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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

SECOND TECHNICAL CONFERENCE OF
STATE UTILITY COMMISSION
ENGINEERS

MARCH 6 AND 7, 1924

MISCELLANEOUS PUBLICATIONS No. 66

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BUREAU OF STANDARDS
George K. Burgess, Director

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**SECOND TECHNICAL CONFERENCE OF
STATE UTILITY COMMISSION
ENGINEERS**

HELD AT THE BUREAU OF STANDARDS
WASHINGTON, D. C., MARCH 6 AND 7, 1924



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1925

Bureau of Standards

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LIST OF ENGINEERS ATTENDING CONFERENCE

- | | |
|---|--------------------------------|
| E. IRVINE RUDD, Connecticut. | CHARLES R. VANNEMAN, New York. |
| WARREN B. HADLEY, District of Columbia. | R. H. NEXSEN, New York. |
| J. HOUSTOUN JOHNSTON, Georgia. | H. S. HARMOUNT, Ohio. |
| CARROLL G. BENNETT, Illinois. | A. I. THOMPSON, Oklahoma. |
| EARL L. CARTER, Indiana. | GEORGE H. MORSE, Pennsylvania. |
| GEORGE CHARLESWORTH, Iowa. | H. B. STOUT, Tennessee. |
| W. F. STROUSE, Maryland. | F. G. PROUTT, Tennessee. |
| LUKE L. ELLIS, Maryland. | MCGREGOR SMITH, Tennessee. |
| SPENCER A. COVELL, Maryland. | R. D. PARKER, Texas. |
| RAY Y. GILDEA, Maryland. | J. W. WEST, Jr., Virginia. |
| J. A. CULLEN, Maryland. | W. BAKER HALL, West Virginia. |
| MANFRED K. TOEPPEN, Michigan. | C. B. HAYDEN, Wisconsin. |
| PHILANDER BETTS, New Jersey. | C. M. LARSON, Wisconsin. |

Howard M. Jones and T. P. Artaud, of the Interstate Commerce Commission, E. J. Cheney, consulting engineer, New York, and A. B. Campbell, National Electric Light Association, were also present, on invitation, to present papers to the conference and participate in the discussions.

EXECUTIVE COMMITTEE

- Chairman:* C. B. HAYDEN, Wisconsin
Secretary: E. C. CRITTENDEN, Bureau of Standards
Members: C. R. VANNEMAN, New York
A. I. THOMPSON, Oklahoma
W. M. BLACK, Maine

SEP 20 1926
VANNEMAN

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FOREWORD

The first Technical Conference of State Utility Commission Engineers held at the Bureau of Standards in March, 1923, was regarded as so successful and useful by all the engineers in attendance that a small Executive Committee was formed to arrange for another conference to be held in 1924. This second conference met March 6 and 7, 1924, engineers representing 18 State utility commissions being in attendance. The proceedings of this second conference are reported herein.

The Bureau of Standards is very glad to have this conference of public utility engineers meet in its laboratories. The conference appears to be established as an annual event, and the bureau welcomes these meetings as an effective means of furthering cooperation in the technical and engineering work of the various commissions.

GEORGE K. BURGESS,
Director, Bureau of Standards.

SECOND TECHNICAL CONFERENCE OF STATE UTILITY COMMISSION ENGINEERS

HELD AT THE BUREAU OF STANDARDS, WASHINGTON, D. C., MARCH 6 AND 7, 1924

FIRST SESSION (MORNING OF THURSDAY, MARCH 6, 1924)

Dr. G. K. Burgess, director of the Bureau of Standards, addressed the conference as follows:

Members of the Second Conference of Engineers of Public Utility Commissions, I take great pleasure in welcoming you and I note with great interest the wide geographical field which you represent. I am sure you will find your meetings of the two days most effective and useful, and will be able to take back to your communities facts which have developed from the discussions which will be of great use in your own communities. I also want to take the opportunity of extending to you a most cordial invitation to visit those parts of the bureau in which you may be most interested. The Bureau of Standards is a great laboratory or series of laboratories in which we have under way investigations covering a great many fields—physics, chemistry, engineering, metallurgy, and, in addition, located at the department are the divisions of simplified practice and of housing, which in some phases may also be of interest to you.

It may be well as a matter of general interest to call attention to two developments in which the Bureau of Standards is very much interested, and which may be of particular interest to you as commission engineers. First is the case of the Federal Specifications Board which is a board established under the Bureau of the Budget, with the director of the Bureau of Standards as ex-officio chairman. This board was established for the purpose of formulating and promulgating standards and specifications for the purchases of the Government. You, of course, have to do with specifications in various forms and I thought it might be of interest to call your attention to the fact that there are now becoming available specifications relating to all Government purchases. This work has not been under way actively for more than a year or a year and a half, but we have already issued about 130 specifications and a large number of committees are at work on additional ones. It is particularly gratifying to note the interest of State purchasing agents, who held a meeting here last May. They were unanimous in their desire to have access to these specifications and as soon as possible a complete list of these specifications will be sent out. This specifications board is at yet young, but its activities are rapidly becoming widely known throughout the country.

Not exactly as an outgrowth of it, but at the same time bearing on the same subject, the Bureau of Standards is taking up the preparation of a directory of specifications. This was suggested by the Secretary, Mr. Hoover, as an effective way of putting on the buyer's

desk a compilation of specifications to which he can refer in making purchases. This directory is a survey of the existing specifications and a selection of specifications which are satisfactory to the industry so as to make them readily available to anyone interested. The work is well under way and is being carried on at the bureau in cooperation with certain divisions of the Bureau of Foreign and Domestic Commerce. It also has the active participation of many outside organizations through their executive offices. I mention these two fields in addition to our experimental work. The Bureau of Standards is an experimental organization, but nevertheless we are very active indeed in the specification field, as well as the experimental field.

Now then, to come to your own problem a little bit. The Bureau of Standards as such has not taken a primary interest in such questions as valuation and rates and they are not within the scope of the work of the Bureau of Standards. The program for to-day is largely taken up with matters in regard to valuation and rates, but these are subjects which, as I said, the Bureau of Standards in the nature of its organization can not take a primary part. There are, however, problems in this connection which have to be solved in the experimental field and in that connection we have taken part.

In all its utility work the bureau has cooperated with all parties concerned. It has not taken sides either with the operating utilities or the regulatory authorities nor does it express any opinion with regard to the relative merits of governmental ownership or operation. In brief, the bureau's field has been first the determination of correct methods of measuring service, second the determination of the facts and practical operating conditions by observation and measurement in the field, and third the preparation of recommended standards of practice which are simply the consensus of opinions which the bureau can obtain. These standards are issued for the information and advice of regulatory authorities and have no legal standing except as may be given them by State and city officials. The bureau not only has no legal authority to apply or enforce any of its requirements, but has not sought such powers. We are in the fortunate position of serving all parties who wish to make use of our services without having to take sides with regard to the settlement of controversial questions. Our general policy has been that of presenting the facts as well as we can determine them and urging all parties to get together and settle their difficulties on the basis of the facts and of engineering economics rather than of purely legal rights.

I may say, in addition, as most of you already know, that the bureau has been very active in formulating service codes as affecting public utility operations and safety codes in various industries in the country. The only field in which the Bureau of Standards has an absolute mandatory power is the measurement of standards of length and weight. All other activities are directed along the line of cooperation.

I have taken the liberty of thrusting these ideas of the activities of the bureau on you, because, coming from such widely distributed regions of the country, I wanted you to have an idea of the underlying principles of the work of the Bureau of Standards and its desire to serve in providing a meeting place for engineers and scientists engaged in solving problems within its field. This meeting to-day

is of that type and I hope it will be successful and that you will want to come back next year to a third conference.

Mr. CRITENDEN. I must explain briefly our failure to get the proceedings of last year's conference printed.¹ It developed during the year that there were so many other demands on our printing funds that it could not be done. What we do expect to do is to prepare a limited number of copies by a lithographic process. Similarly this year we hope to get up an abbreviated report. We have had very urgent requests from those who have found it impossible to attend for copies of the proceedings of this meeting.

Another matter is the form of organization for the conference. Arrangements for this meeting have been made by the executive committee jointly with the bureau. There was considerable discussion last year of holding a meeting farther west at some opportune time. Either to-day or to-morrow we will have a discussion of arrangements for next year. I trust that our meetings this year will indicate the desirability of continuing the conference. As Doctor Burgess has said, the program for to-day is rather outside the bureau's own field. The program has been arranged by the committee on the ground that all of you are interested in questions of valuation, even though the bureau is not directly interested. It is therefore proper that our chairman, Mr. Hayden, take charge of the meeting to-day for the discussion of these questions.

Mr. HAYDEN. Gentlemen of the conference: I wish to say just a word or two before the program starts so that the engineers in attendance may have the opportunity to think the matter over a little more thoroughly, and that is, whether there is to be a definite organization of the engineers or whether we are to continue the plan of working under a committee. We discussed this matter somewhat at length last year but, as I remember it, felt that it would be best to leave it for a year or so. I am inclined to think that is a good plan, so that we may not go into an organization unless we feel pretty sure that such an organization can be a success. Now I have the pleasure of calling on Mr. Carter for his paper on valuation.

Mr. CARTER. Mr. Hayden and gentlemen, I have taken advantage of you, perhaps, in one way. I understood from Mr. Crittenden that it would be advisable to have copies of the paper for distribution and I have prepared them. It is a more or less general paper and I will discuss it and hit the high spots and would rather that you should discuss it yourselves.

Copies of Mr. Carter's paper were distributed and Mr. Carter then presented the most important parts of it. The complete paper is as follows:

PROBLEMS INVOLVED IN MAKING PUBLIC UTILITY VALUATIONS AND RATES

By EARL L. CARTER, *Chief Engineer, Public Service Commission of Indiana*

There is no one specific method to be followed in making valuations and fixing rates in all cases. Each case is a separate and distinct case and must be solved by itself.

¹ The proceedings of this first conference have since been issued as Miscellaneous Publication No. 58 of the Bureau of Standards, Technical Conference of State Utility Commission Engineers, March 2 and 3, 1923.

In fixing rates which are to be equitable, there are a number of questions which must be solved. Some of these are:

1. What is the proper rate base?
2. What is the operating statement?
3. What is the probable relation of the economic conditions at the time of the investigation to those expected to exist during the period of time in which the rates are to apply?
4. What method is followed by the utility in making its collections for service rendered?
5. How are bills paid by the utility?
6. What is the physical condition of the property used by the utility in rendering service?
7. What kind of service is being rendered by the utility?
8. What are the public relations between the utility and the public?
9. What is the fair rate of return necessary for the utility?
10. What allowance should be made to take care of depreciation on the property?
11. How is the utility financed and what are its relations with other financial interests?

In arriving at a fair rate base for any utility which is under consideration, it is advisable to have available information concerning all factors which may affect the determination of the fair value of the property used and useful for rendering service as of the time of the investigation plus contemplated additions and betterments in the immediate future.

The thing to be valued is property. The owners of the property may divide the ownership thereof into shares of stock having much or little relation to the true property value; its securities may fluctuate widely in value and this fluctuation may be determined by considerations which have no relation to property value.

No doubt the earning power of a property is some evidence of its value, but it can be of no use in a rate case, because the earning power is the very point under consideration. In a rate case, where the rates are in dispute, it is impossible to reason back to the value of a property from a consideration of its earning power, because the commission is charged with the duty of determining a proper earning power. Therefore, no attempt to determine the fair value from earnings, in a rate case, is feasible.

In arriving at the fair value some of the factors which should be considered are:

1. Original cost of the property used and useful.
2. A reproduction cost of the property that is used and useful for the public at the time of the investigation, this reproduction cost to be determined by means of applying different price levels such as 10-year average prices, as of the time of the investigation, 5-year average prices, 1-year average prices, and a reproduction price as of the particular time of the investigation.
3. The question of reproducing a new property to render the service that is being rendered by the utility is another question that should be given consideration.

In the writer's opinion the original cost or estimated original cost of a utility property should not be depreciated because the original cost, if prudent, represents the actual investment or at least sub-

stantially the actual investment in the property. It is not fair to deduct from this investment any amount for depreciation unless it be shown that the depreciation fund is in excess of the amount that would have been accumulated by the sinking-fund method. In the making of appraisals on the basis of reproduction theory, it is fair, in the writer's opinion, to depreciate the various units of property because the composite depreciated figure represents, on the basis of prices used, the estimated fair value of the physical property as of the time of the investigation.

The various bases listed above are not to be considered as appearing in their order of importance as each case has to be decided on its own merits and in some cases the original cost might be given predominating weight while in other cases original cost might be given very little, if any, weight.

In a great many cases there is considerable confusion between the term "appraisal" and "valuation." These two, however, are not necessarily the same, as an appraisal simply means an inventory of the property priced with various unit prices, while a valuation of the property means the fair value of the property, and the valuation may be arrived at after considering appraisals made on various bases.

The property costs as shown by the company books is a factor which is sometimes considered. In some States there are tax commissions and the tax laws state that property shall be assessed at 100 per cent of its true cash value. The amount shown on the tax duplicate is another figure which is quite often used, although this is not necessarily a controlling factor.

In arriving at a valuation of a property or a rate base, it is necessary to consider, in addition to the various appraisals of the physical property, items such as "structural overhead," "going value," "cash working capital," "water rights," "materials and supplies," "franchise agreements," etc. In making an appraisal the Indiana commission allows a structural overhead of 15 per cent, which is allowed to cover such items as engineering, superintendence, interest during construction, taxes during construction, fire and liability insurance, small omissions of inventory, contingencies, etc.

"Going value" is sometimes described as the difference in value of a utility due to the fact that it has an established business and is a going concern.

There is no such thing as a standard means of measuring the going value which should be applied to all utility properties.

The item "cash working capital" is an item which varies with the size of the utility and with the manner in which the utility handles its affairs. In some utilities revenues are collected in advance for service, while in other utilities revenues are collected after service has been rendered. Where revenues are collected in advance the utility has the use of these revenues while the utilities where collections are made after the service has been rendered it is necessary for the utility to keep on hand enough money to take care of their current obligations, and these factors must necessarily enter into the question of determining the correct amount of cash working capital to be allowed in conjunction with any determination of a fair rate base.

The item of "materials and supplies" is sometimes carried as part of the physical property. In other cases it is considered as a part of cash working capital. There is no particular difference where this

item is carried, but it is necessary that such an item be allowed as it is essential for every utility of any size to have on hand materials and supplies to take care of the ordinary operating needs in order that good service may be rendered.

There are in certain parts of the country and in part of the State of Indiana, utilities which claim value due to what is commonly known as "water rights." The question of "water rights," of course, is an item which is subject to considerable discussion, and the value to be attached to such rights will vary with different conditions. There are a few utilities in the State of Indiana which have some water rights and in order to determine a fair rate base for these utilities it is necessary to give some consideration to this item. There is no fixed rule which is used by the Indiana commission in arriving at the value to be applied to water rights as there are no two utilities in the State which have water rights that are necessarily using these rights in exactly the same way. Some utilities use the water rights as a source of power to supply electrical energy while a few are using these rights for the purpose of pumping water and others use them as a source of supply for water systems.

The question of regulation of public utility rates is a special field and there is always more or less discussion and criticism wherever there are commissions operating to regulate and control the rates charged by public utilities. There is a vast difference between a public utility and a private industry, yet it is possible to find people of average or above average intelligence who will attempt to argue that utilities should be handled the same as private interests. When business conditions are below normal they will argue that utility rates should be cut to coincide with business conditions, yet when business conditions are good the utility should be held down to a legal rate of return. Obviously this kind of a procedure would result in bankruptcy because if the utility were not allowed to make a uniform rate of return when the business conditions were below normal they would be unable to take care of their fixed charges and operating expenses. The private industry is able to weather depressions in business conditions by virtue of the fact that during good business times they are able to accumulate a surplus or, in other words, to make a rate of return which is in excess of a legal rate of return.

In fixing rates of any utility there are a few pertinent factors which must be obtained. First, what is the fair rate base of the utility? Next, what is the depreciation allowance that should be allowed the utility to keep its property in good operating condition and what rate of return is fair to enable the utility to properly finance itself?

The amount of depreciation allowance will vary with different kinds of utility properties because different properties are made up of items some of which have long lives and others are of very short life. The amount of depreciation allowance will depend upon the manner in which these various items of property enter into the construction of the whole. The depreciation allowance should be large enough to take care of the original cost of the property when and as taken out of plant, but any increase in cost of new property added over and above the cost of the original should be handled as new capital.

There are different kinds of utilities and different rates of return are necessary to take care of proper financing. We have in Indiana

both privately and municipally operated utilities, especially electric and water utilities, and obviously the rate of return that the private utility should have will be higher than that of the municipal, because municipal securities in Indiana are tax exempt, and thus the municipal property can finance itself at a lower rate of interest. Furthermore, municipal securities must be sold at par or at a premium. This, as a general thing, is not true of the private utilities, although there are a few exceptions.

In comparing rates of utilities which are privately owned with those of utilities which are publicly owned, it must be borne in mind that the municipal utility pays no taxes and its securities are tax exempt.

There are different methods of arriving at the depreciation. These are known as straight-line method, sinking-fund method, and various combinations of these methods. The question of depreciation of physical property is one which must be given careful consideration. In making an appraisal of any kind of a utility property it is the practice of the engineers of the Indiana commission to make a physical inspection of the major units of the property and when the appraisals are being made a per cent condition is applied to each major item of property or to groups of property, which represents, in our opinion, the fair physical condition of that particular property at the time of the investigation. The engineering department of the Indiana commission uses what we commonly refer to as a combination method, which is a combination of the 4 per cent compound interest sinking-fund method combined with an actual physical inspection of the property being conditioned. If life tables and the sinking-fund method are used without any consideration to the particular property, it is possible to have a per cent condition on a piece of property very low and at the same time find that the same piece of property is operating and functioning satisfactorily. Because of this fact it is necessary that a combined method be used in determining the per cent condition to apply to different parts of property.

In order to determine the operating statements of the utility it is necessary to make a complete audit of its books, and any rates that are being fixed should not be determined on an operating statement covering a period of time less than 12 months, unless economic conditions are such that operating conditions are changing very rapidly, and even then very careful examination must be made to see that an operating statement for a shorter period reflects a true operating condition.

In fixing rates for any utility, appraisals can be made as of a particular time and an operating statement covering a specific period can be made, but it is not always possible to forecast what general business during the future may be, and if rates are fixed to take care of future operation it is necessary that serious consideration be given to the relation between the appraisal made on a known basis and the operating statement made covering a definite period and the time through which rates are to apply. In some of the cases which have been decided in the courts it has been estimated that rates, if possible, should be so made that they will take care of the next three years of operation.

This, of course, is not always possible, as during the World War operating conditions were changing every day, and when the armistice was signed it was anticipated that operating costs would imme-

diately decline to a pre-war level. This did not happen and operating costs continued to increase on most things until 1920, since which time there have been some deductions. At the present time operating costs are far above pre-war level.

In fixing rates and making a rate of return for a utility, consideration should be given to the kind of service that the utility is rendering. It has been said by various commissions that service is a very important element in rate regulation. "The question of whether given rates are or are not reasonable depends as much upon the character of service supplied as upon the price which the consumer must pay for it. When service supplied by a utility is all that it should be, the conditions under which that service is extended to the community are liberal and the rates charged are found to produce more than a reasonable income, those rates should clearly be reduced. On the other hand, if the service to the community in a broad sense is capable of distinct improvement, it would seem more desirable to reduce any excessive net revenue by increasing the quality of service rather than by decreasing the price paid for it."

The laws of some of the States creating the utility commissions have specified that the cost or the prudent investment should be the rate base, but in most States the laws do not make this specific statement. In the past few years utilities throughout various parts of the United States have not seen fit to accept the rates as fixed by the various commissions and have taken a number of cases to the courts for final determination. The Indiana law states that in valuing the property of the utilities the commission may avail itself of any information in possession of the State board of tax commissioners or of the Interstate Commerce Commission. As one of the elements in such valuation, the commission is required to give weight to the reasonable cost of bringing the property to its then state of efficiency.

A great many court decisions could be cited showing the trend of the higher courts regarding the basis of valuation, but only a few citations will be given in this paper. I would like to quote a part of the dissenting opinion by Judge Brandeis in the Southwestern Bell Telephone case. This case has been referred to time and time again in various arguments before the commissions and in court cases.

PRESENT VALUE

The rule of *Smyth v. Ames* sets the laborious and baffling task of finding the present value of the utility. It is impossible to find an exchange value for a utility, since utilities, unlike merchandise or land, are not commonly bought and sold in the market.

Nor can the present value of the utility be determined by capitalizing its net earnings, since the earnings are determined, in large measure, by the rate which the company will be permitted to charge; and, thus, the vicious circle would be encountered. So, under the rule of *Smyth v. Ames*, it is usually sought to prove the present value of a utility by ascertaining what it actually cost to construct and install it; or by estimating what it should have cost, or by estimating what it would cost to reproduce or to replace it. To this end an enumeration is made of the component elements of the utility, tangible and intangible. Then the actual or the proper cost of producing or of reproducing each part is sought. And finally, it is estimated how much less than the new each part or the whole is worth; that is, the depreciation is estimated. Obviously each step in the process of estimating the cost of reproduction or replacement involves forming an opinion, or exercising judgment, as distinguished from merely ascertaining facts. And this is true, also, of each step in the process of estimating how much less the existing plant is worth than if it were new. There is another potent

reason why, under the rule of *Smyth v. Ames*, the room for difference in opinion as to the present value of a utility is so wide. The rule does not measure the present value either by what the utility cost to produce, or by what it should have cost, or by what it would cost to reproduce or to replace it. Under that rule the tribunal is directed, in forming its judgment, to take into consideration all those and also other elements, called relevant facts.

Obviously "value" can not be a composite of all these elements. Nor can it be arrived at on all these bases. They are very different, and must, when applied in a particular case, lead to widely different results. The rule of *Smyth v. Ames*, as interpreted and applied, means merely that all must be considered. What, if any, weight shall be given to any one must practically rest in the judicial discretion of the tribunal which makes the determination. Whether a desired result is reached may depend upon how any one of many elements is treated. It is true that the decision is usually rested largely upon records of financial transactions, on statistics, and calculations. But as stated in *Louisville v. Cumberland Telegraph & Telephone Co.*, 225 U. S. 430, 436, "every figure * * * that we have set down with delusive exactness" is "speculative."

The efforts of the courts to control commissions' findings of value have largely failed. The reason lies in the character of the rule declared in *Smyth v. Ames*. The rule there stated was to be applied solely as a means of determining whether rates already prescribed by the legislature were confiscatory. It was to be applied judicially after the rate had been made, and by a court which had had no part in making the rate. When applied under such circumstances the rule, although cumbersome, may occasionally be effective in destroying an obstruction to justice, as the action of a court is when it sets aside the verdict of a jury. But the commissions undertook to make the rule their standard for constructive action. They used it as a guide for making or approving rates. And the tendency developed to fix as reasonable the rate which is not so low as to be confiscatory.

Thus the rule which assumes that rates of utilities will ordinarily be higher than the minimum required by the constitution has, by the practice of the commissions, eliminated the margin between a reasonable rate and a merely compensatory rate; and, in the process of rate making, effective judicial review is very often rendered impossible. The result, inherent in the rule itself, is arbitrary action on the part of the rate-regulating body. For the rule not only fails to furnish any applicable standard of judgment but directs consideration of so many elements that almost any result may be justified.

The adoption of present value of the utility's property as the rate base was urged in 1893 on behalf of the community, and it was adopted by the courts largely as a protection against inflated claims based on what were then deemed inflated prices of the past. (See argument in *Smyth v. Ames*, 169 U. S. 466, 479, 480; *San Diego Land & Town Co. v. National City*, 174 U. S. 739, 757, 758; *San Diego Land & Town Co. v. Jasper*, 189 U. S. 439, 442, 443; *Stanislaus County v. San Joaquin & Kings River Canal & Irrigation Co.*, 192 U. S. 201, 214.) Reproduction cost as the measure or as evidence of present value was also pressed then by representatives of the public who sought to justify legislative reductions of railroad rates. The long depression which followed the panic of 1893 had brought prices to the lowest level reached in the nineteenth century. Insistence upon reproduction cost was the shippers' protest against burdens believed to have resulted from watered stocks, reckless financing, and unconscionable construction contracts. Those were the days before State legislation prohibited the issue of public utility securities without authorization from State officials; before accounting was prescribed and supervised; when outstanding bonds and stocks were hardly an indication of the amount of capital embarked in the enterprise; when depreciation accounts were unknown; and when book values, or property accounts, furnished no trustworthy evidence either of cost or of real value. Estimates of reproduction cost were then offered largely as a means either of supplying lacks in the proof of actual cost and investment or of testing the credibility of evidence adduced or of showing that the cost of installation had been wasteful. For these purposes evidence of the cost of reproduction is obviously appropriate.

REPRODUCTION COST

At first reproduction cost was welcomed by commissions as evidence of present value. Perhaps it was because the estimates then indicated values lower than the actual cost of installation. For, even after the price level had begun to rise, improved machinery and new devices tended for some years to reduce construc-

tion costs. Evidence of reproduction costs was certainly welcomed, because it seemed to offer a reliable means for performing the difficult task of fixing, in obedience to *Smyth v. Ames*, the value of a new species of property to which the old tests—selling price or net earnings—were not applicable. The engineer spoke in figures—a language implying certitude.

His estimates seemed to be free of the infirmities which had stamped as untrustworthy the opinion evidence of experts common in condemnation cases. Thus, for some time, replacement cost, on the basis of prices prevailing at the date of the valuation, was often adopted by State commissions as the standard for fixing the rate base. But gradually it came to be realized that the definiteness of the engineer's calculations was delusive; that they rested upon shifting theories; and that their estimates varied so widely as to intensify rather than to allay doubts. When the price levels had risen largely, and estimates of replacement cost indicated values much greater than the actual cost of installation, many commissions refused to consider valuable what one declared to be assumptions based on things that never happened and estimates requiring the projection of the engineer's imagination into the future and methods of construction and installation that have never been and never will be adopted by sane men. Finally, the great fluctuation in price levels incident to the World War led to the transfusion of the engineer's estimate of cost with the economist's prophecies concerning the future price plateaus. Then the view that these estimates were not to be trusted as evidence of present value was frequently expressed. And State utility commissions, while admitting the evidence in obedience to *Smyth v. Ames*, failed, in ever increasing numbers, to pay heed to it in fixing the rate base. The conviction is widespread that a sound conclusion as to the actual value of a utility is not to be reached by a meticulous study of conflicting estimates of the cost of reproducing new the congerie of old machinery and equipment, called the plant, and the still more fanciful estimates concerning the value of the intangible elements of an established business. Many commissions, like that of Massachusetts, have declared recently that "capital honestly and prudently invested must, under normal conditions, be taken as the controlling factor in fixing the basis for computing fair and reasonable rates."

To require that reproduction cost at the date of the rate hearing be given weight in fixing the rate base may subject investors to heavy losses when the high war and postwar price levels pass and the price trend is again downward. The aggregate of the investments which have already been made at high costs since 1914, and of those which will be made before prices and costs can fall heavily, may soon exceed by far the depreciated value of all the public utility investments made theretofore at relatively low cost. For it must be borne in mind that depreciation is an annual charge. That accrued on plants constructed in the long years prior to 1914 is much larger than that accruing on the properties installed in the shorter period since.

That part of the rule of *Smyth v. Ames* which fixes the rate of return deemed fair at the percentage customarily paid on similar investments at the time of the rate hearing also exposes the investor and the public to danger of serious injustice.

If the replacement cost measure of value and the prevailing rate measure of fairness of return should be applied, a company which raised, in 1920, for additions to plant, \$1,000,000 on a 9 per cent basis by a stock issue or by long-term bond issue may find a decade later that the value of the plant (disregarding depreciation) is only \$600,000 and that the fair return on money then invested in such enterprise is only 6 per cent. Under the test of a compensatory rate, urged in reliance upon *Smyth v. Ames*, a prescribed rate would not be confiscatory, if it appeared that the utility could earn under it \$36,000 a year; whereas \$90,000 would be required to earn the capital charges. On the other hand, if a plant had been built in times of low costs at \$1,000,000 and the capital had been raised to the extent of \$750,000 by an issue at par of 6 per cent 30-year bonds and to the extent of \$250,000 by stock at par, and 10 years later the price level was 75 per cent higher and the interest rates 8 per cent, it would be a fantastic result to hold that a rate was confiscatory unless it yielded 8 per cent on the then reproduction cost of \$1,750,000, for that would yield an income of \$140,000, which would give the bondholders \$37,500, and to the holders of the \$250,000 stock \$102,500, a return of 41 per cent per annum. Money required to establish in 1920 many necessary plants has cost the utility 10 per cent on 30-year bonds. These long-time securities, issued to raise needed capital, will in 1930 and thereafter continue to bear the extra high rates of interest which it was necessary to offer in 1920 in order to secure the required capital. The

prevailing rate for such investments may in 1930 be only 7 per cent, or, indeed, 6 per cent, as it was found to be in 1904 in *Stanislaus County v. San Joaquin Co.* (192 U. S. 201); in 1909 in *Knoxville v. Knoxville Water Co.* (212 U. S. 1); and in 1912, the *Cedar Rapids Gas Co. v. Cedar Rapids* (223 U. S. 655, 670). A rule which limits the guaranteed rate of return on utility investments to that which may prevail at the time of the rate hearing may fall far short of the capital charge then resting upon the company.

The public utility reports for 1920, 1921, 1922, and 1923 (to March 1) contain 363 cases in which the rate base or value was passed upon. Reproduction cost at unit prices prevailing at the date of valuation appears to have been the predominant element in fixing the rate base in only 5. In 63 the commission severely criticised, or expressly repudiated, this measure of value. In nearly all of the 363 cases, except 5, the commission either refused to pay heed to this factor as the measure of value, or, indeed, as evidence of any great weight.

The following summary shows the predominant element in fixing the rate base in the several cases:

- In 5 cases: Reproduction cost at unit prices prevailing at the date of the valuation.
- In 28 cases: Reproduction cost at unit prices prevailing at some date, or the averages of some period prior to the date of the valuation.
- In 12 cases: Reproduction cost at unit prices prevailing at some date not specifically stated.
- In 22 cases: Reproduction cost of an inventory of a prior date at prices prevailing at that date or prior thereto, plus subsequent additions at actual cost (so-called split inventory method).
- In 3 cases: Reproduction cost on basis of future predicted prices (so-called trend prices, or new plateau methods).
- In 102 cases: A prior valuation by the commission plus the actual cost of subsequent additions.
- In 85 cases: The actual original cost (including both initial cost and additions).
- In 6 cases: Original cost arbitrarily appreciated.
- In 27 cases: The historical cost or prudent investment.
- In 28 cases: Book cost or investment.
- In 12 cases: Bond and stock capitalization.
- In 36 cases: Determination and classification of methods impossible.

In the various cases presented to commissions or to courts it is necessary for the commissions and courts to make their findings in accordance with the evidence and the facts, and in a great many of the cases which have been taken to the higher courts the evidence has been presented by the utility, and in a majority of the cases very little, if any, evidence has been presented by any representative of the public. This may account somewhat for the findings in some of the opinions.

As pointed out in the *Monroe gas case*, *Monroe, Mich.*, it is the duty of the court to determine the rate base from the evidence before it. The courts have said time and time again that the present fair value of the property is the figure to be obtained, and in arriving at this present fair value it is necessary to consider as a correct element the reproduction of the property.

In the finding in the *Columbus Gaslight Co.* case, which was decided by the Supreme Court of Indiana in 1923, it is stated that the value of the property of a public utility to be considered by the commission in fixing a rate base, the utility being entitled to a fair return on the value of that which it employs for the public convenience, is not the mere original cost, less depreciation, but that increased reproduction cost at the time of rate fixing must be consid-

ered. In the same court decision it is cited that "the commission in fixing rates can not ignore items charged by the utility as operating expenses unless an abuse of discretion in that regard by the utility officials appears."

In the Monroe gas case the court says "The utility is entitled to an opportunity to a reasonable minimum rate upon the proper rate base. How many securities are outstanding is of no importance. Cases may be conceived where the stock and bond history may have evidential value, but its bearing at the best will be remote." The Monroe gas rate further states that "it is well settled that the court can not fix a rate directly or indirectly, but is concerned only with whether the commission rate is confiscatory. If so an injunction must issue."

In the court opinion of the Wisconsin Supreme Court in the Waukesha Gas & Electric Co. v. Railroad Commission of Wisconsin, July, 1923, it is stated that: "A rate which does not permit the utility to earn a reasonable return upon the present fair value of the property at the time it is being used for the public is confiscatory, and therefore, from a judicial standpoint unreasonable, while from the legislative standpoint a rate may be reasonable which is not unfair to the consumer, although it may permit the utility to earn a return much beyond the legal rate of interest on the money invested." (Detroit & M. R. Co. v. Michigan Railroad Co., 203 Fed. 864.)

It may as well be said here as anywhere that the courts approach the question of whether or not a rate is reasonable from an entirely different standpoint than does the commission. Before the court can declare that a rate is unreasonably low it must clearly appear that it will yield less than the minimum return which invested capital has a right to demand. The court must and should in its deliberations exclude questions of public policy. The determination of matters of policy rests with the legislature.

A considerable study of cases leads to the conclusion that since *Smyth v. Ames* (169 U. S. 466), commissions have regarded it as their duty to apply the court rule and establish a rate schedule which shall yield a minimum return and yet not bring their determinations within the field of constitutional condemnation. It is the duty of the commission to prevent unreasonable exactions by the utility on the one hand, and also to protect the rights of investors from confiscation by imposition of rates which are too low on the other. The rate should be in the language of the statute "just and reasonable"; in other words, not so low as to approach the line of confiscation nor so high as to be unjust and oppressive. A just and reasonable rate need not approach either line. (*Milwaukee E. R. & L. Co. v. Railroad Com.*, 153 Wis. 592 at 611.)

Public Utilities Commission of Illinois, ex rel. City of Springfield v. The Springfield Gas & Electric Co., 125 N. E. 891, from which we quote, page 902: "A fair consideration of the record shows that no element was considered, except the original cost of construction, less depreciation. In this the commission was in error. A fair present value of a public utility can not be determined without full and proper consideration being given to the cost to reproduce new."

The true method of determining the value of public utility property, a peculiar property in that it can not be said to have a market value, has engaged the attention of courts and commissions for

nearly 50 years. At the beginning in cases like *Smyth v. Ames*, 169 U. S. 466, *San Diego Land Co. v. Jasper*, 189 U. S. 439 (1903), *Stanislaus Co. v. San Joaquin Co.*, 192 U. S. 201 (1904), the public utilities were endeavoring to establish a right to a fair return upon the original cost of the investment, since, at that time, original costs of the Civil War period were larger than the present values at the time of the decisions, as measured by the then reproduction cost. In those early cases the principle was firmly settled that investment, or original cost, was not the sum upon which a fair return was to be predicated, but rather the fair value of the property.

It is difficult to ascertain when the reproduction-cost method of determining fair value of utilities was first employed. It is strongly suggested by the court, and was, in fact, used in the *Smyth* case. But in the case of *City of Knoxville v. Knoxville Water Co.*, 212 U. S. 1 (1909), this method was used by the master, to whom the question of valuation was referred, and receives approval by the court in an opinion which has become a classic in the law of valuation. In the course of that opinion (p. 9) it is definitely said:

This valuation was determined by the master by ascertaining what it would cost, at the date of the ordinance, to reproduce the existing plant as a new plant.

The Supreme Court, in the *Knoxville* case, disapproved the report of the master because he made no subtraction for accrued depreciation, and upon no other ground.

After the rendition of the *Knoxville* case, the decisions of our highest court became constantly more pronounced and uniform to the effect that the only reasonable standard of measurement of the fair value of a public utility property is its cost of reproduction new, less accrued depreciation, qualified by some examination of future price trends to determine the permanency of the price level at the date of the inquiry.

If there had been no World War, with its profound economic effects, it is probably certain that by this time the method of determining fair value of public utility properties by the reproduction cost new method would not be questioned anywhere since, as a matter of fact, in pre-war years, reproduction cost had, for more than 20 years, not varied much from investment or original cost.

But the World War did come, and the prices of labor and commodities enormously increased all over the world, with a corresponding decrease in the purchasing power of the medium by which the value was to be measured, namely, the dollar.

During the first years of this profound upheaval, public-service commissions and courts, and indeed, many economists, believed the high-price level to be temporary and ephemeral. It was thought that these unusual prices would soon recede and that the pre-war price levels would be resumed. For this reason, during the first two or three years of the war period there was a strong disposition upon the part of courts and commissions to temporize with the situation. Surcharges were allowed for a period of a few months; where valuations were made, they were, confessedly, for a temporary purpose. Price averages over periods of years were used. In other words, both courts and commissions were loath to apply the previously well-settled doctrine of reproduction cost in a period of prices which

was then thought to be temporary. But as the years went on, and particularly after the general peace of 1918, it became obvious that a new plateau of prices had been reached all over the world. The old, pre-war standards were useless for purposes of measuring value. Month by month and year by year it became increasingly apparent that property values of every character must undergo a profound readjustment, and the purchasing power of the dollar was wholly different than the purchasing power which it had before the World War.

It had been five years since the armistice, and these five years have demonstrated, if anything can be demonstrated by experience, that the price of labor is permanently enhanced. The costs of all materials are upon a new level. This applies to every species of property which can be made the subject of ownership, and we have at last learned that public-utility property is not subject to any economic law which does not apply, with equal force, to all other private property.

Public-service commissions and courts met this situation the best they could, and it is profoundly interesting to observe the attitude of courts, and many commissions, when it finally became apparent that the new price level was not a temporary or passing condition, but a permanent factor in the economic life of the world.

If it were the law that a public utility is entitled to a reasonable rate of return upon the amount of its investment, if known, or estimated if not known, the question of rate regulation in this country would doubtless be more simple than it is. But it was decided in this country at a very early period that a public utility is not to be given a fair return upon its investment. That investment might have been improvident, and the people are not required to pay charges sufficient to make a fair return upon an improvident investment. The investment might have been less than the present fair value, in which event the utility is not required to be content with a fair return upon merely the amount of investment. It is now well recognized that a public utility is entitled to earn a fair return upon the present fair value of its property, whether that fair value be greater or less than its known or its estimated cost.

While the amount of prudent investment may, or may not be, an element to be considered in determining fair value, it is not necessarily the ultimate fact to be determined.

When it is desired to convert an appraisal from one known base to some other base, such a conversion can be accomplished by the application of index figures. Below is a series of index figures which are used by the engineering department of the Indiana commission to make quick and rough conversions from a known base to some other desired base.

Component parts of utility properties—Index numbers

All commodities (year)	U. S. Department of Labor index	All commodities (year)	U. S. Department of Labor index	All commodities (year)	U. S. Department of Labor index	All commodities (year)	U. S. Department of Labor index
1890.....	81	1899.....	75	1908.....	90	1917.....	177
1891.....	80	1900.....	81	1909.....	97	1918.....	194
1892.....	75	1901.....	79	1910.....	101	1919.....	205
1893.....	77	1902.....	84	1911.....	93	1920.....	226
1894.....	69	1903.....	86	1912.....	99	1921.....	147
1895.....	70	1904.....	86	1913.....	100	1922.....	149. 2
1896.....	67	1905.....	86	1914.....	98	1923.....	164. 2
1897.....	67	1906.....	89	1915.....	101	Dec., 1923.....	151
1898.....	70	1907.....	94	1916.....	127		

Property index numbers for a representative utility property

[Applicable to electric and telephone properties. Composite plant and structures index numbers weighted 10 to 1]

Year	Plant	Structures	Property	Month	Plant	Structures	Property
1913.....	100.00	100.00	100.00	January.....	147.23	180.18	150.22
1914.....	89.77	96.00	90.34	February.....	151.51	182.18	154.30
1915.....	99.55	98.00	99.41	March.....	158.63	185.18	161.04
1916.....	146.07	112.00	142.97	April.....	163.18	189.75	165.60
1917.....	199.32	133.00	193.29	May.....	161.84	192.38	164.62
1918.....	174.18	146.00	171.62	June.....	164.02	190.26	166.41
1919.....	165.07	166.00	163.34	July.....	162.58	188.26	164.91
1920.....	196.79	224.00	199.26	August.....	162.58	186.26	164.73
1921.....	144.82	166.00	146.74	September.....	161.93	184.38	163.97
1922.....	139.08	170.00	141.89	October.....	160.51	181.38	162.68
1923.....	159.54	186.00	161.95	November.....	159.80	183.88	161.99
				December.....	156.20	182.46	158.59

Index numbers of prices of utility properties—Pole index from base prices

[Northern white cedar poles]

	25 feet, 6 inches	30 feet, 6 inches	30 feet, 7 inches	35 feet, 6 inches	35 feet, inches	40 feet, 7 inches	Average
1913.....	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1914.....	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1915.....	91.65	91.14	96.00	93.00	100.00	100.00	95.30
1916.....	102.85	95.23	96.60	88.83	100.00	100.00	97.25
1917.....	122.62	122.57	115.80	91.67	112.30	110.00	112.53
1918.....	151.14	132.28	140.00	113.18	125.00	120.00	130.27
1919.....	171.43	141.66	150.00	125.00	131.25	130.00	141.56
1920.....	233.31	207.14	193.34	161.11	163.54	165.00	187.24
1921.....	236.90	192.86	185.00	156.94	167.19	168.33	184.54
1922.....	242.86	147.62	153.33	136.11	166.67	163.33	168.32
1923.....	271.43	165.24	171.67	146.53	185.42	179.58	186.64
1914-25, average.....	172.42	139.57	140.17	121.24	135.16	133.62	140.36
1925							
January.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
February.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
March.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
April.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
May.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
June.....	257.14	157.14	160.00	141.67	175.00	170.00	176.82
July.....	285.71	171.43	180.00	154.17	193.75	187.50	195.43
August.....	285.71	171.43	180.00	154.17	193.75	187.50	195.43
September.....	285.71	174.29	185.00	150.00	196.88	190.00	196.88
October.....	285.71	174.29	185.00	150.00	196.88	190.00	196.88
November.....	285.71	174.29	185.00	150.00	196.88	190.00	196.88
December.....	285.71	174.29	185.00	150.00	196.88	190.00	196.88

Property index numbers for representative utility property

[Applicable to gas and water properties. Composite plant and structures index numbers weighted 10 to 1]

Year	Plant	Structures	Property	Month	Plant	Structures	Property
1913.....	100.00	100.00	100.00	January.....	139.29	180.18	143.01
1914.....	88.75	96.00	89.41	February.....	143.79	182.18	147.28
1915.....	99.30	98.00	99.18	March.....	151.29	185.18	154.37
1916.....	148.95	112.00	145.59	April.....	155.47	189.75	168.59
1917.....	205.71	133.00	199.10	May.....	154.07	192.38	157.55
1918.....	177.86	146.00	174.96	June.....	160.70	190.26	163.39
1919.....	164.40	166.00	164.55	July.....	158.46	188.26	161.17
1920.....	197.73	224.00	200.12	August.....	158.46	186.26	160.99
1921.....	136.39	166.00	139.08	September.....	157.70	184.38	160.13
1922.....	131.04	170.00	134.56	October.....	156.20	184.38	158.76
1923.....	153.92	185.80	156.82	November.....	155.46	183.88	158.04
				December.....	156.20	182.46	158.59

Component parts of utility properties index numbers

CAST-IRON B. & S. WATER PIPE

[6-inch prices per ton f. o. b. Chicago]

Year	Average price (per ton)	Index	Year	Average price (per ton)	Index
1885.....	\$26.02	96.7	1905.....	\$28.0833	104.3
1886.....	27.72	103.0	1906.....	31.5000	117.0
1887.....	30.66	113.9	1907.....	36.7333	136.5
1888.....	26.36	97.9	1908.....	26.9167	100.0
1889.....	26.12	97.0	1909.....	26.7917	99.5
1890.....	29.93	111.2	1910.....	26.8750	99.8
1891.....	23.97	89.1	1911.....	24.4167	90.7
1892.....	23.57	87.6	1912.....	26.1875	97.3
1893.....	21.91	81.4	1913.....	26.9167	100.0
1894.....	17.79	66.1	1914.....	24.1250	89.6
1895.....	21.78	80.9	1915.....	24.4167	90.7
1896.....	19.12	71.0	1916.....	31.1667	115.8
1897.....	15.99	59.4	1917.....	53.5833	199.1
1898.....	16.21	60.2	1918.....	59.8250	222.3
1899.....	26.53	98.6	1919.....	58.3000	216.6
1900.....	27.24	101.2	1920.....	75.6500	281.0
1901.....	24.10	89.5	1921.....	53.1000	197.3
1902.....	31.48	117.0	1922.....	46.0667	171.1
1903.....	31.3333	116.4	1923.....	57.0333	211.9
1904.....	25.2083	93.7	January, 1924.....	55.20	205.1

WROUGHT-STEEL PIPE

[3-inch standard black f. o. b. Pittsburgh]

Year	Average price (per foot)	Index	Year	Average price (per foot)	Index
1910.....	\$0.1645	106.0	1918.....	\$0.4054	261.2
1911.....	.1505	97.0	1919.....	.3626	233.6
1912.....	.1473	94.9	1920.....	.3672	236.6
1913.....	.1552	100.0	1921.....	.3144	202.6
1914.....	.1606	103.5	1922.....	.2547	164.1
1915.....	.1660	107.0	1923.....	.3075	198.1
1916.....	.2372	152.8	January, 1924.....	.3075	198.1
1917.....	.3886	250.4			

Component parts of utility properties index numbers—Continued

BAR COPPER

[F. o. b. Rome, N. Y.]

Year	Average price (per pound)	Index	Year	Average price (per pound)	Index
1888	\$0.1678	106.0	1908	\$0.1354	85.5
1889	.1374	86.8	1909	.1342	84.8
1890	.1581	99.9	1910	.1314	83.0
1891	.1309	82.7	1911	.1275	80.5
1892	.1162	73.4	1912	.1671	105.6
1893	.1078	68.1	1913	.1583	100.0
1894	.0954	60.3	1914	.1391	87.9
1895	.1081	68.3	1915	.1894	119.6
1896	.1098	69.4	1916	.2885	182.2
1897	.1133	71.6	1917	.3011	190.2
1898	.1206	76.2	1918	.2474	156.3
1899	.1780	112.4	1919	.19655	124.0
1900	.1666	105.2	1920	.18062	114.1
1901	.1673	105.7	1921	.13062	82.5
1902	.1214	76.7	1922	.13844	87.5
1903	.1579	87.1	1923	.14979	94.6
1904	.1325	83.7	December, 1923	.13250	83.7
1905	.1609	101.6			
1906	.1981	125.1			
1907	.2118	133.8			

TRANSFORMERS

[General Electric type H, 5 KVA single phase, 60 cycle, 2,300/110 volt]

Year	Average price	Index	Year	Average price	Index
1909	\$51.17	112.5	1917	\$55.01	116.5
1910	51.17	112.5	1918	75.02	164.9
1911	46.09	101.3	1919	72.54	139.5
1912	45.49	100.0	1920	70.68	155.4
1913	45.49	100.0	1921	77.50	170.4
1914	45.49	100.0	1922	65.62	144.3
1915	45.49	100.0	1923	64.48	141.7
1916	45.49	100.0	December, 1923	64.48	141.7

TURBO GENERATORS

[1,250 KVA, General Electric 2,300 volts, 60 cycle, 3 phase, 3,600 revolutions per minute, f. o. b. factory]

Year	Average price	Index	Year	Average price	Index
1913	\$13,242	100.0	1919	\$24,895	188.0
1914	13,242	100.0	1920	28,470	215.0
1915	14,366	110.0	1921	26,219	198.0
1916	18,539	140.0	1922	23,836	180.0
1917	23,174	175.0	1923	24,100	182.0
1918	24,493	185.0			

WATER METERS

[Use five-eighth-inch meter as typical]

Year	Average price	Index	Year	Average price	Index
1912	\$6.80	100.0	1918	\$10.43	153.4
1913	6.80	100.0	1919	11.40	167.6
1914	7.05	103.7	1920	11.68	171.8
1915	7.05	103.7	1921	10.20	150.0
1916	8.75	128.7	1922	9.60	141.2
1917	9.90	145.6	1923	9.84	144.7

Component parts of utility properties index numbers—Continued

GAS METERS

[Use 5 light American line as typical, prices f. o. b. Chicago, Ill.]

Year	Average price	Index	Year	Average price	Index
1911.....	\$5.70	96.8	1918.....	\$9.62	163.3
1912.....	5.70	96.8	1919.....	10.13	172.0
1913.....	5.89	100.0	1920.....	9.80	166.4
1914.....	5.89	100.0	1921.....	9.60	163.0
1915.....	5.89	100.0	1922.....	9.00	152.8
1916.....	6.11	103.7	1923.....	8.70	147.7
1917.....	6.89	117.0			

ELECTRIC METERS

[3 amperes General Electric single phase, 60 cycle, 110 volt, 2 wire]

Year	Average price		Index	Year	Average price		Index
	Type 1-10	Type 1-14			Type 1-10	Type 1-14	
1910.....	\$6.25	-----	100.0	1918.....	-----	\$7.31	125.0
1911.....	6.25	-----	100.0	1919.....	-----	8.04	137.4
1912.....	6.25	-----	100.0	1920.....	-----	8.04	137.4
1913.....	6.25	-----	100.0	1921.....	-----	8.94	152.8
1914.....	6.25	\$5.85	100.0	1922.....	-----	8.04	137.4
1915.....	6.25	5.85	100.0	1923.....	-----	8.04	137.4
1916.....	-----	5.85	100.0	December, 1923.....	-----	8.04	137.4
1917.....	-----	6.50	111.1				

In conclusion it may be said that the Public Service Commission of Indiana arrives at the fair value of a utility property by giving due consideration to the probable cost of reproducing the property at the time of investigation in so far as such costs can be determined from the evidence; also the cost of reproducing it on the basis of average prices that have existed in the past as disclosed by the evidence; the trend of prices in the past and the probable trend in the future; the historical book cost; the prudent investment; the amount of working capital necessary in the conduct of its business; its going value; its operating efficiency; its standard of maintenance, character of service; its present attached business and future prospects; its past, present, and probable future earning power; the amount and character of its outstanding obligations; and any and all facts appearing in the evidence and all other matters submitted by the commission or the parties thereto that should be taken into consideration in arriving at the fair value of the property.

DISCUSSION OF VALUATIONS AND RATES

Mr. HAYDEN. The discussion of this very interesting paper of Mr. Carter's will be begun by Howard M. Jones, head of the engineering section of the valuation division of the Interstate Commerce Commission.

Mr. JONES. When I was invited to participate in this meeting I had a little curiosity to know just what the Bureau of Standards had to do with valuation. In fact I had a sympathetic feeling for you if your bureau was to undertake to standardize valuation. I think that your explanation has cleared the atmosphere somewhat,

and I am glad to know that you are a little bit conservative about embarking on this sea of uncertainty.

As you know, the Bureau of Valuation of the Interstate Commerce Commission has been in operation some 10 years; in fact, nearly 11 years. During the course of these years we have had numerous conferences, hearings, court procedures, and I guess we have heard as much talk on this subject as anyone ever heard on any subject that was brought before mankind for consideration. Some of these gentlemen here in the room know something of the details of our work and of the difficulties that we have had to contend with.

Nearly every subject is open to different interpretations, and learned lawyers and engineers have very different conceptions of what court decisions mean and what right and justice call for. It is not my purpose to go into extended discussion, but simply to review some of the different views and point out some of the difficulties we have encountered in trying to steer a straight course for some known destination. If you have read carefully the court decisions and commission decisions you will find that in very few cases have unanimous opinions been rendered, and that in very many cases the differences are so antagonistic that it is difficult to see how men can vary so widely from what is apparently clear, but nevertheless that is a fact and we have to confront these facts and try to find among all these conflicting views an equitable decision. Sometimes I am very pessimistic. The procedure we are now pursuing calls for a hearing on each valuation. So far these hearings have moved slowly and while the preliminary evidence upon which these hearings are based is well-nigh complete, the announcements of final valuations still seem to be far distant.

Speaking more particularly of the paper before you, I have merely sketched a few remarks. I want to point out first the difference between valuation of the common carriers of the United States and the public utilities. Unfortunately the majority of cases brought before the courts have been utility cases, and the law has frequently been fixed by consideration of facts which are not applicable to the great railway systems of the country. The very difference in magnitude of the problem makes a difference in principles necessary. Now that may not seem clear, but the task of making reproduction estimates of the railway systems of the country is so great that you can not apply the present-day theory to it as you can to a utility. The fact that is often overlooked is that it is much easier to announce a theory by law than to give it practical application. The theory of valuation of the railroads as announced by the courts can not possibly be carried out. It may be fundamentally correct, but on account of the ability of the men and the lack of time it is an impossibility.

One of the most important of these principles of valuation is the date of inquiry for the purpose of fixing such valuation. It must be made for a period and the courts must be made to understand that it probably covers a period of not more than five years. It is impossible to make a valuation annually.

The point which I wish to make is that the courts must recognize this difference, and that added to the difference in magnitude, there is a difference in the property involved. In this discussion we will consider the value for rate making only.

(Mr. Jones here began to read from a partially prepared paper and no further stenographic notes were taken. His sudden death at his desk, just a week after the meetings of the conference, makes it impossible to include the main part of the discussion presented.)

Mr. HAYDEN. We certainly appreciate very much this very interesting discussion by Mr. Jones and we feel very sure that he speaks with authority. We will now listen to further discussion by Mr. Cheney, consulting engineer, of New York.

Mr. CHENEY. I presume the principal reason that I was invited to come here is because I was for a number of years connected with the Public Service Commission of New York State, and in thinking that over coming into Washington I was reminded of a story which a good friend of mine told me which seems to me perhaps fitting. It seems that a poor woman had just lost her dearly beloved husband and a kind friend was trying to sympathize with her. She was grieving very much after they had laid the husband away, and the friend said, "Maggie, don't feel so badly about it. That is only the shell that has cracked, the nut has gone to Heaven." It seemed to me that the more a public service commission gets cracked, the more the nut goes into consulting work.

On looking over Mr. Carter's paper, I found that he had covered the field so thoroughly that I didn't see how I could add very much to it unless I got into some detailed discussion that would probably be tiresome, so I took down a few notes in rough form as a basis for talking a few moments about some things that my work with the commission, and since, have happened to impress on my mind, and which may be worth your consideration whether they are right or whether you agree.

It has already been referred to by both Mr. Carter and Mr. Jones that the valuations or appraisals, or estimates, whatever term you give them, of engineers vary so much that the laymen, the judges, and the commissioners have good reason, I think, without knowing any more about the reasons for variation than they do, to be very skeptical even as to the honesty of the people who make the estimates. This is a terribly unfortunate situation. It is unfortunate for engineers personally and professionally, but of much more importance than that, it is unfortunate from the standpoint of the general public welfare that the work of the engineers can not be recognized as usually being honest, as being intelligent and meaning something which can be tied to as a concrete thing and fitted in the solution of whatever problem is up at that time. The greatest part of the differences is due primarily to the different methods of procedure; to working upon different lines and upon different fundamental assumptions, and then the results having been widely different, naturally the fundamental methods and the basic assumptions are not sufficiently explained. They are not plastered on the face of the job in big enough letters so that the court or the commission or the public understands just the basis upon which the estimate is prepared and does not as a result understand why one man's figures so widely differ from another's. Now my plea is for the benefit of all of us and for the welfare of the public as a whole. I think that whatever method you adopt you should stick to rigorously and when on one job stick to that one method and get the answer that it brings out and then specifically, clearly, and emphatically describe what

that method is and what the answer is to be taken to be, so that no one can misunderstand.

We must recognize, I think, that we have this very unfortunate but widespread distrust of engineering estimates largely by misunderstanding of what they are. We should take means to overcome this distrust by making such misunderstandings impossible; and in that light let me suggest that we do not try to usurp the functions of the courts in doing purely engineering work. I do not suggest that the engineers of the public utility commissions circumscribe their work and cease to consider or begin determining what factors shall be considered or anything of the sort; but, gentlemen, please do not try to add all that in at the same time that you are making an appraisal or valuation or an estimate and weigh certain factors as you go along and exercise your opinion as to how these particular items should be treated, and so perform a judicial function. Let me suggest that you make your engineering estimates straightforwardly on a recognized basis.

Let me illustrate what I am thinking about in that connection. I saw a so-called valuation in which practically no overheads were included. This was a valuation offered in a rate case, and the engineer explained when examined that the overheads which he had not included were omitted because this particular utility had made a practice of charging such overhead items to operating expenses in the past; that these expenditures appeared in its operating expense accounts and that he had not adjusted the operating expense accounts, and therefore he did not think it was proper to include them in the valuation. He had a tenable theory, but the figures that he had assembled, put together and added up as a total, he called a valuation, but it was not the value. It was not even the cost of creating that property. Now, if he had simply made very clear that his result was not the full original cost or that it was not full value, but that it was reduced from the actual amount that went into the property by certain factors and for certain reasons, I don't think I would have had much quarrel with him. I think I should have preferred that he find the full cost figure, and then argue that the certain figures that he had included should not be considered because of so-and-so.

I would like to make this suggestion—that you can not make an estimate or cost of reproduction or anything else with any great degree of accuracy without a very careful inventory. It formerly seemed to me too bad that you had to go to a great deal of work and spend a great deal of time and energy in making detailed inventories. I used to have the idea that detailed inventories could be avoided, that you could get close enough by making general inventories and allowing for the little things. You can get a certain degree of accuracy by that method, but there are an awful lot of things that you do not see and think of unless you actually go and get them. I tried this recently. One of my men went out and got the principal items and we thought we had allowed all right enough for the minor items. We thought we had allowed for everything all right and had an answer that was practical. It proved to be incorrect. For instance, we had a number of 6,600-volt transformers. We priced up the transformers but failed to remember that the 6,600-volt lightning arresters did not come under the same heading as trans-

formers. Things of that sort altogether made a difference that I was really ashamed of.

I know an instance where the valuation was made on a certain property and then a very competent but thorough and somewhat inquisitive accounting officer of the company took it. He went very thoroughly into the cost records of that particular company and made all the comparisons that he could. One particular gas holder built at an early date and at a lower price level cost a good deal more than the item which the particular engineer had given it. The company's records showed that there was no bottom where that holder was built. It had had to be built up and a lot of things had to be done to it. You can see that it was a careful inventory, if you please, but there was not any other place outside of the cost records where the real cost data could be obtained.

Another instance. A very capable engineer, I believe, estimated on a property and based his cost for concrete upon his judgment and experience elsewhere, but the records showed that concrete cost a good deal more in that locality and when the records were studied the reasons for these differences appeared. The engineer also figured on rights-of-way cost on that particular job, so much per mile, so much per pole, I have forgotten which, a figure which in his opinion was adequate for that character of country, and so it was, usually speaking, but there are peculiar circumstances connected with that particular section of the country. There has been a lot of condemnation of property for water purposes in that general neighborhood, and the farmers have acquired very inflated ideas as to what their land is worth if some particular public utility or body wants to use it, and the utilities have to pay accordingly.

These things come out if you go into all the data available. The cost records usually are not good enough to be complete. I think I can safely say they never are and ledger accounts may not be very illuminating, but the vouchers themselves and the pay rolls yield an amount of information that is really surprising and most useful. On the job that I spoke of a little while ago we disregarded the accounts, but we went back into those jobs which were large enough to be representative at all and analyzed them for labor, etc., and on material purchases. We took all of the material purchased, regardless of what it was used for. Starting with the present time and going back through the material purchases, we could find the actual cost of practically all the material that was in the property. Don't rely on the cost records to be complete or accurate without some checking up. Go over them and get what you can. Scrutinize them to see whether they are right, and use what you can and then fill in the gaps when you have to. As Mr. Carter pointed out, the book cost is probably not the actual cost. It may be higher or it may be lower. It is very likely to be considerably different one way or the other, and if you rely entirely upon the cost records or even largely, you will be getting in a situation where you have material moving into place, where you have inconsistencies, but pick out the things which you can identify and from them pick the things which are practically indisputable as far as they go and throw the rest away. You will be surprised at the amount which you do have which is useful and which, when you get through, makes you feel certain that you have a result that can be relied upon. Pardon

me if I seem to preach. That is not what I aim to do at all. We have all had a good deal of experience and some of us have had one thing impressed upon us and some of us another, and we put it out as being the gospel but it is only a suggestion.

If I can turn a sharp angle, I have a brief here that I wrote on depreciation. I shall read only those parts which are rather general.

Depreciation: This much confused and abused term is used in so many senses (often in more than one sense at the same time) that it must be defined before it can be used.

In the first place a clear distinction must be made between physical deterioration and decrease (or increase) in money value. While these are somewhat interrelated, they have no direct ratio and are by no means synonymous. Physical deterioration operates to decrease money values, but other causes, for instance, higher price levels, may be operating coincidentally to increase such values, and the combined effect of all factors may be to increase money values, so that the net result is appreciation. Whether the final result constitutes depreciation or appreciation depends, of course, upon the initial or basic figure with which the final value is compared. With respect to one basic figure (for example, reproduction cost) there may be depreciation, while if some other basic figure (for example, original cost) is selected, the combined influence of causes tending to appreciate and depreciate may result in actual appreciation.

In any discussion of depreciation, and particularly in the use of any figures to measure its extent, there must be some clearly understood basic figure—some bench mark, some starting point—from which the discussion may proceed and to which all other figures refer. A large part of the confusion which exists (some of it, perhaps, purposely) is because of failure to state the nature of the basic figure to which the depreciation applies; the failure to measure depreciation and the basic figure in the same terms; and the failure to consider all modifying influences, whether they tend to diminish or enhance values.

In arriving at a rate base, we understand that, with respect to the physical property, two elements may be considered; (1) investment, and (2) present value.

1. By investment is meant the money which was actually put into the property in order to create it. This has nothing to do with physical condition or value, neither does depreciation enter into the consideration of this factor. To the last statement only one exception needs to be made; and that is, if the property has not been well maintained, so that part of the investment is represented by property which is not efficiently serving the public, the operating company (if its revenues have been adequate for proper maintenance) has no right to ask from the public a return on such property. Whether this lack of repair be called depreciation, deferred maintenance, or some other term, the fact is that, if it exists, it is (with the same proviso) a proper deduction from investment cost before the investment cost is given weight in arriving at the rate base; but if such lack of repair does not exist, there is, of course, no deduction to be made.

2. With respect to present value of the property, depreciation, in its broadest sense, is a factor to be considered. By depreciation we here mean any and all lessening in value, below some stated base, due to impaired physical condition by reason of wear or tear; or due to decrease in usefulness by reason of changed conditions, such as development of the business and changes in the art (inadequacy and obsolescence); or for any other reason whatsoever.

We again emphasize that the basic figure must be established and recognized, and that the depreciation must be computed in terms of the same measure of value in which the basic figure is expressed.

And finally, the treatment of this matter must be fair. We must take the lean with the fat, the debits with the credits, the ups with the downs. If any basic figure is to be modified it must be modified in all respects necessary to correct it to present value. Starting with any basic figure, allowance must be made for all effects tending to depreciate, but equally full consideration must be given to all causes tending to appreciate. In no other way can present value be honestly and truly arrived at. To do otherwise would be as unjust as would be a business association in which one partner took all the profits while the other partner made good all the losses.

Original cost is not value. In this case value is much greater than original cost, but that is beside the point; original cost or actual investment, unmodified, is a definite and understandable thing and can be dealt with intelligently. As

soon as it is diminished by any amount it becomes something else, and the question is what meaning or use the something else has.

If original cost is less than value, the result of deducing from it something for "depreciation" is to depart still farther from value. We have faithfully tried to discover some meaning or usefulness in "normal reproduction cost (original cost) less depreciation" as set up by the city, but without any success.

Actual or "observed" depreciation is the diminution in value of the actual property, as compared with the value of perfectly new property, due to physical condition and to any obsolescence and inadequacy which is apparent. It represents the difference between what a capable and intelligent manager, obliged to furnish the service in question, would pay for perfectly new property and what he would pay for the property in question. Such a man, in forming his judgment, would consider whether by purchasing new property he could get something more suitable, efficient, or economical. Any advantages which new property would have in these respects represent obsolescence and inadequacy in the existing property, and would be taken into consideration. Also deterioration in the wearing parts, the repairs which have to be made immediately and the accumulated liability for those which must be made in future, represent a further difference in value as compared with new property.

Mere age plays a small part in real or "observed" depreciation. Most of the elements in gas and electric properties do not wear out. Those minor parts which do wear are renewed from time to time and the physical condition depends upon the state of maintenance. Obsolescence and inadequacy are the chief causes for ultimate retirement of the major units, and these are not functions of age but of developments in the art and in the service requirements. Improved methods, when invented, render obsolete all apparatus or equipment of a particular type whether the units be 1, 10, or 20 years old. Until these developments actually occur they cause no real depreciation. Until the wise manager can see the possibility of getting something which is improved in type he will pay nothing extra for new apparatus because of mere newness. He will pay only for any advantage it has in actual physical condition. Social pride, if there be any, in owning a 1923 model gas machine is not translated into dollars by hard-headed engineers and business men, who are looking only for most economical operation.

Actual depreciation is not a function of age or susceptible of mathematical computation. It depends upon the type of property, its efficiency and suitability, its state of repair, and its general physical condition. These factors can be determined with reasonable accuracy by a man who is familiar with the property and the attendant conditions and has the general knowledge and experience qualifying him to form a correct judgment.

Theoretical depreciation (1) assumes that the total useful life of each component part of the property can be determined and that the ultimate retirement loss accrues regularly and steadily (in a straight line) throughout the entire life, (2) attempts to determine the present age or the remaining useful life of each part, and (3) makes a mathematical computation upon the basis that depreciation is in direct ratio to the portion of expired life. All of this would be important if true, but unfortunately for the exponents of this theory it happens to be in disagreement with the facts.

Of course, every stage of this process is speculative, but its most serious defect lies in the assumption that depreciation is uniform and progressive throughout the entire life of any item. This assumption is approximately correct with respect to those portions of the property which actually wear out in service, but as pointed out above, the greater part of gas and electric properties never wear out, but disappear from service only by reason of changes which make them no longer economical or adequate. Loss in value due to these causes is not progressive or uniform. It does not occur at all until the change takes place which renders the item no longer useful.

It is desirable and proper that an operating company should accumulate a reserve against the probability of future retirements due to causes not yet effective or foreseen, just as it is wise and proper to carry fire insurance against the possibility of fire losses; but it is just as absurd to say that a theoretical accumulated expectancy of future retirement losses (based on the straight-line method) measures depreciation, as it would be to say that the amount in a self-insurance fire fund represents the actual fire losses at any particular date.

I think that is enough of controversial questions, except that I want to drop one thought without telling you what the answer is, as

to whether the original cost, or present value of physical property, or some intermediate figure is the proper element to give supreme or preponderating weight in arriving at a rate base. That thought is only this: The investment or original cost, as we always use it, is measured in terms of the dollars that were required at the time that the property went in, but having measured it in terms of those dollars we think of it and perhaps use it in terms of the dollars which we have to-day. Everybody who knows how property has advanced is familiar with the fact that it is due, partially at least, to the depreciation of the purchasing power of the dollar. I had to pay for a house in order to have a place in which to live, a price three times the price under which the house had been foreclosed, not because it was a better house, and I suppose I didn't pay any more, but I paid more dollars. The dollars were not worth as much. It is like one of Don Marquis's famous characters. He was formerly a saloon keeper, but later when the Volstead Act went into effect became a bootlegger. When asked where he stood in regard to prohibition, he said, "I stand where I always did, but my country went away and left me."

SECOND SESSION (AFTERNOON OF THURSDAY, MARCH 6,
1924)

DISCUSSION OF VALUATIONS AND RATES (Continued)

Mr. HAYDEN. The discussion will be continued on the subject of valuation of public utilities and we have with us Mr. Artaud, who is in charge of the land appraisal staff, of the Interstate Commerce Commission.

Mr. ARTAUD. This is merely in the form of a suggestion. The history of the land appraisal division dates back 10 or 12 years; when I first started with it, and I mean no criticism, but the bulk of it was comprised of insurance men and lots of lawyers. The main question at that time was of land appraisal. Since then the viewpoint has changed and this conference knows the very important part that the engineering profession has played in land-valuation work. You will see this when I tell you that the permanent value of land used by the railroads is about $3\frac{1}{2}$ billion dollars or approximately \$8,400 per mile. The great bulk of this land is in the eastern part of this country. In addition to this we have the land grants. We have been solving problems of mining claims, and you that come from the West know the value of oil in the land. To-day we have in the land section well-qualified mining engineers. The field supervisor, Mr. Stivers, is an engineer. The men who are playing the most prominent part in this work are all engineers. You can not deny the fact that in the general sense of the term land appraisal is merely what the land realtors give it. I was rather surprised the other day when I was elected to membership as associate member of the board of realtors. The thought deserves consideration and I am merely making this as a suggestion. I would be glad at some later time to review those things which we have discussed. It has become almost a science which is purely engineering in its nature, and usually doesn't get the amount of consideration that it ought to get. We at the Interstate Commerce Commission are dealing with millions of dollars—nearly $3\frac{1}{2}$ billions of dollars. It is a difficult problem, we need a lot of help, and you gentlemen can help us.

Mr. HAYDEN. I trust that we will have active discussion, and in order to get the thing well started I want to call on Mr. Vanneman to be the first one to discuss it informally.

Mr. VANNEMAN. I used to think I was pretty well set on the idea of valuation. We in New York State have had a good deal to do with it for a great many years, and Mr. Cheney had an active interest in it in the years during which I have been engaged in it. We have never had any definite method of proceeding with it, but I think to-day I am in the same frame of mind that I have been always, and which was so well expressed by Mr. Cheney. Each case has to stand on its own feet. I can not see how you are going to have any set rule.

I was quite interested in Mr. Jones's expression "reproduction anew." I was trying to decide in my own mind where original cost left off and reproduction anew began. I like the phrase. I think it is very good.

Now we come to the question of depreciation. Some of you may have seen or read a very excellent discussion prepared by the late Robert A. Carter appearing in one of the bulletins of the American Gas Association. Mr. Carter was what we might call a very positive gentleman, and was extremely decided in his ideas. He had been a student of the depreciation matter for years, and he put into the paper practically everything he has said or thought. I commend that paper to you. It may change your viewpoint or it may set it. Mr. Carter's viewpoint was that there was no such thing as depreciation. Speaking broadly, he recognized obsolescence, real and direct, and maintained that obsolescence and depreciation become synonymous.

Mr. Cheney touched on a subject in which I am very much interested, namely, the question of overheads. This is an extremely vital problem with us. I know that all of you know from your experience the change which has taken place in property. You know how some community, either through an individual or group, conceived the idea that it wanted electric lights. It got electric lights chiefly because the individual or group went to some electrical manufacturer and said, "Here is a village of 500 people. We want to furnish energy for illuminating the houses and energy for power. Give us what we need." The General Electric Co. or Westinghouse or some other manufacturer sold a plant to the individual and probably they sold it to him erected and ready for service. When you come to make an appraisal of that property, one of the first things with which you are confronted is the initial cost. If you use book figures as you may be able to find, properly authenticated by vouchers, the engineering factor is contained therein. But in 9 cases out of 10 there never was an engineer employed by the promoters of the plant. Yet in recent valuations submitted, percentages running as high as 26 per cent for the so-called related overheads have been included. It seems to me this is loading such cases pretty high.

Our commission has followed quite closely to a basis of allowing percentages for overheads of from 15 or 18 per cent. We have almost uniformly allowed a 6 per cent charge for engineering work where it was obvious that engineering was actually used in the development of the property.

In certain properties in later years there has come in a distinct element of value assignable to engineering through the employment of so-called engineering management corporations in connection with extensions, replacements, and consolidation of properties. I speak of this factor in order that you may start thinking about it.

I would like to give an illustration of a case we recently had in New York State, which is an example of one extreme. In 1910 a water-power site having a potential aggregate of 3,000 kilowatts was developed, the plant being built when prices for both material and labor were down in the valley of the curve of costs. The stream was well regulated and that plant was put in for somewhere around \$75 per kilowatt. It was remotely located with respect to railroad facilities for delivering materials, and that was quite a factor of the

cost. Nevertheless I am convinced that that plant was constructed for about \$250,000. This included a 12-mile transmission line. A large corporation, since organized, wished to absorb that plant and came before the commission to secure permission to do it. The plant was owned by a business corporation and all the energy was going into the industry. It was so located that it was essentially a part of the entire stream development which the larger corporation had in mind. The price paid for the plant was \$1,700,000, this amount being based on the earning power which could without any doubt be shown, because every kilowatt-hour that plant could produce could be sold at a rate which would show such earning power.

We have another case which shows the other extreme. In this case a small corporation undertook a water-power development aggregating about 100 kilowatts on a stream that—well, the less said about the stream the better—but the plant was built and ran for a few years. It is now abandoned. Now I don't know what that plant cost, but I do know it isn't worth anywhere near to-day what was actually paid in dollars and cents by the corporation to develop it. In fact, it has substantially no value. Now, what is the improvement investment on that plant? What would be the value of that property to the corporation which has acquired it as a part of a distribution system if you went in there to-day to appraise it?

Mr. HAYDEN. We would like to hear from Mr. Larson, chief engineer of the Wisconsin commission.

Mr. LARSON. We started 21 years ago in Wisconsin and are still changing our views on the subject of valuations as we go along. I also want to recommend for your attention the paper prepared by Mr. Carter, the late vice president of the Consolidated Gas Co. I also felt in reading it that there are some very good expressions of ideas, but that Mr. Carter went just a little bit to extremes in this depreciation business.

I want to discuss overheads from a little different point of view. In making valuations I find it always to the advantage of the one who is making the valuations to keep the overheads as low as possible. Put the figures in specific items as far as this can be done. A company in Wisconsin one time informed me that they had some actual construction work in which overheads went as high as 59 per cent. They had given us the details and we made a careful study of them. We found that they had included such items as night watchman, traveling expenses, timekeeping, warehouse operation, hauling, employment expense and transportation, liability insurance, watching, lighting and guarding, flood protection, waste and shrinkage, water and sewerage system, emergency protection, claims and damages, handling and erecting construction equipment, and many other items that had no place in overheads.

When these charges were properly allocated, the regular overheads were a reasonable percentage to be applied. If items which should be in specific construction costs are put in overheads it will be difficult to explain the results, and, furthermore, errors may more readily be made.

Going back to the general subject of valuation, the papers presented this morning were general, but there is one more generality I would like to make. What is the purpose of the public utility? It is not now recognized as a concern which is maintained primarily

to make money. It is here for the purpose of rendering service. Now, if we want that utility, it is because we want it to render service, and we want it to render service continuously. Then how shall we keep it there and keep it rendering such service? The only way we can keep it rendering service is to see that it gets enough in return to pay operating expenses and a sufficient return on the investment to keep the capital coming into the business. It does not make much difference what you do about valuation, but you must provide a rate base which will keep money coming into the business. It may be a new idea that the rate base does not necessarily bear a very close relation to the value of the property, but with this general conception in mind you will have a good deal less trouble in handling this question of a fair rate base.

Now going to this question of appraisals, different commissions have different ideas about that. Mr. Carter's paper this morning dealt with the whole subject of the appraisal of the plant as a rate base. In the engineering department of our State we don't have anything to do with the rate base. We are told to go out and prepare a report on the cost of different pieces of property. That is done on such a basis of pricing as may be specified, but we, as engineers, have nothing to do with the rate base. The engineering department in our particular State does not try to work the case through. Our commission does not want statisticians to handle engineering matters nor the engineering department to handle rates, except as may be necessary in special cases.

Mr. PROUTT. This is the first opportunity we have had to meet with other commission engineers. Mr. Smith and myself represent the Tennessee Railroad and Public Utility Commission, and I must say that our commissioners are very genial and very approachable.

We have heard some discussion about depreciation and I would like to discuss this to a certain extent. Of course, in fixing the value of a property for rate-making purposes accrued depreciation of the property under consideration has to be given due weight, but in our State after a rate base has once been fixed, no further attention is paid by the commission to depreciation under that particular name. We, of course, understand that depreciation may be divided into two separate and distinct parts, one of these parts being accruing depreciation, or that depreciation which is taking place continuously; the other part being realized depreciation, or that portion of the property which actually goes out of use each year due either to wear and tear or obsolescence, and we believe that it is necessary for the company to be provided only with such a renewal and replacement allowance as will continuously take care of realized depreciation. Of course, it is difficult to estimate this amount exactly, therefore, our commission usually after fixing a rate base instructs the company to set up as an operating expense a certain percentage of the value of the depreciable property each year to take care of this realized depreciation, and as a rule the percentage allowed is such as will leave some balance in the renewal and replacement reserve at all times to take care of contingencies.

We have found in certain cases that the company might have set up on its books a depreciation reserve of a certain amount which reserve had been accumulated, perhaps, over many years. When

one case which we have in mind came on for hearing before the commission, this particular company attempted to show that actual depreciation of the property as represented by the percentage of condition equaled the amount in the depreciation reserve; the error of this view, however, is that when we speak of depreciation we speak of the property condition without reference to dollars and cents, while if we attempt to balance the property condition against depreciation reserve, it will be found that if the property be appraised on actual cost, you will have a percentage condition of, we will say, 80 per cent, while if it be appraised on the present-day reproduction value, you will have a condition of 90 per cent, which, of course, is an erroneous conclusion.

Next in fixing the value of a property we do not use life tables in arriving at the percentage condition, but rather look the property over and from actual observation fix a percentage condition of the various elements of which the property may be composed. This seems to be a much fairer way of handling the situation than the use of any life tables. To illustrate this point more clearly, we had one particular case where some generating apparatus had been in service about 25 years, and according to life tables the condition of this apparatus would have been practically zero, but inasmuch as it was still in operation and still giving good service, it would be unfair to the company to depreciate it more than 20 or 25 per cent.

There are several points I would like to discuss briefly with you in regard to some things that in my mind make it necessary that the engineer should discuss with the commission not only purely engineering problems but should be able to discuss with them financial matters also. We must all bear in mind that utility commissioners are human beings just as engineers are, and the easiest method of obtaining information is by discussion, so that in financial matters, if engineers are not already educated, they can only become educated by obtaining this information from other sources, and if the commissioners happen to be educated financially and are willing to discuss finances, we see no easier way for the engineer to broaden his education than by obtaining it in this manner.

Now as to the fixing of values for rate-making purposes, it is impossible for any group of engineers or any group of utility commissioners to fix such a value based on actual scientific data. After all, the question of valuation is purely a question of personal or group opinion, and certain elements in fixing a valuation which might appeal to one group of commissioners would not appeal at all to another group.

We will assume a hypothetical property which has been appraised by engineers along standard lines and the historical or book cost has been worked up in the usual way. Let us assume that the historical cost of this property is \$1,000,000, the value based on the average prices for five years is \$800,000 and the value based on present-day prices is \$900,000. The problem is to find the value for rate-making purposes of this particular property, and to do so it is certainly necessary to have some financial information about the property as to its past earnings, past rate of return on investment, and whether or not the property has earned a sufficient sum to set aside a reasonable amount for depreciation.

Assume that during its entire existence the property earned an average of 6 per cent on its investment; that is, the primary investment may have been much less than \$1,000,000, but has been added to from year to year and in any year it earned 6 per cent on this investment.

Next assume that there is no depreciation reserve, and there are outstanding bonds to the extent of \$1,000,000. There may be any amount of stock outstanding, but we will not consider that at all.

Further assume that the property has been ably managed and can not be criticized on this point. The consideration of this proposition would be about as follows:

1. Six per cent on a public utility investment is somewhat too low a rate of return, considering the risk of the investment.

2. The fact that there is no depreciation reserve fund indicates that the rates have in the past been too low, as rates would not only furnish a reasonable rate of return on the investment, but should, in addition to this, adequately take care of realized and accrued depreciation.

3. Bonds are outstanding to the extent of \$1,000,000 or the full historical cost of the property.

4. The investor should not be penalized by the depletion of his capital in service to the public.

The fair answer to the problem would appear to be a rate base of \$1,000,000, and the rates should be so adjusted as to produce not only a fair rate of return on this valuation, but in addition thereto such a sum as would adequately take care of depreciation. You will note in this case that the rate base would be somewhat higher than present-day prices.

We will next take another hypothetical case somewhat different.

Historical or book cost.....	\$1, 000, 000
Average rate of return earned, 7½ per cent and in addition thereto a depreciation reserve balance is shown on the books of (which has been paid by the public for service in addition to the rate of return and has been used by the company for capital investment, being a part of the \$1,000,000 book cost of the property).....	300, 000
Bonds outstanding.....	700, 000
Next assume an appraised value based on five-year average price of..	900, 000
And a value based on present-day prices of.....	1, 100, 000

In this case we run into some legal difficulties, because the Supreme Court of the United States has ruled that in the valuation of public utilities due consideration must be given to present-day prices, so we must again get further information as to what the value of the property would be based on prevailing prices at the various times its constituent parts were purchased, less depreciation, and this we will assume to be \$800,000.

This indicates that while the company earned and set up for accrued depreciation \$300,000, the actual accrued depreciation is only \$200,000, therefore, an excess of \$100,000 has been earned over and above requirements, and inasmuch as it was paid by the public, this \$100,000 would appear to be property of the utility patrons and should be returned to them; but to combat this conclusion we can not overlook the fact that the rates were made by agreement with some local governing body which probably paid no attention whatever to whether or not the company set up any fund for depreciation; and further, the

company instead of setting up this reserve for depreciation, might have left it in the general surplus and paid it out as dividends.

In any event the title to all the property is in the company, no matter how the property may have been obtained, so we start off with a new set of figures, as follows:

Historical cost less depreciation.....	\$800,000
Five-year average appraisal.....	900,000
Present-day appraisal.....	1,100,000

It will be noted that no consideration need be given to either stock or bonds, as the lowest logical value that might be placed on the property is \$800,000, which is \$100,000 in excess of the bonds outstanding.

We now get into the legal proposition of giving due consideration to present-day prices. In the recent valuation of the Cumberland Telephone & Telegraph Co.'s property in this State, Ross W. Harris, who cooperated with the writer and McGregor Smith in making this valuation, solved the proposition in rather a novel way. He assumed, and we thought correctly, that the historical cost was much nearer the correct value for rate-making purposes than any theoretical valuation, and for this reason it should be given greater weight than any other, and to apply this assumption in a concrete form he assumed that the consideration given to historical cost should be four times as great as that given to five-year average, and eight times as great as that given to present-day prices, but he further stated that some inducement should be given the company in the way of valuation to induce the said company to invest more capital. This he called an induction factor.

In the telephone case Mr. Smith and the writer worked out a valuation along entirely different lines, but the final results showed a difference of less than \$5,000 in a total valuation of nearly \$15,000,000 as between the Harris method and the method used by the writer and Mr. Smith.

Applying Mr. Harris's method would give a valuation in our hypothetical case of practically \$900,000, which is the same as the five-year average value.

Both of the examples presented for your consideration are, as stated, hypothetical cases, but analogous cases have been before the State commission and many others more complex.

The striking thing in these two hypothetical cases is that in one a valuation has been fixed as a matter of public policy to protect the bondholders. In the other case, no consideration has been given the bondholders, but in order to comply with a legal requirement, due weight has been given to present-day prices. The result, however, is to put a lower valuation on the better-paying property, but inasmuch as the public contributed part of its cost, this entails no hardship on the investor, and in an adjustment of rates made to suit each case after the rate bases have been fixed both properties would be placed on the same footing as to earnings.

We might cite many other and more complex examples, but those set out herein will give a general idea of the method of establishing valuations of public utilities for rate-making purposes.

In conclusion I would say that the broader the information of the engineer both as to actual engineering problems and actual financial problems the greater will be his value to the particular commission

for whom he may be working, and for this reason the commission engineer should endeavor to be qualified to discuss fully and thoroughly all the elements of property valuation and rate making.

INFORMAL DISCUSSION

Mr. HAYDEN. In Wisconsin, the railroad commission has control over the issuing of securities. They have had cases where they have been forced to recognize the security issues which were issued before such matters came under their authority, as being the preponderating consideration in determining rates, but where the commission has had charge of the issuing of securities they have considered not only the bonded indebtedness, but also the stock, and hold that the stock should constitute a fair proportion of the securities.

Mr. VANNEMAN. We have had cases in New York where companies were organized prior to the time when the commission had power to control the issuance of securities. I have one company in mind which issued bonds up to practically the last cent and has since been generating no energy. The plant is nothing more than junk, carrying bonds on property which is worth next to nothing.

Mr. LARSON. The Wisconsin commission frequently puts a clause in the permit to issue securities that never in the future shall the value issued in that particular security issue case be brought into any rate case, nor shall the value claimed therein be claimed to influence any rate base. We do that right along to frustrate any attempt on the part of the utilities to get securities approved and then to use the value thus found as a rate base.

Mr. RUDD. I find in listening to you gentlemen that we are so different in Connecticut from most of you that it might be well if I explain how easy it is for our engineering department to get along. Connecticut is different from most States in that the rates charged by the utilities are raised or lowered on their own motion and the rate goes before the commission only when somebody claims it is unreasonable. It then is brought before the commission for adjustment. In that event any valuations for rate-making purposes are not determined on the basis of how much money the company can charge, but whether they are charging too much. We have quite a bit of leeway in making valuations. We try to do it, of course, in an expeditious manner and that means inexpensively. We have not made many, so that our experience is not extensive. We have made some, however, and in particular I may refer to a valuation of one electric property amounting to less than \$200,000. In that particular case the purchase price intended to be paid by the one utility for the other's property seemed to be out of all proportion to the investment account of the particular utility as filed with the commission; so the engineering department was instructed to make a field check. In estimating the distribution plant we went out in automobiles and listed the line equipment; number and type of poles, whether it was a joint or sole ownership pole line, counted the transformers, counted the circuits on the poles, measuring the distances with an odometer on the car. Pricing was on typical sections based on average costs from company records. The appraisal so found and furnished the commission was about 30 per cent lower than the purchase price finally allowed by the commission and about 50 per cent less than the amount specified in the original petition.

One other project, a street railway valuation, was conducted by a method different from any previously used by valuation engineers. The work was completed in about eight months with our own department of four and the engineering force of the street railway, at a total cost to both parties of approximately \$20,000, a rate of 0.04 of 1 per cent, which included some consultant service of two specialists. In that particular valuation we set up the unit of construction and based our estimate on it rather than on the individual items. For instance, the track structure was estimated on 100 feet of track constructed and the overhead work on 1,000 feet. The records of the company were found to be particularly extensive and had been well kept so that the make up of each piece of track was known and we could classify it and make our estimates. The overhead wirings were different; the points of construction change were noted as the line was traversed on an inspection car, and then these different type quantities were priced up. In that way the appraisal cost is very much less than ordinarily expected and the results are satisfactory for most commission purposes.

Mr. VANNEMAN. Where is the burden of proof?

Mr. RUDD. On the corporation.

Mr. TOEPPEN. I have been very much interested in the discussion relative to how far the engineers' functions go. I believe for strictly engineering purposes it goes just up to and through the presentation, as far as physical property is concerned, of the various estimates of cost. You note this, I have said "estimates of cost." When the engineer gets done with his figures I don't think he has the value. Before you get to that point other things must be considered. I believe you will be justified in calling each an estimate of cost under certain conditions.

Mr. Cheney spoke about consulting records before making cost estimates. As far as I can recall, the very first time I came in contact with valuation work, and I believe it was in the biggest case ever done in Michigan, the estimate was based almost entirely on records. I had been told for over eight years that it was impossible to do it from cost records. They could not be analyzed. In the Michigan rate case by taking time and thought we were able to go over and check up the records to provide means for making cost estimates and to thoroughly prove to the company's own engineers that by doing certain things we were able to get by with an overhead charge of 5 to 6½ per cent. The farther back you can carry your allocation of cost, the less trouble you will have in proving your costs are right. They may be just as right when the overheads are 50 per cent as when they are 5 per cent, but for the ordinary man in the street, if you can show him any one individual item, he will believe you far quicker than anything else.

Mr. JOHNSTON. I am rather new in this public utility game. I come from a section of the country that a few years ago was rather strong on the matter of States rights. Yet as I hear the varying opinions and standards, it seems to me that if we could formulate some standard practice just as Mr. Jones, of the Bureau of Valuation, has done for the carriers, we would go a long way toward eliminating these varying opinions by the State courts and finally by the Supreme Court of the United States. I think that a move in that direction might be very beneficial.

Mr. TOEPPEN. The gentleman just before me said something about standard practice. I believe that if we can see the handwriting on the wall as expressed by the Valuation Bureau, something like that will happen. I think we can see the result in the offing. The indefinite system on which rates are based is causing a great deal of dissatisfaction and confusion, and standard practice will be the result unless there is a big change in public opinion.

Mr. HAYDEN. The question of standardization was referred to by Mr. Cheney and Mr. Vanneman by calling attention to existing variations in conditions; that is, each case must be considered on its own merits. I wonder if there is any one here that has anything to say regarding two properties in two towns very similarly situated. In one town when the plant was installed there was engineering advice and engineering expense, and none whatever in the other town. The initial expense for installation of the plants was the same, say \$2,000, or 10 to 12 per cent of the total property. I am wondering how different methods of handling these two cases will be justified.

Mr. CARTER. If you are going to use a reproduction theory it makes no difference what the initial expense has been. Whether any money has been spent for liability insurance or not, you have that line of expense. Somebody has to pay for it. Whether this money is actually paid or somebody donates the time, someone has to be responsible for the development of the utility property if you are using the original cost method. The company may have taken care of material and labor by direct charges, or if the contract to construct the plant had been let to an engineering firm, that would show as the contract price. If the property has been built by an outside firm the contract price would be such as to take care of planning the preliminary service and all that kind of work, and it would be foolish to put structural overheads on top of that. In regard to the question of standardization for making a standard base, there is only one base that can be standard and be consistent. I am not advocating original cost of property as a standard base. It is not always available. You can get the estimated cost. In our State we have properties where if you used present-day prices, you would have a good deal less than what the property actually cost. In other cases it would be considerably more than the properties cost. In either event you have to give to one fellow and take away from another. You have to know your cost and settle it on this cost and you can not put in general credits that apply to all cases.

Mr. SMITH. What would you consider to be the original cost of a property? We have in our State a very large hydroelectric property which cost about \$13,500,000. Recently it has been purchased at \$9,000,000. The original construction cost is one thing and the cost to the present property owners is another thing. I wonder if any of you have had that kind of case and how much weight you would give to the actual construction cost?

Mr. CARTER. The purchase price is not necessarily the controlling factor at all.

Mr. PROUTT. The Chattanooga & Tennessee Power Co. was authorized by Congress to build a dam and lock across the Tennessee River. As soon as this dam was completed it was deeded to the United States Government, but the power company was allowed the use of the dam for 99 years. The power company made a con-

tract with a certain contractor, who also owned a controlling interest in the company, to build the dam for a certain price. The contractor lost something like \$2,000,000 and the question came up as to whether the actual cost was the contract price or \$2,000,000 more. The property was later sold to another company at a lower price.

Mr. CARTER. Your cost is what the property actually costs to build. If it is prudent, it is one situation; if imprudent, it is another. It is not necessarily what any individual paid or what the utility paid. The contractor may have lost money. I am not saying that it is not a rate base.

Mr. PROUTT. Suppose for instance a company contracted to build a plant for \$500,000. Suppose it cost the contractor \$600,000. Then what is your cost?

Mr. CARTER. It is not fair to tax the utility because the contractor lost money.

Doctor WOLFF. While the Bureau of Standards, as we said this morning, is not directly interested in the subject of valuation or any of the related questions like depreciation, yet it happens that the Federal Government is a subscriber to public utility service; for example, it pays the railroads \$5,000,000 annually for hauling the mails. It is quite a large amount in the aggregate. Therefore, the Federal Government is interested in the general problem of valuation. In addition to the duties that we have here in the bureau in my section; that is, the development of methods of measurement as applicable to service standards in telephony, the bureau is represented on the General Supply Committee in making contracts for telephone service for the District of Columbia government service. We have been called upon by the Bureau of the Budget to make surveys of Government telephones in certain cities and to give advice with regard to simplification and standardization of the contractual relations between the utilities and the Government throughout the country, and, therefore, we are interested in this subject of valuation.

Now with regard to the particular question which is under discussion in connection with the Tennessee development, is not one of the very important questions this? What did the owning utility pay for its property? It seems to me definite knowledge on that point that would settle the question, because what the contractor lost is immaterial. You are not giving back anything to that contractor, but you are adding the burden to the subscriber by considering the contractor's loss. I would like to ask Mr. Carter what he thinks about that.

Mr. CARTER. You asked me what the original cost was to the utility.

Mr. PROUTT. You start with the company that employed a contractor who contracted to do a certain piece of work, and lost on his contract something like \$2,500,000.

Mr. SMITH. I think Mr. Jones says that a prudent investment should determine the rate base and I think this is the point. Suppose you have \$10,000,000 worth of property. We can not afford to appraise that property at less than the property cost because in this case the actual cost by vouchers and records was \$13,500,000. Now

suppose the contractor had made \$2,500,000, what would have been the rate base?

Mr. TOEPPEN. It seems to me that the investment was imprudent.

Mr. SMITH. Would you give very much weight to the value or purchase price?

Doctor WOLFF. Doesn't that bring in the question of prudence or competence on the part of the contractor?

Mr. TOEPPEN. It would. We had the same situation in Michigan. About 1908 there was a tax sale. Either party had the choice of bidding on the same property and in a sale between two parties the commission held the purchase price to be prima facie evidence.

Mr. BENNETT. I wanted to ask whether in Indiana the engineer leaves the determination of operating expenses to the accounting force. We in Illinois have a very fine accounting force. We feel that it is not in its field to attempt to set up what the operating costs are to be for the ensuing year. It can tell what they have been for the preceding year. We, the engineers, always take up the question of what has been charged to capital and what has been charged to operating expense. Of course, we both look at the capital charges, but even if the accountant is fairly familiar with the utility in question he is not certain enough to say what should be charged if he does not give most careful consideration to present conditions and to future conditions that may be clearly forecast. Then we go on the witness stand and give our operating estimate and when there are very great differences we explain what they are and why, and whether the costs are going up or down and just what brings it about.

I noted that Mr. Carter spoke of going value. I suppose you engineers have found that a very difficult value to get. In Illinois we have come to the conclusion that the engineering division should present to the commission all the concrete evidence it can get. We think that going value is a matter which is determined largely by theoretical set-ups. So far we have never attempted to make a computation of going value except on the basis of what is now used in Wisconsin. I was particularly interested to see what the other engineers were doing in regard to this going value.

Mr. HAYDEN. Regarding the purchase price, I think it might be the controlling factor.

Mr. CARTER. I could give you properties in Indiana for practically a song.

Mr. BENNETT. I think all of this discussion answers the question whether or not we can arrive at a standard rate base. I do think we can even come to a solution of the proper way to make reproduction valuation. That has been tried out in our commission. Our engineering force is primarily an engineering force, but we are not the judge and jury in the case. We are merely witnesses and we present just the facts that the commission may ask us to present.

In the paper by Mr. Cheney, he brought out a very good point about calling our work appraisal rather than valuation, but I was surprised that he used the term "present value" in connection with depreciation. It seems to me that in our early cases the thing that caused most confusion was using the term "present value" when what we meant was "depreciated value." We have used two methods of determining reproduction cost, one based on a five-year average price and the other based on instant prices. One of the things I did

when I came to the commission was to get away from the term "value" in connection with any of our reports. We now use the terms "cost" and "depreciated cost."

We have heard a lot of talk about depreciation and perhaps you know that the Interstate Commerce Commission is having up with the Bell systems the question of depreciation. In the Chicago Bell Co. case the Illinois commission set up a rather new scheme, by combining a maintenance and depreciation allowance in safeguarding the investment. The primary thought, that the hearing in this case developed, was the inability of two minds to meet on what is maintenance and what is depreciation, on pole lines for instance. Another thing is, that over a period of years, the company is accumulating a depreciation reserve much larger than that required by the commission. The result is brought about because the commission did not make allowance for depreciation charges going to maintenance. I would like to know whether any other commission has given thought to the actual determination of how much depreciation annually is taking place.

Mr. TOEPPEN. I think the Kansas commission is doing that.

Mr. COVELL. I happen to know that the District of Columbia commission in connection with the Georgetown Gas Light Co. and the Washington Gas Light Co. is doing that. I think they set aside something like 9 cents per thousand. Anything aside from that goes to amortization or depreciation reserve. Some other things have been tried out that are rather interesting. There appear to be about as many methods of making appraisals as there are engineers present. In making a reproduction a new appraisal there are a number of things that come up that there really should be some more uniform practice on. I was interested in the remarks about going back to the books and getting records. I happen to know of one case where a company made an appraisal. They took proper costs from the books for the main extensions, but when it came to the cost of cast-iron pipe they applied a price of about 10 per cent higher than they were actually paying for it at that time. Their justification for that was that this work of reproducing the plant was to be done in a certain number of years, and that if they put in an order for a certain amount of pipe with cast iron foundries they would undoubtedly raise the price. They, therefore, put in a price of 10 per cent higher than the market price. In regard to things of that sort there should be some method of ironing them out, some uniform method of doing it. In that particular case we took the labor cost not based on piecemeal construction, but based on doing the job all at once. We were about as inconsistent as they were.

Mr. LARSON. We have had the same trouble in Wisconsin. If you will study the record of the National Association of Railway and Utility Commissioners you will find that they have now adopted a method of eliminating depreciation reserve almost entirely and in its place recommend a replacement reserve, a depreciation reserve being retained only to cover certain factors of much importance. We have been much disappointed with the workings of the depreciation reserve and for years recommended some such action as has recently been taken.

Mr. BENNETT. I have read all the decisions and wonder if you can give me views on them. Has anybody had experience where this

sort of thing has been going on for some time? I would like to know how it is coming out. Has anybody seen this combined fund in operation long enough to know whether it is practicable?

Mr. HAYDEN. I know of one utility in Wisconsin that has set up a yearly budget for handling maintenance. The gas and electric utilities have always handled it by a yearly budget.

Mr. BENNETT. They have a regular scheme, don't they, for allowing an annual depreciation?

Mr. PROUTT. In the Tennessee rulings the commission has worked it out very nicely. The company is urged to set up a certain percentage on depreciable property to take care of realized depreciation. They have to keep the renewals up as they are limited as to the accumulation in the reserve.

Mr. BENNETT. Do you credit any interest to the fund?

Mr. PROUTT. Yes.

Mr. HAYDEN. In Wisconsin the commission has charge of securities. Often utility companies come to the commission to know whether the price that they expect to pay for property is to be allowed them as a basis for security issues.

Mr. VANNEMAN. The gentleman from Illinois spoke about operating expense. In New York we have handled that for a number of years very satisfactorily. The accounting division of our commission first makes an examination of the books to see that they have been kept or are being kept according to the uniform system of accounts. If they are not kept that way, the accounting division makes a report and refers it to the engineering division to see whether the items are properly allocated. We have gotten nearly 65 or 70 per cent of the corporations so that their books are actually kept in accordance with the uniform system of accounts, and the figures in the property accounts reflect accurately that which they are designed to show.

Mr. RUDD. In Connecticut in the case which is coming up next week, the commission expects to have its engineering department as a witness merely for the purpose of introducing its estimate of the cost to build the property and outline the method used.

Mr. BENNETT. Our theory is that the commission employs accountants and engineers, and we are not supposed to be taking any sides at all. We are supposed to present the facts as we find them. In order to present these facts and get them into the record the commission submits us for cross-examination and we have to watch our step very closely. We are so limited that it is just like a court proceeding except that it is not so formal. The engineer must submit himself to cross-examination. I would like to ask the gentleman from New York what his commission does.

Mr. VANNEMAN. The corporation puts in its case. The commissioner cross-examines the witness for either the State or municipality.

Mr. BENNETT. Do you submit a report?

Mr. VANNEMAN. Yes; sometimes we do.

Mr. BENNETT. In a case like that it seems that the commission would be rather limited.

Mr. VANNEMAN. I might add in connection with that, that when our law was amended the commission was authorized to deputize any of its engineers to hold hearings. We found that we could talk

the language of the people who come before it whereas the legal advisers are somewhat at a disadvantage on the technical side.

Mr. BENNETT. Our commission seems to believe it necessary to have a staff of advisers.

Mr. JONES. What sort of record goes to the appellate court if the utility does not like the decision of the commission?

Mr. VANNEMAN. All of the proceedings go properly in the record.

Mr. HAYDEN. If anyone has any questions he would like to bring up for discussion I would suggest that you write them out and bring them in the morning. It has been suggested that we talk over at the dinner to-night the matter of further organization of the utility commission engineers. If there is no objection we will arrange to do that. Is there anyone else here who has something further to say on the question that has been under discussion this afternoon? It has been suggested that we meet at 9.30 to-morrow morning so that we may have half an hour earlier start and continue as long as we like. If there is nothing further, we will stand adjourned.

THIRD SESSION (MORNING OF FRIDAY, MARCH 7, 1924)

Mr. CRITTENDEN. Gentlemen, before taking up the subject first on our program I might mention that we have for distribution a few copies of orders on rural electric service issued by the Indiana and the Illinois commissions. We appreciate the courtesy of Mr. Carter and Mr. Bennett in furnishing these. Also before calling on Mr. Toeppen I might tell you that Mr. Rudd has suggested that this is the one thing his commission is most actively interested in. He has asked that you give him as definite information as you can in regard to this matter. Mr. Rudd can, perhaps, state his case more definitely when the time comes for discussion of the papers. We have with us this morning two additions who are very welcome, Mr. Thompson, of Oklahoma, and A. B. Campbell, of the National Electric Light Association, who was with us last year representing the Iowa commission and comes to-day at the invitation of the bureau. We would have been glad to list Mr. Campbell on our program, but unfortunately the National Electric Light Association were not able to tell us in advance who would come. Mr. Toeppen.

RURAL EXTENSIONS AND RURAL ELECTRIC SERVICE

By M. K. TOEPPEN, *Chief Engineer, Michigan Public Utilities Commission*

GENERAL

It is a long road from the days when it was public service corporation practice to charge, for their commodities, all the traffic would bear to the condition to-day apparently developing in the rural extension and service problem; where the tendency seems to be to attempt to determine rates on a pure "cost of service basis" as applied to each consumer rather than to each class of consumer, and without giving much attention to the "value" of this class of service as compared to other classes of service.

Is the present and future of the rural business sufficient to justify such a departure from existing practice?

THE FIELD FOR RURAL ELECTRIC SERVICE

In Michigan the 1920 population is approximately distributed as follows:

Cities, villages, and unincorporated places of over 2,500 population	2, 264, 408
Cities, villages, and unincorporated places of less than 2,500 population	514, 722
Isolated farms	889, 130
Total	3, 668, 412

Tables 1 and 2 show the distribution of this population as between communities of various sizes and the extent to which service is

available to such population, but not to what extent it is actually used by the population to which it is available. (See page 47.)

Table 1 shows that in Michigan there are 2,049 cities, villages, and unincorporated places, the population ranging from 25, or thereabouts, to over 1,000,000 in the city of Detroit. Of these, 596 have electric service; 1,453 have no service.

Table 2 shows that, to the population of 2,779,282 residing in cities, villages, and unincorporated places service was available, though not necessarily used, to 2,589,063 people, and service was not available to 190,219 people. So, therefore, as far as the population in cities, villages, and unincorporated places is concerned 93 per cent of the people are served or accessible to service; but, as far as communities are concerned, only 29 per cent are at present provided with electric light and power service of some kind or other.

It may be of interest to note that Tables 1 and 2 show that all communities of 2,500 or more population have service and that from this point on as the population decreases the ratio of communities not served increases more or less directly with the decrease in population of each unit so that when we get to the communities of under 100 we find only 6 per cent of the communities and 7 per cent of the total population in such communities accessible to electric service; how many or how few of those accessible to it use it, we don't know, but it is safe to assume that in communities of that kind the saturation is almost complete, and from a population standpoint a saturation of 7 per cent could probably safely be assumed.

In addition, there are 889,130 people living on isolated farms. A special check was made of the service rendered to isolated farms.

Table 3 gives the summary of the reports made by 237 companies to a questionnaire asking for the number of rural customers served, rural customers being defined as follows:

By the word "rural" is meant all customers outside of cities and villages, including those on farms, but not including those on real estate subdivision and developments where the same are outside corporation limits but which are now or may soon become so thickly settled as to warrant the extension of the corporation limits to include them.

The 91 companies reporting service reported service to 9,022 rural customers. This figure could probably be increased somewhat on account of the 44 companies not reporting.

The 1920 census shows 196,447 farms in Michigan; some of these are not being cultivated (probably not over 10 per cent are lying idle); comparing the number of worked farms with the population shows a population of very nearly 5 per farm.

Using only the number of customers actually reported and the above ratio of 5, it is evident that service is being rendered to 45,110 people out of the isolated farm population of 889,130 or to $5\frac{1}{2}$ per cent of the isolated farm population.

Observation has shown that even where a rural power line is available, certain farmers will not avail themselves of the service, detail records are not available, and conclusions must be based entirely on chance observation, but it is believed by the writer that the number of such farms will not be less than one-half and not more than equal to the farms actually served. On such assumption service can be said to be available to about 9.6 per cent of the farm population.

It may be interesting to note that the heaviest developments reported in Table 3 indicate a concentration in areas where smaller farms predominate and where specialized, rather than general, agriculture is carried on.

The concentrations occur around Detroit, in the truck gardening and dairying areas, and the western part of the State in the orchard territory from New Buffalo to Traverse City.

GENERAL PROBLEMS

In Michigan the problem of the service to the isolated farm has been the subject of consideration of a special joint committee, embracing members from the Department of Agriculture, the Michigan Agricultural College, the State grange, the State Farm Bureau, and the utilities commission, the power companies, and other interested parties during the past two years. As the commission has felt that the solution of this problem is primarily a problem for the provider and the consumer; that is, for the power company and the farmer, it has not attempted to take a leading part in this discussion.

One of the great stumbling blocks of progress seems to have been the question of financing and this arises chiefly from the tendency of the larger power companies to insist upon urban standards of construction for the development of all classes of rural business and inability of the farmer to understand the cost of such class of construction where he thinks lighter construction would be suitable.

Another hindrance appears to be in the attempt to apply the relatively high city rate schedules which include all elements of costs from the coal pile to the customer's meter when the proposed method of financing eliminates many of those elements of costs by including them in the fixed charges to be assessed on the basis of the cost of an individual extension. Utility companies should not insist upon the construction of rural lines in accordance with specifications governing the construction in cities, towns, and villages.

CONTINUITY OF SERVICE AND ITS COST

As the utility situation in such communities as New York, Chicago, Detroit, Grand Rapids, Lansing, and other communities of different sizes and characters is carefully reviewed, it will be realized that the standards of construction vary in communities of varying size and character.

In New York and Chicago, except in the most outlying territory, the extent of the aerial distribution dependent on any one underground feeder outlet is very limited and the construction of the aerial distribution exceedingly substantial. This is as it should be, because an interruption of service in even the limited area served by any one distributing unit will inconvenience a large number of people and any failure of such an aerial distribution system will create a hazard endangering many pedestrians and vehicles.

But when we come to a town the size of Grand Rapids or Lansing we find that underground distribution is practically nonexistent; that individual aerial feeders cover far larger areas than in the other communities and that the construction is not as substantial as in New York and Chicago; again, it is a perfectly logical procedure.

The interruption of service in any one of the many branches in such a community will probably not inconvenience any more people, if as

many as the failure of one of the less extensive units in Chicago. Traffic densities on the street are less and, therefore, a failure will not create as large a potential hazard as a similar failure would create in a metropolis; therefore, the chance of failure can be increased somewhat by a decrease in the grade of construction.

Likewise, it can be concluded, that failures on electric transmission or distribution lines along a minor country road will create comparatively little hazard and inconvenience very few consumers. We can, therefore, countenance a higher possibility of such failures by reduced standards of construction.

Due care, of course, must be taken in applying these conclusions to different lines, such as distribution and transmission lines as follow heavy traveled roads and trunk highways, so that they may be sufficiently strong to hold the possibility of failure in proportion of the potential hazards of such heavy traffic roads. Briefly, build the rural line in proportion to the hazard it creates and the number of people served by it. This applies equally to transmission lines tying together small communities and the distribution to the isolated farms.

With possible exception of construction along principal trunk line roads, it seems as if the very minimum of construction countenanced by the National Electrical Safety Code for rural districts will provide all that is necessary under the usual rural condition.

Advantage should also be taken, wherever possible of joint construction with toll and rural telephone lines.

It may be worthy of note that, with exception of the development in the Detroit Edison Co. area, the bulk of the rural service at present being rendered is furnished over relatively light lines such as are almost universally condemned by large company engineers, but that apparently have and are giving continuous and satisfactory service.

METHOD OF FINANCING

The construction of rural lines has in many cases been neglected purely on account of the question of financing. The utility company does not feel, even with appropriate rates, that it can afford to sink considerable amounts in such investments when there is no certainty that it will not have to abandon the facility as soon as constructed.

The farmers have been solicited to finance these matters themselves; as, however, there have usually been a small number who refused to participate in the construction, but insist upon receiving service after the construction has been completed, this method does not seem satisfactory. Further difficulty is also offered by the fact that at times it becomes necessary to extend the line into additional areas beyond that originally served.

Whether or not a forced customer financing will solve the situation remains to be determined. Granting that for the present, such financing is essential. How shall it be handled? Such capital may be provided by all of those desiring service on a basis proportional to the cost of serving each, but such a treatment makes complex provisions necessary to provide for any later participants or the falling away of some of the original parties. If some provision could be made whereby the more venturesome parties concerned could do the financing and if later others were added to the line, a portion of the

burden could be indirectly assigned to them, the problem could be considered solved. A possible solution would be to permit those desiring to do so, to contribute the necessary funds in any desired ratio and to enter into an agreement by which they are to receive 6 per cent interest for such funds, and then providing the money for such interest payments by adding to the charges made against these same consumers—and any other consumers who may be on the line—an interest charge at a corresponding figure calculated against the investment allocated to each particular consumer.

Under this procedure, if all consumers on the line had originally contributed in direct proportion to the cost of their service, they would only be paying themselves the interest on their investment. If, however, they have not contributed thus equally, those who have contributed less than their proper share would receive back less than they paid in, the balance going to those who had paid more than their proper share and, naturally, those who came on later and made no contribution to the cost of the line would be paying an interest charge on the investment assignable to them, but receiving no refund, all of their payments going to the original developers.

There is another very potent reason for the inclusion of this 6 per cent or other equivalent charge in the rate. To omit such a factor from the charge to be made to the rural customers would very rapidly create a false standard of value of rural electric service, because it is a human characteristic to lose sight of those costs which do not make themselves evident day by day or month by month by a cash expenditure.

In other words, the farmer who has contributed to the cost of an extension does not remember to add to his electric bill each month one-half of 1 per cent of the amount he has contributed as representative of the interest on the money so contributed, and just as soon as he starts using considerable quantity of current he will be claiming kilowatt-hour costs based upon his cash expenditure and consumptions and telling his city brother how cheaply he is getting his electric service. Immediately a whole new series of complaints will arise because the country is being favored as against the city.

RATES

Assuming that the consumers have provided the necessary funds for an extension, what rates are to be charged for the service? The line must be maintained, replaced, taxes paid, etc.; and power must be supplied to the line. The first of these charges will go on whether or not any power is sold; the balance depends on the amount of consumption.

It stands to reason that any one development must be self-sustaining and that all costs must be distributed in proportion to the demands of each consumer, and he must pay preceding items, plus the transformer core losses, line losses, and the development demand charge against the system whether he uses any power or not.

Depreciation, maintenance, and taxes will average in the neighborhood of 10 per cent. In addition, there will be the 6 per cent interest charge previously referred to. To these there should be the demand charge accrued against the development and creditable to the system serving the development, together with the stand-by losses.

The cost of the line having been determined and segregated between those common to all consumers and those individual to each consumer, an allocation of the fixed charges, demand charges, and the stand-by energy charges can be made on an equitable basis, very probably on a connected load-mile basis. To this must be added the energy cost of the current actually consumed. Such a flat charge should include an amount of energy equal to the stand-by losses of the line, thereby practically forcing the consumer to use at least as much current as he wastes in stand-by losses.

The rural rates should be quoted on an annual basis, giving the annual service charge or minimum bill, together with the number of kilowatt-hours per year included in such minimum bill; such minimum bill or service charge should be payable semiannually in advance, preferably on April and October 1, and excess energy charges should be payable semiannually in arrears on the same dates.

In arriving at the energy cost, the total probable demand of the installation should be determined, as well as the stand-by losses accompanying such demand, and this cost, together with the cost of an equal amount of productive energy prorated on a proper basis to the various consumers using the company's wholesale or primary power schedule, in determining the cost of the energy delivered to the development. By proper apportioning the stand-by losses and fixed charges, it will be possible to give the consumer the benefit of very low energy costs for consumption above the minimum.

CONCLUSION

All the preceding are only temporary measures, because a rate standard of the kind involved in any rural extension plan so far proposed brings the price of the service on a constantly varying cost of service basis; that is, each farmer, even if making identical use of the power, will pay a certain rate per kilowatt-hour just because it happens that he lives closer to or farther away from the point of the beginning of his particular development.

It would amount to charging the customer in a city who lives just outside of your power station less than the customer who lives 5 miles away and happened to be using the same quantity of power under the same conditions of demand and consumption.

It seems to be fairly well established that like contemporaneous service in any given area is of equal value whether immediately adjacent to or at some distance from the point of generation. This is particularly applicable in system developments where power may be fed in from absolutely opposite directions at different times a day. The entire development of the electric industry in the United States has been based upon uniform rates for like contemporaneous service, and any scheme of rural service similar to those so far proposed will ultimately create the cost of service condition existing in Ontario and by its very nature, and by possible faulty distribution engineering, introduce innumerable discriminations.

The ultimate solution of the small community and rural service problem probably will be found in the development of homogeneous areas on a systematic basis with appropriate fixed charges proportional to the connected loads and consumption charges commensurate with the use. Said fixed charges being based not upon the invest-

ment cost for any particular consumer but on the average investment costs prevailing in the particular area in question when adequately and logically developed.

In other words, the small community and isolated farm business must not be treated as an adjunct of city lighting and power service, but must be developed on a basis individual to it, using types of construction and means of service proportionate to the population and territory involved and not overburdened with conditions applicable to other times and places.

TABLE 1.—Number and percentage of Michigan cities, villages, and unincorporated places served and not served with electricity

Population group	Number served	Served	Number not served	Not served	Total number
		<i>Per cent</i>		<i>Per cent</i>	
100 or under.....	55	5.6	929	94.4	984
101 to 250.....	73	16.8	363	83.2	436
251 to 500.....	156	53.6	135	46.4	291
501 to 1,000.....	107	83.6	21	16.4	128
1,001 to 2,500.....	110	95.6	5	4.4	115
2,501 to 5,000.....	35	100.0			35
5,001 to 10,000.....	31	100.0			31
10,001 to 25,000.....	15	100.0			15
25,001 to 50,000.....	9	100.0			9
50,001 to 100,000.....	3	100.0			3
100,001 to 200,000.....	1	100.0			1
Above 200,000.....	1	100.0			1
Total 2,500 and less.....	501	25.6	1,453	74.4	1,954
Total 2,501 and more.....	95	100.0			95
Total.....	596	29.3	1,453		2,049

TABLE 2.—Population and percentage of population of Michigan cities, villages, and unincorporated places served and not served with electricity

Population group	Population served	Served	Population not served	Not served	Total population
		<i>Per cent</i>		<i>Per cent</i>	
100 or under.....	4,515	7.3	57,654	92.7	62,169
101 to 250.....	13,840	17.8	63,793	82.2	77,633
251 to 500.....	59,846	55.7	47,559	44.3	107,405
501 to 1,000.....	77,743	84.5	14,311	15.5	92,054
1,001 to 2,500.....	168,559	96.1	6,902	3.9	175,461
2,501 to 5,000.....	130,467	100.0			130,467
5,001 to 10,000.....	219,481	100.0			219,481
10,001 to 25,000.....	199,991	100.0			199,991
25,001 to 50,000.....	372,480	100.0			372,480
50,001 to 100,000.....	210,829	100.0			210,829
100,000 to 200,000.....	137,634	100.0			137,634
Above 200,000.....	993,678	100.0			993,678
Total 2,500 and less.....	324,503	63.0	190,219	37.0	514,722
Total 2,501 and more.....	2,264,560	100.0			2,264,560
Total.....	2,589,063	93.2	190,219	6.8	2,779,282
Population on isolated farms.....					889,130
Total, 1920 census.....					3,668,412

TABLE 3.—*Rural customers served by Michigan power companies*

Companies reporting rural service.....	91
Companies reporting no rural service.....	84
Companies reporting sold.....	12
Companies not reporting.....	44

Total questionnaires sent out..... 231

SUMMARY OF ANSWERS

Number of companies	Number of rural customers	Number of companies	Number of rural customers
1.....	2,614	13.....	26-50
1.....	1,735	15.....	11-25
1.....	655	33.....	2-10
1.....	485	12.....	1 only.
5.....	201-400	—	
6.....	101-200	91	9, 022
3.....	51-100		

NUMBER AND PERCENTAGE OF CITIES, VILLAGES, AND UNINCORPORATED PLACES IN MICHIGAN SERVED WITH ELECTRICITY

	Number served	Per cent of total	Number not served	Per cent of total	Total number
Cities.....	112	95.7	5	4.3	117
Villages.....	277	82.4	59	17.6	336
Unincorporated.....	207	12.9	1,389	87.1	1,596
Total.....	596	29.0	1,453	71.0	2,049

NUMBER AND PERCENTAGE OF CITIES, VILLAGES, AND UNINCORPORATED PLACES IN MICHIGAN, WITH A POPULATION OF 2,500 OR UNDER, SERVED WITH ELECTRICITY

	Number served	Per cent of total	Number not served	Per cent of total	Total number
Cities.....	32	86.5	5	13.5	37
Villages.....	263	81.7	59	18.3	322
Unincorporated.....	206	12.8	1,389	87.2	1,595
Total.....	501	25.6	1,453	74.4	1,954

Just before leaving, the Agricultural Department sent me down a summary of their correspondence. Their questionnaire asks 12 questions of the farmers. I will read the question and the average answer. This questionnaire was sent out to about 400 or 450 of the total of 1,200 farmer correspondents scattered throughout the district. The extension of the work is up to the power companies. If the commissions set up detailed requirements, it will usually be found that the companies have to apply it hard and fast, while if the companies develop their own methods the procedure is more flexible and they get further with it. Now, we will shoot at it.

DISCUSSION OF EXTENSIONS AND RURAL ELECTRIC SERVICE

Mr. CRITTENDEN. Mr. Toeppen has set up some good targets, and we will now hear from Mr. Bennett from Illinois on the same subject.

Mr. BENNETT. Not so long ago I had the experience of preparing a very detailed paper on rural service. I sent out a questionnaire and

based the paper on it. I went down to the meeting and at one of the sessions the man called on just before me presented all the thoughts I had incorporated in my paper. Therefore, I only dictated a short memorandum for this meeting. You will probably see that apparently we in Illinois do not agree exactly with what the previous speaker has said with regard to construction, but I think if we could sit down and talk the point over we would be in perfect agreement. In Illinois we believe that the grade of construction is of prime importance, and have particularly emphasized it in these rules. I think you will see why.

It may be truly said that superpower systems are a reality in Illinois. In fact, several superpower systems are operating and serving communities in more or less well-defined areas. Some of these systems serve over 200 towns by transmission lines from several large, highly efficient generating stations, and, in addition, have interconnections with other transmission systems. These transmission lines, in passing from town to town run by the large grain farms that constitute the rural districts of a large part of the State. The demand, therefore, for electric service on the part of the rural resident arose many years ago when some of the lines were first constructed. Of course, it is not possible to render service to individual consumers from high voltage transmission lines, but their presence was a constant reminder to the farmer of the possibility of securing electric service.

Two fellows came along through a community and told the farmers if they would give them the right of way they would put up a transmission line, and the farmers would get their electric service in lieu of the right of way. Before the line was constructed these two fellows sold out their interest and then a transmission company went ahead and put up the line. The farmers can not see why they should not pay even less for service because they gave these people the right of way with the understanding that they would get service.

When rural electric service was first rendered in Illinois, the matter was apparently given little attention by the utilities, as is evidenced by the fact that many of the consumers were served at lower rates than prevailed in adjacent cities and towns. As more study was given to the situation and investigations made, it was found that rural electric business under such conditions was most unprofitable, and the conclusion was drawn that rural electric service under the most favorable conditions was an undesirable class of business. As a result, the demands for such service were not encouraged and in some instances a decided effort was made to keep away from the business.

The farmers have enjoyed the convenience of rural telephone systems for a number of years. Such systems were usually constructed by the farmer who often used native poles, and thereby was enabled to put up a line at a very low cost. The farmer obtained service over such a system at much less rates than the urban subscriber paid for urban telephone service. These facts tended to give the farmer an idea that rural electric service could also be obtained by the use of cheaply constructed lines and at rates that were at least no higher than corresponding rates in the city. When the farmer now begins to think of rural electric service, it is necessary, therefore, to educate him, both with respect to the cost and standard of construction and with respect to the cost of the service. Furthermore, it is practically essential that the farmer be relieved from the mainte-

nance of the rural electric lines, not only for the good of his and his neighbor's service, but also for the protection of the traveling public. No better example than the rural telephone system is needed to show what may be expected if the maintenance of rural electric lines is left to the farmer. Sometimes this lack of maintenance on the rural telephone lines results in a real hazard to the users of the highway and often a whole section of a line will fall over into the road and remain there until sufficient pressure can be brought to bear by the authorities to induce the farmer and his neighbors to either rebuild the line or dismantle it. That is a fact. I nearly ran into a pole that was lying in the road. It lay there over a month during the threshing season and was in a section of line over a mile long.

From the above it is seen that when the commission came to consider the question of rural electric service it was necessary to formulate some plan that would insure proper construction, adequate maintenance and a comprehensive method of charging for service. Fortunately the groundwork for the solution of the construction problem involved in rural electric service had been previously laid. The Illinois Commerce Commission has established, and has had in effect for several years, rules pertaining to overhead electrical construction, designated as General Order 30. The intent of these rules is to make human safety a matter of primary consideration and to fix minimum requirements for the classes of overhead electric construction to which they apply. These rules cover all phases necessary for safe electric construction and in addition make recommendations for the construction and operation of supply systems and signal systems whose lines are involved in parallel. General Order 30 has been in effect for four years and we find that the problem of obtaining compliance is difficult only where small companies or rural lines are involved. In order that all rural electric lines may be constructed in accordance with these standards, the commission has adopted a scheme that has been found to work out satisfactorily.

Before the present rules covering rural electric service were formulated, the Illinois Commerce Commission held extended hearings on this subject for the purpose of receiving evidence from the electric utilities and from the representatives of the rural consumers. At these hearings much evidence was adduced, and in this manner the problems of the utility and things that the farmer did not understand were brought out. In other words, a certain amount of education was given and received by both parties to these hearings, and this was most beneficial. After many conferences between all interested parties the commission adopted a set of rules that are now set forth in General Order 100, and, while these rules do not cover every phase or problem presented in rendering rural electric service, they are intended to cover a majority of the cases met in constructing and operating a rural electric line. There will always be special problems that can not be made the subject of a rule and these are left for solution by the commission as they may arise.

At one of these general hearings the State Electric Association employed a former commissioner who presented the results of some analyses made on some of the lines throughout the State and one of the larger utilities prepared a similar exhibit showing power factor,

what was the core losses and consumption per consumer, cost of line, of maintenance, and all the costs were carefully recorded. It gave a very good picture of the situation on this line that had been in operation for several years. Now in this General Order 100, of which you all have copies, it has been assumed that the rural consumer will fall in one of three classes and, in the language of the order, they are defined as follows:

Class I.—Those prospective rural consumers who shall organize a corporation for the purpose of constructing the lines necessary to furnish electric service, and who propose to render such service to all applicants along and adjacent to the routes of the said lines.

Class II.—Those prospective rural consumers who shall form a corporation, organization, or association of a strictly mutual character for the purpose of operating without profit for the securing of electric service to stockholders alone.

Class III.—Those rural consumers who contemplated receiving electric service as individuals; that is, those consumers who expect the electric utility rendering the service to furnish a meter for each consumer and to read these meters and collect each consumer's bill separately.

It has been often found that we have a group of prospective consumers come in and want to build a line past their community. If they build the line they can not take the community in as a rural consumer; the population is too great and it would not be fair to the farmers. The only way to do is to form a corporation. A corporation formed by consumers for the purpose of rendering electric service is, in all respects, an electric public utility and is therefore under the jurisdiction of the commission. The law requires that before such a corporation constructs a new line it obtain from the commission a certificate that such construction will be a public convenience and is necessary thereto. General Order 30 requires that the utility give notice of its intention to apply for such a certificate to all wire-using companies whose lines are to be crossed or paralleled within a distance of 200 feet. Later the utility must notify these companies as to the time and place of the hearing upon its application, in order that an opportunity may be given to present objections. At the hearing, the utility must show the kind of construction it proposes to use, the voltage of the line; and must file a plat showing the route the line is to follow. After all valid objections have been removed the commission issues the required certificate of convenience and necessity under an order wherein the company is directed to construct the line along the route as shown and in accordance with the standards of construction adopted by the commission. In this way the commission is insuring that the lines are properly installed and, as the organization is a public utility, the commission can, and does, exercise the supervision necessary to see that the lines are properly maintained.

Those consumers who organize an association to operate without profit a mutual organization, designated above as Class II, do not come under the jurisdiction of the commerce commission. To insure proper construction of the lines by such an organization the commission must look to the electric public utility who is to supply energy to these lines. In this case the commission will not permit the supplying company to connect to the circuits constructed by the mutual organization unless the established standards of construction have been fully complied with. Under the terms of General Order 100 the mutual organization may execute a written agreement with the utility under which the latter constructs, maintains, and operates

the lines. The commission insists that such an agreement be reduced to writing as it has often been found impossible to determine who should be held responsible for the replacement of some of the earlier rural electric lines.

The third class of rural electric consumer contemplated under General Order 100 is the individual, and he is in many respects comparable with the individual consumer residing within the municipality. In most cases, however, the rural consumer constructs the line and inasmuch as the commission has no jurisdiction over the individual it again must work through the utility to obtain proper construction. In this case again the commission will permit service to be rendered to such a line only when it conforms to the established standards. In the event that the public utility is to operate the lines in question, the commission requires the utility to first secure a certificate of convenience and necessity. For this class of consumer the commission has pointed out the desirability of all lines being owned by the utility in order that the proper provision may be made for replacements required either through increased load or through deterioration. The utility in any event is held responsible for the proper maintenance and replacement of the line.

The object of all the rules pertaining to construction and operation of the rural lines is to put the control of both in the hands of the utility, for the reason that the commission has jurisdiction over the utility. In this way only can safety and satisfactory service be assured. Our telephone lines present the best example of what would happen in case the maintenance of the line is left to the consumer. Furthermore, the farmer is not equipped to properly maintain electric lines nor has he had sufficient experience in this class of work to realize the personal hazards involved.

The most difficult problem from the standpoint of the commission, in connection with rural electric service, is with respect to the manner of charging for that service. Nearly every rural consumer requires an individual transformer and, in Illinois, there are but two and one-fourth rural consumers per mile of line. The average transformer capacity per consumer on our rural lines is 2 kilovolt-amperes and the average number of consumers per transformer is one and one-half. These figures show that the territory served by rural lines in Illinois is comparatively sparsely settled, as is expected in a country devoted to the raising of grains.

The fact that the rural consumers are so widely separated gives rise to a number of costs that are over and above those involved in serving urban consumers, the nature of which are too well known to warrant discussion here. The average consumption per rural consumer is less than the average consumption of the residential consumer in the city. Most of the rural consumers now use electric energy merely for lighting and, in some instances, the consumption amounts to an average of nine kilowatt hours per month. In only a comparatively few cases farmers are using electric service for power production about the farm.

The commission realized that there were several ways in which the rural consumer could be billed for electric service and the one that appeared most feasible separates the cost of energy from the excess costs incident to rural electric service. The commission, therefore, adopted this scheme and the rural consumer is to be

charged for the energy, whether it be for power or light, in accordance with the schedules that are available for the urban consumer in the town from which rural service is received. The excess cost for which a charge is to be made are embraced in one charge and designated as "excess cost charge," which is a fixed amount, and not dependent on the amount of energy consumed. General Order 100 does not give in detail the manner in which the excess cost charge shall be compiled, but it does provide that in the event such items as interest, depreciation, and maintenance charges on the line are included in the excess cost, a deduction of \$50 per consumer shall first be made from the cost of the line in making the computation. Fifty dollars has been taken as the average amount of investment in distribution system for each urban consumer. The urban rate for energy is assumed to include maintenance, depreciation, and return on \$50 investment in distribution system.

The rural consumer occasions a transformer core loss that is greatly in excess of that found chargeable to the average urban consumer, and it appeared necessary to recognize this excess cost specifically when formulating rules for rural service. There were many reasons why it did not appear necessary to give in detail all of the other excess costs involved and, in fact, some of the larger utilities believe that the best interests of the consumer would be served by not giving specific consideration to all of the costs involved. This is because oftentimes two farmhouses are located very closely although the farms may be located on either side of the road. This permits of splitting the transformer charges. Some of these larger systems have sufficient foresight to realize that the rural electric business is in its infancy, that the use of electricity by the farmer must be encouraged in every way possible, in order that the development stage of this business may be shortened. If every conceivable excess cost were now put into the farmer's bill for service, with his present limited use of that service, an extremely high rate per kilowatt hour results and an antagonistic attitude on the part of the farmer is sure to follow. One large utility in Illinois is willing to forego some of the actual costs involved in serving the farmer in order that it may develop the rural business rapidly and shorten the time before the rural consumer becomes a desirable consumer. That may sound rather altruistic, but it is a fact that the larger systems came in when we had the tentative draft of General Order 100 up for discussion. In that draft we had outlined all conceivable costs and had made provision for companies inserting the item of interest on the investment. One chap said, "Well now, of course, it isn't any of my business, but aren't you inviting trouble? Our company would be willing to forego some cost, but if we have to show all these other companies 3 per cent interest on our money we are going to be in bad. Why can't you leave it to us?" The commissioners left it to the utilities, but made a provision that all additional costs should be filed and submitted to the commission so as to see that the cost would not be greater than justified.

Under present conditions the excess cost charge as applied in Illinois (on the average) constitutes a relatively large portion of the rural electric consumer's bill when service is rendered to him as an individual. The average rural consumer, unless fully aware of the costs occasioning the excess cost charge feels that he is paying for

something that he does not receive, and, in this state of mind, resents the charge. We tried to find another name for this charge, one that would carry an explanation of its necessity because the very nature of its designation leads the farmer to believe that he is being discriminated against as compared to the urban consumer. In our previous rules this charge was termed "service charge," and while the nature of the charge was explained in the rules the bills rendered to the consumer did not and many protests were raised against a charge for which no apparent service was received.

Rural electric service will always be a problem until the rural consumer has received sufficient education as to the costs involved and the advantages of electric service. When the rural consumer becomes a large consumer, then will the attitude of the utility companies change toward one of welcome to rural consumers and then will the stumbling block of the excess cost charge disappear, as it will become relatively unimportant in comparison with the whole bill for energy.

The whole problem of increasing the load on the farm line is one of education of the farmer and must be directed along several avenues. The agricultural students attending the various State universities will be quick to see the advantages of electric power on the farm and when these students become farmers they will put their theory into practice. The present farmers, who have grown up in the business, are apparently slow to realize that electrical energy can be advantageously substituted for labor and the problem of educating these farmers is one that is most difficult of solution. The manufacturers of agricultural equipment can do much to help the farmer, the utility, and their own finances by designing farm machinery to be driven by electric motors. About the best the utility can do along the line of education is to find a farmer who is sufficiently progressive to understand the advantages of electric power on the farm, induce him to put in power-using machines, and then convince the neighboring farmers by actual demonstration.

Many of the utilities are now bending every effort to secure sufficient capacity to take care of the constantly increasing load in the cities. The relatively small rural load does not, therefore, appear of sufficient importance to warrant much attention. At least that is the situation in Illinois particularly throughout the central areas where wheat and corn are the main products. The result is that the majority of the farm lines are now being built by consumers to connect with the existing low voltage lines and such lines are constructed primarily with the idea of rendering little but lighting service. More lines are built daily and the potential load of the existing rural consumers is enormous, to say nothing of the load that future rural consumers may incur in using all the power that can be advantageously consumed on the farm.

The commission has gotten up a scheme that may have some flaws in it but it has some very good points. It educates the farmer forcibly; that is, if a group of consumers want a line built the utility figures about three consumers per mile. That is standard. They take the payment of the proportionate cost of that line as a minimum for two years in advance. The farmer has his money invested and wants to get his money's worth. After he has become educated

by force to the charges of electric power the analyses of the company show that the consumers do not fall off.

Mr. CRITTENDEN. We will hear from Mr Campbell representing the National Electric Light Association.

Mr. CAMPBELL. I fully expected that this subject would be covered in detail by the other speakers and that I would take up more or less the technical construction, so I have left out of my remarks entirely the subject of financing and rates. I have prepared just a brief set of remarks in regard to what is being done by some of the organizations with which I am most familiar. I can readily see how Mr. Bennett might get in some argument with regard to educating the farmer in that manner in view of the fact that the National Electric Light Association is working so closely with the Farm Bureau in solving this thing on its merits and in trying to avoid the farm bloc system.

The past year has seen marked progress toward the solution of some of the important problems connected with the utilization and supplying of electric power for rural service.

One of the most important steps thus far taken is the formulation of a joint committee to deal with this subject and known as the Committee on the Relation of Electricity to Agriculture. The membership of this committee consists of representatives of the American Farm Bureau, the National Electric Light Association, the American Society of Agricultural Engineers, the United States Departments of Agriculture, Commerce, and Interior. The officers of this committee are J. W. Coverdale, chairman; G. C. Neff, secretary; and A. E. White as director. Mr. Coverdale has been closely associated with the American Farm Bureau in an official way for several years; Mr. Neff is vice president of the Wisconsin Power, Light & Heat Co., and has been chairman of the Rural Lines Committee of the National Electric Light Association since it was organized about three years ago; and Mr. White has had a wide experience in farm-power problems and is well qualified to direct the work of this committee.

The national joint committee is now engaged in the following work:

1. Making an extensive survey to determine the number of farmers that are now being served and the mileage of rural electric lines. A compilation of the result of this survey will be prepared and may be available within the next few months.

2. Collecting information concerning the electrical equipment that is necessary to permit farmers to utilize electric power to the best advantage to themselves and to those that are supplying the service.

3. Collecting information bearing on numerous pertinent questions that are frequently asked by farmers concerning electric service, and preparing the information thus obtained so that it can be understood by the farmers themselves.

The United States Department of Agriculture, as a part of its contribution to the activities of this committee, is making a national farm power survey to determine the amount of power of all kinds used on farms. This information will be classified as to animal and mechanical motors, and also as to power requirements, whether draw bar (such as plowing, harrowing, and other operations of open

field work), belt power, and power used for household purposes. This survey will also attempt to arrive at the cost of power per acre necessary to produce certain crops, the relation between cost of farm power and total cost of farm operations, the amount of power required per farm worker, and the distribution of power required for the different types of farming.

The Office of Experiment Stations of the United States Department of Agriculture is also entering into this work, and now is engaged in developing an investigation program in connection with the application of electricity to agriculture. This is intended to point out the chief problems for investigation, and the most logical and practical methods of solution. So far this program has not been carried forward sufficiently so that results are available.

The United States Department of Commerce has arranged to make a survey in foreign countries for the purpose of obtaining all the information available regarding the use of electricity in foreign agriculture. In addition to this the division of simplified practice is lending its facilities toward the standardization of both electrical and mechanical equipment used in rendering rural service in so far as it deemed advisable and practicable to do so.

It should be realized that the Department of Commerce is lending valuable assistance in making it possible for the Bureau of Standards to hold this meeting of commission engineers and arranging for a discussion of the subject of rural electric service by representatives of the various State commissions who are so well informed and fully qualified to discuss these questions.

The Committee on the Relation of Electricity to Agriculture is endeavoring to formulate State committees as rapidly as possible which will carry out in more detail the investigations and surveys outlined by the national committee. This will also make it possible for a given State committee to confine its efforts in this survey work to those activities which are applicable to its own State. It is probable that the work of these various State committees will be compiled in the one general report and coordinated in such a way that the information will be valuable from a national standpoint and will serve to point out methods by which rural service can be better supplied and more economically utilized.

So far the questions of financing and rates to be charged for service have received no attention by the joint committee. As the two are so closely related to each other it is difficult to discuss them separately, and since there were numerous other phases of this problem requiring immediate investigation and study in order that the fundamentals underlying the use and rendering of rural electric service might be properly determined, the national joint committee has so far made no investigation along these lines.

As you all know, the demand for rural electric service started at a time when the utilities were not in a position to give the matter sufficient thought in most sections of the country. This demand was general and presented some very perplexing problems to farmers and the utilities, and as the result of this condition very little was done to offer this service on anything like a uniform contract. Accordingly there were almost as many different forms of contracts as there were places where the service was being given. Oftentimes the same utility would be serving different groups of farmers with different

forms of contracts. The suddenness with which this demand came offered very little opportunity to study and investigate the determining factors of rural service, and as a result, some of the methods that were put into use have since proved to be undesirable and are not now being recommended. There was another disadvantage in the manner in which this service had to be offered and that was that there was no previous experience available upon which the utilities could base their judgment regarding methods and charges.

As a consequence of such conditions there was no recognized influence to turn the tide in any one general direction. Now, however, that the national joint committee is attacking the various problems in connection with rural service in a cooperative manner, and with very promising prospects toward progress, the question of financing and rates will no doubt receive attention in the near future, and we have every reason to believe that results which are mutually satisfactory to the various interests concerned will follow.

It might be said that out of a large number of different forms of contracts that have been brought to the attention of the rural lines committee of the National Electric Light Association that has been working on this matter for the last three years, two general plans have been developed regarding rates for rural service. One of these is to have a graduated rural-service charge which is charged over and above the near-by urban rates. This graduated charge to be so determined and applied that it will decrease as the amount of power consumed increases. The other plan consists of a monthly "ready-to-serve charge" plus a low energy charge. Both of these plans are being followed in several localities and close observations are being made to determine how each of them work out in actual practice.

You will, I am sure, be interested in knowing that the joint national committee has been instrumental in the construction of several experimental farm lines located in various sections of the country. The character of these lines and their locations are such as to represent typical conditions in American agriculture. They are under the close observation of interested and competent men and the results of the operations of these lines will undoubtedly furnish very valuable information to the committee in its future work.

MR. CRITTENDEN. We certainly appreciate Mr. Campbell's outline of the way in which the problem is being attacked. Mr. Campbell has mentioned that several branches of the Department of Commerce are connected to some extent with his committee. One of these is our division of simplified practice, which is so fortunate as to have at its head W. A. Durgin. I will ask Mr. Durgin to speak to us.

MR. DURGIN. I think I am more interested in this subject because of my connection with the Commonwealth Edison Co. than from my connection with the division of simplified practice. In our present work in simplified practice we hope to get a great many of the electrical manufacturers together on a somewhat simplified basis of standard equipment for the farm. The farmer has been handicapped in the past by having every enthusiastic inventor make something to help him which requires special parts. He no sooner gets it than he realizes that it is junk. Secretary Hoover wants the farmer protected to a reasonable extent. When he gets a piece of equipment he should have something sufficiently standardized so

that he can get repair parts quickly. On his ordinary farm equipment the farmer has been heretofore handicapped further on maintenance as the policy of the leading manufacturers has been to make their stuff just enough different so that the farmers will have to get their repair parts from them and no one else. One manufacturer making 12 types of wagon-seat posts made them so different that you would have to have a special seat for each of them. As an illustration, I can tell you what happened when some enthusiastic American went to Brazil to do some farming. While farming implements were sold down there he thought he should get them in the States, so he purchased his equipment from a large house in Chicago. One day he broke a special bolt on his threshing machine. It was a critical bolt and he cabled back for replacement. He waited just 13 weeks for the bolt to arrive and when it came it was an eighth of an inch off. Instead of waiting for another replacement he took the next boat back en route to Chicago and an unpleasant interview for the works manager. That is the sort of thing Secretary Hoover is interested in. The first service we can perform is as a central body which shall bring together manufacturer and distributor and consumer, to find out what their own best judgment indicates as the best common practice. Our second service is in official support of this best common practice. Secretary Hoover is looking to this central committee very largely through the National Electric Light Association to help the simplification movement along. We hope to be able to render service, for that is the only basis of the Department of Commerce.

Mr. CRITTENDEN. We happen to have with us a representative of another organization, Mr. Morse, of the Giant Power Survey of Pennsylvania, who is concerned at least indirectly with rural service. Mr. Morse, will you speak to us?

Mr. MORSE. This is a great surprise as I did not come with the expectation of being asked to speak. We are very much interested in the application of electricity to the farm. A number of the gentlemen present have cooperated by sending copies of papers presented at other meetings and documents from commissions, and I wish to take the opportunity to thank them again and to invite such papers from the rest of them. If they have anything to contribute the Giant Power Survey of Pennsylvania will be more than delighted to receive it. I do not know whether you are all familiar with the origin of this survey. It originated with Governor Pinchot and some of his associates. About the time that he was to take office as governor he asked his associates to make special studies of certain things that might govern the handling of affairs after he came into office. One thing that he started at that time was an intensive study of the activities of the Public Service Commission in Pennsylvania in the light of the work of such commissions all over the country. I came with this survey just about a month ago and one of the first things handed me was three large volumes of manuscript dealing with economic features, legal features, and with public policy features of public service commissions. In that work I have had opportunity to read two volumes out of the three. In perusing them I have been delighted with the field of information discussed. I think you may wish to know that there is in existence such an account of commission activities everywhere over the whole country in various lines.

I have been trying to predict the possible ultimate load from the farmers. I find that the impression is that in a number of communities the average monthly load is 40 kilowatt hours per month. I have found a district where there is already a consumption of 100 kilowatt hours a month per farm. That is a rich district and, perhaps, is a little better situated as a financial field for power on that account. One of the surprising things was that about 30 or 40 per cent out of 200 or 300 farms electrified are using ranges. It was surprising to me. I also made surprising observations on the quantity of electricity used for heating water. That is evidently going to be a large field when rates are properly adjusted, and it is already a large field in the Ontario hydroelectric system. I am not exactly in sympathy with utilizing electricity that has been generated from coal and transmitted at a considerable cost for 30 or 40 miles to heat water. Economically it is bad. From the standpoint of the electrical fraternity who have charge of the loads it is good; but when you could heat the water with one-sixth of the coal, what excuse is there for burning six times the coal in order to get that energy finally landed in the water? What I wish to urge is that it is really better for the world, perhaps better for the electrical fraternity in the end, that we urge the use of electricity for purposes in which it has distinct advantages over any other source of energy; that we always try first to load our lines with loads of a character that we feel can be supplied in no other way, such as electric light and power. In the first place we can get a better return for the investment in these specialized uses than in delivering the load for uses of low economic potential, such as ranges, water heating, and that sort of thing. These are at present an immaterial part of the load and in the aggregate consume only a small part of our coal, but I can not help thinking that in years to come our children and children's children will suffer from want of this coal for heating the house.

I have gone rather far afield and am not prepared to speak more specifically on the survey except to say that we hope to report to the legislature as to what can be done in Pennsylvania to see that the coal is most economically applied in generating electricity, that the generating sources are most economically distributed and that the proper types of distribution lines for transmission purposes are conceived, and that if possible the large percentage of farmers are actually given the advantages of electricity.

Mr. CRITTENDEN. Mr. Morse has raised some very interesting questions. Perhaps, however, we had better come back to questions of more specific application. I will ask Mr. Rudd to present some of the difficulties he has had in mind and let those who have had more experience answer his particular questions.

Mr. RUDD. In Connecticut we have not had any troubles from the mutual associations. All of our State is being served by companies whose territory is limited by the legislative charter which they have been granted. The State is small. The point that comes up before the commission is "rural extension," and I was very definitely instructed to get whatever information I could while down here. I want to listen to the other fellow's way of doing things. The commission has definite methods for dealing with the established power systems, but the problem of rural extension is new and unknown. Their particular interest is in connection with safety. Our docket

1447, order BA, which approves and establishes rules and specifications covering joint pole-line construction, gives a maximum span of 125 feet and specifications concerning the sizes of conductors. These specifications are too rigid for rural line extension because they increase so much the cost of the extensions. The commission has rendered an opinion recently where an application was made for service at 3.2, 2.5, and 1.6 miles, the first having 11 customers and the second 11, and the last 13. They said in approving the construction of these lines that the construction of the electric lines referred to in the application would be permitted with the following modifications: These modifications are (1) the span shall not exceed 175 feet, (2) the signal conductor shall be No. 12 B. & S. hard-drawn copper or larger, (3) the supply line conductors shall be not smaller than No. 6 nor larger than No. 2 B. & S. medium drawn, and (4) the sags shall not be less than those specified in the National Electrical Safety Code for this class of construction.

I would like to hear some comments on the above because as a layman it seems to me that the requirements are entirely too high and to meet them will result in probably heavier construction.

As I said in the first place, the commission wants me to bring home information concerning the practice of others. In connection with the financing of extensions the commission believes that the company should take care of it. A case recently came up in a territory five-eighths of a mile long where there were seven customers. The cost estimate was \$715, and the company was asking a contribution from them of only \$125. That was not to be returned to them at all.

Mr. CRITTENDEN. There are a number of States in which I know these problems have arisen, and we would like to hear from any of you.

Mr. VANNEMAN. The rural line question is one that is very intense in the State of New York, and I have given a great deal of thought to it. About two years ago the problem was coming on us by leaps and bounds, and we decided it should be solved. I am somewhat familiar with conditions in other States, but know most about New York.

Farming interests are divided largely into two general classes, dairy and fruit, although there is some truck gardening. In considering the power problem, many have overlooked one phase which is a very vital factor, namely, load factor. I say emphatically that one of the fundamental considerations that the commission engineers are confronted with is in taking a firm stand as to just what the farmer should use in the power lines. It is absolutely ridiculous to buy a motor to saw wood when the farmer has a Fordson tractor right alongside. He would use the motor two or three times a year for sawing wood, and I don't believe we should encourage or permit the use of power in that manner. The same thing applies to the ensilage cutter. Why should he do that when he has a Fordson tractor, which is more economical? In New York State on dairy farms the use of power is confined to two functions, milking and pumping water. On every farm it can be used for pumping water. What else is there left? I fail to see that there is much left for which he could use it economically.

On the other hand, I disagree with the gentleman from Pennsylvania. Practically every farmer in northern New York has an electric range. I do not know whether any of them have electric washers,

but believe they must have. They all have electric ranges and obtain energy for cooking at rates from $3\frac{1}{2}$ to $4\frac{3}{4}$ cents per kilowatt hour. I would just like to take one of you into one of those houses and have you suggest to the housewife that she is using that energy uneconomically. I would not want to be responsible for the consequences. They will not give it up. This is one of the fundamental things in the use of electricity on the farm, one of the things we have to keep in mind in developing electrical use, one of the things which will make people want to live on farms and keep them from moving to the city. If they can do away with the old hand pump in the kitchen, if they can have the instantaneous effect of the electric range in getting up in the morning and preparing breakfast, then you will find that people will not find it so difficult or inconvenient to live on the farm. This use of electricity from my point of view has grown tremendously in New York. The people have automobiles to go to the centers. Practically every community has electricity, Delco systems supplying small communities. The problem will soon be solved as they are getting superpower systems all over the State of New York, and there are only a few communities which are not being supplied by reliable power.

The development of electricity in rural sections has brought about many ramifications. I think we have as many different ways of providing for the costs of extensions as there are companies in the State. Some apportion the cost either on a definite percentage basis or on absolute payment basis, such as I believe the Illinois commission has done. Others have a definite percentage basis which they pay as a line charge. Others have a transformer charge. Some companies reimburse the consumer on a definite ratio until he has been paid back everything which he has contributed. Others pay him back on a definite percentage basis for a definite number of years. If he uses large quantities, he may get it back; but if not, he may get only a small percentage of it back. One company has a system by which it charges line rental for two years on a percentage basis. They have arbitrarily assumed that this line rental begins with a certain definite point which they call "end of distribution system." Everyone served from that line, no matter at what time, is charged from the same point. I think that plan will be amended so that it will operate more fairly.

There is another problem; that is, where the company has asked contributions toward a line which has been extended for, say, a mile and a half which has been paid for by a portion of those who may be served from it. Later those who did not contribute demand service. The equitable solution would seem to be that each customer should share this extension pro rata, and that those who make the original payment should be reimbursed pro rata, but it is questionable whether there is any statutory basis for enforcing this in New York State.

We have not adopted any standards of construction. The reason is that the American Engineering Standards Committee is developing certain standards, and we have the American Electric Railway Association arguing very strenuously for certain conditions, the telephone interests for others, the National Electric Light Association for others. It seems to me that this condition is confounded, that

the American Engineering Standards Committee is entirely capable of working out standards of its own to conform to these different ideas. Referring to Mr. Rudd's own conditions, we have a Connecticut company which serves communities in New York. We merely see to it that they put in something that we consider to be standard and see that they maintain it properly.

I don't like the policy idea of the farm power development. I think that we must look at it as an essential, something that the farmer must have, that he is entitled to, but that he must not put on the urban consumer a burden which the latter should not bear. The farmer is well able to take care of himself.

Formerly there was in the State of New York a committee of the Empire State Gas and Electric Association, somewhat analogous to the committee of the National Electric Light Association known as the Rural Lines Committee. Last fall at a meeting of the Empire State Association at Lake Placid a report of this committee was presented. I was not a member of the committee, but sat with them on a number of occasions and discussed a great many of their problems. I suggested some of my own ideas as to how they should try to develop that problem. If you are interested, I suggest that you write C. H. B. Chapin, secretary of that association, Grand Central Terminal, New York, and he will be glad to send you a copy of the report. I do not agree with everything in the report, but I do think that if some of the points are followed out it will help materially to solve the problem.

(Excerpt from 1923 report of the Rural Lines Committee read by Mr. Vanneman.)

1. The development of rural territories should be fostered by the utility that is most logically situated to serve such territory because of:

(a) Franchise conditions, giving it the right to operate that particular territory, necessarily carry with them the duty of serving the public located therein.

(b) Revenue possibilities.

(c) Protection of territory against competition through extension of neighboring utilities and the organization of local systems to fill demands not met by the established utilities.

2. Rural development should be carried out through instrumentalities constructed and maintained by the utilities because of:

(a) The natural objection of rural residents to participating in organization and burdening themselves with expenses and the compilation of comparatively unimportant, but legally necessary reports and the responsibility for the proper conduct of the project.

(b) The experience of the telephone companies throughout the entire country has shown that rural customers can not be depended upon to properly construct and maintain the instrumentalities requisite for the desired standard of service.

(c) Control of the facilities by reason of the necessity of increasing capacity of lines and construction of extensions made necessary by new business as well as to facilitate changes.

The rural extensions should be developed upon a self-supporting basis so as not to impose an undue burden upon urban customers. Each single project may be considered by itself or the several projects necessarily radiating from a similar service of supply covering the entire rural territory surrounding such points of supply may be considered as a unit. The choice will, in general, be determined by the character of the territory and density of the rural population.

The most equitable form of rate for rural service is one that takes into consideration the excess cost of furnishing this service over the cost of furnishing urban service. It seems to be generally conceded that such a rate should contain an element dependent upon this excess cost in addition to the energy charge. Such excess being known as a "service" or "line" charge and being apportioned equitably among the customers served by the particular line.

The committee feels that it is possible to develop a rate plan which will be suitable for general use in the determination of rural rates in any particular lo-

cality, and trusts that this subject will be given the further study which it deserves.

Then your committee stated that—

The limited number of customers possible to secure on rural extensions and the limitation of their requirements, thereby producing a low ratio between the revenue, if figured at urban rates, and investment requires that annual charges on the investments necessary to serve rural customers be reduced to the minimum. This can best be accomplished by departure from the construction standards generally adopted for urban lines or taking advantage of the possibility of joint construction with telephone companies where joint occupancy is permissible. In general, the economic limit of joint construction with telephone companies will be found confined to exchange lines, of at least one or limited to two or three cross arms.

The study of the proposition given by your committee during the past two years confirms the views previously expressed and as pointed out in 1921, your committee still feels that the matter of investment necessary to render the service desired now and formulating a rate for such service are of the greatest present importance. While methods of financing and of developing a greater use of the service are of the utmost importance, they are not touched upon in the present report because it is felt that they should follow rather than lead in the study of the general proposition. The main thing, in the opinion of your committee, is to be able to furnish service at the lowest annual cost and to establish a form of rate flexible enough to meet the needs of any condition. The first has been partly met by the preparation of the specifications for low-cost construction to which reference has previously been made. The present tendency of many companies to make an excessive investment in rural lines can well be overcome by following these specifications. The second matter of importance has been studied with the following conclusions:

STATEMENT

Rural extensions should be developed upon a self-supporting basis, so as not to impose an undue burden upon urban customers. The most equitable form of rate for rural service is one which takes into consideration the excess cost of furnishing this service over the cost of furnishing like urban service. Such a rate should contain an element dependent upon this excess cost in addition to the urban rate, such an element being known as "rural charge" and apportioned equitably among rural customers.

DEFINITIONS

1. The term "rural service" is taken to refer to matters relevant to the furnishing of electric service throughout the country districts, outside of the corporate limits of cities or villages having established services of supply or being of such size as to warrant the establishment of independent services of supply, or any other territory having similar character or density of population.

2. The term "rural customers" is taken to refer to customers of electric energy who are not located within the corporate limits of cities or villages having established services or supply, or in any other territory having similar character or density of population, except those sections within the corporate limits of cities and villages which are essentially rural in character.

3. The term "rural charge" is taken to mean the annual charge to be made to rural customers in addition to the regular urban rate, based upon the additional cost of serving such customers over the average cost of serving urban customers receiving the same grade of service.

This additional cost is, in general, composed of two items: (a) The annual charges upon the physical plant provided to serve rural customers, including transformers and services but not including meters or meter installations; (b) the additional line and transformer losses incurred.

Now out of all that you can develop a formula. It carried with it this idea that every rural rate should be composed of a rural charge plus an energy charge. This formula reads as follows:

Let C_m = average cost per mile of rural line, including transformers and services. (Secondary distribution should be omitted, owing to the scattered locations of rural customers and the difficulty of arriving at an average of such distribution which would be representative.

In its place the installation of one $1\frac{1}{2}$ kva. transformer should be assumed for each rural customer; then if secondary distribution is provided, in order to be economical it must produce total annual costs no greater than those produced by a $1\frac{1}{2}$ kva. transformer installation per rural customer.)

N = number of rural customers per mile, as determined by survey.

C_u = average cost of urban distribution system per urban customer.

A_c = annual charges on the rural line, comprising: Retirement expense, taxes, maintenance, return. (If financing of the line is done by the rural customer, the item of interest in the return should be eliminated to the extent that it is applicable to that portion of the financing done by the rural customer.)

T_l = transformer losses.

It is assumed that the total primary loss, transformer copper loss, and secondary loss in rural service is equivalent to the total losses in urban service. This leaves the transformer core loss as an excess loss in rural service. This is a steady load, can be readily calculated, and should be charged for on the basis of production cost only. This core loss is to be taken as the core loss of the average transformer per rural customer, which on the basis of a $1\frac{1}{2}$ kva. amounts to 184 kilowatt hours per year.

In the event of individual transformer installations of more than $1\frac{1}{2}$ kva. per rural customer, the actual core losses should be considered and figured at production cost. The customer requiring the additional transformer capacity should be required to pay for this additional core loss plus the annual charges on the added cost of the transformer installation over the average transformer installation ($1\frac{1}{2}$ kva.).

P_c = production cost per kilowatt hour.

R_c = rural charge.

$$1 R_c = \frac{(C_m - N \times C_u) \times A_c}{N} + 184 \text{ kwh.} \times P_c.$$

EXAMPLE

Assume: C_m (average cost per mile of rural line including transformers and services) = \$1,500. (See report on construction standards.)

Assume: N (number of rural customers per mile) = 4.

Assume: C_u (average cost of urban distribution system per urban customer) = \$75.

Assume: A_c (annual charges on the rural line) = 18 per cent; retirement expense = 4 per cent; taxes = 2 per cent; maintenance = 4 per cent; return = 8 per cent.

Assume: P_c (production cost per kilowatt hour) = \$0.02.

Then: R_c (rural charge) =

$$\frac{(\$1,500 - 4 \times \$75)}{4} \times 18 \text{ per cent} + 184 \times \$0.02 = \$54 + \$3.68 = \$57.68.$$

You will observe that the number of customers is the controlling factor. The minute that that number reaches the point where the line should be self-supporting, which we have found to be approximately at a rate of 20 customers per mile, the rural charge disappears.

Mr. CARTER. I may have a little different ideas of rural rates than some of the others. My general attitude is this: The rural consumer should be given the advantages of electric service and town consumers should pay some of the cost of rendering that service to the rural consumer in order to have a satisfied rural consumer. This may not apply to your State, but it does to ours. The major portion of our population was rural several years ago and now the condition is reversed and the major portion is in the cities. By making your rural convenience such that it will induce the younger generations to stay on the farms you are going to keep down the city congestion and develop rural territory. For that reason I think it is fair to the city consumer that the power company should charge some of that cost of rendering rural service on the city consumer.

The Indiana commission got out a little pamphlet about the same time that the Illinois commission did. I think most of you have a copy. The idea was to formulate a plan so that if any group of farmers wanted service the utility would have to give it to them. The scheme was adopted several years ago. We had a utility located about 20 miles north of Indianapolis in a strictly farming territory. This particular utility is really the pioneer of rural service. They thought rural service was the thing, and proceeded to develop a section of it. We now have several areas where such service is provided, some of them being financed by groups of farmers, some by utilities, and some by combinations. However, for years they were losing money. Incidentally they were giving the same rates for rural service they were giving in town, which I think was 8 cents, with 50 cents minimum charge. A great many of the farmers paid 50 cents, and 50 cents doesn't go very far in setting meters and keeping up property. That was soon found not to be a paying proposition and another scheme was worked out. This general scheme is to work the system up in two parts, one for general equipment and the other local equipment, the main line tying into the distribution system from the original or city territory. The general equipment is to be divided and paid for by the group of consumers. In addition to that is the local equipment, which includes the transformer for the individual and the line running in. The cost of these should not be charged against rural consumers, since it is equivalent to the amount that it costs the utility to render service to the old consumer in town. The rates to be applied are the same as for the same quantity to the consumer in town, plus the rural charge. The rural charge is made up as an annual charge payable one-twelfth each month, being 10 per cent for each consumer of the cost of his share of the entire equipment. The general equipment cost is figured on cost of material plus installation and plus 10 per cent for maintenance. The ultimate equipment is owned and installed by the utility.

We have some of our utilities that are rendering service in this way and working it very satisfactorily. There is another line where the farmers own the line and lease it to the utility. They have been losing money. They want to change the plan and take on new customers. This will not make it possible to make a profit, but will help get by and render service. The property, however, is to become the property of the utility to be maintained by the utility and kept in repair.

The construction of these lines should be under the supervision of the utility. Here is the situation which we have run into. We have in some of our smaller cities electrical contractors who will go in and build a line for a group of farmers and then the farmers will give it over to the electric utility providing they get the service. We have many telephone companies using grounded lines. You know what happens when you build such power lines paralleling these telephones. The electrical contractors generally get in a lot of trouble and hardly a day passes that somebody doesn't come in and complain that the power company has built alongside of the telephone line. If you let the farmers build the line they are all going to have trouble, so let the line be built under the supervision of the utility. It is cheaper in the long run to put up a good line than a cheap one.

Mr. CRITTENDEN. I am going to propose a plan to utilize to the best advantage the time which remains. My proposal would be to hear Doctor Wolff's paper now and then to divide our time this afternoon among the several subjects on which further discussion is desired.

[Discussion of rural electric service is continued on p. 90]

A PROPOSED CLASSIFICATION OF QUANTITY UNITS FOR TELEPHONE SERVICE

By F. A. WOLFF, *Telephone Engineer, Bureau of Standards*

INTRODUCTION

The primary function of the telephone section is the determination of standard measures for quantity and standard methods for specifying the quality of telephone service. The groundwork for this task was laid in Bureau of Standards Circular No. 112 on Telephone Service, published in 1921. One of the concluding chapters of this circular deals with the classification of the principal characteristics of telephone service, the elements to which value is attached in the mind of the subscriber or user. In the introductory chapter of the circular is contained a discussion of the principal classes of telephone service without any particular stress on the quantitative aspects of the subject.

During the past two years the efforts of the telephone section have been largely devoted to the survey of the United States Government telephone systems in the District of Columbia and elsewhere, undertaken by direction of the Bureau of the Budget; to preliminary studies, also under the auspices of the Bureau of the Budget, looking toward the simplification and standardization of the contractual relations between the Government and telephone utilities throughout the United States; and the simplification of the routines involved from the initiation of the requisition for service to the final audit of payment therefor. The Bureau of the Budget has also called upon the telephone section for its cooperation in the formulation of Federal specifications for the purchase of telephone apparatus, equipment, material, and supplies.

In addition the telephone section is represented by two of its members on the General Supply Committee, which revises and negotiates annually on behalf of the Secretary of the Treasury the contract for Government telephone service in the District of Columbia. Active work on the standardization of telephone terminology has

also been carried on under the auspices of a subcommittee of the Standards Committee of the American Institute of Electrical Engineers.

QUANTITY UNITS FOR TELEPHONE SERVICE

The superimposed work of the section has turned out to be in reality laboratory work, with the whole United States as its field, for a study of the quantitative aspects of telephone service from the viewpoint of the subscriber. This work has proven that there is a need for accurately defined quantities of service that may be used as standard units with which to measure service quantity in general. The purpose of measuring the quantity of telephone service is no different from the purpose of measuring any physical commodity; that is, to furnish a basis for charging and checking delivery. The quantity units of telephone service, either simple or composite, are "pegs," so to speak, on which rates and charges are hung.

The mere enumeration of the different quantity units encountered in our work seemed in itself a huge task and the problem of their exact definition seemed endless, particularly in view of the many minor differences found between units of the same kind.

As the result of a happy inspiration this task was much simplified through the recognition of the causes of their apparent complexity, which eventually led to the systematic classification presented.

Classification by major groups.—A natural first step is to consider the quantity units in groups, the units in each group being similar or closely related as shown below:

Classification of quantity units (major groups)

1. Direct exchange service.
2. Private branch exchange switchboards.
3. P.B.X. trunks.
4. Stations.
5. Extra station equipment.
6. Messages.
7. Lines and circuits.
8. Continuing miscellaneous quantities of service.
9. Noncontinuing miscellaneous quantities of service.

Detail classification.—A more detailed study of the subject made it apparent that, in general, each of the quantity units must be defined in terms of two or more different bases of distinction reflected in the wording of the company tariffs. For example, a unit of quantity of direct exchange service is defined in terms of the number of parties on the line, the character of use, the inclusion of originating messages, the length of haul, and sometimes in terms of variation from standard type of line, station equipment, or ringing equipment.

Procedure.—Using these and other distinctions which may be pertinent in the preparation of a table or chart, we arrive at once at a comprehensive understanding of all the possible quantity units for direct exchange service.

THE GENERAL PLAN FOLLOWED

1. It will be seen from Tables 1 to 9, each of which covers one of the major groupings, that a decimal classification scheme has been employed, the particular group as a whole being designated by an

integer. For each basis of further classification a particular decimal place is assigned.

2. The bases of classification set forth are the primary characteristics of the quantity units and are independent of rates or charges which may be associated therewith.

3. The bases of classification are arranged, as far as possible, in the order of their relative importance.

4. Any unit of quantity is defined by reference to the major grouping in which it is included and to the particular subitem under each detail classification heading.

5. Any unit of quantity may be designated by a numerical decimal code. Thus a two-party, residence, message-rate line within a particular local service area with standard type of line, station, and ringing equipment would be designated as 1.3221111. In case a particular basis of detail classification does not apply, a zero in the particular decimal place is inserted except that terminal zero may be omitted. If there is no zoning or its equivalent, and no distinctions are made on the basis of type of line, station, or ringing equipment the last four digits would be zero or omitted entirely.

Tables 1 to 9.—The tables are almost self-explanatory, though it must be emphasized that they are admittedly based on incomplete information, largely that gathered in connection with the Bureau of the Budget and General Supply Committee work.

In addition, it must be pointed out that while the possible number of quantity units based on permutations and combinations is huge in the aggregate, the actual number in a particular locality is definitely limited, ranging in number from that involved in the largest metropolitan areas to a relatively small number in the case of small communities or rural systems.

Time elements.—The question of time is only specifically introduced into Table 6, "messages," in which it is both necessary and essential. All the other quantity units, except a few, as, for example, those involving cost of installation, do involve the element of time, it being understood that the unit of time covered is that prevailing in the particular locality. This may be a month, a quarter, a year, or any specified part thereof in case the service does not cover the full period of time in question. In certain cases there is involved a minimum period of service. In the case of measured service there still exists a distinction between the monthly and the annual settlement basis in reckoning excess messages though the annual settlement basis is rapidly being replaced.

Public telephone service.—The unit quantity of service applicable to public pay stations (as well as semipublic stations except in so far as a minimum number of messages per month must be guaranteed) is obviously the message and this treatment has been adopted.

Company service.—This has been purposely excluded from the classification scheme, since such service may be considered as equitably prorated over the various kinds of quantity units of service rendered in the aggregate within the area served, the number of each quantity unit involved being also taken into account.

Special treatment.—Discounts, free service, or other forms of special treatment which may be accorded Governmental establishments (Federal, State, or municipal), eleemosynary institutions, clergymen, physicians and nurses, company employees, and possibly others are

not included in the tables, since the corresponding portion of the particular unit quantities are, in effect, carried as a "loading" by the aggregate of the other units of service rendered by the utility in the given community.

Terminology.—The definition of each of the quantity units tabulated becomes much simplified by adopting the following procedure:

1. To define accurately the terms employed in the classification into major groups.
2. To define accurately each basis of subclassification in each of the major groups.
3. To define accurately each term under each basis of subclassification.

The definition of any particular quantity unit is thus reduced to a composite set of definitions characteristic of it.

Acknowledgments.—Full acknowledgments are due my associates in the telephone section, particularly W. E. Brown and M. P. Shoemaker, for their valuable criticism and constructive suggestions made in the course of preparation of the material presented.

TABLE 1.—*Direct exchange service*

NUMBER OF PARTIES ON LINE:

- .1 Individual.
- .2 Auxiliary.
- .3 Two-party.
- .4 Four-party.
- .5 Eight-party.
- .6 Ten-party.
- .7 Multiparty.
- .8 Rural.

CHARACTER OF USE:

- .01 Business (high average demand).
- .02 Residence (lower average demand).
- .03 Business or residence (no distinction).
- .04 Coin box, business or residence (small average demand).

INCLUSION OF ORIGINATING MESSAGES:

- .001 All messages included (flat rate).
- .002 All messages up to a specified number included (message rate).
- .003 No messages included, though subject to a minimum guarantee (coin box and semipublic).

LENGTH OF HAUL:

- .0001 Average distance within local service area.
- .0002 Average distance within zone 1.
- .0003 Average distance within zone 2.
- .0004 Average distance within zone 3.
- .0005 Average distance within specified groups of C. O. areas.
- .0006 Average distance within specified contiguous or overlapping local service areas.

VARIATIONS FROM STANDARD TYPE OF STATION EQUIPMENT:

- .00001 Type adopted as standard.
- .00002 Desk.
- .00003 Wall.
- .00004 Dial, desk.
- .00005 Dial, wall.

VARIATIONS FROM STANDARD TYPE OF LINE:

- .000001 Type adopted as standard.
- .000002 Metallic.
- .000003 Ground return.

VARIATIONS FROM STANDARD TYPE OF RINGING EQUIPMENT:

- .0000001 Type adopted as standard.
- .0000002 Selective.
- .0000003 Semiselective.
- .0000004 Code.

TABLE 2.—*Private branch exchange switchboards*

[Exclusive of parts treated as separate equipment units]

TYPE OF SWITCHBOARD:

- .1 Cordless.
- .2 Nonmultiple, cord.
- .3 Multiple, cord.
- .4 Push button, key.
- .5 Automatic.

BASIS OF RATING:

- .01 Switchboard as a whole.
- .02 Positions or equivalent units.
- .03 Station lines.
- .04 Trunk lines.
- .05 Tie lines.
- .06 Station lines and trunk lines.
- .07 Station lines, trunk and tie lines.
- .08 Switchboard devices.

BASIS OF CALCULATION:

- .001 Capacity.
- .002 Number equipped.
- .003 Number in use.

SIZE AS RELATED TO NUMBER OF LINES:

- .0001 First group.
- .0002 Second group.
- .0003 Third group.
- .0004 Fourth group.
- .0005 Fifth group.

EQUIPMENT UNITS:

- .00001 Station drop and jack.
 - .000011 Station drop.
 - .000012 Multiple jack.
 - .000013 Multiple jacks in strips of 10.
- .00002 Extra operator set.
- .00003 Class D switching device.
 - .000031 10-point.
 - .000032 20-point.
 - .000033 30-point.
 - .000034 11-point.
 - .000035 21-point.
 - .000036 31-point.
- .00004 Automatic switching equipment units.
 - .000041 Connector.
 - .000042 Selector.
- .00005 Automatic power equipment units.
 - .000051 Station line unit.
 - .000052 Connector unit.
 - .000053 Selector unit.
- .00006 Automatic line equipment units.
 - .000061 Zero operator line.
 - .000062 Trunk dialing equipment.
 - .000063 Tie line terminal equipment A.
 - .000064 Tie line terminal equipment B.
 - .000065 Tie line terminal equipment C.
 - .000066 Tie line terminal equipment D.
 - .000067 Tie line terminal equipment E.
- .00007 Switchboard dial.

TABLE 3.—*P. B. X. Trunks*

KINDS OF P. B. X. TRUNKS:

- .1 Two-way.
- .2 One-way (outgoing).
- .3 One-way (incoming).

RELATIVE DEMAND FOR OUTGOING SERVICE:

- .01 Business (high average demand).
- .02 Residence (lower average demand).
- .03 Business or residence (no distinction).

INCLUSION OF MESSAGES:

- .001 Included with trunk (flat rate).
- .002 Specified maximum number included with first trunk (message rate).
- .003 Not included with trunk ("additional" MR trunks, or P. B. X. trunks on toll basis).

TABLE 4.—*Stations (not included elsewhere)*

CLASS:

- .1 Extension station (direct exchange service).
- .2 P. B. X. main station.
- .3 P. B. X. extension station.
- .4 Private line station.

RELATIVE DEMAND FOR MESSAGES:

- .01 Business (high average).
- .02 Residence (lower average).
- .03 Business or residence (no distinction).
- .04 Coin box, business or residence (small average demand).

INCLUSION OF ORIGINATING MESSAGES:

- .001 Included with station (flat rate).
- .002 Not included (message rate or coin box).

LIMITATION OF USE:

- .0001 No restrictions.
- .0002 Restricted to service between P. B. X. stations.
- .0003 Restricted to incoming service and service between P. B. X. stations.

AGGREGATE NUMBER:

- .00001 Representative station in first group.
- .00002 Representative station in second group.
- .00003 Representative station in third group, etc.

TABLE 5.—*Extra station equipment (not included elsewhere)*

KIND AND TYPE:

- .1 Head receiver.
- .2 Extension bell.
- .3 Extension gong.
- .4 Booth.
 - .41 Single.
 - .42 Unit type.
- .5 Transmitter arm.
 - .51 Tubular type.
 - .52 Jointed type.
- .6 Desk stand carrier bracket.
- .7 Station wiring plan.
 - .71 Plan a.
 - .72 Plan b.
 - .73 Plan c.
 - .74 Plan d, etc.
- .8 Extra length desk cord.
- .9 Station dial.
- .X Coin box.

TABLE 6.—*Messages (not included elsewhere)*

CLASS:

- .1 Local.
- .2 Suburban toll.
- .3 Long distance.

ORIGINATING STATION:

- .01 Subscriber station.
- .02 Public station, attended.
- .03 Public station, unattended.

KIND:

- .001 Station to station, except to particular P. B. X. station.
- .002 Station to particular P. B. X. station.
- .003 Person to person.
- .004 Appointment.
- .005 Messenger.
- .006 Report.

LENGTH OF HAUL:

- .0001 Average distance within local service area.
- .0002 Average distance within zone 1.
- .0003 Average distance within zone 2.
- .0004
- .0005
- .0006 Average distance within specified C. O. area.
- .0007 Average distance within specified contiguous local service areas.
- .0008 Approximate air-line distance.
- .0009 Shortest distance, pole line or railroad.

INITIAL DURATION:

- .00001 Five minutes or fraction thereof.
- .00002 Three minutes or fraction thereof.
- .00003 Two minutes or fraction thereof.

ADDITIONAL DURATION:

- .000001 Each additional five minutes.
- .000002 Each additional three minutes.
- .000003 Each additional two minutes.
- .000004 Each additional minute.

AGGREGATE NUMBER:

- .0000001 Representative local message in first block of additional local measured service messages.
- .0000002 Representative local message in second block.
- .0000003 Representative local message in third block.
- .0000004 Representative local message in fourth block.
- .0000005
- .0000006
- .0000007 Representative local messages in block above a specified number.
- .0000008 The particular message (public station, suburban toll, and long distance).

TABLE 7.—*Lines and circuits (not included elsewhere)*

KINDS:

- .1 Individual.
- .2 Party including rural.
- .3 P. B. X. station.
- .4 Trunk.
- .5 Tie.
- .6 Three-wire P. B. X. station.
- .7 Lines in leased cable (on private property, or on Government reservation).
- .8 Leased.
- .9 Private.

LOCATION OF SWITCHBOARD OR STATION:

- .01 In C. O. area local thereto.
- .02 In area of foreign C. O. in same local service area.
- .03 In local service area beyond base rate area.
- .04 Outside local service area.

BUILDING HOUSING SWITCHBOARD:

- .001 Wholly within building.
- .002 Running outside of building.

BASIS OF CALCULATION:

- .0001 Unit length.
- .0002 As a whole.

BASIS OF LENGTH MEASUREMENT:

- .00001 Route.
- .00002 Shortest regular route.
- .00003 Shortest street route.
- .00004 Air line.
- .00005 Minimum.
- .00006 Average length for particular locality in question.

UNIT OF LENGTH:

- .000001 One foot
- .000002 0-100 feet.
- .000003 0-300 feet.
- .000004 0-600 feet.
- .000005 300-1320 feet.
- .000006 One tenth mile or fraction.
- .000007 One quarter mile or fraction.
- .000008 Nearest quarter mile.
- .000009 Specified minimum.

SIZE OF GROUP BETWEEN SAME TWO POINTS:

- .0000001 Size 1.
- .0000002 Size 2.
- .0000003 Size 3.
- .0000004 Size 4.
- .0000005 Size 5.

TABLE 8.—Continuing miscellaneous quantities of service

NATURE OF SERVICE:

- .1 Operation of P. B. X. switchboard.
- .2 Switching service.
- .3 Extra directory listing.
- .4 Special night listing.
- .5 Night number listing.
- .6 Maintenance, etc., on irrecoverable labor and material costs involved in installation.
- .7 Maintenance, etc., on recoverable labor and material costs involved in installation.
- .8 Maintenance, etc., on whole installation.
- .9 Service not otherwise specified.

TABLE 9.—Noncontinuing miscellaneous quantities of service

NATURE OF SERVICE:

- .1 Service connection.
- .2 Excess labor, material, etc., over ordinary installation.
- .3 Labor, material, etc., in special installation.
- .4 Move.
- .5 Change of type or style of equipment.
- .6 Change of P. B. X. branch number.
- .7 Termination.
- .8 Service not otherwise specified.

PART OF PLANT INVOLVED:

- .01 Station.
- .02 Trunk line.
- .03 Tie line.
- .04 Nonmultiple switchboard.
- .05 Multiple switchboard.
- .06 Class D system.
- .07 Automatic switchboard.
- .08 Night service switchboard.

WHOLE OR PART THEREOF:

- .001 Applying to whole.
- .002 Applying to irrecoverable portion thereof.
- .003 Applying to recoverable portion thereof.
- .004 Representative average.

FACILITIES IN PLACE:

- .0001 Facilities in place.
- .0002 Facilities not in place.

BUILDING:

- .00001 In same building.
- .00002 Not in same building.

PREMISES:

- .000001 On same premises.
- .000002 Not on same premises.

ROOM:

- .0000001 In same room.
- .0000002 Not in same room.

DISCUSSION OF CLASSIFICATION OF QUANTITY UNITS FOR TELEPHONE SERVICE

Mr. CRITTENDEN. We have a few minutes left which might be taken for questions in regard to this subject. This study has grown out of Doctor Wolff's telephone work here at the bureau in the preparation of Circular 112 on telephone service and the survey of Government telephone service in the District of Columbia. Another aspect has been the wide diversity of terms for the same item of service used by different companies.

Colonel BETTS. The Bell telephone companies in New Jersey recently filed new rates. Heretofore there had been a rate based on 600 messages per annum. The ordinary schedule raises the charge per month, but allows a proportionately larger number of messages per month. I was wondering whether Doctor Wolff had formed any opinion as to which was the more equitable way of charging.

Doctor WOLFF. I think both schemes are equitable, but I think 50 messages per month and 600 messages per year are not equivalent. The small user will try to limit himself to the minimum number stipulated, and, therefore, will "play safe" by using a smaller number. It must be understood that 50 messages per month means that unused messages in one month can not be used in some other month. If he is on an annual basis he will use up nearly the whole number by freer usage.

Colonel BETTS. In New Jersey we have a great many seasonal resorts. At the end of the season the people close their houses and go away. Take 600 calls per year for a small subscriber, he could go away, close the house for the winter, and get a partial rebate of half of the normal amount. If the houses are closed for a couple of months under the new basis, a man has to be careful and keep down to 60 messages per month. At least he has no way of making up during the 12 months the 720 messages which he would have for the year.

Doctor WOLFF. We have been very careful to steer clear of rate questions, and this is such a question. The message rate schedules throughout the country are now largely on a monthly settlement basis.

Colonel BETTS. There is one omission in the classification of lines. You have left out the six-party line. The Trenton switchboard was built some years ago. It was the only one in the State designed to meet a peculiar local condition. A competing company built up cheap service with I don't know how many people on the line. There were a great many on the line at a low rate. The Bell system absorbed one of the competing systems, and thought it should try and hold these customers. So it installed a switchboard designed to serve six-party lines and designed with the idea of giving a lower grade of service.

Doctor WOLFF. I might say that there are admittedly a considerable number of items omitted in the classification. I invited you to point them out by sending out advance copies of this paper. I tried to limit the number of items in each column to a minimum, because two decimal places are required where the number is over 10. We would like very much to have you furnish us a list of any quantity units existing in your territory which are not included in this classification.

Mr. CRITTENDEN. Mr. Gildea, will you speak to us on this subject? Mr. Gildea is from the Maryland commission.

Mr. GILDEA. I feel that Doctor Wolff has gone into the matter in such a thorough and masterful way that there is hardly anything on the particular points that he has covered that I could go into without being very tiresome.

I think, however, that I might take up a few minutes discussing telephone problems with which the commissions are concerned, and which we hope will eventually be solved by the approach which Doctor Wolff has taken. The Maryland commission is as much interested as most of the commissions, and probably more than some of them, because our law is more liberal; our commission has power to investigate the situation, and spends quite a good deal of time on surveys.

Maryland is also peculiar in that we have practically no independent telephone systems. The American Telephone & Telegraph Co. and the Chesapeake & Potomac Telephone Co. of Baltimore City, a Bell company, operate over practically the entire State. The three or four independent companies in our State are very small, and we hope that eventually the Bell interests will buy them out. The Maryland commission has taken a definite stand in regard to competing companies. This was brought out recently in the case (not a telephone case, however) of a municipal electric light plant that was competing with a privately owned company which is becoming rather powerful and operating in the western part of our State. The municipality asked authority for a bond issue to rehabilitate and in fact to build a new plant. After investigating the case the commission felt that the plant could not be built for the amount contemplated and vetoed the bond issue. The legislature, however, passed a bill releasing the municipal company from the jurisdiction of the Maryland commission, so Maryland has some of the troubles that New York has.

In Maryland we have adopted the word "standard" instead of the word "rule." We have done this to get away from legal arguments. As far as telephones are concerned, standards are followed. We have adopted merely the general rules of the Wisconsin and Illinois commissions. We do not go into details because we are hoping that Doctor Wolff will supply something very definite in the near future. What we have in mind to do now is just to make some very general statements and impress the companies with the fact that we are going to require a certain grade of service. I agree with the consensus of opinion that the majority of rate questions will have to be solved on the merits of individual cases. They should be decided as much along the lines of service as along the lines of rates. I think you are all having trouble with the utilities' policies, especially since the war, and there are several matters which will have to be decided sooner or later. One that strikes us in Maryland is the amount of excess plant that the companies must carry in the future. There is no doubt in the world that in a good many instances before the war the amount of reserve plant was too large and since then the reserve has been too small. Nearly all companies in consequence have a long list of applications. We have been trying to solve this for two years, but have not gotten very far with it.

The directory is another problem. The Bell companies now publish two a year. Probably one would suffice in some places,

but I don't believe two directories a year are enough for a metropolitan district. When we get back to normal two will be enough, but an inadequate number of directory issues puts a burden on the traffic department, which is not fair. Some solution of this directory problem should certainly be undertaken. There has been suggested the issuance of supplements, but I don't think that will be satisfactory at the present time.

In regard to the rural-extension problem which was discussed this morning, I don't think I can add anything. I would like to say that we have about the same proportion of mutual companies that Mr. Vanneman spoke of. There seems to be a need for some kind of extension rule that will take care of automatic exchanges and it is a question whether the automatic development will be slowed down by the American Telephone & Telegraph Co., as it looks as if they are going along too slowly. If they are going to adopt automatic switching it looks as if they should go ahead and do it.

In the surveys we have made I think we have done something tangible during the last few years by keeping a strict record of complaints. We think this will provide us data in a couple of years which will give us something to go on when we want to lay down definite rules.

This spirit of cooperation between the commissions is a splendid thing. We can get some tangible results from it. I would like to suggest that we can get these ideas in a more concrete form than by each commission sending out questionnaires as has been done in recent years. My idea was to suggest that the conference have the Bureau of Standard act as a clearing house. In fact, if it can not, and if you think it would be desirable, the Maryland commission will offer to act as a clearing house on the telephone problem. If you will send your questions in, say in the next month or two, we will incorporate them into one questionnaire, summarize the answers, and submit them for everybody's benefit.

Maryland will be very glad to do what she can for you.

The discussion of telephone quantity units is continued on p. 95]

FOURTH SESSION (AFTERNOON OF FRIDAY, MARCH 7, 1924)

Mr. CRITTENDEN. Before we begin our regular procedure I should like to give Doctor Meyer a chance to make an announcement.

Doctor MEYER. I simply want to direct the attention of the engineers to the second edition of Circular 56, Standards for Electric Service, recently issued. If there are any engineers here who have not received a copy we will be glad to supply them.

DISCUSSION OF SUGGESTED QUESTIONS

Mr. CRITTENDEN. We have before us three items: The discussion of rural extension, telephone service, and the questions which have been distributed in mimeographed form. We will take up the questions first. There are 10 of these, and that means that we can devote only a few minutes to each one.

I will read the first question:

1. The National Electrical Safety Code, in classifying circuits as to grade of construction required, makes divisions at 750 and 7,500 volts where power circuits alone are involved, and at 750, 5,000, and 7,500 volts where telephone circuits are involved. The two latter figures involve the performance of telephone protectors. Is it desirable to eliminate one of the latter divisions? If so, should all circuits above 5,000 volts between conductors (or 2,900 volts to ground) be placed in the highest division?

Doctor LLOYD. I should like to speak a word in regard to this question. I think all of you know that we are now revising the National Electrical Safety Code and some of you are members of the committee that has that in charge. The details of procedure are being handled by various subcommittees and this question has come up in one of them. As stated here, the present code recognizes these three main groups for supply lines crossing signal lines. Nearly all of the States which at present have rules on the subject have followed the same classification. There are some exceptions, however, California, Connecticut (in its joint-pole rules), and Illinois have put all lines of 5,000 volts between conductors (or 2,900 volts to ground) in the class requiring the highest grade of construction. Pennsylvania has substantially the same thing in regard to 5,000 volts, although it gives 2,500 to ground. All the other States have followed the code and made the distinction of an additional class and applied an additional grade of construction to it. The thing hinges largely on how much protection the ordinary telephone protector gives and whether it will take care of the situation in case of contact of the telephone wire with a foreign circuit carrying a higher voltage. The American Telephone & Telegraph Co. and all the Bell representatives have maintained for years that the proper dividing line was 5,000 volts (or about half that to ground), and above that the telephone protector would not offer the necessary protection. About 1914, before the previous edition of the code was issued, experiments

and tests were carried out in order to try and settle that question. Some of the tests were made at Schenectady at the General Electric works, and some at Milwaukee. The general result of these tests in the opinion of the members of the bureau's staff who participated in them, and I think of most of the other representatives, except possibly those of the telephone company, was that the telephone company's claims were not substantiated and that for higher voltages the telephone protectors did give adequate protection. For a contact with a 6,600-volt circuit the protectors would ordinarily function properly, but sometimes they were uncertain in action, their behavior depending upon other conditions of the circuit. The decision was made at that time, consequently, in that uncertain range a recognition should be given to the fact that they will usually give protection, although they sometimes fail. Telephone and telegraph men are now claiming that the only proper place to draw the dividing line is 5,000 volts (or 2,900 to ground), anything above that constituting the maximum hazard. I should be glad to hear from you in regard to that question, as I am on the committee.

Mr. TOEPPEN. In Grand Rapids, ever since the citizens' company was organized down to the present time, joint use in line work has been carried out between the telephone company and the power company with a 7,200-volt distribution system. Only the usual precautions that are applied to the 5,000-volt construction are in force. There has been no record of serious accidents as a result. In the present adaptation and reframing of the National Code into a special code in Michigan we are going to set joint use at 7,500 volts, with only the 5,000-volt grade of construction required in maintenance work.

Mr. CRITTENDEN. Question 2 reads "Should the boundaries between heavy, medium, and light loading territory in the National Electrical Safety Code be revised?"

Doctor LLOYD. There are very few of you men here to-day who have these boundaries involved in your own territory. The present boundary between heavy and medium territory starts at the Atlantic coast, dips down a little as it goes west, and then goes north along the line of the Rocky Mountains. There is considerable question as to whether the territory in Montana should be shifted. There is also some question as to whether that line and also the line between medium and light territory would need some shift in Texas, and also where it approaches the Atlantic coast coming from Georgia. The line between light and medium territory comes east at the present time through Georgia and up near the coast into South and North Carolina. The new proposal is for continuing this line directly along east latitude 33° to the coast and this would involve principally some territory in South Carolina. As there are so few men here affected, I don't know that it is worth while to take the time to discuss it.

Mr. TOEPPEN. It would probably result in a line between the eastern and central zones rather than a theoretically smooth curve.

Doctor LLOYD. That is true; and some States that come in the dividing line have made very much more detailed division; California and Nevada for instance. Local districting might well be carried out by other States, especially where cut by the boundary line, but they have done nothing so far.

Mr. CRITTENDEN. Question 3. The National Electrical Safety Code at present prescribes medium and light loading in terms of heavy loading ($2/3$ and $4/9$), which assumes an 8-pound wind blowing upon conductors covered with ice one-half inch thick radially. Would it be preferable to express medium and light loading independently? For instance, medium as 0.3 inch ice and 8-pound wind; light as no ice and 12-pound wind.

Doctor LLOYD. That question was listed with the expectation that there would be a number of engineers present whose work lay in that territory. Mr. Johnston is the only one here interested, and the question requires quite a detailed consideration. I suggest that we allow the discussion to go over.

Mr. CRITTENDEN. Question 4. To what extent are gas-service conditions responsible for carbon monoxide poisoning? The bureau has had occasion to work particularly with the Maryland authorities on some questions involving this matter, and questions have arisen in other ways also. To get the question definitely before you, I will call on Mr. Weaver, who is in charge of our gas engineering work, to explain the situation.

Mr. WEAVER. The present situation with regard to poisoning from carbon monoxide is a rather serious one. I don't think it is necessary to go into how serious it is. We don't know definitely about it, but we do know that it is one of the very serious hazards to life and health at the present time. Everything that is possible should be done to eliminate this hazard. Quite an appreciable number of cases arise from suicide. People deliberately poison themselves with manufactured gas. There is also in the case of manufactured gas a considerable number of cases arising from poor installation, from leaky rubber tubes, from other flexible tubing, from accidentally opened burners, and things of that kind which do not have to do with the conditions of gas service as rendered by the utilities in eliminating this hazard.

Probably the greater part of the trouble is caused from the fact that the gas in the appliances themselves is frequently not burned completely. If any carbonaceous fuel, such as manufactured gas or natural gas, is burned and the combustion is not entirely complete, carbon monoxide results and carbon monoxide is, of course, a very dangerous poison even in very small concentrations if breathed continuously over a long period of time. The production of carbon monoxide in appliances can be usually traced to the fact that the appliance is not suitably designed for the service conditions which exist. If you have a free-burning flame; that is, one to which there is free access of air you will get complete combustion whether you have any primary air or not. By primary air we mean air that is mixed with the gas before it comes out of the burner. If you restrict the access of air to the flame in an oven or radiant heater, particularly if the flame is quickly cooled at any point, carbon monoxide is likely to be produced. Now here is where the service conditions come in. We have gas distributed in the United States ranging from about 300 British thermal units per cubic foot to 1,300 or 1,400 British thermal units. There are nearly 2,000 companies in the United States. There is no definite gap between manufactured gas and natural gas because some of the high heating manufactured gas is as high as 675 British thermal units per cubic foot, and some natural gas companies

are beginning to mix manufactured and natural gas and are giving gas of 700 British thermal units. Gases of approximately the same British thermal units content, whatever their composition, require more or less the same amount of air to burn them. We also have various pressure conditions from less than one-half inch water pressure at the appliances, to an extreme case of which I have been told, of 37 inches in the consumer's appliance. The manager of one company told me a number of weeks ago that there was a factor of 32 in the pressure at different consumers' appliances in his district. From less than half an ounce some appliances went up to 16 ounces. It is perfectly plain that it is impossible to get any appliance that will burn gas completely and satisfactorily under all these conditions. To make the problem more definite, if we have everywhere the same uniform conditions of gas service there would be no difficulty in designing, supplying, and having used those appliances which are suitable for the gas supplied. At the present time the appliance manufacturer frequently does not know whether his appliance is going to be sold for use with high or low pressure or with a rich or poor gas. Under such conditions he can not intelligently design his appliance. If conditions change, the appliances should be changed, but usually there is nobody competent to take care of adjustments to new conditions. The changes in service conditions are extremely serious because they affect people's health. We would like to have your opinion as to how far it is practicable to go, particularly in the natural gas territories, in eliminating these conditions and in getting gas companies and appliance manufacturers together.

Mr. VANNEMAN. We recently had an experience of that kind. It arose in connection with a section where the people used water heaters in their bathrooms. The result has been a recommendation to practically all companies to make a survey to enable them to eliminate water heaters from bathrooms and to refuse to render service to the customer where the heater is put in the bathroom. We had one case where we had prohibited the use of natural gas in furnaces on account of a limited supply. One customer asked permission to use gas, giving as his reason that on account of a cracked dome in his hot-air heater when he burned coal, coal gas escaped and came up into his house. We have had some experience with appliances improperly designed, but this has been chiefly in the case of conversions where companies have mixed manufactured and natural gas. These have been overcome.

Colonel BETTS. There is danger from using flat tops with old ranges. I know of one large company which is not selling them except in cases which are adapted for them. If you try to put a flat top on some of these ranges so that the gas flame will impinge on the top, you will see the desirability, perhaps, of having actual laws passed forbidding the sale of flat tops for use with old ranges. The department stores sell these appliances and the situation is not within the control of gas companies.

The gas companies ought to serve gas at the premises of the consumers under some fairly close range of pressure. One customer has one-half inch pressure and another customer three or four times as much. In such a case the company is really culpable. Householders do not know just what conditions are at their homes. Most

of our troubles and complaints have come from lack of uniformity in pressure.

Mr. HALL. In West Virginia we find that they are having a great deal of trouble with the distribution systems. Lots of towns are supplied with pressure at a pound or $1\frac{1}{2}$ pounds. In an investigation in Wheeling it was found that the town has outgrown the distribution system. It will take a great deal of study to find out what to do. If the pipes suitable for natural gas are not suitable for artificial gas, should we when the companies go out to enlarge their distribution systems require them to use pipes that are required for manufactured gas? How much variation should there be allowed in pressures to get the best results?

Mr. WEAVER. The problem is one of getting the appliance suited to the gas supply. At present there are all sorts of variations from city to city, and there is no way of controlling the sale and installation of appliances. There is no way of knowing whether the appliance is suited to your town or some other town.

Mr. HALL. Our pressure will vary each day in winter.

Mr. WEAVER. There is no reason why natural gas should be allowed to vary more than artificial gas except that most companies do not have an adequate distributing system. Natural gas is harder to burn than artificial gas. It is harder to get a sufficient amount of air mixed with it. There is even more reason from the standpoint of health for keeping the pressures uniform in territory supplied with natural gas than in one supplied with manufactured gas. Users of manufactured gas would not stand for the pressure variations that you get in natural gas regions. The large pressure variations which occur are probably responsible for the fact that we get more asphyxiations in natural gas regions than in others, in spite of the fact that natural gas is not poisonous.

Colonel BETTS. I don't think any company should furnish gas at a pressure exceeding 10 inches. The companies should see that it did not exceed this limit. In New Jersey we said that the minimum should not be less than $1\frac{1}{2}$ inches and the maximum not more than 6 inches, but at no meter should the variation exceed 100 per cent of the minimum at that particular customer's premises. In other words, if the minimum pressure at a particular customer's appliance were 2 inches, then the maximum should not exceed 4. Investigation indicates that this is too wide a range for good service. If the pressure varies from 2 to 4 inches, and you adjusted appliances at 3 inches, at 2 inches the service is inadequate with almost all appliances, and at 4 inches throttling is necessary. If the variation is from 3 to 6, results are bad, although our rules would allow that. The actual pressure range should be much narrower than the rules generally allow.

Mr. CRITTENDEN. When the flame blows against the cold metal it might cause very serious results. In fact the whole question is one which has its difficulties because it is not advisable to set forth a campaign of alarm for gas users because everybody must use gas more or less and should not be unduly scared. Nevertheless, there is more or less need for a campaign of safety. It is surprising how many cases we have found of improperly adjusted appliances in our own experience. A large proportion of cases of poor adjustment cause

carbon monoxide poisoning to some degree. How much can be done by the commission is open to question.

Mr. HAYDEN. The limits in Wisconsin are the same as in New Jersey. We have found that inadequate service pipes are a trouble in causing low pressure. The companies in our State to-day are not generally putting in services of less than $1\frac{1}{4}$ inches.

Mr. HALL. I can say that our gas companies are using $1\frac{1}{4}$ -inch services.

Mr. COVELL. I feel that this question of carbon monoxide poisoning puts a new aspect on the standard rules for service which should be adopted by the commissions. I don't believe that when the ordinary requirements for pressure variation were adopted, any consideration was given to this question, but in mains that have a variation of 2 to 6 inches, which a number of States allow, there is a possibility of forming carbon monoxide under certain conditions. One of the things which, perhaps, keeps this difficulty from being more serious than it is, is the fact that appliances are ordinarily adjusted when the pressure is above the minimum. In other words, ordinarily the man that makes the adjustment will get around to the house some time when the pressure is above the minimum and he will adjust the flow of gas for the pressure at that time rather than for the minimum within a given heating value. The wide fluctuations in heating value may change the flame characteristics so that it might produce carbon monoxide. Another phase of it is the adjustment of the appliance. In one instance I happen to remember a water heater installed in the kitchen that gave off considerable odor. I watched the test hand on the meter and timed it, and the water heater which was supposed to be consuming 30 to 35 feet per minute was consuming 125 feet; there was almost an open flow into the heater. The adjustment had been done by the company. Now such cases as that are inexcusable. I happened to go into a house not long ago while a survey was being made in the town during the peak load. The water column apparently didn't move and when I looked again it was 0.2 of an inch. I asked the lady how the gas service was and she said, "We can usually use the top burners but when we try to use the oven it blows the flame out."

Mr. BRUMBAUGH. I think your attention ought to be called to the survey made by the Baltimore city health department and the Bureau of Standards last winter. There was no single case in the Baltimore investigation that was attributed to pressure. They put in the right size orifice and had the air shutter adjusted properly. The trouble evidently was improper adjustment, and I believe about 8 per cent of the cases were caused by old or improperly made flexible tubing. The average appliance should be made so flexible that the average cooking burner and oven burner could be used at the same time without any trouble. We are working with manufacturers of appliances and those interested in them to eliminate improper design. We feel that we have done a lot, but when you have something like 190 appliance manufacturers and most of them learn the way from someone else, we have a difficult problem to solve.

Colonel BETTS. The appliance companies should be warned that they should not sell flat tops unless they know they are designed for the pressure range they are to be used on.

Mr. WEAVER. Nobody ought to sell anything to go on top of an existing gas appliance. But there is no reason why a properly designed flat-top range should not be used.

Mr. CRITTENDEN. Gas appliances are only a small part of the causes of carbon monoxide poisoning.

Mr. BRUMBAUGH. Couldn't the commissions help us out on this thing? Would they go further in controlling the service conditions? I believe that if these conditions are not corrected they will curb the use of gas.

Mr. CRITTENDEN. The next question also involves the question of gas service. Question 5. Under what conditions and with what limitations is it desirable to take action similar to that of the Colorado commission in permitting gas companies to choose their own heating value standards for gas?

Mr. HAYDEN. When the new British thermal unit standard was established in Wisconsin it was placed at a minimum of 520 with a variation of 4 per cent below and 5 per cent above, with the provision in the order that each utility was to use that British thermal unit standard which could be secured most efficiently with the manufacturing equipment which they had. I think that with few exceptions in the State the utilities have gone to a 520 British thermal unit standard. Now it may be that if the utility is given the right to establish any standard it sees fit, the result may be somewhat the same. The question is, will they reduce the British thermal unit content just as low as will admit of only the minimum service? I don't feel that the utility is going to the extreme and making the most they can out of the public. I don't know what the results have been in Colorado, but I can not see that the results in Wisconsin have been other than good, and, as I said before, most of the companies have gone to the 520 British thermal unit standard.

Mr. WEAVER. Let me ask whether, if they decide that they want to make another form of gas, you would let them make another change without holding them to the 520 standard; that is, under what conditions should they be allowed to make the change? Each gas company thinks they know better than anyone else what their plant is capable of doing, and under what conditions they can manufacture gas to the best advantage to themselves. If they are allowed to make the change in standard, in case they want a change, are you going to tell them that they can't do it until you make an investigation and satisfy yourself that the price is right, or will you leave it to them to make any change which they see fit? I think we should not forget that the consumer is buying available heat and not cubic feet. You have two factors of equal importance, volume and heating value.

I have recently been making a review of the published data on the relative usefulness to the consumer of the different heating values of gas. There is an absolutely false impression based on figures that have been published, that gas of one heating value is as good as that of another, but there is not time to go into that. A careful study of the data shows that equal service is given by equal quantities of heat whether supplied in 400 or 600 British thermal unit gas. The amount of heat he gets is the matter of interest to the customer. He is buying heat, not cubic feet.

Mr. HAYDEN. When the British thermal unit standard was reduced in Wisconsin it was reduced with the thought of providing the better service. An extended investigation was made in a very thorough manner and we were satisfied that if the British thermal unit standard was reduced to 520, the consumer would get better service than at 600, and I may say that we had more complaints on gas service in Wisconsin before this standard was adopted than we have had since.

Colonel BETTS. We took actual records of 700 domestic customers in Jersey City and the same number in Newark, all of which had been customers for at least five years before the change took place, and at least two years after the change took place. The analysis of these figures from 1,400 customers showed that the consumption had not been greater nor less for all those 1,400 customers. The reduction from 600 to 525 as measured at the plant meant nothing to the customer. The original reason for the reduction was because oil was scarce and expensive and everybody said we should save oil. Just as Mr. Hayden said, we also have had almost nothing in the way of complaints, excepting during the period while the change was being made and appliances were being adjusted. About the time that the reduction was made we warned the gas companies to make a house to house canvass and instead of the reduction taking place suddenly most of them took it in about two steps. The complaints, however, which rose from 2 or 3 a day to 100 a day came down to practically nothing. They developed in areas where the pressures were poor, but after the service pipes were cleaned or renewed and appliances adjusted, we got rid of the trouble and everything has been all right.

Mr. WEAVER. Let me suggest that when you got your gas companies to go around to adjust conditions in a house to house canvass you eliminated most of the causes of your prospective complaints for the next five or six years to come. People are slow to register complaints about unsatisfactory conditions, particularly those which develop gradually. When the gas man adjusted the appliances the customer had opportunity to call his attention to every indication of unsatisfactory service, and he was able to remedy or explain the trouble right there.

Colonel BETTS. I don't mean to say that there wouldn't be any variation in value of gas if you changed from 1,200 down to 900. However, as far as the small gas consumer is concerned, his bill is practically the same whether the standard is 600 or 525.

Mr. CARTER. I think one of the more important phases of gas service is not so much heating value as constant supply and constant pressure, constant quality and pressure.

Mr. RUDD. In answering that question about the limitations in allowing companies to choose their own heating values, about four years ago we visited all the heating companies in Connecticut and talked with them and asked each one if they were allowed to reduce the British thermal unit standard of gas, would they prefer to do that and reduce the rates, or maintain the standard then in effect and hold to the existing rates. They said any reduction in British thermal unit standard would play such a small part in their total expense it would not be worth considering.

Mr. TOEPPEN. Don't lose sight of the fact that the ordinary appliance as manufactured to-day is relatively inefficient and reaches the

point of maximum efficiency at a relatively low British thermal unit and then falls down, depending on the average efficiency of the housewife in using it. While you are talking of 500 and 600 British thermal units that change is within the limits of error of use that anyone has noticed.

Doctor WOLFF. One question I would like to raise when you speak of error. Errors may be plus and minus. If you decrease this heating value you certainly would expect, other factors being the same, to have a correspondingly increased consumption.

Mr. TOEPFEN. My argument there was that you are not getting to from 10 to 20 per cent of the heat in the cooking utensil.

Mr. CRITTENDEN. The housekeeper turns on the gas and burns all that comes.

Mr. COVELL. The idea of the Colorado commission is excellent. Only reductions of heating value should be made with the advice and consent of the commission. We have in Maryland a 600 British thermal unit standard. We have, however, a provision in the rules that any company that finds it advisable to use any other heating value, may reduce it after a hearing by the commission. In Baltimore we have a 500 British thermal unit standard. A number of the very small companies are not governed by what British thermal units they can operate best on. In the case of coal gas companies in particular, there would be a tendency to supply gas mixed with air and that will result in corrosion of the pipes which will result in drying out the meter diaphragms and, perhaps, corrosion of the meter and then the house piping and that is an important fact that should be taken into consideration. As far as 600 British thermal units goes, I feel that is a little high because by the time the gas reaches the limits of the distribution system the heating value may be quite considerably under 600. My own opinion is that about 550 is correct for ordinary use. For a gas plant with the present prices of oil it would be too low. With coal gas plants which are so small that they can also do without mixing air, they should not be allowed to make any reduction, at least not by any such method as mixing air with it.

Mr. BENNETT. We have considered this somewhat in Illinois. The commission had extended hearings at which the gas companies appeared and testified. We primarily looked to the possibility of using Illinois coal in the production of gas. That could be done, but the larger aspect of the question was using Illinois coal and conserving other high-grade coals. From the standpoint of the engineering section we were interested in getting a more constant grade of gas. The standard was 565 British thermal units. There is no question that uniform gas can be sent out if the heating value should be reduced to 500 or 525, which would be better than the fluctuating heating value of gas as now sent out. I am not subscribing to the evidence submitted to our commission. Some experts assured the commission that householders would not use more cubic feet of gas with the 500 than with the 565, and assured the commission that any reduction in the cost of manufactured gas would not be felt within the first year, and then the commission had control. But I think the question of rates would take care of itself. It is a fair issue for the city council to take up as a resolution. I think in the consideration of the British thermal unit content you should

take account of what you are going to save in quality and increase of steadiness of service.

Mr. WEAVER. Let me say that we fully recognize that the gas that is sent out uniformly is going to be the most desirable gas, and I don't think anyone in the Bureau of Standards would ever advocate the use of a heating value so high that the gas could not be kept reasonably uniform. On the other hand, there has been a whole lot of evidence given and a great deal of talk about gas of lower heating value being equally useful to the customer, for example, that 560 gas was just as good as 600. I have devoted probably a month and a half to the published data and have gone over practically everything that has been published. Almost without exception, all measurements made of the useful effects obtained show exactly the same thing—that there is no greater thermal efficiency when using gas of lower heating value. The best known data on consumption are those published by the Committee on Calorific Standards of the American Gas Association in 1920. They analyzed results of the change of heating value in Massachusetts during 1916 and 1918. The comparison gives 19 companies called Group A which were, in general, in the big industrial cities, which were allowed to change to a heating value basis of 500 British thermal units from the 16 candlepower basis 18 months before the other 39 companies were placed on the 528 basis. The committee itself divided the cities of the second group into two subgroups, one of which was made up of the larger cities and called Group C. There were 18 of these. If you compare the calorific values stated by the committee with the official records, you will find that there was a very serious mistake in the calculation. They took the heating value for the companies that did not change the first time, the Class B companies for July, 1917, to July 1, 1918, at 614 British thermal units. These companies had not supplied gas of this quality for four years previously. They had gone down to 598 in 1915. The committee arbitrarily assumes that during the war period they went back from 598 to 614 and assumes that they kept that standard during the hard winter of 1918 to July 1, 1918, although they were on the 528 basis after January 1. The error entirely destroys the validity of their argument. Making the comparison with the correct figures for 1918 and omitting the doubtful year 1917, we find that the change in relative consumption was 78 per cent of that predicted from the change of relative heating value for Groups A and B, and 96 per cent of that predicted from a comparison of Groups A and C. Group A included almost all the large industrial cities. Group B was made up largely of small residential communities. The figures for several years show that conditions were changing in the small cities in a different manner than in the large. If we compare the large cities with Group B, in which the small towns are predominant, we get a relative change of consumption considerably less than in inverse proportion to the relative change of heating value. If we compare the larger towns of Group C with the cities, the relative changes of heating value and consumption per meter were nearly equal. From this it appears that if the larger cities could be compared with others of their own class in which the heating value was changed at a different time, the change of consumption would have been greater than in inverse proportion to the change of heating value. The same sort

of mistake was made by the Calorific Standards Committee in the case of Reading, Pa., as in the case of Massachusetts. The heating values and consumptions chosen for comparison are not for corresponding periods of time. The comparison made in the case of Toronto was of consumption during April, 1918, and April, 1920, and takes no account of the effect of the cessation of the manufacture of munitions. Consumption increased $2\frac{1}{2}$ per cent in this period, and the committee assumes that this is a normal increase. In the neighboring city of Buffalo the heating value has not changed, but the consumption decreased 10 per cent in the same period. Data are available from several other localities, and when such statistics are considered as a whole, we find that the increase in consumption corresponds very nearly to, and in some cases is greater than, the decrease in heating value.

Mr. HAYDEN. Is that for individual consumers?

Mr. WEAVER. Consumption per meter.

Mr. HAYDEN. Divided into classes?

Mr. WEAVER. It takes in all of the industrial loads.

Mr. HAYDEN. Can you figure out theoretically any such reduction?

Mr. WEAVER. I do not know of any reason why the consumption should increase more than in proportion. The domestic load in Massachusetts changed more rapidly than the industrial. Therefore, the small cities which were largely residential communities showed in every year a big relative increase except when the industrial cities changed their standard. The residential community showed by far the bigger increase in sales per meter. This increase was probably tied up with the difficulty in getting fuel during the war period, the severe winters that we had, and the fact that the house heating radiant heaters were coming in; that explains why we have an excessive increase in consumption in this case. The comparison was not made and can not be made to eliminate all these factors. It partially eliminates them and is as good a comparison as you can make on that basis. It is far more reliable than when you take a company here and a company there, chosen by those who are financially interested.

Mr. HAYDEN. Did they make their comparison on the total output per meter?

Mr. WEAVER. Yes.

Doctor MEYER. Do you mean to say, Mr. Weaver, that the changes increased 112 per cent?

Mr. WEAVER. No; the proportionate change was 112 per cent in the opposite direction.

Mr. LARSON. It has been demonstrated to us that as a general thing the ultimate cost of gas is less if sent out at 528 British thermal units than if sent out at 600 British thermal units. Under our system of rate regulation the consumer pays the bill, and will receive the benefit of the most economical operation. It would seem to be best to let the companies decide at what heat value they can operate most economically; and prescribe such limitations only as may be found necessary to make the best use of the gas appliances.

Mr. WEAVER. If you can produce your billion British thermal units at less cost with 500 British thermal unit gas than with 520 British thermal units, by all means do it. The cost to be considered is total cost to the consumer and not holder cost, however.

Mr. LARSON. The companies think they could send out their gas more cheaply at a lower British thermal unit value.

Mr. CRITTENDEN. Question 6. A number of State rules for electric service allow 3 per cent, plus and minus, variation from standard voltage for lighting service. Is this a practicable and enforceable allowance? What is the answer?

Mr. HAYDEN. We have found in Wisconsin within reasonable limits that this can be met. Of course, it can not be met always. Those are the requirements in Wisconsin for the larger companies, 6 per cent variation. With smaller companies, 10 per cent variation during nonlighting hours. For all companies the power variation would be 10 per cent. We have found no particular difficulty in getting reasonable compliance with this.

Colonel BETTS. Just before the bureau sent out its questionnaire we had adopted a rule requiring that the voltage variation should not be more than 3 per cent above or 3 per cent below standard. I sent a letter out to all the companies in the State and asked what difficulty they had had. They said that they had not had any difficulty except in connection with complaints in regard to very considerable drops in voltage. The voltage instead of being 110 or 115 was down to 98, 10 or 15 per cent away from what it should have been. We made a survey of a town where the voltage went down to 93 or 94 volts. We required that they get busy and make a survey. We found that they have made a good many changes and ordered new transformers. We have never had any complaints anywhere in our territory where the regulation on the system is within 3 per cent.

Doctor MEYER. As Colonel Betts says, you don't get complaints until fluctuations are much more than 3 per cent, but I don't believe there are many companies that stay within 3 per cent. I have heard the vice president of one of the largest companies say that they can stay within 3 per cent plus or 3 per cent minus, but the smaller companies can not. We recommend 5 per cent, plus or minus in the second edition of Circular 56. A 5 per cent variation in voltage makes a difference in luminous flux of over 15 per cent in incandescent lamps, and will practically double or halve the life of the lamp as the case may be. It is a large amount, but I don't believe in putting into the rules a figure that can not ordinarily be maintained.

Mr. CRITTENDEN. How many States have records to show that 3 per cent is too low?

Mr. NEXSEN. It is practically impossible to maintain these standards, and especially so since the war. Prior to the war they were just about on the edge of it.

Mr. TOEPPEN. We discussed that question with the Edison Co. in Detroit before writing our rules last year, and Mr. Marshall said that they would get another engineer if that one could not hold to that.

Mr. HAYDEN. I think that it is, as Doctor Meyer says, quite impossible to maintain continually 3 per cent regulation. I am inclined to believe, however, that it would be better to set 3 per cent regulation and let them shoot at it. I don't think it could be adhered to at all times. Sometimes it would be exceeded, but I am inclined to think it could be put into rules as a good regulation requirement. That is what it amounts to with us. We do not go to the company and say that because they have gone over they have to correct the condition.

Mr. CRITTENDEN. I don't believe it is far from the truth to say that the variations run very nearly 10 per cent with many power companies.

Question 7. The Code for Electricity Meters is now under revision. To what extent do commission engineers use the code in question concerning metering?

Mr. TOEPPEN. What is the Code for Electricity Meters?

Doctor MEYER. It is a code produced by a joint committee of the National Electric Light Association and the Association of Edison Illuminating Companies. Last year it was approved by the American Engineering Standards Committee as an American standard. It is a code setting limits and tolerances for the acceptance of types of watt-hour meters. In the District of Columbia, Missouri, New York, and Washington the public service commission laws require that before a meter is installed the type shall be approved by the commission. The code states the engineering limits for making tests on the approval and acceptance of types of meters. It is now under revision by a sectional committee working under the auspices of the American Engineering Standards Committee.

Mr. CRITTENDEN. Question 8. Do any commissions require electric station records to be kept on uniform prescribed forms?

Colonel BETTS. We have no prescribed forms, but we require all companies to keep station records.

Doctor MEYER. We have had several requests from utilities for suggestions as to approved forms.

Mr. NEXSEN. In connection with the subway contracts with the city of New York, a body of engineers headed by a professor of Columbia University has prepared and is about to issue a set of such forms based on comprehensive investigations. For further particulars reference should be made to the mechanical engineer, Transit Commission, New York.

Mr. CRITTENDEN. Question 9. What are the respective advantages of the indeterminate form of street lighting contract? What is the reason for its very restricted application in view of the fact that material satisfaction with it has been expressed by the parties to it where it has been applied? In some cases the law requires street lighting contracts to be approved by the commission.

Colonel BETTS. The way we have gotten around it is by requiring the companies to adhere to their schedules. A special form has not been set by the board. Our utilities do not think it necessary for them to make contracts. Our idea has been that the standard schedule should be followed in every case, and the Public Service Electric Co. take an ordinary form, fill in the number and type of lamps required, and the rest is all printed in the rate schedule and saves a great deal of embarrassment due to tendencies to dicker.

Mr. CARTER. The Indiana commission follows practically the same scheme as referred to by Colonel Betts, but the street lighting in Indianapolis is by contract for a 10-year period and one year prior to the ending of the contract a new one is negotiated. I think at the present time a new contract will be let which will take effect next year. This will be done by the city and not by the commission.

DISCUSSION OF RURAL ELECTRIC SERVICE (Continued)

Mr. CRITTENDEN. Are there any further comments on that question? If not, we will resume the discussion of rural service where we left off this morning.

Mr. HAYDEN. I may be able to further befog the issue a little. I did make some notes this morning. In regard to the point that was brought out by Mr. Bennett, first, I believe that there were a great many schemes put into effect by the utilities in the States and that they were all different. Mr. Vanneman spoke about that particularly and said that they were all different. I think that is the net result because the average utility operator didn't realize what he was up against. We have all had instances in rural service that were really very ludicrous. I know of one case where the line extended out for two farmers and on that line there were three 5-kilowatt transformers. The average consumption bill for electricity for these two farms amounted to about 20 kilowatt hours. The line was built a mile and a half long, and it will not take you very long to figure out how much the company was making on that installation.

While the Wisconsin commission has not established any rules for rural service, we have four or five companies operating in the State that have a certain definite plan which conforms, in general, to the plan that was outlined by Mr. Vanneman. I presume the plan in Wisconsin would result in about the same complication if it were to be done under the direct formula suggested by Mr. Vanneman. We have also established the plan of prorating the connection charges for new customers after the cost of the line has been met. We have followed this view for lateral lines and we have made the connection for the lateral lines the same as the connection for the main line, if the cost of the lateral line per consumer is not more than that of the main line and the difference is divided among all consumers then connected to the main and lateral line. If the cost is more there will be no rebate to the original consumers. We have found this to be an equitable way to determine the connection charge and also that this method tends to level the cost for all consumers. It has resulted in reducing the connection charge in many instances to a very normal figure, so that in some cases it has been reduced to as low as \$100 by the prorating of the connection charges for consumers coming on subsequently.

We have established in Wisconsin the code for safe electrical construction, operation and better rural construction, with minimum requirements for rural construction. I think safe construction is something that some of the larger companies have gone to the extreme on. Some of the rural construction has been a great deal higher in cost than is necessary, but, on the other hand, I think the other extreme has been followed by some companies in that their construction has been below a reasonable standard. I think, however, in general, construction has been reasonable. It has been the feeling there that if the extension of rural service is not on the basis of the cost of the service, then, of course, the consumer in the villages and cities must pay for this service, and I think there is some question of the right of a company to extend the service in rural communities on any other than a compensatory basis.

I have held, I think, perhaps, extreme ideas in regard to the use of power on the farm. In the first place I believe that lighting is of prime importance. In other words, lighting is the most important part of service for rural communities, because if they have light they are getting something that they need more than any other user of electricity to my mind. I think on the average the use of power is limited to about 3 horsepower. A motor of this size will give the farmer all the power needed for his regular work. I am speaking of the average farmer. I am not speaking of the big dairy farmer, the big fruit farmer, or the wealthy man of the city living on a farm. I am speaking of the average farmer, the real dirt farmer, down in our part of the country. He should have service, and he is willing to pay for it. I think I am safe in saying that of the hundreds of farmers that have come to my office there is just one man that I was not able to convince that he should pay for what he was getting. If the average farmer can be shown that his service is costing a certain amount he will say, "I am willing to pay for it. I don't want anybody to give it to me. If you can show me what the cost of the service is, I am willing to pay for it." I believe all that is necessary is just to convince the farmer that he is not being made to pay more than his share of the installation. I know of lines where the demand charge, or the monthly charge before the energy rates are considered, amounts to from \$2.75 to \$4. This is on a line that was built by some farmers in a mutual company who came to us to have us fix rates for them, and we told them that they would have to charge \$3 per month per consumer. We also told them they would have to provide for wear and tear on the line. They couldn't see it. About a week after they were in, two 25-kilowatt transformers were destroyed by lightning, so that when they came into the office again they could see the reason and did put into effect the suggested rates.

I want to say a few words about cooking on the farm by electricity. I believe that the use of electricity for cooking on the average farm (I am not speaking of the districts near the cities or the summer resort districts or the districts where you have the fruit farms and large dairy farms, I mean the average farm that I spoke of before) will be practical enough as long as there is no native source of supply of fuel. I speak of wood as fuel in this connection; as long as there is wood that can be used for fuel it should be used. Usually the kitchen is the only big room that has to be heated. In the summer time the farmers use kerosene stoves and gasoline stoves.

I believe in regard to this investigation of the greater use of electricity on the farm, it is going to be very useful in the future. I don't believe it is necessary now. The farmer wants it as soon as he is in position to have it economically. In our section of the country the farmer doesn't object at all if he can be supplied with lighting and small power at from \$3 to \$5 per month. Our farmers are pretty well to do. The farming is diversified.

Mr. CHARLESWORTH. In Iowa the Railroad Commission has jurisdiction over the construction, maintenance, and operation of the transmission lines outside of cities and towns, but not over rates or service. In Iowa there are approximately 1,200 miles of strictly rural supply lines which have only farmer connections. Most of these supply lines operate at 2,300 or 6,600 volts with a few operating at 4,400 volts. Most of these lines are operating single

phase with a few operating three phase. There is one thing that I should like to know, and that is, what is the climbing space between pole conductors in other States?

Mr. RUDD. We use 30 inches.

Mr. CHARLESWORTH. Should there be special construction used for these rural lines? The minimum requirements in Iowa limit the length of span to 175 feet when No. 6 hard or medium hard drawn copper wire is used. When 25-foot poles of either class C northern white cedar or class D western red cedar are used the maximum length of span is 150 feet for the reason that longer spans for this length of pole will not maintain the necessary clearance between the conductors and the ground due to the sag in the wire in the middle of the span. During the last two years creosoted yellow pine poles have been used quite extensively in our State. In estimating the resisting moment of these poles, we use a fiber stress of 3,250 pounds. We require all supply lines to be built with reference to the strength of poles to meet grade B construction in a heavily loaded district. There is also considerable aluminum cable being used for the higher voltage lines, but not very much on rural supply lines.

Mr. RUDD said something about joint use of poles. What we term joint use of poles according to the safety code is where supply circuits and signal circuits are on the same pole line, but he uses the term where secondary and primary lines are on the same pole line.

Mr. RUDD. That was a misunderstanding.

Mr. HAYDEN. I would like to inquire as to what Mr. RUDD referred to in their requirements in regard to pole strength.

Mr. RUDD. Particularly in pole spacing and not line.

Mr. HAYDEN. The pole spacing would depend on strength requirements. In regard to joint use of poles, the Wisconsin commission, while it has not ruled against it, discourages the joint use of poles in rural districts because of the fact that you have not the proper maintenance or supervision, and it is felt that one side of the highway should be occupied by the telephone lines and the other by the electric lines. This is particularly necessary in Wisconsin because we have a great many grounded lines.

Colonel BETTS. About a year ago our New Jersey Public Utility Commission developed a set of rules covering extensions for gas, water, and electricity. These rules are not in the form of an order but have been recommended for adoption by the companies and although a few companies have rules slightly more favorable to the customer, most of the companies have adopted them as recommended. In the process of development I obtained information from every State in the Union that had a public service or railroad commission. In some States the commission has no jurisdiction. In others where they have jurisdiction no action had been taken on this subject. I made a careful digest of the rules and regulations of all commissions which had issued rules and included in the digest also rules and regulations of a number of cities and towns which had developed individual rules. In quite a number of cases it was provided that companies must make an extension of a certain length per customer; in others, that they must expend a certain amount of money per customer. Neither of these rules appealed to me, as the physical conditions in our State vary considerably. In the northern

part of the State the laying of mains frequently involves rock cutting and blasting; in the southern part of the State excavation is easy and \$1 expended in the installation of mains will go very much farther than where rock is encountered. From the outset I adopted the plan which required the company to make a certain investment for each dollar of permanent annual revenue. By relating the required expenditure to the revenue obtained therefrom or thereby, proper recognition is given to the varying conditions under which mains are laid. Our rule varies, of course, with the different classes of plant. We require a water company to expend \$3.50 in connection with the installation of the main itself (exclusive of the cost of the service connections), an electric company \$3, and a gas company \$2 for each \$1 of assured annual revenue. In connection with these rules we were able also to differentiate the real estate promotor from the individual applicant for service who lived a little farther out on a road leading toward the suburbs. With regard to promotors, our rules assume that there are no customers waiting for service and based on this assumption the promotor must advance all of the money required in placing the distribution system in the tract to be developed. As houses are built and become actual customers of the utility, refunds will be made to those who have deposited the money on the basis referred to; that is, a rate of \$3.50 for each \$1 of annual revenue in connection with water service, and corresponding figures in connection with gas and electricity. With regard to the individual applicant who already has his house built and occupied, and is awaiting service, our rule requires the company to invest without question such amount of money as the revenue in sight will support. The balance of the investment must be deposited by the applicant and will be held by the utility company without interest until such time as the revenues increase sufficiently to warrant the return. Any amount not refunded within 10 years shall remain the property of the company. For example, Mr. Smith applies to the water company for service. The gross revenue per year is estimated at \$30. The cost of the extension (main only) is \$200. Under the rule the company is required to expend \$3.50 for each \$1 of annual revenue, or \$105. This leaves an amount of \$95 which the immediately anticipated revenue will not support. Mr. Smith is required to deposit this with the company without interest. If no further revenue other than the \$30 per year is received from connections made directly to this section of main, Mr. Smith never regains the deposit which he has made of \$95. If, however, any time before the expiration of 10 years, another house is built, three and one-half times the revenue from which equals or exceeds the amount which Mr. Smith has deposited, he will have returned to him the whole of his deposit. At the present high cost of main construction, there are numerous instances where all of the deposit will never be refunded to the applicants for service. We have found these rules to work out very well and our complaint department has been very much relieved by the reduction in complaints concerning the inability or unwillingness of companies to make extensions. I might add that we do not call these rules "rural" rules. New Jersey is a small State and there is hardly any area, excepting in the desert pineland in the south central part of

the State, more than 10 miles from existing utility services. Although some local franchises do, our rules generally do not require that companies shall make extensions indiscriminately within municipal boundaries, as appears to be the case in some other States; so that we treat the entire subject in the same manner and believe that the rules should be applied uniformly, no matter what the character of the territory is, providing, however, that the applicants are within the general area which properly belongs to a given utility.

Mr. HARMOUNT. The Ohio commission does not undertake to supervise the construction of any rural lines, and practically no lines within the city limits of the municipality except those in conflict or crossing telephone lines, or crossing railroads, and for these exceptions we have a definite set of rules. An order that has just been revised covers almost all conditions that can arise in this work. Crossings and parallel lines are covered definitely in these rules. In many parts of the State we have two telephone companies operating so that in many cases both sides of the roadways are occupied by telephone lines. In that case the company constructing the new line generally has to make some arrangements with one or the other telephone company to construct the line. The rules recommend joint construction where local supply lines and local signal lines are on the same highway. Where there are high voltage lines involved we recommend that the high tension lines shall be on one side and the telephone lines on the other. We encourage joint use when lines are not considered as transmission lines.

Colonel BETTS. Joint use of poles cuts down the cost.

Mr. BENNETT. The Illinois commission rules on joint construction require that the supply service shall be at least 30 inches above the signal circuit. The thought that has occurred to me is that the energy used ought to determine the rules to be used. It seems that farmers in different States are different. I know from my own experience. In Missouri he is different from what he is in Illinois. I don't believe that the farmer is not going to use one thing. For instance, I am taking exception to Mr. Hayden's statement that he is never going to use electric stoves in cooking, for in some cases they are beginning to use them. Rules will have to be made up for the State in which they are going to apply. The Illinois rules will not be of use in Connecticut or in New Jersey. There are different individuals in different States.

Mr. HAYDEN. I want to make myself clear on that. I didn't say the farmer was not going to use electricity for cooking, but I will submit it to those who have had most to do with farmers that in fact they will not do so for some time to come. I mean the everyday over-all farmer, the dirt farmer, the young fellow who is coming in and takes the farm over from the old man. He may say I am going to use electricity for cooking. He will use it for a little while, but when he gets down to economy he is going to use what he can afford. He will use electricity first for lighting and then for power and lastly for cooking. I think we have in Wisconsin as successful farmers as there are throughout the country, but I do not think they will use the large motor when they have the tractor.

Mr. TOEPPEN. It seems to me we have covered just about every possible angle in the situation, and, as Mr. Bennett has said, it depends on the farmer and the farmer will barely eke out a living.

Mr. BENNETT. Somebody said he didn't think my other idea about the farmer advancing the cost of construction of a line was a very good one. It has this advantage, however. Most of the lines are constructed by the farmer and then turned over to the company and the farmer doesn't have any chance to get his money back, but in the other scheme he does get it back.

Mr. CRITTENDEN. Now we come back again to the telephone subject.

DISCUSSION OF TELEPHONE QUANTITY UNITS (Continued)

Mr. TOEPPEN: I take it that substantially the telephone quantity standards conform to those of the Chesapeake & Potomac Telephone Co. These could be laid before the nonassociated Bell companies in asking them to revise their classification somewhat. The troubles come when you attempt to readjust the classification of non-associated companies. The independent company schedules list all types of service which occur in their parts of the country and anywhere else. Just at present we don't see the particular need of indexing, although I see the convenience. In this connection, however, I will suggest a number of changes in the tables. Table 1 is concerned with control office service, and Table 2 with P. B. X. service. I believe we could better the arrangement if from Table 1 we drop the item "auxiliary line" now under "number of parties on line," and regard it as an "individual line," though it really might be considered a proper subdivision under the second column heading instead of under the first. I also suggest carrying back under "character of use," Table 2, the three subdivisions of column 1, Table 3, which are two-way and one-way P. B. X. trunks.

Doctor WOLFF. The thought we had in mind was this, that broadly classified we have "direct exchange service," and we have "private branch exchange service with direct trunks." Our tables would have looked more complete if we repeated in the different tables the items which are common kinds of service.

Mr. TOEPPEN. I have written for Michigan a number of schedules; the first ones I wrote were P. B. X. schedules. I included P. B. X. trunks with the line services and in the P. B. X. service only included indirect service. The P. B. X. service or indirect service signifies anything justified by the character of the line. Our last records of Detroit showed direct line business, I think around 250 per month as a minimum up to about 3,000 per month. The P. B. X. line was furnishing about 1,000 per month, so I am inclined to put P. B. X. up with "character of use" rather than in an extra grouping and I believe some similar combinations could be made between Tables 2 and 4.

Mr. CRITTENDEN. When you have had opportunity to make more detailed comments I am sure Doctor Wolff would be glad to have them.

Doctor WOLFF. Mr. Brown has some comments which I would like you to hear.

Mr. BROWN. Unit quantities of telephone service are solely for the purpose of measuring gross quantities. They enable the fixation, determination, and specification of gross quantity. The accuracy of such quantitative measurement depends upon the accuracy

of the definition of the unit quantities. This involves preagreement as to the meaning of adopted terms.

As members of the telephone committee of the General Supply Committee, which is authorized to annually contract for supplies and service in the District of Columbia, we have been able to convert the Government contract for telephone service from a form replete with ambiguous definitions to one which is slowly but surely gaining a reputation for definitions that really fix, determine, and fully specify the basis of agreement as to the quantities involved.

I have before me a copy of the Government contract for telephone service during the fiscal year ending June 30, 1924, and will call your attention to certain quantity units therein. These appear as numbered items. This contract, by the way, states that it is in accordance with the company's tariffs.

A single multiple jack (items 20032, 20033, and 20034) appears as a quantity unit because it carries a rate. The corresponding item in the company's general tariffs reads: "Multiple station, tie line and trunk jacks, in excess of one per line in strips of 10 jacks in use, per jack." Repeated futile endeavors to check up bills rendered, resulted in the present wording of the item in the contract which states: "For each multiple jack, of a number to be calculated, as of the last day of the month, by multiplying the total multiple jacks by the ratio of the number of lines in use to the number of lines for which jacks are provided, subtracting one for each line in use from this product where there are no separate answering jacks, and raising the result to the next even 10 if not an even 10." This is how the company calculates the number for which charge is made and is, therefore, what the tariff wording means.

Connectors and selectors (items 20052 and 20053) used in connection with automatic switching equipment at private branch exchanges are representative quantity units. The Government contract originally made no distinction between machines in use and spare. A machine in use is now the accepted unit and includes its share of spares.

A quarter mile of line is a unit quantity for calculating mileage charges. When a station is located beyond the boundary of the base-rate area the contract (item 20241) says the distance beyond shall be measured "air line." Evidently the station is one end of the air line, but where the other end of the air line would be was not known. It could be at the point on the boundary where the cable crosses, it could be the point on the boundary nearest the station and it could be on a theoretical line drawn from the station to the connecting central office. It has been determined that the nearest point on the boundary is the other end of the air line.

Charge is made for a part of the cost of installing a push-button type of private branch exchange (item 20212). Installing the cable system is the wording of the tariffs involved in this quantity unit, but the company claimed before the Interstate Commerce Commission that it could not keep its records so as to separately account for installing the cable system and the switches, and for installing the stations. In fact, then the entire installation is involved in this unit of service and the present wording of the Government contract is now known to be incorrect.

Multiple switchboards carry rates based on the number of positions (item 20031). The Government contract quotes a rate for each position. The question was raised as to whether an end position, not equipped with switching cords, should be counted, as is being done in one case. It has been agreed that the quantity unit in question does not apply to such positions.

Private branch exchange trunks are quoted as quantity units (item 20111 et seq.). Such trunks to the same switchboard are usually assigned consecutive numbers, but this involves the provision of spare equipment. Adequate spares are not always provided. We have had occasion to ask if the quantity unit includes a definite provision for additional trunks having consecutive numbers.

Another case involves the provision of metal molding to protect station wires run across a floor. Recognition of such a definite quantity unit was declined by the Supply Committee on the basis of no specification in either the Government contract or the tariffs of the company.

A private branch exchange with automatic switching equipment may have outgoing trunks to a city central office (item 20057). As the service is now rendered, in two cases, it includes refusal, on the part of the company, of toll calls over these trunks. It is evident that full advantage of automatic operation could not be taken if this service did not include refusal of toll calls, but in one city at least this particular quantity unit is not available.

It is very generally understood that on a long-distance person-to-person call (items 20353 and 20415) the timing begins when the calling and called parties first address each other. It has been found, however, that if a clerk, secretary, or operator representing one of the parties to such a call insists upon speaking to the other party in order to verify the establishment of the connection, the timing of the service for which the charge is made begins when such a representative addresses the other party. It follows that accurate definition of this quantity unit must include such cases.

The illustrations which I have given are but a few of those that could be given, but they should be sufficient to show the need for similar studies for other parts of the country. In the short time remaining I will add a few remarks concerning standardization of telephone terminology.

The accurate specification of quantity of service involves agreement upon standard terms and definitions of those terms. Our experience with regard to telephone service in general and quantity units in particular has shown conclusively the great need for uniform designations and uniform phraseology. Some work has been done along this line by a standardization committee of the A. I. E. E. but there is much to be done.

It would seem that the term which should be defined first is the term "telephone," if for no other reason than to serve as a basis for other definitions. I know of no such standard definition. The definition of a "telephone station" would logically follow that of a telephone and then the definitions of all kinds of telephone stations of which one is a "subscriber station" and another a "public station."

It is an unfortunate fact that in times past the term subscriber station, instead of telephone station has been used as a base for the definition of other kinds of telephone stations. This is indicated in

most of the literature pertaining to the art. The increasing number of telephones not subscribed for is, however, making it necessary to discontinue the use of the term "subscriber station" as a base. As an example it may be stated that the Federal Government alone owns and operates thousands of telephone stations not one of which is in any sense a subscriber station.

Similar arguments apply to lines and different kinds of lines. The basic term to be defined is a telephone line. The definitions of station lines and trunk lines would logically follow that of a telephone line and then the definitions of all kinds of station lines and all kinds of trunk lines. Subscriber lines and public telephone lines are different kinds of station lines.

A very good illustration of the need for standardization of terms was found when we endeavored to collect data concerning telephone service for which the Government is a subscriber in different parts of the country. That service which in Washington is known as individual line service, is known in other parts of the country by at least nine other terms. These are "direct line," "straight line," "one-party line," "private line," "exchange line," "main line," "independent line," "single line," and "single-party line."

Mr. HAYDEN. I want to make this suggestion to all of the engineers that are here, that bearing in mind what we have done this year and what was done last year at the conference, each one make it a point to dig up this year all that he can bring as a suggestion to the committee for next year. I wish you would do so within the next week while it is fresh in your mind, and if anything additional comes up between now and the time for fixing the program for the next meeting, I would like to know about it. I am making this as a suggestion because I know you have right in your mind whether you feel that it has been a success, or if you have something in the nature of criticism, that by all means should be discussed. I want to name as the committee on permanent organization, Mr. Bennett, Mr. Johnston, and Mr. Charlesworth.

Mr. GILDEA. I want to offer a motion of thanks to the Bureau of Standards for making this conference even more interesting and valuable than last year and for their courtesy in calling it.

Mr. BENNETT. Make it a rising vote of thanks.

Everybody stands.

The conference then adjourned sine die.



