DEPARTMENT OF COMMERCE AND LABOR

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 32

STATE AND MUNICIPAL REGULATIONS FOR THE QUALITY, DISTRIBUTION, AND TESTING OF ILLUMINATING GAS

[1st Edition]
Issued April 1, 1912

WASHINGTON
GOVERNMENT PRINTING OFFICE
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INTRODUCTION

OBJECT AND SCOPE OF THIS CIRCULAR

As an outgrowth of an investigation of the methods and standards employed in gas photometry and in gas calorimetry, the Bureau of Standards, two years ago, began a study of the methods employed at the present time in this country in the official inspection and testing of illuminating gas.

Although it can not be expected that methods employed in testing gas will ever be entirely uniform throughout the country, it was believed that if the results of a thorough study of the subject were published greater uniformity of method and in some cases more accurate measurements would result.

This study has in no way concerned itself with the financial regulation of gas companies; nor has it included any consideration of the comparative value of various methods employed in works management. It deals rather with methods of testing and the properties and constants of the materials and apparatus used. We have gone outside this field of study only so far as is essential to an intelligent understanding of those points with which we are more immediately concerned.

A study of the laboratory and field methods to be used in the testing of gas and the inspection of gas service has necessitated a preliminary investigation of legal requirements, particularly of those concerning the testing and inspection service. The results of this study, which are presented in this circular, have furnished much information of value and have led to some important conclusions as to the desirability of certain regulations. A circular on the chemical testing of gas and the measurement of the candlepower and heating value will be issued later.

The attitude of the Bureau is entirely advisory, and its intention is only to place in the hands of the technical and general public an impartial and, as nearly as may be, accurate summary of the facts which must be considered in connection with the inspection and testing of the quality and distribution of illuminating gas.

The subject matter of this circular applies in general to coal gas,[1] carburetted water gas, by-product gas, and their mixtures. There is no

[1] Gas made by the Lowe oil-gas process may be regarded as water gas except in discussion of candlepower, in which respect it is perhaps more like coal gas. All references to water gas and oil gas made in this circular include only carburetted water gas and Lowe oil-gas, respectively.

special distinction made between methods which are desirable for privately operated companies and those under municipal ownership and management since all apply to each case equally well.

The material is arranged as follows:

Part I gives a summary of the municipal gas ordinances now operative, presents a general discussion of municipal gas requirements and proposes an ordinance which has been prepared as a compilation of the best ordinance requirements now in force, as determined by consultation with a considerable number of well-known gas engineers and inspectors.

Part II deals similarly with State control of gas questions and proposes technical rules prepared in the same way as the proposed ordinance of Part I.

Part III quotes a few of the ordinances now in force in this country, selected as representative of recently enacted ordinances, and gives all portions of the State gas laws now in force which are of any considerable importance to the subjects considered in this circular.

The detailed directions for all the methods which would be required in the enforcement of the provisions of Parts I,C and II,C would make practically a textbook of gas testing and inspection. It is planned that at a later date such material shall be compiled and published by the Bureau, but at the present time our investigations on these subjects would not warrant such publication.

The Bureau will at all times appreciate any cooperation or criticism from gas engineers, inspectors, or other gas experts, which may enable it to make a more complete and accurate statement regarding any phase of the subject. It is especially desired to have suggestions as to those phases of the subject which are incompletely treated, in order that in later issues the usefulness of this circular as an authoritative publication may be increased.

Such revision will be made not only to increase the accuracy and scope of this circular, but also to revise the recommendations as to the requirements, since the requirements suitable for present conditions may be very different from those needed in the future under different conditions of fuel supply or with different methods of gas manufacture.

It is not necessary to discuss here the desirability of laws or ordinances controlling gas companies, but it is proper to emphasize the fact that the value of such legislation is not wholly to the public. There is no doubt that the public can be and is protected by the existence and observance of such laws, and that the advantage to the public is in proportion to such protection. However, in proportion to the benefit thus gained by the consumer should also be the gain to the company, since one of the essentials of success for a public-service corporation is public confidence, and by no other means can it so surely gain this as by a feeling of security on the part of the public itself. On this basis any equitable law and its enforcement should be welcome to the company as an aid in the maintenance of a proper relation between it and the public.

A further advantage to the gas company of such public confidence is the prevention of the passage of laws and ordinances which are unfair to the company, or the enforcement of laws in such a way as to be unjust to the manufacturer. The members of State legislatures and city councils are not usually technically trained men and are necessarily dependent upon information gathered by others. Hence it is important that reliable and carefully collated information should be made available to State and city officials who are called upon either as legislators to formulate laws or municipal ordinances, or as executives to carry out existing regulations. We trust that these results of a careful study of existing laws and the conditions under which gas is made and distributed will be of benefit both to gas manufacturers and to the general public.

S. W. Stratton, *Director.*

PART I.—MUNICIPAL GAS ORDINANCES

A. SUMMARY OF REQUIREMENTS NOW IN FORCE

The following compilation of gas-ordinance requirements is a practically complete tabulation of the municipal provisions made previous to 1911 in the cities of this country larger than 25 000 population (census 1910) relative to the candlepower, heating value, purity, and pressure of gas, the accuracy of gas meters, and the methods of enforcement or inspection provided. In addition to the data given for these larger cities, there are included at the end of the tables a considerable number of facts for smaller places. For the collection of these data the following inquiry contained in a circular letter, together with blank form, were sent to the city clerk of each city:

The Bureau of Standards is making a compilation of the laws and ordinances which relate to illuminating gas. We desire to obtain from your office a complete, certified copy of all such laws, rules, and ordinances as are now in force or soon to become operative in your city concerning the manufacture and distribution of illuminating gas, its inspection and testing, and the testing of gas meters. In addition to such regulatory ordinances, we desire a copy of any ordinances granting a franchise to a gas company.

Please fill out the inclosed form and return it to us with the copy of the ordinances above requested. When no requirement is made in your city, please specify "none." Your reply will be of value even if you are able to make only negative answers, since such are as important as others in making up summaries.

GAS-INSPECTION DATA

Date.....1910.

City of.....State of.....

Name of gas company.....

.....

The legal requirements or rules now in force demand that:

1. Candlepower shall be.....
   The standard specified is: Candles or Pentane lamp, or.....
2. Heating value shall be.....
   The apparatus specified for the test is .....
3. Pressure of gas, tested at.....shall
   (*a*) Not be greater than.....
   (*b*) Not be less than.....
   (*c*) Not vary more than.....during.....
4. Purity of the gas.....
   .....
   (*a*) Hydrogen sulphide (sulphuretted hydrogen).....
   .....
   (*b*) Total sulphur.....
   (*c*) Ammonia.....
   (*d*) Other impurities.....
   .....

The legal requirements or rules, etc.—Continued.

5. Gas meters (*a*) shall be correct within.....
   (*b*) Shall be tested (how often).....
   (By whom).....
6. Price of gas.....
7. Miscellaneous requirements.....
   .....
   .....
8. The testing shall be done by (Official title).....
   (Name)..... (Address).....
9. Are there any State or county laws or officers controlling the testing in your city? .....
   If so, who and what? .....
   .....
   .....
10. Is there any legislation now pending? .....
    If so, what? .....
    .....
    .....
11. Is any investigation of gas inspection now in progress? .....
    If so, what? .....
    .....
    .....
12. Are there any legal disputes on this subject now in the courts? .....
    If so, what? .....
    .....
    .....

Name.....
Title.....
(Official signature.)

From the 228 cities in the United States which exceed 25 000 in population practically complete information has been collected. Of these cities 60 have more or less complete municipal requirements as to candlepower, heating value, purity or pressure of the gas, or the testing of gas meters, 103 are under State laws on these subjects and have no additional municipal regulations, 7 are supplied with natural gas only, 47 have no requirements on the subjects considered, 3 have no such requirements, but these matters are at present under investigation or subjects of legal controversy, and from 8 cities the information furnished is so incomplete as to prevent classification.

The 60 cities which have gas regulations now in force are given below. The numbers following the name of the city indicate what requirements are in force and refer to the tables of this section, these being numbered 1 to 6, referring, respectively, to candlepower, heating value, purity, pressure, meter testing, and inspection official. Those cities marked "G" have only a general statement as to gas quality and make no specific requirements, and those cities marked thus "*" are under State laws, but have also a few special local provisions.

Aurora, Ill.....1, 2, 5, 6
Baltimore, Md.....1, 5, *
Bay City, Mich.....1, 4, 5, 6
Birmingham, Ala.....1, 2, 3, 4, 5, 6
Buffalo, N. Y.....1, 3, 6, *
Cedar Rapids, Iowa.....1, 2, 3, 5, 6
Chicago, Ill.....1, 2, 3, 4, 5, 6
Council Bluffs, Iowa.....1, 4
Danville, Ill.....5, 6
Decatur, Ill.....G
Des Moines, Iowa.....1
Detroit, Mich.....1, 2, 3, 4, 5, 6
East St. Louis, Ill.....1, 3, 5, 6
Elgin, Ill.....1, 2, 4, 5, 6
El Paso, Tex.....1, 3, 5, 6
Erie, Pa.....5, 6
Fort Wayne, Ind.....1, 2, 4, 5
Grand Rapids, Mich.....1, 4, 5
Houston, Tex.....1
Indianapolis, Ind.....1, 2, 5, 6
Jackson, Mich.....1, 2, 4, 5, 6
Joilet, Ill.....1, 2, 5, 6
Joplin, Mo.....1
Kalamazoo, Mich.....1, 2, 4, 5, 6
Kansas City, Mo.....1, 4, 5, 6
Knoxville, Tenn.....1, 5, 6
Lansing, Mich.....1, 2, 4, 5, 6
Lincoln, Nebr.....1, 2, 3, 4, 5, 6
Little Rock, Ark.....3
Los Angeles, Cal.....1, 2, 3, 4, 5, 6, *
Louisville, Ky.....1, 4, 5, 6
Memphis, Tenn.....1, 4, 5, 6
Milwaukee, Wis.....2, *
Minneapolis, Minn.....1, 2, 3, 4, 5, 6
Montgomery, Ala.....G
Nashville, Tenn.....1, 5, 6
New York, N. Y.....1, 3, 4, 5, *
Oakland, Cal.....1, 2, *
Omaha, Nebr.....1, 2, 3, 4, 5, 6
Pasadena, Cal.....1, 3, 4, 5, 6
Pawtucket, R. I.....1, 3, 6
Peoria, Ill.....1
Philadelphia, Pa.....1, 5, 6
Pittsburgh, Pa.....1, 3, 5, 6
Providence, R. I.....1
Pueblo, Colo.....1, 4
Rochester, N. Y.....1, 3
St. Louis, Mo.....1, 3, 5, 6
St. Paul, Minn.....1, 5
Salt Lake City, Utah.....G
San Francisco, Cal.....1, 2, 3, 5, *
Scranton, Pa.....5, 6
South Bend, Ind.....5
Springfield, Ill.....1, 2, 3, 4, 5, 6
Springfield, Mo.....1
Syracuse, N. Y.....1, 3, 4, 5, 6, *
Tampa, Fla.....1
Washington, D. C.....1, 3, 5, 6
Waterloo, Iowa.....1, 5
Wilmington, Del.....1, 5, 6

In 15 States[2] the municipal gas regulations have been practically superseded by State laws. These States and the number of cities over 25 000 thus affected are as follows:

State	Affected only by State law	Under additional municipal regulations
Connecticut	7	.....
Georgia	4	.....
Kansas[3]	3	.....
Maryland	0	1
Massachusetts	25	.....
Nevada	0	.....
New Hampshire	2	.....
New Jersey	14	.....
New York	17	4
Ohio	14	.....
Oklahoma	2	.....
Vermont	0	.....
Virginia	5	.....
Washington	3	.....
Wisconsin[4]	7	1
Total	103	6

[2] California railroad commission has just been given authority over gas matters.
[3] The Kansas Public Service Commission does not have authority over companies operating wholly within one city.
[4] Superior, Wis., though affected only by State regulations, does a certain amount of meter testing under city authority.

The cities thus affected in which municipal regulations are not completely eliminated are as follows: New York, Buffalo, Rochester, and Syracuse, N. Y.; Milwaukee, Wis.; and Baltimore, Md. These cities are affected by the State laws, but have additional requirements which are listed among the others in the tables which follow.

In the following seven cities only natural gas is supplied: Covington, Ky.; Dallas, Tex.; Lexington, Ky.; New Castle, Pa.; Newport, Ky.; St. Joseph, Mo.; Shreveport, La.

The following cities have no gas regulations on the subjects considered in this circular. In a few cases no illuminating gas is distributed:

Allentown, Pa.
Altoona, Pa.
Austin, Tex.
Battle Creek, Mich.
Berkeley, Cal.
Butte, Mont.
Charleston, S. C.
Charlotte, N. C.
Chattanooga, Tenn.
Chester, Pa.
Colorado Springs, Colo.
Columbia, S. C.
Davenport, Iowa.
Denver, Colo.
Dubuque, Iowa.
Duluth, Minn.
Easton, Pa.
Evansville, Ind.
Flint, Mich.
Galveston, Tex.
Harrisburg, Pa.
Hazelton, Pa.
Jacksonville, Fla.
Johnstown, Pa.
Lancaster, Pa.
Lewiston, Me.
McKeesport, Pa.
Mobile, Ala.
New Orleans, La.
Newport, R. I.
Norristown, Pa.
Ogden, Utah.
Portland, Me.
Portland, Oreg.
Reading, Pa.
Sacramento, Cal.
San Antonio, Tex.
San Diego, Cal.
San Jose, Cal.
South Omaha, Neb.[5]
Terre Haute, Ind.
Warwick, R. I.
Wheeling, W. Va.
Wilkes-Barre, Pa.
Williamsport, Pa.
Wilmington, N. C.
York, Pa.

In the following cities there are no gas regulations, but these matters are now subjects of legal controversy or of special investigation: Bloomington, Ill.; Quincy, Ill.; Rockford, Ill.

The data available from the following cities are so incomplete as to prevent classification: Clinton, Iowa; Fort Worth, Tex.; Huntington, W. Va.; Saginaw, Mich.; Shenandoah, Pa.; Sioux City, Iowa; Waco, Tex.; Woonsocket, R. I.

The following six tables give a tabulation of the important municipal requirements of all cities over 25 000 in population and some further data regarding a number of smaller cities. Only the few cities named in the preceding paragraph are omitted from the compilation.

In these tables all statute requirements are indicated whether or not they are actively enforced.

[5] South Omaha furnished with gas from the Omaha company, but not under ordinances of Omaha.

TABLE 1

Candlepower Requirements

The data of the ensuing table are arranged as follows: (1) The nominal value of the candlepower required; (2) standard of reference, when such standard is stated in the law or is directly implied therein (in cases of uncertainty no standard is quoted in the table); (3) burner specified for use in testing gas; (4) form of photometer required to be used for the determination; (5) frequency which is specified for the official test (the values given are minimum frequencies); (6) cities which fix the rate of burning of gas during test, indicated thus (*) (the rate in each case is 5 cubic feet per hour); (7) miscellaneous specifications of special interest relative to this test and a statement of the kind of gas distributed under this law. (The kind of gas is, of course, not indicated in the law.)

IN CITIES OVER 25 000 IN POPULATION

City	Candle-power required	Standard specified	Burner specified	Photometer specified	Frequency of test	Specify rate of burning	Remarks
Aurora, Ill.	16			Standard bar, furnished by company.	Time to time		Mixed gas.
Baltimore, Md.	20						Mixed gas.
Bay City, Mich.	18	Standard sperm candles.	Lava-tipped Bunsen argand.		Daily by company	(*)	Penalty only on monthly average. Coal gas.
Birmingham, Ala.	15	Sperm candles	Self-luminous, best adapted.		Daily and repeat twice if <15 cp.	(*)	Mixed gas.
Buffalo, N. Y.	Not specified.				Semimonthly		Required for gas used by city. Coal gas.
Cedar Rapids, Iowa.	16	English sperm candles.					Mixed gas.
Chicago, Ill.	22	Pentane lamp standardized with standard English sperm candles.	Bray No. 7 slit union	100-inch standard bar.	Daily		<0.12% CO_2 in air of room at time of test. Mixed gas.
Council Bluffs, Iowa	22						Water gas.
Des Moines, Iowa.	22						Water gas.
Detroit, Mich.	18	Sperm candles	Lava-tipped Bunsen argand.		Daily	(*)	Mixed gas.
East St. Louis, Ill.	20	Candles		Standard			Water gas.
Elgin, Ill.	16						Average of 3 months. Mixed gas.
El Paso, Tex.	16						Mixed gas.
Fort Wayne, Ind.	18						Mixed gas.

Grand Rapids, Mich	18				Time to time		Mixed gas.
Houston, Tex	18						Water gas.
Indianapolis, Ind	Not specified.						City reserves right to test. Mixed gas.
Jackson, Mich	20 if water gas; 16 if coal gas.				At request of council		Mixed gas.
Joilet, Ill	16			Standard bar			Penalty after 24-hour notice. Mixed gas.
Joplin, Mo	14	Standard candles		Jet			
Kalamazoo, Mich	18	Sperm candles	Lava-tipped Bunsen argand.		Three times per week	(*)	Pressure at burner $\frac{7}{10}$ inch. Coal gas.
Kansas City, Mo	22	Standard sperm candles.		100-inch bar	Daily	(*)	Mixed gas.
Knoxville, Tenn	15						Mixed gas.
Lansing, Mich	18	"Usual"			City tests on complaint		Mixed gas.
Lincoln, Nebr	18						Water gas.
Los Angeles, Cal	18	Standard sperm candles.	Self-luminous, best adapted.		Daily, but twice repeated if <15 cp.	(*)	Oil gas.
Louisville, Ky	18	Sperm candles					Mixed gas.
Memphis, Tenn	20			Bar			Water gas.
Minneapolis, Minn	18	Pentane lamp with Bureau of Standards certificate.	Open-flame, lava-tipped.	Standard bar	Twice daily	(*)	See ordinance (p. 100). Mixed gas.
Nashville, Tenn	15	Standard sperm candles.					City reserves right to test. Mixed gas.
New York, N. Y	22	Sperm candles			Daily	(*)	Special rules. Mixed gas.
Oakland, Cal	20	Hefner		Bunsen with Lummer-Brodhum head.			Ruling of city electrical department. Oil gas.
Omaha, Nebr	23 at works; 21.2 at station; 18 if coal gas.	Standard sperm candles.	Lava-tipped, open-flame, etc.		Weekly	(*)	See ordinance (p. 114). Water gas.
Pasadena, Cal	16	Sperm candles			Monthly		Oil gas.
Pawtucket, R. I	16	Standard English candles.	Best adapted	Disk		(*)	Mixed gas.
Peoria, Ill	16						Mixed gas.
Philadelphia, Pa	22				Daily		Mixed gas.

TABLE 1—Continued

Candlepower Requirements—Continued

IN CITIES OVER 25 000 IN POPULATION—Continued

City	Candlepower required	Standard specified	Burner specified	Photometer specified	Frequency of test	Specify rate of burning	Remarks
Pittsburgh, Pa	15	Standard candles	Argand described		Trimonthly	(*)	Allegheny County law. Mixed gas.
Providence, R. I	Same as at time of franchise, i. e., 19.5						Mixed gas.
Pueblo, Colo	16						Mixed gas.
Rochester, N. Y	20						18 regular by commission rules. Mixed gas.
St. Louis, Mo	18	English sperm candles.	Argand	Standard Bunsen	Daily	(*)	Define condition of test. Mixed gas.
St. Paul, Minn	16 if coal gas; 22 if water gas.						At 1½ miles from holders. Mixed gas.
San Francisco, Cal	19	Candles					Oil gas.
Springfield, Ill	18			60-inch Bunsen bar			Mixed gas.
Springfield, Mo	18 if coal gas; 22 if water gas.						Mixed gas.
Syracuse, N. Y	18	Sperm candles	Argand F or Bray No. 7 slit union.		Weekly	(*)	Test at 1½ miles from holders. Mixed gas.
Tampa, Fla	20						Water gas.
Washington, D. C	22		Bray No. 7 slit union	Bunsen		(*)	Mixed gas.
Waterloo, Iowa	16	Sperm candles		Company must provide	Upon complaint, by expert.		Cost of test by loser. Mixed gas.
Wilmington, Del	Not specified.				Daily		Water gas.

Boone, Iowa	22						Required for gas used by city. Water gas.
Carthage, Mo	22 if water gas; 18 if coal gas.						
Cheyenne, Wyo	16						Coal gas.
Columbus, Ind	16						Mixed gas.
Elkhart, Ind	18						Mixed gas.
Escanaba, Mich	35						Oil gas.
Freeport, Ill	16				Daily		City may, but company must test. Mixed gas.
Great Falls, Mont	15	Candles					At 1 mile from works. Coal gas.
Hammond, Ind	20						Mixed gas.
Helena, Mont	14	Candles	Open flame	Weber			Mixed gas.
Ironwood, Mich	16	Candles					Water gas.
Ishpeming, Mich	16						Coal gas.
Jackson, Mich	16						Mixed gas.
Jefferson City, Mo	18						Water gas.
Kankakee, Ill	18						Coal gas.
Lincoln, R. I	16	English candles		Disk			Mixed gas.
Manistee, Mich	20						Water gas.
Menominee, Mich	16						Coal gas.
Ottawa, Ill	17						Mixed gas.
Phoenix, Ariz	27						Oil gas.
Port Huron, Mich	16		Bray No. 7 slit union				Coal gas.
Richmond, Ind	15						Water gas.
Roswell, N. Mex	18						Oil gas.
St. Cloud, Minn	14						Coal gas.
Sault Ste. Marie, Mich.	18		Standard			(*)	Coal gas.
Sedalia, Mo	18						Coal gas.
Stillwater, Minn	14					(*)	Coal gas.
Stockton, Cal	18						Oil gas.
Waukegan, Ill	20	Candles					Mixed gas.

TABLE 2

Heating Value Requirements

The data of the table are arranged as follows: (1) Heating value required, given in British thermal units per cubic foot of gas, unless otherwise stated; (2) the calorimeter specified for test, "Standard" meaning in general, "any standard instrument;" (3) frequency which is set for the determination; (4) miscellaneous specifications.

CITIES OVER 25 000 IN POPULATION

City	Heating value required (in B t u unless labeled)	Instrument specified for test	Frequency of test	Miscellaneous
Aurora, Ill	600 "Heat units" gross			
Birmingham, Ala	575 gross		Daily with 2 extra if <575.	Define conditions of test.
Cedar Rapids, Iowa	600			Proposed requirement
Chicago, Ill	600 gross	Standard	Daily	
Detroit, Mich	600 gross	Standard		
Elgin, Ill	600 net			Average of 10 tests made in period of 3 months.
Fort Wayne, Ind	550			
Indianapolis, Ind	600	Standard		
Jackson, Mich	600			
Joilet, Ill	600 "Heat units"		"Time to time"	
Kalamazoo, Mich	600 gross	Standard		
Lansing, Mich	600	Usual	City tests on complaint.	
Lincoln, Nebr	625	Junkers		
Los Angeles, Cal	600 gross		Daily with 2 extra if <600.	Define conditions of test.
Milwaukee, Wis	635 gross			Company agrees to give 635, law requires 600.
Minneapolis, Minn	Monthly average 600 gross; daily minimum 550.		Twice daily	Discount in gas price if less than 600 monthly average.
Oakland, Cal	600	Junkers		Ruling of city electrical department. No ordinance.
Omaha, Nebr	600 net	Junkers	Weekly	Penalty on monthly average. Test at 1½ miles from works.
San Francisco, Cal	600			
Springfield, Ill	650			

PARTIAL LIST OF CITIES SMALLER THAN 25 000 IN POPULATION

Adrian, Mich	"Average of" 600			
Elkhart, Ind	600			
Elyria, Ohio	600 "Heat units"			
Freeport, Ill	Monthly average, 600; minimum, 550.			
Helena, Mont	500			
Kankakee, Ill	600 "Heat units"			
Ottawa, Ill	600			
Port Huron, Mich	600 gross			
Sault Ste. Marie, Mich	500			
Stockton, Cal	600			

TABLE 3

Purity (Chemical Requirements)

The table of data on this portion of the subject is arranged as follows: (1) Cities making specifications limiting or forbidding hydrogen sulphide, with the frequency of test specified; (2) cities which give in more or less detail the methods which must be used to determine the presence or absence of this impurity (the extent to which these details are given by each city is discussed on pp. 40-41); (3) maximum amount of sulphur allowed in 100 cubic feet of gas and the frequency of the determination required of company or inspector; (4) similar data regarding ammonia limits; (5) similar data regarding carbon monoxide requirements; (6) miscellaneous specifications regarding purity.

CITIES OVER 25 000 IN POPULATION

City	Hydrogen sulphide must be—	Test is specified for hydrogen sulphide	Sulphur limited to (grains per 100 cu. ft.)—	Ammonia limited to (grains per 100 cu. ft.)—	Carbon monoxide limited to—	Miscellaneous
Birmingham, Ala.	Absent daily...	Implied...	25 daily.....	5 daily.....	25 per cent by volume.	Free from all noxious impurities and those which clog appliances. Two extra tests if first shows failure to comply with law.
Buffalo, N. Y...	.....	.....	Monthly.....	Monthly.....	.....	On gas used by the city.
Cedar Rapids, Iowa.	Absent.....	.....	30	4	.....	
Chicago, Ill.....	Absent daily...	Yes.....	20 weekly.....	5 weekly.....	.....	Specify method for S and NH_3 determination.
Detroit, Mich...	Absent weekly	.....	30	10	.....	Inspector required to make analysis of gas.
East St. Louis, Ill.	Absent.....	Yes.....	20	5	.....	
El Paso, Tex....	.....	.....	.....	.....	.....	Shall be pure and refined gas.
Lincoln, Nebr...	Absent.....	.....	20	10	.....	
Little Rock, Ark.	.....	.....	.....	.....	.....	As free as possible from sulphur and air.
Los Angeles, Cal.	Absent daily...	Implied...	25 daily.....	5 daily.....	25 per cent by volume.	Two extra tests if impurities exceed limits.
Minneapolis, Minn.	Absent daily..	Yes.....	20 in summer, 30 in winter; weekly.	4 weekly.....	.....	All methods of test defined. Daily tests if impurities above limits.
New York, N.Y.	Not more than a trace.	.....	20	5	.....	
Omaha, Nebr...	Absent monthly.	Yes.....	15 monthly....	5 monthly.....	.....	
Pasadena, Cal..	Absent monthly.	.....	20 monthly....	5 monthly.....	25 per cent monthly.	
Pawtucket, R.I.	Absent.....	.....	20	10	.....	Sulphur and ammonia limited on three successive tests.
Pittsburgh, Pa..	.....	.....	.....	.....	.....	Free from sulphur, ammonia, and carbon dioxide.
Rochester, N.Y.	.....	Yes.....	.....	5	.....	

TABLE 3—Continued

Purity (Chemical Requirements)—Continued

CITIES OVER 25 000 IN POPULATION—Continued

City	Hydrogen sulphide must be—	Test is specified for hydrogen sulphide	Sulphur limited to (grains per 100 cu. ft.)—	Ammonia limited to (grains per 100 cu. ft.)—	Carbon monoxide limited to—	Miscellaneous
St. Louis, Mo.	As free from as is practicable.	.....	.....	See margin.	.....	As free from ammonia and carbon dioxide as is possible.
San Francisco, Cal.	Absent.	.....	.....	.....	.....	
Springfield, Ill.	Absent.	.....	15 other than CS_2 and H_2S.	5	.....	No carbon bisulphide or carbon dioxide allowed.
Syracuse, N. Y.	Absent 15 times per year.	Yes.	20, 15 times per year.	10, 15 times per year.	.....	
Washington, D. C.	Absent.	Yes.	20	5	.....	

CITIES UNDER 25 000 IN POPULATION

Adrian, Mich.	.....	Yes.	30	10	.....	.....
Hammond, Ind.	Absent.	Yes.	20	.....	.....	.....
Lincoln, R. I.	Absent.	.....	20	10	.....	.....
Port Huron, Mich.	Absent weekly	.....	30	10	.....	.....
Sault Ste. Marie, Mich.	Absent.	.....	10	.....	.....	.....

TABLE 4

Pressure Regulations

CITIES OVER 25 000 IN POPULATION

City	Gas pressure tested at—	Must not exceed (in inches)—	Must not be less than (in inches)—	Records of test specified	Remarks
Bay City, Mich					Subject to rulings of board of public works.
Birmingham, Ala		9	2	Continuous in each specified district.	"While any appliance is in operation."
Chicago, Ill	Meter inlet		1.5	Continuous	Tests at 3 times as many places as there are regular test stations. Maximum variation allowed, 100 per cent of minimum pressure.
Council Bluffs, Iowa					Require "uniform" pressure.
Detroit, Mich	Meter inlet	4.5	1.5		Daily at each station.
Elgin, Ill	Meter inlet	4.5	1.5		
Fort Wayne, Ind	Consumer's		2.5		
Grand Rapids, Mich	Meter inlet	4.5	1.8		
Jackson, Mich	Meter outlet	4.5	1.5		
Kalamazoo, Mich	Meter inlet	4	2	Weekly	
Kansas City, Mo		4	1.5		Company must put on check burner if >3 inches and regulator if >4 inches.
Lansing, Mich		4.5	1.5		
Lincoln, Nebr		5	1.5	Continuous	
Los Angeles, Cal		9	2	Continuous in each specified district.	"While any appliance is in operation."
Louisville, Ky	City hall laboratory.		2		
Memphis, Tenn		3.5	2		
Minneapolis, Minn	Meter inlet	6 (4 after Jan. 1, 1913.)	2	10 continuous	Not greater than 100 per cent daily variation.
New York, N. Y		2.5	1		Overruled by Supreme Court.
Omaha, Nebr		4.5	2		Ruling of commissioner.
Pasadena, Cal			2		"At an even pressure."
Pueblo, Colo			2.3		
Springfield, Ill	Any burner		2		

PARTIAL LIST OF CITIES UNDER 25 000 IN POPULATION

Adrian, Mich		4.5	1.5	Weekly by company.	
Elkhart, Ind	Company's works.	4	2		
Ottawa, Ill		6	2		
Port Huron, Mich		4.5	1.5	Continuous	
Roswell, N. Mex		6	2		

TABLE 5

Meter Testing Requirements

The more important details of the provisions for the testing of gas meters are tabulated under the following subjects: (1) "All must be tested," referring to cities which require all meters to be inspected before being placed in service and those which specify under certain conditions that all must be so examined; (2) city makes arrangements for testing the meters complained of by the consumers or require that such meters shall be tested by the company; (3) the ordinance requires that the test shall be made by comparison with a meter prover; (4) other tests are required upon all complaint meters, "leak," and "small registration," indicating that these cities require inspector to test for leakage and to prove that the meter will register small quantities of gas; (5) variation from exact registration which is allowed or which is considered in the region "correct;" (6) fee for test—where this fee is indicated as being paid by loser it indicates that the complainant pays unless the meter is fast beyond the allowable limit, in which latter case the fee is paid by the company—(in general, these fees refer to complaint testing, although where the city tests all new and repaired meters the company often is charged a fee for such service); (7) refund period or period on the gas bills of which the company is required to make refund for the overcharge due to a "fast" meter, i. e., the period during which the meter is assumed to have been in the same condition as at the time of test; (8) miscellaneous requirements.

CITIES OVER 25 000 IN POPULATION

City	All must be tested by—	Complaint meters tested by—	Prover test specified	Other tests specified	Variation allowed (per cent)	Fee for complaint tests (paid by and amount)	Refund period	Miscellaneous
Aurora, Ill		City				Loser	90 days	
Baltimore, Md	State	State			±2			One-half of fee to company.
Bay City, Mich		City	(*)			Loser, $1		
Birmingham, Ala	City	do	(*)	Leak, small registration.	±2	do	3 months	Method of test specified. City requires 3 meters with Bureau of Standards certificate for standards.
Cedar Rapids, Iowa	do	do			±2	Loser, $0.50		
Chicago, Ill	do	do	(*)		±2	Loser, $1	6 months	Test at 1.5 inches pressure; 3 meters certified by Bureau of Standards as standards.
Danville, Ill		do			±3	Loser, $0.25		Compare with a "standard meter."
Detroit, Mich		do			±2	Loser, $1		One-half of fee to company.
East St. Louis, Ill		do			±2			
Elgin, Ill		do			±2	Loser, $1	3 months	
El Paso, Tex		City may						
Erie, Pa	City	City	(*)	Leak; small registration.	±1	do		Test every 2 years; 3 meters with Bureau of Standards certificate as standards.
Fort Wayne, Ind		do			±2	do		Fee to company, as it pays fixed monthly fee toward expenses.
Grand Rapids, Mich	City	do	(*)			do		
Indianapolis, Ind	do	do			±2			Optional with city.

TABLE 5—Continued

Meter Testing Requirements—Continued

CITIES OVER 25 000 IN POPULATION—Continued

City	All must be tested by—	Complaint meters tested by—	Prover test specified	Other tests specified	Variation allowed (per cent)	Fee for complaint tests (paid by and amount)	Refund period	Miscellaneous
Jackson, Mich	City	City			±2	Loser, $1	One-half bill since last test.	Ordinance not enforced.
Joliet, Ill		do				Loser, cost	30 days	
Kalamazoo, Mich	City	do			±2	Loser, $1	3 months.	Refund on half of bills for past 3 months.
Kansas City, Mo	do	do	(*)		±2	do	3 months.	Fee to company unless fast; company pays general inspection expense.
Knoxville, Tenn		do			±2	$0.25 and cost of removal.		Ordinance; but not enforced.
Lansing, Mich	City	do			±2	Loser, $1	One-half of all bills since last test.	Fee shared with company.
Lincoln, Nebr					+3 or −2	$1		
Los Angeles, Cal	City	City			+2 or −3	Loser, $0.25 to $3.		Test at 2–9 inches water pressure; method of test defined.
Louisville, Ky		do			+2 or −3			
Memphis, Tenn	City	do			±2			Not oftener than 4 times a year.
Minneapolis, Minn	do	do	(*)	Leak; small registration.	±2	Loser, $1	6 months.	All tested every 3 years; fee for routine test $0.25 from company.
New York, N. Y	State	State	(*)		±2			See State rules.
Omaha, Nebr	City	City	(*)	Leak; small registration.	±2	Loser, $1		
Pasadena, Cal		do			±2	Loser, $2.50, deposit; $1 fee.	3 months.	Method of test defined.
Philadelphia, Pa	City	do				Complainant if not fast, $1.		Company pay fixed sum toward expense of testing.
Pittsburgh, Pa		County						
St. Louis, Mo	City	City			±1	By complainant unless fast, $1.	Last bill.	Meter allowed if 1½ per cent slow, at company's request.

TABLE 5—Continued

Meter Testing Requirements—Continued

CITIES OVER 25 000 IN POPULATION—Continued

City	All must be tested by—	Complaint meters tested by—	Prover test specified	Other tests specified	Variation allowed (per cent)	Fee for complaint tests (paid by and amount)	Refund period	Miscellaneous
St. Paul, Minn	City	City			±2	Applicant, $0. 50		
San Francisco, Cal	do	do			±2			All must be tested under State laws, which see.
Scranton, Pa		do						
South Bend, Ind		do			±2	Loser, $0.50		
Springfield, Ill	City	do			±2			
Washington, D. C	do	do	(*)	Test at 3 rates.	±2 at normal, ±3 at other rates.	Loser, $0.50		
Waterloo, Iowa		Company			+2	Complainant, $1.	3 months.	Fee returned if fast.
Wilmington, Del		City				Loser, $0.50		"United States Standard."

CITIES UNDER 25 000 IN POPULATION

Burlington, Iowa	City	City			±2	Loser, $0.50		
Elkhart, Ind		Company			+2 or −3			By company's sworn inspector.
Elyria, Ohio		City				Loser, $1		$0.50 to company for each.
Fort Madison, Iowa		Company			±2			
Freeport, Ill		City				Loser, cost	90 days	
Hammond, Ind		do						Not enforced.
Helena, Mont	City	do			±2			At wish of city only.
Ironwood, Mich	do	do			±5	Loser, $1		One-half of fee to company.
Manistee, Mich					±2			
Marshalltown, Iowa		Company						
Ottawa, Ill		City						
Palestine, Tex					±2			
Phoenix, Ariz	City	City						Reserves right to test.
Port Huron, Mich	do	do				Loser, $1		All meters tested every 5 years.
Reno, Nev	do	do			±2	Loser, $1.50	3 months.	$0.50 to company for each.
Richmond, Ind		do						
St. Joseph, Mo		do			±2			
Roswell, N. Mex					±2			
Warren, Ohio	City	City			±5			On demand of city.

TABLE 6

Inspection Official

The officers in charge of the inspection work in the following cities and the method of their appointment is indicated in the following table:

Aurora, Ill.	Official designated by the mayor.
Bay City, Mich.	Board of public works.
Birmingham, Ala.	Inspector elected like other city officials.
Buffalo, N. Y.	City chemist, ex officio.
Cedar Rapids, Iowa.	Gas inspector, appointed by mayor; at the present time, plumbing inspector.
Chicago, Ill.	Inspector appointed by mayor; but testers, who do all the inspection work, are appointed under municipal civil-service rules.
Danville, Ill.	City electrician, ex officio.
Detroit, Mich.	Gas analyst and inspector, appointed by the commissioners of public works.
East St. Louis, Ill.	City electrician, ex officio.
Elgin, Ill.	Inspector, appointed by the mayor.
Erie, Pa.	Gas meter inspector, appointed by the mayor.
Fort Wayne, Ind.	Board of public works.
Indianapolis, Ind.	Under board of public works, city chemist.
Jackson, Mich.	Board of public works.
Joilet, Ill.	Plumbing inspector.
Kalamazoo, Mich.	City engineer, ex officio.
Kansas City, Mo.	Inspector, appointed by the mayor.
Knoxville, Tenn.	Inspector of weights, measures, and meters.
Lansing, Mich.	Inspector, appointed by the mayor.
Lincoln, Nebr.	Inspector, under water commissioner.
Los Angeles, Cal.	Inspector, appointed by the mayor.
Louisville, Ky.	City gas inspector.
Memphis, Tenn.	City gas inspector.
Milwaukee, Wis.	City chemist.
Minneapolis, Minn.	Gas inspector, appointed by city council, after examination.
Nashville, Tenn.	City reserves right to appoint.
New York, N. Y.	Bureau of lighting and State officials.
Oakland, Cal.	City electrician, ex officio.
Omaha, Nebr.	City gas commissioner.
Pasadena, Cal.	City health officer.
Pawtucket, R. I.	Inspector, designated by city council.
Philadelphia, Pa.	Bureau of gas.
Pittsburgh, Pa.	Allegheny County gas inspector.
St. Louis, Mo.	Inspector, appointed by city council.
St. Paul, Minn.	City chemist, ex officio.
San Francisco, Cal.	Board of public works and city light and water inspector.
Scranton, Pa.	City meter inspector.
South Bend, Ind.	Board of public safety.
Springfield, Ill.	City gas inspector.
Syracuse, N. Y.	Commissioner of public works under State public-service rules.
Washington, D. C.	Inspector, appointed by Commissioners of the District of Columbia.
Waterloo, Iowa.	Expert called in by city on complaint.
Wilmington, Del.	Plumbing inspector, ex officio.

B. DISCUSSION OF GAS ORDINANCE REQUIREMENTS

The selection of proper gas ordinance requirements must be influenced by two considerations of primary importance: First, what is the desirable condition to be attained, and, second, what is possible from the manufacturing, distributing, or financial standpoint. It is of course, as undesirable to select the most severe condition which any company could meet as to select the least severe condition which the public will tolerate. Such intermediate requirements should be made as represent the best service attainable without undue increase of cost per unit of service. It must be recognized that

increase in cost of manufacture or in cost of distribution must directly affect, sooner or later, the price of gas. A third consideration will sometimes influence the selection of gas requirements, namely, Can the inspection work necessary to insure the enforcement of the requirements be performed at such expense as will not more than overcome the advantage gained by such enforcement? This question arises in small cities and towns.

The following sections are prepared as a discussion of the various phases of municipal gas regulation from three points of view, viz:

(1) Good service to the consumer;

(2) Specifications practicable from the manufacturing, distributing, and financial standpoints;

(3) Inspection sufficient to show whether requirements are met.[5a]

In all cases the opinions and conclusions expressed in these sections are the result of conferences with gas engineers and inspectors who were well qualified to express opinions. A large amount of the information thus collected was given in confidence, and the Bureau is therefore not at liberty to indicate here the sources of its information. In each case, however, care has been exercised to confirm the statements made and to reconcile differences of opinion. Where uncertainty still remains, such fact is indicated in the discussion.

In all cases the use of summarized statistics as the sole basis for a conclusion has been avoided, and the greatest weight has been given to the practical experiences of those active in the manufacture and testing of gas.

Early in the history of gas manufacture rules were adopted for the regulation of the quality of gas and its distribution. The first regulations were very general in character, becoming more specific as knowledge of the subject increased. Even at the present time a considerable number of vague general regulations are in force, some of which might better be replaced by more definite requirements.

Such general specifications are those making requirement of "best quality" or "highest purity" or provision that the quality shall be equal to that in certain other places. The first of these is by far the most frequent; but the uselessness of such regulation is apparent, unless some standard of quality and purity is given. If a recognized standard were established, it would greatly facilitate the preparation of gas ordinances.

The provision that the gas furnished shall be equal in quality to that in other neighboring cities, or in some particular city designated, is scarcely more satisfactory than a provision such as described in the previous paragraph. One city having an ordinance of this type requires the gas to be as good as that furnished in each of three cities, which latter have widely varying conditions and regulations. Just how such provisions could be enforced is not clear. However, within this type is a group of cities which seem well protected by regulations of this form. These cities are supplied with gas from the same distributing system as larger adjacent cities, and thus can depend upon the regulations in force in the large cities for protection.

[5a] The question of cost has been considered only so far as it affects the economic suitability of the various rules. Fixing of such low rates as to prevent good service, even to rather sparsely settled districts, is undesirable.

1. PRINCIPAL KINDS OF ILLUMINATING GAS

Before discussing the gas-ordinance requirements it is desirable to briefly describe the methods of gas manufacture and the advantages of each.

Coal Gas.—Coal gas is the gas resulting from the destructive distillation of a gas coal in externally heated clay retorts. The types of retort settings vary greatly, from the simple horizontal direct-fired bench to the elaborate installations of inclined ovens and vertical retorts, equipped with various kinds of economizers and labor-saving devices.

Only such coals as contain a high percentage of volatile matter and are reasonably free from sulphur are suitable for the production of commercial coal gas, the average yield of gas being from 4.5 to 5.5 cubic feet per pound of coal. The quality of this gas is dependent upon the coal selected and also upon the methods that are employed in its manufacture. Generally speaking, with a given coal, the greater the yield per pound the lower the quality of the gas both in heating value and candlepower. There is, however, no definite method whereby gas of a certain heating value or candlepower may be produced, as the conditions that affect the manufacture of gas from different grades of coal are variable. Among the important factors affecting the quality of the resultant gas are the temperatures of the distilling retorts and the length of time the gas is exposed to these temperatures. The result is an increase or a decrease of the candlepower of the gas by changing the character of the heavy hydrocarbons, those constituents of the gas which produce illumination.

Moreover, the methods adopted in treating the gas after it has been manufactured greatly affect its illuminating quality. The candlepower of the gas obtained from a coal may be increased by limiting the yield per pound. The gas first driven off from the coal is of a higher illuminating value than the average yield, and as the distillation proceeds the resultant gas gradually decreases in illuminating value until that produced at the end of the charge is practically nonluminous and of low heating value. Therefore, to produce a coal gas of an illuminating value higher than the average, it is necessary to reject the gas coming off last. Such a practice, however, means a decrease in the yield and, of course, an increase in the cost of manufacture.

This practice prevails to-day in the manufacture of by-product gas in coke ovens where the ovens are fired with the gas coming off during the latter part of the charge, and the richer portions that come off during the earlier parts of the charge are made available for distribution. But in this method of manufacture the ovens are primarily a coke-producing plant and are operated in a manner best suited for that purpose rather than with the primary object of producing an illuminating gas.

The average heating value of coal gas produced in this country to-day, assuming yields of 5 cubic feet of gas per pound of coal, ranges from 550 to 630 Btu gross. Heating value, like candlepower, is not uniformly produced in the generation of the gas, as the richer gases evolved during the earlier parts of the distillation are considerably higher in heating value than at the

latter part; however, the range in heating value is not as great as the range in candlepower.

In the larger manufacturing plants, where greater yields of gas per pound of coal are obtained, due to more efficient operation, there is a tendency toward a slight reduction both in illuminating and heating value of the "raw" gas. However, this is more than compensated for by a more efficient handling of the gas during condensing, washing, and purification.

Coke-oven gas is a coal gas made in ovens designed primarily for production of a high grade of coke, the gas being considered the by-product. As is above indicated, only the richer portions of this gas are utilized for commercial distribution, and even then the product unless specially enriched is usually inferior in candlepower and heating value to coal gas made in the ordinary process.

Carburetted Water Gas.—Carburetted water gas is formed by action of steam on incandescent coke or anthracite coal, with enrichment by the addition of an oil gas simultaneously generated.

The manufacture of carburetted water gas in the United States has reached such proportions that from 60–70 per cent of the total quantity of illuminating gas is now made by this process. The reasons for this remarkable development will be apparent from the advantages explained below.

The generation of carburetted water gas takes place in cylindrical steel chambers, lined with fire brick and internally heated by the partial combustion of the coal or coke. Straight water gas, or "blue gas," as it is sometimes called, is first made; this consists, theoretically, of equal volumes of hydrogen and carbon monoxide, but in practice the quantity of carbon monoxide is usually appreciably lower than this, depending upon the quantity of carbon dioxide formed. The enrichment of this straight water gas is necessary, as it is not suitable for commercial distribution, being a nonluminous, nonodorous gas of relatively low heating value, averaging about 300 British thermal units per cubic foot.

The illuminating and heating value are increased by enrichment with oil gas, and the gas is given a strong pungent odor. The illuminating and heating value of the enriched gas depend upon the quantity and grade of oil used and upon the degree of efficiency attained in gasifying this oil. The carburetting process, however, should be carried on only between certain limits, determined by the commercial practicability of manufacture. In the average operating conditions in the United States from 3½ to 5 gallons of oil are employed per thousand feet of gas made, producing illuminating values, when measured on the distribution system, of from 15 to 24 candlepower. Such a gas should have a gross heating value ranging from 500 to 650 British thermal units per cubic foot. As the illuminating value of the gas is dependent on the efficiency obtained in gasifying the oil, it will be seen that, on the average, from 5 to 6 candlepower can be produced for each gallon of oil used per thousand cubic feet of gas made. It is evident, therefore, that both the illuminating value and the heating value will be increased by increasing the quantity of oil used for carburetting.

The differences in oil efficiency are due to the methods and temperatures employed in gasifying the oil, which are not at all times controllable. High oil efficiencies seem to coincide with the formation of a relatively greater quantity of benzol vapors which give a higher candlepower to the gas than do corresponding percentages of other illuminants. As the benzol and its homologues thus formed are in the gas in the form of a vapor instead of in the form of a fixed gas, they are rightly called "unfixed illuminants;" they represent a part of the gaseous mixture that is not permanent under all conditions and, to a greater or lesser extent, are deposited in the gas works and distribution system when unusually high pressures or low temperatures are encountered. The loss in candlepower experienced in distribution is due to the deposition of these unfixed illuminants.

The heating value of the gas is also raised as the quantity of oil used for enrichment is increased, but not in the same ratio as the illuminating value; and the deposition of the unfixed illuminants affects the heating value of the gas, but no definite figures are available to show just what is the extent of this loss. It is generally conceded that the loss in heating value is very much less proportionally than the loss in illuminating value, especially when the gas contains any appreciable quantity of benzol and its homologues, as these vapors contribute considerably more to illuminating value than they do to heating value.

Mixed Gas.—Mixed gas is usually understood to be a mixture of carburetted water gas and coal or coke oven gas. It is supplied in many cities in the United States where the requirements permit of a mixed gas being supplied.

The manufacturing installation for mixed gas is practically two complete installations, one for coal gas and one for carburetted water gas, with their auxiliary scrubbing, condensing, purifying, and metering apparatus entirely independent and separate. The manufactured mixed gas, however, is stored in common holders and delivered through a single distribution system.

Advantages of Each Kind of Gas.—The advantages of coal, water, and mixed gas must be considered primarily from the economic or manufacturing standpoint, since the advantages of each to the user are in most cases only the indirect result of the economy of manufacture.

Coal gas finds its greatest advantage over water gas in the sale of its by-products, namely, coke, tar, ammonia, and occasionally cyanide. Under favorable conditions these return to the manufacturer a large percentage of the cost of the gas manufactured; and, indeed, unless the by-products are intelligently and economically handled and unless a favorable market for them is available, coal gas cannot be made at sufficiently low net cost to allow it to compete with water gas. The greatest difficulty in extension of large coal-gas works is the lack of a suitable outlet for the coke, as the coke produced is ordinarily not suitable for foundry or metallurgical purposes. The demand for coke for domestic consumption may often be increased by active advertisement, but in some cases this automatically reduces the use

of gas for heating and industrial work. This result is, of course, not desired by the gas maker. In distribution, coal gas can be subjected to pressure and low temperature with less loss of heating and lighting value than water gas. Because of this and the greater uniformity of its manufacture, the product delivered to a consumer is at times more uniform in the case of coal gas. This is a large factor in determining satisfaction in the operation of gas appliances. The advantage of the less toxic character of coal gas is discussed later.

The remarkable increase in the manufacture of water gas has been due, in part at least, to the following factors: The abundant production of anthracite coal at reasonable price (in certain parts of the country); the low price of the gas oils (the oil now used for gas making is utilized for practically no other purposes); the ability to make economically a gas of high candlepower to meet municipal requirements and popular demand (both of these no longer so prominent, due to increased emphasis upon heating value); the lower investment required for manufacturing plant (approximately only one-half that for coal gas); greater flexibility of operation from hour to hour or day to day (allowing rapid change in rate of manufacture to meet the changes in demand); freedom from labor difficulties, due to smaller number of men required to operate a water-gas plant; and, perhaps most important of all, no difficulty is met in the disposal of the by-products which are produced in much smaller quantity than in a coal-gas plant. No coke is made; much less tar is formed than in the case of coal gas, and this is often burned under the boilers; and practically no ammonia need be cared for.

All of the advantages of mixed gas would also be influential in increasing the amount of water gas made. The advantages of mixed gas are as follows The coke made in the coal gas works can be used to make water gas; the candlepower of the mixture can be economically raised by the use of high candlepower water gas; the more stable character of the coal gas permits distribution of the mixed gas without undue loss of the illuminants; the coal gas is usually somewhat cheaper when uniform rate of make and a good coke outlet are assured, the water gas part taking care of variations in demand and utilizing surplus coke. The relative amounts of coal and water gas in a mixture are determined by a large number of local factors, but mixed gas of varying proportions is distributed to some extent in practically all of the large cities of this country.

2. CANDLEPOWER AND HEATING VALUE

The earliest specific requirements made as to gas quality were as to the candlepower of the gas supplied, and even at the present time this form of regulation is most frequently made. However, the very general use of gas for gas ranges and incandescent-mantle lighting has raised the question as to whether a calorific standard is not better than a candlepower standard for commercial gas. Except in the larger cities, it has been estimated that less than 10 per cent of the gas is employed in open-flame gas burners,

where the candlepower is of primary importance to the consumer. In the larger Eastern cities, however, it seems probable that as high as 20 per cent of the gas may be thus employed. The question as to the comparative advantage of heating value and candlepower specifications, or the necessity for both of these, is therefore of great importance.

The Double Standard.—The value of a double standard, i. e., specification of both candlepower and heating value, may be inferred from the following considerations, which are derived from or are expressed in the work on this subject which has been published. A general summary is given of the important conclusions of these comparative studies.

Considering water gas, coal gas, or their mixtures:

First. Eighteen-candlepower gas does not necessarily have a heating value of 600 Btu, and 600 Btu does not necessarily insure a candlepower of 18 candles. Even with the same kind of gas, increase of heat value does not *necessitate* increase in candlepower, and vice versa; but such is the usual rule.

Second. Six hundred Btu, "gross," and 15 cp for coal gas and 18 cp for water gas are reasonably attainable values in any well-managed plant.

Third. The lowest candlepowers at all probable when 600-Btu gas is made are 13 cp for coal gas and 16 cp for water gas. This secures the public against gas of insufficient candlepower for open flame. Note that the values given are probable minima—the averages would be about 16 and 19 cp, respectively.

It is of interest to note that in 20 cities of over 25 000 population double requirements are now in force and, considering only the quality of gas desirable, a double standard would be useful in all such cities. However, after a consideration of the increased difficulty in manufacturing and distributing gas to meet both heating and illuminating requirements, and especially in view of the comparatively close relation between them, a majority of gas engineers and inspectors have expressed the opinion that at least for cities smaller than 100 000 to 200 000 a double requirement is not desirable.

Although, as just shown, the photometric control of the gas is not as important as formerly provided that the heating value of the gas is regularly tested, nevertheless, candlepower regulations are also desirable for some cities having a population greater than 200 000. These larger cities contain districts, especially among the poorer classes, where a considerable amount of gas is used in open-flame burners. The inclusion of cities larger than 200 000 in the class requiring photometric control will require that such rules shall be in force in about 25 cities, which may be considered to be those where such conditions exist.

The use of a double standard does not appear to work a hardship in the large cities where it is now in force, since the larger companies operating there are, in general, not only equipped to make these tests, but also, through the wide experience of their engineers and superintendents, are able to manufacture gas which will meet a double requirement without difficulty. This, of course, assumes that either the candlepower or the

heating value demanded is rather lower than would be expected to correspond with the other value required, for if both requirements are high the difficulty of compliance is greater. For example, 600 Btu and 22 cp might be too severe, but 600 Btu and 18 cp not unreasonable for water gas.

Candlepower vs. Heating Value.—If, after consideration of local conditions, it is determined for any particular city that a double standard is not necessary, then the choice of heating value or of candlepower as the quality by which the gas shall be regulated depends upon the following considerations:

(1) Which quality can be better regulated by the manufacturer?

(2) Which quality is the better measure of the usefulness of the gas to the consumer?

(3) Which can be more accurately determined in testing?

(4) Which causes the smaller testing expense?

In one city a novel means has been adopted to prevent the necessity of decision of these matters at the time of ordinance adoption. This city requires that the gas company furnish 20 cp water gas or 16 cp coal gas or that the heating value of their product be 600 Btu per cubic foot. The decision as to which standard shall be met is thus left with the company.

Up to the present time many gas manufacturers have had much less experience in operating to meet a heating-value standard than a candlepower specification, and hence feel greater confidence in their ability regularly to meet the latter. This condition is probably the cause of the hesitancy of the gas companies in making changes from candlepower to heating-value standards. On the other hand, a considerable number of works have with success operated to meet heating-value regulations and seem to have suffered in no way by the change. It is less difficult to meet sudden weather changes in operating to conform to thermal specifications, since the sudden changes in heating value appear to be less marked than the corresponding changes in candlepower of the gas in the holders and in the distributing system. Moreover, it seems to be certain that the irregularities in works operation cause less trouble when the heating value of the product is the basis of the control than when a candlepower standard is to be met.

The use to which the gas is to be put determines largely which quality is the more suitable as a measure of its value. In general, four uses are made of commercial gas, viz, for heating and cooking, for open-flame lights, for mantle lights, and for power purposes. In the first the heating value is of first importance, in the second the candlepower represents the desired measure, but in the last two groups the temperature attained by the mantle or by the gas in the cylinder of an engine is dependent upon several conditions. It is certain that the candlepower for incandescent mantles does not exactly follow the heating value of the gas, but in general the relation is so nearly constant that the heating value offers an excellent means of judging the quality of the gas for such use. For gas engines the same condition holds.

Because the gas used for heating, cooking, mantle lighting, and power purposes is in most cases more than 75 per cent and in many cities over

90 per cent of the total consumption, the general tendency is toward heating-value regulations. Candlepower measurements are more and more being made to test the efficiency of various mantles and appliances in addition to testing the quality of the gas itself, and in some cases photometric measurements have been replaced by calorimetric measurements for the latter purpose.

In this connection it is assumed that the gas companies, as public-service corporations will feel that their own interest demands the education of the people to obtain light in the most economical way, i. e., by the incandescent mantle. And, on the other hand, the city ordinance or other regulation, which by enforcement of unduly high candlepower tends to increase the use of the open-flame burner of admittedly low efficiency, can be said to encourage wastefulness.

In the matter of the precision of its determination, the heating value is superior to candlepower. It is generally conceded that an irregularity of more than 3 per cent in the heating-value determination need not occur even in traveling-inspection work, whereas it is only by great care that the candlepower determination can be made with this precision. When candles are used as a standard, the error in candlepower will often be as much as 5 or 10 per cent. One matter which is important in this connection, especially in State gas regulation, is the fact that the best forms of apparatus used for heating value determinations are readily portable, while most portable gas photometers are not suited for accurate work.

As to the relative expense of candlepower and heating-value determination, very few general conclusions can be drawn, since the grades and types of apparatus vary so widely as to prevent comparison. The comparative skill required for the two kinds of work shows no decided difference, although the greater accuracy of the calorimetric determination would allow somewhat less skillful operation without undue diminution in the value and significance of the results obtained.

The public-service commission of the second district of New York, after an investigation of the usefulness of a heating value standard, states:

A general survey of the entire study leads to the following conclusions:

1. That of the coal gas, carburetted water gas, and mixed gas furnished within the territorial jurisdiction of this Commission the proportion used in open-flame burners probably does not exceed 20 per cent of the total supply.

2. That the existing photometric standards by which is judged the illuminating power of the gas afford the proper basis of measuring the real value of this proportion of the supply.

3. That unless and until the amount of the gas supply used in open-flame burners becomes diminished considerably below its present proportion of the total gas consumed, it is desirable that the existing photometric standards be maintained.

4. That the present test for illuminating power is not suited to a determination of the real value of gas used in the various methods now employed in incandescent lighting, nor does it afford a proper standard of measure for gas used for heat and power.

5. That the amount of gas used in these methods and for these purposes constitutes fully 80 per cent of the total gas supply.

6. That the real value of this portion of the gas supply lies in the heating properties of the gas, for which no standard of measurement exists in this State.

7. That by reason of the large class of consumers to whom the value of gas as a generator of heat is a matter of primal importance it is desirable that the calorific power of gas be standardized by the introduction of appropriate tests.

Since it is apparent from these considerations that both candlepower and heating-value regulations are at times needed in municipal gas ordinances, both have been included in the ordinance proposed in Part I, C; and the details of both such requirements are discussed in the following paragraphs.

Candlepower Specifications[6]—*Candlepower Unit Defined.*—Unfortunately there is no primary photometric standard that is sufficiently constant and reproducible to be generally accepted as an international standard. France, Germany, and Great Britain each has its own primary flame standard, and a great deal of effort has been expended in attempting to determine accurately the relations between them. Until the flame standards themselves are better understood, however, and the atmospheric and other conditions more perfectly controlled the unit of light can not be preserved as accurately by primary flame standards as by incandescent electric lamps used as primary standards.

Careful distinction should be made in this connection between a *unit* and a *standard.* An international unit maintained by the cooperative effort of several national standardizing institutions and checked from time to time by means of all the best primary standards in use is more likely to be maintained constant than if it were defined to be represented by any single primary standard, unless such a primary standard were reproducible to a very high degree of precision. Such a *unit* can be continued permanent, even though all present primary *standards* are ultimately superseded by better ones. Uniformity among different countries and continuity of value are prime necessities with respect to the *unit;* but the particular standard by which the unit is realized in practice is largely a matter of convenience and circumstance. In the photometry of electric lamps electric standards are most suitable. In gas photometry one form of flame standard or another will be employed, according to circumstances.

After extended comparison of their standards the National Physical Laboratory, London, the Laboratoire Central d'Électricité, Paris, and the Bureau of Standards, Washington, agreed to adopt on April 1, 1909, a common unit and to cooperate in maintaining the common value constant. The unit adopted was called the "international candle."

The accepted relation between the various units in use is—

1 International candle = 1 Pentane candle,
1 International candle = 1 Bougie décimale,
1 International candle = 1 American candle,
1 International candle = 1.11 Hefner unit,
1 International candle = 0.104 Carcel unit,
Therefore, 1 Hefner unit = 0.90 International candle.

The pentane and other photometric standards in use in America are now standardized by the Bureau of Standards in terms of this unit. This,

[6] See sec. 7, p. 62.

within the limits of experimental error, brings the photometric units for both gas and electrical industries in America and Great Britain and for the electrical industry in France to a single value, and the Hefner unit is in the simple ratio of nine-tenths to the International candle.

The proposal to call the common unit of light to be maintained jointly by the national standardizing laboratories of America, France, and Great Britain the "International candle" has been submitted to the International Electrotechnical Commission, and it is hoped to secure the indorsement of the proposal by all countries of the world which are represented on that commission.

The above described agreement between the national laboratories of France, England, and the United States marked an important step forward in the history of photometric measurements. For many years the British parliamentary candle was the unit recognized in this country, but the lack of precision in practical photometry did not permit its value to be very accurately expressed or reproduced. In recent years the gas industry has employed the 1-candlepower sperm candle, the 10-candlepower Harcourt pentane lamp, the Hefner lamp, and various secondary standards, while the electrical industry has employed incandescent electric lamps either certified by the Bureau of Standards or rated in terms of standards that are consistent with those of the Bureau. The use of the new unit, although requiring no change in the value of the flame standards, is of great importance, since it lends greater definiteness to their values. The value specified in the proposed ordinance is therefore given in terms of the International candle. (See p. 62.)

Candlepower Required.—As may be noted in the tabulation of candlepower requirements now in force, on pages 12 ff., the values demanded by various cities range from 14 to 35 cp. The variation is due to difference in local condition, to variation in kind of gas made, and in some measure to misunderstandings of the proper function of a candlepower requirement.

In so far as a generalization is possible, it seems certain that with the present American practice any water-gas plant can regularly furnish 18 cp gas and any coal-gas plant 15 cp gas without undue difficulty or expense; but if it is shown that the manufacture of this quality of gas in any particular locality necessitates expensive enrichment of the coal gas or excessive use of oil in carbureting the water gas, then such requirements would perhaps be too high. However, such condition exists in very few cities. This and the following paragraphs assume the measurement of Argand candlepower of coal gas; and consider that when only a small amount of water gas is made that the mixed gas be treated as if coal gas.

The requirement of a monthly average of 18 candlepower for the proposed ordinance (p. 62) would not be severe in most of the large cities for which a candlepower requirement seems essential, since practically all of these cities are supplied with water gas or mixed gas containing large amounts of water gas. At the present time only two cities with over 200 000 population are supplied with a gas of lower quality than this, and a considerable number of these and other cities have requirements of 20 and 22

cp. There is considerable evidence that such high values increase the cost of manufacture to such an extent that the cost to the customer per unit of service is greater than it would be for a gas of 18 cp. Moreover, for ordinary use in mantle lighting the high candlepower gas is often less desirable, as it tends to blacken the mantles and shorten their life.[6a] On this basis 18 cp seems sufficiently high. If a reduction of the candlepower to this figure is allowed in cities now receiving more than this quality, the price of the gas would be expected to be lowered correspondingly.[6b] If at the same price for gas a company can afford to give better service than it is furnishing, then it may properly be required to do so; or if the quality is already satisfactory, it may be better to require a continuance of the same quality at a lower price. Which plan is preferable would be determined by local conditions, as that one is best which gives to the gas customer the most service per dollar of cost.

If the monthly average candlepower required be 18 candles, then on any one day the average should not be less than 16 candles. Greater variation than this below the average will not occur in a carefully operated works except under very unusual conditions.

Only one company with annual sales over 500 million cubic feet distributes coal gas unmixed with water gas. If a different candlepower requirement is made for companies distributing straight coal gas, it may be desirable to make the monthly average requirement 15 or 16 candlepower and at the same time reduce to 14 candlepower the minimum specified in section 14, (1) for a single-day penalty. When considerable water gas is employed there seems to be no reason for such reduction. The specification of 16, or perhaps even 15, candlepower would offer ample protection to the public if a heating value of 600 Btu were also required, and under these circumstances there is no need to distinguish between coal gas, Lowe oil gas, water gas, or by-product gas as to the candlepower specified.[6c]

Burner Employed in Testing.—The choice of a burner to be used in the testing of gas determines largely what value will be obtained from the test, since the same gas gives varying results with different burners. Since the function of the candlepower determination is primarily to protect those consumers who use the gas in open-flame lights, the use of an open-flame burner for the test would seem rational, even though this burner does not in all cases give the full intensity obtainable from the gas by other burners, such as the Argand type.

In the testing of water gas and mixed gas containing more than 50 per cent of water gas, the use of the Bray No. 7 Union Jet or Slit Union Burner is most satisfactory, according to tests of the second district commission of New York. Generally an open-flame burner is most satisfactory for this kind of gas, and it is used by the majority of inspectors for water-gas work.

[6a] High candlepower gas can not be made and distributed with as great uniformity of product at point of consumption as can gas of lower candlepower. Since uniformity of quality is very desirable, especially for mantle lights, stoves, and other burners of the Bunsen type, high candlepower gas is, in this respect at least, less satisfactory to users.

[6b] This lowering of price would not be proportional to the lowering of candlepower, but it might be more than proportional to the lowering of heating value. (See p. 38.)

[6c] When no heating value requirement is in force a higher candlepower is desirable for water gas than for coal gas, in order that the heating value of the two kinds may be about the same.

For coal gas the Argand type of burner is more efficient than any open-flame burner. There are, therefore, many cities and States which use this type for inspection work; but this is criticized, on the ground that very few Argand burners are in use for domestic lighting, and the value obtained from them on testing does not represent the ordinary value obtained in practice. Nevertheless, the use of an Argand burner for testing coal gas has become so firmly established that it appears desirable to allow its use to be continued for the few companies making coal gas where a candlepower requirement is made. As will be noted in Table 1 of the previous section, this will apply only to 13 companies.

For water-gas testing the Bray No. 7 Slit Union Burner is generally used. For coal gas either the D or F Argands may be used. The use of the very expensive Metropolitan No. 2 (Carpenter) Argand is not recommended, but if it is used a higher candlepower requirement should be made. Unenriched coal gas giving 13 to 14 cp in a Bray No. 7 Slit Union Burner will give 15 to 16 cp in an Argand and about 17 in a Carpenter Metropolitan No. 2.

Certain freedom in choice of burner is allowed by the proposed rule, but to go to the extreme of permitting the use of "any other burner best suited to the gas" is unwise, as it is too indefinite.

Testing the gas when burning at the rate of 5 cubic feet per hour is the usual procedure, but the specification of "five cubic feet per hour, measured under existing atmospheric conditions," is not common. This latter rule (see p. 62) seems most desirable, however, as the gas may most conveniently be passed at 5 cubic feet per hour measured under existing conditions and then corrected for pressure and temperature in the calculation of candlepower, as no preliminary calculation is then required to determine the desired meter registration.

Standard Specified.—It can not be too strongly emphasized that *the term "candlepower" does not imply that candles must be used as a standard.* Moreover, the use of candles, where accuracy is desired, should be discouraged. The general use of candles is not sufficient ground for the continuance of the use of so unreliable a standard.

The specification of the pentane lamp in the proposed ordinance is not intended to suggest that this lamp is the only one which may be used or that it is necessarily preferable in all cases to other working standards. The preference given to the pentane lamp is partly because the American Gas Institute has recommended it after an extensive experience in gas photometry and partly because the Bureau of Standards, after a very careful study, has found it a reliable working standard. The substitution of any other form of flame standard will necessitate no change in other portions of the proposed section.

The specification in an ordinance of the standard to be used is desirable mainly because it eliminates any chance of dispute between company and inspector. When the lamp employed is certified by the Bureau of Standards, much of the trouble arising from disputes over claimed deficiency of candlepower is obviated.

The standardization of such lamps by the Bureau of Standards for State commissions or State institutions is free (as provided by act of Congress); when done for municipalities or corporations a fee is charged. The charges for standardization will be given on application to the Bureau.

Form of Photometer.—The question of form of photometer will be more fully discussed in a later circular under the description of approved methods of testing. The methods of test are confined mainly to the open and closed bar instruments. The advantages claimed for each are as follows:

In favor of the closed bar—Smaller initial cost, and the flames are less subject to draft.

In favor of the open bar—Better ventilation to flames, less chance for reflections from inside of gallery, and less temperature variation due to long burning of the flames.

Ventilation of the room is of great importance in gas photometry, and for that reason the open bar is much to be preferred. The open bar is generally used.

For official testing the jet photometer is not suitable, since it is not really a photometer, but must itself be frequently calibrated by a photometer in order to give trustworthy results. If properly used, it is a useful guide to the gas manufacturer in a coal or oil gas works. For water gas it is not generally applicable, since the density of this kind of gas does not change proportionately with the candlepower.

The portable photometer in many cases may be useful, but the necessities of its form of construction render it less reliable than the stationary open-bar type. In large cities where a permanent equipment is necessary the portable form is not used. In general, it should not be used at any time for official results when a fixed apparatus can be secured. It is suitable for official use only in traveling work of state inspectors, and even then it should be frequently calibrated by comparison with a good stationary instrument.

Any definite statement of the "make" of instrument is wholly unnecessary, as many forms can be used with equal success, but it is desirable to specify either open or closed bar instrument, in order to eliminate the portable and the jet photometers.

Frequency of Tests.—In order to maintain any reasonable control of the quality of the gas, the photometric determination should be made, if possible, twice daily. A single test would be sufficient unless the gas were found to be below the standard specified, in which case a repetition of test is desirable. These tests, when made at only one point, do not necessarily represent the gas throughout the whole city; but since this test is less important than the heating-value determination, one station is sufficient, and the requirement of only a single photometer will materially reduce the expense of inspection apparatus and the time required for regular tests. When no heating-value determinations are made, a larger number of candlepower tests would be desirable.

When more than one company operates in a city one test should be made upon the gas furnished by each, which can usually be done on a single

photometer. However, the difficulty in the use of a single wet meter for more than one gas would suggest the necessity of employing a separate meter for each gas to be tested. The second determination provided for in the proposed paragraph (a) (see p. 62) has the obvious purpose of freeing the company from penalty for failure to meet a single test. It is, however, not probable that two tests two hours apart would relieve them from any irregularity in the manufacturing process which lowered the candlepower by as much as two candles, since during this short period it would not be possible to regain normal working conditions and also to replace the low-quality stock in the distributing system by one meeting the requirements. Such accidents, when unavoidable, are cared for in a later section of the ordinance. (See sec. 14, p. 67.)

The averaging of a month's determinations of candlepower before penalty for small deficiency removes wholly the chance of injustice due to any experimental error of a single determination. It also allows reasonable time for the company to overcome the irregularities of operation which might affect a single day's test. A fuller discussion of this point is found on page 39.

Heating Value Specifications—*"Gross" or "Net" Value Required.*—The "gross" value as ordinarily determined is the heat produced by the combustion of the gas, including that due to the cooling of the products of combustion down to room temperature and the heat liberated when some[7] of the water vapor in the products of combustion condenses to the liquid state. The "net" value does not include the heat of condensation of the water vapor. Both gross and net values have been used in the specification of gas quality.

In very few of the ordinary gas-consuming appliances is the heat liberated by condensation of the water utilized. Therefore, in the most efficient forms of apparatus the "net" heating value of the gas usually represents the maximum amount of the energy available. The "net" value is thus perhaps the more exact measure of the quality of the gas than the gross value.

The net value would represent the maximum amount of heat that is available when the gas is used in heating a room, as the water vapor formed in the flame is not condensed. On the other hand, where the gas is used for mantle lighting, cooking, furnace operations, power purposes, etc., where the products of combustion escape at relatively high temperatures, the heat that can be utilized is much less than the net heating value of the gas. The gross heating value is almost never realized in practice.

A variation in hydrogen content makes it possible that two gases of the same gross heating value might differ quite widely in their net values. For example, hydrogen and carbon monoxide have very nearly the same gross heating value, while the net value of the latter is about 16 per cent higher. In the usual makes of flow calorimeter, which is the type of instrument generally used for the determination of the heating value of gases,

[7] In the flow calorimeters used to determine the heating value of gases water vapor is carried off in the escaping products of combustion.

both gross and net heating value can be very readily determined, the latter with a somewhat higher precision, as the gross values are influenced by variations in atmospheric humidity.[7a] However, for the various kinds of illuminating gas usually met with commercially, the ratio between gross and net heating value is so nearly constant that either may be satisfactorily used for the commercial specification of quality, so that for practical purposes there appears to be no very great advantage in one value over the other. For these reasons, and since specification of the gross value has been the usual practice in this country, it has been made in this circular. Only two cities are at present employing net specifications.

Heating Value Required.—The general tendency toward the selection of 600 Btu gross (approximately equivalent to 550 Btu net) per cubic foot as the value to be required is apparent from the compilation of present requirements. (See p. 16.)

There are some places in this country where gas of higher heating values is being made at little or no increase in expense per unit of service over that necessary for 600 Btu gas. These places exist, however, through unusually favorable local conditions or exceptionally able management, and can not be considered to vitiate the general rule as given above. The opposite may also be true, that unfavorable locality or careless management will render a 600 Btu gas impossible without considerable increase in expense. It is not contended that local conditions can always be overcome, but inefficient management should be.

Where local conditions are such that a reduction of the monthly average required would permit a more than proportional lowering of the price, then such reduction could well be considered desirable; but if the price lowering is only proportional to the loss in heat value, it seems undesirable to go below a monthly average of 600 Btu, since a gas of low heat value can hardly be said to give "best service."

The public-service commission and the gas companies of the second district of New York are at the present time carrying on an extensive investigation as to the most economical heating value, and are trying to determine what heating value the gas companies of the State of New York should be required to furnish. When their investigations have been completed they will doubtless have reliable data upon which to base a calorimetric requirement, and it may be found desirable to modify the conclusions which are implied by section 8 of the proposed ordinance (p. 63). However, at the present time the gross value of 600 Btu per cubic foot seems satisfactory for normal conditions, and it may probably be regarded as the lowest value which need be specified under any but extreme conditions.

Monthly Averages and Minimum Values.—It is a well-recognized fact that even with the best of management a gas works can not furnish an exactly uniform product. The allowance of "monthly average" values, to determine the question of satisfactory quality of gas, relieves the company of penalty in many cases where they could not be held responsible for unforeseen conditions, causing a temporary drop below the average required.

[7a] This point will be discussed at length in the circular on gas testing methods.

The satisfaction which such a rule has given after two years' trial throughout Wisconsin has led to its adoption in the ordinance proposed.

Although some allowance must be made for irregularities in working conditions which are beyond easy control of the manufacturers, still it must be recognized that large irregularities are not consistent with good service. Permitting a temporary deficiency of 50 Btu allows sufficient freedom in works management and at the same time prevents wide variations, which might cause very great trouble to consumers. When an appliance is adjusted for 600 Btu gas it will operate with fair satisfaction down to 550 Btu or up to 650 Btu, but wider changes from the normal should not be allowed. In fact, there is some question whether so much latitude is necessary for a well-managed plant, but until it is clearly indicated that the ordinary manufacturer regularly can run within narrower limits such freedom must be permitted.

Frequency of Tests.—Where there are several testing stations the number of daily tests required is ordinarily equal to the number of stations. When tests are made at all stations they represent a very fair result on the gas throughout the city, but the lack of one, or in large cities several, of these tests does not destroy the value of their averages as a means to judge the whole amount of gas distributed. An average for one day should be made only when 60 per cent or more of the required tests give results without suspicion.

Apparatus Specified.—A number of makes of gas calorimeter may be used with satisfactory results. The instruments most generally used for the determination of the heating value of gases are of the flow calorimeter type, of which the Junker's is a well-known example. Various makes of this type of calorimeter that have found wide use in the gas industries in this country and in England and Germany are under investigation in the laboratories of the Bureau, and the results will be published as soon as the work is completed. This investigation includes a study of the sources of error to which these instruments are liable and of the precautions that should be observed in their use, together with a comparison of the accuracy of the results obtained with them as compared with the results obtained with a standard calorimeter of the bomb type. It is sufficient to state here that these calorimeters will probably meet the present-day requirements of industrial testing. The different instruments tested were found to give results in agreement with one another to 2 per cent or better, and with certain easily taken precautions in their use to within 1 per cent. There are various sources of error that may affect the result found for the heating value to the extent of several per cent, but means have been found to reduce these errors by the exercise of suitable precautions. The effect of such errors is, in general, to give too low a result for the heating value of the gas. For the purposes of controlling works operations, relative heating values from time to time serve a useful purpose, but no test with any calorimeter can be regarded as authoritative unless the thermometers used with the

calorimeter have been carefully standardized and the scale errors allowed for in the test.

3. PURITY—CHEMICAL TESTING.

At the present time there are only three impurities which receive much consideration in municipal control of the quality of the gas, namely, hydrogen sulphide, total sulphur, and ammonia. It is now recognized that the presence of carbon dioxide, nitrogen, and oxygen, while not beneficial to the gas, do not demand special control, since the specification of candlepower and heating value (either one or both) necessitates a control by the company of the amount of these diluents. The question as to the control of the amount of carbon monoxide will be discussed on page 43.

Hydrogen Sulphide.—The question whether or not a regulation concerning the presence of hydrogen sulphide should be made has been carefully considered and the conclusions reached are expressed in the ordinance proposed. The important facts and opinions on this question may be briefly stated as follows:

First. As *opposed* to hydrogen sulphide restriction:

Hydrogen sulphide and other sulphur compounds form the same objectionable products of combustion, namely, sulphur dioxide and sulphuric acid; therefore, hydrogen sulphide is no worse than other sulphur compounds.

Hydrogen sulphide when burned with illuminating gas does not, as sometimes claimed, give odors other than that of sulphur dioxide.

The amount of hydrogen sulphide present is not sufficient to be poisonous, especially when compared with the amounts of carbon monoxide present.

The bad odor due to the presence of hydrogen sulphide is beneficial rather than otherwise, since it makes leaks more noticeable, and thus minimizes the danger of fire or asphyxiation which are greater with faintly odored gases.

Second. As *favoring* a hydrogen sulphide restriction:

The hydrogen sulphide can be removed with comparative ease and with very small expense.

The hydrogen sulphide will increase the sulphur dioxide in the products of combustion and hence should be removed if possible. It should be noted that the other sulphur compounds can not be reduced by purification methods below a certain figure fixed by quality of coal and operating methods, except at prohibitive expense.

Even small amounts of hydrogen sulphide corrode brass and silver ware when minute leaks are allowed.

The test proposed is not severe as it will allow the unavoidable traces of hydrogen sulphide to pass without detection.

Because of its unpleasant odor the presence of hydrogen sulphide in the gas is conducive to unfriendly relations between company and consumer.

Finally, and what is most important of all, the removal of hydrogen sulphide necessitates careful management in all previous parts of the purifi-

cation of the gas, i. e., condensing and scrubbing, and thus its absence is indicative of careful work through the whole process of manufacture.

The possibility of setting some more definite numerical limit, e. g., 1 grain of hydrogen sulphide per 100 cubic feet, has been carefully considered; but it was rejected as undesirable for several reasons.

First. No information is at present available as to the exact sensitiveness of the tests with lead acetate paper when used under the various conditions of test often recommended. The benefit of past experience would thus be lost by use of a new test which had not previously had wide application.

Second. The quantitative determination of such amounts of hydrogen sulphide as could be allowed in an illuminating gas is a much more difficult and lengthy process than would be practicable in any but the large works where a trained chemist is employed.

Third. There are no conclusive experiments at present available by which to determine whether or not a specification of 1 grain per 100 cubic feet of gas would be reasonable.

A more detailed discussion of the hydrogen sulphide test is not within the scope of this circular but will be included in a later circular on "Methods of Testing and Inspection of Illuminating Gas." An idea of the comparative sensitiveness of the various tests specified for this impurity can be obtained from an article in the Proceedings of the American Gas Institute for 1909, page 453. Some doubt has been expressed as to the absolute sensitiveness claimed in this article for the methods of test described; but there is no question as to the reliability of their comparative sensitiveness as there described.

A daily test for hydrogen sulphide is essential; but since the whole test requires less than five minutes, its frequency works no hardship.

Since it requires about two days after detection of hydrogen sulphide to insure its removal from the system, it is but reasonable to commence penalty for its presence only after such period. However, when the company does not remove the trouble within three days of its discovery, fear of penalty seems to be the most effective agent to insure an effort on its part to remove the cause of such trouble.

As specified in section 14 (p. 66) "each day" shall begin from the first observation of the presence of hydrogen sulphide and continue, counting Sundays and holidays, until the gas is again free from the impurity. For there is no reason to suppose that if hydrogen sulphide was present both on Saturday and Monday that it was not present on the Sunday intervening.

Total Sulphur and Ammonia.—The question as to total sulphur limits is not what amount of sulphur is dangerous to either health or property; but rather, what is the least sulphur readily obtainable in good practice with the present coal supplies. From experience in many cities it seems certain that 30 grains of sulphur will not do serious injury to the property of the user of gas, and under the present conditions of American practice this amount need not be exceeded.

The amount of total sulphur present in the purified gas is not wholly within the control of the company, as it depends not only on the methods

of works operation but also on the character of the coal or oil employed. Because of the growing scarcity of high-grade gas coal many companies are being compelled to use an inferior grade, and the resulting gas is thus higher in sulphur. If a supply of poor coal were received by a small company, it might be impossible for it to furnish a gas of normal purity until this stock was exhausted.

In any city where water gas alone is made it is not necessary to allow more than 20 grains of sulphur, but such limit might at times be too severe for coal gas. However, the extra allowance will give relief in certain localities where high sulphur coals are used and will permit other companies to meet this requirement with the lower grades of coal which some of them will, of necessity, use at some future time. A restriction of the total sulphur should always be made to prevent the distribution of high-sulphur gas, such as would result from the use of the poorer grades of coal.

The real necessity for an ammonia limit is not so apparent. In large gas works the reduction of the ammonia to a very small figure is usual, because of the value of the recovered ammonia. With the smaller works the use of a large excess of scrubbing water is customary and the amount of ammonia passing into the gas is small. The harm which may result from the presence of considerable ammonia in the gas is sometimes disputed. But it is generally believed that it has an injurious effect upon the meters and also upon the fixtures and should therefore be eliminated from the gas as completely as possible. The determination is simple and the requirement proposed is not hard to meet (p. 63).

In certain cases where the scrubbing capacity of a plant is limited, either through scarcity of water or because of insufficient installation, it may be necessary to raise the proposed limit on ammonia to 10 grains; but for ordinary conditions there will be no difficulty with the limit as set. In a few cases difficulty may be met in preventing the gas from being contaminated by ammonia taken up from the water in the holders and the distributing system. This, however, would be an exceptional condition and could occur only in hot weather.

The daily determination of sulphur and ammonia (required in some cities) gives an excellent control of the quality of the gas in these respects; but it adds very much to the time and therefore the expense of inspection, with scarcely the equivalent advantage in protection of the consumer. Since the weekly test may be made without notice to the company at any time during the week, the company must always be prepared to meet the requirement, and such frequency will thus offer ample surety of the proper conditions at all times.

The determination of sulphur and ammonia can be made with sufficient accuracy to insure the company against penalty when not deserved, for the experimental error is not over 1 grain in the sulphur and even less in the ammonia, and the limits have been set enough higher than otherwise necessary to cover errors in the determination. Penalties based on two determinations are therefore not unreasonable. (See sec. 14, p. 66.)

Carbon Monoxide.—A review of existing legislation shows no tendency to limit the carbon monoxide content of gas, although there is no doubt that the danger to life is greater with the use of gas of high carbon monoxide content than with the use of gas containing a lower percentage of this substance. Carbon monoxide is the only constituent of illuminating gas which, in the amounts ordinarily found, is poisonous. Other constituents would produce suffocation, but not poisoning.

Coal gas contains from 5 to 10 per cent of carbon monoxide; water gas from 25 to 30 per cent. The limiting of the amount of carbon monoxide in the gas sold, therefore, may operate to limit the amount of water gas made. It is apparent that such regulations as would prevent the operation of water-gas plants now in existence would be very radical, and for the reasons stated on pages 25 to 28 it does not appear economically possible to restrict the use of water gas to any appreciable extent.

The question as to the limitation of the carbon monoxide content of the gas distributed is based upon the fact that this substance is the only toxic constituent of illuminating gas which is present in large amount, and there is from two to five times as much of it in water gas as in coal gas. Therefore the use of water gas necessitates the use of a gas more toxic in character than coal gas. Just how far this fact can be used as an argument for restricting the use of water gas is not yet clear; but this Bureau is attempting to get such information as will give some basis for a discussion as to the increased danger attending the use of water gas over that attending the use of coal gas. At this time it is not amiss also to point out some of the facts which indicate that the use of water gas may possibly not be much more dangerous than coal gas. Briefly stated, these facts are as follows: A large proportion of the cases of death or illness caused by gas poisoning are suicidal, due to irresponsible condition, such as drunkenness, or to gross ignorance; and in the majority of these cases the character of the gas would perhaps have only a small influence upon the seriousness of the result. A smaller number of deaths and cases of gas poisoning are due, not to the illuminating gas itself, but to the carbon monoxide formed by combustion of the gas with insufficient supply of air, due to a faulty appliance or to an appliance improperly set or connected with insufficient or improper flues. These matters all have an important bearing upon the subject, and it is possible that the protection of the public from danger will be found to lie rather along lines of regulation of appliance form and setting and general education of gas users as to proper precautions than in the limitation of the carbon monoxide content of the gas itself. The Bureau will probably have further information to offer on this subject in the near future.

4. GAS PRESSURE

The pressure at which gas is supplied to the consumer is a primary element of good service.

Discussing gas pressure the Wisconsin railroad commission make the following statement in their third annual report (1909):

> It has been shown that in general the gas furnished in cities of this State has been of good quality and the value has been uniform. In spite of this fact, complaint is frequently heard of "poor

gas." The summary of gas complaints, and our own experience, has shown "poor gas," as the consumer uses the term, to be synonymous usually with "poor pressure," and may be due to one or more of a number of causes. It may be that the pressure furnished to the mains is inadequate, that the service or housepiping is inadequate or otherwise faulty, or that the pressure is unsuited to the adjustment of the appliances in which gas is used. In most cases, however, it goes back to the matter of pressure. For this reason the control of the gas pressure is the most important single factor in securing satisfactory service.

The use of gas has been greatly extended in the last few years and all of the appliances which have come into use require a higher pressure than the old open flame burner. It is stated in the discussion of gas pressure in bulletin U–21, that the pressure under 1½ inches is unsatisfactory. Most of the companies in the state maintain a standard pressure of above 2½ inches and it has been noticed that in general, where the pressure drops below 2 inches complaints are heard.

Because of the importance of pressure regulation, a section of the proposed ordinance has been drawn to cover this subject (p. 64). The necessity of sometimes varying this general rule to meet local conditions must be recognized.

The present tendency in gas distribution is toward maintenance of higher pressures. The cause of this is twofold; first, the increased amount of gas which can be sent through a pipe of fixed size, thus continuing the use of mains otherwise insufficient in size; and second, the greater efficiency of some gas appliances at higher pressures. The large majority of present-day gas appliances (mantle lamps, stoves, and industrial appliances) when set and operated at pressures of 4 to 6 inches have been found to be more economical than when used at 1 to 2 inch pressures as formerly generally used.

The increased leakage due to higher pressures upon old distributing systems and in case of broken mains is a consideration against higher pressures; but this difficulty may be largely met by renewal of worn-out systems, rather than by the sacrifice of efficiency for economy in distribution.

The specification of a maximum allowable pressure at the meter is based on the assumption that pressure regulators will be used if necessary and that in such cases a high-pressure distributing system may be employed. The basis upon which six inches was chosen (p. 64) was:

(1) The gas company's customers can not be trusted to regulate their own appliances when the pressure goes above 6 inches.

(2) Ordinary gas burners, both for stoves and for lights, are set for a normal pressure of about 2 to 4 inches. They will not operate well above 6 inches unless the proper change in regulation is made, or in many cases, until the gas outlets are changed for the higher pressure sizes.

(3) The allowance of unlimited maximum would permit gas companies to distribute gas through their mains without feeders or auxiliary holders and so cause great irregularities in pressure throughout the city; close to distribution centers high pressures would prevail, while at great distances low pressures would be maintained. This would make it impossible for any dealer to sell devices suitable for all parts of the city, and thus the public would not be able to purchase fittings already properly adjusted.

(4) By the use of high-pressure lines or a booster system and gas governors (the latter for a district or for each meter) the gas company can meet this requirement and still utilize the most modern methods of distribution.

(5) Six-inch pressure is sufficient to allow the operation of ordinary appliances with good efficiency.

The objections to restriction of the maximum pressure are in some cases valid and to meet them the following addition can well be made after the first paragraph of section 10 (p. 64):

Provided, however, That the company shall be allowed, under special contract with any customer, to furnish to said customer gas at pressures higher than six inches of water pressure when such supply is required by said customer for high-pressure gas appliances.

In a great many places a minimum of 1.5 inches is specified, and sometimes it is as low as 1 inch. It is generally believed, however, that the best satisfaction in operation of incandescent mantles and gas stoves is obtained only with pressures greater than 2 inches. Where a normal pressure of 3 to 3.5 is carried the difficulties of operation of these appliances is apparent when the pressure drops below 1.5 inches.

A sudden drop in pressure with a subsequent rise to normal, which sometimes occurs, is the most serious menace to public safety to be guarded against. Such a sudden drop may extinguish lights, and the subsequent increase of pressure will then fill the room with unburned gas, with attendant danger of fire and asphyxiation. Lights would probably not be extinguished at pressures above 1 inch; but the less serious though quite appreciable difficulty of "snapping back" of stove burners occurs even above 1-inch pressure, especially when the stove is set for relatively high pressures.

More important than either the maximum or the minimum pressure is the variation in pressure. If an appliance be set for a normal of 3.5 inches, it does not render best service at a pressure much different from this value, and hence the necessity of uniformity. A large number of gas companies in this country, including both large and small, maintain such uniformity as is required by the proposed rule. (See report for New York State, on p. 80, and sec. 10, p. 64). Companies who do not, unless prevented by some adequate reason, should be compelled to meet such requirement. It is of course understood that some time will be necessary to accomplish such alterations, but the sooner pressure regulation is required the sooner will good service be established.

When a particularly high area is to be supplied and the maximum pressure is limited, the use of pressure governors is necessary to prevent undue rises. The increase in pressure due to elevation above the holder level is from one-half to 1 inch of water pressure per 100 feet difference in level, varying with the density of the gas, being larger with coal gas than with water gas. The differences actually occurring depend not only on the specific gravity of the gas but also on the loss of pressure due to friction.

It must be recognized that such a regulation as proposed in section 10 (p. 64) can not be put in force at once in any city unless gas-distribution conditions there are such as to make it possible to distribute the necessary quantity of gas at these pressures. No company, however willing, can make considerable alteration in its distribution system without a reasonable allowance of time. As an example of the method of handling such cases, see

section 12 of the ordinance recently adopted by the Minneapolis city council, pages 100–102. This section may not represent the best method in all respects, but is an excellent example of the problems to be met in such cases. It seems advisable, however, to make few, if any, specifications as to how the company shall meet the new requirements. If ample time is allowed and temporary pressure regulations (less rigid than those ultimately intended) are at once enforced, the company should be allowed to choose its own method of accomplishing the final result. Whether they wish to use more holders, high-pressure belt lines, the booster system of feeding mains, local or district govenors or larger low-pressure mains is immaterial, if the final requirement is met.

There may be a few medium-size cities in which the low-pressure distributing system will become inadequate before the installation of an auxiliary belt line seems practicable; and in such cases greater latitude in pressure may be needed. Allowance of pressure greater than 6 inches may then be desirable; but the variation allowed probably should not be greater than 100 per cent of the minimum.

When section 10 as proposed (p. 64) is in force, the protection of the company demands that it shall have control of the service pipes to all houses, at least to the extent of determining their minimum size. Otherwise the company should not be held liable for low pressures in such house, as the pressures when the gas is not used may be within requirements and the insufficient size of service pipe prevent the maintenance of such pressures when the consumption is a maximum. Where the company installs and is responsible for the services, it can be held to the proposed rule without qualifying it, as is often done, by the phrase, "when no gas is being used by said consumer."

In case the pressure falls below the allowed minimum in any one house due to the installation without the knowledge of the company of an appliance using gas so rapidly as to make too small a service pipe which was otherwise adequate, then the company must be relieved from penalty for such failure to meet the pressure requirements, as the case is clearly one beyond the control of the company. Whether under such circumstances a company which is usually required to furnish and maintain the service pipes should be expected to install a new service would depend largely on the total amount of gas to be used by the new appliance.

The objection to measurement of the pressures on the mains only is that this does not permit easy access to places for testing. The rule proposed will allow the inspector to place his recording instruments at any convenient point on the distributing system. The measurement at the outlet rather than as is usually done at the inlet of the meter would operate, in a measure, to control the repair work on meters, since with such regulation the company would take greater care that the meters do not require more than a small pressure difference to operate them. However, a result obtained by test at a meter inlet is more likely to represent the condition of a district than if the measurement is made at the meter outlet, since it would eliminate the meter effect. Moreover, it is much easier to set a gauge at the end

of a service than at the outlet of the meter. The usual practice of testing at the service outlet has, therefore, been adopted in the proposed ordinance.[7b]

The best arrangement by which the inspector can judge the conditions of service is a continuous record. Scattered readings, or even regular readings, for a few days are unsatisfactory and often misleading. This record can be kept most readily when the gauge is located at the office of the inspector. The form, setting and operation of this gauge will be discussed under rules for testing in a later circular.

The requirement of "additional gauges" (p. 64) may not apply to many small cities where the variation of pressure over the area supplied does not warrant the extra expense involved. Under these circumstances one or more simple portable U-shaped water gauges should be used to check up outside conditions when this is required.

The gauges are located at the discretion of the inspector without notice or consent of the gas company. It is of course understood that permission must be had from the owner when these gauges are located upon private property.

The removal of gauges from one place to another should not ordinarily be made oftener than once a week, since the conditions can not be judged properly by observations covering a shorter period. Unless any particular location seems specially suited as a pressure-testing station for a neighborhood, it would be well to move all gauges at least once in three months, since a longer observation at one point will rarely offer new information which could not be equally well gained elsewhere in the vicinity; and the more points in a neighborhood examined the better can the inspector judge the true conditions and determine the area over which any particular condition prevails.

The specific statement (p. 64) that the inspector may go out and search for irregularities of service might prevent dispute on this point and avoid legal complication, but since the inspector is a public official appointed to secure the safety and financial welfare of the public on these matters, it is assumed that he will be allowed and, indeed, expected to search out irregularities and report them.

The surprising percentage of the complaints of "poor gas," which, on investigation, resolve themselves into poor pressure, is sufficient reason for the uses of gauges for complaint investigation. However, poor pressure may be due to insufficient size or stoppage of service pipe or to improper adjustment of the appliance as often as to inadequte gas supply.

5. METERS AND METER TESTING

Since the record given by a meter of the amount of gas passed is the basis of all settlements between company and customer, the importance of correct registration is evident. The most satisfactory method of protecting the company and satisfying the customer of the reliability of the meter is

[7b] Although ordinances usually provide for measurement of the pressure at the meter inlet, the actual tests are made at the service outlet. The latter point is usually, but not always, the same as the meter inlet.

a regular test. With these objects in mind the proposed section (p. 64) on this subject was drawn, after very careful study of the requirements and practice of some of the largest and most progressive companies of the country.

Two methods of checking the meters are available—one in which every meter is tested by the inspector, the other by which the company is required to make these tests. Since a choice between the two must be largely dependent upon the attitude of the company and the ability of the city to provide facilities for such testing, what is best in one place may not be in another. The choice of city inspection will require some initial expense for assistants and testing shops, but will give to the city a control over the accuracy and regularity of the tests, and if proper fees are provided should soon become self-maintaining. If a company, however, makes a practice of regular removal and testing of the old meters in service, such as would correspond with the requirements of this rule, and does this work in connection with a good meter-repair shop, there is reason to believe that they can do as good work as is possible by official testing.

For cities of class 3 where no inspector is provided, the tests required in paragraph (e) (p. 65) should, if possible, be made by the city engineer or other town official. In any city where the company has as many as 500 meters in service it should certainly be required to purchase and use a standard meter prover to test all meters regularly, as provided in the rule. This applies, of course, only where no city official tests the meters. If no prover is available, the series method of meter testing will be necessary. When this method of testing "in tandem" is used the portion of paragraph (b) (p. 65) which refers to new meters may be omitted.

In any case, the requirement that "every meter" be tested is the only safe plan, since picking a few meters from a shipment and allowing the results on these few to represent the value for the whole lot is not safe either for the company or the customer. For this work the use of a prover is better than testing "in tandem." When this latter method is necessary, as in small cities, the ordinance should read "in comparison with an accurate testing meter."

It is sometimes urged that when the city tests all meters the company is too largely relieved of the responsibility for their accuracy, and careless work in meter repairing results. Those of this opinion favor having the company carry on all of the testing, and giving the inspector the privilege of supervision and of retest of a few meters, at any time he may wish in addition to testing complaint meters. In any event the company should be held responsible for the condition of its meters.

The allowable error of 2 per cent represents only the necessary leeway due to inaccuracy of testing methods and inability to construct commercially a perfect gas meter. Such small variation from correct working is of very small consequence in any one customer's bill. The company is amply

protected, since the plus and minus errors will naturally almost balance. Two per cent is the usual variation permitted.

The sealing of the meters can be done in several ways, which will be described under methods of testing. When the regular inspection is done by the company, it should seal the meters in some way, in order that both company and customer can see at once the date of the last test.

When a new ordinance goes into effect the initial testing of old meters is one of the most serious considerations. As drawn, the proposed section (p. 64) arranges for the testing first of those meters which have been longest in use. Unless the company can at once furnish "tested and sealed meters" for the use of new customers, it must, of course, be allowed to set meters contrary to the provision of the ordinance until arrangements can be made to test and seal the meters as required for use.

The testing of a meter just purchased from the manufacturer may seem unreasonable, since these meters are supposed to be very carefully adjusted. If this adjustment could always be depended upon, the rule would be needless, but the experience of many inspectors and company meter testers shows the rule to be a good one. If an official test is made at the factory, an additional test is unnecessary.

The choice of five years (p. 64) as a limit of time between testings is, of course, arbitrary. The experience of those who have attempted enforcement of shorter periods would scarcely warrant recommending three years for this limit throughout the country, and a longer period would be undesirable generally. A meter must be tested in some way for time deterioration, and five years seems to be a reasonable limit to set for such inspection. It may be thought that the company, for its own protection, will care for the meters sufficiently well, but in actual practice it is often found that the companies neglect their meters.

If after longer experience it is found that meters will continue for longer than five years in a satisfactory condition, then the time during which a meter may be left in service without test may be extended. The use of "dipping meters" has been very successful in this respect in some places.

The system used by some companies by which experts are constantly going over the ledgers to see in what meters the consumption of gas is falling off and to investigate such cases does in a measure protect the company, but such a process does not offer the consumer any protection against "fast" meters. In fact, such plan tends necessarily to increase the percentage of "fast" meters by weeding out those which are "slow." Just how successful such plan would be in eliminating both "fast" and "slow" meters by noting changes of consumption is not known, although it has been attempted by some companies and some credit given to it. We believe, however, that such precautions at best should only be depended upon between actual tests at not too infrequent intervals.

When the five-year removal rule is in force it can be assumed that each year there must be as many meters tested as are equivalent to 25 per cent of the total number installed. This includes complaints, removals due

to change of consumer, repairs, and new meters. The reason that a shorter period might well work a hardship on the company is evident when we realize that a four-year removal rule means over 30 per cent to be tested each year, a three-year removal rule about 40 per cent a year, etc.

Because of their greater importance meters larger than the "10-light size" should be tested more often than the smaller sizes. This can be left to the company, however, as it must watch these large meters closely for its own protection.

Since at least half of the expense of testing is due to time required to remove a meter and replace it by a new one it works no hardship on the company to require test on a meter which has been removed after three years' service. In general, such rule will work as a saving to the company, since a second removal for test after less than two years more of use would be more expensive than immediate test, with the extended period before a second removal would become necessary.

The expense of removal, setting, and hauling meters to and from the testing shops is obviously a part of the company's expense of distribution. Since the company owns and is responsible for all meters, no one but its employees or agents should be allowed to disconnect or install any meter.

The refund to customers (p. 65) is so arranged that the customer recovers only the probable excess in charge during the previous three months. We can not assume that the meter has been uniformly coming to its error at the time of test and that, therefore, the refund should be for half the time which this meter has been in use. Although this practice is followed in some cities, it seems better to use a uniform period of three months for determining the amount of refund. This latter plan saves much quibbling between company and complainant, to the advantage of both.

A number of cities require that the company shall test any meter upon request of the customer using it rather than that the inspector shall make all complaint tests. If such a regulation is desired, it can be made by insertion of the following paragraph as part of section 11 (p. 64):

> Any meter shall be tested free of charge by the company, upon complaint of a customer. *Provided*, First, that said meter has not previously been tested by the company or by the inspector within one year of said complaint; second, that the customer shall agree to accept the result of such test by the company as a basis for settlement of the difference claimed.

There are probably only a small number of complaints which will come under this rule, since if the customer, after explanation, is not convinced that his meter is correct, he would prefer to make the required deposit and have an official test. However, certain complaints which are well founded will be met by it, and the company will gain more by its enforcement than they will lose in expense. It is also fair that the company should have this opportunity to deal justly with its customers, rather than that all complaints should go directly to the city inspector and the company be given no previous opportunity to adjust them.

Testing oftener than once a year is unnecessary. Few cases will ever be met where this frequency of test is demanded, and it can scarcely work any

hardship to the company. A second test within a year should be made when demanded, but the charges must then fall on the customer unless the meter shall prove to be fast.

A rule has been in force in Wisconsin for three years requiring the company to make a test on request of any customer, not oftener than once in six months, and it has been found to work no hardship there.

If the complaining customer will not agree to accept the results of the company's test, it is best he should be served by the inspector's test, whose accuracy he can not question. If such test is desired the fee of $1 is reasonable, since the company will bear the expense of removal of his meter and replacement by one recently tested. The basis of settlement referred to here should be the same as that described in paragraph (e) unless the particular case gives obvious reason for choice of other terms.

It would seem rather unnecessary to include in the section on meter testing the requirement that the inspector give written notice both to the customer and to the company before testing a complaint meter. These notices are required in a few cities, but where the proper sort of inspection is provided, they are not needed, even as a matter of form. Similarly, a statement that the customer may be present at the time of testing of his meter seems unnecessary, although such privilege should be granted by the inspector when it is requested.

6. INSPECTOR—APPOINTMENT, DEPUTIES, DUTIES, ETC.

The advantage derived from examining the inspector before appointment leaves no doubt as to its advisabiltiy whenever possible. Where a city has an established municipal civil-service system, the form proposed (p. 60) can be eliminated or incorporated into the existing plan of appointments.

The necessary restrictions as to who is eligible have such obvious purpose that comment seems scarcely needed. The gas company should welcome all precautions that will protect it from the charge of undue influence over the inspector or the inspection work. However, it should not be supposed that a man formerly in the employ of a gas company is disqualified for the position of inspector, as has been contended in some cases. Such experience would be a valuable preparation for this position.

As examples of the harm which may come from the lack of the considerations here noted, we cite three cases which have come under the notice of the Bureau of Standards where the situations were as described, at the time these officers were visited by a representative of this Bureau.

City A; population in excess of 200 000: The inspector was directly interested and actively engaged in the manufacture of gas meters. He left his office wholly in charge of an assistant who knew nothing of the scientific or technical details of gas or meter testing. The efficiency of the office may be imagined from the method of testing. This was accomplished by filling a large 10 or 15 gallon tin can with the gas and carrying such sample

(confined over water) from the works of the company to the office of the inspector. Here it was used for a determination of candlepower. This process was carried out about once in three months. The laws controlling gas manufacture in this city had been in effect 41 years without change.

City B; one of the largest cities of the country: The inspector was a politician with no knowledge of the tests required by the local gas ordinance. Fortunately, however, his first assistant was a capable man. The salary of the inspector was $3500 per year; the tester who had charge of all the work received about $2500.

City C; another large city: The inspector, a political appointee, had held office for two years and was at the time of the visit getting acquainted with his duties and becoming trained in making the few tests he undertook. At this time, however, he was just about to be replaced by a new inspector through change of the local administration.

Under such inspection the public can feel no security as to the service rendered by the gas company, and with many cities in similar conditions it is to the credit of the gas companies that such good service is found in the majority of places.

An ordinance requirement, similar to the one proposed, was recently adopted in Minneapolis, according to which the examining board was constituted as follows (see p. 94): "That the head of the department of chemistry and the head of the department of physics of the Minnesota State University and the principal of the Minneapolis Central High School shall constitute a board for the examination of all persons desiring to apply for such position of inspector." A similar membership would not generally be possible, but the same idea can be applied in a very large number of cases. The members of this board should be selected for their ability and willingness to judge the qualifications of the applicants for the position of inspector. They should be fitted to examine the chemical, engineering, and executive business ability of the candidates, and hence the board may well consist of a chemist, an engineer, and a business man. None of the members of such board should be connected either with the political offices of the city or the city council, without good reason. The choice of men to compose the board who are well known in their professions and whose integrity is above question, will be a long step toward securing an inspector who will be fair and satisfactory to all concerned.

It is an open question whether or not the gas company should be represented upon the examining board. The best results will probably be gained, not only for the city but also for the company, if the latter takes no part in the matter of the appointment of inspectors. It is, however, fair to receive suggestions from the gas company as to the character of the examination. It must not be forgotten that the applicants expect to *test* the gas, not to *make* it, and their knowledge of testing methods is more essential than their familiarity with works management, even though the latter be not wholly neglected.

Where a suitable board of three is not available, a smaller number may be used. Care should be exercised when there is a single examiner that personal interest or prejudice can not be charged against such person.

The city chemist or city engineer may serve to advantage on such board, but the further removed from city officials' influence the examining board is, the better.

No uniform rule can be made as to the remuneration of the examiners. In many cases no compensation is necessary, as when those selected to serve in this capacity will consider it their duty as citizens to render such service. The fee might vary between $10 and $25 per member, and would have to be paid usually not oftener than once in two years.

The meetings for examination should be so arranged that all who are qualified and desire to apply can be examined. A public notice in advance is essential (see p. 60).

The character of the examination will be determined by the number of applicants and the qualifications which they possess as well as by the duties prescribed by the city for the office in question. The information and directions to be given in a later circular of this Bureau will offer a basis for the questioning of candidates. Actual experimental examinations may at times be desirable, though they are much more difficult to carry out in practice.

The oath of office and the bond required can be adjusted to meet local conditions. The amount of the bond, if this is desired, will vary with the amount of funds handled by the inspector.

In general the inspector should hold office for the same period as the other city officials (p. 52). Too frequent appointment of new men increases the chance of inexperience and its attendant inefficiency. The first appointment should be made as soon as possible after the passage of an ordinance to fill out the partial term remaining till the next regular time for such appointments.

The salary of an inspector is determined by the local conditions and by the number and frequency of tests required of him. In any event, a competent, well-paid inspector is the most economical in the long run. An inefficient inspector may cause trouble between city and company, and will often cause more expense through legal difficulties than is saved by the lower salary. In many cases the city gas inspection will require much less than the whole of a man's time; in such cases an efficient worker who is at the same time employed elsewhere can often be procured to direct the work or even to carry it out himself.

The provisions of section 3 (p. 60) are necessary, in order that in the absence of the inspector the regular official testing can be done. The deputies should be able to carry out the regulations of the ordinance even in the absence of the inspector, but the assistants, while competent to make any one form of test, need not be familiar with all the various duties of the inspector. In small cities no deputies or assistants may be necessary, but at least one deputy may be appointed, even though he may take no regular

part in the official work nor be upon the pay roll of the city, except in the absence of the inspector.

The proposed section on duties of the inspector (p. 61) is drawn to cover the most comprehensive cases and must be shortened or modified to fit the other sections as they may be adopted in any case. However, there is very little that will need change for even smaller cities, since the duties defined are, in general, only such as would naturally accompany the office of inspector, whether this officer be specially appointed for this work, or one of the other regular city officials to whom the gas testing has been assigned. From the standpoint of the inspector these duties should be guarded by two precautions: First, every effort should be made to avoid giving cause for an antagonistic attitude on the part of the company, since it is only by friendly cooperation in such testing and inspection work that the greatest success can be attained; second, great care must be exercised in handling complaints, even though they are often based upon imaginary trouble, in order to protect the company and the inspector from unjust criticism.

The customers of gas companies often have excellent ground for complaint, but due to their unfamiliarity with meters and the difficulties of gas distribution they sometimes complain without reason. However, the public pays both for the gas it uses and for the cost of inspection, and is entitled to courteous and patient treatment when it complains.

Provision is made in section 4, paragraph (d), that the monthly report of the inspector or an abstract of it shall be published. This would give considerable publicity to the matter and might offer an added incentive to the company to furnish gas always within the specified limits. An exaggerated advertisement of a slight deficiency in a way to subject the company to unfair criticism, of course, is to be condemned; however, the simple statement that the quality of the gas was found to be above standard or deficient to a certain degree might be of some advantage in any city.

7. MISCELLANEOUS REQUIREMENTS

Testing Stations.—A city of class 2 or class 3 needs, in general, only a single testing station, but a city of class 1 may require a larger number. In any city where two companies distribute gas over the same district a single station may easily be equipped for testing the gas from both.

Geographic considerations are very important, since in a closely settled city such as New York, with a high consumption of gas per mile of main, the stations need not be so numerous in proportion to consumption as otherwise. The reverse case is found in many middle-western cities where six or eight million cubic feet per day is distributed over an area nearly as great as that covered by twenty million in an eastern city.

The location of testing stations will, in a measure, determine their number, since when one station can test the gas supplied to a whole district there is no need for a second station, even though the consumption may be four or five million cubic feet daily. Again, a station may be required at

some points where only half a million cubic feet is the daily output, since the tests at no other station would be affected by the gas going to such district. This latter case is particularly true where the company has several manufacturing plants in operation. In general, there should be at least one station for each manufacturing plant.

The location of the testing station at the proper point has an important bearing upon the efficiency of the testing done, for, if the gas tested does not really represent that throughout the station's district, the results are misleading and unfair either to the company or to the public. Definite requirements as to location of the station are made in the ordinance (p. 61) in order to insure that these essential conditions are met.

In small cities the location of the testing equipment in the office of some other city official can advantageously be made. Under these circumstances the restriction of distance from the works may be impossible. Since the gas during its first mile of travel changes very much in quality this restriction should be complied with, if possible; unless, indeed, the large majority of the consumers are located as near the works of the company as the testing station itself.

After a laboratory is properly located the lack of a proper service-pipe connection may render good results difficult. Such trouble is met with when the service pipe is too small, or too long, or when it passes through a long air shaft, or through a cold basement or hot furnace room, or has many side connections. The service pipe should be as short as possible, with few or no turns and the least possible change of temperature from the main to the laboratory. No testing station should be chosen where the conditions do not permit approximate compliance with the above requirements of service connection.

No pains should be spared to make the tests required representative of the gas of the district in which such tests are made. The inspector, when properly qualified for his position, is well fitted to superintend the purchase and installation of the necessary equipment. Therefore, his recommendations as to the laboratory, the office, and their equipment should have great weight. The details of station equipment are now being investigated by this Bureau and a discussion of certain phases of this question will be included in the circular on methods of testing.

Gas Testing Expense.—The expense of gas testing may be divided as follows:

(1) Equipment expense, consisting of service pipe and blow-off connection, laboratory apparatus, office furnishings, and meter-testing equipment.

(2) Current expense, including rent of testing stations, rent of meter shop, salaries of inspector and assistants, and supplies for office and laboratory.

Certain parts of each kind of expense seem to be reasonably chargeable to the company and others to be chargeable to the city treasury. However, no general rule can be laid down for the distribution of the expense. In some cities the expense is borne entirely by the city, in others chiefly by the gas companies, and in still others the expense is divided.

Company Records.—The requirement of keeping records, as proposed in section 12 (p. 65), is reasonable; similar records should be kept by any progressive company, even without requirement. This section then becomes merely a requirement that the company shall allow access to its records. The necessity for this use of company records by the inspector will be apparent in connection with complaints which come to his office. The data required to be kept are essential to intelligent action in many cases, and will furnish the inspector with the necessary facts for action on each case as it arises. It will also insure that the inspector sees "the other side of the story" when a complaint is made to him.

All of the records required are simple except the fourth (p. 66). The great importance of the latter to the company as well as the inspector makes it essential that such record be kept.

The first two records combined give full information in the meter-testing work. There is no more ready means of dealing with meter problems than by having full data of each meter and a full record of each customer on a card which can be found in an instant by reference to a file.

The use of such files by the company's "complaint department" will amply repay the time and expense of its installation and maintenance, and when this file is open to the inspector he can more fully appreciate the company's standpoint in each situation which may demand investigation on his part.

The complaint file, arranged by the residences of complainants, provides a defense for the company against the charge that is often made that no attention was paid to complaints made by the customers. When such file is examined with reference to subjects of complaint it is an instructive means of showing the necessary changes in equipment or policy needed to bring about friendly relations between the company and its customers.

It should be noted that no record of a complaint is required except when a violation of this ordinance is charged. Complaints as to "high bills" and "poor gas," when supported by no definite information, are often due to a misunderstanding of the facts. When disposed of by a simple explanation they need not be recorded. However, the company must not disregard such complaints, as the provisions of section 14 include "all complaints."

The "map record" is frequently required by cities, but generally in connection with the franchise ordinance. An example of this type of provision is to be found in the Minneapolis ordinance, quoted on page 95 of this circular.

Penalties.—Two forms of penalty are imposed by various cities. The first and most common form is a fine, and less frequently a rebate to all customers. A rebate to be paid to all customers is a cumbersome method of penalizing a gas company and with a proper ordinance and an efficient testing department would never be necessary. A fine for failure to comply with the ordinance is then of course necessary.

The fines are stated in the proposed section (p. —) as $X and $Y according to the seriousness of the offense, $X being a larger sum than $Y. The obvious advantage of making a distinction between an offense causing serious loss or danger to the consumers and one involving only inconvenience of rather temporary character, needs no emphasis.

As the size of a city largely determines the seriousness of offense, X and Y can be varied to fit local conditions. As an approximation as to the size of fines now in use or desirable we would submit the following:

Cities of class 1,	$X = $200–1 000	$Y = $50–200.
Cities of class 2,	$X = 50– 200	$Y = 10– 25.
Cities of class 3,	$X = 10– 25	$Y = 5– 10.

The conditions for penalties specified in parts (1) to (7) have already been discussed under the sections where the corresponding requirements are made. In cases (8) and (9) either of two circumstances is sufficient for penalty, but both penalties of either paragraph could not be collected for a single offense; however, penalty might be demanded under both (8) and (9) for the same day. The "written permission of the inspector," referred to in cases (10) and (11), should be granted only when the company can not test and seal meters for installation as fast as they are required.

The cases of exemption from penalty described cover all of the cases in which reasonable objection can be made. If the tests made with the privilege of supervision by a representative of the company are not satisfactory to the company, the method of settlement is provided elsewhere (sec. 15); unless it avails itself of such method, it should be held to the fines as here required.

By the system advocated and described in section 14 (p. 68) company can pay the penalty, and without any legal proceedings can settle the matter. However, when it desires to defend itself against the charges made, it will have ample opportunity to do so by mere refusal to pay within 10 days and the use of the regular methods of defense in the proper courts.

The suit for payment of the amount claimed can be brought in any proper court of the city by any officer to whom the city council wishes to to assign this duty. Since the city clerk receives a copy of the report, he should be responsible for bringing it to the notice of the officer who takes the legal action whenever the company should thus be compelled to make payment. A delay of payment may be allowed by the city council in order to settle any dispute by means of the arbitration methods elsewhere described. When such arbitration proceedings are pending the fines affected by their decision should be made subject to such decision.

Disputes over Testing Methods.—One of the most frequent sources of trouble between the gas inspectors and the gas companies has been the selection of testing methods and the interpretation of inspection results. In order largely to eliminate such difficulty, it has proven desirable for a city to adopt rather detailed provisions in its gas-testing ordinance, and such provisions have been embodied in the ordinance proposed. However,

it is clearly impossible to provide for all details in the ordinance itself and some means of settlement of differences is desirable. A few American and a large number of English cities have for this purpose made reference to the reports of the London gas referees and thus made them the basis for settlement. This course has proven very satisfactory for the English cities, but, because of the different conditions in the manufacturing methods of the two countries, the American cities have found this reference to English practice less satisfactory.

In order to furnish to the American gas inspectors a source of information on standard testing methods, the Bureau of Standards is preparing to issue a circular on this subject which will represent not only a summary of work done at the Bureau but also a review of the experience of some of the well-known gas chemists and municipal inspectors. This circular will be revised from time to time in order to have it at all times represent the latest available information. In anticipation of this publication the third paragraph of section 6 (p. 62) proposes that all matters of dispute shall be settled in accordance with the provisions of such circular.

In the preparation of this circular all conclusions expressed as to apparatus or methods of testing will first be confirmed either by actual experience of the Bureau with such apparatus, or by the agreement of the majority of those who have given fair trial to the method in question.

When prepared on this basis it seems certain that the reference to such circular as a basis for settlement can be made with the assurance that the result of such reference would be as fair to both parties as is possible with the existing knowledge and experience. The effect of any change in such circular upon the methods or apparatus used in testing would be limited by the definite provisions of the ordinance itself, and so could not work serious injury either to the gas company or to the public.

Section 15 (p. 68) provides also a technical board of last resort. Since cases not covered by any other sections or provisions can readily be imagined and may on rare occasions occur, they should be provided for. It is more desirable that this be done by the arbitration board than by the courts, which in most cases are not familiar with the technical points involved. Resort to this board would be only of rare occurrence.

C. PROPOSED CITY ORDINANCES

The following rules have been arranged as far as possible in the form and wording suitable for a municipal ordinance. They should, however, be read in connection with the discussion given above. The character, object, and scope of the rules suggested have also been discussed in the general introduction to this circular.

The proposed ordinance is intended for use under ordinary conditions, and should be modified where necessary to meet unusual conditions.[7c] After

[7c] The proposed regulations are not the most severe which could be enacted; but they are probably sufficiently rigid to offer good protection to the gas users under ordinary conditions of manufacture.

an examination of nearly all existing gas ordinances, the Bureau has attempted to embody in the following proposed ordinances the best features of existing ordinances and such additional matter as seemed necessary, and to arrange the several sections in a logical and convenient form.

No opinion is expressed by the Bureau as to whether in any particular class of cities a candlepower requirement, or a heating-value requirement, or both, should be made. Some cities require one, some require the other, and some require both. The proposed ordinance contains both, but this should not be interpreted as meaning that both are necessary in every case.

Several considerations influence the classification of cities as to the type of gas ordinance required. The most important considerations are: (1) The size of city, or area covered by the gas system, and (2) amount of gas distributed.

When there is more than one company in a city the number of separate tests of gas per week may be greater than if one company served the entire city, but the requirements and methods of test would generally be the same, and no distinction is therefore made in the proposed ordinance.

The amount of gas distributed is perhaps the most general means of classification. When the area covered is greater than the average, the number of testing stations may be increased. The rules given below are, however, intended to meet normal conditions:

Class 1 includes all cites where the annual sales are 500 million or more cubic feet.

Class 2 includes cities where the annual sales are between 500 and 50 million cubic feet.

Class 3 includes cities where the annual sales are less than 50 million cubic feet.

The following ordinance is intended to apply as it stands to cities of class 1, and with a few slight changes, suggested on page 68, to cities of class 2 also. A second briefer ordinance, intended especially for cities of class 3, is given on pages 69–71.

FOR CITIES OF CLASS 1

AN ORDINANCE Providing for the appointment of a gas inspector and defining the duties of such officer; providing for the inspection of gas and gas meters; prescribing rules and regulations for the quality, pressure, and measurement of gas supplied to consumers, and for the enforcement thereof; and prescribing penalties for the violation of such rules and regulations.

The mayor and city council of ——— do ordain as follows:

SECTION 1. *Definitions.*—In this ordinance and the various sections and parts thereof the words "city" and "company" shall be understood, taken and construed to refer, respectively, to the city of ——— and the ——— Gaslight Company; the word "gas" shall include any and all gas made by said company and distributed for the use of either public or private consumer in said city; the word "customer" shall include any person, company, corporation, or other party to whom said gas company shall furnish gas for use within said city; and the words "mayor," "city clerk," "city treasurer," "inspector" and "city council" shall be under-

stood and construed to refer, respectively, to the mayor, the city clerk, the city treasurer, the gas inspector, and the city council of said city of ———.

SEC. 2. *Appointment of Inspector.*—The city council shall, at the time specified for the appointment of other city officers, appoint as inspector a suitable person who is qualified and recommended to the city council as hereinafter provided (p. 51).

The inspector, his deputies or his assistants, shall not be pecuniarily interested, either directly or indirectly, in the manufacture or sale of gas, gas meters, or any article or commodity used by gaslight companies, or used for any purpose connected with the consumption of gas. The inspector, his deputies or his assistants, shall not give certificates or written opinions to a maker or vendor of any such article or commodity.

A and B and C shall constitute a board for the examination of all persons who shall apply for the position of inspector. Said board shall give public notice of the time and place of such examination at least one month before the same is to be held, and the notice shall be published in the official papers of the city at least twice each week during said month. At the time and place so fixed the board shall examine all applicants, in such manner as it shall deem necessary, to determine their technical knowledge and competency to perform all duties of inspector, as called for in this ordinance (p. 52).

Said board shall, within two weeks after such examination, certify to the city council the names of such persons as said board shall deem fully competent to make such tests. Only persons whose names are so certified shall be eligible to be appointed inspector: *Provided, however,* That any person who shall previously have held the office of inspector may be reappointed to said office without such certificate from the board: *Provided also,* That a person who has once been certified as competent by said board shall be subsequently eligible for appointment without again being examined thereby during a period of five years from such first examination.

The inspector shall take and file an oath of office such as is required of other city officials (p. 53).

The inspector, appointed as hereinabove provided, shall serve for a term of two years, or until his successor shall be properly appointed. The salary of said inspector shall be ——— per annum (p. 53).

SEC. 3. *Deputies and Assistants.*—The inspector, with the consent and approval of the city council, may appoint one or more deputy inspectors. Each of said deputies shall be competent to perform any or all tests herein provided for which he shall be required or directed to make. Said deputies so appointed shall have the power, under the direction of the inspector, to perform any duty which may be required of the inspector under the provisions of this ordinance (p. 53).

The inspector, with the consent and approval of the city council, may appoint one or more assistants or clerks (who need not necessarily be competent to make the tests herein provided for) who shall, under his direction, aid in the performance of the duties of this office (p. 53).

Each of said deputies and assistants shall take and file an oath of office such as is regularly required of other city officers.

SEC. 4. *Duties of the Inspector.*—The inspector in person or by deputy or assistant shall perform the following duties (p. 54):

(a) He shall test or determine, as hereinafter prescribed, the quality and pressure of the gas and the accuracy of gas meters. He shall have full charge of all testing stations, laboratories and offices provided for his use for such testing and for the keeping of records.

(b) He shall receive and investigate complaints regarding the quality of the gas or gas pressure or the accuracy of gas meters (p. 54).

(c) He shall keep at said office a record of all tests, calibrations and formal complaints, which shall be preserved complete and correct. He shall open said records to the company and, in his discretion, to any person who wishes to examine the records.

(d) He shall make a monthly report of the tests made as to candlepower, heating value, impurities and pressure of the gas, and of the tests made of gas meters. One copy of said report shall be sent to the company, one to the city council and one to the city clerk, and the whole or an abstract of said report shall be published by the city clerk in the official papers of the city. The inspector shall also render monthly an itemized statement of the amount due to the city from the company for penalties or fees required in section fourteen of this ordinance (p. 68).

(e) He shall make a special report to the city clerk whenever the quality or pressure of the gas shall be shown by test not to conform to the requirements of this ordinance. The substance of said special report shall be communicated to the company by telephone or by special messenger from the inspector immediately upon completion of the test which showed such condition to exist. A confirmation of any such telephone message shall be delivered to the company in writing not later than the next working day following that on which the test is completed, and the company shall acknowledge in writing the receipt of the report when so requested.

(f) He shall perform any and all other duties naturally connected with this office as required or implied by any part of this ordinance, or as specially assigned to him at any time by the city council.

SEC. 5. *Testing Stations.*—(a) As soon as practicable after the passage of this act the city shall provide and maintain the necessary testing stations, and it shall equip and maintain the same with such apparatus and supplies as may be needed for carrying out the provisions of this ordinance. Said stations shall be located at or near centers of gas consumption, and, if possible, shall not be less than one mile nor more than two miles, measured in a direct line, from any manufacturing plant of the company (p. 54).[8]

(b) The company shall run a special service pipe into each of said testing stations, the same to be of such size and installed in such manner as

[8] "Measured along the shortest line of gas mains from ——" may be preferable in a city where measurement in a straight line would allow the location of a station at a point more than 2 miles away from the works by the nearest line of gas mains, which at the same time was only about a mile away in a straight line; however, measurement in a straight line prevents ambiguity, chance for dispute as to along which line of main the measurement shall be made, and necessity of change of measurement and of location, because of possible changes in main connections after the station has been selected.

may be directed by the inspector: *Provided*, That the company shall be allowed to so protect this service as to prevent its exposure to temperatures lower than those of the gas-supplying main (p. 55).

(c)[9] One of said testing stations shall also be equipped by the city with a gas meter prover and all the necessary appliances which the inspector shall require for the testing of such meters as are tested on complaint, under the regulations of paragraph (e) of section eleven of this ordinance (p. 48).

SEC. 6. *Methods of Testing—General Provisions.*—The tests provided for herein shall be made by the inspector or his authorized assistant, and the company may, if it so desires, have a representative present at any of said tests (p. 57).

All tests of the quality of the gas used in the determination of liability for any penalty of section fourteen shall be made at the regular testing stations. Special tests of gas quality may be made at places other than the regular testing station without notice to the company, and the results of such tests may be communicated to the company, at the discretion of the inspector.

The character of the apparatus, equipment, and supplies used in all testing, the standardization or calibration of said apparatus and equipment, the testing of said supplies, and the methods of making official tests shall be as determined by the provisions of the current issue of the National Bureau of Standards' circular, "Methods of Inspection and Testing of Illuminating Gas," except in so far as said provisions may be contrary to any part or section of this ordinance (p. 58).[10]

All of the equipment and apparatus used in making any tests shall be tested for accuracy from time to time, so that said tests made therewith shall be as accurate and fair as is reasonably possible.

Unless otherwise provided a cubic foot of gas shall mean that amount of gas which occupies the volume of one cubic foot under the pressure of thirty inches of mercury and at the temperature of sixty degrees Fahrenheit, when saturated with water.

SEC. 7. *Candlepower.*—The gas supplied by the company when tested as herein provided shall show a monthly average candlepower of not less than ——— International candles, and it shall show a daily average candlepower of not less than ——— International candles (pp. 32–36).

(a) The candlepower of the gas shall be determined by the inspector at least once each working day at each of the testing stations provided in section five of this ordinance. The average of all of the results thus obtained on any one day, at the various testing stations, shall be considered the daily average candlepower for that day: *Provided, however*, That less than two single determinations shall not be used to determine a daily average. The average of all of the daily averages, obtained thus during any one calendar month, shall constitute the monthly average candlepower for that month: *Provided further*, That not less than twenty daily averages shall be used to

[9] Omit (c) paragraph if city tests all meters at company's shop.
[10] It is not intended that this paragraph be adopted by any city until after the second circular is issued.

determine a monthly average upon which penalty is demanded under section fourteen hereof (p. 33).

(b) The candlepower determination shall be made upon the gas burning at the rate of five cubic feet per hour, measured under existing atmospheric conditions,[11] from a Bray "No. 7 Slit Union Burner," or such other open-flame burner as may be agreed upon by the inspector and the company (p. 34). Subsequent correction shall be made for the effect of temperature and barometric pressure, so as to determine the candlepower that would have been observed if the gas had been measured at sixty degrees Fahrenheit and thirty inches of mercury pressure (p. 35).

(c) The standard lamp used for comparison shall be a "10-candlepower pentane lamp." This lamp shall be tested and certified by the National Bureau of Standards, and the value assigned to it by such certification shall be used in the measurement of the candlepower of the gas (p. 35).

(d) The photometer employed shall be of the open-bar type, of a make generally accepted as correct and reliable (p. 36).

(e) The measurement and calculation of the candlepower of the gas shall be made in the manner specified in the current issue of the National Bureau of Standards' circular, "Methods of Inspection and Testing of Illuminating Gas" (p. 57).

SEC. 8. *Heating Value.*—The gas supplied by the company, when tested as herein provided, shall show a monthly average gross heating value of not less than six hundred British thermal units per cubic foot of gas. However, no daily average gross heating value of the gas shall be less than five hundred and fifty British thermal units per cubic foot of gas (pp. 37–40).

(a) The heating value of the gas shall be determined by the inspector at least once each working day at each of the testing stations provided in section five of this ordinance. The average of all of the results thus obtained on any one day at the various testing stations shall be considered the daily average gross heating value for that day: *Provided, however,* That less than two single determinations shall not be used to determine a daily average. The average of all the daily averages, obtained thus during any one calendar month, shall constitute the monthly average gross heating value of the gas for that month: *Provided further,* That not less than twenty daily averages shall be used to determine a monthly average upon which penalty is demanded under section fourteen hereof (p. 38).

(b) The determination of the heating values of the gas shall be made by means of a gas calorimeter with the necessary accessories, of an approved form (p. 39). The operation of said calorimeter and the calculations of the resulting data shall be according to the specifications in the current issue of the National Bureau of Standards' circular, "Methods of Inspection and Testing of Illuminating Gas" (p. 57).

SEC. 9. *Impurities.*—The gas supplied by the company, when tested as prescribed herein, shall not show the presence of any hydrogen sulphide, and shall contain in one hundred cubic feet of gas not more than thirty

[11] This form is for water gas or mixed gas; see p. 35 for changes if coal gas is to be tested.

grains of sulphur in any and all forms, known as "total sulphur," and not more than five grains of ammonia (pp. 41–42).

(a) Once each working day at each station the gas shall be tested for hydrogen sulphide by exposing a strip of white filter paper, freshly moistened with a solution containing six and one-half per cent by weight of lead acetate, to a stream of the gas flowing at the rate of five cubic feet per hour for three minutes. The gas shall not impinge directly from a jet upon the test paper. The gas shall be judged free from hydrogen sulphide if the paper thus exposed shall show no darkening perceptible by comparison with another similar strip of paper which is wet with the same solution but has not been exposed to the gas (pp. 40–41).

(b) The determination of total sulphur and ammonia shall be made once each week at each testing station by any method which is known to give accurate and reliable results: *Provided*, That if the gas shows on a first test either total sulphur or ammonia in excess of that allowed under the first paragraph of this section, a second determination shall be made beginning on the day on which said first test is completed; and the average of the two tests thus made shall be considered as representing the quantity of total sulphur or ammonia in the gas for that week (p. 42).

SEC. 10. *Pressure of Gas.*—(a) The gas shall be supplied by the company at a pressure of not less than two inches nor more than six inches of water pressure, measured at the outlet of the company's service pipes; and the daily variation in said pressure at any such outlet shall never exceed one hundred per cent of the minimum pressure during that period at that point (pp. 43–47).

Each testing station shall be equipped with a continuously recording pressure gauge by means of which a record shall be made of the gas pressure at said station. Additional gauges shall be employed regularly to determine the pressure of the gas at other places throughout the city (p. 47).

SEC. 11. *Meters and Meter Testing.*—Every meter which shall be used by the company for the measurement of gas supplied to any customer shall be tested by the company under the supervision of the inspector, and if found correct, shall be sealed by it before installation for use (p. 47). The rules given by the National Bureau of Standards in the current issue of the circular on "Methods of Inspection and Testing of Illuminating Gas," shall determine the method of said testing (p. 57). Any meter which, when tested in the manner provided, shows in comparison with a standard meter prover, an error of not more than two per cent shall be considered correct within the meaning of this act (p. 48).

Meters shall be tested as follows (p. 49):

(a) During each period of one year after the passage of this ordinance, until all such meters have been tested, the company shall remove not less than twenty per cent of the meters now in service. Said meters shall be tested and sealed, as required of meters described in paragraph (c) of this section. The removal of said meters now in service shall be made as nearly as possible in the order of the length of time since they were last tested, those longest in service being removed first (p. 49).

(b) All new meters purchased by the company and all old meters which shall have been repaired or adjusted shall be tested and sealed before installation (p. 47 ff).

(c) Any meter which for any cause shall be removed from its place of installation after a period of more than three years from the date of its last testing and sealing, shall be again tested and sealed before being again put into service (p. 50).

(d) No meter after being once tested and sealed shall be allowed to remain in service longer than five years before being again tested and sealed, as provided above (p. 49).

(e) Upon application of any customer and after deposit by said customer of the sum of one dollar with the inspector, the inspector shall test said customer's meter in the manner prescribed above. If the meter proves to be slow or correct, one-half of said deposit shall be paid to the company and one-half of the deposit shall be paid into the city treasury by the inspector, as a fee for said test. If the meter proves more than two per cent fast, the company owning the meter shall pay into the city treasury fifty cents as the fee for said test, and the deposit of one dollar shall be returned to said customer; and further, the company shall refund to the complaining customer such a percentage of the amount of the bills for the three months just previous to said complaint. or for the time said meter was in use not exceeding three months, as the meter shall have been shown to be in error at the time of said test. If the meter proves more than two per cent slow, the company may charge to the complaining customer such percentages of the amount of the bills for the three months just previous to said complaint, or during the time said meter was in use not exceeding three months, as the meter shall have been shown to be in error at the time of said test (p. 50).

The removal and transportation of all meters shall be done by the company at its own expense, except as provided in the preceding paragraph.

For purposes of supervision of the testing of meters the inspector shall have access at all reasonable hours to the shops of the company where such tests are made and to the records of all such tests as are performed under the provisions of this ordinance. He shall be allowed at any time to examine or calibrate the provers used for the testing of meters and to check the results of tests on any number of meters which he may wish to examine. This supervision shall be such as not to interrupt the regular testing work of the company more than is necessary to insure careful and accurate tests of all meters, and the company shall in no case be relieved of the responsibility for the accuracy of its meters.

SEC. 12. *Company Records.*—The company shall maintain complete and correct records, described hereinafter, and shall allow free access to said records at all reasonable hours to the inspector or other city official who may be authorized by the city council to have such privilege (p. 56).

The records shall include the following:

First. A record of all customers purchasing gas from the company and the number of the meter or meters in use by each.

Second. A record of all the meters owned by the company, with the date of their purchase and a record of the use, repairs and tests to which each has been subjected, with the result of each testing and the location of each meter.

Third. A record of all complaints made to the company regarding (a) the quality of the gas, (b) the pressure of the gas and (c) the accuracy of meters, and of the method of disposal of each of said complaints.

Fourth. A record with the necessary maps and charts of all gas mains, gas-service pipes, governors and other connections or appliances owned and used by the company in the distribution of gas (p. 56).

SEC. 13. *Complaints.*—The company shall make a reasonable investigation of all complaints made to it by the city or by any customer, and shall promptly make all such changes, alterations or additions to its methods or apparatus and equipment as may be necessary in order that the quality and the pressure of the gas shall be such as is required by the provisions of this ordinance. When requested by any complainant, the company shall inform said complainant as to the results of said investigation, stating the cause of the difficulty and the approximate time when it will be corrected.

SEC. 14. *Penalties.*—The company shall be subject to and shall pay to the city a penalty of the amount herein stated, whenever and as often as it shall violate this ordinance and shall be convicted thereof, in the manner hereinafter provided, in each of the following cases, viz (p. 56):

(1) In case that the daily average candlepower of the gas shall be less than ——— International candles on any day, ——— dollars ($Y) for each such day (p. 33).

(2) In case that the monthly average candlepower of the gas shall be less than ——— International candles in any month, ——— dollars ($X) for each such month (p. 33).

(3) In case that the daily average gross heating value of the gas shall be less than five hundred and fifty British thermal units per cubic foot of gas on any day, ——— dollars ($Y) for each such day (p. 37).

(4) In case that the monthly average gross heating value of the gas shall be less than six hundred British thermal units per cubic foot of gas for any month, ——— dollars ($X) for each such month (p. 37).

(5) In case that hydrogen sulphide is shown by the specific test provided therefor to be present in the gas for three successive working days, ——— dollars ($Y) for each day within such period of three or more working days (p. 40).

(6) In case that the total sulphur is found by any two tests, made as specified in section nine, to be in excess of thirty grains per one hundred cubic feet of gas, ——— dollars ($Y) for each such week (p. 41).

(7) In case that the ammonia is found by any two tests, made as specified in section nine, to be in excess of five grains per one hundred cubic feet of gas, ——— dollars ($Y) for each such week (p. 41).

(8) In case that the pressure of the gas at any service pipe is at any time less than equivalent to one inch of water pressure, ——— dollars ($X) for each day when such pressure shall occur, or in case that the pressure of the gas at any service pipe is at any time less than equivalent to one and one-half inches of water pressure, but during the same day never less than equivalent to one inch of water pressure, ——— dollars ($Y) for each day when such pressure shall occur (p. 45): *Provided, however,* That if the deficiency of the pressure noted is due to a stoppage of the single service pipe to the point of test, then the company shall not be held liable for the penalty of this section unless such stoppage is not removed by the company within three days from the time when such pressure deficiency is reported to the company.

In case that the gas pressure in any district shall be found to be less than equivalent to two inches of water pressure, due to insufficient capacity of mains to this district, then the company shall, if possible, correct this deficiency within three months of the time when it is first reported to the company: *Provided, however,* That if this deficiency of pressure be first reported to the company between November first and April first, then the company shall be allowed until the first of the following July to make such correction; but if at any time a pressure shall be reported to the company as less than one and one-half inches, then such extension of time shall not be allowed (p. 46).

(9) In case that the pressure of the gas at any service pipe is at any times greater than equivalent to six inches of water pressure, or that the pressure of the gas at any service pipe at any time during one day is more than equivalent to twice the pressure at the same service pipe at any other time during that same day, ——— dollars ($Y) for each such day (p. 44).

(10) In case that any meter which has not been tested and sealed by the company is installed or used by the company without the written permission of the inspector for such use or installation, ——— dollars ($Y) for each meter so used or installed (p. 47).

(11) In case that without the written permission of the inspector any meter is used or left installed for the use of any customer longer without testing and sealing than is allowed by section eleven of this ordinance, ——— dollars ($Y) for each such meter (p. 48).

(12) In case that after one month's notice in writing by the inspector the company shall fail or refuse to prepare, maintain or disclose such records, as they are required to do by provisions of this ordinance, ——— dollars ($X) for each week or fraction thereof during which they so fail or refuse to carry out said requirements (p. 56).

Provided, however, That the company shall not be liable for any one of the penalties hereinbefore specified—first, if the inspector shall not have given to the company such report as is required by paragraph (e) of section four hereof, regarding the test on which said penalty is claimed; or second, if the tests upon which said penalties are claimed were not made as "official tests," as defined in section six hereof; or third, if the conditions which caused the gas or gas service to be other than those which are required herein, were conditions beyond the control or prevention of the company

by reasonable care and forethought on its part (p. 56): *Provided further*, That the Sundays and holidays on which no tests are made shall not be considered in the determination of the number of successive working days which are necessary before penalty can be required, but said Sundays and holidays shall be counted in calculating the number of days for which penalty must be paid when said Sunday or holiday shall intervene between the first and last days of any one period for which such penalty may be demanded (p. 41).

The city clerk shall prepare monthly an itemized statement of the fees, fines, charges and other indebtedness which is due from the company to the city, as shown by the reports of the inspector, according to the provisions of this ordinance, for the month covered by said statement. Said statement shall be verified and sworn to by the inspector, and a copy of it shall be sent to the company. This statement shall be filed with the city treasurer. The company, within ten days of the delivery to it of said report, shall pay to the city treasurer the amount shown to be due by said statement; and if the company shall fail to pay said amount as herein required within said ten days, then the city, by its proper officials, shall at once take action as provided in section fifteen hereof or, if necessary, in the ——— court to compel the payment of said amount (p. 57).

SEC. 15. *Disputed Cases.*—In case of any dispute between the city or its inspector on the one side and the company on the other as to choice of methods or apparatus for testing the gas or for carrying out any provision of this ordinance which is not provided for elsewhere in this ordinance, then said dispute or difference shall be settled as follows: An arbitration board, as between the city and the company, shall be appointed—one member by the city, one member by the company and a third member by agreement between said first two members. The decision of these three, or a majority of them, shall be final, conclusive and binding upon all concerned[11a] (p. 58).

SEC. 16. *Repeal.*—All ordinances of the city and parts thereof contravening or inconsistent with the terms of this ordinance are hereby repealed.

SEC. 17. *Time of Becoming Effective.*—This ordinance shall take effect and be in force from and after ———.

FOR CITIES OF CLASS 2

For cities of class 2 the above ordinance would require very few modifications. As is indicated in the discussion of Part I,B, it is anticipated that most cities of this group would require only one testing station. If provision is made for only one testing station, then no change need be made in the other sections of the ordinance except sections 7 and 8, of which paragraphs (a) should then read:

The heating value [candlepower] of the gas shall be determined by the inspector twice each working day, at an interval of not less than four hours, at the testing station provided for by section five of this ordinance. The average of the two results thus obtained on any one day shall be considered the daily average gross heating value [candlepower] for that day. The

[11a] Suitable provision may be made in this section for the payment of this board.

average of all the daily averages obtained thus during any one calendar month shall constitute the monthly average gross heating value [candlepower] of the gas for that month. However, not less than twenty daily averages shall be used to determine a monthly average, upon which penalty is demanded under section fourteen hereof (p. 38).

FOR CITIES OF CLASS 3

It is recognized that a considerable number of small cities will find the provisions made in the ordinances proposed for cities of classes 1 and 2 rather more elaborate than is desirable for their use. Therefore, the following simpler ordinance has been compiled after a study of a number of ordinances now in force in cities of less than 25 000 population. In all cities where the application of the ordinance proposed above is feasible, it is recommended in preference to the following one, which is suitable only for towns and small cities up to 10 000 or 15 000 population. Since the discussion of Part I,B covers practically all the technical requirements made in the following ordinance, no special discussion is necessary.

Since it is probable that a small city will not need both candlepower and heating-value regulations, one or the other of these may be omitted from the following form. To accomplish such modification it will be necessary only to omit either the phrases relating to candlepower, which are inclosed in brackets in sections 3 and 4, or the corresponding phrases relating to heating value, which immediately follow these.

AN ORDINANCE Providing for an inspector of gas and gas meters, defining the duties of that officer, prescribing rules for the quality, pressure and measurement of gas, and for the enforcement thereof, and fixing penalties for the violation of such rules.

The mayor and city council of ——— do ordain as follows:

SECTION 1. *Appointment of Inspector.*—The office of inspector of gas and gas meters is hereby created. The city engineer shall serve as inspector of gas and gas meters, known hereinafter as inspector, and he is hereby required to perform all duties hereafter imposed upon said inspector. With the consent and approval of the mayor, the inspector may appoint a deputy, who shall be empowered to perform any of the duties of the inspector in his absence or at his request (p. 51).

SEC. 2. *Testing Station.*—As soon as practicable after the passage of this act the city shall provide a testing station at or near the center of gas consumption for the testing of gas, as provided for in this ordinance. Said station shall be furnished with such apparatus and supplies as shall be necessary to test said gas. The ——— Gas Company shall run a special service pipe into this station, the same to be of such size and installed in such manner as may be directed by the inspector (p. 54).

SEC. 3. *Quality of Gas.*—The gas supplied by the ——— Gas Company shall show [a candlepower of ——— International candles] a gross heating value of six hundred British thermal units per cubic foot, and shall not show the presence of any hydrogen sulphide when tested as provided herein,

and it shall not contain more than thirty grains of sulphur per one hundred cubic feet of gas (p. 41).

Once each working day the inspector shall test the gas for hydrogen sulphide, by exposing a strip of white filter paper freshly moistened with a solution containing six and one-half per cent, by weight, of lead acetate, to a stream of the gas flowing at the rate of five cubic feet per hour for three minutes. The gas shall not impinge directly from a jet upon the test paper. The gas shall be judged free from hydrogen sulphide if the paper thus exposed shall show no darkening perceptible by comparison with another similar strip of paper which is wet with the same solution but has not been exposed to the gas (p. 40).

SEC. 4. *Special Inspection of the Quality of Gas.*—Whenever and as often as the mayor has reasonable ground to conclude that the gas furnished by the ——— Gas Company is not of the quality required by this ordinance either as to [candlepower] heating value or purity, he may, without notice to the company, employ a disinterested gas expert to make a test of said qualities of the gas. And if said test, made as hereinafter provided, shall show the gas to be deficient in [candlepower] heating value or to contain amounts of sulphur in excess of that allowed by this ordinance, then the company shall pay the expense of said test and shall also be liable for the penalties required by section ten of this ordinance; but if the gas prove to be of the quality herein required the city shall bear the expense of said testing.

The character of all apparatus and methods employed for the testing of gas, gas pressure or meter accuracy, as required by this ordinance, shall be as determined by the provisions of the current issue of the National Bureau of Standards' circular, "Methods of Inspection and Testing of Illuminating Gas," except in so far as said provisions may be contrary to any part of this ordinance. And, in the event that said circular shall make no provision regarding any point of difference or dispute, the decision of a board, composed of one person selected by the city, one person selected by the company, and a third person selected by said first two persons, shall be binding upon both city and company for a period of at least two years.

The ——— Gas Company may have a representative present at any regular test made by the inspector or his deputy, or at any test made by an expert employed by the mayor. The company shall be notified by the inspector at least one hour before the time of said latter test of the time and place at which said test is to be made.

SEC. 5. *Pressure of Gas.*—Gas shall be supplied by the ——— Company at a pressure of not less than two inches nor more than six inches of water pressure measured at the outlet of the company's service pipes, and the daily variation in said pressure at any such outlet shall never exceed one hundred per cent of the minimum pressure during that period at that point (p. 43).

The inspector shall keep continuous records of the pressure of the gas at two places in the city, as follows: The testing station shall be equipped with a recording-pressure gauge by which a record shall be made of the gas

pressure at said station. The city shall also provide at least one additional portable recording-pressure gauge, with which the inspector shall determine the gas pressure at other places throughout the city (p. 47).

SEC. 6. *Meters and Meter Testing.*[12]—(Same as section eleven for cities of class one; see p. 64.)

SEC. 7. *Company Records.*—(Same as section twelve for cities of class one; see p. 65.)

SEC. 8. *Complaints.*—(Same as section thirteen for cities of class one; see p. 66.)

SEC. 9. *Penalties.*—(Same as section fourteen for cities of class one, omitting conditions (1), (2), (3), (4), (6), and (7); see p. 66.)

SEC. 10. *Inspector's Records and Reports.*—The inspector shall keep at the testing station a complete and correct record of all tests and formal complaints and shall open said records to the company and, in his discretion, to any person who wishes to examine them.

The inspector shall make a monthly report to the mayor and the city council of the results of all tests made as to the purity and pressure of the gas and the accuracy of gas meters. He shall also make a special report to the mayor and to the company whenever the gas shall be shown by the prescribed tests to contain any hydrogen sulphide or to be delivered at such pressures as are in violation of this ordinance. Said special report shall be delivered to the company not later than the next working day following that on which the test is completed, and the company shall acknowledge in writing the receipt of the report when so requested (p. 51).

The inspector shall also submit monthly an itemized statement of the fees, fines, charges and other indebtedness which is due from the company to the city for the month covered by said report, according to the provisions of this ordinance; and the company, within ten days of the delivery to it of said report, shall pay to the city treasurer the amount shown to be due by said statement; and further, if the company shall fail to pay said amount as herein required within said ten days, then the city, by its proper officials, shall at once take action in the municipal court to compel the payment of said amount (p. 56).

SEC. 11. *Repeal.*—(Same as section sixteen for cities of class one; see p. 68.)

SEC. 12. *Time of Becoming Effective.*—(Same as section seventeen for cities of class one; see p. 68.)

PART II.—STATE GAS LAWS

The following part of this circular is arranged as a discussion of state gas inspection in much the same way that Part I treats of municipal testing. The discussion and proposed rules of the following sections are based on the existing laws and inspection practice of those states in which state control has been undertaken. The result represents a summary of the best features

[12] This section would be satisfactory in most cases, but with some small companies might not be feasible.

found in each form of law or state ruling, with only such new matter added as seemed essential for a full protection of the public and the gas companies. As in Part I, only the technical requirements and the methods of their enforcement are discussed. The inspection of construction and installation work is not considered in this part, as these are more properly under municipal control through the office of city engineer or plumbing inspector.

The technical requirements of the states and the general form of inspection provided are tabulated in the first section, and in the following sections the present methods of application and the results obtained are made the basis of a general discussion of state inspection rules and the foundation for a set of rules proposed as suitable for such use.

A. SUMMARY OF LAWS NOW IN FORCE

The present tendency toward state control of the public utilities has led to the enactment of a considerable number of state laws regulating the operation of gas companies. The Bureau of Standards has attempted to make a complete compilation of all such legislation as relates to the candlepower, heating value, purity and pressure of the gas and the testing of gas meters. The facts given in this section represent practically complete data (to October, 1911) regarding those states or the particular subjects to which they refer. These data are compiled mainly from the laws furnished by the various secretaries of state in reply to our request for a copy of "the laws, now in force, which relate to the subjects of the manufacture and testing of illuminating gas, its distribution, and the testing of gas meters"; but the information as to the inspection practice of the various commissions has been furnished in each case by the commission itself.

The following 32 states report that they have no laws upon the subjects discussed in this circular.

Alabama	Louisiana	Oregon
Arizona	Maine	Pennsylvania
Arkansas	Michigan [13]	Rhode Island
Colorado	Minnesota	South Carolina
Delaware	Mississippi	South Dakota
Florida	Missouri	Tennessee
Idaho	Montana	Texas
Illinois	Nebraska	Utah
Indiana	New Mexico	West Virginia
Iowa	North Carolina	Wyoming
Kentucky	North Dakota	

Of the following 16 states which have more or less complete provisions as to the quality of gas and gas service and the accuracy of meters, the 9 marked thus * have laws making provision for state gas regulation, but the

[13] Under certain conditions the Michigan railroad commission has authority to inspect gas companies' operations.

commissions which are provided for carrying on this work have not yet actively taken up the inspection of gas:

California	Nevada	*Oklahoma
*Connecticut	*New Hampshire	*Vermont
*Georgia	New Jersey	*Virginia
*Kansas	New York	*Washington
Maryland	*Ohio	Wisconsin
Massachusetts		

1. FORM OF INSPECTION PROVIDED

Of the 7 states actively enforcing technical gas requirements, the form of inspection service provided is as follows:

California.—The state inspector of meters is in charge of all meter tests of this state. Municipal inspectors of gas are required in all cities of over 100,000 population, and these cities are required to make provisions as to certain qualities of the gas distributed. This latter requirement at the present time affects only Los Angeles, Oakland and San Francisco.

Maryland.—The public-service commission has charge of all gas and gas-meter inspection. All parts of the state are subject to any regulations which may be adopted by action of the commission; such rulings, however, may not be made in such form as to nullify a local or previously existing state law. Rules are now under consideration by the commission.

Massachusetts.—This state has a gas and electric commission of three members, with considerable executive and judicial authority and certain limited legislative powers. However, the work of this commission has been mainly judicial and executive in character. They are actively exercising their powers of testing and inspection.

Nevada.—The public-service commission of this state has recently issued rules and instructions for gas inspection and is beginning the enforcement of these regulations.

New Jersey.—A public-utilities commission was established in 1910 with full power of fixing the character of service and quality of gas which shall be considered "safe and adequate." A set of rules has been issued recently, to be in force after November 15, 1911.

New York.—The two commissions of this state are making active inspections of meters, and the second district commission also tests the quality of gas and the service rendered. These commissions, within certain limits, have legislative powers and have exercised the same.

Wisconsin.—The railroad commission of this state has practically full legislative, judicial and executive authority in technical matters relating to gas companies, and is actively exercising these powers.

2. CANDLEPOWER

State laws make definite provisions as to the candlepower of gas distributed, as follows:

California.—Sixteen cp in all cities of 100,000 population. The testing is done by municipal inspectors who are required to be appointed in each such city (applies to Los Angeles, Oakland and San Francisco).

Maryland.—Twenty cp throughout the state is the proposed regulation for water gas, for coal gas the standard may be about 17 or 18 cp.

Massachusetts.—Sixteen cp minimum provision by state act. Commission may not fix a lower, but can require a higher standard of any company. They, however, have made no such rulings. They carry on active inspection work in all parts of the state.

New York.—Sixteen cp for coal gas, 18 cp for mixed gas, 20 cp for water gas. Provisions of the state law for second-class cities, which requirements are now enforced by the second district commission throughout all of the state except New York City. This commission conducts active inspection work.

Twenty-two cp for the city of New York, i. e., for the first district. Municipal authorities are in charge of the testing.

In each case certain special provisions have been made as to the method of determination of the candlepower. These provisions may be found in the quotations of the state laws on pages 120 to 130.

3. HEATING VALUE

Wisconsin, New Jersey and Nevada are the only states in which a heating value requirement has been made by the state authorities. By the ruling of the state commissions the monthly average "gross" heating value demanded in the first two is 600 Btu per cubic foot of gas, with a minimum value of 550 Btu allowed; in the last named the values specified are 550 and 500 respectively.

The public-service commission of the second district of New York has made "An Inquiry into the Necessity for a Calorific Standard in Measuring the Value of Gas," and in conclusion, among their other deductions, state "that by reason of the large class of consumers to whom the value of gas as a generator of heat is a matter of primal importance, it is desirable that the calorific power of gas be standardized by the introduction of appropriate tests." However, from other considerations "it appears that the Commission at present is without authority to fix any standard for gas other than 'the standard of illuminating power and purity,'" and they therefore urge such amendments to the state law as will allow the desired thermal requirements to be made by the commission. It is also of interest to note that they are already making extended tests in cooperation with the companies of this district to determine the desirable standards to establish.

The public service commission of Maryland is not yet prepared to establish a requirement as to heating value for the entire State.

4. PURITY—CHEMICAL REQUIREMENTS

Total Sulphur.—The maximum amount of sulphur, in all forms, allowed in 100 cubic feet of gas distributed in the following States, is: Massachu-

setts, 30 grains; Nevada, 30; New Jersey, 30; New York, 20; and Wisconsin, 30 grains.

Hydrogen Sulphide.—Massachusetts, New Jersey, and New York laws require that the gas distributed be free from hydrogen sulphide, and in the first two named the test to be used in the detection of this impurity is specified. The railroad commission of Wisconsin and the public service commissions of Nevada and New Jersey have ruled that no more than a trace of hydrogen sulphide will be allowed, but they have not defined "trace" or specified the test to be used.

Ammonia.—Laws or commission ruling of Massachusetts and New York limit the ammonia in the gas to 10 grains per 100 cubic feet.

5. PRESSURE OF THE GAS SUPPLY

Pennsylvania requires "suitable appliances for preventing or taking up any leakage," in case the gas pressure is greater than 4 ounces per square inch.

The New York law for second-class cities requires a minimum gas pressure equivalent to 1½ inches of water pressure and allows no greater pressures than equivalent to 3¾ inches of water plus 1 inch additional for each rise of 100 feet between gas holder and point of consumption. The second district commission has also made a number of special rulings for individual companies.

The Wisconsin railroad commission and the public service commissions of Nevada and New Jersey are enforcing the following rule: "Gas pressure as measured at meter inlets shall never be less than 1½ inches nor more than 6 inches of water pressure; and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than 100 per cent of the minimum pressure."

6. METER TESTING

In Massachusetts, New York, California and Maryland all of the meters used must be tested, sealed and stamped by the state officials. Special rules have been adopted in each, which rules are quoted under the state reports in Part III,B of this circular.

In Wisconsin and Nevada the companies are required to test all meters once in three years, and in New Jersey once in six years. The state inspectors test any meter upon formal complaint, but make no other routine meter tests.

Certain local meter regulations are still in force in New Jersey, pending the decision of state authorities who are now investigating this matter.

B. STATE CONTROL OF GAS SERVICE

Two considerations will determine the comparative advantage of state and city control of gas conditions: First, which authority can and will enact the most suitable form of technical requirement; and, second, which

will be able to carry out most efficiently the inspection work necessary for the enforcement of these requirements.

The experience of several states which have successfully undertaken the enforcement of technical gas regulations indicates that it is possible for a state to adopt suitable regulations for enforcement, and it seems probable that, through its larger resources, a state legislature or state commission could gather the information necessary to enact proper control laws better than the average municipal legislative body. Moreover, a state has greater incentive, because of the larger influence of its decisions, to make the preliminary study necessary for proper legislation, and through this study made by experts each small city gains the benefit of the large experience of men whom it could not employ if acting alone. If the desirability of having certain gas laws generally in force be admitted, it must be recognized that such laws are more likely to be enacted by a state than by all of the cities of the state acting separately.

The more important considerations in determining the efficiency of state inspection are: The number of companies in the state, the size of each and the distance between the cities in which they operate. A consideration of each state on these grounds indicates that there are four groups of about equal number, which groups may be described as follows:

(1) State inspection seems inadvisable.

(2) State inspection could be carried on, but apparently not to advantage.

(3) State inspection could be done to advantage.

(4) State inspection is either already in effect or appears to be certain of success and economical for all concerned.

The divisions between these groups are not sharp, there being all gradations from Wyoming, with only one gas company operating, to New York, with over a hundred companies, all under the supervision of two active commissions. The comparative efficiency of state and city enforcement can be judged best by a study of the results obtained in the states where commissions have been active in this work.

1. PRESENT STATE INSPECTION PRACTICE

Since the experience of the state commissions of Massachusetts, New York, and Wisconsin extend over a longer period of time and cover a larger number of technical matters than those of any other states, the history and present practice of these three boards is of greatest importance. In each of these states the service requirements are uniform for all companies, but the price of gas, which is subject to the orders of the commission, is so varied that those companies having relatively more difficulty and expense in conforming to these regulations are allowed a proportionate advance in selling price.

Massachusetts.—Since 1861 this state has had certain laws regulating gas distribution, but only since 1885 has the board of gas and electric light

commissioners been in charge of the enforcement of such state laws. The present gas laws and the existing practice of the board represent the result of over 25 years' experience, and are thus of great importance.

During the five years from 1905–1909, under these laws and those which they have superseded, the board has made a large number of inspections. These are summarized in the report of the board for 1909, from which report we have taken the following figures:

	1905	1906	1907	1908	1909
Number of inspections	979	916	977	1018	929
Number of companies subject to inspection	72	67	67	68	68
Candlepower (average found):					
Coal gas (22 companies)	17.15	16.79	17.01	16.92	17.11
Water gas (12 companies)	21.45	21.18	20.61	20.30	20.66
Mixed gas (28 companies)	18.40	18.05	18.23	17.67	18.23
Average (62 companies)	18.46	18.19	18.14	18.01	18.30
Number of companies showing deficiency in candlepower on any test	19	22	18	16	15
Amount of sulphur (average) in grains	12.05	12.53	12.29	14.11	13.86
Number of companies showing excess of sulphur (see note)	21	19	27	29	[14] 22
Amount of ammonia (average) in grains	1.86	1.37	1.83	1.43	< 1
Number of companies showing excess of ammonia	6	3	7	4	6
Number of companies showing hydrogen sulphide	16	13	10	11	15
Total number of meters tested	52 030	61 034	[15] 59 475	58 875	73 994
Number of "complaint" meters tested	758	424	[16] 356	438	415

[14] The 22 companies here listed show 20 who were at fault during the first six months of the year (limit, 20 grains of sulphur) and two during the second six months, when the limit was 30 grains.

[15] The meter-test figures for 1907 are for 11 months.

The laws under which this work is carried on are given on pages 120–121, sections 9 to 12, relating to meters, and sections 13 and 14 to gas testing.

The inspection work of this state is done by the inspector of gas and his assistants, who are appointed by the governor for a term of three years and are responsible to the board. The board, however, is authorized to appoint deputies to aid in the inspection, but such appointment can be only for one year or a shorter period. All of the expense of the board and the work of inspection is assessed against the companies concerned in proportion to their gross earnings, except such expense as is met by special fees required by the law.

The inspection consists of a determination of candlepower, sulphur, and ammonia and a test for hydrogen sulphide. For the use of the inspecting officer, each company making more than 15 000 000 cubic feet of gas per year is required to provide a testing station at least a quarter of a mile from the gas works and equip this station with a disc photometer. The gas is tested while burning from "the burner best adapted to it, and at as near the rate of 5 feet an hour as is practicable." The board has adopted the various sizes of the Sugg London Argand burner for all except high

candlepower water gas and oil gas, for which latter they use a Sugg "table-top tip" open burner or a small iron tip open burner. It may be noted that less than 3 per cent of the tests made in 1909 showed a candlepower less than 16.

Under the provisions of the law of 1909 the board has determined that not more than 30 grains of sulphur and not more than 10 grains of ammonia will be allowed per 100 cubic feet of gas. As is noted above, under this new ruling as to the sulphur limit, only two companies were found showing more than this amount of sulphur at any time in the first six months during which the rule was in force. During the previous six months, of the 39 tests showing more than 20 grains, which was more than the maximum amount then allowed, none were above 30 grains, which is the present limit. It is anticipated that no difficulty will be met in conforming to the new limit. The table given above shows that the ammonia limit as now set is easily met. Indeed, if ammonia were limited to 5 grains per 100 cubic feet of gas, no difficulty would be met, as only four of the Massachusetts companies approach this figure closely for the average, and 48 of them averaged less than 1 grain during 1909. The gas must be found to average more than the allowed amounts of sulphur or ammonia on three successive tests before penalty is imposed.

The absence of hydrogen sulphide from the gas is required by the law, but no test is specified for the determination of its presence or absence. It will be noted in the above table that 15 companies were found to show hydrogen sulphide one or more times during 1909, but this means that only 24 tests out of over 900 showed the presence of this impurity.

In the State law the fees for certain meter tests are fixed as follows:

> For examining, comparing and testing meters, with or without stamping them, the board may collect a fee of twenty-five cents for each meter delivering not more than a cubic foot of gas in four revolutions, vibrations or complete repetitions of its action, and for each meter so delivering more than a cubic foot, a fee of thirty cents with twenty cents added for every additional cubic foot so delivered. For examining, testing, comparing or calibrating meter provers and test or photometer meters, with or without sealing or certifying to the same, the board may collect such fees as it may from time to time establish therefor.

Under the provisions of this last sentence the board has fixed fees as follows: "For meter provers, $5 for each 2-foot prover, with an additional 50 cents for every additional foot of capacity; and for photometer meters, $2 per meter."

During the year 1909 the testing of meters gave an income of over $18 000, and the operating expenses, including salaries of gas and gas-meter inspectors, was only about $13 000. The board thus had a surplus of $5000 for that year from its gas-inspection department.

Since the report above referred to was made after more than six months' experience with the latest revision of the State law, and since the board made no request for changes in legislation which affect these technical

matters, and further, since no complaint either from consumers or gas companies as to matters discussed in this circular was at that time pending before the board, it is inferred that the law and its enforcement in this State are proving satisfactory.

New York.—The public-service commissions law enacted in 1907 by New York provides for two commissions of five members each, the one for the first district having jurisdiction in New York City, the other board covering all of the rest of the state. The work of the two commissions is kept distinct, that in the first district, so far as gas work is concerned, being confined to meter inspection, while the second district commission is active in gas testing as well. Since the work of the first district is confined to meter testing in the one city, its discussion at this point is unnecessary. It should be noted that the municipal bureau of lamps and lighting carries on active gas inspection.

The second district commission has a well-organized system for inspection of candlepower, purity and pressure of the gas and the testing of meters, and has undertaken extended investigations of the heating-value determination, with a view to fixing a requirement as to this quality. In the study of this last question the commission has decided that a heating-value requirement is desirable, but that it is without power to fix any such regulation. (See p. 38.) Since the laws of this commission are quoted in Part III,B, it is not necessary to review these here, and the following summary represents only a review of the inspection methods and results as given by a recent report of the commission supplemented by special information furnished by the commission.

The systematic testing of the gas quality and service is accomplished by visits of traveling inspectors, who at each visit determine candlepower, amount of sulphur and ammonia, test for hydrogen sulphide and take one or more pressure records. In this manner each company making annually less than 10 000 000 cubic feet of gas is visited six times per year and for each additional 10 000 000 cubic feet an additional test is made, up to a maximum of 26 per year. This system required about 750 tests for the supervision of the 81 companies visited in 1908. For convenience of operation the state is subdivided into three gas-inspection districts with headquarters as follows: One at Albany, with the chief inspector and two assistant gas inspectors; one at Mount Vernon, with one assistant gas inspector; and one at Rochester, with one assistant gas inspector.

In a similar manner the meter testing is done by districts, of which there are four, with headquarters as follows: One at Albany, with the chief inspector and two meter inspectors; one at Brooklyn, with one meter inspector; one at Syracuse, with one inspector; and one district with three inspectors operating from Rochester, Buffalo, and Jamestown.

Every Saturday each inspector receives from the chief inspector the outline of his work for the next week, and this is so arranged as to bring him back to his headquarters at the end of the week's trip. The results of this

traveling gas inspection during 1908 are summarized from the report of the commission for that year, as follows:

Inspections	Coal gas	Mixed gas	Water gas	All
Total number	284	74	378	736
Showing deficiency in candlepower	110	11	107	228
Showing presence of hydrogen sulphide	25	0	38	63
Showing presence of excessive sulphur	22	1	8	31
Showing presence of excessive ammonia	9	0	0	9
Showing gas to be satisfactory	140	60	255	455
Number of companies	37	7	37	81

Pressure of gas supplied:	Number of companies
Less than 2 inches	18
Less than 1.5 inches	0
More than 6 inches	1
Variation greater than 100 per cent	0

The results of these tests for candlepower, hydrogen sulphide and ammonia are communicated to the company by the inspector immediately upon completion of the test; and if later correction is found necessary, this is made upon the official report from the commission, which also gives the result of tests for sulphur. On receipt of the official notice the company is required to explain deficiencies reported, if any, and to state what remedy has been applied.

This state requires that all meters be tested by a state official before installation by any company. The inspection work is carried on by seven meter inspectors, located in four districts, aided occasionally by the gas inspectors, and is so organized that practically no delay occurs either in testing at request of the companies or in inspection of complaint meters. Each company provides the apparatus and shop needed for the meter work, and when they desire to have testing done they are required to notify the commission. Thus, no regular routes are laid out, but the inspectors are given instructions weekly by the chief inspector as to their trips for the following week. The provers provided by the companies are tested by the commission and then used for its routine work. Thus, during the year 1908 over 100 000 meters were tested by the commission. Of this number less than 300 were tested on complaint of a customer.

The expenses of the gas and gas-meter inspection of the state are met by appropriation from the state treasury. No fees are charged except for testing of complaint meters.

Wisconsin.—The public-utilities law enacted in 1907 makes the Wisconsin railroad commission responsible for the requirement and enforcement of such conditions as will render gas service adequate. The method by which the commission has undertaken to attain this may best be given in the words of their own report, issued July 24, 1908:

Both the direct mandates of the statute, quoted herein, and the variations in standards of service actually in existence in the state of Wisconsin make it imperative for this Commission to issue uniform standards of service for public utilities. The present order is confined to gas and electric service. The preliminary investigations, conferences and other work preceding the adoption of these standards are discussed and a series of rules prescribed for the guidance of the managements of gas and electric companies. While these rules apply to every gas and electric plant in the state, on application to the Commission and for sufficient cause shown, such modifications, exemptions and concessions may be made with reference to these rules as the facts in each case shall warrant. Without an express order of the Commission authorizing it, every departure from these rules will be regarded as a violation of the law.

The provisions of the Public Utilities Law relating to standards for public utilities operating in Wisconsin read as follows:

"1. The commission shall ascertain and fix adequate and serviceable standards for the measurement of quality, pressure, initial voltage or other condition pertaining to the supply of the product or service rendered by any public utility and prescribe reasonable regulations for examination and testing of such product or service and for the measurement thereof.

"2. It shall establish reasonable rules, regulations, specifications and standards to secure the accuracy of all meters and appliances for measurements, and every public utility is required to carry into effect all orders issued by the commission relative thereto." (Sec. 1797m–23, ch. 499, Laws of 1907.)

With a view to performing the duties imposed upon the Commission by the above quoted paragraphs of the Public Utilities Law, a number of experts were added to its engineering staff, who, under the immediate supervision and direction of W. D. Pence, chief engineer, and C. F. Burgess, expert on light and heat, undertook comprehensive laboratory and field investigations.

After sufficient progress had been made in different lines of investigation to reflect the general situation in this state, a conference of representatives of gas and electric companies was called for the purpose of arriving at a better understanding of the problems involved in the establishment of standards for gas and electric service. This conference was held at Madison, March 3, 1908, and was attended by about two hundred representatives of gas and electric companies as well as by other experts from different parts of the country. The Bureau of Standards, of Washington, also sent a representative.

The conference proceedings have since been supplemented by letters and communications, all of which have been carefully considered. The results of this consideration have been formulated in the shape of formal rules and annotations which are now published for the guidance of the managements of the various gas and electric plants in Wisconsin. If any management anticipates or experiences difficulty in complying fully with such rules and regulations, it is expected that application for a modification of the rule or rules with regard to which difficulties are encountered will be made to the Commission; but until a modification of any rule or regulation herein prescribed has been expressly authorized by the Commission, the gas and electric companies will be expected to comply strictly with the terms of every rule and regulation ordered herein. It is possible that certain plants are operated under conditions which make it impracticable or not to the best interest of the public to meet all the requirements of all the rules. Under such conditions it devolves upon the utility to show to the Commission, by complete and convincing evidence, that a modification of some rule or rules should be made.

The rules which were selected and announced July 24, 1908, are still in force. They are given in full on pages 124–125. The enforcement of these rules has been more or less fully provided for by state inspectors. The third

annual report of the commission gives many interesting comments on the results of such inspection, as follows:

Tests for heat value have been made in the various cities during the year as frequently as the limited staff would permit and the results of the tests are shown in table III. [Not quoted.] The visits covered from one to three or four days, and one or two sets of readings were taken daily during the stay of the inspector. It will be noted that in only three cities were readings taken during the year where the average of any set of readings dropped below 550. In one of these cases this was explained by a temporary abnormal condition at the works. In the other case the operating conditions were apparently incorrect, but have since been remedied. The tests were taken generally at the office of the company. The equipment was set up and the first set of readings taken as soon as practicable after the arrival of the inspector. These readings were, therefore, uninfluenced by the company's knowledge of his presence. The order and frequency of inspections were determined by the geographical location of the plants and the inspectors available for the work. They cover, generally, two seasons, summer and winter. These tests, considered with former tests made by the Commission and the records of tests made by companies owning their own equipment, indicate that practically all the companies furnishing coal and water gas have conformed during the year with the Commission's order regarding heat value. The results show, beyond doubt, that plants operating under Wisconsin conditions can furnish gas of uniform quality exceeding 600 B. T. U. for the monthly average, and that the standard set by the Commission can be attained in practice without the imposition of an undue burden. It is perhaps worthy of note that none of the companies who were, previous to the adoption of this standard, furnishing gas considerably in excess of 600 heat value, have lowered their standard since the rules went into effect. On the other hand, a number of companies have been compelled to raise the average heat value in order to comply with the law. This, of course, does not include the gasoline and acetylene plants of the state. They have been made the subject of a special investigation and will be considered separately.

The data of "table III," mentioned in the above quotation, may be summarized:

Companies visited	27
Number of visits	38
Sets of determinations (1 "set" is from 3 to 5 determinations)	107
Sets showing less than 600 Btu	28
Companies averaging less than 600 Btu	5
Sets showing less than 550 Btu	6
Companies averaging less than 550 Btu	2

(These summaries do not include visits when no regular inspection was made.)

Purity of the Gas.—The rules require that the gas shall not contain more than a trace of sulphur as H_2S and that the total sulphur shall not exceed 30 grains. No specific statement defining "more than a trace of sulphur" has been issued as yet, but a large number of tests have been made by our inspectors using the method of exposing lead acetate paper to a flow of gas for periods of from three minutes to one hour and a slight amount of sulphur has been frequently found by these tests. It is believed that in general the companies are substantially complying with the rule in regard to H_2S. From the total sulphur tests made and from the absence of complaint in regard to objectionable amounts of sulphur in the gas, it is believed that the rule regarding the total sulphur is also being complied with. There is no question of the ability of the companies to comply with sulphur requirements and the rules governing purity of gas will be rigidly enforced.

It is of interest to note in this connection that the state inspectors no longer make regular determinations of the total sulphur, though occasional

tests are still made for this impurity. The reason for discontinuing this test may be inferred from the above paragraph. The conditions outlined there are still existent. No limit has been placed upon the ammonia in the gas, the commission being of the opinion that such regulation was not essential.

Accuracy of Gas Meters.—In carrying out the provisions of the Public Utilities Law relative to the examination and testing of meters, the Commission has not undertaken the testing and sealing of all meters. The aim has rather been to supervise the testing performed by the companies themselves in such a manner as to insure the periodical testing, the use of suitable equipment and methods, and the keeping of full records of such tests. The inspectors examine these records whenever a regular inspection is made, and summaries of meter tests are collected and filed with the Commission.

During the past year the meter provers of nearly all the companies in the state were checked for accuracy by the inspectors of the Commission. For this work a one-half cubic foot glass bottle, designed by members of the staff, was used.

It may be said that the examination of the meter provers was very satisfactory and that with one or two exceptions they were found to be substantially correct.

In addition to prescribing methods and checking prover equipment, it is the practice of the Commission to send inspectors to the various cities occasionally and to choose at random and remove from service a number of meters for test. The number tested is such as will give an indication of the actual condition of those in service and is an effective check upon the company's practice. It is believed in this manner the state insures, at comparatively slight expense, the accuracy of service meters. The law also provides for the test of service meters by inspectors of the Commission on complaint of consumer, and a few meters have been tested under this provision.

It is provided, besides, that a consumer may have his meter tested by the company at any time he may so desire (provided this is not oftener than once in six months), and it is believed that under the conditions existing in Wisconsin most of the disputes regarding the accuracy of meters can be settled without appeal to the Commission.

It has come to the notice of inspectors that in some cases companies have failed to comply with this rule and have not tested meters promptly on request of consumers. Regardless of any concessions made to individual companies regarding the periodical testing of meters, it is considered the consumer's privilege to have his meter tested, as provided in the rules, whenever he believes it to register inaccurately.

Gas pressure.—A summary of the tests made and reported in this annual statement gives the following data:

Companies visited	23
Number of tests (24-hour charts)	111
Tests showing pressures less than 1½ inches	6
Tests showing pressures less than 1 inch	1
Tests showing pressures greater than 6 inches	8
Tests showing pressures greater than 7 inches	0
Tests showing variation greater than 100 per cent of minimum	29
Tests showing variation of 100–110 per cent of minimum	10
Tests showing variation of 110–150 per cent of minimum	10
Tests showing variation of more than 150 per cent of minimum	9
Companies showing variation greater than 100 per cent of minimum	10
Companies averaging variation greater than 100 per cent of minimum	4

The report states:

In making this survey the gages were set in what appeared from the inspection of the arrangement of the distribution system to be the most unfavorable location. This should be taken into consideration in studying the tables. It seems certain that where the standard pressure is from 2½ to 4 inches that the rule for gas pressure, as formulated by the Commission, will give satisfactory service and that it is as stringent a requirement as can be complied with under conditions existing in this state.

The discussion of complaints of service, as given by this commission report, will be found in Part I, B, under discussion of complaint handling.

2. REQUIREMENTS AND THEIR ENFORCEMENT

From a consideration of the present practice of state gas inspection, as outlined in the preceding section, it appears that a number of conclusions as to state gas requirements are well established. The discussion of this section and the proposed technical rules which follow present these conclusions, together with a few other matters which have been suggested by the experience of state commissions and of certain gas engineers. In each case where uncertainty or difference of opinion appears to exist, this fact has been indicated in order that the whole matter may be presented without prejudice and that the degree of certainty of any conclusion may be clear.

(a) **Form and Powers of Commission.**—For the purposes of this circular it is of no consequence what form of state commission is chosen, since we are considering only the technical gas requirements and their enforcement. Thus, in a state which would choose to have a general public-utilities commission, with a department of heat and light, under which would be a bureau of gas, and by still further classification of this bureau into divisions, one to be a division of gas testing, the data of this circular would relate to work of this last subdivision. Therefore, in the following portions of this circular the word "commission" refers to that subdivision or those representatives of the state commission who are in charge of the technical gas matters.

Since it seems certain that the adoption and enforcement by a state of uniform requirements as to gas quality and service would demand that the state also have authority in the matter of price, and since such jurisdiction has been given to all commissions thus far established, the following discussion is based on the assumption that such condition will exist.

The grant of limited legislative powers which has been made to all the state commissions thus far established has been attended by considerable advantage and in some respects is essential to the success of any state gas inspection. Its limitation is accomplished in some states by fixing the maximum or minimum requirement which may be made of any company in respect to certain of the more important technical matters. The advantage of this method of limitation is the assurance to the companies concerned that their interests will be protected by the state law; but with a commission of technical experts the disadvantage of limiting their technical

authority is apparent, for in many cases no opportunity is allowed for the adoption of requirements specially suited to a particular company concerned. Indeed, the fixing by state law of a limit of the requirements to be made of the companies is generally interpreted to mean that this limit of the requirement shall be the requirement itself.

For purposes of this discussion it will be assumed that the commission is to be empowered to fix the requirements to be met by the companies under its jurisdiction. This is the practice in Wisconsin, New York, and to a limited extent in Massachusetts. In fact, the present tendency seems to be strongly toward granting such authority to the state commission.

In certain states the commission is empowered to order changes in method of manufacture, and is actively exercising such right. When considered from certain points of view this authority may seem unnecessary and perhaps unwise. The object of a gas law is to insure the public a gas supply of good quality, properly delivered at a reasonable price. These results may, in general, be accomplished by any effective method a company may desire to use, and the commission, while perhaps advising means of best accomplishment, scarcely need influence the method chosen further than to insist upon attainment of the proper results.

The following statement from the chief inspector of one of the commissions having this authority is probably a fair conclusion:

> In regard to giving commissions authority to order specific changes in operating practices, it would seem that such authority should be exercised with great caution. Generally it would probably be sufficient to require good service and to make, if necessary, general suggestions as to how this should be accomplished. It is believed, however, that occasions arise where it is of great advantage for the commission to have the authority to order specific changes.

(b) **Technical Requirements.**—The selection of a technical requirement suitable for enforcement throughout a whole state might appear very difficult, but the experience of the three commissions given at length above, seems to prove that it is practicable to do so. It will be noted that in each of the three states all of the companies are required to conform to the same limits as to gas quality and service. Moreover, as far as can be learned, this uniformity of regulation has produced no hardships. To be sure, a small company may find greater expense attendant upon certain operations to meet the requirements than does the larger company; but the commissions invariably recognize such differences by allowing different prices to be charged by the different companies. It will be observed that the proposed rules do not call for penalties in case of failure to meet the requirements. This is the practice in all states. The influence of public opinion and the knowledge that persistent failure will subject them to penalty for noncompliance with orders of the state commission have always proven sufficient to insure good results from gas companies without penalties directly imposed by the commissions.

In the selection of requirements for state enforcement the same considerations apply as have been discussed under municipal regulations in

Part I, B. In fact, a state gas law appears to be little more than a municipal regulation applied over larger territory, for the methods of enforcement and the inspection routine have proven to be the main sources of difficulty. Since these general considerations influencing the choice of technical requirements have already been discussed, it is only necessary to indicate here the basis upon which each rule is proposed. The form adopted by the Wisconsin railroad commission for its regulations is used as it appears to be simplest and at the same time sufficiently comprehensive.

Both candlepower and heating value rules are given as both may be desired in some States.

Candlepower.—The experience of New York indicates that 16-candlepower gas can be required from all companies. Although 20 candlepower is required in this state for all water gas distributed, it appears that 18 candlepower would afford ample protection to the public if a heating-value regulation is also in force. If this last condition is not fulfilled, some uncertainty would exist, since high candlepower carbureted water gas is of rather variable heating value.

The provision is made in New York State that all companies making more than fifteen million cubic feet of gas per year provide a photometer, and that only the gas of companies smaller than this be inspected by the use of a portable instrument. This rule would seem rather more severe than necessary if a heating-value requirement is in force and for this reason it is proposed (Rule 2) that only companies whose annual output exceeds fifty million be required to furnish a photometer. If no heating-value regulation is in force, then the New York limit would perhaps be preferable.

Heating Value.—The proposed regulation of heating value (Rules 3 and 4, p. 91) is very similar to that made in Wisconsin. As has been indicated in the discussion of municipal rules the New York commission is now making an investigation of this matter, and it may seem desirable to modify these rules when the results of this investigation are available. It is not quite certain that companies making less than twenty million cubic feet of gas annually could not well be required to purchase and use a calorimeter. The expense of such purchase and use would scarcely be excessive for any company making ten million cubic feet per year, if it were sure that such small company could and would afford the time of a competent man to use the instrument properly.

Purity (Chemical Requirements).—The rule proposed (Rule 5, p. 91) for hydrogen sulphide is perhaps less rigid than that in force in New York and corresponds fairly closely with the practice of Wisconsin inspectors. The testing for this impurity specified in Rule 6 (p. 92) is not too severe and yet would give sufficient information to permit very good control.

The setting of two limits for sulphur and ammonia (Rules 7 and 8, p. 92) is distinctly different from the usual practice where one limit is provided for all kinds of gas. There seems to be no doubt, however, that water gas can be economically made with a lower sulphur and ammonia content than can coal gas, and hence the limits for the two may well be different.

The values chosen are similar to those now in force in all states making any such regulations.

Gas Pressure.—The general experience of gasmen indicates that a limit such as proposed by Rule 9 (p. 92) would be desirable in any city if it could be enforced. However, it is probably too severe for immediate enforcement in most states, and hence the minimum allowed would probably need to be 1½ inches for at least the first year. New York and Wisconsin are enforcing such minimum at the present time. The maximum proposed is the same as that of Wisconsin.

The limitation of the pressure variation is made in Wisconsin, and, practically speaking, the New York companies all conform to this rule, though it is not specified in such form. (See report of New York companies, p. 80.)

Gas Meters.—The provisions proposed in Rules 10 to 13 inclusive, have been discussed in Part I,B (p. 47ff).

Miscellaneous Rules.—The several regulations of Rules 14 to 17 (p. 92) are scarcely more than the adaptation of common municipal requirements to state use. None of the provisions is sufficiently novel or complex to require detailed explanation or comment.

(c) **Inspection Routine.**—The work of gas testing throughout a state may be divided into three parts, as follows:

1. Regular routine tests, made by the company or by a representative of the commission permanently located in the city where this work must be done.

2. Occasional tests, made by traveling inspectors to check the work of the regular routine.

3. Meter testing, done as the complaints of meters may demand.

Routine Testing.—The general rules proposed for the regulation of the companies testing are given in Section C, which follows (p. 91) and have already been discussed (pp. 85ff). These rules include the statements as to the routine candlepower, heating value, sulphur and ammonia determinations and the hydrogen sulphide tests required of the companies. In addition to these it seems desirable that in each city where a gas works is located the commission appoint a deputy to carry out a few simple tests and to act as their local representative. Such work would correspond to the work of a municipal inspector in a city of class 3 (see p. 69) and would be mainly a daily test for hydrogen sulphide and maintenance of a few continuous pressure records. Such duties would require only a small amount of time, and no special technical training would be needed. This plan has, as far as the Bureau is informed, never been in use, but it appears to offer considerable advantage in watching at least two of the matters which the commission has in charge. The number of pressure records needed would be determined about as in municipal testing work (see Part I on "Pressure," p. 43).

Traveling Inspection.—In the arrangement of this part of the testing work the first question is the frequency of test required. Although the

answer to this question would be largely affected by local conditions, the experience in the three States, Massachusetts, New York, and Wisconsin, offers a basis for a few general conclusions.

It is assumed that each test made by a traveling inspector would include determination of sulphur, ammonia, heating value, and, if the company made more than 50 million cubic feet of gas per year, candlepower of the gas. The frequency of visits for such purpose may be best determined by the size of the company concerned. The practice in New York State provides six tests per year for each company and one extra test for each 10 million cubic feet of gas produced after the first 10 million, but with a maximum of 26 tests per year. In Massachusetts the law requires at least two tests per year for each company, but the board makes an average of 12 to 15 tests per year per company, the range being from 2 to 49. The Wisconsin commission has made a much smaller number of tests, averaging only about two per year per company. Based on the experience of the first two of these three States, the following table has been prepared as a suggestion of the frequency suitable for normal conditions:

Annual sales (million cubic feet)	Minimum frequency of tests by traveling inspector
Less than 20	Bimonthly
20–50	Monthly
50–200	Semimonthly
Over 200	Weekly

On the other hand, the experience of the Wisconsin railroad commission has led to a different conclusion, expressed by their chief gas inspector as follows:

> In the regulation of gas service throughout an entire state, it is believed that the work of the state should be largely supervisory and that the responsibility in all cases should be left with the company so far as this is possible. Small plants can not make all of the technical tests required but the larger plants should be required to make these tests and the state inspectors need only make such visits as will insure compliance with the law. If the companies are required to keep accurate records it is believed that more visits should be made to small companies than to large ones. Since these smaller plants can do very little themselves in the way of testing, these inspections could be made monthly, at least, to advantage. Plants a little larger, however, which are equipped for testing the quality of the gas would need to be visited less frequently than monthly. Bi-monthly or quarterly inspections should give very good control. * * * The companies should be visited frequently enough to keep track of what they are doing and occasionally without warning an exhaustive investigation should be made. It is believed that more is accomplished by "follow up" inspections where companies have failed to comply with the rules than by very frequent inspections of all plants. Two plants of the same size do not require of necessity the same number of inspections.

The frequency of test may be subject to frequent modification by the commission, since it is obviously unnecessary to visit a progressive company which makes all reasonable effort to comply with the rules, as often as

another of the same size which, either intentionally or because of poor management, continually fails to conform to the regulations.

Having determined the frequency of test necessary in each city, the division of the work into inspection districts similar to the arrangement made by the New York commission is a very simple matter. From the amount of work required in certain of the largest cities it would probably be necessary to have an inspector permanently located in each of these places. If such inspector also had charge of the meter work in his city, then conditions governing the work would be very similar to those in any municipal inspection office. For the smaller places the visits should be arranged by the chief inspector from week to week, as is done by the New York officials.

As all but the smallest companies would have testing apparatus for the use of the inspectors the instruments which need be carried would be very few in numbers. A discussion of portable instruments will be included in the circular on testing methods.

One other portion of the traveling inspection work is the calibration or standardization of the companies' testing apparatus and instruments. For all of the company tests and for many of those by the inspectors this apparatus will be used, and its calibration is essential previous to any inspection work. One of the most satisfactory ways of calibration will doubtless be by comparison of results obtained by the company's apparatus with those resulting from the use of a portable outfit, which latter would also be required for use at small works where no apparatus is provided by the companies. Such comparison could be made by the regular inspector once or twice a year, as seemed necessary.

The methods to be employed for routine and for special testing, the character of stations needed, as well as the methods for adapting the ordinary apparatus to traveling inspection, will form a part of a later circular on methods of gas testing.

Meter Testing.—The matter of meter testing, if done by state officials, would in no case be subject to such definite preliminary arrangement as the traveling gas inspection, since work of this character would be determined by the needs of the various companies for meters which they wished tested before installation. The work could, however, be planned by the chief inspector from week to week according to the requests received from the companies for meter inspection. This plan has met with success in the New York inspection work.

If we assume that because of complaint, repairs, purchase of new meters, etc., the equivalent of one-fourth of all the meters in use would require test each year, a basis of calculation is furnished for determining the number of meter testers required in any state. The number of meters which one inspector could test during a year would vary so widely, due to difference of distance between meter shops, length of stay at any one place, and the character of the conveniences which could be provided by the various companies, that no exact estimate can be made as to the time required. The first district commission of New York estimated that for the routine meter inspec-

tion a single meter tester could prove and seal 75 meters per day, but in working through a state no such speed could be maintained. An allowance of 25 meters per man per working day would probably be a conservative estimate, and on this basis one inspector would test about 7000 meters per year. The meter inspectors could readily be aided by the gas inspectors when their time was not wholly occupied with the routine gas tests. This combination of duties would be especially desirable when a long side trip was necessary to reach a single city, since then one trip could answer for both gas and meter testing.

Settlement of Disputes and Complaints.—Two classes of disputes will demand consideration by the commission: First, complaints of customers or city officials regarding the quality of gas or gas service rendered to them, and, second, differences arising between the companies under supervision and the commission itself.

The complaints of customers as to the service rendered them by the company should, if possible, be first referred to the company itself for consideration, since the commission need take action only in case of a serious difference which can not be adjusted by such procedure.

Settling of disputes by public hearing and subsequent ruling of the commission does not grant undue authority to this body since only technical matters with which it should be very familiar are in question. The immediate reference of all such disputes to a court of law would make their settlement unnecessarily complex and formal, and later resort to legal procedure is in no way hindered when such course proves essential.

Records and Reports.—The records and reports required of each company are given in sufficient detail in the proposed Rules 16 and 17 (p. 93). They are also discussed in Part I (p. 51ff).

Each inspector, meter tester and deputy should make two reports on each test or inspection made by him. The first of these reports should be rendered to the company at once at the conclusion of the test, and the second should be sent to the commission as a part of the weekly report. The immediate report to the company would enable it to undertake at once the correction of any irregularity which might be indicated thereby, and it would be subject to correction, as noted later. The weekly report to the commission would serve as the permanent record of tests, after it had been verified by the chief inspector. This follows the New York system of reports closely.

The technical records of the commission would be of three classes: Records of routine tests and inspection, monthly reports of each company under their supervision, and records of the complaints made and the investigation or hearing proceedings necessary for their settlement. The first of these records is merely a file of the inspectors' reports, suggested in the preceding paragraph, with such summaries of these as may be desirable for reference purposes. Similarly, the reports required by Rule 17 (p. 93) constitute the second record of the commission. The character of the third

report is, in general, the same as that outlined for a city office. (See the discussion of Part I, p. 56.)

A monthly statement from the commission to each company might be made as the official summary of all of the inspection of that month which concerned that company, and it would contain any corrections to the preliminary reports of tests furnished by the inspector, which were found necessary after verification of the calculations from the test data. The object and probable result accomplished by these statements would be similar to that obtained in the city inspector's reports. (See proposed ordinance, sec. 4, p. 61.)

C. PROPOSED TECHNICAL RULES

The following rules are proposed as representing the conclusions of the previous sections in a condensed form. They should be considered in connection with the preceding discussion, since the basis upon which the various parts rest is by no means equally well settled, and it is only by the consideration of the facts already presented that the comparative value of each rule proposed can be learned.

RULE 1. The monthy average candlepower of all gas distributed in this state shall be not less than sixteen International candles if coal gas or mixed coal and water gas containing more than fifty per cent of coal gas, and not less than eighteen International candles if water gas or mixed coal and water gas containing fifty per cent or less of coal gas (p. 86).

RULE 2. Each company distributing more than fifty million cubic feet of gas per year shall provide and maintain at its offices or works a photometer and all necessary accessories therefor of a form approved by the Commission; and each such company shall regularly make determinations of the candlepower of the gas distributed by it, these determinations to be made in a manner approved by the Commission (p. 86).

RULE 3. The monthly average gross heating value of all gas distributed in this state shall be not less than six hundred British thermal units per cubic foot of gas, and at no time shall the heating value be less than five hundred and fifty British thermal units per cubic foot (p. 86).

RULE 4. Each company distributing more than twenty million cubic feet of gas per year shall provide and maintain at its offices or works a calorimeter and all necessary accessories therefor of a form approved by the Commission; and each such company shall regularly make determinations of the heating value of the gas distributed by it, these determinations to be made in a manner approved by the Commission (p. 86).

RULE 5. All gas distributed in this state shall be free from hydrogen sulphide. The gas shall be considered free from hydrogen sulphide if a strip of white filter-paper, moistened with a solution of lead acetate, shows no darkening perceptible on comparison with a second paper freshly moistened after the first paper has been for three minutes exposed to a stream of the gas flowing at the rate of five cubic feet per hour, the gas not impinging directly from a jet upon the test paper (p. 86).

RULE 6. Each company distributing gas shall daily test the gas leaving its holders for the presence of hydrogen sulphide, in the manner specified in Rule 5 (p. 86).

RULE 7. All gas distributed in this state shall contain, per one hundred cubic feet, less than thirty grains of sulphur and less than ten grains of ammonia if coal gas or mixed water and coal gas, or less than twenty grains of sulphur and less than five grains of ammonia if water gas (p. 86).

RULE 8. Each company distributing more than one hundred million cubic feet of gas per year shall provide and maintain such apparatus of a form approved by the Commission as is necessary for the determination of sulphur and ammonia in gas, and each such company shall determine the amount of sulphur and ammonia in the gas distributed by it at least once each week (p. 86).

RULE 9. The pressure of the gas distributed in this state, as measured at the outlet of any service pipe, shall never be less than two inches nor more than six inches of water pressure; and the daily variation in such pressure at any one service pipe shall never exceed one hundred per cent of the minimum pressure registered at that same point (p. 87).

RULE 10. Any meter used for the measurement of gas shall be considered correct if, when tested at its normal rate, it shows an error in registration of not more than two per cent. No meter which is not of such accuracy may be sealed by the company, as provided in Rule 11 (p. 47).

RULE 11. All new meters and all meters which have been repaired or adjusted shall be tested before installation and, if correct, shall be sealed by the company.[16] No meter not so tested and sealed shall be installed by any company for the measurement of gas unless written permission is granted by the Commission for such installation. And, further, no meter shall be used for the measurement of gas for a period longer than five years without being again tested and sealed (p. 47).

RULE 12. Each gas company, upon request of any customer, shall test the accuracy of the meter used by him, provided that, first, the meter in question has not, within one year previous to such complaint, been tested and found correct either by this company or by the Commission, and, second, the customer will agree to accept the result of the test made by the company as the basis for settlement of the differences claimed. No charge shall be made to the customer for any such test (p. 50).

RULE 13. On formal application to the Commission by any user of gas, the Commission will test his meter. The fee for such test shall be one dollar, which fee shall be paid by the complainant if the meter be slow or correct, otherwise by the company owning or installing such meter.

RULE 14. Each company distributing gas in this state shall provide, equip and maintain a station for the testing of gas and gas meters, and the equipment therefor, such as may be necessary for the testing required in any preceding rule; and such station, with its equipment, shall at all reasonable

[16] See p. 88ff. for discussion of the comparative advantage of the testing of meters by the company rather than by public official.

hours be open to the inspection and use of any authorized representative of the Commission.

RULE 15. Each gas company shall make a reasonable investigation of all complaints made to it by any customer, and shall make a record, with statement of method of settlement, of any and all complaints regarding the quality or purity of the gas distributed, the character of service rendered, the accuracy of any meter, and any other technical matter considered by the rules of the Commission or laws of this state.

RULE 16. Each gas company shall keep the following records, which shall at all reasonable times be open to any representative of the Commission (p. 90):

First. A record of all customers, stating address, name and the number of the meter in use by each.

Second. A record of all meters owned or used by the company, stating date of purchase, record of use, repairs and tests to which each has been subjected, and the present location of each.

Third. A record of all complaints, as specified in Rule 15.

Fourth. A record of the results of all tests made as required by the rules of the Commission or by the laws of the state, especially in regard to candlepower, heating value, purity and pressure of the gas.

RULE 17. Each company shall, on or before the tenth day of each month,[17] report to the commission (p. 90):

First. The result of all tests recorded under paragraph four of Rule 16.

Second. A statement as to all complaints required to be recorded by Rule 15.

Third. A statement as to all meters purchased, installed, removed from service, adjusted, repaired, etc., such report to cover the period of the previous calendar month.

PART III.—GAS LAWS QUOTED

A. SELECTED CITY ORDINANCES

The following ordinance quotations are included as examples of recently enacted laws which at the present time are being successfully enforced.

The ordinances selected are from cities of widely varying size, Chicago representing cities of 1 000 000 or more population, Minneapolis and Los Angeles those of about 300 000, Omaha those of about 100 000, and Lansing the smaller cities of about 25 000 population.

MINNEAPOLIS, MINN.

The city council of Minneapolis in March, 1910, enacted two gas ordinances, one in the nature of a contract and the second regulatory in character. The latter is quoted in full. It will be noted that the ordinance

[17] If the reports prove too burdensome to small companies, they may be required less frequently.

proposed in Part I,C follows this ordinance very closely in many of its requirements.

AN ORDINANCE Providing for the appointment of an Inspector of Gas and defining the duties of such officer, providing for the inspection of gas and gas meters, prescribing rules and regulations for the pressure, manufacture, measurement, quality and distribution of gas supplied to consumers, and for the enforcement thereof, and prescribing penalties for the violation of such rules and regulations.

The City Council of the City of Minneapolis do ordain as follows:

SECTION 1. *Definitions.*—That in this ordinance and the various sections and parts thereof the words "city" and "company" shall be understood, taken and construed to refer respectively to the City of Minneapolis and the Minneapolis Gas Light Company, the word "streets" shall include avenues, alleys, public squares, parks and parkways within the limits of said city; and the words "Mayor," City Clerk," "City Treasurer," "City Engineer," "Inspector" and "City Council," shall be understood, taken and construed to refer respectively to the Mayor, City Clerk, the City Treasurer, the City Engineer, the Gas Inspector, and the City Council of said city.

SEC. 2. *Appointment of Inspector.*—That the City Council shall, at the time specified in Chapter 3 of the City Charter for the appointment of other city officers, appoint as Inspector a suitable person recommended to the City Council, in the manner hereinafter provided, as one competent to test gas meters and the quality, purity, pressure and illuminating and heating power of gas.

That the head of the department of chemistry, and the head of the department of physics of the Minnesota State University and the principal of the Minneapolis Central High School shall constitute a board for the examination of all persons desiring to apply for such position of Inspector. Said board shall, when seasonably requested to do so by any person desiring to take such examination fix a time when it will examine applicants for said position, which time, unless the City Council shall otherwise direct, shall be in the month of December of each even numbered year; and it shall notify the City Clerk of the time so fixed at least two (2) weeks prior thereto. The City Clerk shall, within one week prior to the time so fixed, publish in the official paper of the city a notice of the meeting of said board and the purpose thereof. At the time so fixed, and at such time or times thereafter as said board may by adjournment determine, it shall examine applicants in such manner as it shall deem necessary, respecting their competency to test the quality, purity, pressure and illuminating and heating power of gas and the correctness of gas meters. After such examination, said board shall forthwith, and during the month when it shall so convene, certify to the City Council the names of such persons as said board shall deem fully competent to make such tests. And only persons whose names are so certified shall be eligible to be appointed Inspector; provided, however, that any person who shall have previously held the office of Inspector may be appointed to said office without such certificate from said examining board; and provided, also, that a person who has once passed a satisfactory examination before said board, and whose competency has been so certified to by it, shall be subsequently eligible for appointment to the office of inspector without again being examined thereby.

That each member of said board of examiners, as hereby constituted, shall be paid by the city the sum of twenty-five (25) dollars for his services as examiner of applicants for said position.

SEC. 3. *Deputies and Assistants.*—That the Inspector may, by and with the consent and approval of the City Council, appoint one or more deputy inspectors, each of whom shall be competent to make any and all of the tests, herein provided for, which he shall be required or directed to make. Each said deputy so appointed shall have the power, under the direction of the Inspector, to perform any duty which he shall be competent to perform and which the Inspector is herein or hereby required to do. And the Inspector and each of his deputies, shall take and file an oath of office, as other city officers are required to do, and shall respectively execute to the city and file with its City Clerk a bond, the Inspector in the sum of one thousand dollars, and each of his deputies in the sum of five hundred dollars, with such conditions as the City Council shall prescribe or approve.

That the Inspector may also, by and with the approval of the City Council, appoint one or more assistants (who need not necessarily be competent to make the tests herein provided for) who shall under his direction supervise the installation of gas and gasoline lamps used in the lighting of streets; see to it that the equipment thereof complies with the requirements of the City Council, and that the same are lighted and extinguished in accordance with the schedule prescribed therefor; and also assist the Inspector in the auditing of bills for street lighting, as the same are from time to time presented, and the performance of such other duties as the Inspector may prescribe or direct.

SEC. 4. *Maps, Card Catalogues and Blue Prints.*—That maps of all its existing system of mains and service connections shall, within six (6) months from the passage of this ordinance, be made or completed by and at the expense of the company as follows: (a) Sectional maps, each drawn to a scale of one hundred feet (100 feet) to the inch, upon sheets twenty inches (20 inches) in width by thirty inches (30 inches) in length, showing the location and size of all mains in its system and all services from mains to houses or other connections (in so far as the same are known to the company) and designating all such mains and services, so that, by scale measurement, the distance of each main from the boundary line of the street, and of each service from the nearest line of the nearest intersecting street may as accurately as possible be ascertained and determined. (b) A general map of the whole city divided into four rectangular sections cornering at or near the old City Hall, drawn to a scale of four hundred feet (400 feet) to the inch, showing by proper signs the location and sizes of all mains, all district governors and all booster or high pressure mains, but not the details of intersection or house connection or services, which map shall be supplemented from time to time by new maps so as to show all new extensions, district governors and booster or high pressure mains, as the same shall hereafter be laid or installed by the company.

That the company shall at its own expense, within six months from the passage of this ordinance, prepare and deliver a complete set of blue prints of all said sectional and general maps, to the Inspector and City Engineer, respectively, and thereafter make such additions to, or changes in, said blue prints that the same will at the end of each year then correspond with said maps, as the same shall be from time to time added to or enlarged; all of which blue prints shall be kept and retained by said Inspector and City Engineer, as a part of the records and files belonging to their respective offices. And the company shall also at its own expense, and as soon hereafter as may be practicable (in any event within nine months after the passage of this ordinance) prepare and deliver to the City Engineer a true and correct copy of all of its card catalogue, giving every detail and the measurements locating all its services and mains, which shall at all times be kept up to date for the use of the City Engineer and be placed and kept in his office, as a part of the records and files belonging thereto.

SEC. 5. *Laying of Mains and Services.*—That the company shall at the request of any person about to become a consumer of gas, in front or at the side of whose premises a main shall exist, without cost to him, connect such main to said premises by the usual service connection. That the company shall also upon the order of the City Council, free from all cost to the city or its citizens, extend its mains in such streets as may be designated, which shall have been previously graded, and in such streets though ungraded, where the grade shall have been established, and the contour of the ground on an average, figured along the entire length of the proposed extension and over the full width of the roadway, shall be not more than six inches above or below the established grade. Provided, that in every such case at least one consumer on an average for every one hundred and thirty-three (133) feet of the extension ordered, shall first in writing agree to take gas from the company, for a period of not less than one (1) year at the then established rates, or that the estimated annual sales of gas derived from the extension ordered will yield at least twenty per cent (20 per cent) of the total cost thereof. And provided also that the company may after obtaining proper permits and locations therefor from the City Engineer enlarge, replace, extend or improve its system of mains or services in excess of the above mentioned requirements to such extent as it shall deem necessary for the improvement or expansion of its business or the regulation of gas pressure.

That the location of new mains in the street shall conform as nearly as may be to the existing system of the company, and shall in all cases be established by the City Engineer, without whose duly signed permit, designating the location, no main or house connection shall be laid. And all mains hereafter laid or replaced by the company shall be cast iron mains and shall be not less than six (6) inches inside diameter, unless the City Engineer and the Inspector shall jointly, after careful examination in each instance and for a special reason deemed by them to be sufficient, grant a special permit for a smaller size of wrought iron main or for a steel main more than thirty (30) inches in diameter. And the company shall also, so far as practicable, place all gas mains hereafter installed or laid, all services therefrom and all services from existing mains, at such depth below the surface of the ground as will prevent any deterioration from frost or cold in the quality or flowage of the gas supplied therefrom.

That whenever any street is hereafter paved or repaved (not intending to include ordinary grading or macadamizing of streets) the company shall remove therefrom all mains less than six (6) inches in diameter, replace therein cast iron mains six (6) inches or more in diameter (unless the City Council shall, by resolution, in special instances for reasons deemed to be sufficient, otherwise provide) and shall also examine and renew all defective services, and also add services for such prospective consumers as may be obtained by a careful canvass of the locality.

That if at any time it shall be necessary to change the position of any main or service of the company to permit the city to lay, make or change street grades, pavements, sewers, water mains or other city structures, or city work of any kind, such changes in mains or services shall be made by the company at its own expense according to the instructions of the City Engineer.

That all digging of ditches, laying of mains and other operations required for gas distribution shall be done at the risk of the company, which shall assume the entire risk of all accidents and hold the city harmless from all cost or damage occasioned thereby; and it shall, if so directed by the City Council, file such bond as may be required to indemnify the city against all damage or other suits resulting therefrom.

That before the company shall interfere with, remove, or alter any pavement, sewer, sewer inlet, or other city structure, it shall deposit with the City Treasurer a sum sufficient to repair, replace, or re-erect the same in the manner required of electric and conduit companies. And the company shall also, when so directed by the City Engineer replace all material excavated from the streets in the laying of its mains or connections, in such manner as he shall direct; and shall also, if so directed by the City Engineer, during the time intervening between its removal and replacing of street paving of a permanent nature, temporarily plank the space from which the paving has been removed in such manner as to insure a reasonably smooth street surface across or along the same.

SEC. 6. *Meters and Meter Testing.*—That the company shall, upon the request of any consumer not in arrears with respect to the payment of any gas bill due to the company, install for his use a prepayment meter, otherwise called a "quarter meter," of not more than twenty light capacity, in lieu of the meter in common use which is read monthly; and whenever any such prepayment meter is removed, the consumer shall be refunded such part of any deposit, therein previously made, which shall not have been exhausted.

That the Inspector shall, on or prior to the first day of January, nineteen hundred and eleven (1911), provide and thereafter maintain at the city's expense a suitable place (to be known as the meter inspection room) for the purpose of testing therein all meters complained of by consumers of gas and all other meters used by the company for the measurement thereof. And the company shall be entitled to have a representative present in said room at all times while any meter is being tested, proved or sealed therein, and be entitled also at all reasonable times to test and prove the accuracy of any appliance used in the testing of meters and the methods used in the testing thereof.

That when a consumer shall make complaint concerning the accuracy of his meter and pay to the Inspector a fee of one dollar, the Inspector shall give notice of such complaint to the com-

pany, which shall thereupon, in the presence of the Inspector at such time as he shall designate, remove said meter from the premises of the consumer to the meter inspection room, and shall also at the same time install, in place of the one so removed, another meter duly tested, proved and sealed. The Inspector, at the time of such removal of any meter, shall securely paste thereon a slip of paper containing his signature, the date of such removal and a description of the premises from which the meter is removed. The meter so removed shall, unless another time be agreed upon, be tested at 9 o'clock a. m. of the succeeding day (omitting Sundays and holidays) at which time a representative of the company and also the consumer may be present. And if upon being tested the meter so complained of be found inaccurate or defective upon any of the tests herein provided for, the one dollar ($1.00) paid by the complainant shall be returned to him, and the company shall in his stead pay one dollar ($1.00) to the City Treasurer, as herein provided.

And whenever any meter upon being tested, as in this paragraph provided, shall be found to measure quantities more than 2 per cent in excess of the standard measurement of gas, the consumer from whose premises such meter shall have been removed shall be entitled to receive from the company a rebate or return of a sum equal to the percentage of such excess of all moneys paid by the consumer to the company and measured by such meter from the time it had been installed or previously tested until the time of such retesting thereof, not exceeding, however, a period of six months.

That the company shall not after said inspection room shall have been so provided install any gas meter in the premises of any consumer which shall not have been, subsequent to the prior use of the same, tested, proved, and sealed by the Inspector, as herein provided. And the company shall not thereafter use any such gas meter within said city more than three (3) years after it shall have been tested, proved and sealed, or retested, re-proved and re-sealed by the Inspector, in accordance with the provisions hereof; provided, however, that the company may continue the use of each of its meters now installed and in service unless complaint thereof be made, or unless found to be defective, until the same shall be tested by the Inspector, as herein provided.

That from and after the time when the inspection room shall be provided and maintained by the Inspector, as aforesaid, the company shall detach and remove thereto to be tested, proved and sealed by the Inspector as herein provided, its meters now or then in service as follows, to-wit, At least one thousand (1,000) thereof each and every month, and all of the same prior to the first day of April, nineteen hundred and thirteen (1913); said meters to be so removed and delivered to the Inspector respectively in the order in which the same have been tested, or retested by the company; another meter duly tested, proved and sealed being installed in the place of each one so removed. And (except as hereinbefore specified, in case of a meter complained of by a consumer) for each such meter which shall be thus proved, tested and sealed by the Inspector, the company shall pay to the City Treasurer the sum of twenty-five (25) cents as specified herein.

That the Inspector shall carefully protect and guard all meters which come into his possession for inspection, and shall tightly cork all such meters during the time the same are in his custody and not being tested. And the Inspector in the testing of each meter shall subject the same to three tests: first, one which proves accurately its registration by means of the standard prover in ordinary use; second, one which proves the steadiness of the light and the freedom of the meter leakage; and, third, one which proves that the meter registers small quantities of gas. If, under the first test, any meter shall be found to register quantities incorrectly to an extent exceeding two per cent (2 per cent); or if under the second test, the meter is found to leak, or if any noticeable fluctuation in the light is observed; or if, under the third test, the meter fails to register small quantities of gas consumed, the meter shall be turned over to the company for readjustment and the same shall not be again used until the defect is remedied, the meter again tested, found to be correct and duly sealed. But every meter shall be considered correct as to the first test when duly certified and sealed which shall register quantities varying not more than two (2) percentum from the standard measure of gas.

That the Inspector shall have a card made which he shall attach to each meter tested by him and upon such card shall be given the data connected with the testing of the meter and the time of the testing. If the meter be found to be correct and be so certified by the Inspector, he shall seal the same by a suitable device. And no person other than the Inspector or his deputy shall unseal any such meter or deface, alter, or remove any card so attached thereto by him, or place thereon any card or writing purporting to be the certificate of the Inspector.

That the Inspector shall also number consecutively each and all meters by him tested upon the said card attached thereto, and shall enter in a book kept as a part of the records of his office the number of each meter so tested, the date of the testing thereof, the manufacturer's name and number and the company's number if the same appear thereon.

That the Inspector shall upon the first day of each month file in the office of the City Clerk a certified statement, showing the sum due from the company to the city for the testing of meters upon the complaint of consumers, or otherwise, during the previous calendar month; and the company shall within five (5) days thereafter pay to the City Treasurer the sum due from it to the city for such testing of meters during such previous month. And all money received by the Inspector upon complaint of any consumer, when it is determined that his meter is not inaccurate or defective by any of the tests herein prescribed, shall forthwith be paid to the City Treasurer by the Inspector.

SEC. 7. *Testing Stations.*—That the city shall at its own expense, as soon as practicable, provide and maintain at least two testing stations (hereinafter called the testing stations) which shall be more than one mile apart, and each of which shall be at or near a center of gas consumption, and not less than one mile, nor more than one and one-half miles, measured in a direct line, from any manufacturing plant of the company.

That the city shall also at its own expense provide and maintain in each of said testing stations such calorimeters, photometers, pressure gauges and other supplies and apparatus as shall be necessary to determine the pressure, purity, candle power and heating value of the gas supplied by the company, and in the making of any other tests that may from time to time be deemed necessary or desirable by the Inspector.

That all of the equipment and supplies, so to be provided and maintained by the city and so to be used in the making of tests, shall be of the standard types and qualities, and such as are generally used for such purpose, and shall be tested for accuracy from time to time, so that the tests made hereunder shall be as accurate and fair as is reasonably possible.

That the company shall run a pipe to each testing station (and if so demanded by the Inspector, a new pipe to the existing City Hall Station) from the gas main nearest thereto, all under the supervision of the Inspector, and in such manner as he shall approve; or, if this be not done by the company, the Inspector is authorized to put in the service himself at the cost of the company. And each pipe so run to any testing station shall be free from all gas cocks or other obstructions which might interfere with, or in any way affect, the proper flow or quality of gas.

That until the city shall provide, maintain and equip testing stations, as herein provided, all tests except as to pressure shall be made at the testing station now located at the City Hall (herein called the City Hall Station). Until such time the provisions of this ordinance as to the averages at separate stations shall be disregarded and the tests and the average of tests as made at the City Hall Station, as to all matters except pressure, shall be considered the tests and the average of the tests to be made at said testing stations so to be provided, maintained and equipped by the city.

That in case of any dispute between the city or its Inspector on the one side and the company on the other, as to the methods or apparatus employed in the testing of the pressure, purity, candle power or heating value of the gas supplied by the company, the latest notification of the Gas Referees covering Metropolis Gas, London, England, at the time obtainable, when not inconsistent with the express provisions of this ordinance, shall prevail and be conclusive as to such matters upon all concerned. And if any technical matter arise and be in dispute, not covered by this

ordinance or by such notification, an arbitration board, as between the city and the company, may be provided upon the demand of either the company or city as follows: The city shall select one expert and the company shall select another; these two selecting a third to be jointly paid by the city and the company; and the decision of these three or a majority of them upon the matter so in dispute shall be final and conclusive, as to such technical matter, for the period of one year thereafter.

SEC. 8. *Methods of Testing—General Provisions.*—That all tests herein provided for shall be made by the Inspector or his deputy; and the company may, if it so desires, have a representative present at any of the usual or stated tests herein mentioned. All tests of candle or heating power, regularly required, shall be made between nine o'clock a. m. and five o'clock p. m., unless such time be for any reason changed by the Inspector, in which event he shall give the company reasonable notice in advance of the change of time. And the volume of all gas used upon such tests shall be corrected to a standard temperature of sixty (60) degrees Fahrenheit and to a standard barometric pressure of thirty (30) inches of mercury. But the Inspector may, if he deem it advisable, make tests of the pressure, purity, candle power and heating value of gas at as many places (including the works of the company) as he may select without notifying the company thereof, such tests to be in addition to the usual tests made at the regular testing stations; but the same shall not be used by the Inspector in the making out of the daily or monthly averages herein provided for.

That the Inspector shall keep a full and complete record of all tests by him made, which shall at all reasonable times be open to the inspection of the company, and shall make monthly reports thereof to the City Council. He shall, moreover, each day post in a public place in the testing stations or City Hall the results of any and all tests upon which the gas is found not to comply with the requirements of this ordinance.

That whenever upon any test made of gas for the purpose of ascertaining its purity, candle power or heating value, as herein provided, it shall be found in any such respect not to comply with the requirements of this ordinance, the Inspector shall forthwith and within twenty-four hours thereafter (not including Sundays or holidays) deliver at the office of the company a notice in writing specifying such defect; and he shall thereupon make similar tests on each and every day thereafter, except Sundays and holidays (advising the company in like manner as to the result thereof), until the gas shall be found to be free from such defect.

That whenever the Inspector is required by this ordinance to deliver any notice or other paper at the office of the company, Mayor or City Clerk, he may do so by a deputy or other messenger; and that the company shall at all times during the usual office hours, have some representative in its office who shall receive such notice or paper so delivered and acknowledge in writing the time of the receipt thereof.

SEC. 9. *Impurities in Gas.*—That tested as provided herein the gas supplied by the company shall not at any time contain more than four (4) grains of ammonia in any one hundred (100) cubic feet thereof; nor shall the gas, so tested, at any time between the first day of April and the first day of October in any year, contain more than twenty (20) grains of total sulphur in any one hundred (100) cubic feet of the same, or at any other time more than thirty (30) grains of total sulphur in any one hundred (100) cubic feet thereof. And the gas supplied by the company shall at all times be wholly free from sulphuretted hydrogen, as determined by the particular test herein specified.

That the Inspector shall test the gas supplied by the company to determine the quantity of total sulphur and ammonia therein at least once in each week, and to determine the presence of sulphuretted hydrogen therein on each one of at least twenty (20) days of each calendar month, using for that purpose in each instance the test prescribed therefor in the notification of the Gas Referees, covering Metropolis Gas, London, England, published in the year 1909, or such other test as may be agreed upon by the company and the inspector, and which as applied to total sulphur and ammonia will give accurate results. And whenever and as often as the test prescribed for sulphuretted hydrogen shall show the presence thereof in the gas, or the test prescribed for total

sulphur and ammonia, respectively, shall show the presence thereof in excess of the quantity herein prescribed, he shall as to each test wherein the gas fails to comply with the requirements hereof make a like test on each and every day thereafter (except on Sundays and holidays) until the test shall show that the gas complies, in the particulars involved therein, with the requirements of this section.

SEC. 10. *Candle Power of Gas.*—That the gas supplied by the company, tested as provided in this section, shall be of at least eighteen (18) candle power, that is, of such quality that the gas when burned at the rate of five cubic feet per hour, under standard conditions of temperature and barometric pressure, in any ordinary lava tip or open flame burner in common use, giving the full candle power of the gas, shall give a light as measured by any standard bar photometer in common use, of not less than eighteen (18) standard candles—it being understood that a standard candle is the unit of light prescribed and maintained by the United States Bureau of Standards, known as the International candle, which is equal to one Pentane candle, one Bougie decimale, one American candle, 1.11 Hefner units, or 0.104 Carcel units.

That the Inspector shall test the candle power of the gas upon at least twenty (20) separate days of each month. In the making of such tests he may use Pentane lamps, previously standardized by the United States Bureau of Standards or such other suitable burner or apparatus agreed upon between the Inspector and the company as will measure the correct candle power of the gas, as herein defined.

That the Inspector shall make two (2) separate and distinct tests on each day when tests are made to determine such candle power, at an interval of not less than four (4) hours, at the City Hall Station or testing stations, and the average of the tests so made shall be deemed to represent the candle power of the gas on the day of such tests.

SEC. 11. *Heating Power of Gas.*—That the gas supplied by the company, tested at the City Hall Station or testing stations as provided herein, shall give a monthly average gross heating value of not less than six hundred (600) British thermal units per cubic foot of gas; and that the daily average gross heating value of the gas supplied by the company, tested at any such station, shall not on any day be less than five hundred and fifty (550) British thermal units.

That the gas shall be tested for the purpose of determining its heating value twice each day, at an interval of not less than four (4) hours, upon at least twenty (20) days during each and every month, at the City Hall Station or testing stations.

That the average of each of the two tests at the City Hall Station or at the testing stations (hereinafter called the daily average at the stations) shall be deemed to represent the gross heating value of the gas on the day of such tests; and that the daily average so ascertained, for each and every day of the month upon which said tests shall have been made, shall be again averaged and the result (hereinafter called the monthly average at the stations) shall be deemed to represent the gross heating value of the gas during the then current calendar month.

That the Inspector shall after the computation of any monthly or daily average of the heating value of gas, so ascertained, forthwith, and within twenty-four (24) hours deliver a statement thereof at the company's office, so it may know the averages thus obtained, and also file a statement of such monthly average in the office of the City Clerk.

SEC. 12. *Pressure of Gas.*—That the company shall proceed forthwith to repair, reinforce and re-equip its present system of distribution and regulate and equalize the same, so that its system shall as soon as possible be in all respects adequate to meet, as to pressure of gas, the requirements hereinafter set forth, within the time hereinafter specified, and in any event on or prior to January first, nineteen hundred and twelve (1912). And to that end, the company shall, within two (2) years after this ordinance shall become effective, construct and thereafter maintain a gas holder, at some suitable place within the city upon the east side of the Mississippi river, of such capacity as will adequately supply the demand for gas in that locality, and maintain the pressure thereof within the limits herein prescribed. And the company shall also hereafter maintain, extend and

improve its distributing system, with due regard to the fact that it is the intention of the city (hereby expressed) to require the company on and after January first, 1913, without the use of house governors, to maintain a pressure of gas as uniform as may be, that will never be less than two (2) inches nor more than four (4) inches of water pressure in any of its mains on the level of the water in the gas works holder, or elsewhere except as the same may be due to the elevation of the main above such level.

That on and after the first day of July, nineteen hundred and ten (1910) the pressure of gas supplied by the company, tested at any point where the unobstructed service pipe enters the building of the consumer, shall never be less than two (2) inches nor more than six (6) inches of water pressure, and that the variation of pressure upon any day at any such point shall never be greater than one hundred per cent (100 per cent) of the minimum pressure upon the same day and at the same point. Provided, however, that the company may prior to January first, nineteen hundred twelve (1912) install a house governor at the place where the gas enters the consumer's premises upon filing in each instance with the Inspector a written declaration of its purpose to install the same, together with a description of the premises in which it is to be placed, which declaration shall be kept by the Inspector as a part of the records and files of his office; provided also that the company may, after January first, nineteen hundred and twelve (1912) install any such house governor upon obtaining from the Inspector a special permit therefor, as hereinafter provided. The company shall whenever any such house governor is removed, forthwith file written notice of such removal with the Inspector, and shall on the first day of each and every month file in the office of the City Clerk its certified statement showing the aggregate number of such house governors then in use by the company. But the company shall not, after the first day of January, nineteen hundred and twelve (1912) continue the use of any house governor previously installed, and shall not thereafter install, maintain or use any such governor, except at such place and for such period of time only as the Inspector shall, after careful examination in each instance and for some special reason, deemed by him to be sufficient, by his duly signed permit, allow. And whenever any such special permit shall be granted, a duplicate copy thereof shall be kept and preserved by the Inspector as a part of the records and files of his office.

That from and after the passage of this ordinance the Inspector shall at least once each month, if he so determines, without notifying the company, make a general test of the maximum and minimum pressure of gas supplied by the company at any hour or at all the hours of one whole day; and the Inspector shall also obtain and keep a continuous record of gas pressure daily at not less than ten (10) points within the district furnished with gas, by means of recording gauges, so distributed as to cover as nearly as possible the whole distribution system of the company, the supply of gas to said recording gauges being taken from unobstructed service pipes direct from the mains. The Inspector may also, in like manner, at any time prior to January 1st, 1912, without notice to the company, determine, at as many points as he may deem advisable, the gas pressure in any street main, or in any service pipe at the inlet and outlet of the meter of any consumer.

And it shall be the duty of the Inspector and City Engineer during the years nineteen hundred and ten (1910) and nineteen hundred and eleven (1911) by reference to the record of gas pressure so obtained, and their knowledge of the work being done by the company to restore and perfect its distribution system, to make monthly joint or separate reports concerning the same to the City Council and to suggest and recommend such additions, alterations, or enlargements therein as will in their opinion correct any defect in gas pressure deemed by them or either of them to then exist therein.

That if at any time, between the first day of July, nineteen hundred and ten (1910) and the first day of January, nineteen hundred and twelve (1912) the pressure of the gas supplied by the company to any consumer shall fail to comply with the requirements of this section, and the consumer complain thereof to the company, it shall, if the defect be due to local conditions, within seventy-two (72) hours thereafter, and if due to other conditions, within a reasonable time there-

after, remedy the defective pressure, so that the pressure will comply with such requirements; and if necessary to remedy the same the company shall at its own expense install and maintain a house governor at the point where the gas enters the consumer's premises, first filing with the Inspector a notice of its intention to install the same, as hereinbefore provided. And should any such consumer, after the company has undertaken to remedy any such defect in pressure, pursuant to the requirements of this paragraph, be of the opinion that the same has not been corrected, as herein required, and give to the Inspector notice thereof, the Inspector shall forthwith test the pressure of gas supplied to the consumer's premises by the use of recording or visual gauges and furnish to the consumer and the company, respectively, a written statement of the results thereof. And the company shall also, on each and every Monday between July 1st, 1910, and January 1st, 1912, file with the Inspector its certified statement showing the number of such complaints made within the previous calendar week, together with the respective names and residences of the complainants, and the respective points at which the pressure is so complained of.

That on and after the first day of January, nineteen hundred and twelve (1912) the Inspector, if he deems it proper, may, and in case improper pressure as herein defined be complained of shall, test the pressure of gas in the service or house pipe at the inlet or outlet of any consumer's meter by means of a recording or visual gauge; and if it be thus found that the pressure at any such point does not comply with the requirements of this ordinance, due allowance being made for meter friction, the Inspector shall within twenty-four hours thereafter deliver at the company's office a notice in writing of the defect; and the company shall, if the defect be due to imperfect conditions in the service pipe or in any governor placed by the company therein, remedy such defect within forty-eight (48) hours thereafter, or if due to any other cause, remedy such defect within a reasonable time thereafter. And the company shall, upon remedying such defect as aforesaid, forthwith and within twenty-four hours notify the Inspector that the defect has been corrected, so he may ascertain if the pressure then complies with this ordinance.

SEC. 13. *Meter Deposits, Disconnections and Gas Bills.*—That the deposit required of any consumer of gas as security for payment therefor shall not exceed the probable amount of his one month's consumption thereof. And the company shall pay interest at the rate of six (6) per cent per annum on every such deposit heretofore or hereafter made for the purpose aforesaid, if the sum exceeds one dollar, ($1.00), such interest to be paid semiannually.

That forty-eight hours notice in writing shall be given the company by a consumer before he shall quit the premises where he shall have been supplied with gas; and in default of such notice the consumer so quitting shall be liable to pay the company for any gas supplied to said premises before the time for the next reading of the meter therein.

That in addition to the usual form of gas bills made out by the company there shall be printed upon the face thereon in bold type the following words: "Discount allowed for deficiency in gross heating value;" and the amount of the discount, if any there be, to the consumer pursuant to the provisions of this ordinance shall be inserted after such words and be deducted from the amount of the bill.

SEC. 14. *Discount for Heating Deficiency.*—That should the monthly average gross heating value of the gas at the City Hall Station or testing stations (determined according to Section 11 hereof) at any time fall below six hundred (600) British Thermal Units, every consumer of gas within the city during the month when the deficiency shall occur, shall be entitled to and shall receive a pro rata discount upon his gas bill therefor. The percentage of such discount shall be ascertained by dividing the number of British Thermal Units of such average monthly deficiency at the City Hall or testing stations by the standard of thermal units specified therefor by said Section 11, which percentage shall be used by the company in computing the discount of its bills for the month, which discount shall be deducted from the gas bill for the succeeding month or be paid to the consumer in cash.

That the Inspector shall deliver at the office of the City Clerk and the Mayor respectively, and also deliver at the office of the company, a copy of his computation of the discount in the

monthly bills, for each month in which a discount therefrom shall be made pursuant hereto, on or before the 5th day of the succeeding month, and also post a copy thereof in the usual place selected by him for that purpose, certifying therein that the average of heating value as determined at the City Hall Station or testing stations, is the average of at least twenty (20) tests made two in each day upon separate days during said month, wherein the deficiency shall occur.

SEC. 15. *Penalties.*—The company shall be subject to and pay a fine of one hundred dollars ($100) whenever and as often as it shall violate this ordinance and be convicted thereof in the Municipal Court of the City of Minneapolis in each of the following cases, viz: (a) In case it shall fail for any three successive days after January first, nineteen hundred and twelve (1912) to correct within a reasonable time any defect in the pressure of gas (as prescribed in Section 12 hereof) not due to improper conditions in the service pipe or the governor connection by the company thereto; (b) In case of any deficiency for any three successive days in the candle power of the gas prescribed by Section 10 of this ordinance; (c) In case of the presence in the gas for any three successive days of sulphuretted hydrogen according to the test prescribed by Section 9 hereof; (d) In case of the presence in the gas for any three successive days of sulphur other than sulphuretted hydrogen, in excess of the quantity prescribed in said Section 9; (e) In case of the presence in the gas for any three successive days of ammonia in excess of the quantity prescribed in said Section 9; (f) in case of the company's failure for any three successive days to furnish gas the average daily gross heating value of which at the City Hall Station or testing stations shall not be at least five hundred and fifty (550) British Thermal Units as prescribed in Section 11 hereof. Provided, however, that before the company shall in any such case be or become subject to any such fine the Inspector shall, upon the discovery of the specified defect in the pressure or quality of the gas, by the test hereinbefore provided for the detection thereof, forthwith and within twenty-four (24) hours thereafter (not including Sundays or holidays) deliver, at the office of the company a notice in writing specifying such defect and deliver a like notice at the office of the Mayor and City Clerk respectively; and shall, if upon the succeeding day he finds the same defect, again give notice thereof in like manner, and shall on the third succeeding day if he finds the same defect forthwith and within twenty-four (24) hours thereafter give notice thereof by means of an affidavit, stating the three days' defect, duly verified before an officer authorized to administer oaths, delivered at the office of the company, and by like affidavit delivered at the office of the Mayor and City Clerk respectively.

That if the company shall violate this ordinance by not delivering to the City Engineer and Inspector, respectively, blueprints of the maps of its mains and services and a copy of its card catalogue in the form prescribed by Section 4 hereof, within the time or times prescribed in said section, or by failure to supplement, add to or enlarge the same as therein provided, it shall, upon conviction thereof in said Municipal Court, be subject to and pay a fine of one hundred dollars ($100), and for each day's additional delay in so delivering the same thereafter shall, upon conviction thereof in said court, be subject to and pay a further and additional fine of fifty dollars ($50).

That whenever and as often as the company shall on or after the first day of January, nineteen hundred and twelve (1912), violate this ordinance by failing to correct any defect in pressure of gas, due to any improper condition of the service pipe or any governor connected by the company therewith, within seventy-two (72) hours after notice of such defect, as hereinbefore provided, it shall upon conviction thereof in said Municipal Court be subject to and pay a fine of ten dollars ($10) and for each additional seventy-two (72) hours' delay in correcting such defect, it shall upon conviction thereof in said court be subject to and pay a further and additional fine of ten dollars ($10).

That whenever and as often as the company shall at any time on or between the first day of July, nineteen hundred and ten (1910) and the first day of January, nineteen hundred and twelve (1912), violate this ordinance by failing to remedy any defect in pressure of gas upon the complaint of any consumer, as required by Section 12 of this ordinance, it shall upon conviction thereof in

said Municipal Court be subject to and pay a fine of ten dollars ($10); and for each additional seventy-two (72) hours' delay in remedying such defect, as required by said section, the company shall upon conviction thereof in said court be subject to and pay a further and additional fine of ten dollars ($10).

That whenever and as often as the company shall at any time violate this ordinance, in the laying or replacing of any main which shall not be a cast iron main or shall be less than six inches inside diameter, without the consent of the City Council or without having previously obtained a special permit therefor from the City Engineer and Inspector, as provided in Section 5 hereof, the company shall upon conviction thereof in said Municipal Court be subject to and pay a fine of one hundred (100) dollars. And upon any such violation of this ordinance each and every officer, agent and servant of the company and every other person concerned therein, or who shall directly or indirectly participate in such violation thereof shall, upon conviction thereof before said Municipal Court, be punished therefor by a fine of one hundred (100) dollars or by imprisonment for a term not exceeding ninety (90) days.

That whenever and as often as the company shall violate this ordinance by failing, neglecting or refusing to lay any service or main when required or ordered to do so pursuant to the provisions of Section 5 hereof, it shall upon conviction thereof in said Municipal Court be subject to and pay a fine not exceeding one hundred (100) dollars, and for each day's additional delay in laying such service or main, the company shall upon conviction thereof in said court be subject to and pay a further and additional fine not exceeding fifty (50) dollars.

That whenever and as often as any person other than the Inspector or his deputy shall unseal any meter, or deface, alter or remove any card or paper attached thereto or pasted thereon by the Inspector, or place thereon or attach thereto any card or writing purporting to be the certificate of the Inspector, he shall upon conviction thereof in said Municipal Court be punished by a fine of twenty-five (25) dollars or by imprisonment for a term not exceeding twenty-five (25) days.

That whenever and as often as the company shall make, deliver or transmit to any consumer a gas bill contrary to the requirements of Section 13 hereof, or fail to deduct from any gas bill rendered to a consumer, or to pay to the consumer in cash, the full amount of any discount determined and computed, as provided in Section 14 hereof, which may become due to such consumer as therein provided, the company shall upon conviction thereof in said Municipal Court be subject to and pay a fine not exceeding the sum of ten dollars ($10).

And whenever and as often as the company, at any time hereafter, shall violate any provisions of this ordinance, on its part to be complied with or performed, in any respect or particular not hereinbefore in this section specified, either by failing, neglecting or refusing to do that which is herein in this ordinance required, or in the doing of that which is herein in this ordinance forbidden, it shall upon conviction of such violation thereof in said Municipal Court be subject to and pay a fine not exceeding the sum of one hundred dollars ($100).

SEC. 16. *Repeal.*—That all ordinances of the city and parts thereof contravening or inconsistent with the terms of this ordinance are hereby repealed.

SEC. 17. *Time of Becoming Effective.*—That this ordinance shall take effect and be in force from and after its passage and publication.

Passed March 24th, 1910.

CHICAGO, ILL.

All of the gas ordinance requirements of Chicago which refer to any subject of this circular are given below as last amended (November, 1909). The requirements are very similar in effect to those made in Minneapolis (see previous ordinance); but, because of several amendments of the original form, this arrangement is rather less logical. The section numbers refer to sections in the city code; in the last few sections quoted, however, they

refer to the sections of the ordinance as passed, these latter not yet being included in the city codes. It is of interest to note that these requirements regulate what is probably the largest gas manufacturing and distributing company in this country, if not in the world.

SEC. 921. *Bureau of Gas Inspection Established.*—There is hereby established a bureau, in the department of electricity, to be known as the bureau of inspection of gas meters and gas; which shall be under the supervision and control of the city electrician.

SEC. 922. *Office Created—Appointment.*—There is hereby created the office of inspector of gas meters and gas. He shall be appointed by the mayor, by and with the advice and consent of the city council, and shall be the head of said bureau. Said bureau shall embrace the said inspector and such assistants and employes as the city council may by ordinance provide.

SEC. 923. *Bond.*—Said inspector shall before entering upon the duties of his office execute a bond to the city, in the sum of ten thousand dollars, with such sureties as the city council shall approve, conditioned for the faithful performance of the duties of his office.

SEC. 924. *Duty to Test Meters.*—It shall be the duty of such Inspector to examine and test any gas meter furnished to any consumer of gas by any gas company furnishing gas for heating, power or illuminating purposes in this city whenever requested to do so by such consumer. Said inspection upon the request of a consumer shall be made substantially in accordance with the following requirements: Whenever any consumer of gas furnished by a gas company furnishing gas in the city shall make a request for such inspector to have any meter or meters so furnished and installed by such gas company on the premises of such consumer inspected for the purpose of ascertaining whether such meter registers accurately and correctly and pays the fee as hereinafter fixed, said inspector shall proceed to make a test of such gas meter. Before making any such test the inspector shall give notice to the person making application for such test, and also to the gas company whose meter is about to be tested, of the time and place where he intends to test such meter. Notice to the company shall be given in writing sent by mail to such gas company at its principal office in the city and notice shall be sent to such applicant in writing by mail addressed to the premises described in the application for such test. Such notice shall be mailed at least twenty-four hours before the time set for the test of such meter. The test of such meter shall be made by the inspector or his duly authorized agent or agents at such place as he may designate in such notice or notices, and shall be made in such manner as to thoroughly test such meter with a view of ascertaining whether it registers accurately.

SEC. 925. *Testing of Meters—Unit of Measure—Pressure at Which Test is to be Made—Standard Meters—Variations Allowed.*—The unit of measure to be employed by the inspector in making the test of meters herein provided for shall be the cubic foot containing 62.321 pounds of rain or distilled water at a temperature of sixty-two degrees Fahrenheit, and at a barometric pressure of thirty inches.

All meters shall be tested at a pressure which will balance a column of water one and five-tenths of an inch in height, and the accuracy of such meter shall be determined by the use of standard meter provers designed and constructed for the purpose.

There shall be maintained in the office of the Inspector of Gas Meters and Gas at least three standard gas meters which have been tested, sealed and certified by the United States Bureau of Standards. The meters so maintained shall be used as standards for the purpose of checking the working provers which are used by said Inspector in checking and testing meters used by consumers of gas. Any consumer's meter tested by said Inspector shall be deemed to be correct if it registers not to exceed two per cent. above or two per cent. below accuracy. Any meter found to be either fast or slow as herein defined shall be adjusted by the gas company owning same so as to bring it as close as practical to accuracy within the limits herein specified before again being placed in service.

SEC. 926. *Inspection Conclusive.*—The inspection herein provided for to be made by such Inspector shall be conclusive both upon the gas company owning such meter, and the consumer in or upon whose premises such meter was installed, and the amount of gas flowing through such meter for a period of six months before the close of the month in which such meter shall be inspected shall be adjudged to be as if such meter were during such six months in the same condition as it was at the time such inspection was made.

SEC. 927. *By Whom Fee Is to Be Finally Paid.*—If the result of any such inspection shall show any meter so inspected to be inaccurate as herein defined, and to have registered in such a manner as to show a greater consumption of gas than was actually consumed or than actually flowed through such meter, the amount advanced by the person desiring such test shall be forthwith returned to such person, and such inspection shall be made without any cost or expense of any kind to him, the cost of making such inspection of any meter so found to be inaccurate shall be paid by the company furnishing gas through the same, and by whom or for whose benefit such meter was installed, and the amount of the fee as herein fixed for such inspection shall be paid by such company upon a bill being presented to it by the Inspector with his certificate showing that such meter was found by him to be inaccurate. If the result of any inspection of any meter shall show such meter to be registering accurately as herein defined or to have registered a smaller amount of gas than actually flowed through such meter, in such case the expense of such inspection shall be paid for out of the fee required to be advanced by the person, firm or corporation making application for such inspection, and no part of such fee shall in any case be returned to such applicant.

SEC. 928. *Fees.*—Any person, firm or corporation desiring the inspection of any gas meter within the city as provided in Section 4 (four) hereof shall accompany the application for such inspection with a fee of one dollar which shall be paid to the City Collector, and for which such applicant shall obtain a receipt from the City Collector, showing such payment, which receipt shall describe the location of the gas meter to be inspected and shall contain the name of the person, firm or corporation for whose benefit said gas meter was installed, said receipt when presented to the Inspector shall be his authority for making the inspection herein provided for.

SEC. 929. *Disconnection of Meters to Be Inspected.*—Whenever a request shall be made to inspect any meter which is installed in any premises, the Inspector of Gas Meters and Gas shall have the right, upon giving the notices hereinbefore provided for, to require the gas company owning the same to disconnect and detach such meter and convey the same to such place as he may direct for the purpose of making his inspection, the said gas company installing another meter in place of the one so removed for inspection and test.

SEC. 930. *Office Hours—Apparatus.*—Said Inspector shall keep an office in the City Hall, where he shall be found during all business hours of each business day, except when absent on business connected with his official duties.

He shall keep in his office a standard one hundred inch bar photometer, with the ordinary and usual accessories of the same.

SEC. 931. *Supervision over Street Lamps.*—It is hereby made the duty of said inspector, subject to the direction of the city electrician, to exercise a supervision over all public street lamps together with the burners thereto attached and to see that such lamps and burners are kept clean and in good order; that the burners are of equal size and of the size provided for in the contract between the city and any person or corporation furnishing or supplying the gas or other illumination used in such street lamps.

SEC. 932. *Records to Be Kept.*—Said Inspector shall keep a register or registers in his office, in which he shall record the number and description of each meter inspected by him, and the time when it was tested by him, together with a record of all notices sent or given by him, and all other proceedings of his office. Such records shall at all times be open to the inspection of the Mayor, any member of the City Council, and the head of any department, or any citizen of the City of Chicago.

SEC. 933. Said inspector shall test, or cause to be tested in each testing station hereinafter provided for, the gas manufactured and furnished by the various gas companies engaged in the business of furnishing a supply of gas to consumers in the city.

He shall determine the candle power and calorific value and pressure of gas and shall make tests for sulphuretted hydrogen at least once every day, and shall make tests for sulphur and ammonia at least once every week in the manner hereinafter set forth. He shall communicate to the City Council the result of such tests at least once a month; provided, however, that should such tests disclose that the gas is below the standard required by the ordinances of the City of Chicago the said Gas Inspector shall report such fact to the City Council through the City Clerk at the next regular meeting of the City Council after such fact is determined by said Gas Inspector, and said Inspector shall keep on file and open for public inspection all reports made by him.

He shall obtain at least three continuous records of the gas pressure during each twenty-four (24) hours at the inlets of consumers' meters at three different points in each district wherein a testing station is established. Such records shall show the gas pressures at each instant during the twenty-four (24) hours. The location of the recording meters used for the purpose of obtaining continuous pressure tests shall be changed from time to time so as to determine gas pressure at the meters of the various customers on the system or systems of gas companies operating within the City of Chicago.

He shall secure samples of the gas supplied at various points on the said system or systems and shall test such samples to determine the calorific value of such gas and shall have at all times in his possession a record of the general quality of such gas.

SEC. 934. *Annual Estimate.*—Said inspector shall on or before the first day of November in each and every year prepare and submit to the comptroller an estimate of the whole cost and expense of providing for and maintaining his office during the ensuing fiscal year; which estimate shall be in detail and shall be laid by said comptroller before the city council with his annual estimate.

SEC. 935. *Monthly and Annual Report.*—Said Inspector shall immediately after the first day of each month prepare and submit to the Comptroller a report of the number of meters inspected during the previous month. Said Inspector shall annually on or before the first day of May in each year report in writing to the City Council the transactions of his office during the preceding year, with such other information as he may deem necessary and proper.

SEC. 936. *Penalty.*—Any person who shall alter or change any gas meter or the register thereon with the intent to defraud any person or corporation, or who shall tamper with or change any certificate issued by said inspector relating to the inspection of any gas meter for the purpose of defrauding any person or corporation, shall be fined not less than ten dollars nor more than one hundred dollars for each offense; and any person who shall violate or refuse to comply with any of the provisions of this article, shall be fined not less than ten dollars or more than one hundred dollars for each offense.

SEC. 937. *Purity of Gas.*—Any person or corporation engaged in carrying on, or conducting the business of furnishing or supplying illuminating gas in the city to any consumer or consumers shall be and hereby is required to furnish and supply such gas which shall be so far free from sulphuretted hydrogen that it shall not discolor a test paper imbued with acetate of lead when such test paper is exposed to a column of gas issuing at a rate of not less than five cubic feet per hour for sixty seconds under a pressure of one and five-tenths of an inch of water, and so that one hundred cubic feet of such gas shall not contain more than twenty grains of sulphur, and so that one hundred cubic feet of such gas shall not contain more than five grains of ammonia.

All tests to be made for the purpose of establishing the percentage of sulphuretted hydrogen in illuminating gas furnished by any person or corporation furnishing gas in the city shall be made, or conducted with the Tutweiller Sulphuretted Hydrogen apparatus, and the sulphur in other forms shall be determined by means of the Gas Referees Sulphur-Determining Apparatus, and methods ordinarily employed in the use of the same.

SEC. 938. *Illuminating Power.*—Any person or corporation engaged in carrying on or conducting the business of furnishing or supplying illuminating gas in the city to any consumer or consumers shall be and hereby is required to furnish and supply gas of an illuminating power of not less than twenty-two candle power. The gas while being tested shall be burned by means of a No. 7 Bray Slit-Union low pressure burner when used in connection with a standard one hundred inch bar photometer and the requisite accessories. The room in which the photometric tests are made shall be so ventilated that the carbon dioxide present in the air shall not exceed twelve one-hundredths of one per cent.

The unit of standard of light shall be that intensity of light emitted in a horizontal direction by one standard English sperm candle, when burning at the rate of 120 grains of sperm an hour.

In order to facilitate the daily tests of candle power the standard Vernon-Harcourt Pentane Lamp of ten candle power may be used. This standard, however, shall be standardized monthly with a standard Vernon-Harcourt Pentane lamp, which has been verified within one month by comparison with the aforesaid standard English sperm candle, or directly with the aforesaid candle.

SEC. 938a. All gas furnished by any person or corporation engaged in, carrying on or conducting the business of furnishing or supplying gas for heating, power or illuminating purposes in the city to any customer or customers shall be and hereby is required to have a calorific value of not less than six hundred British Thermal units gross per cubic foot, as determined by a standard calorimeter measured at sixty (60) degrees Fahrenheit and under a barometric pressure of thirty (30) inches of mercury.

SEC. 938b. The pressure of all manufactured gas for heating, power or illuminating purposes supplied or furnished to any customer or customers by any person or corporation engaged in, carrying on or conducting the business of furnishing or supplying gas within the city shall at no time at the inlet of consumer's meter be less than one and one-half (1½) inches of water.

SEC. 938c. No consumer shall be supplied with gas having more than 100 per cent fluctuation in pressure above the minimum pressure at the inlet of such consumer's meter.

SEC. 938d. Gas testing stations shall be from time to time erected and maintained but not exceeding seven in number, exclusive of a station in the City Hall, and all such stations, excepting said City Hall station, shall be located at a distance of not less than one mile from the nearest point at which gas is manufactured so that gas taken from the mains shall be fairly representative of the gas supplied within the district in which such station is located.

SEC. 939. *No Deposit for Meters.*—It shall be unlawful for any person or corporation engaged in the business of furnishing or supplying gas for consumption in the city to require, demand, or receive a deposit of money or other valuable thing as a condition precedent to or as a security for furnishing any consumer with a meter.

SEC. 940. Any person or corporation engeged in, carrying on or conducting the business of furnishing or supplying gas for heating, power or illuminating purposes in the city to any consumer or consumers who shall furnish gas of a quality below the standard prescribed in the ordinances of the City of Chicago, or who shall furnish to any consumer or consumers any gas, the pressure of which shall be less than the minimum limit or of greater fluctuation than that specified by said ordinances, or who shall violate any other provision of this article, shall be fined not less than fifty nor more than two hundred dollars for each offense, and each and evey day on which any such person or corporation shall furnish or supply illuminating gas to any person in the city in violation of any of the provisions of this article shall be deemed a separate and distinct offense. Any person or corporation who violates, neglects or refuses to comply with or who resists or opposes the enforcement of any of the provisions of this ordinance shall be fined not less than fifty dollars nor more than two hundred dollars for each offense.

SEC. 14. *New Meters.*—All new meters installed by any gas company after the passage of this ordinance shall be examined and tested under the supervision of the inspector of gas meters and gas previous to the installation of same, and said inspector shall seal the same with some suitable seal or stamp indicating that said meter has been examined and tested under the supervision of such

inspector and found to be registering accurately and said seal shall specify the date under which said inspection was made. No gas company furnishing gas in the city shall after the passage of this ordinance install any meter unless the same has been examined, tested and sealed as herein provided and all meters disconnected for inspection and test as herein provided or for repairs after the passage of this ordinance shall also be examined, tested and sealed in the same manner as is required in the case of new meters before the same shall again be connected or reinstalled.

SEC. 15. *Representative of Company at Test.*—Any company supplying gas to the city or its inhabitants, or any gas consumer, may at his or its option be represented at any and all tests made of the gas meters, supplied or used by the said company or person.

SEC. 16. *Penalty.*—Any gas company, corporation or vendor of gas within this city, who shall furnish or use any meter contrary to, or in violation of the provisions of this article, shall, on conviction thereof, be fined not less than twenty-five dollars nor more than one hundred dollars for each and every offense.

LOS ANGELES, CAL.

The laws of California require each city of over 100 000 in population to appoint a gas inspector and to make certain provisions as to gas quality, etc. Under this act the city of Los Angeles has enacted (December, 1907) the ordinance given below. Sections 1 and 2, which refer to price of gas and financial matters, and sections 15 to 18, which have been repealed, are omitted from the quotation; but the first paragraph of section 7 and the portions of section 9, which refer to pressure districts, are included, although neither of these is enforced at the present time.

AN ORDINANCE Regulating the sale and use of gas in the City of Los Angeles, the inspection of gas and gas meters and providing for the appointment of a Gas Inspector, and prescribing his duties.

The Mayor and Council of the City of Los Angeles do ordain as follows:

* * * * * * *

SEC. 3. The office of Gas Inspector is hereby created. Said Gas Inspector shall be appointed by the Mayor, and no person shall be eligible to be so appointed, who is or has been within the period of one year next preceding the date of his appointment, directly or indirectly interested in, or connected with any person, firm or corporation engaged in the business of manufacturing, distributing, supplying or conducting gas in or to the City of Los Angeles, or to its inhabitants, either as a stockholder, employee, or otherwise; and said Gas Inspector shall be removed from his office by reason of any such interest or connection, as above specified, or by reason of any such interest or connection acquired by him subsequent to his appointment.

The Gas Inspector shall have a general knowledge of chemistry and mechanical engineering as applied to the art of gas making, and a particular knowledge of the most approved methods of examining and testing gas meters, and the illuminating power, heating value, purity, chemical composition and other qualities of gas, and shall be familiar with the appliances generally used for such examination and testing.

Before entering upon the discharge of his duties, the Gas Inspector shall take and subscribe an oath to faithfully perform the duties of his office, and give a bond to the City of Los Angeles in the sum of Five Thousand ($5000.00) Dollars, with at least two sufficient sureties, to be approved by the City Council, conditioned for the faithful discharge of the duties of said office. The Gas Inspector shall perform such duties as are hereinafter prescribed. The Gas Inspector shall receive a salary of $175.00 per month, which said sum shall be in full compensation for all services of any kind performed by him.

SEC. 4. That the minimum illuminating and heating power and quality of gas, supplied in or to the City of Los Angeles, or to the inhabitants thereof, by any person, firm or corporation

engaged in the business of conducting, supplying or distributing gas in or to said city or to its inhabitants, are hereby fixed and established at a standard illuminating power of eighteen candle power, with a gross heat value of six hundred British Thermal Units per cubic foot; that is to say: Of such illuminating power that when burned with a self-luminous flame in a burner adapted to the development of the greatest illuminating efficiency of the gas, and consuming five cubic feet of such gas per hour, it shall give an illumination equivalent to that afforded by eighteen standard sperm candles each consuming 120 grains of sperm per hour, and of such heat producing quality that the combustion of one cubic foot of such gas in a calorimeter will liberate sufficient heat to raise 600 pounds avoirdupois of water one degree Fahrenheit in temperature, when such gas is supplied to said calorimeter under a pressure of one atmosphere, which is equal to 14.73 pounds per square inch, or 30 inches by the barometer, and when both gas and water are supplied to said calorimeter at a temperature of 60 degrees Fahrenheit; said temperature and pressure are hereby fixed as the standard conditions under which all measurements of gas volumes shall be made for the purpose of the tests mentioned in this Ordinance.

SEC. 5. That the purity of gas furnished in or to the City of Los Angeles, or to the inhabitants thereof, by any person, firm or corporation engaged in the business of supplying, conducting or distributing gas in or to said city, or its inhabitants, is hereby fixed and established as follows:

Such gas shall not contain more than 25 grains of sulphur in all forms, nor more than 5 grains of ammonia in all forms, in each 100 cubic feet thereof; such gas shall be free from the impurity known as sulphuretted hydrogen, and shall not contain more than 25 per centum by volume of carbon monoxide, and shall be free from all other noxious impurities, and from all impurities that will diminish the efficiency of, or clog the appliances used for the consumption of gas.

SEC. 6. That gas furnished in or to the City of Los Angeles, or to the inhabitants thereof, by any person, firm or corporation engaged in the business of furnishing supplying or distributing gas in or to said city, or to its inhabitants shall be so furnished or delivered in accordance with the following regulations:

Such gas shall be continuously and uninterruptedly delivered under a uniform and well governed pressure in each and every service pipe through which said gas is received for consumption by said city, or its inhabitants; such pressure exerted by said gas in each and every such service pipe shall not be less than that which is required to sustain a column of water two inches in height against the pressure of the atmosphere, or shall not be more than that required to sustain a column of water nine inches in height against the pressure of the atmosphere, while any or all appliances connected with such service pipe are in operation.

SEC. 7. It is hereby made the duty of every person, firm or corporation supplying gas in or to the City of Los Angeles, or to its inhabitants, within ninety days after the passage of this Ordinance, to file with the Gas Inspector a set of maps, each drawn to a scale of not less than 200 feet to the inch; which said set of maps shall show in detail the exact location, size, description, and date, if known, of installation of all gas mains, lateral and service pipes, and of all valves, pressure regulators, drips or other appliances installed beneath the surface of the streets, alleys, or other public places, or elsewhere, in the City of Los Angeles, belonging to or under the control of such person, firm or corporation, or in which such person, firm or corporation has any interest; and it shall be the duty of every such person, firm or corporation to file, within fifteen days after the expiration of each and every month after the filing of such maps, with said Gas Inspector, a statement containing a complete report of all new work of the character herein mentioned, installed during the preceding month. Each such map shall be accompanied by an affidavit endorsed thereon, subscribed and sworn to by such person, or by a member of such firm, or by the president or secretary of such corporation, to the effect that the same correctly exhibits the details herein required to be shown thereon; and each such monthly statement shall be subscribed and sworn to in like manner.

It shall be the duty of any person, firm or corporation supplying or delivering gas in or to the City of Los Angeles, or to its inhabitants to permit said Gas Inspector at any time to examine

or inspect any or all of his or its plants, pipe lines or other equipment used in manufacturing, conducting, furnishing, supplying, or distributing gas, and also to furnish to said Gas Inspector any information or data he may require in regard to the generating, storage and distributing capacity of such plant, pipe lines or other equipment.

SEC. 8. It shall be the duty of the Gas Inspector to make an examination and test the accuracy and condition of any gas meter in the City of Los Angeles installed and used, or to be installed and used for the purpose of measuring gas furnished to the City of Los Angeles or to any person, firm or corporation therein. Such examination and test shall be made upon the written request of the person, firm or corporation proposing to install such meter, or of the person, firm or corporation delivering, receiving or using gas through and measured by the meter to be tested. After making such examination and test the Gas Inspector shall give a certificate in writing, showing the result thereof, to the person, firm or corporation at whose request the examination and test is made; and if such meter is in use, he shall deliver to the person, firm or corporation furnishing the gas measured by said meter a duplicate of such certificate. Such certificate shall show the time and place of the examination, the number and make of the meter examined, and the percentage and character of error, if any, in the measurement made thereby.

The Gas Inspector shall use in the examination and testing of all meters a standard meter prover which shall accurately test and measure the quantity of gas passing through such meters under standard conditions and precautions regarding temperature. No meter shall be approved and sealed as correct by the Gas Inspector that indicates or registers more than two per centum more gas than actually passes through the same nor more than three per centumn less gas than actually passes through the same when such meter is delivering gas under a pressure sufficient to raise a column of water not less than two (2) inches nor more than nine (9) inches against the pressure of the atmosphere.

Whenever a test of a meter that is in use shall be made by the Gas Inspector, upon request as hereinbefore provided, and such meter shall be found to be faster or slower than prescribed by this Ordinance, the person, firm or corporation owning or controling, or delivering gas through the same, shall within two (2) days after written notice by the Gas Inspector remove said meter and shall install in place thereof another meter that shall be tested, approved and sealed by the Gas Inspector. No such meter that has been tested on request, and found incorrect and ordered removed by the Gas Inspector as aforesaid, shall be installed or placed in service again until it shall have been corrected and shall also have been retested, approved and sealed by the Gas Inspector.

If any meter proposed to be installed and placed in service is, prior to being so installed or placed in service, tested by the Gas Inspector at the request of the person, firm or corporation owning or controlling the same, and is found by the Gas Inspector to be incorrect, and so certified by him, to such person, firm or corporation, it shall be unlawful for any person, firm or corporation to thereafter install or use such meter until it shall have been corrected and shall also have been retested, approved and sealed by the Gas Inspector.

The Gas Inspector shall collect in advance from the person, firm or corporation requesting the test of any meter, the fee therefor at the scale of prices hereinafter in this Ordinance prescribed, together with such additional costs as may be allowed hereby. If such meter is in use, and the test and examination has been made at the request of the person, firm or corporation receiving gas measured thereby, and such test shall show that such meter is correct, the person, firm or corporation at whose request the inspection was made shall not be entitled to the refunding of the amount so advanced, but the same shall be retained by the Gas Inspector, and deposited by him as hereinafter provided, in the Gas Meter Testing Fund. If the Gas Inspector shall find that any such meter is faster than any prescribed by this Ordinance, the fee and any other costs for making such test shall be a charge against the person, firm or corporation owning or controlling the same, or delivering the gas measured thereby, and such person, firm or corporation shall pay such charge to the Gas Inspector on demand, who shall upon such payment being made, refund to the person, firm or corporation paying the same in advance any charge therefor previously collected by him.

It shall be the duty of the Gas Inspector, if he shall approve any meter, upon examination and test, as aforesaid, to seal the same in such manner that the mechanism or operation of such meter can not thereafter be altered without breaking such seal.

The unit of measure for the delivery and sale of gas by meter shall be the cubic foot containing 62.321 pounds avoirdupois weight of distilled or rain water weighed in air of the temperature of 62 degrees Fahrenheit scale, the barometer being at 30 inches.

SEC. 9. It shall be the duty of the Gas Inspector to test and examine at least once during each day the illuminating power, heating value and purity of the gas furnished and distributed in or to the City of Los Angeles, or to the inhabitants thereof, by any person, firm or corporation, he shall also examine and test the pressure of such gas, and keep a continuous record of the same by the use of recording pressure gauges so stationed in the several pressure districts of the city, established for each such person, firm or corporation, as hereafter provided, so as to give an average of the condition of the pressure in the service pipes connected with the mains of each person, firm or corporation engaged in the business of so furnishing or distributing gas. The number and location of such pressure districts and recording pressure gauges for each such person, firm or corporation, shall be determined and fixed by the City Council by Ordinance in the following manner: The Gas Inspector shall, as soon as practicable after his appointment, present a report in writing to the City Council, with his recommendation as to the number and limits of such districts, and location of such recording pressure gauges, for each such person, firm or corporation; and the City Council shall fix a time for hearing such report, not less than ten days thereafter. The City Clerk shall thereupon give five days notice in writing of the time and place of such hearing to any such person, firm or corporation mentioned in said report.

At the time and place of such hearing, the City Council shall hear said report, and any objections thereto, and pass upon the same, and shall approve or modify said report. And thereupon the City Council shall by Ordinance fix and establish the number and limits of such pressure districts, and stations of such recording pressure gauges, in such manner as to make the stations so located represent the average pressure in the district prescribed thereby. If the Gas Inspector shall deem it necessary at any time to change the number or limits of any such pressure districts or the location of any such recording pressure gauges, he shall make report thereof to the City Council, and thereupon and thereafter such recording pressure districts and locations of recording pressure gauges may thereafter be changed by the City Council under proceedings taken in like manner.

It shall be the duty of any person, firm or corporation, whose pressure districts and stations of recording pressure gauges shall be established by Ordinance, as aforesaid, to install such recording pressure gauges within sixty days after the passage of such Ordinance mentioned in this Section.

SEC. 10. It shall be the duty of the Gas Inspector to investigate any complaint made to him in regard to pressure or service of gas, and to ascertain whether such pressure or service conforms to the provisions of this Ordinance; and if, on examination, said Gas Inspector shall find that such pressure or service does not conform to the provisions of this Ordinance, and is caused by inadequate, defective or inferior pipes, or other appliances installed and in use by any such person, firm or corporation for the purpose of so conducting, supplying, or distributing gas, or by any obstruction, the said Gas Inspector shall notify such person, firm or corporation in writing to cause such pressure or service to conform to the provisions of this Ordinance; and such person, firm or corporation shall comply with the terms of said notice within such reasonable time as shall be prescribed in said notice, not exceeding five days; provided, however, that for good cause shown, such further extension of time may be granted therefor by the Gas Inspector as may be necessary.

SEC. 11. In case either the illuminating power or the heating value or purity of any gas tested as herein provided, shall be lower than the standards provided in this Ordinance, the Gas Inspector shall make two further tests of said qualities of such gas, on the same day, at intervals of not less than three hours apart, and shall ascertain the average of each such quality on that day. Prior

to making such two additional tests, the Gas Inspector shall give notice to the person, firm or corporation conducting, supplying or distributing such gas, of the time of making such tests, in order that such person, firm or corporation may be represented thereat. The test papers of the sulphuretted hydrogen test, the records of all other tests and the records of the pressure gauges, shall be certified by the Gas Inspector, and filed by him in his office.

If any such person, firm or corporation, after receipt of notice from the Gas Inspector, as in this Section provided, shall not be represented at any test provided for in this Ordinance, such person, firm or corporation shall be deemed to waive all objections to such test and records, and to accept the same as correct.

SEC. 12. The Gas Inspector shall report in writing to the City Council, at its second regular meeting in each month, the result of all tests and examinations of gas and gas meters made by him during the preceding month. He shall keep a record of all such tests and examinations, showing in detail the name of the person, firm or corporation furnishing, conducting, supplying or distributing the gas tested, or owning any meter or meters tested, the date of each test, and the candle power, heat value, purity and pressure of such gas, as shown by such tests, according to the standards and in the manner provided by this Ordinance. Such records shall, during regular office hours, be open to public inspection.

SEC. 13. The Gas Inspector shall charge and collect in advance for the making of any examinations or test, under the provisions of this Ordinance, of meters delivered free at the Gas Inspector's office, the following fees:

For a 2 light meter	$0.25
For a 3 light meter	.25
For a 5 light meter	.25
For a 10 light meter	.30
For a 20 light meter	.30
For a 30 light meter	.30
For a 45 light meter	.30
For a 50 light meter	.30
For a 60 light meter	.30
For a 70 light meter	.50
For a 80 light meter	.50
For a 100 light meter	.50
For a 150 light meter	.90
For a 200 light meter	1.25
For a 250 light meter	1.50
For a 300 light meter	1.70
For a 400 light meter	2.00
For a 500 light meter	2.25
For a 600 light meter	2.50
For a 800 light meter	2.75
For a 1000 light meter	3.00

If it shall be necessary that any meter be brought to the Gas Inspector's office to be tested, the cost of cartage thereof shall be added to the testing fee, and collected at the time of collecting said fee.

The Gas Inspector shall charge double the above rates in addition to any expense incurred in such test for every meter tested at the place where the same is installed.

SEC. 14. That the Gas Inspector shall pay into the City Treasury of said City on every business day, all fees collected by him during the preceding business day for the making of such tests; and that all moneys collected and paid to the City Treasury by the Gas Inspector shall be by the City

Treasurer placed to the credit of a fund to be designated as the "Gas Meter Testing Fund," which shall be used for the purpose of paying the salary of the Gas Inspector, the expense of making tests provided by this Ordinance, and for the maintenance and purchase of apparatus therefor.

SEC. 19. Any person, firm or corporation violating any of the provisions of this Ordinance shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punishable by a fine of not less than $10.00, nor more than $500.00, or by imprisonment in the City Jail for a period of not less than five days nor more than six months, or by both such fine and imprisonment; and every such person, firm or corporation shall be deemed guilty of a separate offense for each day during which, or any portion of which, any violation of any provision of this Ordinance is done or permitted.

SEC. 20. That all Ordinances and parts of Ordinances in conflict herewith are hereby repealed.

Approved this 27th day of December, 1907.

OMAHA, NEBR.

The gas ordinance now in force in this city (passed August, 1908) is as follows:

AN ORDINANCE Fixing a Standard Purity and Quality of Gas Manufactured, Sold or Distributed Within the City of Omaha, and Providing for the Inspection and Testing Thereof, and Providing Rules and Regulations for Manufacture, Inspection and Distribution Thereof to Consumers Within the City of Omaha, and Providing Penalties for the Violation of the Provisions of Said Ordinance.

SECTION 1. All gas furnished by any person, firm or corporation for illuminating purposes within the City of Omaha shall be so manufactured by such company, firm or corporation, that such gas shall be merchantable, illuminating gas of not less than twenty-three sperm candles at the works and holders and not less than 21.2 candle power at the room provided for testing the gas, that is, of such quality that the burner consuming five cubic feet per hour at a pressure not exceeding eleven-tenths inches at the photometric burner, shall give a light as measured by the photometric apparatus in ordinary use of not less than twenty-three standard sperm candles, six to the pound, each consuming 120 grains per hour. The burner used in all tests shall be the ordinary lava-tipped fish-tailed or bats-winged burner. In case the full illuminating value of the gas furnished by said company is not given by the burner above described, such burner shall be used as will give the full amount of light obtainable from the gas. The heating value of the gas to be not less than 600 B. T. U. net per cubic foot, with gas volume corrected to 30-inch barometric pressure and 60 degrees Fahrenheit, as shown by the Junker Calorimeter at the room provided for testing the gas and within a radius of one mile and one-half from the holders. If any firm, person or corporation furnishes to the people of the City of Omaha an all-coal gas, the candle power thereof shall be not less than eighteen candle power under the test hereinbefore provided, except that the pressure shall not exceed six-tenths water inches. Said gas to have the illuminating quality above specified as it leaves the holders of said company. Such quality to be determined by monthly average of weekly tests made by the City Gas Commissioner of the City of Omaha.

All persons, firms or corporations shall so adjust their mains for the distribution of gas that the illuminating power of gas in the mains within a radius of one and one-half miles of their works shall be at least 92 per cent of the illuminating power of such gas when it leaves the holders of said company.

SEC. 2. The City Gas Commissioner shall make tests weekly or oftener at the holders of all such persons, firms or corporations or at some place or places not more than one and one-half miles distant from the point where such gas works in said city are situated and at such other places as said gas commissioner may deem necessary, or as may be ordered by the council, and ascertain whether the gas being supplied to consumers is of the quality as regards heating and illumination power required by section 1 of ordinance No. 5871, as amended by Ordinance No. 6201, and he

shall at the end of each month make an average of said tests made during that month, which average shall be deemed to show correctly the quality of gas as regards its illuminating and heating power, furnished by all persons, firms or corporations to consumers during such month; and he shall within twenty-four hours thereafter, notify each person, firm or corporation of such average.

For the purpose of making tests of gas, rooms shall be provided and fitted up at the expense of the City of Omaha, at some place not more than one and one-half miles distant from the works of such gas companies, and the gas companies shall conduct gas from each of their mains, and from the mains leading from each of their holders to the rooms of said gas commissioner so fitted for that purpose, by such pipes as the City Gas Commissioner may direct, adapted for submitting such gas from the various mains leading from each of such gas holders for all the tests required by this ordinance. And the gas commissioner shall also make tests at such other and different places throughout the city as he may deem proper or necessary to test the quality of gas being supplied to all parts of said city.

For all purposes and in any suit in court where the provisions of this ordinance or the quality of gas provided for therein may be material or involved, whether on account of violations of the provisions of this ordinance, or otherwise, all tests made by the Gas Commissioner of the City of Omaha or his deputy in their official capacity, of gas furnished to consumers therein by any firm, person or corporation, when certified to or supported by oath of said gas commissioner or deputy, shall be deemed and accepted as prima facie correct, and all instruments used by said Gas Commissioner in making such tests, where such gas tests are made, shall for all such purposes be deemed and held to be correct.

SEC. 3. Gas supplied by any person, firm or corporation to consumers within the City of Omaha, shall not contain more than fifteen grains of sulphur in any form in one hundred cubic feet of gas, nor more than five grains of ammonia in any form in one hundred cubic feet of gas, and shall be free of the impurity known as sulphuretted hydrogen, said impurity to be determined by passing the gas through a glass vessel containing strips of bibulous paper moistened with a solution of the acetate of lead, and if any discoloration of the test paper is found to have taken place, this is to be held conclusive as to the presence of sulphuretted hydrogen in the gas; and such gas shall be free from all other impurities producing noxious products of combustion.

SEC. 4. All persons, firms or corporations shall so adjust and complete their systems of holders and mains that gas shall be distributed throughout the entire system of gas mains in the city, at a proper and reasonable pressure subject to the inspection and approval of the City Gas Commissioner of the City of Omaha.

SEC. 5. The City Gas Commissioner shall at least once in every month, and as much oftener as is in his judgment necessary, make a test of gas supplied to consumers within the City of Omaha for illuminating and heating purposes, to ascertain its purity and specific gravity; and he shall from time to time make tests at different points throughout the system of mains in the City of Omaha to ascertain the pressure of gas within such mains. Said City Gas Commissioner shall make monthly tests to determine whether the street lights supplied by any firm, person or corporation under its contract with the City of Omaha are in all respects equal to the specifications and requirements contained in such contract.

Said City Gas Commissioner shall have, for the purpose of making the tests and inspection herein required, access to all gas works, and have the right to make such connections with all gas mains of said companies as may be necessary for the purpose of properly making the tests herein provided for. And such person, firm or corporation may have a representative present at any and all tests made by the City Gas Commissioner.

SEC. 6. Said City Gas Commissioner shall keep a full and complete official record of all tests made by him; and he shall notify any firm, person or corporation engaged in the manufacture and sale of gas within twenty-four hours after any test is made by him of the result of such test, provided that it is below the standard required.

Said Gas Commissioner shall at the beginning of each month and at such other times as the City Council may request, or said Gas Commissioner may deem necessary, report to the City Council the result of all tests made by him since the last preceding report to the City Council, which report shall be filed in the office of the Comptroller, a record of which shall be kept by such officer.

SEC. 7. If any firm, person or corporation shall fail to furnish to consumers within the City of Omaha gas of the quality prescribed in Section 1 of Ordinance No. 5871, as amended by Ordinance No. 6201, during any month, then such person, firm or corporation shall forfeit and pay to the City of Omaha for each month in which said average falls below the standard so fixed, a sum of money equal to 15 per cent of the value of the gas consumed in the City of Omaha during such month, for each candle power or fraction thereof below the standard required to be furnished by any person, firm or corporation, and a sum equal to 15 per cent of the value of the gas so consumed for such month for every ten British Thermal Units or fraction thereof below the standard as fixed in Section 1 of Ordinance No. 5871 as amended by Ordinance No. 6201; the price fixed by the franchise of such gas company shall be considered the value of the gas so consumed during any such month.

PROVIDED, that the City of Omaha shall through its Mayor and Council deduct from any amount due to any firm, person or corporation engaged in supplying gas to consumers in said city, an amount equal to all sums which by the terms of this ordinance have been forfeited to the city by reason of a violation of the terms and provisions thereof; and before any appropriation shall be made by the Mayor and Council in favor of any such person, firm or corporation for any purpose the amount so forfeited to the city under the provisions of this ordinance shall be deducted by the Comptroller from the amount due to any such firm, person or corporation under contract or otherwise.

And any and all amounts so forfeited to the City of Omaha or required to be paid to the City of Omaha by the terms of this ordinance shall also be recoverable in civil action brought in the name of the City of Omaha against any such person, firm or corporation.

SEC. 8. In case any person, firm or corporation shall after receiving notice of the result of any test made by the City Gas Commissioner, continue the manufacture and distribution of, through its mains within the City of Omaha gas different from that prescribed by the terms of this ordinance, such person, firm or corporation and the managing officers and agents thereof, shall be deemed guilty of a misdemeanor and upon conviction thereof, shall be punished by a fine of not more than one hundred dollars (100.00) or by imprisonment for a term not exceeding ninety days, and each day that such person, firm or corporation shall so continue to manufacture and distribute through its mains within the City of Omaha, gas different from that prescribed by the terms of this ordinance, shall be deemed a separate offense and punishable as such.

That all persons, firms and corporations engaged in the manufacture and distribution of gas in the City of Omaha shall within thirty days from the approval of this ordinance furnish to the Gas Commissioner of the City of Omaha, plans and drawings showing the location of all mains, holders, plants, distributing points and all connections of the entire system. Any person, firm or corporation failing to so furnish such plans and drawings as herein provided, and its officers and agents shall be deemed guilty of a misdemeanor and upon conviction shall be fined in the sum of One Hundred ($100.00) Dollars, and committed to jail for a period not exceeding thirty (30) days, for each offense, and each day that any person, firm or corporation shall fail to comply with said provision shall be deemed a separate offense.

SEC. 9. It shall be the duty of said City Gas Commissioner when so requested, to inspect, examine, approve and ascertain the accuracy of any and all meters used or intended to be used for measuring and ascertaining the quantity of gas furnished by any person, firm or corporation to a consumer of gas within the City of Omaha, and when found to be correct, to seal, stamp or mark all such meters and each of them with some suitable device which shall be recorded in the office of the City Clerk.

SEC. 10. The City Gas Commissioner of the City of Omaha, or his authorized deputy, shall have the right at any time to direct any person, firm or corporation engaged in the manufacture, sale and distribution of gas, to remove any meter of such person, firm or corporation, between the hours of 8 A. M. and noon of any week day, from the premises of any consumer, in the presence of said City Gas Commissioner, for the purpose of testing said meter; and shall whenever deemed necessary by such City Gas Commissioner be required to supply to any consumer whose meter may be removed for inspection, another meter for use during the time required for such inspection. Whenever any person, firm or corporation shall fail to so remove any meter under the direction of said inspector, it shall be lawful for said Gas Commissioner to remove such meter for the purpose of testing the same.

Any consumer of gas within the city, shall have the right of paying to the City Treasurer a fee of one dollar, to have his meter tested, and may be present at such test, if he so desires. And the Company shall, in all cases, have notice when such test is to be made. There shall be three tests made of gas meters by said City Gas Commissioner.

First—To prove accurately the registration of the meter, by means of the standard prover in ordinary use; second—to prove the steadiness of the light and the freedom of the meter from leakage; third—to prove that the meter registers small quantities of gas. If any meter on being so tested shall be found to register quantities incorrectly to an extent exceeding two per cent, or if under the second test said meter is found to leak, or if any noticeable fluctuation in the light is observed; or if, under the third test, the meter fails to register small quantities of gas consumed, the meter shall be turned over to the person, firm or corporation operating the gas plant, for readjustment and the same shall not be again used until the defect is remedied, the meter again inspected by said City Gas Commissioner and found to be correct and duly sealed. Every meter shall be considered correct as to the first test and so certified and sealed, which shall register quantities varying not more than two per centum from the standard measure of gas.

Whenever such meter on being tested shall be found to register incorrectly to the injury of the consumer to an extent exceeding two per cent, the fee of one dollar paid by said consumer for such inspection shall be re-paid to said consumer.

All meters hereafter furnished by any person, firm or corporation engaged in the manufacture, sale and distribution of gas, to consumers, shall whenever required by the City Gas Commissioner, be first inspected, proved and sealed by him.

SEC. 11. It is made the duty of the City Gas Commissioner to carefully protect and guard all meters which come into his possession for inspection and he shall tightly cork all meters during the time in which they are in his possession and not being tested. He shall have a card made which he shall attach to each meter inspected by him and upon this card shall be given the data connected with the inspection of the meter, and when so tested. If found correct, and so certified by him on such card, it will be deemed sealed by him.

It shall be unlawful for any person other than said City Gas Commissioner or his deputies, to deface, alter or remove any card so placed by the City Gas Commissioner upon any meter, or to place upon any meter a certificate purporting to be the certificate of said City Gas Commissioner.

SEC. 12. This ordinance shall take effect and be in force from and after its publication.

Passed Aug. 11, 1908.

The power to make regulations as to the pressure of the gas supply granted to the gas commissioner by section 4 of the preceding ordinance has been exercised by that officer, and the present ruling demands that the pressure of gas at any point must not be greater than 4½ nor less than 2 inches of water pressure.

LANSING, MICH.

The franchise ordinance of the city of Lansing (passed June, 1908) makes several provisions as to gas quality, etc., and is supplemented by a special ordinance making provisions for inspection. Although not wholly free from points which might be criticized, these regulations are among the best in force in the smaller cities of the country. The important parts of the former act and all of the latter are as follows:

SEC. 3. The gas supplied under this ordinance shall be of a quality containing an average of not less than 600 British thermal units per cubic foot (low value), and of an average of not less than 18 candle-power, to be determined by the usual methods and standards.

SEC. 10. The mayor of said city, by and with the consent of the Common Council thereof, may appoint a gas inspector, who shall receive such compensation from the City of Lansing as shall be fixed by the Common Council; and such gas inspector shall at all reasonable times have access to and be permitted to examine the works, pipes and meters of the said company, their successors or assigns, for the purpose of testing the accuracy of the meters and the quality of the gas, with the exercise of such reasonable powers and under such reasonable rules and regulations as the Common Council may prescribe.

SEC. 11. If any gas meter so tested shall be found to register in excess [18] of two per cent (2%) of the amount of gas actually passing through it, the inspector shall mark it "condemned," and the said gas company shall remove and not reset the same until such inaccuracy shall have been properly corrected and the gas company shall refund to the consumer an amount equivalent to such excess in the gas bills rendered and paid for three (3) months preceding such test.

SEC. 12. Any consumer of gas in the City of Lansing shall have the right, on the payment to the above inspector of a fee of one dollar ($1.00) to have his meter inspected and tested and to be present at such inspection and test. The said Lansing Fuel and Gas Company shall also have due notice that such a test is to be made, and shall have the privilege of having a representative present.

If any gas meter so tested shall be found to be correct within two per cent (2%) of the amount of gas actually passing through it, it shall be considered correct and the inspector making the test shall furnish to the gas company and the consumer a certificate to that effect.

SEC. 13. The city inspector of gas is also authorized, at the request of any consumer of gas to inspect the gas being furnished to him in the presence of a representative of said company if it desires and if the same is found to be less than 600 British thermal units per cubic foot (low value) and less than 18 candlepower upon three tests, to be made within a period of ten days, said company shall forfeit one hundred dollars ($100.00), which shall be paid to the treasurer of the City of Lansing for the benefit of such city, in each case where such three tests so made shall show such failure on the part of said company to furnish the quality of gas provided in Section 3.

SEC. 17. The city of Lansing hereby reserves the right to make such further reasonable rules and regulations as may at any time be deemed necessary for the interest, welfare or accommodation of the public in relation to the conduct of the public business of said company and the extensions of the pipes of said company in the streets and alleys of said city.

Under the provisions of this last section the following ordinance has also been passed and is now in force:

AN ORDINANCE To provide for testing and accuracy of the meters and the quality of the gas supplied consumers by the Lansing Fuel and Gas Company.

Be it ordained by the Common Council of the City of Lansing:

SECTION 1. The superintendent of public works shall be the inspector of gas, gas meters and gas pipes used for public or private purposes in the City of Lansing, and test the same from time to time.

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[18] This phrase doubtless was intended to read "to register two per cent (2%) in excess of the amount" as indicated by the last paragraph of section 12 and by section 3 of the next ordinance.

SEC. 2. The superintendent of public works, shall, upon the written request of a gas consumer and the payment of a fee of $1.00, carefully test any meter furnished such gas consumer by the Lansing Fuel and Gas Company, through which such consumer is furnished gas; and said superintendent shall also upon request of said gas company, make a like test of any meter owned by said company. If a meter tested by the superintendent, in accordance with the provisions of this ordinance is determined to be fast, within the meaning of the term as hereinafter defined, then said superintendent shall collect from the gas company the sum of $1.00 hereinbefore mentioned, and refund the same to the gas consumer who has made the complaint. If the meter so tested shall be determined to be accurate or slow within the meaning of either term as hereinafter defined, then the fee of $1.00 paid by said gas consumer shall be equally divided between the City of Lansing and the gas company.

SEC. 3. A meter shall be considered accurate, if, when subjected by the superintendent to a standard test, its register indicates not to exceed 2 per cent more or 2 per cent less than the actual quantity of gas passed through it. If its register indicates to exceed 2 per cent more than such actual quantity it shall be considered fast to that extent. If its register indicates to exceed 2 per cent less than such actual quantity, it shall be considered slow.

SEC. 4. If a meter tested upon complaint of a consumer by the superintendent of public works, shall have been determined to register fast, the gas company shall pay to the gas consumer who made the request for test of such meter, and who was at the time of making said complaint taking gas through such meter, a sum equal to the per cent fast multiplied by one-half the amount of all bills paid by such gas consumer for gas registered by such meter between the date on which such gas consumer last began taking gas registered by such meter and the date upon which it was removed for testing; and if a meter so tested is determined to register slow, the gas company is hereby empowered to collect from the gas consumer, who has been supplied with gas through such meter, a sum equal to the per cent slow multiplied by one-half the amount of all the bills rendered such gas consumer for gas registered by such meter, between the date such gas consumer last began taking gas registered by such meter and the day it was removed for testing.

SEC. 5. The superintendent of public works shall have the privilege to remove from the premises of any gas consumer on his request and compliances with the regulations contained herein, any gas meter of the Lansing Fuel and Gas Company, for the purpose of testing the accuracy of the same, and said gas company shall be required to supply another meter to supply such consumer during the time required for such test.

SEC. 6. The superintendent of public works shall keep a book in his office in which shall be recorded the number of each meter tested and proved by him and the result thereof; also, when taken, a record of the pressure of the gas in the pipes, and the quality of the gas being furnished. All gas furnished by the gas company shall be delivered at the outlet of the consumer's meter at pressure not in excess of four and one-half (4½) inches nor less than one and one-half (1½) inches and it shall be of a quality to average not less than eighteen (18) candlepower.

SEC. 7. The superintendent of public works shall turn over all fees collected to the city treasurer at least once each month and shall make a report of the meters tested and fees received to the Common Council at least twice during the fiscal year. The superintendent of public works, while making such tests shall be designated "Gas Inspector," and shall sign all receipts and certificates as such.

B. STATE LAWS QUOTED

This section gives the text of the more important laws making the technical provisions tabulated by subject in Part II, A. Under some of the States there are also given the rulings of commissions which are of greatest interest. The information given covers practically all of the provisions in force as to candlepower, heating value, purity and pressure of the gas supplied and the testing of gas meters.

MASSACHUSETTS

The board of gas and electric light commissioners of Massachusetts was established in 1885, and this is thus the oldest of all State gas-inspection bodies. Some of the more important provisions, now in force, as to the powers and duties of this board are as follows:

Said board shall have the general supervision of all corporations and companies which are engaged in the manufacture and sale of gas or electricity for light or heat, and shall make all necessary examinations and inquiries and keep themselves informed as to the compliance of the several corporations and companies with the provisions of the law.

The board shall, from time to time, ascertain what degree of purity can reasonably be required in gas made and supplied by corporations and companies engaged in the manufacture and sale of gas for light or heat, and shall report to the general court, when, in its opinion, any change in the law relative thereto is desirable.

Upon the complaint * * *, either of the quality or price of the gas or electric light sold and delivered, the board * * * shall give a public hearing * * *, and after said hearing may order any reduction in the price of gas or electric light or improvement in quality thereof * * *.

The work of this board now includes (*a*) testing of the candlepower and chemical quality of the gas for total sulphur, ammonia and hydrogen sulphide, and (*b*) proving and sealing of all gas meters. In this inspection the State law allows the board some freedom in establishing the standard which shall be required of the companies, but makes the following definite provisions, which are not subject to the decision of the board:

SEC. 9. Every gas light company with a capital paid in of one hundred thousand dollars or more, and every other gas light company if required by the board of gas and electric light commissioners, and all makers and vendors of meters shall set up at some convenient place upon their premises one or more meter provers of a size and type approved by the board and tested and calibrated by the board, by means of which meters may be tested. A meter shall not be stamped correct if it varies more than two per cent from the standard measure. The board shall keep a correct record of all meters examined by its inspectors with their proof at the time of inspection, which shall be open at all times for examination by the officers of any gas light company in the commonwealth.

SEC. 10. A gas company providing a meter for measuring gas supplied to a customer which has not been duly sealed and stamped shall be punished by a fine of five dollars for every such meter in use, payable to the city or town in which the meter is situated.

SEC. 11. Meters in use shall be tested by the inspector or by one of his assistants or a deputy on the request of the consumer or of the gas light company, in the presence of the consumer if desired, and with sealed apparatus. If he finds that the meter is correct, the person requesting the inspection shall pay the fees for such inspection and the expense of removing the meter for the purpose of being tested, and the re-inspection shall be stamped on the meter. If he finds that the meter is incorrect, the gas light company shall pay such expenses and shall furnish a new meter without charge to the consumer.

SEC. 12. Meters for measuring gas supplied to consumers shall register the quantity of gas passing through them in cubic feet so that the number of cubic feet of gas consumed can be easily ascertained by the consumer thereof. No meter shall be used which may confuse or deceive the consumer in ascertaining the price he pays per thousand cubic feet or the number of cubic feet consumed. No charge for the use of a meter during any portion of twelve consecutive months shall be made if the consumer during said time uses gas to the value of seven dollars.

SEC. 13. Every gas light company which annually manufactures or sells more than fifteen million cubic feet of gas shall, when required by the board of gas and electric light commissioners, provide and maintain a suitable room at least a quarter of a mile from the gas works with a disc photometer and its appurtenances of a construction approved by the board, which shall be open to the inspector and assistant inspectors on every working day from eight o'clock in the morning until six o'clock in the afternoon.

SEC. 14. The gas of every company which supplies more than fifty consumers, except gas made and used exclusively for heating, cooking, chemical and mechanical purposes, shall be inspected at least twice a year and as much oftener as the board of gas and electric light commissioners may determine. The gas shall be tested for illuminating power by means of a disc photometer and during such test, shall be burned from the burner best adapted to it, which is at the same time suitable for domestic use, and at as near the rate of five feet an hour as is practicable. The board of gas and electric light commissioners shall, for the purpose of establishing a standard of purity for gas, and after a public hearing, determine how many grains of sulphur and ammonia per hundred cubic feet of gas may be permitted, and the board shall have power to change such standards from time to time, after a public hearing; but not more than thirty grains of sulphur per hundred cubic feet and no sulphuretted hydrogen shall be allowed.

If the gas of any gas company or of any city or town supplying gas is found on three consecutive inspections, or on three inspections made within a period of thirty consecutive days, to give less light than sixteen standard English candles, or upon such averaging of inspections as the board may prescribe, to be below the standard of purity fixed under this act, unless such defect is in the opinion of the board due to unavoidable cause or accident, a fine of one hundred dollars shall be paid by such company, city or town into the treasury of the commonwealth.

If during the test the consumption of gas varies from five feet an hour, or the candle from one hundred and twenty grains an hour, a proportionate correction shall be made for the candle power. Upon such complaint and after such notice and hearing as are provided for by section thirty-four of chapter one hundred and twenty-one of the Revised Laws the board may require a company to supply such gas as will give, when tested in the manner prescribed in this section, a light equivalent to such number of standard English candles, not less than sixteen, as said board may determine.

During the last five years, under these provisions, the board has made about 1 000 inspections per year of the quality of the gas distributed, and has tested between 50 000 and 75 000 meters annually.

The Massachusetts commission has not exercised its power to fix the candlepower or chemical quality of the gas at other than those minimum or maximum limits which are prescribed in the State law.

NEW YORK

The public service commission law (ch. 48 of the Consolidated Laws of New York) provides for two commissions, one to have jurisdiction in New York City and the other throughout the remainder of the State, and gives to this State the most elaborate system of gas inspection now in force. The commissions are empowered to establish standards, carry out inspections and investigations, and to enforce their own rulings by ordering such changes or additions in plant or system of the companies as will insure safe and adequate service. This act and others passed by the State make the following special provisions:

SEC. 67. *Inspection of gas and electric meters.*—1. Each commission shall appoint inspectors of gas and electric meters whose duty it shall be when required, to inspect, examine, prove and

ascertain the accuracy of any and all gas meters used or intended to be used for measuring or ascertaining the quantity of illuminating or fuel gas or natural gas furnished by any gas corporation to or for the use of any person and any and all electric meters used or intended to be used for measuring and ascertaining the quantity of electric current furnished for light, heat and power by any electrical corporation to or for the use of any person or persons and when found to be or made to be correct, the inspector shall stamp or mark all such meters and each of them with some suitable device, which device shall be recorded in the office of the secretary of state.

2. No corporation or person shall furnish or put in use any gas meter which shall not have been inspected, proved and sealed, or any electric meter which shall not have been inspected, approved, stamped or marked by an inspector of the commission. Every gas and electrical corporation shall provide or keep in and upon its premises a suitable and proper apparatus, to be approved and stamped or marked by the commission, for testing and proving the accuracy of gas and electric meters furnished for use by it, and by which apparatus every meter may and shall be tested, on the written request of the consumer to whom the same shall be furnished, and in his presence if he desires it.

If any consumer to whom a meter has been furnished, shall request the commission in writing to inspect such meter, the commission shall have the same inspected and tested; if the same on being so tested shall be found to be, four per cent. if an electric meter, or two per cent. if a gas meter, defective or incorrect to the prejudice of the consumer, the inspector shall order the gas or electrical corporation forthwith to remove the same and to place instead thereof a correct meter, and the expense of such inspection and test shall be borne by the corporation; if the same on being so tested shall be found to be correct the expense of such inspection and test shall be borne by the consumer. A uniform reasonable charge shall be fixed by the commission for this service.

CHAPTER 557, LAWS 1907

AN ACT Fixing standards of purity, illuminating power and pressure of gas in cities of the second class.

SECTION 1. The gas furnished or supplied by any corporation, association, co-partnership or person in any city of the second class shall be free from sulphuretted hydrogen, to be determined by exposing for thirty seconds a slip of white paper saturated with acetate of lead to a jet of gas flowing about five feet per hour, and each one hundred cubic feet shall not contain more than ten grains of ammonia nor twenty grains of sulphur.

SEC. 2. The maximum illuminating power required and minimum illuminating power permitted of gas so furnished or supplied in any such city shall be as follows: if a coal gas, sixteen candles; if a mixed coal and water gas, eighteen candles; if a carburetted water gas, twenty candles. A candle shall mean a sperm candle, six to a pound, burning at the rate of one hundred and twenty grains of spermaceti per hour. The test for illuminating power shall be made with gas obtained from a service pipe or main located at a distance of not less than one mile nor more than one and one-half miles from any distributing holder, using for coal gas and mixed coal and water gas containing more than fifty per centum of coal gas an F Argand burner, and for mixed coal and water gas containing fifty per centum and less of coal gas and for carburetted water gas a No. 7 slit union Bray burner, on a basis of consumption of five cubic feet of gas per hour.

SEC. 3. The minimum pressure of gas so furnished or supplied which shall be permitted in any service main in any such city shall be sufficient to balance a column of water one and one-half inches in height. The maximum pressure therein allowed shall be an amount sufficient to balance a column of water three and three-fourths inches in height, plus an allowance at the rate of one inch for variation of each one hundred feet of increase in altitude in the distributing system between the holder and the point of consumption, except that no maximum pressure shall be prescribed in service mains the pressure of gas from which is regulated by service governors, supplied and maintained without charge to consumers.

There are also several state acts which affect only the gas companies in some individual cities. In so far as they are known we have included them in a previous portion of this circular under the city ordinances.

The commission of the second district has by official order made provisions as follows for all of the state under its jurisdiction, i. e., all except the city of New York.

IN THE Matter of fixing and establishing a standard of illuminating power and purity of gas manujactured and sold by persons, corporations and municipalities for lighting purposes.

Order entered June 15, 1907, by the Commission of Gas and Electricity.

Pursuant to the provisions of section 9, subdivision 3 of chapter 737 of the Laws of 1905, and on reading and filing the notice of hearing herein, dated February 6, 1907, and the same having been duly served upon the companies and corporations affected thereby, and a public hearing having been had thereon, pursuant to such notice, at the Capitol, in the city of Albany, on the 21st day of February, 1907, it is

Ordered, That the Commission of Gas and Electricity does hereby fix and establish the standard of illuminating power and purity of coal gas, mixed coal and water gas and water gas, respectively, manufactured and sold in the State of New York, as follows, viz: Except as otherwise prescribed by law, the gas sold, or manufactured and sold, by any person, corporation or municipality in the State of New York for lighting purposes, except to lighting companies, shall have an illuminating power, if the same be coal gas, of at least sixteen candle power; if mixed coal and water gas, of at least eighteen candle power; and if water gas, of at least twenty candle power. A candle shall mean a standard English sperm candle weighing six to the pound, burning at the rate of one hundred twenty grains of spermaceti per hour, and correction shall be made for any variation from this rate of consumption. The test for illuminating power of gas shall be made with gas taken from a service at a distance of not less than one mile from the nearest distributing holder where possible, and where not possible by reason of limited distribution system, said test shall be made from farthest available service; and it is further

Ordered, That tests of candle power shall be made on a basis of consumption of five cubic feet of gas per hour, corrections being made for temperature and pressure above or below the normal, to wit: sixty degrees Fahrenheit and thirty inches barometer; and it is further

Ordered, That such tests of said gas for illuminating power shall be made with a standard bar photometer of an approved make, equipped with either a New Style F Argand burner, Old Style D Argand burner or Number 7 Slit Union Bray burner, as may be best suited to the gas tested; and it is further

Ordered, That each one hundred cubic feet of said gas shall not contain more than ten grains of ammonia, nor more than twenty grains of sulphur compounds; and it is further

Ordered, That the gas sold, or manufactured and sold, shall exhibit no trace of hydrogen sulphide when tested as follows: If a strip of white paper moistened with a solution of acetate of lead and exposed to a current of gas flowing at the rate of about five cubic feet per hour, does not after thirty seconds of such exposure become discolored, the gas shall be considered to contain no hydrogen sulphide; and it is further

Ordered, That this order shall take effect on the fifteenth day of June, 1907.

IN THE Matter of the installation of stationary photometers by corporations supplying and distributing 15,000,000 cubic feet or more per annum of coal, water or mixed gas.

Order entered June 15, 1907, by the Commission of Gas and Electricity.

On reading and filing the notice of hearing herein, dated January 8, 1907, and the same having been duly served by mail upon the companies and corporations affected thereby; and a public hearing having been had thereon, pursuant to said notice, at the Capitol in the city of Albany on the sixteenth day of January, 1907; now, due deliberation having been had, it is

Ordered, That each and every corporation manufacturing and supplying or distributing fifteen million (15,000,000) cubic feet or more of either coal gas, water gas or mixed coal and water gas per annum, or a total amount of fifteen million (15,000,000) cubic feet of any or all of them shall on or before September 1, 1907, properly install and maintain a stationary bar photometer of an approved make for testing the candle power of the gas manufactured and supplied or distributed by said company in order to ascertain the candle power of gas furnished to the consumer; and it is further

Ordered, That such photometers shall be supplied with suitable burners for testing the various kinds of gas manufactured, supplied or distributed by the company; and it is further

Ordered, That in case the gas distributed or supplied be manufactured by or purchased from another company, said approved photometer may be installed at or near the main distributing holder of the purchasing company, or the installation of said approved photometer by the purchasing company may be dispensed with in the discretion of the Commission, provided the gas has been tested by an approved photometer from the mains of the company manufacturing the same; and it is further

Ordered, That each company affected by this order and already supplied with a photometer or hereafter installing a photometer in pursuance of this order, shall report to this Commission immediately for approval, the style and make of such photometer now installed, or the style and make of the photometer which it is proposed to install in accordance with this order.

The commission for the first district, i. e., New York City, proves and seals all meters used within its district under the provisions of the state law but has not exercised its right to test the gas quality or pressure.

WISCONSIN

The public utilities law, passed in 1907 by Wisconsin, makes very broad provisions for the railroad commission of Wisconsin, granting them powers as follows:

SEC. 1797 m–2. The railroad commission of Wisconsin is vested with power and jurisdiction to supervise and regulate every public utility in this state and to do all things necessary and convenient in the exercise of such power and jurisdiction.

SEC. 1797 m–23. 1. The commission shall ascertain and fix adequate and serviceable standards for the measurement of quality, pressure, initial voltage or other condition pertaining to the supply of the product or service rendered by any public utility and prescribe regulations for examination and testing of such product or service and for the measurement thereof.

2. It shall establish reasonable rules, regulations, specifications and standards to secure the accuracy of all meters and appliances for measurements, and every public utility is required to carry into effect all orders issued by the commission relative thereto.

In exercise of this authority the commission has established and is enforcing the following set of rules:

RULES FOR GAS SERVICE

RULE 1. A meter may be considered as correct if, when passing gas at the rate of six cubic feet per hour per light capacity, it shows, in comparison with a standard gas prover, an error which is not greater than two per cent.

RULE 2. No gas company shall allow a gas meter to remain in service for a period longer than three years without checking it for accuracy and readjusting it if found to be inaccurate.

RULE 3. Each company shall keep a record of tests made on meters before installation and upon receiving them from the services.

RULE 4. Each gas company shall provide itself with equipment necessary for testing meters, such equipment to consist of a standard meter prover with suitable accessories.

RULE 5. Each gas company shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not a make a request for test more frequently than once in six months. A report giving the results of such tests shall be made to the consumer, and a complete record of such tests shall be kept on file in the office of the company.

RULE 6. Upon formal application of any consumer to the Railroad Commission a test shall be made upon the consumer's meter by an inspector employed by the Railroad Commission, such test to be made as soon as practicable after receipt of the application. For such test a fee of two dollars ($2.00) shall be paid by the consumer making application for the test if the meter is found to be slow or correct within the allowable limits, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

RULE 7. Meter dials shall read directly in cubic feet of gas, and bills rendered periodically by the company shall designate the readings of the meter at the beginning and end of the time for which the bill is rendered, and give the dates at which the readings were taken.

RULE 8. The company furnishing gas which, within a one mile radius from the distribution center, gives a monthly average total heating value of not less than 600 B. T. U., with a minimum which shall never fall below 550 B. T. U., may be considered as giving adequate service as far as the heating value of the gas is concerned.

RULE 9. Each gas company, whose output exceeds twenty million cubic feet a year, shall equip itself with a standard calorimeter outfit, with which periodic tests upon the gas shall be made. A record of these tests shall be made and kept open for public inspection.

RULE 10. Gas pressure, as measured at meter inlets, shall never be less than 1½ inches nor more than 6 inches of water pressure; and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than 100 per cent of the minimum pressure.

RULE 11. Each company shall make frequent measurements of the pressure and pressure variations, and these shall be kept on record and open for public inspection.

RULE 12. In no case shall the gas contain more than thirty grains of total sulphur per 100 cubic feet, and not more than a trace of sulphur as sulphuretted hydrogen.

RULE 13. Each company shall keep a record of complaints which shall include the name and address of the consumer, the date, the nature of the complaint, and the remedy. A classified summary of these records shall be submitted to the Commission on or before the twenty-eighth day of each month for the preceding month.

CALIFORNIA

The General Laws of California, 1910, in act 1344, make provision for the appointment of inspectors and the fixing of the quality, illuminating power, and price of gas by local ordinances, which "are hereby authorized and required," for each city having a population of more than 100 000 (Los Angeles, Oakland and San Francisco). No provisions are made in this act for any smaller cities or towns, although the latter, when larger than 3500 in population, are by other acts allowed, but not required, to frame a charter for their local government, which charter might properly include matters of gas company regulation.

The text of this law is as follows:

SECTION 1. *Quality and Price of Gas to be Fixed by Whom.*—That in all cities in the state of California having a population of one hundred thousand or more, the local legislative body thereof,

whether known or designated as the board of supervisors, or board of aldermen, or common council, or board of trustees, or otherwise, are hereby authorized and required to fix the standard quality and illuminating power of gas to be furnished, and the rate and price for each one thousand cubic feet to be charged therefor by any person, company, or corporation whose pipes or mains are or shall be laid down in the streets and highways of such city, for the purpose of supplying gas for the use of such city, or for the inhabitants thereof, or for such city and its inhabitants; provided, however, that said board or local authority shall not fix or establish the standard quality and illuminating power of gas in such city at less than sixteen candle power, or such that five cubic feet of gas per hour so furnished shall give light at least equal to that afforded by the combustion of sixteen standard sperm candles consuming one hundred and twenty grains of sperm each per hour, the burner to be used in making such test to be that best adapted to the economical consumption of gas; and provided, further, that such board of supervisors, or local legislative authority, by whatever name it may be known, shall not fix or establish the rate or price of gas so furnished to such city or its inhabitants at any greater price or rate than three dollars per thousand cubic feet.

SEC. 2. *Mayor to Appoint an Inspector.*—It shall be the duty of the mayor of each city having the population mentioned in section 1 of this act, and such mayor is hereby required, within thirty days after the passage and approval of this act, to appoint, subject to the approval of the board of supervisors, or other local legislative body aforesaid, a person of competent experience and knowledge of and concerning the proper qualities and illuminating power of gas, and who shall not be directly or indirectly interested in or connected with any person, company, or corporation engaged in the manufacture or furnishing of illuminating gas in such city, or elsewhere, either to such city or its inhabitants, or any of them, either as a stockholder or otherwise, who shall be known and designated as gas inspector of such city, who shall hold his said office for the term of two years, or until his successor shall be appointed and qualified; subject, however, to removal from his said office by the mayor, with the concurrence of a majority of the board of supervisors, or other local legislative board aforesaid, for any one of the following causes, to wit, by reason of any interest in the manufacture or furnishing of gas in such city, whether such interest existed at the date of his appointment or was afterward acquired, or for want of competent knowledge, skill, or experience to enable him properly to discharge the duties of said office, or for any neglect, misconduct, or inefficiency in the discharge of the duties of said office, to the prejudice of such city, or its inhabitants, or any of them. The person so appointed shall, before he enters upon the duties of said office, and within ten days after his appointment and confirmation, take and subscribe an oath or affirmation before the county judge of the county in which such city is situated; that he will faithfully and impartially perform and discharge all the duties required by this act and the ordinances or resolutions of said board passed or adopted under and pursuant to the provisions thereof, as such gas inspector of such city, and shall also, within the same time, give bond to the city in and for which he is appointed, in the sum of ten thousand dollars, with sureties to be approved by said board, conditioned for the faithful performance of the duties of said office, which said oath and bond shall be filed with the clerk of said board. Such gas inspector shall be entitled to a salary to be fixed and allowed by said board, which shall be paid monthly out of the general fund of such city.

SEC. 3. *Duty of Inspector.*—It shall be the duty of such inspector, immediately upon his appointment and qualification as such officer, as aforesaid, to make a careful examination and inquiry by inspection, letter, or otherwise, as to the quality and illuminating power of the gas furnished and used in the principal cities of the United States, and the prices charged therefor, and also the comparative cost of the manufacture and supply of gas in other cities of the United States, with the cost of the manufacture and supply of the same in the city for which he is such inspector, and report fully the result of such examination and information to said board within six months after his appointment and qualification; and upon receiving such reports, said board shall proceed to fix and establish the quality and standard illuminating power of gas to be used in such city, and the maximum price to be charged therefor; and such standard and price may be changed by said

board from time to time, not oftener than once every year, as increased consumption or other circumstances may in their judgment require.

SEC. 4. *Same.*—After said board shall have fixed and established the quality and illuminating power, and the price of gas, as hereinbefore, it shall be the duty of such inspector to examine and inspect, from time to time, at least once every week, without notice to the person, company, or corporation furnishing the same, the quality and illuminating power of the gas furnished to such city and the inhabitants thereof, and in case the same shall fall below the standard fixed by said board, the said inspector shall forthwith report the same to said board; and at such other times as he may be requested thereto by the mayor or any committee of said board, he shall report to said board upon any and all matters connected with the manufacture, supply and consumption of gas coming within the scope of his official duties, and specially upon any subject or subjects, matters or things, connected therewith and specified in such request.

SEC. 5. *Certain Acts Declared Unlawful.*—After said board shall have fixed and established the quality and standard illuminating power of the gas, and the price per thousand cubic feet, as in this act to be charged therefor, it shall be unlawful for any person, company, or corporation to furnish to such city, or any inhabitant thereof, or other person therein, for illuminating purposes, gas of a lower standard or quality, or to charge or receive therefor a higher price than is provided by said board, under the authority and subject to the limitations of this act; and for every violation of the provisions of this act, or the provisions of any order, resolution, or ordinance of said board made in pursuance thereof, every such person, company, or corporation shall incur a penalty of not less than one hundred nor more than one thousand dollars, to be recovered in a civil action in the name and for the use of such city, in any court of competent jurisdiction; and each day upon which such person, company, or corporation shall, without reasonable cause or excuse therefor, furnish gas of a lower quality or standard illuminating power than that fixed by said board, shall constitute and be considered and held one violation thereof, and each month or shorter period for which said person, company, or corporation shall take an account of gas consumed, and for which they shall charge or receive a price greater than that fixed by said board, shall be held and regarded as one offense, and any number of such offenses of either class, or both, may be joined in the same action, and the several penalties for the several violations proved or confessed in said action may be united and recovered in the same judgment; and such person, company, or corporation shall also be liable to such city and to any and each person or corporation who shall be injured by any such violation, in double the amount of damages actually sustained.

SEC. 6. *Actions Tried, by Whom.*—All actions for penalties under the provisions of this act shall be tried by the court, unless a jury be demanded by either party; and when such action shall be tried by a jury, the jury shall find, as to each violation charged in the complaint, that "the defendant is guilty," or "the defendant is not guilty;" and upon each charge in respect to which the jury has found the defendant guilty, the court shall fix the penalty, and render judgment for the aggregate amount of such penalties, together with costs of suit.

SEC. 7. All penalties recovered under this act shall be paid into the general fund of such city.

SEC. 8. This act shall apply to the city and county of San Francisco, as well as to cities whose municipal government is distinct from the county in which they are located.

SEC. 9. This act shall take effect immediately.

The Political Code of 1909 in Article XV makes provision for state meter inspection as follows:

INSPECTOR OF GAS-METERS.

SEC 577. *To Provide Testing Apparatus.*—The inspector of gas-meters must provide and keep suitable apparatus for testing the accuracy of gas-meters.

SEC. 578. *Seal.*—He must provide a suitable seal with which to seal meters inspected by him and found to be correct, and must file a copy of such seal in the office of the secretary of state.

SEC. 579. *May Appoint Deputies.*—He may appoint deputies.

SEC. 580. *Powers and Duties of—Mode of Inspecting and Sealing.*—He must, whenever requested, inspect and test the accuracy of any gas-meters used or intended to be used for measuring the quantity of gas furnished by any gas company in this state, and when he finds the same correct, seal the same with his seal. No meter shall be accounted correct which registers an amount more than three per cent greater or less than the amount actually passed through it, but the inspector may seal meters registering more than three per cent against the gas company, when requested by the company to do so. Reasonable notice shall be given to the applicant, and also the individual or gas company furnishing or proposing to furnish the gas, of the time and place of the inspection of the meter, and opportunity afforded them, their servants or agents, to be present at and witness the inspection.

SEC. 581. *Unsealed Meters, Use of a Misdemeanor; Reinspection.*—Any individual or gas company placing or using for measuring gas a meter which has not been inspected by the state inspector and does not bear his seal, shall be guilty of a misdemeanor, nor shall any charge for gas supplied through such a meter be legally collectable; nor shall the refusal of a consumer to pay the same give authority to the company to refuse to supply him with gas. When a meter, properly sealed, is once placed for the use of a consumer, an inspection may be had as often as the consumer may request the same in writing, he to pay the fee therefor whenever the meter is found not to register too fast. When the meter is found to register too fast the gas company must pay the fee, together with the costs of removing and resetting the meter, and the inspector shall remove the seal if there be one upon it; provided, that when any meter found incorrect shall be corrected, it shall be sealed by the inspector without additional charge if presented to him for reinspection within one month.

SEC. 582. *Compensation.*—He may collect a fee of two dollars and fifty cents for each meter tested.

SEC. 583. *Residence.*—He must reside in the city of San Francisco.

SEC. 584. *Official Bond.*—He must execute an official bond in the sum of five thousand dollars.

NEW JERSEY

RULE I. A meter may be considered correct if, when passing gas at the rate of six cubic feet per hour, per light capacity, it shows, in comparison with a standard gas prover, an error which is not greater than two per cent.

RULE II. No gas company shall allow a gas meter to remain in service for a period longer than six years without checking it for accuracy and readjusting it if found to be inaccurate.

RULE III. Each company shall keep a record of tests made on meters before installation and upon receiving them from the services. The original of such record shall be kept in the meter shop, and available for examination at any time by the inspectors of the Board. A report shall be made up from such record book, giving a summary of records and sent to the office of the Board at stated periods. Each company having over 500 meters shall report monthly; each company having less than 500 meters shall report quarterly. Blank forms will be furnished by the Board on which reports are to be made.

RULE IV. Each gas company shall provide itself with equipment necessary for testing meters, such equipment to consist of a standard meter prover with suitable accessories. Each prover will be inspected by the Board and furnished with an inspection tag or plate. After January 1st, 1912, tests made with an uncertified prover shall not be deemed authoritative. Provers will be set up permanently in the location where they are to be used, and will be tested by an Inspector of the Board, using a standard cubic foot bottle which has been previously calibrated and certified by the National Bureau of Standards at Washington.

RULE V. Each gas company shall, without charge, make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make a request for test more frequently

than once in six months. A report giving the results of such tests shall be made to the consumer, and a complete record of such tests shall be kept on file in the office of the company.

RULE VI. Upon formal application by any consumer to the Board of Public Utility Commissioners, a test shall be made of the consumer's meter by an inspector employed by the Board, such test to be made as soon as practicable after receipt of the application. For such test a fee of one dollar ($1.00) shall be paid by the consumer, at the time application is made for the test, this fee to be retained if the meter is found to be slow or correct, within the allowable limits. If the meter is found to be fast beyond the allowable limits the fee of one dollar ($1.00) will be returned to the consumer and collected from the company owning the meter. Each meter to be so tested is to be removed and will be tested by an inspector of the Board using the nearest certified prover. In certain cases tests will be made with a portable test meter. In cases of dispute, however, as to the accuracy of such meter, the test made with the prover shall be considered the correct one.

RULE VII. Meter dials shall read directly in cubic feet of gas, and bills rendered periodically by the company shall designate the readings of the meter at the beginning and end of the time for which the bill is rendered, and give the dates at which the readings were taken; bills shall also show the gross amount charged and the net amount after deducting any rebate, if any, allowed for prompt payment. Where prepayment meters are in use, the meter reader, at the time of reading same, shall leave with the customer a slip showing the reading as well as the amount of money which has been collected from the meter.

RULE VIII. No company shall make any charge for changing a meter found defective or where test is to be made; and no charge shall be made for changing a meter of one type for a meter of another type unless the first meter referred to has been in use less than one year, in which case a charge, which in no case shall exceed $1.00, may be made to cover the actual expense of making the change.

RULE IX. The company furnishing gas which, within a one-mile radius from the distribution center, gives a monthly average total heating value of not less than 600 B. T. U., with a minimum which shall never fall below 550 B. T. U., may be considered as giving adequate service as far as the heating value of the gas is concerned.

RULE X. Each gas company whose output exceeds twenty million cubic feet a year shall equip itself with a standard calorimeter outfit, constructed and calibrated as approved by the National Bureau of Standards, with which periodic tests upon the gas shall be made. A record of these tests shall be made and kept on file in the office of the company.

RULE XI. Gas pressure, as measured at meter inlets, shall never be less than one and one-half (1½) inches nor more than six (6) inches of water pressure; and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than one hundred per cent. of the minimum pressure.

RULE XII. Each company shall make frequent measurements of the pressure and pressure variations, and these shall be kept on file in the office of the company.

RULE XIII. In no case shall the gas contain more than thirty grains of total sulphur per 100 cubic feet, and not more than a trace of sulphur as sulphuretted hydrogen.

RULE XIV. Each company shall keep a record of complaints, in regard to service, which shall include the name and address of the consumer, the date, the nature of the complaint and the remedy.

RULE XV. Each company supplying gas shall inform each of its customers where peculiar or unusual conditions prevail, as to the conditions under which efficient and satisfactory service may be secured from its system.

RULE XVI. Each company supplying gas shall adopt some method to inform its customers as to the reading of meters, either by printing on bills a description of the method of reading meters,

or a notice to the effect that the methods will be readily explained on application. It is recommended that an exhibition meter be kept on display in each commercial office maintained by a gas company.

NEVADA

RULE 1. A meter may be considered as correct if, when passing gas at the rate of six cubic feet per hour per light capacity, it shows, in comparison with a standard gas-prover, an error which is not greater than two per cent.

RULE 2. No gas company shall allow a gas meter to remain in service for a period longer than three years without checking it for accuracy and readjusting it if found to be inaccurate.

RULE 3. Each company shall keep a record of all tests made on meters both before installation and while in service.

RULE 4. Each gas company shall provide itself with equipment necessary for testing meters, such equipment to consist of a standard meter prover with suitable accessories.

RULE 5. Each gas company shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make a request for tests more frequently than once in six months. A report giving the results of such tests shall be made to the consumer, and a complete record of such tests shall be forwarded to the Public Service Commission.

RULE 6. Upon formal application of any consumer to the Public Service Commission a test shall be made upon the consumer's meter by an inspector employed by the Commission, such test to be made as soon as practicable after receipt of the application. For such test a fee of one dollar and fifty cents (1.50) shall be paid by the consumer making the application for the test if the meter is found to be slow or correct within the allowable limits, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

RULE 7. Meter dials shall read directly in cubic feet of gas, and bills rendered periodically by the company shall designate the readings of the meter at the beginning and end of the time for which the bill is rendered, and give the dates at which the readings were taken.

RULE 8. The company furnishing gas, which, within a one mile-radius from the distribution center, gives a monthly average total heating value of not less than 550 B. T. U., with a minimum which shall never fall below 500 B. T. U., may be considered as giving adequate service as far as the heating value of the gas is concerned.

RULE 9. Each gas company, whose output exceeds five million cubic feet a year, shall equip itself with a standard calorimeter outfit, with which periodic tests upon the gas shall be made. A record of these tests shall be kept open for public inspection.

RULE 10. Gas pressure, as measured at meter inlets, shall never be less than 1½ inches nor more than 6 inches of water pressure; and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than 100 per cent of the minimum pressure.

RULE 11. Each company shall make frequent measurements of the pressure and pressure variations, and these shall be kept on record and open for public inspection.

RULE 12. In no case shall the gas contain more than thirty grains of total sulphur per 100 cubic feet, and not more than a trace of sulphur as sulphuretted hydrogen.

RULE 13. Each company shall keep a record of complaints which shall include the name and address of the consumer, the date, the nature of the complaint, and the remedy. A classified summary of these records shall be submitted to the commission on or before the thirtieth day of each month for the preceding month.

APPENDIXES

The following tables have been prepared from the data most readily available in the hope that the information thus summarized will be of value to those interested in the manufacture and distribution of gas. Although no conclusions of the previous sections have been based upon these data, they offer, in general, a confirmation of the earlier conclusions. The source of the data from which the tables are compiled is indicated in each case. These sources have been used in preference to correspondence with all of the gas companies of this country, since they furnished the data desired in a form sufficiently trustworthy for the present purpose.

TABLE 1

Gas Production and Value

(a. Data from U. S. G. S.—"Mineral Resources" 1908)

	Coal or by-product gas	Water or oil gas	Total
Number of companies	506	552	1058
Annual sales (billion cubic feet):			
For illumination	32.5 or 60%	76.8 or 75%	109.3 or 70%
For fuel	21.1 or 40%	26.6 or 25%	47.7 or 30%
Total	53.6	103.4	157.0
Total value	$37,000,000	$96,000,000	$133,000,000

(b. Data from Brown's "Directory of American Gas Companies," 1911)

Total sales (1910), 156.7 billion cubic feet (907 companies reporting).
Total miles of main, 48 177 (947 companies reporting).
Total number of consumers, 5 648 000 (930 companies reporting).

TABLE 2

Kind of Gas Made by Companies of Various Size

(Data from Brown's " Directory of American Gas Companies," 1911)

Kind of gas	Gas companies (size, in million cubic feet of annual sales)									
	More than 1000	500–1000	200–500	100–200	50–100	20–50	Less than 20	Size not stated	Total of all sizes	Per cent of all companies
Coal	0	1	5	8	24	85	189	14	326	33
By-product	3	0	4	1	3	1	2	0	14	1
Water	9	9	17	25	24	56	186	35	361	38
Mixed coal and water	17	15	24	28	22	30	20	1	157	16
Oil	3	1	3	3	5	16	67	14	112	12
Character not stated	0	0	1	0	0	0	0	1	2	0
Total	32	26	54	65	78	188	464	65	972	100

TABLE 3

Distribution Data for Companies of Various Size

(Data from Brown's 'Directory of American Gas Companies," 1911)

	Size of company (annual sales in million cu. ft.)						
	Greater than 1000	1000–500	500–200	200–100	100–50	50–20	Less than 20
Annual sales per mile of main (million cu. ft.):							
Maximum	18.7	6.0	5.0	4.0	9.4	3.7	5.0
Minimum	2.3	1.3	.4	.6	.6	.3	.003
Average [19]	6.1	3.4	2.6	2.3	2.3	1.5	1.07
Number of consumers per mile of main:							
Maximum	600	240	190	300	164	160	210
Minimum	20	48	18	38	15	14	1
Average [20]	175	123	98	98	84	73	59
Annual sales per consumer (thousands cu. ft.):							
Maximum	50	50	50	70	47	80	65
Minimum	22	16	14	12	13	5	1
Average [21]	33	29	26	25	24	21	19

[19] General average, 2.65.
[20] General average, 76.3.
[21] General average, 21.3.

TABLE 4

Gas Main Pressures

(Data from Brown's 'Directory of American Gas Companies," 1911)

Number of companies—	Pressure stated (inches of water pressure)								Total number reporting
	Greater than 10	8–10	6–8	5–6	4–5	3–4	2–3	Less than 2	
Stating maximum	[22] 8	12	19	43	185	290	81	5	643
Stating minimum	1	0	5	11	28	167	318	47	577

[22] This does not include those companies using only high-pressure distribution.

TABLE 5

Candlepower

(Data from Brown's "Directory of American Gas Companies," 1911)

Number of companies reporting candlepower of—	Kind of gas				Total number
	Coal or by-product gas	Water gas	Mixed coal and water gas	Oil gas	
24 or above	0	46	0	12	58
22 to 24	4	122	16	23	165
20 to 22	15	124	26	41	206
18 to 20	119	37	70	23	249
16 to 18	162	6	39	3	210
14 to 16	13	1	0	0	14
Less than 14	3	1	0	0	4
Not stated	24	24	6	10	64
Total	340	361	157	112	970
Average candlepower [23]	17.0	21.5	18.5	21.0	

[23] General average, 20.2.

TABLE 6

Heating Value

(Data from Brown's "Directory of American Gas Companies," 1911)

Number of companies reporting heating value of—	Kind of gas				Total number
	Coal or by-product gas	Water gas	Mixed coal and water gas	Oil gas	
700 or above	7	2	2	1	12
650–700	28	28	15	16	87
625–650	31	15	19	2	67
600–625	47	43	34	10	134
550–600	12	8	2	3	25
Less than 550	0	2	0	0	2
Total	125	98	72	32	327
Average heating value [24]	620	620	620	625	

[24] General average heating value, 620 Btu.