40.00	8.150	2	2.375	7.017	180.59
			2-1/2	2.875	6.863	170.21
			3	3.500	6.624	154.86
9	45.00	8.032	2	2.375	6.905	173.00
			2-1/2	2.875	6.750	162.84
			3	3.500	6.506	147.61
9	50.20	7.910	2	2.375	6.791	165.49
			2-1/2	2.875	6.632	155.36
			3	3.500	6.385	140.40
9	55.00	7.812	2	2.375	6.698	159.52
			2-1/2	2.875	6.538	149.55
			3	3.500	6.266	134.67
9-5/8	29.30	9.063	2	2.375	7.871	245.25
			2-1/2	2.875	7.736	234.25
			3	3.500	7.523	217.44
9-6/8	40.00	8.838	2	2.375	7.660	228.16
			2-1/2	2.875	7.519	217.13
			3	3.500	7.301	200.75
9-5/8	43.50	8.755	2	2.375	7.579	221.78
			2-1/2	2.875	7.442	211.25
			3	3.500	7.223	195.07
9-5/8	47.00	8.681	2	2.375	7.515	216.62
			2-1/2	2.875	7.372	205.99
			3	3.500	7.148	189.72
9-5/8	53.50	8.535	2	2.375	7.378	206.44
			2-1/2	2.875	7.232	195.72
			3	3.500	7.006	179.63
9-3/8	58.00	8.435	2	2.375	7.285	199.57
			2-1/2	2.875	7.132	188.59
			3	3.500	6.908	173.20
10-3/4	45.50	9.950	2	2.375	8.696	320.01
			2-1/2	2.875	8.573	308.08
			3	3.500	8.383	290.21
10-3/4	51.00	9.850	2	2.375	8.603	310.97
			2-1/2	2.875	8.479	299.16
			3	3.500	8.286	281.34
10-3/4	55.50	9.760	2	2.375	8.519	302.93
			2-1/2	2.875	8.394	290.69
			3	3.500	8.200	273.62
11-3/4	47.00	11.000	2	2.375	9.667	424.40
			2-1/2	2.875	9.556	411.52
			3	3.500	9.385	392.18
11-3/4	54.00	10.880	2	2.375	9.552	411.07
			2-1/2	2.875	9.444	396.79
			3	3.500	9.271	379.60
11-5/4	60.00	10.772	2	2.375	9.486	400.14
			2-1/2	2.875	9.343	387.51
			3	3.500	9.169	366.56

$$D_{EFF} = 0.9\sqrt{(\text{I.D. CASING})^2 - (\text{O.D. TUBING})^2}$$

TABLE 10

CORRECTION FACTORS FOR DENSITY OF FLOWING COLUMN

P_w/P_1	F	P_w/P_1	F	P_w/P_1	F
1.000	1.000	.932	.966	.861	.932
.998	.999	.930	.965	.858	.931
.996	.998	.928	.964	.856	.930
.994	.997	.926	.963	.854	.929
.992	.996	.924	.962	.852	.928
.990	.995	.922	.961	.850	.927
.988	.994	.919	.960	.848	.926
.986	.993	.916	.959	.846	.925
.984	.992	.914	.958	.813	.924
.982	.991	.912	.957	.841	.923
.980	.990	.910	.956	.839	.922
.978	.989	.908	.955	.837	.921
.976	.988	.906	.954	.835	.920
.974	.987	.904	.953	.833	.919
.972	.986	.902	.952	.831	.918
.970	.985	.900	.951	.829	.917
.968	.984	.898	.950	.827	.916
.966	.983	.896	.949	.824	.915
.964	.982	.894	.948	.822	.914
.962	.981	.892	.947	.820	.913
.960	.980	.890	.946	.818	.912
.958	.979	.888	.945	.816	.911
.956	.978	.886	.944	.814	.910
.954	.977	.884	.943	.811	.909
.952	.976	.882	.942	.809	.908
.950	.975	.880	.941	.807	.907
.948	.974	.877	.940	.805	.906
.946	.973	.875	.939	.803	.905
.944	.972	.873	.938	.801	.904
.942	.971	.871	.937	.798	.903
.940	.970	.869	.936	.796	.902
.938	.969	.867	.935	.794	.901
.936	.968	.865	.934	.792	.900
.934	.967	.863	.933		

$$F = 2/3 \left(1 + P_w/P_1 - \frac{P_w/P_1}{1 + P_w/P_1} \right)$$

CHART NO. 1

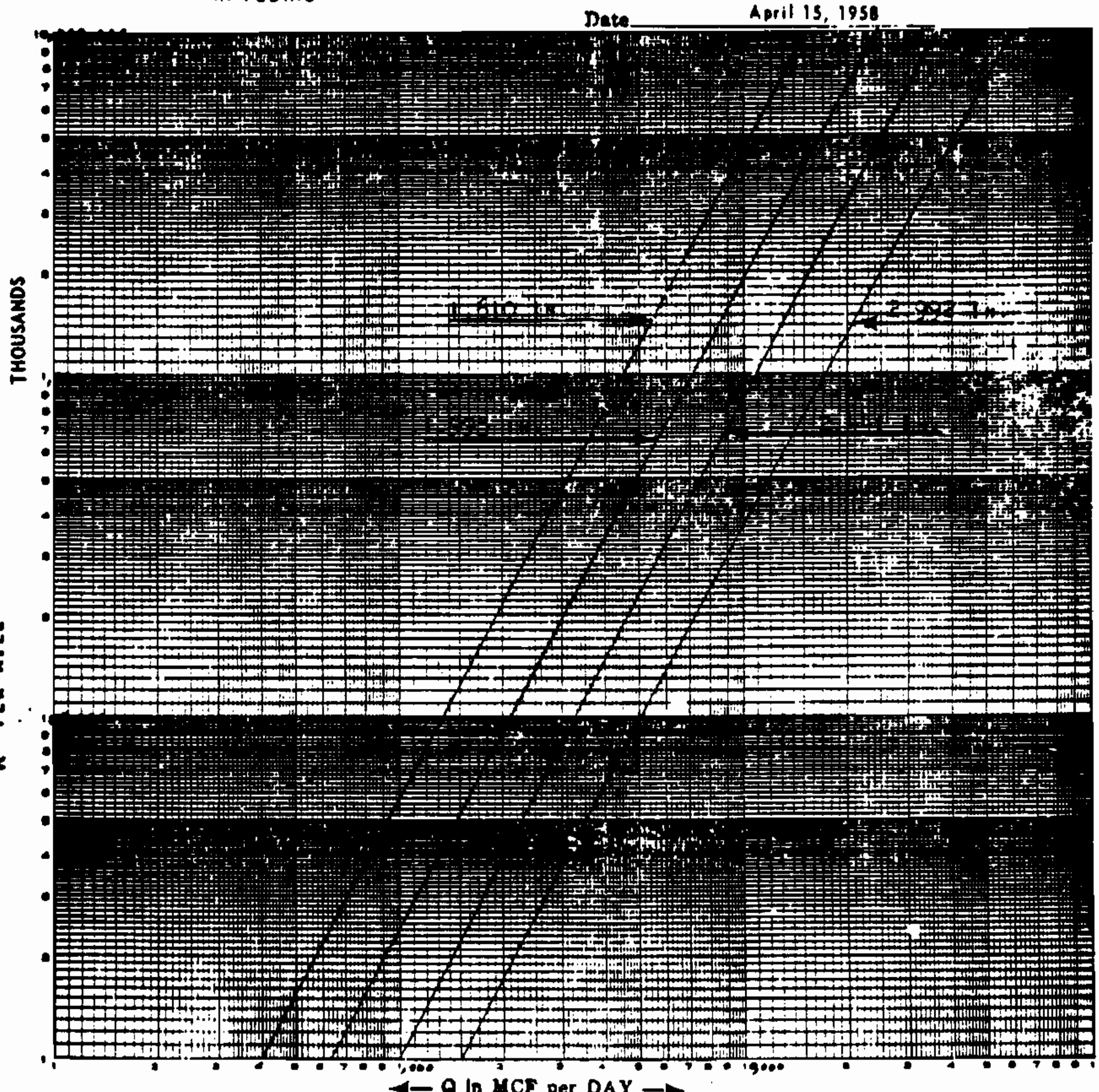
GAS WELL BACK PRESSURE CURVE

PRESSURE DROP IN TUBING

PREPARED BY

SOUTHERN PETROLEUM LABORATORIES, Inc.

Date April 15, 1958



Courtesy of
Southern Petroleum Laboratories, Inc.

Southern PETROLEUM Laboratories, Inc.

RESEARCH AND DEVELOPMENT

CONSULTING CHEMISTS AND ENGINEERS

P. O. BOX 14555, HOUSTON 21, TEXAS

W. A. FRIER,

April 15, 1958

DATA EMPLOYED FOR CALCULATING PRESSURE DROP IN GAS WELL TUBING AS PLOTTED IN CHART No. 1

Size of tubing, Inches	1.610	1.995	2.441	2.992
Gravity (raw gas)	0.651	0.651	0.651	0.651
Average shut-in temperature, °R	628	628	628	628
Length of tubing, Ft.	9162	9162	9162	9162

PRESSURE DROP CALCULATIONS

$(D_{eff.})^{8/3}$.	3.561	6.310	10.806	18.595
Sq. root of 628	25.06	25.06	25.06	25.06
C	158.87	281.51	482.08	829.58
Sq. root of GL.	77.22	77.22	77.22	77.22
Sq. root of GL + C.	0.48606	0.274306	0.16020	0.09310

	FLOW RATES/DAY				
R^2/mile . .	6,000 MCF	4900	1561	533	180
R^2/mile . .	4,000 MCF	2178	693	237	79.5
R^2/mile . .	3,000 MCF	1225	390	133	45.0
R^2/mile . .	1,500 MCF	306	97	33	11.5

R^2 PRESSURE PER MILE FROM CURVES

	FLOW RATES/DAY	*	**	**	*
R^2.	6,000 MCF	1720	705	315	137
R^2.	4,000 MCF	800	327	145	63.5
R^2.	3,000 MCF	462	188	83	36.6
R^2.	1,500 MCF	133	51	22	9.2

* - Values taken from Chart No. 2 Curves Nos. 5 to 8 Incl. Attached.

** - Values taken from Humble Curves in RR Comm. Manual for Back-Pressur test of Gas Wells.

Southern Petroleum Laboratories, Inc.

By W. A. Frier

W. A. Frier

HUMBLE CURVE

GAS WELL BACK PRESSURE CURVE

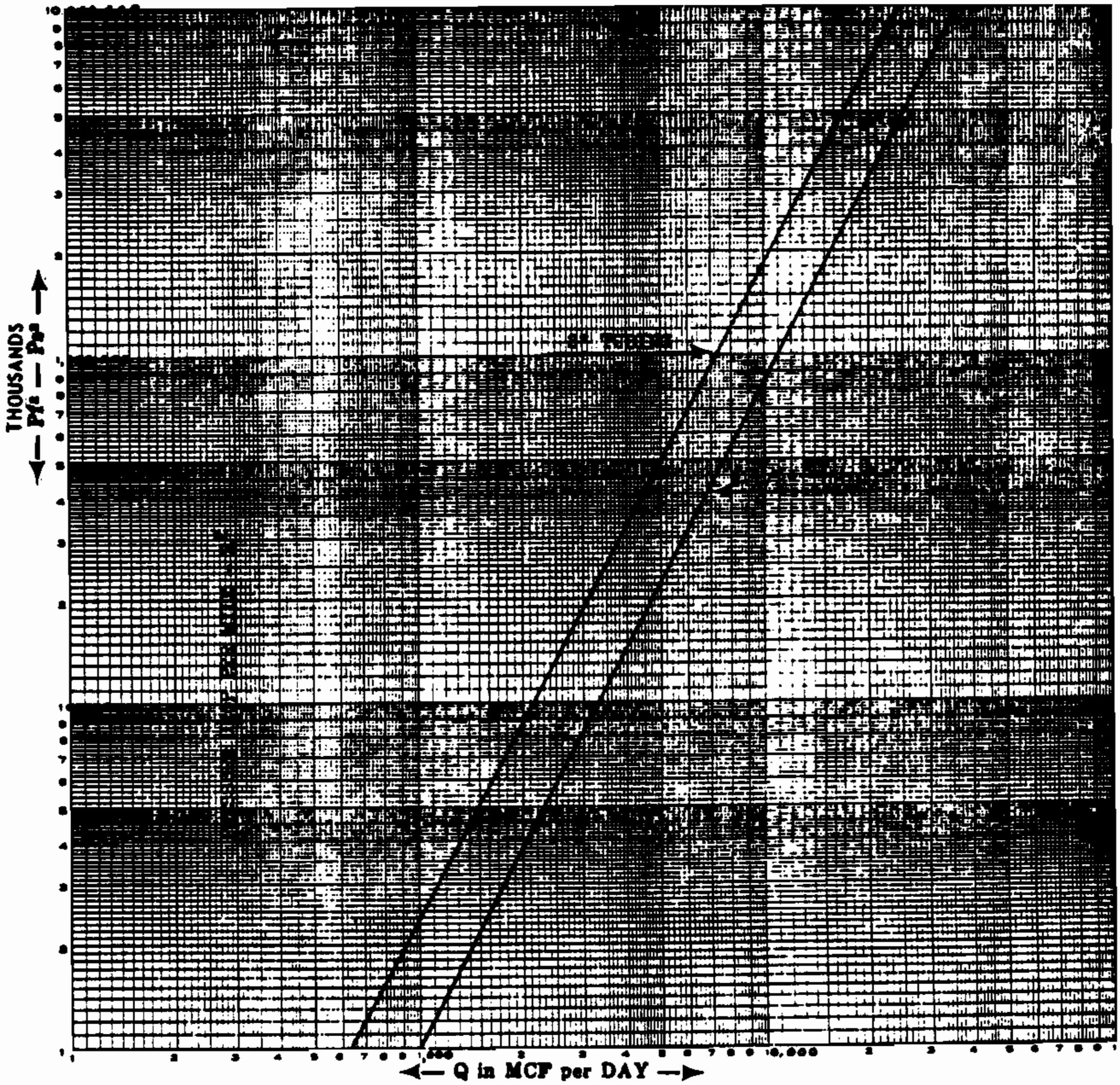
County ______________ Field ______________

Operator ______________________________

Lease ______________________ Well No. __________

Volume ______________________ MCF/24 hr.

Date ______________________



Courtesy of
Humble Oil and Refining Company

TABLE 11

PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES

Reproduced By Permission of the
California Natural Gasoline Association
Material taken from their Bulletin No. TS–461

G Specific Gravity Air=1.00	P_c Pseudo-Critical Pressure psia	T_c Pseudo-Critical Temperature °F Abs.
.55	673	336
.56	673	341
.57	672	346
.58	672	350
.59	672	354
.60	671	358
.61	671	362
.62	671	365
.63	670	368
.64	670	372
.65	670	375
.66	670	378
.67	669	382
.68	669	385
.69	669	388
.70	668	392
.71	668	395
.72	668	398
.73	668	401
.74	667	405
.75	667	408
.76	667	411
.77	666	415
.78	666	418
.79	666	421
.80	665	424
.81	665	428
.82	665	431
.83	665	434
.84	664	438
.85	664	441
.86	664	444
.87	663	448
.88	663	451
.89	662	454
.90	662	457
.91	662	461
.92	662	464
.93	661	467
.94	661	471
.95	660	474
.96	660	477
.97	659	481
.98	659	484
.99	659	487
1.00	658	491
1.01	658	494
1.02	657	497
1.03	656	500
1.04	656	504
1.05	655	507
1.06	655	510
1.07	654	514
1.08	654	517
1.09	653	520
1.10	652	524
1.11	652	527
1.12	651	530
1.13	651	534
1.14	650	537
1.15	649	540

TABLE 12

Reproduced By Permission of The California Natural Gasoline Association
Material taken from their Bulletin No. TS–461

VALUES OF F_{px}

All Headings Inclusive to Next Higher Reading—Do Not Interpolate

Red. Press. P_r	Reduced Temperature, T_r							
	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
.55	1.114	1.111	1.107	1.103	1.100	1.096	1.093	1.090
.60	1.130	1.126	1.121	1.117	1.112	1.108	1.104	1.101
.65	1.147	1.142	1.137	1.132	1.126	1.121	1.116	1.112
.70	1.165	1.159	1.153	1.147	1.140	1.134	1.128	1.123
.75	1.181	1.175	1.169	1.162	1.154	1.146	1.140	1.135
.80	1.204	1.196	1.188	1.179	1.170	1.161	1.154	1.148
.85	1.230	1.220	1.210	1.200	1.188	1.178	1.169	1.162
.90	1.257	1.245	1.232	1.219	1.206	1.195	1.185	1.176
.95	1.284	1.268	1.253	1.239	1.225	1.211	1.200	1.190
1.00	1.322	1.302	1.282	1.265	1.247	1.231	1.218	1.207
1.05	1.372	1.346	1.319	1.295	1.275	1.255	1.239	1.226
1.10	1.422	1.389	1.356	1.327	1.301	1.278	1.260	1.245
1.15	1.472	1.432	1.392	1.357	1.328	1.301	1.281	1.264
1.20	1.543	1.492	1.441	1.398	1.361	1.328	1.305	1.286
1.25	1.635	1.569	1.502	1.446	1.401	1.361	1.333	1.311
1.30	1.746	1.658	1.571	1.499	1.443	1.396	1.362	1.338
1.35	1.877	1.763	1.649	1.557	1.490	1.432	1.394	1.365
1.40	1.951	1.828	1.704	1.606	1.534	1.472	1.429	1.396
1.45	1.968	1.853	1.739	1.647	1.576	1.514	1.468	1.428
1.50	1.979	1.873	1.767	1.682	1.618	1.554	1.501	1.457
1.55	1.985	1.887	1.788	1.706	1.639	1.573	1.528	1.482
1.60	1.987	1.895	1.802	1.724	1.660	1.596	1.549	1.503
1.65	1.985	1.897	1.810	1.736	1.675	1.614	1.567	1.521
1.70	1.976	1.894	1.813	1.743	1.685	1.627	1.580	1.534
1.75	1.961	1.886	1.812	1.747	1.691	1.635	1.590	1.545
1.80	1.944	1.875	1.807	1.747	1.694	1.641	1.597	1.553
1.85	1.925	1.862	1.800	1.744	1.694	1.644	1.602	1.560
1.90	1.908	1.849	1.792	1.739	1.692	1.644	1.605	1.565
1.95	1.891	1.836	1.782	1.732	1.688	1.643	1.606	1.570
2.00	1.873	1.822	1.771	1.725	1.683	1.640	1.606	1.571
2.05	1.854	1.807	1.760	1.717	1.677	1.636	1.603	1.570
2.10	1.836	1.792	1.749	1.708	1.670	1.632	1.601	1.569
2.15	1.817	1.777	1.737	1.699	1.663	1.628	1.598	1.568
2.20	1.798	1.762	1.724	1.690	1.656	1.624	1.595	1.566
2.25	1.779	1.746	1.711	1.680	1.649	1.620	1.592	1.564
2.30	1.761	1.731	1.699	1.670	1.642	1.615	1.587	1.561
2.35	1.745	1.716	1.688	1.661	1.635	1.608	1.582	1.557
2.40	1.728	1.702	1.674	1.651	1.626	1.601	1.577	1.553
2.45	1.712	1.698	1.658	1.641	1.617	1.594	1.571	1.549
2.50	1.696	1.674	1.652	1.630	1.608	1.585	1.564	1.543
2.55	1.680	1.659	1.639	1.619	1.597	1.576	1.557	1.536
2.60	1.664	1.645	1.627	1.608	1.588	1.568	1.550	1.530
2.65	1.650	1.632	1.616	1.599	1.580	1.561	1.543	1.525
2.70	1.635	1.620	1.605	1.589	1.571	1.554	1.536	1.518
2.75	1.620	1.607	1.594	1.579	1.562	1.545	1.528	1.511
2.80	1.608	1.595	1.582	1.567	1.552	1.535	1.519	1.503
2.85	1.595	1.582	1.570	1.556	1.541	1.526	1.510	1.494
2.90	1.582	1.570	1.558	1.545	1.531	1.516	1.501	1.486
2.95	1.570	1.557	1.546	1.533	1.520	1.507	1.492	1.477
3.00	1.557	1.545	1.534	1.522	1.510	1.497	1.483	1.469

Red. Press. P_r	Reduced Temperature, T_r							
	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
.55	1.086	1.083	1.081	1.078	1.074	1.071	1.068	1.066
.60	1.097	1.093	1.090	1.086	1.082	1.079	1.076	1.072
.65	1.108	1.103	1.099	1.096	1.092	1.087	1.083	1.080
.70	1.119	1.114	1.109	1.105	1.100	1.096	1.091	1.086
.75	1.130	1.124	1.119	1.114	1.110	1.104	1.098	1.094
.80	1.142	1.135	1.129	1.124	1.118	1.112	1.106	1.101
.85	1.154	1.147	1.140	1.133	1.127	1.121	1.115	1.109
.90	1.168	1.159	1.151	1.144	1.137	1.130	1.123	1.118
.95	1.180	1.171	1.162	1.153	1.146	1.139	1.132	1.126
1.00	1.195	1.184	1.174	1.165	1.156	1.148	1.141	1.135
1.05	1.216	1.200	1.189	1.178	1.169	1.160	1.152	1.144
1.10	1.230	1.216	1.203	1.192	1.181	1.171	1.162	1.154
1.15	1.248	1.232	1.218	1.205	1.193	1.183	1.173	1.164
1.20	1.268	1.249	1.233	1.219	1.206	1.194	1.183	1.173
1.25	1.289	1.269	1.251	1.234	1.219	1.205	1.193	1.181
1.30	1.313	1.289	1.269	1.250	1.232	1.217	1.204	1.192
1.35	1.337	1.311	1.288	1.277	1.247	1.231	1.217	1.203
1.40	1.363	1.332	1.307	1.283	1.262	1.245	1.229	1.215
1.45	1.389	1.353	1.325	1.300	1.277	1.259	1.242	1.227
1.50	1.414	1.375	1.343	1.317	1.292	1.272	1.255	1.239
1.55	1.437	1.396	1.363	1.334	1.307	1.286	1.267	1.250
1.60	1.457	1.414	1.380	1.350	1.323	1.300	1.279	1.261
1.65	1.474	1.431	1.397	1.367	1.338	1.314	1.292	1.273
1.70	1.488	1.441	1.411	1.381	1.351	1.328	1.304	1.281
1.75	1.499	1.454	1.424	1.394	1.364	1.339	1.314	1.290
1.80	1.509	1.465	1.435	1.405	1.375	1.350	1.326	1.301
1.85	1.518	1.476	1.446	1.416	1.386	1.361	1.337	1.312
1.90	1.526	1.486	1.456	1.426	1.396	1.372	1.348	1.324
1.95	1.533	1.497	1.467	1.437	1.407	1.383	1.359	1.335
2.00	1.537	1.503	1.474	1.445	1.415	1.392	1.368	1.345
2.05	1.538	1.505	1.477	1.450	1.422	1.399	1.377	1.354
2.10	1.538	1.507	1.480	1.454	1.428	1.406	1.385	1.363
2.15	1.538	1.508	1.483	1.459	1.434	1.413	1.392	1.370
2.20	1.537	1.508	1.485	1.462	1.438	1.417	1.397	1.376
2.25	1.536	1.508	1.486	1.463	1.440	1.420	1.400	1.379
2.30	1.534	1.507	1.485	1.463	1.441	1.421	1.402	1.382
2.35	1.532	1.506	1.484	1.463	1.441	1.422	1.403	1.384
2.40	1.529	1.505	1.484	1.463	1.441	1.422	1.404	1.385
2.45	1.526	1.504	1.483	1.462	1.441	1.422	1.404	1.385
2.50	1.522	1.502	1.481	1.460	1.440	1.421	1.403	1.385
2.55	1.517	1.497	1.478	1.457	1.438	1.421	1.402	1.385
2.60	1.511	1.493	1.474	1.455	1.436	1.419	1.401	1.384
2.65	1.506	1.488	1.470	1.452	1.434	1.417	1.399	1.382
2.70	1.501	1.483	1.465	1.449	1.431	1.414	1.397	1.380
2.75	1.494	1.478	1.460	1.444	1.427	1.411	1.395	1.378
2.80	1.486	1.471	1.454	1.438	1.422	1.407	1.391	1.375
2.85	1.478	1.463	1.447	1.432	1.417	1.402	1.387	1.372
2.90	1.471	1.456	1.441	1.427	1.411	1.398	1.383	1.368
2.95	1.463	1.448	1.434	1.421	1.406	1.393	1.379	1.365
3.00	1.455	1.441	1.428	1.415	1.401	1.389	1.375	1.362

Red. Press. P_r	Reduced Temperature, T_r							
	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28
.55	1.064	1.062	1.061	1.059	1.058	1.056	1.055	1.053
.60	1.070	1.068	1.067	1.065	1.064	1.062	1.061	1.059
.65	1.077	1.075	1.073	1.071	1.069	1.067	1.065	1.063
.70	1.083	1.081	1.080	1.077	1.075	1.073	1.071	1.069
.75	1.091	1.088	1.086	1.083	1.080	1.078	1.075	1.074
.80	1.098	1.095	1.093	1.089	1.086	1.084	1.081	1.079
.85	1.105	1.102	1.099	1.096	1.093	1.090	1.087	1.085
.90	1.113	1.110	1.106	1.102	1.099	1.095	1.092	1.090
.95	1.121	1.116	1.113	1.109	1.105	1.101	1.098	1.095
1.00	1.129	1.124	1.120	1.116	1.112	1.107	1.104	1.001
1.05	1.138	1.133	1.127	1.122	1.118	1.114	1.111	1.107
1.10	1.147	1.140	1.135	1.130	1.125	1.120	1.117	1.113
1.15	1.156	1.149	1.142	1.136	1.132	1.127	1.123	1.119
1.20	1.164	1.157	1.150	1.144	1.139	1.134	1.130	1.125
1.25	1.172	1.165	1.158	1.151	1.146	1.141	1.136	1.132
1.30	1.182	1.174	1.166	1.159	1.153	1.148	1.143	1.138
1.35	1.193	1.184	1.175	1.168	1.161	1.155	1.149	1.144
1.40	1.204	1.193	1.184	1.176	1.168	1.161	1.155	1.150
1.45	1.215	1.204	1.193	1.184	1.176	1.168	1.162	1.157
1.50	1.225	1.213	1.202	1.192	1.183	1.175	1.168	1.163
1.55	1.236	1.223	1.211	1.201	1.191	1.182	1.175	1.169
1.60	1.246	1.233	1.220	1.209	1.199	1.189	1.182	1.175
1.65	1.257	1.242	1.229	1.218	1.207	1.197	1.189	1.182
1.70	1.266	1.251	1.236	1.225	1.214	1.204	1.196	1.188
1.75	1.274	1.259	1.243	1.232	1.222	1.211	1.203	1.195
1.80	1.285	1.268	1.252	1.241	1.230	1.219	1.211	1.201
1.85	1.296	1.279	1.262	1.250	1.238	1.226	1.218	1.208
1.90	1.306	1.289	1.272	1.259	1.246	1.234	1.225	1.215
1.95	1.317	1.298	1.281	1.268	1.254	1.241	1.232	1.222
2.00	1.327	1.308	1.289	1.276	1.262	1.248	1.238	1.228
2.05	1.336	1.317	1.298	1.283	1.269	1.255	1.245	1.234
2.10	1.344	1.325	1.306	1.291	1.276	1.261	1.251	1.240
2.15	1.351	1.332	1.313	1.298	1.283	1.268	1.256	1.245
2.20	1.357	1.337	1.319	1.304	1.289	1.274	1.262	1.251
2.25	1.361	1.342	1.324	1.309	1.294	1.279	1.267	1.256
2.30	1.364	1.346	1.328	1.313	1.299	1.284	1.272	1.260
2.35	1.366	1.349	1.331	1.316	1.302	1.287	1.275	1.263
2.40	1.368	1.351	1.333	1.319	1.304	1.290	1.279	1.267
2.45	1.369	1.352	1.336	1.322	1.307	1.293	1.282	1.270
2.50	1.369	1.353	1.337	1.323	1.309	1.295	1.284	1.273
2.55	1.369	1.353	1.337	1.324	1.310	1.296	1.286	1.275
2.60	1.368	1.353	1.338	1.325	1.311	1.298	1.288	1.277
2.65	1.367	1.353	1.339	1.326	1.312	1.299	1.289	1.278
2.70	1.366	1.352	1.338	1.326	1.313	1.301	1.291	1.280
2.75	1.365	1.351	1.337	1.325	1.314	1.302	1.292	1.281
2.80	1.362	1.349	1.336	1.324	1.313	1.301	1.292	1.281
2.85	1.360	1.347	1.335	1.323	1.312	1.301	1.291	1.281
2.90	1.357	1.346	1.334	1.323	1.312	1.300	1.291	1.280
2.95	1.355	1.344	1.333	1.322	1.311	1.300	1.290	1.280
3.00	1.352	1.342	1.332	1.321	1.310	1.299	1.290	1.280

Red. Press. P_r	Reduced Temperature, T_r							
	1.29	1.30	1.31	1.32	1.33	1.34	1.35	1.36
.55	1.052	1.051	1.050	1.048	1.047	1.045	1.044	1.042
.60	1.057	1,055	1.054	1.052	1.051	1.049	1.048	1.046
.65	1.062	1.060	1.059	1.057	1.055	1.053	1.052	1.050
.70	1.067	1.065	1.063	1.061	1.060	1.058	1.056	1.054
.75	1.072	1.070	1.068	1.066	1.064	1.062	1.060	1.058
.80	1.077	1.075	1.073	1.070	1.068	1.066	1.064	1.062
.85	1.082	1.080	1.077	1.075	1.073	1.070	1.068	1.066
.90	1.087	1.085	1.083	1.080	1.077	1.075	1.072	1.070
.95	1.092	1.090	1.087	1.085	1.082	1.079	1.076	1.074
1.00	1.098	1.096	1.093	1.090	1.086	1.083	1.080	1.078
1.05	1.104	1.101	1.098	1.094	1.091	1.088	1.085	1.083
1.10	1.110	1.106	1.103	1.100	1.096	1.093	1.090	1.087
1.15	1.115	1.111	1.108	1.104	1.101	1.098	1.095	1.092
1.20	1.121	1.117	1.114	1.110	1.106	1.102	1.099	1.096
1.25	1.127	1.122	1.118	1.114	1.110	1.107	1.104	1.100
1.30	1.133	1.128	1.124	1.120	1.116	1.112	1.108	1.105
1.35	1.139	1.134	1.129	1.125	1.121	1.116	1.113	1.110
1.40	1.145	1.140	1.135	1.130	1.126	1.121	1.117	1.114
1.45	1.151	1.145	1.140	1.136	1.131	1.126	1.121	1.117
1.50	1.157	1.151	1.146	1.141	1.135	1.130	1.125	1.121
1.55	1.163	1.157	1.151	1.146	1.141	1.135	1.130	1.126
1.60	1.169	1.163	1.157	1.151	1.145	1.139	1.134	1.130
1.65	1.175	1.168	1.161	1.156	1.150	1.144	1.139	1.134
1.70	1.181	1.173	1.167	1.161	1.155	1.149	1.143	1.139
1.75	1.187	1.179	1.173	1.167	1.160	1.154	1.148	1.144
1.80	1.193	1.185	1.179	1.173	1.166	1.160	1.153	1.148
1.85	1.199	1.190	1.184	1.178	1.171	1.165	1.158	1.153
1.90	1.205	1.196	1.189	1.183	1.176	1.169	1.162	1.157
1.95	1.212	1.202	1.195	1.188	1.181	1.173	1.166	1.161
2.00	1.218	1.208	1.201	1.193	1.185	1.177	1.170	1.165
2.05	1.224	1.214	1.206	1.198	1.190	1.182	1.174	1.169
2.10	1.229	1.219	1.211	1.203	1.194	1.186	1.178	1.172
2.15	1.234	1.223	1.215	1.207	1.199	1.191	1.183	1.177
2.20	1.239	1.228	1.220	1.211	1.203	1.195	1.187	1.181
2.25	1.244	1.233	1.225	1.216	1.208	1.199	1.191	1.185
2.30	1.249	1.237	1.229	1.220	1.212	1.203	1.195	1.188
2.35	1.252	1.240	1.232	1.223	1.215	1.206	1.198	1.191
2.40	1.256	1.244	1.236	1.227	1.219	1.210	1.202	1.195
2.45	1.259	1.248	1.239	1.230	1.222	1.213	1.205	1.198
2.50	1.262	1.251	1.242	1.233	1.225	1.216	1.207	1.200
2.55	1.265	1.254	1.245	1.236	1.228	1.219	1.210	1.203
2.60	1.267	1.256	1.247	1.238	1.230	1.221	1.212	1.205
2.65	1.268	1.258	1.249	1.240	1.232	1.223	1.214	1.207
2.70	1.270	1.260	1.251	1.242	1.234	1.225	1.216	1.209
2.75	1.272	1.262	1.253	1.245	1.237	1.228	1.219	1.211
2.80	1.272	1.262	1.253	1.245	1.238	1.229	1.220	1.213
2.85	1.272	1.262	1.254	1.246	1.239	1.230	1.221	1.214
2.90	1.271	1.262	1.254	1.246	1.239	1.231	1.222	1.215
2.95	1.271	1.262	1.255	1.247	1.240	1.232	1.223	1.216
3.00	1.271	1.262	1.255	1.247	1.240	1.232	1.224	1.217

Red. Press. P_r	Reduced Temperature, T_r							
	1.37	1.38	1.39	1.40	1.41	1.42	1.43	1.44
.55	1.041	1.039	1.038	1.037	1.036	1.035	1.034	1.034
.60	1.045	1.043	1.042	1.041	1.040	1.039	1.038	1.038
.65	1.049	1.047	1.046	1.044	1.043	1.042	1.041	1.041
.70	1.053	1.051	1.049	1.048	1.047	1.046	1.045	1.044
.75	1.057	1.055	1.053	1.051	1.050	1.049	1.048	1.047
.80	1.061	1.059	1.057	1.055	1.054	1.053	1.051	1.050
.85	1.064	1.062	1.060	1.058	1.057	1.056	1.055	1.053
.90	1.068	1.066	1.064	1.062	1.061	1.059	1.057	1.056
.95	1.072	1.069	1.067	1.065	1.064	1.062	1.061	1.059
1.00	1.076	1.073	1.071	1.069	1.068	1.066	1.064	1.063
1.05	1.080	1.078	1.075	1.073	1.072	1.070	1.068	1.066
1.10	1.085	1.082	1.080	1.077	1.075	1.073	1.071	1.069
1.15	1.089	1.087	1.084	1.081	1.079	1.077	1.075	1.072
1.20	1.093	1.091	1.088	1.085	1.083	1.081	1.079	1.076
1.25	1.097	1.094	1.091	1.089	1.086	1.084	1.081	1.079
1.30	1.102	1.098	1.095	1.093	1.090	1.088	1.085	1.083
1.35	1.106	1.103	1.100	1.097	1.094	1.091	1.088	1.085
1.40	1.110	1.107	1.104	1.101	1.098	1.095	1.092	1.089
1.45	1.114	1.111	1.108	1.104	1.101	1.098	1.095	1.092
1.50	1.118	1.115	1.112	1.108	1.105	1.102	1.098	1.095
1.55	1.122	1.119	1.116	1.112	1.109	1.105	1.102	1.098
1.60	1.126	1.123	1.120	1.116	1.113	1.109	1.105	1.102
1.65	1.130	1.127	1.123	1.119	1.116	1.112	1.108	1.105
1.70	1.135	1.131	1.127	1.123	1.119	1.116	1.112	1.109
1.75	1.139	1.135	1.130	1.126	1.122	1.119	1.115	1.112
1.80	1.143	1.139	1.134	1.129	1.125	1.121	1.118	1.114
1.85	1.148	1.143	1.138	1.133	1.129	1.125	1.121	1.117
1.90	1.152	1.147	1.142	1.137	1.133	1.128	1.124	1.119
1.95	1.156	1.150	1.145	1.140	1.136	1.131	1.127	1.122
2.00	1.160	1.154	1.149	1.144	1.139	1.135	1.130	1.126
2.05	1.163	1.158	1.152	1.147	1.142	1.138	1.133	1.129
2.10	1.167	1.161	1.156	1.150	1.145	1.140	1.136	1.131
2.15	1.171	1.165	1.159	1.153	1.148	1.143	1.139	1.134
2.20	1.175	1.168	1.162	1.156	1.151	1.146	1.141	1.136
2.25	1.178	1.172	1.165	1.159	1.154	1.149	1.143	1.138
2.30	1.182	1.175	1.169	1.162	1.157	1.151	1.146	1.140
2.35	1.185	1.178	1.172	1.165	1.160	1.154	1.149	1.143
2.40	1.188	1.181	1.174	1.167	1.162	1.156	1.151	1.145
2.45	1.191	1.184	1.177	1.170	1.164	1.159	1.153	1.148
2.50	1.193	1.186	1.179	1.172	1.166	1.161	1.155	1.150
2.55	1.196	1.188	1.181	1.174	1.168	1.163	1.157	1.152
2.60	1.198	1.190	1.183	1.176	1.170	1.165	1.159	1.154
2.65	1.200	1.192	1.185	1.178	1.172	1.166	1.161	1.155
2.70	1.202	1.194	1.187	1.180	1.174	1.168	1.162	1.156
2.75	1.204	1.196	1.189	1.181	1.175	1.169	1.163	1.157
2.80	1.206	1.198	1.191	1.183	1.177	1.171	1.165	1.159
2.85	1.207	1.199	1.192	1.184	1.178	1.172	1.166	1.160
2.90	1.208	1.200	1.193	1.186	1.180	1.174	1.167	1.161
2.95	1.209	1.201	1.194	1.187	1.181	1.175	1.168	1.162
3.00	1.210	1.202	1.195	1.188	1.182	1.176	1.169	1.163

Red. Press. P_r	Reduced Temperature, T_r 1.45	1.46	1.47	1.48	1.49	1.50	1.52	1.54
.55	1.033	1.032	1.032	1.031	1.030	1.029	1.028	1.027
.60	1.037	1.036	1.035	1.034	1.034	1.031	1.030	1.029
.65	1.039	1.038	1.038	1.037	1.036	1.034	1.032	1.031
.70	1.043	1.042	1.041	1.040	1.039	1.037	1.035	1.032
.75	1.045	1.044	1.044	1.043	1.042	1.040	1.037	1.034
.80	1.049	1.048	1.047	1.046	1.045	1.042	1.039	1.036
.85	1.052	1.051	1.049	1.048	1.047	1.045	1.042	1.039
.90	1.055	1.054	1.053	1.052	1.051	1.048	1.045	1.042
.95	1.057	1.056	1.055	1.054	1.053	1.051	1.048	1.045
1.00	1.061	1.059	1.058	1.057	1.056	1.053	1.050	1.047
1.05	1.064	1.063	1.061	1.060	1.058	1.055	1.052	1.049
1.10	1.067	1.065	1.064	1.062	1.061	1.057	1.054	1.051
1.15	1.070	1.069	1.067	1.065	1.063	1.059	1.056	1.053
1.20	1.074	1.072	1.069	1.067	1.065	1.061	1.058	1.055
1.25	1.077	1.075	1.073	1.071	1.068	1.064	1.061	1.057
1.30	1.080	1.078	1.075	1.073	1.071	1.066	1.063	1.059
1.35	1.083	1.081	1.079	1.076	1.074	1.070	1.065	1.061
1.40	1.086	1.083	1.081	1.079	1.076	1.072	1.067	1.063
1.45	1.089	1.087	1.084	1.081	1.079	1.075	1.070	1.065
1.50	1.092	1.089	1.087	1.084	1.081	1.077	1.072	1.067
1.55	1.095	1.092	1.089	1.087	1.084	1.079	1.074	1.070
1.60	1.098	1.095	1.092	1.089	1.086	1.081	1.076	1.072
1.65	1.102	1.098	1.095	1.092	1.089	1.084	1.079	1.074
1.70	1.105	1.102	1.098	1.095	1.091	1.086	1.081	1.076
1.75	1.108	1.105	1.101	1.098	1.094	1.089	1.084	1.079
1.80	1.110	1.107	1.103	1.100	1.096	1.091	1.086	1.081
1.85	1.113	1.109	1.106	1.102	1.099	1.092	1.087	1.082
1.90	1.115	1.111	1.108	1.104	1.101	1.094	1.089	1.084
1.95	1.118	1.114	1.111	1.107	1.104	1.097	1.092	1.087
2.00	1.121	1.117	1.113	1.110	1.106	1.099	1.094	1.089
2.05	1.124	1.120	1.116	1.112	1.108	1.101	1.096	1.091
2.10	1.126	1.122	1.118	1.114	1.110	1.103	1.098	1.093
2.15	1.129	1.125	1.121	1.116	1.112	1.105	1.100	1.094
2.20	1.131	1.127	1.123	1.118	1.114	1.107	1.102	1.096
2.25	1.133	1.129	1.124	1.120	1.115	1.108	1.103	1.097
2.30	1.135	1.131	1.126	1.122	1.117	1.110	1.105	1.099
2.35	1.138	1.133	1.129	1.124	1.120	1.112	1.106	1.100
2.40	1.140	1.135	1.131	1.126	1.122	1.114	1.108	1.102
2.45	1.142	1.137	1.133	1.128	1.124	1.116	1.109	1.103
2.50	1.144	1.139	1.135	1.130	1.126	1.118	1.111	1.105
2.55	1.146	1.141	1.137	1.132	1.128	1.120	1.113	1.106
2.60	1.148	1.143	1.139	1.134	1.130	1.121	1.114	1.107
2.65	1.149	1.144	1.140	1.135	1.131	1.122	1.115	1.108
2.70	1.150	1.145	1.141	1.136	1.132	1.123	1.116	1.109
2.75	1.151	1.146	1.142	1.137	1.133	1.124	1.117	1.110
2.80	1.153	1.148	1.144	1.139	1.135	1.126	1.118	1.111
2.85	1.154	1.149	1.145	1.140	1.136	1.127	1.119	1.111
2.90	1.155	1.150	1.146	1.141	1.137	1.128	1.120	1.112
2.95	1.156	1.151	1.147	1.142	1.138	1.129	1.121	1.113
3.00	1.157	1.152	1.148	1.143	1.139	1.130	1.122	1.114

Red. Press. P_r	Reduced Temperature, T_r							
	1.56	1.58	1.60	1.62	1.64	1.66	1.68	1.70
.55	1.025	1.024	1.022	1.021	1.020	1.019	1.018	1.017
.60	1.027	1.026	1.024	1.023	1.022	1.021	1.020	1.019
.65	1.029	1.028	1.026	1.025	1.024	1.022	1.021	1.020
.70	1.030	1.029	1.027	1.026	1.025	1.024	1.023	1.021
.75	1.032	1.031	1.029	1.028	1.027	1.025	1.024	1.022
.80	1.034	1.033	1.031	1.030	1.029	1.027	1.026	1.024
.85	1.037	1.035	1.033	1.032	1.031	1.029	1.027	1.025
.90	1.040	1.038	1.036	1.034	1.032	1.030	1.029	1.027
.95	1.043	1.040	1.038	1.036	1.034	1.032	1.030	1.028
1.00	1.045	1.042	1.040	1.038	1.036	1.034	1.032	1.030
1.05	1.047	1.044	1.042	1.040	1.038	1.036	1.033	1.031
1.10	1.049	1.046	1.044	1.041	1.039	1.037	1.035	1.033
1.15	1.051	1.048	1.046	1.043	1.041	1.039	1.036	1.034
1.20	1.053	1.050	1.048	1.045	1.043	1.041	1.038	1.036
1.25	1.055	1.053	1.051	1.048	1.045	1.043	1.040	1.038
1.30	1.057	1.055	1.053	1.050	1.047	1.044	1.042	1.040
1.35	1.059	1.056	1.054	1.051	1.048	1.046	1.042	1.040
1.40	1.061	1.058	1.056	1.053	1.050	1.047	1.044	1.042
1.45	1.062	1.059	1.057	1.054	1.051	1.048	1.045	1.043
1.50	1.064	1.061	1.059	1.056	1.053	1.050	1.047	1.044
1.55	1.067	1.064	1.060	1.057	1.054	1.051	1.048	1.046
1.60	1.069	1.066	1.062	1.059	1.056	1.053	1.050	1.047
1.65	1.070	1.067	1.063	1.060	1.057	1.054	1.051	1.048
1.70	1.072	1.069	1.065	1.062	1.059	1.056	1.053	1.050
1.75	1.075	1.072	1.068	1.065	1.061	1.057	1.054	1.051
1.80	1.077	1.074	1.070	1.067	1.063	1.059	1.056	1.053
1.85	1.078	1.075	1.071	1.068	1.064	1.060	1.057	1.054
1.90	1.080	1.076	1.072	1.069	1.065	1.061	1.058	1.055
1.95	1.082	1.077	1.073	1.070	1.066	1.062	1.059	1.056
2.00	1.084	1.079	1.075	1.071	1.067	1.064	1.060	1.057
2.05	1.086	1.081	1.077	1.073	1.069	1.065	1.061	1.058
2.10	1.088	1.083	1.079	1.075	1.070	1.066	1.062	1.059
2.15	1.089	1.084	1.080	1.076	1.071	1.067	1.063	1.060
2.20	1.091	1.086	1.081	1.077	1.073	1.069	1.065	1.061
2.25	1.092	1.087	1.082	1.078	1.074	1.070	1.066	1.062
2.30	1.094	1.089	1.084	1.080	1.075	1.071	1.067	1.063
2.35	1.095	1.090	1.085	1.081	1.076	1.072	1.068	1.064
2.40	1.096	1.091	1.086	1.082	1.077	1.073	1.069	1.065
2.45	1.097	1.092	1.087	1.083	1.078	1.074	1.070	1.066
2.50	1.099	1.093	1.088	1.084	1.079	1.075	1.071	1.067
2.55	1.100	1.094	1.089	1.085	1.080	1.076	1.072	1.068
2.60	1.101	1.096	1.091	1.086	1.082	1.078	1.073	1.069
2.65	1.102	1.097	1.092	1.087	1.083	1.079	1.074	1.070
2.70	1.103	1.098	1.093	1.088	1.083	1.079	1.074	1.070
2.75	1.104	1.099	1.094	1.089	1.084	1.080	1.075	1.071
2.80	1.105	1.100	1.095	1.089	1.085	1.081	1.076	1.072
2.85	1.105	1.100	1.095	1.089	1.085	1.081	1.076	1.072
2.90	1.106	1.101	1.096	1.090	1.086	1.082	1.077	1.073
2.95	1.107	1.102	1.097	1.091	1.087	1.082	1.077	1.073
3.00	1.108	1.103	1.098	1.093	1.088	1.083	1.078	1.073

Red. Press. P_r	Reduced Temperature, T_r							
	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86
.55	1.016	1.015	1.014	1.013	1.013	1.012	1.012	1.012
.60	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013
.65	1.019	1.018	1.017	1.016	1.016	1.014	1.014	1.014
.70	1.020	1.019	1.018	1.017	1.016	1.016	1.015	1.015
.75	1.021	1.020	1.019	1.018	1.018	1.016	1.016	1.016
.80	1.023	1.022	1.021	1.020	1.019	1.018	1.017	1.016
.85	1.024	1.023	1.022	1.021	1.020	1.019	1.018	1.018
.90	1.026	1.025	1.024	1.023	1.021	1.020	1.019	1.018
.95	1.027	1.026	1.025	1.024	1.022	1.021	1.020	1.020
1.00	1.029	1.028	1.026	1.026	1.024	1.022	1.021	1.020
1.05	1.030	1.029	1.028	1.026	1.024	1.024	1.022	1.021
1.10	1.032	1.030	1.028	1.028	1.026	1.024	1.023	1.022
1.15	1.033	1.031	1.030	1.028	1.026	1.026	1.024	1.023
1.20	1.035	1.033	1.031	1.030	1.028	1.027	1.025	1.024
1.25	1.036	1.035	1.033	1.031	1.029	1.028	1.027	1.025
1.30	1.038	1.036	1.034	1.032	1.030	1.030	1.028	1.026
1.35	1.038	1.038	1.036	1.034	1.032	1.030	1.030	1.028
1.40	1.040	1.038	1.036	1.034	1.032	1.031	1.030	1.028
1.45	1.041	1.040	1.037	1.035	1.033	1.032	1.030	1.029
1.50	1.042	1.040	1.038	1.036	1.034	1.032	1.030	1.030
1.55	1.044	1.042	1.038	1.036	1.034	1.034	1.032	1.030
1.60	1.044	1.042	1.040	1.037	1.035	1.034	1.032	1.031
1.65	1.046	1.044	1.040	1.038	1.036	1.035	1.034	1.032
1.70	1.047	1.044	1.042	1.038	1.037	1.036	1.034	1.032
1.75	1.048	1.046	1.044	1.041	1.039	1.038	1.036	1.034
1.80	1.050	1.047	1.045	1.042	1.040	1.038	1.036	1.035
1.85	1.051	1.048	1.046	1.043	1.041	1.039	1.037	1.036
1.90	1.052	1.049	1.047	1.044	1.042	1.040	1.038	1.036
1.95	1.053	1.050	1.048	1.045	1.043	1.041	1.039	1.037
2.00	1.054	1.051	1.049	1.046	1.044	1.042	1.039	1.037
2.05	1.055	1.052	1.050	1.047	1.045	1.043	1.040	1.038
2.10	1.056	1.053	1.050	1.047	1.045	1.043	1.040	1.038
2.15	1.057	1.054	1.051	1.048	1.046	1.044	1.041	1.039
2.20	1.058	1.055	1.052	1.049	1.046	1.044	1.041	1.039
2.25	1.059	1.056	1.053	1.050	1.047	1.045	1.042	1.040
2.30	1.060	1.056	1.053	1.050	1.047	1.045	1.042	1.040
2.35	1.061	1.057	1.054	1.051	1.048	1.046	1.043	1.041
2.40	1.062	1.058	1.054	1.051	1.048	1.046	1.043	1.041
2.45	1.063	1.059	1.055	1.052	1.049	1.047	1.044	1.042
2.50	1.064	1.060	1.056	1.053	1.050	1.048	1.045	1.043
2.55	1.065	1.061	1.057	1.054	1.051	1.049	1.046	1.044
2.60	1.066	1.062	1.058	1.055	1.052	1.049	1.047	1.045
2.65	1.067	1.063	1.059	1.056	1.053	1.050	1.048	1.046
2.70	1.067	1.063	1.059	1.056	1.053	1.050	1.048	1.046
2.75	1.068	1.064	1.060	1.057	1.054	1.051	1.048	1.046
2.80	1.068	1.064	1.060	1.057	1.054	1.051	1.048	1.046
2.85	1.068	1.064	1.060	1.057	1.054	1.051	1.048	1.046
2.90	1.069	1.065	1.061	1.057	1.054	1.051	1.049	1.047
2.95	1.069	1.065	1.061	1.057	1.054	1.051	1.059	1.047
3.00	1.069	1.065	1.061	1.057	1.054	1.051	1.049	1.047

Red. Press. P_r	Reduced Temperature, T_r 1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.05
.55	1.012	1.012	1.010	1.010	1.010	1.009	1.009	1.008
.60	1.012	1.012	1.011	1.010	1.010	1.009	1.009	1.009
.65	1.013	1.013	1.012	1.012	1.011	1.010	1.010	1.009
.70	1.014	1.014	1.013	1.012	1.012	1.011	1.011	1.009
.75	1.015	1.015	1.014	1.014	1.013	1.012	1.012	1.010
.80	1.016	1.015	1.014	1.014	1.013	1.012	1.012	1.010
.85	1.016	1.016	1.015	1.015	1.014	1.013	1.013	1.011
.90	1.018	1.017	1.016	1.015	1.015	1.014	1.013	1.012
.95	1.018	1.018	1.017	1.016	1.016	1.015	1.014	1.013
1.00	1.019	1.018	1.017	1.016	1.016	1.015	1.014	1.013
1.05	1.020	1.019	1.018	1.017	1.017	1.016	1.015	1.014
1.10	1.021	1.020	1.019	1.018	1.017	1.016	1.015	1.014
1.15	1.022	1.021	1.020	1.019	1.018	1.017	1.016	1.015
1.20	1.023	1.022	1.020	1.020	1.018	1.018	1.016	1.015
1.25	1.024	1.022	1.022	1.020	1.020	1.018	1.017	1.016
1.30	1.026	1.024	1.022	1.021	1.020	1.019	1.017	1.016
1.35	1.026	1.024	1.024	1.022	1.021	1.020	1.018	1.016
1.40	1.027	1.025	1.024	1.022	1.022	1.020	1.019	1.016
1.45	1.028	1.026	1.025	1.024	1.022	1.022	1.020	1.018
1.50	1.028	1.026	1.026	1.024	1.023	1.022	1.020	1.018
1.55	1.030	1.028	1.026	1.026	1.024	1.023	1.021	1.019
1.60	1.030	1.028	1.027	1.026	1.024	1.024	1.022	1.019
1.65	1.031	1.029	1.028	1.027	1.026	1.024	1.022	1.020
1.70	1.031	1.029	1.028	1.027	1.026	1.025	1.023	1.020
1.75	1.033	1.031	1.030	1.028	1.027	1.026	1.024	1.021
1.80	1.033	1.031	1.030	1.028	1.027	1.026	1.024	1.021
1.85	1.034	1.032	1.031	1.029	1.028	1.027	1.025	1.022
1.90	1.034	1.032	1.031	1.029	1.028	1.027	1.025	1.022
1.95	1.035	1.033	1.032	1.030	1.029	1.028	1.026	1.023
2.00	1.035	1.033	1.032	1.030	1.029	1.028	1.026	1.023
2.05	1.036	1.034	1.033	1.031	1.030	1.029	1.026	1.023
2.10	1.036	1.034	1.033	1.031	1.030	1.029	1.026	1.023
2.15	1.037	1.035	1.034	1.032	1.031	1.030	1.027	1.024
2.20	1.037	1.035	1.034	1.032	1.031	1.030	1.027	1.024
2.25	1.038	1.036	1.035	1.033	1.031	1.030	1.027	1.024
2.30	1.038	1.036	1.035	1.033	1.031	1.030	1.027	1.024
2.35	1.039	1.037	1.036	1.034	1.032	1.031	1.028	1.025
2.40	1.039	1.037	1.036	1.034	1.032	1.031	1.028	1.025
2.45	1.040	1.038	1.036	1.034	1.033	1.031	1.028	1.025
2.50	1.041	1.039	1.037	1.035	1.033	1.031	1.028	1.025
2.55	1.042	1.040	1.038	1.036	1.034	1.032	1.029	1.026
2.60	1.042	1.040	1.038	1.036	1.034	1.032	1.029	1.026
2.65	1.043	1.041	1.039	1.036	1.034	1.032	1.029	1.026
2.70	1.043	1.041	1.039	1.036	1.034	1.032	1.029	1.026
2.75	1.043	1.041	1.039	1.037	1.035	1.033	1.029	1.026
2.80	1.043	1.041	1.039	1.037	1.035	1.033	1.030	1.027
2.85	1.043	1.041	1.039	1.037	1.035	1.033	1.030	1.027
2.90	1.044	1.042	1.040	1.037	1.035	1.033	1.030	1.027
2.95	1.044	1.042	1.040	1.037	1.036	1.034	1.030	1.027
3.00	1.044	1.042	1.040	1.038	1.036	1.034	1.031	1.028

Red. Press. P_r	Reduced Temperature, T_r 2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45
.55	1.007	1.006	1.006	1.005	1.004	1.003	1.003	1.002
.60	1.007	1.006	1.006	1.005	1.004	1.003	1.003	1.002
.65	1.008	1.007	1.007	1.005	1.005	1.003	1.003	1.002
.70	1.009	1.007	1.007	1.006	1.005	1.004	1.004	1.003
.75	1.010	1.008	1.008	1.006	1.006	1.004	1.004	1.003
.80	1.010	1.008	1.008	1.006	1.006	1.004	1.004	1.003
.85	1.010	1.009	1.008	1.007	1.006	1.005	1.004	1.003
.90	1.011	1.009	1.008	1.007	1.006	1.005	1.005	1.004
.95	1.011	1.010	1.008	1.008	1.006	1.006	1.005	1.004
1.00	1.011	1.010	1.008	1.008	1.006	1.006	1.005	1.004
1.05	1.012	1.011	1.009	1.008	1.007	1.006	1.005	1.004
1.10	1.012	1.011	1.009	1.009	1.007	1.007	1.006	1.004
1.15	1.013	1.012	1.010	1.009	1.008	1.007	1.006	1.004
1.20	1.013	1.012	1.010	1.009	1.008	1.007	1.006	1.004
1.25	1.014	1.013	1.011	1.010	1.008	1.007	1.006	1.004
1.30	1.014	1.013	1.011	1.010	1.008	1.007	1.006	1.004
1.35	1.015	1.013	1.011	1.010	1.009	1.008	1.006	1.005
1.40	1.015	1.013	1.011	1.010	1.009	1.008	1.006	1.005
1.45	1.016	1.014	1.012	1.011	1.009	1.008	1.006	1.005
1.50	1.016	1.014	1.012	1.011	1.009	1.008	1.006	1.005
1.55	1.017	1.015	1.013	1.012	1.010	1.009	1.007	1.006
1.60	1.017	1.015	1.013	1.012	1.010	1.009	1.007	1.006
1.65	1.018	1.015	1.013	1.012	1.010	1.009	1.007	1.006
1.70	1.018	1.015	1.013	1.012	1.010	1.009	1.007	1.006
1.75	1.019	1.016	1.014	1.012	1.011	1.009	1.007	1.006
1.80	1.019	1.016	1.014	1.012	1.011	1.009	1.007	1.006
1.85	1.019	1.016	1.014	1.013	1.011	1.010	1.008	1.006
1.90	1.019	1.016	1.014	1.013	1.011	1.010	1.008	1.006
1.95	1.020	1.017	1.015	1.013	1.012	1.010	1.008	1.006
2.00	1.020	1.017	1.015	1.013	1.012	1.010	1.008	1.006
2.05	1.020	1.017	1.015	1.013	1.012	1.010	1.008	1.006
2.10	1.020	1.017	1.015	1.013	1.012	1.010	1.008	1.006
2.15	1.021	1.018	1.016	1.014	1.012	1.010	1.008	1.006
2.20	1.021	1.018	1.016	1.014	1.012	1.010	1.008	1.006
2.25	1.021	1.018	1.016	1.014	1.012	1.010	1.008	1.006
2.30	1.021	1.018	1.016	1.014	1.012	1.010	1.008	1.006
2.35	1.022	1.019	1.017	1.015	1.013	1.011	1.009	1.007
2.40	1.022	1.019	1.017	1.015	1.013	1.011	1.009	1.007
2.45	1.022	1.019	1.017	1.015	1.013	1.011	1.009	1.007
2.50	1.022	1.019	1.017	1.015	1.013	1.011	1.009	1.007
2.55	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.60	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.65	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.70	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.75	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.80	1.023	1.020	1.018	1.016	1.013	1.011	1.009	1.007
2.85	1.023	1.020	1.018	1.016	1.013	1.010	1.008	1.007
2.90	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
2.95	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.00	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006

Red. Press. P_r	Reduced Temperature, T_r							
	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
3.05	1.545	1.534	1.523	1.511	1.500	1.488	1.474	1.461
3.10	1.535	1.522	1.512	1.500	1.489	1.478	1.465	1.452
3.15	1.521	1.511	1.501	1.489	1.479	1.469	1.456	1.444
3.20	1.510	1.500	1.490	1.479	1.469	1.459	1.448	1.436
3.25	1.499	1.490	1.480	1.469	1.460	1.450	1.439	1.428
3.30	1.489	1.479	1.470	1.460	1.450	1.441	1.430	1.420
3.35	1.478	1.469	1.460	1.450	1.441	1.432	1.421	1.412
3.40	1.468	1.459	1.450	1.440	1.432	1.423	1.413	1.404
3.45	1.458	1.449	1.441	1.431	1.423	1.414	1.405	1.396
3.50	1.448	1.440	1.431	1.422	1.414	1.406	1.397	1.389
3.55	1.438	1.430	1.422	1.413	1.405	1.397	1.389	1.381
3.60	1.429	1.421	1.413	1.405	1.397	1.389	1.381	1.374
3.65	1.420	1.412	1.405	1.397	1.390	1.382	1.374	1.367
3.70	1.411	1.404	1.396	1.389	1.382	1.375	1.367	1.360
3.75	1.402	1.395	1.388	1.381	1.374	1.368	1.360	1.353
3.80	1.393	1.387	1.380	1.374	1.367	1.360	1.353	1.347
3.85	1.384	1.378	1.372	1.366	1.359	1.353	1.346	1.340
3.90	1.375	1.370	1.363	1.358	1.351	1.346	1.339	1.333
3.95	1.366	1.361	1.355	1.350	1.344	1.339	1.332	1.326
4.00	1.358	1.353	1.347	1.343	1.337	1.332	1.326	1.320
4.05	1.351	1.346	1.340	1.336	1.330	1.325	1.320	1.314
4.10	1.344	1.339	1.333	1.329	1.323	1.319	1.313	1.308
4.15	1.336	1.332	1.326	1.322	1.317	1.312	1.307	1.302
4.20	1.329	1.325	1.319	1.315	1.310	1.305	1.301	1.296
4.25	1.322	1.317	1.312	1.308	1.303	1.299	1.294	1.291
4.30	1.315	1.310	1.305	1.301	1.296	1.292	1.288	1.285
4.35	1.307	1.303	1.298	1.294	1.290	1.285	1.282	1.279
4.40	1.300	1.296	1.291	1.287	1.283	1.279	1.275	1.273
4.45	1.293	1.289	1.284	1.280	1.276	1.272	1.269	1.267
4.50	1.286	1.282	1.278	1.274	1.270	1.266	1.263	1.261
4.55	1.279	1.276	1.272	1.268	1.265	1.261	1.258	1.256
4.60	1.273	1.269	1.266	1.263	1.259	1.256	1.253	1.251
4.65	1.266	1.263	1.260	1.257	1.254	1.251	1.248	1.246
4.70	1.260	1.257	1.254	1.251	1.248	1.246	1.243	1.241
4.75	1.253	1.251	1.248	1.246	1.243	1.240	1.238	1.236
4.80	1.247	1.245	1.242	1.240	1.237	1.235	1.233	1.231
4.85	1.240	1.238	1.236	1.234	1.232	1.230	1.228	1.226
4.90	1.234	1.232	1.230	1.229	1.226	1.225	1.223	1.221
4.95	1.227	1.226	1.224	1.223	1.221	1.220	1.218	1.216
5.00	1.221	1.221	1.219	1.218	1.216	1.215	1.213	1.211
5.05	1.216	1.216	1.214	1.213	1.211	1.210	1.208	1.206
5.10	1.211	1.211	1.209	1.208	1.206	1.206	1.204	1.202
5.15	1.206	1.206	1.204	1.203	1.202	1.201	1.199	1.198
5.20	1.201	1.201	1.199	1.199	1.197	1.197	1.195	1.193
5.25	1.196	1.196	1.195	1.194	1.193	1.192	1.191	1.189
5.30	1.191	1.191	1.190	1.189	1.188	1.187	1.186	1.184
5.35	1.186	1.186	1.165	1.184	1.183	1.183	1.182	1.180
5.40	1.181	1.181	1.180	1.180	1.179	1.178	1.177	1.176
5.45	1.176	1.176	1.175	1.175	1.174	1.174	1.173	1.171
5.50	1.171	1.171	1.171	1.170	1.170	1.169	1.168	1.167

Red. Press. P_r	Reduced Temperature, T_r							
	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
3.05	1.447	1.434	1.421	1.409	1.396	1.384	1.371	1.359
3.10	1.440	1.427	1.415	1.403	1.391	1.379	1.368	1.356
3.15	1.432	1.420	1.408	1.397	1.386	1.374	1.364	1.353
3.20	1.424	1.413	1.402	1.391	1.380	1.369	1.360	1.349
3.25	1.417	1.406	1.396	1.385	1.375	1.364	1.355	1.345
3.30	1.409	1.399	1.389	1.380	1.369	1.359	1.351	1.341
3.35	1.402	1.392	1.383	1.374	1.364	1.354	1.346	1.337
3.40	1.394	1.386	1.377	1.368	1.359	1.350	1.342	1.333
3.45	1.387	1.379	1.371	1.362	1.354	1.345	1.337	1.329
3.50	1.380	1.372	1.364	1.357	1.349	1.341	1.333	1.324
3.55	1.373	1.365	1.358	1.351	1.344	1.336	1.328	1.320
3.60	1.366	1.359	1.352	1.345	1.339	1.331	1.323	1.316
3.65	1.359	1.353	1.346	1.339	1.334	1.326	1.318	1.311
3.70	1.353	1.346	1.340	1.334	1.328	1.321	1.313	1.306
3.75	1.346	1.340	1.334	1.328	1.322	1.315	1.308	1.301
3.80	1.340	1.334	1.328	1.322	1.317	1.310	1.303	1.296
3.85	1.333	1.328	1.322	1.316	1.311	1.304	1.298	1.291
3.90	1.327	1.321	1.316	1.311	1.305	1.299	1.293	1.286
3.95	1.320	1.315	1.310	1.305	1.300	1.294	1.288	1.281
4.00	1.314	1.309	1.304	1.299	1.295	1.289	1.283	1.277
4.05	1.309	1.304	1.299	1.294	1.290	1.284	1.278	1.273
4.10	1.303	1.298	1.294	1.289	1.285	1.280	1.274	1.269
4.15	1.297	1.293	1.289	1.284	1.280	1.275	1.270	1.265
4.20	1.292	1.288	1.284	1.279	1.275	1.270	1.265	1.261
4.25	1.286	1.282	1.278	1.274	1.270	1.266	1.261	1.256
4.30	1.281	1.277	1.273	1.269	1.265	1.261	1.256	1.252
4.35	1.275	1.271	1.268	1.264	1.260	1.257	1.252	1.248
4.40	1.269	1.266	1.263	1.259	1.255	1.252	1.248	1.244
4.45	1.264	1.261	1.258	1.254	1.250	1.247	1.243	1.240
4.50	1.258	1.256	1.253	1.249	1.246	1.243	1.239	1.236
4.55	1.253	1.251	1.248	1.244	1.241	1.239	1.235	1.232
4.60	1.248	1.246	1.243	1.240	1.237	1.234	1.231	1.228
4.65	1.243	1.241	1.238	1.235	1.233	1.230	1.227	1.224
4.70	1.238	1.236	1.233	1.231	1.228	1.226	1.223	1.220
4.75	1.233	1.231	1.229	1.226	1.224	1.221	1.218	1.216
4.80	1.228	1.226	1.224	1.222	1.219	1.217	1.214	1.212
4.85	1.223	1.221	1.219	1.217	1.215	1.213	1.210	1.208
4.90	1.218	1.216	1.214	1.213	1.211	1.208	1.206	1.204
4.95	1.213	1.211	1.209	1.208	1.206	1.204	1.202	1.200
5.00	1.209	1.207	1.205	1.204	1.202	1.200	1.198	1.196
5.05	1.205	1.203	1.201	1.200	1.198	1.196	1.194	1.192
5.10	1.200	1.198	1.197	1.196	1.194	1.192	1.190	1.188
5.15	1.196	1.194	1.192	1.192	1.190	1.188	1.186	1.185
5.20	1.192	1.190	1.188	1.188	1.186	1.184	1.182	1.181
5.25	1.187	1.186	1.184	1.183	1.182	1.180	1.179	1.177
5.30	1.183	1.182	1.180	1.179	1.178	1.176	1.175	1.173
5.35	1.179	1.177	1.176	1.175	1.174	1.172	1.171	1.169
5.40	1.174	1.173	1.172	1.171	1.170	1.168	1.167	1.166
5.45	1.170	1.169	1.168	1.167	1.166	1.164	1.163	1.162
5.50	1.166	1.165	1.163	1.163	1.161	1.161	1.159	1.158

Red. Press. P_r	Reduced Temperature, T_r							
	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28
3.05	1.349	1.339	1.329	1.319	1.308	1.298	1.289	1.279
3.10	1.346	1.336	1.327	1.317	1.307	1.297	1.288	1.278
3.15	1.343	1.333	1.324	1.315	1.305	1.296	1.287	1.277
3.20	1.340	1.330	1.321	1.313	1.303	1.294	1.285	1.276
3.25	1.336	1.327	1.318	1.310	1.301	1.293	1.284	1.275
3.30	1.333	1.324	1.315	1.307	1.299	1.291	1.282	1.274
3.35	1.329	1.321	1.312	1.304	1.297	1.290	1.281	1.273
3.40	1.325	1.317	1.309	1.301	1.294	1.287	1.279	1.271
3.45	1.321	1.313	1.306	1.298	1.291	1.284	1.276	1.269
3.50	1.317	1.310	1.302	1.295	1.288	1.281	1.274	1.266
3.55	1.313	1.306	1.299	1.292	1.285	1.278	1.271	1.264
3.60	1.309	1.302	1.295	1.288	1.281	1.275	1.269	1.262
3.65	1.304	1.298	1.291	1.285	1.278	1.272	1.266	1.259
3.70	1.300	1.294	1.288	1.281	1.275	1.269	1.263	1.257
3.75	1.295	1.290	1.284	1.278	1.272	1.266	1.260	1.255
3.80	1.291	1.285	1.280	1.274	1.268	1.263	1.258	1.252
3.85	1.286	1.281	1.276	1.271	1.265	1.260	1.255	1.250
3.90	1.282	1.277	1.273	1.267	1.262	1.257	1.252	1.248
3.95	1.277	1.273	1.269	1.264	1.259	1.254	1.249	1.245
4.00	1.273	1.269	1.265	1.260	1.255	1.251	1.246	1.242
4.05	1.269	1.265	1.261	1.257	1.252	1.248	1.243	1.239
4.10	1.265	1.261	1.257	1.253	1.249	1.245	1.240	1.236
4.15	1.261	1.257	1.254	1.249	1.245	1.242	1.237	1.233
4.20	1.257	1.253	1.250	1.246	1.242	1.239	1.234	1.230
4.25	1.253	1.250	1.246	1.242	1.239	1.235	1.231	1.227
4.30	1.249	1.246	1.242	1.239	1.236	1.232	1.228	1.224
4.35	1.245	1.242	1.238	1.235	1.232	1.229	1.225	1.221
4.40	1.241	1.238	1.235	1.231	1.229	1.226	1.222	1.218
4.45	1.237	1.234	1.231	1.228	1.226	1.223	1.219	1.215
4.50	1.233	1.230	1.227	1.224	1.222	1.219	1.215	1.211
4.55	1.229	1.226	1.223	1.220	1.218	1.215	1.212	1.208
4.60	1.225	1.222	1.219	1.217	1.215	1.212	1.208	1.205
4.65	1.221	1.219	1.216	1.213	1.211	1.208	1.205	1.201
4.70	1.217	1.215	1.212	1.209	1.207	1.204	1.201	1.198
4.75	1.214	1.211	1.208	1.206	1.204	1.201	1.198	1.195
4.80	1.210	1.207	1.204	1.202	1.200	1.197	1.194	1.192
4.85	1.206	1.203	1.200	1.198	1.196	1.193	1.191	1.188
4.90	1.202	1.200	1.197	1.195	1.193	1.190	1.187	1.185
4.95	1.198	1.196	1.193	1.191	1.189	1.186	1.184	1.182
5.00	1.194	1.192	1.189	1.187	1.185	1.182	1.180	1.178
5.05	1.190	1.189	1.186	1.184	1.182	1.179	1.177	1.175
5.10	1.187	1.185	1.182	1.180	1.178	1.176	1.174	1.172
5.15	1.183	1.181	1.179	1.177	1.175	1.172	1.171	1.169
5.20	1.179	1.178	1.175	1.173	1.171	1.169	1.167	1.166
5.25	1.175	1.174	1.171	1.170	1.168	1.166	1.164	1.162
5.30	1.172	1.170	1.168	1.166	1.165	1.163	1.161	1.159
5.35	1.168	1.167	1.164	1.163	1.161	1.159	1.158	1.156
5.40	1.164	1.163	1.161	1.159	1.158	1.156	1.154	1.153
5.45	1.160	1.159	1.157	1.156	1.154	1.153	1.151	1.150
5.50	1.157	1.156	1.154	1.152	1.151	1.149	1.148	1.146

Red. Press. P_r	Reduced Temperature, T_r							
	1.29	1.30	1.31	1.32	1.33	1.34	1.35	1.36
3.05	1.270	1.261	1.254	1.246	1.239	1.232	1.224	1.217
3.10	1.269	1.260	1.253	1.246	1.239	1.231	1.224	1.217
3.15	1.268	1.259	1.252	1.245	1.238	1.231	1.224	1.217
3.20	1.267	1.259	1.252	1.245	1.238	1.231	1.224	1.217
3.25	1.266	1.258	1.251	1.244	1.237	1.230	1.223	1.217
3.30	1.265	1.257	1.250	1.243	1.237	1.230	1.223	1.216
3.35	1.264	1.256	1.249	1.242	1.236	1.229	1.222	1.216
3.40	1.263	1.255	1.248	1.241	1.235	1.229	1.222	1.216
3.45	1.261	1.254	1.247	1.240	1.234	1.228	1.221	1.215
3.50	1.259	1.252	1.246	1.239	1.233	1.127	1.221	1.215
3.55	1.257	1.251	1.245	1.238	1.232	1.226	1.220	1.214
3.60	1.255	1.249	1.243	1.237	1.231	1.225	1.219	1.213
3.65	1.253	1.247	1.241	1.236	1.230	1.224	1.218	1.211
3.70	1.251	1.245	1.240	1.234	1.228	1.222	1.217	1.210
3.75	1.249	1.243	1.238	1.232	1.226	1.221	1.215	1.208
3.80	1.246	1.242	1.236	1.231	1.225	1.219	1.214	1.207
3.85	1.244	1.240	1.234	1.229	1.223	1.218	1.212	1.205
3.90	1.242	1.238	1.233	1.227	1.221	1.216	1.211	1.204
3.95	1.240	1.236	1.231	1.226	1.220	1.215	1.210	1.202
4.00	1.238	1.234	1.229	1.224	1.218	1.213	1.208	1.201
4.05	1.235	1.231	1.226	1.221	1.216	1.211	1.206	1.199
4.10	1.232	1.228	1.223	1.218	1.213	1.208	1.204	1.197
4.15	1.229	1.225	1.221	1.216	1.211	1.206	1.202	1.196
4.20	1.226	1.222	1.218	1.213	1.209	1.204	1.200	1.194
4.25	1.223	1.219	1.215	1.211	1.206	1.202	1.198	1.192
4.30	1.220	1.216	1.212	1.208	1.204	1.200	1.196	1.191
4.35	1.217	1.213	1.210	1.206	1.202	1.197	1.194	1.189
4.40	1.214	1.210	1.207	1.203	1.199	1.195	1.192	1.187
4.45	1.211	1.207	1.204	1.200	1.197	1.193	1.190	1.185
4.50	1.208	1.204	1.201	1.198	1.195	1.191	1.188	1.183
4.55	1.205	1.201	1.198	1.195	1.192	1.188	1.185	1.180
4.60	1.202	1.198	1.195	1.192	1.189	1.185	1.182	1.178
4.65	1.199	1.195	1.192	1.189	1.186	1.183	1.180	1.175
4.70	1.196	1.192	1.189	1.186	1.183	1.180	1.177	1.173
4.75	1.192	1.189	1.186	1.184	1.181	1.178	1.175	1.170
4.80	1.189	1.186	1.183	1.181	1.178	1.175	1.172	1.168
4.85	1.186	1.183	1.180	1.178	1.175	1.172	1.169	1.165
4.90	1.183	1.180	1.177	1.175	1.172	1.170	1.167	1.163
4.95	1.180	1.177	1.174	1.172	1.169	1.167	1.164	1.160
5.00	1.176	1.174	1.171	1.169	1.167	1.165	1.162	1.158
5.05	1.173	1.171	1.168	1.166	1.164	1.162	1.159	1.155
5.10	1.170	1.168	1.165	1.163	1.161	1.159	1.156	1.152
5.15	1.167	1.165	1.162	1.160	1.158	1.156	1.153	1.150
5.20	1.164	1.162	1.159	1.157	1.155	1.153	1.150	1.147
5.25	1.161	1.159	1.156	1.154	1.152	1.150	1.147	1.144
5.30	1.158	1.156	1.153	1.151	1.149	1.147	1.144	1.141
5.35	1.155	1.153	1.150	1.148	1.146	1.144	1.142	1.139
5.40	1.152	1.150	1.147	1.145	1.143	1.141	1.139	1.136
5.45	1.149	1.147	1.144	1.142	1.140	1.138	1.136	1.133
5.50	1.145	1.144	1.141	1.139	1.138	1.136	1.133	1.130

Red. Press. P_r	Reduced Temperature, T_r							
	1.37	1.38	1.39	1.40	1.41	1.42	1.43	1.44
3.05	1.210	1.202	1.196	1.189	1.183	1.177	1.170	1.164
3.10	1.210	1.203	1.196	1.189	1.183	1.177	1.170	1.165
3.15	1.210	1.203	1.197	1.190	1.184	1.178	1.171	1.166
3.20	1.210	1.204	1.197	1.190	1.184	1.178	1.172	1.166
3.25	1.210	1.204	1.197	1.190	1.184	1.178	1.172	1.166
3.30	1.209	1.203	1.196	1.190	1.184	1.178	1.173	1.167
3.35	1.209	1.203	1.196	1.190	1.184	1.178	1.173	1.167
3.40	1.209	1.203	1.196	1.190	1.184	1.178	1.173	1.167
3.45	1.208	1.202	1.196	1.190	1.184	1.178	1.172	1.167
3.50	1.208	1.202	1.195	1.189	1.183	1.177	1.172	1.166
3.55	1.207	1.201	1.194	1.188	1.182	1.177	1.171	1.166
3.60	1.206	1.200	1.193	1.187	1.181	1.176	1.170	1.165
3.65	1.204	1.198	1.192	1.186	1.180	1.175	1.169	1.164
3.70	1.203	1.197	1.190	1.184	1.179	1.174	1.168	1.163
3.75	1.201	1.195	1.189	1.183	1.178	1.173	1.167	1.162
3.80	1.200	1.194	1.188	1.182	1.176	1.171	1.167	1.162
3.85	1.199	1.193	1.187	1.181	1.175	1.170	1.166	1.161
3.90	1.198	1.192	1.185	1.179	1.174	1.169	1.165	1.160
3.95	1.196	1.190	1.184	1.178	1.173	1.168	1.164	1.159
4.00	1.195	1.189	1.183	1.177	1.172	1.167	1.163	1.158
4.05	1.193	1.187	1.182	1.176	1.171	1.166	1.162	1.157
4.10	1.192	1.186	1.180	1.175	1.170	1.165	1.161	1.156
4.15	1.190	1.184	1.179	1.173	1.168	1.163	1.159	1.154
4.20	1.189	1.183	1.178	1.172	1.167	1.162	1.158	1.153
4.25	1.187	1.181	1.176	1.171	1.166	1.161	1.157	1.152
4.30	1.185	1.180	1.175	1.170	1.165	1.160	1.156	1.151
4.35	1.184	1.178	1.174	1.169	1.164	1.159	1.155	1.150
4.40	1.183	1.177	1.173	1.167	1.162	1.157	1.153	1.148
4.45	1.181	1.175	1.171	1.166	1.161	1.156	1.152	1.147
4.50	1.179	1.174	1.170	1.165	1.160	1.155	1.151	1.146
4.55	1.177	1.172	1.168	1.163	1.158	1.153	1.149	1.144
4.60	1.174	1.169	1.166	1.161	1.156	1.151	1.147	1.142
4.65	1.172	1.167	1.163	1.159	1.154	1.149	1.145	1.141
4.70	1.170	1.165	1.161	1.157	1.152	1.147	1.144	1.139
4.75	1.167	1.162	1.159	1.154	1.150	1.145	1.142	1.137
4.80	1.165	1.160	1.157	1.152	1.148	1.144	1.140	1.136
4.85	1.162	1.158	1.154	1.150	1.146	1.142	1.139	1.134
4.90	1.160	1.156	1.152	1.148	1.144	1.140	1.137	1.132
4.95	1.157	1.153	1.150	1.146	1.142	1.138	1.135	1.130
5.00	1.155	1.151	1.148	1.144	1.140	1.136	1.133	1.129
5.05	1.152	1.148	1.146	1.142	1.138	1.134	1.131	1.127
5.10	1.150	1.146	1.143	1.139	1.136	1.132	1.129	1.125
5.15	1.147	1.143	1.141	1.137	1.133	1.130	1.127	1.123
5.20	1.144	1.141	1.138	1.134	1.131	1.128	1.125	1.121
5.25	1.142	1.138	1.136	1.132	1.129	1.126	1.123	1.119
5.30	1.139	1.136	1.133	1.130	1.127	1.124	1.121	1.117
5.35	1.136	1.133	1.131	1.127	1.125	1.122	1.119	1.115
5.40	1.134	1.131	1.128	1.125	1.122	1.119	1.116	1.113
5.45	1.131	1.128	1.126	1.122	1.120	1.117	1.114	1.111
5.50	1.128	1.125	1.123	1.120	1.118	1.115	1.112	1.108

Red. Press. P_r	Reduced Temperature, T_r							
	1.45	1.46	1.47	1.48	1.49	1.50	1.52	1.54
3.05	1.158	1.153	1.149	1.144	1.140	1.131	1.123	1.115
3.10	1.159	1.154	1.149	1.145	1.140	1.131	1.123	1.115
3.15	1.160	1.155	1.150	1.146	1.141	1.132	1.124	1.116
3.20	1.160	1.155	1.150	1.146	1.141	1.132	1.124	1.116
3.25	1.160	1.155	1.151	1.146	1.142	1.133	1.125	1.117
3.30	1.161	1.156	1.151	1.147	1.142	1.133	1.126	1.118
3.35	1.161	1.156	1.152	1.147	1.143	1.134	1.127	1.119
3.40	1.161	1.156	1.152	1.147	1.143	1.134	1.127	1.119
3.45	1.161	1.156	1.152	1.147	1.143	1.134	1.127	1.119
3.50	1.160	1.156	1.151	1.147	1.142	1.134	1.127	1.120
3.55	1.160	1.156	1.151	1.147	1.142	1.134	1.127	1.120
3.60	1.159	1.155	1.150	1.146	1.141	1.133	1.126	1.120
3.65	1.158	1.154	1.149	1.145	1.140	1.132	1.125	1.119
3.70	1.157	1.153	1.148	1.144	1.139	1.131	1.125	1.119
3.75	1.157	1.152	1.148	1.144	1.139	1.131	1.124	1.118
3.80	1.156	1.152	1.147	1.143	1.138	1.130	1.124	1.118
3.85	1.155	1.151	1.146	1.142	1.137	1.129	1.123	1.117
3.90	1.155	1.150	1.146	1.142	1.137	1.129	1.123	1.117
3.95	1.154	1.149	1.145	1.141	1.136	1.128	1.122	1.116
4.00	1.153	1.148	1.144	1.140	1.135	1.127	1.122	1.116
4.05	1.152	1.147	1.143	1.139	1.134	1.126	1.121	1.115
4.10	1.151	1.146	1.142	1.138	1.133	1.126	1.120	1.114
4.15	1.149	1.145	1.141	1.137	1.133	1.125	1.120	1.114
4.20	1.148	1.144	1.140	1.136	1.132	1.124	1.119	1.113
4.25	1.147	1.143	1.139	1.135	1.131	1.123	1.118	1.112
4.30	1.146	1.142	1.138	1.134	1.130	1.123	1.117	1.111
4.35	1.145	1.141	1.137	1.133	1.129	1.122	1.116	1.110
4.40	1.143	1.139	1.136	1.132	1.129	1.121	1.116	1.110
4.45	1.142	1.138	1.135	1.131	1.128	1.121	1.115	1.109
4.50	1.141	1.137	1.134	1.130	1.127	1.120	1.114	1.108
4.55	1.139	1.135	1.132	1.128	1.125	1.119	1.113	1.107
4.60	1.138	1.134	1.131	1.127	1.124	1.117	1.112	1.106
4.65	1.136	1.132	1.129	1.125	1.122	1.116	1.110	1.105
4.70	1.135	1.131	1.128	1.123	1.121	1.115	1.109	1.104
4.75	1.133	1.129	1.126	1.122	1.119	1.113	1.108	1.103
4.80	1.131	1.128	1.125	1.120	1.118	1.112	1.107	1.102
4.85	1.130	1.126	1.123	1.119	1.117	1.111	1.106	1.101
4.90	1.128	1.125	1.122	1.117	1.115	1.110	1.104	1.100
4.95	1.127	1.123	1.120	1.116	1.113	1.108	1.103	1.099
5.00	1.125	1.122	1.119	1.115	1.112	1.107	1.102	1.098
5.05	1.123	1.120	1.117	1.113	1.110	1.105	1.100	1.096
5.10	1.121	1.118	1.115	1.111	1.108	1.103	1.099	1.095
5.15	1.119	1.116	1.113	1.109	1.106	1.101	1.097	1.093
5.20	1.117	1.114	1.111	1.107	1.104	1.100	1.095	1.091
5.25	1.115	1.112	1.109	1.106	1.102	1.098	1.094	1.090
5.30	1.113	1.110	1.107	1.104	1.100	1.096	1.092	1.088
5.35	1.111	1.109	1.106	1.102	1.099	1.094	1.090	1.086
5.40	1.109	1.107	1.104	1.100	1.097	1.093	1.089	1.085
5.45	1.107	1.105	1.102	1.098	1.095	1.091	1.087	1.083
5.50	1.105	1.103	1.100	1.097	1.093	1.089	1.085	1.081

Red. Press. P_r	Reduced Temperature, T_r							
	1.56	1.58	1.60	1.62	1.64	1.66	1.68	1.70
3.05	1.109	1.104	1.099	1.094	1.089	1.084	1.079	1.074
3.10	1.110	1.105	1.100	1.095	1.090	1.085	1.080	1.075
3.15	1.111	1.106	1.101	1.096	1.091	1.086	1.081	1.076
3.20	1.111	1.106	1.101	1.096	1.091	1.086	1.081	1.076
3.25	1.112	1.107	1.102	1.097	1.092	1.087	1.082	1.077
3.30	1.113	1.108	1.102	1.097	1.092	1.087	1.082	1.077
3.35	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.40	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.45	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.50	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.55	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.60	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.65	1.114	1.109	1.103	1.098	1.093	1.088	1.083	1.078
3.70	1.113	1.108	1.103	1.098	1.093	1.088	1.083	1.078
3.75	1.113	1.108	1.102	1.097	1.092	1.087	1.082	1.078
3.80	1.112	1.107	1.102	1.097	1.092	1.087	1.082	1.077
3.85	1.112	1.107	1.102	1.097	1.092	1.087	1.082	1.077
3.90	1.112	1.107	1.101	1.096	1.091	1.086	1.081	1.077
3.95	1.111	1.106	1.101	1.096	1.091	1.086	1.081	1.077
4.00	1.111	1.106	1.101	1.096	1.091	1.086	1.081	1.077
4.05	1.110	1.105	1.100	1.095	1.090	1.085	1.081	1.077
4.10	1.110	1.105	1.100	1.095	1.090	1.085	1.080	1.076
4.15	1.109	1.104	1.099	1.094	1.089	1.084	1.080	1.076
4.20	1.108	1.104	1.099	1.094	1.089	1.084	1.079	1.075
4.25	1.107	1.103	1.098	1.093	1.088	1.083	1.079	1.075
4.30	1.107	1.102	1.098	1.093	1.088	1.083	1.079	1.075
4.35	1.106	1.102	1.097	1.092	1.087	1.082	1.078	1.074
4.40	1.105	1.101	1.097	1.092	1.087	1.082	1.078	1.074
4.45	1.105	1.101	1.096	1.091	1.086	1.081	1.077	1.073
4.50	1.104	1.100	1.096	1.091	1.086	1.081	1.077	1.073
4.55	1.103	1.099	1.095	1.090	1.085	1.080	1.076	1.072
4.60	1.102	1.098	1.094	1.089	1.084	1.079	1.075	1.071
4.65	1.101	1.096	1.092	1.088	1.083	1.078	1.074	1.070
4.70	1.100	1.095	1.091	1.087	1.082	1.077	1.073	1.069
4.75	1.099	1.094	1.090	1.086	1.081	1.076	1.072	1.068
4.80	1.097	1.093	1.089	1.084	1.079	1.075	1.071	1.067
4.85	1.096	1.092	1.088	1.083	1.078	1.074	1.070	1.066
4.90	1.095	1.090	1.086	1.082	1.077	1.073	1.069	1.065
4.95	1.094	1.089	1.085	1.081	1.076	1.072	1.068	1.064
5.00	1.093	1.088	1.084	1.080	1.075	1.071	1.067	1.063
5.05	1.091	1.086	1.083	1.079	1.074	1.070	1.066	1.062
5.10	1.090	1.085	1.081	1.077	1.073	1.069	1.065	1.061
5.15	1.088	1.083	1.080	1.076	1.072	1.068	1.064	1.060
5.20	1.087	1.082	1.078	1.074	1.070	1.066	1.063	1.059
5.25	1.085	1.080	1.077	1.073	1.069	1.065	1.062	1.058
5.30	1.084	1.079	1.075	1.071	1.068	1.064	1.061	1.057
5.35	1.082	1.077	1.074	1.070	1.067	1.063	1.059	1.055
5.40	1.080	1.076	1.073	1.069	1.065	1.062	1.058	1.054
5.45	1.079	1.074	1.072	1.068	1.064	1.061	1.057	1.053
5.50	1.077	1.073	1.070	1.066	1.063	1.060	1.056	1.052

Red. Press. P_r	Reduced Temperature, T_r							
	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86
3.05	1.070	1.066	1.062	1.058	1.055	1.052	1.049	1.047
3.10	1.071	1.066	1.062	1.058	1.055	1.052	1.050	1.048
3.15	1.072	1.067	1.063	1.059	1.056	1.053	1.050	1.048
3.20	1.072	1.067	1.063	1.059	1.056	1.053	1.050	1.048
3.25	1.072	1.068	1.064	1.060	1.056	1.053	1.050	1.048
3.30	1.073	1.068	1.064	1.060	1.057	1.054	1.051	1.048
3.35	1.073	1.069	1.065	1.060	1.057	1.054	1.051	1.048
3.40	1.073	1.069	1.065	1.060	1.057	1.054	1.051	1.048
3.45	1.073	1.069	1.065	1.060	1.057	1.054	1.051	1.048
3.50	1.074	1.069	1.065	1.061	1.057	1.054	1.051	1.048
3.55	1.074	1.069	1.065	1.061	1.057	1.054	1.051	1.048
3.60	1.074	1.069	1.065	1.061	1.057	1.054	1.051	1.048
3.65	1.074	1.069	1.065	1.061	1.057	1.054	1.051	1.048
3.70	1.074	1.069	1.065	1.061	1.057	1.054	1.051	1.048
3.75	1.073	1.069	1.065	1.060	1.057	1.054	1.051	1.048
3.80	1.073	1.068	1.064	1.060	1.057	1.054	1.051	1.048
3.85	1.073	1.068	1.064	1.060	1.057	1.054	1.051	1.048
3.90	1.072	1.068	1.064	1.059	1.057	1.054	1.051	1.048
3.95	1.072	1.068	1.064	1.059	1.057	1.054	1.051	1.048
4.00	1.072	1.068	1.064	1.059	1.057	1.054	1.051	1.048
4.05	1.072	1.068	1.064	1.059	1.056	1.053	1.050	1.048
4.10	1.071	1.067	1.063	1.058	1.056	1.053	1.050	1.047
4.15	1.071	1.067	1.063	1.058	1.055	1.052	1.049	1.047
4.20	1.070	1.066	1.062	1.057	1.055	1.052	1.049	1.045
4.25	1.070	1.066	1.062	1.057	1.054	1.051	1.049	1.046
4.30	1.070	1.066	1.062	1.057	1.054	1.051	1.048	1.046
4.35	1.069	1.065	1.061	1.056	1.053	1.050	1.048	1.046
4.40	1.069	1.065	1.061	1.055	1.053	1.050	1.047	1.045
4.45	1.068	1.064	1.060	1.055	1.052	1.049	1.047	1.045
4.50	1.068	1.064	1.060	1.054	1.052	1.049	1.047	1.045
4.55	1.067	1.063	1.059	1.054	1.051	1.048	1.046	1.044
4.60	1.066	1.062	1.058	1.053	1.051	1.048	1.046	1.044
4.65	1.065	1.061	1.057	1.053	1.050	1.047	1.045	1.043
4.70	1.064	1.060	1.056	1.052	1.049	1.046	1.044	1.042
4.75	1.063	1.059	1.055	1.051	1.048	1.045	1.043	1.041
4.80	1.063	1.059	1.055	1.050	1.048	1.045	1.043	1.041
4.85	1.062	1.058	1.054	1.050	1.047	1.044	1.042	1.040
4.90	1.061	1.057	1.053	1.049	1.046	1.043	1.041	1.039
4.95	1.060	1.056	1.052	1.048	1.046	1.043	1.041	1.039
5.00	1.059	1.055	1.051	1.047	1.045	1.042	1.040	1.038
5.05	1.058	1.054	1.050	1.046	1.044	1.041	1.039	1.037
5.10	1.057	1.053	1.049	1.045	1.043	1.040	1.038	1.036
5.15	1.056	1.052	1.048	1.044	1.042	1.039	1.037	1.035
5.20	1.055	1.051	1.047	1.043	1.041	1.038	1.036	1.034
5.25	1.054	1.050	1.046	1.042	1.040	1.037	1.035	1.033
5.30	1.053	1.049	1.045	1.041	1.039	1.036	1.034	1.032
5.35	1.052	1.048	1.044	1.040	1.038	1.035	1.033	1.031
5.40	1.051	1.047	1.043	1.039	1.037	1.034	1.032	1.030
5.45	1.050	1.046	1.042	1.038	1.036	1.033	1.031	1.029
5.50	1.048	1.044	1.041	1.038	1.035	1.033	1.030	1.028

Red. Press. P_r	Reduced Temperature, T_r							
	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.05
3.05	1.044	1.042	1.040	1.038	1.036	1.034	1.031	1.028
3.10	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.028
3.15	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.028
3.20	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.028
3.25	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.028
3.30	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.35	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.40	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.45	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.50	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.55	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.60	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.65	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.70	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.75	1.045	1.043	1.041	1.038	1.036	1.034	1.031	1.027
3.80	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
3.85	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
3.90	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
3.95	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
4.00	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
4.05	1.045	1.043	1.040	1.038	1.036	1.033	1.030	1.026
4.10	1.044	1.042	1.039	1.037	1.035	1.032	1.029	1.025
4.15	1.044	1.042	1.039	1.037	1.035	1.032	1.029	1.025
4.20	1.043	1.041	1.038	1.036	1.034	1.031	1.028	1.024
4.25	1.043	1.041	1.038	1.036	1.034	1.031	1.028	1.024
4.30	1.043	1.041	1.038	1.036	1.034	1.031	1.028	1.024
4.35	1.043	1.041	1.038	1.036	1.034	1.031	1.028	1.023
4.40	1.042	1.040	1.037	1.035	1.033	1.030	1.027	1.023
4.45	1.042	1.040	1.037	1.035	1.033	1.030	1.027	1.022
4.50	1.042	1.040	1.037	1.035	1.033	1.030	1.027	1.022
4.55	1.041	1.039	1.036	1.034	1.032	1.029	1.026	1.021
4.60	1.041	1.039	1.036	1.034	1.032	1.029	1.026	1.021
4.65	1.040	1.038	1.035	1.033	1.031	1.028	1.025	1.020
4.70	1.039	1.037	1.034	1.032	1.030	1.027	1.024	1.020
4.75	1.038	1.036	1.033	1.031	1.029	1.026	1.023	1.019
4.80	1.038	1.036	1.033	1.031	1.029	1.026	1.023	1.018
4.85	1.037	1.035	1.032	1.030	1.028	1.025	1.022	1.018
4.90	1.036	1.034	1.031	1.029	1.027	1.024	1.021	1.017
4.95	1.036	1.034	1.031	1.029	1.027	1.024	1.021	1.017
5.00	1.035	1.033	1.030	1.028	1.026	1.023	1.020	1.016
5.05	1.034	1.032	1.029	1.027	1.025	1.022	1.019	1.015
5.10	1.033	1.031	1.028	1.026	1.024	1.021	1.018	1.014
5.15	1.032	1.030	1.027	1.025	1.023	1.020	1.017	1.014
5.20	1.031	1.029	1.026	1.024	1.020	1.019	1.017	1.013
5.25	1.030	1.028	1.026	1.024	1.022	1.019	1.016	1.012
5.30	1.029	1.027	1.025	1.023	1.021	1.018	1.015	1.011
5.35	1.029	1.027	1.024	1.022	1.020	1.017	1.014	1.011
5.40	1.028	1.026	1.023	1.021	1.019	1.017	1.014	1.010
5.45	1.027	1.025	1.022	1.020	1.018	1.016	1.013	1.009
5.50	1.026	1.024	1.022	1.020	1.018	1.015	1.012	1.009

Red. Press. P_r	Reduced Temperature, T_r							
	2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45
3.05	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.10	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.15	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.20	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.25	1.024	1.021	1.018	1.015	1.013	1.010	1.008	1.006
3.30	1.024	1.020	1.017	1.014	1.012	1.009	1.008	1.006
3.35	1.024	1.020	1.017	1.014	1.012	1.009	1.008	1.006
3.40	1.024	1.020	1.017	1.014	1.012	1.009	1.008	1.006
3.45	1.024	1.020	1.017	1.014	1.012	1.009	1.007	1.005
3.50	1.024	1.020	1.017	1.014	1.011	1.008	1.007	1.005
3.55	1.024	1.020	1.017	1.014	1.011	1.008	1.006	1.004
3.60	1.024	1.020	1.017	1.014	1.011	1.008	1.006	1.004
3.65	1.024	1.020	1.017	1.014	1.011	1.008	1.006	1.004
3.70	1.023	1.019	1.016	1.013	1.010	1.007	1.005	1.003
3.75	1.023	1.019	1.016	1.013	1.010	1.007	1.005	1.003
3.80	1.023	1.019	1.016	1.013	1.010	1.007	1.005	1.003
3.85	1.023	1.019	1.016	1.013	1.010	1.007	1.005	1.003
3.90	1.022	1.018	1.015	1.012	1.009	1.006	1.004	1.002
3.95	1.022	1.018	1.015	1.012	1.009	1.006	1.004	1.002
4.00	1.022	1.018	1.015	1.012	1.009	1.006	1.004	1.002
4.05	1.022	1.017	1.014	1.011	1.008	1.005	1.003	1.001
4.10	1.021	1.017	1.014	1.011	1.008	1.005	1.003	1.001
4.15	1.021	1.016	1.013	1.010	1.007	1.004	1.002	1.000
4.20	1.020	1.016	1.013	1.010	1.007	1.004	1.002	1.000
4.25	1.020	1.015	1.012	1.009	1.006	1.003	1.001	.999
4.30	1.020	1.015	1.012	1.009	1.006	1.003	1.001	.999
4.35	1.019	1.014	1.011	1.008	1.005	1.002	1.000	.998
4.40	1.019	1.014	1.011	1.008	1.005	1.002	1.000	.998
4.45	1.018	1.013	1.010	1.007	1.004	1.001	.999	.997
4.50	1.018	1.013	1.010	1.007	1.004	1.001	.999	.997
4.55	1.017	1.012	1.009	1.006	1.003	1.000	.998	.996
4.60	1.017	1.012	1.009	1.006	1.003	1.000	.998	.996
4.65	1.016	1.011	1.008	1.005	1.002	.999	.997	.995
4.70	1.016	1.011	1.008	1.005	1.002	.999	.997	.995
4.75	1.015	1.010	1.007	1.004	1.001	.998	.996	.994
4.80	1.014	1.010	1.006	1.003	1.000	.997	.995	.993
4.85	1.014	1.009	1.006	1.003	1.000	.997	.995	.993
4.90	1.013	1.009	1.005	1.002	.999	.996	.994	.992
4.95	1.013	1.008	1.005	1.002	.999	.996	.994	.992
5.00	1.012	1.008	1.004	1.001	.998	.995	.993	.991
5.05	1.011	1.007	1.003	1.000	.997	.994	.992	.990
5.10	1.011	1.007	1.003	1.000	.997	.994	.992	.990
5.15	1.010	1.006	1.002	.999	.996	.993	.991	.989
5.20	1.009	1.006	1.002	.999	.996	.993	.991	.989
5.25	1.008	1.005	1.001	.998	.995	.992	.990	.988
5.30	1.008	1.004	1.001	.998	.995	.992	.990	.988
5.35	1.007	1.004	1.000	.997	.994	.991	.989	.987
5.40	1.006	1.003	.999	.996	.993	.990	.988	.987
5.45	1.005	1.003	.999	.996	.993	.990	.988	.986
5.50	1.005	1.002	.998	.995	.992	.989	.987	.985

Red. Press. P_r	Reduced Temperature, T_r							
	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
5.55	1.166	1.166	1.166	1.165	1.165	1.165	1.164	1.162
5.60	1.161	1.161	1.161	1.161	1.160	1.160	1.159	1.158
5.65	1.156	1.156	1.156	1.156	1.156	1.156	1.155	1.154
5.70	1.151	1.151	1.151	1.151	1.151	1.151	1.150	1.149
5.75	1.146	1.146	1.147	1.146	1.146	1.146	1.146	1.145
5.80	1.141	1.141	1.142	1.142	1.142	1.142	1.142	1.140
5.85	1.136	1.136	1.137	1.137	1.137	1.137	1.137	1.136
5.90	1.131	1.131	1.132	1.132	1.133	1.133	1.133	1.132
5.95	1.126	1.126	1.127	1.127	1.128	1.128	1.128	1.127
6.00	1.122	1.122	1.123	1.123	1.124	1.124	1.124	1.123
6.05	1.118	1.118	1.119	1.119	1.120	1.121	1.121	1.120
6.10	1.115	1.115	1.116	1.116	1.117	1.117	1.117	1.116
6.15	1.111	1.111	1.112	1.112	1.113	1.113	1.113	1.113
6.20	1.107	1.107	1.108	1.108	1.109	1.110	1.110	1.109
6.25	1.103	1.104	1.105	1.105	1.106	1.106	1.106	1.106
6.30	1.100	1.100	1.101	1.101	1.102	1.102	1.103	1.102
6.35	1.096	1.096	1.097	1.097	1.098	1.099	1.099	1.099
6.40	1.092	1.093	1.094	1.094	1.095	1.095	1.095	1.095
6.45	1.088	1.089	1.090	1.090	1.091	1.091	1.092	1.092
6.50	1.085	1.085	1.086	1.086	1.087	1.088	1.088	1.088
6.55	1.081	1.081	1.082	1.082	1.083	1.084	1.084	1.084
6.60	1.077	1.078	1.079	1.079	1.080	1.080	1.081	1.081
6.65	1.073	1.074	1.075	1.075	1.076	1.077	1.077	1.077
6.70	1.070	1.070	1.071	1.071	1.072	1.073	1.074	1.074
6.75	1.066	1.067	1.068	1.068	1.069	1.069	1.070	1.070
6.80	1.062	1.063	1.064	1.064	1.065	1.066	1.067	1.067
6.85	1.058	1.059	1.060	1.060	1.061	1.062	1.063	1.063
6.90	1.055	1.055	1.057	1.057	1.057	1.058	1.059	1.059
6.95	1.051	1.052	1.053	1.053	1.054	1.055	1.056	1.056
7.00	1.047	1.048	1.049	1.049	1.051	1.052	1.053	1.053
7.05	1.044	1.045	1.046	1.046	1.048	1.049	1.050	1.050
7.10	1.041	1.042	1.043	1.043	1.045	1.046	1.047	1.047
7.15	1.038	1.039	1.040	1.040	1.042	1.043	1.044	1.044
7.20	1.035	1.036	1.037	1.037	1.039	1.040	1.041	1.041
7.25	1.032	1.033	1.034	1.034	1.036	1.037	1.038	1.038
7.30	1.029	1.030	1.031	1.031	1.033	1.034	1.035	1.035
7.35	1.026	1.027	1.028	1.028	1.030	1.031	1.032	1.032
7.40	1.023	1.024	1.025	1.025	1.027	1.028	1.029	1.029
7.45	1.020	1.021	1.022	1.022	1.024	1.025	1.026	1.026
7.50	1.016	1.017	1.019	1.019	1.021	1.022	1.023	1.024
7.55	1.013	1.014	1.016	1.016	1.018	1.019	1.020	1.021
7.60	1.010	1.011	1.013	1.013	1.015	1.016	1.017	1.018
7.65	1.007	1.008	1.010	1.010	1.012	1.013	1.014	1.015
7.70	1.004	1.005	1.007	1.007	1.009	1.010	1.011	1.012
7.75	1.001	1.002	1.004	1.004	1.006	1.007	1.008	1.009
7.80	.998	.999	1.001	1.001	1.003	1.004	1.005	1.006
7.85	.995	.996	.998	.998	1.000	1.001	1.002	1.003
7.90	.992	.993	.995	.995	.997	.998	.999	1.000
7.95	.989	.990	.991	.992	.994	.995	.996	.997
8.00	.986	.987	.988	.989	.991	.992	.993	.994

Red. Press. P_r	Reduced Temperature, T_r							
	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
5.55	1.162	1.161	1.159	1.159	1.157	1.157	1.155	1.154
5.60	1.157	1.156	1.155	1.155	1.153	1.153	1.151	1.150
5.65	1.153	1.152	1.151	1.151	1.149	1.149	1.147	1.147
5.70	1.149	1.148	1.147	1.147	1.145	1.145	1.143	1.143
5.75	1.144	1.144	1.143	1.142	1.141	1.141	1.139	1.139
5.80	1.140	1.140	1.138	1.138	1.137	1.137	1.136	1.135
5.85	1.136	1.135	1.134	1.134	1.133	1.133	1.132	1.131
5.90	1.131	1.131	1.130	1.130	1.129	1.129	1.128	1.128
5.95	1.127	1.127	1.126	1.126	1.125	1.125	1.124	1.124
6.00	1.123	1.123	1.122	1.122	1.121	1.121	1.120	1.120
6.05	1.120	1.120	1.119	1.119	1.118	1.118	1.117	1.117
6.10	1.116	1.116	1.115	1.115	1.115	1.115	1.114	1.114
6.15	1.113	1.113	1.112	1.112	1.111	1.111	1.111	1.111
6.20	1.109	1.109	1.109	1.109	1.108	1.108	1.108	1.108
6.25	1.106	1.106	1.105	1.105	1.105	1.105	1.104	1.104
6.30	1.102	1.102	1.102	1.102	1.102	1.102	1.101	1.101
6.35	1.099	1.099	1.098	1.098	1.098	1.098	1.098	1.098
6.40	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095
6.45	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092
6.50	1.088	1.088	1.088	1.088	1.088	1.088	1.088	1.088
6.55	1.085	1.085	1.085	1.085	1.085	1.085	1.085	1.085
6.60	1.081	1.081	1.081	1.081	1.082	1.082	1.082	1.082
6.65	1.078	1.078	1.078	1.078	1.078	1.078	1.079	1.079
6.70	1.074	1.074	1.075	1.075	1.075	1.075	1.076	1.076
6.75	1.071	1.071	1.071	1.071	1.072	1.072	1.072	1.072
6.80	1.067	1.067	1.068	1.068	1.068	1.068	1.069	1.069
6.85	1.064	1.064	1.064	1.064	1.065	1.065	1.066	1.066
6.90	1.060	1.060	1.061	1.061	1.062	1.062	1.063	1.063
6.95	1.057	1.057	1.058	1.058	1.059	1.059	1.060	1.060
7.00	1.054	1.054	1.055	1.055	1.056	1.056	1.057	1.057
7.05	1.051	1.051	1.052	1.052	1.053	1.053	1.054	1.054
7.10	1.048	1.048	1.049	1.049	1.050	1.050	1.051	1.051
7.15	1.045	1.045	1.046	1.046	1.047	1.047	1.048	1.048
7.20	1.042	1.042	1.043	1.043	1.044	1.044	1.045	1.046
7.25	1.039	1.039	1.040	1.040	1.041	1.041	1.042	1.043
7.30	1.036	1.036	1.037	1.037	1.038	1.038	1.039	1.040
7.35	1.033	1.034	1.035	1.035	1.036	1.036	1.037	1.037
7.40	1.030	1.031	1.032	1.032	1.033	1.033	1.034	1.035
7.45	1.027	1.028	1.029	1.029	1.030	1.030	1.031	1.032
7.50	1.025	1.025	1.026	1.026	1.027	1.028	1.029	1.029
7.55	1.022	1.022	1.023	1.023	1.024	1.025	1.026	1.026
7.60	1.019	1.019	1.020	1.020	1.021	1.022	1.023	1.024
7.65	1.016	1.016	1.017	1.017	1.018	1.019	1.020	1.021
7.70	1.013	1.014	1.015	1.015	1.016	1.017	1.018	1.018
7.75	1.010	1.011	1.012	1.012	1.013	1.014	1.015	1.015
7.80	1.007	1.008	1.009	1.009	1.010	1.011	1.012	1.013
7.85	1.004	1.005	1.006	1.006	1.007	1.008	1.009	1.010
7.90	1.001	1.002	1.003	1.003	1.004	1.005	1.006	1.007
7.95	.998	.999	1.000	1.000	1.001	1.002	1.003	1.004
8.00	.996	.997	.998	.998	.999	1.000	1.001	1.002

Red. Press. P_r	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.28
	Reduced Temperature, T_r							
5.55	1.153	1.152	1.150	1.149	1.147	1.146	1.145	1.143
5.60	1.149	1.148	1.147	1.145	1.144	1.143	1.141	1.140
5.65	1.145	1.145	1.143	1.142	1.140	1.139	1.138	1.137
5.70	1.142	1.141	1.139	1.138	1.137	1.136	1.135	1.134
5.75	1.138	1.137	1.136	1.135	1.134	1.133	1.132	1.130
5.80	1.134	1.134	1.132	1.131	1.130	1.130	1.128	1.127
5.85	1.130	1.130	1.129	1.128	1.127	1.126	1.125	1.124
5.90	1.127	1.126	1.125	1.124	1.123	1.123	1.122	1.121
5.95	1.123	1.123	1.122	1.121	1.120	1.120	1.119	1.118
6.00	1.119	1.119	1.118	1.117	1.116	1.116	1.116	1.116
6.05	1.116	1.116	1.115	1.114	1.113	1.113	1.113	1.112
6.10	1.113	1.113	1.112	1.111	1.110	1.110	1.110	1.109
6.15	1.110	1.110	1.109	1.108	1.107	1.107	1.107	1.106
6.20	1.107	1.107	1.106	1.105	1.104	1.104	1.104	1.103
6.25	1.104	1.104	1.103	1.102	1.101	1.101	1.101	1.100
6.30	1.101	1.101	1.100	1.099	1.098	1.098	1.098	1.097
6.35	1.097	1.097	1.097	1.096	1.095	1.095	1.095	1.094
6.40	1.094	1.094	1.094	1.093	1.092	1.092	1.092	1.091
6.45	1.091	1.091	1.091	1.090	1.089	1.089	1.089	1.088
6.50	1.088	1.088	1.087	1.087	1.086	1.086	1.086	1.086
6.55	1.085	1.085	1.084	1.084	1.083	1.083	1.083	1.083
6.60	1.082	1.082	1.081	1.081	1.080	1.080	1.080	1.080
6.65	1.078	1.078	1.078	1.078	1.077	1.077	1.077	1.077
6.70	1.075	1.075	1.075	1.075	1.074	1.074	1.074	1.074
6.75	1.072	1.072	1.072	1.072	1.071	1.071	1.071	1.071
6.80	1.069	1.069	1.069	1.069	1.068	1.068	1.068	1.068
6.85	1.066	1.066	1.066	1.066	1.065	1.065	1.065	1.065
6.90	1.063	1.063	1.063	1.063	1.063	1.062	1.062	1.062
6.95	1.060	1.060	1.060	1.060	1.059	1.059	1.059	1.059
7.00	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057
7.05	1.054	1.054	1.054	1.054	1.054	1.054	1.054	1.054
7.10	1.051	1.051	1.051	1.051	1.051	1.052	1.052	1.052
7.15	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049
7.20	1.046	1.046	1.046	1.046	1.046	1.047	1.047	1.047
7.25	1.043	1.043	1.043	1.043	1.044	1.044	1.044	1.044
7.30	1.040	1.040	1.041	1.041	1.041	1.041	1.041	1.042
7.35	1.038	1.038	1.038	1.038	1.038	1.039	1.039	1.039
7.40	1.035	1.035	1.035	1.035	1.036	1.036	1.036	1.037
7.45	1.032	1.032	1.033	1.033	1.033	1.034	1.034	1.034
7.50	1.030	1.030	1.030	1.030	1.031	1.031	1.031	1.032
7.55	1.027	1.027	1.028	1.028	1.028	1.029	1.029	1.029
7.60	1.024	1.024	1.025	1.025	1.025	1.026	1.026	1.027
7.65	1.022	1.022	1.022	1.022	1.023	1.024	1.024	1.024
7.70	1.019	1.019	1.020	1.020	1.020	1.021	1.021	1.022
7.75	1.016	1.016	1.017	1.017	1.018	1.018	1.018	1.019
7.80	1.013	1.013	1.014	1.014	1.015	1.016	1.016	1.017
7.85	1.011	1.011	1.012	1.012	1.012	1.013	1.013	1.014
7.90	1.008	1.008	1.009	1.009	1.010	1.011	1.011	1.012
7.95	1.005	1.005	1.006	1.006	1.007	1.008	1.008	1.009
8.00	1.003	1.003	1.004	1.004	1.005	1.006	1.006	1.007

Red. Press. P_r	Reduced Temperature, T_r							
	1.29	1.30	1.131	1.32	1.33	1.34	1.35	1.36
5.55	1.142	1.41	1.138	1.136	1.135	1.133	1.130	1.128
5.60	1.139	1.138	1.135	1.133	1.132	1.130	1.127	1.125
5.65	1.136	1.135	1.132	1.130	1.129	1.127	1.125	1.122
5.70	1.133	1.132	1.129	1.127	1.126	1.124	1.122	1.119
5.75	1.130	1.129	1.126	1.124	1.123	1.121	1.119	1.116
5.80	1.127	1.126	1.123	1.121	1.120	1.118	1.116	1.114
5.85	1.124	1.123	1.120	1.118	1.117	1.115	1.113	1.111
5.90	1.121	1.120	1.117	1.115	1.114	1.112	1.110	1.108
5.95	1.118	1.117	1.114	1.112	1.111	1.109	1.107	1.105
6.00	1.115	1.114	1.112	1.110	1.109	1.107	1.105	1.103
6.05	1.112	1.111	1.109	1.107	1.106	1.104	1.102	1.100
6.10	1.109	1.108	1.106	1.104	1.103	1.101	1.099	1.098
6.15	1.106	1.105	1.103	1.101	1.101	1.099	1.097	1.095
6.20	1.103	1.102	1.101	1.099	1.098	1.096	1.094	1.093
6.25	1.100	1.099	1.098	1.096	1.095	1.093	1.092	1.090
6.30	1.097	1.096	1.095	1.093	1.092	1.091	1.089	1.088
6.35	1.094	1.094	1.092	1.090	1.090	1.088	1.086	1.085
6.40	1.091	1.091	1.089	1.088	1.087	1.085	1.084	1.083
6.45	1.088	1.088	1.086	1.085	1.084	1.083	1.081	1.080
6.50	1.086	1.085	1.084	1.082	1.082	1.080	1.079	1.077
6.55	1.083	1.082	1.081	1.079	1.079	1.078	1.076	1.075
6.60	1.080	1.079	1.078	1.077	1.076	1.075	1.073	1.072
6.65	1.077	1.077	1.075	1.074	1.074	1.072	1.071	1.070
6.70	1.074	1.074	1.072	1.071	1.071	1.070	1.068	1.067
6.75	1.071	1.071	1.070	1.068	1.068	1.067	1.066	1.065
6.80	1.068	1.068	1.067	1.066	1.065	1.064	1.063	1.062
6.85	1.065	1.065	1.064	1.063	1.063	1.062	1.060	1.060
6.90	1.062	1.062	1.061	1.060	1.060	1.059	1.058	1.057
6.95	1.059	1.059	1.058	1.057	1.057	1.056	1.055	1.055
7.00	1.057	1.057	1.056	1.055	1.055	1.054	1.053	1.052
7.05	1.054	1.054	1.053	1.052	1.052	1.052	1.051	1.050
7.10	1.052	1.052	1.051	1.050	1.050	1.049	1.048	1.048
7.15	1.049	1.049	1.049	1.048	1.048	1.047	1.046	1.045
7.20	1.047	1.047	1.046	1.045	1.045	1.045	1.044	1.043
7.25	1.044	1.045	1.044	1.043	1.043	1.042	1.041	1.041
7.30	1.042	1.042	1.041	1.041	1.041	1.040	1.039	1.038
7.35	1.039	1.040	1.039	1.038	1.038	1.038	1.037	1.036
7.40	1.037	1.037	1.037	1.036	1.036	1.035	1.034	1.034
7.45	1.034	1.035	1.034	1.034	1.034	1.033	1.032	1.032
7.50	1.032	1.032	1.032	1.031	1.031	1.031	1.030	1.029
7.55	1.029	1.030	1.029	1.029	1.029	1.029	1.028	1.027
7.60	1.027	1.027	1.027	1.027	1.027	1.026	1.025	1.025
7.65	1.024	1.025	1.025	1.024	1.024	1.024	1.023	1.023
7.70	1.022	1.022	1.022	1.022	1.022	1.022	1.021	1.020
7.75	1.019	1.020	1.020	1.020	1.020	1.019	1.018	1.018
7.80	1.017	1.018	1.017	1.017	1.017	1.017	1.016	1.016
7.85	1.014	1.015	1.015	1.015	1.015	1.015	1.014	1.013
7.90	1.012	1.013	1.013	1.013	1.013	1.012	1.011	1.011
7.95	1.009	1.010	1.010	1.010	1.010	1.010	1.009	1.009
8.00	1.007	1.008	1.008	1.008	1.008	1.008	1.007	1.007

Red. Press. P_r	Reduced Temperature, T_r							
	1.37	1.38	1.39	1.40	1.41	1.42	1.43	1.44
5.55	1.126	1.122	1.121	1.118	1.116	1.113	1.110	1.106
5.60	1.123	1.120	1.118	1.115	1.114	1.111	1.108	1.104
5.65	1.121	1.117	1.116	1.113	1.111	1.108	1.105	1.102
5.70	1.118	1.115	1.113	1.111	1.109	1.106	1.103	1.100
5.75	1.115	1.113	1.111	1.108	1.107	1.105	1.102	1.098
5.80	1.113	1.110	1.108	1.106	1.105	1.103	1.100	1.096
5.85	1.110	1.108	1.106	1.104	1.103	1.101	1.098	1.094
5.90	1.107	1.105	1.103	1.102	1.101	1.099	1.096	1.092
5.95	1.105	1.103	1.101	1.099	1.098	1.096	1.093	1.090
6.00	1.102	1.100	1.099	1.097	1.096	1.093	1.090	1.088
6.05	1.099	1.097	1.096	1.094	1.093	1.091	1.088	1.086
6.10	1.097	1.095	1.094	1.092	1.091	1.088	1.086	1.084
6.15	1.094	1.092	1.091	1.089	1.088	1.086	1.084	1.082
6.20	1.092	1.090	1.089	1.087	1.086	1.084	1.081	1.080
6.25	1.089	1.087	1.086	1.084	1.083	1.082	1.079	1.077
6.30	1.087	1.085	1.084	1.082	1.081	1.079	1.077	1.075
6.35	1.084	1.082	1.081	1.080	1.079	1.077	1.075	1.073
6.40	1.082	1.080	1.079	1.077	1.076	1.075	1.072	1.071
6.45	1.079	1.077	1.076	1.075	1.074	1.073	1.070	1.069
6.50	1.076	1.075	1.074	1.072	1.071	1.070	1.068	1.066
6.55	1.074	1.073	1.072	1.069	1.068	1.067	1.066	1.064
6.60	1.071	1.070	1.069	1.067	1.066	1.065	1.063	1.062
6.65	1.069	1.068	1.067	1.065	1.064	1.063	1.061	1.060
6.70	1.066	1.065	1.064	1.063	1.062	1.060	1.059	1.058
6.75	1.064	1.063	1.062	1.061	1.060	1.058	1.057	1.055
6.80	1.061	1.060	1.059	1.058	1.057	1.055	1.054	1.053
6.85	1.059	1.058	1.057	1.056	1.055	1.053	1.052	1.051
6.90	1.056	1.055	1.054	1.053	1.052	1.051	1.050	1.049
6.95	1.054	1.053	1.052	1.051	1.050	1.049	1.048	1.047
7.00	1.051	1.051	1.050	1.049	1.048	1.047	1.046	1.045
7.05	1.049	1.049	1.048	1.047	1.046	1.045	1.044	1.043
7.10	1.047	1.047	1.046	1.045	1.044	1.043	1.042	1.041
7.15	1.044	1.044	1.044	1.043	1.042	1.041	1.040	1.039
7.20	1.042	1.042	1.042	1.041	1.040	1.039	1.038	1.037
7.25	1.040	1.040	1.039	1.039	1.038	1.037	1.036	1.035
7.30	1.037	1.037	1.037	1.037	1.036	1.035	1.034	1.033
7.35	1.035	1.035	1.035	1.035	1.034	1.033	1.032	1.031
7.40	1.033	1.033	1.033	1.033	1.032	1.031	1.030	1.029
7.45	1.031	1.031	1.031	1.031	1.030	1.029	1.028	1.027
7.50	1.028	1.028	1.028	1.028	1.028	1.026	1.026	1.025
7.55	1.026	1.026	1.026	1.026	1.026	1.024	1.024	1.023
7.60	1.024	1.024	1.024	1.024	1.024	1.022	1.022	1.021
7.65	1.022	1.022	1.022	1.022	1.022	1.020	1.020	1.019
7.70	1.019	1.019	1.019	1.019	1.019	1.018	1.018	1.017
7.75	1.017	1.017	1.017	1.017	1.017	1.016	1.016	1.015
7.80	1.015	1.015	1.015	1.015	1.015	1.014	1.014	1.013
7.85	1.013	1.013	1.013	1.013	1.013	1.012	1.012	1.011
7.90	1.011	1.011	1.011	1.011	1.011	1.010	1.010	1.009
7.95	1.009	1.009	1.009	1.009	1.009	1.008	1.008	1.007
8.00	1.007	1.007	1.007	1.007	1.007	1.006	1.006	1.005

Red. Press. P_r	Reduced Temperature, T_r							
	1.45	1.46	1.47	1.48	1.49	1.50	1.52	1.54
5.55	1.104	1.101	1.098	1.095	1.091	1.087	1.084	1.080
5.60	1.102	1.099	1.096	1.093	1.089	1.086	1.082	1.078
5.65	1.100	1.098	1.095	1.091	1.088	1.084	1.080	1.076
5.70	1.098	1.096	1.093	1.089	1.086	1.082	1.079	1.075
5.75	1.096	1.094	1.091	1.088	1.084	1.080	1.077	1.073
5.80	1.094	1.092	1.089	1.086	1.082	1.079	1.075	1.071
5.85	1.092	1.090	1.087	1.084	1.080	1.077	1.074	1.080
5.90	1.090	1.088	1.085	1.082	1.078	1.075	1.072	1.068
5.95	1.088	1.086	1.083	1.080	1.076	1.073	1.070	1.066
6.00	1.086	1.084	1.081	1.079	1.075	1.072	1.069	1.065
6.05	1.084	1.082	1.079	1.077	1.073	1.070	1.067	1.063
6.10	1.082	1.080	1.077	1.075	1.071	1.068	1.065	1.062
6.15	1.080	1.078	1.075	1.073	1.070	1.067	1.064	1.060
6.20	1.078	1.076	1.073	1.071	1.068	1.065	1.062	1.059
6.25	1.076	1.074	1.071	1.069	1.066	1.063	1.060	1.057
6.30	1.074	1.072	1.069	1.067	1.064	1.062	1.059	1.056
6.35	1.071	1.070	1.067	1.066	1.063	1.060	1.057	1.054
6.40	1.069	1.068	1.065	1.064	1.061	1.058	1.055	1.053
6.45	1.067	1.066	1.063	1.062	1.059	1.057	1.054	1.051
6.50	1.065	1.063	1.062	1.060	1.058	1.055	1.052	1.049
6.55	1.063	1.061	1.060	1.058	1.056	1.053	1.050	1.047
6.60	1.061	1.059	1.058	1.056	1.054	1.052	1.049	1.046
6.65	1.058	1.057	1.056	1.055	1.053	1.050	1.047	1.044
6.70	1.056	1.055	1.054	1.053	1.051	1.048	1.045	1.043
6.75	1.054	1.053	1.052	1.051	1.049	1.047	1.044	1.041
6.80	1.052	1.051	1.050	1.049	1.048	1.045	1.042	1.040
6.85	1.050	1.049	1.048	1.047	1.046	1.043	1.040	1.038
6.90	1.048	1.047	1.046	1.045	1.044	1.042	1.039	1.037
6.95	1.046	1.045	1.044	1.043	1.042	1.040	1.037	1.035
7.00	1.044	1.043	1.042	1.041	1.040	1.039	1.036	1.034
7.05	1.042	1.041	1.040	1.039	1.038	1.037	1.034	1.032
7.10	1.040	1.039	1.038	1.037	1.036	1.035	1.032	1.031
7.15	1.038	1.037	1.036	1.035	1.034	1.033	1.031	1.029
7.20	1.036	1.035	1.034	1.033	1.032	1.031	1.029	1.027
7.25	1.034	1.033	1.032	1.032	1.031	1.030	1.027	1.025
7.30	1.032	1.031	1.030	1.030	1.029	1.028	1.026	1.024
7.35	1.030	1.030	1.029	1.028	1.027	1.026	1.024	1.022
7.40	1.028	1.028	1.027	1.026	1.025	1.024	1.022	1.020
7.45	1.026	1.026	1.025	1.024	1.023	1.022	1.020	1.018
7.50	1.025	1.024	1.023	1.023	1.022	1.021	1.019	1.017
7.55	1.023	1.022	1.021	1.021	1.020	1.019	1.017	1.015
7.60	1.021	1.020	1.019	1.019	1.018	1.017	1.015	1.013
7.65	1.019	1.018	1.017	1.017	1.016	1.015	1.014	1.012
7.70	1.017	1.017	1.016	1.015	1.014	1.013	1.012	1.010
7.75	1.015	1.015	1.014	1.014	1.013	1.012	1.011	1.009
7.80	1.013	1.013	1.012	1.012	1.011	1.010	1.009	1.007
7.85	1.011	1.011	1.010	1.010	1.009	1.008	1.007	1.006
7.90	1.009	1.009	1.008	1.008	1.007	1.006	1.005	1.004
7.95	1.007	1.007	1.006	1.006	1.005	1.004	1.003	1.002
8.00	1.005	1.005	1.004	1.004	1.003	1.002	1.001	1.000

Red. Press. P_r	Reduced Temperature, T_r							
	1.56	1.58	1.60	1.62	1.64	1.66	1.68	1.70
5.55	1.075	1.072	1.069	1.065	1.062	1.059	1.055	1.051
5.60	1.073	1.070	1.067	1.063	1.060	1.058	1.054	1.050
5.65	1.072	1.069	1.066	1.062	1.059	1.057	1.052	1.048
5.70	1.070	1.067	1.065	1.060	1.058	1.056	1.051	1.047
5.75	1.069	1.066	1.064	1.059	1.057	1.055	1.050	1.046
5.80	1.067	1.064	1.062	1.057	1.055	1.053	1.049	1.045
5.85	1.066	1.063	1.061	1.056	1.054	1.051	1.048	1.044
5.90	1.064	1.061	1.059	1.055	1.053	1.050	1.047	1.043
5.95	1.063	1.060	1.058	1.054	1.052	1.048	1.046	1.042
6.00	1.062	1.059	1.056	1.053	1.050	1.047	1.044	1.041
6.05	1.060	1.057	1.055	1.052	1.049	1.046	1.043	1.040
6.10	1.059	1.056	1.053	1.050	1.047	1.044	1.041	1.038
6.15	1.057	1.054	1.052	1.049	1.046	1.043	1.040	1.037
6.20	1.056	1.053	1.050	1.047	1.044	1.041	1.038	1.036
6.25	1.055	1.052	1.049	1.046	1.043	1.040	1.037	1.034
6.30	1.053	1.050	1.047	1.044	1.041	1.038	1.035	1.033
6.35	1.052	1.049	1.046	1.043	1.040	1.037	1.034	1.031
6.40	1.050	1.047	1.044	1.041	1.038	1.036	1.033	1.030
6.45	1.049	1.046	1.043	1.040	1.037	1.034	1.031	1.029
6.50	1.047	1.044	1.041	1.038	1.035	1.033	1.030	1.027
6.55	1.046	1.043	1.040	1.037	1.034	1.031	1.028	1.026
6.60	1.044	1.041	1.039	1.036	1.033	1.030	1.027	1.025
6.65	1.043	1.040	1.037	1.034	1.031	1.029	1.026	1.023
6.70	1.042	1.039	1.036	1.033	1.030	1.027	1.024	1.022
6.75	1.040	1.037	1.034	1.031	1.028	1.026	1.023	1.020
6.80	1.039	1.036	1.033	1.030	1.027	1.024	1.021	1.019
6.85	1.037	1.034	1.031	1.028	1.025	1.023	1.020	1.018
6.90	1.036	1.033	1.030	1.027	1.024	1.021	1.018	1.016
6.95	1.034	1.031	1.028	1.025	1.022	1.020	1.017	1.015
7.00	1.032	1.029	1.027	1.024	1.021	1.019	1.016	1.014
7.05	1.030	1.027	1.025	1.023	1.020	1.018	1.015	1.013
7.10	1.029	1.026	1.024	1.021	1.018	1.016	1.013	1.011
7.15	1.027	1.024	1.022	1.019	1.017	1.015	1.012	1.010
7.20	1.026	1.023	1.021	1.018	1.015	1.013	1.011	1.009
7.25	1.024	1.021	1.019	1.016	1.014	1.012	1.010	1.008
7.30	1.023	1.019	1.017	1.015	1.012	1.010	1.008	1.006
7.35	1.021	1.018	1.016	1.013	1.011	1.009	1.007	1.005
7.40	1.019	1.016	1.014	1.012	1.010	1.008	1.006	1.004
7.45	1.017	1.015	1.013	1.010	1.009	1.007	1.005	1.003
7.50	1.016	1.014	1.012	1.009	1.007	1.005	1.003	1.001
7.55	1.014	1.012	1.010	1.008	1.006	1.004	1.002	1.000
7.60	1.012	1.010	1.008	1.007	1.004	1.002	1.001	.999
7.65	1.011	1.009	1.007	1.006	1.003	1.001	.999	.997
7.70	1.009	1.007	1.005	1.004	1.002	1.000	.998	.996
7.75	1.008	1.006	1.004	1.003	1.001	.999	.996	.994
7.80	1.006	1.004	1.002	1.001	.999	.997	.995	.993
7.85	1.005	1.003	1.001	1.000	.998	.996	.994	.992
7.90	1.003	1.001	.999	.998	.996	.994	.993	.991
7.95	1.001	1.000	.998	.997	.995	.993	.991	.989
8.00	.999	.998	.996	.995	.993	.991	.990	.988

Red. Press. P_r	Reduced Temperature, T_r							
	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86
5.55	1.047	1.043	1.040	1.037	1.034	1.032	1.029	1.027
5.60	1.046	1.042	1.039	1.036	1.033	1.031	1.028	1.026
5.65	1.045	1.041	1.038	1.035	1.032	1.030	1.027	1.025
5.70	1.044	1.040	1.037	1.034	1.031	1.029	1.026	1.024
5.75	1.043	1.039	1.036	1.033	1.030	1.028	1.025	1.023
5.80	1.042	1.038	1.035	1.032	1.029	1.027	1.024	1.022
5.85	1.041	1.037	1.034	1.031	1.028	1.026	1.023	1.021
5.90	1.040	1.036	1.033	1.030	1.027	1.025	1.022	1.020
5.95	1.039	1.035	1.032	1.029	1.026	1.024	1.021	1.019
6.00	1.038	1.034	1.031	1.028	1.025	1.023	1.020	1.018
6.05	1.037	1.033	1.030	1.027	1.024	1.022	1.019	1.017
6.10	1.035	1.032	1.029	1.026	1.023	1.021	1.018	1.016
6.15	1.034	1.030	1.027	1.025	1.022	1.020	1.017	1.015
6.20	1.033	1.029	1.026	1.024	1.021	1.019	1.016	1.014
6.25	1.031	1.028	1.025	1.022	1.020	1.018	1.015	1.013
6.30	1.030	1.027	1.024	1.021	1.019	1.017	1.014	1.012
6.35	1.028	1.026	1.023	1.020	1.017	1.016	1.013	1.011
6.40	1.027	1.024	1.021	1.019	1.016	1.015	1.012	1.010
6.45	1.026	1.023	1.020	1.018	1.015	1.014	1.011	1.009
6.50	1.025	1.022	1.019	1.016	1.014	1.012	1.010	1.008
6.55	1.024	1.021	1.018	1.015	1.013	1.011	1.009	1.007
6.60	1.023	1.019	1.016	1.014	1.012	1.010	1.008	1.006
6.65	1.021	1.018	1.015	1.013	1.010	1.009	1.007	1.005
6.70	1.020	1.017	1.014	1.012	1.009	1.008	1.006	1.004
6.75	1.018	1.016	1.013	1.010	1.008	1.007	1.005	1.003
6.80	1.017	1.014	1.011	1.009	1.007	1.006	1.004	1.002
6.85	1.016	1.013	1.010	1.008	1.006	1.005	1.003	1.001
6.90	1.014	1.012	1.009	1.007	1.005	1.004	1.002	1.000
6.95	1.013	1.011	1.008	1.006	1.004	1.003	1.001	.999
7.00	1.012	1.010	1.007	1.005	1.003	1.002	1.000	.998
7.05	1.011	1.009	1.006	1.004	1.002	1.001	.999	.997
7.10	1.010	1.008	1.005	1.003	1.001	1.000	.998	.996
7.15	1.008	1.006	1.004	1.002	1.000	.999	.997	.995
7.20	1.007	1.005	1.002	1.001	.999	.998	.996	.994
7.25	1.006	1.004	1.001	.999	.997	.996	.995	.993
7.30	1.005	1.003	1.000	.998	.996	.995	.994	.992
7.35	1.003	1.001	.999	.997	.995	.994	.992	.991
7.40	1.002	1.000	.997	.996	.994	.993	.991	.990
7.45	1.001	.999	.996	.995	.993	.992	.990	.989
7.50	.999	.997	.995	.993	.991	.990	.989	.987
7.55	.998	.996	.994	.992	.990	.989	.988	.986
7.60	.997	.995	.992	.991	.989	.988	.987	.985
7.65	.995	.993	.991	.990	.988	.987	.986	.984
7.70	.994	.992	.990	.989	.987	.986	.984	.983
7.75	.993	.991	.989	.987	.985	.984	.983	.982
7.80	.992	.990	.987	.986	.984	.983	.982	.981
7.85	.990	.988	.986	.985	.983	.982	.981	.980
7.90	.989	.987	.985	.984	.982	.981	.980	.979
7.95	.988	.986	.984	.983	.981	.980	.979	.978
8.00	.987	.985	.983	.982	.980	.979	.978	.977

Red. Press. P_r	Reduced Temperature, T_r							
	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.05
5.55	1.025	1.023	1.021	1.019	1.017	1.014	1.011	1.008
5.60	1.024	1.022	1.020	1.018	1.016	1.014	1.011	1.007
5.65	1.024	1.022	1.019	1.017	1.015	1.013	1.010	1.007
5.70	1.023	1.021	1.018	1.016	1.014	1.012	1.009	1.006
5.75	1.022	1.020	1.018	1.016	1.014	1.011	1.008	1.005
5.80	1.021	1.019	1.017	1.015	1.013	1.011	1.008	1.005
5.85	1.020	1.018	1.016	1.014	1.012	1.010	1.007	1.004
5.90	1.019	1.017	1.015	1.013	1.011	1.009	1.006	1.003
5.95	1.018	1.016	1.014	1.012	1.010	1.008	1.005	1.002
6.00	1.017	1.015	1.013	1.011	1.009	1.007	1.004	1.001
6.05	1.016	1.014	1.012	1.010	1.008	1.006	1.003	1.000
6.10	1.015	1.013	1.011	1.009	1.007	1.005	1.002	.999
6.15	1.014	1.012	1.010	1.008	1.006	1.004	1.001	.998
6.20	1.013	1.011	1.009	1.007	1.005	1.003	1.001	.998
6.25	1.012	1.010	1.008	1.006	1.004	1.003	1.000	.997
6.30	1.011	1.009	1.007	1.005	1.003	1.002	.999	.996
6.35	1.010	1.008	1.006	1.005	1.003	1.001	.998	.995
6.40	1.009	1.007	1.005	1.004	1.002	1.000	.998	.995
6.45	1.008	1.006	1.004	1.003	1.001	.999	.997	.994
6.50	1.007	1.005	1.004	1.002	1.000	.999	.996	.993
6.55	1.006	1.004	1.003	1.000	.999	.998	.995	.992
6.60	1.005	1.003	1.002	1.000	.998	.997	.995	.992
6.65	1.004	1.002	1.001	1.000	.998	.996	.994	.991
6.70	1.003	1.001	1.000	.999	.997	.995	.993	.990
6.75	1.002	1.000	.999	.998	.996	.995	.992	.989
6.80	1.001	.999	.998	.997	.995	.994	.992	.989
6.85	1.000	.998	.997	.996	.994	.993	.991	.988
6.90	.999	.997	.996	.995	.993	.992	.990	.987
6.95	.998	.996	.995	.994	.992	.991	.989	.986
7.00	.997	.995	.994	.993	.991	.990	.988	.985
7.05	.996	.994	.993	.992	.990	.989	.987	.984
7.10	.995	.993	.992	.991	.989	.988	.986	.983
7.15	.994	.992	.991	.990	.988	.987	.985	.982
7.20	.993	.991	.990	.989	.987	.986	.984	.981
7.25	.992	.990	.989	.988	.986	.985	.983	.981
7.30	.991	.989	.988	.987	.985	.984	.982	.980
7.35	.990	.988	.987	.986	.985	.984	.982	.979
7.40	.989	.987	.986	.985	.984	.983	.981	.978
7.45	.988	.986	.985	.984	.983	.982	.980	.977
7.50	.986	.985	.984	.983	.982	.981	.979	.977
7.55	.985	.984	.983	.983	.981	.980	.978	.976
7.60	.984	.983	.982	.982	.980	.979	.977	.975
7.65	.983	.982	.981	.981	.980	.979	.977	.974
7.70	.982	.981	.980	.980	.979	.978	.976	.973
7.75	.981	.980	.979	.979	.978	.977	.975	.973
7.80	.980	.979	.978	.978	.977	.976	.974	.972
7.85	.979	.978	.977	.977	.976	.975	.973	.971
7.90	.978	.977	.976	.976	.975	.974	.972	.970
7.95	.977	.976	.975	.975	.974	.973	.971	.969
8.00	.976	.975	.974	.974	.973	.972	.970	.968

Red. Press. P_r	Reduced Temperature, T_r							
	2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45
5.55	1.004	1.001	.998	.995	.992	.989	.987	.984
5.60	1.003	1.000	.997	.994	.991	.988	.986	.984
5.65	1.002	.999	.996	.993	.990	.987	.985	.983
5.70	1.002	.999	.996	.993	.990	.987	.985	.983
5.75	1.001	.998	.995	.992	.989	.986	.984	.982
5.80	1.000	.997	.995	.992	.989	.986	.984	.982
5.85	.999	.997	.994	.991	.988	.985	.983	.981
5.90	.999	.996	.994	.991	.988	.985	.983	.981
5.95	.998	.996	.993	.990	.987	.984	.982	.980
6.00	.998	.995	.992	.989	.986	.983	.981	.980
6.05	.997	.994	.991	.988	.985	.982	.980	.979
6.10	.996	.993	.990	.988	.985	.982	.980	.979
6.15	.995	.992	.990	.987	.984	.981	.979	.978
6.20	.995	.992	.989	.987	.984	.981	.979	.978
6.25	.994	.991	.988	.986	.983	.980	.978	.977
6.30	.993	.990	.987	.985	.982	.980	.978	.977
6.35	.992	.989	.987	.984	.981	.979	.977	.976
6.40	.992	.989	.986	.984	.981	.979	.977	.976
6.45	.991	.988	.985	.983	.980	.978	.976	.975
6.50	.990	.987	.985	.983	.980	.977	.975	.974
6.55	.989	.986	.984	.982	.979	.976	.974	.973
6.60	.989	.986	.983	.981	.979	.976	.974	.973
6.65	.988	.985	.983	.981	.978	.975	.973	.972
6.70	.987	.984	.982	.980	.977	.975	.973	.972
6.75	.986	.983	.981	.979	.976	.974	.972	.971
6.80	.986	.983	.981	.978	.976	.974	.972	.971
6.85	.985	.982	.980	.977	.975	.973	.971	.970
6.90	.984	.981	.979	.977	.975	.973	.971	.970
6.95	.983	.980	.978	.976	.974	.972	.970	.969
7.00	.982	.979	.977	.975	.973	.971	.969	.968
7.05	.981	.978	.976	.974	.972	.970	.968	.967
7.10	.980	.977	.975	.974	.972	.970	.968	.967
7.15	.979	.977	.975	.973	.971	.969	.967	.966
7.20	.979	.976	.974	.972	.970	.969	.967	.966
7.25	.978	.975	.973	.971	.969	.968	.966	.965
7.30	.977	.974	.972	.971	.969	.967	.965	.964
7.35	.976	.974	.972	.970	.968	.967	.965	.964
7.40	.976	.973	.971	.969	.967	.966	.964	.963
7.45	.975	.972	.970	.968	.966	.966	.964	.963
7.50	.974	.972	.970	.968	.966	.965	.963	.962
7.55	.973	.971	.969	.967	.965	.964	.962	.961
7.60	.973	.970	.968	.966	.964	.964	.962	.961
7.65	.972	.970	.968	.965	.963	.963	.961	.960
7.70	.971	.969	.967	.965	.963	.963	.961	.960
7.75	.970	.968	.966	.964	.962	.962	.960	.959
7.80	.970	.968	.966	.963	.961	.961	.959	.958
7.85	.969	.967	.965	.962	.960	.961	.959	.958
7.90	.968	.966	.964	.962	.960	.960	.958	.957
7.95	.967	.965	.963	.961	.959	.959	.957	.956
8.00	.966	.964	.962	.961	.959	.958	.956	.955

Table 13

Supercompressibility Factor Tables For Orifice Meter Measurement

Notes:

The factors in the attached tables were taken from the California Natural Gasoline Association's Bulletins No. TS-402 and TS-461. Factors for pressures from 0 to 499 psig inclusive were taken from TS-402, and factors for pressures from 500 to 999 psig were taken from TS-461.

The mean value of the corresponding ranges of flowing temperature, pressure and specific gravity were used in determination of each supercompressibility factor in the attached tables.

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range 38° – 42°

Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.005	1.005	1.006	1.006
50–99	1.007	1.008	1.010	1.012	1.013	1.016
100–149	1.011	1.013	1.016	1.019	1.021	1.025
150–199	1.015	1.018	1.022	1.026	1.030	1.036
200–249	1.019	1.023	1.028	1.034	1.040	1.045
250–299	1.022	1.028	1.036	1.042	1.049	1.057
300–349	1.027	1.034	1.042	1.050	1.059	1.068
350–399	1.030	1.040	1.049	1.058	1.070	1.083
400–449	1.036	1.045	1.056	1.068	1.079	1.094
450–499	1.040	1.051	1.063	1.077	1.091	1.107
500–549	1.048	1.060	1.073	1.084	1.101	1.124
550–599	1.051	1.064	1.083	1.095	1.118	1.144
600–649	1.058	1.071	1.087	1.101	1.126	1.153
650–699	1.060	1.076	1.098	1.114	1.144	1.178
700–749	1.065	1.084	1.103	1.120	1.154	1.192
750–799	1.067	1.088	1.114	1.134	1.173	1.219
800–849	1.073	1.097	1.118	1.141	1.181	1.234
850–899	1.076	1.101	1.129	1.155	1.203	1.277
900–949	1.083	1.109	1.135	1.161	1.215	1.283
950–999	1.086	1.112	1.140	1.168	1.227	1.300

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range 43° – 47°

Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.005	1.005	1.006	1.006
50–99	1.007	1.008	1.010	1.012	1.013	1.016
100–149	1.011	1.013	1.016	1.019	1.021	1.024
150–199	1.015	1.018	1.022	1.025	1.030	1.035
200–249	1.019	1.023	1.028	1.033	1.039	1.044
250–299	1.022	1.028	1.035	1.041	1.048	1.056
300–349	1.027	1.033	1.041	1.049	1.058	1.066
350–399	1.030	1.039	1.048	1.057	1.068	1.081
400–449	1.035	1.044	1.055	1.066	1.077	1.091
450–499	1.039	1.050	1.061	1.075	1.088	1.104
500–549	1.047	1.059	1.068	1.079	1.095	1.118
550–599	1.050	1.062	1.077	1.090	1.110	1.137
600–649	1.057	1.069	1.082	1.095	1.116	1.146
650–699	1.059	1.074	1.091	1.107	1.133	1.169
700–749	1.063	1.082	1.096	1.113	1.140	1.181
750–799	1.065	1.086	1.106	1.125	1.157	1.206
800–849	1.071	1.094	1.110	1.132	1.165	1.219
850–899	1.074	1.098	1.121	1.144	1.184	1.247
900–949	1.081	1.106	1.126	1.150	1.193	1.262
950–999	1.084	1.109	1.131	1.157	1.204	1.277

48° – 52°

Pressure Range (psig)	1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.004	1.004	1.005	1.005
50–99	1.006	1.008	1.010	1.012	1.013	1.015
100–149	1.011	1.013	1.015	1.018	1.020	1.023
150–199	1.014	1.017	1.021	1.024	1.029	1.034
200–249	1.018	1.022	1.027	1.034	1.038	1.043
250–299	1.021	1.027	1.034	1.040	1.046	1.054
300–349	1.026	1.032	1.040	1.047	1.056	1.064
350–399	1.029	1.038	1.046	1.055	1.066	1.078
400–449	1.034	1.043	1.053	1.064	1.075	1.088
450–499	1.038	1.049	1.059	1.073	1.085	1.100
500–549	1.045	1.057	1.066	1.077	1.093	1.112
550–599	1.049	1.060	1.075	1.087	1.106	1.130
600–649	1.055	1.067	1.079	1.092	1.113	1.139
650–699	1.057	1.072	1.088	1.104	1.127	1.160
700–749	1.061	1.079	1.093	1.110	1.135	1.171
750–799	1.063	1.083	1.102	1.121	1.150	1.194
800–849	1.069	1.091	1.107	1.127	1.158	1.205
850–899	1.072	1.095	1.116	1.139	1.175	1.231
900–949	1.078	1.102	1.121	1.145	1.184	1.245
950–999	1.081	1.106	1.126	1.151	1.193	1.259

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range 53° – 57°	Specific Gravity Range					
Pressure Range (psig)	1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.004	1.004	1.005	1.005
50–99	1.006	1.007	1.009	1.011	1.012	1.014
100–149	1.010	1.012	1.014	1.018	1.020	1.023
150–199	1.013	1.016	1.021	1.024	1.028	1.032
200–249	1.018	1.022	1.026	1.031	1.037	1.042
250–299	1.021	1.026	1.033	1.039	1.045	1.053
300–349	1.025	1.031	1.039	1.046	1.055	1.063
350–399	1.028	1.037	1.045	1.054	1.065	1.077
400–449	1.032	1.042	1.052	1.063	1.074	1.087
450–499	1.036	1.048	1.058	1.072	1.084	1.098
500–549	1.045	1.056	1.064	1.075	1.089	1.101
550–599	1.048	1.059	1.072	1.085	1.102	1.118
600–649	1.054	1.066	1.076	1.090	1.109	1.126
650–699	1.056	1.071	1.085	1.101	1.122	1.144
700–749	1.060	1.078	1.090	1.106	1.130	1.154
750–799	1.062	1.082	1.099	1.117	1.144	1.173
800–849	1.068	1.089	1.104	1.122	1.151	1.181
850–899	1.071	1.093	1.113	1.134	1.168	1.203
900–949	1.077	1.100	1.117	1.140	1.176	1.215
950–999	1.080	1.104	1.121	1.145	1.184	1.227

58° – 62°						
0–49	1.002	1.003	1.004	1.004	1.005	1.005
50–99	1.006	1.007	1.009	1.011	1.012	1.014
100–149	1.010	1.012	1.014	1.017	1.019	1.022
150–199	1.013	1.016	1.020	1.023	1.027	1.031
200–249	1.017	1.021	1.025	1.030	1.035	1.040
250–299	1.020	1.025	1.031	1.037	1.043	1.050
300–349	1.024	1.030	1.037	1.044	1.052	1.060
350–399	1.027	1.035	1.043	1.051	1.061	1.072
400–449	1.031	1.040	1.049	1.060	1.069	1.082
450–499	1.035	1.045	1.055	1.067	1.079	1.093
500–549	1.042	1.053	1.061	1.073	1.086	1.098
550–599	1.045	1.056	1.068	1.083	1.099	1.105
600–649	1.051	1.062	1.072	1.087	1.105	1.121
650–699	1.053	1.066	1.080	1.098	1.118	1.138
700–749	1.057	1.073	1.085	1.103	1.125	1.147
750–799	1.059	1.077	1.093	1.114	1.139	1.164
800–849	1.064	1.084	1.097	1.118	1.146	1.172
850–899	1.066	1.088	1.106	1.129	1.161	1.193
900–949	1.072	1.095	1.110	1.135	1.168	1.204
950–999	1.075	1.098	1.114	1.140	1.176	1.215

Flowing Temp. Range

63° – 67°

Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.004	1.004	1.005	1.005
50–99	1.006	1.007	1.009	1.011	1.012	1.014
100–149	1.010	1.012	1.014	1.017	1.018	1.021
150–199	1.013	1.016	1.019	1.022	1.026	1.030
200–249	1.017	1.020	1.024	1.029	1.034	1.038
250–299	1.019	1.024	1.030	1.036	1.041	1.048
300–349	1.023	1.029	1.036	1.042	1.050	1.058
350–399	1.026	1.034	1.041	1.049	1.059	1.069
400–449	1.030	1.038	1.047	1.058	1.066	1.079
450–499	1.034	1.043	1.053	1.064	1.076	1.089
500–549	1.040	1.051	1.059	1.068	1.084	1.095
550–599	1.043	1.054	1.066	1.077	1.095	1.110
600–649	1.049	1.060	1.069	1.082	1.101	1.116
650–699	1.051	1.063	1.078	1.091	1.114	1.133
700–749	1.055	1.070	1.082	1.096	1.120	1.140
750–799	1.057	1.074	1.091	1.106	1.134	1.157
800–849	1.061	1.081	1.094	1.110	1.141	1.165
850–899	1.063	1.085	1.103	1.121	1.155	1.184
900–949	1.069	1.091	1.107	1.126	1.161	1.193
950–999	1.072	1.094	1.111	1.131	1.168	1.204

68° – 72°

Pressure Range (psig)	1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.004	1.004	1.005	1.005
50–99	1.006	1.007	1.008	1.010	1.011	1.013
100–149	1.009	1.011	1.013	1.016	1.018	1.021
150–199	1.012	1.015	1.019	1.022	1.025	1.029
200–249	1.016	1.020	1.023	1.028	1.033	1.037
250–299	1.019	1.023	1.029	1.034	1.040	1.046
300–349	1.022	1.028	1.034	1.041	1.048	1.055
350–399	1.025	1.033	1.040	1.047	1.056	1.067
400–449	1.029	1.037	1.045	1.055	1.064	1.076
450–499	1.033	1.042	1.051	1.062	1.073	1.086
500–549	1.039	1.049	1.057	1.066	1.079	1.093
550–599	1.042	1.052	1.064	1.075	1.090	1.106
600–649	1.047	1.057	1.067	1.079	1.095	1.113
650–699	1.049	1.061	1.075	1.088	1.107	1.127
700–749	1.053	1.068	1.080	1.093	1.113	1.135
750–799	1.055	1.071	1.088	1.102	1.125	1.150
800–849	1.059	1.078	1.091	1.107	1.132	1.158
850–899	1.061	1.081	1.100	1.116	1.144	1.175
900–949	1.067	1.088	1.104	1.121	1.150	1.184
950–999	1.069	1.091	1.108	1.126	1.157	1.193

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range

73° – 77°

Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.003	1.004	1.004	1.004	1.004
50–99	1.005	1.006	1.008	1.010	1.011	1.013
100–149	1.009	1.011	1.013	1.016	1.017	1.020
150–199	1.012	1.015	1.018	1.021	1.024	1.028
200–249	1.016	1.019	1.022	1.026	1.031	1.036
250–299	1.018	1.022	1.028	1.033	1.038	1.045
300–349	1.022	1.026	1.033	1.039	1.046	1.053
350–399	1.024	1.031	1.038	1.046	1.054	1.064
400–449	1.028	1.036	1.044	1.053	1.062	1.073
450–499	1.031	1.040	1.049	1.060	1.070	1.083
500–549	1.037	1.047	1.054	1.064	1.077	1.089
550–599	1.040	1.050	1.061	1.072	1.087	1.102
600–649	1.046	1.055	1.064	1.076	1.092	1.109
650–699	1.047	1.059	1.072	1.085	1.104	1.122
700–749	1.051	1.065	1.075	1.090	1.110	1.130
750–799	1.053	1.069	1.083	1.099	1.121	1.144
800–849	1.057	1.075	1.086	1.104	1.127	1.151
850–899	1.059	1.078	1.094	1.113	1.139	1.168
900–949	1.064	1.085	1.098	1.117	1.145	1.176
950–999	1.067	1.087	1.101	1.121	1.151	1.184

78° – 82°

0–49	1.002	1.003	1.003	1.003	1.004	1.004
50–99	1.005	1.006	1.008	1.010	1.011	1.012
100–149	1.009	1.011	1.012	1.015	1.017	1.020
150–199	1.012	1.014	1.018	1.020	1.023	1.027
200–249	1.015	1.019	1.022	1.026	1.030	1.034
250–299	1.018	1.022	1.027	1.032	1.037	1.043
300–349	1.021	1.026	1.032	1.038	1.045	1.051
350–399	1.023	1.030	1.037	1.044	1.052	1.062
400–449	1.027	1.034	1.042	1.051	1.059	1.070
450–499	1.030	1.039	1.047	1.058	1.068	1.080
500–549	1.036	1.046	1.053	1.062	1.075	1.086
550–599	1.039	1.048	1.059	1.070	1.085	1.099
600–649	1.044	1.053	1.062	1.074	1.090	1.105
650–699	1.046	1.057	1.070	1.083	1.101	1.118
700–749	1.049	1.063	1.073	1.087	1.106	1.125
750–799	1.051	1.066	1.081	1.096	1.117	1.139
800–849	1.055	1.072	1.084	1.100	1.122	1.146
850–899	1.057	1.075	1.091	1.110	1.134	1.161
900–949	1.062	1.082	1.095	1.114	1.140	1.168
950–999	1.064	1.084	1.098	1.117	1.145	1.176

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range / Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
83° – 87°						
0–49	1.002	1.002	1.003	1.003	1.004	1.004
50–99	1.005	1.006	1.008	1.010	1.010	1.012
100–149	1.009	1.010	1.012	1.015	1.016	1.019
150–199	1.011	1.014	1.017	1.020	1.023	1.026
200–249	1.015	1.018	1.021	1.025	1.029	1.033
250–299	1.017	1.021	1.026	1.031	1.036	1.042
300–349	1.020	1.025	1.031	1.036	1.043	1.050
350–399	1.023	1.029	1.036	1.042	1.051	1.059
400–449	1.026	1.033	1.041	1.050	1.057	1.068
450–499	1.029	1.037	1.046	1.056	1.066	1.077
500–549	1.035	1.044	1.051	1.059	1.073	1.081
550–599	1.037	1.046	1.057	1.066	1.083	1.092
600–649	1.042	1.051	1.061	1.069	1.087	1.098
650–699	1.044	1.055	1.068	1.078	1.098	1.111
700–749	1.047	1.060	1.071	1.082	1.103	1.117
750–799	1.049	1.064	1.079	1.091	1.114	1.130
800–849	1.053	1.070	1.081	1.094	1.118	1.136
850–899	1.055	1.073	1.088	1.103	1.129	1.149
900–949	1.059	1.079	1.092	1.107	1.135	1.155
950–999	1.062	1.081	1.095	1.111	1.140	1.162
88° – 92°						
0–49	1.002	1.002	1.003	1.003	1.004	1.004
50–99	1.005	1.006	1.007	1.009	1.010	1.012
100–149	1.008	1.010	1.012	1.014	1.016	1.018
150–199	1.011	1.013	1.017	1.019	1.021	1.025
200–249	1.014	1.017	1.020	1.024	1.028	1.031
250–299	1.017	1.020	1.025	1.029	1.034	1.040
300–349	1.020	1.024	1.029	1.034	1.041	1.047
350–399	1.021	1.028	1.034	1.040	1.048	1.056
400–449	1.025	1.031	1.039	1.047	1.054	1.064
450–499	1.028	1.035	1.043	1.053	1.062	1.073
500–549	1.033	1.042	1.050	1.057	1.070	1.079
550–599	1.035	1.044	1.056	1.064	1.080	1.090
600–649	1.040	1.049	1.059	1.067	1.085	1.095
650–699	1.042	1.052	1.066	1.075	1.094	1.107
700–749	1.045	1.057	1.069	1.080	1.100	1.113
750–799	1.046	1.060	1.076	1.088	1.110	1.125
800–849	1.050	1.066	1.079	1.091	1.114	1.132
850–899	1.052	1.070	1.085	1.100	1.125	1.144
900–949	1.056	1.075	1.089	1.104	1.130	1.150
950–999	1.059	1.078	1.092	1.108	1.136	1.157

SUPERCOMPRESSIBILITY FACTORS FOR ORIFICE METER MEASUREMENT

Flowing Temp. Range: 93° – 97°

Pressure Range (psig)	Specific Gravity Range 1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.002	1.003	1.003	1.004	1.004
50–99	1.005	1.006	1.007	1.009	1.010	1.012
100–149	1.009	1.010	1.012	1.014	1.016	1.018
150–199	1.011	1.013	1.017	1.019	1.021	1.024
200–249	1.014	1.017	1.020	1.023	1.027	1.030
250–299	1.017	1.020	1.024	1.028	1.033	1.039
300–349	1.020	1.023	1.028	1.033	1.040	1.046
350–399	1.021	1.027	1.033	1.039	1.047	1.054
400–449	1.024	1.030	1.038	1.046	1.053	1.063
450–499	1.027	1.034	1.042	1.051	1.060	1.071
500–549	1.032	1.041	1.048	1.055	1.066	1.077
550–599	1.034	1.043	1.054	1.062	1.075	1.087
600–649	1.039	1.047	1.056	1.065	1.079	1.092
650–699	1.041	1.050	1.063	1.073	1.088	1.104
700–749	1.044	1.055	1.065	1.077	1.093	1.110
750–799	1.045	1.058	1.072	1.085	1.102	1.121
800–849	1.049	1.064	1.075	1.089	1.107	1.127
850–899	1.050	1.068	1.081	1.097	1.116	1.139
900–949	1.054	1.073	1.083	1.101	1.121	1.145
950–999	1.057	1.076	1.087	1.104	1.126	1.151

98° –102°

Pressure Range (psig)	1 .55–.59	2 .60–.64	3 .65–.69	4 .70–.74	5 .75–.79	6 .80–.84
0–49	1.002	1.002	1.003	1.003	1.004	1.004
50–99	1.004	1.005	1.007	1.009	1.009	1.011
100–149	1.008	1.009	1.011	1.013	1.015	1.017
150–199	1.010	1.013	1.016	1.018	1.020	1.023
200–249	1.013	1.016	1.019	1.022	1.026	1.029
250–299	1.016	1.019	1.023	1.027	1.032	1.037
300–349	1.019	1.022	1.027	1.032	1.038	1.044
350–399	1.020	1.026	1.032	1.037	1.045	1.052
400–449	1.023	1.029	1.036	1.044	1.051	1.061
450–499	1.026	1.033	1.040	1.049	1.058	1.069
500–549	1.031	1.039	1.046	1.053	1.064	1.073
550–599	1.033	1.041	1.052	1.059	1.072	1.083
600–649	1.037	1.045	1.054	1.062	1.076	1.087
650–699	1.039	1.048	1.060	1.070	1.085	1.098
700–749	1.042	1.053	1.062	1.073	1.090	1.103
750–799	1.043	1.056	1.067	1.081	1.099	1.114
800–849	1.047	1.062	1.071	1.084	1.104	1.118
850–899	1.048	1.065	1.076	1.091	1.113	1.129
900–949	1.052	1.070	1.079	1.095	1.117	1.135
950–999	1.055	1.073	1.081	1.098	1.121	1.140

SQUARES OF WHOLE NUMBERS*

	0	1	2	3	4	5	6	7	8	9
...	...	...	...	.01	.02	.03	.04	.05	.06	.08
10	.10	.12	.14	.17	.20	.23	.26	.29	.32	.36
20	.40	.44	.48	.53	.58	.63	.68	.73	.78	.84
30	.90	.96	1.02	1.09	1.16	1.23	1.30	1.37	1.44	1.52
40	1.60	1.68	1.76	1.85	1.94	2.03	2.12	2.21	2.30	2.40
50	2.50	2.60	2.70	2.81	2.92	3.03	3.14	3.25	3.36	3.48
60	3.60	3.72	3.84	3.97	4.10	4.23	4.36	4.49	4.62	4.76
70	4.90	5.04	5.18	5.33	5.48	5.63	5.78	5.93	6.08	6.24
80	6.40	6.56	6.72	6.89	7,06	7.23	7.40	7.57	7.74	7.92
90	8.10	8.28	8.46	8.65	8.84	9.03	9.22	9.41	9.60	9.80
100	10.00	10.20	10.40	10.61	10.82	11.03	11.24	11.45	11.66	11.88
110	12.10	12.32	12.54	12.77	12.99	13.23	13.46	13.69	13.92	14.16
120	14.40	14.64	14.88	15.13	15.38	15.63	15.88	16.13	16.38	16.64
130	16.90	17.16	17.42	17.69	17.96	18.23	18.50	18.77	19.04	19.32
140	19.60	19.88	20.16	20.45	20.74	21.03	21.32	21.61	21.90	22.20
150	22.50	22.80	23.10	23.41	23.72	24.03	24.34	24.65	24.97	25.28
160	25.60	25.92	26.24	26.57	26.90	27.23	27.56	27.89	28.22	28.56
170	28.90	29.24	29.58	29.93	30.28	30.63	30.98	31.33	31.68	32.04
180	32.40	32.76	33.12	33.49	33.86	34.23	34.60	34.97	35.34	35.72
190	36.10	36.48	36.86	37.25	37.64	38.03	38.42	38.81	39.20	39.60
200	40.00	40.40	40.80	41.21	41.62	42.03	42.44	42.85	43.26	43.68
210	44.10	44.52	44.94	45.37	45.80	46.23	46.66	47.09	47.52	47.96
220	48.40	48.84	49.28	49.73	50.18	50.63	51.08	51.53	51.98	52.44
230	52.90	53.36	53.82	54.29	54.76	55.23	55.70	56.17	56.64	57.12
240	57.60	58.08	58.56	59.05	59.54	60.03	60.52	61.52	61.50	62.00
250	62.50	63.00	63.50	64.01	64.52	65.03	65.54	66.05	66.56	67.08
260	67.60	68.12	68.64	69.17	69.70	70.23	70.76	71.29	71.82	72.36
270	72.90	73.44	73.98	74.53	75.08	75.63	76.18	76.73	77.28	77.84
280	78.40	78.96	79.52	80.09	80.66	81.23	81.80	82.37	82.94	83.52
290	84.10	84.68	85.26	85.85	86.44	87.03	87.62	88.21	88.80	89.40
300	90.00	90.60	91.20	91.81	92.42	93.03	93.94	94.25	94.86	95.48
310	96.10	96.72	97.34	97.67	98.59	99.23	99.86	100.49	101.12	101.76
320	102.40	103.04	103.68	104.33	104.98	105.63	106.28	106.93	107.58	108.24
330	108.90	109.56	110.22	110.89	111.56	112.23	112.90	113.57	114.24	114.29
340	115.60	116.28	116.96	117.65	118.34	119.03	119.72	120.41	121.10	121.80
350	122.50	123.20	123.90	124.61	125.32	126.03	126.74	127.45	128.16	128.88
360	129.60	130.32	131.04	131.77	132.50	133.23	133.96	134.69	135.42	136.16
370	136.90	137.64	138.38	139.13	139.88	140.63	141.38	141.13	142.88	143.64
380	144.40	145.16	145.92	146.69	147.46	148.23	148.99	149.77	150.54	151.32
390	152.10	152.88	153.66	154.45	155.24	156.03	156.82	157.61	158.40	159.20
400	160	161	162	162	163	164	165	166	166	167
410	168	169	169	171	171	172	173	174	175	176
420	176	177	178	179	180	181	181	182	183	184
430	185	186	187	187	188	189	191	192	193	193
440	194	194	195	196	197	198	199	200	201	202
450	203	203	204	205	206	207	208	209	210	211
460	212	213	213	214	215	216	217	218	219	220
470	221	222	223	224	225	226	227	228	228	229
480	230	231	232	233	234	235	236	237	238	239
490	240	241	242	243	244	245	246	247	248	249
500	250	251	252	253	254	255	256	257	258	259
510	260	261	262	263	264	265	266	267	268	269
520	270	270	272	274	275	276	277	278	279	280
530	281	282	283	284	285	286	287	288	289	291
540	292	293	294	295	296	297	298	299	300	301
550	303	304	305	306	307	308	309	310	311	312
560	314	315	316	317	318	319	320	321	323	324
570	325	326	327	328	329	331	332	333	334	335
580	336	338	339	340	341	342	343	345	346	347
590	348	349	350	351	352	354	355	356	357	358

*Squares of numbers are expressed in thousands.

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
600	360	361	362	364	365	366	367	368	370	371
610	372	373	375	376	377	378	379	381	382	383
620	384	386	387	388	389	391	392	393	394	396
630	397	398	399	401	402	403	404	406	407	408
640	410	411	412	413	415	416	417	419	420	421
650	423	424	425	426	428	429	430	432	433	434
660	436	437	438	440	441	442	444	445	446	448
670	449	450	452	453	454	456	457	458	460	461
680	462	464	465	466	468	469	471	472	473	475
690	476	477	478	480	481	483	484	486	487	488
700	490	491	493	494	496	497	498	500	501	503
710	504	506	507	508	510	511	513	514	516	517
720	518	520	521	523	524	526	527	529	530	531
730	533	534	536	537	539	540	541	543	545	546
740	548	549	551	552	554	555	557	558	560	561
750	562	564	566	567	569	570	572	573	575	576
760	578	579	581	582	584	585	587	588	590	591
770	593	594	596	598	599	601	602	604	605	607
780	608	610	612	613	615	616	618	619	621	623
790	624	626	627	629	630	632	634	635	637	638
800	640	642	643	645	646	648	650	651	653	654
810	656	658	659	661	663	664	666	667	669	671
820	672	674	676	677	679	681	682	684	686	687
830	689	691	692	694	696	697	699	701	702	704
840	706	707	709	711	712	714	716	717	719	721
850	723	724	726	728	729	731	733	734	736	738
860	740	741	743	745	746	748	750	752	753	755
870	757	759	760	762	764	766	767	769	771	773
880	774	776	778	780	781	783	785	787	789	790
890	792	794	796	797	799	801	803	805	806	808
900	810	812	814	815	817	819	821	823	824	826
910	828	830	832	834	835	837	839	841	843	845
920	846	848	850	852	854	856	857	859	861	863
930	865	867	869	870	872	874	876	878	880	882
940	884	885	887	889	891	893	895	897	899	901
950	903	904	906	908	910	912	914	916	918	920
960	922	924	925	927	929	931	933	935	937	939
970	941	943	945	947	949	951	953	955	956	958
980	960	962	964	966	968	970	972	974	976	978
990	980	982	984	986	988	990	992	994	996	998
1000	1,000	1,002	1,004	1,006	1,008	1,010	1,012	1,014	1,016	1,018
1010	1,020	1,022	1,024	1,026	1,028	1,030	1,032	1,034	1,036	1,038
1020	1,040	1,042	1,044	1,047	1,049	1,051	1,053	1,055	1,057	1,059
1030	1,061	1,063	1,065	1,067	1,069	1,071	1,073	1,075	1,077	1,080
1040	1,082	1,084	1,086	1,088	1,090	1,092	1,094	1,096	1,098	1,100
1050	1,103	1,105	1,107	1,109	1,111	1,113	1,115	1,117	1,119	1,121
1060	1,124	1,126	1,128	1,130	1,132	1,134	1,136	1,138	1,141	1,143
1070	1,145	1,147	1,149	1,151	1,153	1,156	1,158	1,160	1,162	1,164
1080	1,166	1,169	1,171	1,173	1,175	1,177	1,179	1,182	1,184	1,186
1090	1,188	1,190	1,192	1,195	1,197	1,199	1,201	1,203	1,206	1,208
1100	1,210	1,212	1,214	1,217	1,219	1,221	1,223	1,225	1,228	1,230
1110	1,232	1,234	1,237	1,239	1,249	1,243	1,245	1,248	1,250	1,252
1120	1,254	1,257	1,259	1,261	1,263	1,266	1,268	1,270	1,272	1,275
1130	1,277	1,279	1,281	1,284	1,286	1,288	1,290	1,293	1,295	1,297
1140	1,300	1,302	1,304	1,306	1,309	1,311	1,313	1,316	1,318	1,320
1150	1,323	1,325	1,327	1,329	1,332	1,334	1,336	1,339	1,341	1,343
1160	1,346	1,348	1,350	1,353	1,355	1,357	1,360	1,362	1,364	1,367
1170	1,369	1,371	1,374	1,376	1,378	1,381	1,383	1,385	1,388	1,390
1180	1,392	1,395	1,397	1,399	1,402	1,404	1,407	1,409	1,411	1,414
1190	1,416	1,418	1,421	1,423	1,426	1,428	1,430	1,433	1,435	1,438

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
1200	1,440	1,442	1,445	1,447	1,450	1,452	1,454	1,457	1,459	1,462
1210	1,464	1,466	1,469	1,471	1,474	1,476	1,479	1,481	1,484	1,486
1220	1,488	1,491	1,493	1,496	1,498	1,501	1,503	1,506	1,508	1,510
1230	1,513	1,515	1,518	1,520	1,523	1,525	1,528	1,530	1,533	1,535
1240	1,538	1,540	1,543	1,545	1,548	1,550	1,553	1,555	1,558	1,560
1250	1,563	1,565	1,568	1,570	1,573	1,575	1,578	1,580	1,583	1,585
1260	1,588	1,590	1,593	1,595	1,598	1,600	1,603	1,605	1,608	1,610
1270	1,613	1,615	1,618	1,621	1,623	1,626	1,628	1,631	1,633	1,636
1280	1,638	1,641	1,644	1,646	1,649	1,651	1,654	1,656	1,659	1,662
1290	1,664	1,667	1,669	1,672	1,674	1,677	1,680	1,682	1,685	1,687
1300	1,690	1,693	1,695	1,698	1,700	1,703	1,706	1,708	1,711	1,713
1310	1,716	1,719	1,721	1,724	1,727	1,729	1,732	1,734	1,737	1,740
1320	1,742	1,745	1,748	1,750	1,753	1,756	1,758	1,761	1,764	1,766
1330	1,769	1,772	1,774	1,777	1,780	1,782	1,785	1,788	1,790	1,793
1340	1,796	1,798	1,801	1,804	1,806	1,809	1,812	1,814	1,817	1,820
1350	1,823	1,825	1,828	1,831	1,833	1,836	1,839	1,841	1,844	1,847
1360	1,850	1,852	1,855	1,858	1,860	1,863	1,866	1,869	1,871	1,874
1370	1,877	1,880	1,882	1,885	1,888	1,891	1,893	1,896	1,899	1,902
1380	1,904	1,907	1,910	1,913	1,915	1,918	1,921	1,924	1,927	1,929
1390	1,932	1,935	1,938	1,940	1,943	1,946	1,949	1,952	1,954	1,957
1400	1,960	1,963	1,966	1,968	1,971	1,974	1,977	1,980	1,982	1,985
1410	1,988	1,991	1,994	1,997	1,999	2,002	2,005	2,007	2,011	2,014
1420	2,016	2,019	2,022	2,025	2,028	2,031	2,033	2,036	2,039	2,042
1430	2,045	2,048	2,051	2,053	2,056	2,059	2,062	2,065	2,068	2,070
1440	2,074	2,077	2,079	2,082	2,085	2,088	2,091	2,094	2,097	2,100
1450	2,103	2,105	2,108	2,111	2,114	2,117	2,120	2,123	2,126	2,129
1460	2,132	2,135	2,137	2,140	2,143	2,146	2,149	2,152	2,155	2,158
1470	2,161	2,164	2,167	2,170	2,173	2,176	2,179	2,182	2,184	2,187
1480	2,190	2,193	2,196	2,199	2,202	2,205	2,208	2,211	2,214	2,217
1490	2,220	2,223	2,226	2,229	2,232	2,235	2,238	2,241	2,244	2,247
1500	2,250	2,253	2,256	2,259	2,262	2,265	2,268	2,271	2,274	2,277
1510	2,280	2,283	2,286	2,289	2,292	2,295	2,298	2,301	2,304	2,307
1520	2,310	2,313	2,316	2,320	2,323	2,326	2,329	2,332	2,335	2,338
1530	2,341	2,344	2,347	2,350	2,353	2,356	2,359	2,362	2,365	2,369
1540	2,372	2,375	2,378	2,381	2,384	2,387	2,390	2,393	2,396	2,399
1550	2,403	2,406	2,409	2,412	2,415	2,418	2,421	2,424	2,427	2,430
1560	2,434	2,437	2,440	2,443	2,446	2,449	2,452	2,455	2,459	2,462
1570	2,465	2,468	2,471	2,474	2,477	2,481	2,484	2,487	2,490	2,493
1580	2,496	2,500	2,503	2,506	2,509	2,512	2,515	2,519	2,522	2,525
1590	2,528	2,531	2,534	2,538	2,541	2,544	2,547	2,550	2,554	2,557
1600	2,560	2,563	2,566	2,570	2,573	2,576	2,579	2,582	2,586	2,589
1610	2,592	2,595	2,599	2,602	2,605	2,608	2,611	2,615	2,618	2,621
1620	2,624	2,628	2,631	2,634	2,637	2,641	2,644	2,647	2,650	2,654
1630	2,657	2,660	2,663	2,667	2,670	2,673	2,676	2,680	2,683	2,686
1640	2,690	2,693	2,696	2,699	2,703	2,706	2,709	2,713	2,716	2,719
1650	2,723	2,726	2,729	2,732	2,736	2,739	2,742	2,746	2,749	2,752
1660	2,756	2,759	2,762	2,766	2,769	2,772	2,776	2,779	2,782	2,786
1670	2,789	2,792	2,796	2,799	2,802	2,806	2,809	2,812	2,816	2,819
1680	2,822	2,826	2,829	2,832	2,836	2,839	2,843	2,846	2,849	2,853
1690	2,856	2,859	2,863	2,866	2,870	2,873	2,876	2,880	2,883	2,887
1700	2,890	2,893	2,897	2,900	2,904	2,907	2,910	2,914	2,917	2,921
1710	2,924	2,928	2,931	2,934	2,938	2,941	2,945	2,948	2,952	2,955
1720	2,958	2,962	2,965	2,969	2,972	2,976	2,979	2,983	2,986	2,989
1730	2,993	2,996	3,000	3,003	3,007	3,010	3,014	3,017	3,021	3,024
1740	3,028	3,031	3,035	3,038	3,042	3,045	3,049	3,052	3,056	3,059

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
1750	3,063	3,066	3,070	3,073	3,077	3,080	3,084	3,087	3,091	3,094
1760	3,098	3,101	3,105	3,108	3,112	3,115	3,119	3,122	3,126	3,129
1770	3,133	3,136	3,140	3,144	3,147	3,151	3,154	3,158	3,161	3,165
1780	3,168	3,172	3,176	3,179	3,183	3,186	3,190	3,193	3,197	3,201
1790	3,204	3,208	3,211	3,215	3,218	3,222	3,226	3,229	3,233	3,236
1800	3,240	3,244	3,247	3,251	3,254	3,258	3,262	3,265	3,269	3,272
1810	3,276	3,280	3,283	3,287	3,291	3,294	3,298	3,301	3,305	3,309
1820	3,312	3,316	3,320	3,323	3,327	3,331	3,334	3,338	3,342	3,345
1830	3,349	3,353	3,356	3,360	3,364	3,367	3,371	3,375	3,378	3,382
1840	3,386	3,389	3,393	3,397	3,400	3,404	3,408	3,411	3,415	3,419
1850	3,423	3,426	3,430	3,434	3,437	3,441	3,445	3,448	3,452	3,456
1860	3,460	3,463	3,467	3,471	3,474	3,478	3,482	3,486	3,489	3,493
1870	3,497	3,501	3,504	3,508	3,512	3,516	3,519	3,523	3,527	3,531
1880	3,534	3,538	3,542	3,546	3,549	3,553	3,557	3,561	3,565	3,568
1890	3,572	3,576	3,580	3,583	3,587	3,591	3,595	3,599	3,602	3,606
1900	3,610	3,614	3,618	3,621	3,625	3,629	3,633	3,637	3,640	3,644
1910	3,648	3,652	3,656	3,660	3,663	3,667	3,671	3,675	3,679	3,683
1920	3,686	3,690	3,694	3,698	3,702	3,706	3,709	3,713	3,717	3,721
1930	3,725	3,729	3,733	3,736	3,740	3,744	3,749	3,752	3,756	3,760
1940	3,764	3,767	3,771	3,775	3,779	3,783	3,787	3,791	3,795	3,799
1950	3,803	3,806	3,810	3,814	3,818	3,822	3,826	3,830	3,834	3,838
1960	3,842	3,846	3,849	3,853	3,857	3,861	3,865	3,869	3,873	3,877
1970	3,881	3,885	3,889	3,893	3,897	3,901	3,905	3,909	3,912	3,916
1980	3,920	3,924	3,928	3,932	3,936	3,940	3,944	3,948	3,952	3,956
1990	3,960	3,964	3,968	3,972	3,976	3,980	3,984	3,988	3,992	3,996
2000	4,000	4,004	4,008	4,012	4,016	4,020	4,024	4,028	4,032	4,036
2010	4,040	4,044	4,048	4,052	4,056	4,060	4,064	4,068	4,072	4,076
2020	4,080	4,085	4,088	4,093	4,097	4,101	4,105	4,109	4,113	4,117
2030	4,121	4,125	4,129	4,133	4,137	4,141	4,145	4,149	4,153	4,158
2040	4,162	4,166	4,170	4,174	4,178	4,182	4,186	4,190	4,194	4,198
2050	4,203	4,207	4,211	4,215	4,219	4,223	4,227	4,231	4,235	4,239
2060	4,244	4,248	4,252	4,256	4,260	4,264	4,268	4,272	4,277	4,281
2070	4,285	4,289	4,293	4,297	4,301	4,306	4,310	4,314	4,318	4,322
2080	4,326	4,331	4,335	4,339	4,343	4,347	4,351	4,356	4,360	4,364
2090	4,368	4,372	4,376	4,381	4,385	4,389	4,393	4,397	4,402	4,406
2100	4,410	4,414	4,418	4,423	4,427	4,431	4,435	4,439	4,444	4,448
2110	4,452	4,456	4,461	4,465	4,469	4,473	4,477	4,482	4,486	4,490
2120	4,494	4,499	4,503	4,507	4,511	4,516	4,520	4,524	4,528	4,533
2130	4,537	4,541	4,545	4,550	4,554	4,558	4,562	4,567	4,571	4,575
2140	4,580	4,584	4,588	4,592	4,597	4,601	4,605	4,610	4,614	4,618
2150	4,623	4,627	4,631	4,635	4,640	4,644	4,648	4,653	4,657	4,661
2160	4,666	4,670	4,674	4,679	4,683	4,687	4,692	4,696	4,700	4,705
2170	4,709	4,713	4,718	4,722	4,726	4,731	4,735	4,739	4,744	4,748
2180	4,752	4,757	4,761	4,765	4,770	4,774	4,779	4,783	4,787	4,792
2190	4,796	4,800	4,805	4,809	4,814	4,818	4,822	4,827	4,831	4,836
2200	4,840	4,844	4,849	4,853	4,858	4,862	4,866	4,871	4,875	4,880
2210	4,884	4,889	4,893	4,897	4,902	4,906	4,911	4,915	4,920	4,924
2220	4,928	4,933	4,937	4,942	4,946	4,951	4,955	4,960	4,964	4,968
2230	4,973	4,977	4,982	4,986	4,991	4,995	5,000	5,004	5,009	5,013
2240	5,018	5,022	5,027	5,031	5,036	5,040	5,045	5,049	5,054	5,058
2250	5,063	5,067	5,072	5,076	5,081	5,085	5,090	5,094	5,099	5,103
2260	5,108	5,112	5,117	5,121	5,126	5,130	5,134	5,139	5,144	5,148
2270	5,153	5,157	5,162	5,167	5,171	5,176	5,180	5,185	5,189	5,194
2280	5,198	5,203	5,208	5,212	5,217	5,221	5,226	5,230	5,235	5,240
2290	5,244	5,249	5,253	5,258	5,262	5,267	5,272	5,276	5,281	5,285

	0	1	2	3	4	5	6	7	8	9
2300	5,290	5,295	5,299	5,304	5,308	5,313	5,318	5,322	5,327	5,331
2310	5,336	5,341	5,345	5,350	5,355	5,359	5,364	5,368	5,373	5,378
2320	5,382	5,387	5,392	5,396	5,401	5,406	5,410	5,415	5,420	5,424
2330	5,429	5,434	5,438	5,443	5,448	5,452	5,457	5,462	5,466	5,471
2340	5,476	5,480	5,485	5,490	5,494	5,499	5,504	5,508	5,513	5,518
2350	5,523	5,527	5,532	5,537	5,541	5,546	5,551	5,555	5,560	5,565
2360	5,570	5,574	5,579	5,584	5,588	5,593	5,598	5,603	5,607	5,612
2370	5,617	5,622	5,626	5,631	5,636	5,641	5,645	5,650	5,655	5,660
2380	5,664	5,669	5,674	5,679	5,683	5,688	5,693	5,698	5,703	5,707
2390	5,712	5,717	5,722	5,726	5,731	5,736	5,741	5,746	5,750	5,755
2400	5,760	5,765	5,770	5,774	5,779	5,784	5,789	5,794	5,798	5,803
2410	5,808	5,813	5,818	5,823	5,827	5,832	5,837	5,842	5,847	5,852
2420	5,856	5,861	5,866	5,871	5,876	5,881	5,885	5,890	5,895	5,900
2430	5,905	5,910	5,915	5,919	5,924	5,929	5,934	5,939	5,944	5,949
2440	5,954	5,958	5,963	5,968	5,973	5,978	5,983	5,988	5,993	5,998
2450	6,003	6,007	6,012	6,017	6,022	6,027	6,032	6,037	6,042	6,047
2460	6,052	6,056	6,061	6,066	6,071	6,076	6,081	6,086	6,091	6,096
2470	6,101	6,106	6,111	6,116	6,121	6,126	6,131	6,136	6,140	6,145
2480	6,150	6,155	6,160	6,165	6,170	6,175	6,180	6,185	6,190	6,195
2490	6,200	6,205	6,210	6,215	6,220	6,225	6,230	6,235	6,240	6,245
2500	6,250	6,255	6,260	6,265	6,270	6,275	6,280	6,285	6,290	6,295
2510	6,300	6,305	6,310	6,315	6,320	6,325	6,330	6,335	6,340	6,345
2520	6,350	6,355	6,360	6,366	6,371	6,376	6,381	6,386	6,391	6,396
2530	6,401	6,406	6,411	6,416	6,421	6,425	6,431	6,436	6,441	6,447
2540	6,452	6,457	6,462	6,467	6,472	6,477	6,482	6,487	6,492	6,497
2550	6,503	6,508	6,513	6,518	6,523	6,528	6,533	6,538	6,543	6,548
2560	6,554	6,559	6,564	6,569	6,574	6,579	6,584	6,589	6,595	6,600
2570	6,605	6,610	6,615	6,620	6,625	6,631	6,636	6,641	6,646	6,651
2580	6,656	6,662	6,667	6,672	6,677	6,682	6,687	6,693	6,698	6,703
2590	6,708	6,713	6,718	6,724	6,729	6,734	6,739	6,744	6,750	6,755
2600	6,760	6,765	6,770	6,776	6,781	6,786	6,791	6,796	6,802	6,807
2610	6,812	6,817	6,823	6,828	6,833	6,838	6,843	6,849	6,854	6,859
2620	6,864	6,870	6,875	6,880	6,885	6,891	6,896	6,901	6,906	6,912
2630	6,917	6,922	6,927	6,933	6,938	6,943	6,948	6,954	6,959	6,964
2640	6,970	6,975	6,980	6,985	6,991	6,996	7,001	7,007	7,012	7,017
2650	7,023	7,028	7,033	7,038	7,044	7,049	7,054	7,060	7,065	7,070
2660	7,076	7,081	7,086	7,092	7,097	7,102	7,108	7,113	7,118	7,124
2670	7,129	7,134	7,140	7,145	7,150	7,156	7,161	7,166	7,172	7,177
2680	7,182	7,188	7,193	7,198	7,204	7,209	7,215	7,220	7,225	7,231
2690	7,236	7,241	7,247	7,252	7,258	7,263	7,268	7,274	7,279	7,285
2700	7,290	7,295	7,301	7,306	7,312	7,317	7,322	7,328	7,333	7,339
2710	7,344	7,350	7,355	7,360	7,366	7,371	7,377	7,382	7,388	7,393
2720	7,398	7,404	7,409	7,415	7,420	7,426	7,431	7,437	7,442	7,447
2730	7,453	7,458	7,464	7,469	7,475	7,480	7,486	7,491	7,497	7,502
2740	7,508	7,513	7,519	7,524	7,530	7,535	7,541	7,546	7,552	7,557
2750	7,563	7,568	7,574	7,579	7,585	7,590	7,596	7,601	7,607	7,612
2760	7,618	7,623	7,629	7,634	7,640	7,645	7,651	7,656	7,662	7,667
2770	7,673	7,678	7,684	7,690	7,695	7,701	7,706	7,712	7,717	7,723
2780	7,728	7,734	7,740	7,745	7,751	7,756	7,762	7,767	7,773	7,779
2790	7,784	7,790	7,795	7,801	7,806	7,812	7,818	7,823	7,829	7,834
2800	7,840	7,846	7,851	7,857	7,862	7,868	7,874	7,879	7,885	7,890
2810	7,896	7,902	7,907	7,913	7,919	7,924	7,930	7,935	7,941	7,947
2820	7,952	7,958	7,964	7,969	7,975	7,981	7,986	7,992	7,998	8,003
2830	8,009	8,015	8,020	8,026	8,032	8,037	8,043	8,049	8,054	8,060
2840	8,066	8,071	8,077	8,083	8,088	8,094	8,100	8,105	8,111	8,117

	0	1	2	3	4	5	6	7	8	9
2850	8,123	8,128	8,134	8,140	8,145	8,151	8,157	8,162	8,168	8,174
2860	8,180	8,185	8,191	8,197	8,202	8,208	8,214	8,220	8,225	8,231
2870	8,237	8,243	8,248	8,254	8,260	8,266	8,271	8,277	8,283	8,289
2880	8,294	8,300	8,306	8,312	8,317	8,323	8,329	8,335	8,341	8,346
2890	8,352	8,358	8,364	8,369	8,375	8,381	8,387	8,393	8,398	8,404
2900	8,410	8,416	8,422	8,427	8,433	8,439	8,445	8,451	8,456	8,462
2910	8,468	8,474	8,480	8,486	8,491	8,497	8,503	8,509	8,515	8,521
2920	8,526	8,532	8,538	8,544	8,550	8,556	8,561	8,567	8,573	8,579
2930	8,585	8,591	8,597	8,602	8,608	8,614	8,620	8,626	8,632	8,638
2940	8,644	8,649	8,655	8,661	8,667	8,673	8,679	8,685	8,691	8,697
2950	8,703	8,708	8,714	8,720	8,726	8,732	8,738	8,744	8,750	8,756
2960	8,762	8,768	8,773	8,779	8,785	8,791	8,797	8,803	8,809	8,815
2970	8,821	8,827	8,833	8,839	8,845	8,851	8,857	8,863	8,868	8,874
2980	8,880	8,886	8,892	8,898	8,904	8,910	8,916	8,922	8,928	8,934
2990	8,940	8,946	8,952	8,958	8,964	8,970	8,976	8,982	8,988	8,994
3000	9,000	9,006	9,012	9,018	9,024	9,030	9,036	9,042	9,048	9,054
3010	9,060	9,066	9,072	9,078	9,084	9,090	9,096	9,102	9,108	9,114
3020	9,120	9,126	9,132	9,139	9,145	9,151	9,157	9,163	9,169	9,175
3030	9,181	9,187	9,193	9,199	9,205	9,211	9,217	9,223	9,229	9,236
3040	9,242	9,248	9,254	9,260	9,266	9,272	9,278	9,284	9,290	9,296
3050	9,303	9,309	9,315	9,321	9,327	9,333	9,339	9,345	9,351	9,357
3060	9,364	9,370	9,376	9,382	9,388	9,394	9,400	9,406	9,413	9,419
3070	9,425	9,431	9,437	9,443	9,449	9,456	9,462	9,468	9,474	9,480
3080	9,486	9,493	9,499	9,505	9,511	9,517	9,523	9,530	9,536	9,542
3090	9,548	9,554	9,560	9,567	9,573	9,579	9,585	9,591	9,598	9,604
3100	9,610	9,616	9,622	9,629	9,635	9,641	9,647	9,653	9,660	9,666
3110	9,672	9,678	9,685	9,691	9,697	9,703	9,709	9,716	9,722	9,728
3120	9,734	9,741	9,747	9,753	9,759	9,766	9,772	9,778	9,784	9,791
3130	9,797	9,803	9,809	9,816	9,822	9,828	9,834	9,841	9,847	9,853
3140	9,860	9,866	9,872	9,878	9,885	9,891	9,897	9,904	9,910	9,916
3150	9,923	9,929	9,935	9,941	9,948	9,954	9,960	9,967	9,973	9,979
3160	9,986	9,992	9,998	10,005	10,011	10,017	10,024	10,030	10,036	10,043
3170	10,049	10,055	10,062	10,068	10,074	10,081	10,087	10,093	10,100	10,106
3180	10,112	10,119	10,125	10,131	10,138	10,144	10,151	10,157	10,163	10,170
3190	10,176	10,182	10,189	10,195	10,202	10,208	10,214	10,221	10,227	10,234
3200	10,240	10,246	10,253	10,259	10,266	10,272	10,278	10,285	10,291	10,298
3210	10,304	10,311	10,317	10,323	10,330	10,336	10,343	10,349	10,356	10,362
3220	10,368	10,375	10,381	10,388	10,394	10,401	10,407	10,414	10,420	10,426
3230	10,433	10,439	10,446	10,452	10,459	10,465	10,472	10,478	10,485	10,491
3240	10,498	10,504	10,511	10,517	10,524	10,530	10,537	10,543	10,550	10,556
3250	10,563	10,569	10,576	10,582	10,589	10,595	10,602	10,608	10,615	10,621
3260	10,628	10,634	10,641	10,647	10,654	10,660	10,667	10,673	10,680	10,686
3270	10,693	10,699	10,706	10,713	10,719	10,726	10,732	10,739	10,745	10,752
3280	10,758	10,765	10,772	10,778	10,785	10,791	10,798	10,804	10,811	10,818
3290	10,824	10,831	10,837	10,844	10,850	10,857	10,864	10,870	10,877	10,883
3300	10,890	10,897	10,903	10,910	10,916	10,923	10,930	10,936	10,943	10,949
3310	10,956	10,936	10,963	10,976	10,983	10,989	10,996	11,002	11,009	11,016
3320	11,022	11,029	11,036	11,042	11,049	11,056	11,062	11,069	11,076	11,082
3330	11,089	11,096	11,102	11,109	11,116	11,122	11,129	11,136	11,142	11,149
3340	11,156	11,162	11,169	11,176	11,182	11,189	11,196	11,202	11,209	11,216
3350	11,223	11,229	11,236	11,243	11,249	11,256	11,263	11,269	11,276	11,283
3360	11,290	11,296	11,303	11,310	11,316	11,323	11,330	11,337	11,343	11,350
3370	11,357	11,364	11,370	11,377	11,384	11,391	11,397	11,404	11,411	11,418
3380	11,424	11,431	11,438	11,445	11,451	11,458	11,465	11,472	11,479	11,485
3390	11,492	11,499	11,506	11,512	11,519	11,526	11,533	11,540	11,546	11,553

	0	1	2	3	4	5	6	7	8	9
3400	11,560	11,567	11,574	11,580	11,587	11,594	11,601	11,608	11,614	11,621
3410	11,628	11,635	11,642	11,649	11,655	11,662	11,669	11,676	11,683	11,690
3420	11,696	11,703	11,710	11,717	11,724	11,731	11,737	11,744	11,751	11,758
3430	11,765	11,772	11,779	11,785	11,792	11,799	11,806	11,813	11,820	11,827
3440	11,834	11,840	11,847	11,854	11,861	11,868	11,875	11,882	11,889	11,896
3450	11,903	11,909	11,916	11,923	11,930	11,937	11,944	11,951	11,958	11,965
3460	11,972	11,979	11,985	11,992	11,999	12,006	12,013	12,020	12,027	12,034
3470	12,041	12,048	12,055	12,062	12,069	12,076	12,083	12,090	12,096	12,103
3480	12,110	12,117	12,124	12,131	12,138	12,145	12,152	12,159	12,166	12,172
3490	12,180	12,187	12,194	12,201	12,208	12,215	12,222	12,229	12,236	12,243
3500	12,250	12,257	12,264	12,271	12,278	12,285	12,292	12,299	12,306	12,313
3510	12,320	12,327	12,234	12,341	12,348	12,355	12,362	12,369	12,376	12,383
3520	12,390	12,397	12,404	12,412	12,419	12,426	12,433	12,440	12,447	12,454
3530	12,461	12,468	12,475	12,482	12,489	12,496	12,503	12,510	12,517	12,525
3540	12,532	12,539	12,546	12,553	12,560	12,567	12,574	12,581	12,588	12,595
3550	12,603	12,610	12,617	12,624	12,631	12,638	12,645	12,652	12,659	12,666
3560	12,674	12,681	12,688	12,695	12,702	12,709	12,716	12,723	12,731	12,738
3570	12,745	12,752	12,759	12,766	12,773	12,781	12,788	12,795	12,802	12,809
3580	12,816	12,824	12,831	12,838	12,845	12,852	12,859	12,867	12,874	12,881
3590	12,088	12,895	12,902	12,910	12,917	12,924	12,931	12,938	12,946	12,953
3600	12,960	12,967	12,974	12,982	12,989	12,996	13,003	13,010	13,018	13,025
3610	13,032	13,039	13,047	13,054	13,061	13,068	13,075	13,083	13,090	13,097
3620	13,104	13,112	13,119	13,126	13,133	13,141	13,148	13,155	13,162	13,170
3630	13,177	13,184	13,191	13,199	13,206	13,213	13,220	13,228	13,235	13,242
3640	13,250	13,257	13,264	13,271	13,279	13,286	13,293	13,301	13,308	13,315
3650	13,323	13,330	13,337	13,344	13,352	13,359	13,366	13,374	13,381	13,388
3660	13,396	13,403	13,410	13,418	13,425	13,432	13,440	13,447	13,454	13,462
3670	13,469	13,476	13,484	13,491	13,498	13,506	13,513	13,520	13,528	13,535
3680	13,542	13,550	13,557	13,564	13,572	13,579	13,587	13,594	13,601	13,609
3690	13,616	13,623	13,631	13,638	13,646	13,653	13,660	13,668	13,675	13,683
3700	13,690	13,697	13,705	13,712	13,720	13,727	13,734	13,742	13,749	13,757
3710	13,764	13,772	13,779	13,786	13,794	13,801	13,809	13,816	13,824	13,831
3720	13,838	13,846	13,853	13,861	13,868	13,876	13,883	13,891	13,898	13,905
3730	13,913	13,920	13,928	13,935	13,943	13,950	13,958	13,965	13,973	13,980
3740	13,988	13,995	14,003	14,010	14,018	14,025	14,033	14,040	14,048	14,055
3750	14,063	14,070	14,078	14,085	14,093	14,100	14,108	14,115	14,123	14,130
3760	14,138	14,145	14,153	14,160	14,168	14,175	14,183	14,190	14,198	14,205
3770	14,213	14,220	14,228	14,236	14,243	14,251	14,258	14,266	14,273	14,281
3780	14,288	14,296	14,304	14,311	14,319	14,326	14,334	14,341	14,349	14,357
3790	14,364	14,372	14,379	14,387	14,394	14,402	14,410	14,417	14,425	14,432
3800	14,440	14,448	14,455	14,463	14,470	14,478	14,486	14,493	14,501	14,508
3810	14,516	14,524	14,531	14,539	14,547	14,554	14,562	14,569	14,577	14,585
3820	14,592	14,600	14,608	14,615	14,623	14,631	14,639	14,646	14,654	14,661
3830	14,669	14,677	14,684	14,692	14,700	14,707	14,715	14,723	14,730	14,738
3840	14,746	14,753	14,761	14,769	14,776	14,784	14,792	14,799	14,807	14,815
3850	14,823	14,830	14,838	14,846	14,853	14,861	14,869	14,876	14,884	14,892
3860	14,900	14,907	14,915	14,923	14,930	14,938	14,946	14,954	14,961	14,969
3870	14,977	14,985	14,992	15,000	15,008	15,016	15,023	15,031	15,039	15,047
3880	15,054	15,062	15,070	15,078	15,085	15,093	15,101	15,109	15,117	15,124
3890	15,132	15,140	15,148	15,156	15,163	15,171	15,179	15,187	15,194	15,202
3900	15,210	15,218	15,226	15,233	15,241	15,249	15,257	15,265	15,272	15,280
3910	15,288	15,296	15,304	15,312	15,319	15,327	15,335	15,343	15,351	15,359
3920	15,366	15,374	15,382	15,390	15,398	15,406	15,413	15,421	15,429	15,437
3930	15,445	15,453	15,461	15,468	15,476	15,484	15,492	15,500	15,508	15,516
3940	15,524	15,531	15,539	15,547	15,555	15,563	15,571	15,579	15,587	15,595

	0	1	2	3	4	5	6	7	8	9
3950	15,603	15,610	15,618	15,626	15,634	15,642	15,650	15,658	15,666	15,674
3960	15,682	15,690	15,697	15,705	15,713	15,721	15,729	15,737	15,745	15,753
3970	15,761	15,769	15,777	15,785	15,793	15,801	15,809	15,817	15,824	15,832
3980	15,840	15,848	15,856	15,864	15,872	15,880	15,888	15,896	15,904	15,912
3990	15,920	15,928	15,936	15,944	15,952	15,960	15,968	15,976	15,984	15,992
4000	16,000	16,008	16,016	16,024	16,032	16,040	16,048	16,056	16,064	16,072
4010	16,080	16,088	16,096	16,104	16,112	16,120	16,128	16,136	16,144	16,152
4020	16,160	16,168	16,176	16,184	16,192	16,201	16,209	16,217	16,225	16,233
4030	16,241	16,249	16,257	16,265	16,273	16,281	16,289	16,297	16,305	16,314
4040	16,322	16,330	16,338	16,346	16,354	16,362	16,370	16,378	16,386	16,394
4050	16,403	16,411	16,419	16,427	16,435	16,443	16,451	16,459	16,467	16,475
4060	16,484	16,492	16,500	16,508	16,516	16,524	16,532	16,540	16,549	16,557
4070	16,565	16,573	16,581	16,589	16,597	16,606	16,614	16,622	16,630	16,638
4080	16,646	16,655	16,663	16,671	16,679	16,687	16,695	16,704	16,712	16,720
4090	16,728	16,736	16,744	16,753	16,761	16,769	16,777	16,785	16,794	16,802
4100	16,810	16,818	16,826	16,835	16,843	16,851	16,859	16,867	16,876	16,884
4110	16,892	16,900	16,909	16,917	16,925	16,933	16,941	16,950	16,958	16,966
4120	16,974	16,983	16,991	16,999	17,007	17,016	17,024	17,032	17,040	17,049
4130	17,057	17,065	17,073	17,082	17,090	17,098	17,106	17,115	17,123	17,131
4140	17,140	17,148	17,156	17,164	17,173	17,181	17,189	17,198	17,206	17,214
4150	17,223	17,231	17,239	17,247	17,256	17,264	17,272	17,281	17,289	17,297
4160	17,306	17,314	17,322	17,331	17,339	17,347	17,356	17,364	17,372	17,381
4170	17,389	17,397	17,406	17,414	17,422	17,431	17,439	17,447	17,456	17,464
4180	17,472	17,481	17,489	17,497	17,505	17,514	17,522	17,531	17,539	17,548
4190	17,556	17,564	17,573	17,581	17,590	17,598	17,606	17,615	17,623	17,632
4200	17,640	17,648	17,657	17,665	17,674	17,682	17,690	17,699	17,707	17,716
4210	17,724	17,733	17,741	17,749	17,758	17,766	17,775	17,783	17,792	17,800
4220	17,808	17,817	17,825	17,834	17,842	17,851	17,859	17,868	17,876	17,884
4230	17,893	17,901	17,910	17,918	17,927	17,935	17,944	17,952	17,961	17,969
4240	17,978	17,986	17,995	18,003	18,012	18,020	18,029	18,037	18,046	18,054
4250	18,063	18,071	18,080	18,088	18,097	18,105	18,114	18,122	18,131	18,139
4260	18,148	18,156	18,165	18,173	18,182	18,190	18,199	18,207	18,216	18,224
4270	18,233	18,241	18,250	18,259	18,267	18,276	18,284	18,293	18,301	18,310
4280	18,318	18,327	18,336	18,344	18,353	18,361	18,370	18,378	18,387	18,396
4290	18,404	18,413	18,421	18,430	18,438	18,447	18,456	18,464	18,473	18,481
4300	18,490	18,499	18,507	18,516	18,524	18,533	18,542	18,550	18,559	18,567
4310	18,576	18,585	18,593	18,602	18,611	18,619	18,628	18,636	18,645	18,654
4320	18,662	18,671	18,680	18,688	18,697	18,706	18,714	18,723	18,732	18,740
4330	18,749	18,758	18,766	18,775	18,784	18,792	18,801	18,810	18,818	18,827
4340	18,836	18,844	18,853	18,862	18,870	18,879	18,888	18,896	18,905	18,914
4350	18,923	18,931	18,940	18,949	18,957	18,966	18,975	18,983	18,992	19,001
4360	19,010	19,018	19,027	19,036	19,044	19,053	19,062	19,071	19,079	19,088
4370	19,097	19,106	19,114	19,123	19,132	19,141	19,149	19,158	19,167	19,176
4380	19,184	19,193	19,202	19,211	19,219	19,228	19,237	19,246	19,255	19,263
4390	19,272	19,281	19,290	19,298	19,307	19,316	19,325	19,334	19,342	19,351
4400	19,360	19,369	19,378	19,386	19,395	19,404	19,413	19,422	19,430	19,439
4410	19,448	19,457	19,466	19,475	19,483	19,492	19,501	19,510	19,519	19,528
4420	19,536	19,545	19,554	19,563	19,572	19,581	19,589	19,598	19,607	19,616
4430	19,625	19,634	19,643	19,651	19,660	19,669	19,678	19,687	19,696	19,705
4440	19,714	19,722	19,731	19,740	19,749	19,758	19,767	19,776	19,785	19,794
4450	19,802	19,811	19,820	19,829	19,838	19,847	19,856	19,865	19,874	19,883
4460	19,892	19,901	19,909	19,918	19,927	19,936	19,945	19,954	19,963	19,972
4470	19,981	19,990	19,999	20,008	20,017	20,026	20,035	20,044	20,052	20,061
4480	20,070	20,079	20,088	20,097	20,106	20,115	20,124	20,133	20,142	20,151
4490	20,160	20,169	20,178	20,187	20,197	20,205	20,214	20,223	20,232	20,241

	0	1	2	3	4	5	6	7	8	9
4500	20,250	20,259	20,268	20,277	20,286	20,295	20,304	20,313	20,322	20,331
4510	20,340	20,349	20,358	20,367	20,376	20,385	20,394	20,403	20,412	20,421
4520	20,430	20,439	20,448	20,458	20,467	20,476	20,485	20,494	20,503	20,512
4530	20,521	20,530	20,539	20,548	20,557	20,566	20,575	20,584	20,593	20,603
4540	20,612	20,621	20,630	20,639	20,648	20,657	20,666	20,675	20,684	20,693
4550	20,702	20,712	20,721	20,730	20,739	20,748	20,757	20,766	20,775	20,784
4560	20,794	20,803	20,812	20,821	20,830	20,839	20,848	20,857	20,866	20,876
4570	20,885	20,894	20,903	20,912	20,921	20,931	20,940	20,949	20,950	20,967
4580	20,976	20,986	20,995	21,004	21,013	21,022	21,031	21,041	21,050	21,059
4590	21,068	21,077	21,086	21,096	21,105	21,114	21,123	21,132	21,142	21,151
4600	21,160	21,169	21,178	21,188	21,197	21,206	21,215	21,224	21,234	21,243
4610	21,252	21,261	21,271	21,280	21,289	21,298	21,307	21,317	21,326	21,335
4620	21,344	21,354	21,363	21,372	21,381	21,391	21,400	21,409	21,418	21,428
4630	21,437	21,446	21,455	21,465	21,474	21,483	21,492	21,502	21,511	21,520
4640	21,530	21,539	21,548	21,557	21,567	21,576	21,585	21,595	21,604	21,613
4650	21,623	21,632	21,641	21,650	21,660	21,669	21,678	21,688	21,697	21,706
4660	21,716	21,725	21,734	21,744	21,753	21,762	21,772	21,781	21,790	21,800
4670	21,809	21,818	21,828	21,837	21,846	21,856	21,865	21,874	21,884	21,893
4680	21,902	21,912	21,921	21,930	21,940	21,949	21,959	21,968	21,977	21,987
4690	21,996	22,005	22,015	22,024	22,034	22,043	22,052	22,062	22,071	22,081
4700	22,090	22,099	22,109	22,118	22,128	22,137	22,146	22,156	22,165	22,175
4710	22,184	22,194	22,203	22,212	22,222	22,231	22,241	22,250	22,260	22,269
4720	22,278	22,288	22,297	22,307	22,316	22,326	22,335	22,345	22,354	22,363
4730	22,373	22,382	22,392	22,401	22,411	22,420	22,430	22,439	22,449	22,458
4740	22,468	22,477	22,487	22,496	22,506	22,515	22,525	22,534	22,544	22,553
4750	22,562	22,572	22,582	22,591	22,601	22,610	22,620	22,629	22,639	22,648
4760	22,658	22,667	22,677	22,686	22,696	22,705	22,715	22,724	22,734	22,743
4770	22,753	22,762	22,772	22,782	22,791	22,801	22,810	22,820	22,829	22,839
4780	22,848	22,858	22,868	22,877	22,887	22,896	22,906	22,915	22,925	22,935
4790	22,944	22,954	22,963	22,973	22,982	22,992	23,002	23,011	23,021	23,030
4800	23,040	23,050	23,059	23,069	23,078	23,088	23,098	23,107	23,117	23,126
4810	23,136	23,146	23,155	23,165	23,175	23,184	23,194	23,203	23,213	23,223
4820	23,232	23,242	23,252	23,261	23,271	23,281	23,290	23,300	23,310	23,319
4830	23,329	23,339	23,348	23,358	23,368	23,377	23,387	23,397	23,406	23,416
4840	23,426	23,435	23,445	23,455	23,464	23,474	23,484	23,493	23,503	23,513
4850	23,522	23,532	23,542	23,552	23,561	23,571	23,581	23,590	23,600	23,610
4860	23,620	23,629	23,639	23,649	23,658	23,668	23,678	23,688	23,697	23,707
4870	23,717	23,727	23,736	23,746	23,756	23,766	23,775	23,785	23,795	23,805
4880	23,814	23,824	23,834	23,844	23,853	23,863	23,873	23,883	23,893	23,902
4890	23,912	23,922	23,932	23,941	23,951	23,961	23,971	23,981	23,990	24,000
4900	24,010	24,020	24,030	24,039	24,049	24,059	24,069	24,079	24,088	24,098
4910	24,108	24,118	24,128	24,138	24,147	24,157	24,167	24,177	24,187	24,197
4920	24,206	24,216	24,226	24,236	24,246	24,256	24,266	24,275	24,285	24,295
4930	24,305	24,315	24,325	24,334	24,344	24,354	24,364	24,374	24,384	24,394
4940	24,404	24,413	24,423	24,433	24,443	24,453	24,463	24,473	24,483	24,493
4950	24,502	24,512	24,522	24,532	24,542	24,552	24,562	24,572	24,582	24,592
4960	24,602	24,612	24,621	24,631	24,641	24,651	24,661	24,671	24,681	24,691
4970	24,701	24,711	24,721	24,731	24,741	24,751	24,761	24,771	24,780	24,790
4980	24,800	24,810	24,820	24,830	24,840	24,850	24,860	24,870	24,880	24,890
4990	24,900	24,910	24,920	24,930	24,940	24,950	24,960	24,970	24,980	24,990
5000	25,000	25,010	25,020	25,030	25,040	25,050	25,060	25,070	25,080	25,090
5010	25,100	25,110	25,120	25,130	25,140	25,150	25,160	25,170	25,180	25,190
5020	25,200	25,210	25,220	25,231	25,241	25,251	25,261	25,271	25,281	25,291
5030	25,301	25,311	25,321	25,331	25,341	25,351	25,361	25,371	25,381	25,392
5040	25,402	25,412	25,422	25,432	25,442	25,452	25,462	25,472	25,482	25,492

	0	1	2	3	4	5	6	7	8	9
5050	25,502	25,513	25,523	25,533	25,543	25,553	25,563	25,573	25,583	25,593
5060	25,604	25,614	25,624	25,634	25,644	25,654	25,664	25,674	25,685	25,695
5070	25,705	25,715	25,725	25,735	25,745	25,756	25,766	25,776	25,786	25,796
5080	25,806	25,817	25,827	25,837	25,847	25,857	25,867	25,878	25,888	25,898
5090	25,908	25,918	25,928	25,939	25,949	25,959	25,969	25,979	25,990	26,000
5100	26,010	26,020	26,030	26,041	26,051	26,061	26,071	26,081	26,092	26,102
5110	26,112	26,122	26,133	26,143	26,153	26,163	26,173	26,184	26,194	26,204
5120	26,214	26,225	26,235	26,245	26,255	26,266	26,276	26,286	26,296	26,307
5130	26,317	26,327	26,337	26,348	26,358	26,368	26,378	26,389	26,399	26,409
5140	26,420	26,430	26,440	26,450	26,461	26,471	26,481	26,492	26,502	26,512
5150	26,522	26,533	26,543	26,553	26,564	26,574	26,584	26,594	26,605	26,615
5160	26,626	26,636	26,646	26,657	26,667	26,677	26,688	26,698	26,708	26,719
5170	26,729	26,739	26,750	26,760	26,770	26,781	26,791	26,801	26,812	26,822
5180	26,832	26,843	26,853	26,863	26,874	26,884	26,895	26,905	26,915	26,926
5190	26,936	26,946	26,957	26,967	26,976	26,988	26,998	27,009	27,019	27,030
5200	27,040	27,050	27,061	27,071	27,082	27,092	27,102	27,113	27,123	27,134
5210	27,144	27,155	27,165	27,175	27,186	27,196	27,207	27,217	27,228	27,238
5220	27,248	27,259	27,269	27,280	27,290	27,301	27,311	27,322	27,332	27,342
5230	27,353	27,363	27,374	27,384	27,395	27,405	27,416	27,426	27,437	27,447
5240	27,458	27,468	27,479	27,489	27,500	27,510	27,521	27,531	27,542	27,552
5250	27,562	27,573	27,584	27,594	27,605	27,615	27,626	27,636	27,647	27,657
5260	27,668	27,678	27,689	27,699	27,710	27,720	27,731	27,741	27,752	27,762
5270	27,773	27,783	27,794	27,805	27,815	27,826	27,836	27,847	27,857	27,868
5280	27,878	27,889	27,900	27,910	27,921	27,931	27,942	27,952	27,963	27,974
5290	27,984	27,995	28,005	28,016	28,026	28,037	28,048	28,058	28,069	28,079
5300	28,090	28,101	28,111	28,122	28,132	28,143	28,154	28,164	28,175	28,185
5310	28,196	28,207	28,217	28,228	28,239	28,249	28,260	28,270	28,281	28,292
5320	28,302	28,313	28,324	28,334	28,345	28,356	28,366	28,377	28,388	28,398
5330	28,409	28,420	28,430	28,441	28,452	28,462	28,473	28,484	28,494	28,505
5340	28,516	28,526	28,537	28,548	28,558	28,569	28,580	28,590	28,601	28,612
5350	28,623	28,633	28,644	28,655	28,665	28,676	28,687	28,697	28,708	28,719
5360	28,730	28,740	28,751	28,762	28,772	28,783	28,794	28,805	28,815	28,826
5370	28,837	28,848	28,858	28,869	28,880	28,891	28,901	28,912	28,923	28,934
5380	28,944	28,955	28,966	28,977	28,987	28,998	29,009	29,020	29,031	29,041
5390	29,052	29,063	29,074	29,084	29,095	29,106	29,117	29,128	29,138	29,149
5400	29,160	29,171	29,182	29,192	29,203	29,214	29,225	29,236	29,246	29,257
5410	29,268	29,279	29,290	29,301	29,311	29,322	29,333	29,344	29,355	29,366
5420	29,376	29,387	29,398	29,409	29,420	29,431	29,441	29,452	29,463	29,474
5430	29,485	29,496	29,507	29,517	29,528	29,539	29,550	29,561	29,572	29,583
5440	29,594	29,604	29,615	29,626	29,637	29,648	29,659	29,670	29,681	29,692
5450	29,702	29,713	29,724	29,735	29,746	29,757	29,768	29,779	29,790	29,801
5460	29,812	29,823	29,833	29,844	29,855	29,866	29,877	29,888	29,899	29,910
5470	29,921	29,932	29,943	29,954	29,965	29,976	29,987	29,998	30,008	30,019
5480	30,030	30,041	30,052	30,063	30,074	30,085	30,096	30,107	30,118	30,129
5490	30,140	30,151	30,162	30,173	30,184	30,195	30,206	30,217	30,228	30,259
5500	30,250	30,261	30,272	30,283	30,294	30,305	30,316	30,327	30,338	30,349
5510	30,360	30,371	30,382	30,393	30,404	30,415	30,426	30,437	30,448	30,459
5520	30,470	30,481	30,492	30,504	30,515	30,526	30,537	30,548	30,559	30,570
5530	30,581	30,592	30,603	30,614	30,625	30,636	30,647	30,658	30,669	30,681
5540	30,692	30,703	30,714	30,725	30,736	30,747	30,758	30,769	30,780	30,791
5550	30,802	30,814	30,825	30,836	30,847	30,858	30,869	30,880	30,891	30,902
5560	30,914	30,925	30,936	30,947	30,958	30,969	30,980	30,991	31,003	31,014
5570	31,025	31,036	31,047	31,058	31,069	31,081	31,092	31,103	31,114	31,125
5580	31,136	31,148	31,159	31,170	31,181	31,192	31,203	31,215	31,226	31,237
5590	31,248	31,259	31,270	31,282	31,293	31,304	31,315	31,326	31,338	31,349

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
5600	31,360	31,371	31,382	31,394	31,405	31,416	31,427	31,438	31,450	31,461
5610	31,472	31,483	31,495	31,506	31,517	31,528	31,539	31,551	31,562	31,573
5620	31,584	31,596	31,607	31,618	31,629	31,641	31,652	31,663	31,674	31,686
5630	31,697	31,708	31,719	31,731	31,742	31,753	31,764	31,776	31,787	31,798
5640	31,810	31,821	31,832	31,843	31,855	31,866	31,877	31,889	31,900	31,911
5650	31,922	31,934	31,945	31,956	31,968	31,979	31,990	32,002	32,013	32,024
5660	32,036	32,047	32,058	32,070	32,081	32,092	32,104	32,115	32,126	32,138
5670	32,149	32,160	32,172	32,183	32,194	32,206	32,217	32,228	32,240	32,251
5680	32,262	32,274	32,285	32,296	32,308	32,319	32,331	32,342	32,353	32,365
5690	32,376	32,387	32,399	32,410	32,422	32,433	32,444	32,456	32,467	32,479
5700	32,490	32,501	32,513	32,524	32,536	32,547	32,558	32,570	32,581	32,593
5710	32,604	32,616	32,627	32,638	32,650	32,661	32,673	32,684	32,696	32,707
5720	32,718	32,730	32,741	32,753	32,764	32,776	32,787	32,799	32,810	32,821
5730	32,833	32,844	32,856	32,867	32,879	32,890	32,902	32,913	32,925	32,936
5740	32,948	32,959	32,971	32,982	32,994	33,005	33,017	33,028	33,040	33,051
5750	33,062	33,074	33,086	33,097	33,109	33,120	33,132	33,143	33,155	33,166
5760	33,178	33,189	33,201	33,212	33,224	33,235	33,247	33,258	33,270	33,281
5770	33,293	33,304	33,316	33,328	33,339	33,351	33,362	33,374	33,385	33,397
5780	33,408	33,420	33,432	33,443	33,455	33,466	33,478	33,489	33,501	33,513
5790	33,524	33,536	33,547	33,559	33,570	33,582	33,594	33,605	33,617	33,628
5800	33,640	33,652	33,663	33,675	33,686	33,698	33,710	33,721	33,733	33,744
5810	33,756	33,768	33,779	33,791	33,803	33,814	33,826	33,837	33,849	33,861
5820	33,872	33,884	33,896	33,907	33,919	33,931	33,942	33,954	33,966	33,977
5830	33,989	34,001	34,012	34,024	34,036	34,047	34,059	34,071	34,082	34,094
5840	34,106	34,117	34,129	34,141	34,152	34,164	34,176	34,187	34,199	34,211
5850	34,222	34,234	34,246	34,258	34,269	34,281	34,293	34,304	34,316	34,328
5860	34,340	34,351	34,363	34,375	34,386	34,398	34,410	34,422	34,433	34,445
5870	34,457	34,469	34,480	34,492	34,504	34,516	34,527	34,539	34,551	34,563
5880	34,574	34,586	34,598	34,610	34,621	34,633	34,645	34,657	34,669	34,680
5890	34,692	34,704	34,716	34,727	34,739	34,751	34,763	34,775	34,786	34,798
5900	34,810	34,822	34,834	34,845	34,857	34,869	34,881	34,893	34,904	34,916
5910	34,928	34,940	34,952	34,964	34,975	34,987	34,999	35,011	35,023	35,035
5920	35,046	35,058	35,070	35,082	35,094	35,106	35,117	35,129	35,141	35,153
5930	35,165	35,177	35,189	35,200	35,212	35,224	35,236	35,248	35,260	35,272
5940	35,284	35,295	35,307	35,319	35,331	35,343	35,355	35,367	35,379	35,391
5950	35,402	35,414	35,426	35,438	35,450	35,462	35,474	35,486	35,498	35,510
5960	35,522	35,534	35,545	35,557	35,569	35,581	35,593	35,605	35,617	35,629
5970	35,641	35,653	35,665	35,677	35,689	35,701	35,713	35,725	35,736	35,748
5980	35,760	35,772	35,784	35,796	35,808	35,820	35,832	35,844	35,856	35,868
5990	35,880	35,892	35,904	35,916	35,928	35,940	35,952	35,964	35,976	35,988
6000	36,000	36,012	36,024	36,036	36,048	36,060	36,072	36,084	36,096	36,108
6010	36,120	36,132	36,144	36,156	36,168	36,180	36,192	36,204	36,216	36,228
6020	36,240	36,252	36,264	36,277	36,289	36,301	36,313	36,325	36,337	36,349
6030	36,361	36,373	36,385	36,397	36,409	36,421	36,433	36,445	36,457	36,470
6040	36,482	36,494	36,506	36,518	36,530	36,542	36,554	36,566	36,578	36,590
6050	36,602	36,615	36,627	36,639	36,651	36,663	36,675	36,687	36,699	36,711
6060	36,724	36,736	36,748	36,760	36,772	36,784	36,796	36,808	36,821	36,833
6070	36,845	36,857	36,869	36,881	36,893	36,906	36,918	36,930	36,942	36,954
6080	36,966	36,979	36,991	37,003	37,015	37,027	37,039	37,052	37,064	37,076
6090	37,088	37,100	37,112	37,125	37,137	37,149	37,161	37,173	37,186	37,198
6100	37,210	37,222	37,234	37,247	37,259	37,271	37,283	37,295	37,308	37,320
6110	37,332	37,344	37,357	37,369	37,381	37,393	37,405	37,418	37,430	37,442
6120	37,454	37,467	37,479	37,491	37,503	37,516	37,528	37,540	37,552	37,565
6130	37,577	37,589	37,601	37,614	37,626	37,638	37,650	37,663	37,675	37,687
6140	37,700	37,712	37,724	37,736	37,749	37,761	37,773	37,786	37,798	37,810

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
6150	37,822	37,835	37,847	37,859	37,871	37,884	37,896	37,909	37,921	37,933
6160	37,946	37,958	37,970	37,982	37,995	38,007	38,020	38,032	38,044	38,057
6170	38,069	38,081	38,094	38,106	38,118	38,131	38,143	38,155	38,168	38,180
6180	38,192	38,205	38,217	38,229	38,242	38,254	38,267	38,279	38,291	38,304
6190	38,316	38,328	38,341	38,353	38,366	38,378	38,390	38,403	38,415	38,428
6200	38,440	38,452	38,465	38,477	38,490	38,502	38,514	38,527	38,539	38,552
6210	38,564	38,576	38,589	38,601	38,614	38,626	38,639	38,651	38,664	38,676
6220	38,688	38,701	38,713	38,726	38,738	38,751	38,763	38,776	38,788	38,800
6230	38,813	38,825	38,838	38,850	38,863	38,875	38,888	38,900	38,913	38,925
6240	38,938	38,950	38,963	38,975	38,988	39,000	39,013	39,025	39,038	39,050
6250	39,062	39,075	39,088	39,100	39,113	39,125	39,138	39,150	39,163	39,175
6260	39,188	39,200	39,213	39,225	39,238	39,250	39,263	39,275	39,288	39,300
6270	39,313	39,325	39,338	39,351	39,363	39,376	39,388	39,401	39,413	39,426
6280	39,438	39,451	39,464	39,476	39,489	39,501	39,514	39,526	39,539	39,552
6290	39,564	39,577	39,589	39,602	39,614	39,627	39,640	39,652	39,665	39,677
6300	39,690	39,703	39,715	39,728	39,740	39,753	39,766	39,778	39,791	39,803
6310	39,816	39,829	39,841	39,854	39,867	39,879	39,892	39,904	39,917	39,930
6320	39,942	39,955	39,968	39,980	39,993	40,006	40,018	40,031	40,044	40,056
6330	40,069	40,082	40,094	40,107	40,120	40,132	40,145	40,158	40,170	40,183
6340	40,196	40,208	40,221	40,234	40,246	40,259	40,272	40,284	40,297	40,310
6350	40,322	40,335	40,348	40,361	40,373	40,386	40,399	40,411	40,424	40,437
6360	40,450	40,462	40,475	40,488	40,500	40,513	40,526	40,539	40,551	40,564
6370	40,577	40,590	40,602	40,615	40,628	40,641	40,653	40,666	40,679	40,692
6380	40,704	40,717	40,730	40,743	40,755	40,768	40,781	40,794	40,807	40,819
6390	40,832	40,845	40,858	40,870	40,883	40,896	40,909	40,922	40,934	40,947
6400	40,960	40,973	40,986	40,998	41,011	41,024	41,037	41,050	41,062	41,075
6410	41,088	41,101	41,114	41,127	41,139	41,152	41,165	41,178	41,191	41,204
6420	41,216	41,229	41,242	41,255	41,268	41,281	41,293	41,306	41,319	41,332
6430	41,345	41,358	41,371	41,383	41,396	41,409	41,422	41,435	41,448	41,461
6440	41,474	41,486	41,499	41,512	41,525	41,538	41,551	41,564	41,577	41,590
6450	41,602	41,615	41,628	41,641	41,654	41,667	41,680	41,693	41,706	41,719
6460	41,732	41,745	41,757	41,770	41,783	41,796	41,809	41,822	41,835	41,848
6470	41,861	41,874	41,887	41,900	41,913	41,926	41,939	41,951	41,964	41,977
6480	41,990	42,003	42,016	42,029	42,042	42,055	42,068	42,081	42,094	42,107
6490	42,120	42,133	42,146	42,159	42,172	42,185	42,198	42,211	42,224	42,237
6500	42,250	42,263	42,276	42,289	42,302	42,315	42,328	42,341	42,354	42,367
6510	42,380	42,393	42,406	42,419	42,432	42,445	42,458	42,471	42,484	42,497
6520	42,510	42,523	42,536	42,550	42,563	42,576	42,589	42,602	42,615	42,628
6530	42,641	42,654	42,667	42,680	42,693	42,706	42,719	42,732	42,745	42,758
6540	42,772	42,785	42,798	42,811	42,824	42,837	42,850	42,863	42,876	42,889
6550	42,902	42,916	42,929	42,942	42,955	42,968	42,981	42,994	43,007	43,020
6560	43,034	43,047	43,060	43,073	43,086	43,099	43,112	43,125	43,139	43,152
6570	43,165	43,178	43,191	43,204	43,217	43,231	43,244	43,257	43,270	43,283
6580	43,296	43,310	43,323	43,336	43,349	43,362	43,375	43,389	43,402	43,415
6590	43,428	43,441	43,454	43,468	43,481	43,494	43,507	43,520	43,534	43,547
6600	43,560	43,573	43,586	43,600	43,613	43,626	43,639	43,652	43,666	43,679
6610	43,692	43,705	43,719	43,732	43,745	43,758	43,771	43,785	43,798	43,811
6620	43,824	43,838	43,851	43,864	43,877	43,891	43,904	43,917	43,930	43,944
6630	43,957	43,970	43,983	43,997	44,010	44,023	44,036	44,050	44,063	44,076
6640	44,090	44,103	44,116	44,129	44,143	44,156	44,169	44,183	44,196	44,209
6650	44,222	44,236	44,249	44,262	44,276	44,289	44,302	44,316	44,329	44,342
6660	44,356	44,369	44,382	44,396	44,409	44,422	44,436	44,449	44,462	44,476
6670	44,489	44,502	44,516	44,529	44,542	44,556	44,569	44,582	44,596	44,609
6680	44,622	44,636	44,649	44,662	44,676	44,689	44,703	44,716	44,729	44,743
6690	44,756	44,769	44,783	44,796	44,810	44,823	44,836	44,850	44,863	44,877

	0	1	2	3	4	5	6	7	8	9
6700	44,890	44,903	44,917	44,930	44,944	44,957	44,970	44,984	44,997	45,011
6710	45,024	45,038	45,051	45,064	45,078	45,091	45,105	45,118	45,132	45,145
6720	45,158	45,172	45,185	45,199	45,212	45,226	45,239	45,253	45,266	45,279
6730	45,293	45,306	45,320	45,333	45,347	45,360	45,374	45,387	45,401	45,414
6740	45,428	45,441	45,455	45,468	45,482	45,495	45,509	45,522	45,536	45,549
6750	45,562	45,576	45,590	45,603	45,617	45,630	45,644	45,657	45,671	45,684
6760	45,698	45,711	45,725	45,738	45,752	45,765	45,779	45,792	45,806	45,819
6770	45,833	45,846	45,860	45,874	45,887	45,901	45,914	45,928	45,941	45,955
6780	45,968	45,982	45,996	46,009	46,023	46,036	46,050	46,063	46,077	46,091
6790	46,104	46,118	46,131	46,145	46,158	46,172	46,186	46,199	46,213	46,226
6800	46,240	46,254	46,267	46,281	46,294	46,308	46,322	46,335	46,349	46,362
6810	46,376	46,390	46,403	46,417	46,431	46,444	46,458	46,471	46,485	46,499
6820	46,512	46,526	46,540	46,553	46,567	46,581	46,594	46,608	46,622	46,635
6830	46,649	46,663	46,676	46,690	46,704	46,717	46,731	46,745	46,758	46,772
6840	46,786	46,799	46,813	46,827	46,840	46,854	46,868	46,881	46,895	46,909
6850	46,922	46,936	46,950	46,964	46,977	46,991	47,005	47,018	47,032	47,046
6860	47,060	47,073	47,087	47,101	47,114	47,128	47,142	47,156	47,169	47,183
6870	47,197	47,211	47,224	47,238	47,252	47,266	47,279	47,293	47,307	47,321
6880	47,334	47,348	47,362	47,376	47,389	47,403	47,417	47,431	47,445	47,458
6890	47,472	47,486	47,500	47,513	47,527	47,541	47,555	47,569	47,582	47,596
6900	47,610	47,624	47,636	47,651	47,665	47,679	47,693	47,707	47,720	47,734
6910	47,748	47,762	47,776	47,790	47,803	47,817	47,831	47,845	47,859	47,873
6920	47,886	47,900	47,914	47,928	47,942	47,956	47,969	47,983	47,997	48,011
6930	48,025	48,039	48,053	48,066	48,080	48,094	48,108	48,122	48,136	48,150
6940	48,164	48,177	48,191	48,205	48,219	48,233	48,247	48,261	48,275	48,289
6950	48,302	48,316	48,330	48,344	48,358	48,372	48,386	48,400	48,414	48,428
6960	48,442	48,456	48,469	48,483	48,497	48,511	48,525	48,539	48,553	48,567
6970	48,581	48,595	48,609	48,623	48,637	48,651	48,665	48,679	48,692	48,706
6980	48,720	48,734	48,748	48,762	48,776	48,790	48,804	48,818	48,832	48,846
6990	48,860	48,874	48,888	48,902	48,916	48,930	48,944	48,958	48,972	48,986
7000	49,000	49,014	49,028	49,042	49,056	49,070	49,084	49,098	49,112	49,126
7010	49,140	49,154	49,168	49,182	49,196	49,210	49,224	49,238	49,252	49,266
7020	49,280	49,294	49,308	49,323	49,337	49,351	49,365	49,379	49,393	49,407
7030	49,421	49,435	49,449	49,463	49,477	49,491	49,505	49,519	49,533	49,548
7040	49,562	49,576	49,590	49,604	49,618	49,632	49,646	49,660	49,674	49,688
7050	49,702	49,717	49,731	49,745	49,759	49,773	49,787	49,801	49,815	49,829
7060	49,844	49,858	49,872	49,886	49,900	49,914	49,928	49,942	49,957	49,971
7070	49,985	49,999	50,013	50,027	50,041	50,056	50,070	50,084	50,098	50,112
7080	50,126	50,141	50,154	50,169	50,183	50,197	50,211	50,226	50,240	50,254
7090	50,268	50,282	50,296	50,311	50,325	50,339	50,353	50,367	50,382	50,396
7100	50,410	50,424	50,438	50,453	50,467	50,481	50,495	50,509	50,524	50,538
7110	50,552	50,566	50,581	50,595	50,609	50,623	50,637	50,652	50,666	50,680
7120	50,694	50,709	50,723	50,737	50,751	50,766	50,780	50,794	50,808	50,823
7130	50,837	50,851	50,865	50,880	50,894	50,908	50,922	50,937	50,951	50,965
7140	50,980	50,994	51,008	51,022	51,037	51,051	51,065	51,080	51,094	51,108
7150	51,122	51,137	51,151	51,165	51,180	51,194	51,208	51,223	51,237	51,251
7160	51,266	51,280	51,294	51,309	51,323	51,337	51,352	51,366	51,380	51,395
7170	51,409	51,423	51,438	51,452	51,466	51,481	51,495	51,509	51,524	51,538
7180	51,552	51,567	51,581	51,595	51,610	51,624	51,639	51,653	51,667	51,682
7190	51,696	51,710	51,725	51,739	51,754	51,768	51,782	51,797	51,811	51,826
7200	51,840	51,854	51,869	51,883	51,898	51,912	51,926	51,941	51,955	51,970
7210	51,984	51,999	52,013	52,027	52,042	52,056	52,071	52,085	52,100	52,114
7220	52,128	52,143	52,157	52,172	52,186	52,201	52,215	52,230	52,244	52,258
7230	52,273	52,287	52,302	52,316	52,331	52,345	52,360	52,374	52,389	52,403
7240	52,418	52,432	52,447	52,461	52,476	52,490	52,505	52,519	52,534	52,548

	0	1	2	3	4	5	6	7	8	9
7250	52,562	52,577	52,592	52,606	52,621	52,635	52,650	52,664	52,679	52,693
7260	52,708	52,722	52,737	52,751	52,766	52,780	52,795	52,809	52,824	52,838
7270	52,853	52,867	52,882	52,897	52,911	52,926	52,940	52,955	52,969	52,984
7280	52,998	53,013	53,028	53,042	53,057	53,071	53,086	53,100	53,115	53,130
7290	53,144	53,159	53,173	53,188	53,202	53,217	53,232	53,246	53,261	53,275
7300	53,290	53,305	53,319	53,334	53,348	53,363	53,378	53,392	53,407	53,421
7310	53,436	53,451	53,465	53,480	53,495	53,509	53,524	53,538	53,553	53,568
7320	53,582	53,597	53,612	53,626	53,641	53,656	53,670	53,685	53,700	53,714
7330	53,729	53,744	53,758	53,773	53,788	53,802	53,817	53,832	53,846	53,861
7340	53,876	53,890	53,905	53,920	53,934	53,949	53,964	53,978	53,993	54,008
7350	54,023	54,037	54,052	54,067	54,081	54,096	54,111	54,125	54,140	54,155
7360	54,170	54,184	54,199	54,214	54,228	54,243	54,258	54,273	54,287	54,302
7370	54,317	54,332	54,346	54,361	54,376	54,391	54,405	54,420	54,435	54,450
7380	54,464	54,479	54,494	54,509	54,523	54,538	54,553	54,568	54,583	54,597
7390	54,612	54,627	54,642	54,656	54,671	54,686	54,701	54,716	54,730	54,745
7400	54,760	54,775	54,790	54,804	54,819	54,834	54,849	54,864	54,878	54,893
7410	54,908	54,923	54,938	54,953	54,967	54,982	54,997	55,012	55,027	55,042
7420	55,056	55,071	55,086	55,101	55,116	55,131	55,145	55,160	55,175	55,190
7430	55,205	55,220	55,235	55,249	55,264	55,279	55,294	55,309	55,324	55,339
7440	55,350	55,368	55,383	55,398	55,413	55,428	55,443	55,458	55,473	55,488
7450	55,502	55,517	55,532	55,547	55,562	55,577	55,592	55,607	55,622	55,637
7460	55,652	55,667	55,681	55,696	55,711	55,726	55,741	55,756	55,771	55,786
7470	55,801	55,816	55,831	55,846	55,861	55,876	55,891	55,906	55,920	55,935
7480	55,950	55,965	55,980	55,995	56,010	56,025	56,040	56,055	56,070	56,085
7490	56,100	56,115	56,130	56,145	56,160	56,175	56,190	56,205	56,220	56,235
7500	56,250	56,265	56,280	56,295	56,310	56,325	56,340	56,355	56,370	56,385
7510	56,400	56,415	56,430	56,445	56,460	56,475	56,490	56,505	56,520	56,535
7520	56,550	56,565	56,580	56,596	56,611	56,626	56,641	56,656	56,671	56,686
7530	56,701	56,716	56,731	56,746	56,761	56,776	56,791	56,806	56,821	56,837
7540	56,852	56,867	56,882	56,897	56,912	56,927	56,942	56,957	56,972	56,987
7550	57,002	57,018	57,033	57,048	57,063	57,078	57,093	57,108	57,123	57,138
7560	57,154	57,169	57,184	57,199	57,214	57,229	57,244	57,259	57,275	57,290
7570	57,305	57,320	57,335	57,350	57,365	57,381	57,396	57,411	57,426	57,441
7580	57,456	57,472	57,487	57,502	57,517	57,532	57,547	57,563	57,578	57,593
7590	57,608	57,623	57,638	57,654	57,669	57,684	57,699	57,714	57,730	57,745
7600	57,760	57,775	57,790	57,806	57,821	57,836	57,851	57,866	57,882	57,897
7610	57,912	57,927	57,943	57,958	57,973	57,988	58,003	58,019	58,034	58,049
7620	58,064	58,080	58,095	58,110	58,125	58,141	58,156	58,171	58,186	58,202
7630	58,217	58,232	58,247	58,263	58,278	58,293	58,308	58,324	58,339	58,354
7640	58,370	58,385	58,400	58,415	58,431	58,446	58,461	58,477	58,492	58,507
7650	58,522	58,538	58,553	58,568	58,584	58,599	58,614	58,630	58,645	58,660
7660	58,676	58,691	58,706	58,722	58,737	58,752	58,768	58,783	58,798	58,814
7670	58,829	58,844	58,860	58,875	58,890	58,906	58,921	58,936	58,952	58,967
7680	58,982	58,998	59,013	59,028	59,044	59,059	59,075	59,090	59,105	59,121
7690	59,136	59,151	59,167	59,182	59,198	59,213	59,228	59,244	59,259	59,275
7700	59,290	59,305	59,321	59,336	59,352	59,367	59,382	59,398	59,413	59,429
7710	59,444	59,460	59,475	59,490	59,506	59,521	59,537	59,552	59,568	59,583
7720	59,598	59,614	59,629	59,645	59,660	59,676	59,691	59,707	59,722	59,737
7730	59,753	59,768	59,784	59,799	59,815	59,830	59,846	59,861	59,877	59,892
7740	59,908	59,923	59,939	59,954	59,970	59,985	60,001	60,016	60,032	60,047
7750	60,062	60,078	60,094	60,109	60,125	60,140	60,156	60,171	60,187	60,202
7760	60,218	60,233	60,249	60,264	60,280	60,295	60,311	60,326	60,342	60,357
7770	60,373	60,388	60,404	60,420	60,435	60,451	60,466	60,482	60,497	60,513
7780	60,528	60,544	60,560	60,575	60,591	60,606	60,622	60,637	60,653	60,669
7790	60,684	60,700	60,715	60,731	60,746	60,762	60,778	60,793	60,809	60,824

	0	1	2	3	4	5	6	7	8	9
7800	60,840	60,856	60,871	60,887	60,902	60,918	60,934	60,949	60,965	60,980
7810	60,996	61,012	61,027	61,043	61,059	61,074	61,090	61,105	61,121	61,137
7820	61,152	61,168	61,184	61,199	61,215	61,231	61,246	61,262	61,278	61,293
7830	61,309	61,325	61,340	61,356	61,372	61,387	61,403	61,419	61,434	61,450
7840	61,466	61,481	61,497	61,513	61,528	61,544	61,560	61,575	61,591	61,607
7850	61,622	61,638	61,654	61,670	61,685	61,701	61,717	61,732	61,748	61,764
7860	61,780	61,795	61,811	61,827	61,843	61,858	61,874	61,890	61,905	61,921
7870	61,937	61,953	61,968	61,984	62,000	62,016	62,032	62,047	62,063	62,079
7880	62,094	62,110	62,126	62,142	62,157	62,173	62,189	62,205	62,221	62,236
7890	62,252	62,268	62,284	62,299	62,315	62,331	62,347	62,363	62,378	62,394
7900	62,410	62,426	62,442	62,457	62,473	62,489	62,505	62,521	62,536	62,552
7910	62,568	62,584	62,600	62,616	62,631	62,647	62,663	62,679	62,695	62,711
7920	62,726	62,742	62,758	62,774	62,790	62,806	62,821	62,837	62,853	62,869
7930	62,885	62,901	62,917	62,932	62,948	62,964	62,980	62,996	63,012	63,028
7940	63,044	63,059	63,075	63,091	63,107	63,123	63,139	63,155	63,171	63,187
7950	63,202	63,218	63,234	63,250	63,266	63,282	63,298	63,314	63,330	63,346
7960	63,362	63,378	63,393	63,409	63,425	63,441	63,457	63,473	63,489	63,505
7970	63,521	63,537	63,553	63,569	63,585	63,601	63,617	63,633	63,648	63,664
7980	63,680	63,696	63,712	63,728	63,744	63,760	63,776	63,792	63,808	63,824
7990	63,840	63,856	63,872	63,888	63,904	63,920	63,936	63,952	63,968	63,984
8000	64,000	64,016	64,032	64,048	64,064	64,080	64,096	64,112	64,128	64,144
8010	64,160	64,176	64,192	64,208	64,224	64,240	64,256	64,272	64,288	64,304
8020	64,320	64,336	64,352	64,369	64,385	64,401	64,417	64,433	64,449	64,465
8030	64,481	64,497	64,513	64,529	64,545	64,561	64,577	64,593	64,609	64,626
8040	64,642	64,658	64,674	64,690	64,706	64,722	64,738	64,754	64,770	64,786
8050	64,803	64,819	64,835	64,851	64,867	64,883	64,899	64,915	64,931	64,947
8060	64,964	64,980	64,996	65,012	65,028	65,044	65,060	65,076	65,093	65,109
8070	65,125	65,141	65,157	65,173	65,189	65,206	65,222	65,238	65,254	65,270
8080	65,286	65,303	65,319	65,335	65,351	65,367	65,383	65,400	65,416	65,432
8090	65,448	65,464	65,480	65,497	65,513	65,529	65,545	65,561	65,578	65,594
8100	65,610	65,626	65,642	65,659	65,675	65,691	65,707	65,723	65,740	65,756
8110	65,772	65,788	65,805	65,821	65,837	65,853	65,869	65,886	65,902	65,918
8120	65,934	65,951	65,967	65,983	65,999	66,016	66,032	66,048	66,064	66,081
8130	66,097	66,113	66,129	66,146	66,162	66,178	66,194	66,211	66,227	66,243
8140	66,260	66,276	66,292	66,308	66,325	66,341	66,357	66,374	66,390	66,406
8150	66,423	66,439	66,455	66,471	66,488	66,504	66,520	66,537	66,553	66,569
8160	66,586	66,602	66,618	66,635	66,651	66,667	66,684	66,700	66,716	66,733
8170	66,749	66,765	66,782	66,798	66,814	66,831	66,847	66,863	66,880	66,896
8180	66,912	66,929	66,945	66,961	66,978	66,994	67,011	67,027	67,043	67,060
8190	67,076	67,092	67,109	67,125	67,142	67,158	67,174	67,191	67,207	67,224
8200	67,240	67,256	67,273	67,289	67,306	67,322	67,338	67,355	67,371	67,388
8210	67,404	67,421	67,437	67,453	67,470	67,486	67,503	67,519	67,536	67,552
8220	67,568	67,585	67,601	67,618	67,634	67,651	67,667	67,684	67,700	67,716
8230	67,733	67,749	67,766	67,782	67,799	67,815	67,832	67,848	67,865	67,881
8240	67,898	67,914	67,931	67,947	67,964	67,980	67,997	68,013	68,030	68,046
8250	68,063	68,079	68,096	68,112	68,129	68,145	68,162	68,178	68,195	68,211
8260	68,228	68,244	68,261	68,277	68,294	68,310	68,327	68,343	68,360	68,376
8270	68,393	68,409	68,426	68,443	68,459	68,476	68,492	68,509	68,525	68,542
8280	68,558	68,575	68,592	68,608	68,625	68,641	68,658	68,674	68,691	68,708
8290	68,724	68,741	68,757	68,774	68,790	68,807	68,824	68,840	68,857	68,873
8300	68,890	68,907	68,923	68,940	68,956	68,973	68,990	69,006	69,023	69,039
8310	69,056	69,073	69,089	69,106	69,123	69,139	69,156	69,172	69,189	69,206
8320	69,222	69,239	69,256	69,272	69,289	69,306	69,322	69,339	69,356	69,372
8330	69,389	69,406	69,422	69,439	69,456	69,472	69,489	69,506	69,522	69,539
8340	69,556	69,572	69,589	69,606	69,622	69,639	69,656	69,672	69,689	69,706

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
8350	69,723	69,739	69,756	69,773	69,789	69,806	69,823	69,839	69,856	69,873
8360	69,890	69,906	69,923	69,940	69,956	69,973	69,990	70,007	70,023	70,040
8370	70,057	70,074	70,090	70,107	70,124	70,141	70,157	70,174	70,191	70,208
8380	70,224	70,241	70,258	70,275	70,291	70,308	70,325	70,342	70,359	70,375
8390	70,392	70,409	70,426	70,442	70,459	70,476	70,493	70,510	70,526	70,543
8400	70,560	70,577	70,594	70,610	70,627	70,644	70,661	70,678	70,694	70,711
8410	70,728	70,745	70,762	70,779	70,795	70,812	70,829	70,846	70,863	70,880
8420	70,896	70,913	70,930	70,947	70,964	70,981	70,997	71,014	71,031	71,048
8430	71,065	71,082	71,099	71,115	71,132	71,149	71,166	71,183	71,200	71,217
8440	71,234	71,250	71,267	71,284	71,301	71,318	71,335	71,352	71,369	71,386
8450	71,403	71,419	71,436	71,453	71,470	71,487	71,504	71,521	71,538	71,555
8460	71,572	71,589	71,605	71,622	71,639	71,656	71,673	71,690	71,707	71,724
8470	71,741	71,758	71,775	71,792	71,809	71,826	71,843	71,860	71,876	71,893
8480	71,910	71,927	71,944	71,961	71,978	71,995	72,012	72,029	72,046	72,063
8490	72,080	72,097	72,114	72,131	72,148	72,165	72,182	72,199	72,216	72,233
8500	72,250	72,267	72,284	72,301	72,318	72,335	72,352	72,369	72,386	72,403
8510	72,420	72,437	72,454	72,471	72,488	72,505	72,522	72,539	72,556	72,573
8520	72,590	72,607	72,624	72,642	72,659	72,676	72,693	72,710	72,727	72,744
8530	72,761	72,778	72,795	72,812	72,829	72,846	72,863	72,880	72,897	72,915
8540	72,932	72,949	72,966	72,983	73,000	73,017	73,034	73,051	73,068	73,085
8550	73,103	73,120	73,137	73,154	73,171	73,188	73,205	73,222	73,239	73,256
8560	73,274	73,291	73,308	73,325	73,342	73,359	73,376	73,393	73,411	73,428
8570	73,445	73,462	73,479	73,496	73,513	73,531	73,548	73,565	73,582	73,599
8580	73,616	73,634	73,651	73,668	73,685	73,702	73,719	73,737	73,754	73,771
8590	73,788	73,805	73,822	73,840	73,857	73,874	73,891	73,908	73,926	73,943
8600	73,960	73,977	73,994	74,012	74,029	74,046	74,063	74,080	74,098	74,115
8610	74,132	74,149	74,167	74,184	74,201	74,218	74,235	74,253	74,270	74,287
8620	74,304	74,322	74,339	74,356	74,373	74,391	74,408	74,425	74,442	74,460
8630	74,477	74,494	74,511	74,529	74,546	74,563	74,580	74,598	74,615	74,632
8640	74,650	74,667	74,684	74,701	74,719	74,736	74,753	74,771	74,788	74,805
8650	74,823	74,840	74,857	74,874	74,892	74,909	74,926	74,944	74,961	74,978
8660	74,996	75,013	75,030	75,048	75,065	75,082	75,100	75,117	75,134	75,152
8670	75,169	75,186	75,204	75,221	75,238	75,256	75,273	75,290	75,308	75,325
8680	75,342	75,360	75,377	75,394	75,412	75,429	75,447	75,464	75,481	75,499
8690	75,516	75,533	75,551	75,568	75,586	75,603	75,620	75,638	75,655	75,673
8700	75,690	75,707	75,725	75,742	75,760	75,777	75,794	75,812	75,829	75,847
8710	75,864	75,882	75,899	75,916	75,934	75,951	75,969	75,986	76,004	76,021
8720	76,038	76,056	76,073	76,091	76,108	76,126	76,143	76,161	76,178	76,195
8730	76,213	76,230	76,248	76,265	76,283	76,300	76,318	76,335	76,353	76,370
8740	76,388	76,405	76,423	76,440	76,458	76,475	76,493	76,510	76,528	76,545
8750	76,563	76,580	76,598	76,615	76,633	76,650	76,668	76,685	76,703	76,720
8760	76,738	76,755	76,773	76,790	76,808	76,825	76,843	76,860	76,878	76,895
8770	76,913	76,930	76,948	76,966	76,983	77,001	77,018	77,036	77,053	77,071
8780	77,088	77,106	77,124	77,141	77,159	77,176	77,194	77,211	77,229	77,247
8790	77,264	77,282	77,299	77,317	77,334	77,352	77,370	77,387	77,405	77,422
8800	77,440	77,458	77,475	77,493	77,510	77,528	77,546	77,563	77,581	77,598
8810	77,616	77,634	77,651	77,669	77,687	77,704	77,722	77,739	77,757	77,775
8820	77,792	77,810	77,828	77,845	77,863	77,881	77,898	77,916	77,934	77,951
8830	77,969	77,987	78,004	78,022	78,040	78,057	78,075	78,093	78,110	78,128
8840	78,146	78,163	78,181	78,199	78,216	78,234	78,252	78,269	78,287	78,305
8850	78,323	78,340	78,358	78,376	78,393	78,411	78,429	78,446	78,464	78,482
8860	78,500	78,517	78,535	78,553	78,570	78,588	78,606	78,624	78,641	78,659
8870	78,677	78,695	78,712	78,730	78,748	78,766	78,783	78,801	78,819	78,837
8880	78,854	78,872	78,890	78,908	78,925	78,943	78,961	78,979	78,997	79,014
8890	79,032	79,050	79,068	79,085	79,103	79,121	79,139	79,157	79,174	79,192

	0	1	2	3	4	5	6	7	8	9
8900	79,210	79,228	79,246	79,263	79,281	79,299	79,317	79,335	79,352	79,370
8910	79,388	79,406	79,428	79,442	79,459	79,477	79,495	79,513	79,531	79,549
8920	79,566	79,584	79,602	79,620	79,638	79,656	79,673	79,691	79,709	79,727
8930	79,745	79,763	79,781	79,798	79,816	79,834	79,852	79,870	79,888	79,906
8940	79,924	79,941	79,959	79,977	79,995	80,013	80,031	80,049	80,067	80,085
8950	80,103	80,120	80,138	80,156	80,174	80,192	80,210	80,228	80,246	80,264
8960	80,282	80,300	80,317	80,335	80,353	80,371	80,389	80,407	80,425	80,443
8970	80,461	80,479	80,497	80,515	80,533	80,551	80,569	80,587	80,604	80,622
8980	80,640	80,658	80,676	80,694	80,712	80,730	80,748	80,766	80,784	80,802
8990	80,820	80,838	80,856	80,874	80,892	80,910	80,928	80,946	80,964	80,982
9000	81,000	81,018	81,036	81,054	81,072	81,090	81,108	81,126	81,144	81,162
9010	81,180	81,198	81,216	81,234	81,252	81,270	81,288	81,306	81,324	81,342
9020	81,360	81,378	81,396	81,415	81,433	81,451	81,469	81,487	81,505	81,523
9030	81,541	81,559	81,577	81,595	81,613	81,631	81,649	81,667	81,685	81,704
9040	81,722	81,740	81,758	81,776	81,794	81,812	81,830	81,848	81,866	81,884
9050	81,903	81,921	81,939	81,957	81,975	81,993	82,011	82,029	82,047	82,065
9060	82,084	82,102	82,120	82,138	82,156	82,174	82,192	82,210	82,229	82,247
9070	82,265	82,283	82,301	82,319	82,337	82,356	82,374	82,392	82,410	82,428
9080	82,446	82,465	82,483	82,501	82,519	82,537	82,555	82,574	82,592	82,610
9090	82,628	82,646	82,664	82,683	82,701	82,719	82,737	82,755	82,774	82,792
9100	82,810	82,828	82,846	82,865	82,883	82,901	82,919	82,937	82,956	82,974
9110	82,992	83,010	83,029	83,047	83,065	83,083	83,101	83,120	83,138	83,156
9120	83,174	83,193	83,211	83,229	83,247	83,266	83,284	83,302	83,320	83,339
9130	83,357	83,375	83,393	83,412	83,430	83,448	83,466	83,485	83,503	83,521
9140	83,540	83,558	83,576	83,594	83,613	83,631	83,649	83,668	83,686	83,704
9150	83,723	83,741	83,759	83,777	83,796	83,814	83,832	83,851	83,869	83,887
9160	83,906	83,924	83,942	83,961	83,979	83,997	84,016	84,034	84,052	84,071
9170	84,089	84,107	84,126	84,144	84,162	84,181	84,199	84,217	84,236	84,254
9180	84,272	84,291	84,309	84,327	84,346	84,364	84,383	84,401	84,419	84,438
9190	84,456	84,474	84,493	84,511	84,530	84,548	84,566	84,585	84,603	84,622
9200	84,640	84,658	84,677	84,695	84,714	84,732	84,750	84,769	84,787	84,806
9210	84,824	84,843	84,861	84,879	84,898	84,916	84,935	84,953	84,972	84,990
9220	85,008	85,027	85,045	85,064	85,082	85,101	85,119	85,138	85,156	85,174
9230	85,193	85,211	85,230	85,248	85,267	85,285	85,304	85,322	85,341	85,359
9240	85,378	85,396	85,415	85,433	85,452	85,470	85,489	85,507	85,526	85,544
9250	85,563	85,581	85,600	85,618	85,637	85,655	85,674	85,692	85,711	85,729
9260	85,748	85,766	85,785	85,803	85,822	85,840	85,859	85,877	85,896	85,914
9270	85,933	85,951	85,970	85,989	86,007	86,026	86,044	86,063	86,081	86,100
9280	86,118	86,137	86,156	86,174	86,193	86,211	86,230	86,248	86,267	86,286
9290	86,304	86,323	86,341	86,360	86,378	86,397	86,416	86,434	86,453	86,471
9300	86,490	86,509	86,527	86,546	86,564	86,583	86,602	86,620	86,639	86,657
9310	86,676	86,695	86,713	86,732	86,751	86,769	86,788	86,806	86,825	86,844
9320	86,862	86,881	86,900	86,918	86,937	86,956	86,974	86,993	87,012	87,030
9330	87,049	87,068	87,086	87,105	87,124	87,142	87,161	87,180	87,198	87,217
9340	87,236	87,254	87,273	87,292	87,310	87,329	87,348	87,366	87,385	87,404
9350	87,423	87,441	87,460	87,479	87,497	87,516	87,535	87,553	87,572	87,591
9360	87,610	87,628	87,647	87,666	87,684	87,703	87,722	87,741	87,759	87,778
9370	87,797	87,816	87,834	87,853	87,872	87,891	87,909	87,928	87,947	87,966
9380	87,984	88,003	88,022	88,041	88,059	88,078	88,097	88,116	88,135	88,153
9390	88,172	88,191	88,210	88,228	88,247	88,266	88,285	88,304	88,322	88,341
9400	88,360	88,379	88,398	88,416	88,435	88,454	88,473	88,492	88,510	88,529
9410	88,548	88,567	88,586	88,605	88,623	88,642	88,661	88,680	88,699	88,718
9420	88,736	88,755	88,774	88,793	88,812	88,831	88,849	88,868	88,887	88,906
9430	88,925	88,944	88,963	88,981	89,000	89,019	89,038	89,057	89,076	89,095
9440	89,114	89,132	89,151	89,170	89,189	89,208	89,227	89,246	89,265	89,284

	0	1	2	3	4	5	6	7	8	9
9450	89,303	89,321	89,340	89,359	89,378	89,397	89,416	89,435	89,454	89,473
9460	89,492	89,511	89,529	89,548	89,567	89,586	89,605	89,624	89,643	89,662
9470	89,681	89,700	89,719	89,738	89,757	89,776	89,795	89,814	89,832	89 851
9480	89,870	89,889	89,908	89,927	89,946	89,965	89,984	90,003	90,022	90,041
9490	90,060	90,079	90,098	90,117	90,136	90,155	90,174	90,193	90,212	90,231
9500	90,250	90,269	90,288	90,307	90,326	90,345	90,364	90,383	90,402	90,421
9510	90,440	90,459	90,478	90,497	90,516	90,535	90,554	90,573	90,592	90,611
9520	90,630	90,649	90,668	90,688	90,707	90,726	90,745	90,764	90,783	90,802
9530	90,821	90,840	90,859	90,878	90,897	90,916	90,935	90,954	90,973	90,993
9540	91,012	91,031	91,050	91,069	91,088	91,107	91,126	91,145	91,164	91,183
9550	91,203	91,222	91,241	91,260	91,279	91,298	91,317	91,336	91,355	91,374
9560	91,394	91,413	91,432	91,451	91,470	91,489	91,508	91,527	91,547	91,566
9570	91,585	91,604	91,623	91,642	91,661	91,681	91,700	91,719	91,738	91,757
9580	91,776	91,796	91,815	91,834	91,853	91,872	91,891	91,911	91,930	91,949
9590	91,968	91,987	92,006	92,026	92,045	92,064	92,083	92,102	92,122	92,141
9600	92,160	92,179	92,198	92,218	92,237	92,256	92,275	92,294	92,314	92,333
9610	92,352	92,371	92,391	92,410	92,429	92,448	92,467	92,487	92,506	92,525
9620	92,544	92,564	92,583	92,602	92,621	92,641	92,660	92,679	92,698	92,718
9630	92,737	92,756	92,775	92,795	92,814	92,833	92,852	92,872	92,891	92,910
9640	92,930	92,949	92,968	92,987	93,007	93,026	93,045	93,065	93,084	93,103
9650	93,123	93,142	93,161	93,180	93,200	93,219	93,238	93,258	93,277	93,296
9660	93,316	93,335	93,354	93,374	93,393	93,412	93,432	93,451	93,470	93,490
9670	93,509	93,528	93,548	93,567	93,586	93,606	93,625	93,644	93,664	93,683
9680	93,702	93,722	93,741	93,760	93,780	93,799	93,819	93,838	93,857	93,877
9690	93,896	93,915	93,935	93,954	93,974	93,993	94,012	94,032	94,051	94,071
9700	94,090	94,109	94,129	94,148	94,168	94,187	94,206	94,226	94,245	94,265
9710	94,284	94,304	94,323	94,342	94,362	94,381	94,401	94,420	94,440	94,459
9720	94,478	94,498	94,517	94,537	94,556	94,576	94,595	94,615	94,634	94,653
9730	94,673	94,692	94,712	94,731	94,751	94,770	94,790	94,809	94,829	94,848
9740	94,868	94,887	94,907	94,926	94,946	94,965	94,985	95,004	95,024	95,043
9750	95,063	95,082	95,102	95,121	95,141	95,160	95,180	95,199	95,219	95,238
9760	95,258	95,277	95,297	95,316	95,336	95,355	95,375	95,394	95,414	95,433
9770	95,453	95,472	95,492	95,512	95,531	95,551	95,570	95,590	95,609	95,629
9780	95,648	95,668	95,688	95,707	95,727	95,746	95,766	95,785	95,805	95,825
9790	95,844	95,864	95,883	95,903	95,922	95,942	95,962	95,981	96,001	96,020
9800	96,040	96,060	96,079	96,099	96,118	96,138	96,158	96,177	96,197	96,216
9810	96,236	96,256	96,275	96,295	96,315	96,334	96,354	96,373	96,393	96,413
9820	96,432	96,452	96,472	96,491	96,511	96,531	96,550	96,570	96,590	96,609
9830	96,629	96,649	96,668	96,688	96,708	96,727	96,747	96,767	96,786	96,806
9840	96,826	96,845	96,865	96,885	96,904	96,924	96,944	96,963	96,983	97,003
9850	97,023	97,042	97,062	97,082	97,101	97,121	97,141	97,160	97,180	97,200
9860	97,220	97,239	97,259	97,279	97,298	97,318	97,338	97,358	97,377	97,397
9870	97,417	97,437	97,456	97,476	97,496	97,516	97,535	97,555	97,575	97,595
9880	97,614	97,634	97,654	97,674	97,693	97,713	97,733	97,753	97,773	97,792
9890	97,812	97,832	97,852	97,871	97,891	97,911	97,931	97,951	97,970	97,990
9900	98,010	98,030	98,050	98,069	98,089	98,109	98,129	98,149	98,168	98,188
9910	98,208	98,228	98,248	98,268	98,287	98,307	98,327	98,347	98,367	98,387
9920	98,406	98,426	98,446	98,466	98,486	98,506	98,525	98,545	98,565	98,585
9930	98,605	98,625	98,645	98,665	98,684	98,704	98,724	98,744	98,764	98,784
9940	98,804	98,823	98,843	98,863	98,883	98,903	98,923	98,943	98,963	98,983
9950	99,003	99,022	99,042	99,062	99,082	99,102	99,122	99,142	99,162	99,182
9960	99,202	99,222	99,241	99,261	99,281	99,301	99,321	99,341	99,361	99,381
9970	99,401	99,421	99,441	99,461	99,481	99,501	99,521	99,541	99,560	99,580
9980	99,600	99,620	99,640	99,660	99,680	99,700	99,720	99,740	99,760	99,780
9990	99,800	99,820	99,840	99,860	99,880	99,900	99,920	99,940	99,960	99,980

TABLE 14
CONVERSION OF A.P.I. TO SPECIFIC GRAVITY

Degrees API at 60°F.	Specific Gravity	Degrees API at 60°F.	Specific Gravity	Degrees API at 60°F.	Specific Gravity
0	1.076	34	.8550	68	.7093
1	1.068	35	.8498	69	.7057
2	1.060	36	.8448	70	.7022
3	1.052	37	.8398	71	.6988
4	1.044	38	.8348	72	.6953
5	1.037	39	.8299	73	.6919
6	1.029	40	.8251	74	.6886
7	1.022	41	.8203	75	.6852
8	1.014	42	.8155	76	.6819
9	1.007	43	.8109	77	.6787
10	1.000	44	.8063	78	.6754
11	.9930	45	.8017	79	.6722
12	.9861	46	.7972	80	.6690
13	.9792	47	.7927	81	.6659
14	.9725	48	.7883	82	.6628
15	.9659	49	.7839	83	.6597
16	.9593	50	.7796	84	.6566
17	.9529	51	.7753	85	.6536
18	.9465	52	.7711	86	.6506
19	.9402	53	.7669	87	.6476
20	.9340	54	.7628	88	.6446
21	.9279	55	.7587	89	.6417
22	.9218	56	.7547	90	.6388
23	.9159	57	.7507	91	.6360
24	.9100	58	.7467	92	.6331
25	.9042	59	.7428	93	.6303
26	.8984	60	.7389	94	.6275
27	.8927	61	.7351	95	.6247
28	.8871	62	.7313	96	.6220
29	.8816	63	.7275	97	.6193
30	.8762	64	.7238	98	.6166
31	.8708	65	.7201	99	.6139
32	.8654	66	.7165	100	.6112
33	.8602	67	.7128		

$$\text{SP. GR.} = \frac{141.5}{131.5 \quad {}^{\circ}\text{A.P.I.}}$$

TABLE 15

VALUES OF e^{ks}

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.000	1.00000	1.00010	1.00020	1.00030	1.00040	1.00050	1.00060	1.00070	1.00080	1.00090
.001	1.00100	1.00110	1.00120	1.00130	1.00140	1.00150	1.00160	1.00170	1.00180	1.00190
.002	1.00200	1.00210	1.00220	1.00230	1.00240	1.00250	1.00260	1.00270	1.00280	1.00290
.003	1.00300	1.00310	1.00321	1.00331	1.00341	1.00351	1.00361	1.00371	1.00381	1.00391
.004	1.00401	1.00411	1.00421	1.00431	1.00441	1.00451	1.00461	1.00471	1.00481	1.00491
.005	1.00501	1.00511	1.00521	1.00531	1.00542	1.00552	1.00562	1.00572	1.00582	1.00592
.006	1.00602	1.00612	1.00622	1.00632	1.00642	1.00652	1.00662	1.00672	1.00682	1.00692
.007	1.00702	1.00713	1.00723	1.00733	1.00743	1.00753	1.00763	1.00773	1.00783	1.00793
.008	1.00803	1.00813	1.00823	1.00833	1.00843	1.00853	1.00863	1.00873	1.00883	1.00893
.009	1.00904	1.00914	1.00924	1.00934	1.00944	1.00954	1.00964	1.00974	1.00984	1.00994
.010	1.01005	1.01015	1.01025	1.01035	1.01045	1.01055	1.01065	1.01075	1.01085	1.01095
.011	1.01106	1.01116	1.01126	1.01136	1.01146	1.01156	1.01166	1.01176	1.01186	1.01197
.012	1.01207	1.01217	1.01227	1.01237	1.01247	1.01257	1.01267	1.01278	1.01288	1.01298
.013	1.01308	1.01319	1.01329	1.01339	1.01349	1.01359	1.01369	1.01379	1.01390	1.01400
.014	1.01410	1.01420	1.01430	1.01440	1.01450	1.01460	1.01470	1.01480	1.01491	1.01501
.015	1.01511	1.01521	1.01532	1.01542	1.01552	1.01562	1.01572	1.01583	1.01593	1.01603
.016	1.01613	1.01624	1.01634	1.01644	1.01654	1.01664	1.01674	1.01684	1.01694	1.01704
.017	1.01715	1.01725	1.01735	1.01745	1.01755	1.01765	1.01776	1.01786	1.01796	1.01806
.018	1.01816	1.01826	1.01837	1.01847	1.01857	1.01867	1.01877	1.01888	1.01898	1.01908
.019	1.01918	1.01928	1.01939	1.01949	1.01959	1.01969	1.01979	1.01990	1.02000	1.02010
.020	1.02020	1.02030	1.02041	1.02051	1.02061	1.02071	1.02081	1.02092	1.02102	1.02112
.021	1.02122	1.02132	1.02143	1.02153	1.02163	1.02173	1.02184	1.02194	1.02204	1.02214
.022	1.02224	1.02235	1.02245	1.02255	1.02265	1.02276	1.02286	1.02296	1.02306	1.02316
.023	1.02327	1.02337	1.02347	1.02357	1.02368	1.02378	1.02388	1.02398	1.02409	1.02419
.024	1.02429	1.02439	1.02450	1.02460	1.02470	1.02480	1.02491	1.02501	1.02511	1.02521
.025	1.02532	1.02542	1.02552	1.02562	1.02573	1.02583	1.02593	1.02603	1.02614	1.02624
.026	1.02634	1.02644	1.02655	1.02665	1.02675	1.02685	1.02696	1.02706	1.02716	1.02727
.027	1.02737	1.02747	1.02757	1.02768	1.02778	1.02788	1.02798	1.02809	1.02819	1.02829
.028	1.02840	1.02850	1.02860	1.02870	1.02881	1.02891	1.02901	1.02912	1.02922	1.02932
.029	1.02942	1.02953	1.02963	1.02973	1.02984	1.02994	1.03004	1.03015	1.03025	1.03035
.030	1.03045	1.03056	1.03066	1.03076	1.03087	1.03097	1.03107	1.03118	1.03128	1.03138
.031	1.03148	1.03159	1.03169	1.03180	1.03190	1.03200	1.03210	1.03221	1.03231	1.03241
.032	1.03252	1.03262	1.03272	1.03283	1.03292	1.03303	1.03314	1.03324	1.03334	1.03345
.033	1.03355	1.03365	1.03376	1.03386	1.03396	1.03407	1.03417	1.03427	1.03438	1.03448
.034	1.03458	1.03469	1.03479	1.03490	1.03500	1.03510	1.03521	1.03531	1.03541	1.03552
.035	1.03562	1.03572	1.03583	1.03593	1.03603	1.03614	1.03624	1.03634	1.03645	1.03655
.036	1.03666	1.03676	1.03686	1.03697	1.03707	1.03717	1.03728	1.03738	1.03749	1.03759
.037	1.03769	1.03780	1.03790	1.03800	1.03811	1.03821	1.03832	1.03842	1.03852	1.03863
.038	1.03873	1.03884	1.03894	1.03904	1.03915	1.03925	1.03935	1.03946	1.03956	1.03967
.039	1.03977	1.03987	1.03998	1.04008	1.04019	1.04029	1.04039	1.04050	1.04060	1.04071
.040	1.04081	1.04091	1.04102	1.04112	1.04123	1.04133	1.04144	1.04154	1.04164	1.04175
.041	1.04185	1.04196	1.04206	1.04217	1.04227	1.04237	1.04248	1.04258	1.04269	1.04279
.042	1.04289	1.04300	1.04310	1.04321	1.04331	1.04342	1.04352	1.04362	1.04373	1.04383
.043	1.04394	1.04404	1.04415	1.04425	1.04436	1.04446	1.04456	1.04467	1.04477	1.04488
.044	1.04498	1.04509	1.04519	1.04530	1.04540	1.04550	1.04561	1.04571	1.04582	1.04592
.045	1.04603	1.04613	1.04624	1.04634	1.04645	1.04655	1.04666	1.04676	1.04686	1.04697
.046	1.04707	1.04718	1.04728	1.04739	1.04749	1.04760	1.04770	1.04781	1.04791	1.04802
.047	1.04812	1.04823	1.04833	1.04844	1.04854	1.04865	1.04875	1.04886	1.04896	1.04907
.048	1.04917	1.04928	1.04938	1.04949	1.04959	1.04970	1.04980	1.04991	1.05001	1.05012
.049	1.05022	1.05033	1.05043	1.05054	1.05064	1.05075	1.05085	1.05096	1.05106	1.05117

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.050	1.05127	1.05138	1.05148	1.05159	1.05169	1.05180	1.05190	1.05201	1.05211	1.05222
.051	1.05232	1.05243	1.05253	1.05264	1.05274	1.05285	1.05295	1.05306	1.05317	1.05327
.052	1.05338	1.05348	1.05359	1.05369	1.05380	1.05390	1.05401	1.05411	1.05422	1.05432
.053	1.05443	1.05454	1.05464	1.05475	1.05485	1.05496	1.05506	1.05517	1.05527	1.05538
.054	1.05548	1.05559	1.05570	1.05580	1.05591	1.05601	1.05612	1.05622	1.05633	1.05644
.055	1.05654	1.05665	1.05675	1.05686	1.05696	1.05707	1.05717	1.05728	1.05739	1.05749
.056	1.05760	1.05770	1.05781	1.05792	1.05802	1.05813	1.05823	1.05834	1.05844	1.05855
.057	1.05866	1.05876	1.05887	1.05897	1.05908	1.05919	1.05929	1.05940	1.05950	1.05961
.058	1.05971	1.05982	1.05993	1.06003	1.06014	1.06025	1.06035	1.06046	1.06056	1.06067
.059	1.06078	1.06088	1.06099	1.06109	1.06120	1.06131	1.06141	1.06152	1.06162	1.06173
.060	1.06184	1.06194	1.06205	1.06216	1.06226	1.06237	1.06247	1.06258	1.06269	1.06279
.061	1.06290	1.06301	1.06311	1.06322	1.06332	1.06343	1.06354	1.06364	1.06375	1.06386
.062	1.06396	1.06407	1.06418	1.06428	1.06439	1.06449	1.06460	1.06471	1.06481	1.06492
.063	1.06503	1.06513	1.06524	1.06535	1.06545	1.06556	1.06567	1.06577	1.06588	1.06599
.064	1.06609	1.06620	1.06631	1.06641	1.06652	1.06663	1.06673	1.06684	1.06695	1.06705
.065	1.06716	1.06727	1.06737	1.06748	1.06759	1.06769	1.06780	1.06791	1.06801	1.06812
.066	1.06823	1.06833	1.06844	1.06855	1.06865	1.06876	1.06887	1.06898	1.06908	1.06919
.067	1.06930	1.06940	1.06951	1.06962	1.06972	1.06983	1.06994	1.07004	1.07015	1.07026
.068	1.07037	1.07047	1.07058	1.07069	1.07079	1.07090	1.07101	1.07112	1.07122	1.07133
.069	1.07144	1.07154	1.07165	1.07176	1.07187	1.07197	1.07208	1.07219	1.07229	1.07240
.070	1.07251	1.07262	1.07272	1.07283	1.07294	1.07304	1.07315	1.07326	1.07337	1.07347
.071	1.07358	1.07369	1.07380	1.07390	1.07401	1.07412	1.07423	1.07433	1.07444	1.07455
.072	1.07466	1.07476	1.07487	1.07498	1.07509	1.07519	1.07530	1.07541	1.07552	1.07562
.073	1.07573	1.07584	1.07595	1.07605	1.07616	1.07627	1.07638	1.07648	1.07659	1.07670
.074	1.07681	1.07691	1.07702	1.07713	1.07724	1.07735	1.07745	1.07756	1.07767	1.07778
.075	1.07788	1.07799	1.07810	1.07821	1.07832	1.07842	1.07853	1.07864	1.07875	1.07885
.076	1.07896	1.07907	1.07918	1.07929	1.07939	1.07950	1.07961	1.07972	1.07983	1.07993
.077	1.08004	1.08015	1.08026	1.08037	1.08047	1.08058	1.08069	1.08080	1.08091	1.08101
.078	1.08112	1.08123	1.08134	1.08145	1.08156	1.08167	1.08177	1.08188	1.08199	1.08210
.079	1.08220	1.08231	1.08242	1.08253	1.08264	1.08275	1.08285	1.08296	1.08307	1.08318
.080	1.08329	1.08340	1.08350	1.08361	1.08372	1.08383	1.08394	1.08405	1.08415	1.08426
.081	1.08437	1.08448	1.08459	1.08470	1.08480	1.08491	1.08502	1.08513	1.08524	1.08535
.082	1.08546	1.08556	1.08567	1.08578	1.08589	1.08600	1.08611	1.08622	1.08632	1.08643
.083	1.08654	1.08665	1.08676	1.08687	1.08698	1.08709	1.08719	1.08730	1.08741	1.08752
.084	1.08763	1.08774	1.08785	1.08796	1.08806	1.08817	1.08828	1.08839	1.08850	1.08861
.085	1.08872	1.08883	1.08893	1.08904	1.08915	1.08926	1.08937	1.08948	1.08959	1.08970
.086	1.08981	1.08992	1.09002	1.09013	1.09024	1.09035	1.09046	1.09057	1.09068	1.09079
.087	1.09090	1.09101	1.09111	1.09122	1.09133	1.09144	1.09155	1.09166	1.09177	1.09188
.088	1.09199	1.09210	1.09221	1.09232	1.09242	1.09253	1.09264	1.09275	1.09286	1.09297
.089	1.09308	1.09319	1.09330	1.09341	1.09352	1.09363	1.09374	1.09385	1.09395	1.09406
.090	1.09417	1.09428	1.09439	1.09450	1.09461	1.09472	1.09483	1.09494	1.09505	1.09516
.091	1.09527	1.09538	1.09549	1.09560	1.09571	1.09582	1.09592	1.09603	1.09614	1.09625
.092	1.09636	1.09647	1.09658	1.09669	1.09680	1.09691	1.09702	1.09713	1.09724	1.09735
.093	1.09746	1.09757	1.09768	1.09779	1.09790	1.09801	1.09812	1.09823	1.09834	1.09845
.094	1.09856	1.09867	1.09878	1.09889	1.09900	1.09911	1.09922	1.09933	1.09944	1.09955
.095	1.09966	1.09977	1.09988	1.09999	1.10010	1.10021	1.10032	1.10043	1.10054	1.10065
.096	1.10076	1.10087	1.10098	1.10109	1.10120	1.10131	1.10142	1.10153	1.10164	1.10175
.097	1.10186	1.10197	1.10208	1.10219	1.10230	1.10241	1.10252	1.10263	1.10274	1.10285
.098	1.10296	1.10307	1.10318	1.10329	1.10340	1.10351	1.10362	1.10373	1.10385	1.10396
.099	1.10407	1.10418	1.10429	1.10440	1.10451	1.10462	1.10473	1.10484	1.10495	1.10506

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.100	1.10517	1.10528	1.10539	1.10550	1.10561	1.10572	1.10583	1.10594	1.10605	1.10617
.101	1.10628	1.10639	1.10650	1.10661	1.10672	1.10683	1.10694	1.10705	1.10716	1.10727
.102	1.10738	1.10749	1.10760	1.10772	1.10783	1.10794	1.10805	1.10816	1.10827	1.10838
.103	1.10849	1.10860	1.10871	1.10882	1.10893	1.10904	1.10916	1.10927	1.10938	1.10949
.104	1.10960	1.10971	1.10982	1.10993	1.11004	1.11016	1.11027	1.11038	1.11049	1.11060
.105	1.11071	1.11082	1.11093	1.11104	1.11115	1.11127	1.11138	1.11149	1.11160	1.11171
.106	1.11182	1.11193	1.11204	1.11216	1.11227	1.11238	1.11249	1.11260	1.11271	1.11282
.107	1.11293	1.11305	1.11316	1.11327	1.11338	1.11349	1.11360	1.11371	1.11382	1.11394
.108	1.11405	1.11416	1.11427	1.11438	1.11449	1.11460	1.11472	1.11483	1.11494	1.11505
.109	1.11516	1.11527	1.11538	1.11550	1.11561	1.11572	1.11583	1.11594	1.11605	1.11617
.110	1.11628	1.11639	1.11650	1.11661	1.11672	1.11684	1.11695	1.11706	1.11717	1.11728
.111	1.11739	1.11751	1.11762	1.11773	1.11784	1.11795	1.11806	1.11818	1.11829	1.11840
.112	1.11851	1.11862	1.11874	1.11885	1.11896	1.11907	1.11918	1.11930	1.11941	1.11952
.113	1.11963	1.11974	1.11986	1.11997	1.12008	1.12019	1.12030	1.12042	1.12053	1.12064
.114	1.12075	1.12086	1.12098	1.12109	1.12120	1.12131	1.12142	1.12154	1.12165	1.12176
.115	1.12187	1.12199	1.12210	1.12221	1.12232	1.12243	1.12255	1.12266	1.12277	1.12288
.116	1.12300	1.12311	1.12322	1.12333	1.12344	1.12356	1.12367	1.12378	1.12389	1.12401
.117	1.12412	1.12423	1.12434	1.12446	1.12457	1.12468	1.12479	1.12491	1.12502	1.12513
.118	1.12524	1.12536	1.12547	1.12558	1.12569	1.12581	1.12592	1.12603	1.12614	1.12626
.119	1.12637	1.12648	1.12659	1.12671	1.12682	1.12693	1.12704	1.12716	1.12727	1.12738
.120	1.12750	1.12761	1.12772	1.12784	1.12795	1.12806	1.12817	1.12829	1.12840	1.12851
.121	1.12862	1.12874	1.12885	1.12896	1.12908	1.12919	1.12930	1.12941	1.12953	1.12964
.122	1.12975	1.12987	1.12998	1.13009	1.13021	1.13032	1.13043	1.13054	1.13066	1.13077
.123	1.13088	1.13100	1.13111	1.13122	1.13134	1.13145	1.13156	1.13168	1.13179	1.13190
.124	1.13202	1.13213	1.13224	1.13236	1.13247	1.13258	1.13269	1.13281	1.13292	1.13303
.125	1.13315	1.13326	1.13337	1.13349	1.13360	1.13371	1.13383	1.13394	1.13405	1.13417
.126	1.13428	1.13440	1.13451	1.13462	1.13474	1.13485	1.13496	1.13508	1.13519	1.13530
.127	1.13542	1.13553	1.13564	1.13576	1.13587	1.13598	1.13610	1.13621	1.13633	1.13644
.128	1.13655	1.13667	1.13678	1.13689	1.13701	1.13712	1.13724	1.13735	1.13746	1.13758
.129	1.13769	1.13780	1.13792	1.13803	1.13815	1.13826	1.13837	1.13849	1.13860	1.13871
.130	1.13883	1.13894	1.13906	1.13917	1.13928	1.13940	1.13951	1.13963	1.13974	1.13985
.131	1.13997	1.14008	1.14020	1.14031	1.14042	1.14054	1.14065	1.14077	1.14088	1.14099
.132	1.14111	1.14122	1.14134	1.14145	1.14156	1.14168	1.14179	1.14191	1.14202	1.14213
.133	1.14225	1.14236	1.14248	1.14259	1.14271	1.14282	1.15293	1.14305	1.14316	1.14328
.134	1.14339	1.14351	1.14362	1.14374	1.14385	1.14396	1.14408	1.14419	1.14431	1.14442
.135	1.14454	1.14465	1.14476	1.14488	1.14499	1.14511	1.14522	1.14534	1.14545	1.14557
.136	1.14568	1.14580	1.14591	1.14603	1.14614	1.14625	1.14637	1.14648	1.14660	1.14671
.137	1.14683	1.14694	1.14706	1.14717	1.14729	1.14740	1.14752	1.14763	1.14775	1.14786
.138	1.14798	1.14809	1.14820	1.14832	1.14843	1.14855	1.14866	1.14878	1.14889	1.14901
.139	1.14912	1.14924	1.14935	1.14947	1.14958	1.14970	1.14981	1.14993	1.15004	1.15016
.140	1.15027	1.15039	1.15050	1.15062	1.15073	1.15085	1.15096	1.15108	1.15119	1.15131
.141	1.15142	1.15154	1.15165	1.15177	1.15188	1.15200	1.15211	1.15223	1.15234	1.15246
.142	1.15258	1.15269	1.15281	1.15292	1.15304	1.15315	1.15327	1.15338	1.15350	1.15361
.143	1.15373	1.15384	1.15396	1.15408	1.15419	1.15431	1.15442	1.15454	1.15465	1.15477
.144	1.15488	1.15500	1.15511	1.15523	1.15535	1.15546	1.15558	1.15569	1.15581	1.15592
.145	1.15604	1.15615	1.15627	1.15639	1.15650	1.15662	1.15673	1.15685	1.15696	1.15708
.146	1.15720	1.15731	1.15743	1.15754	1.15766	1.15777	1.15789	1.15801	1.15812	1.15824
.147	1.15835	1.15847	1.15858	1.15870	1.15882	1.15893	1.15905	1.15916	1.15928	1.15940
.148	1.15951	1.15963	1.15974	1.15986	1.15998	1.16009	1.16021	1.16032	1.16044	1.16056
.149	1.16067	1.16079	1.16090	1.16102	1.16114	1.16125	1.16137	1.16149	1.16160	1.16172

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.150	1.16183	1.16195	1.16207	1.16218	1.16230	1.16241	1.16253	1.16265	1.16276	1.16288
.151	1.16300	1.16311	1.16323	1.16334	1.16346	1.16358	1.16369	1.16381	1.16393	1.16404
.152	1.16416	1.16428	1.16439	1.16451	1.16462	1.16474	1.16486	1.16497	1.16509	1.16521
.153	1.16532	1.16544	1.16556	1.16567	1.16579	1.16591	1.16602	1.16614	1.16626	1.16637
.154	1.16649	1.16661	1.16672	1.16684	1.16696	1.16707	1.16719	1.16731	1.16742	1.16754
.155	1.16766	1.16777	1.16789	1.16801	1.16812	1.16824	1.16836	1.16847	1.16859	1.16871
.156	1.16883	1.16894	1.16906	1.16918	1.16929	1.16941	1.16953	1.16964	1.16976	1.16988
.157	1.16999	1.17011	1.17023	1.17035	1.17046	1.17058	1.17070	1.17081	1.17093	1.17105
.158	1.17116	1.17128	1.17140	1.17152	1.17163	1.17175	1.17187	1.17198	1.17210	1.17222
.159	1.17234	1.17245	1.17257	1.17269	1.17281	1.17292	1.17304	1.17316	1.17327	1.17339
.160	1.17351	1.17363	1.17374	1.17386	1.17398	1.17410	1.17421	1.17433	1.17445	1.17457
.161	1.17468	1.17480	1.17492	1.17504	1.17515	1.17527	1.17539	1.17551	1.17562	1.17574
.162	1.17586	1.17598	1.17609	1.17621	1.17633	1.17645	1.17656	1.17668	1.17680	1.17692
.163	1.17704	1.17715	1.17727	1.17739	1.17751	1.17762	1.17774	1.17786	1.17798	1.17809
.164	1.17821	1.17833	1.17845	1.17857	1.17868	1.17880	1.17892	1.17904	1.17915	1.17927
.165	1.17939	1.17951	1.17963	1.17975	1.17986	1.17998	1.18010	1.18022	1.18034	1.18045
.166	1.18057	1.18069	1.18081	1.18093	1.18104	1.18116	1.18128	1.18140	1.18152	1.18164
.167	1.18175	1.18187	1.18199	1.18211	1.18223	1.18234	1.18246	1.18258	1.18270	1.18282
.168	1.18294	1.18305	1.18317	1.18329	1.18341	1.18353	1.18365	1.18376	1.18388	1.18400
.169	1.18412	1.18424	1.18436	1.18447	1.18459	1.18471	1.18483	1.18495	1.18507	1.18518
.170	1.18530	1.18542	1.18554	1.18566	1.18578	1.18590	1.18601	1.18613	1.18625	1.18637
.171	1.18649	1.18661	1.18673	1.18684	1.18696	1.18708	1.18720	1.18732	1.18744	1.18756
.172	1.18768	1.18780	1.18791	1.18803	1.18815	1.18827	1.18839	1.18851	1.18863	1.18874
.173	1.18886	1.18898	1.18910	1.18922	1.18934	1.18946	1.18958	1.18970	1.18981	1.18993
.174	1.19005	1.19017	1.19029	1.19041	1.19053	1.19065	1.19077	1.19088	1.19100	1.19112
.175	1.19124	1.19136	1.19148	1.19160	1.19172	1.19184	1.19196	1.19208	1.19220	1.19232
.176	1.19244	1.19256	1.19267	1.19279	1.19291	1.19303	1.19315	1.19327	1.19339	1.19351
.177	1.19363	1.19375	1.19387	1.19399	1.19411	1.19422	1.19434	1.19446	1.19458	1.19470
.178	1.19482	1.19494	1.19506	1.19518	1.19530	1.19542	1.19554	1.19566	1.19578	1.19590
.179	1.19602	1.19614	1.19626	1.19638	1.19650	1.19662	1.19674	1.19686	1.19698	1.19710
.180	1.19722	1.19734	1.19746	1.19757	1.19769	1.19781	1.19793	1.19805	1.19817	1.19829
.181	1.19841	1.19853	1.19865	1.19877	1.19889	1.19901	1.19913	1.19925	1.19937	1.19949
.182	1.19961	1.19973	1.19985	1.19997	1.20009	1.20021	1.20033	1.20045	1.20057	1.20069
.183	1.20081	1.20093	1.20105	1.20117	1.20129	1.20141	1.20153	1.20165	1.20177	1.20189
.184	1.20201	1.20213	1.20225	1.20237	1.20249	1.20262	1.20274	1.20286	1.20298	1.20310
.185	1.20322	1.20334	1.20346	1.20358	1.20370	1.20382	1.20394	1.20406	1.20418	1.20430
.186	1.20442	1.20454	1.20466	1.20478	1.20490	1.20502	1.20514	1.20526	1.20538	1.20550
.187	1.20563	1.20575	1.20587	1.20599	1.20611	1.20623	1.20635	1.20647	1.20659	1.20671
.188	1.20683	1.20695	1.20707	1.20719	1.20732	1.20744	1.20756	1.20768	1.20780	1.20792
.189	1.20804	1.20816	1.20828	1.20840	1.20852	1.20865	1.20877	1.20889	1.20901	1.20913
.190	1.20925	1.20937	1.20949	1.20961	1.20973	1.20985	1.20998	1.21010	1.21022	1.21034
.191	1.21046	1.21058	1.21070	1.21082	1.21094	1.21107	1.21119	1.21131	1.21143	1.21155
.192	1.21167	1.21179	1.21191	1.21203	1.21216	1.21228	1.21240	1.21252	1.21264	1.21276
.193	1.21288	1.21300	1.21313	1.21325	1.21337	1.21349	1.21361	1.21373	1.21385	1.21398
.194	1.21410	1.21422	1.21434	1.21446	1.21458	1.21470	1.21483	1.21495	1.21507	1.21519
.195	1.21531	1.21543	1.21555	1.21568	1.21580	1.21592	1.21604	1.21616	1.21628	1.21641
.196	1.21653	1.21665	1.21677	1.21689	1.21701	1.21714	1.21726	1.21738	1.21750	1.21762
.197	1.21774	1.21787	1.21799	1.21811	1.21823	1.21835	1.21847	1.21860	1.21872	1.21884
.198	1.21896	1.21908	1.21921	1.21933	1.21945	1.21957	1.21969	1.21982	1.21994	1.22006
.199	1.22018	1.22030	1.22043	1.22055	1.22067	1.22079	1.22092	1.22104	1.22116	1.22128

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.200	1.22140	1.22153	1.22165	1.22177	1.22189	1.22201	1.22214	1.22226	1.22238	1.22250
.201	1.22262	1.22275	1.22287	1.22299	1.22311	1.22324	1.22336	1.22348	1.22360	1.22373
.202	1.22385	1.22397	1.22409	1.22421	1.22434	1.22446	1.22458	1.22470	1.22483	1.22495
.203	1.22507	1.22519	1.22532	1.22544	1.22556	1.22568	1.22581	1.22593	1.22605	1.22617
.204	1.22630	1.22642	1.22654	1.22667	1.22679	1.22691	1.22703	1.22716	1.22728	1.22740
.205	1.22753	1.22765	1.22777	1.22789	1.22802	1.22814	1.22826	1.22838	1.22851	1.22863
.206	1.22875	1.22888	1.22900	1.22912	1.22924	1.22937	1.22949	1.22961	1.22974	1.22986
.207	1.22998	1.23011	1.23023	1.23035	1.23047	1.23060	1.23072	1.23084	1.23097	1.23109
.208	1.23121	1.23134	1.23146	1.23158	1.23171	1.23183	1.23195	1.23207	1.23220	1.23232
.209	1.23244	1.23257	1.23269	1.23281	1.23294	1.23306	1.23318	1.23331	1.23343	1.23355
.210	1.23368	1.23380	1.23392	1.23405	1.23417	1.23429	1.23442	1.23454	1.23467	1.23479
.211	1.23491	1.23504	1.23516	1.23528	1.23541	1.23553	1.23565	1.23578	1.23590	1.23602
.212	1.23615	1.23627	1.23639	1.23652	1.23664	1.23676	1.23689	1.23701	1.23714	1.23726
.213	1.23738	1.23751	1.23763	1.23776	1.23788	1.23800	1.23813	1.23825	1.23837	1.23850
.214	1.23862	1.23875	1.23887	1.23899	1.23912	1.23924	1.23936	1.23949	1.23961	1.23974
.215	1.23986	1.23998	1.24011	1.24023	1.24036	1.24048	1.24060	1.24073	1.24085	1.24098
.216	1.24110	1.24123	1.24135	1.24147	1.24160	1.24172	1.24185	1.24197	1.24210	1.24222
.217	1.24234	1.24247	1.24259	1.24272	1.24284	1.24296	1.24309	1.24321	1.24334	1.24346
.218	1.24359	1.24371	1.24384	1.24396	1.24408	1.24421	1.24433	1.24446	1.24458	1.24471
.219	1.24483	1.24496	1.24508	1.24520	1.24533	1.24545	1.24558	1.24570	1.24583	1.24595
.220	1.24608	1.24620	1.24633	1.24645	1.24657	1.24670	1.24682	1.24695	1.24707	1.24720
.221	1.24732	1.24745	1.24757	1.24770	1.24782	1.24795	1.24807	1.24820	1.24832	1.24845
.222	1.24857	1.24870	1.24882	1.24895	1.24907	1.24920	1.24932	1.24945	1.24957	1.24970
.223	1.24982	1.24995	1.25007	1.25020	1.25032	1.25045	1.25057	1.25070	1.25082	1.25095
.224	1.25107	1.25120	1.25132	1.25145	1.25157	1.25170	1.25182	1.25195	1.25207	1.25220
.225	1.25232	1.25245	1.25257	1.25270	1.25282	1.25295	1.25307	1.25320	1.25332	1.25345
.226	1.25358	1.25370	1.25383	1.25395	1.25408	1.25420	1.25433	1.25445	1.25458	1.25470
.227	1.25483	1.25496	1.25508	1.25521	1.25533	1.25546	1.25558	1.25571	1.25583	1.25596
.228	1.25609	1.25621	1.25634	1.25646	1.25659	1.25671	1.25684	1.25696	1.25709	1.25722
.229	1.25734	1.25747	1.25759	1.25772	1.25784	1.25797	1.25810	1.25822	1.25835	1.25847
.230	1.25860	1.25873	1.25885	1.25898	1.25910	1.25923	1.25935	1.25948	1.25961	1.25973
.231	1.25986	1.25999	1.26011	1.26024	1.26036	1.26049	1.26062	1.26074	1.26087	1.26099
.232	1.26112	1.26125	1.26137	1.26150	1.26162	1.26175	1.26188	1.26200	1.26213	1.26225
.233	1.26238	1.26251	1.26263	1.26276	1.26289	1.26301	1.26314	1.26327	1.26339	1.26352
.234	1.26364	1.26377	1.26390	1.26402	1.26415	1.26428	1.26440	1.26453	1.26466	1.26478
.235	1.26491	1.26503	1.26516	1.26529	1.26541	1.26554	1.26567	1.26579	1.26592	1.26605
.236	1.26617	1.26630	1.26643	1.26655	1.26668	1.26681	1.26693	1.26706	1.26719	1.26731
.237	1.26744	1.26757	1.26769	1.26782	1.26795	1.26807	1.26820	1.26833	1.26846	1.26858
.238	1.26871	1.26884	1.26896	1.26909	1.26922	1.26934	1.26947	1.26960	1.26972	1.26985
.239	1.26998	1.27010	1.27023	1.27036	1.27049	1.27061	1.27074	1.27087	1.27099	1.27112
.240	1.27125	1.27138	1.27150	1.27163	1.27176	1.27188	1.27201	1.27214	1.27227	1.27239
.241	1.27252	1.27265	1.27278	1.27290	1.27303	1.27316	1.27328	1.27341	1.27354	1.27367
.242	1.27379	1.27392	1.27405	1.27418	1.27430	1.27443	1.27456	1.27469	1.27481	1.27494
.243	1.27507	1.27520	1.27532	1.27545	1.27558	1.27571	1.27583	1.27596	1.27609	1.27622
.244	1.27634	1.27647	1.27660	1.27673	1.27686	1.27698	1.27711	1.27724	1.27737	1.27749
.245	1.27762	1.27775	1.27788	1.27800	1.27813	1.27826	1.27839	1.27852	1.27864	1.27877
.246	1.27890	1.27903	1.27916	1.27928	1.27941	1.27954	1.27967	1.27980	1.27992	1.28005
.247	1.28018	1.28031	1.28044	1.28056	1.28069	1.28082	1.28095	1.28108	1.28120	1.28133
.248	1.28146	1.28159	1.28172	1.28184	1.28197	1.28210	1.28223	1.28236	1.28249	1.28261
.249	1.28274	1.28287	1.28300	1.28313	1.28326	1.28338	1.28351	1.28364	1.28377	1.28390

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.250	1.28403	1.28415	1.28428	1.28441	1.28454	1.28467	1.28480	1.28493	1.28505	1.28518
.251	1.28531	1.28544	1.28557	1.28570	1.28583	1.28595	1.28608	1.28621	1.28634	1.28647
.252	1.28660	1.28672	1.28685	1.28698	1.28711	1.28724	1.28737	1.28750	1.28763	1.28775
.253	1.28788	1.28801	1.28814	1.28827	1.28840	1.28853	1.28866	1.28879	1.28891	1.28904
.254	1.28917	1.28930	1.28943	1.28956	1.28969	1.28982	1.28995	1.29008	1.29020	1.29033
.255	1.29046	1.29059	1.29072	1.29085	1.29098	1.29111	1.29124	1.29136	1.29149	1.29162
.256	1.29175	1.29188	1.29201	1.29214	1.29227	1.29240	1.29253	1.29266	1.29279	1.29292
.257	1.29304	1.29317	1.29330	1.29343	1.29356	1.29369	1.29382	1.29395	1.29408	1.29421
.258	1.29434	1.29447	1.29460	1.29473	1.29486	1.29499	1.29512	1.29524	1.29537	1.29550
.259	1.29563	1.29576	1.29589	1.29602	1.29615	1.29628	1.29641	1.29654	1.29667	1.29680
.260	1.29693	1.29706	1.29719	1.29732	1.29745	1.29758	1.29771	1.29784	1.29797	1.29810
.261	1.29823	1.29836	1.29849	1.29862	1.29875	1.29888	1.29901	1.29914	1.29927	1.29940
.262	1.29953	1.29966	1.29979	1.29992	1.30005	1.30018	1.30031	1.30044	1.30057	1.30070
.263	1.30083	1.30096	1.30109	1.30122	1.30135	1.30148	1.30161	1.30174	1.30187	1.30200
.264	1.30213	1.30226	1.30239	1.30252	1.30265	1.30278	1.30291	1.30304	1.30317	1.30330
.265	1.30343	1.30356	1.30369	1.30382	1.30395	1.30408	1.30421	1.30434	1.30447	1.30460
.266	1.30473	1.30487	1.30500	1.30513	1.30526	1.30539	1.30552	1.30565	1.30578	1.30591
.267	1.30604	1.30617	1.30630	1.30643	1.30656	1.30669	1.30682	1.30695	1.30709	1.30722
.268	1.30735	1.30748	1.30761	1.30774	1.30787	1.30800	1.30813	1.30826	1.30839	1.30852
.269	1.30865	1.30879	1.30892	1.30905	1.30918	1.30931	1.30944	1.30957	1.30970	1.30983
.270	1.30996	1.31010	1.31023	1.31036	1.31049	1.31062	1.31075	1.31088	1.31101	1.31114
.271	1.31127	1.31141	1.31154	1.31167	1.31180	1.31193	1.31206	1.31219	1.31232	1.31246
.272	1.31259	1.31272	1.31285	1.31298	1.31311	1.31324	1.31337	1.31351	1.31364	1.31377
.273	1.31390	1.31403	1.31416	1.31429	1.31443	1.31456	1.31469	1.31482	1.31495	1.31508
.274	1.31521	1.31535	1.31548	1.31561	1.31574	1.31587	1.31600	1.31614	1.31627	1.31640
.275	1.31653	1.31666	1.31679	1.31693	1.31706	1.31719	1.31732	1.31745	1.31758	1.31772
.276	1.31785	1.31798	1.31811	1.31824	1.31837	1.31851	1.31864	1.31877	1.31890	1.31903
.277	1.31917	1.31930	1.31943	1.31956	1.31969	1.31983	1.31996	1.32009	1.32022	1.32035
.278	1.32049	1.32062	1.32075	1.32088	1.32101	1.32115	1.32128	1.32141	1.32154	1.32168
.279	1.32181	1.32194	1.32207	1.32220	1.32234	1.32247	1.32260	1.32273	1.32287	1.32300
.280	1.32313	1.32326	1.32339	1.32353	1.32366	1.32379	1.32392	1.32406	1.32419	1.32432
.281	1.32445	1.32459	1.32472	1.32485	1.32498	1.32512	1.32525	1.32538	1.32551	1.32565
.282	1.32578	1.32591	1.32604	1.32618	1.32631	1.32644	1.32657	1.32671	1.32684	1.32697
.283	1.32711	1.32724	1.32737	1.32750	1.32764	1.32777	1.32790	1.32803	1.32817	1.32830
.284	1.32843	1.32857	1.32870	1.32883	1.32896	1.32910	1.32923	1.32936	1.32950	1.32963
.285	1.32976	1.32989	1.33003	1.33016	1.33029	1.33043	1.33056	1.33069	1.33083	1.33096
.286	1.33109	1.33123	1.33136	1.33149	1.33163	1.33176	1.33189	1.33202	1.33216	1.33229
.287	1.33242	1.33256	1.33269	1.33282	1.33296	1.33309	1.33322	1.33336	1.33349	1.33362
.288	1.33376	1.33389	1.33402	1.33416	1.33429	1.33442	1.33456	1.33469	1.33482	1.33496
.289	1.33509	1.33523	1.33536	1.33549	1.33563	1.33576	1.33589	1.33603	1.33616	1.33629
.290	1.33643	1.33656	1.33669	1.33683	1.33696	1.33710	1.33723	1.33736	1.33750	1.33763
.291	1.33776	1.33790	1.33803	1.33817	1.33830	1.33843	1.33857	1.33870	1.33883	1.33897
.292	1.33910	1.33924	1.33937	1.33950	1.33964	1.33977	1.33991	1.34004	1.34017	1.34031
.293	1.34044	1.34058	1.34071	1.34085	1.34098	1.34111	1.34125	1.34138	1.34152	1.34165
.294	1.34178	1.34192	1.34205	1.34219	1.34232	1.34245	1.34259	1.34272	1.34286	1.34299
.295	1.34313	1.34326	1.34339	1.34353	1.34366	1.34380	1.34393	1.34407	1.34420	1.34434
.296	1.34447	1.34460	1.34474	1.34487	1.34501	1.34514	1.34528	1.34541	1.34555	1.34568
.297	1.34581	1.34595	1.34608	1.34622	1.34635	1.34649	1.34662	1.34676	1.34689	1.34703
.298	1.34716	1.34730	1.34743	1.34757	1.34770	1.34784	1.34797	1.34810	1.34824	1.34837
.299	1.34851	1.34864	1.34878	1.34891	1.34905	1.34918	1.34932	1.34945	1.34959	1.34972

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.300	1.34986	1.34999	1.35013	1.35026	1.35040	1.35053	1.35067	1.35080	1.35094	1.35107
.301	1.35121	1.35134	1.35148	1.35161	1.35175	1.35188	1.35202	1.35216	1.35229	1.35243
.302	1.35256	1.35270	1.35283	1.35297	1.35310	1.35324	1.35337	1.35351	1.35364	1.35378
.303	1.35391	1.35405	1.35418	1.35432	1.35446	1.35459	1.35473	1.35486	1.35500	1.35513
.304	1.35527	1.35540	1.35554	1.35568	1.35581	1.35595	1.35608	1.35622	1.35635	1.35649
.305	1.35662	1.35676	1.35690	1.35703	1.35717	1.35730	1.35744	1.35757	1.35771	1.35785
.306	1.35798	1.35812	1.35825	1.35839	1.35852	1.35866	1.35880	1.35893	1.35907	1.35920
.307	1.35934	1.35948	1.35961	1.35975	1.35988	1.36002	1.36016	1.36029	1.36043	1.36056
.308	1.36070	1.36084	1.36097	1.36111	1.36124	1.36138	1.36152	1.36165	1.36179	1.36193
.309	1.36206	1.36220	1.36233	1.36247	1.36261	1.36274	1.36288	1.36302	1.36315	1.36329
.310	1.36342	1.36356	1.36370	1.36383	1.36397	1.36411	1.36424	1.36438	1.36452	1.36465
.311	1.36479	1.36492	1.36506	1.36520	1.36533	1.36547	1.36561	1.36574	1.36588	1.36602
.312	1.36615	1.36629	1.36643	1.36656	1.36670	1.36684	1.36697	1.36711	1.36725	1.36738
.313	1.36752	1.36766	1.36779	1.36793	1.36807	1.36820	1.36834	1.36848	1.36861	1.36875
.314	1.36889	1.36903	1.36916	1.36930	1.36944	1.36957	1.36971	1.36985	1.36998	1.37012
.315	1.37026	1.37040	1.37053	1.37067	1.37081	1.37094	1.37108	1.37122	1.37135	1.37149
.316	1.37163	1.37177	1.37190	1.37204	1.37218	1.37231	1.37245	1.37259	1.37273	1.37286
.317	1.37300	1.37314	1.37328	1.37341	1.37355	1.37369	1.37382	1.37396	1.37410	1.37424
.318	1.37437	1.37451	1.37465	1.37479	1.37492	1.37506	1.37520	1.37534	1.37547	1.37561
.319	1.37575	1.37589	1.37603	1.37616	1.37630	1.37644	1.37658	1.37671	1.37685	1.37699
.320	1.37713	1.37726	1.37740	1.37754	1.37768	1.37781	1.37795	1.37809	1.37823	1.37837
.321	1.37850	1.37864	1.37878	1.37892	1.37906	1.37919	1.37933	1.37947	1.37961	1.37975
.322	1.37988	1.38002	1.38016	1.38030	1.38044	1.38057	1.38071	1.38085	1.38099	1.38113
.323	1.38126	1.38140	1.38154	1.38168	1.38182	1.38196	1.38209	1.38223	1.38237	1.38251
.324	1.38265	1.38278	1.38292	1.38306	1.38320	1.38334	1.38348	1.38361	1.38375	1.38389
.325	1.38403	1.38417	1.38431	1.38445	1.38458	1.38472	1.38486	1.38500	1.38514	1.38528
.326	1.38541	1.38555	1.38569	1.38583	1.38597	1.38611	1.38625	1.38638	1.38652	1.38666
.327	1.38680	1.38694	1.38708	1.38722	1.38735	1.38749	1.38763	1.38777	1.38791	1.38805
.328	1.38819	1.38833	1.38847	1.38860	1.38874	1.38888	1.38902	1.38916	1.38930	1.38944
.329	1.38958	1.38972	1.38985	1.38999	1.39013	1.39027	1.39041	1.39055	1.39069	1.39083
.330	1.39097	1.39111	1.39124	1.39138	1.39152	1.39166	1.39180	1.39194	1.39208	1.39222
.331	1.39236	1.39250	1.39264	1.39278	1.39292	1.39305	1.39319	1.39333	1.39347	1.39361
.332	1.39375	1.39389	1.39403	1.39417	1.39431	1.39445	1.39459	1.39473	1.39487	1.39501
.333	1.39515	1.39528	1.39542	1.39556	1.39570	1.39584	1.39598	1.39612	1.39626	1.39640
.334	1.39654	1.39668	1.39682	1.39696	1.39710	1.39724	1.39738	1.39752	1.39766	1.39780
.335	1.39794	1.39808	1.39822	1.39836	1.39850	1.39864	1.39878	1.39892	1.39906	1.39920
.336	1.39934	1.39948	1.39962	1.39976	1.39990	1.40004	1.40018	1.40032	1.40046	1.40060
.337	1.40074	1.40088	1.40102	1.40116	1.40130	1.40144	1.40158	1.40172	1.40186	1.40200
.338	1.40214	1.40228	1.40242	1.40256	1.40270	1.40284	1.40298	1.40312	1.40326	1.40340
.339	1.40354	1.40368	1.40382	1.40396	1.40410	1.40424	1.40438	1.40452	1.40466	1.40480
.340	1.40495	1.40509	1.40523	1.40537	1.40551	1.40565	1.40579	1.40593	1.40607	1.40621
.341	1.40635	1.40649	1.40663	1.40677	1.40691	1.40705	1.40720	1.40734	1.40748	1.40762
.342	1.40776	1.40790	1.40804	1.40818	1.40832	1.40846	1.40860	1.40874	1.40889	1.40903
.343	1.40917	1.40931	1.40945	1.40959	1.40973	1.40987	1.41001	1.41015	1.41030	1.41044
.344	1.41058	1.41072	1.41086	1.41100	1.41114	1.41128	1.41142	1.41156	1.41171	1.41185
.345	1.41199	1.41213	1.41227	1.41241	1.41255	1.41269	1.41284	1.41298	1.41312	1.41326
.346	1.41340	1.41354	1.41368	1.41382	1.41397	1.41411	1.41425	1.41439	1.41453	1.41467
.347	1.41481	1.41496	1.41510	1.41524	1.41538	1.41552	1.41566	1.41581	1.41595	1.41609
.348	1.41623	1.41637	1.41651	1.41665	1.41680	1.41694	1.41708	1.41722	1.41736	1.41751
.349	1.41765	1.41779	1.41793	1.41807	1.41821	1.41836	1.41850	1.41864	1.41878	1.41892

Values of $e^{KS} = (2.71828)^{KS}$

KS	.0000	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
.350	1.41906	1.41921	1.41935	1.41949	1.41963	1.41977	1.41992	1.42006	1.42020	1.42034
.351	1.42048	1.42063	1.42077	1.42091	1.42105	1.42120	1.42134	1.42148	1.42162	1.42176
.352	1.42191	1.42205	1.42219	1.42233	1.42247	1.42262	1.42276	1.42290	1.42304	1.42319
.353	1.42333	1.42347	1.42361	1.42376	1.42390	1.42404	1.42418	1.42433	1.42447	1.42461
.354	1.42475	1.42489	1.42504	1.42518	1.42532	1.42547	1.42561	1.42575	1.42589	1.42604
.355	1.42618	1.42632	1.42646	1.42661	1.42675	1.42689	1.42703	1.42718	1.42732	1.42746
.356	1.42761	1.42775	1.42789	1.42803	1.42818	1.42832	1.42846	1.42860	1.42875	1.42889
.357	1.42903	1.42918	1.42932	1.42946	1.42960	1.42975	1.42989	1.43003	1.43018	1.43032
.358	1.43046	1.43061	1.43075	1.43089	1.43104	1.43118	1.43132	1.43146	1.43161	1.43175
.359	1.43189	1.43204	1.43218	1.43232	1.43247	1.43261	1.43275	1.43290	1.43304	1.43318
.360	1.43333	1.43347	1.43361	1.43376	1.43390	1.43404	1.43419	1.43433	1.43447	1.43462
.361	1.43476	1.43490	1.43505	1.43519	1.43533	1.43548	1.43562	1.43576	1.43591	1.43605
.362	1.43620	1.43634	1.43648	1.43663	1.43677	1.43691	1.43706	1.43720	1.43734	1.43749
.363	1.43763	1.43778	1.43792	1.43806	1.43821	1.43835	1.43850	1.43864	1.43878	1.43893
.364	1.43907	1.43922	1.43936	1.43950	1.43965	1.43979	1.43994	1.44008	1.44022	1.44037
.365	1.44051	1.44066	1.44080	1.44095	1.44109	1.44123	1.44138	1.44152	1.44167	1.44181
.366	1.44196	1.44210	1.44224	1.44239	1.44253	1.44268	1.44282	1.44297	1.44311	1.44325
.367	1.44340	1.44354	1.44369	1.44383	1.44398	1.44412	1.44427	1.44441	1.44456	1.44470
.368	1.44484	1.44499	1.44513	1.44528	1.44542	1.44557	1.44571	1.44586	1.44600	1.44615
.369	1.44629	1.44643	1.44658	1.44672	1.44687	1.44701	1.44716	1.44730	1.44745	1.44759
.370	1.44773	1.44788	1.44802	1.44817	1.44831	1.44846	1.44860	1.44875	1.44889	1.44904
.371	1.44918	1.44933	1.44947	1.44962	1.44976	1.44991	1.45005	1.45020	1.45034	1.45049
.372	1.45063	1.45078	1.45092	1.45107	1.45121	1.45136	1.45150	1.45165	1.45179	1.45194
.373	1.45208	1.45223	1.45238	1.45252	1.45267	1.45281	1.45296	1.45310	1.45325	1.45339
.374	1.45354	1.45368	1.45383	1.45397	1.45412	1.45426	1.45441	1.45456	1.45470	1.45485
.375	1.45499	1.45514	1.45528	1.45543	1.45557	1.45572	1.45586	1.45601	1.45616	1.45630
.376	1.45645	1.45659	1.45674	1.45688	1.45703	1.45718	1.45732	1.45747	1.45761	1.45776
.377	1.45790	1.45805	1.45820	1.45834	1.45849	1.45863	1.45878	1.45892	1.45907	1.45922
.378	1.45936	1.45951	1.45965	1.45980	1.45995	1.46009	1.46024	1.46039	1.46053	1.46068
.379	1.46082	1.46097	1.46112	1.46126	1.46141	1.46155	1.46170	1.46185	1.46199	1.46214
.380	1.46229	1.46243	1.46258	1.46272	1.46287	1.46302	1.46316	1.46331	1.46346	1.46360
.381	1.46375	1.46389	1.46404	1.46419	1.46433	1.46448	1.46463	1.46477	1.46492	1.46507
.382	1.46521	1.46536	1.46551	1.46565	1.46580	1.46595	1.46609	1.46624	1.46639	1.46653
.383	1.46668	1.46683	1.46697	1.46712	1.46727	1.46741	1.46756	1.46771	1.46785	1.46800
.384	1.46815	1.46829	1.46844	1.46859	1.46873	1.46888	1.46903	1.46917	1.46932	1.46947
.385	1.46961	1.46976	1.46991	1.47006	1.47020	1.47035	1.47050	1.47064	1.47079	1.47094
.386	1.47108	1.47123	1.47138	1.47153	1.47167	1.47182	1.47197	1.47211	1.47226	1.47241
.387	1.47256	1.47270	1.47285	1.47300	1.47315	1.47329	1.47344	1.47359	1.47374	1.47388
.388	1.47403	1.47418	1.47433	1.47447	1.47462	1.47477	1.47492	1.47506	1.47521	1.47536
.389	1.47551	1.47565	1.47580	1.47595	1.47610	1.47624	1.47639	1.47654	1.47669	1.47683
.390	1.47698	1.47713	1.47728	1.47742	1.47757	1.47772	1.47787	1.47802	1.47816	1.47831
.391	1.47846	1.47861	1.47875	1.47890	1.47905	1.47920	1.47935	1.47949	1.47964	1.47979
.392	1.47994	1.48009	1.48023	1.48038	1.48053	1.48068	1.48083	1.48097	1.48112	1.48127
.393	1.48142	1.48157	1.48171	1.48186	1.48201	1.48216	1.48231	1.48246	1.48260	1.48275
.394	1.48290	1.48305	1.48320	1.48335	1.48349	1.48364	1.48379	1.48394	1.48409	1.48424
.395	1.48438	1.48453	1.48468	1.48483	1.48498	1.48513	1.48528	1.48542	1.48557	1.48572
.396	1.48587	1.48602	1.48617	1.48632	1.48646	1.48661	1.48676	1.48691	1.48706	1.48721
.397	1.48736	1.48750	1.48765	1.48780	1.48795	1.48810	1.48825	1.48840	1.48855	1.48870
.398	1.48884	1.48899	1.48914	1.48929	1.48944	1.48959	1.48974	1.48989	1.49004	1.49018
.399	1.49033	1.49048	1.49063	1.49078	1.49093	1.49108	1.49123	1.49138	1.49153	1.49167
.400	1.49182									

APPENDIX

Procedure for Determining the Slope of the Back Pressure Curve

The exponent n of the flow equation is the cotangent of the Angle 0 (determined by direct measurement or by mathematical calculation) between the straight line and the volume ordinate. It is referred to as the slope of the Back-Pressure curve. The value of n (page 113) is equal to $\frac{x}{y}$ which if measured gives $\frac{5.94}{7.50}$ inches = 0.792 which corresponds to an angle or slope of 51.6°. This hasty method of calculating the slope may be used in the field to determine if the slope falls within specified limits as discussed in the foregoing report.

It is to be noted that in the hasty determination of the slope, any uniform units that are consistent may be used; i.e., inches, centimeters, etc. If a protractor is available, the angle may be read directly by placing it on the horizontal axis (0° mark coinciding with this axis) and reading the degrees between the axis and back-pressure curve. The limits in degrees corresponding to a minimum and maximum slope of 0.5 and 1.0 is 63.4 and 45 respectively.

The mathematical calculation of the value of n is based upon the definition of a straight line. The equation is referred to as the point slope and is given by—

$$X_2-X_1 = n\,(Y_2-Y_1)$$

or by mathematical rearrangement —

$$n = \frac{X_2-X_1}{Y_2-Y_1}$$

The easiest method for solving this equation is to choose values of Y ($P_f2 - P_s2$) that correspond to any multiple of the number 1. Thus it may be seen that the denominator will contain only the differences of the characteristics of the $P_f2 - P_s2$, and will eliminate looking up their logs. It must be remembered, however, that in determining these characteristics that $P_f2 - P_s2$ and Q are in thousands; therefore, 3 zeros must be added to the value which is read from the curve.

Values on page 93 which have been selected for the calculation of the slope are:

$$X_2 = \log 4{,}000{,}000 = 6.60206$$
$$X_1 = \log 17{,}000 = 4.23045$$
$$Y_2 = \log 1{,}000{,}000 = 6.00000$$
$$Y_1 = \log 1{,}000 = 3.000$$

Therefore: $n = \frac{X_2-X_1}{Y_2-Y_1} = \frac{6.60206-4.23045}{6.00000-3.00000}$

$$n = \frac{2.37161}{3} = 0.79054$$

The corresponding angle as found from natural Trigonometric Tables is 51.6°

Procedure for Determining the Value of a Number Raised to a Power by Use of Logarithms

PROBLEM: To find the value of $(8.249)^{8/3}$
This may also be written $(8.249)^{2.667}$
Now by Logarithms we have 2.667 log 8.249

From the Logarithms Table we find that the log of the number 9.249 = 0.916401

NOTE: To find the characteristics of the answer, count over the number of places from the natural decimal place, that is, between the first two whole numbers.

EXAMPLE: 9.249 the characteristic = 0
For .00008249 the characteristic = -5
For 824900.0 the characteristic = 5

The characteristic is placed in front of the log corresponding to the number: in our example we therefore have 0.916401

Now multiplying the exponent (2.667) times the log of 8.249, we have

2.667 x 0.916401 = 2.444042

We are now ready to look up the antilog of **2.444042**

Enter the log tables with the number .444042

Opposite .444045 we find the value of 2780

Opposite .443889 we find value of 2779

Difference 156

Since our value of .444042 does not appear in the table it becomes necessary to find this value by interpolation.

GAS WELL BACK PRESSURE CURVE

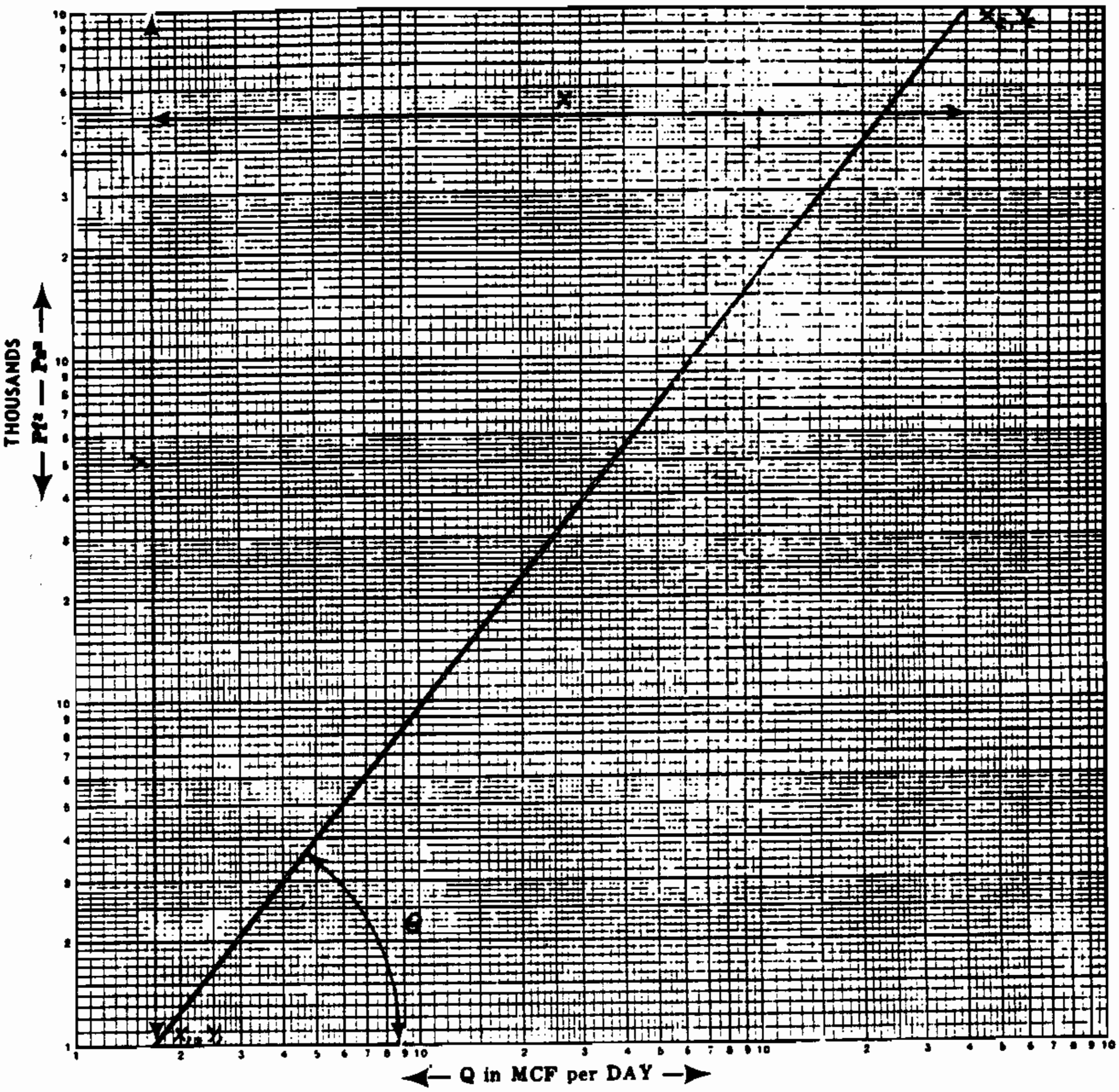
County______________ Field______________

Operator______________________________

Lease____________________ Well No.__________

Volume____________________ MCF/24 hr.

Date______________________________



Now setting up a simple proportion

$$\frac{156}{1} = \frac{3}{X}$$

$$X = .02$$

Since our number of .444042 is below the number of .444045 we subtract the value of X from the antilog of .444045.

$$\begin{array}{r} 2780.00 \\ -\quad .02 \\ \hline 2779.98 \end{array}$$

The decimal is applied here for interpolation purposes only.

Therefore, the number we are seeking is 277998

Now, since the characteristic is 2 (2.444042)

We point off as noted above to give our final answer

277.998

Derivation of Formula Used in Arriving at Shut-In Formation Pressure

If a well is shut-in and no gas is flowing, the absolute shut-in pressure in the sand (P_f) equals the absolute pressure at the well head (P_w) plus the pressure due to the weight of the gas column. If there is no flow from the well there is no pressure drop due to friction in the producing string; consequently the only factors to be considered in determining the absolute pressure at the well-head and the pressure due to the weight of the static column of gas from the sand to the well-head.

We may write

$$BHP = P_f = P_s = P_w + \Delta P_e$$

Where:

BHP = Bottom-hole pressure, psia.

P_f = Shut-in formation pressure, psia.

P_s = Sand face pressure in well-bore, psia.

P_w = Well head pressure, psia.

ΔP_e = Weight of the static gas column, psia.

In order to evaluate ΔP_e to determine the approximate bottom hole pressure, the following formula is presented.

$$\Delta P_e = \frac{29}{359} \times \frac{492}{T_{si}} \times \frac{P_w}{14.7} \times \frac{G_{mix}L}{144}$$

Where:

29 = Molecular weight of air, $\frac{lb}{lb\text{-}Mol.}$

359 = Number of cubic feet in 1 lb-Mol of a perfect gas.

492 = standard conditions of temperature, °R

T_{si} = Average shut-in temperature, °R

P_w = Well-head pressure, psia

14.7 = Average atmospheric pressure, psia

G_{mix} = Specific gravity of mixture in producing string.

L = Average length of gas column, ft.

144 = Number of square inches in 1 square foot.

Written Dimensionally, we have

$$\frac{\frac{lb}{lb\text{-}Mol.} \times \text{Degrees} \times \text{psia} \times \text{Ft.}}{\frac{Ft^3}{lb\text{-}Mol.} \times \text{Degrees} \times \text{psia} \times \frac{in^2}{Ft^2}} = \frac{lb}{in^2}$$

or, incorporating the constants, we have:

$$\Delta P_e = \frac{14.268 \times P_w \; G_{mix}L}{759.931 \times T_{si}}$$

Thus:

$$BHP = P_w + \frac{14.268 \times P_w \; G_{mix}L}{759.931 \times T_{si}}$$

This will give a good indication of the BHP for purposes of calculating the super-expansibility factor in arriving at the shut-in formation pressure in calculations for the back-pressure method.

Formula for Determining Fractional Part of Oil in a Fluid Sample for Use in Determining Whether a Well is a Gas or Oil Well

(Specific Gravity of Oil Well Sample) (X) + (1-X) (Specific Gravity of gas well Sample) = Specific Gravity of Well in question

Solve for X:

Then:

$$(X)\ \left(\frac{100{,}000}{\text{Gas Oil Ratio of Well in question}}\right) = \text{Fraction part of oil in sample}$$

Example:

	A.P.I. Gravity at 60°F	Sp. Gr.	GOR
Statutory Oil Well	41.5	0.8179	
Statutory Gas Well	63.8	0.7245	
Well in question	62.8	0.7283	10,798

Note: The above gravities must be from wells in the same reservoir.

Substituting in formula, we have,

$$0.8179\,x + (1\text{-}X)\,0.7245 = 0.7283$$

$$0.8179\,x + 0.7245 - 0.7245X = 0.7283$$

$$X = 0.04$$

Then: $\frac{100{,}000}{10{,}798} = 9.26$

Fractional part of oil = 0.26 x = (9.26) (0.04) = 0.3704 Bbl. of oil per 100,000 cu.ft. of gas in the reservoir.

Since the fractional part is less than 1 bbl., this sample proves the well to be a gas well.

Gas Oil Ratio in Reservoir $= \frac{100{,}000}{0.3704} = 269{,}978$

Test Procedure for Determining Hydrogen Sulphide and Mercaptan Content of Gas

The method devised by the Railroad Commission of Texas for determining the hydrogen sulphide and mercaptan content of a natural gas consists of absorbing these gases in certain chemical solutions, titrating the solutions for the amount of sulphur present, and finally making the required calculations:

Since the natural gas may contain hydrogen sulphide and mercaptans in varying amounts, it became necessary to devise some method of determination that would embrace the following factors:

(1) The selection of a chemical solution which would completely absorb all of the hydrogen sulphide in the natural gas and allow the mercaptans to pass on.

(2) The use of an absorbent which could catch the above separated mercaptans.

(3) Complete absorption of these gases by use of properly designed scrubbing bottles.

A neutral or slightly acid solution of cadmium sulphate is used as an absorbent since it reacts quantitatively and rapidly with hydrogen sulphide. The concentration of the cadmium sulphate solution is not critical, a satisfactory concentration being obtained with the use of approximately 140 grams of cadmium sulphate ($3CdSO_4 \cdot 8H_2O$) per liter of solution. For absorbing hydrogen sulphide this solution should be neutral or slightly acidic and in no case should be allowed to become alkaline as the mercaptans have weak acidic properties and are readily absorbed by an alkaline solution.

For absorbing mercaptans the above neutral cadmium sulphate solution is made alkaline with a strong solution of sodium hydroxide. A 6N (240 grams NaOH per liter of solution) can be used. The sodium hydroxide should be added until the solution is alkaline to phenolphthalein.

An alternate method for absorbing the mercaptans involves the use of a .025 N solution of silver nitrate which successfully absorbs the mercaptan gas passing through the scrubber bottle.

The two most important factors to insure complete absorption are the length of passage in which liquid and gas are in contact and the size of the gas bubbles dispersed within the liquid. The absorber used is of the Schott type with a Jena-fritted-glass disk extending down the inside of the bottle. The approximate pore diameters are from 100 to 120 microns, giving a fine dispersion of gas. It has been found that a very simple type of absorber can be made from a 1" x 8" test tube fitted with a two-hole rubber stopper, through which passes a glass inlet tube extending almost to the bottom of the test tube.

A set of two absorbers, connected by a short piece of sulphur-free tubing and if practicable "spray traps" should be used at the outlet of the absorbers. Into the first absorber about 40 cc of the cadmium sulphate is introduced. The second absorber contains the alkaline "cadmium sulphate" solution or the 40 cc of silver nitrate for the alternate method. These two absorbers, connected in series are in turn connected to a suitable meter in order to measure the amount of gas passed through the solution.

It is important that the gas procured be a representative sample. If gas is allowed to remain in the well for a period of time, it may be stripped of part of its hydrogen sulphide due to the action of the gas upon the steel tubing. Also without any circulation of the gas in the well, the hydrogen sulphide and mercaptans present will tend to settle to the bottom of the hole due to their higher specific gravities. For this reason, shut-in-wells should be blown for several minutes before testing, to be sure that a true sample is run into the absorber. Whenever possible, samples are taken from the well head, the closest point to the source of the gas.

The flow of gas through the absorbers is regulated by the control valve, while the bleeder valve enables a more representative sample to enter the absorbers. The gas is passed at a rate of about 2 cubic feet per hour. The formation of a yellow cadmium sulphide precipitate indicates that the gas contains appreciable quantities of hydrogen sulphide and the solution is approaching its saturation point. For wells containing this sour gas approximately .3 cubic feet of gas is passed. On the other hand, if there is no color change in the cadmium sulphate solution, the test is allowed to run from 2 to 4 cubic feet.

Upon completion of the test, the absorption train is disconnected and prepared for titration. The cadmium sulphate solution reacts with hydrogen sulphide to give a cadmium sulphide precipitate and sulphuric acid.

$$CD\,SO_4 + H_2S = CdS + H_2SO_4$$

The volume is brought up to approximately 75 cc with distilled water and a known amount of standard iodine solution added so as to give an excess of iodine. This is followed with 15 cc of concentrated hydrochloric acid to dissolve the precipitate.

$$CdS + 2HCl = H_2S + CdCl_2$$

$$H_2S + I_2 = 2HI + S$$

The titration of the excess iodine with standard sodium thiosulphate solution is carried out in the same absorption vessels. Freshly prepared starch solution is used as an indicator and is not added until nearly all of the iodine color has disappeared. This gives a very sharp end point which can easily be detected. The chemical reactions between the iodine and thiosulphate is as follows:

$$I_2 + 2\,Na_2S_2O_3 = 2\,Na\,I + Na_2S_4O_6$$

A .IN solution of iodine and of sodium thiosulphate can be used for titrating the hydrogen sulphide sample where the sulphur content is rather "high" and solutions as low as .OlN improves the accuracy for "low" sulphur content. Mercaptan samples when absorbed in alkaline "cadmium sulphate" should be titrated with solution of a normality suitable to the mercaptan content. Solutions of .025 normality are satisfactory for a wide range of sulphur concentrations. In the Panhandle Field, .OlN solutions are sufficiently strong. In using any solution a blank should be run because of the fact that the iodine solution is rather unstable causing its normality to change appreciably from day to day. The thiosulphate is considered to be more stable but it is desirable to check its normality. Any standard method may be used. Several methods for standardizing sodium thiosulphate are given in *Scotts Methods of Chemical Analysis*, Vol. I.

In using the alkaline "Cadmium sulphate" method for determining mercaptans, the titration should be carried out in a closed titrating vessel. A known amount of a standard iodized solution and 15 cc of concentrated hydrochloric acid are added to a small test tube and carefully introduced into the titrating vessel. The top is placed on the vessel and the contents of the tube mixed with the absorbed mercaptans. After the white precipitate is completely dissolved, the excess iodine is the titrated with standard sodium thiosulphate solution.

In the case of the mercaptan gas the reaction is as follows:

$$Cd(OH)_2 + 2\,RSH = Cd(SH)_2 + 2\,ROH$$

$$CD(SH)_2 + 2HCl = 2H_2S + CdCl_2$$

$$H_2S + I_2 = 2HI + S$$

The formula for the calculation of the hydrogen sulphide present is as follows:

$$G = \frac{(1-3)(.6573)}{V}$$

Where:

G = Grains of hydrogen sulphide per 100 cu. ft. of gas

I = Iodine solution used, cc

S = Sodium thiosulfate solution used, cc

V = Corrected volume cubic feet (60° F & 14.7 #/sq. in.)

The factor .6573 is arrived at in the following manner:

17.0378 grams of H_2S per 1000 cc x 15.432 grains per gram x .025 normality

= 6.573 grains per 1000 cc per one cubic foot of gas

= .006573 grains per cc per one cubic foot of gas

= .6573 grains per cc 100 cubic feet of gas

For .IN solution factor = 2.63

When the alternate method of mercaptan determination involving the use of silver nitrate is used the reaction is as follows:

$$AgNO_3 + R\text{-}SH = AgRS + MNO_3$$

To the mercaptan sample absorbed in silver nitrate 40 cc of .025 N sodium chloride solution are added forming a white precipitate of silver chloride and the neutral sodium mercaptide.

$$Ag\,RS + NaCl = AgCl + Na\,RS$$

The excess sodium chloride is back titrated with a silver nitrate solution using a saturated solution of sodium chromate as an indicator. The end point is detected as the first permanent orange color is obtained.

Calculations for mercaptans is as follows:

$$G = \frac{S \times \text{Factor}}{V}$$

Where:

G = Grains of mercaptan sulphur per 100 cubic feet of gas

S = Silver nitrate used in titrating, cc.

V = Corrected volume cubic feet (60° F & 14.7 #/sq. in.)

The factor for mercaptans is derived as follows:

32.06 grams of Sulphur/liter x 15.432 grains/grams x .IN

= 49.47 grains/1000 cc/cu.ft. of gas

= 0.04947 grains/cc/cu.ft. of gas

= 4.947 grains/cc/100 cu.ft. of gas

Standard solutions of iodine thiosulphate may be prepared by the methods recommended in standard reference books for volumetric solutions or they may be purchased prepared and standardized from chemical supply houses.

Wells producing natural gas containing less than 1-1/2 grains of hydrogen sulphide per 100 cubic feet and less than 30 grains of total sulphur (H_2S + R-SH) per 100 cubic feet of gas are classified as sweet gas wells.

Calculation of Reservoir Displacement

Example: BHP = 4505 psia
BHP = 208°F
Shrinkage Factor = 0.552
Supercompressibility Factor = 1.008

To find the corresponding volume in cubic feet of one barrel of oil at the surface.

$$1 \text{ bbl.} \times \frac{1}{0.552} = 1 \times 1.81 = 1.81 \text{ bbl of oil}$$

in the reservoir

1.81 x 5.61 (cu.ft/bbl.) = 10.15 cu.ft. in reservoir

To find what this gas volume would be at the surface, we use the following formula

$$\frac{P_1V_1}{T_1Z_1} = \frac{P_2V_2}{T_2Z_2}$$

Where: P_1 = Pressure at surface, psia

V_1 = Volume at surface, cu.ft.

T_1 = Temperature at surface, -°Rankine

Z_1 = Supercompressibility factor at surface

P_2 = Pressure in Reservoir, psia

V_2 = Volume in Reservoir, cu.ft.

T_2 = Temperature in Reservoir, °Rankine

Z_2 = Supercompressibility factor in Reservoir

Substituting, we have:

$$\frac{14.65 \times V_1}{520 \times 1} = \frac{4505 \times 10.15}{668 \times 1.008}$$

Solving for V_1, we have

$$V_1 = \frac{4505}{14.65} \times \frac{520}{668} \times \frac{1}{1.008} \times 10.15$$

$$= 307.5 \times 0.7784 \times 0.992 \times 10.15$$

$$= 2.410 \text{ cu.ft.}$$

Procedure for the Determination of Raw Gas Gravity When the Separator Gas Gravity, Specific Gravity of Liquids and Gas-Liquid Ratio are Known

In numerous cases the raw gas gravity is unknown but the separtor gas gravity, Specific Gravity of the hydrocrbon liquids, and gas-liquid ratio may be obtained.

If the A.P.I. Gravity is known but not the specific gravity, the specific gravity may be calculated from the following equation:

$$\text{Specific Gravity} = \frac{141.5}{131.5 + \text{degrees API}}$$

The raw gas gravity may be calculated from the following equation:

$$\text{Raw Gas Gravity} = \frac{\text{Separator Gas Gravity} + \frac{4591\ G_1}{R}}{1 + \frac{1123}{R}}$$

Where G_1 = Specific gravity of hydrocarbon liquids

R = Gas liquid ratio, cubic feet per barrel

Example: Calculate the raw gas gravity with the following given:

Separator gas gravity = .600

Gravity of liquid hydrocarbons = 35.3° API

Separator gas/liquid ratio = 787.89 Mcf per barrel

$$\text{Specific Gravity} = \frac{141.5}{131.5+35.3} = \frac{141.5}{166.8} = .8483$$

$$\text{Raw Gas Gravity} = \frac{.600 + \frac{(4591)(.8483)}{787{,}890}}{1 + \frac{1123}{787{,}890}}$$

$$= \frac{.600 + .00494}{1 + .00143}$$

$$\frac{.60494}{1.00143} = 6041$$

If the A.P.I. or Specific Gravity of the hydrocarbon liquids are uknown but the separator gas gravity and gas/liquid ratio are known, the following chart may be used.

Example: Calculate the raw gas gravity with the following given:

Separator gas gravity = .700

Gas liquid ratio = 25,000 cubic feet/barrel

The barrels of liquid per million cubic feet of gas is $\left(\frac{1}{25{,}000}\right)$ times 1,000,000 or 40.

From the following chart for 40 barrels of condensate per million cubic feet, the ratio of raw gas gravity to separator gas gravity is found to be 1.19.

The raw gas gravity is (.700) (1.19) = .834.

Procedure for Adjusting an Absolute Open Flow When a New Shut-in Well Head Pressure is Taken (as required by Statewide Rule 24)

(1) Calculate new P_F (Shut-in formation pressure, psia) in the manner described in the preceding examples. If the new P_F is obtained with a bottom-hole instrument, these calculations are unnecessary.

(2) Draw a horizontal line equal to the new $(P_F)^2$ on a copy of the back pressure curve obtained from the previous back pressure test.

(3) Draw a vertical line through the point obtained by the inter-section of the horizontal line equal to the new $(P_F)^2$ and the back pressure curve from the previous back pressure test.

(4) The value read from the intersection of the vertical line and the abscissa is the adjusted absolute open flow potential.

(5) Submit a copy of the graph used with each copy of the Forn GWT-1 submitted.

If it is not desirable to obtain copies of the previous back pressure curve the adjusted absolute open flow potential may be calculated from the equation:

$$OF_2 = OF_1 \left[\frac{(P_{F2})^2}{(P_{F2})^2}\right]^N$$

Where

OF_2 = Adjusted absolute open flow, MCF

OF_1 = Old Absolute open flow, MCF (From latest back pressure test accepted by the Commission's Engineering Department)

P_{F2} = New shut-in formation pressure, psia

P_{F1} = Old shut-in formation pressure, psia (From the latest back pressure test accepted by the Commission's Engineering Department)

N = Slop of back pressure curve obtained on latest back pressure test cotangent of angle between back pressure curve and the horizontal (Q) axis of the curve sheet.

Example:

OF_1 = 10,000 MCF

P_{F2} = 900 psia

P_{F1} = 1,000 psia

N = Cotan 48° = tan 42° = .900

$$\log OF_2 = \log OF_1 + (2N \log P_{F2}) - (2n \log P_{F1})$$

$$= \log 10{,}000 + (2)(.9)(\log 900) - (2)(.9)(\log 1000)$$

$= 4.00000 + (2)(.9)(2.98424) - 2(.9)(3.00000)$

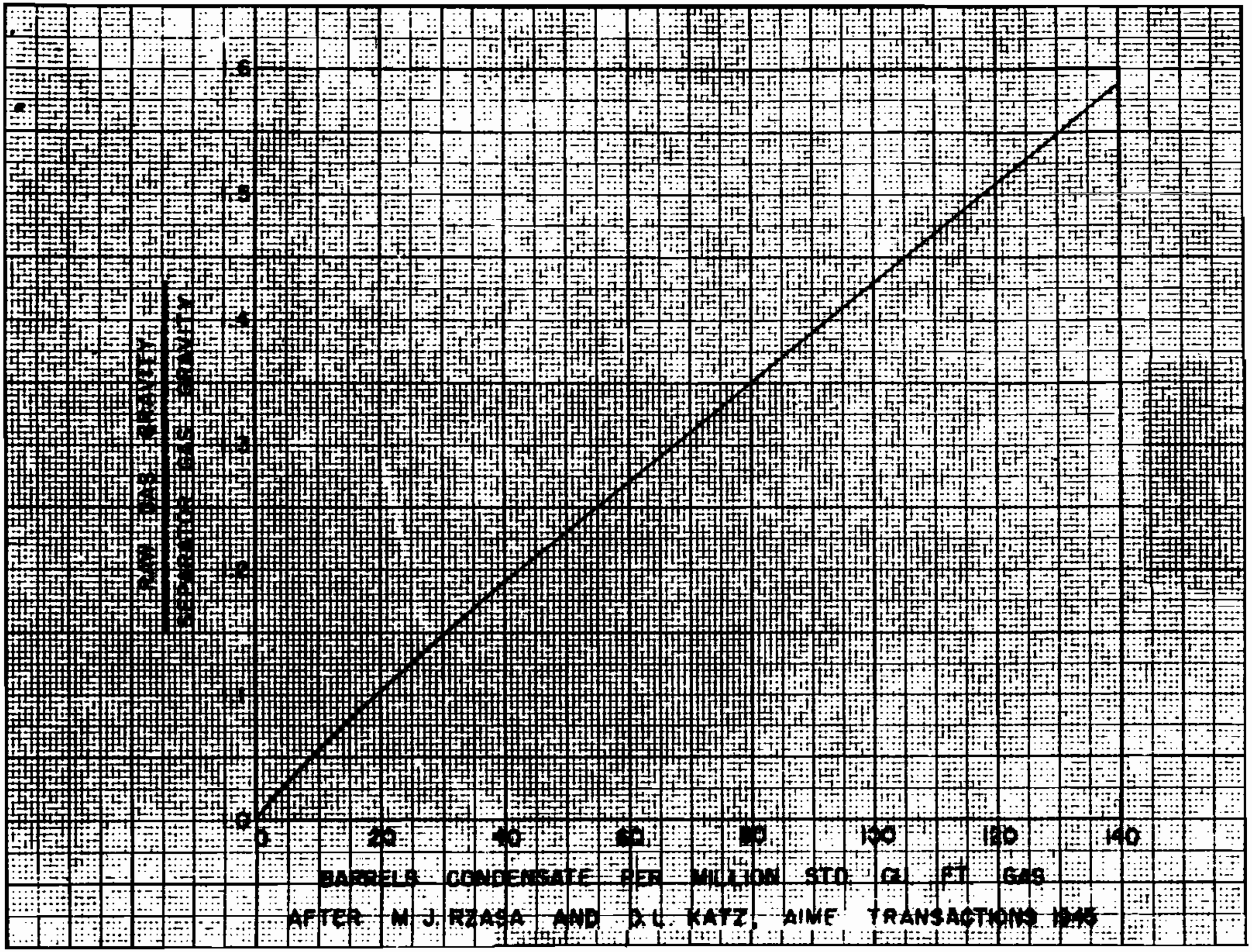
$= 4.00000 + 5.31763 - 5.40000$

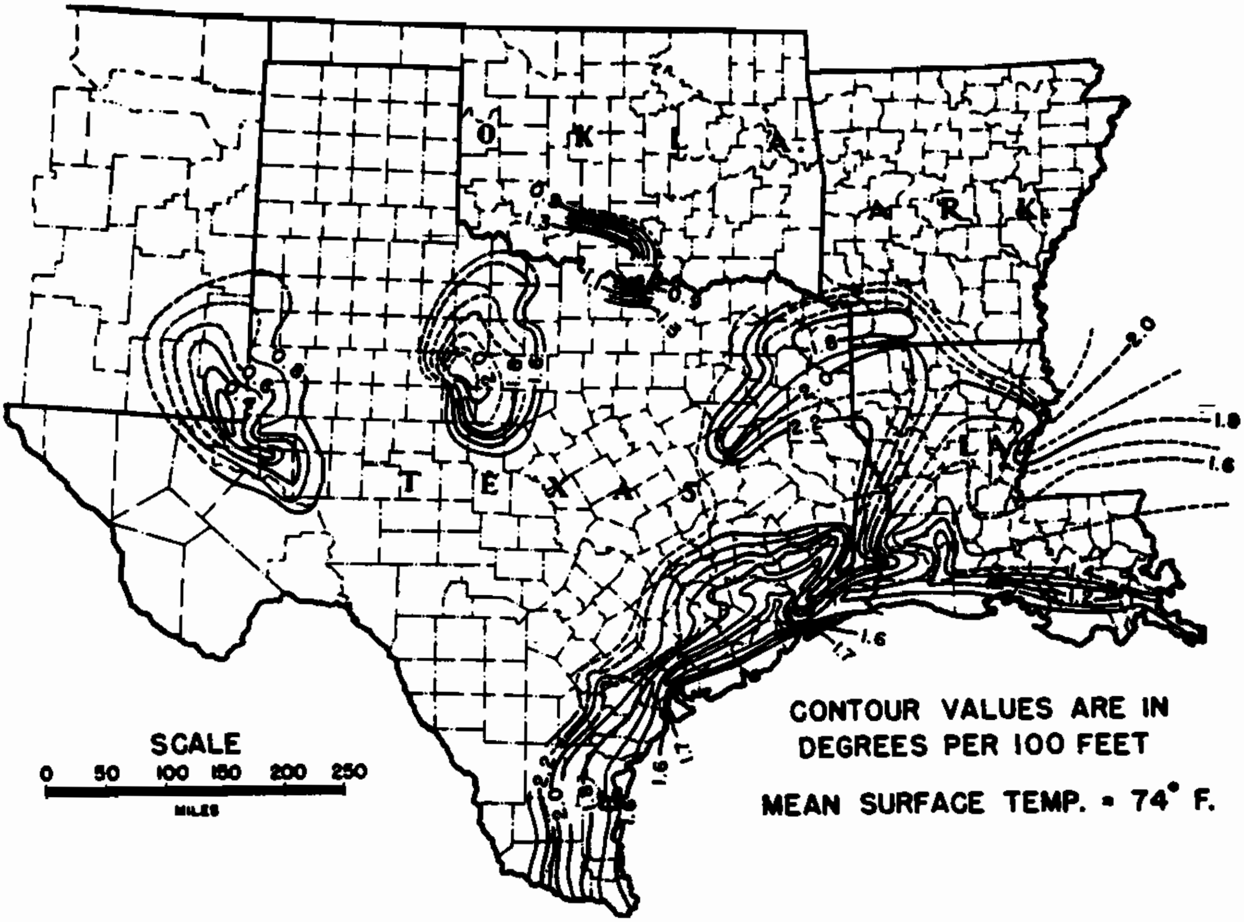
$= 3.91763$

$OF_2 = 8270$

In this method the results should be obtained to only three significant figures as this is as close as the back pressure curve can be read.

In shallow gas wells very little error will result in the calculation method described above, if wellhead shut-in pressures are used in place of formation shut-in pressures. If an operator prefers to use wellhead shut-in presures, he may do so, although the use of formation pressures will not result in a lower adjusted absolute open flow potential.


RAW GAS GRAVITY
SEPARATOR GAS GRAVITY
0
20
40
60
80
100
120
140
BARRELS CONDENSATE PER MILLION STD CU FT GAS
AFTER M J. RZASA AND D.L. KATZ, AIME TRANSACTIONS 1945



Contour Map of Geothermal Gradients in Southwest United States (after Earl A. Nichols, Aime Transactions, 1947)

This Map may be used in estimating Bottom-hole temperatures in the following manner:

Estimated Temp., Deg. F = Well depth in hundreds of feet X
Gradient from Map + 74° F.

Contours should not be extrapolated into areas not contoured. In areas of dotted contours, the number of control points were insufficient for accurately defining the position of the Gradient Lines, and they should be used with this in mind. Example: A well in the Whelan Field, Harrison County, Texas has a depth of 6,818 feet. From the Map the Gradient for NW Harrision County is found to be 1.9. The bottom hole temperature is then (68.18) (1.9) + 74 = 130 + 74 = 204° F.

CONTANGENT TABLE

Slopes of Back Pressures Curves

θ Angle	N
45	1.000
45.5	.983
46	.966
46.5	.949
47	.932
47.5	.916
48	.900
48.5	.885
49	.869
49.5	.854
50	.839
50.5	.824
51	.810
51.5	.795
52	.781
52.5	.767
53	.754
53.5	.740
54	.727
54.5	.713
55	.700
55.5	.687
56	.675
56.5	.662
57	.649
57.5	.637
58	.625
58.5	.613
59	.601
59.5	.589
60	.577
60.5	.566
61	.554
61.5	.543
62	.532
62.5	.521
63	.510
63.5	.499