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ENGINEERING APPLIED TO
POWER SALES.

Being the Analysis of a Modern Engineering Application
to Central Station Power Sales.

Thesis for Degree of Electrical Engineering.

Emerson Allen Armstrong

1922.

THESE

ENGINEERING APPLIED TO POWER SALES.

In a recent technical editorial in the most prominent central station magazine the thought is brought out that the development of the industry has passed from the period when the technical phases predominate, to the period when it is a combination of technical and merchandising problems. The following discussion is written with this in mind.

Although much is written in current magazines and books about different phases of power utility work, little can be found which brings out the relation between these phases.

It is possible that some divisions of the central station organization can do good work without much insight into the methods of other departments, but certainly all can do better by knowing their co-workers' methods. In some departments it is necessary that the fundamentals of all divisions should be understood and considered.

The Contract or New Business Department is one of those which must know and continually consider all sides of the many central station problems. In the power sales division this quality of knowing reasons for methods used in other departments must necessarily be most developed.

It is thought that an analysis of the methods used in power sales work may be of help to young engineers, who expect to go into central station work, in bringing out the relation of the phases, both engineering and commercial.

The attitude of present day central station management is to sell service. This is in marked contrast to the older and practically extinct idea of selling just kilowatt hours, as the grocer sells a pound of sugar or a dozen eggs. Good central station executives know that their business will be operating just the same ten or twenty years from now, therefore are using policies of selling and delivering their service which will bring the greatest return possible over a long period, rather than methods which will bring the largest immediate return. These policies, however, are limited to some extent by unavoidable conditions. For instance, the present impossibility of obtaining sufficient funds, even for making needed profitable extensions, is a very severe handicap to the operation of the central stations of today.

The idea of selling service is a constantly expanding one and has progressed steadily since the first central stations began to furnish light at so much per lamp per month "from darkness to 11 P.M." One of the first steps was the furnishing of lamps at little or no charge other than a hidden charge covered in the flat rate. At the present day, rates include advisory lighting, power and heating engineering service with the electrical energy sold. On superficial thought it looks like poor business to supply engineering advice when it is evident that many such recommendations will tend to reduce the customer's payments to the company. Yet very few, if any, methods of getting new business are as effective as this very one.

This brings up the question of why central stations maintain a corps of consulting engineers, under the name of

power salesmen, in order to give free and more or less detailed engineering service to their customers as a part of their policy of service.

The present tendency in all modern progress is toward specialization. It is like large quantity production in manufacturing, in that the larger the quantity the lower the unit cost for the same service, or the better the service for the same cost. As the utilities have grown the result has been better engineering service rendered at the same cost or less. Next to continuity of actual electric service, the greatest advantage to power consumers from the consolidating of small systems into large interconnected groups, has been the engineering service made available.

The majority of power consumers would never go to a consulting engineer who charged directly for his service for the following three reasons: first, it is not generally realized that such service can be bought; second, many feel that the services rendered will not yield a reasonable return on the cost; and, third, that they actually cannot pay it as a lump sum.

The economics of these charges are of interest. Comparatively few, except among the largest separate consulting organizations, can afford to have a man for electric power engineering clients only, so that a man must divide his attention between this and some other type of work. Where the clientele is large enough to keep a group of men working on electric power application all the time, so that there is no division of interest, the cost is still prohibitive for a large percentage of any central station's power customers, as the proportion of overhead

charges increases very rapidly for such service as the size of the load investigated decreases. The importance of this item is emphasized by noting that out of 596 power customers having over one horse power connected load in and around a manufacturing city of 50,000 population, 207 had less than twenty-five horse power, and only 42 had over one hundred horse power connected load.

The unattached organization must charge more for its overhead than if it were simply a division of a very large organization, and its charges must also cover dead time. Most separate concerns must ask for their fee at the time when it is most difficult for the customer to pay; that is, when he is just making extensive improvements, before he has started production and has a regular income therefrom, or at a time when the product is costing "too much" and he must cut his expenses, as many have been forced to do in the last year of depression. What small charges there are for the service from the central station organization are spread over the time of production as a very small amount per kilowatt hour, which is thus surprisingly well distributed to the different customers. A small consumer has a small consumption while a large one uses a large amount of kilowatt hours, each carrying its share of the engineering service cost, thus apportioning the cost in a most equitable manner. The actual cost per kilowatt hour is very difficult to determine for it is combined with the cost of protective inspection and obtaining new business. Both of the latter would have to be maintained if no consulting service were given, as will be discussed later on.

The central station engineer's interests more nearly coincide with the customer's than do the interests of engineers for concerns supplying machinery and other equipment. It is quite natural that a man, knowing if he advises against his company's equipment they will lose this sale, should hesitate to say any word that would eliminate that prospect for at least the normal life of a machine.

An instance came under observation recently of a utility engineer who advised the use of 500,000 cir. mils cable, but the contractor advised the use of 400,000 cir. mils cable because he had it on hand.

The central station wants the customer to use their power to his best advantage, for they expect to serve him day after day and want to see his business grow as fast as is reasonable. They are more interested in his growth than they are in his present purchases.

The central station must maintain contact and supervision over all loads as they are taken on and periodically afterward to prevent loads being connected that would seriously damage the service in some section, or possibly the whole system. The most usual danger from this angle is swinging loads such as hoists or spot welders on small capacity lines. There are many other undesirable loads, as poor power factor loads or other loads where the income will not be commensurate with the required investment.

The changing conditions brought about by constant improvement in the electrical art demand constant adaptation of new service rates, so that the central station must constantly be on the alert in order to be ready to give and

equitably charge for any new service as needed. This work of keeping in touch properly falls to the Contract Engineering Department, for it is there that the interests of the company and customer meet. Being an employee, the power salesman has the company's interests at heart, and is at the same time the customer's best representative in the organization.

Every customer who is taken on at equitable rates is an economic advantage to all other customers served by the system. First, he increases the total number of kilowatt hours used, therefore produced and thus reduces the production cost. Second, if he tends to increase the load density he decreases the unit distribution cost. The importance of this item can be noted in the rates in the city of Chicago compared with the rates in the immediate surrounding territory. The policies of the two utilities serving these territories are the same, yet because of the greater quantities manufactured and the greater average load per square mile in Chicago, the rates are lower there. Some idea of the amount of this difference in load density can be gained from comparing the annual peak load of the two systems divided by the square miles served.

City of Chicago-	2500 kw. per square mile
District around Chicago-	14 kw. per square mile

Even if the above advantages did not exist, the assistance given to sales by the maintenance of a Contract Engineering Department is enough to warrant the expense, for the making of an engineering report on a customer's plant not only affords the best opportunity to find what possible uses for power there are, but establishes a much closer relationship between the company and the power user, if the negotiations and report are properly handled.

Equitable rates, mentioned above, cover what many men have put years of study on. It is not only a question for the salesman and the bookkeeper, but a most important one for every central station man to consider, as well as every citizen who is interested in the development of the use of electrical energy, which from now on will be one of the important elements of our civilization. Rates that are too high will retard the use of electricity, but good service cannot be maintained if the rates are too low, so the result would be similarly disastrous.

Rates should cover the cost of the particular service plus a reasonable profit. Although "reasonable profit" to the company has been much discussed, ruled and regulated, the hardest, as well as the most important part of rate making, is to find just what the cost of a particular service is. It would be easy enough to find the cost if only one class of customers were served, for there would be only one variable, as there was when lighting within certain hours was the only use for current. The fuel, labor and other variable charges per unit were easily found, as were the fixed charges per unit. But as soon as service was given for other than those certain hours, the question of the proportion of these charges between the "on peak" and the "off peak" customers began, and it has become more complicated every year since that time.

Much of the progress in rate application has depended on the instrument available to measure the units on which a part of the rate depends. The old flat rate where the charges were so much per lamp per month, was used because a reliable kilowatt

hour meter could not be made cheap enough. When reasonably reliable demand meters became available, rates with demand charges became more popular, and when a suitable power factor meter is obtainable "power factor clauses" will become a part of the usual rates instead of a theory. Until it is possible to meter all variables, it is necessary to assume or disregard the unmeasured ones.

These variables can be divided into two classes. One of these represents energy cost, varying approximately with the number of kilowatt hours delivered, as coal. These are sometimes called "energy charges" for that reason, and they are the ones that change for the same load, depending on the hours operated per month. The other class covers all costs that vary with the demand; that is, the costs necessitated by the company having to be ready to serve the load at any time, whether it is ever used or not. This includes such items as interest on the money invested in all equipment to serve this customer, interest on money spent for power house, generators, transformers, lines, etc. Another important item included in this class is meter reading, bookkeeping and billing costs, for these costs are nearly the same for all customers. This last class is also partially cared for in the "minimum charge" of the bill. Few people not in the central station industry realize how far this development from the old flat rate has advanced in an endeavor to establish equitable rates for different types of load.

A business man who uses several hundred horse power told a power salesman recently: "Your Company stands 100 per

cent high with me and I am satisfied with my power costs, but as to understanding your contracts, no one in the world can do it." This feeling is due to some extent to the fact that many men who are accustomed to figuring in horse power and horse power hours are frightened when they see the terms "kilowatt" or "kilowatt hours." Other reasons for this feeling are that there are very few industries in which the detailed costs have been studied so carefully as with central station industry, and where the profit is so low that any variation in cost must soon appear in rates. The fourth, and probably most important, reason for this feeling is the seeming predominance of the demand charges, either under the heading of demand charges or under some other heading not so obtrusive, such as where there is a higher rate for the first given number of hours use or some such stipulation.

The fact that interest on the necessary investment amounts to 35 to 45 per cent of the cost to the central station is the reason for this predominance of demand charges. There are few industries outside of the public utilities in which the actual amount of money invested in equipment is so large in proportion to the income. It requires approximately \$5.00 investment for every \$1.00 per year of electrical income. In other words, while the average grocer may turn his stock five or even more times a year, the central station can expect to turn its investment only about once in five years, or, as the grocer would say, their turnover is one-fifth against his of five. That means that interest on the investment is twenty-five times more important to the central stations than it is to the average grocer,

which explains why the demand charges seem high to the man who does not realize this difference.

With this great importance attached to the interest charges, the central station must not only recognize them in its tariffs, but any methods that will keep these expensive investments working longer hours per year, or comparatively decrease them, is of the utmost importance. This can be done in several ways. Increasing the power factor of the load is very effective. A problem recently investigated will make its importance clear. A transmission line having 20,000 kv-a. transformer capacity at both step up and step down ends, which can be safely loaded to 25,000 kv-a. (25 per cent overload), now has 21,400 kv-a. at 60 per cent power factor peak load on it and can take on 3,600 kv-a. additional load at 60 per cent power factor. But if the new load has a power factor of 80 per cent, 3,970 kv-a. can be taken on, while if some load at 100 per cent power factor was added it could be 5,650 kv-a. In other words, the transformer interest charges would be the same for a load of 3,600 kv-a. at 60 per cent power factor as for a 5,650 kv-a. load at 100 per cent power factor, or 2,000 kv-a. difference. Using \$5.00 per kv-a. of capacity as an estimated cost for the transformers at both ends of the line, the saving of a \$20,000 investment at 6 per cent means a yearly saving of \$1,200 interest.

One way of reducing the investment, which is within the control of the central station, is by decreasing the reserve held in readiness as standby and under repairs. A few years ago electrical machinery and steam turbines were not as reliable as they are today, nor were there many large interconnected systems

which afforded the possibilities of temporary help from neighboring plants. Then it was considered necessary to have at least 30 per cent and many times 50 per cent of reserve capacity over the maximum demand for any generating station. Many systems now are operating with only 18 or 20 per cent reserve, which means a reduction of one-sixth of the previous interest charges on generating stations where such saving can be applied.

As the average size of equipment has increased, the decrease in cost per unit of capacity has tended to help decrease the investment per kilowatt to a great extent. This is explained by the fact that the price of a 1 kv-a. transformer is practically one-half the price of a 5 kv-a., or that the price of a 10 kv-a. is over one-fifth the price of a 100 kv-a. The increased use of electricity has required the manufacture of many more units of equipment, which also has assisted in lowering the cost by enabling the use of larger quantity production methods.

The power salesman assists in lowering the cost by increasing the yearly load factor on the system through the addition of more consumers. There are few manufacturing plants whose load characteristics are exactly alike, so that, as the number of users served increases, the combined load factor tends to increase within certain limits. The gravel pits, stone quarries and other outdoor industries are all summer or "off peak" loads, which use the same generating equipment during the summer that would be required to carry the lighting peak in the winter months. This really means that the investment made necessary by the three or four long-evening months light-

ing load can be put to use serving these industries practically all the months they would otherwise be lying idle. The president of a middle-western utility recently brought out the progress made in this direction by stating that, during his connection with the business, the portion of energy used during the winter months had changed from 80 per cent of the yearly production to 53 per cent, and that the load factor had changed from 20 per cent to 45 per cent. If loads can be found to use service only at the times of present small use, they can be given ^{low} extremely/rates, as has been done by the communication companies in night letters and other special night rates.

Load factor is considered in the customer's rates in that the greater the number of hours use shown in their higher consumption compared with their maximum demand gives a lower net rate.

No discussion of rates is complete without mention of the present methods of rate making and comparing them with some of the previous methods.

The old franchise method was inadequate and unsatisfactory for several reasons. First, it was inflexible, as rates were made to continue over a certain number of years without regard to changes in various cost conditions. For example, the cost of gas manufacture increased and the cost of production of electricity decreased during the past twenty years. However, both suffered during the reign of the franchise method, for in the first case many companies were ruined, while in the other the maintenance of the price curtailed the use. Second, in most all cases the franchise method was administered by men who had little or

no experience and did not give it the study necessary to equitably fix rates.

There have been some cases where a type of cost plus a percentage plan was used, but the result was similar to the war contracts on the same basis, where there was no reward for efficiency and the same percentage of profit was paid on extravagance and waste as was paid on legitimate costs.

To do away with such conditions the "sliding scale" methods were tried, where the profit increased as the cost to the consumer was reduced. This was only a way of dodging the real issue, for a basic cost and profit had to be determined before the method could be applied, and they were subject to the same objections that the old franchise rates were.

An additional trouble with the above three methods as actually practiced was that the governing bodies were of too local a nature. Several of these troubles have been remedied by the forming of state commissions of one kind or another in most states with power to revise rates either up or down, if, when and as necessary. This makes it possible and, in spite of politics, probable that specialists will consider and pass on these matters to the best interests of the public at large, taken over a period of years.

These state commissions have had two additional questions to answer besides those of dividing the charges properly between classes of customers. They are the questions of what is the real value of a property, and what is a reasonable return on this investment. Both have been subject to extreme variation in the last ten years.

RATE "B." REGULAR POWER SERVICE**Rate:**

11 cents per kilowatt hour for electricity used equivalent to or less than the first 30 hours' use per month of the maximum demand.

6 cents per kilowatt-hour for additional electricity used equivalent to or less than the next 30 hours' use per month of the maximum demand.

4 cents per kilowatt-hour for all electricity used per month in excess of the equivalent of 60 hours' use of the maximum demand.

Whenever the portion of any monthly bill for electricity represented by charges at the 6 cent rate, or at the 6 and 4 cent rates, shall exceed \$45.00, the Company will allow a discount from such portion in accordance with the following table: (Intermediate discounts will be determined by interpolation.)

When such portion is \$ 45.00,	no discount.
When such portion is 50.00,	10 per cent discount.
When such portion is 100.00,	15 per cent discount.
When such portion is 150.00,	20 per cent discount.
When such portion is 200.00,	25 per cent discount.
When such portion is 300.00,	30 per cent discount.
When such portion is 400.00,	35 per cent discount.
When such portion is 500.00,	40 per cent discount.
When such portion is 750.00,	45 per cent discount.
When such portion is 1000.00,	50 per cent discount.

Determination of Maximum Demand:

The maximum demand is deemed to be a certain proportion of the kilowatt equivalent of the rated horse-power of all motors connected in accordance with the following table:

Where the installation is under 10 horse-power and only one motor is used.....	85%
Where installation is under 10 horse-power and more than one motor is used.....	75%
Where installation is from 10 to 50 horse-power, both inclusive, irrespective of number of motors.....	65%
Where installation is over 50 horse power, irrespective of number of motors.....	55%

Prompt Payment Discount:

1 cent per kilowatt-hour from the portion of any monthly bill represented by a charge at the 11 cent rate, provided the bill be paid on or before 10 days after its date.

Minimum Charge:

50 cents per month for each horse-power, or fraction thereof, of the total rated capacity of the motor, or motors, or other apparatus, connected.

Standard Riders:

Applicable to contracts hereunder are shown hereinafter.

RATE "C" LARGE LIGHT AND POWER SERVICE
Alternating Current—Low Tension**Rate:****Demand Charge:**

\$3.00 per month per kilowatt for the first 50 kilowatts of maximum demand in the month.
 \$2.50 per month per kilowatt for the next 450 kilowatts of maximum demand in the month.
 \$2.00 per month per kilowatt for the excess of the maximum demand in the month over 500 kilowatts.

Energy Charge. (In addition to the demand charge, for all electricity used.)

6.0 cents per kilowatt-hour for the first 1,000 kilowatt-hours of consumption in the month.
 4.0 cents per kilowatt-hour for the next 2,000 kilowatt-hours of consumption in the month.
 2.5 cents per kilowatt-hour for the next 2,000 kilowatt-hours of consumption in the month.
 1.3 cent per kilowatt-hour for the next 25,000 kilowatt-hours of consumption in the month.
 1.0 cent per kilowatt-hour for the next 70,000 kilowatt-hours of consumption in the month.
 0.9 cent per kilowatt-hour for the next 400,000 kilowatt-hours of consumption in the month.
 0.8 cent per kilowatt-hour for the excess consumption in the month over 500,000 kilowatt-hours.

Determination of Maximum Demand:

The maximum demand per month will be deemed to be a certain proportion of the kilowatt equivalent of the rated horse-power capacity of all motors or other apparatus connected, in accordance with the following table:

Where installation is under 10 H. P. (only one motor)	85%
Where installation is under 10 H. P. (more than one motor)	75%
Where installation is from 10 H. P. to 50 H. P. (both inclusive, irrespective of number of motors)	65%
Where installation is over 50 H. P. (irrespective of number of motors)	55%

The Company reserves the right to measure the maximum demand by maximum demand instruments, and the Customer shall have the right upon request to have the maximum demand determined by maximum demand instruments. In case the maximum demand is determined by maximum demand instruments, the maximum demand in any month shall be the average number of kilowatts indicated or recorded in the 30-minute interval in such month in which the consumption of electricity is greater than in any other 30-minute interval in the month; provided, that in the case of hoists, elevators, welding machines, furnaces or other installations, where the use of electricity is intermittent or subject to violent fluctuation, the Company reserves the right to base the Customer's maximum demand upon a 5-minute instead of a 30-minute interval and to require the Customer to provide, at its own expense, suitable equipment to reasonably limit such intermittence or fluctuation.

Prompt Payment Discount:

3 per cent. of the total charges for any month when the bill for the month is paid on or before 10 days after its date.

Minimum Charge:

50c per month for each horse-power, or fraction thereof, of the total rated capacity of the motor, or motors, or other apparatus, connected.

Standard Riders:

Applicable to contracts hereunder are shown hereinafter.

STANDARD RIDERS. (1)

Emerson A. Armstrong

No.	Rider	Apply to Rate	Min. yrs	Requirement of Customer	Consideration
I	Breakdown (or standby)	ABC	1	\$24/yr/kw. required minimum guaranteed. Install load limit. circuit breaker	Will supply service
II	Discount where customer is a Charitable institution.	ABC	1	Funds received from charitable sources only	Allow 25% discount. 40% kw. yr. discount. minimum is limit of discount reduction
III	Discount where customer is a semi-charitable institution.	ABC	1	Funds received from charitable sources in part	Allow 15% discount. 40% kw. yr. or contract minimum is limit of discount reduction
IV	Temporary service rider	AB	Tom	Cost of providing the temporary service, the terms of standard contract	Will supply service
V	Lighting on power service	B	5	Minimum connected power load 100 h.p. Maximum connected lighting load & consumption 10% or less of connected power & consumption. Install necessary balance coil	Allow lighting at B rate and guarantee only power voltage regulation
VI	Outdoor limited hour service	B	5	Must be an outdoor industry of 100 h.p. or more. Use no current between 4 & 8 P.M. in Nov. Dec. Jan. Feb.	Allow 15% & 5% discount following March on previous years bills
VII	Discount where customer uses A.C. untransformed. Company to furnish transformers.	B	5	Disconnect for Nov. Dec. Jan. Feb.	Waive minimum bills besides discounts
VIII	Discount where customer uses A.C. untransformed. Customer to furnish transformers.	B	5	Pay extra cost of high tension metering when service is above 4000v. 50 kw. guaranteed minimum demand	Furnish transformers. Allow discount of 5% on net bill
				Same as No. VII and furnish transformers	Allow discount of 10% on net bill

S T A N D A R D R I D E R S . (3)

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STANDARD RIDERS. (2)

Eaton A. Armstrong

No.	Rider	Apply Rate	Min Yrs	Requirement of Customer	Consideration
IX	Limited hour auto charging in public garage	B	1	A public garage for charging automobiles only. Use no current between 4 & 8-30 P.M. during Oct.-Nov. Dec. Jan. Feb. -ing Oct.-Nov. Dec. Jan. Feb.	Rate will not exceed 4¢/kw.hr. (Does not reduce minimum)
X	Limited hour auto charging in private garage	B	1	Used for charging automobiles only. Use no current between 4 & 8-30 P.M. during Oct.-Nov. Dec. Jan. Feb.	Rate will not exceed 5¢/kw.hr. (Does not reduce minimum)
XI	Discount where customer uses A.C. untransformed. Company to furnish transformers	C	5	Pay extra cost of high tension metering when service is above 4000v. 50 kv. guaranteed minimum demand	Furnish transformers. Allow discount of 5¢ on bill
XII	Discount where customer uses A.C. untransformed. Customer to furnish transformers	C	5	Same as No. XI and furnish transformers	Allow discount of 10% on bill
XIII	Limited hour service A.C.	C	5	Minimum connected load 100 h.p. No maximum demand of over 20% of yearly maximum demand to be used between 4 & 8-30 P.M. in Nov. Dec. Jan. Feb. May limit apply to 20% during peak	Discount during on demand charges or less than 100 kw to 100 kw or less than 100 kw to 100 kw
XIV	Waiver of monthly minimum charge-Limited hour-A.C. Low tension	C	5	Have service disconnected during Nov. Dec. Jan. Feb.	Waive minimum during months disconnected

The general aim now is to consider the value as the cost of reproduction (diminished by existing depreciation) of physical property actually used to serve the public and add reasonable values for working capital and overhead expenses, such as organization expense, engineering and legal expense, taxes and interest during construction, etc.

It is well recognized by the commissions that the return on the investment, to be best for the public at large over a number of years, should be as low as possible yet be attractive enough, yield and stability considered, to obtain all the money necessary for properly financing all needed extensions to care for the growth of the community.

The company whose rates are used as an example in this discussion, pride themselves on having very few power rates. They have only two actual power contract forms, called "Rate B" and "Rate C", but these are modified into different rates by fourteen "riders." Mention of some of these riders will perhaps more clearly illustrate the various requirements.

Rider No. I (see table "Riders") for emergency or standby service asks a guarantee of \$24.00 per year per contracted kilowatt of maximum demand, for it requires practically as much investment to serve a customer who uses it for five or ten hours while his isolated plant is being repaired, as it does to serve the same customer without a plant of his own who would use a good many times as much current.

In opposition to the above condition, rider No. VI recognizes both the daily peak and the yearly peak, giving the

customer a liberal discount for staying off the daily peak, and, in addition, waives the minimum for the yearly peak if he will stay off the lines entirely for the peak months. This is highly desirable for such outdoor industry customers as stone quarries or gravel pits, for it is during this time that they must close their plant because of weather conditions. The company, on the other hand, does not have to increase its capacity or investment in turbines, generators and distribution lines, for they are on only at the times when this peak load capacity is not needed.

Riders No. IX, XIII, X and XIV are other types of "off peak" variations where the customer gets various considerations for limiting his use of current in different ways. The theory on which rider No. V is based is not so plain as the foregoing although it is the same, but stated in the reverse way. First, it limits its application to blocks of power of at least 100 horse power, and, second, it limits the lighting (natural peak) load business to only 10 per cent of the power or long hour business. In other words, the company takes the 10 per cent peak load business to obtain the advantage of the "off peak" business.

Riders No. VII and XI recognize the costs of transformation and allow the customer a 5 per cent discount if he assumes these losses; and if he will assume the interest and depreciation charges on the substation equipment as well, by owning them, riders No. VIII and XII allow him still another 5 per cent discount.

The moral obligation of every corporation operating within a territory to do its share in maintaining charitable

institutions, as hospitals, orphanages, old people's homes, etc., is recognized in riders No. II and III.

The "Temporary Service" rider No. IV is based on the idea that the standard contract rates cover certain installation costs when spread over several years of a normal contract. However, when a customer uses the service for only a few months, it is better to let him understand that he is paying for this accommodation of installing and removing equipment separately, than to have his expense averaged with the others and thus raise the rate to all customers.

Sales policy and rate policy are inseparable, and both must be controlled by the contract department of the central station company. In the direction of these policies the broadest type of engineering skill and the highest class of business ability must be used. Otherwise the central station industry will be seriously retarded, for it is at this place that determination of policies and the information of the public as to these policies, meet.

The development and understanding of fundamentals and policies goes through a regular sequence. The progress of any truth is more or less the same up to the time everyone accepts it as a fact, in that it progresses from recognition by a very few gradually to universal belief. Load factor, power factor and conjunctional operation are three subjects which today seem to represent three stages of development.

The importance of load factor is known by all central stations. Most of them have maximum demand rates, which is the way load factor is normally recognized in charges.

2. The second section focuses on the role of technology in modern business operations. It highlights how digital tools and software can streamline processes, reduce errors, and improve overall efficiency. The author argues that embracing technology is not just a competitive advantage but a necessity for staying relevant in today's fast-paced market. Examples of various digital solutions are provided to illustrate their practical applications.

3. The third part of the document addresses the challenges of managing a diverse workforce. It discusses the importance of fostering a positive work environment, promoting employee engagement, and providing opportunities for professional growth. The text suggests that effective communication and leadership are key to overcoming these challenges and building a high-performing team.

4. The fourth section explores the impact of market trends and external factors on business performance. It encourages organizations to stay informed about industry developments and to adapt their strategies accordingly. The author notes that flexibility and innovation are crucial for navigating uncertain markets and seizing new opportunities.

5. The final part of the document provides a summary of the key points discussed and offers some concluding thoughts. It reiterates the importance of continuous improvement and the need for organizations to remain agile and responsive to change. The text ends with a call to action, urging readers to implement the strategies discussed and to strive for excellence in all their endeavors.

At present a very small part of the industrial world outside of central stations understand the importance or even the meaning of load factor. The public will have to be informed.

The seriousness of the variable, power factor, is recognized by the larger companies. Some are trying to use rates considering it, in spite of the lack of a reliable meter. But many companies, and most of the public, do not feel that it need be considered. The public and some of the central stations will learn.

The future electric service system will be looked on as the organization which must avail itself of all power sources to deliver the cheapest possible power to all users. Therefore, although conjunctional operation of isolated generating plants with central stations is frowned upon by most public service companies at present, it seems that if the industry of the future is to fulfill all of its economic place, a broad policy on this question will have to be established. All will have to learn what the correct policy is.

WRITING AN ENGINEERING SALES REPORT.

With the foregoing discussion to establish an atmosphere, we can analyze more in detail the methods used in selling power.

Like the old English recipe for roasting a hare which said "first catch the hare", the first thing to do is to catch the customer. Again, like finding the hare, many times finding the customer is one of the biggest parts of the job; therefore, every method of finding a possible consumer should be used.



There are only two sources of additional load other than new industries which establish new plants in the territory. One is the increased use of energy by present customers already on the lines, and the other is the taking over of loads which have been previously driven by isolated engines.

Perhaps the easiest opening for the discussion of additional power uses is when the customer asks for advice or engineering service. This can only be expected of customers who have in some way previously learned that such service is gladly given to old customers as well as new or prospective ones.

The most usual lead is perhaps the high current bill complaint. This is given attention by helping the customer to obtain all the benefits of the rate he is on, such as helping him reduce his maximum demand, if this is measured in his case. While making the investigation, whether it is general or detailed, it is usually possible to see some way in which added electric service can be used to the customer's advantage. Sometimes it is added motors, sometimes it is a special heating equipment, and usually the lighting needs remodeling, if nothing else does; all of which, from the customer's standpoint, will improve the quality of his product and increase his production.

More difficult to reach are consumers having isolated power sources with either electric or other transmission. They must be convinced that it will pay to scrap present equipment in addition to buying new.

From this point on, there are two persons in most organizations who must be considered: the man with authority to make the necessary expenditure and his technical advisor.

For the first, things must be condensed to dollars saving for dollars investment, for what he wants to know is the figures with the \$ sign before them, and know that they are correct. He depends to a great extent on his assistant for technical accuracy. These two must be kept constantly in mind in all dealings, as their trust is the key to all progress in obtaining additional load. Their permission for an investigation is the first thing of importance.

Due thought must be given both to the data to be obtained and the methods of obtaining it. The conditions of each case are different. They require more or less special treatment to be of value and must not include any glaring engineering mistakes, such as trying to take the power input of an alternating current motor by the voltmeter ammeter method, for instance, if it is expected to keep the respect of the technical advisor.

The average technical graduate's training has given him a reasonable basis to work on regarding the necessary tests, but few have had any real assistance during their college course in writing letters and reports. His training has not had as its object the five C's of Clearness, Correctness, Conciseness, Courtesy and Character. The present literary attitude of the artistic must be replaced by one of utility, with the aim of the writing being to convey a complete idea in the least number of words. As a few high schools are now teaching their vocational students "trade English" by tradesmen, so should engineering schools teach Engineering English by Engineers, using Engineering subject matter. The report of the investigation after it is made is usually the hardest part of all the negotiations, and therefore will be discussed a little more in detail.

The diction and phraseology of writing should fit the readers. The engineering advisor can probably pass on the correctness of the investigation if only the tabulations and a few explanatory notes are given him. But even he will probably not be as enthusiastic as if it were a smooth, easily read article containing the same material. To win the confidence of the executive it must be written so that he, and possibly the directors of the company, can read it without encountering words too far outside of their vocabulary. Sometimes the customer will receive the report best if the style is informative, while for other types of men the argumentative style would be more fitting.

The subject should be kept well in mind, digressing only when and so far as other subjects bear on the results or conclusions. The amount of detail given to different subjects should be in accord with their relative importance. It is no more proper to go into fine detail on one point and merely skim over another than it is to work to ten-thousandths in one part of a problem where the accuracy of only tenths is possible in another part.

Reports can, in general, be divided into four sections: introduction, methods of tests, results of tests and recommendations.

The introduction should tell what it will cover, why the investigation was made and the report written, more or less of what the conclusions are and make the reader receptive. The first thing after the title page should be a table of contents with page reference, which is really a short form of the outline

used in writing the report. This gives the busy man a chance to pick the important parts at a glance.

A paragraph telling the reason the work was done, of course, treats it from the customer's standpoint. It may be to help him lower his maximum demand or his current consumption and thus reduce his bills, or to help him find the reason for some peculiar operating condition that is troubling him, or possibly to show him the probable saving by using central station service.

A suggestion of what the conclusions will be gives perspective, for it enables the reader to see the relation of the different points discussed.

The introduction should also include descriptions telling the location, conditions and processes in detail. These serve two purposes. First, it makes the customer feel "the author has observed these things that I know about and given them attention- his new ideas are probably as well thought out." Second, a reader unfamiliar with the plant is given a background so that he can understand the following discussions.

The section telling of the methods used in making the tests is more especially for the technical advisor, to show him that proper methods were followed. Many times this part is also very important for reference if some point has to be further investigated at a later date. It should be complete enough so that the tests could be duplicated, if necessary, from the data given.

The results obtained from the tests should be explained with special care to make clear all points used in arriving at

1. The first step in the process of the scientific method is to ask a question.

2. The second step is to do background research on the topic.

3. The third step is to form a hypothesis, which is a prediction about the outcome of the experiment.

4. The fourth step is to design and conduct the experiment.

5. The fifth step is to analyze the data and draw conclusions.

6. The sixth step is to communicate the results of the experiment.

7. The seventh step is to repeat the experiment to verify the results.

8. The eighth step is to apply the results to other situations.

9. The ninth step is to evaluate the results.

10. The tenth step is to draw a conclusion.

11. The eleventh step is to communicate the results.

12. The twelfth step is to repeat the experiment.

13. The thirteenth step is to draw a conclusion.

14. The fourteenth step is to communicate the results.

15. The fifteenth step is to repeat the experiment.

16. The sixteenth step is to draw a conclusion.

17. The seventeenth step is to communicate the results.

18. The eighteenth step is to repeat the experiment.

19. The nineteenth step is to draw a conclusion.

20. The twentieth step is to communicate the results.

21. The twenty-first step is to repeat the experiment.

22. The twenty-second step is to draw a conclusion.

23. The twenty-third step is to communicate the results.

24. The twenty-fourth step is to repeat the experiment.

25. The twenty-fifth step is to draw a conclusion.

26. The twenty-sixth step is to communicate the results.

27. The twenty-seventh step is to repeat the experiment.

28. The twenty-eighth step is to draw a conclusion.

the conclusions. This division of conclusions is of interest to all who would read the report, as it is the division of recommendations.

The conclusions and their presentation are the most important part of the whole discussion for they contain the information in which the customer is most interested, and it is here that he must be convinced that central station service will save him money. All questions, complaints or other items previously unsettled should be answered. The remedies for the conditions can very reasonably carry suggestions for new uses of electric service. The conclusions must finally close leaving the customer in an attitude to follow the recommendations.

The whole report should progress logically to the close in easy steps, each taking up one detail. This smoothness depends a great deal on the sentences and paragraphing.

Sentences are the smallest unit used and probably the hardest to form so that the meaning is always clear. Variety in length, with short sentences predominating, are easiest to read and therefore help to keep the reader from tiring.

Paragraphs are each little reports and most all of the discussion of arrangements, etc., of reports could be applied to paragraphs. They should have a topic and have it settled at the end so that the reader may proceed to the next topic with a clear mind. They should not be too long.

Before typing, the report should be carefully read over by someone not familiar with it, to see if all the statements are clear. A good stenographer or other office help can do this, for they need not be technically trained, as the aim is

clearness of expression.

The use of sub-titles greatly assists in emphasizing certain topics, as well as being convenient for use in finding different parts of the report for reference.

There is plenty of variety, even on a common typewriter, to show several grades of importance. Capitals with underscore, lower case with underscore, capitals or lower case alone, all indicate different shades of emphasis which can many times be used to advantage.

The typing should be carefully and neatly done, using one side of the paper, with wide margins and an extra margin on the left side for binding. The importance of double or triple spacing between lines is sometimes forgotten, but it materially helps to make the reading easier, and therefore does not tire the reader so much as being on a constant strain to follow back where the spacing is close. Pages should be numbered at the right top corner or the bottom center.

Care and neatness in general are very important in unconsciously instilling trust and confidence in the reader's mind.

The paper used should be white, medium thickness and letter (8-1/2 inches by 11 inches) size, unless some other definite form is standard because of some very special reason.

Illustrations should have a descriptive title as well as a reference figure number. Otherwise many times the effectiveness of the picture is lost, due to the reader's mind being distracted by trying to match up the number and reference.

Drawings, plans and sketches, if not so complicated as to bewilder the non-technical man, are many times valuable. These should also have conspicuous titles. They, as well as illustrations, should be as near the text referring to them as possible, or all together at the back of the report.

The binding should be in accord with the time and expense spent in getting data, making the report, and the money it advises spending.

The outside should be marked with the title, the name of the writer, his company and the date. This data should also be included on the title page.

The data and references used in making up the reports should all be kept for further reference, if necessary.

The letter of transmittal should be given due thought for it is the last personal touch before reading the report. It should not be too stiff, but carry a certain friendliness to hold contact with the customer, and not let him feel that now the report is made he will be forgotten.

The analysis of a sample report, noting the application of some of these principles, and some digressions as well, may illustrate these points more fully. The accompanying report was not chosen for its perfection, but will serve the purpose as a concrete example.

A SAMPLE REPORT.

REPORT ON
BLANKMAN HARDWARE COMPANY

DASH, ILLINOIS.

JULY 19, 1921.

To
Mr. C. W. PenDell,
Contract Engineer,
by
Emerson A. Armstrong
and
E. E. Noll
--- ---

Public Service Company
of Northern Illinois.

BLANKMAN HARDWARE COMPANY
DASH, ILLINOIS.

Introduction

*(1.) The purpose of this report is to give a general description of the plant of the Blankman Hardware Company, Dash, Ill., and to make suggestions and recommendations for a general improvement in the condition of the plant. The investigation made on May 11th and 12th and June 20th was prompted by a complaint of this Customer regarding the size of power bills.

General Description

(2) The plant is located in the southwestern part of Dash at the foot of Nettle Street, near the Illinois & Michigan Canal and approximately one quarter mile west of the Public Service Company substation.

(3) The nature of the business is the manufacture of iron sash pullies and furniture castors, together with small quantities of other light iron castings. The process of manufacture is as follows:

(4) Coke, iron and other raw material are received from railroad cars at south side of the plant. Iron in the form of pigs is placed in stock piles, while the coke is dumped into a hopper from which a portable inclined

* (Paragraph numbers were not shown in original report but were added for ease in reference.)

elevator lifts and distributes it into stock piles. From stock piles the raw material is wheeled to an elevator where a Shepard hoist lifts and conveys it to the cupola charging floor. Same hoist is also used for lifting sprews, gates and foundry scrap back to charging floor.

(5) After each heat of the cupola the castings are collected and conveyed to the rattler room by means of an overhead track system and Shepard hoist elevator. Castings are cleaned off in tumbling barrels and carried on small push railway cars to the various grinding, drilling and assembling machines in the Machine Shop.

(6) The furniture castors are made almost entirely in the Steel Room by the use of punch presses and riveting machines.

ELECTRICAL EQUIPMENT

(7) A Public Service Company 2300 volt line is brought to a transformer bank located immediately east of the Steel Room, where voltage is reduced from 2300 volts to 220 volts, both windings being connected in delta.

(8) Service box and metering equipment are located in the Steel Room. The service box contains a 600 ampere main service knife switch, three power feeder switches, one lighting switch, and one 1 Kv-a G. E. Co. balance coil for lighting service. Fuses on the feeders are in bad condition; many are reinforced with external fuse wires, thus practically doing away with all protection which fuse should provide. One fuse block showed evidence of numerous blow outs.

(9) All motors are three phase, squirrel cage type, and those larger than 5 h.p. are equipped with undervoltage release starting compensators. Following is a list of the motors:

Carpenter Shop.

- (10) 5 h.p. Westinghouse, 1735 r.p.m. belted to twenty foot line shaft driving rip saw, band saw, cut off saw, planer, drill press and wood lathe.

Pattern Shop.

- (11) 3 h.p. Westinghouse, 1830 r.p.m. belted to twenty foot line shaft driving grindstone, emery wheel, drill press, small speed drill, small taper, two small speed lathes and small blower.

Steel Room.

- (12) 10 h.p. Westinghouse, 1140 r.p.m. belted to line shaft driving tool grinder, small speed lathe, drill press, horizontal drill, stamping press, eight punches and two small tumblers.

Foundry.

- (13) 40 h.p. for a large Root blower. This motor although electrically connected is mechanically disconnected from the blower and is not being used.

24 h.p. Western Electric Co., 3600 r.p.m. direct connected to a 2500 cu. ft. centrifugal blower for cupola.

3 h.p. on portable coke elevator.

2- 3 h.p. Lincoln Electric Co. motors on Shepard hoists.

Shipping Room.

- (14) 3 h.p. Westinghouse, 1130 r.p.m. belted to an air compressor.

Tumbler Room.

- (15) 25 h.p. Westinghouse, 625 r.p.m. belted to line shaft driving four 40 in. by 15 in. tumblers and two 64 in. by 36 in. tumblers.

30 h.p. Allis Chalmers, 1150 r.p.m. belted to pair of four foot suction fans drawing dust from tumbler and emery wheels.

3 h.p. on beater in the dust collector for cleaning screens.

Machine Shop.

(16) 25 h.p. Allis Chalmers, 1150 r.p.m. belted to 140 ft. 3 inch, line shaft with fourteen bearings driving nine double wheel emery grinders, double wheel buffer, four wheel special automatic grinding machine, three wheel special automatic grinding machine, small tool grinder, fourteen spindle automatic drilling machine, three riveting punches, two bulldozers, header, two red cut-off shears, four machine lathes, four drill presses and a punch press.

5 h.p. Westinghouse, 1735 r.p.m., in tool room belted to a 45 ft. 2.5 inch line shaft driving four machine lathes, drill press, hack saw, small planer and shaper.

3 h.p. 1130 r.p.m., drives a vacuum pump for returning condensate from Dunham heating system.

General Conditions

(17) From information received during the investigation we learned that a force of approximately 200 men were employed during April, May and June, 1920, whereas during the months of April and May, 1921, the force consisted of only 30 men. However, the kilowatt demand and monthly kilowatt hour consumption for these two periods were approximately the same, averaging 70 Kw. and 9000 Kw. hr., respectively. An explanation of this condition is given under "Recommendations."

(18) All motors listed above were in operation during both periods with the exception of the 3 h.p. motors on the elevator and hoists, and the 30 h.p. motor on the suction fan, which replaces an old Sturtevant fan belted to the line shaft in the Machine Shop. The 30 h.p. fan motor was install-

ed in July, 1920, and the small motors some time during the year.

(19) A test to determine power input was made on each motor with the exception of several small motors and the 40 h.p. motor on the Root blower, which was out of service. Tests were made as follows: Two of the motor leads were disconnected and the primaries of two portable current transformers were connected in circuit. By means of an ammeter, voltmeter and a three phase wattmeter the current per phase, voltage and power input were measured.

(20) Results of these tests are shown in tabulated form accompanying this report. The tests show that every motor with the exception of the motor on the cupola blower was only partially loaded under present operating conditions.

(21) The dust suction fan has suction pipes leading to all tumblers and to grinders in the grinding room. During operation, all of these suction pipes are open and the motor carries practically a constant load regardless of the number of grinders and tumblers in use.

(22) The motors in the Steel Room, Machine Shop and Tool Room derive a great portion of their load from numerous line shafts, pulleys and belts.

(23) Line shafts, counter shafts and bearings are in need of overhauling and repair.

(24) Many switches are faulty due to loose handles and burned or bent contact clips, and most of the fuses were found parallel with external fuse wire. Many circuits are improper-

ly protected against overload in that the fuse in the circuit is many times too large.

RECOMMENDATIONS.

(25) The original purpose of the investigation was to suggest improvements in operating conditions so as to effect a reduction in power costs. The investigation also called our attention to the electrical construction and the lighting in the plant which it is thought should be improved so that the plant would have a complete and up-to-date electrical installation. Consequently comprehensive recommendations for better lighting and electrical wiring have been included in this report.

General

(26) The first object in mind was to explain the small change in power cost with a large decrease in amount of labor employed. The probable monthly consumptions of each motor were calculated and the total was found to be 9189 Kw. hr. This compares very favorably with the average actual consumption of 9000 Kw. hr. The figures showed that the suction fan motor was consuming 3380 Kw. hr. a month and the machine shop motor 4160 Kw. hr. a month. The fact that the suction fan motor was installed in July, 1920, and was therefore not included in the comparison for the period of April, May and June, 1920, and that the machine shop motor carried a heavy line shaft load regardless of the number of machines in service, accounts for the small change in power bills.

(27) The suction fan equipment should be given attention because the actual suction capacity needed at this time is only a small portion of the capacity of the fan. By placing dampers in all suction lines, which are to be closed when lines are not in use, the energy taken by the fan will be materially reduced. A reduction in operating hours of this motor could be made by employing more labor a portion of the day so that all grinding can be done in the time that the tumblers, which provide a large portion of the suction load, are in operation.

(28) Another arrangement would be to install a small temporary suction fan driven from the machine shop line shaft, and connected so as to collect dust from the few grinders which have to run when the tumblers are not in operation, making it possible to shut down the large fan for nearly six hours per day. During the time of the investigation five small suction openings would have been sufficient in the grinding room instead of twenty-five or more.

(29) The maximum demand can be reduced by shutting down the Steel Room motor, tumbler motor and suction fan motor while the cupola blower is in operation. This should not be a difficult matter since the blower is in operation only three-quarters of an hour on alternating days. Therefore, by reducing the kilowatt hour consumption and kilowatt demand as outlined, power costs will be materially reduced.

Power Installation

(30) Present construction work for the most part does not meet with Rule 19 a of the Regulations of the National

Secondly, it highlights the role of internal controls in preventing fraud and ensuring the integrity of the financial statements. The document provides a detailed overview of the various control mechanisms in place.

Thirdly, it addresses the challenges faced by the organization in terms of resource allocation and budget management. It offers practical suggestions for optimizing the use of available resources.

Finally, the document concludes with a summary of the key findings and recommendations. It stresses the importance of continuous monitoring and improvement of the financial management system.

The following table provides a breakdown of the financial data for the period under review. It includes details on revenue, expenses, and the resulting net income.

It is important to note that the figures presented in the table are preliminary and subject to audit. The final financial statements will be released once the audit process is complete.

The management team is committed to ensuring the highest level of accuracy and transparency in all financial reporting. We will continue to work towards improving our financial management practices.

For more information on the financial performance and the measures taken to address the identified issues, please refer to the full report attached to this document.

The document is intended for the use of the board of directors and the management team. It is not to be distributed to the public without prior approval.

Thank you for your attention and support. We look forward to your feedback and suggestions for further improvements.

The following table provides a breakdown of the financial data for the period under review. It includes details on revenue, expenses, and the resulting net income.

It is important to note that the figures presented in the table are preliminary and subject to audit. The final financial statements will be released once the audit process is complete.

The management team is committed to ensuring the highest level of accuracy and transparency in all financial reporting. We will continue to work towards improving our financial management practices.

Board of Fire Underwriters as regards electric wiring. This Rule states that on constant potential circuits, all switches controlling circuits supplying current to motors or heating devices, and all fuses, unless otherwise provided, must be so arranged that the fuses will protect and the opening of the switch will disconnect all of the wires in the circuit. That is, the capacity of the fuse shall not be larger than the Underwriters allowable carrying capacity of the wire, and that every wire of the circuit must be disconnected by the switch.

(31) In order that the above rule may be complied with and to put all of the electrical construction into a first class condition, a new layout of power circuits has been worked out and is specified below.

(32) Replace the present main distribution cabinet with a new cabinet, see sketch No. 1, consisting of a 600 ampere, main service switch, and a panel board with 2- 400 amp., 2- 200 amp., 2- 100 amp. and 4- 60 amp. feeder switches. Cabinet will also contain the two current transformers.

(33) Locations of power circuits are shown on sketch No. 2 and details of circuits on sketch No. 3. The details are as follows:

(34) Circuit "A" Foundry. 400 amp. switch and 300 amp. fuses in main cabinet. 3- 350,000 cir. mil rubber covered conductors in a 3" iron conduit to outside of Steel Room directly west of cabinet. 3- No. 4/0 weather-proof conductors to east wall of Foundry. Install six pin crossarms on pole west of Steel Room 3- 350,000 cir. mil conductors to 400 amp. line

switch and 250 amp. fuses, at 40 h.p. blower motor. Present compensator and overload trip coils need not be changed.

(35) Branch off with 3- 350,000 cir. mil conductor in 3" conduit to 200 amp. line switch and 150 amp. fuses to 24 h.p. blower motor. Present compensator and over-load trip coils need not be changed.

(36) At convenient point branch off through 30 amp. fuses with 3- #10 rubber covered conductors in 3/4" conduit to 30 amp. Motor Starter switch equipped with 20 amp. fuses to 3 h.p. hoist motor. (This type of starter has a non-fused starting position while the running position is arranged for fuses.)

(37) At line switch for 40 h.p. motor branch off through 30 amp. fuses with 3- #10 conductors in 3/4" conduit to 30 amp. Motor Starter switch equipped with 20 amp. fuses to 3 h.p. elevators motor.

(38) Circuit "B" Tumbler Room. 400 amp. switch and 250 amp. fuses in main cabinet. 3- 250,000 cir. mil rubber covered conductors in a 2-1/2" iron conduit through Steel Room and Grinding Room to 200 amp. line switch at 30 h.p. suction fan motor. 100 amp. running fuses to be installed in a suitable fuse block. Line and motor lead connections on starting compensator are at present incorrect; should be interchanged.

(39) At line switch for 30 h.p. motor branch off with 3- 250,000 cir. mil conductors in 2-1/2" conduit to 200 amp. line switch at 25 h.p. tumbler motor. 100 amp. running fuses to be installed in a suitable fuse block. Present starting compensator is suitable.

- (40) At line switch for 30 h.p. motor branch off through 30 amp. fuses with 3- #10 rubber covered conductors in a 3/4" conduit to 30 amp. Motor Starter switch equipped with 20 amp. fuses to 3 h.p. hoist motor.
- (41) At line switch for 30 h.p. motor branch off through 30 amp. fuses to 3 h.p. dust collector motor. Present line and starting switch need not be changed.
- (42) Circuit "C" Machine Shop. 200 amp. switch and 150 amp. fuses in main cabinet. 3- No. 2/0 rubber covered conductors in a 2" conduit to outside of wall of Steel Room adjacent to main service entrance. Outside wiring to machine shop need not be replaced. 3- No. 2/0 conductors in a 2" conduit to 200 amp. line switch and 150 amp. fuses at 25 h.p. machine shop motor. Running switch and fuses, 100 amp.
- (43) At line switch for 25 h.p. motor branch off through 45 amp. fuses with 3- No. 6 rubber covered conductors in 1-1/4" conduit to 30 amp. Motor Starter switch equipped with 20 amp. fuses to tool room motor.
- (44) Circuit "D" Vacuum Pump. 60 amp. switch and 25 amp. fuses in main cabinet. Present line to the pump motor need not be changed.
- (45) Circuit "E" Steel Room. 60 amp. switch and 60 amp. fuses in main cabinet. 3- No. 6 rubber covered conductors in a 1-1/4" conduit to 10 h.p. steel room motor. Present starting compensator is suitable. Running switch and fuses, 60 amp. and 40 amp., respectively.
- (46) Circuit "F" Carpenter Shop. 60 amp. switch and

50 amp. fuses in main cabinet. 3- No. 6 rubber covered wire in 1-1/4" conduit to 30 amp. Motor Starter switch equipped with 20 amp. fuses at 5 h.p. carpenter shop motor.

(47) At convenient point branch off with 3- No. 6 rubber covered conductors in 1-1/4" conduit to 30 amp. Motor Starter switch equipped with 15 amp. fuses at 3 h.p. motor in pattern shop.

(48) Circuit "G" Compressor. 60 amp. switch and 25 amp. fuses in main cabinet. 3- No. 10 rubber covered conductors in 3/4" conduit to 30 amp. Motor Starter switch equipped with 15 amp. fuses to 3 h.p. compressor motor.

Lighting Installation

(49) Due to the inadequacy of lighting a complete new lighting layout has been designed and is specified below.

(50) From the 100 amp. lighting switch in the main cabinet equipped with 100 amp. fuses extend 2- No. 0 rubber covered wires in a 1-1/2" iron conduit to a 4 Kv-a, 110/220 volt balance coil installed immediately north of the window adjacent to the present metering equipment. Below balance coil install a lighting cabinet containing one 60 amp. and two 30 amp. three pole knife switches and three two-wire snap switches. Diagram of cabinet is shown on sketch No.4. Location of lighting circuits are shown on sketch No. 3 and details of circuits on sketch No. 5.

(51) Circuit No. 1. 30 amp. switch and 20 amp. fuses in main lighting cabinet. 3- No. 6 rubber covered conductors

in 1-1/4" conduit south to grinding room and east to lighting panels in grinding room and machine shop. Where conduit turns east in grinding room branch off with 3- No. 10 rubber covered conductors in 3/4" conduit to lighting cabinet in tumbler room.

(52) Circuit No. 2. 60 amp switch and 50 amp. fuses in main lighting cabinet. 3- No. 2 rubber covered conductors to lighting panels in all foundry and core rooms. Where conductors are outside between steel room and foundry insulation must be weatherproof.

(53) Circuit No. 3. 30 amp. switch and 10 amp. fuses in main lighting cabinet. 3- No. 10 rubber covered conductors in 3/4" conduit to carpenter shop, storeroom and office.

Lighting Distribution

(54) All lighting panels are to be equipped with 30 amp., three-pole fused main switch. Branches are to be equipped with 10 amp. rotary snap switches, arranged for 10 amp. plug fuses. Branch wires are to be No. 14 rubber covered installed in 1/2" conduit. Branches are to be connected so as to balance the load between the two outside wires of the 110/220 volt mains.

(55) Main Foundry. Present locations of outlets are satisfactory as installed. 200 watt type C lamps are to be installed in each outlet. Old lighting panel to be replaced with a new panel with same number of circuits similar to panels which are specified for other rooms. Main fuses to be of 15 amp. capacity.

(56) 105' by 45' Core Rooms and Foundry. Install fourteen outlets each equipped with a 200 watt type C lamp and flat cone

reflector and arranged for four circuits as shown on sketch No. 6. Install panel east of south entrance, main fuses to be 15 amp. capacity.

(57) Tumbler Room. Install five outlets each equipped with a 100 watt type C lamp and flat cone reflector and arranged for two circuits as shown on sketch No. 6. Install panel north of east entrance, main fuses to be 10 amp. capacity.

(58) South West Foundry. Install sixteen outlets each equipped with a 200 watt type C lamp and flat cone reflector and arranged for four circuits as shown on sketch No. 7. Install panel south of east entrance in north wing, main fuses to be 15 amp. capacity.

(59) Steel Room. Install eight outlets each equipped with a 150 watt type C lamp and R.L.M. dome reflector and arranged for three circuits as shown on sketch No. 7. Circuits are to be controlled from the main lighting cabinet installed in this room, each circuit to be arranged for a 10 amp. snap switch and 10 amp. plug fuses, as shown in sketch No. 4.

(60) Machine Shop and Tool Room. Install eighteen outlets each equipped with R.L.M. dome reflectors. Machine Shop outlets to be fitted with 200 watt type C lamps arranged for five circuits and tool room. 100 watt type C lamps arranged for two circuits. Arrangement is shown on sketch No. 8. Install panel on fifth column from west wall, main fuses to be 15 amp. capacity.

(61) Grinding Room. Install twelve outlets each equipped with a 150 watt lamp and R.L.M. dome reflector and arranged for four circuits as shown on sketch No. 8. Install panel on fifth column from west wall, main fuses to be 15 amp.capacity.

(62) Miscellaneous. Install four 100 watt lamps in carpenter shop and pattern shop, five 100 watt lamps in store room and four 100 watt lamps in core baking department, each equipped with a flat cone reflector. Install four 100 watt bowl frosted lamps and glass bowl reflectors in office. Lamps in store room and office to be controlled by ceiling pull switches, and those in carpenter shop, pattern shop and core baking department by wall snap switches.

(63) In order that the efficiency of the lighting may not be impaired all reflectors should be cleaned at least once a month.

Respectfully submitted,

(Signed) Emerson A. Armstrong
 E. E. Noll

Results of Load Tests

Cupola Blower Motor
 22- 24 h.p. Rating
 3600 R.P.M.

V ratio $\pm 1/1$
 A " $\pm 25/1$
 W " $\pm 25/1$

<u>Load</u>	<u>Volt</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv-a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.%</u>
Damper closed	238	1.4	470	35	14.41	11.75	15.8	81
1/5 open	242	1.75	650	44	18.32	16.25	21.7	91
2/5 open	235	2.675	1000	67	27.48	25.	33.5	91
3/5 open	234	3.15	1200	79	31.98	30.	40.4	96
4/5 open	233	3.45	1290	86	34.66	32.25	43.5	93
Open	230	4.15	1530	104	41.48	38.33	51.	92

Now operates 2- 1/2 hours per week (estimated)
 using 25 kw. as average.

$$25 \times 2\text{-}1/2 \times \frac{26}{6} = 271 \text{ kw.hr. per month.}$$

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Dust Suction Fan Motor
30 h.p. Rating
1150 R.P.M.

V ratio = 1/1
A " = 25/1
W " = 25/1

<u>Load</u>	<u>Volts</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv-a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.%</u>
Present	236	1.7	520	42	17.15	13.0	17.4	75

Now operates 60 hours per week (estimated)

$13 \times 60 \times \frac{26}{6} = 3380 \text{ kw.hr per month}$

"Steel Room" Motor D
10 h.p. Rating
1140 R.P.M.

V ratio = 1/1
A " = 25/1
V " = 25/1

<u>Load</u>	<u>Volts</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv-a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.</u>
Line shaft only	238	.70	50	17	7.00	1.25	1.67	18
2 punches	238	.75	130	19	7.82	3.25	4.35	42
2 punches	238	.80	150	20	8.23	3.75	5.02	45

Now operates 24 hours per week (estimated)

using 3 kw. as average.

$3 \times 24 \times \frac{26}{6} = 312 \text{ kw. hr per month.}$

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Tumbler Motor F
at h.p. Rating
625 R.P.M.

V ratio = 1/1
A " = 25/1
W " = 25/1

<u>Load</u>	<u>Volts</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv.a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.%</u>
Line Shaft only	237	.975	70	24	9.84	1.75	2.35	18
1 Loaded tumbler on	236	1.00	120	25	10.21	3.00	4.02	29
2 loaded tumbler on	236	1.00	110	25	10.21	2.75	3.67	27
3 loaded tumbler on	237	1.02	160	25	10.25	4.00	5.36	39
3 loaded tumblers & 1 empty	236	1.05	190	26	10.62	4.75	6.36	47
	236		220			5.50	7.48	
						(High Swing)		

Now operates 24 hours per week (estimated)

Using 4 kw. as average

$4 \times 24 \times \frac{26}{6} = 416$ kw.hr. per month.

Machine Shop Motor B
25 h.p. Rating
1150 R.P.M.

V ratio = 1/1
A " = 25/1
W " = 25/1

<u>Load</u>	<u>Volts</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv-a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.%</u>
Line shaft only	240	1.20	300	30	12.45	7.50	10.01	60
Normal at 12:45 P.M.	236	2.30	800	58	23.68	20.00	26.8	84
12:50 P.M.*	236	2.40	860	60	24.50	21.50	27.8	86
1:00 P.M.*	236	1.90	600	48	19.50	15.00	20.1	77
1:10 P.M.*	240	1.15	190	29	12.04	4.75	6.8	39

* Average for 30 sec.

- Now operates 60 hours per week (estimated)

Using 16 kw. as average

$16 \times 60 \times \frac{26}{6} = 4160 \text{ kw.hr. per month}$

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Tool Room Motor
5 h.p. Rating
1735 R.P.M.

V ratio = 1/1

A " = 1/1

W " = 2/1

<u>Load</u>	<u>Volts</u>	<u>Amp. Reading</u>	<u>Watt Reading</u>	<u>Amp. Actual</u>	<u>Kv-a.</u>	<u>Kw.</u>	<u>H.P.</u>	<u>P.F.%</u>
Line shaft only	238	6.4	700	6.4	2.64	1.4	1.8	53
Shaper	238	6.6	800	6.6	2.72	1.6	2.1	59
Shaper & planer	238	9.0	1500	9.0	3.7	3.0	4.0	81
Shaper, Planer & lathe	238	9.75	1600	9.75	4.1	3.2	4.3	78

Now operating 60 hours per week (estimated)
Using 2.5 kw. as average.

$2.5 \times 60 \times \frac{26}{6} = 650 \text{ kw.hr. per month.}$

Monthly kilowatt hour consumption.

271	Cupola Blower
4160	Machine Shop
416	Tumbler
3380	Dust Suction
312	Steel Room
650	Tool Room
<u>9189</u>	kw.hr.

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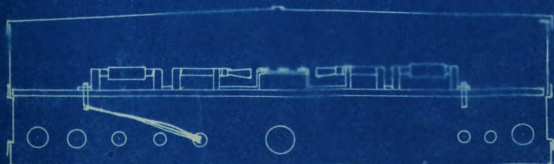
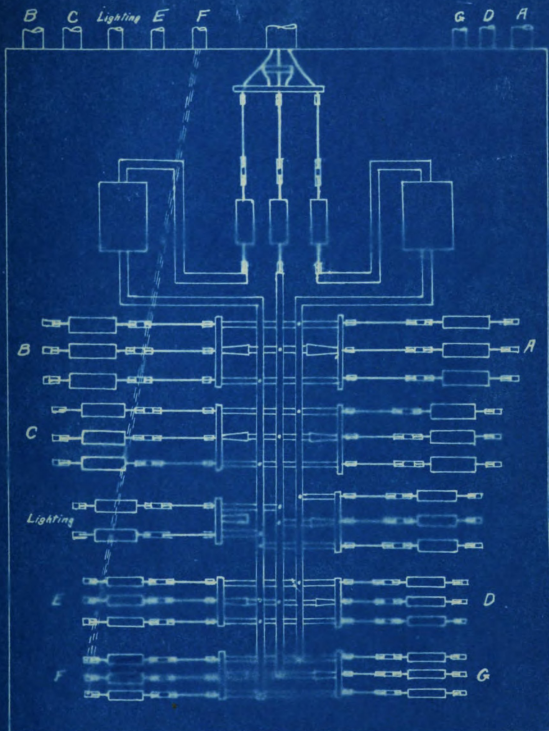
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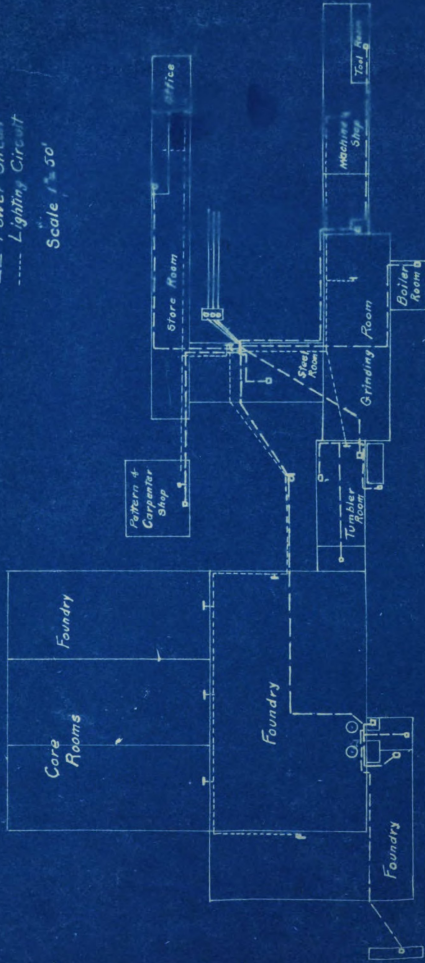
MAIN DISTRIBUTION CABINET Steel Room



PLANT LAYOUT

- ◻ Motor
- Distribution Panel
- - - Power Circuit
- - - - - Lighting Circuit

Scale 1" = 50'



3 hp Pattern Shop.



350,000 C.M.
Rubber Covered Wire
5 Inside

5 hp.
Carpenter
Shop

4/0 Weather-proof
Outside

300 amp.
400 amp.

50 amp.
60 amp.

60 amp.
60 amp.

60 amp.
60 amp.

60 amp.
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Power
Transformers

600 amp.
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600 amp.

POWER WIRING LAYOUT

- Switch
- Fuse
- Starting Compensator

250,000 C.M.
Rubber covered
wire.

10 hp
Steel Room

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

60 amp.
40 amp.

4/10 wire

3 hp.
Compressor

50 amp.
30 amp.

50 amp.
30 amp.

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30 amp.

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2/10 wire
4-5 amp

200 amp.
150 amp.

200 amp.
150 amp.

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30 amp.

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20 amp.
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20 amp.
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2/10 wire
4-5 amp

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150 amp.

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2/10 wire
4-5 amp

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200 amp.
150 amp.

2/10 wire
4-5 amp

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200 amp.
150 amp.

2/10 wire
4-5 amp

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4-5 amp

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2/10 wire
4-5 amp

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2/10 wire
4-5 amp

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200 amp.
150 amp.

2/10 wire
4-5 amp

200 amp.
150 amp.

200 amp.
150 amp.

200 amp.
150 amp.

200 amp.
150 amp.

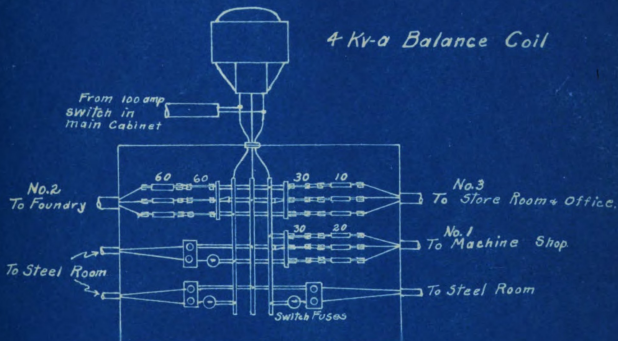
2/10 wire
4-5 amp

200 amp.
150 amp.

200 amp.
150 amp.

200 amp.
150 amp.

200 amp.
150 amp.

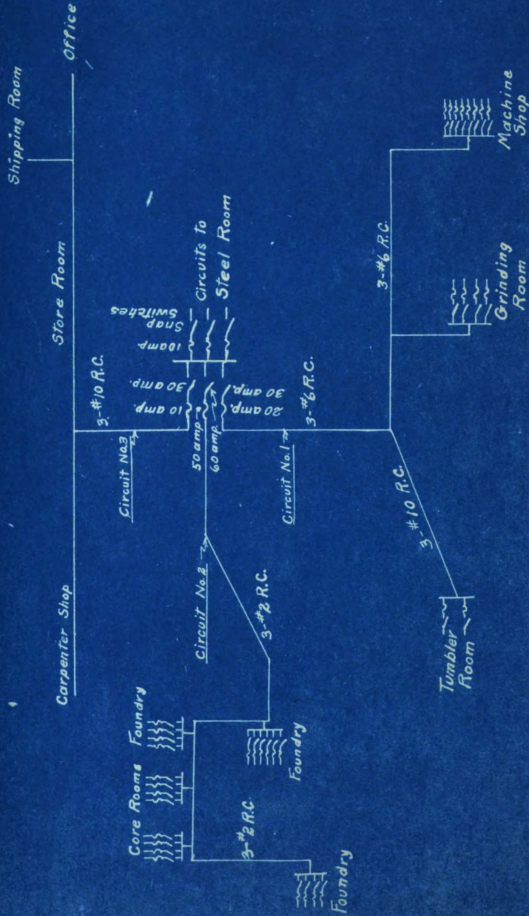


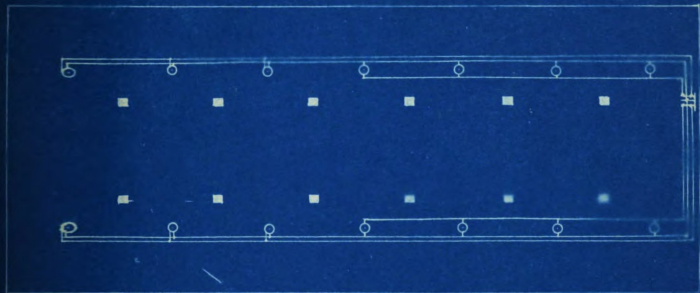
*Lighting Distribution Cabinet
Steel Room*

Lighting Circuits

Switch

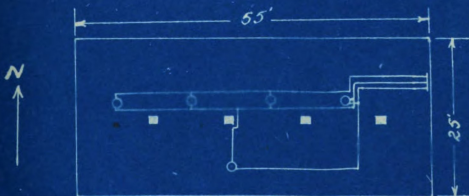
Fuse





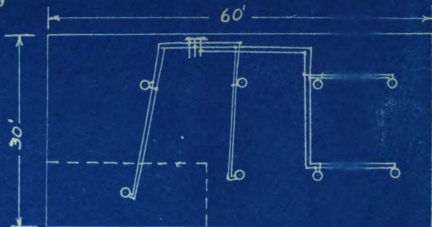
105' x 45' CORE ROOMS & FOUNDRY

*14-200 watt Type C-Lamps
Flat Cone Reflector
Four Circuits*



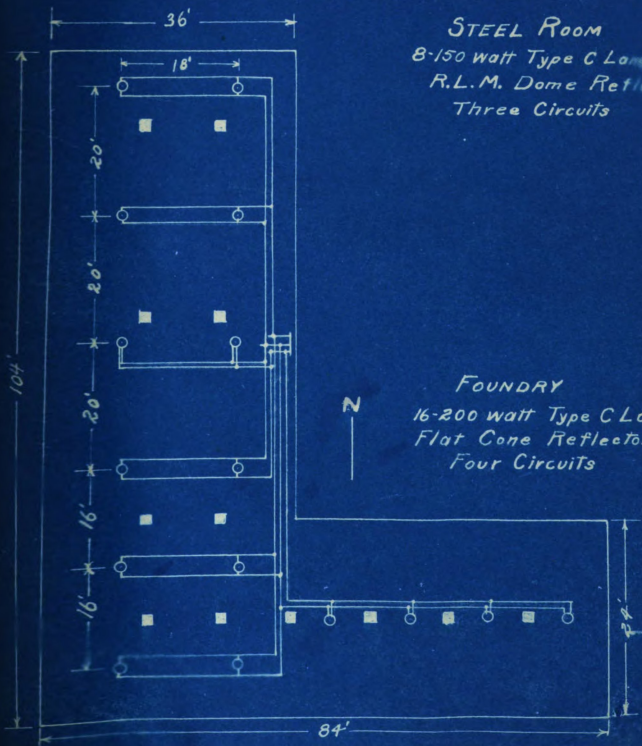
TUMBLER ROOM

*5-100 watt Lamps Type C
Flat Cone Reflector
Two Circuits*



STEEL ROOM

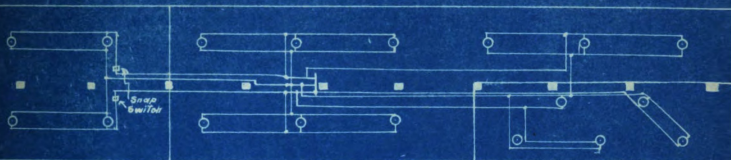
8-150 watt Type C Lamps
R.L.M. Dome Reflector
Three Circuits



FOUNDRY

16-200 watt Type C Lamps
Flat Cone Reflector
Four Circuits

120'



MACHINE SHOP

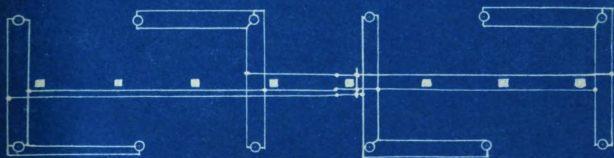
*13-200 watt Type C Lamps
R.L.M. Dome Reflector
Five Circuits*



TOOL ROOM

*5-100 watt Type C Lamps
R.L.M. Dome Reflector
Two Circuits*

108'



GRINDING ROOM

*12-150 watt Type C Lamps
R.L.M. Dome Reflector
Four Circuits*



VIEWS OF PLANT.

(Not included in Report.)



Fig. 1. General view looking west. Top of transformer rack can be seen over freight car. See blue print sketch 2.

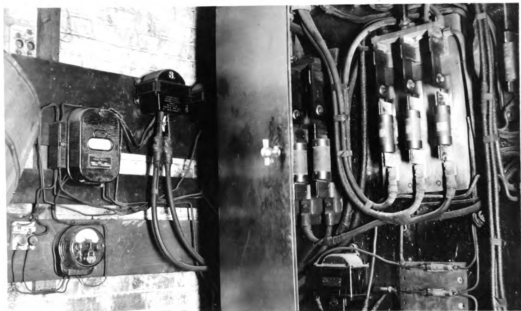


Fig. 2. Watthour meter, maxicator, current transformers and part of service cabinet.

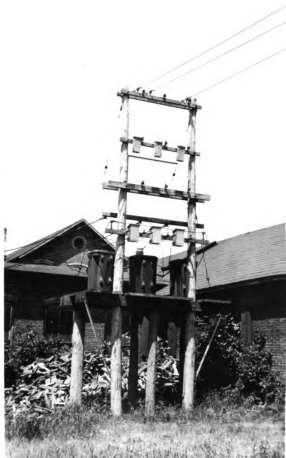


Fig. 3. Transformer Rack. Showing lightning arresters, outouts, transformers, and service wires. The service cabinet is inside just at the left of the window shown at the left.

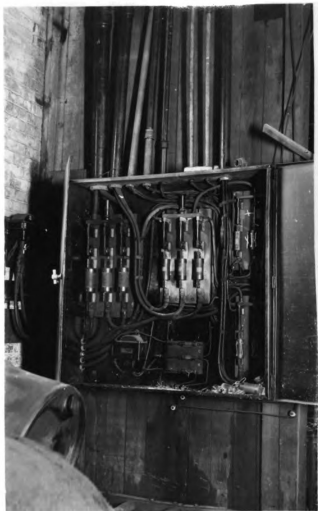


Fig. 4. Service Cabinet. Service wires come in through large conduit to service switch on left side. Inside of left hand door was spotted with aluminum oxide from the burning of reinforcing wires, which can also be seen in use on several fuses.



Fig. 5. Reinforced fuses on branch circuits in service cabinet and remains of some blown fuses. Due to unequal resistance of the several current paths it is almost impossible to estimate the capacity of such a makeshift and therefore they are over fused, thus loosing all benefit of fuse protection.

... rest
... increased
... proper line.



Fig. 6. Machine shop motor showing belting to line shaft. Switch box on column by punch press is shown in Fig. 8.



Fig. 7. Outside distribution center looking east toward Steel Room. Size of these wires should be increased and installed in a workman like manner using proper insulators, cross arms &c.

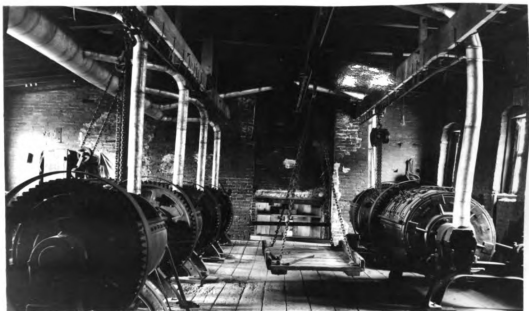


Fig. 9. Tumblers showing how dust suction connections are made. Overhead track system carrier is also shown.



Fig. 10. Sash pulley body facing grinder showing suction connections. These castings are dropped into slots seen in the conveyor belt and passed under all three emery wheels.



Fig. 11. The Battery of Emery Grinders showing dust hoods which maintain the suction load as long as the intakes are open. Installation of sheet iron slide valves in these and the tumbler suction pipes would have solved much of the high current cost complaint.



Fig. 12. Dust collector. There are several screens and a shaker motor in this housing. The air is drawn through and cleaned before going to the fan so no dust passes through the fan.



Fig. 13. Cupolas in foundry. Slag festoons can also be seen on the wires &c.



Fig. 14. First Building of the group built. Now used for a pattern shop. Date on insert stone 1889.



Fig. 15. North Foundry. This and the core rooms of similar construction were built within the last year or so.

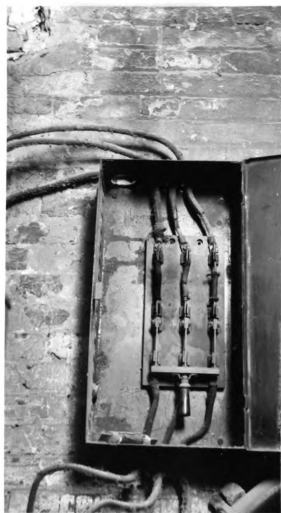


Fig. 16. "Fuses" and switch in cupola blower circuit. This type of fuse does not burn out so often for it is copper wire, but neither does it protect the motor at all. Due to trouble in obtaining good contact the resistance in different motor leads is liable to be considerably different, thus causing unbalance. The switch is upside down as gravity would tend to close it from the open position.



Fig. 17. Tumbler Motor and wiring.
This is fed from the pole shown in Fig. 7.
out in the court.



Fig. 18. Tumbler motor switch, fuses and starter. The switch is upside down. The cutout arrangement is a very serious hazard for the wires are sprung into the old clips and if one wire was pulled loose and short-circuited with either of the others the only fuse protection would be at the service switch and on the high tension side of the transformers. The renewable fuse links are mechanically very weak. The slightest pull breaks them causing loss of productive time.



Fig. 19. Slag Festoons on wires near
cupola. Illustrating why wires should be in
conduit.

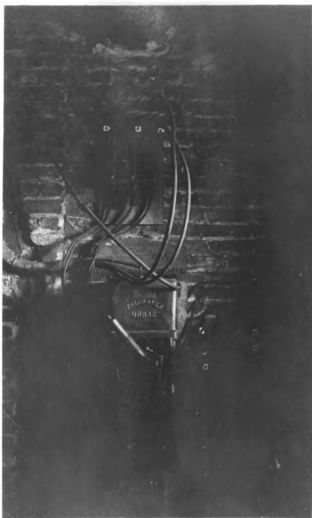


Fig. 20. Dust fan motor wiring. When this motor was started, during the tests, all meters went high to the pin. On investigation it was found that the motor side was connected to the line, that is the connections were reversed. As the starter is only an open delta autotransformer connected on the 50% taps this mistake made the starting voltage 440 instead of 110 as was intended.

CRITICISM OF SAMPLE REPORT.

The title page fills the requirements very well but in some instances it might be well to arrange the authorship differently, depending on conditions. This report was written for the Contract Engineer, who in turn gave the original copy to the customer, this being considered the best approach to this customer. If, instead, the report had been submitted to the customer directly, it should have read "by C. W. Pendell", without giving any recognition to his subordinates.

The table of contents has been omitted, although even in a report as short as this one, an item of interest can be pretty well lost. This can be proved by thinking of some important statement made in it and trying to refer back to that statement quickly, as an executive would do when talking to his board of directors about making the changes recommended. The average person will have to hurriedly read two or three pages, at least, in order to find the desired item. A table of contents would reduce this to one or less pages.

Paragraph 1 of the introduction is concise and gives most of the information it should, except suggesting what the conclusions are, which does not give the reader perspective that might help to make the whole report easier to read. There are two conditions which would possibly permit the omission of this item, both depending on the characteristics of the readers. If the man already knows the usual answer to such problems, it would not be necessary to state the conclusions. Or if the man might have a prejudice against the whole report if he knew the conclusions before being convinced of the details, it would be best to omit them.

Paragraph 2 gives a more definite mental picture of the plant and some engineering data that would be of importance to a technical man who might raise the question of low voltage, for it states that the substation is only about a quarter of a mile distant. He can almost read between the lines that this point has been considered.

Paragraphs 3 to 6 not only give the reader who is not acquainted with the plant an idea of the processes, but also gives the customer the feeling that details of his plant have been noticed and considered, rather than just recommending some of a stock lot of answers. It also introduces several of the most important parts of the plant, the relation of which make up the key to the answer of the problem in this report.

A mistake was made in paragraph 7 in that the transformer bank is located with respect to the "Steel Room", which is just as indefinite. This could have been remedied by referring to page 2 of the blue prints and would have given the reader an idea of the general layout of buildings which he needs to enable him to understand the description of circuits and motor applications that is to follow. Mention is made that the transformers are connected delta-delta, as that is an unusual connection on the lines of the Public Service Company of Northern Illinois, which generally uses star-delta connection, and would therefore be of interest to anyone considering the plant service.

Paragraph 8 could have been enlarged upon to some extent, for the conditions regarding "reinforced" fuses had been the cause of many shut-downs of from five to thirty minutes. This item figured in dollars and cents for idleness of production

labor and equipment, while the trouble was found and repaired, would in a year go far toward paying for the installation of the modern equipment. This fact was brought to the customer's mind by a little mental figuring during the discussion of the advisability of making the new installations recommended in the report. If the whole plant was shut down ten minutes a week for the fifty-two weeks in a year, with thirty men, it would mean 260 man hours per year, or, with two hundred men, 866 man hours per year. This, figured at fifty cents per hour, would amount to \$130.00 and \$433.00 per year, respectively, or a fifteen per cent return on investments of \$860.00 and \$2,880.00.

Another item worth noting in the same paragraph is the use of the word "reinforced", describing the condition of the fuses, instead of the trade vernacular, as "strapped" or "jumped." The reader's mind must not be bothered by the use of terms with which he is unfamiliar, for he immediately concludes he cannot understand this article and loses interest. This also applies to the use of unnecessary technical words in parts of the report intended for the manager or other men interested who are not technically trained, although, of course, it does not apply to the parts meant entirely for the technical advisor, such as test data, etc.

Paragraphs 17 and 18 sum up the cause of the complaint, therefore the cause of the report as far as the customer is concerned, and outlines the problem the investigators have to solve.

Paragraph 19 describes the tests made well enough so they could be duplicated. It should be noted here that all three

2. The second section focuses on the role of internal controls in preventing fraud and mismanagement. It highlights that strong internal controls are not only a defense against external threats but also a means to ensure the integrity of internal operations. The document recommends that organizations should regularly review and update their internal control systems to adapt to changing risks and regulatory requirements.

3. The third part of the document addresses the importance of communication and collaboration within an organization. It states that effective communication is key to ensuring that all team members are aligned with the organization's goals and objectives. The text encourages the use of various communication channels, including meetings, reports, and digital tools, to facilitate the exchange of information and ideas.

4. The fourth section discusses the need for continuous learning and development. It argues that in a rapidly changing environment, organizations must invest in the growth of their workforce. This can be achieved through training programs, workshops, and the sharing of knowledge and best practices among employees. The document suggests that organizations should create a culture of learning where employees are encouraged to seek out new skills and knowledge.

5. The fifth part of the document touches upon the importance of ethical considerations in business operations. It stresses that organizations have a responsibility to act ethically and transparently, not only to their stakeholders but also to the wider community. The text recommends that organizations should establish clear ethical guidelines and ensure that all employees are aware of and committed to these principles.

6. The sixth section discusses the role of technology in modern business operations. It notes that while technology offers numerous opportunities for efficiency and innovation, it also presents challenges, such as data security and privacy concerns. The document advises organizations to carefully evaluate the risks and benefits of new technologies and to implement appropriate safeguards to protect sensitive information.

7. The seventh part of the document addresses the importance of financial management and budgeting. It states that effective financial management is crucial for the long-term sustainability of an organization. The text recommends that organizations should develop realistic budgets, monitor financial performance closely, and make adjustments as needed to stay on track.

8. The eighth section discusses the importance of customer satisfaction and loyalty. It argues that in a competitive market, providing excellent customer service is a key differentiator for organizations. The document suggests that organizations should invest in training for customer-facing staff, implement feedback mechanisms, and strive to exceed customer expectations.

9. The ninth part of the document touches upon the importance of environmental and social responsibility. It states that organizations have a responsibility to minimize their environmental impact and to contribute positively to society. The text recommends that organizations should adopt sustainable practices, such as reducing waste and energy consumption, and engage in social responsibility initiatives that benefit the community.

10. The final section of the document provides a summary of the key points discussed and offers some concluding thoughts. It reiterates the importance of the various factors discussed, from record-keeping to ethical considerations, and encourages organizations to take a holistic approach to their operations. The document concludes by stating that success in the modern business environment requires a commitment to excellence, transparency, and continuous improvement.

measurements are likely to be of interest in an investigation of this kind, although at first thought it might seem that the wattage readings were the only important ones. The voltage readings are important, as is shown in the results of load tests on the cupola blower motor, where the line loss increased to eight volts as the load increased. The ampere measurements were not of particular use in this case except for getting the approximate power factor, although in another investigation made recently they were the most important, for readings appeared too high on the first phase measured, as did the second one, while the third was normal. This led to locating a fault, which was wasting nearly thirty per cent of the power input to the motor and making a serious increase in the customer's bill, as it was a 100 horse power motor of long hour operation.

Paragraph 20 suggests a point that no doubt has a small bearing on current consumption, in that the motors are underloaded and are therefore operating at considerably lower efficiency than they would at the time the full operating force of 200 men were working, thus increasing the comparative losses. However, the loss due to change in efficiency was very small compared with the waste due to operating the suction fan under exactly the same load with three men working, as it did when there were twenty to twenty-two men, for the same suction area was open. Installation of valves on this suction system alone would have made an appreciable reduction in the customer's current bill, if nothing else was done.

The conditions mentioned in paragraphs 22 and 23 are not surprising when it is realized that nearly all the buildings

were erected at different times, the oldest having the date 1889 on an insert stone, while the last or new building was erected within the last year or so.

The recommendations begin by suggesting to the customer that, besides the actual causes of his complaint, there are other things, the redesign of which would be advantageous to him. He was not told how "poor" his present installation was, but simply that it could be improved, thus maintaining his interest after he reads the answer to his complaint.

Paragraph 26 tells why the consumption seems comparatively higher than the previous year, so the complaint is here answered, while the next two paragraphs assist the customer in remedying some of his troubles by suggesting methods of reducing the kilowatt hour consumption. The large fan operating with all inlets open practically all the working time was no doubt the biggest item to be considered, especially as it had been added since the full force operation of the previous year.

This customer has a Rate C contract with a measured maximum demand. As his demand never runs over 85 kilowatts, a meter known under the trade name of "Maxicator" is used. This instrument is equipped with two movable arms. One, the "pusher" arm, is notched up one point on a ratchet every time the watt hour meter makes a certain number of revolutions, and, through a cam arrangement, closes a contact. Every half hour this arm is released by an electric clock mechanism, so that it falls back to zero point. This combination of a revolution counter and clock really divides kilowatt hours

C. W. PENDALL
ENGINEER

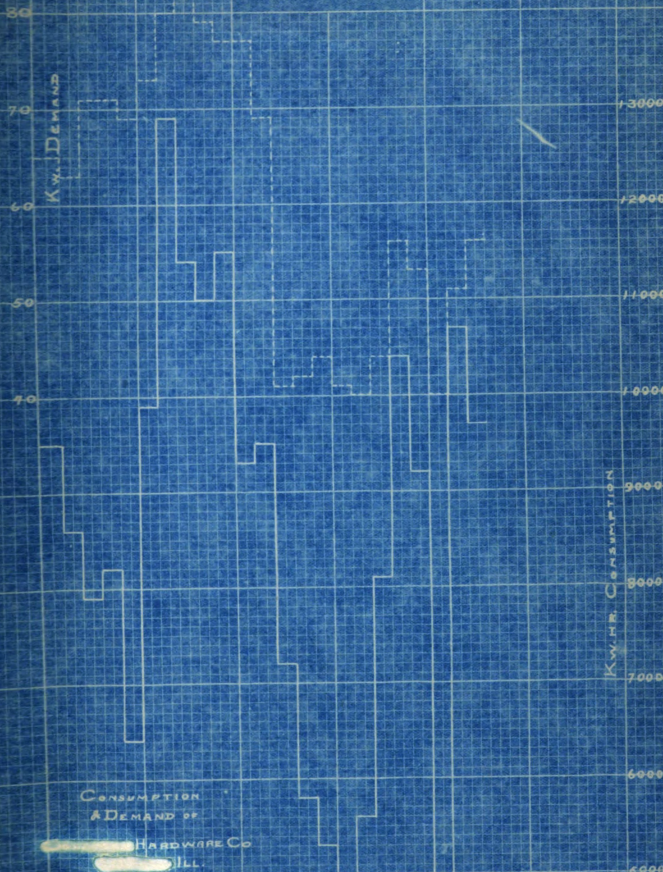
KW. DEMAND

KW. HR. CONSUMPTION

CONSUMPTION
AND DEMAND OF

HARDWARE CO
ILL.

M J J A S O N D J F M A M J J A S O N D J F M A
1920 * 1921 * 1922



by time and a constant, thus reading kilowatts demand each half hour. The second arm is pushed forward by the pusher arm, but is reset only by the meter reader. Thus, this second arm always reads the highest half hour maximum demand since being reset. This type of meter does not show the time at which the maximum demand occurs, as do the graphic meters used on larger installations, so it was necessary to make a careful study of operating conditions before making any statements regarding the demand charge part of the customer's bill, as in the 29th paragraph.

It is sufficient to note that the customer's bill was reduced twenty-five per cent the first month after following the recommendations of this report, as is suggested by the accompanying curves of consumption and maximum demand. The maximum demand shows the greatest effect, as would be expected, because it would not be increased a great deal until the working force was nearly back to normal. The inventory shut-down is shown in January 1922 consumption.

At this point it should be noted that this particular report was supplemented by personal verbal conviction of the customer, both before and at the time of submitting the report; that the fire risk was great if the installation was not up to the requirements of the Fire Underwriters' Code; and that there would be operating advantages, besides a possible insurance rate reduction, if these standards were followed. Or, in salesman's terms, he had been sold the idea of a National Board of Fire Underwriters' Code job by the time the report was ready. Similarly, the idea of increasing production by better lighting had been sold to him during the same time. It was, therefore,

not advisable to lengthen this report by including these arguments as might be best sometimes.

There is nothing unusual in paragraphs 30 to 48, which only specifies Underwriters' requirements, unless the reason for recommending entire new equipment for the service cabinet, when several of the old switches might have been used, is of interest. If old switches had been used it would have meant that the installing electrician would have had to make all the bus work by hand, on the job, while by using a shop assembled cabinet where machinery can be used to the fullest extent, the saving in labor expense would almost, if not entirely, cover the cost of new equipment; The expense of having new material and a good installation was practically no more than it would have been to have used the secondhand switches.

Paragraphs 49 to 63 are merely descriptions of a new lighting layout along the lines of good illuminating engineering.

This report would have left the reader with a more finished feeling, if a short summary paragraph had been added at the last, stating briefly the findings of the investigation and the recommendations.

This report has given illustrations of some of the principles discussed in the previous sections and is probably typical for its class. The customer's mental processes must be followed and directed constantly to make him trust the writer and his conclusions. This demands the best possible engineering, together with a careful study of character and good business principles.

RECAPITULATION.

The following items might be noted in conclusion.

The economic and commercial side of central station operation is equally as important as engineering today.

The present meaning of "service" is much broader than selling of continuous kilowatt hours.

The power salesman should be the customer's consulting engineer on electrical problems, for it is the best way to permanently sell power.

The central station is more interested in the customer's permanent growth than in his present purchases.

Rates must pay a reasonable return on a fair valuation as a whole, and each must be in proportion to the cost of the particular service.

Demand charges are very important because of the predominance of interest charges in central station costs, on account of slow turnover of invested money.

The turnover can be increased by any means that will increase the load factor or power factor, or decrease the investment in equipment capacity or the cost per unit of capacity.

The salesman's engineering report, whether verbal or written, is important and should follow the same principles. The reader must be indirectly convinced of the salesman's ability to handle the problem, and that he took time and pains to do it correctly.

The report must be written for both the executive and his technical advisor.

The methods of obtaining data and the data itself must be correct, and recorded in such a manner that the reader can check them if he wishes.

English that is clear, correct and courteous should be used and it must fit the reader.

The subject should be kept in mind and the report should progress smoothly from known data to the conclusions.

The sentences, paragraphing, typing, paper, binding and other small details are important, both in making it easy for the reader to understand and in convincing him that the author has given thought and care to the preparation of the report.

The report must be simple, correct and carry conviction, as the customer must be sold the advice whether it is methods of use of present power equipment or new uses for power.

The letter of transmittal which accompanies the report is the personal touch and should be given careful consideration.

A P P E N D I X.
CONTRACTS AND RIDERS.

C D 22—10-26-20

Meter Set or

Turn on Order No. _____

Name _____

Previous

Address _____

RATE "A"

APPLICATION FOR ELECTRIC SERVICE

The Undersigned, hereinafter called the Customer, hereby makes application to Public Service

Company of Northern Illinois, to be supplied with electricity for _____

sockets, at the premises (which are adjacent to the Company's lines) No. _____

_____ in _____
and agrees to pay for the same, in accordance with the Company's filed and published rate, and to comply with—

The Terms and Conditions Printed on the Back Hereof

The Company will furnish the original installation of incandescent lamps at its established prices for such lamps. Renewals of standard carbon filament lamps will be furnished by the Company upon the return by the Customer of the lamps with glass intact to the Company's district lamp room.

The Customer agrees to pay to the Company a net minimum bill of Fifty Cents (50c) per meter per month whether electricity is consumed or not.

The Company shall have the right at any time to require the Customer to make a reasonable deposit in advance to secure the prompt payment of bills.

No agent has the power to amend, modify or alter this application or waive any of its conditions, or to bind the Company by making any promise or representation not contained herein.

DATE _____

19 _____

Customer

Name of Firm or Company and Position _____

By _____

TERMS AND CONDITIONS

All wiring and other electrical equipment in the premises or connecting the premises with the Company's service, furnished by the Customer, shall be suitable for the purpose intended and shall be maintained by the Customer at all times in conformity with the regulations of the National Board of Fire Underwriters, the properly constituted local authorities and the reasonable rules and regulations of the Company in force from time to time.

The Company shall not be responsible for damages for any failure to supply electricity or for interruption or reversal of the supply, if such failure, interruption or reversal is without willful default or negligence on its part.

The properly authorized agents of the Company shall, at all reasonable hours, have free access to the premises for the purpose of inspecting the Customer's installation and of examining, repairing or removing the Company's meter, or other property, and for such purpose the Customer hereby grants to the Company and its agents full and free access to the premises.

The Company reserves the right to refuse to supply electricity for any cause resulting to the Customer or to third persons from the use of electricity or the presence of the Company's appliances in the Customer's premises, unless due to willful fault or neglect on the part of the Customer.

The Company shall have the right to discontinue all electric service to the Customer on due notice, and to remove its property from the Customer's premises whenever bills for electricity are in arrears and in case the Customer fails to comply with or perform any of the conditions or obligations hereof.

The electric service shall be measured by a meter or meters to be installed by the Company upon the premises at a point most convenient to the Company's service, and upon the installation of a meter or meters all bills shall be calculated on the basis of the ordinary consumption. The Company will install in the Customer's premises but one meter or one undivided set of meters. Where, for the Company's convenience, more than one meter or one undivided set of meters is installed, the sum of the registrations shall in all cases constitute the total registration. The term "meters," as used herein, includes all measuring instruments and accessories thereon.

All meters and other appliances and equipment furnished by and at the expense of the Company, which may at any time become defective, shall, without charge, be promptly repaired hereon, be and remain the property of the Company, and the Customer shall protect the property from loss or damage, and no one who is not an agent of the Company shall be permitted to remove or tamper therewith.

Notice to discontinue the supply of electricity must be given to the Company's office in writing. The Customer will be held responsible for all electricity consumed up to the time of the disconnection of the meter.

The Company will install free of charge service wires without charge, provided that the setting of a pole, or poles, on private property is not required. The Customer agrees to pay for the cost of furnishing and installing service wires from the first pole section provided, and to the Customer shall be paid for the cost of furnishing and setting all poles erected on private property, such cost to be paid by the Customer for each pole so installed. All underground service wires, including the cable leading to the meter, from the Company's overhead lines shall be furnished and installed at the Customer's expense. The Company will not extend its primary lines beyond and within the Customer's premises except at the expense of the Customer.

A transformer, or transformers, of sufficient capacity shall be installed by the Company at its expense, at one point only. Any additional service connections or transformers requested by the Customer for his convenience shall be furnished and installed at the Customer's expense.

No other electric light or power service shall, except under a contract for auxiliary service, be used by the Customer on the same installation in conjunction with the Company's service, either by means of a "throw-over" switch or any other connection.

C D 22

RATE "A." GENERAL LIGHTING SERVICE**Rate:**

13 cents per kilowatt-hour for electricity used equivalent to, or less than, the first 30 hours' use per month of the maximum demand in the month.

9 cents per kilowatt-hour for all electricity used per month in excess of the equivalent of 30 hours' use of the maximum demand.

Determination of Maximum Demand.

- (a) Where the rated capacity of the installation connected exceeds 5 kilowatts, measurement is by maximum demand indicators.
- (b) Where the rated capacity of the installation connected is 5 kilowatts or less, the number of kilowatt-hours equivalent to 30 hours' use per month of the maximum demand will be estimated and fixed in accordance with the table set out below.

A. The figures in line "A" of the table designate the number of sockets, or receptacles, of installation connected. (Where the lighting installation has a total rated capacity of 5 kilowatts or less, motors having a total rated capacity of 1 horse-power or under and small household utensils are disregarded in determining the active installation connected, unless the connection is permanent, in which case each motor or utensil is taken at its full rated capacity.)

B. The figures in line "B" of the table designate the maximum number of kilowatt-hours to be paid for at the 13 cent rate, in the case of residence Customers.

C. The figures in line "C" of the table designate the maximum number of kilowatt-hours to be paid for at the 13 cent rate, in the case of Commercial Customers.

A.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50				
B.....	2	3	5	6	7	8	9	10	10	11	11	12	12	13	13	14	14	15	15	16	17	18	18	19	19	20	20	21	22	22	23	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34		
C.....	2	3	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22	23	23	24	24	25	26	26	27	28	29	30	31	32	33	33	34	35	35	36	37	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A—Cont'd..	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100				
B—Cont'd..	32	32	33	33	33	34	34	35	35	36	36	37	37	38	38	39	39	40	40	41	41	41	42	42	42	43	43	43	44	44	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51	52	52	53	53	54	54			
C—Cont'd..	44	45	46	46	47	47	48	48	49	50	50	51	52	53	54	55	56	57	58	59	60	60	61	62	63	63	64	65	65	66	67	67	68	69	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	79		

Prompt Payment Discount.

1 cent per kilowatt-hour when bills are paid on or before 10 days after their respective dates.

Minimum Charge.

50 cents per meter per month.

Lamp Renewals.

The Company will furnish free renewals of standard carbon (Gem) lamps.

Standard Riders.

Applicable to contracts hereunder are shown hereinafter.

August 1, 1920

Date of Issue, May 5, 1920.

All changes are indicated by italics.

Date Effective, August 1, 1920.

Issued by George R. Jones, Secretary,
72 W. Adams St., Chicago, Ill.

**PUBLIC SERVICE COMPANY
OF NORTHERN ILLINOIS.**

General Office:
72 West Adams Street, Chicago, Illinois.

SUPPLEMENT No.

**to
SCHEDULE No. 1.
(Electricity)**

**I. P. U. C. No. 1
1st Revised Sheet**

For....., Illinois,
and the unincorporated contiguous territory.

(Cancelling Original Sheet for correspond-
ing Rate "A," Commercial Lighting
Service.)

RATE "A." COMMERCIAL LIGHTING SERVICE

Available for any Customer using the Company's standard lighting service, for stores, offices, restaurants, saloons, lodge and dance halls, laundries, depots, theatres, churches, factories, livery stables, hotels, clubs, schools, shops, etc.

RATE:

12 cents per kilowatt-hour.

PROMPT PAYMENT DISCOUNT:

1 cent per kilowatt-hour when bills are paid on or before 10 days after their respective dates.

MINIMUM CHARGE:

50 cents per meter per month.

LAMP RENEWALS:

The Company will furnish free renewals of carbon filament (Gem) lamps.

August 1, 1920

Date of Issue, May 5, 1920.

The increase in the rate is the only change from the sheet cancelled hereby.

Date Effective, June 15, 1920

Issued by George R. Jones, Secretary,
72 West Adams Street, Chicago.

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

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CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

APPLICATION FOR ELECTRIC POWER

RATE B (2)—REGULAR POWER SERVICE—ALTERNATING CURRENT

Service Requested.

The Undersigned, hereinafter called the Customer, requests the Public Service Company of Northern Illinois, herein after called the Company, to furnish, in accordance with the terms hereof, alternating current electricity (transformed to approximately _____ volts, _____ phase, frequency 60 cycles), for power purposes at the Customer's premises _____, in _____ County of _____ Illinois.

The Customer's apparatus consists of _____

having a total rated capacity of _____ horse-power. "Power" is defined as electric service used for any purpose other than lighting. It does not include the running of dynamos for electric lighting purposes.

It is mutually agreed, notwithstanding anything to the contrary herein contained, that the Company shall not be required to furnish service, under this application, for a connected load in excess of _____ horse-power, rated capacity.

The Customer must specially apply for any additional service.

Rate.

For the service requested, the Customer agrees to pay the Company as follows:

- 11 cents per kilowatt-hour for electricity used equivalent to or less than the first 30 hours' use per month of the maximum demand in the month.
- 6 cents per kilowatt-hour for additional electricity used equivalent to or less than the next 30 hours' use per month of the maximum demand.
- 4 cents per kilowatt-hour for all electricity used per month in excess of the equivalent of 60 hours' use of the maximum demand.

Whenever the portion of any monthly bill for electricity represented by charges at the 6 cent rate, or at the 6 and 4 cent rates, shall exceed \$45.00, the Company will allow a discount from such portion in accordance with the following table:

When such portion is \$ 45.00, no discount.	When such portion is \$ 300.00, 30 per cent discount.
When such portion is 50.00, 10 per cent discount.	When such portion is 400.00, 35 per cent discount.
When such portion is 100.00, 15 per cent discount.	When such portion is 500.00, 40 per cent discount.
When such portion is 150.00, 20 per cent discount.	When such portion is 750.00, 45 per cent discount.
When such portion is 200.00, 25 per cent discount.	When such portion is 1000.00, 50 per cent discount.

Intermediate discounts will be determined by interpolation.

The rates herein stated are the present legal rates of this Company as on file with the Public Utilities Commission of the State of Illinois and are subject to change by order of said Commission.

Determination of Maximum Demand.

The maximum demand per month will be deemed to be a certain proportion of the kilowatt equivalent of the rated horse-power capacity of all motors or other apparatus connected in accordance with the following table:

Where installation is under 10 horse-power (only one motor)	85%
Where installation is under 10 horse-power (more than one motor)	75%
Where installation is from 10 to 50 horse-power, both inclusive, irrespective of number of motors	65%
Where installation is over 50 horse-power, irrespective of number of motors	55%

Monthly Bills. Prompt Payment Discount.

As soon as practicable after the end of each month the Company shall render a bill to the Customer for the amount due hereunder for such month, and the Customer agrees to pay such bill within 10 days after its date; and if such bill be paid within such 10 days the Customer shall be entitled to a discount of 1 cent per kilowatt-hour from the portion of the bill represented by the charges at the 11 cent rate.

A "month" under this application shall mean the period between any two consecutive regular readings by the Company of the meters at the premises; such readings to be taken, as nearly as may be practicable, every thirty days.

Minimum Charge.

Notwithstanding anything to the contrary hereinbefore contained the Customer agrees to pay for each month's service hereunder a minimum charge of 50 cents per horse-power or fraction thereof, of the total rated capacity of the motor or motors or other apparatus connected.

Lamp Service.

The Company will not furnish lamps of any description, or renewals of lamps, hereunder.

Term of Contract.

The obligations of both parties hereunder shall commence on the date when the Company begins to supply electricity hereunder (such date to be about _____, 192____), and shall continue for a fixed term of _____ year _____, and after the expiration of such fixed term until 30 days after the receipt by either party from the other of written notice to discontinue service.

The Terms and Conditions printed on the back hereof are hereby made a part of this application.

This application, although signed, is subject to the approval of an Officer of the Company, and shall not be binding upon the Company until endorsed with his approval.

Dated _____ 192____

CUSTOMER.

Approved _____ 192____
Public Service Company of Northern Illinois.

By _____

By _____

Official Capacity.

I

AUXILIARY OR BREAK-DOWN SERVICE
(Applicable to Rates "A", "B" and "C" only)

Rider to, and hereby made a part of, the attached Contract or Application (hereinafter referred to as the "Contract") dated _____ 192__, for electric service furnished by the Public Service Company of Northern Illinois (hereinafter and in said Contract called the "Company") to the undersigned Customer.

Notwithstanding anything to the contrary in the attached Contract contained, it is hereby agreed as follows:

The Customer (whose premises are regularly supplied with light or power, or both, from a privately owned source of electrical energy) shall have the privilege, upon the conditions named in this rider, of using the Company's electric service under said Contract as a reserve, auxiliary or break-down service in connection with his usual source of supply.

The Company agrees to stand ready to supply to the Customer at all times during the life of said Contract electricity to the amount of, but not to exceed _____ (_____) kilowatts (not less than one kilowatt); and the Customer agrees to pay a net minimum yearly charge under said Contract of _____ (\$_____) Dollars for each year during the life of the Contract, being twenty-four (\$24.00) dollars per kilowatt or fraction thereof, reckoned upon the number of kilowatts which the Company is so obliged to stand ready to supply. Until the Customer shall in any year, have paid the full minimum charge for the year, he shall pay to the Company each month not less than _____ (\$_____) Dollars (being \$2.00 per kilowatt reckoned upon the number of kilowatts which the Company must stand ready to supply).

In case said Contract be under the Company's rate for General Lighting Service (Rate "A") the contract term shall not be less than one year.

The Customer shall at his own expense furnish, install and connect a suitable circuit breaker, which shall be under the sole control and regulation of the Company, of a character approved by the Company and which shall be set to break the connection with the Company's service in case the Customer's maximum demand shall at any time exceed the number of kilowatts of electricity, at eighty (80%) per cent power factor, which the Company is obliged to stand ready to supply hereunder; and the Customer shall not in any way interfere with the adjustment or operation of such circuit breaker. The Customer shall also furnish and install, when same is required by the Company, at his own expense, a locked steel box to contain such circuit breaker.

I (Continued)

AUXILIARY OR BREAK-DOWN SERVICE (Cont'd)

If at any time while the Customer is using the Company's electricity hereunder his demand shall be so great as to cause said circuit breaker to open the circuit, the Company shall renew the connection upon due notice and upon receiving satisfactory assurance that the Customer's demand will be reduced to an amount not to exceed the number of kilowatts which the Company agrees to stand ready to supply hereunder.

The Customer shall not at any instant operate his usual source of supply in multiple with the Company's service, and shall, in any event, reimburse the Company for loss or damage sustained by the Company by reason of his use of the Company's service hereunder.

All the terms and provisions of said Contract except as modified in this rider, shall be and remain in full force and effect.

This rider, although signed, is subject to the approval of an Officer of the Company and shall not be binding upon the Company until endorsed with his approval.

PUBLIC SERVICE COMPANY
of Northern Illinois

Dated _____ 192__

By _____

Approved _____ 192__

Public Service Company
of Northern Illinois

Customer

By _____

By _____

Official Capacity

Official Capacity

III

DISCOUNT WHERE CUSTOMER IS A SEMI-CHARITABLE INSTITUTION
(Applicable to Rates "A", "B", (except limited hour service) and "C")

Rider to, and hereby made a part of, the attached contract,
or application, (hereinafter referred to as the "contract") dated

_____ 19 _____ for _____
service furnished by the Public Service Company of Northern Illinois
(hereinafter and in said contract called the "Company") to the
undersigned Customer.

Inasmuch as the Customer is a semi-charitable institution
doing charitable work in part, the Customer shall be entitled
to a discount from its monthly bill for electricity furnished
during the month, which discount shall be 15 per cent of such
net monthly bills, provided that the net rate to be paid by the
Customer for electricity consumed hereunder in any month shall
not be lower than 4½ cents per kilowatt hour, and provided fur-
ther that in no case shall the net charge for electricity in
any month be less than the minimum charge specified in the
attached contract.

This rider, although signed, is subject to the approval
of an Officer of the Company and shall not be binding upon
the Company until endorsed with his approval.

Customer.

By _____

Dated _____ 19 _____

Approved _____ 19 _____
Public Service Company
of Northern Illinois.

By _____
Vice-President.

#1375

IV
TEMPORARY SERVICE RIDER

(APPLICABLE TO RATES "A" AND "B" AND "C")

Rider to, and hereby made a part of, the attached Contract dated _____, for electric service to be furnished by the Public Service Company of Northern Illinois (hereinafter and in said Contract called the "Company") to the undersigned Customer.

It is expressly agreed that, as electricity is to be used under the attached Contract for temporary purposes only, the Customer shall pay to the Company in advance (in addition to all amounts to accrue for consumption of electricity) the sum of _____ (\$ _____) Dollars as the cost to the Company of providing for said temporary service.

All the terms and provisions of said Contract, except as modified in this rider, shall be and remain in full force and effect.

This rider, although signed, is subject to the approval of an Officer of the Company, and shall not be binding upon the Company until endorsed with his approval.

Customer

Dated _____ 192__ By _____

Approved _____ 192__
Public Service Company
of Northern Illinois _____
Official Capacity

By _____

No lamps of any description, renewals of lamps, wiring or electric appliances of any kind (except meters as herein provided) are to be furnished by the Company under this agreement.

This rider, although signed, is subject to the approval of an Officer of the Company and shall not be binding upon the Company until endorsed with his approval.

Customer

By _____

Dated _____ 192__

Approved _____ 192__
Public Service Company
of Northern Illinois

By _____

VI

OUT-DOOR LIMITED HOUR SERVICE
(Applicable to Rate "B" only provided
Customer has a connected motor load
of 100 H.P. or over.)

Rider to, and hereby made a part of, the attached contract,
or application, (hereinafter referred to as the "contract") dated

_____ 19____ for _____
service furnished by the Public Service Company of Northern
Illinois (hereinafter and in said contract called the "Company")
to the undersigned Customer.

Available only for customers using the Company's standard
service at stone quarries, gravel pits, brick yards and similar
out-door places of business.

In consideration of the Customer executing a five (5) year
contract and agreeing not to use any electricity between the
hours of 4:00 P.M. and 8:00 P.M. of each day in the calendar
months of November, December, January and February, the Company
agrees to allow the customer discounts of 15 per cent and 5
per cent on all net monthly bills for electricity furnished
hereunder, said discount to be allowed, if earned, on the first
day of March in each year.

In consideration of the Customer giving the Company
written notice, of its intention to cease operation for the
winter season not later than October Fifteenth and agrees
not to use any electricity during the months of November,
December, January and February, the Company agrees to waive
the minimum charge specified in the attached contract during
said months. It is further agreed that the Company shall
have the right to disconnect or remove its transformers
during the said months.

This rider, although signed, is subject to the approval
of an Officer of the Company and shall not be binding upon
the Company until endorsed with his approval.

Customer.

By _____

Dated _____ 19____

Approved _____ 19____
Public Service Company
of Northern Illinois.

By _____

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS
530 SOUTH EAST ASIAN AVENUE
CHICAGO, ILLINOIS 60607-7080

TO THE EDITOR OF THE JOURNAL OF THE
ROYAL SOCIETY OF MEDICINE
LONDON
Dear Sir,
I have the honor to acknowledge the receipt of your letter of the 14th inst. in relation to the above-mentioned matter. I am sorry to hear that you have been unable to obtain the necessary information from the authorities concerned. I am, however, sure that the matter will be cleared up in due time. I am, Sir, very respectfully,
Yours faithfully,
J. H. [Name]
[Signature]

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS
530 SOUTH EAST ASIAN AVENUE
CHICAGO, ILLINOIS 60607-7080
[Additional text or signature block]

VII

DISCOUNT WHERE CUSTOMER USES ALTERNATING CURRENT UNTRANSFORMED;
THE COMPANY TO FURNISH TRANSFORMERS.
(Applicable to Rate "B" only.)

Rider to, and hereby made a part of, the attached contract,
or application, (hereinafter referred to as the "Contract")
dated _____ 19____ for _____
service furnished by the Public Service Company of Northern
Illinois (hereinafter and in said contract called the "Company")
to the undersigned Customer.

Notwithstanding anything to the contrary in said contract
contained the Customer agrees (1) that the fixed term of said
contract shall be five (5) years; (2) that the electricity
furnished under said contract shall be alternating current un-
transformed and shall be measured on the primary circuit, the
difference between the cost of furnishing and installing metering
equipment for measuring the energy on the primary circuit and the
cost of furnishing and installing the necessary equipment for
measuring the energy at 2200 or 4400 volts, to be paid by the
Customer; (3) that the charges under said contract for each
month shall be based upon a maximum demand of not less than
50 kilowatts; and in consideration of such agreement on the
Customer's part, the Company agrees (1) to furnish all necessary
transformers and (2) to allow the Customer a discount of 5 per
cent from the net amount (determined in the manner provided
in said contract) of each month's bill.

This rider, although signed, is subject to the approval
of an officer of the Company, and shall not be binding upon
the Company until endorsed with his approval.

Customer.

By _____

Dated _____ 19____

Approved _____ 19____

Public Service Company
of Northern Illinois

By _____

4. The fourth part of the document discusses the implications of the findings. It suggests that the results have significant implications for the field of research and may lead to further developments.

5. The fifth part of the document concludes the study. It summarizes the key findings and provides a final statement on the importance of the research.

6. The sixth part of the document includes a list of references and a bibliography. It cites the works of other researchers in the field and provides a comprehensive overview of the literature.

7. The seventh part of the document includes a list of appendices and a bibliography. It provides additional information and data that support the findings of the study.

VIII

DISCOUNT WHERE CUSTOMER USES ALTERNATING CURRENT UNTRANSFORMED:
THE CUSTOMER TO FURNISH TRANSFORMERS.
(Applicable to Rate "B" only.)

Rider to, and hereby made a part of, the attached contract, or application, (hereinafter referred to as the "Contract") dated 19 for service furnished by the Public Service Company of Northern Illinois (hereinafter and in said contract called the ("Company")) to the undersigned Customer.

Notwithstanding anything to the contrary in said contract contained the Customer agrees (1) that the fixed term of said contract shall be five (5) years; (2) that the electricity to be furnished under said contract shall be alternating current untransformed and shall be measured on the primary circuit; (3) that the charges under said contract for each month shall be based upon a maximum demand of not less than 50 kilowatts; (4) that the Customer shall furnish, install and maintain at his own expense all transformers necessary to reduce the electricity furnished to either 220 or 440 volts; the difference between the cost of furnishing and installing metering equipment for measuring the energy on the primary circuit and the cost of furnishing and installing the necessary equipment for measuring the energy at 2200 or 4400 volts, to be paid by the Customer; and in consideration of such agreement on the Customer's part, the Company agrees to allow the Customer a discount of 10 per cent from the net amount (determined in the manner provided in said contract) of each month's bill.

This rider, although signed, is subject to the approval of an officer of the Company and shall not be binding upon the Company until endorsed with his approval.

By _____

Dated _____ 19 _____

Approved _____ 19 _____

Public Service Company
of Northern Illinois

By _____

IX

No. 1451

LIMITED HOUR AUTOMOBILE CHARGING IN PUBLIC GARAGE
(Applicable to Rate "B" only)

Rider to, and hereby made a part of, the attached Contract, or Application (hereinafter referred to as the "Contract") dated _____ 192__ for electric service furnished by the Public Service Company of Northern Illinois (hereinafter and in said Contract called the "Company") to the undersigned Customer.

Notwithstanding anything to the contrary in the attached Contract contained, it is agreed as follows:

The electricity to be furnished under the attached Contract shall be used on the Customer's premises (being a public garage) for the purpose of charging electrically propelled automobiles, and for no other purpose.

The Customer agrees not to use any electricity from the service covered by this Contract during the period of time between the hours of 4:00 P.M. and 8:30 P.M. of each day, except Sundays and legal holidays, in the calendar months of November, December, January and February during the period of this Contract.

In consideration of such agreements on the part of the Customer, the Company agrees that the Customer's net rate for electricity furnished hereunder shall not exceed four and one-half (4½¢) cents per kilowatt-hour; provided, however, that in no case shall the net charge hereunder for any month be less than the minimum charge specified in said Contract.

This rider, although signed, is subject to the approval of an Officer of the Company and shall not be binding upon the Company until endorsed with his approval.

PUBLIC SERVICE COMPANY
of Northern Illinois.

Dated _____ 192__

By _____

Approved _____ 192__

Public Service Company
of Northern Illinois

Customer

By _____

By _____

Official Capacity.

Official Capacity

X

LIMITED HOUR AUTOMOBILE CHARGING IN PRIVATE GARAGE
(Applicable to Rate "B" only)

Rider to, and hereby made a part of, the attached contract, or application, (hereinafter referred to as the "contract") dated

_____ 19____ for _____
service furnished by the Public Service Company of Northern Illinois (hereinafter and in said contract called the "Company") to the undersigned Customer.

Notwithstanding anything to the contrary in the attached contract contained, it is agreed as follows: The electricity to be furnished under the attached contract shall be used in the Customer's premises (being a private garage) for the purpose of charging automobiles, and for no other purpose.

The Customer agrees not to use any electricity hereunder during the period of time between the hours of 4:00 P.M. and 8:30 P.M. of each day in the calendar months of October, November, December, January and February during the period of this contract, and in consideration of such agreement on the part of the Customer, the Company agrees that the Customer's net rate for electricity furnished hereunder shall not exceed 5 cents per kilowatt hour, provided that in no case shall the net charge hereunder for any month be less than the minimum charge specified in said contract.

This rider, although signed, is subject to the approval of a Vice-President of the Company and shall not be binding upon the Company until endorsed with his approval.

Customer.

By _____

Dated _____ 191_____

Approved _____ 191_____
Public Service Company
of Northern Illinois

By _____
Vice-President.

[illegible]

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Arar and Collins (1971) using a Shimadzu 1601 UV-Visible Spectrophotometer.

10-10-68

10-10-68

100-36042-1034

XI

41453

DISCOUNT WHERE CUSTOMER USES ALTERNATING CURRENT UNTRANSFORMED
THE COMPANY TO FURNISH TRANSFORMERS
(Applicable to Rate "C" Only.)

Rider to, and hereby made a part of, the attached contract, or application, (hereinafter referred to as the "Contract") (dated _____ 192__ for _____

service furnished by the Public Service Company of Northern Illinois (hereinafter and in said contract called the "Company") to the undersigned customer.

Notwithstanding anything to the contrary in said contract contained the Customer agrees (1) that the fixed term of said contract shall be five (5) years; (2) that the electricity furnished under said contract shall be alternating current untransformed and shall be measured on the primary circuit, the difference between the cost of furnishing and installing metering equipment for measuring the energy on the primary circuit and the cost of furnishing and installing the necessary equipment for measuring the energy at 2200 or 4400 volts, to be paid by the Customer; and (3) that the Customer's demand charge for each month shall be based on not less than 50 kilowatts; and in consideration of such agreement on the Customer's part, the Company agrees (1) to furnish all necessary transformers and (2) to allow the Customer a discount of 5 per cent from the total amount of each month's bill, said discount to be deducted before deducting the discount, if any, allowed for prompt payment.

This rider, although signed, is subject to the approval of an Officer of the Company, and shall not be binding upon the Company until endorsed with his approval.

Customer

Dated _____ 192__ By _____

Approved _____ 192__
Public Service Company
of Northern Illinois

Official Capacity

By _____

XII

1485

DISCOUNT WHERE CUSTOMER USES ALTERNATING CURRENT UNTRANSFORMED
THE CUSTOMER TO FURNISH TRANSFORMERS
(Applicable to Rate "C" only.)

Rider to, and hereby made a part of, the attached contract,
or application; (hereinafter referred to as the "Contract") dated
_____ 192__ for _____
service furnished by the Public Service Company of Northern Illinois
(hereinafter and in said contract called the "Company") to
the undersigned customer.

Notwithstanding anything to the contrary in said contract contained
the Customer agrees (1) that the fixed term of said contract shall be
five (5) years; (2) that the electricity to be furnished under said
contract shall be alternating current untransformed and shall be
measured on the primary circuit; (3) that the Customer's demand charge
for each month shall be based on not less than 50 kilowatts; (4) that
the Customer shall furnish, install and maintain at his own expense
all transformers necessary to reduce the electricity furnished to
either 220 or 440 volts, the difference between the cost of furnishing
and installing metering equipment for measuring the energy on the
primary circuit and the cost of furnishing and installing the necessary
equipment for measuring the energy at 2200 or 4400 volts, to be paid by
the Customer; and in consideration of such agreement on the Customer's
part, the Company agrees to allow the Customer a discount of 10 per
cent from the total amount of each month's bill, said discount to be
deducted before deducting the discount, if any, allowed for prompt
payment.

This rider, although signed, is subject to the approval of an
officer of the Company and shall not be binding upon the Company until
endorsed with his approval.

Customer

Dated _____ 192__ By _____

Approved _____ 192__
Public Service Company
of Northern Illinois

(Official Capacity)

By _____

LIMITED HOUR SERVICE—ALTERNATING CURRENT

(Applicable to Rate "C" only, where rated capacity of Customer's installation is not less than 100 H. P.)

Rider to, and hereby made a part of, the attached contract or application (hereinafter referred to as the "Contract") dated _____, 192____, for _____ service furnished by the Public Service Company of Northern Illinois (hereinafter and in said contract called the "Company") to the undersigned Customer.

Notwithstanding anything to the contrary in said contract contained, the Customer agrees (1) that during any peak period (such period being defined as the period of time between the hours of 4:00 P. M. and 8:30 P. M. of each day, except Sundays and legal holidays, in the calendar months of November, December, January and February) his maximum demand in kilowatts will not exceed 20% of the highest monthly maximum demand recorded hereunder during the eight consecutive months immediately preceding the four months containing such peak period, and (2) that the Company may discontinue, without notice to the Customer, the supplying of electricity hereunder in excess of such 20% at any time during the peak period; and in consideration of such agreement on the Customer's part the Company agrees to allow the Customer an annual discount based upon his maximum demand charges for any twelve consecutive months ending with the month of February, in accordance with the following table, such discount in each case to be allowed, if earned, as soon as practicable after the February billing:

Ratio of maximum demand during peak period to maximum demand during the eight months preceding the four months containing such peak period:

Discount expressed in percentage of demand charges:

Up to and including 5%
6% to 10%, inclusive
11% to 15%, inclusive
16% to 20%, inclusive
More than 20%

30%
20%
10%
5%
None

Intermediate discounts shall be determined by interpolation. The discount allowed for any such twelve months' period will be credited upon the Customer's bill or bills next accruing under the contract.

This rider, although signed, is subject to the approval of an Officer of the Company and shall not be binding upon the Company until endorsed with his approval.

Dated, _____, 19____

CUSTOMER.

Approved, _____, 19____
Public Service Company of Northern Illinois.

By _____

By _____

OFFICIAL CAPACITY.

XIV

WAIVER OF MONTHLY MINIMUM CHARGE - LIMITED HOUR
SERVICE - ALTERNATING CURRENT, LOW TENSION (Applicable
to Rate "C" only.)

Rider to, and hereby made a part of, the attached contract, or application, (hereinafter referred to as the "Contract") dated _____ 19____ for _____ service furnished by the Public Service Company of Northern Illinois (hereinafter and in said contract called the "Company") to the undersigned Customer.

Notwithstanding anything to the contrary in said contract or in any rider attached thereto contained, it is agreed as follows:

If the customer shall, on or before the 15th day of October in any year give the Company written notice of his intention to cease using any electricity under said contract during the next succeeding months of November, December, January, and February, and shall actually cease such use during such four months, the Company shall waive, for such four months, the minimum monthly charge specified in said contract; and in such case the Company shall have the right to disconnect its service and remove its meter and other property from the Customer's premises for and during such four months.

This rider although signed, is subject to the approval of an officer of the Company and shall not be binding upon the Company until endorsed with his approval.

Customer

Dated _____ 19____

By _____

Approved _____ 19____
Public Service Company
of Northern Illinois.

By _____

PUBLIC SERVICE COMPANY
OF NORTHERN ILLINOIS
General Offices:
72 West Adams Street, Chicago, Illinois

For Illinois,
and the unincorporated contiguous territory.

(Cancelling four previously exist-
ing Sheets entitled "Rate 'E' Flat
Rate Lighting Service.")

RATE "E"—FLAT RATE LIGHTING SERVICE

Signs, Window Outline Lighting, Bill Board Lighting, Ornamental Lamp Posts and Interior Store Lighting
Where Type "B" or Type "C" Mazda Lamps Only Are Used.

Available for any Customer who shall furnish the entire installation (wiring, fixtures, etc.) in territory where the Company shall be regularly maintaining patrols for switching on and off the lamps, and in territory where the Company does not maintain such patrol service, provided the Customer will furnish an approved standard time switch.

RATE:

At the rates specified in the following table the Company will furnish electricity for lighting, and maintain patrol service, provided that said patrol service is at the time of the signing of the contract regularly maintained in the territory in which the Customer's premises are located.

	Dusk to 10 P. M., 6 nights; to 12 M., 1 night	Dusk to 11 P. M., 6 nights; to 12 M., 1 night	Dusk to 12 M., 7 nights	Dusk to 1 A. M., 7 nights	Dusk to daylight, 7 nights
<i>Mazda "B" Lamps</i>					
10 watt, per lamp per week.....	\$0.08	\$0.0825	\$0.085	\$0.09	\$0.105
40 watt, per lamp per week.....	0.15	0.16	0.17	0.18	0.24
50 watt, per lamp per week.....	0.17	0.19	0.21	0.23	0.30
60 watt, per lamp per week.....	0.22	0.25	0.27	0.30	0.40
<i>Mazda "C" Lamps</i>					
75 watt, per lamp per week.....	\$0.26	\$0.29	\$0.33	\$0.37	\$0.58
100 watt, per lamp per week.....	0.33	0.38	0.43	0.48	0.75
150 watt, per lamp per week.....	0.47	0.55	0.60	0.70	1.10
200 watt, per lamp per week.....	0.60	0.70	0.80	0.90	1.45
300 watt, per lamp per week.....	0.90	1.00	1.20	1.30	2.00
400 watt, per lamp per week.....	1.15	1.30	1.55	1.75	2.90
500 watt, per lamp per week.....	1.45	1.65	1.90	2.15	3.60

PROMPT PAYMENT DISCOUNT:

Bills are rendered weekly and when bills are paid on or before three days after their respective dates, the Company allows a discount of five cents per lamp per week. By mutual agreement bills will be rendered upon a monthly basis.

MINIMUM CHARGE:

The flat rates mentioned.

LAMP RENEWALS:

The rates given above include free renewals of lamps of the same kind and wattage as the lamps originally installed.

TERM OF CONTRACT:

A fixed term of not less than one year from the date when the Company begins to supply electricity hereunder.

Date of Issue, March 15, 1920.

Date Effective, April 15, 1920.
Issued by George R. Jones, Secretary,
72 West Adams Street, Chicago, Ill.

All changes are indicated by italics. The rating of lamps in watts instead of candle power, the insertion of additional lamps and prices therefor, and the cancellation of Sheets relating to "Signs and Private Street Posts" are the only changes from the Sheets cancelled hereby.

SUPPLEMENT NO. 14

to

**SCHEDULE NO. 1.
(Electricity)**

**PUBLIC SERVICE COMPANY
OF NORTHERN ILLINOIS.**

General Office:
72 West Adams Street, Chicago, Illinois.

For.....Illinois.

I. P. U. C. No. 1.
Additional Sheet,
(Cancelling Rider Entitled
"Cooking and Heating Service,"
applicable to Rate "B" only.)

RATE "F"—COOKING AND HEATING SERVICE

Available for any Customer using the Company's standard service for an electric range having a rated capacity of not less than 3 kilowatts; provided that electricity will not be furnished hereunder for lighting or power purposes.

RATE:

10.5 cents per kilowatt hour for the first 10 kilowatt hours consumed in any month.
3.5 cents per kilowatt hour for the excess consumption in the month over 10 kilowatt hours.

PROMPT PAYMENT DISCOUNT:

0.5 cent per kilowatt hour when bills are paid on or before ten days after their respective dates.

MINIMUM CHARGE:

\$24.00 per meter per year for any installation having a total connected load of 6000 watts or less, rated capacity.

\$ 4.00 per year for each additional 1000 watts, or fraction thereof, of the total connected load in excess of 6000 watts, rated capacity.

Until the Customer shall in any year have paid in full the minimum charge for such year, he shall pay to the Company each month not less than one-twelfth of the minimum charge for the year; and in so far as any such monthly minimum payment shall represent an excess over the regular charge for electricity used in such month, such excess shall, after the minimum charge for such year is fully paid, be allowed as a credit against bills for service hereunder in subsequent months in such year, such credit to be allowed, however, at the end of the year.

TERM OF CONTRACT:

A fixed term of one year commencing on the date when the Company begins to supply electricity. The obligations of both parties shall continue in effect after the expiration of such fixed term until 30 days after the receipt by either party from the other of written notice to discontinue the service.

TERMS AND CONDITIONS:

The Customer agrees to install a special interior circuit in conduit entirely separate from any lighting or power circuit, and install and maintain thereon an electric cooking range having a rated capacity of not less than 3 kilowatts. The Customer may also connect to said circuit any other electrical cooking or heating appliances; such as cookers, toasters, broilers, ovens, kettles, flat irons, water heaters, and luminous radiators.

The use of electricity hereunder for lighting or power purposes shall be deemed a breach of this contract.

Date of Issue, March 31, 1919.

Filed with the Public Utilities Commission of Illinois on
April 1, 1919.

Date Effective, May 1, 1919.

**Issued by P. D. Sexton, Secretary,
72 W. Adams St., Chicago, Ill.**

ROOM USE ONLY

ROOM USE ONLY



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