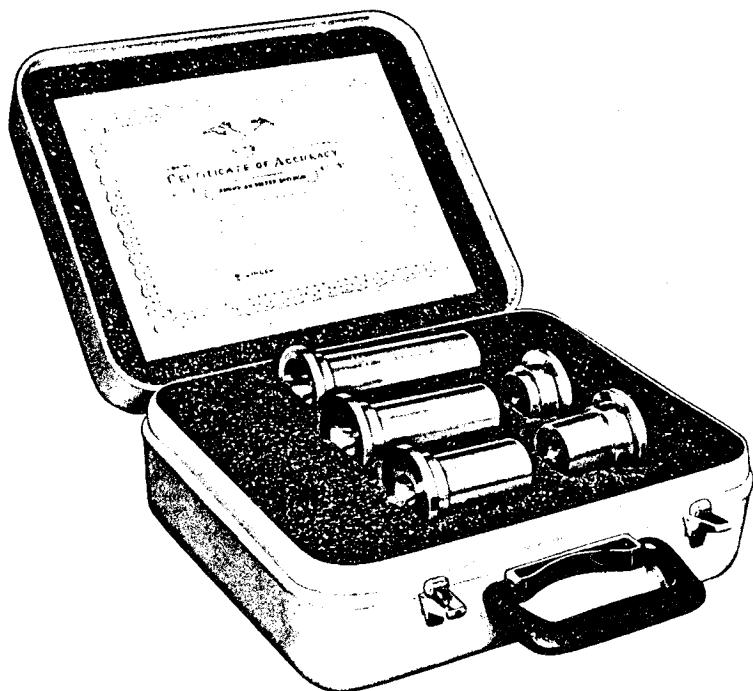


INSTRUCTIONS

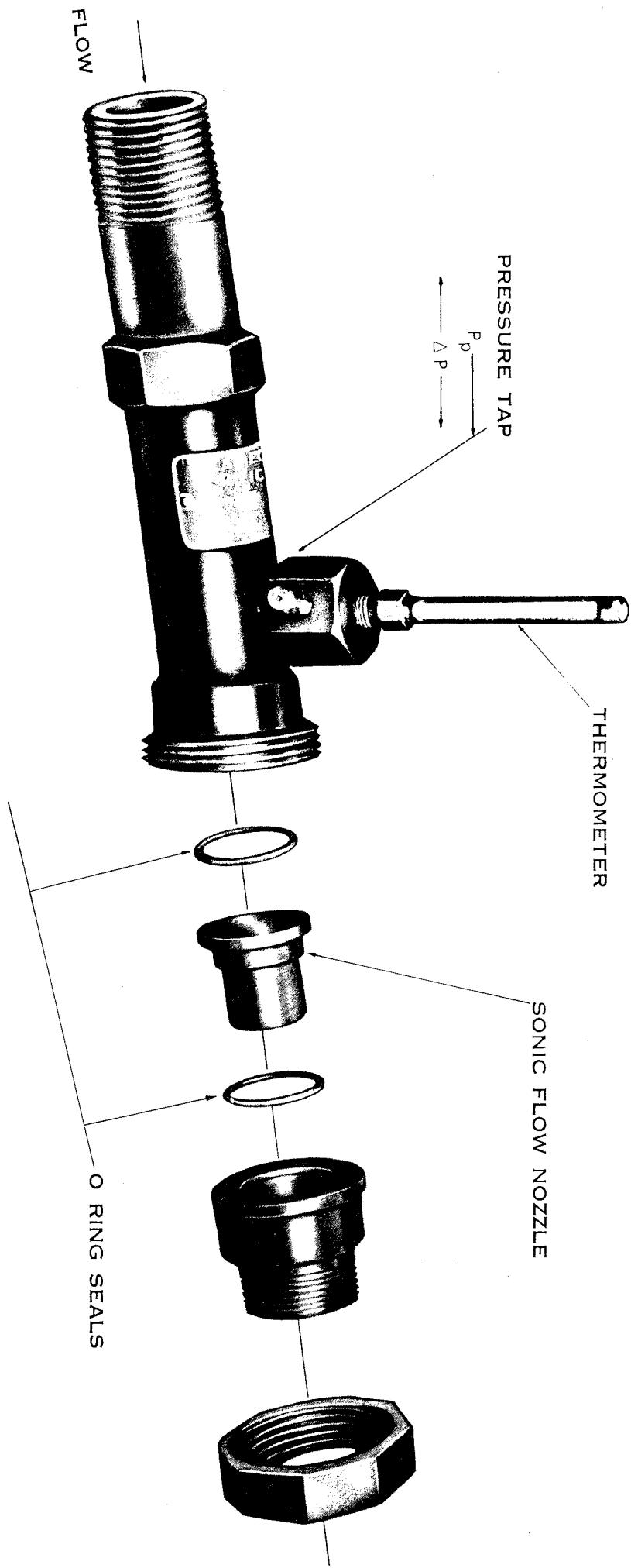
REVISED AUGUST, 1978

AMERICAN* SONIC NOZZLE FLOW PROVER



**AMERICAN
METER COMPANY**
Measurement Engineers Since 1836

**SONIC FLOW NOZZLE AND
FLOW PROVER HOLDER**



INSTRUCTIONS FOR SONIC NOZZLE FLOW PROVER

<u>INDEX</u>	<u>PAGE</u>
SECTION I - SONIC FLOW PROVING	3
SECTION II - OPERATING PRECAUTIONS	5
Connecting the Prover	5
Test Time	6
Pressure	6
Temperature	6
Nozzles	6
Supercompressibility	7
Gases high in N ₂ or CO ₂	7
SECTION III - METER PROVING USING NATURAL GAS	8
Calculations - Method A	9
Calculations - Method B	12
SECTION IV - PROVING WITH AIR	14
 <u>TABLES:</u>	
Table 1 C* \sqrt{Z}	19-20
Table 2 \sqrt{Z}	21-22
Table 3 F _R Factors	23
Table 4 F _g Factors	23
Table 5 Combined N and Gravity Factor	24-31
Table 6 F _{pv} Factors	32-35
Table 7 F _A Factor for Air	36-39
SECTION V - SONIC NOZZLE VACUUM PROVING	40
Table 8 Humidity Factor	42



CERTIFICATE OF ACCURACY

AMERICAN METER COMPANY

SONIC NOZZLE PROVING STANDARDS

STANDARD TIMES FOR ONE FOOT OF AIR AT 60°F AND SPECIFIED PRESSURE

Serial No. N 129 B	T _s	18.53	Sec. ± 0.15%	at	24.696	psia
Serial No. N 144 D	T _s	4.556	Sec. ± 0.15%	at	24.696	psia
Serial No. N 123 F	T _s	2.0270	Sec. ± 0.15%	at	24.696	psia
Serial No. N 139 H	T _s	1.1357	Sec. ± 0.15%	at	24.696	psia
Serial No. N 140 J	T _s	0.7255	Sec. ± 0.15%	at	24.696	psia

By J. A. Lee
Engineer
Date MARCH 7, 1974

AMERICAN
METER COMPANY
Measurement Engineers Since 1836

SECTION 1 - SONIC FLOW NOZZLE PROVING

The Sonic Nozzle Flow Prover is intended for calibrating gas meters. The prover is connected to the meter outlet and gas or air is passed through the meter and the prover. The time necessary for a chosen number of cubic feet to register on the meter is determined using a stopwatch. The meter proof is calculated as shown in Section 3.

Maximum Test Pressure

The maximum permissible test pressure is 1000 psig, which is the maximum safe working pressure rating of the prover holder.

Minimum Test Pressure

The minimum test pressure is governed by the fact that sufficient pressure drop must exist across the nozzle to insure sonic velocity at the nozzle throat. This requirement is met when the nozzle discharge absolute pressure is less than 85%* of the absolute nozzle upstream pressure. For example, when discharging to atmosphere (14.7 psia) a pressure of about 2.6 psig is required at the nozzle inlet.

* 80% for nozzle sizes A (.094") and B (.125")

Approximate Flow Rates

APPROXIMATE CRITICAL FLOW RATES OF SONIC FLOW NOZZLES

Nominal Throat Diameter Inch	Size Code	Air Time for One Cu. Ft. Index Reading Seconds	Approximate Index Rate (AIR) cfh	Approximate Index Rate (GAS) cfh
0.094*	A	36.00	100	125
0.125	B	18.00	200	250
0.188*	C	8.00	450	562
0.250	D	4.50	800	1000
0.312*	E	2.88	1250	1560
0.375	F	2.00	1800	2250
0.438*	G	1.47	2450	3060
0.500	H	1.13	3200	4000
0.625	J	0.75	4800	6000

* Special sizes, available on request.

The preceding table contains approximate index rates in cubic feet an hour at the upstream pressure for nozzles of various diameters; also the approximate time required for the passage of one cubic foot of air. This table is used for determining the sizes of nozzles which should be used for proof tests.

Testing

When testing diaphragm meters, do not exceed the published maximum index rate specified by the manufacturer. These maximum index rates are set so as to limit the maximum differential developed across the meter to a safe value.

It is suggested that tests be conducted at, at least two and preferably three, flow rates. If three flow rates are employed, they should be at index rates of 10 to 20 percent, about 50 percent and at 80 to 100 percent of the index rate for the rated capacity of the meter.

Example: an AL-2300 meter, which has a gas capacity of 19,000 scfh at 75 psig, is to be tested with a critical flow prover at that pressure. This capacity corresponds to an index rate of about 3100 cfh. The nozzles selected for the test could be the .125-inch, .312-inch and 0.438-inch throat diameter; with corresponding approximate gas capacities of 250, 1560 and 3060 cfh.

Numerous experiments and investigations have established the fact that if the proof of a meter is correct at a rate which produces a certain differential pressure between the inlet and outlet of a meter, then the proof will also be correct if the meter is used under different line pressure conditions, provided that the rate of flow is such that the same differential pressure is created between the inlet and the outlet of the meter.

For example, if the proof of a meter is correct at an index rate of 5,000 cfh at four ounces pressure at a differential of 1.7 inches water, the proof of the same meter will be correct at an index rate of 2,500 cfh at 45 psig, since the differential produced at an index rate of 2,500 cfh at 45 psig is 1.7 inches water.

Testing at High Rates

When testing meters at a rate greater than 6000 cubic feet an hour it is advisable to use two or more sonic flow nozzles in parallel. By the use of a tee with two provers, two nozzles can be placed in parallel.

The standard air time for two or more nozzles used in parallel is equal to the reciprocal of the sum of the reciprocals.

$$t = \frac{1}{\frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} \text{ etc}} \quad \text{or} \quad \frac{t_1 \times t_2}{t_1 + t_2} \quad \text{for two nozzles}$$

where:

t = standard air time for one cubic foot for two or more critical flow nozzles.

t_1 t_2 = respectively, standard air time for each individual nozzle.

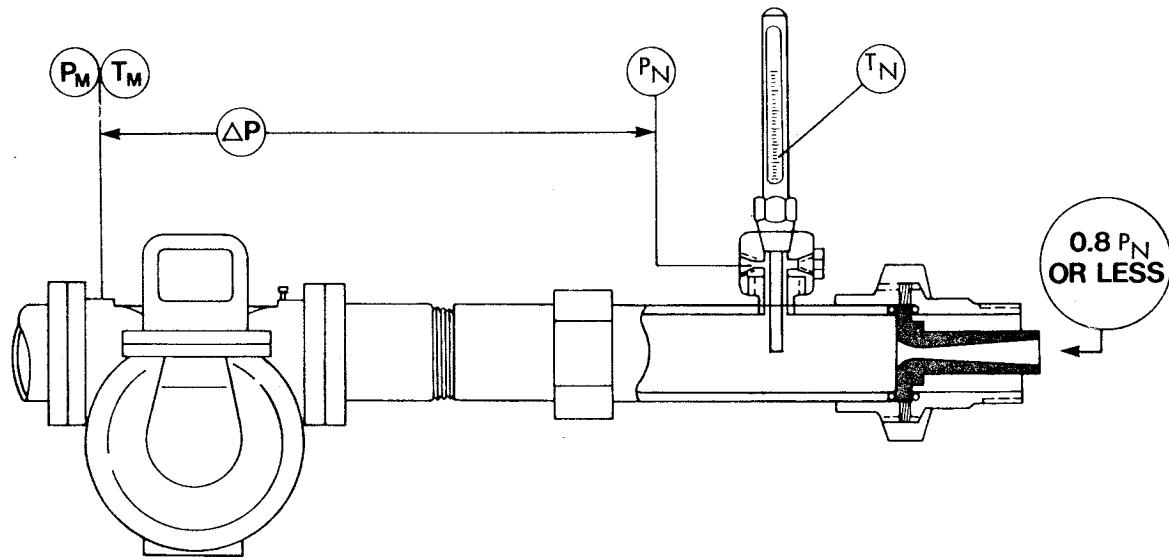
If the standard air time for one nozzle is 4.50 seconds and for another nozzle is 2.00 seconds, the air time for the two nozzles when used in parallel is:

$$t = \frac{1}{\frac{1}{2.00} + \frac{1}{4.50}} = 1.385 \quad \text{or} \quad \frac{2.00 \times 4.50}{2.00 + 4.50} = 1.385$$

SECTION 11 - OPERATING PRECAUTIONS

Connecting the Prover

The prover should be connected close to the meter outlet with no appreciable intervening restriction - See Figure 1. This will keep the temperature and the pressure in the nozzle inlet very close to those in the meter. In most cases it will not be necessary to measure the difference in pressure and temperature between the meter inlet and the nozzle inlet.



SONIC FLOW NOZZLE PROVING CONFIGURATION

FIGURE 1

However, 1°F of temperature difference will make 0.1% difference in meter proof. A pressure difference of 1.0 inch of water will make a proof difference of 0.2% at 4 psig operating pressure; proportionally less at higher absolute pressures.

An inspection of the joints or connections between the inlet of the meter and the prover should be made. Small leaks between the inlet of the meter and the nozzle will have an effect on the test. Test the thermometer connection for leaks. When the flow prover is connected to a tee at the outlet of a meter, be sure that the outlet valve does not leak, which would allow some gas to pass from the outlet line through the valve and through the prover.

The sonic flow provers are furnished with the outlet fitting threaded so that a hose or pipe can be attached to the outlet fitting and the gas can be conveyed to the outside of the building, or to a point in the piping at which the absolute pressure is less than 80% of the nozzle inlet absolute pressure.

In testing meters in the field, special precaution should be used, as the rate of flow of gas through the meter is considerably more than that which occurs in ordinary testing, and this gas should be conveyed from the room to the outside of the building in which the meter is located so that there will be no possibility of an explosive mixture occurring within the building. This is especially true when the critical flow prover is used, because of the large volumes of gas which may be employed.

Test Time

The test time should not be less than 100 seconds. The index reading covered by the period of the test must be equal to one or more complete revolutions of the proving hand of the index.

Pressure

The pressure at the field meter should be maintained fairly constant during the test. If the pressure on the meter is not the same at the end of any test as at the beginning of any test, an error will exist because of the change of quantity or weight of gas in the displacement meter produced by the change in pressure.

A differential manometer can be used to measure ΔP , Figure 1; then a factor can be applied for the difference in pressure between the meter inlet and the prover pressure tap.

Temperature

The gas should be passed through the meter and prover until the temperature shown on the thermometer remains reasonably steady. It is always desirable to have constant temperature conditions during a proving operation.

A thermometer may be mounted in the pipe ahead of the meter and correction made for a difference in temperature between the meter and the prover. If there is a relatively constant difference between the meter inlet and outlet (prover) temperatures, the average of the two values will best represent the actual meter temperature. As a rough guide, a difference in temperature between the meter inlet and outlet should not exceed 2°F to be consistent with good field proving practice. If test conditions make it desirable to correct for differences in temperature between the meter and the nozzle, a thermometer must be mounted in the pipe immediately ahead of the meter and a correction factor applied.

Nozzles

The nozzles are stamped to indicate the time required for the passage of one cubic foot of air at 60°F and 24.696 psia. These values should not change except for corrosion, abrasion, or rough handling. The nozzles are made of stainless steel and there is very little likelihood of change of values unless they are used for testing gas containing foreign matter. They should be examined after each test to be sure that no foreign matter has collected in the throat of the nozzle.

The nozzles should be handled very carefully. When not in use they should be kept in their case.

Due to the small size of these nozzles, it is not practical to calculate the standard air time by the measurement of the diameter of the throat. It is always determined by the manufacturer's calibration test and is stamped on the outlet side of the nozzle. This stamped figure is referred to as t_s , or the "standard time" for the nozzle being used. It appears on each nozzle along with the serial number.

For example : N131B - (Serial number)
13.46 - (t_s) seconds

Supercompressibility

Supercompressibility affects the performance of a critical flow in substantially the same manner in which it affects the flow through an orifice meter. That is, F_{pv} , for conditions upstream of the nozzle becomes a multiplier of the time stamped on the nozzle--along with the other applicable factors. Values for F_{pv} can be obtained from the AGA tables used in conjunction with orifice meters.

It should not be assumed that the use of this factor "proves supercompressibility into the meter". This is not the case. The use of this factor merely takes the deviation (supercompressibility) into account as it affects the proving operations. The meter is then on the same proof basis as if it had been proved with a bell prover at a rate which would create the same meter differential. With the meter proved in this manner, the subsequent measurements indicating displaced volume are subject to application of the customary factor, $(F_{pv})^2$, for the pressure and the temperature conditions which prevailed during the measurement period--if correction for deviation is specified in the measurement contract.

Gases with High N₂ or CO₂

Gases with over 7% of nitrogen may give abnormally large errors when calculating the flow rate using the methods described in these instructions. The same is true of gases with large amounts (over 3%) of carbon dioxide.

SECTION 111 - METER PROVING USING NATURAL GAS

Figure 1 is a simplified sketch showing the prover connected to a meter to be calibrated. Although the sketch shows a rotary meter, it applies equally well to any other type of gas meter.

Two methods are given for calculating the meter proof from the test results.

Method A is similar to that used in publication E-4 of the American Meter Division for use with a critical flow prover. It is also the calculation method used in the A.G.A. Report #6 - Testing Large Capacity Displacement Meters. In that report, the factors used are tabulated as logarithms to facilitate field calculations. In view of the availability of small electronic calculators, the logarithmic method will not be used in the following instructions.

The first method (A) has the following features:

- . Tables are supplied in these instructions that are reliable for test pressures up to 500 psig and for temperatures from 20°F to 100°F. when natural gas is the test medium. As the test pressure is increased above 500 psig to 1000 psig, possible inaccuracies can exceed 1%.
- . The specific gravity of the gas must be known. The mol percent of N₂ and CO₂ should also be known in order to calculate F_{pv}.

The second method will be referred to as Method B. Its features are:

- . It covers a wider range of temperatures and pressures than Method A.
- . It is useful for pressures up to 1,000 psig and for temperatures from 0°F. to 200°F.
- . It requires a knowledge of the gas composition.
- . Although the calculations are somewhat complex, they are facilitated by using the tables provided in these instructions. These tables take care of the ratio of specific heats, the compressibility factor and the nozzle discharge coefficient.

Calculation of Meter Proof Using Method "A"

The meter proof is given by the ratio of the test time to the correct time. The test time is the seconds shown by the stopwatch for a predetermined volume to register on the meter. The correct time is the time stamped on the nozzle multiplied by a set of factors which adjust t_s to the test volume and for departure of the test conditions from 60°F, 24.696 psia, and air. The factors account for a difference in specific gravity, N (k' and flowing temperature), F_{pv} (supercompressibility) and F_R (nozzle sensitivity factor).

The F_R factor is required to adjust the nozzle flow for an effect due to Reynolds' number. This effect is small and only significant with small nozzles operated at high pressures.

The basic relation is:

$$\begin{aligned} \text{Percent Proof} &= 100 \times \frac{\text{Test Time}}{\text{Correct Time}} \\ &= 100 \times \frac{t}{(t_s)(Q_M)(N)(F_{pv})(F_{pc})(F_{tc})} \times F_R \quad (1) \end{aligned}$$

Where:

t = test time (stopwatch) seconds

t_s = nozzle stamped time (sec/cf)

Q_M = meter index reading (cf)

N = from Table 5

F_{pv} = from Table 6

$$F_{pc} = 1 + \frac{P_M - P_N}{P_N} = 1 + \frac{\Delta P}{P_N} \quad \text{where } (\Delta P = P_M - P_N)$$

$$F_{tc} = 1 - \frac{T_M - T_N}{T_M} = 1 - \frac{\Delta T}{T_M} \quad \text{where } (\Delta T = T_M - T_N)$$

P_M = Meter Pressure - psia

P_N = Nozzle Pressure - psia

T_M = Meter Temperature - °R

T_N = Nozzle Temperature - °R

P_a = Atmospheric Pressure - psia

F_R = Reynold's number adjustment factor

Example of Method "A"

A test gave the following results:

$$\text{Test time} = 187.5 \text{ sec.}$$

$$t_s = 0.7478 \text{ sec.}$$

$$Q_M = 300 \text{ cf}$$

$$G = .620$$

$$T_N = T_M = 72.1^\circ\text{F.} = 532.1^\circ\text{R}$$

$$F_{tc} = 1.000$$

$$P_N = 500 \text{ psig} + 14.6 \text{ psi}$$

$$= 514.6 \text{ psia}$$

$$\Delta P = 2.4 \text{ psi}$$

$$P_a = 29.7" \text{ Mercury} @ 32^\circ\text{F} = 14.59 \text{ psia}$$

$$\text{Mol \% N}_2 = 2.10$$

$$\text{Mol \% CO}_2 = 2.54$$

Step #1 Determine N from Table #5
@ .620 specific gravity and 72.1°F. $N = .8016$

Step #2 Determine F_{pv} from Table #6 and adjusted pressure and temperatures.

.620 gas with diluents:

$$P_{adj.} = 495.0 \text{ psig} \quad F_{pv} = 1.0362$$

$$T_{adj.} = 76.4^\circ\text{F.}$$

Step #3 Determine F_R from Table #3

$$.7500 \text{ nozzle} @ 500 \text{ psig} \quad F_R = 1.002$$

Step #4 Determine F_{pc}

$$F_{pc} = 1 + \frac{2.4}{514.6} = 1.0047$$

Step #5 Substitute above values in (1) Page 9

$$\text{Percent Proof} = 100 \frac{(187.5)}{(0.7478)(300)(0.8016)(1.0362)(1.0047)(1.000)} \times 1.002 = 100.36\%$$

$$\% \text{ Accuracy} = \frac{100}{\% \text{ Proof}} \times 100 = \frac{100}{100.36} \times 100 = 99.64\%$$

Calculation of Meter Proof Using Method "B"

The meter proof is obtained by calculating the actual flow rate through the nozzle at the test conditions and comparing it with the flow rate as indicated by the meter.

The volumetric flow rate through the nozzle is given by the following equation in which the volume is taken at upstream conditions of temperature and pressure.

$$V_N = \frac{0.06402}{t_s} C^* Z F_G \sqrt{T_N} F_R \quad (2)$$

The flow rate indicated on the meter is:

$$V_M = \frac{Q_M}{t}$$

$$\begin{aligned} \text{Percent Proof} &= \frac{V_N}{V_M} \times 100 \\ &= 100 (0.06402) \left(\frac{t}{t_s} \right) \left(\frac{1}{Q_M} \right) \left(\frac{T_M}{T_N} \right) \left(\frac{P_N}{P_M} \right) (C^* \sqrt{Z}) (\sqrt{Z}) (\sqrt{T_N}) (F_G) (F_R) \quad (3) \end{aligned}$$

Where:

V_M = Meter flow rate - cfs

V_N = Nozzle flow rate - cfs

Q_M = Indicated meter volume - cf

t = Test time - seconds

T_N = Nozzle temperature - °R

P_N = Nozzle pressure - psia

T_M = Meter temperature - °R

P_M = Meter pressure - psia

G = Specific gravity

$$F_G = \sqrt{\frac{1}{G}} - \text{Table 4}$$

$$C^* \sqrt{Z} = a_c f + b_c - \text{Table 1}$$

$$\sqrt{Z} = a_z f + b_z - \text{Table 2}$$

f = Composition factor

$$= X(C_2 H_6) + X(CO_2) - 1/2 X(N_2) + 2 X(C_3 H_8) + 3X(C_4 H_{10}) + 4X(C_5 H_{12}) \quad (4)$$

Where X is the decimal molecular fraction of the gas composition.

F_R = Factor for change in t_s due to test pressure being different than the nozzle calibration pressure of 10 psig. Factors are given in Table #3.

C^* and Z express the ratio of specific heats and the supercompressibility for a gas having the calculated composition factor. They are obtained from Tables #1 and #2 after calculating the composition factor.

$C^* Z$ is broken down into $(C^* \sqrt{Z}) (\sqrt{Z})$ in (3) and in the tables since using the quantities in this way gives better accuracy than could be obtained from tables of C^* and Z .

Example of Method "B"

A typical test gave the following results:

$$Q_M = 300 \text{ cf}$$

$$t = 187.5 \text{ seconds}$$

$$t_s = 0.7478 \text{ seconds}$$

$$G = .620 (F_G = 1.2700), \text{ Table 4}$$

$$P_N = 500 \text{ psig} + 14.6 = 514.6 \text{ psia}$$

$$T_M = T_N = 72.1^\circ\text{F.} = 532.1^\circ\text{R}, \left(\frac{T_M}{T_N} = 1.000 \right), \left(\sqrt{532.1} = 23.067 \right)$$

$$\Delta P = 66.44 \text{ inches of water} @ 60^\circ\text{F} = 2.4 \text{ psi}$$

$$P_M = 514.6 + 2.4 = 517.0 \text{ psia}$$

$P_a = 29.7$ inches of mercury @ $32^\circ F$

$$= 14.59 \text{ psia}$$

Step #1 Compute the composition factor using equation (4). From an analysis of the gas we have:

$$f = 0.0344 + 0.0254 - 1/2(0.0210) + 2(0.0090) + 3(0.001) + 4(0.003) = 0.0823$$

Step #2 Find $(C^* \sqrt{Z})$ and \sqrt{Z}

From Tables #1 and #2 we find: Pages 19 through 22

$$a_c = -0.0425$$

$$b_c = 0.6714$$

$$a_z = -0.0819$$

$$b_z = 0.9687$$

Then:

$$C^* \sqrt{Z} = (-0.0425)(0.0823) + 0.6714 = 0.6679$$

$$\sqrt{Z} = (-0.0819)(0.0823) + 0.9687 = 0.9620$$

Step #3 Find F_R in Table #3, Page 23

$$F_R = 1.002 @ 500 \text{ psig for nominal } 0.7500 \text{ sec. nozzle}$$

Step #4 Substituting in equation (3), Page 11

$$\text{Percent Proof} = 100 \left(0.06402\right) \left(\frac{187.5}{0.7478}\right) \left(\frac{1}{300}\right) \left(\frac{532.1}{532.1}\right) \left(\frac{514.6}{517.0}\right) (0.6679) (0.9620) (23.067) (1.2700) (1.002)$$

$$= 100.45\%$$

$$\text{NOTE: \% Accuracy} = \frac{100}{\% \text{ Proof}} \times 100$$

$$\% \text{ Accuracy} = \frac{100}{100.45} \times 100 = 99.55\%$$

SECTION IV - PROVING WITH DRY AIR

Table #7 is provided to facilitate calculations when air is used as a test medium.

The accuracy is somewhat better with air than with natural gas, since air has a better defined composition and is nearer to being an ideal gas.

Table #7 lists a factor which is the product of C^* , Z , $\sqrt{T_N}$, and a numerical constant representing the gas constant. Knowing P_N and T_N , enter the table to find the factor F_A .

$$\text{Percent Proof} = \left(\frac{t}{t_s} \right) \left(\frac{1}{Q_M} \right) F_A \left(\frac{T_M}{T_N} \right) \left(\frac{P_N}{P_M} \right) (F_R) \quad (4)$$

Where:

t = test time - seconds

t_s = nozzle standard time - seconds

Q_M = test volume - cf (from meter index)

F_A = from Table #7 (Factor for air)

T_M = meter temperature - $^{\circ}R$ = ($^{\circ}F + 460$)

T_N = nozzle temperature - $^{\circ}R$ = ($^{\circ}F + 460$)

P_N = nozzle pressure - psia (psig + p_a)

P_M = meter pressure - psia (psig + p_a)

F_R = from Table #3

p_a = atmospheric pressure - psia

Example:

A proving test gave the following results:

$$P_a = 29.9 \text{ inches of mercury} @ 32^\circ F = 14.7 \text{ psia}$$

$$t = 171.2 \text{ seconds}$$

$$t_s = 1.1357$$

$$Q_M = 150 \text{ cf}$$

$$T_M = 70^\circ + 460^\circ = 530^\circ R.$$

$$T_N = 69^\circ + 460^\circ = 529^\circ R.$$

$$P_N = 58.8 \text{ psig} + 14.7$$

$$= 73.5 \text{ psia}$$

$$\Delta P = \text{meter to nozzle} = 1.0 \text{ psi}$$

$$P_M = 74.5 \text{ psia}$$

From Table #7 $F_A = 100.88$ (at $69^\circ F$ and 73.5 psia)

From Table #3 $F_R = 1.002$

Substituting in (4)

$$\text{Percent Proof} = \frac{171.2}{1.1357} \times \frac{1}{150} \times 100.88 \times \frac{530}{529} \times \frac{73.5}{74.5} \times 1.002 = 100.41\%$$

$$\text{Percent accuracy} = \frac{100}{\% \text{ Proof}} \times 100$$

$$\frac{100}{100.41} \times 100 = 99.59\% \text{ accuracy}$$

REFERENCES

BECK, H. V. - Displacement Gas Meters - Handbook E-4
American Meter Division of The Singer Company - 1970

BECK, H. V. & CRABTREE, G. M. - Orifice Meter Constants - Handbook E-2
American Meter Division of The Singer Company - 1973

The recommended Procedure for Testing Large Capacity Displacement Meters with a Critical Flow Prover -- Published by the Measurement Committee of the American Gas Association.

Tables #1 and #2 are from NASA TN-D2565 - Real Gas Effects in Critical Flow Through Nozzles and Tabulated Thermodynamic Properties - JOHNSON, R. C.

Users having computer facilities and programming capability may find useful the following reference which describes a method for calculating nozzle flows of natural gas that is probably the most accurate presently available. It is, however, too complex for simple field tests:

NASA SP-3074 - JOHNSON - Tables of Critical Flow Functions and Thermodynamic Properties for Methane and Computational Methods for both Methane and Natural Gas.

TABLES

Table 1	$C^* \sqrt{Z}$ - Natural Gas
Table 2	\sqrt{Z} - Natural Gas
Table 3	F_R Factors
Table 4	F_g Factors
Table 5	Combined N and Gravity Factor*
Table 6	F_{pv} Factors
Table 7	Factor for Air

$$* N_{COMB} = \left(\frac{520}{460 + T_N} \right)^{0.48} \sqrt{\frac{0.4117}{k'} \left(\frac{k' + 1}{2} \right)^n G}$$

k' = pseudo isentropic exponent

G = specific gravity

$$n = \frac{k' + 1}{k' - 1}$$

USING TABLES 1 AND 2

Table 1 gives a_c and b_c for use in calculating $C^*\sqrt{Z}$ when T_N , P_N and the gas composition factor f are known.

$$C^*\sqrt{Z} = a_c f + b_c$$

Table 2 gives a_z and b_z for calculating \sqrt{Z} under the same conditions of T_N , P_N and f .

$$\sqrt{Z} = a_z f + b_z$$

It is generally not necessary to interpolate between the temperatures given on the table. Use the table temperature nearest to the test temperature T_N .

On the pressure scale the intervals have been chosen so as to permit linear interpolation.

TABLE 1, VALUES OF a_c

$$C^* \sqrt{Z} = a_{cf} + b_c$$

T_N °R	INLET PRESSURE, P_N (psia)									
	0	50	100	150	200	250	300	350	400	450
450	-0.0265	-0.0281	-0.0297	-0.0313	-0.0330	-0.0347	-0.0365	-0.0382	-0.0399	-0.0414
460	-0.0272	-0.0287	-0.0302	-0.0318	-0.0334	-0.0350	-0.0366	-0.0382	-0.0398	-0.0412
470	-0.0279	-0.0293	-0.0308	-0.0323	-0.0338	-0.0353	-0.0368	-0.0383	-0.0398	-0.0411
480	-0.0285	-0.0299	-0.0313	-0.0327	-0.0342	-0.0356	-0.0371	-0.0384	-0.0398	-0.0410
490	-0.0292	-0.0305	-0.0318	-0.0332	-0.0346	-0.0359	-0.0373	-0.0386	-0.0399	-0.0410
500	-0.0298	-0.0311	-0.0324	-0.0337	-0.0350	-0.0362	-0.0375	-0.0387	-0.0400	-0.0411
510	-0.0304	-0.0316	-0.0329	-0.0341	-0.0353	-0.0365	-0.0378	-0.0389	-0.0401	-0.0411
520	-0.0310	-0.0321	-0.0333	-0.0345	-0.0357	-0.0368	-0.0380	-0.0391	-0.0402	-0.0412
530	-0.0315	-0.0326	-0.0338	-0.0349	-0.0361	-0.0372	-0.0383	-0.0393	-0.0404	-0.0413
540	-0.0321	-0.0332	-0.0343	-0.0354	-0.0365	-0.0375	-0.0386	-0.0396	-0.0406	-0.0415
550	-0.0326	-0.0336	-0.0347	-0.0357	-0.0368	-0.0378	-0.0388	-0.0397	-0.0407	-0.0416
560	-0.0331	-0.0341	-0.0351	-0.0361	-0.0371	-0.0381	-0.0391	-0.0400	-0.0409	-0.0417
570	-0.0335	-0.0345	-0.0355	-0.0365	-0.0375	-0.0384	-0.0393	-0.0402	-0.0411	-0.0419
580	-0.0340	-0.0349	-0.0359	-0.0368	-0.0378	-0.0387	-0.0396	-0.0404	-0.0412	-0.0420
590	-0.0344	-0.0353	-0.0362	-0.0371	-0.0380	-0.0389	-0.0398	-0.0406	-0.0414	-0.0421
600	-0.0348	-0.0357	-0.0366	-0.0374	-0.0383	-0.0391	-0.0400	-0.0407	-0.0415	-0.0422
610	-0.0351	-0.0359	-0.0368	-0.0376	-0.0385	-0.0393	-0.0401	-0.0408	-0.0416	-0.0423
620	-0.0354	-0.0362	-0.0371	-0.0379	-0.0387	-0.0395	-0.0403	-0.0410	-0.0417	-0.0423
630	-0.0357	-0.0365	-0.0373	-0.0381	-0.0389	-0.0396	-0.0404	-0.0411	-0.0418	-0.0424
640	-0.0360	-0.0367	-0.0375	-0.0382	-0.0390	-0.0397	-0.0405	-0.0411	-0.0418	-0.0424
650	-0.0362	-0.0369	-0.0377	-0.0384	-0.0392	-0.0399	-0.0406	-0.0412	-0.0418	-0.0424

T_N °R	INLET PRESSURE, P_N (psia)										
	500	550	600	650	700	750	800	850	900	950	1000
450	-0.0430	-0.0441	-0.0452	-0.0455	-0.0458	-0.0446	-0.0435	-0.0398	-0.0361	-0.0283	-0.0206
460	-0.0426	-0.0437	-0.0448	-0.0452	-0.0457	-0.0450	-0.0443	-0.0418	-0.0394	-0.0342	-0.0290
470	-0.0424	-0.0434	-0.0445	-0.0450	-0.0455	-0.0451	-0.0448	-0.0431	-0.0414	-0.0378	-0.0343
480	-0.0423	-0.0432	-0.0442	-0.0447	-0.0453	-0.0452	-0.0451	-0.0439	-0.0428	-0.0402	-0.0376
490	-0.0422	-0.0431	-0.0441	-0.0446	-0.0452	-0.0452	-0.0452	-0.0444	-0.0437	-0.0418	-0.0399
500	-0.0422	-0.0431	-0.0440	-0.0445	-0.0451	-0.0452	-0.0454	-0.0448	-0.0443	-0.0429	-0.0416
510	-0.0422	-0.0430	-0.0439	-0.0445	-0.0451	-0.0453	-0.0455	-0.0451	-0.0448	-0.0437	-0.0427
520	-0.0422	-0.0430	-0.0439	-0.0444	-0.0450	-0.0452	-0.0455	-0.0453	-0.0451	-0.0443	-0.0436
530	-0.0423	-0.0431	-0.0439	-0.0444	-0.0450	-0.0453	-0.0456	-0.0455	-0.0454	-0.0448	-0.0443
540	-0.0424	-0.0431	-0.0439	-0.0444	-0.0450	-0.0453	-0.0456	-0.0456	-0.0456	-0.0452	-0.0448
550	-0.0425	-0.0432	-0.0439	-0.0444	-0.0450	-0.0453	-0.0457	-0.0457	-0.0458	-0.0455	-0.0452
560	-0.0426	-0.0433	-0.0440	-0.0445	-0.0451	-0.0454	-0.0458	-0.0458	-0.0459	-0.0457	-0.0455
570	-0.0427	-0.0433	-0.0440	-0.0445	-0.0451	-0.0454	-0.0458	-0.0459	-0.0461	-0.0459	-0.0458
580	-0.0428	-0.0434	-0.0441	-0.0446	-0.0451	-0.0454	-0.0458	-0.0460	-0.0462	-0.0461	-0.0460
590	-0.0428	-0.0434	-0.0441	-0.0446	-0.0451	-0.0455	-0.0459	-0.0460	-0.0462	-0.0462	-0.0462
600	-0.0429	-0.0435	-0.0441	-0.0446	-0.0451	-0.0455	-0.0459	-0.0461	-0.0463	-0.0463	-0.0463
610	-0.0430	-0.0436	-0.0442	-0.0446	-0.0451	-0.0455	-0.0459	-0.0461	-0.0463	-0.0463	-0.0464
620	-0.0430	-0.0436	-0.0442	-0.0446	-0.0451	-0.0454	-0.0458	-0.0460	-0.0463	-0.0463	-0.0464
630	-0.0430	-0.0436	-0.0442	-0.0446	-0.0451	-0.0454	-0.0458	-0.0460	-0.0462	-0.0463	-0.0464
640	-0.0430	-0.0435	-0.0441	-0.0445	-0.0450	-0.0453	-0.0457	-0.0459	-0.0462	-0.0463	-0.0464
650	-0.0430	-0.0435	-0.0441	-0.0445	-0.0449	-0.0452	-0.0456	-0.0458	-0.0461	-0.0462	-0.0463

TABLE 1, CONTINUED VALUES OF b_c

$$C^* \sqrt{Z} = a_c f + b_c$$

T_N °R	INLET PRESSURE, P_N (psia)									
	0	50	100	150	200	250	300	350	400	450
450	0.6719	0.6717	0.6715	0.6714	0.6713	0.6712	0.6712	0.6712	0.6713	0.6715
460	0.6717	0.6715	0.6714	0.6713	0.6712	0.6712	0.6712	0.6712	0.6713	0.6715
470	0.6714	0.6713	0.6712	0.6711	0.6711	0.6711	0.6711	0.6712	0.6714	0.6716
480	0.6712	0.6711	0.6710	0.6710	0.6710	0.6710	0.6711	0.6712	0.6713	0.6715
490	0.6709	0.6708	0.6708	0.6708	0.6708	0.6708	0.6709	0.6710	0.6712	0.6714
500	0.6707	0.6706	0.6706	0.6706	0.6706	0.6707	0.6708	0.6709	0.6711	0.6713
510	0.6704	0.6703	0.6703	0.6703	0.6704	0.6705	0.6706	0.6708	0.6710	0.6712
520	0.6701	0.6701	0.6701	0.6701	0.6702	0.6703	0.6704	0.6706	0.6708	0.6711
530	0.6698	0.6698	0.6698	0.6698	0.6699	0.6700	0.6702	0.6704	0.6706	0.6709
540	0.6694	0.6694	0.6695	0.6696	0.6697	0.6698	0.6700	0.6702	0.6704	0.6706
550	0.6691	0.6691	0.6692	0.6693	0.6694	0.6695	0.6697	0.6699	0.6701	0.6704
560	0.6687	0.6688	0.6689	0.6690	0.6691	0.6692	0.6694	0.6696	0.6699	0.6701
570	0.6684	0.6684	0.6685	0.6686	0.6687	0.6689	0.6691	0.6693	0.6696	0.6698
580	0.6680	0.6680	0.6681	0.6682	0.6684	0.6686	0.6688	0.6690	0.6692	0.6695
590	0.6676	0.6677	0.6678	0.6679	0.6680	0.6682	0.6684	0.6686	0.6689	0.6692
600	0.6672	0.6673	0.6674	0.6675	0.6677	0.6679	0.6681	0.6683	0.6686	0.6689
610	0.6668	0.6669	0.6670	0.6671	0.6673	0.6675	0.6677	0.6679	0.6682	0.6685
620	0.6663	0.6664	0.6666	0.6667	0.6669	0.6671	0.6673	0.6675	0.6678	0.6681
630	0.6659	0.6660	0.6662	0.6663	0.6665	0.6667	0.6669	0.6671	0.6674	0.6677
640	0.6655	0.6656	0.6657	0.6659	0.6661	0.6663	0.6665	0.6667	0.6670	0.6673
650	0.6650	0.6651	0.6653	0.6654	0.6656	0.6658	0.6661	0.6663	0.6666	0.6669

T_N °R	INLET PRESSURE, P_N (psia)										
	500	550	600	650	700	750	800	850	900	950	1000
450	0.6717	0.6720	0.6723	0.6728	0.6733	0.6740	0.6747	0.6757	0.6767	0.6779	0.6791
460	0.6717	0.6720	0.6724	0.6729	0.6734	0.6741	0.6748	0.6757	0.6766	0.6777	0.6789
470	0.6718	0.6721	0.6725	0.6729	0.6734	0.6740	0.6747	0.6755	0.6764	0.6775	0.6786
480	0.6718	0.6721	0.6725	0.6729	0.6734	0.6740	0.6747	0.6755	0.6763	0.6773	0.6783
490	0.6717	0.6720	0.6724	0.6729	0.6734	0.6740	0.6746	0.6753	0.6761	0.6770	0.6780
500	0.6716	0.6719	0.6723	0.6728	0.6733	0.6739	0.6745	0.6752	0.6759	0.6768	0.6777
510	0.6715	0.6718	0.6722	0.6726	0.6731	0.6737	0.6743	0.6750	0.6757	0.6765	0.6774
520	0.6714	0.6717	0.6721	0.6725	0.6730	0.6735	0.6741	0.6748	0.6755	0.6763	0.6771
530	0.6712	0.6715	0.6719	0.6723	0.6728	0.6733	0.6739	0.6745	0.6752	0.6759	0.6767
540	0.6709	0.6713	0.6717	0.6721	0.6726	0.6731	0.6736	0.6742	0.6749	0.6756	0.6764
550	0.6707	0.6710	0.6714	0.6718	0.6723	0.6728	0.6734	0.6740	0.6746	0.6753	0.6760
560	0.6704	0.6708	0.6712	0.6716	0.6720	0.6725	0.6731	0.6737	0.6743	0.6749	0.6756
570	0.6701	0.6705	0.6709	0.6713	0.6717	0.6722	0.6727	0.6733	0.6739	0.6746	0.6753
580	0.6698	0.6702	0.6706	0.6710	0.6714	0.6719	0.6724	0.6729	0.6735	0.6741	0.6748
590	0.6695	0.6698	0.6702	0.6706	0.6711	0.6715	0.6720	0.6726	0.6732	0.6738	0.6744
600	0.6692	0.6695	0.6699	0.6703	0.6707	0.6712	0.6717	0.6722	0.6728	0.6734	0.6740
610	0.6688	0.6691	0.6695	0.6699	0.6703	0.6708	0.6713	0.6718	0.6723	0.6729	0.6735
620	0.6684	0.6687	0.6691	0.6695	0.6699	0.6704	0.6709	0.6714	0.6719	0.6725	0.6731
630	0.6680	0.6683	0.6687	0.6691	0.6695	0.6700	0.6705	0.6710	0.6715	0.6720	0.6726
640	0.6676	0.6679	0.6683	0.6687	0.6691	0.6695	0.6700	0.6705	0.6710	0.6715	0.6721
650	0.6672	0.6675	0.6679	0.6683	0.6687	0.6691	0.6696	0.6701	0.6706	0.6711	0.6717

TABLE 2, VALUES OF a_z

$$\sqrt{Z} = a_z f + b_z$$

T_N °R	INLET PRESSURE, P_N (psia)									
	0	50	100	150	200	250	300	350	400	450
450	0.0000	-0.0126	-0.0252	-0.0391	-0.0530	-0.0683	-0.0837	-0.1008	-0.1179	-0.1370
460	0.0000	-0.0117	-0.0234	-0.0362	-0.0490	-0.0630	-0.0770	-0.0924	-0.1078	-0.1247
470	0.0000	-0.0109	-0.0218	-0.0336	-0.0454	-0.0582	-0.0710	-0.0849	-0.0989	-0.1141
480	0.0000	-0.0101	-0.0203	-0.0313	-0.0422	-0.0539	-0.0657	-0.0784	-0.0911	-0.1047
490	0.0000	-0.0095	-0.0190	-0.0291	-0.0393	-0.0501	-0.0610	-0.0726	-0.0842	-0.0965
500	0.0000	-0.0089	-0.0178	-0.0272	-0.0366	-0.0466	-0.0567	-0.0673	-0.0780	-0.0892
510	0.0000	-0.0083	-0.0166	-0.0254	-0.0342	-0.0435	-0.0528	-0.0626	-0.0724	-0.0827
520	0.0000	-0.0078	-0.0156	-0.0238	-0.0321	-0.0407	-0.0493	-0.0584	-0.0675	-0.0769
530	0.0000	-0.0073	-0.0147	-0.0224	-0.0301	-0.0381	-0.0462	-0.0546	-0.0630	-0.0717
540	0.0000	-0.0069	-0.0138	-0.0210	-0.0283	-0.0358	-0.0433	-0.0511	-0.0589	-0.0669
550	0.0000	-0.0065	-0.0130	-0.0198	-0.0266	-0.0336	-0.0406	-0.0478	-0.0551	-0.0626
560	0.0000	-0.0061	-0.0123	-0.0187	-0.0251	-0.0316	-0.0382	-0.0450	-0.0518	-0.0587
570	0.0000	-0.0058	-0.0116	-0.0176	-0.0236	-0.0298	-0.0360	-0.0423	-0.0487	-0.0551
580	0.0000	-0.0055	-0.0110	-0.0166	-0.0223	-0.0281	-0.0339	-0.0398	-0.0458	-0.0518
590	0.0000	-0.0052	-0.0104	-0.0157	-0.0211	-0.0265	-0.0320	-0.0376	-0.0432	-0.0488
600	0.0000	-0.0049	-0.0099	-0.0149	-0.0200	-0.0251	-0.0303	-0.0355	-0.0408	-0.0461
610	0.0000	-0.0047	-0.0094	-0.0142	-0.0190	-0.0238	-0.0287	-0.0336	-0.0385	-0.0435
620	0.0000	-0.0044	-0.0089	-0.0134	-0.0180	-0.0226	-0.0272	-0.0318	-0.0365	-0.0411
630	0.0000	-0.0042	-0.0085	-0.0128	-0.0171	-0.0214	-0.0258	-0.0302	-0.0346	-0.0390
640	0.0000	-0.0040	-0.0081	-0.0121	-0.0162	-0.0203	-0.0245	-0.0286	-0.0328	-0.0369
650	0.0000	-0.0038	-0.0077	-0.0115	-0.0154	-0.0193	-0.0233	-0.0272	-0.0311	-0.0350

T_N °R	INLET PRESSURE, P_N (psia)										
	500	550	600	650	700	750	800	850	900	950	1000
450	-0.1561	-0.1774	-0.1988	-0.2226	-0.2464	-0.2727	-0.2991	-0.3277	-0.3564	-0.3863	-0.4162
460	-0.1417	-0.1603	-0.1790	-0.1994	-0.2199	-0.2421	-0.2644	-0.2881	-0.3118	-0.3364	-0.3610
470	-0.1293	-0.1457	-0.1622	-0.1800	-0.1978	-0.2169	-0.2360	-0.2561	-0.2762	-0.2968	-0.3175
480	-0.1184	-0.1331	-0.1478	-0.1634	-0.1791	-0.1957	-0.2123	-0.2296	-0.2469	-0.2646	-0.2823
490	-0.1089	-0.1221	-0.1353	-0.1492	-0.1631	-0.1777	-0.1923	-0.2074	-0.2225	-0.2378	-0.2532
500	-0.1005	-0.1124	-0.1243	-0.1368	-0.1493	-0.1622	-0.1752	-0.1885	-0.2018	-0.2153	-0.2288
510	-0.0931	-0.1039	-0.1147	-0.1259	-0.1371	-0.1487	-0.1604	-0.1722	-0.1841	-0.1960	-0.2079
520	-0.0864	-0.0962	-0.1061	-0.1163	-0.1265	-0.1369	-0.1474	-0.1580	-0.1687	-0.1793	-0.1900
530	-0.0804	-0.0894	-0.0984	-0.1077	-0.1170	-0.1265	-0.1360	-0.1456	-0.1552	-0.1647	-0.1743
540	-0.0750	-0.0833	-0.0916	-0.1001	-0.1086	-0.1172	-0.1259	-0.1346	-0.1433	-0.1519	-0.1606
550	-0.0701	-0.0777	-0.0854	-0.0932	-0.1010	-0.1089	-0.1169	-0.1248	-0.1327	-0.1406	-0.1485
560	-0.0656	-0.0727	-0.0798	-0.0870	-0.0942	-0.1015	-0.1088	-0.1160	-0.1233	-0.1305	-0.1377
570	-0.0616	-0.0682	-0.0748	-0.0814	-0.0881	-0.0948	-0.1015	-0.1082	-0.1149	-0.1215	-0.1281
580	-0.0579	-0.0640	-0.0701	-0.0763	-0.0825	-0.0887	-0.0949	-0.1010	-0.1072	-0.1133	-0.1194
590	-0.0545	-0.0602	-0.0659	-0.0716	-0.0774	-0.0831	-0.0889	-0.0946	-0.1003	-0.1059	-0.1116
600	-0.0514	-0.0567	-0.0621	-0.0674	-0.0728	-0.0781	-0.0835	-0.0888	-0.0941	-0.0993	-0.1045
610	-0.0485	-0.0535	-0.0585	-0.0635	-0.0685	-0.0735	-0.0785	-0.0834	-0.0883	-0.0931	-0.0980
620	-0.0458	-0.0505	-0.0552	-0.0599	-0.0646	-0.0692	-0.0739	-0.0785	-0.0831	-0.0876	-0.0921
630	-0.0434	-0.0478	-0.0522	-0.0566	-0.0610	-0.0653	-0.0697	-0.0740	-0.0783	-0.0825	-0.0867
640	-0.0411	-0.0452	-0.0494	-0.0535	-0.0577	-0.0617	-0.0658	-0.0698	-0.0739	-0.0778	-0.0818
650	-0.0390	-0.0429	-0.0468	-0.0507	-0.0546	-0.0584	-0.0623	-0.0660	-0.0698	-0.0735	-0.0772

TABLE 2, CONTINUED VALUES OF b_z

$$\sqrt{Z} = a_z f + b_z$$

T_N °R	INLET PRESSURE, P_N (psia)									
	0	50	100	150	200	250	300	350	400	450
450	1.0000	0.9945	0.9891	0.9835	0.9780	0.9723	0.9667	0.9609	0.9552	0.9493
460	1.0000	0.9949	0.9899	0.9847	0.9796	0.9744	0.9692	0.9638	0.9585	0.9531
470	1.0000	0.9953	0.9906	0.9858	0.9810	0.9762	0.9714	0.9665	0.9616	0.9567
480	1.0000	0.9956	0.9912	0.9868	0.9824	0.9779	0.9734	0.9689	0.9644	0.9598
490	1.0000	0.9959	0.9918	0.9877	0.9836	0.9794	0.9753	0.9711	0.9669	0.9627
500	1.0000	0.9962	0.9924	0.9885	0.9847	0.9808	0.9770	0.9731	0.9693	0.9654
510	1.0000	0.9964	0.9929	0.9893	0.9857	0.9821	0.9785	0.9749	0.9714	0.9678
520	1.0000	0.9966	0.9933	0.9899	0.9866	0.9833	0.9800	0.9767	0.9734	0.9701
530	1.0000	0.9968	0.9937	0.9906	0.9875	0.9844	0.9813	0.9782	0.9752	0.9721
540	1.0000	0.9970	0.9941	0.9912	0.9883	0.9854	0.9826	0.9797	0.9768	0.9740
550	1.0000	0.9972	0.9945	0.9918	0.9891	0.9864	0.9837	0.9810	0.9784	0.9758
560	1.0000	0.9974	0.9949	0.9923	0.9898	0.9873	0.9848	0.9823	0.9798	0.9774
570	1.0000	0.9976	0.9952	0.9928	0.9904	0.9880	0.9857	0.9834	0.9811	0.9788
580	1.0000	0.9977	0.9955	0.9932	0.9910	0.9888	0.9867	0.9845	0.9824	0.9803
590	1.0000	0.9979	0.9958	0.9937	0.9916	0.9895	0.9875	0.9855	0.9835	0.9816
600	1.0000	0.9980	0.9960	0.9940	0.9921	0.9902	0.9883	0.9864	0.9846	0.9828
610	1.0000	0.9981	0.9963	0.9944	0.9926	0.9908	0.9891	0.9873	0.9856	0.9839
620	1.0000	0.9982	0.9965	0.9948	0.9931	0.9914	0.9898	0.9881	0.9865	0.9849
630	1.0000	0.9983	0.9967	0.9951	0.9935	0.9919	0.9904	0.9889	0.9874	0.9859
640	1.0000	0.9984	0.9969	0.9954	0.9939	0.9924	0.9910	0.9896	0.9882	0.9869
650	1.0000	0.9985	0.9971	0.9957	0.9943	0.9929	0.9916	0.9903	0.9890	0.9877

T_N °R	INLET PRESSURE, P_N (psia)										
	500	550	600	650	700	750	800	850	900	950	1000
450	0.9434	0.9374	0.9315	0.9255	0.9195	0.9135	0.9075	0.9015	0.8955	0.8896	0.8837
460	0.9478	0.9424	0.9370	0.9315	0.9261	0.9206	0.9152	0.9098	0.9044	0.8991	0.8938
470	0.9518	0.9468	0.9419	0.9369	0.9320	0.9270	0.9221	0.9172	0.9124	0.9076	0.9028
480	0.9553	0.9508	0.9463	0.9418	0.9373	0.9328	0.9283	0.9239	0.9195	0.9152	0.9109
490	0.9586	0.9544	0.9503	0.9461	0.9420	0.9379	0.9339	0.9299	0.9259	0.9220	0.9181
500	0.9616	0.9577	0.9539	0.9501	0.9464	0.9426	0.9389	0.9352	0.9316	0.9280	0.9245
510	0.9643	0.9608	0.9573	0.9538	0.9503	0.9469	0.9435	0.9402	0.9369	0.9336	0.9304
520	0.9668	0.9635	0.9603	0.9571	0.9539	0.9508	0.9477	0.9446	0.9416	0.9386	0.9357
530	0.9691	0.9661	0.9631	0.9601	0.9572	0.9543	0.9515	0.9487	0.9459	0.9432	0.9406
540	0.9712	0.9684	0.9657	0.9630	0.9603	0.9576	0.9550	0.9524	0.9499	0.9474	0.9450
550	0.9732	0.9706	0.9681	0.9656	0.9631	0.9606	0.9582	0.9558	0.9535	0.9512	0.9490
560	0.9750	0.9726	0.9702	0.9679	0.9656	0.9634	0.9612	0.9590	0.9569	0.9548	0.9527
570	0.9766	0.9744	0.9723	0.9701	0.9680	0.9659	0.9639	0.9619	0.9599	0.9580	0.9562
580	0.9782	0.9761	0.9741	0.9721	0.9702	0.9683	0.9664	0.9646	0.9628	0.9610	0.9593
590	0.9797	0.9778	0.9759	0.9741	0.9723	0.9705	0.9688	0.9671	0.9654	0.9638	0.9622
600	0.9810	0.9792	0.9775	0.9758	0.9741	0.9725	0.9709	0.9693	0.9678	0.9663	0.9649
610	0.9823	0.9806	0.9790	0.9774	0.9759	0.9744	0.9729	0.9715	0.9701	0.9688	0.9674
620	0.9834	0.9819	0.9804	0.9790	0.9776	0.9762	0.9748	0.9735	0.9722	0.9710	0.9698
630	0.9845	0.9831	0.9817	0.9804	0.9791	0.9778	0.9766	0.9754	0.9742	0.9730	0.9719
640	0.9856	0.9843	0.9830	0.9817	0.9805	0.9793	0.9782	0.9771	0.9760	0.9750	0.9740
650	0.9865	0.9853	0.9841	0.9830	0.9819	0.9808	0.9797	0.9787	0.9777	0.9767	0.9758

TABLE 3
F_R FACTOR

t _s Nominal	Size Code	Nominal Throat Diameter Inches	P _N - psig									
			3	4	5	10	20	30	40	50	100	500
36.00	A	.094	0.998	0.998	0.999	1.000	1.002	1.003	1.004	1.005	1.007	1.008
18.00	B	.125	0.998	0.998	0.999		1.002	1.003	1.004	1.004	1.006	1.007
8.00	C	.188	0.998	0.999	0.999		1.001	1.002	1.003	1.003	1.005	1.005
4.50	D	.250	0.999	0.999			1.001	1.002	1.003	1.003	1.004	1.004
2.88	E	.312	0.999	0.999			1.001	1.002	1.002	1.003	1.004	1.004
2.00	F	.375	0.999				1.001	1.002	1.002	1.002	1.002	1.003
1.47	G	.438	0.999					1.002	1.002	1.002	1.002	1.003
1.13	H	.500	0.999					1.001	1.002	1.002	1.001	1.002
0.75	J	.625						1.001	1.002		1.002	1.002

FACTOR = 1.000 WHERE NOT SHOWN

TABLE 4

$$F_G = \sqrt{\frac{1}{G}}$$

FACTORS TO ADJUST FOR SPECIFIC GRAVITY

Specific Gravity G	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
.560	1.3363	1.3351	1.3339	1.3327	1.3316	1.3304	1.3292	1.3280	1.3269	1.3257
.570	1.3245	1.3234	1.3222	1.3211	1.3199	1.3188	1.3176	1.3165	1.3153	1.3142
.580	1.3131	1.3119	1.3108	1.3097	1.3086	1.3074	1.3063	1.3052	1.3041	1.3030
.590	1.3019	1.3008	1.2997	1.2986	1.2975	1.2964	1.2953	1.2942	1.2932	1.2921
.600	1.2910	1.2899	1.2888	1.2878	1.2867	1.2856	1.2846	1.2835	1.2825	1.2814
.610	1.2804	1.2793	1.2783	1.2772	1.2762	1.2752	1.2741	1.2731	1.2720	1.2710
.620	1.2700	1.2690	1.2680	1.2669	1.2659	1.2649	1.2639	1.2629	1.2619	1.2609
.630	1.2599	1.2589	1.2579	1.2569	1.2559	1.2549	1.2539	1.2529	1.2520	1.2510
.640	1.2500	1.2490	1.2480	1.2471	1.2461	1.2451	1.2442	1.2432	1.2423	1.2413
.650	1.2403	1.2394	1.2384	1.2375	1.2365	1.2356	1.2347	1.2337	1.2328	1.2318
.660	1.2309	1.2300	1.2290	1.2281	1.2272	1.2263	1.2254	1.2244	1.2235	1.2226
.670	1.2217	1.2208	1.2199	1.2190	1.2181	1.2172	1.2163	1.2154	1.2145	1.2136
.680	1.2127	1.2118	1.2109	1.2100	1.2091	1.2082	1.2074	1.2065	1.2056	1.2047
.690	1.2039	1.2030	1.2021	1.2012	1.2004	1.1995	1.1986	1.1978	1.1969	1.1961
.700	1.1952	1.1944	1.1935	1.1927	1.1918	1.1910	1.1901	1.1893	1.1884	1.1876
.710	1.1868	1.1859	1.1851	1.1843	1.1834	1.1826	1.1818	1.1810	1.1802	1.1793
.720	1.1785	1.1777	1.1769	1.1761	1.1752	1.1744	1.1736	1.1728	1.1720	1.1712

TABLE 5

COMBINED N AND GRAVITY FACTOR

T _N	0 - 500 psig									
Temp.	SPECIFIC GRAVITY									
°F	0.560	0.562	0.564	0.566	0.568	0.570	0.572	0.574	0.576	0.578
20	0.7957	0.7973	0.7989	0.8004	0.8020	0.8036	0.8051	0.8067	0.8083	0.8099
22	0.7941	0.7957	0.7973	0.7988	0.8004	0.8020	0.8035	0.8051	0.8067	0.8082
24	0.7925	0.7941	0.7957	0.7972	0.7988	0.8004	0.8019	0.8035	0.8051	0.8066
26	0.7910	0.7925	0.7941	0.7957	0.7972	0.7988	0.8004	0.8019	0.8035	0.8050
28	0.7894	0.7910	0.7925	0.7941	0.7957	0.7972	0.7988	0.8003	0.8019	0.8035
30	0.7879	0.7894	0.7910	0.7925	0.7941	0.7957	0.7972	0.7988	0.8003	0.8019
32	0.7863	0.7879	0.7894	0.7910	0.7926	0.7941	0.7957	0.7972	0.7988	0.8003
34	0.7848	0.7863	0.7879	0.7895	0.7910	0.7926	0.7941	0.7957	0.7972	0.7988
36	0.7833	0.7848	0.7864	0.7879	0.7895	0.7910	0.7926	0.7941	0.7957	0.7972
38	0.7818	0.7833	0.7849	0.7864	0.7880	0.7895	0.7910	0.7926	0.7941	0.7957
40	0.7803	0.7818	0.7834	0.7849	0.7864	0.7880	0.7895	0.7911	0.7926	0.7941
42	0.7788	0.7803	0.7819	0.7834	0.7849	0.7865	0.7880	0.7895	0.7911	0.7926
44	0.7773	0.7788	0.7804	0.7819	0.7834	0.7850	0.7865	0.7880	0.7896	0.7911
46	0.7758	0.7773	0.7789	0.7804	0.7820	0.7835	0.7850	0.7865	0.7881	0.7896
48	0.7743	0.7759	0.7774	0.7789	0.7805	0.7820	0.7835	0.7851	0.7866	0.7881
50	0.7729	0.7744	0.7759	0.7775	0.7790	0.7805	0.7821	0.7836	0.7851	0.7866
52	0.7714	0.7730	0.7745	0.7760	0.7775	0.7791	0.7806	0.7821	0.7836	0.7851
54	0.7700	0.7715	0.7730	0.7746	0.7761	0.7776	0.7791	0.7806	0.7822	0.7837
56	0.7685	0.7701	0.7716	0.7731	0.7746	0.7762	0.7777	0.7792	0.7807	0.7822
58	0.7671	0.7686	0.7702	0.7717	0.7732	0.7747	0.7762	0.7777	0.7793	0.7808
60	0.7657	0.7672	0.7687	0.7703	0.7718	0.7733	0.7748	0.7763	0.7778	0.7793
62	0.7643	0.7658	0.7673	0.7688	0.7704	0.7719	0.7734	0.7749	0.7764	0.7779
64	0.7629	0.7644	0.7659	0.7674	0.7689	0.7705	0.7720	0.7735	0.7750	0.7765
66	0.7615	0.7630	0.7645	0.7660	0.7675	0.7690	0.7705	0.7720	0.7735	0.7750
68	0.7601	0.7616	0.7631	0.7646	0.7661	0.7676	0.7691	0.7706	0.7721	0.7736
70	0.7587	0.7602	0.7617	0.7633	0.7648	0.7663	0.7677	0.7692	0.7707	0.7722
72	0.7574	0.7589	0.7604	0.7619	0.7634	0.7649	0.7664	0.7679	0.7693	0.7708
74	0.7560	0.7575	0.7590	0.7605	0.7620	0.7635	0.7650	0.7665	0.7680	0.7695
76	0.7546	0.7561	0.7576	0.7591	0.7606	0.7621	0.7636	0.7651	0.7666	0.7681
78	0.7533	0.7548	0.7563	0.7578	0.7593	0.7608	0.7622	0.7637	0.7652	0.7667
80	0.7520	0.7535	0.7549	0.7564	0.7579	0.7594	0.7609	0.7624	0.7639	0.7653
82	0.7506	0.7521	0.7536	0.7551	0.7566	0.7581	0.7595	0.7610	0.7625	0.7640
84	0.7493	0.7508	0.7523	0.7538	0.7552	0.7567	0.7582	0.7597	0.7612	0.7626
86	0.7480	0.7495	0.7510	0.7524	0.7539	0.7554	0.7569	0.7583	0.7598	0.7613
88	0.7467	0.7482	0.7496	0.7511	0.7526	0.7541	0.7555	0.7570	0.7585	0.7600
90	0.7454	0.7468	0.7483	0.7498	0.7513	0.7527	0.7542	0.7557	0.7572	0.7586
92	0.7441	0.7455	0.7470	0.7485	0.7500	0.7514	0.7529	0.7544	0.7558	0.7573
94	0.7428	0.7443	0.7457	0.7472	0.7487	0.7501	0.7516	0.7531	0.7545	0.7560
96	0.7415	0.7430	0.7444	0.7459	0.7474	0.7488	0.7503	0.7518	0.7532	0.7547
98	0.7402	0.7417	0.7432	0.7446	0.7461	0.7475	0.7490	0.7505	0.7519	0.7534
100	0.7389	0.7404	0.7419	0.7433	0.7448	0.7463	0.7477	0.7492	0.7506	0.7521
102	0.7377	0.7391	0.7406	0.7421	0.7435	0.7450	0.7464	0.7479	0.7494	0.7508
104	0.7364	0.7379	0.7393	0.7408	0.7423	0.7437	0.7452	0.7466	0.7481	0.7495
106	0.7352	0.7366	0.7381	0.7396	0.7410	0.7425	0.7439	0.7454	0.7468	0.7483
108	0.7339	0.7354	0.7368	0.7383	0.7398	0.7412	0.7427	0.7441	0.7455	0.7470

TABLE 5

COMBINED N AND GRAVITY FACTOR

T _N Temp. °F	SPECIFIC GRAVITY									
	0.580	0.582	0.584	0.586	0.588	0.590	0.592	0.594	0.596	0.598
20	0.8114	0.8130	0.8145	0.8161	0.8177	0.8192	0.8208	0.8223	0.8239	0.8254
22	0.8098	0.8114	0.8129	0.8145	0.8160	0.8176	0.8191	0.8207	0.8222	0.8238
24	0.8082	0.8097	0.8113	0.8128	0.8144	0.8159	0.8175	0.8190	0.8206	0.8221
26	0.8066	0.8081	0.8097	0.8112	0.8128	0.8143	0.8159	0.8174	0.8190	0.8205
28	0.8050	0.8066	0.8081	0.8096	0.8112	0.8127	0.8143	0.8158	0.8173	0.8189
30	0.8034	0.8050	0.8065	0.8081	0.8096	0.8111	0.8127	0.8142	0.8157	0.8173
32	0.8019	0.8034	0.8049	0.8065	0.8080	0.8096	0.8111	0.8126	0.8142	0.8157
34	0.8003	0.8018	0.8034	0.8049	0.8064	0.8080	0.8095	0.8110	0.8126	0.8141
36	0.7987	0.8003	0.8018	0.8034	0.8049	0.8064	0.8079	0.8095	0.8110	0.8125
38	0.7972	0.7987	0.8003	0.8018	0.8033	0.8049	0.8064	0.8079	0.8094	0.8109
40	0.7957	0.7972	0.7987	0.8003	0.8018	0.8033	0.8048	0.8064	0.8079	0.8094
42	0.7941	0.7957	0.7972	0.7987	0.8003	0.8018	0.8033	0.8048	0.8063	0.8078
44	0.7926	0.7942	0.7957	0.7972	0.7987	0.8002	0.8018	0.8033	0.8048	0.8063
46	0.7911	0.7926	0.7942	0.7957	0.7972	0.7987	0.8002	0.8017	0.8033	0.8048
48	0.7896	0.7911	0.7927	0.7942	0.7957	0.7972	0.7987	0.8002	0.8017	0.8032
50	0.7881	0.7897	0.7912	0.7927	0.7942	0.7957	0.7972	0.7987	0.8002	0.8017
52	0.7867	0.7882	0.7897	0.7912	0.7927	0.7942	0.7957	0.7972	0.7987	0.8002
54	0.7852	0.7867	0.7882	0.7897	0.7912	0.7927	0.7942	0.7957	0.7972	0.7987
56	0.7837	0.7852	0.7867	0.7882	0.7898	0.7913	0.7928	0.7943	0.7957	0.7972
58	0.7823	0.7838	0.7853	0.7868	0.7883	0.7898	0.7913	0.7928	0.7943	0.7958
60	0.7808	0.7823	0.7838	0.7853	0.7868	0.7883	0.7898	0.7913	0.7928	0.7943
62	0.7794	0.7809	0.7824	0.7839	0.7854	0.7869	0.7884	0.7899	0.7913	0.7928
64	0.7780	0.7795	0.7810	0.7825	0.7839	0.7854	0.7869	0.7884	0.7899	0.7914
66	0.7765	0.7780	0.7795	0.7810	0.7825	0.7840	0.7855	0.7870	0.7885	0.7899
68	0.7751	0.7766	0.7781	0.7796	0.7811	0.7826	0.7841	0.7855	0.7870	0.7885
70	0.7737	0.7752	0.7767	0.7782	0.7797	0.7812	0.7826	0.7841	0.7856	0.7871
72	0.7723	0.7738	0.7753	0.7768	0.7783	0.7797	0.7812	0.7827	0.7842	0.7856
74	0.7709	0.7724	0.7739	0.7754	0.7769	0.7783	0.7798	0.7813	0.7828	0.7842
76	0.7696	0.7710	0.7725	0.7740	0.7755	0.7769	0.7784	0.7799	0.7814	0.7828
78	0.7682	0.7697	0.7711	0.7726	0.7741	0.7756	0.7770	0.7785	0.7800	0.7814
80	0.7668	0.7683	0.7698	0.7712	0.7727	0.7742	0.7756	0.7771	0.7786	0.7800
82	0.7655	0.7669	0.7684	0.7699	0.7713	0.7728	0.7743	0.7757	0.7772	0.7787
84	0.7641	0.7656	0.7670	0.7685	0.7700	0.7714	0.7729	0.7744	0.7758	0.7773
86	0.7628	0.7642	0.7657	0.7672	0.7686	0.7701	0.7715	0.7730	0.7745	0.7759
88	0.7614	0.7629	0.7643	0.7658	0.7673	0.7687	0.7702	0.7716	0.7731	0.7745
90	0.7601	0.7616	0.7630	0.7645	0.7659	0.7674	0.7688	0.7703	0.7717	0.7732
92	0.7588	0.7602	0.7617	0.7631	0.7646	0.7661	0.7675	0.7690	0.7704	0.7719
94	0.7574	0.7589	0.7604	0.7618	0.7633	0.7647	0.7662	0.7676	0.7691	0.7705
96	0.7561	0.7576	0.7590	0.7605	0.7620	0.7634	0.7648	0.7663	0.7677	0.7692
98	0.7548	0.7563	0.7577	0.7592	0.7606	0.7621	0.7635	0.7650	0.7664	0.7679
100	0.7535	0.7550	0.7564	0.7579	0.7593	0.7608	0.7622	0.7637	0.7651	0.7665
102	0.7523	0.7537	0.7551	0.7566	0.7580	0.7595	0.7609	0.7624	0.7638	0.7652
104	0.7510	0.7524	0.7539	0.7553	0.7567	0.7582	0.7596	0.7611	0.7625	0.7639
106	0.7497	0.7511	0.7526	0.7540	0.7555	0.7569	0.7583	0.7598	0.7612	0.7626
108	0.7484	0.7499	0.7513	0.7527	0.7542	0.7556	0.7570	0.7585	0.7599	0.7613

TABLE 5
COMBINED N AND GRAVITY FACTOR

T _N Temp. °F	SPECIFIC GRAVITY									
	0.600	0.602	0.604	0.606	0.608	0.610	0.612	0.614	0.616	0.618
20	0.8270	0.8285	0.8300	0.8316	0.8331	0.8347	0.8362	0.8377	0.8393	0.8408
22	0.8253	0.8268	0.8284	0.8299	0.8315	0.8330	0.8345	0.8361	0.8376	0.8391
24	0.8237	0.8252	0.8267	0.8283	0.8298	0.8313	0.8329	0.8344	0.8359	0.8375
26	0.8220	0.8236	0.8251	0.8266	0.8282	0.8297	0.8312	0.8328	0.8343	0.8358
28	0.8204	0.8220	0.8235	0.8250	0.8265	0.8281	0.8296	0.8311	0.8326	0.8342
30	0.8188	0.8203	0.8219	0.8234	0.8249	0.8264	0.8280	0.8295	0.8310	0.8325
32	0.8172	0.8187	0.8203	0.8218	0.8233	0.8248	0.8263	0.8279	0.8294	0.8309
34	0.8156	0.8171	0.8187	0.8202	0.8217	0.8232	0.8247	0.8263	0.8278	0.8293
36	0.8140	0.8156	0.8171	0.8186	0.8201	0.8216	0.8231	0.8246	0.8262	0.8277
38	0.8125	0.8140	0.8155	0.8170	0.8185	0.8200	0.8215	0.8231	0.8246	0.8261
40	0.8109	0.8124	0.8139	0.8154	0.8170	0.8185	0.8200	0.8215	0.8230	0.8245
42	0.8094	0.8109	0.8124	0.8139	0.8154	0.8169	0.8184	0.8199	0.8214	0.8229
44	0.8078	0.8093	0.8108	0.8123	0.8138	0.8153	0.8168	0.8183	0.8198	0.8213
46	0.8063	0.8078	0.8093	0.8108	0.8123	0.8138	0.8153	0.8168	0.8183	0.8198
48	0.8048	0.8063	0.8078	0.8093	0.8108	0.8122	0.8137	0.8152	0.8167	0.8182
50	0.8032	0.8047	0.8062	0.8077	0.8092	0.8107	0.8122	0.8137	0.8152	0.8167
52	0.8017	0.8032	0.8047	0.8062	0.8077	0.8092	0.8107	0.8122	0.8137	0.8151
54	0.8002	0.8017	0.8032	0.8047	0.8062	0.8077	0.8092	0.8107	0.8121	0.8136
56	0.7987	0.8002	0.8017	0.8032	0.8047	0.8062	0.8077	0.8091	0.8106	0.8121
58	0.7973	0.7987	0.8002	0.8017	0.8032	0.8047	0.8062	0.8076	0.8091	0.8106
60	0.7958	0.7973	0.7988	0.8002	0.8017	0.8032	0.8047	0.8062	0.8076	0.8091
62	0.7943	0.7958	0.7973	0.7988	0.8002	0.8017	0.8032	0.8047	0.8061	0.8076
64	0.7929	0.7943	0.7958	0.7973	0.7988	0.8002	0.8017	0.8032	0.8047	0.8061
66	0.7914	0.7929	0.7944	0.7958	0.7973	0.7988	0.8003	0.8017	0.8032	0.8047
68	0.7900	0.7914	0.7929	0.7944	0.7959	0.7973	0.7988	0.8003	0.8017	0.8032
70	0.7885	0.7900	0.7915	0.7930	0.7944	0.7959	0.7974	0.7988	0.8003	0.8017
72	0.7871	0.7886	0.7901	0.7915	0.7930	0.7945	0.7959	0.7974	0.7988	0.8003
74	0.7857	0.7872	0.7886	0.7901	0.7916	0.7930	0.7945	0.7959	0.7974	0.7989
76	0.7843	0.7858	0.7872	0.7887	0.7901	0.7916	0.7931	0.7945	0.7960	0.7974
78	0.7829	0.7844	0.7858	0.7873	0.7887	0.7902	0.7916	0.7931	0.7945	0.7960
80	0.7815	0.7830	0.7844	0.7859	0.7873	0.7888	0.7902	0.7917	0.7931	0.7946
82	0.7801	0.7816	0.7830	0.7845	0.7859	0.7874	0.7888	0.7903	0.7917	0.7932
84	0.7787	0.7802	0.7816	0.7831	0.7845	0.7860	0.7874	0.7889	0.7903	0.7918
86	0.7774	0.7788	0.7803	0.7817	0.7832	0.7846	0.7861	0.7875	0.7889	0.7904
88	0.7760	0.7775	0.7789	0.7803	0.7818	0.7832	0.7847	0.7861	0.7876	0.7890
90	0.7746	0.7761	0.7775	0.7790	0.7804	0.7819	0.7833	0.7847	0.7862	0.7876
92	0.7733	0.7747	0.7762	0.7776	0.7791	0.7805	0.7819	0.7834	0.7848	0.7862
94	0.7720	0.7734	0.7748	0.7763	0.7777	0.7791	0.7806	0.7820	0.7834	0.7849
96	0.7706	0.7721	0.7735	0.7749	0.7764	0.7778	0.7792	0.7807	0.7821	0.7835
98	0.7693	0.7707	0.7722	0.7736	0.7750	0.7765	0.7779	0.7793	0.7807	0.7822
100	0.7680	0.7694	0.7708	0.7723	0.7737	0.7751	0.7766	0.7780	0.7794	0.7808
102	0.7667	0.7681	0.7695	0.7710	0.7724	0.7738	0.7752	0.7767	0.7781	0.7795
104	0.7654	0.7668	0.7682	0.7696	0.7711	0.7725	0.7739	0.7753	0.7767	0.7782
106	0.7641	0.7655	0.7669	0.7683	0.7698	0.7712	0.7726	0.7740	0.7754	0.7768
108	0.7628	0.7642	0.7656	0.7670	0.7685	0.7699	0.7713	0.7727	0.7741	0.7755

TABLE 5

COMBINED N AND GRAVITY FACTOR

 T_N

Temp.

°F	SPECIFIC GRAVITY									
	0.620	0.622	0.624	0.626	0.628	0.630	0.632	0.634	0.636	0.638
20	0.8423	0.8439	0.8454	0.8469	0.8484	0.8500	0.8515	0.8530	0.8545	0.8560
22	0.8406	0.8422	0.8437	0.8452	0.8467	0.8483	0.8498	0.8513	0.8528	0.8543
24	0.8390	0.8405	0.8420	0.8435	0.8451	0.8466	0.8481	0.8496	0.8511	0.8526
26	0.8373	0.8388	0.8404	0.8419	0.8434	0.8449	0.8464	0.8479	0.8494	0.8509
28	0.8357	0.8372	0.8387	0.8402	0.8417	0.8432	0.8447	0.8463	0.8478	0.8493
30	0.8340	0.8355	0.8371	0.8386	0.8401	0.8416	0.8431	0.8446	0.8461	0.8476
32	0.8324	0.8339	0.8354	0.8369	0.8384	0.8399	0.8414	0.8429	0.8444	0.8459
34	0.8308	0.8323	0.8338	0.8353	0.8368	0.8383	0.8398	0.8413	0.8428	0.8443
36	0.8292	0.8307	0.8322	0.8337	0.8352	0.8367	0.8382	0.8397	0.8412	0.8427
38	0.8276	0.8291	0.8306	0.8321	0.8336	0.8351	0.8366	0.8381	0.8395	0.8410
40	0.8260	0.8275	0.8290	0.8305	0.8320	0.8335	0.8350	0.8364	0.8379	0.8394
42	0.8244	0.8259	0.8274	0.8289	0.8304	0.8319	0.8334	0.8348	0.8363	0.8378
44	0.8228	0.8243	0.8258	0.8273	0.8288	0.8303	0.8318	0.8332	0.8347	0.8362
46	0.8213	0.8228	0.8242	0.8257	0.8272	0.8287	0.8302	0.8317	0.8331	0.8346
48	0.8197	0.8212	0.8227	0.8242	0.8257	0.8271	0.8286	0.8301	0.8316	0.8330
50	0.8182	0.8197	0.8211	0.8226	0.8241	0.8256	0.8271	0.8285	0.8300	0.8315
52	0.8166	0.8181	0.8196	0.8211	0.8225	0.8240	0.8255	0.8270	0.8284	0.8299
54	0.8151	0.8166	0.8181	0.8195	0.8210	0.8225	0.8240	0.8254	0.8269	0.8284
56	0.8136	0.8151	0.8165	0.8180	0.8195	0.8210	0.8224	0.8239	0.8254	0.8268
58	0.8121	0.8135	0.8150	0.8165	0.8180	0.8194	0.8209	0.8224	0.8238	0.8253
60	0.8106	0.8120	0.8135	0.8150	0.8165	0.8179	0.8194	0.8208	0.8223	0.8238
62	0.8091	0.8106	0.8120	0.8135	0.8149	0.8164	0.8179	0.8193	0.8208	0.8222
64	0.8076	0.8091	0.8105	0.8120	0.8135	0.8149	0.8164	0.8178	0.8193	0.8207
66	0.8061	0.8076	0.8090	0.8105	0.8120	0.8134	0.8149	0.8163	0.8178	0.8192
68	0.8047	0.8061	0.8076	0.8090	0.8105	0.8119	0.8134	0.8148	0.8163	0.8177
70	0.8032	0.8047	0.8061	0.8076	0.8090	0.8105	0.8119	0.8134	0.8148	0.8163
72	0.8017	0.8032	0.8047	0.8061	0.8076	0.8090	0.8105	0.8119	0.8133	0.8148
74	0.8003	0.8018	0.8032	0.8047	0.8061	0.8075	0.8090	0.8104	0.8119	0.8133
76	0.7989	0.8003	0.8018	0.8032	0.8047	0.8061	0.8075	0.8090	0.8104	0.8119
78	0.7974	0.7989	0.8003	0.8018	0.8032	0.8047	0.8061	0.8075	0.8090	0.8104
80	0.7960	0.7975	0.7989	0.8004	0.8018	0.8032	0.8047	0.8061	0.8075	0.8090
82	0.7946	0.7961	0.7975	0.7989	0.8004	0.8018	0.8032	0.8047	0.8061	0.8075
84	0.7932	0.7946	0.7961	0.7975	0.7990	0.8004	0.8018	0.8033	0.8047	0.8061
86	0.7918	0.7932	0.7947	0.7961	0.7976	0.7990	0.8004	0.8018	0.8033	0.8047
88	0.7904	0.7919	0.7933	0.7947	0.7962	0.7976	0.7990	0.8004	0.8019	0.8033
90	0.7890	0.7905	0.7919	0.7933	0.7948	0.7962	0.7976	0.7990	0.8005	0.8019
92	0.7877	0.7891	0.7905	0.7920	0.7934	0.7948	0.7962	0.7976	0.7991	0.8005
94	0.7863	0.7877	0.7892	0.7906	0.7920	0.7934	0.7948	0.7963	0.7977	0.7991
96	0.7849	0.7864	0.7878	0.7892	0.7906	0.7921	0.7935	0.7949	0.7963	0.7977
98	0.7836	0.7850	0.7864	0.7879	0.7893	0.7907	0.7921	0.7935	0.7949	0.7963
100	0.7822	0.7837	0.7851	0.7865	0.7879	0.7893	0.7907	0.7922	0.7936	0.7950
102	0.7809	0.7823	0.7837	0.7852	0.7866	0.7880	0.7894	0.7908	0.7922	0.7936
104	0.7796	0.7810	0.7824	0.7838	0.7852	0.7866	0.7880	0.7895	0.7909	0.7923
106	0.7783	0.7797	0.7811	0.7825	0.7839	0.7853	0.7867	0.7881	0.7895	0.7909
108	0.7769	0.7784	0.7798	0.7812	0.7826	0.7840	0.7854	0.7868	0.7882	0.7896

TABLE 5
COMBINED N AND GRAVITY FACTOR

T _N Temp. °F	SPECIFIC GRAVITY									
	0.640	0.642	0.644	0.646	0.648	0.650	0.652	0.654	0.656	0.658
20	0.8575	0.8591	0.8606	0.8621	0.8636	0.8651	0.8666	0.8681	0.8696	0.8711
22	0.8558	0.8573	0.8588	0.8604	0.8619	0.8634	0.8649	0.8664	0.8679	0.8694
24	0.8541	0.8556	0.8571	0.8586	0.8602	0.8617	0.8632	0.8647	0.8661	0.8676
26	0.8524	0.8539	0.8554	0.8569	0.8584	0.8599	0.8614	0.8629	0.8644	0.8659
28	0.8508	0.8523	0.8538	0.8553	0.8568	0.8583	0.8597	0.8612	0.8627	0.8642
30	0.8491	0.8506	0.8521	0.8536	0.8551	0.8566	0.8581	0.8596	0.8610	0.8625
32	0.8474	0.8489	0.8504	0.8519	0.8534	0.8549	0.8564	0.8579	0.8594	0.8608
34	0.8458	0.8473	0.8488	0.8503	0.8517	0.8532	0.8547	0.8562	0.8577	0.8592
36	0.8441	0.8456	0.8471	0.8486	0.8501	0.8516	0.8531	0.8545	0.8560	0.8575
38	0.8425	0.8440	0.8455	0.8470	0.8485	0.8499	0.8514	0.8529	0.8544	0.8558
40	0.8409	0.8424	0.8439	0.8453	0.8468	0.8483	0.8498	0.8513	0.8527	0.8542
42	0.8393	0.8408	0.8422	0.8437	0.8452	0.8467	0.8482	0.8496	0.8511	0.8526
44	0.8377	0.8392	0.8406	0.8421	0.8436	0.8451	0.8465	0.8480	0.8495	0.8509
46	0.8361	0.8376	0.8390	0.8405	0.8420	0.8435	0.8449	0.8464	0.8479	0.8493
48	0.8345	0.8360	0.8375	0.8389	0.8404	0.8419	0.8433	0.8448	0.8463	0.8477
50	0.8329	0.8344	0.8359	0.8373	0.8388	0.8403	0.8417	0.8432	0.8447	0.8461
52	0.8314	0.8328	0.8343	0.8358	0.8372	0.8387	0.8402	0.8416	0.8431	0.8445
54	0.8298	0.8313	0.8328	0.8342	0.8357	0.8371	0.8386	0.8400	0.8415	0.8430
56	0.8283	0.8297	0.8312	0.8327	0.8341	0.8356	0.8370	0.8385	0.8399	0.8414
58	0.8267	0.8282	0.8297	0.8311	0.8326	0.8340	0.8355	0.8369	0.8384	0.8398
60	0.8252	0.8267	0.8281	0.8296	0.8310	0.8325	0.8339	0.8354	0.8368	0.8383
62	0.8237	0.8252	0.8266	0.8281	0.8295	0.8310	0.8324	0.8338	0.8353	0.8367
64	0.8222	0.8236	0.8251	0.8265	0.8280	0.8294	0.8309	0.8323	0.8338	0.8352
66	0.8207	0.8221	0.8236	0.8250	0.8265	0.8279	0.8294	0.8308	0.8322	0.8337
68	0.8192	0.8206	0.8221	0.8235	0.8250	0.8264	0.8278	0.8293	0.8307	0.8322
70	0.8177	0.8191	0.8206	0.8220	0.8235	0.8249	0.8263	0.8278	0.8292	0.8306
72	0.8162	0.8177	0.8191	0.8205	0.8220	0.8234	0.8248	0.8263	0.8277	0.8291
74	0.8148	0.8162	0.8176	0.8191	0.8205	0.8219	0.8234	0.8248	0.8262	0.8277
76	0.8133	0.8147	0.8162	0.8176	0.8190	0.8205	0.8219	0.8233	0.8247	0.8262
78	0.8118	0.8133	0.8147	0.8161	0.8176	0.8190	0.8204	0.8218	0.8233	0.8247
80	0.8104	0.8118	0.8133	0.8147	0.8161	0.8175	0.8190	0.8204	0.8218	0.8232
82	0.8090	0.8104	0.8118	0.8132	0.8147	0.8161	0.8175	0.8189	0.8203	0.8218
84	0.8075	0.8090	0.8104	0.8118	0.8132	0.8146	0.8161	0.8175	0.8189	0.8203
86	0.8061	0.8075	0.8090	0.8104	0.8118	0.8132	0.8146	0.8160	0.8175	0.8189
88	0.8047	0.8061	0.8075	0.8090	0.8104	0.8118	0.8132	0.8146	0.8160	0.8174
90	0.8033	0.8047	0.8061	0.8075	0.8090	0.8104	0.8118	0.8132	0.8146	0.8160
92	0.8019	0.8033	0.8047	0.8061	0.8075	0.8090	0.8104	0.8118	0.8132	0.8146
94	0.8005	0.8019	0.8033	0.8047	0.8061	0.8076	0.8090	0.8104	0.8118	0.8132
96	0.7991	0.8005	0.8019	0.8033	0.8048	0.8062	0.8076	0.8090	0.8104	0.8118
98	0.7977	0.7992	0.8006	0.8020	0.8034	0.8048	0.8062	0.8076	0.8090	0.8104
100	0.7964	0.7978	0.7992	0.8006	0.8020	0.8034	0.8048	0.8062	0.8076	0.8090
102	0.7950	0.7964	0.7978	0.7992	0.8006	0.8020	0.8034	0.8048	0.8062	0.8076
104	0.7937	0.7951	0.7965	0.7979	0.7993	0.8007	0.8020	0.8034	0.8048	0.8062
106	0.7923	0.7937	0.7951	0.7965	0.7979	0.7993	0.8007	0.8021	0.8035	0.8049
108	0.7910	0.7924	0.7938	0.7952	0.7965	0.7979	0.7993	0.8007	0.8021	0.8035

TABLE 5

COMBINED N AND GRAVITY FACTOR

T _N	SPECIFIC GRAVITY									
Temp. °F	0.660	0.662	0.664	0.666	0.668	0.670	0.672	0.674	0.676	0.678
20	0.8726	0.8741	0.8756	0.8771	0.8786	0.8801	0.8816	0.8831	0.8846	0.8860
22	0.8709	0.8724	0.8739	0.8753	0.8768	0.8783	0.8798	0.8813	0.8828	0.8843
24	0.8691	0.8706	0.8721	0.8736	0.8751	0.8766	0.8781	0.8796	0.8810	0.8825
26	0.8674	0.8689	0.8704	0.8719	0.8734	0.8749	0.8763	0.8778	0.8793	0.8808
28	0.8657	0.8672	0.8687	0.8702	0.8717	0.8731	0.8746	0.8761	0.8776	0.8790
30	0.8640	0.8655	0.8670	0.8685	0.8699	0.8714	0.8729	0.8744	0.8758	0.8773
32	0.8623	0.8638	0.8653	0.8668	0.8682	0.8697	0.8712	0.8727	0.8741	0.8756
34	0.8606	0.8621	0.8636	0.8651	0.8666	0.8680	0.8695	0.8710	0.8724	0.8739
36	0.8590	0.8605	0.8619	0.8634	0.8649	0.8663	0.8678	0.8693	0.8707	0.8722
38	0.8573	0.8588	0.8603	0.8617	0.8632	0.8647	0.8661	0.8676	0.8691	0.8705
40	0.8557	0.8571	0.8586	0.8601	0.8615	0.8630	0.8645	0.8659	0.8674	0.8689
42	0.8540	0.8555	0.8570	0.8584	0.8599	0.8614	0.8628	0.8643	0.8657	0.8672
44	0.8524	0.8539	0.8553	0.8568	0.8583	0.8597	0.8612	0.8626	0.8641	0.8655
46	0.8508	0.8522	0.8537	0.8552	0.8566	0.8581	0.8595	0.8610	0.8624	0.8639
48	0.8492	0.8506	0.8521	0.8536	0.8550	0.8565	0.8579	0.8594	0.8608	0.8623
50	0.8476	0.8490	0.8505	0.8519	0.8534	0.8548	0.8563	0.8577	0.8592	0.8606
52	0.8460	0.8474	0.8489	0.8503	0.8518	0.8532	0.8547	0.8561	0.8576	0.8590
54	0.8444	0.8459	0.8473	0.8488	0.8502	0.8516	0.8531	0.8545	0.8560	0.8574
56	0.8428	0.8443	0.8457	0.8472	0.8486	0.8501	0.8515	0.8529	0.8544	0.8558
58	0.8413	0.8427	0.8442	0.8456	0.8470	0.8485	0.8499	0.8514	0.8528	0.8542
60	0.8397	0.8412	0.8426	0.8440	0.8455	0.8469	0.8483	0.8498	0.8512	0.8527
62	0.8382	0.8396	0.8410	0.8425	0.8439	0.8454	0.8468	0.8482	0.8496	0.8511
64	0.8366	0.8381	0.8395	0.8409	0.8424	0.8438	0.8452	0.8467	0.8481	0.8495
66	0.8351	0.8365	0.8380	0.8394	0.8408	0.8423	0.8437	0.8451	0.8465	0.8480
68	0.8336	0.8350	0.8364	0.8379	0.8393	0.8407	0.8422	0.8436	0.8450	0.8464
70	0.8321	0.8335	0.8349	0.8364	0.8378	0.8392	0.8406	0.8421	0.8435	0.8449
72	0.8306	0.8320	0.8334	0.8348	0.8363	0.8377	0.8391	0.8405	0.8419	0.8434
74	0.8291	0.8305	0.8319	0.8333	0.8348	0.8362	0.8376	0.8390	0.8404	0.8418
76	0.8276	0.8290	0.8304	0.8318	0.8333	0.8347	0.8361	0.8375	0.8389	0.8403
78	0.8261	0.8275	0.8289	0.8304	0.8318	0.8332	0.8346	0.8360	0.8374	0.8388
80	0.8246	0.8261	0.8275	0.8289	0.8303	0.8317	0.8331	0.8345	0.8359	0.8373
82	0.8232	0.8246	0.8260	0.8274	0.8288	0.8302	0.8316	0.8330	0.8345	0.8359
84	0.8217	0.8231	0.8245	0.8260	0.8274	0.8288	0.8302	0.8316	0.8330	0.8344
86	0.8203	0.8217	0.8231	0.8245	0.8259	0.8273	0.8287	0.8301	0.8315	0.8329
88	0.8188	0.8202	0.8217	0.8231	0.8245	0.8259	0.8273	0.8287	0.8301	0.8315
90	0.8174	0.8188	0.8202	0.8216	0.8230	0.8244	0.8258	0.8272	0.8286	0.8300
92	0.8160	0.8174	0.8188	0.8202	0.8216	0.8230	0.8244	0.8258	0.8272	0.8286
94	0.8146	0.8160	0.8174	0.8188	0.8202	0.8216	0.8229	0.8243	0.8257	0.8271
96	0.8132	0.8146	0.8160	0.8173	0.8187	0.8201	0.8215	0.8229	0.8243	0.8257
98	0.8118	0.8132	0.8146	0.8159	0.8173	0.8187	0.8201	0.8215	0.8229	0.8243
100	0.8104	0.8118	0.8132	0.8145	0.8159	0.8173	0.8187	0.8201	0.8215	0.8229
102	0.8090	0.8104	0.8118	0.8132	0.8145	0.8159	0.8173	0.8187	0.8201	0.8214
104	0.8076	0.8090	0.8104	0.8118	0.8131	0.8145	0.8159	0.8173	0.8187	0.8200
106	0.8062	0.8076	0.8090	0.8104	0.8118	0.8131	0.8145	0.8159	0.8173	0.8187
108	0.8049	0.8063	0.8076	0.8090	0.8104	0.8118	0.8131	0.8145	0.8159	0.8173

TABLE 5

COMBINED N AND GRAVITY FACTOR

SPECIFIC GRAVITY

T _N Temp. °F	0.680	0.682	0.684	0.686	0.688	0.690	0.692	0.694	0.696	0.698
20	0.8875	0.8890	0.8905	0.8920	0.8935	0.8949	0.8964	0.8979	0.8994	0.9009
22	0.8858	0.8872	0.8887	0.8902	0.8917	0.8932	0.8946	0.8961	0.8976	0.8991
24	0.8840	0.8855	0.8870	0.8884	0.8899	0.8914	0.8929	0.8943	0.8958	0.8973
26	0.8823	0.8837	0.8852	0.8867	0.8882	0.8896	0.8911	0.8926	0.8940	0.8955
28	0.8805	0.8820	0.8835	0.8849	0.8864	0.8879	0.8893	0.8908	0.8923	0.8937
30	0.8788	0.8803	0.8817	0.8832	0.8847	0.8861	0.8876	0.8891	0.8905	0.8920
32	0.8771	0.8785	0.8800	0.8815	0.8829	0.8844	0.8859	0.8873	0.8888	0.8902
34	0.8754	0.8768	0.8783	0.8798	0.8812	0.8827	0.8841	0.8856	0.8871	0.8885
36	0.8737	0.8751	0.8766	0.8781	0.8795	0.8810	0.8824	0.8839	0.8853	0.8868
38	0.8720	0.8734	0.8749	0.8764	0.8778	0.8793	0.8807	0.8822	0.8836	0.8851
40	0.8703	0.8718	0.8732	0.8747	0.8761	0.8776	0.8790	0.8805	0.8819	0.8834
42	0.8686	0.8701	0.8716	0.8730	0.8745	0.8759	0.8773	0.8788	0.8802	0.8817
44	0.8670	0.8684	0.8699	0.8713	0.8728	0.8742	0.8757	0.8771	0.8786	0.8800
46	0.8653	0.8668	0.8682	0.8697	0.8711	0.8726	0.8740	0.8755	0.8769	0.8783
48	0.8637	0.8652	0.8666	0.8680	0.8695	0.8709	0.8724	0.8738	0.8752	0.8767
50	0.8621	0.8635	0.8650	0.8664	0.8678	0.8693	0.8707	0.8722	0.8736	0.8750
52	0.8605	0.8619	0.8633	0.8648	0.8662	0.8676	0.8691	0.8705	0.8719	0.8734
54	0.8589	0.8603	0.8617	0.8632	0.8646	0.8660	0.8675	0.8689	0.8703	0.8717
56	0.8573	0.8587	0.8601	0.8616	0.8630	0.8644	0.8658	0.8673	0.8687	0.8701
58	0.8557	0.8571	0.8585	0.8600	0.8614	0.8628	0.8642	0.8657	0.8671	0.8685
60	0.8541	0.8555	0.8569	0.8584	0.8598	0.8612	0.8626	0.8641	0.8655	0.8669
62	0.8525	0.8539	0.8554	0.8568	0.8582	0.8596	0.8611	0.8625	0.8639	0.8653
64	0.8509	0.8524	0.8538	0.8552	0.8566	0.8581	0.8595	0.8609	0.8623	0.8637
66	0.8494	0.8508	0.8522	0.8537	0.8551	0.8565	0.8579	0.8593	0.8607	0.8621
68	0.8478	0.8493	0.8507	0.8521	0.8535	0.8549	0.8563	0.8578	0.8592	0.8606
70	0.8463	0.8477	0.8491	0.8506	0.8520	0.8534	0.8548	0.8562	0.8576	0.8590
72	0.8448	0.8462	0.8476	0.8490	0.8504	0.8518	0.8532	0.8546	0.8561	0.8575
74	0.8433	0.8447	0.8461	0.8475	0.8489	0.8503	0.8517	0.8531	0.8545	0.8559
76	0.8417	0.8432	0.8446	0.8460	0.8474	0.8488	0.8502	0.8516	0.8530	0.8544
78	0.8402	0.8416	0.8431	0.8445	0.8459	0.8473	0.8487	0.8501	0.8515	0.8529
80	0.8387	0.8402	0.8416	0.8430	0.8444	0.8458	0.8472	0.8485	0.8499	0.8513
82	0.8373	0.8387	0.8401	0.8415	0.8429	0.8443	0.8457	0.8470	0.8484	0.8498
84	0.8358	0.8372	0.8386	0.8400	0.8414	0.8428	0.8442	0.8455	0.8469	0.8483
86	0.8343	0.8357	0.8371	0.8385	0.8399	0.8413	0.8427	0.8441	0.8454	0.8468
88	0.8328	0.8342	0.8356	0.8370	0.8384	0.8398	0.8412	0.8426	0.8440	0.8453
90	0.8314	0.8328	0.8342	0.8356	0.8370	0.8383	0.8397	0.8411	0.8425	0.8439
92	0.8299	0.8313	0.8327	0.8341	0.8355	0.8369	0.8383	0.8396	0.8410	0.8424
94	0.8285	0.8299	0.8313	0.8327	0.8340	0.8354	0.8368	0.8382	0.8396	0.8409
96	0.8271	0.8285	0.8298	0.8312	0.8326	0.8340	0.8354	0.8367	0.8381	0.8395
98	0.8257	0.8270	0.8284	0.8298	0.8312	0.8325	0.8339	0.8353	0.8367	0.8380
100	0.8242	0.8256	0.8270	0.8284	0.8297	0.8311	0.8325	0.8339	0.8352	0.8366
102	0.8228	0.8242	0.8256	0.8270	0.8283	0.8297	0.8311	0.8324	0.8338	0.8352
104	0.8214	0.8228	0.8242	0.8255	0.8269	0.8283	0.8297	0.8310	0.8324	0.8338
106	0.8200	0.8214	0.8228	0.8241	0.8255	0.8269	0.8282	0.8296	0.8310	0.8323
108	0.8186	0.8200	0.8214	0.8227	0.8241	0.8255	0.8268	0.8282	0.8296	0.8309

TABLE 5
COMBINED N AND GRAVITY FACTOR

T_N

Temp.

°F	SPECIFIC GRAVITY									
	0.700	0.702	0.704	0.706	0.708	0.710	0.712	0.714	0.716	0.718
20	0.9023	0.9038	0.9053	0.9067	0.9082	0.9097	0.9111	0.9126	0.9141	0.9155
22	0.9005	0.9020	0.9035	0.9049	0.9064	0.9079	0.9093	0.9108	0.9123	0.9137
24	0.8987	0.9002	0.9017	0.9031	0.9046	0.9061	0.9075	0.9090	0.9104	0.9119
26	0.8970	0.8984	0.8999	0.9014	0.9028	0.9043	0.9057	0.9072	0.9086	0.9101
28	0.8952	0.8967	0.8981	0.8996	0.9010	0.9025	0.9039	0.9054	0.9069	0.9083
30	0.8934	0.8949	0.8964	0.8978	0.8993	0.9007	0.9022	0.9036	0.9051	0.9065
32	0.8917	0.8932	0.8946	0.8961	0.8975	0.8990	0.9004	0.9019	0.9033	0.9048
34	0.8900	0.8914	0.8929	0.8943	0.8958	0.8972	0.8987	0.9001	0.9015	0.9030
36	0.8882	0.8897	0.8911	0.8926	0.8940	0.8955	0.8969	0.8984	0.8998	0.9012
38	0.8865	0.8880	0.8894	0.8909	0.8923	0.8937	0.8952	0.8966	0.8981	0.8995
40	0.8848	0.8863	0.8877	0.8891	0.8906	0.8920	0.8935	0.8949	0.8963	0.8978
42	0.8831	0.8846	0.8860	0.8874	0.8889	0.8903	0.8918	0.8932	0.8946	0.8961
44	0.8814	0.8829	0.8843	0.8858	0.8872	0.8886	0.8901	0.8915	0.8929	0.8943
46	0.8798	0.8812	0.8826	0.8841	0.8855	0.8869	0.8884	0.8898	0.8912	0.8926
48	0.8781	0.8795	0.8810	0.8824	0.8838	0.8853	0.8867	0.8881	0.8895	0.8910
50	0.8764	0.8779	0.8793	0.8807	0.8822	0.8836	0.8850	0.8864	0.8879	0.8893
52	0.8748	0.8762	0.8777	0.8791	0.8805	0.8819	0.8834	0.8848	0.8862	0.8876
54	0.8732	0.8746	0.8760	0.8774	0.8789	0.8803	0.8817	0.8831	0.8845	0.8860
56	0.8715	0.8730	0.8744	0.8758	0.8772	0.8786	0.8801	0.8815	0.8829	0.8843
58	0.8699	0.8713	0.8728	0.8742	0.8756	0.8770	0.8784	0.8798	0.8813	0.8827
60	0.8683	0.8697	0.8712	0.8726	0.8740	0.8754	0.8768	0.8782	0.8796	0.8810
62	0.8667	0.8681	0.8695	0.8710	0.8724	0.8738	0.8752	0.8766	0.8780	0.8794
64	0.8651	0.8665	0.8680	0.8694	0.8708	0.8722	0.8736	0.8750	0.8764	0.8778
66	0.8635	0.8650	0.8664	0.8678	0.8692	0.8706	0.8720	0.8734	0.8748	0.8762
68	0.8620	0.8634	0.8648	0.8662	0.8676	0.8690	0.8704	0.8718	0.8732	0.8746
70	0.8604	0.8618	0.8632	0.8646	0.8660	0.8674	0.8688	0.8702	0.8716	0.8730
72	0.8589	0.8603	0.8617	0.8631	0.8645	0.8659	0.8673	0.8686	0.8700	0.8714
74	0.8573	0.8587	0.8601	0.8615	0.8629	0.8643	0.8657	0.8671	0.8685	0.8699
76	0.8558	0.8572	0.8586	0.8600	0.8614	0.8628	0.8641	0.8655	0.8669	0.8683
78	0.8543	0.8556	0.8570	0.8584	0.8598	0.8612	0.8626	0.8640	0.8654	0.8668
80	0.8527	0.8541	0.8555	0.8569	0.8583	0.8597	0.8611	0.8624	0.8638	0.8652
82	0.8512	0.8526	0.8540	0.8554	0.8568	0.8582	0.8595	0.8609	0.8623	0.8637
84	0.8497	0.8511	0.8525	0.8539	0.8553	0.8566	0.8580	0.8594	0.8608	0.8622
86	0.8482	0.8496	0.8510	0.8524	0.8537	0.8551	0.8565	0.8579	0.8593	0.8606
88	0.8467	0.8481	0.8495	0.8509	0.8523	0.8536	0.8550	0.8564	0.8578	0.8591
90	0.8453	0.8466	0.8480	0.8494	0.8508	0.8521	0.8535	0.8549	0.8563	0.8576
92	0.8438	0.8452	0.8465	0.8479	0.8493	0.8507	0.8520	0.8534	0.8548	0.8561
94	0.8423	0.8437	0.8451	0.8464	0.8478	0.8492	0.8505	0.8519	0.8533	0.8546
96	0.8409	0.8422	0.8436	0.8450	0.8463	0.8477	0.8491	0.8504	0.8518	0.8532
98	0.8394	0.8408	0.8422	0.8435	0.8449	0.8463	0.8476	0.8490	0.8503	0.8517
100	0.8380	0.8393	0.8407	0.8421	0.8434	0.8448	0.8462	0.8475	0.8489	0.8502
102	0.8365	0.8379	0.8393	0.8406	0.8420	0.8434	0.8447	0.8461	0.8474	0.8488
104	0.8351	0.8365	0.8378	0.8392	0.8406	0.8419	0.8433	0.8446	0.8460	0.8473
106	0.8337	0.8351	0.8364	0.8378	0.8391	0.8405	0.8418	0.8432	0.8446	0.8459
108	0.8323	0.8336	0.8350	0.8364	0.8377	0.8391	0.8404	0.8418	0.8431	0.8445

SUPERCOMPRESSIBILITY FACTOR, F_{pv} - TABLE 6

The method of supercompressibility factor evaluation presented here is from the A.G.A. "Manual for the Determination of Supercompressibility Factors for Natural Gas". It relates the compressibility variation of various natural gases to that of a 0.600 specific gravity hydrocarbon gas. Table 6 is a condensed version of the supercompressibility factor table for a 0.600 specific gravity, hydrocarbon gas presented in the A.G.A. supercompressibility manual.

The use of the data presented is intended to apply only to normal natural gas mixtures. Normal mixtures are defined as mixtures of essentially methane and ethane plus heavier hydrocarbon components, but not containing appreciable concentration of the much heavier natural gas hydrocarbons. The specific gravity should not exceed .72. The diluent content of any gas mixture to which the method is to be applied should be limited to 3 mol percent carbon dioxide and 7 mol percent nitrogen.

The specific gravity, carbon dioxide and nitrogen contents, in conjunction with the flowing pressure and temperature is used to determine the adjusted pressure and adjusted temperature necessary for relating any gas to the supercompressibility data of the 0.600 specific gravity, hydrocarbon gas.

The adjusted pressure is obtained by multiplying the gage pressure (P_f) of the flowing gas by the pressure adjusting factor F_p and the adjusted temperature is obtained by multiplying the absolute temperature (T_f) of the flowing gas by the temperature adjusting factor F_T and subtracting 460 from this product. Adjusting factors F_p and F_T are calculated as follows:

$$F_p = \frac{156.47}{160.8 - 7.22G + K_p}$$

Where: $K_p = M_c - 0.392 M_n$

And $F_T = \frac{226.29}{99.15 + 211.9G - K_T}$

Where: $K_T = M_c + 1.681 M_n$

And G = Specific gravity of flowing gas

M_c = Mol percent carbon dioxide

M_n = Mol percent nitrogen

Adjusted Pressure = $P_f F_p$ psig

Adjusted Temperature = $T_f F_T - 460^{\circ}\text{F}$

After the adjusted pressure and the adjusted temperature are determined the supercompressibility factor F_{pv} can be found in Table 6.

NOTE: For complete discussion of supercompressibility factor determination methods refer to the A.G.A. "Manual for the Determination of Supercompressibility Factors for Natural Gas".

Tabular values for F_p and F_T are published in American Meter's Handbook E-2, Orifice Meter Constants.

TABLE 6

SUPERCOMPRESSIBILITY FACTOR

P _N PSIG	T _N							
	TEMPERATURE °F							
	-20	-10	0	10	20	30	40	50
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0026	1.0025	1.0023	1.0022	1.0020	1.0019	1.0018	1.0017
40	1.0053	1.0050	1.0047	1.0044	1.0041	1.0038	1.0036	1.0034
60	1.0081	1.0076	1.0071	1.0066	1.0062	1.0058	1.0054	1.0051
80	1.0109	1.0101	1.0095	1.0089	1.0083	1.0077	1.0072	1.0068
100	1.0137	1.0128	1.0119	1.0111	1.0104	1.0097	1.0091	1.0085
120	1.0165	1.0154	1.0144	1.0134	1.0125	1.0117	1.0109	1.0102
140	1.0194	1.0181	1.0169	1.0157	1.0147	1.0137	1.0128	1.0119
160	1.0224	1.0208	1.0194	1.0181	1.0168	1.0157	1.0147	1.0137
180	1.0253	1.0236	1.0219	1.0204	1.0190	1.0177	1.0165	1.0154
200	1.0283	1.0263	1.0245	1.0228	1.0212	1.0198	1.0184	1.0172
220	1.0314	1.0292	1.0271	1.0252	1.0234	1.0218	1.0203	1.0190
240	1.0345	1.0320	1.0297	1.0276	1.0257	1.0239	1.0223	1.0207
260	1.0376	1.0349	1.0324	1.0301	1.0279	1.0260	1.0242	1.0225
280	1.0408	1.0378	1.0350	1.0325	1.0302	1.0281	1.0261	1.0243
300	1.0441	1.0408	1.0378	1.0350	1.0325	1.0302	1.0281	1.0261
320	1.0473	1.0438	1.0405	1.0375	1.0348	1.0323	1.0300	1.0279
340	1.0507	1.0468	1.0433	1.0401	1.0371	1.0345	1.0320	1.0298
360	1.0541	1.0499	1.0461	1.0426	1.0395	1.0366	1.0340	1.0316
380	1.0575	1.0530	1.0489	1.0452	1.0418	1.0388	1.0360	1.0334
400	1.0610	1.0561	1.0518	1.0478	1.0442	1.0410	1.0380	1.0353
420	1.0645	1.0593	1.0546	1.0504	1.0466	1.0431	1.0400	1.0371
440	1.0681	1.0625	1.0576	1.0531	1.0490	1.0454	1.0420	1.0390
460	1.0717	1.0658	1.0605	1.0558	1.0515	1.0476	1.0440	1.0408
480	1.0754	1.0691	1.0635	1.0585	1.0539	1.0498	1.0461	1.0427
500	1.0792	1.0725	1.0665	1.0612	1.0564	1.0521	1.0481	1.0446
520	1.0830	1.0759	1.0696	1.0639	1.0589	1.0543	1.0502	1.0464
540	1.0869	1.0793	1.0727	1.0667	1.0614	1.0566	1.0523	1.0483
560	1.0908	1.0828	1.0758	1.0695	1.0639	1.0589	1.0543	1.0502
580	1.0948	1.0864	1.0789	1.0723	1.0665	1.0612	1.0564	1.0521
600	1.0989	1.0900	1.0821	1.0752	1.0690	1.0635	1.0585	1.0540
620	1.1030	1.0936	1.0853	1.0781	1.0716	1.0658	1.0606	1.0559
640	1.1072	1.0973	1.0886	1.0809	1.0742	1.0681	1.0627	1.0578
660	1.1115	1.1010	1.0919	1.0839	1.0768	1.0705	1.0648	1.0598
680	1.1158	1.1047	1.0952	1.0868	1.0794	1.0728	1.0670	1.0617
700	1.1202	1.1086	1.0985	1.0898	1.0820	1.0752	1.0691	1.0636
720	1.1246	1.1124	1.1019	1.0928	1.0847	1.0776	1.0712	1.0655
740	1.1292	1.1163	1.1053	1.0958	1.0874	1.0800	1.0734	1.0675
760	1.1337	1.1203	1.1088	1.0988	1.0901	1.0823	1.0755	1.0694
780	1.1384	1.1243	1.1123	1.1018	1.0927	1.0847	1.0776	1.0713

TABLE 6

SUPERCOMPRESSIBILITY FACTOR

P _N PSIG	T _N							
	TEMPERATURE °F							
	60	70	80	90	100	110	120	130
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0016	1.0015	1.0014	1.0013	1.0012	1.0011	1.0011	1.0010
40	1.0032	1.0030	1.0028	1.0026	1.0024	1.0023	1.0021	1.0020
60	1.0047	1.0044	1.0042	1.0039	1.0037	1.0034	1.0032	1.0030
80	1.0063	1.0059	1.0056	1.0052	1.0049	1.0046	1.0043	1.0040
100	1.0079	1.0074	1.0070	1.0065	1.0061	1.0057	1.0054	1.0050
120	1.0096	1.0089	1.0084	1.0078	1.0073	1.0069	1.0065	1.0061
140	1.0112	1.0104	1.0098	1.0092	1.0086	1.0080	1.0075	1.0071
160	1.0128	1.0120	1.0112	1.0105	1.0098	1.0092	1.0086	1.0081
180	1.0144	1.0135	1.0126	1.0118	1.0110	1.0103	1.0097	1.0091
200	1.0161	1.0150	1.0140	1.0131	1.0123	1.0115	1.0108	1.0101
220	1.0177	1.0165	1.0155	1.0145	1.0135	1.0127	1.0118	1.0111
240	1.0194	1.0181	1.0169	1.0158	1.0148	1.0138	1.0129	1.0121
260	1.0210	1.0196	1.0183	1.0171	1.0160	1.0150	1.0140	1.0131
280	1.0227	1.0212	1.0198	1.0184	1.0172	1.0161	1.0151	1.0141
300	1.0243	1.0227	1.0212	1.0198	1.0185	1.0173	1.0161	1.0151
320	1.0260	1.0243	1.0226	1.0211	1.0197	1.0184	1.0172	1.0161
340	1.0277	1.0258	1.0241	1.0225	1.0210	1.0196	1.0183	1.0171
360	1.0294	1.0274	1.0255	1.0238	1.0222	1.0207	1.0194	1.0181
380	1.0311	1.0289	1.0270	1.0251	1.0234	1.0219	1.0204	1.0191
400	1.0328	1.0305	1.0284	1.0265	1.0247	1.0230	1.0215	1.0201
420	1.0345	1.0321	1.0299	1.0278	1.0259	1.0242	1.0225	1.0210
440	1.0362	1.0336	1.0313	1.0292	1.0272	1.0253	1.0236	1.0220
460	1.0379	1.0352	1.0328	1.0305	1.0284	1.0265	1.0247	1.0230
480	1.0396	1.0368	1.0342	1.0318	1.0296	1.0276	1.0257	1.0240
500	1.0413	1.0384	1.0357	1.0332	1.0309	1.0288	1.0268	1.0250
520	1.0430	1.0400	1.0371	1.0345	1.0321	1.0299	1.0278	1.0259
540	1.0448	1.0415	1.0386	1.0359	1.0333	1.0310	1.0289	1.0269
560	1.0465	1.0431	1.0401	1.0372	1.0346	1.0322	1.0299	1.0279
580	1.0482	1.0447	1.0415	1.0385	1.0358	1.0333	1.0310	1.0288
600	1.0500	1.0463	1.0430	1.0399	1.0370	1.0344	1.0320	1.0298
620	1.0517	1.0479	1.0444	1.0412	1.0383	1.0356	1.0331	1.0308
640	1.0535	1.0495	1.0459	1.0426	1.0395	1.0367	1.0341	1.0317
660	1.0552	1.0511	1.0473	1.0439	1.0407	1.0378	1.0351	1.0327
680	1.0569	1.0527	1.0488	1.0452	1.0419	1.0389	1.0362	1.0336
700	1.0587	1.0542	1.0502	1.0465	1.0432	1.0400	1.0372	1.0345
720	1.0604	1.0558	1.0517	1.0479	1.0444	1.0412	1.0382	1.0355
740	1.0622	1.0574	1.0531	1.0492	1.0456	1.0423	1.0392	1.0364
760	1.0639	1.0590	1.0546	1.0505	1.0468	1.0434	1.0402	1.0373
780	1.0657	1.0606	1.0560	1.0518	1.0480	1.0445	1.0412	1.0383

TABLE 7

F_A FACTOR FOR AIR PROVING *

T _N Temp.	P _N (PSIA)									
°F	10	20	30	40	50	60	70	80	90	100
-30	90.90	90.88	90.86	90.84	90.82	90.80	90.78	90.76	90.74	90.72
-28	91.12	91.10	91.08	91.06	91.04	91.02	91.00	90.98	90.96	90.94
-26	91.33	91.31	91.29	91.27	91.25	91.23	91.21	91.19	91.18	91.16
-24	91.54	91.52	91.50	91.48	91.46	91.44	91.42	91.41	91.39	91.38
-22	91.75	91.73	91.71	91.69	91.67	91.66	91.64	91.62	91.61	91.59
-20	91.96	91.94	91.92	91.90	91.89	91.87	91.85	91.83	91.82	91.81
-18	92.17	92.15	92.13	92.11	92.10	92.08	92.06	92.05	92.03	92.02
-16	92.38	92.36	92.34	92.32	92.31	92.29	92.27	92.26	92.25	92.23
-14	92.58	92.57	92.55	92.53	92.52	92.50	92.49	92.47	92.46	92.45
-12	92.79	92.78	92.76	92.74	92.73	92.71	92.70	92.68	92.67	92.66
-10	93.00	92.98	92.97	92.95	92.94	92.92	92.91	92.89	92.88	92.87
-8	93.21	93.19	93.18	93.16	93.15	93.13	93.12	93.11	93.10	93.09
-6	93.41	93.40	93.39	93.37	93.36	93.34	93.33	93.32	93.31	93.30
-4	93.62	93.61	93.59	93.58	93.57	93.56	93.54	93.53	93.52	93.51
-2	93.83	93.81	93.80	93.79	93.78	93.77	93.75	93.74	93.73	93.73
0	94.03	94.02	94.01	94.00	93.99	93.98	93.97	93.96	93.95	93.94
2	94.24	94.23	94.21	94.20	94.19	94.18	94.17	94.16	94.16	94.15
4	94.44	94.43	94.42	94.41	94.40	94.39	94.38	94.37	94.36	94.36
6	94.64	94.63	94.63	94.62	94.61	94.60	94.59	94.58	94.57	94.57
8	94.85	94.84	94.83	94.82	94.81	94.80	94.79	94.79	94.78	94.77
10	95.05	95.04	95.03	95.03	95.02	95.01	95.00	94.99	94.99	94.98
12	95.25	95.25	95.24	95.23	95.22	95.21	95.21	95.20	95.20	95.19
14	95.46	95.45	95.44	95.43	95.43	95.42	95.41	95.41	95.40	95.40
16	95.66	95.65	95.64	95.64	95.63	95.62	95.62	95.61	95.61	95.60
18	95.86	95.85	95.85	95.84	95.84	95.83	95.82	95.82	95.81	95.81
20	96.06	96.05	96.05	96.04	96.04	96.03	96.03	96.02	96.02	96.02
22	96.26	96.25	96.25	96.24	96.24	96.23	96.23	96.22	96.22	96.22
24	96.46	96.45	96.45	96.44	96.44	96.43	96.43	96.43	96.42	96.42
26	96.66	96.65	96.65	96.64	96.64	96.63	96.63	96.62	96.62	96.62
28	96.86	96.85	96.85	96.84	96.84	96.83	96.83	96.82	96.82	96.82
30	97.06	97.05	97.05	97.04	97.04	97.03	97.02	97.02	97.02	97.02
32	97.25	97.25	97.24	97.24	97.24	97.23	97.23	97.23	97.23	97.23
34	97.45	97.45	97.44	97.44	97.44	97.43	97.43	97.43	97.43	97.43
36	97.65	97.65	97.64	97.64	97.64	97.63	97.63	97.63	97.63	97.63
38	97.85	97.84	97.84	97.84	97.84	97.84	97.83	97.83	97.83	97.83
40	98.04	98.04	98.04	98.04	98.04	98.04	98.03	98.03	98.04	98.04
42	98.24	98.24	98.24	98.24	98.24	98.23	98.23	98.23	98.23	98.24
44	98.44	98.44	98.43	98.43	98.43	98.43	98.43	98.43	98.43	98.43
46	98.63	98.63	98.63	98.63	98.63	98.63	98.63	98.63	98.63	98.63
48	98.83	98.83	98.83	98.83	98.83	98.83	98.83	98.83	98.83	98.83

$$* F_A = 6.402 C^* Z \sqrt{T_N}$$

TABLE 7

F_A FACTOR FOR AIR PROVINGT_N

Temp.

°F	P _N (PSIA)									
	10	20	30	40	50	60	70	80	90	100
50	99.02	99.02	99.02	99.02	99.02	99.02	99.02	99.03	99.03	99.03
52	99.22	99.22	99.22	99.22	99.22	99.22	99.22	99.22	99.22	99.23
54	99.41	99.41	99.41	99.41	99.41	99.42	99.42	99.42	99.42	99.42
56	99.60	99.61	99.61	99.61	99.61	99.61	99.61	99.62	99.62	99.62
58	99.80	99.80	99.80	99.80	99.81	99.81	99.81	99.82	99.82	99.82
60	99.99	99.99	99.99	100.00	100.00	100.00	100.00	100.01	100.01	100.02
62	100.18	100.18	100.19	100.19	100.19	100.20	100.20	100.20	100.21	100.21
64	100.37	100.37	100.38	100.38	100.39	100.39	100.39	100.40	100.40	100.41
66	100.56	100.56	100.57	100.57	100.58	100.58	100.59	100.59	100.60	100.60
68	100.75	100.75	100.76	100.76	100.77	100.78	100.78	100.79	100.79	100.80
70	100.94	100.94	100.95	100.96	100.96	100.97	100.98	100.98	100.99	100.99
72	101.13	101.13	101.14	101.15	101.15	101.16	101.17	101.17	101.18	101.19
74	101.32	101.32	101.33	101.34	101.34	101.35	101.36	101.37	101.37	101.38
76	101.51	101.51	101.52	101.53	101.53	101.54	101.55	101.56	101.56	101.57
78	101.70	101.70	101.71	101.72	101.72	101.73	101.74	101.75	101.75	101.76
80	101.88	101.89	101.90	101.91	101.91	101.92	101.93	101.94	101.95	101.95
82	102.07	102.08	102.09	102.10	102.11	102.11	102.12	102.13	102.14	102.15
84	102.26	102.27	102.28	102.29	102.30	102.30	102.31	102.32	102.33	102.34
86	102.45	102.46	102.47	102.48	102.49	102.49	102.50	102.51	102.52	102.53
88	102.64	102.65	102.66	102.67	102.68	102.68	102.69	102.70	102.71	102.72
90	102.83	102.84	102.85	102.85	101.86	102.86	102.88	102.89	102.90	102.91
92	103.01	103.02	103.03	103.04	103.05	103.06	103.07	103.08	103.09	103.10
94	103.20	103.21	103.22	103.23	103.24	103.25	103.26	103.27	103.28	103.29
96	103.39	103.40	103.41	103.42	103.43	103.44	103.45	103.46	103.47	103.47
98	103.57	103.58	103.59	103.60	103.61	103.62	103.63	103.64	103.65	103.66
100	103.76	103.77	103.78	103.79	103.80	103.81	103.82	103.83	103.84	103.85
102	103.94	103.95	103.96	103.97	103.99	104.00	104.01	104.02	104.03	104.04
104	104.13	104.14	104.15	104.16	104.17	104.18	104.19	104.20	104.21	104.23
106	104.31	104.32	104.33	104.35	104.36	104.37	104.38	104.39	104.40	104.41
108	104.50	104.51	104.52	104.53	104.54	104.55	104.56	104.58	104.59	104.60
110	104.68	104.69	104.70	104.71	104.73	104.74	104.75	104.76	104.77	104.79
112	104.86	104.87	104.89	104.90	104.91	104.92	104.93	104.95	104.96	104.97
114	105.04	105.05	105.07	105.08	105.09	105.10	105.12	105.13	105.14	105.16
116	105.22	105.24	105.25	105.26	105.28	105.29	105.30	105.31	105.33	105.34
118	105.40	105.42	105.43	105.44	105.46	105.47	105.49	105.50	105.51	105.52
120	105.58	105.60	105.61	105.63	105.64	105.65	105.67	105.68	105.69	105.71
122	105.76	105.78	105.79	105.81	105.82	105.84	105.85	105.87	105.88	105.89
124	105.95	105.96	105.98	105.99	106.00	106.02	106.03	106.05	106.06	106.08
126	106.13	106.14	106.16	106.17	106.19	106.20	106.22	106.23	106.25	106.26
128	106.31	106.32	106.34	106.35	106.37	106.38	106.40	106.41	106.43	106.44

TABLE 7

F_A FACTOR FOR AIR PROVING

T _N Temp. °F	P _N (PSIA)									
	100	200	300	400	500	600	700	800	900	1000
-30	90.72	90.54	90.39	90.28	90.19	90.14	90.13	90.16	90.24	90.37
-28	90.94	90.77	90.62	90.51	90.43	90.39	90.38	90.42	90.51	90.64
-26	91.16	90.99	90.85	90.75	90.67	90.64	90.64	90.68	90.77	90.90
-24	91.38	91.22	91.09	90.99	90.92	90.88	90.89	90.94	91.04	91.17
-22	91.59	91.44	91.32	91.23	91.16	91.13	91.15	91.20	91.30	91.44
-20	91.81	91.66	91.55	91.46	91.40	91.38	91.40	91.46	91.57	91.70
-18	92.02	91.88	91.77	91.70	91.64	91.63	91.65	91.72	91.82	91.96
-16	92.23	92.10	92.00	91.93	91.88	91.87	91.90	91.97	92.08	92.22
-14	92.45	92.32	92.23	92.16	92.12	92.12	92.15	92.22	92.33	92.48
-12	92.66	92.54	92.45	92.39	92.36	92.36	92.39	92.47	92.59	92.74
-10	92.87	92.76	92.68	92.62	92.60	92.61	92.64	92.73	92.84	93.00
-8	93.09	92.98	92.90	92.85	92.83	92.85	92.89	92.98	93.09	93.26
-6	93.30	93.20	93.12	93.08	93.06	93.09	93.13	93.23	93.34	93.51
-4	93.51	93.42	93.34	93.31	93.30	93.32	93.37	93.47	93.59	93.77
-2	93.73	93.64	93.57	93.54	93.53	93.56	93.62	93.72	93.84	94.02
0	93.94	93.86	93.79	93.76	93.76	93.80	93.86	93.97	94.09	94.28
2	94.15	94.07	94.01	93.99	93.99	94.03	94.10	94.21	94.34	94.53
4	94.36	94.28	94.23	94.21	94.22	94.27	94.34	94.45	94.59	94.77
6	94.57	94.50	94.45	94.44	94.45	94.50	94.58	94.69	94.83	95.02
8	94.77	95.71	94.67	94.66	94.68	94.73	94.82	94.93	95.08	95.26
10	94.98	94.92	94.89	94.89	94.91	94.96	95.06	95.17	95.33	95.51
12	95.19	95.14	95.10	95.11	95.14	95.20	95.29	95.41	95.57	95.76
14	95.40	95.35	95.32	95.33	95.36	95.43	95.52	95.64	95.81	96.00
16	95.60	95.56	95.54	95.55	95.59	95.66	95.75	95.88	96.05	96.24
18	95.81	95.77	95.76	95.77	95.81	95.89	95.99	96.12	96.29	96.49
20	96.02	95.98	95.97	96.00	96.04	96.12	96.22	96.35	96.53	96.73
22	96.22	96.19	96.19	96.21	96.26	96.34	96.45	96.58	96.76	96.97
24	96.42	96.40	96.40	96.43	96.48	96.57	96.68	96.82	97.00	97.20
26	96.62	96.61	96.61	96.65	96.71	96.79	96.91	97.05	97.23	97.44
28	96.82	96.81	96.82	96.86	96.93	97.02	97.14	97.29	97.46	97.67
30	97.02	97.02	97.04	97.08	97.15	97.24	97.37	97.52	97.70	97.91
32	97.23	97.23	97.25	97.29	97.37	97.46	97.59	97.75	97.93	98.14
34	97.43	97.43	97.46	97.51	97.58	97.69	97.82	97.97	98.16	98.38
36	97.63	97.64	97.67	97.72	97.80	97.91	98.04	98.20	98.39	98.61
38	97.83	97.84	97.88	97.93	98.02	98.13	98.26	98.42	98.62	98.84
40	98.04	98.05	98.09	98.14	98.23	98.35	98.49	98.65	98.85	99.07
42	98.24	98.25	98.30	98.36	98.45	98.57	98.71	98.87	99.08	99.30
44	98.43	98.46	98.51	98.57	98.67	98.79	98.93	99.10	99.31	99.53
46	98.63	98.66	98.71	98.78	98.88	99.00	99.15	99.32	99.53	99.75
48	98.83	98.87	98.92	99.00	99.09	99.22	99.37	99.55	99.76	99.98

TABLE 7

F_A FACTOR FOR AIR PROVING

T _N	P _N (PSIA)									
Temp. °F	100	200	300	400	500	600	700	800	900	1000
50	99.03	99.07	99.13	99.21	99.31	99.44	99.59	99.77	99.98	100.21
52	99.23	99.27	99.33	99.42	99.52	99.65	99.81	99.99	100.20	100.43
54	99.42	99.47	99.54	99.62	99.73	99.87	100.03	100.21	100.43	100.66
56	99.62	99.67	99.74	99.83	99.94	100.08	100.24	100.43	100.65	100.88
58	99.82	99.87	99.94	100.04	100.15	100.29	100.46	100.65	100.87	101.11
60	100.02	100.07	100.15	100.24	100.36	100.50	100.67	100.87	101.09	101.33
62	100.21	100.27	100.35	100.45	100.57	100.72	100.89	101.08	101.30	101.55
64	100.41	100.47	100.55	100.65	100.78	100.93	101.10	101.30	101.52	101.77
66	100.60	100.66	100.76	100.86	100.99	101.14	101.32	101.51	101.74	101.99
68	100.80	100.86	100.96	101.06	101.20	101.35	101.53	101.73	101.95	102.21
70	100.99	101.06	101.16	101.27	101.41	101.57	101.74	101.95	102.17	102.43
72	101.19	101.26	101.36	101.47	101.62	101.77	101.95	102.16	102.38	102.64
74	101.38	101.45	101.56	101.67	101.82	101.98	102.16	102.37	102.60	102.86
76	101.57	101.65	101.76	101.87	102.02	102.19	102.37	102.58	102.81	103.07
78	101.76	101.84	101.95	102.07	102.23	102.39	102.58	102.79	103.02	103.29
80	101.95	102.04	102.15	102.28	102.43	102.60	102.79	103.00	103.24	103.50
82	102.15	102.23	102.35	102.48	102.63	102.81	103.00	103.21	103.45	103.72
84	102.34	102.43	102.54	102.68	102.84	103.01	103.20	103.42	103.66	103.93
86	102.53	102.62	102.74	102.88	103.04	103.21	103.41	103.63	103.87	104.14
88	102.72	102.82	102.94	103.08	103.24	103.42	103.62	103.83	104.08	104.35
90	102.91	103.01	103.13	103.28	103.45	103.62	103.82	104.04	104.29	104.56
92	103.10	103.20	103.33	103.48	103.64	103.82	104.03	104.25	104.50	104.77
94	103.29	103.39	103.52	103.67	103.84	104.02	104.23	104.46	104.70	104.98
96	103.47	103.59	103.71	103.87	104.04	104.23	104.44	104.67	104.91	105.19
98	103.66	103.78	103.91	104.07	104.24	104.43	104.65	104.87	105.12	105.39
100	103.85	103.97	104.10	104.26	104.44	104.63	104.85	105.08	105.33	105.60
102	104.04	104.16	104.30	104.46	104.63	104.83	105.05	105.28	105.53	105.81
104	104.23	104.35	104.49	104.65	104.83	105.03	105.25	105.48	105.74	106.01
106	104.41	104.54	104.68	104.85	105.03	105.23	105.45	105.69	105.95	106.22
108	104.60	104.73	104.87	105.04	105.22	105.43	105.64	105.89	106.15	106.42
110	104.79	104.92	105.07	105.24	105.42	105.63	105.84	106.09	106.36	106.63
112	104.97	105.10	105.26	105.43	105.62	105.83	106.04	106.29	106.56	106.83
114	105.16	105.29	105.45	105.62	105.81	106.02	106.24	106.49	106.76	107.04
116	105.34	105.47	105.64	105.81	106.01	106.22	106.44	106.69	106.96	107.24
118	105.52	105.66	105.83	106.01	106.20	106.41	106.65	106.89	107.16	107.44
120	105.71	105.84	106.02	106.20	106.39	106.60	106.84	107.09	107.36	107.65
122	105.89	106.03	106.21	106.39	106.58	106.80	107.04	107.29	107.56	107.85
124	106.08	106.22	106.40	106.58	106.78	106.99	107.23	107.48	107.76	108.04
126	106.26	106.40	106.58	106.77	106.97	107.18	107.43	107.68	107.96	108.24
128	106.44	106.59	106.77	107.97	107.16	107.38	107.63	107.88	108.16	108.44

SECTION V - SONIC NOZZLE VACUUM PROVING

Description:

These instructions describe how to use sonic nozzles in a procedure in which the air in the meter being proven is at atmospheric pressure. A vacuum is drawn on the nozzle outlet to obtain the flow.

Figure 2 shows the piping arrangement. The nozzle holder is connected directly to the meter outlet. A vacuum blower draws air through the meter and the nozzle.

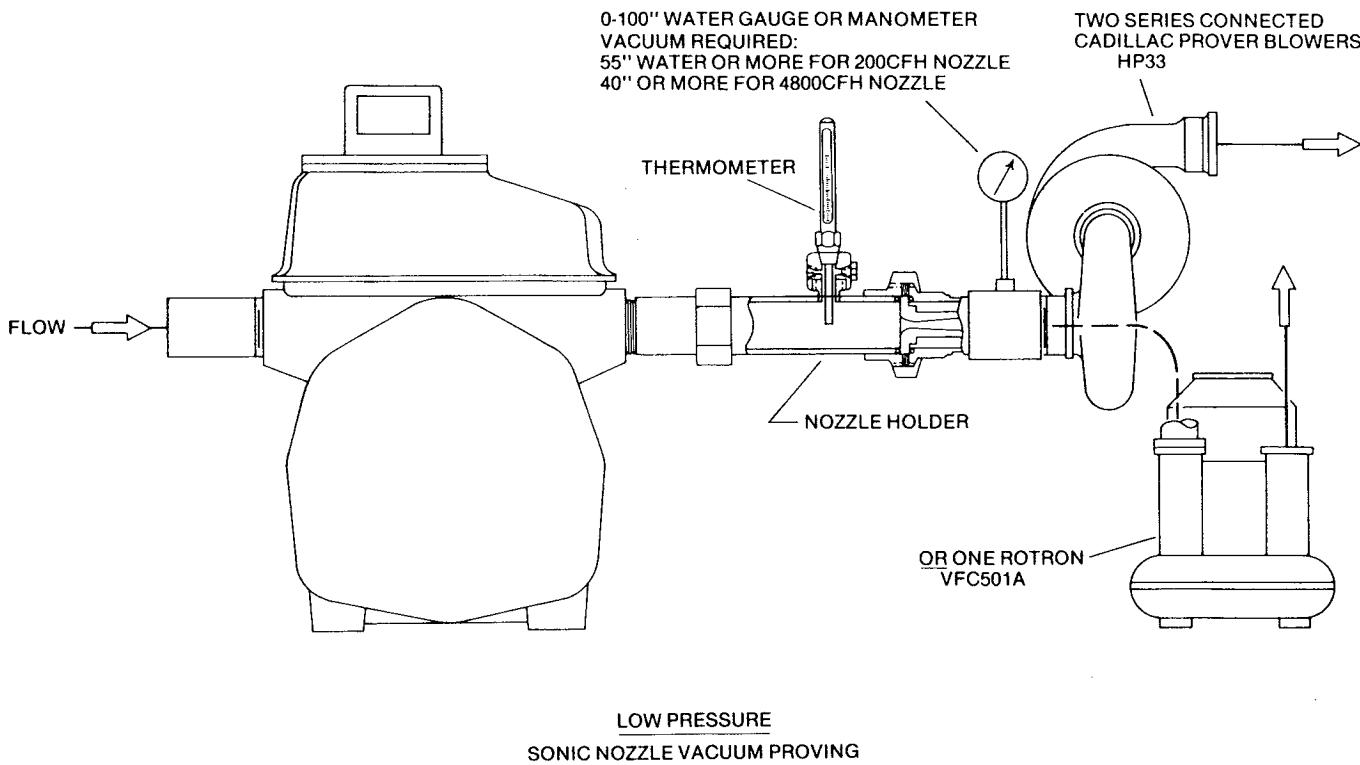


FIGURE 2

WARNING - A meter removed from gas service should be purged or allowed to ventilate before running the proving process.

Vacuum Blowers

Either of the blower systems specified in Figure 2 will sustain sufficient vacuum to guarantee critical flow in the nozzles. A gauge (or manometer) should be connected as shown to monitor this vacuum and to make sure that it is at least as high as specified in Figure 2. The required vacuum is about proportional to nozzle size and ranges from 55 inches of water (4 inches of mercury) for a 200 CFH nozzle to 40 inches of water (3 inches of mercury) for a 4800 CFH nozzle. Of course, a higher vacuum than necessary will not introduce a significant error.

Meter Temperature

The proving method described assumes that there will be no significant temperature difference between the meter and the nozzle. This is usually true of vacuum proving if the flow is allowed to run for a reasonable time prior to the actual test.

The test should not be made until the meter is substantially at ambient temperature. A thermometer may be placed in the meter inlet and if tests must be made under unusual conditions which prevent the meter from assuming ambient temperature, an average of the meter inlet and the prover temperatures can be used to indicate the average meter temperature. If there is an appreciable difference between the prover temperature and the average meter temperature, the correct proof is equal to the proof (obtained from calculations in the form shown on Page 42) multiplied by a factor, $1.000 + 0.0019 (T_M - T_p)$; where T_M is the average meter temperature and T_p is the prover temperature.

Procedure

1. Connect the meter, nozzle holder and blower(s) as shown in Figure 2. Note that no valve is used between the meter and the nozzle holder.
2. Be sure that there are no leaks in that part of the piping which is between the meter outlet and nozzle inlet.
3. Place a nozzle in the holder, start the blower(s), and allow flow to pass until the temperature settles down. The TEST TEMPERATURE ($^{\circ}$ F) is the average of several temperature readings taken during a test run. However, the maximum difference between the readings should not be more than 1° F.
4. Using a stopwatch, carefully determine and record the TEST TIME. This is the time interval for a chosen Volume in Cubic Feet to pass through the meter. This is called METER REGISTRATION. Its volume must be large enough for the TEST TIME to be over 100 seconds.

The timing can be done by watching the meter index. Indexes with sweep hands are particularly convenient. In some cases more accuracy is obtained by removing the meter index and attaching a simple pointer (piece of wire etc.) to the meter wriggler and timing this as it passes a reference point attached to the meter body. The cubic foot value of a wriggler rotation is given in the meter manufacturer's literature.

5. Using the TEST TEMPERATURE from Step 3, calculate the nozzle factor. The nozzle factor is calculated from the T_S stamped on the nozzle and the test temperature as follows:

$$\text{Nozzle Factor} = \frac{.04385V}{T_S} \sqrt{\text{Test Temperature } ^{\circ}\text{F} + 460}$$

6. Estimate or measure the relative humidity (RH) of the air entering the meter. This does not have to be a highly accurate figure. However, one should distinguish between relatively dry conditions such as inside heated air in winter, etc. and humid summer air. In the first case, one can use 30% RH, in the latter 80% RH, without encountering a large proof error.
7. Calculate the meter proof from:

$$\% \text{ Proof} = \frac{\text{Test Time (Secs)}}{\text{Meter Reg. (CF)}} \times \text{Nozzle Factor} \times \text{Humidity Factor} \times 100$$

$$\text{The accuracy is: } \% \text{ Accuracy} = \frac{100}{\% \text{ Proof}} \times 100$$

Temperature Compensated Meters

On a TC Meter the proof as determined above is the "Apparent Proof".

The Base Temperature Proof is obtained by multiplying the Apparent Proof by the following:

$$\frac{\text{Temperature Base } (^{\circ}\text{F}) + 460}{\text{Test Temperature } (^{\circ}\text{F}) + 460}$$

Example:

A test on a temperature compensated meter gave the following results:

Test Time	=	189.8 sec.
Meter Registration	=	10.0 CF
Test Temperature	=	70°F
Relative Humidity (Estim.)	=	30%
Nozzle Calibration (T_S)	=	18.53

From .04385 $\frac{\text{Test Temperature} + 460}{T_S}$ we find the Nozzle Factor = .05448

From the Test Temperature and the Relative Humidity, we find the Humidity Factor for air from Humidity Factor Table below.

Then: % Apparent Proof = $\frac{189.8}{10} \times .05448 \times 1.0014 \times 100 = 103.5$

60°F Base Temperature Proof = $103.5 \times \frac{520}{530} = 101.6$

TABLE 8
HUMIDITY FACTOR

Air Temp. °F	Relative Humidity									
	10	20	30	40	50	60	70	80	90	
40	1.0000	1.0000	1.0005	1.0006	1.0008	1.0009	1.0011	1.0012	1.0014	
50	1.0000	1.0005	1.0007	1.0009	1.0011	1.0014	1.0016	1.0018	1.0021	
60	1.0000	1.0007	1.0010	1.0013	1.0016	1.0020	1.0023	1.0026	1.0030	
70	1.0005	1.0009	1.0014	1.0019	1.0023	1.0028	1.0033	1.0037	1.0042	
80	1.0007	1.0013	1.0020	1.0026	1.0033	1.0039	1.0046	1.0052	1.0059	
90	1.0009	1.0018	1.0027	1.0036	1.0045	1.0054	1.0063	1.0073	1.0082	
100	1.0012	1.0024	1.0037	1.0049	1.0061	1.0073	1.0087	1.0099	1.0111	

NOTE: American Meter does not recommend air vacuum proving if the temperature is above 100°F or the relative humidity is over 90%.



**AMERICAN
METER COMPANY**

Measurement Engineers Since 1836

AMERICAN METER

13500 Philmont Avenue
Philadelphia, PA 19116
Tel: 215-673-2100 Telex: 83-4625

CANADIAN METER

3037 Derry Rd., West
Milton, Ontario L9T 2X6
Tel: 416-878-2361 Telex: 0696-1430

IGR INTERNATIONAL GAS APPARATUS

Glebeland Road, York Industrial Estate
Camberley, Surrey, England, GU15 3EX
Tel: 0276-20036 Telex: 851-858432