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PROBLEMS OF GAS DISTRIBUTION

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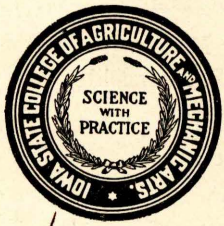

Bulletin 91

ENGINEERING EXTENSION DEPARTMENT
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THE RELATION OF GAS DEPARTMENT EMPLOYEES TO THE PUBLIC

By A. W. Borden
District Manager Central Power Company, Hastings, Nebraska

The question of public relations has been dealt with very many times, and in very many different ways. Many of the things which have been said appear so obvious—matters to be taken so much for granted—that one almost hesitates to dwell upon it for fear of too much repetition. And yet, it seems to me there is no more vital phase to our business, or to any business. Only through keeping constantly alive to this fact, may it finally become a fixture in our subconscious minds and so govern us outwardly.

How keenly does the average gas company employee sense the true significance of his or her position insofar as it relates to the public?

A gas company is a recognized public servant. All business is, in a broad sense, a public servant. The nature of our business as a public utility is such, that it is recognized by the public and by itself, as a true public servant. This is a highly important point, that every person connected with the company should grasp and hold, regardless of his or her capacity. Each employee has a vital part to do in the rendering of an important service, and each should seek to carry into his work an attitude in keeping with the high order of his calling.

It has been said many times (and nothing could be more true), that the public forms its mass opinion of an institution through its contact with the representatives of that institution, consequently the public will think well or otherwise of a gas company in direct measure as it may think well or otherwise of the employees of that company.

From the standpoint of public relations, every individual in a gas company is just as vitally important as every other individual, regardless of what may be his particular job. With this in mind, there is no place in a gas company organization for an unimportant employee, when considering public relations.

It is true that certain employees, such as meter readers, repairmen, fitters, salesmen and the people in the downtown offices, are brought most frequently into contact with the consumers, and the general public. It is especially essential, therefore, that these employees develop within themselves those elements which will reflect credit upon the company by which they are employed. Their daily tasks are such that they are called upon constantly to employ the utmost tact, courtesy and patience. Nevertheless, employees should remember to conduct all dealings with customers with courtesy and directness, to maintain complete control of themselves under all circumstances and to deal

straight from their end of the game. The general public will have confidence in a business whose employees keep it so in hand.

The gas company renders a twenty-four hour service, therefore, its employees may be said to be twenty-four hour employees. They should bear in mind that their conduct ought to be such at all times, on or off duty, as will react with credit upon the institution they represent. In this connection, I was privileged recently to hear a lecture on the "Philosophy of Service" and among the statements made, I was struck by the simple strength of this one—"Men serve by what they are as well as by what they do."

Adherance to these principles constitutes loyalty. One of the essentials to the rounding out of an employee is a proper conception of loyalty to his company. Loyalty to the company must not, with the rarest exceptions, manifest itself in a belligerent attitude toward the public. Occasionally, an employee may be obliged to listen to what seems to be an unjust criticism of the company, or possibly of some member of the company for which he works. It rarely serves a useful purpose for him to take up the cudgel too vigorously or too emphatically; therein lies the danger of a mistaken sense of loyalty. True loyalty, in such instances, takes the form of a patient and painstaking effort to learn the causes of the disturbance and to correct these, if possible (and it is almost invariably quite possible to do so), and gradually alter the state of mind of the disgruntled one. That is real loyalty to the business which you represent and such instances offer great opportunities for the development of self discipline and tact.

The requirements of our customers should be given our first and best attention. Work tickets should be promptly and thoroly executed. Close co-operation should be maintained with the office that issues them. Nothing is quite so trying and embarrassing to the office people as to have a customer call a second time about a complaint or some other matter which should have been cared for in the ordinary course of work. This includes a conscientious regard for a customer's rights and property while on his premises. Perhaps strict observance of this principle will do more than anything else to establish confidence on the part of the company's patrons, while it is obvious that failure to work promptly, thoroly and conscientiously will result in an opposite and most unsatisfactory reaction.

There is yet another way to view this matter. Every act of a gas company employee may be construed in terms of dollars and cents. Whether or not we are profitable employees rests with the character of the work that we do. Pecuniary advancement and personal satisfaction may be realized only through the advancement of the interests of our company and let us not forget that such results may be attained only through regard for the best interests of the consumers of our company.

"Public Relations" is such a broad and fundamental term that time will not permit of more than a mere hasty survey of it. However,

not a single activity or policy of a gas company, or any other public utility, may be conducted or designed without due consideration for this all-important element. Neither is there a single employee who by reason of his or her knowledge and attitude toward this question may not contribute in some degree to the advancement of these policies.

Let us consider organized "Safety Work." This has become a regular program feature of modern public utility practice and has a wholesome bearing upon public relations. Men are being taught to protect themselves and each other in the pursuit of their daily tasks. Sustained and systematic effort to reduce to a minimum, injury and death by accident in the ranks of our employees, is something which must command the commendation and respect of society at large. Closely allied is the practice of plant cleanliness. This will command the esteem of others and like neatness of person will denote self-respect.

Customer and employee ownership of company securities is another movement of this modern day. The successful sale of an issue of a company's securities becomes a very practical and direct manifestation of the fact that the interests of the company, its customers and employees, are mutual. This is a particular activity in which the employee may play a large and important part.

Great value attaches itself to seeking the opportunity among friends and associates for telling the story of the utilities. If he will do so, nearly every employee can cultivate the ability to make short addresses before schools, clubs and other organizations. It is quite customary for the science classes of high schools and colleges to visit the gas works and an intelligent description of the processes by the works operators will create a lasting and beneficial impression.

A business man of our town recently visited our plant for the first time, and was so favorably impressed by the manner in which the operator described the works that he took the trouble to call me and compliment the man. That sort of thing has immeasurable value.

There is yet another angle to the whole question that is worthy of consideration. It is the present day interdependence of various public utilities. In a recent report of the New England Bureau of Public Speaking, this point is emphasized in the following statement: "The time is long past when a utility company can consider itself answerable only for its own acts. The public has come to view the utility business much as a unit, and the acts of any part are more or less chargeable to the whole."

While the gas industry has achieved much, the future unquestionably holds a possibility of expansion and development which promises to overshadow any accomplishment of the past. Many problems will present themselves for solution, and not the least of these will be the need for enlisting a clear and sympathetic understanding of the gas industry on the part of the great consuming public which we serve. This is a job which must be done very largely by the employees of the industry, because through their ranks will be opened the natural channels for the dissemination of correct information.

CARE IN HANDLING METERS

By Robert L. Fearnside
Des Moines Gas Company, Des Moines, Iowa

Care in the handling of meters has been brought to your attention many times; nevertheless, because of its importance it was included again in the program. This subject is worthy of repetition as it should be kept constantly before those who are responsible for the handling of meters, and because it affects directly the appearance, accuracy and future attention required of meters. It is hoped that this paper will serve as a review of present practices, the reasons for the need of care, and as an introduction to discussion in which ideas and practices may be compared.

We all realize the importance of meters, since they alone measure the gas consumed that determines the gross revenue derived from gas sales. For this reason, meters must possess dependability and accuracy. They are expected to operate satisfactorily for a period of years unattended, when placed in service, except for the frequent visits of the meter-readers. The meters receive less attention than any other single piece of equipment in service, although they are very sensitive and delicate. Therefore it does not pay to handle meters carelessly, during installation.

Meter repairing for the most part is standardized and the work performed by trained men; trained either directly or indirectly by schools similar to this short course. The repair-shop men are responsible for preparing meters for use and we will assume that the product of their work is accurate, strong, neat-appearing meters which are mechanically and physically perfect. The meters then pass into the hands of the order men or meter setters whose job is to transport the meters to the premises of the consumers and install them in service. This transportation and installation should be of such character that the accuracy and appearance of the meters will be the same as when they leave the shop. Otherwise, the care taken in the shop will be of no avail.

The comparison of a meter and a watch for accuracy and sensitiveness has been used many times, and illustrates the need for care. A young fellow is presented with a watch for the first time, and told to handle it with care if he wishes to preserve the accuracy and usefulness of the watch. He learns soon enough and sadly, that dropping the watch will injure not only the case, but also the internal mechanism. Instinctively he develops a sense of protection and carefulness. Likewise, the order man or meter setter should be concerned with the safe and careful handling of the gas meters. These men should be instructed until they understand the delicate and physical limitations

of the apparatus they handle. They should know the strength of the many soldered seams and that the meter is no stronger than the seams. They should have a knowledge of the internal mechanism so that they will understand how jars and bumps may cause binds, and thereby throw the meter off test.

The importance of handling meters carefully is not sufficiently appreciated by many meter setters and order men. It becomes necessary for those responsible for the supervision of this work to see that all men entrusted with the handling of meters realize their responsibility, and not set meters which have been dropped or handled roughly.

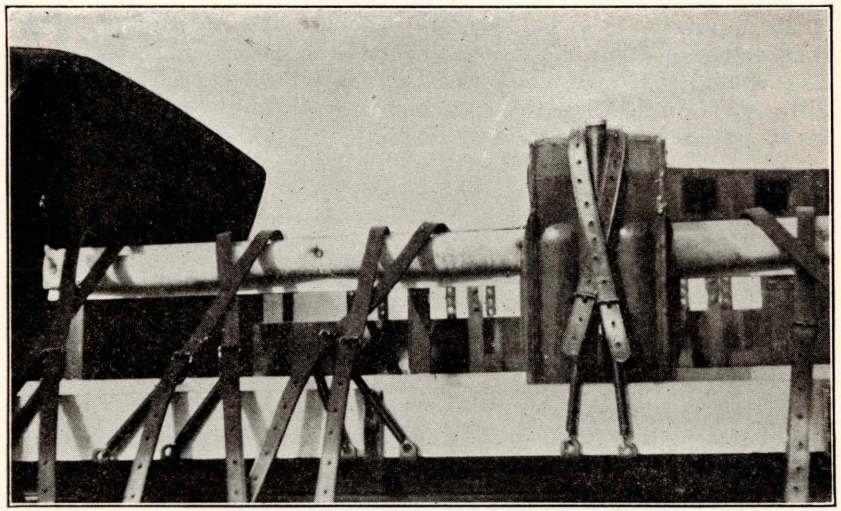
It becomes necessary also for the company to provide a suitable means of transportation. When this is done, it should be remembered that the trip taken by the meter may be either long or short and over rough or smooth streets. Therefore, provision should be made for the worst conditions that may be encountered. Meters used to be placed frequently on the floor of trucks, free to bounce up and down and mingle with the tools, fittings and pipe. In some instances, separate compartments were used, padded on all sides and on the bottom. Tests have demonstrated that meters placed in these compartments bounced up and down enough to injure them during transportation.

Past experience has proven that meters should be held firmly in place so that they cannot bounce or bump against one another. It is true, that meters fastened firmly to a truck bed are subject to some bumps, but the truck springs provide a sort of dash-pot action so that bumps of this nature are apt to be less harmful than bumps caused by meters bouncing into the air and crashing back to the floor. There are many ways to fasten meters to the truck and it is sufficent to say that there are no companies who do not fasten the meters against some kind of padding. There are many different methods employed that serve equally well.

I might describe briefly, the method employed by the Des Moines Gas Co. This method is the result of many trials and discussions. One advantage of this method is a secure grip that places no undue strain on the meters, and a method adaptable to both tin-case and iron-case meters. Each meter is fastened separately and may be removed independently of the others. Every meter is easily accessible.

Light Ford trucks are used, each of which is provided with a shelf on both sides. Two straps are provided for each meter, with one end of each strap fastened to the shelf. These straps are passed over the meter from inlet to outlet and are crossed on top of the meter in front of the inlet connection. They are continued over the side of the meter, crossed again and fastened to buckles at the lower side of the shelf. These buckles are fastened to springs that keep a tension on the straps. In this manner, a loop is made around both the inlet and outlet connections of the meter.

The shelves are padded both at the back and on the bottom, and



Meter Strapped on Truck Shelf

the padding together with the springs provide a firm and resilient grip. When a strap is drawn through the buckle and tension placed on it, the spring is elongated until a hole in the strap is brought to the buckle, so that it is not necessary to pull the strap tighter than required by the strength of the spring. A hole in the strap will always be found convenient even though meters are variable in size. This method is quite simple and inexpensive, both with regard to initial cost and maintenance. The parts may be obtained anywhere. When not in use, the straps are always fastened firmly to the shelf on the truck.

I have mentioned the desirability of transporting meters without scratching the paint or denting the cases. The reasons for this are apparent. The average consumer is often skeptical about the efficiency of the little box hung in the cellar, and although he seldom looks at the meter, the psycholgical effect produced by a trim-appearing, neatly painted meter is evident. A consumer who sees a meter with a dented case or with the paint badly scratched or with the tin rusted and pitted, may feel that he is justified in complaining about his bill. A repaired meter may be made to present the appearance of a new meter by having neatly soldered joints, by having any rough solder cleaned off the case and by having the old paint removed and the new coat applied properly. A good coat of paint is important because it lessens the danger of rusting and pitting, thereby increasing the useful life of the meter.

The relation between the company and the consumer may be affected if the meter starts to leak soon after it is set. Friendly relations

with the customers may be inversely proportional to the amount of attention required by the meters. In addition, the good will of the customers and the amount of attention required by the meters has a direct effect on the distribution cost, and we are interested in keeping this cost as low as possible.

There are other contributing features that should be included in a discussion of this nature. Perhaps the method of carrying the meters to and from the truck is one of the more important. The man doing this should be instructed to carry the meters under his arm, always keeping them in an upright position. It is true, that carrying meters by one of the threaded connections may injure the threads or subject meter columns to undue strain which may cause leakage. However, the important feature of carrying meters under the arm is keeping them upright, in which position the possibility of dropping them is greatly decreased. Also, this position lessens the possibility of small pellets of solder becoming lodged in the dial gears or of any foreign matter being deposited on the valve seats. The lid over the dial glass should be kept closed in order to afford the greatest protection against breaking the glass. Caps should be placed over the threaded portion of the meter columns at all times. This is of particular importance when meters are taken out of service because when air comes into contact with the diaphragms, it may tend to harden them and cause their undue removal. Also, it is just possible that dirt or foreign particles may become lodged in the meter column which will be prevented by the meter cap.

It has been my intention to mention certain things that are regarded as fundamental and to emphasize the need for care. If we can lessen the possibility of placing defective meters in service and improve relations with the consumer by handling meters carefully, it would seem rather worth while.

GAS METER INSTALLATIONS, CHANGES AND REMOVALS

By H. E. Heil
Assistant to General Superintent, Distribution Department
Peoples Gas Light and Coke Company
Chicago, Illinois

A subject of great interest and concern to the gas industry throughout the United States is gas meter installations, changes and removals. The gas meter, figuratively speaking, is the cash register of all companies, and upon the accuracy of it virtually depends the life of the industry. The necessity for extreme care in handling, transporting and installing meters has been explained to you, doubtlessly, by Mr. Geo. A. Lane, therefore that feature will only be mentioned briefly in connection with meter installing, meter changing and meter removing operations.

Meter Installation. Perhaps it will be of interest to know the volume of this class of work performed by the Peoples Gas Light and Coke Company of Chicago, during the period of one year. We installed 59,570 of the 5 and 10 light domestic size meters, and 1,548 of the larger sizes, principally for central house heating plants and industrial uses, during the year 1925.

Methods of Installation. On account of the tremendous volume of installation work, it is natural that we strive constantly to ascertain the best method and type of connection that is economical.

Excluding the lead connection, our greatest concern has been the elimination of strains placed on the meter tubes, which later cause a leak at that part of the meter. Various types of connections are used by the different companies throughout the country, such as, the lead connection, the solid connection made up of nipples and ells, or the split bar and the solid bar connection.

The Peoples Gas Light and Coke Company discarded the lead connection several years ago, and substituted the solid or nipple connection. This was done because the solid connection is much less of a fire hazard, and not so likely to split or break, when handled frequently, which was found in the case with the lead connections.

The lead connection should be bent with care, because a restriction is liable to be placed in the connection due to improper bends by the fitter at the time of installation. Furthermore, a solid connection holds the meter perfectly rigid and eliminates the necessity for a meter shelf on the smaller size meters.

We experimented with the split bar connection about three years ago, installing at that time, several thousand of them throughout the

city. An inspection of these installations was made after they had been installed for a period of six months or more. It was found that in a great many instances the bolts through the bars connecting the inlet and outlet connections were not tight, and in a number of instances the bolts were missing entirely. Leaks at the meter tubes and the unions were not lessened by the use of this connection. It is my personal opinion, that frequently a strain on the meter tubes is locked in with the use of the split bar connections. This, of course, is due to the human element with which we must always contend. Doubtless, this type of connection could be used successfully in smaller companies where the labor turn-over is not so great as it is in Chicago. It was found that several companies preferred this particular type of connection, upon investigating the subject of meter connections. An inspection is not made of each installation in Chicago, and when this is not done, fitters are inclined to become more or less careless, and conditions, like we experienced, are apt to occur.

A committee was appointed by our Vice-President some time ago, to make a study of the various types of connections used by other companies, for the purpose of recommending the type of connection best suited to our use, consistent with economy. After considerable study, investigating and experimenting, this committee has just completed its work. It is my opinion, that the committee will recommend the adoption of the solid bar connection since it is thought that this connection, when made properly is the most nearly fool-proof in the elimination of strains on the meter tubes. Also, this method of connecting meters will cost little more than the iron pipe connection used by The Peoples Gas, Light and Coke Company. Another saving may be made if this connection is adopted, by permitting gasfitting contractors to install it on the house piping at the time buildings are piped. This, I understand is done by some of the eastern companies.

The actual fitting operation of meter setting is one that does not require highly skilled workmen, particularly during the installation of the smaller size meters. The larger size meters, which are set frequently in batteries, require more highly skilled workmen.

Meters are set frequently in batteries of two or more for large industrial institutions, large hotels and restaurants, and apartment buildings. A shut-off is placed on both the inlet and outlet of each meter, when they are set in this manner, so that when it is necessary to change one of the meters, the supply of gas to the customer will not be interrupted.

It is our practice, when making up meter connection preparatory to installing a meter, to have both connections made up and brought to the point where the meter is to set. Meter swivels are then properly centered, the meter is lifted up by the fitter, and both unions tightened before releasing the weight of the meter. The gas is then turned on, and a test made for tightness and meter registration.

Meter Swivels. Considerable trouble has been experienced from time to time with meter swivels. We have frequently found threads that were not true that caused the shoulder of the swivel to set unevenly on the meter screw. It was found also, that the bends on some swivels were flattened to such an extent that the cap would not pass over the bend. The condition was caused by the shortness of the swivel, as it was impossible to get the proper chuck hold on the swivel in order to thread it. It was also difficult to secure a safe hold on the short swivel when it was inserted into the meter connection.

The committee assigned to study this question recommended a longer swivel with a 1″ offset, rather than the shorter swivel with only a ½″ offset. This wider offset allows more lee-way in making up connections, as a variation of 2″ between the width of the meter screws and connections, can be taken care of by the two 1″ offset swivels.

Meter Washers. A study was made of leaks at meter unions due to defective washers, about a year ago, in order to minimize the complaints regarding leaks received from our customers. Up to that time we had used leather washers exclusively.

The investigation disclosed several interesting facts. In some instances, leaks would occur at the meter unions within a very short period after the installation of the meters, and it would be necessary to tighten the union, which to all appearances had become loosened. In other instances, leaks occurred at locations where meters had been in service a number of years, and it was found that the leak could not be stopped by tightening the union, so that a new washer had to be inserted.

It was found that the leather washers varied considerably in thickness. The variation in thickness from one side of the washer to the other, would be from one sixty-fourth to one thirty-second of an inch. It is obvious, therefore, that the compression on the thicker side of the washer, will be greater when the union is made up. This would allow gas to leak past the thin side of the washer.

Washers on meters, that had been in service for a considerable time, were found to be so hard that they could not be compressed further, and so a new washer would be required. In a great many instances, the washers were so hardened that they could be pulverized with the fingers.

A number of gas companies throughout the country were consulted, in determining the best type of washer to use, and after several tests it was decided to use a composition washer. This washer is of uniform thickness and is one thirty-second of an inch thick. On coming in contact with the moisture in the gas, it has a tendency to swell instead of becoming more compressed and drying out as is the case with the leather washer, thereby making a tighter joint.

A study was made of the operation of our turn-on and cut-off department, some time ago, in a further effort to determine the cause of leaks

at meters, meter unions and meter connections. We have employed in this department (depending upon the season of the year) from one hundred to two hundred men whose sole duty is to turn on and turn off meters at the request of the customers. This investigation disclosed some very interesting facts; the principal one was, that approximately seventy-five per cent of the meters for which they had cut-off orders, had been previously shut off by either the customer, a janitor or a furniture mover.

Obviously, the meter and connections will be disturbed, when undue force is used to operate a meter cock that has been set in one position for a long time. Oftentimes, a gas leak is the result. The employees in the turn-on and cut-off department are very careful as a rule to see that the core of the meter cock operates freely. Observations disclosed the fact, however, that in a few instances when a meter cock was turned on or off, three or four meters setting in a row would be moved by the effort used on the one meter cock.

Meter Changing. This operation is considerably greater in volume than the operation of meter installations. We changed 94,135 meters during the year 1925.

Both meter setting and meter removing operations are included in a meter change. Ordinarily, these operations do not require skilled workmen because there are no connections to be made up, and workmen do not work on live gas.

In a great many instances, however, meter setting and removing does require somewhat skilled workmen, because the fitters are working on live gas when making up the inlet connection on a meter set, or plugging the service on a meter remove order. The fitters on meter-change work often change from twenty-five to thirty meters per day.

In doing this work, it is necessary to see that all appliances on the customers' premises are shut off. Then shut off the meter cock, remove the old meter and connect the new one, always using a new washer. The fitter then opens the meter cock, and observes the proving hand on the meter to see that there is no registration. He then lights a burner on an appliance and makes another observation of the proving hand on the meter, to make sure that it registers.

This completes the operation with the exception of filling out the necessary work tickets.

Meter Removals. The Peoples Gas, Light and Coke Company made 24,803 meter removals during the year 1925.

This operation is very simple. However, it requires competent workmen, because like meter installing, fitters are required to work on open gas since the meter cock must also be removed from the service with the removal of meter and the service plugged.

HOUSE GOVERNORS

By T. J. COLLINS
Superintendent of Meters, Kansas City Gas Company
Kansas City, Missouri

The subject, house governors, is very important and a subject that requires due consideration. Governor difficulties in Kansas City are what might be termed a minimum, due to the fact that we have a very clean, dry natural gas which does not deposit foreign substances in the governors. This, as you well know, is in direct contrast with conditions in the manufactured gas district, where gummy deposits collect in the governors and cause non-operation.

No doubt, the short course committee thought a general discussion and exchange of ideas on this subject would produce better results than a one-man paper or speech. Consequently we will work to that end.

Reynolds Governors. There is here a No. 2 Reynolds governor, that we have used in Kansas City for a number of years. It is called a combination spring and dead-weight governor. The inlet and outlet connections are ¾ inch. This governor is termed a high-pressure governor and requires a mercury seal and a vent pipe. The inlet pressure used on this governor in Kansas City, varies from five to fifteen pounds. This pressure is reduced to 4 inches of water column for domestic use. However, any pressure may be obtained on the outlet side by the adjustment screw and spring. We are of the opinion, that this is an advantage over the straight dead-weight type governor.

A 1¼ inch vent-pipe is used on this governor which runs to the most convenient location on the outside of the house. Care is always used in order that the open end of the pipe will not be near a window, and to have the open end of pipe eight feet or more from the ground. In some cases, the location we select for the vent-pipe is not satisfactory with the customer. When this condition exists, we usually run the vent-pipe to suit the customer rather than the gas company. A 1¼ inch elbow is screwed on the top of the vent-pipe. A twenty-eight gauge, perforated brass-disc is then placed in the open end of the ell. This prevents stoppage from the outside. Also, the expense of installing this safety feature is protected.

The object of the vent is familiar to all those here, but for the purpose of discussion, it may be said that the vent is the route for gas to escape in case the diaphragm is punctured, or in case of any other internal trouble that will cause non-operation of the valve, and thereby permit high-pressure gas to enter the customer's house-pipes and appliances. Several years ago, the manufacurer of this governor

furnished a mercury cup that contained about one pound of mercury. It was later discovered that one-half pound of mercury was sufficient, thus the installation and maintenance costs were reduced by half.

Emco Governors. The Emco governor is the next one to be discussed. We have used this governor in Kansas City for three years. The governor works under exactly the same conditions as the Reynolds governor; i. e., with five to fifteen pounds inlet pressure that is reduced to a determined outlet pressure. It also requires a mercury seal and a vent. Access to the valve chamber is an advantage of this governor. We have had very few occasions to use this governor in Kansas City, however, it may be an advantage to those of you who furnish manufactured gas. We find that a large per cent of governor trouble originates in the valve chambers, consequently this opening into the valve chamber is an asset.

Crawford Sensitive Governors. We have used this governor on our distribution system, for a number of years. It has been used on industrial installations during the last two years. It is a governor of high capacity and may be purchased either as a combination dead-weight and spring, as a permanent dead-weight, or as an adjustable, dead-weight governor. In either case, it is necessary to give the manufacturer the desired inlet and outlet pressure. We have had some trouble with this governor from chattering which seems to occur when the governor is operating near its minimum capacity.

Baylis Governors. The Kansas City Gas Company has used this governor about twenty years. They operate under different pressure conditions than the other governors discussed. The inlet pressure supplied to this governor is twelve to fifteen inches of water column which is reduced to a determined outlet pressure. The rated capacity of this governor is nearly 500 cubic feet per hour. Perhaps, you wish to know why we use this governor instead of other governors we have discussed. The answer is, that it is an intermediate and not a high pressure governor, and does not require a mercury seal or a vent. The Baylis governor regulates and maintains a constant outlet pressure as long as there is gas being used, but when consumption ceases, the outlet pressure becomes equal to the inlet pressure. This probably is due to the fact that the valve is a metal-to-metal seat rather than a metal-to-leather seat, as it is in high pressure governors. The built up pressure within the house pipes is not considered to be a hazard or a liability as long as the specified inlet pressure is not over one pound. The inlet pressure supplied to this governor is nearly one-half pound.

For the sake of discussion, it may be added, that the care and handling of governors is important. A governor should not be transported with the shipping pin removed. A fitter should not remove the shipping pin until he is ready to turn gas into the governor. Another

important feature relative to installation is, be sure the governor sets level. A valve, that is forced to enter its seat from a side position rather than from the center position, will wear on the side that makes contact first and eventually will not function as one part of the mechanism.

UNACCOUNTED FOR GAS

By Amos H. Abbott
Superintendent of Gas Distribution, Northern States Power Company
St. Paul, Minnesota

It is essential in any discussion of this nature, to have in mind a proper definition of the subject. By unaccounted-for-gas, is meant the difference between the readings of the station meter and the consumers' meters over a certain period of time. The station meter records the volume of gas manufactured and placed in the holders and mains, and represents the total send-out of the gas company. The meters of all the consumers measure the volume of gas sold to them which indicates total gas sales of the company. The difference between these readings over a period of time, represented usually as a per cent of the total send out, is the unaccounted-for-gas. It usually means a loss in revenue to the gas company and represents a huge sum of money annually, that it is the duty of the gas man to try to save. To give an idea of the magnitude of this loss, there are approximately 500,000,000 cubic feet of gas manufactured annually in this country. Eight per cent of this gas is not measured by the meters of the consumers. If we assume an average value of this gas at 50c per thousand cubic feet, the difference between the readings of the station meter and the consumers' meters of manufactured gas alone will represent a loss of approximately $20,000,000 per year.

There are quite a number of factors which make up unaccounted-for-gas. The table at the end of this paper shows some of these factors with particular reference to meter study, together with an approximate idea of their importance. My statements will be confined to a discussion of these various factors.

There has been considerable research work done on this subject at various times and places, and a recent study has been made on the Pacific Coast which is being followed with very commendable results. Some of the information presented in this paper was secured from reports of the work done by the Pacific Gas Association.

The first factor entering into this subject is, of course, the station meter. This meter we have assumed to be correct. Doubtless very few station meters are always absolutely correct and, of course, an error in the station meter will be affected by either an increase or a decrease in the unaccounted-for-gas. The station meter measures the volume of gas manufactured and delivered to the distribution system. There are certain standard methods of metering gas at the station meter with the temperature and pressure of the gas reduced to standard conditions for purposes of comparison. Good practice makes

it advisable for the manufacturing department to calibrate periodically the station meter to determine its accuracy. Therefore, let us start this discussion by assuming that the station meters are correct and measure the exact volume of gas, corrected for 30 inches of mercury pressure and a temperature of 60° F, delivered to the distribution and transmission system.

The second factor in this discussion is the meters of the consumers taken as a group. We are here to study particularly these meters. The primary object of the gas meter-man is to perform his work so as to insure the correct registration of all the gas passing through the meters of the consumers. We are all aware of the fact that some individual meters run slow and some run fast at various intervals of time, nevertheless, we are all quite impressed with the fact, that the average meter readings of any large group of meters are very nearly correct. The average error in registration of the meters of all consumers is very close to zero. Let us assume then, that the average error is small and is approximately 5-10 of 1 per cent slow for all the meters. We could just as easily assume that the error is fast instead of slow, and in an average company it is difficult to say whether this error is fast or slow. The meter-man as stated before is interested primarily in correct meter registration, and one of the objects of this short course is to inform the meter-man of the best practices in repairing and testing meters.

The primary object for periodically changing and testing meters is to insure correct registration. No doubt, every company in existence brings in occasionally some D. R. meters or meters that are passing gas without registering it. Quite frequently some meters pass a very small volume of gas without registering it, so that various shop tests are made to insure us that all meters going out of the shop will register correctly any quantity of gas passing through them, and will continue to so register.

In order to give an idea of the losses that will exist if meters do not register on the slow flame test, let us assume that the average pilot light on a gas range burns approximately 3-10 of a cubic foot per hour. Now, for example, select a company with 10,000 meters. Any company with 10,000 meters will have at least 5,000 pilot lights of this small consumption. Also, let us assume that these meters will not register 3-10 of a cubic foot of gas per hour. This would mean consumption of approximately 13,000,000 cubic feet of gas per year not registered and with an average value of 50 cents per thousand cubic feet would represent $6,500 annually per 10,000 meters. This example is used merely to illustrate the necessity for meters to register even the smallest consumption of gas.

The impossibility in most cases, to read the meters of all of the consumers on one date, is another factor affecting these readings. Many meter reading dates cover a period of from several days to a month,

consequently, the time element we are considering must be taken into account. In most companies, a report is made of unaccounted-for-gas every month, but due to different meter reading dates and the fact that all meters cannot be read every month, there is often a wide variation in unaccounted-for-gas figured over monthly period. It is generally agreed that a one year period is necessary to obtain a fair idea of the per cent of unaccounted-for-gas.

The third factor affecting unaccounted-for-gas is the variation between the registration of the station meter and the meters of the consumers due to the effect of different temperatures of the gas measured at two places. As stated before, the station-meter reading is usually corrected for a temperature of 60° F. If this reading is not corrected a volume of gas is measured at the temperature of the gas at the meter, and we all know that the volume of gas varies with a change in temperature. The meters of the consumers are of a volumetric displacement type and, of course, measure the actual volume of gas passing through them at the temperature and pressure that exists at the meter. In the northern climates, the average temperature of the gas in the consumer's meter is probably lower than 60° F., while in the south it may be higher. My experience has been mostly in the northern climates and it is my belief that conditions are often met with in the northern companies where the average temperature of the gas at the consumer's meter is approximately 50° F. This means, that for a cubic foot of gas at the station meter corrected for a temperature of 60° F., will register 1.9 per cent less gas at consumer's meter at the temperature of 50° F., and on the chart is indicated as being an error showing 1.9 per cent loss.

The fourth factor is difference of pressure. We correct station-meter readings usually, for an absolute pressure of 30 inches of mercury. The gas at the meters of the consumers has an average pressure of approximately 5 inches of water column plus the average barometer pressure. This absolute pressure at the meters of the consumers varies with different climates, elevations and seasons. For illustration purposes and because of conditions that exist in some of the northern companies, let us assume that the absolute pressure equivalent to 29.72 inches of mercury. This pressure is somewhat less than the 30 inches at the station meter, and means that a cubic foot of gas at the station meter is measured under slightly less pressure so that at the meters of the consumers a little more than 1 cubic foot of gas is measured. The error indicated on the chart amounts to a difference in volume of minus 9-10 of 1 per cent at the consumer's meters, and is a gain in this case rather than a loss of registration.

Another factor entering in this subject is the effect of condensation in the gas when it is measured at the station and again by the meters of the consumers. The gas at the station meter is usually saturated with water vapor at 60° F., or if the gas is measured without making

a correction for temperature it is saturated at the actual temperature existing at the station meter. When the gas reaches the consumer it is usually at an average temperature somewhat lower than 60° F., particularly in the northern climates. This gas at a lower temperature is also saturated with water vapor, and due to the drop in temperature between the station meter and the points of consumption, there is a condensation of water vapor which collects in the drips. As this condensation passed through the station meter as water vapor or gas it occupied a certain volume. Since it has condensed in the mains of the distribution system it does not pass through the meters of the consumers, consequently an error is introduced in meter readings that in the case of some northern companies amounts to approximately 1 per cent loss in registration.

The sixth factor is stolen gas or theft of gas. It, of course, is the gas consumed through illegal connections. It is difficult to say or to even estimate how much of an item this is in an average company. None of us like to believe this item is very large. A figure taken from some other studies made on this topic is combined in the table with the next factor which is also small as 1-10 of 1 per cent. Even though this loss is small, it is the duty of the gas man to keep this loss at a minimum, both by the control of the piping system so that it will be difficult to use gas not registered by the meter, and by the control and inspection of installations and accounts.

Gas lost in the mains and services due to construction and operation of the distribution system is measured by the station meter but not by the meters of the consumers. This item is also small and, as stated before, is combined with the factor of theft. Together they are estimated at 1-10 of 1 per cent. When new gas mains and services are laid pipe capacity is added to the distribution system. This additional capacity is filled with gas and remains filled. It is also apparent that during the pipe laying process a certain amount of purging of the pipe is done. The air is bled out of the new pipe and to be certain that all of the air is out a certain amount of gas is also bled through the pipe. This loss of gas plus the gas required to fill the additional pipe capacity is a slight factor in the unaccounted for column. We find that gas is lost through operating conditions such as the blowing of drips and, in some cases, possibly the blowing of holder seals.

The preceding factors are subject to conditions over which there is a very little control or possibility of elimination. The problem for us is to insure correct meter registration and also to lessen the amount of stolen gas. The losses due to natural conditions such as changes of temperature, condensation and gas used during construction and operation are factors, which are somewhat out of control and in a sense may not be considered as actual losses although they are a part of the total loss in the unaccounted-for-gas column.

We now come to the factor of leakage which is probably the largest item. It is quite difficult to estimate in detail the leakage from various sources between the station meter and the meters of the consumers. This leakage exists possibly to some extent in the storage holders, to a large extent in the mains, to some extent in the services which includes the pipe line from the main to the meter union, to some extent in the inlet meter union, and to some extent in the inlet neck as well as case leaks in the meter in order to fill up the column for unaccounted-for-gas and to make an average total loss of 8 per cent. I have grouped leakage from various causes into one figure and estimated it at 5.4 per cent of the total send-out of gas. Leakage in the storage holder is possibly small and is included merely to point out the necessity for the gas man, who is usually from the production department, to keep down the leakage in the storage holders. This is done usually by periodical inspection, painting and repairs.

There have been some studies made and figures presented showing the portion of leakage that comes from the gas mains. An estimate of this is not being made in this paper, but rather the necessity for the distribution man of today is to insure that new piping systems, new mains that are laid, and old pipes that are overhauled be made as bottle tight as the best of thought and experience can provide. Not only should the gas man build a bottle-tight distribution system, but he should build a system that will remain bottle-tight for years to come.

Leaks in gas mains occur principally from three sources, which are joints where the pipe is put together, from corrosion, which results in pitted pipe and deterioration from various causes as well as some leakage due to broken mains. Each of these three items is a subject on which there has been a great deal of discussion and investigation. One of the common units for expressing unaccounted-for-gas is based on the length and size of gas mains in the ground. When unaccounted-for-gas is expressed in cubic feet lost per mile of main on a three inch basis, it is meant to be a criterion of the tightness of the gas main system. It is a measure of lost gas per unit of exposed surface of the pipe, and in some states the regulatory bodies judge the efficiency of the operating companies to some extent by the expression of lost gas per miles of main on a three inch basis.

Practically all our gas mains are laid using either cast iron or steel pipe. Various kinds of joints are made on both kinds of pipe. The kind of pipe to be laid, the protection necessary on the pipe to prevent corrosion, the kind of joint which may be made tight and will remain tight, and the elimination of broken pipe are problems that the distribution man is now concentrating his efforts upon in order to reduce the large percentage of unacounted-for-gas.

Practically the same condition exists from leaks in services as from leaks in mains. The services are nearly all laid with steel pipe and

likewise such things as making proper joints, the protection against corrosion and breakage are of primary consideration to the distribution man.

Every company has some unaccounted-for-gas, but particular attention must be given to secure a tight piping system in the larger companies, as leakage usually means more than just the loss of gas. A bottle tight system is especially desirable to prevent escaping gas from becoming harmful in large cities, where pavements, duct lines, man holes, extended basements, undermining of the piping system and other conditions are encountered. The cost of building such a system is offset not only by the economy of saving the gas, but also by eliminating the large element of hazard due to escaping gas. In attempting to decrease gas losses in the piping system, it is considered good practice to conduct a little routine inspecting or testing of the gas mains in the ground, in order that leakage at joints, and broken or corroded pipe may be detected before serious damage results or much gas is lost. "Barring" for leaks and surface inspection are common occurances with practically all companies, and are intended, of course, to keep down leakage in the distribution system.

Another place where leaks occur is at the inlet meter union. This is mentioned in particular to bring out the fact that a large percentage of the reports on leaks received by gas companies come from leaking meter unions. Probably these leaks are due to the kind of washers used in the union and the quality of workmanship of the meter installers. There is considerable doubt in my mind as to how much gas is lost through this source, and doubtless we all appreciate the fact that it is a source of nuisance as well as a hazard, that the meter-man must strive to eliminate.

The last item in the list as it has been analyzed is leakage through the meter itself, either at the inlet neck or in the meter case. This is another problem of the meter-man in particular. There is some doubt in my mind as to the quantity of the gas lost through this source. It may be reasonable to think that leakage in the basements of the consumers amounts to very little. If we assume that leaks of any consequence are reported and fixed before much gas has escaped, it may be reasonable to think that the gas lost both at the meter union and the meter neck is very small. It is probably more a case of nuisance than actual loss of gas. Leakage from this source in tin meters is generally caused by breaking the neck due to a strain in setting, the rusting through of the case of the meter, damaging the case in transit, and improper soldering. Leaks of this kind in iron meters, are probably due to flanges and joints not being tight. Proper protection of the meters during handling and setting are necessary, of course, to insure that the meter does not leak. The paint of the meter should be in good condition when the meter is set to protect it from rust; also

care should be exercised in setting the meter to prevent strains which will cause leaks.

Every item that is included under unaccounted-for-gas, in fact every sub-item has been the subject of special study for years. Those items that the gas man is able to control, such as errors in the meters of the consumers and leaks from various parts of the distribution system, are still subjects of active discussion, and they are worthy of the best efforts of the gas fraternity in order to find a permanent solution.

Losses included in unaccounted-for-gas expressed in per cent of total send-out.

1.	Station Meters	0.0
2.	Consumers' Meters	0.5
3.	Effect of Temperature Difference	1.9
4.	Effect of Pressure Difference (Gain)	0.9
5.	Condensation	1.0
6.	Theft	0.1
7.	Gas Used in Construction and Operation	
8.	Leakage from Storage Holders	5.4
9.	Leakage from Mains	
10.	Leakage from Services	
11.	Leakage at Inlet Meter Union	
12.	Leakage at Meter	
	Total	8.0

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