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PUBLIC UTILITY SERVICE STANDARDS OF QUALITY  
AND SAFETY

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SCOPE OF THE WORK

The Bureau of Standards has been engaged for several years in a study of the standards of good practice and good service as applied to public utilities. This work includes (1) scientific and engineering research, (2) the study of public-relations questions, (3) the preparation of specifications regarding the quality of public-utility service, (4) investigation of methods of testing and inspection employed by municipalities and commissions, (5) preparation of safety rules for use by the utility companies to safeguard their employees and the public, and (6) the collection and distribution of information by published papers and through correspondence.

The following sections contain brief outlines of some of this work, together with lists of the publications bearing on the various subjects which are issued by the Bureau.

STANDARDS FOR ELECTRIC SERVICE

For several years the Bureau has been studying the question of standards for electric light and power service and the requirements that should be made by cities and State commissions of public-utility companies furnishing such service.

The results of this study are given in Bureau Circular 56, Standards for Electric Service (262 pages, issued July, 1916). This report was prepared with the cooperation of public-service commissions and engineers of operating companies and represents accepted good practice in electric service regulation and operating experience. The principal factors entering into good service are its quality and reliability and the accuracy of the meters used to measure the service. Steadiness of voltage and continuity of service, without which electric lighting is not satisfactory, are fundamental requirements in all regulatory rules and ordinances, in addition to definite requirements as to permissible errors of meters and their periodic testing.

All State rules and regulations for electric service now in force are given in full, and a set of rules suitable for adoption by State commissions is proposed. Three ordinances, adapted to conditions in cities of different size and class, are proposed. Those sections of all State public-utility laws that relate to electric service are given, and a number of city ordinances relating to service regulations. Based on the Meter Code, the standard approved by all operating companies, the report proposes specifications for the acceptance of types of meters. These specifications and the proposed service rules have already been adopted by a number of regulatory bodies. Other sections of the report are given to descriptions of standardizing laboratories of regulating commissions, and to discussion of the adequacy and safety of electric service.

#### STANDARDS FOR GAS SERVICE

Bureau Circular 32, now in third edition, 197 pages, covers the subject of "Standards for Gas Service." This paper includes a discussion of technical specifications and the methods of their enforcement, proposed forms for regulations, and a summary of the laws now in force, of much the same character and scope for the gas industry as Circular 56 is for electric service. Regulations for gas service, as made by cities or State commissions, include among other things the requirements as to meter accuracy and the testing of meters, the specifications of the heating value or candlepower of the gas (or both), the degree of chemical purity, and the manner and frequency of tests to determine whether the operating companies conform to the requirements. The Bureau has discussed these questions fully in this publication, especially emphasizing the relative importance of the different requirements.

The increasing use of gas for cooking, heating, and industrial purposes, together with the gradual change from open-flame to mantle lighting, has made the heating value of gas of much greater significance than formerly. Because of this change in commercial conditions, the Bureau has given especial attention to the matter of substitution of heating-value standards for candle-power requirements. The problem is, in general, an economic one, since it is important that the customers receive the largest practicable amount of useful heat for each dollar of total cost to them for the gas service. The circular in discussing this subject points out briefly how to properly determine the best standards for each locality.

#### STANDARD METHODS FOR GAS TESTING

To determine whether or not companies are complying with the requirements of the standards for gas service, tests of gas quality and of meter accuracy, and records of gas pressure, are required. Methods for this work have been investigated by the Bureau and are summarized in its Circular 48, entitled "Standard Methods of Gas Testing," 202 pages. This paper describes in detail methods of measuring heating values, candlepower determination, determination of impurities, pressure records, meter testing, apparatus and laboratory equipment, and contains various tables and curves.

Research reports covering special phases of this subject have also been issued, as follows:

Technological Paper 20. Determination of Sulphur in Illuminating Gas; by R. S. McBride and E. R. Weaver; 46 pages. This is an experimental study of the different methods in use. Recommendations are given as to the forms of apparatus best adapted for different purposes and directions for carrying out the determinations.

Technological Paper 34. Determination of Ammonia in Illuminating Gas; by J. D. Edwards; 23 pages. This paper discusses the choice of absorption apparatus, indicators, use of glass beads, tests of apparatus, and recommendations as to the best methods for use under different conditions.

Technological Paper 36. Industrial Gas Calorimetry; by C. W. Waidner and E. F. Mueller; 150 pages. This is a complete investigation of the types of calorimeters and the factors affecting heating-value determinations. Directions are given for operating the different types of calorimeters.

Technological Paper 41. Lead Acetate Test for Hydrogen Sulphide in Gas; by R. S. McBride and J. D. Edwards; 46 pages. This paper gives the results of studies as to the effects of important variables in this method, the forms of testing apparatus, the significance of the tests, and a recommended testing procedure.

Technological Paper 89. A Specific Gravity Balance for Gases; by J. D. Edwards; 20 pages. A method and apparatus for the rapid determination of gas density is described and operating directions and precautions are given.



Technological Paper 94. Effusion Method of Determining Gas Density; by J. D. Edwards; 30 pages. The results of an experimental study of the effusion method are given, together with a discussion of the sources of error, accuracy obtainable, and operating precautions.

Scientific Paper 216. The Pentane Lamp as a Working Standard; by E. C. Crittenden and A. H. Taylor; 26 pages. The testing and use of the pentane lamp as a standard for light measurements are described in detail.

Scientific Paper 222. Flame Standards in Photometry; by E. B. Rosa and E. C. Crittenden; 38 pages. This paper discusses the effects of atmospheric conditions upon flame standards and gives observations of the several types of lamps.

#### NATIONAL ELECTRICAL SAFETY CODE

The Bureau has been engaged for nearly four years in a thorough study of the life hazard in electrical practice and in the preparation of the National Electrical Safety Code. In this work it has had the cordial cooperation and assistance of the national associations concerned and a large number of electrical engineers connected with the electrical operating and manufacturing companies. The inspectors of State commissions and municipalities have also cooperated in the development of the safety code. The importance of having a truly national code, uniform in all the States and cities, is quite as great for accident prevention rules as for fire rules, and the advantage of having such a code prepared by a national agency that can study the subject thoroughly and consult all the interests affected is obvious.

A thorough study has been made by the Bureau of the diverse conditions under which electricity is generated, distributed, and utilized, and of the operating practice in different parts of the country. It has also given very careful attention to the effect of the code on operating and construction costs to the end that no unreasonable expense will be involved in its use.

The safety code consists of four principal parts, as follows:

1. Rules for the installation and maintenance of machinery, switchboards, and wiring in central stations and substations.
2. Rules for the construction and maintenance of overhead and underground lines for the transmission and distribution of electrical energy and intelligence.
3. Rules for the installation and maintenance of electrical apparatus and wiring in factories, residences, and wherever electricity is utilized for light, heat, or power.
4. Rules to be observed by employees in the operation of electrical equipment and lines.

The code also includes a set of definitions and a section covering the methods of grounding electrical equipment and circuits.

The code is recommended for examination, trial, and constructive criticism and for adoption (tentatively during an initial trial period) by State, industrial, and public service commissions and municipalities, and as a guide to electrical practice to public service and industrial organizations. It is also used by casualty underwriters, workers, and students interested in the subject.

The code has been adopted voluntarily in whole or in part by a large number of operating companies, including some of the largest as well as some of the smallest in the country. A number of State commissions and municipalities have also in one form or another adopted the code or recommended its use by the utilities under their jurisdiction. It has also been made the basis for the requirement of casualty-inspection departments. It is expected to further develop the code by revisions and amendments from time to time, with the cooperation of all parties interested.

The code has been issued in the form of Bureau Circular No. 54, 323 pages. Copies may be obtained from the Superintendent of Documents, Washington, D. C., paper bound at 20 cents or cloth bound at 30 cents each.

#### ELECTROLYSIS MITIGATION

The subject of electrolysis mitigation refers to the overcoming of the electrolytic damage to gas and water pipes, cable sheaths, and other underground metallic structures by an electric current, as it flows through the earth back to the generating station, usually coming from street-railway systems.

The economic importance of the electrolysis problem, together with the indirect life and fire hazard due to electrolysis, have caused the Bureau to carry on extensive studies in this field for the past six years. Electrolysis surveys have been made in over a dozen cities, varying in scope from preliminary tests to detect the presence of electrolysis to complete surveys with the design of mitigative systems. These surveys are sometimes made with the active cooperation of all the interested parties and the success of the results in such cases depends in part upon the fact that all of these parties come to understand the existing conditions and the necessity for the improvements recommended. Laboratory work has also been carried on in conjunction with the field work to obtain basic data necessary for intelligent action in solving the problems which arise.

The following technologic papers have been published relating to this subject:

Technological Paper 15. Surface Insulation of Pipes as a Means of Preventing Electrolysis; by Burton McCollum and O. S. Peters; 44 pages. This paper describes tests of a large number of metal preservative paints and pipe wrappings used as insulating coatings and summarizes the experience of 19 large pipe-owning companies with pipe coatings under various conditions.

Technological Paper 18. Electrolysis in Concrete; by E. B. Rosa, Burton McCollum, and O. S. Peters; 137 pages. A number of experiments are described which were made to determine the effects of electric current on reinforced concrete of various mixtures. The cause of cracking of concrete at anode and softening of bond at cathode and the conditions under which this phenomenon occurs are shown. Precautions to be taken to avoid electrolysis in reinforced concrete are discussed.

Technological Paper 25. Electrolytic Corrosion of Iron in Soils; by Burton McCollum and K. H. Logan; 60 pages. This paper describes the effects of current density, moisture, temperature, and certain chemicals on electrolytic corrosion. The electrical resistance of soils is discussed and data on soil resistance in several cities are given.

Technological Paper 26. Earth Resistance and its Relation to Electrolysis of Underground Structures; by Burton McCollum and K. H. Logan; 48 pages. This paper gives methods of determining soil resistance, the factors effecting the resistance, and the relation between soil resistance and electrolysis.

Technological Paper 27. Special Studies in Electrolysis Mitigation: I. A Preliminary Study of Conditions in Springfield, Ohio, with Recommendations for Its Mitigation; by E. B. Rosa and Burton McCollum; 56 pages. Out of print. Data on the return insulated feeder system are given.

Technological Paper 28. Methods of Making Electrolysis Surveys; by Burton McCollum and G. H. Ahlborn; 84 pages. This paper shows what data should be taken for determining electrolysis conditions and methods and apparatus for obtaining it. The interpretation of the data is discussed and tables are given for computing the currents carried by pipes. This paper is prepared especially for the information of those who desire either to make electrolysis surveys themselves, or to cooperate intelligently in such a survey.

Technological Paper 32. Special Studies in Electrolysis Mitigation No. 2: Electrolysis from Electric Railway Currents and Its Prevention—Experimental Test on a System of Insulated Negative Feeders in St. Louis; by E. B. Rosa, Burton McCollum, and K. H. Logan; 34 pages. Data on an insulated return feeder system are given as well as the change in over-all potentials, potential differences, and leakage currents due to its use.

Technological Paper 52. Electrolysis and Its Mitigation; by E. B. Rosa and Burton McCollum; 143 pages. Electrolysis phenomena are briefly described and methods are discussed of electrolysis mitigation applicable to pipe systems and to the railway negative return system. Foreign practice in regard to electrolysis regulations is discussed and suggestions made as to desirable bases for regulation in the United States. This paper is prepared particularly for the general reader and officials desirous of becoming familiar with methods of dealing with electrolysis problems.

Technological Paper 54. Special Studies in Electrolysis Mitigation: III. A Report on Conditions in Springfield, Ohio, with Insulated Feeder System Installed; by Burton McCollum and G. H. Ahlborn; 64 pages.

Technological Paper 55. Special Studies in Electrolysis Mitigation: IV. A Preliminary Report on Electrolysis Conditions in Elyria, Ohio, with Recommendations for Mitigation; by Burton McCollum and K. H. Logan; 49 pages. The methods used



for determining the size and location of insulated return feeders are described and data on the cost of the recommended system are given.

Technological Paper 62. *Modern Practice in Construction and Maintenance of Rail Joints and Bonds in Electric Railways*; by E. R. Shepherd; 123 pages. This paper contains an analysis of the experience of 42 electric railway companies with bonds of different types, as well as a full discussion of costs, durability, and methods of installation of all types of bonds and joints in common use.

Technological Paper 63. *Leakage of Currents from Electric Railways*; by Burton McCollum and K. H. Logan; 31 pages. This paper deals mathematically with the relation of track resistance between rails and earth, to leakage of current from the rails under different conditions. The relations found are plotted in the form of curves, and a summary of the results of the paper is arranged for the benefit of those who do not care to follow the mathematical development of the ideas.

Technological Paper 72. *Influence of Frequency of Alternating or Infrequently Reversed Current on Electrolytic Corrosion*; by Burton McCollum and G. H. Ahlborn; 31 pages. The results of experiments on electrolytic corrosion when the direction of current periodically reverses are described and discussed. Iron and lead electrodes were used.

Technological Paper 75. *Data on Electric Railway Track Leakage*; by G. H. Ahlborn; 22 pages. The tests on track leakage on three suburban lines are described. The paper is of interest in connection with the formulas developed and discussed in Technologic Paper 63.

#### FURTHER ACTIVITIES

For several years the Bureau has been engaged in the preparation of a national gas safety code similar in general purpose to the National Electrical Safety Code. Considerable progress has been made in this work, but the code is not yet ready for publication.

Work has also been carried well along in the preparation of a circular on street lighting which will give in considerable detail the technical foundations for street-lighting installations, and model contracts which will be of value to cities entering into new contracts.

Experimental studies have been made of telephone apparatus, and some testing of such apparatus has been done. Studies have also been undertaken to ascertain to what extent the different grades of telephone service required under various conditions can be described in a series of standard service specifications, especially with a view of improving service without burdening, to an undue degree, the operating company.

The Bureau is constantly called upon to answer questions and to carry out special investigations, and endeavors to keep in touch with current practice. Many of the unpublished results of this work can be made available to those interested.

The Bureau is ready to cooperate with State and municipal officials and municipal engineering associations in the study of any of these subjects and to act as coordinating agency in assisting to bring about uniform standards of practice and requirements in public-utility regulation.

The publications referred to in the foregoing pages, unless indicated as being out of print, are available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a nominal price.

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