



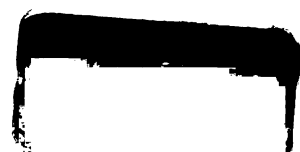
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A METHOD FOR ALLOCATING
ELECTRIC POWER COMPANY PROPERTY VALUES

THESIS FOR DEGREE OF M. S.
THOMAS C. DEL

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THESIS

INTRODUCTION

At this time, when electric service rates are of vital interest in the United States, there is a definite demand for a method of cost-of-service analysis which will show the relation between the cost of the service rendered and the charges for such service, not only for service as a whole but also for each of the various classes of electric service rendered.

Certain state utility regulatory bodies have called on utilities under their jurisdiction for cost analyses of this kind by classes of service or by rate schedules. In some cases it has been claimed that an accurate analysis of this kind cannot be made, or, that even if it were possible, the analysis would have very little permanent value because of the ever-changing conditions of the relative volume, demand and other characteristics of each of the various classes of service rendered.

The author recognizes that an analysis of the cost of service for a period in the past does not necessarily result in determining the proper rate to be charged in the future, and that the analysis cannot determine the effect upon rates of changing economic, social and industrial conditions which may increase or decrease the future demands for any certain class of electric service. Nevertheless, he believes that analyses of this type may be made of great value in establishing reasonable rates and that periodic analyses must furnish the guide by which intelligent management plots its future pathway in regard to rates. Such an analysis, for example, is invaluable for the study of a proposed new rate schedule, in the defense of the reasonableness of an existing rate or in resisting the establishment of an unreasonable and confiscatory rate.

The method described in this thesis covers only that part of the analysis which concerns the allocation of property value against each of the various classes of electric service rendered by an electric power utility. The method is not new in principle but, so far as the author has been able to determine by extensive reading and consultation, is new in its manner of determining the necessary factors for such an allocation of property value. Briefly, the method outlined in this thesis utilizes commercial and operating data collected as a matter of routine operation by the majority of large operating companies and requires little or no special data. To this extent it is new and outlines a system whereby the vast expense of the usual methods of allocation can be considerably decreased.

The method described has been utilized recently by a large utility in determining its property value allocation against certain classes of service rendered.

GENERAL

Factors Involved in Determining Rates

A fair rate for any class of electric service must be based on the cost of supplying that service. In all fairness the costs incurred on the behalf of one class of customers must be paid by that class. This involves an allocation of costs incurred against the various classes of service, a process of intricate detail and apparently at times impossible. Yet the problem yields to intelligent attack and the method, while laborious in the extreme, is accurate to an extent not at first apparent.

The term "cost of service" must include both operating expense and carrying charges on the value of the electric system. Operating expense includes the costs of labor and of material used in rendering electric service. Labor costs include such items as wages paid to linemen, groundmen, substation and power plant operators, load dispatchers, metermen, troublemen, clerks, stenographers, foremen, engineers, superintendents, managers and other labor of numerous types. Material includes coal for the boilers, oil for the turbines, repair parts for damaged apparatus and so on through a list of thousands of items. Included in the cost of operation also are many forms of insurance and taxes, such as fire, automobile and compensation insurance and income and excise taxes.

Carrying charges on the value of the electric system include such items as interest, the rental price or hire of the dollars used in building the system; depreciation and obsolescence, the provision for the replacement of the capital invested in the system, which may vanish from wear or from functional old age of the equipment; and all those taxes which are based on the value of physical property.

The item of carrying charges on the value of the electric system is a major factor in arriving at the cost of service. In the majority of companies it represents from fifty to eighty percent or more of the cost of service; hence the necessity for an accurate allocation of the value of property used and useful in rendering service against the various classes of property which it serves.

Of importance also are the trends of operating costs and carrying charges over a period of years. Any allocation is at best only a temporary picture of conditions as they then exist; conditions may have been radically different last year and equally as well may be radically different next year. For instance, in these depression times the investment in electric systems is as great as or greater than it was during the more prosperous period of several years ago. Yet the load served, both in kilowatts of demand and in total kilowatt hours sold, is much less than that of 1929, for example. Operating labor can be reduced but slightly with decreasing loads and the same is true of operating material. Hence, any analysis at a given period must be

viewed to some extent from the standpoint of a long term of years and the probable future picture, before it can be used in establishing rates. The best guide for planning the future is obviously the experience of the past; therefore the long term trend of operating costs and carrying charges is tremendously important.

Allocation of Property Against Classes of Service

In any rate case, whether it is the establishment of a new rate or the defense of an existing rate, the problem is relatively simple in principle. Briefly, after subtracting operating expenses from income, the remainder should provide for property taxes, depreciation and obsolescence, and a fair rate of return on the value of the property used and useful in rendering service.

In theory a single simple universal rate applicable to all classes of electric service would seem to be ideal. Such a rate, however, would actually be discriminatory and would result in certain classes of customers obtaining service at only part of its actual cost, the balance of the cost being borne by other classes of customers. The proper single rate might be evolved, but it would be so complex as to render its use practically impossible. Hence it is the common practice amongst electric power companies to divide the whole field of customers into a relatively small number of classes, this division being based on the character of use of electric service. For each different class of customer or service there is a rate structure based on the cost of service to that particular class.

The general divisions or classes of service are essentially the same for all electric power companies, almost without exception, though further subdivisions may vary considerably. These general divisions are residential service, commercial lighting service, commercial (or retail) power service and industrial (or wholesale) power service. In addition there may be special classes of service, including that supplied to electric railways, ice-manufacturing companies, electric welding operations, pipeline pumping companies, irrigation projects and others whose use of electric service varies so far from the characteristics of the usual classes that a special rate is necessary.

The residential service class is marked by definite characteristics, applicable to the vast majority of customers of this class, of small kilowatt hour consumption per customer, relatively large time diversity of demand, low load factor, small demand per unit of geographic area, large investment in electric system per customer and per kilowatt of demand, and high cost of service per kilowatt hour. The major use of residential electric service is for lighting and for small household appliances, with a relatively small use for cooking and water heating. In number of customers, the residential class of service is in the vast majority and constitutes approximately ninety percent of the customers of the usual electric power company.

The next most common class of service is that supplied to commercial lighting customers. The characteristics of this class are moderate kilowatt hour consumption per customer, small time diversity of demand, higher load factor than for residential service, moderate to large demand per unit of geographic area, large investment in electric system per customer but moderate on a per kilowatt of demand basis, and a somewhat lower cost of service per kilowatt hour than that for residential service. The predominant use to which this class of service is put is lighting, with incidental use for small power. This class of customers usually numbers eight to ten percent of the total for the usual electric power company.

The commercial power customers are the next class in order of number of customers. Small to moderate kilowatt hour consumption, large time diversity of demand, low load factor, and usually low cost of service per kilowatt hour are the usual characteristics of this class of service. The majority of use is for small industrial power purposes, with a relatively large proportion of lighting. This class usually includes only one percent or less of the total number of customers for the average electric power company.

The industrial power class includes practically all of the remaining customers, with a few special class customers having special rate structures. This class of service is marked by large kilowatt hour consumption per customer, small time diversity of demand, high load factor, relatively low investment in electric system per kilowatt of demand and low cost of service per kilowatt hour. The use of service is almost entirely large industrial power, with only a relatively small amount of lighting. The number of this class of customers is very small.

To serve all these various classes of customers there is required in the usual electric power company four distinct types of property, as follows:

Generating equipment, to generate electric power at a relatively low voltage and deliver it either to the transmission equipment, or to the distribution system equipment or both.

Transmission equipment, to "step-up" the power delivered to it to high voltages of the order of 22 kv. to 220 kv., transmit it to local load centers and there deliver it to the distribution substation, either directly or through the medium of other transmission substations and lower voltage transmission lines. The transmission equipment may and usually does include both transmission substations and transmission lines.

Distribution substation equipment, which "steps-down" the voltage of the power delivered to it to voltages of the order of 2.3 kv. to 6.9 kv and delivers it to the distribution system equipment.

Distribution system equipment, which delivers the electric power to the customers, including all of the residential, commercial lighting and commercial power class and to some of the industrial power class. The distribution system consists of primary circuits (2.3 kv. to 6.9 kv.), distribution transformers and their associated equipment, secondary circuits (115 to 460 volts), services, meters and in some cases building wiring and equipment.

All of these types of property are used simultaneously by certain classes of service, though not all classes of service use all types of property. Ordinarily the residential, commercial lighting and commercial power classes will use all four types of property simultaneously. The industrial power class may use only the generating equipment and part of the transmission line, as is shown in Figure 2, "Simplified Diagram of an Electric Power System"; or may use all four types of equipment, as shown in the same figure. Since carrying charges on the value of that part of the electric system used and useful in supplying electric service are a major part of the cost of supplying service, in any attempt to determine the proper rate for a certain class of service the value of types of property used simultaneously by two or more classes of service must be properly allocated against the classes by which it is used.

A further complication of the problem of allocation is introduced by geographic location, in many instances. In some companies the rate for a certain class of service is the same regardless of the geographic location of the territory served; in many others, particularly those in which rate negotiations are conducted with the authorities of each of the communities served, no such uniformity of rates is possible. In such cases different rates for the same class of service usually prevail for the different communities, even though they are served from the same electric power company and in general with the same equipment.

Figure 1 "Production and Transmission System" will serve to illustrate the complexity of geographically allocating generating and transmission equipment for a system of only moderate size. Figure 2 "Simplified Diagram of an Electric Power System" is a simplified diagram of part of Figure 1 and in addition shows a small part of the distribution substation and distribution system equipment involved; this figure will illustrate the same complexity of geographical allocation as it applies to distribution substation and distribution system equipment. Referring to Figure 2, it is apparent that the generating equipment serves customers of all classes both inside and outside the area in which the rates are assumed to be in dispute. The same is true of the transmission system, including the transmission substations and both the high voltage and the low voltage transmission lines. In addition, distribution substations located inside the area serve customers of several classes located inside the area as well as

customers located outside the area; distribution substations located outside the area do likewise. Distribution systems originating inside the area serve customers both inside and outside the area, as do distribution systems originating outside the area.

PROPERTY VALUES TO BE ALLOCATED

Primarily the allocation of property against the various classes of service is an allocation of dollar value, rather than an allocation of actual physical equipment. Thus the value of the property involved must be determined.

The determination of value is a matter of actual physical count in the field of the various elements involved in the electric system. This must be done by trained and competent engineers, by a disinterested group whose technical ability and honesty are above question and who work to a considerable extent under the direction of the State Public Utilities Commission. After the physical count a fair cost value per unit must be applied by the same group of engineers in order to arrive at the value of the property used in any way in supplying service to those customers whose rates are being studied.

The appraisal of value, which is the result of the physical count and the application of unit costs, gives values of property according to certain definite subdivisions in accordance with the standard classification of accounts as set up by the State Commission authorities. These standard classifications are as follows, the subdivisions as shown being practically the same throughout the United States, though their actual titles may be different from those given here:

FIXED CAPITAL ACCOUNTS - ELECTRIC

General Accounts

- Intangible Fixed Capital
- Construction Overheads
- Unclassified Accounts

Land

- Steam Power Plant Land
- Hydro Electric Power Plant Land
- Gas Electric Power Plant Land
- Transmission System Land - Substations
- Transmission System Land - Lines
- Distribution System Land - Substations
- Distribution System Land - Lines
- General Office Land
- Miscellaneous Land Devoted to Electric Operations

Buildings, Structures and Improvements to Land

Steam Power Plant Structures
 Hydro Electric Power Plant Structures
 Gas Electric Power Plant Structures
 Transmission System Structures - Substations
 Transmission System Structures - Lines
 Distribution System Structures - Substations
 Distribution System Structures - Lines
 General Office Structures
 Miscellaneous Structures Devoted to Electric Operations

Generating Stations - Steam

Boiler Plant Equipment
 Prime Movers and Auxiliaries
 Turbo-Generator Units
 Electrical Equipment
 Miscellaneous Power Plant Equipment

Generating Stations - Hydro

Reservoirs, Dams and Waterways
 Roads, Trails and Bridges
 Water Turbines and Water Wheels
 Turbo-Generator Units
 Electrical Equipment
 Miscellaneous Power Plant Equipment

Generating Stations - Gas

Fuel Holders, Producers and Accessories
 Internal Combustion Engines
 Electrical Equipment
 Miscellaneous Power Plant Equipment

Transmission Lines and Substations

Poles, Towers and Fixtures
 Overhead Conductors
 Underground Conduit
 Underground Conductors
 Roads and Trails
 Substation Equipment

Distribution Lines and Substations

Poles, Towers and Fixtures
 Overhead Conductors
 Underground Conduit
 Underground Conductors
 Substation Equipment
 Storage Battery Equipment

Services and Consumers Installations

Services
 Line Transformers and Devices
 Line Transformers Installation
 Consumers' Meters
 Meter Installations
 Installation on Consumers' Premises
 Commercial Lamps
 Street Lighting Equipment
 Electrical Appliances

General Equipment

General Equipment
 Miscellaneous Tangible Capital

In making a final determination of the value of the property to be allocated, some of the classifications given above will be finally spread over or transferred to other accounts. Construction Overheads, for example, is spread over the total amount of construction work done and will appear as part of each item in the final determination. Land will be assigned against the part of the electric system for which it is used. Other accounts must be similarly handled, such as buildings, equipment, and other general property, each of which may require a different method of spreading values.

The value of the entire property cannot be determined only by accounts; the geographical location of the equipment must also be taken into consideration. For instance, referring to Figure 2 and assuming that the rates in Area X are being studied, the value of the high voltage transmission lines to Division A must be found, but not of those to Divisions B and C. Again, the section of the high voltage transmission line from the main line to the industrial power customer served directly from the high voltage transmission line does not play any part in serving those customers in Area X, hence its value must be left out of the study. As another example, transmission substation No. 1 is used to serve Divisions A, B and C, while transmission substation No. 2 serves only part of the load of Division A; a proper allocation requires that the value of each substation be determined separately. Grouping the proper values together for allocation purposes will require many divisions based on geographical location of the equipment, these divisions being determined entirely by the arrangement of the system being studied and the particular purpose of the study.

METHODS OF PROPERTY ALLOCATION

There is no one undisputed method of allocating electric system value against the various classes of electric service. There are, however, various generally accepted methods which have been used in formal rate cases before State Public Utilities Commissions and which therefore bear the stamp of official approval. The following paragraphs give a brief description of these methods; no discussion of their merits and defects will be given, since this thesis deals only with methods of allocation.

Method No. 1 - The "Peak Responsibility" method of allocation is based on the theory that, since the capacity of various parts of the electric system is determined by the maximum or peak kilowatt load they must be capable of handling, the allocation of the property value must be made in accordance with kilowatt demands of the various classes of service at the time of peak kilowatt load. For instance, referring to Figure 3 "Assumed Daily Demands of Four Classes of Customers" the kilowatt demands of the various classes of service at the time of system peak kilowatt load (6 to 7 P.M.) is

	<u>Kw Demand</u> <u>at time of System Peak</u>	<u>% of System Peak Load</u>
Class A	100	10%
Class B	100	10
Class C	800	80
Class D	-	-
Total	1,000	100%

By this method the value of the electric system would be allocated 10% against Class A, 10% against Class B, 80% against Class C and none against Class D.

Method No. 2 - The "Non-Coincident Demand" method of allocation is based upon the maximum kilowatt demands of each class of service regardless of when the maximum demands occur, and the value of the electric system is allocated against each class of service in the proportion of its maximum demand to the sum of the maximum kilowatt demands of all the various classes of service. Referring to Figure 3 these figures would be

	<u>Max. Kw Demand</u>	<u>% of Sum of all Max. Demands</u>
Class A	100	6.25%
Class B	500	31.25
Class C	800	50.00
Class D	200	12.50
Total	1,600	100.00%

By this method the value of the electric system would be allocated 6.25% against Class A, 31.25% against Class B, 50% against Class C and 12.5% against Class D.

Method No. 3 - The "Phantom Customer" method of allocation is based on the non-coincident maximum demands of the various classes, the possible output in kilowatt-hours of the system at 100% load factor and the actual kilowatt-hours used by each class of service. A portion of the value of the electric system, in the ratio of the actual kilowatt-hours output of the system to the possible output at 100% load factor, is allocated against each of the various classes in the proportion the kilowatt-hour output to each class bears to the actual kilowatt-hours output; the remainder of the value is allocated against each of the classes in the proportion its excess kilowatt demand (maximum demand minus average demand) bears to the sum of the excess demands of all classes of service. Referring to Figure 3 and assuming figures for daily kilowatt hours, the following is the basic data and percentage allocations:

	<u>Max. Kw. Demand</u>	<u>Daily Kw-hr</u>	<u>Average Demand</u>	<u>Excess Demand</u>	<u>% of Investment Allocated</u>
Class A	100	2,400	100	-	10.0%
Class B	500	4,500	187.5	312.5	34.4
Class C	800	2,300	96.0	704	44.9
Class D	200	300	12.5	187.5	10.7
Total	1,600	9,500	396	1204	100.0%
System	1,000	9,500	396	604	
Phantom		14,500			
Possible	1,000	24,000	1,000		

Method No. 4 - The "Kw-hr Use" method of allocation is based entirely on the kilowatt-hours output to each class in proportion to the total actual output of the system, and the value of the system is so allocated. Using the kilowatt-hour figures assumed for the "phantom customer" method of allocation, the following figures would hold.

	<u>Daily Kw-hr</u>	<u>% of Total Daily Kw-hr</u>
Class A	2,400	25.3%
Class B	4,500	47.3
Class C	2,300	24.2
Class D	300	3.2
Total	9,500	100.0%

Method No. 5 - The "Number of Customers" method of allocation is based entirely on the number of customers of each class and the value of the system is allocated in the proportion the number of customers of each class bears to the total number of customers of all classes. With assumed figures for numbers of customers, the results would be as follows:

	<u>Number of Customers</u>	<u>% of Total Number of Customers</u>
Class A	2	.06%
Class B	145	4.40
Class C	3,150	95.45
Class D	<u>3</u>	<u>.09</u>
Total	3,300	100.00%

Method No. 6 - The "Gross Income" method of allocation is based on the ratio that the gross income from each class bears to the total gross income from all classes and the value of electric system is so proportioned. With assumed figures for gross income from each class, the following will hold good:

	<u>Gross Annual Income</u>	<u>% of Total Gross Income</u>
Class A	\$ 3,000	6%
Class B	15,000	30
Class C	30,000	60
Class D	<u>2,000</u>	<u>4</u>
Total	\$50,000	100%

FINAL DATA NECESSARY FOR ALLOCATION BY EACH METHOD

Allocation by Methods 4, 5, and 6 is relatively simple; having the proper data as to kilowatt-hours output, number of customers, or gross income, the allocation becomes merely a matter of multiplying, by the proper ratio, the value of the property used simultaneously by the class of service whose rates are being studied and other classes of service. One ratio will not hold good, of course, for all parts of the system, because as has been said before all parts of the system are not used simultaneously by all classes of service, and neither does every study include all parts of the entire system. However, determining

figures as to kilowatt-hours output to, number of customers of or gross income from any class of service for any given geographical area is a relatively simple and relatively accurate process, since it requires only the laborious but simple collection of information from ledger pages after the geographical boundaries of the area have been determined. It is sometimes necessary to make assumptions where accurate information is not readily available; very few assumptions are necessary, however, and their numerical size and the part they play in the final formula of allocation is so small that even a large percentage of error in the assumptions would cause only a very slight and negligible error in the final results.

Allocation by Methods 1, 2, and 3 is not so simple. Here the basis of allocation is kilowatts demand or a combination of kilowatts demand and kilowatt hours use or output. For instance, to properly allocate the value of the various parts of the system of Figure 2 against the residential class of service in Area X, under the plan of allocation most often used it has been necessary to determine the kilowatts demand of or kilowatt hours output to that group of customers at several different times of day and year and at several points on the system, including the generating station, transmission substations Nos. 1 and 2, distribution substations a, b and c, and at several other points. It has also been necessary to know the demands and kilowatt hours of other classes of service and other groups of customers at these same times and locations. Here lies the weakness of such a plan; very little of such data is available from actual operating records, hence much of the data for the various locations on the system must be calculated.

For instance, referring to Figure 2 and assuming a study of the residential rates within Area X, the process often followed is as described below. Graphic recording instruments are installed at typical customers premises, at the primary or secondary side of the distribution transformers and at points on the distribution primary in such locations that only the data for one certain class of service will be obtained. In this way the characteristics of the loads of each class of service will be measured. With these data as a basis, the next step in the compilation of the measured results and the determination of average demands per customer or per kw-hr sold for each hour, the kw-hr output to the average customer of each class, load factors of each class of service, and power factors. After these data are obtained, the demands and kw-hr output to each class of service must be determined for points at each distribution substation, each transmission substation and at the generating plant. It is obviously impossible to install meters to measure the demand and kilowatt hours of one class of service in locations such as the substations, transmission lines and generating station, since these are used simultaneously by several classes of service. Hence the demands and kilowatt-hours at these points must be calculated.

These calculations require many assumptions as to load factors, power factors, diversity factors and loss factors. Engineering opinion and knowledge of the factors to be assumed in any given case may and usually does vary widely and, no matter what numerical figures are assumed, honest dispute is certain to arise. The large number of factors to be assumed, together with their possible range of numerical variation, is so great that the actual final allocation values may vary over a wide range with different assumptions. The figures assumed by one group of engineers will seem unreasonable to another group, and any figures assumed as a compromise between divergent opinions will satisfy neither group.

Other drawbacks to this procedure are the necessity for the installation and attendance upon thousands of graphic meters of all sorts, a great many times more of such meters than the utility normally owns; the long elapsed time for obtaining the meter data, as this must include at least a year in order to cover all conditions of load; and the thousands of compilations involved in studying the charts to arrive at only preliminary data.

Under the scheme outlined in this thesis, very few assumptions are necessary and such figures as must be assumed cannot vary greatly enough to cause final allocation figures to vary between other than very narrow limits. The accuracy of the final allocation is well within the limits of accuracy of properly maintained meters at various points in the system.

Briefly, with this scheme and for the problem assumed, it is not necessary to know the demands and kilowatt hours of the Area X residential class at the generating station, the transmission substations and the high and low voltage transmission lines; it is only necessary to know these demands and kilowatt hours at the distribution substations. These figures can be easily and accurately determined, as will be described later. There is no necessity for the installation of graphic meters and the compilation of data from many individual charts, with its attendant great expense.

By this method the property value of each part of the system, beginning with the generating station and ending with the distribution system, is allocated against the next successive part of the system toward the customer. Thus, in Figure 2, the value of the generating station and transmission substation No. 1 is allocated against the high voltage transmission lines to each Division. The value of the high voltage transmission line to Division A, plus the value of the generating station and transmission substation No. 1 allocated against it, is then allocated against transmission substation No. 2 and against those customers served directly from the high voltage transmission line. Then the value of transmission substation No. 2, plus its accumulated

allocation of generating station, transmission substation No. 1 and high voltage transmission line to Division A, is allocated against the low voltage transmission lines. This process of allocation is continued as far as necessary. Not until the distribution substations are reached need the demands and kilowatt hours of the Area X residential class be used.

The chief advantage of this method of allocation is the fact that accurate data for the proper allocation is usually readily available from operating records of the various generating stations, substations, and customers and, wherever calculations are necessary, very few assumptions need be made. Even where assumptions must be made, in most cases commonly accepted figures are available and there is little likelihood of difference of opinion among competent engineers. Where assumptions must be made, they are relatively unimportant and of such minor value, that even a wide variation in the figures assumed will result in only unimportant differences in the final allocation figures.

Using the scheme outlined, for the conditions as assumed in Figure 2, the following final data will be necessary for proper allocation of the values of different parts of the system for any period studied.

Method No. 1 - Peak Responsibility

- 1 - Kilowatts of demand, measured at generating station and transmission substation No. 1, at time of peak demand at that location.
 - a - Of entire system
 - b - of Division A
 - c - Of transmission substation No. 2
- 2 - Kilowatts of demand, measured at transmission substation No. 2, at time of peak demand at that location.
 - a - Of transmission substation No. 2
 - b - Of distribution substations a, b, and c.
 - c - Of customers in Area X served directly from the low voltage transmission lines.
- 3 - Kilowatts of demand, measured at distribution substations a, b, and c, at time of peak demand at those locations.
 - a - Of distribution substations a, b, and c.
 - b - Of each class of service in Area X served through distribution substations a, b, and c.

Method No. 2 - Non-Coincident Demand

- 1 - Kilowatts of peak demand, measured at generating station and transmission substation No. 1
 - a - Of each Division
 - b - Of transmission substation No. 2
 - c - Of customers in Division A served directly from high voltage transmission line.

- 2 - Kilowatts of peak demand, measured at transmission substation No. 2
 - a - Of distribution substations a, b, and c.
 - b - Of all other distribution substations served through transmission substation No. 2
 - c - Of customers in Area X served directly from low voltage transmission lines through transmission substation No. 2.
 - d - Of all other customers in Division A served directly from low voltage transmission lines through transmission substation No. 2.

- 3 - Kilowatts of peak demand, measured at distribution substations a, b, and c.
 - a - Of each class of service in Area X served through distribution substations a, b, and c.
 - b - Of each class of service outside Area X served through distribution substations a, b, and c.

Method No. 3 - Phantom Customer

- 1 - Kilowatts of peak demand and of average demand of, and kilowatt-hours to, measured at generating station and transmission substation No. 1
 - a - Entire system
 - b - Each Division
 - c - Transmission substation No. 2
 - d - Customers in Division A served directly from high voltage transmission line.

- 2 - Kilowatts of peak demand and of average demand of, and kilowatt-hours output to, measured at transmission substation No. 2
 - a - System served by transmission substation No. 2
 - b - Distribution substations a, b, and c.
 - c - All other distribution substations served through transmission substation No. 2
 - d - Customers in Area X served directly from low voltage transmission lines through transmission substation No. 2
 - e - All other customers in Division A served directly from low voltage transmission lines through transmission substation No. 2

- 3 - Kilowatts of peak demand of, and kilowatt hours output to, measured at distribution substations a, b, and c.
 - a - System served by distribution substations a, b, and c.
 - b - Each class of service in Area X served through distribution substations a, b, and c.
 - c - Each class of service outside Area X served through distribution substations a, b, and c.
- 4 - Total possible kilowatt hours output at 100% load factor and measured peak demands above, of
 - a - Generating station and transmission substation No. 1
 - b - Transmission substation No. 2
 - c - Distribution substations a, b, and c.

Method No. 4 - Kilowatt Hour Use

- 1 - Kilowatt hour use, measured at customers' meters, of
 - a - All customers of entire system, total
 - b - All customers of Division A, total
 - c - All customers of Area X
 - d - Each class of service in Area X

Method No. 5 - Number of Customers

- 1 - Number of customers
 - a - Total in entire system
 - b - Total in Division A
 - c - Total in Area X
 - d - Each class in Area X

Method No. 6 - Gross Income

- 1 - Gross income from customers in
 - a - Entire System
 - b - Division A
 - c - Area X
 - d - Each class in Area X

ORIGINAL DATA AVAILABLE FROM COMPANY RECORDS

The sources of data for the allocation of value here described are the usual records kept by most operating companies in the normal routine of business. Such records as are kept in the commercial and operating departments of the company will furnish most, if not all, of the necessary data.

The commercial department ledgers will list the name of each customer, the location of the premises served, the rate schedule (or class of service) at which the service is supplied, the kilowatt hours used each month, and the net bill by months. The ledger pages are almost invariably arranged by location of the premises served, so that pages representing accounts for premises located on a given street are arranged in the ledgers in the numerical order of the addresses on that street. The groups of ledger pages, each group representing the premises served on a given street, are arranged in the ledgers alphabetically by street names. In addition, the sets of ledgers are arranged by rate schedules, or classes of service, so that the set of ledgers representing residence customers, for example, is entirely separate from the set representing commercial lighting customers and other classes.

With such a set-up of ledger pages, groups and sets, it is a relatively easy matter to determine the number of customers, kilowatt hours use, and the net bill for any given class of service, for any given period and for any area whose boundaries are known. A count from the ledger pages will furnish this information and, while laborious, does not require any difficult calculations, hence can be readily made by the usual clerical force of the company.

In addition to the ledger pages spoken of, the commercial department will also have additional data on all industrial power customers and on many commercial lighting and commercial power customers. This additional data will consist of graphic demand charts showing kilowatt or kilovolt-ampere (or both) demands of each customer at all hours of the day for the entire period since service was first supplied to that customer or, at the least, for the past three to five years. In addition, graphic power factor charts, made during periodic checks and covering periods from several days to a week, are usually also available for most of these customers.

From the operating department records are available daily log sheets for each attended generating station and attended substation; for each unattended or automatic generating station and substation a weekly or monthly summary sheet will be available.

The daily log sheets will show periodic (usually hourly, but sometimes half-hourly) indicating ammeter, voltmeter and sometimes power-factor meter, readings for each primary distribution circuit served from the substation, for each street lighting circuit served from the substation, for incoming and outgoing transmission lines, and for special groups of apparatus within the substation, such as distribution substation transformer banks, street lighting transformers, rotary converters and their transformers, and similar combinations of equipment. A simplified typical system and the various points at which such measurements are usually made is shown in Figure 7, "Data Available for Demand Analysis". Similarly, integrated kilowatt hour input and output readings

are also shown on these daily log sheets for many of the points at which indicating meter readings are taken.

The weekly or monthly summary sheets for the unattended generating stations and substations will usually give only the integrated kilowatt hour input and output readings at certain points within the generating station and substation, as shown in Figure 7, the interval between readings being a week or a month.

In addition to the daily log sheets and the weekly or monthly summary sheets for generating stations and substations, the operating department will have much other information necessary for the allocation study. Such information will include maps showing the geographic location of generating stations, transmission lines, substations, distribution primary lines, distribution transformers, street lighting lines and street lights; system diagrams, showing the electrical arrangement of the entire system; station diagrams, giving similar data for stations; and equipment card files containing miscellaneous mechanical and electrical data on the major items of equipment on the entire system. From these various sources can be obtained the vast majority of data necessary in those cases where the log sheets and summary sheets do not give readings at a sufficient number of points and calculation must be resorted to.

METHOD OF USING ORIGINAL DATA TO DETERMINE FINAL DATA NECESSARY

It is not possible to determine offhand what the peak demand of a given part of the electric system is nor just when it occurs. Hence it becomes necessary to determine all the hourly demands for the period covered by the study, in order to select the maximum demand and to know when it occurred. Sometimes the figure is not available directly, but must be reached by subtracting from the total demand the demand of other parts of the system; to get this data may be likened to measuring the depth of water in all parts of an ocean where a heavy sea is running and the contour of the bottom of the ocean is rugged. In order to make such an analysis, demands must be determined and plotted at various points on the system in the form of curves similar to that shown in Figure 6, "Typical Demands of Parts of a System", which has been built up for reference to Figure 2 conditions.

A strictly accurate analysis of conditions will require the building up of demand curves for each class of customers, each distribution substation, each transmission substation, each transmission line and each generating station for every hour of every day of the period for which the study is to be made, a laborious job with a tremendous amount of detail. However, a preliminary study of system conditions, coupled with an intimate knowledge of the system and the typical characteristics of the demand curves of the various

classes of service, will enable the engineer to determine dates and times of the day at which such an analysis will give results accurate within the degree of accuracy of the meters installed at the various points on the system. Such a preliminary study will usually result in the choice of one day each month and a fourteen or sixteen hour period for each of these days as the periods for which the study must be made in detail, resulting in a study requiring only 168 sets of calculations as against the 8,760 sets of calculations required for a complete hourly study of a one year period. The proper choice of days and hours depends entirely on the individual system, of course, but the limits quoted above have proved in one case to give results accurate within one percent plus or minus, the maximum accuracy of the indicating meters used in the various substations; greater refinement than this is unnecessary and illogical.

Referring to Figure 2, the first group of figures necessary in this scheme of allocation are the demands of and kilowatt-hours output to each of the high voltage transmission lines to Divisions A, B and C, as well as the maximum demand for the entire group, at the generating station and transmission substation No. 1. The generating station and transmission substation in this case can be considered as one unit. Referring to Figure 7, the operating record data here will give amperes, volts and kilowatt hours hourly by circuits and for the station as a whole. The usual standard calculations will provide the demand figures for the curves covering the period studied. Kilowatt hour output figures are directly available. Calculation will provide figures for average demands and total possible kilowatt hour output at 100% load factor and measured peak demand, as required by the "phantom customer" method of allocation. Hence the value of the generating station and the transmission substation No. 1 can be allocated against each of the high voltage transmission lines to the Divisions, and no controversial items such as assumptions of any sort have been introduced in the allocation.

It is now necessary to determine the demands, at transmission substation No. 1 on the 132 kv side, of transmission substation No. 2 and of the customers served directly from the high voltage transmission line. The demands and kilowatt hours at the customers' premises on the 132 kv side are available directly from readings at the customers' meters. These must be translated to the 132 kv bus at transmission substation No. 1 and the results subtracted from the figures for the entire line in order to get the data for transmission substation No. 2. The translation must be made by calculation, but since all factors are known, no controversial items are introduced. The same is true of the average demand and possible kilowatt hour output for the "phantom customer" method of allocation.

This same general process can be followed down to and including the demands and kilowatt-hour output of the distribution substations, on the low voltage side. Some of the distribution substations very probably will be unattended and there will be available only a weekly or monthly summary of the kilowatt-hours output of the substation as a whole; no hourly readings of amperes, volts and power factor for the substation as a whole and for each circuit will be available. However, to determine demand values for the substation as a whole, it will be sufficiently accurate to use the known values of demands for the attended substations as a base and to multiply these base figures by the ratio of the unattended substation kilowatt-hours output to the attended substation kilowatt-hours output. The sum of demands for the attended and the unattended substations will give the demands of the group. When a distribution substation serves loads both inside and outside the area being studied, its value can be reasonably accurately allocated on the basis of the relative kva of distribution transformer capacity inside and outside the area served from the distribution primary circuits fed by the substation.

Here it becomes necessary to determine the demands of and kilowatt-hours output to each of the various classes of service supplied through the substation. To do this, analyses of typical residential and commercial lighting distribution primary circuits within the area in which the rates are to be studied must be made. In choosing the circuits to be analyzed, an intimate knowledge of the distribution system is necessary, since the circuits chosen must serve typical customers, rather than unusual ones. In choosing the residential circuits to be studied, for example, it is necessary that the average kilowatt-hour use of the customers on the circuits to be studied should closely approximate the average kilowatt-hour use of the total group of residence customers in the entire area studied. The same requirement is not so necessary for the commercial lighting circuits, but it is highly desirable.

In making the selection of circuits of each type to be analyzed, it is usually necessary to choose tentatively two to three times the number of circuits it is finally desired to study, this tentative choice being based on the assumed characteristics of the average use per customer on each of the circuits. The average kilowatt-hour use per customer in the entire area studied is determined by first establishing the boundaries of the area by street name and number; from the commercial department ledgers is determined the total kilowatt-hour use of each class of service and the total number of customers of that class, these figures serving to determine the average use per customer. A similar analysis for each of the circuits tentatively chosen as typical will give the average use for the customers on that circuit, and will serve as the basis for the elimination of those tentatively chosen circuits which are not suitable for the final analysis.

After the final choice of circuits to be analyzed, the daily log sheets will give the necessary data for the calculation of demands and kilowatt hours at the distribution substations for each circuit. This data consists of the circuit amperes, volts, power factor and kilowatt hours. Grouping the data for all the circuits of each given class analyzed will provide a reasonably accurate picture of the demands of each class of customers. To determine the demands and kilowatt hours at the substation of all of the customers of each class within the area, it is only necessary to multiply the figures obtained from the circuit analysis by the ratio of the total kilowatt-hour use of all the customers of that class within the area to the total use of all the customers of that class on the circuits analyzed. Demands and kilowatt hours determined in this way are the demands and kilowatt hours at the distribution substation bus; they include demands and kilowatt hours at the customers' premises plus losses in the secondaries, distribution transformers and primaries, together with all the effects of diversity from the customers' premises to the distribution substation.

The selection of distribution primary circuits serving residential customers only, or serving residential customers in such proportion that the inclusion of other classes has no practical effect, can be done satisfactorily in most systems. The same thing is true, but not to such a great extent, for distribution primary circuits serving commercial customers.

The probability of selecting such circuits for retail power or industrial power customers is relatively remote, and where such a choice cannot be made, recourse must be had to analyses of customers' demand charts from the commercial department. The first step in the analysis of customers' demand charts is the division of customers into groups based on type of business or load factor. This division into groups is made necessary by the fact that charts are usually available for some of the customers but not for all of them, and the load characteristics of customers served at the same rate schedule, particularly in the commercial power and industrial power classes, may vary considerably from each other, as is evident in Figures 4 and 5. Such a division into groups can usually be made on the basis of type of business. A typical division might include such groups, for instance, as Large Retail Stores; Hospitals; Hotels; Mass Production Factories; Custom Production Factories; Office Buildings; etc., the actual grouping being entirely dependent upon local conditions and usually being fairly clearly indicated by a preliminary inspection of those customers' demand charts which are available.

After the division of the customers into groups, the demands of the customers within each group for whom demand charts are available are compiled from the charts and then consolidated. The demands of the entire group are then obtained by multiplying the consolidated demands by

the ratio of the kilowatt-hour use of the entire group to the kilowatt-hour use of the customers for whom the demands are known. The consolidation of the demands of all the groups served at any one rate schedule will result in the demands of all the customers served at that rate schedule.

During the process of determining these consolidated demand and kilowatt-hour figures, it will be necessary to take into account the points on the circuits at which the demands and kilowatt hours as shown by the customers' charts and meter readings are located, in order that the figures obtained may eventually be translated into figures at the distribution substations.

For instance, measurements on the primary side of a transformer bank include transformer and secondary circuit losses, while measurements taken on the secondary side of the transformer bank do not include the losses through the transformers. Neither measurements include primary circuit losses from the distribution substation bus down to the point at which the measurement is taken. To translate measurements taken on the secondary side of a transformer bank into terms of measurements on the primary side is a simple process of calculation, since transformer electrical data is well known or can readily be obtained; hence no controversial items of importance are introduced here.

After these measurements have been translated to the primary side of the transformers, there remains the question of losses in the distribution primary circuit. These are relatively easily determined and allocated against the proper classes of service. From the demands and kilowatt hours of all classes of service at the distribution substation bus there must be subtracted the demands and kilowatt hours of the residential and commercial lighting classes of service at the substation bus, as determined from the circuit analyses previously referred to. The remainder is the combined demands and kilowatt hours of the commercial power and industrial power customers served from the distribution substations; it includes the losses in the distribution circuits up to the point and which measurements of demands and kilowatt hours are taken at the customers' premises, in addition to those measured demands and kilowatt hours. From this remainder is subtracted the measured demands and kilowatt hours of the commercial power and industrial power customers, leaving a remainder which is losses in the distribution circuit due to these customers' loads. These losses can then be allocated to each of the two classes of service on the basis of loss factor, as described in an article on page 59 of the July 14, 1928 issue of *Electrical World*, entitled "Load Factor - Equivalent Hour Values Compared", by Buller and Woodrow.

It will usually be found that the circuits serving residential customers and those serving commercial lighting customers will also serve commercial power customers and perhaps industrial power customers.

Careful selection of circuits usually will eliminate these customers almost entirely from the analyses, at least to such an extent that their influence is unimportant. If they cannot be so eliminated, however, and it is desired to eliminate their influence practically entirely from the final figures, it can be done. This involves the determination of demands and kilowatt hours as already described, for each class of service. Then the figures as determined for each class of service, (such as commercial lighting, commercial power and industrial power can be used to eliminate (from the analysis of the residential service circuits, for example) the effect of those classes of service, and new figures arrived at for each class of service. This process will render the results obtained more accurate than the first determination and a second similar process will render them even more accurate. It has been found that the second of these processes will produce so little change in most cases that a third similar manipulation is of little value; sometimes even the second change is unnecessary.

This process completes the determination of all data necessary for allocation by the peak responsibility and non-coincident demand methods. For the phantom customer method there remains to be determined the total possible kilowatt hours output of the various parts of the system at its peak demand and 100% load factor. This is merely a matter of multiplying the peak demand by the total number of hours in the period for which the study is made, usually one year.

ACTUAL ALLOCATION OF PROPERTY - TYPICAL CASE

In order to illustrate a typical case of allocation, figures are assumed below for a system as shown in Figure 2, in which it is also assumed that the residential rates in Area X are being studied. All property values as given include the proper distribution of the General Accounts; Land Account, Buildings, Structures and Improvements to Land Account; and General Equipment Account. For simplicity's sake only one method of allocation, the peak responsibility method, is shown and it has been assumed that peak demands occur on the various parts of the electrical system at the same time and day. Instrument readings are assumed as available in accordance with the details of Figure 7 and in addition it is assumed that analyses of distribution primary circuits and customers' charts have been made and demands of the various classes of customers determined at the distribution substation.

In order to make the final allocation of the distribution system in this example, it is necessary to subdivide the "Overhead Conductors" subdivision of the "Distribution Lines and Substations" account into two parts, one part including only the primary circuit conductors and the other including the secondary circuit conductors. It is assumed that this has been done and that the value of the Poles, Towers and Fixtures account has been allocated against the primary

circuit and the secondary circuit in proportion to their relative circuit-miles.

Again for simplicity's sake, no underground distribution system is assumed to be involved in this study.

Generating Station and Transmission Substation No. 1

Appraisal value of generating station and transmission substation No. 1	\$20,000,000
System peak demand measured at 132 kv side of transmission substation No. 1	100,000 KVA
Demand of Division A at time of system peak demand, measured at 132 kv side of transmission substation No. 1	50,000 KVA
Value of generating station and transmission substation No. 1 allocated against high voltage line to Division A (30,000 + 100,000) x \$20,000,000	\$10,000,000

High Voltage Line to Division A.

Appraisal value of high voltage line to Division A	\$3,000,000
Portion of value of generating station and transmission substation No. 1 allocated against this line	\$10,000,000
Total	\$13,000,000
Demand of Division A at time of system peak demand, measured at 132 kva side of transmission substation No. 1	50,000 KVA
Demand of transmission substation No. 2 at time of system peak demand, measured at 22 kv side of substation but calculated back to 132 kv side of transmission substation No. 1	40,000 KVA
Value of high voltage transmission line, generating station and transmission substation No. 1 allocated against transmission substation No. 2 (40,000 + 50,000) x \$13,000,000	\$10,400,000

Transmission Substation No. 2

Appraisal value of transmission substation No. 2	\$1,600,000
Portion of value of high voltage transmission line, generating station and transmission substation No. 1 allocated against transmission substation No. 2	<u>\$10,400,000</u>
Total	<u>\$12,000,000</u>
Peak demand at transmission substation No. 2, measured at 22 kv side of substation	38,000 KVA
Demand of low voltage transmission lines serving distribution substations a, b, and c and other loads at time of peak demand on transmission substation No. 2, measured on 4 kv side of distribution substations and at 22 kv side of customers' installations and calculated back to 22 kv side of transmission substation No. 2	22,800 KVA
Value of high voltage transmission line, generating station, transmission substation No. 1 and transmission substation No. 2 allocated against low voltage transmission lines serving distribution substations a, b, and c and other loads (22,800 + 38,000) x \$12,000,000	\$7,200,000

Low Voltage Transmission Lines

Appraisal value of low voltage transmission lines serving distribution substations a, b, and c and other loads	\$800,000
Portion of value of transmission substations Nos. 1 and 2, high voltage transmission line and generating station allocated against low voltage transmission lines serving distribution substations a, b, and c and other loads	<u>\$7,200,000</u>
Total	<u>\$8,000,000</u>
Peak demand of these low voltage transmission lines at transmission substation No. 2, calculated at 22 kv side of substation	22,800 KVA

Demand of distribution substations a, b and c at time of peak demand on these low voltage transmission lines, measured at 4 kv side of distribution substations and calculated at 22 kv side of transmission substation No. 2 17,100 KVA

Value of low voltage and high voltage transmission lines, transmission substations and generating station allocated against distribution substations a, b and c.
 $(17,100 + 22,800) \times \$8,000,000$ \$6,000,000

Distribution Substations a, b and c.

Appraisal value of distribution substations a, b and c	\$500,000
Portion of value of transmission lines, transmission substations and generating station allocated against distribution substations a, b and c	\$6,000,000
Appraisal value of distribution primary circuits served from distribution substations a, b and c.	\$500,000
Total	<u>\$7,000,000</u>

Peak demand at distribution substations a, b and c, measured at 4 kv side 16,800 KVA

Demand of residential class of service in Area X, at time of peak demand at distribution substations a, b and c, measured at 4 kv side of distribution substations 15,960 KVA

Value of distribution primary circuit, distribution substations, transmission substations, transmission lines and generating station allocated against residential class of service in Area X
 $(15,960 + 16,800) \times \$7,000,000$ \$6,650,000

(Note - Up to this point the peak responsibility method of allocation has been followed and all property values involved have been so allocated. Now, however, in the remaining parts of the system from here to the customer there is much less simultaneous use of any certain part of the system by several classes of service, and more accurate allocation is possible. In fact, no general simultaneous use, by several classes of service, of any given type of equipment will exist from here on. Individual cases of such simultaneous use will occur, however.

Distribution transformers serving residential customers in any given area can be actually counted in the field, as can distribution secondary circuits, services, meters and installations on customers' premises. The distribution transformers and secondary circuits may be involved in some few cases in serving both residential customers and commercial lighting customers, but the values involved in these few cases are so small in proportion to the total values that any reasonable allocation will affect the total allocation figures only to a very small degree. It has been assumed here that the property values involved in these few cases of simultaneous use have been allocated on the peak responsibility basis, the demand figures used being demands at the distribution substations as determined from circuit analyses. These figures are applied only according to the loads actually served from the distribution transformers and secondary circuits involved in simultaneous use; no general allocation of all distribution transformers and all distribution secondary circuits is necessary.

The values of services, meters and installations on customers' premises to be allocated against the residential class of service are a matter of actual field count.)

Distribution Transformers - Distribution Secondary Circuits -
Services - Meters - Installations on Customers' Premises

Value of distribution primary circuit, distribution substations, transmission substations, transmission lines and generating stations allocated against residential class of service in Area X	\$6,650,000
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Value of specific items of other distribution property in Area X allocated against residential customers in Area X

Distribution transformers, allocated in vast majority of cases by actual field count and, in a very few cases of simultaneous use, on peak responsibility basis	\$800,000
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Distribution secondary circuits, allocated as of distribution transformers	\$400,000
--	-----------

Services, allocated by actual field count	\$600,000
---	-----------

Meters, allocated by actual field count	\$600,000
---	-----------

Installation on customers' premises, allocated by actual field count	\$50,000
--	----------

Total Electric System Property Value allocated to residential customers in Area X	\$9,100,000
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GENERAL COMMENTS

The plan for allocating property values, as described in the preceding pages, is primarily a plan for determining data for any of several different commonly accepted methods of allocation. It involves the minimum of assumptions and hence the minimum of controversial features, which is its strongest feature.

Its actual use is relatively simple, as is shown by the example of allocation illustrated. While a more complex electrical system than that shown in Figure 2 will involve considerably more detail than has been shown in this paper, yet the principle remains the same and is equally applicable to the simple and to the complex system.

ILLUSTRATIONS

PRODUCTION AND TRANSMISSION SYSTEM

1925

SYMBOLS

- TRANSMISSION LINE
- STEAM DRIVEN GENERATOR
- ⊙ HYDRAULICALLY DRIVEN GENERATOR
- △ TRANSFORMER BANK Δ-Y
- △ TRANSFORMER BANK Δ-Δ
- △ TRANSFORMER BANK Δ-D (AUTOTRANSFORMER) (SINGLE COILS)
- △ TRANSFORMER SINGLE PHASE
- AIR BREAK SWITCH
- DISCONNECTING SWITCH
- ON CIRCUIT BREAKER

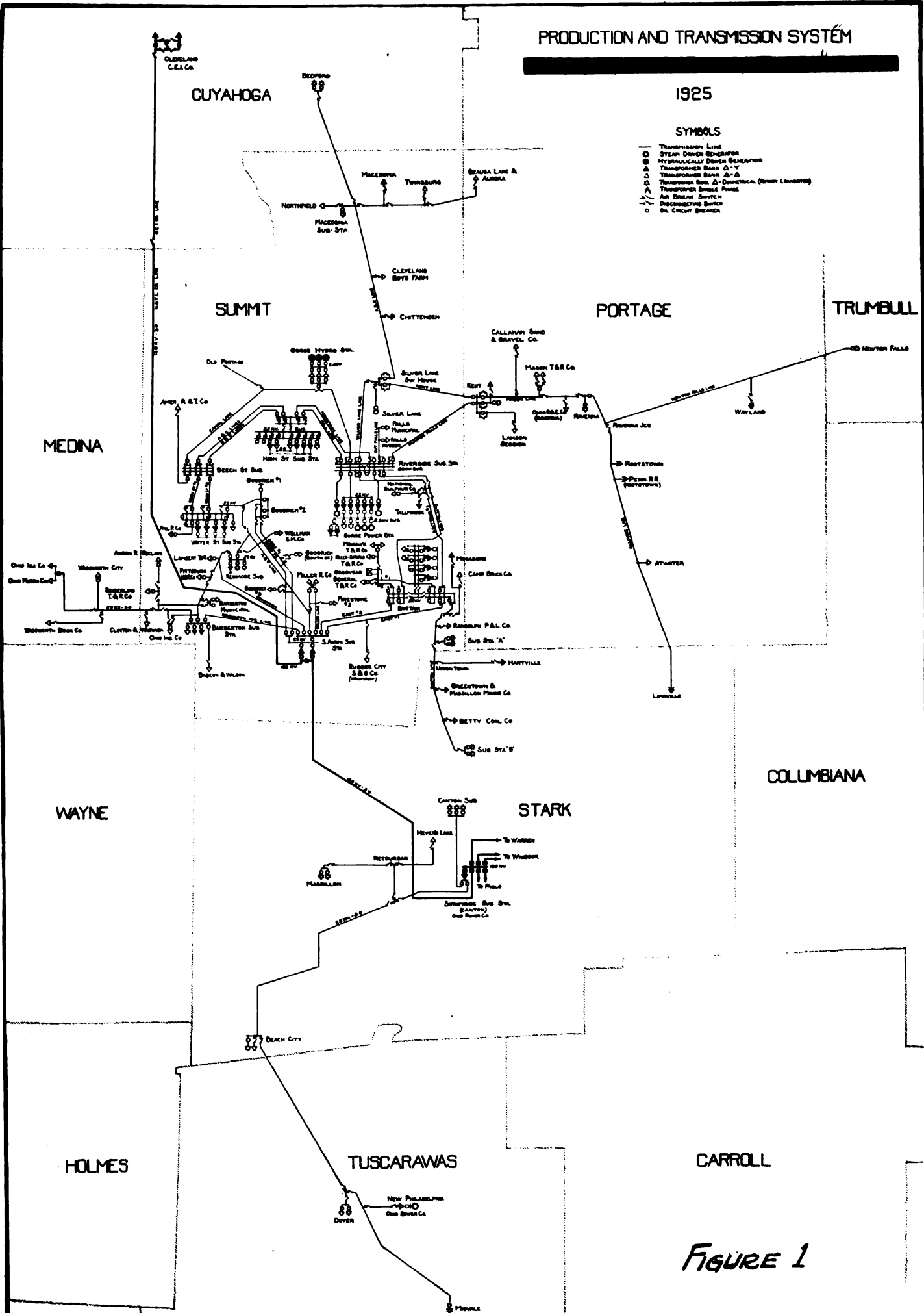


FIGURE 1

SIMPLIFIED DIAGRAM OF AN ELECTRIC POWER SYSTEM

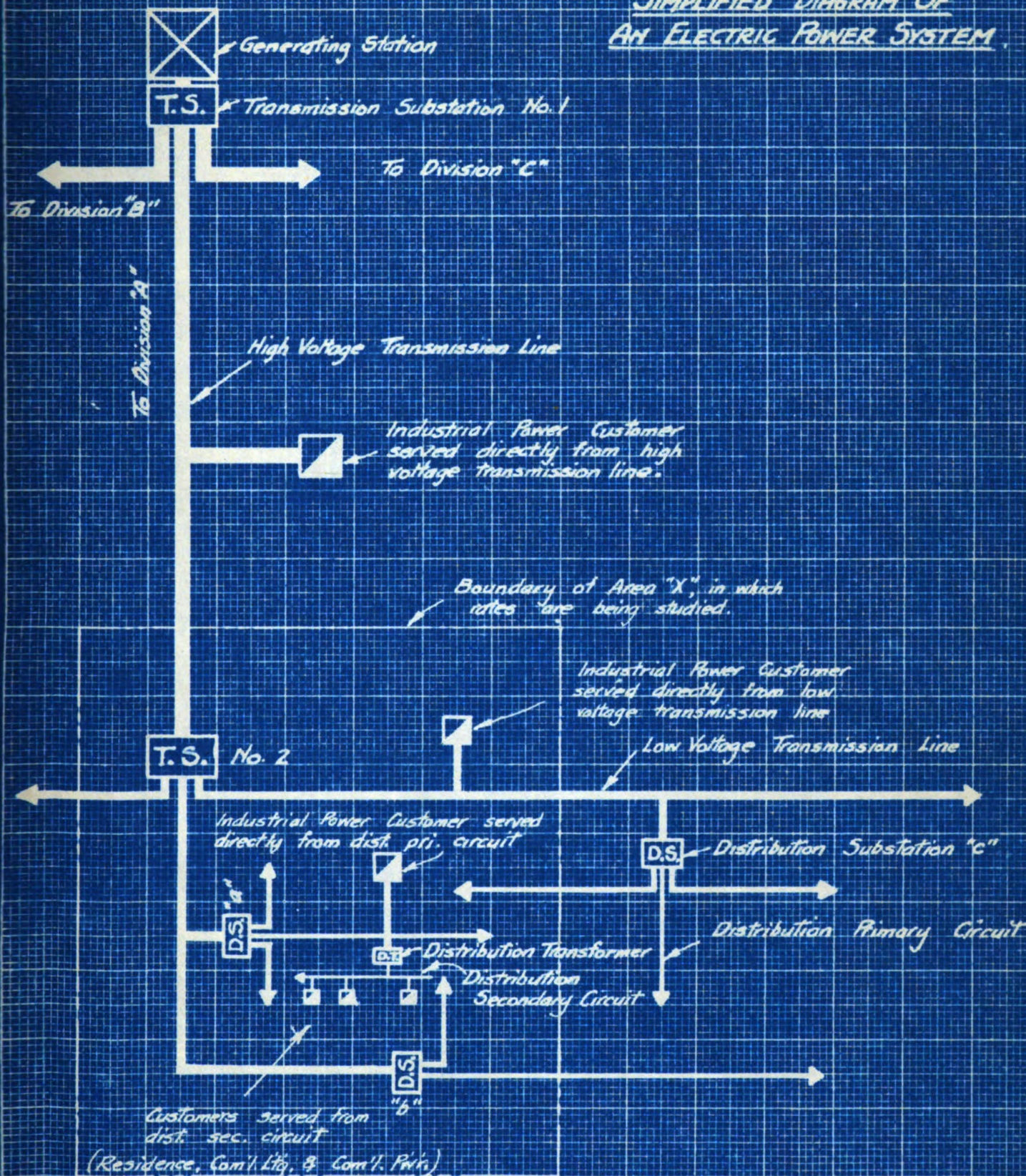


FIGURE 2

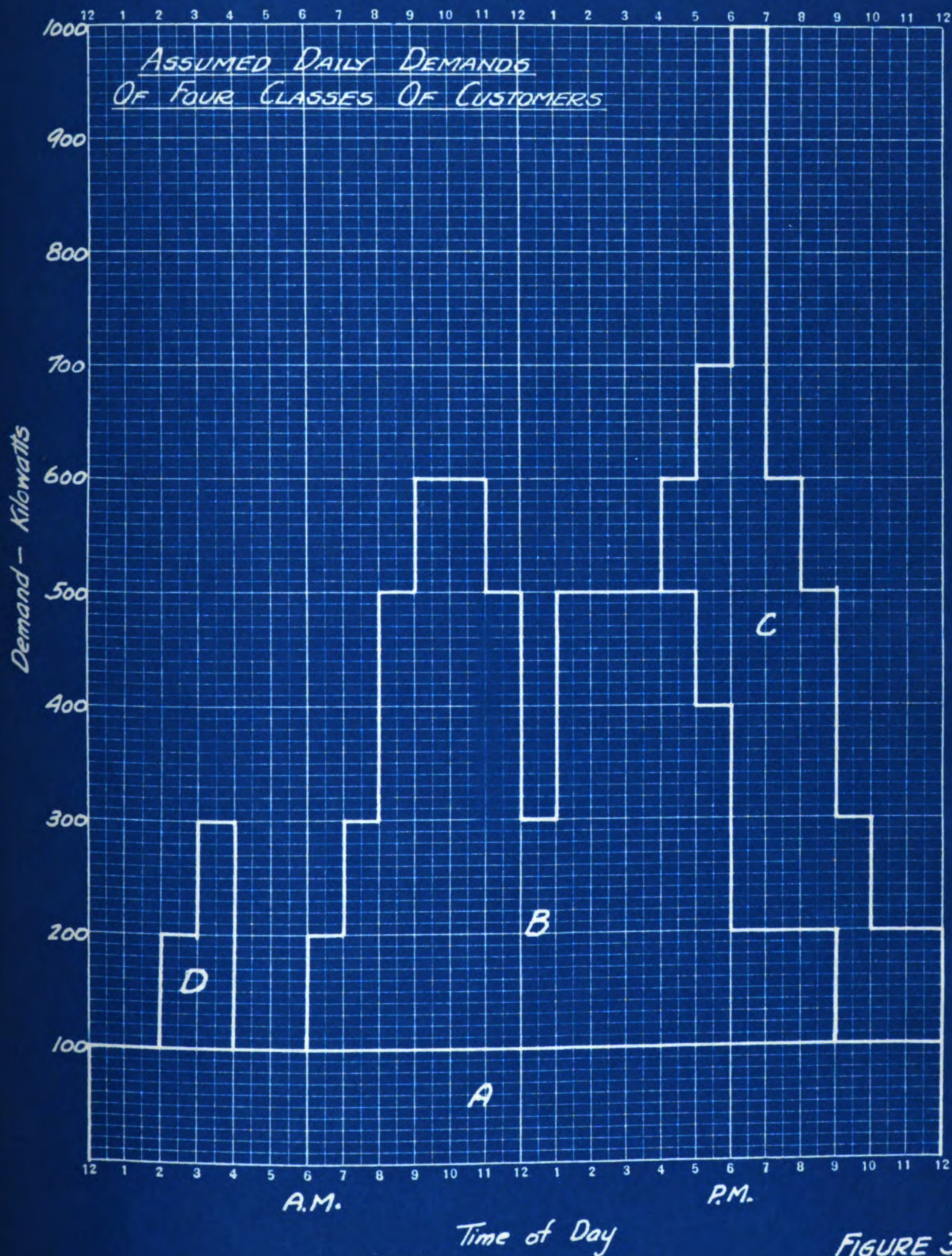


FIGURE 3

TYPICAL DEMAND CHART
OF SHORT HOUR COMMERCIAL POWER CUSTOMER

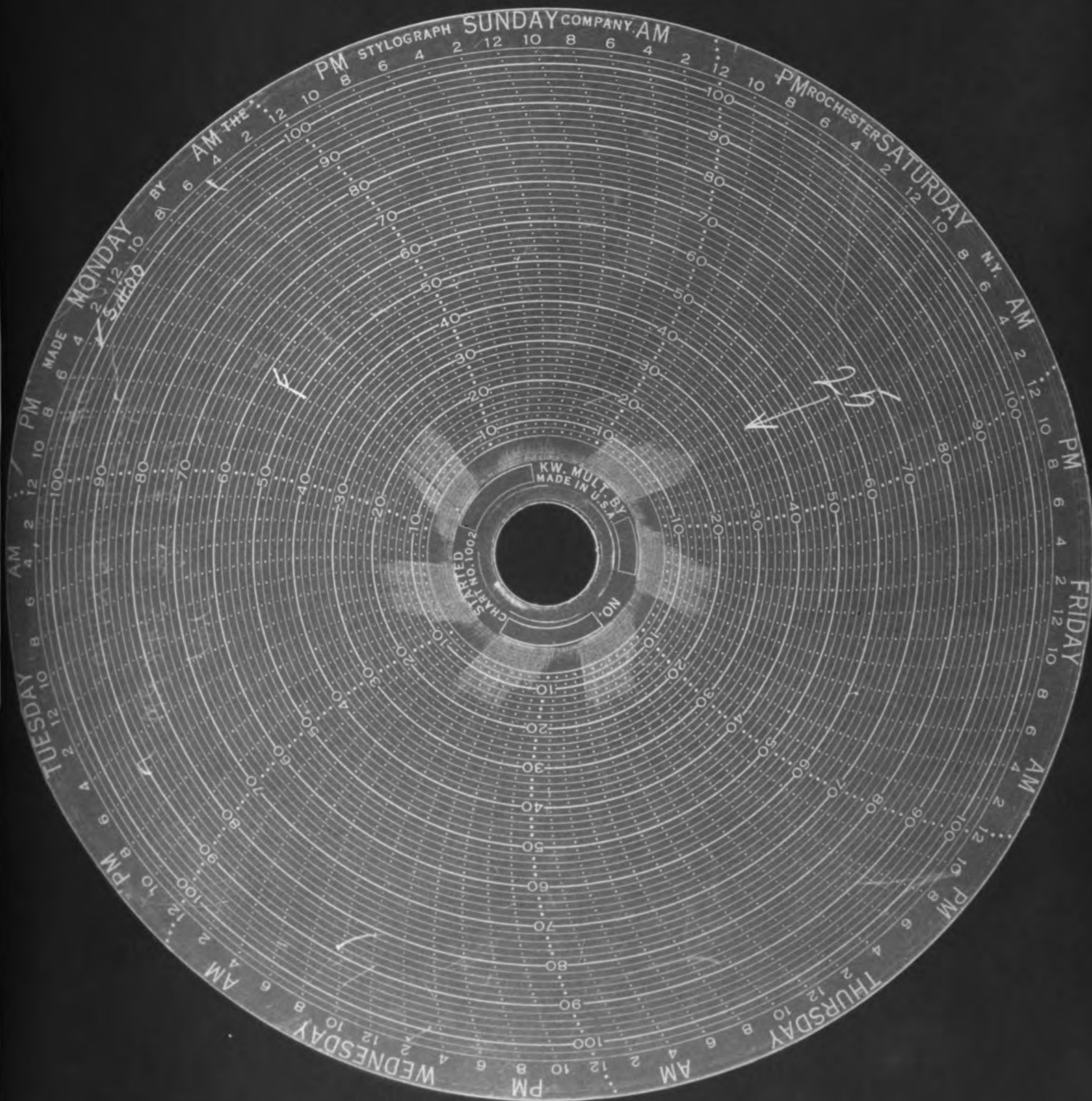


FIGURE 4

TYPICAL DEMAND CHART
OF LONG HOUR COMMERCIAL POWER CUSTOMER

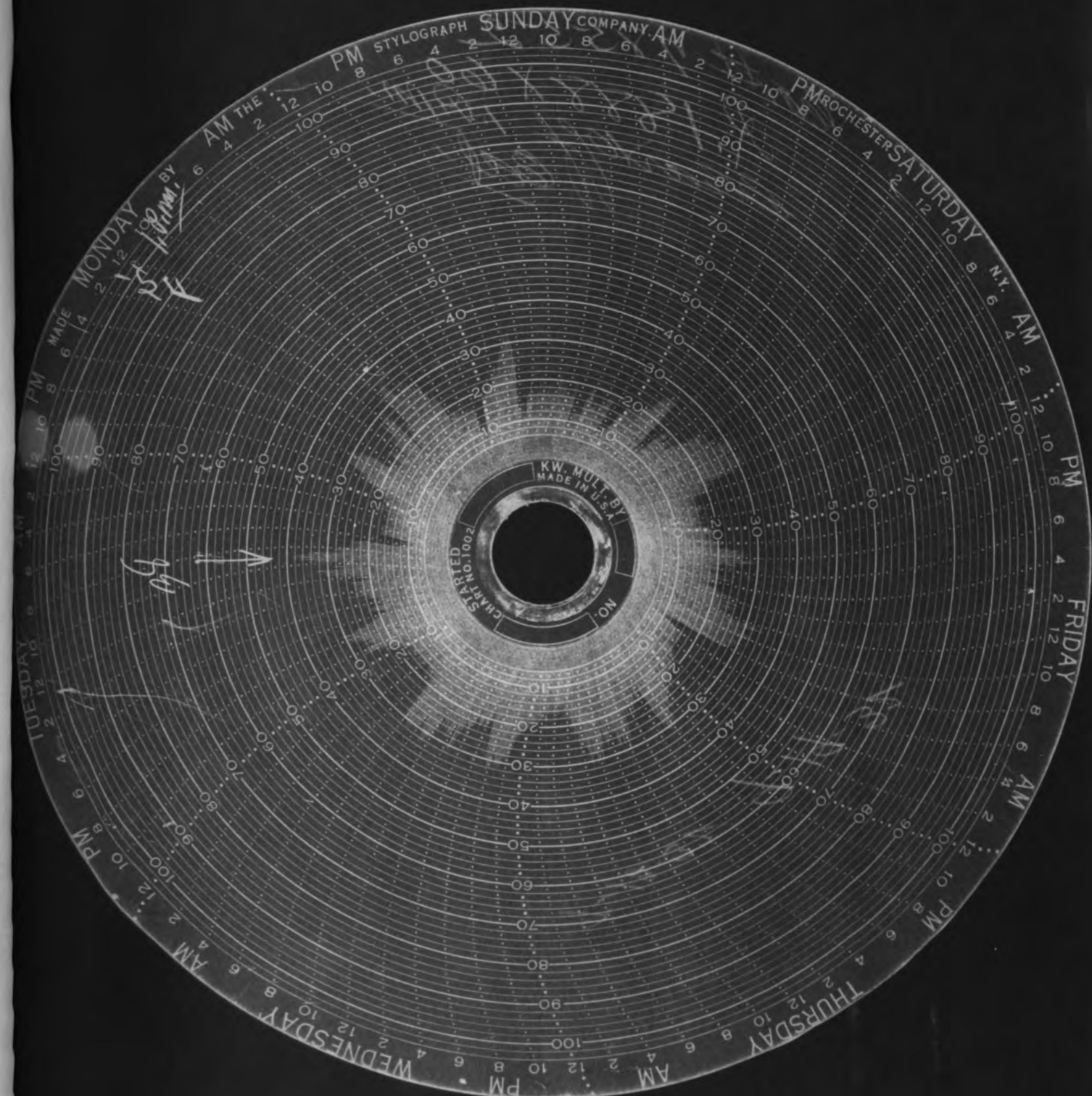


FIGURE 5

Demands - Thousands of Kilowatts

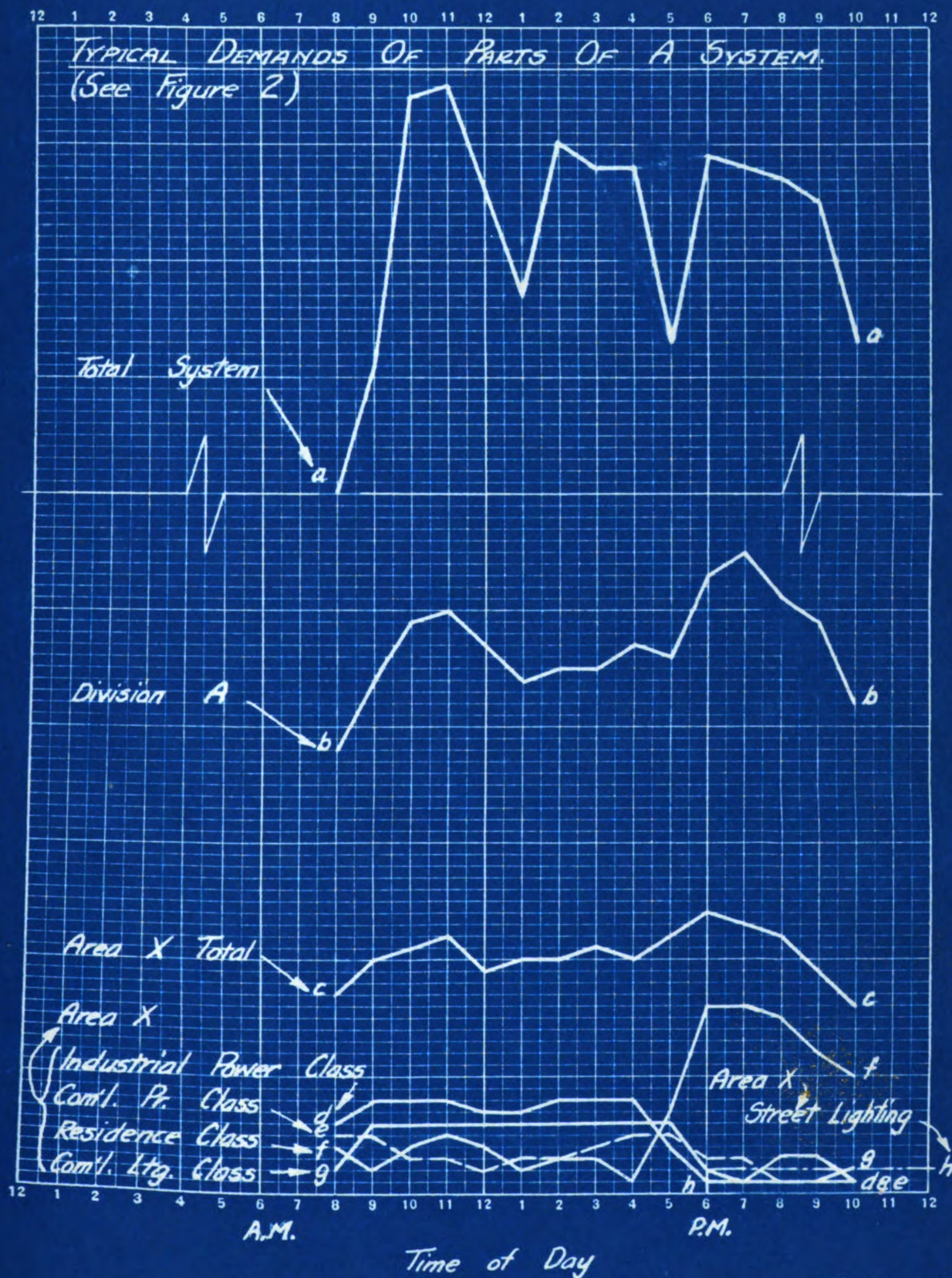


FIGURE 6

DATA AVAILABLE FOR DEMAND ANALYSIS

	<u>Point No.</u>	<u>Location</u>	<u>Instrument Rags Available</u>
	1	Generating Station	As below
	2	Transmission Substation (13.2 to 132 Kv.)	Ampere, Volts, & Kwh. hourly by circuits and for sub. as a whole, 132 Kv. side.
High Voltage Transmission System	3	Transmission Customer (High Voltage)	KVA by 15 min. periods & Kwh. monthly, by customers, 132 Kv. side.
	4	Transmission Substation (132 to 22 Kv.)	Ampere, Volts, & Kwh. hourly by circuits and for sub. as a whole, 22 Kv. side.
Low Voltage Transmission System	5	Transmission Customer (Low Voltage)	KVA by 15 minute periods & Kwh. monthly, by customers, 22 kv. side.
	6	Distribution Substation	Ampere, hourly by circuits Volts, Power Factor, and Kwh. hourly for sub. as a whole, 4 Kv. side.
Distribution Primary Lines	7	Industrial Power Customer	KW by 15 min. periods, & Kwh. monthly, by cus- tomers, 4 Kv. side
	8	Distribution Transformer	None
Distribution Secondary Lines	9	Commercial Power Customer Commercial Lighting Residence	KWH, monthly, by cus- tomers, .23 KV side " "

FIGURE 7

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