

THE ECONOMIC ASPECT OF THE ELECTRIFICATION  
OF THE ILLINOIS CENTRAL SUBURBAN SERVICE

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For

THE DEGREE OF ELECTRICAL ENGINEER

By

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PREFACE

This thesis is the result of my work and observation in connection with the electrification of the Illinois Central suburban service in Chicago during the last three years. I hope to add to the first hand information on electric railways and electrification now on file in the Engineering Library.

The thesis has been made as short as possible that it might be more inviting, especially to the senior student in electric railways. I feel that it gives an accurate picture of the economic situation in electrification and would be instructive to those interested in such work.

Mr. W.M. Vandersluis, electrical engineer in charge of the work has read and approved the thesis.

I have been requested by the Railroad Company to refrain from publication, especially of the numerous operating figures given, and request the reader to do likewise.

Paul R. Dunkelberg  
Chicago, May 1, 1928.

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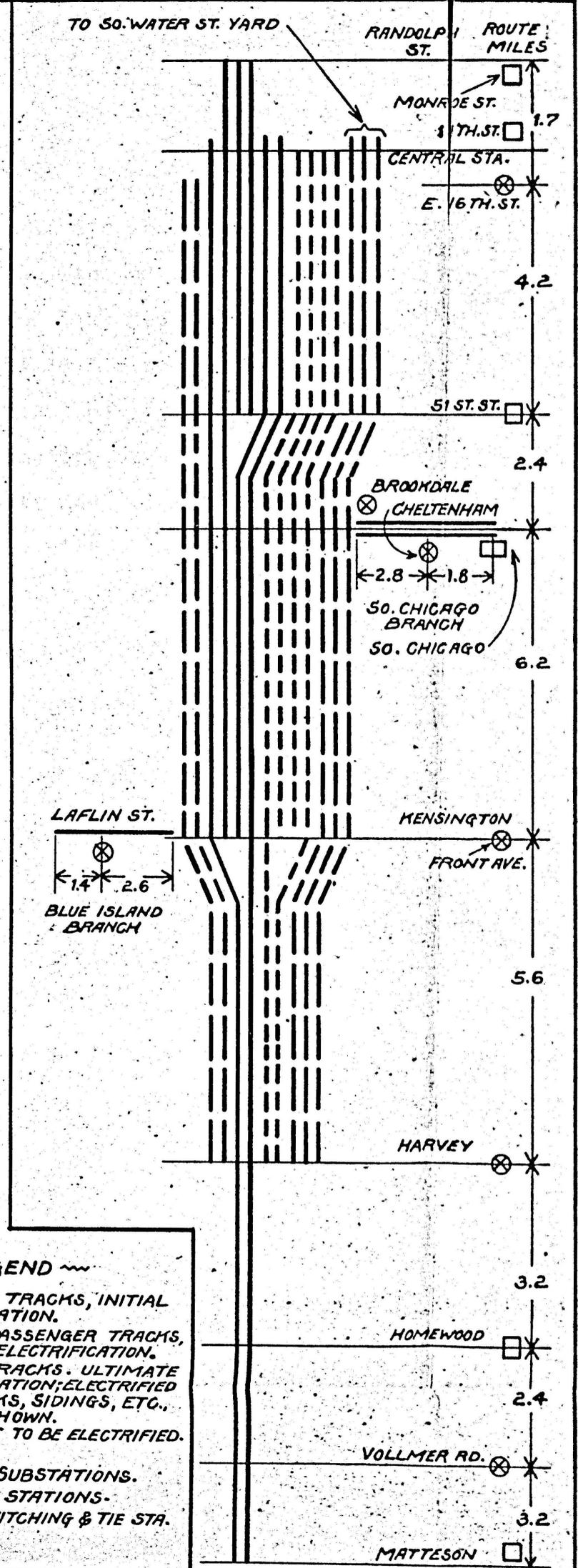
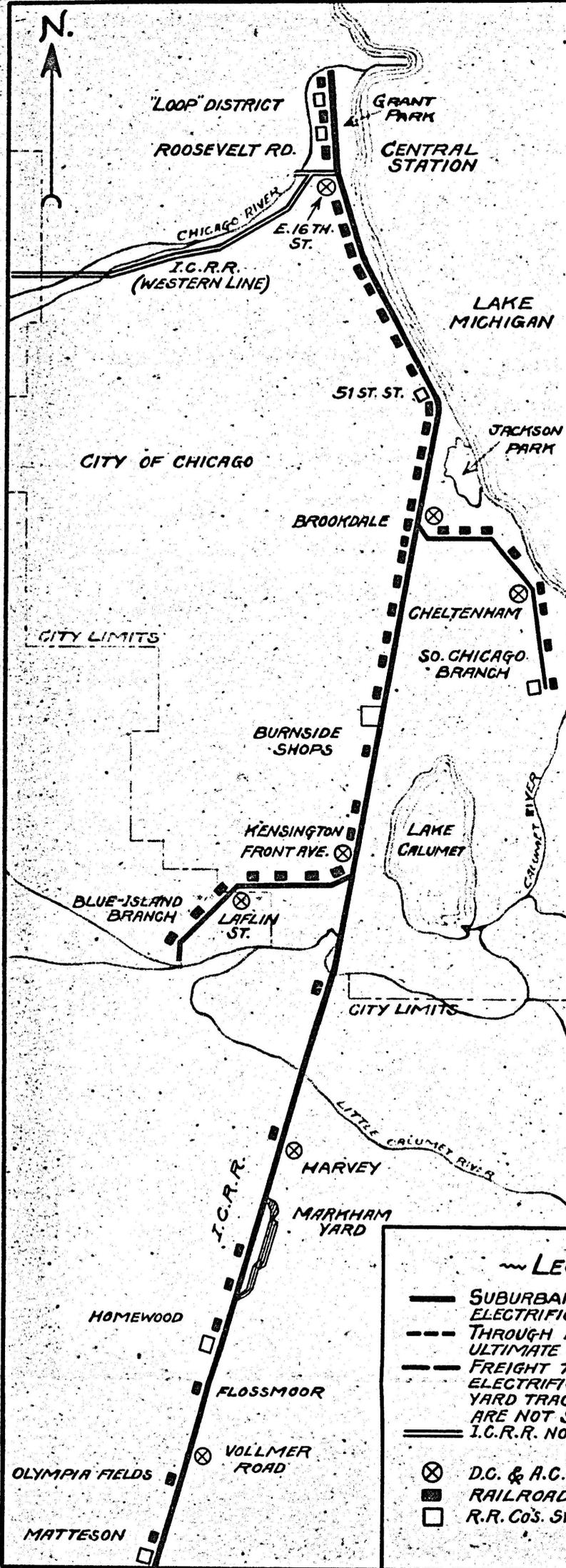
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## SCOPE OF PAPER

The electrification of the suburban service of the Illinois Central in Chicago has attracted wide spread attention in the past two years. This is for several reasons, namely, it marks the first attempt to eliminate the smoke nuisance in the City of Chicago, it gives to the commuting people on the south side a fast, clean and reliable means of transportation, and the Railroad Company has experienced a large decrease in operating costs per seat mile and about a 20% increase in revenue passengers. The property values adjacent to the right of way have also increased in value because of the speedy transportation adjacent to them. I will mention some of the general features of the electrification, explain how and why it was brought about, but in the main I will elaborate upon the economic aspect, that is, the cost, operating expenses and comparisons between steam and electric operation. There is much information available about the mechanical features of the work but little about the economics of the situation and the results of such a large investment. I hope to set forth the facts in such a way that they will convince other railroads in similar locations that they can afford to make the outlay for the change with full confidence that the results will be gratifying and that the revenue will be appropriate. With these preliminary remarks in mind, let us examine the map of territory served by the Illinois Central suburban lines.



~ ~ ~ LEGEND ~ ~ ~

- SUBURBAN TRACKS, INITIAL ELECTRIFICATION.
- THROUGH PASSENGER TRACKS, ULTIMATE ELECTRIFICATION.
- FREIGHT TRACKS. ULTIMATE ELECTRIFICATION; ELECTRIFIED YARD TRACKS, SIDINGS, ETC., ARE NOT SHOWN.
- I.C.R.R. NOT TO BE ELECTRIFIED.
- D.C. & A.C. SUBSTATIONS.
- RAILROAD STATIONS.
- R.R. Co's. SWITCHING & TIE STA.

## LOCATION OF SUBURBAN TERRITORY

When the Illinois Central was granted its Charter by the State in 1854, the City of Chicago designated that it should enter the city along the shores of Lake Michigan, there being no part of the city south of 16th Street and no thought was given to the value of the right of way, its location, smoke from an occasional locomotive or other similar questions which confront the city now. The people were glad to have the railroad enter the city. However, now there are 1,200,000 people living on the south side, thousands within walking distance of the railroad. The downtown terminal is between Randolph Street and South Water Street. Trains entering the terminal (known as Randolph Street, as this is the name of the station) pass through what is known as Grant Park, Chicago's front yard. This brings passengers to the downtown or loop district where so many people work in the offices. While this location is ideal for the person working in the loop and living near the stations on the south side, the smoke and grime caused by 400 suburban locomotives entering and leaving the terminal was a great nuisance to the people in the downtown district, and a constant expense to the building owners, besides marring the civic beauty of the park. And probably equally important is the question of riparian rights held by the railroad north of 51st Street. The city wished to fill in the lake and extend Grant Park south, but were pre-

vented from doing so because they did not own the riparian rights. On the other hand the railroad wished more room for its terminal facilities at South Water Street but did not have permission to fill in the lake. The result was the Lake Front Ordinance.

#### LAKE FRONT ORDINANCE AND ELECTRIFICATION COMMISSION.

The Lake Front Ordinance was passed by the City Council of the City of Chicago on July 21, 1919. This three party contract between the City of Chicago, the South Park Commissioners, and the Illinois Central Railroad Company covered the release of its riparian rights along Lake Michigan between 12th Street and 51st Street; extensive grade revisions by the Railroad Company in this territory to permit the construction of viaducts and subways to the lake; exchange of certain pieces of property and the electrification of the railroad within the city limits. The approval of the War Department was required as the filling of certain submerged lands was involved.

The Ordinance was finally approved by all concerned and provided specifically for the electrification of the suburban service within the city limits by February 21, 1927, the freight service north of 12th Street by 1930, the freight service south of 12th Street to the city limits on the main line by 1935, and the through passenger service of the Illinois Central Railroad Companies by 1940, provided a certain proportion of the tenant roads then using the passenger station

on East Roosevelt Road (12th Street) are electrically operated at that time.

It might be well to point out at this time that some of the suburban tracks lie outside of the city and obviously would have to be electrified if those within the city were. Thus it may be stated that the Lake Front Ordinance made it necessary for the complete electrification of the suburban service. The reader should also note that the electrification was brought about by the smoke nuisance, and the desire of the Railroad Company to secure additional terminal yards at South Water Street, coupled with the desire of the South Park Board to extend Grant Park to the south along the lake front, and not to provide better transportation, to decrease operating costs, or to stimulate the growth of suburban traffic. These things did follow but were not the incentive. Now similar railroad companies are electrifying their service solely to decrease operating expenses and to increase business and meet competition. With this background, I will pass to some of the general features of the electrification.

The president of the Illinois Central appointed an Electrification Commission in 1920 to make a thorough analysis and study of the requirements of the service in order to determine what system of electrification should be followed. There were and are today, many systems employed in this country and abroad, some for suburban only, some for through passenger and freight, some for interurban, and the common street railway. Both alternating and direct current are employed with

equal success. However, each system has advantages over the other in certain fields and must be adapted to the requirements.

The Commission considered the following systems as applicable to the Railroad Company's combined requirements:

- (1) 1500-volt direct current with overhead contact.
- (2) 11000-volt, single-phase alternating current with overhead contact.
- (3) 750-volt direct current with third rail.
- (4) 3000-volt direct current with overhead contact.

Complete first cost, maintenance, and operating estimates were prepared to cover the four systems. The merits of the various systems ranked in the order that they are listed. The advantage influencing the 1500-volt direct current with overhead contact were lower first cost, lowest operating expense, simpler cars, especially the control mechanism, and absence of inductive interference trouble and expense inherent to the alternating current system. The Commission's recommendations were approved by the president. The Commission was released and a larger and more permanent organization was formed to carry out the design and construction of the electrification.

#### PURCHASE OF POWER.

One of the most important features of an electrification is its power supply. The engineers made comprehensive estimates of the cost of power if the Illinois Central should build and operate its own power plants and sub-stations.

This would appear to be low as the Railroad Company owns large coal mines in southern Illinois and could transport the coal over its own lines at cost. The energy could be supplied direct to the equipment at practically the cost of production, where a power company would demand at least a small profit. However, the Commonwealth Edison Company of Chicago and the Public Service Company of Northern Illinois, a subsidiary organization operating outside the city limits, wished to be considered. They had already taken over all the contracts for supplying 600-volt direct current for both the Chicago Surface Lines and the Chicago Rapid Transit (elevated road) and had given better service than the railway companies had had from their own power plants and at less cost to them and still at a profit to the Commonwealth Edison Company. Thus from their former experience they felt confident they could handle the Illinois Central power supply more economically than the Railroad Company could itself. Then too, if they were able to secure a favorable contract from the first electrification, the next and all subsequent ones would be that much easier. The magnitude of the power business, which might accrue from the electrification of railroads in Chicago is apparent to the reader when he reflects the number of railroads and the railroad traffic which enters and leaves Chicago.

The Power Company proposed to deliver high voltage alternating current energy to sub-stations owned and operated by Railroad Company, or to own and operate the sub-stations themselves and deliver the 1500-volt direct current to the Railroad Company's right of way. The engineers considered both

schemes and found that it would be more economical to purchase power at the right of way at 1500-volts direct current. The reasons are as follows:

1. The Power Company agreed to build seven sub-stations instead of five that the Railroad Company would have built. They did so because they contemplated additional load from other railroads in the same vicinity when they should electrify, thus one sub-station might serve a number of railroads, where the Illinois Central owned and operated sub-stations would only be able to serve the one railroad. This addition of two sub-stations made for a decrease in the line losses, at no additional expense to the railroad.

2. The Power Company could build the sub-stations more economically than the Railroad Company as they had a regular force of engineers who did that particular line of work and were organized to do it.

3. The Power Company could train and furnish experienced operators in less time and at less expense than the Railroad Company as they were organized to do that type of work, as well as the construction.

4. The Railroad Company would be able to build only one small generating station, while the Power Company had several very large power generating stations, all interconnected. They were in a position to furnish continuous service in case one plant should be temporarily inoperative.

5. The Railroad Company could not hope to approximate the economy obtained by the Power Company in their larger and more efficient boilers and turbines. The Railroad Company has a

morning and evening peak demand of about 25000 kilowatts for the initial installation and the remainder of the time the load drops off to 1/3 or 1/4 of this. Thus for about eighteen or twenty hours of the day, the plant would have a very low load factor and a corresponding low efficiency. The Power Company has a diversified load of shops, office, street railway, etc. and can utilize their equipment to a greater efficiency as they can keep it loaded for a longer time. The Railroad Company would have no such opportunity.

For the foregoing reasons, the Railroad Company entered into a contract with the Commonwealth Edison Company to supply 1500-volt direct current and 4000/2300-volt alternating current to the right of way. The contract was known as the Electric Service Agreement and has attracted wide spread attention from many power users and producers. It is said to be one of the fairest contracts ever drawn up and will undoubtedly be used as a model for many future contracts in this city and elsewhere. The writer thinks it is of such importance that he has caused a copy to be bound in the rear of this thesis that it might be available to anyone desiring to get into the details of the same. For those not so interested, I will comment upon some of the most important features.

The Power Company agrees to furnish power at

\$1.85 per month per kilowatt up to and including 5,000 kilowatts;

\$1.70 per month per kilowatt for the excess over 5,000 kilowatts and up to and including 10,000 kilowatts;

\$1.60 per month per kilowatt for the excess over

10,000 kilowatts and up to and including  
15,000 kilowatts;

\$1.50 per month per kilowatt for the excess over  
15,000 kilowatts.

The demand charges are based on the average of the three highest clock hours of the month. The clock hours have been chiefly at 5 to 6 P.M. but a few have occurred at 7 to 8 A.M. This demand charge is for the calendar month only and changes from month to month. This is a distinct advantage as the old form of charge was that once a customer established a maximum demand, that demand was always used in billing until a higher one was reached. In other words, he received no compensation for a reduced demand. The writer points this out as it is one of the elements in the contract which seems to point toward fairness to the user, and certainly one which leads to economy for him. The demands in Kws are measured automatically by printometers attached to the watthour meters on each machine, thus eliminating the human element from the billing of the demand charge.

The energy charge is 6.5 mills per kilowatt hour for the first 5,000,000 kilowatt hours and 6.45 mills for all between 5,000,000 kilowatt hours and 7,500,000 kilowatt hours. Over 7,500,000 kilowatt hours the rate is 6.40 mills. This is based on a price of coal delivered to the Edison Company of \$4.00 per ton. If the price of coal varies either way, the energy charge is adjusted in proportion. So far the cost of coal has been about \$3.80 per ton. In addition to the price scale, there is provision made for the quality of the coal. The

standard is 10,500 B.T.U., a variation up or down of 500 B.T.U. is permissible but more than 500 is corrected according to the formula, -

$$\frac{\text{Cost X 10,500}}{\text{heat units}} + 2.5 = \text{mills per kilowatt hour for consumption in such month up to and including 5,000,000 kilowatt hours.}$$

Note: - This is based on the assumption that it takes two pounds of coal to generate one kilowatt hour.

For all energy from 5,000,000 kilowatt hours the added factor in the formula is 2.45 (instead of 2.5) and for all over 7,500,000 kilowatt hours it is 2.4. Thus the Power Company is protected against the rise in the price of coal and the Railroad Company pays in accordance with the value received, that is, if the price of coal went up, they too would be forced to pay more if they operated their own plant. And conversely too the Railroad Company receives the rebate when the price of coal is low as it has been in the first years operation. This appears to be a very fair contract as both parties are protected and both share in the actual cost of coal.

The Railroad Company was granted exemption from demands arising when the temperature fell to 5° above 0° F. during the maximum hour. Of course they were under obligation to pay the energy charge as they consumed the current, but the demand clause has saved them quite a little money. The Railroad Company is also granted exemption from demand charges arising during abnormal railroad traffic caused by failure of other lines of transportation in Chicago (strikes)

special trains on holidays, train accidents and delays due to damaged overhead, etc. However, the Railroad Company must give written notice of its declaration of abnormal traffic within forty-eight (48) hours and such abnormal period must not be more than ten days in duration, that is exemption will not be allowed after that time.

I will now cite two examples of monthly billing to illustrate the actual working of the contract. The average demand for the three highest clock hours during January 1928 was 23,340 kilowatt. It occurred 5-6 PM January 20, 7-8 AM January 26 and 5-6 PM January 27. The demand charge was computed as follows:-

First	5,000	kilowatts	@\$1.85	\$9,250.00
Second	5,000	"	1.70	8,500.00
Third	5,000	"	1.60	8,000.00
Excess	8,340	"	1.50	12,510.00
	<u>23,340</u>			<u>38,260.00</u>

The secondary charge for 6,050,981 kilowatt hours of energy was computed as follows:-

The weighted average cost per ton of coal for the twelve months ending December 31, 1927 to the Edison Company was

$$\frac{\$12,913,365.00 \text{ (total cost of coal)}}{3,293,776 \text{ (tons used)}} = \$3.92 \text{ per ton}$$

The weighted average B.T.U. per pound of coal for the same period was :-

$$\frac{70,498,317,596,500 \text{ (total B.T.U.)}}{6,587,552,000 \text{ (pounds used)}} = 10,700 \text{ average B.T.U. per pound.}$$

This is only a variation of 200 B.T.U.

from standard, hence there is no correction for heating value.

The correction for the cost of coal (\$3.92 instead of

\$4.00) is as follows:-

$$.00392 \times \frac{10,500}{10,500} + .0025 = .00642 \text{ per kilowatt hour}$$

for the first 5,000,000 kilowatt hours. Between 5,000,000 and 7,500,000 the price is:-

$$.00392 \times \frac{10,500}{10,500} + .00245 = .00637 \text{ per kilowatt hour}$$

The energy charge is then,-

5,000,000 kilowatt hours	@.642¢	\$32,100.00
1,050,981 " "	.637¢	6,694.75
		<u>38,794.75</u>

The total bill is then;-

Demand charge for 23,340 kilowatts	\$38,260.00
Energy charge " 6,050,981 kilowatt hours	
	<u>38,794.75</u>
	77,054.75

The average cost per kilowatt hour is 1.27343 ¢. Notice that the energy charge is slightly larger than the demand charge.

The other example of billing is for the month of June 1927. (a summer month) The average demand for the three highest clock hours during the month was 16,317 kilowatts which occurred 5-6 PM June 17, 5-6 PM June 28 and 5-6 PM June 30. The demand charge was computed as follows:-

First	5,000 kilowatts	@1.85	\$9,250.00
Second	5,000 "	1.70	8,500.00
Third	5,000 "	1.60	8,000.00
Excess	1,317 "	1.50	1,975.50
	<u>16,317</u>		<u>27,725.00</u>

The secondary charge for 4,208,482 kilowatt hours of energy was computed as follows:-

$$\frac{\$12,873,384.00 \text{ (total cost of coal)}}{3,422,181 \text{ (tons used)}} = 3.76 \text{ per ton}$$

of  
The weighted average B.T.U. per pound coal for the twelve months ending June 30, 1927 to the Edison Company (calculated)

as above) was 10,399 hence no correction.

The correction for the cost per ton of coal (\$3.76 instead of \$4.00) as calculated above is .626¢ per kilowatt hour.

The energy charge is then,-

4,208,482 kilowatt hours @ .626¢	\$26,345.10
----------------------------------	-------------

The total bill is,-

Demand charge for 16,317 kilowatts	\$27,725.50
------------------------------------	-------------

Energy charge for 4,208,428 kilowatt hours	
	26,345.10
	<u>54,070.10</u>

The average cost per kilowatt is 1.2848¢. Notice that in this case the demand charge exceeds the energy charge. The above bills are concrete examples of the working of the contract, and illustrate the demand charge, the energy charge and the correction for the price of coal.

The author has elaborated on the power supply and contract in order to point out the factors which have tended toward economical operation. Perhaps greater savings have been accomplished by the purchase of power from the Power Company, than in any other way. This is not limited to the operation but also as pointed out, to the first cost and to annual charges. The plan for the power supply from generation to monthly payment of the bill is complete and future electrifications may study with profit. Electric propulsion is not new but the method of handling the power situation is new and a most effective one. I will now pass on to the overhead arrangement.

## OVERHEAD DISTRIBUTION SYSTEM

The overhead arrangement for the electrification has two distinct features, one, twin contact wires, the other absence of auxiliary messenger suspended from the main messenger by hangers. Clipped to the auxiliary messenger are the twin contact wires. The main messenger is .81" in diameter and is composed of nineteen strands. The inside seven strands are copper clad steel, the steel furnishing the added strength and the copper protecting the steel from chemical action of sulphuric acid caused by smoke and moisture. The ultimate strength of the main messenger is 3,500 lbs. North of 67th Street is the section of dense traffic and the twin contact wires are 3/0 cadmium bronze with 80% conductivity. The cadmium hardens the copper so it will resist wear but also lowers the conductivity to 80%. The decrease in conductivity was compensated for by the increased size of the auxiliary messenger. South of 67th Street the twin contact wires are each 4/0 hard drawn copper. The auxiliary messenger for this section was 1/0, 19 strand hard drawn copper while that north of 67th Street was 200,000 circular mills, the added size being necessary to compensate for the smaller 3/0 wires of only 80% conductivity. Although the auxiliary messenger in this section was larger as stated, the decreased weight of the contact wires (3/0) made it possible to use 20 foot spacing of hangers while south of 67th Street, it was necessary to have 15 foot spacing. The hangers themselves



6 Track section, looking north from 44<sup>th</sup> st. Sept 1926

are made from 3/8" copper rod. The clips and fittings on both ends of the hangers are non-ferrous. The clips for the contact wires are spaced at half the interval of the hangers and each contact wire is supported from alternate clips. Thus the bronze contact wires are supported at twenty foot intervals and the copper contact wires at fifteen foot intervals. The wires hang side by side with points of support staggered and show no appreciable sag.

The double contact wire arrangement has been used previously but suspended directly from the main messenger with lifting hangers. The stranded auxiliary messenger increases the flexibility of the system and practically eliminates hardness of contact, in other words, the contact wires have a certain amount of springiness in them. When the pantograph bears against the contact wires, it lifts them slightly but never takes all the weight off the auxiliary messenger. With this arrangement there are no moving parts in the catenary system as there are with lifting hangers and a good contact is insured with at least one wire and generally with both.

The catenary system is self contained, that is, it provides the required current capacity without additional feeders. The average conductivity over every track throughout the life of the contact wire would be 790,000 cir. mills copper equivalent. This system allows for an average voltage drop about 12% in the normal rush hour service and an all day average at about 3%. The arrangement might prove prohibitive for some installations but for the Illinois Central electri-



*Two track section north of Riverdale*

*Sept. 1926*

fication, it appears to be a distinct economy. The copper equivalent would be required in any event to limit the line losses to an economical figure. It was much more economical to include the copper in the catenary system, that is, about the same labor was required for installation as if only one contact wire were used and no auxiliary messenger and the same insulators are used to support the added copper. If feeders had been employed, additional insulators, additional labor for stringing, and an additional switching arrangement would be necessary with no increase in distribution efficiency.

Another interesting and practical feature of the distribution system is the tie stations and supervisory control for controlling them. At various points between sub-stations and at stub end feeds, (see map) the Railroad Company has built small buildings which house high speed circuit breakers. These breakers tie the different sections to a station buss but in case of ground or short circuit in any section, the breaker will open and isolate the section. These breakers perform two functions, that is, under normal operation they tie together and parallel the feeders and in trouble they open and isolate the faulty section until it can be cleared, allowing the remainder of the system to function normally.

Any opening or closing of the breakers is indicated to the load dispatcher through a system of codes sent in by the breaker and supervisory control system. Likewise, the power supervisor may open and close any breaker in the tie stations and the system has been extended to include the breakers in the sub-stations of the Power Company. Thus the power super-



*"High speed" circuit breakers at 51st St. Tie station*

*July 1936*

visor may open and close any and all breakers from his desk (at Randolph Street).

### EQUIPMENT

The equipment has many interesting features, several of which I shall point out. The trains are composed of motor-car trailer units, semi-permanently coupled together. That is, they are always together when in service but may be disconnected in the shop. Hence, all trains are of an even number of cars, two, four, six or up to eight car trains have been operated. The eight car train is a little long for the present platforms and has been abandoned for the present. The cars themselves are the same length, have the same seating capacity, etc. and appear similar from the exterior with the exception that the motor car has two pantographs mounted upon it. Some of the general dimensions are as follows:

Length over all coupled - 72' 7 $\frac{1}{2}$ "

Length between truck centers - 47' 9"

Width over all at eaves - 9' 11 $\frac{1}{2}$ "

Height from top of rail to top of platform 4' 3-5/8"

Clear width of end vestibule door (for passing  
between adjacent cars) 2' 0"

Clear width of sliding end doors leading from car  
to vestibule - 4' 0"

Clear width of sliding doors between vestibule and  
station platforms 4' 0"

Spacing of cross seats, center to center 2' 9 $\frac{1}{2}$ "

Aisle width 2' 7 $\frac{1}{4}$ "

Total seating capacity - 84

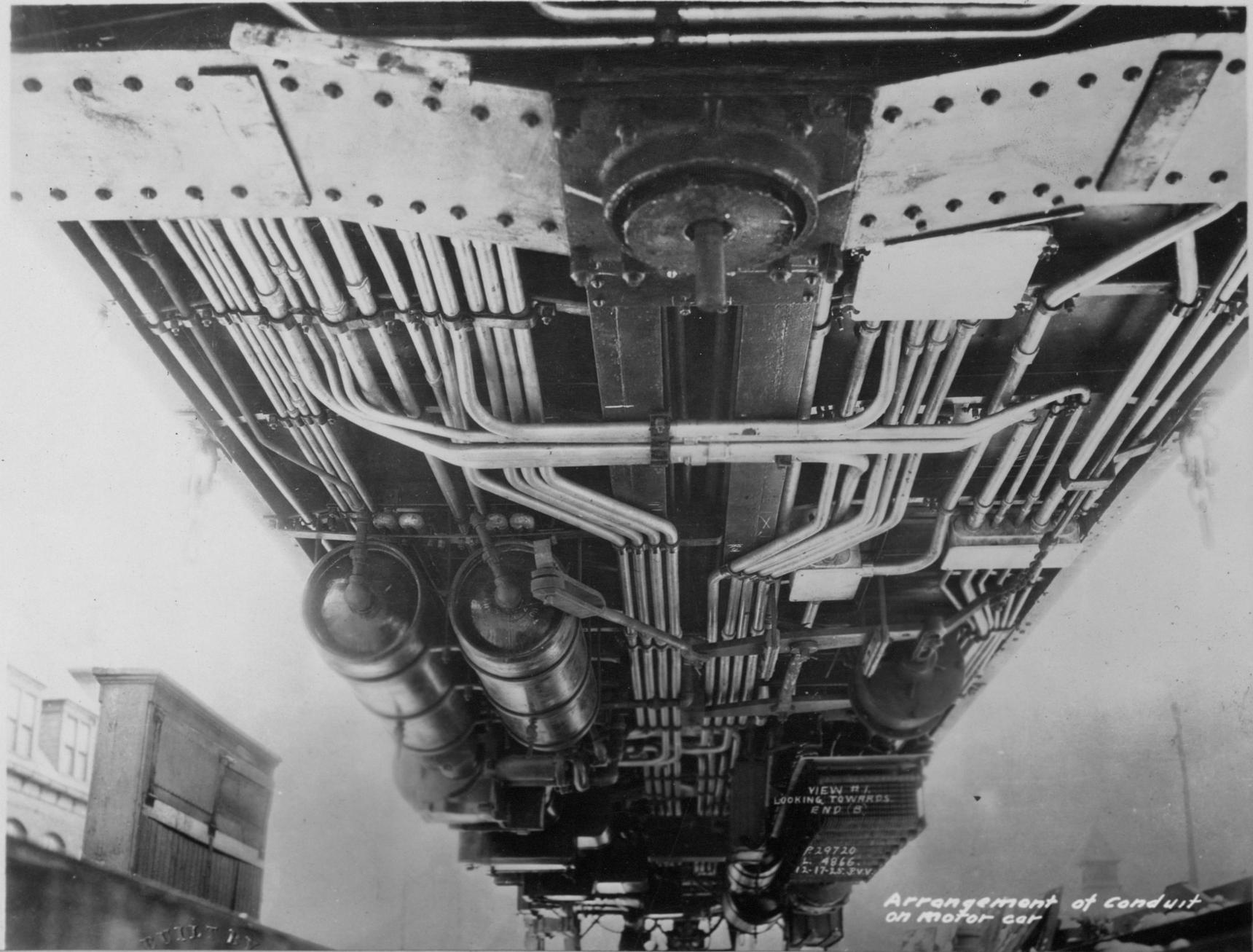
Weight of motor car light - 141,200 pounds

Weight of trailer car - 87,200 pounds



*4 Car train at Kensington, May 3, 1926*

The accompanying illustration shows two motor-car trailer-car units and portrays the general appearance of the equipment. The interior view shows the arrangement. The reader will note the spacious aisle and head room. Also that there is a window by each seat and this window is long enough to give clear vision to tall passengers. They do not need to duck their heads to look out. The seats are accessible as there are no arm rests. There is also room for one hundred and ten (110) standing passengers, even one hundred and forty (140) may be carried for short distances. The familiar coat and parcel racks have been eliminated and the space is filled with advertising which now brings in a substantial income. And too, it presents a much neater appearance. The interior of the car ceilings are all white. The woodwork and seats are in mahogany. The lamps are placed directly over the seats instead of at the center of the car, thus there are no shadows. I wish to call the readers attention to the general roomy, clean, neat and appealing appearance of the interior of the cars. The large seats with plenty of leg room, large aisles allowing two people to stand and a third to pass through, plenty of light at the right place, and large exit doors present a most pleasing invitation to the commuter. The increased patronage has borne this out. Though the refinements cost money at the time, yet they have given results in the increased patronage, which was undoubtedly influenced by the appearance of the cars as well as the increased schedules. There is an apparent contrast to the appearance of these cars and the ordinary suburban car or street car or elevated.



VIEW #1  
LOOKING TOWARDS  
END IS.

P29720  
L 4866  
12-17-15.P.V.

Arrangement of conduit  
on motor car

The passenger does not notice any jolt, jar or shock when the train starts, shuts off power or brakes. There is no movement between cars. The train is made a solid mass by the Tomlinson tightlock coupler. This is a most decided advantage when the trains must make a great many stops and starts. The couplers lock and make all air and control connections (2 air and 28 control) by merely pressing the coupler button in the motorman's cab. This feature alone saves a great deal of time at the terminal in the rush hours, and eliminates any possibility of injury to a man coupling the usual type of coupler. There are no jumpers to maintain and all the wiring is in conduit which protects it from mechanical injury and from the weather. Other roads have since adopted this type of coupler for multiple unit equipments. It is in addition a safety factor as in the slight accidents which have occurred, the couplers have always held and cars have undoubtedly been prevented from overturning. Prevention of loss of life and liability damage is another way of reducing operating costs. Claims paid under electric operation are less than half those paid under steam operation. The saving is apparent.

Another place where economy was effected was in the extensive use of aluminum. All conduit, junction boxes, and fittings are composed of an aluminum alloy which reduces the weight of the new car approximately 6100 lbs. as compared to one equipped with iron conduit and boxes. The estimated cost of carrying one pound per year is about \$0.01874 which for the 6100 lbs. means an annual saving of \$114.00 per motor car. On the trailer car aluminum conduit was also used but the

saving was not so large as only a small amount of conduit was necessary to carry the control wires through. The inside sheathing and inside doors are of pure aluminum and the roof sheets and lower deck sheets are of aluminum alloy.

When all the doors are closed, a small green light burns in the motorman's cab, and he is permitted to swing the control handle all the way around. The acceleration is automatic at the rate of  $1\frac{1}{2}$  miles per hour per second. The balancing speed has been found to be about sixty-five miles per hour and is reached in a run of about four miles. Under favorable conditions of high voltage and light load speeds of 72 miles per hour have been attained. If the motorman should have his reverser lever in reverse position as in switching, a small orange lamp will light. The controller itself is of the dead man type, that is, if it is released at any other position than off, it will fly up and cut off the power and immediately apply the air brake. The braking is at the rate of one and three-quarters miles per hour per second and is electrically controlled, thus applying the air at the same time and in equal amounts to all the cars at the same time. Deceleration is fast but gradual. As soon as the train stops and the trainmen open the doors, the green light goes out. When it comes on again, the motorman knows that all the doors are closed and that it is safe to start. Inspection of the photograph shows that it is impossible for a passenger to even hang on a train after the doors are closed.

The first forty-five (45) cars which were converted for trailer operation were equipped with pneumatic door engines.



*Interior of Motor Car*

The new cars were all equipped with electric door engines. These engines are small motors on the 32-volt auxiliary system. They open and close the doors, and are operated by switches placed at the vestibules of each car. There are two switches for each door, one to open and close the individual door and one to open and close all the four doors of a unit at one operation. These are the ones usually used. These effect a saving of time, enabling the trainman to close the four doors in three seconds. The company effected an annual saving of \$18.00 per car by the installation of electric door engines. This may be explained by the fact that the efficiency of the air compressor is much less than that of the motor-generator set and battery and too the air leakage and efficiency of the air engine is less than 50% while that of the electric door engine is about 90%. This may be small for one operation but the estimated operations per car for the year are 117,000.

The cars are electrically heated, directly from the 1500-volt trolley. The connected load is 30 kilowatt per unit, each cross seat heater being a 375 watt heater. The longitudinal seats (seat 4) have 560 watts. The heat is controlled by thermostats in each car. One thermostat cuts out at 50 degrees and the other at 60 degrees. This prevents waste of heat, and provides a uniform temperature. The company has found it possible to reduce the heat during the morning and evening rush hours, as the cars were usually warm before, and the bodily heat supplied by the passengers was enough to maintain the temperature in the cars. This was accomplished by switching on the 50 degree thermostat.

SUBURBAN TRAIN OPERATIONS FOR THE  
CALENDAR YEAR 1927.

During the calendar year of 1927 the suburban trains ran 9,361,914 revenue car miles (which also includes dead head movements of equipment during the morning and evening rush hours) and consumed 48,785,223 kilowatt hours of electricity, an average of 5.211 kilowatt hours per car mile. During the summer months of June, July, August and September the trains ran 3,081,838 revenue car miles and consumed 14,430,978 kilowatt hours, an average of 4.683 kilowatt hours per car mile. This may be assumed to be the traction current only (including that used for control and for lighting the cars). The traction current may be slightly higher in winter, due to increased train resistance and to somewhat longer hours of lighting, but on an average it is small and may be neglected. For the remaining eight months, the cars ran 6,280,076 car miles and consumed 34,354,245 kilowatt hours, an average of 5.4703 kilowatt hours per car mile. The average heating consumption was .787 kilowatt hours per car mile. The total amount chargeable to heating was  $6,280,076 \times .787735 = 4,943,375$  kilowatt hours. The value of this heating current at the average cost of current for the year of 1.2604¢ per kilowatt, is \$62,306.00.

During steam operation the cost of coal, water and Pintsch gas (for lighting the cars) for the year, September 1925 to August 1926 inclusive, (just preceding electric operation) was \$434,452.00. During May, June, July 1926 and September 1925 the average cost of fuel, water, etc. was

\$32,727.00 per month, which may be assumed to be without steam heat,  $\$434,452.00 - (32727 \times 12) = \$41,728.00$  for heating.

The steam car miles for the year mentioned above were 9,763,233 but the new cars seat 84 whereas the average of all the cars used in steam service was 60 seats. Thus, there has been provided 40% additional seats, which means that it is now necessary to heat 40% more space than under steam operation. If the \$41,728.00 is increased by 40% (which it would have been had the same facilities been provided under steam operation) it becomes \$58,500 as against \$62,306 paid for the electric. Although the electric heating is slightly more expensive than the steam, the evidence refutes the opinion that electric heating is expensive. If the cost of hauling the added weight due to steam heat were added to the above figure, it would doubtless exceed the cost of electric heat.

Another feature which speeds up loading and unloading of passengers, thus makes for speedier schedules is the use of high platforms. With high platforms the passengers step directly from the platform to the vestibule or visa versa. Steps necessitate time and cause accidents. During the rush hours some of the trains are so heavily loaded that they are obliged to stop thirty seconds for unloading. For instance, a train stopping at all stops between 72nd and Kensington (nine stops) consumes four minutes in stops and fourteen minutes in running time. If steps were employed, twice the time would undoubtedly be required in making the stops. The high platforms have undoubtedly contributed somewhat to the reduction in injuries to persons as set forth above. I think any sub-

urban electrification, however small, would be money and time ahead to adopt high platforms throughout.

#### COMPARISON OF STEAM AND ELECTRIC OPERATION.

We now come to the result of the first year of operation. It will probably be as easy and as useful to compare the cost of the various accounts under steam and electric operation. Only those accounts which are directly affected will be considered. The accounts are divided into three distinct divisions, namely, maintenance of way and structures, maintenance of equipment and transportation.

Under maintenance of way, superintendents and salaries did not show any change in expense, the same force being retained at the same salary. The expense of \$3,500 a year for maintenance of water stations was eliminated. Another thousand dollars a year was saved in the maintenance of fuel stations. Shops and engine house maintenance under electric operation were \$4,000 less than under steam operation. The maintenance of shop grounds was slightly higher but the amount small as the total for the year was only \$25.00. The largest item was of course, power distribution systems, including power line poles and fixtures. It cost approximately \$84,000.00 to maintain the catenary and alternating current distribution system during the first year of electric operation. The total costs for maintenance of the items listed were, electric operation \$115,000.00 while for steam it was only \$40,000.00, an increase of \$75,000.00, practically all of which is contained in the maintenance of the distribution system. The maintenance

of the distribution system was somewhat higher than might be expected. The cost per track mile is \$660.00 (including bonding, tie stations and supervisory control) which will be reduced when the electrification is completed and the same maintenance force will be able to maintain the total electrification of 480 track miles. The second year of operation will also show a decrease in the cost of maintenance because the maintenance gang will have become more experienced and many of the weaker spots have been eliminated.

Superintendents' salaries and expenses, for maintenance of equipment were likewise about equal to steam operation. The charges for maintenance of shop machinery showed a decrease of \$5,000.00 for the year. This decrease was earned because less machinery was necessary to maintain the multiple unit cars than was necessary to maintain steam locomotives and wooden suburban cars. The same reasons hold for the charges to maintenance of power plant machinery which is also on the basis of cars and locomotives handled and which showed a decrease of \$3,000.00 for the year. The maintenance of the motor equipment of the new motor cars and the maintenance of the cars themselves amounted to \$555,000.00 for the year. The maintenance of passenger locomotives, switching locomotives and passenger train cars under steam operation was only \$452,000.00. The depreciation of the new equipment (taken at 4%) amounted to \$402,000.00 while for the steam locomotives and wooden coaches, it was only about \$165,000.00. The small amount of depreciation shown for steam equipment is logical because the equipment was purchased ten to twenty-five years ago when prices were much lower than they are now.

Replacement of the steam equipment at the present time would necessitate a much larger capital investment than is indicated by the depreciation shown on the old equipment. In other words, the depreciation shown is low because the equipment had been in service so long, some of it twenty-five years. The total maintenance of equipment under electric operation for the first year was \$998,000.00 as against \$673,000.00 for the last year of steam operation. This shows an increase of \$325,000.00 or about 50% increase in the cost of maintenance of equipment alone. While the cost of maintaining equipment under electric operation is expected to exceed that under steam, it is not expected that the present figure will hold during the second year of operation. Practically all of the men employed in the maintenance of the electric equipment were formerly employed in the maintenance of the steam equipment. Practically no men experienced on the electrical maintenance of the multiple unit equipment were imported. The former employes were all trained during this first year and have become quite proficient. The cost of instructing these men and familiarizing them with the routine and duties in repairing multiple unit equipment has made the maintenance for the first year higher than it will be for the succeeding years. It may be said that additional material may be required for maintenance as time goes on but cost of labor to apply such material will tend to decrease.

The next and largest division of accounts is that called transportation or rail line. This includes any expense or cost involving the operation of trains, stations, interlocking

plants, etc. Superintendents' salaries and expenses charged to transportation, showed an increase of \$7,000.00 for the first year of electric operation, due quite largely to additional instructors and engineers making tests on the operation of the electric trains. This has been eliminated and now the superintendence is about the same as when operated by steam. Additional men have been shifted to other jobs.

The fuel for passenger locomotives, yard locomotives, water for these locomotives and Pintsch gas for lighting the cars during the last year of steam operation amounted to \$434,000.00 while the cost of electricity purchased, including train power produced was \$640,000.00. The train power produced is the salaries and expenses of the power supervisor and assistants and the cost of the current consumed in the tie stations (for control). These figures show the increased cost of transportation with electric power. The concensus of opinion seems to be that electricity costs less than steam and railroad officials expected the power bill to be less than that of coal and water. This would probably have been true had we used small electric locomotives to pull the light wooden cars used under steam operation. I estimate that 460,000,000 ton miles were necessary under electric operation (not including weight of motors and control) while under steam operation, we hauled only 268,000,000 ton miles (not including weights of engines and tenders). The added weight of the new cars is responsible for the increased cost for motive power as against coal and water. If the cost per unit (ton mile) is considered, the electric power has the decided advantage as the average

cost per ton mile for the year was less than .6 of a cent while for steam operation it was over .9 of a cent.

Other supplies for passenger and yard locomotives (other than coal and water) cost \$7,700.00 per year under steam operation and nothing under electric. Lighting for passenger cars, other than gas, cost \$3,000.00 less under electric operation than under steam.

The wages and supplies used by engine house men in the maintenance of passenger and yard locomotives amounted to \$196,000.00. This expense was entirely eliminated with electric operation. Lubricants for passenger and yard locomotives and for cleaning and lubricating passenger cars amounted to \$75,000.00 under steam operation while the cleaning and lubricating of passenger cars under electric operation was \$114,000.00. This increase in cleaning and lubricating is to be expected when one considers the additional motor bearings, air compressors, motor generator set, etc. which are on every motor car. The total expenses for maintenance of locomotives, lighting of cars, lubricants and cleaning of passenger cars was \$326,000.00 under steam operation and only \$132,000.00 under electric.

This leaves only the wages of the engine men, motormen, conductors, switch tenders, etc. The company paid \$361,000.00 during the last year of steam operation as wages to passenger and yard engineers and firemen. In place of this, they paid train motormen (former engineers) \$203,000.00. Under steam operation yard conductors and brakemen received \$39,000.00 and under electric operation, only \$5,000.00 was paid for similar yard employes. Yard switch and signal tenders, yard masters,

and yard clerks, together have remained substantially the same and their wages have been the same in each case.

Passenger trainmen receive \$10,000.00 more under electric operation than under steam, due largely to the increased number of trains operated and not to any increase in the number of men. The total wages paid enginemen or motormen, yard employes and trainmen was \$908,000.00 under the last year of steam operation and \$698,000.00 under the first year of electric operation. It is apparent that electric operation effects a substantial saving in wages paid to enginemen and trainmen.

The total charges (as set forth) against transportation under steam operation were \$1,721,000.00 as against \$1,530,000.00 under electric operation. However, the saving effected by transportation was consumed by the added cost for maintenance of way and structures and maintenance of equipment. The grand total of suburban service for the items directly affected and enumerated above was \$2,435,000.00 for steam operation and for electric operation, \$2,643,000.00. This shows a net increase of \$208,000.00 for the first year of electric operation against the last year of steam operation. The author does not wish to convey the idea that the electrification has not been successful but wishes to point out the reasons for the increased total. Under steam operation, it was necessary to run 9,763,000 car miles and while under electric operation with the larger cars, the car miles was reduced to 9,217,000 car miles. With the large car mileage under steam operation

an average of 60 seats per car, we furnished 624,072,000 seat miles, while the electric operation, we furnished 774,242,000 seat miles. The cost to furnish 1,000 seat miles under steam operation is \$3.74 while with electric operation, it was reduced to \$3.41. These figures show that the cost per unit (1,000 seat miles) has been materially reduced. The company is now providing an additional 150,000,000 seat miles annually with only a slight additional cost. As stated above, the new cars and new service have consumed and reflect the profits of electrification, rather than large decrease in the operating expense. The commuters have been given the benefits of the electrification rather than the balance sheet of the company. As time goes on and the traffic increases, as I will elaborate on later, the Company's balance sheet will show a most decided gain, especially if they were to provide the same service with steam equipment, although they would not be permitted to do so under the terms of the Lake Front Ordinance.

#### GENERAL IMPROVEMENTS AND SERVICE

The improved service has manifested itself in many ways. The latest electric time table showed a decrease in running time over the old steam service of from eleven to twenty-eight percent for the various classes of trains, the larger percentage resulting for trains to Kensington and beyond. The decrease in overall time results from high maximum speeds and by the use of high accelerating and braking rates. Acceleration is at the rate of one and one-half miles per hour

per second, which is about six times as rapid as that of through passenger steam trains. Under normal operation, a train will attain a speed of twenty-eight miles per hour in twenty seconds. After that point the rate of acceleration falls off but on level tangent track, a train will attain a speed of fifty miles per hour in two minutes. As mentioned in the description of the cars, the balancing speed is about sixty-five miles per hour.

There has been a large gain made in electric operation as compared with steam operation from the standpoint of operating a congested terminal. This improvement will become of greater importance as the number of trains is increased inasmuch as under steam operation the limit to the number of trains physically possible to move in or out of the Randolph Street Terminal was rapidly being approached. It is readily apparent that this gain was made by the elimination of movements necessary for steam engines in changing ends of train and also in being brought from and taken to the engine terminal, since the movements must be made over tracks serving useful train movements. The electric train requires only the normal loaded movements over these busy sections except when brought from or taken to storage tracks at the beginning or end of rush hours.

The last electric time table (no. 8) shows 497 week day trains operated in the suburban service and an additional seventy-two operated by the Chicago South Shore and South Bend Railway over the special tracks between Randolph Street and Kensington. This is an increase of 87 week day trains for

the Illinois Central and 32 for the C.S.S. & S.B. over the first electric time table (Time table No. 1). This (Time Table No.8) is an increase of 119 week day trains for the Illinois Central and 54 for the C.S.S. & S.B. over the last steam time table which just preceded the electric time table No. 1. This increase in trains has been occasioned by increase in revenue passengers carried. In the calendar year 1927 (all electric operation) showed an increase over 1926 (4 mos. electric operation) of 4,500,000 revenue passengers or about 19%. Parallel with the increase in revenue passengers has been the increase in gross revenue. The gross revenue for the calendar year 1927 increased about 18% including revenue paid by the C.S.S.& S.B. for operation over our tracks.

#### OUTLOOK

As announced in the newspapers, during the latter months of 1927, the operating income is now on the right side with an indicated profit of \$637,000.00 for the year 1927 as against the loss for the year 1926, although electric operation was in service four complete months of that year. Previous to 1926 the deficit from operating was about \$1,000,000.00 a year. Everything seems to point favorably to electric operation as responsible for the profit instead of the loss. This has been accomplished by attracting increased patronage thus securing increased revenue rather than decreasing the actual operating expenses. In other words, the company spends as much money as it used to but in return receives a much larger income

than heretofore because it offers increased service.

It must be borne in mind that these figures do not take into account any investment in road and equipment. In providing the electrified service, the railroad spent ten and one-half million dollars for new equipment and about four million for electrical work including overhead, switching equipment, negative return and miscellaneous. There was an additional nine and one-half millions for re-arrangement of old tracks, new tracks and station facilities and separation of grades or a total of thirty four million in improvements only. An additional twenty million dollars was spent in the re-arrangement of the terminal facilities for the whole electrification project.

## BIBLIOGRAPHY

All the information contained in this thesis was compiled by myself from records, reports, drawings and statements on file in the office of the Chief Engineer of the Chicago Terminal Improvement, Illinois Central Railroad, Chicago, Illinois. Many of these reports and much of the information contained herein was gathered or computed by myself.

The operating costs, showing the comparisons between steam and electric operation, have not been published heretofore. The mechanical details of the electrification are fully described in the "General Electric Review" for April, 1927, Volume 30, Number 4, published by the General Electric Company at Schenectady, New York. The reader should consult this publication if he is interested in the various mechanical and electrical features of the electrification.

Paul R. Dunkelberg.

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# ELECTRIC SERVICE AGREEMENT

BETWEEN

COMMONWEALTH EDISON COMPANY

AND

ILLINOIS CENTRAL RAILROAD COMPANY

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DATED OCTOBER 1, 1924

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GUNTHERP-WARREN PRINTING COMPANY, CHICAGO.

**Agreement**, Made this first day of October, A. D. 1924, by and between **COMMONWEALTH EDISON COMPANY**, a corporation organized under the laws of the State of Illinois (hereinafter commonly referred to as the "Edison Company"), and **ILLINOIS CENTRAL RAILROAD COMPANY**, likewise a corporation organized under the laws of the State of Illinois (hereinafter commonly referred to as the "Railroad Company"),

WITNESSETH:

WHEREAS, the Railroad Company, in compliance with the **Preamble.** provisions of an ordinance of the City of Chicago, Illinois, passed July 21, 1919, effective February 20, 1920, is now engaged in the electrification of portions of its railway system situated within its Chicago Terminal District (as hereinafter in Article X defined) in and in the vicinity of the City of Chicago, Illinois, and has found it advisable to take from the Edison Company during the term hereof, and during any extension or extensions of such term under the provisions hereof, electrical energy to the extent and in the manner hereinafter in this agreement provided, and the Edison Company desires to furnish such electrical energy to the Railroad Company;

Now, THEREFORE, in consideration of the premises and of One Dollar (\$1) and other valuable considerations each to the other in hand paid, the receipt of which is hereby mutually acknowledged, and in consideration of the mutual covenants and conditions hereinafter set forth and the benefits expected to result herefrom, the parties hereto do hereby agree with each other as follows:

## ARTICLE I.

## TERM OF CONTRACT.

**Original term.** SECTION 1. For and during the term of ten (10) years, commencing on January 1, 1927, or on such earlier or later date (but not later than January 1, 1928) as may be designated by the Railroad Company, in compliance with the provisions of said ordinance and in accordance with the provisions of this section, as the date of the commencement of the term, and for and during any extension or extensions of said term under the provisions hereof, the Edison Company shall supply and at all times stand ready to supply all the electrical energy which the Railroad Company shall require from the Edison Company in the Chicago Terminal District of the Railroad Company under and in accordance with and subject to the terms and provisions hereinafter set forth.

**Date of commencement of term.** In case the Railroad Company shall desire to have the term commence on a date prior to January 1, 1927, it shall give to the Edison Company not less than twelve (12) months' written notice of the date upon which it desires the term to commence. In case the Railroad Company shall desire to have the term commence on a date subsequent to January 1, 1927, it shall give to the Edison Company, not later than January 1, 1926, written notice that the Railroad Company does not desire that the term shall commence on January 1, 1927, and shall thereafter and prior to January 1, 1927, give to the Edison Company not less than twelve (12) months' written notice of the date (not later than January 1, 1928) upon which it desires the term to commence. If on the day specified in any such notice as the date of the commencement of the term the Railroad Company shall not be ready to commence complete, or substantially complete, operation hereunder, it shall pay to

the Edison Company for each month during which it shall not be so ready an amount of money equivalent to one-half ( $\frac{1}{2}$ ) of one per cent (1%) of the cost of the unused portion of substation buildings, machinery, apparatus, transmission lines and other equipment theretofore installed by the Edison Company for the purposes of the operation contemplated to be commenced on the said day specified and necessary therefor. Such electrical energy (hereinafter commonly referred to as "energy") shall be in the form of direct current and alternating current as hereinafter in Section 1 of Article IV provided, and shall be used by the Railroad Company only in connection with the operation, construction and maintenance of its railway system and appurtenances within its Chicago Terminal District as hereinafter in Article X provided.

The energy.

SECTION 2. The Railroad Company shall have the privilege of extending the original term hereof for a period of five (5) years by giving to the Edison Company, not later than one year prior to the expiration of the original term, written notice of its election to make such extension. If such extension be made the Railroad Company shall have the right to three (3) further extensions for periods of five (5) years each by giving to the Edison Company in each case, not later than one year prior to the date of the expiration of the then current five (5) year period, written notice of its election to make such extension; *provided, however, that if any such extension shall run later than May 31, 1947, the term hereof shall nevertheless terminate on that date unless prior to that date the ordinance of the City of Chicago under which the Edison Company is now operating shall have been extended, or a new ordinance obtained, or legislation enacted, authorizing the Edison Company to continue to operate in at least as ample or broad manner as at the time of the execution hereof. Unless otherwise indicated by the context the word "term" as used in this contract shall include not only the*

Extension of term.

Definition of "term."

original term of the contract but also any and every period of extension effected by election of the Railroad Company under the provisions of this section; and during any extension of the term all of the obligations of each of the parties hereto shall continue and remain in force.

**Preliminary  
period defined.**

SECTION 3. The period of time commencing at the date of this contract and extending to the first day of the term determined in the manner provided in Section 1 of this Article will hereinafter in this contract be referred to as the "Preliminary Period" of the contract.

## ARTICLE II.

### DEMAND.

**Determination  
of maximum  
demand.**

SECTION 1. As soon as practicable after the end of each calendar month in the term the Railroad Company's maximum demand in kilowatts for such month shall be ascertained as hereinafter stated in this section. The Edison Company shall select from such month the three (3) hours (one to be taken from each of three (3) different days) in which the aggregate output of energy supplied hereunder by the Edison Company shall be greater than the aggregate output of energy supplied hereunder by the Edison Company in any other three (3) hours in such month (one to be taken from each of three (3) different days), and one-third (1/3) of the aggregate number of kilowatt hours drawn and consumed by the Railroad Company during the three (3) hours selected as aforesaid from such month shall be deemed and considered as the number of kilowatts constituting the Railroad Company's maximum demand of energy supplied hereunder during such month; *provided, however*, that in ascertaining the maximum demand hereunder for any month the Edison Company shall not select any hour or hours of abnormal demand (as defined below), except as hereinafter

in this section specified, but *provided, further*, that if in any month every hour shall be an hour of abnormal demand the maximum demand for such month shall be the number of kilowatts constituting the maximum demand for the last preceding month in which the maximum demand was ascertained in the manner hereinabove in this section stated.

The term "maximum demand," as used in this contract, shall be considered to mean the maximum demand of the Railroad Company hereunder, ascertained and determined in the manner aforesaid. The term "hour," as used in this contract, shall be considered to mean the sixty (60) minute period between any two (2) consecutive even clock hours, as for example: between one o'clock and two o'clock. The term "abnormal period," as used in this contract, shall be considered to mean any interval of time during which there shall be abnormally heavy railroad traffic or abnormally low temperature or other abnormally severe weather conditions. The term "abnormally heavy railroad traffic", as used in this contract, shall be considered to mean traffic caused by failure of other transportation line or lines to furnish its or their normal service, traffic arising from extraordinary assemblages, such as fairs, race meets, ball games, conventions, and the like; congestion of traffic arising from a railroad accident, derangement of power supply or other emergency condition or other excessive traffic beyond that usually carried by the Railroad Company and due to some unusual circumstance or condition; *provided, however*, that, in the event that such "abnormally heavy railroad traffic," due to failure of other transportation lines to furnish their normal service or due to extraordinary assemblages, shall continue beyond ten (10) consecutive days in any month, the Edison Company in ascertaining the maximum demand for such month may select, in accordance with the provisions of the first paragraph of this section, any hour or hours (whether of abnormal demand or not, provided such

**Definitions:**  
"maximum demand";

"hour";

"abnormal period";

"abnormally heavy railroad traffic";

abnormal demand is due to said last mentioned two causes) occurring in such month after such ten (10) days, but any monthly maximum demand resulting from the selection of any hour or hours of abnormal demand shall not be used in determining the load factor for such month under the provisions of Section 4 of Article III, nor in determining the primary charge for any subsequent month under the provisions of Section 1 of Article III. The term "abnormally low temperature," as used in this contract, shall be considered to mean a temperature of five degrees (5°) Fahrenheit, above zero, or any lower temperature, as officially determined and recorded by the United States Weather Bureau at Chicago. But it is agreed that no period shall be considered as abnormal because of "abnormally heavy railroad traffic" unless notice of such abnormally heavy traffic shall be given by the Railroad Company, as required under the provisions of Section 1 of Article XII hereof. The term "hour of abnormal demand", as used in this contract, shall be considered to mean an hour during all or some part of which an abnormal period exists.

"abnormally low temperature";

"hour of abnormal demand."

Provision in case of lack of surplus capacity.

It is agreed that if the total usable surplus generating, transmitting and converting capacity of the Edison Company shall at any time be insufficient or unavailable to enable it to supply to the Railroad Company a portion of the excess energy in an abnormal period, due to abnormally heavy railroad traffic, as in this section provided, the Railroad Company shall, upon notice by telephone, or otherwise, from the Edison Company, refrain or immediately cease from drawing and consuming such portion of the excess energy until notified by the Edison Company that surplus generating, transmitting and converting capacity is available for supplying such portion of the excess energy; but in such case if the Edison Company shall have surplus capacity which is then unavailable it shall make such capacity available as promptly as possible. Nothing in this paragraph contained shall be construed as allowing or permitting the Edison Company to discriminate

in any way against the Railroad Company in supplying the necessary energy hereunder.

SECTION 2. During the term hereof, the Edison Company shall be able and ready to supply and shall supply to the Railroad Company, as required by it, and the Railroad Company shall take, in accordance with the provisions hereof, all the electrical energy which the Railroad Company shall require in such of its operations within its Chicago Terminal District as are required to be electrically performed, from time to time, by the said ordinance of the City of Chicago, Illinois, effective February 20, 1920; and, in consideration of the foregoing, the Edison Company further agrees that it will supply to the Railroad Company, as required, such additional or further electrical energy as the Railroad Company may from time to time desire it to furnish during said term in any other of its operations within said Chicago Terminal District, or in the operations of any other company or companies within the provisions of Article X hereof; *provided*, that twelve (12) months' notice in writing shall be given to the Edison Company of any such additional supply of electrical energy desired by the Railroad Company in accordance with the provisions of Sections 4 and 5 of Article IV. The Edison Company shall furnish all such electrical energy and the Railroad Company shall pay therefor on the basis and at the rates in this contract provided.

General obligations as to supply.

SECTION 3. The Edison Company shall also supply to the Railroad Company during the Preliminary Period of the contract all such alternating current energy at the points specified in Section 2 of Article IV hereof for delivery of alternating current energy as the Railroad Company may from time to time desire to draw and use hereunder (such energy in any case to be supplied as promptly as possible) and also all such direct current energy as the Railroad Company may from time to time desire to draw and use here-

Supply of energy during preliminary period.

Rate during preliminary period.

under if and so far as the Edison Company shall have such direct current energy available. Such energy shall be measured as to kilowatt hours consumed in like manner as other energy supplied during the term of this contract is metered. For all energy so supplied during the Preliminary Period the Railroad Company shall pay at the total rate of one and six-tenths cents (1.6c) per kilowatt hour.

### ARTICLE III.

#### RATES.

Basis of primary (demand) charges.

SECTION 1. For each calendar month of the term of this contract the Railroad Company shall pay to the Edison Company (subject, however, to reductions, if any, under the provisions of Article VI) a primary charge per kilowatt, reckoned upon the maximum demand hereunder (ascertained in accordance with the provisions of, and as defined in, Section 1 of Article II) for such month, or upon an amount of energy equal to seventy per centum (70%) of the highest one of the several maximum demands (so ascertained and defined) established for the last preceding twelve (12) months, whichever is greater, such primary charge to be in accordance with the following schedule:

#### SCHEDULE OF PRIMARY CHARGES.

Scale of same.

\$1.85 per month per kilowatt up to and including 5,000 kilowatts;  
 \$1.70 per month per kilowatt for the excess over 5,000 kilowatts and up to and including 10,000 kilowatts;  
 \$1.60 per month per kilowatt for the excess over 10,000 kilowatts and up to and including 15,000 kilowatts;  
 \$1.50 per month per kilowatt for the excess over 15,000 kilowatts.

Basis of secondary (energy) charges.

SECTION 2. In addition to the primary charge to be paid by the Railroad Company for each month as aforesaid the Railroad Company shall also pay to the Edison Company a

secondary charge for each month based upon the number of kilowatt hours drawn and used by the Railroad Company under this contract during such month, which secondary charge, except as otherwise provided in Section 3 of this Article, shall be in accordance with the following schedule:

SCHEDULE OF SECONDARY CHARGES.

- 6.5 mills per kilowatt hour for consumption in such month up to and including 5,000,000 kilowatt hours; **Scale of same.**
- 6.45 mills per kilowatt hour for the excess over 5,000,000 kilowatt hours and up to and including 7,500,000 kilowatt hours;
- 6.4 mills per kilowatt hour for the excess over 7,500,000 kilowatt hours.

SECTION 3. It is understood that the schedule of secondary charges established by Section 2 of this Article is based in part on the cost of coal used by the Edison Company in generating electrical energy at its several generating stations at the time of the execution of this contract, and it is the intent of the parties hereto that the secondary charges for energy supplied hereunder by the Edison Company to the Railroad Company shall vary from time to time with the variation in the cost to the Edison Company and the heat content of coal used by it in generating such electrical energy. The fuel consumed by the Edison Company during the three years next preceding the date of this contract consisted of coal taken from mines in Illinois, Indiana, and Kentucky, having a weighted average heating value of ten thousand five hundred (10,500) B. T. U. per pound. The secondary charges provided for in Section 2 of this Article are based upon a cost to the Edison Company of Four Dollars (\$4.00) per ton of coal of ten thousand five hundred (10,500) B. T. U. per pound and shall be subject to an increase or decrease per kilowatt hour, depending upon the average cost and heating value of the coal used from month to month by the Edison Company in the production of energy. **Secondary charges to vary with cost of coal.**

**Standard conditions for coal.**

Formulas for  
variation in  
secondary  
charges.

For any month in which the average cost of coal during the last preceding twelve (12) months shall have been more or less than Four Dollars (\$4.00), or in which the average heat units per pound of coal used by the Edison Company during the last preceding twelve (12) months shall have been more than 11,000 B. T. U. or less than 10,000 B. T. U. per pound, or in which both of the above described conditions shall have existed, the secondary charge for such month shall be determined in accordance with the following formulae:

$$\frac{\text{Cost} \times 10,500}{\text{heat units}} + 2.5 = \text{mills per kilowatt hour for consumption in such month up to and including 5,000,000 kilowatt hours.}$$

$$\frac{\text{Cost} \times 10,500}{\text{heat units}} + 2.45 = \text{mills per kilowatt hour for the excess over 5,000,000 kilowatt hours and up to and including 7,500,000 kilowatt hours.}$$

$$\frac{\text{Cost} \times 10,500}{\text{heat units}} + 2.4 = \text{mills per kilowatt hour for the excess over 7,500,000 kilowatt hours.}$$

Definitions:  
"ton";

"cost";

The term "ton" as used in this contract shall be considered to mean a ton of two thousand (2,000) pounds. The term "cost" as used in the foregoing formulae and as applying to any given month shall be the weighted average of the cost (in dollars and hundredths thereof) per ton to the Edison Company of all coal delivered to it for the uses aforesaid during the last preceding twelve (12) months, including all freight, switching and car service charges paid by it in connection with such coal so delivered and including the cost of storing and handling the coal whenever the Edison Company shall store surplus coal for emergency purposes. While, as above stated, the secondary charges stated in Section 2 of this Article are based in part on the cost of coal to the Edison Company and are to vary from time to time with the variation in such cost, it is distinctly understood and agreed that no increase in such secondary charges, either as specifically set out in said Section 2 or as may at any time be established under the provisions of this section, shall at any time become

effective when such increase is due to any arbitrary price, wage, charge, act, practice or rule of the Edison Company nor unless such increase be consistent with a contemporaneous general change, if any, in the cost of mining coal in the States of Illinois, Indiana and Kentucky and in the cost of transportation of such coal to Chicago and in the cost of labor used in the handling thereof. It is further understood that in computing such coal cost the actual cost of such coal and the charges directly relating thereto shall only be considered, and such computation shall be made without inclusion of any overhead or other like charges and expense.

Upon request of the Railroad Company at any time or times made, the Edison Company shall freely make available to the Railroad Company, for examination, all records of the Edison Company which may be required to establish the cost and heat content of coal, including all the items of cost above enumerated, for the purposes of this section.

The term "heat units" as used in said formulae and as applying to any given month shall be the weighted average number of B. T. U. per pound of coal used by the Edison Company during the last preceding twelve (12) months; *provided, however*, that if such weighted average number is not more than eleven thousand (11,000) nor less than ten thousand (10,000), then the number of heat units to be used in said formulae shall be ten thousand five hundred (10,500). "heat units."

SECTION 4. The Railroad Company agrees and guarantees that during each month of the term of this contract its total consumption of energy in kilowatt hours shall not fall below thirty per centum (30%) of the equivalent of its maximum demand for such month used continuously throughout the month for twenty-four (24) hours each day, and that its total aggregate payments for kilowatt hours consumed in such month shall not be less than such a load factor would require, subject, however, to the provisions of Section 1 of Article II and the provisions of Article VI hereof. Minimum load factor (30%).

Deficiency in  
load factor.

The deficiency, if any, between the amount of energy actually consumed during any month and the amount which the Railroad Company has under this section guaranteed to consume in such month and to pay for, shall be considered as additional energy supplied hereunder by the Edison Company in such month, and in making up its bill hereunder for such month the Edison Company shall include the charge for such deficiency so considered at the rate for which the amount of energy represented by such deficiency would have been billed under the provisions of Sections 2 and 3 of this Article, if such energy had been actually consumed.

Billing.

SECTION 5. As soon as practicable after the end of each month, except as otherwise specifically provided herein, the Edison Company shall render to the Railroad Company a bill or bills for all amounts due for such month under any and all provisions of this contract (including in such bill or bills any credit or credits to which the Railroad Company may be entitled for such month under any of the provisions of this contract), and the Railroad Company shall pay each such bill within thirty (30) days after the receipt thereof. If it shall be found that any such bill is erroneous in any respect, the Edison Company shall forthwith, and in any event within thirty (30) days, render to the Railroad Company a supplementary bill for any additional amount due from, or a credit memorandum for any amount to be credited to, the Railroad Company to correct such error. The Railroad Company shall pay any such supplementary bill within thirty (30) days after the receipt thereof.

Bills payable  
in 30 days.

#### ARTICLE IV.

##### FACILITIES AND OPERATION.

Forms of en-  
ergy to be sup-  
plied.

SECTION 1. The energy to be supplied hereunder shall be in the form of (a) direct current at a nominal voltage of fifteen hundred (1500) volts, and (b) sixty (60) cycle alternat-

ing current, three (3) phase, four (4) wire, at a nominal voltage of four thousand (4,000) volts between the phases and at a nominal voltage of twenty-three hundred (2300) volts from each phase to neutral, and (c) sixty (60) cycle alternating current at such other voltages and number of phases as may be mutually agreed upon.

SECTION 2. The energy to be supplied hereunder shall be delivered by the Edison Company to the Railroad Company on the outgoing feeders from substations which substations shall be constructed and equipped by the Edison Company either upon property owned or leased by it or upon the right of way or property of the Railroad Company, which latter locations shall be approved by the Railroad Company, and which shall be located initially at or near the points specified in the table below; and such energy shall be delivered in the form of direct current (D. C.) at a nominal voltage of fifteen hundred (1500) volts and alternating current (A. C.) at a nominal voltage of four thousand (4000) volts between phases and twenty-three hundred (2300) volts from each phase to neutral, as indicated in the following table by the symbols "D. C." and "A. C." respectively:

Points of delivery of energy.

<i>Points of Delivery.</i>	<i>Kind of Energy.</i>
South Water St., Chicago .....	A. C.
12th Street (Central Station), Chicago.....	A. C.
16th Street, Chicago .....	D. C.
69th Street, Chicago .....	D. C.
79th Street (Cheltenham), Chicago .....	D. C.
95th Street (Burnside Shops), Chicago.....	A. C.
115th Street, Chicago .....	D. C.
156th Street, Harvey, Illinois.....	D. C.
Vollmer Road, Illinois.....	D. C.
A point between Ashland Ave. and Vermont St., Blue Island, Illinois.....	D. C.
	A. C.

It is understood and agreed that no direct current fifteen hundred (1500) volt converting apparatus will initially be provided by the Edison Company at the points of delivery for which no supply of direct current energy is indicated in

**Railroad Co.  
to supply space  
for A. C. sub-  
station appa-  
ratus.**

the foregoing table. It is further understood and agreed that the Railroad Company shall provide suitable substation space within its own buildings for the installation of alternating current apparatus for the supply of alternating current at the points of delivery above mentioned from which no direct current is to be supplied. The Edison Company will provide feeder pressure regulators in any case where the length of the A. C. circuit or character of the A. C. service requires close pressure regulation.

**Feeder pres-  
sure regula-  
tors.**

**Facilities for  
supply of  
energy.**

SECTION 3. The Edison Company agrees to provide by purchase or lease such real estate as may be necessary for substation purposes hereunder, except such real estate as may be furnished by the Railroad Company under the provisions of this Article. The Edison Company further agrees to provide and maintain upon such real estate (whether provided by it or by the Railroad Company) at or near each of the points of delivery mentioned in Section 2 of this Article, except as otherwise specifically provided in said Section 2, and at or near any location specified in a request for an additional substation under the provisions of Section 4 of this Article, a suitable substation building, and to install therein and thereafter to maintain and operate such machinery, apparatus and other equipment as may be required for the constant and adequate supply of energy hereunder.

**Adequacy of  
equipment.**

The design and arrangement of each such substation, the type and capacity of the machinery, apparatus and other equipment installed therein, the construction work in connection therewith, the spare unit or reserve capacity to be provided and maintained, and the operation thereof, shall be in accordance with the most approved engineering practice and adequate for the service requirements of the Railroad Company as in this contract specified.

**Initial capaci-  
ties of D. C.  
substations.**

In the several substations there shall be installed initially for the traction service of the Railroad Company units of not less than the following number and continuous capacity:

16th Street	3	3000 Kw. Units
69th “	3	3000 “ “
115th “	2	3000 “ “
Harvey	2	3000 “ “
Vollmer Road	2	1500 “ “
Cheltenham	2	3000 “ “
Blue Island	1	1500 “ “

The Edison Company agrees that there shall at all times be installed in the several substations from which the Edison Company is required to supply energy hereunder to the Railroad Company sufficient spare or reserve capacity to supply the traction power requirements of the Railroad Company as specified herein and in accordance with the provisions of this contract and especially of Section 8 of this Article whenever one unit of any particular kind of apparatus is out of service in any substation except initially at the Blue Island substation.

**Spare capacity  
in traction  
substations.**

In any substation from which the Edison Company is required to supply energy in the form of direct current hereunder, the Edison Company shall install, maintain and operate in accordance with the most approved engineering practice, the necessary conversion apparatus, with suitable control and switching equipment, and the necessary feeder equipment. The number and kind of such feeders shall be such as are specified by the Railroad Company, in order to properly and safely control and sectionalize all main line tracks, yard tracks, and gap sections within interlocking limits near substations, and all such feeders shall be equipped with adequate protective apparatus for the electrical disconnection at the substation of the distribution lines which they serve.

**D. C. substation  
and feeder  
facilities.**

In any substation from which the Edison Company is required to supply energy hereunder in the form of alternating current, the Edison Company shall install, maintain and operate, in accordance with the most approved engineering practice, three (3) phase four (4) wire feeders with approximately four thousand (4,000) volts

**A. C. substation  
and feeder  
facilities.**

between phases and approximately twenty-three hundred (2300) volts from each phase to neutral, twenty-three hundred (2300) volt single phase feeders, and feeders at such other voltages and phases as may be agreed upon under the provisions of Section 1 of this Article; the number and kind of feeders in each case to be such as are required by the Railroad Company; and the Edison Company shall install, maintain, and operate in each such substation suitable switching and protective equipment. Said feeders, so far as practicable and necessary, and as provided in Section 2 of this Article, shall be equipped with automatic induction feeder regulators. The energy supplied to said feeders shall be such that feeders from adjacent points of supply hereunder (mentioned in Section 2 of this Article) located along the right of way of the Railroad Company may be interconnected by the Railroad Company through its distribution lines.

**Feeders to R.  
R. right of  
way.**

In case any substation from which energy is supplied hereunder is not located on or immediately adjacent to the right of way of the Railroad Company the Edison Company shall install, maintain and operate the necessary feeders connecting such feeder equipment in such substation with the Railroad Company's feeders at a point on the Railroad Company's right of way line most readily reached from such substation and which shall be satisfactory to the Railroad Company.

**Provisions for  
additional sub-  
stations.**

SECTION 4. If at any time for any reason the Railroad Company shall require additional fifteen hundred (1500) volt direct current energy at any point along its right of way in the portion of its Chicago Terminal District located within the State of Illinois to which such energy may not be economically transmitted from any then existing substation hereunder, and shall request the Edison Company in writing to provide an additional substation hereunder, specifying in such request the approximate location of the proposed additional substation, the estimated amount of additional energy

to be supplied at such additional substation and the approximate date of first delivery, which date shall be not less than twelve (12) months after the making of such request, then the Edison Company shall install at or near such location an additional substation (within the limits of said Chicago Terminal District within the State of Illinois) at which energy shall be delivered hereunder, and shall from and after the date so specified and during the balance of the term, supply hereunder to the Railroad Company at such additional substation the amount of energy in the form requested, *provided, however*, that the amount of additional energy to be so supplied in the vicinity of any such additional substation shall not be less than three thousand (3,000) kilowatts, and *provided, further*, that the Railroad Company shall provide and lease to the Edison Company under the provisions of Section 9 of this Article the necessary ground space for any such additional substation unless the Edison Company already possesses space suitable and available for such additional substation, and *provided, further*, that if such additional substation shall be located outside of the limits of the City of Chicago, the Edison Company shall be able to obtain from the authorities of the municipality in which such additional substation is to be located the necessary consent to extend its transmission lines from said city limits over and across public thoroughfares in such municipality to such additional substation.

SECTION 5. The Edison Company agrees that it will provide and at all times maintain sufficient generating, transmitting and converting equipment to furnish to the Railroad Company in accordance with the provisions hereof such energy as the Railroad Company shall require to meet its traffic and business. The Railroad Company agrees, however, to give to the Edison Company at least twelve (12) months' written notice of any expected substantial increase in the Railroad Company's traffic or business which may require the installation on the part of the Edison Company of additional generating, transmitting or converting equipment.

Provisions for  
increase of  
load.

Easement for  
Edison Co.  
transmission  
lines.

SECTION 6. The Railroad Company agrees that the Edison Company may construct in the right of way of the Railroad Company underground conduits and may install therein wires and cables for the transmission of energy, *provided*, that the location and details of such construction and installation shall be satisfactory to the Railroad Company, and, *provided, further*, that such conduits, wires and cables are installed primarily to supply energy hereunder to the Railroad Company. Detailed plans of any such construction and installation shall be submitted by the Edison Company to the Railroad Company for approval, and be approved by it before any such work is done.

Type and  
number of  
transmission  
lines.

All transmission lines extending from any generating station of the Edison Company to any substation from which energy is delivered hereunder shall be installed underground except such transmission lines or portions of such lines as shall be required outside the city limits of the City of Chicago, and any such transmission lines or portion thereof installed outside said city limits may, at the election of the Edison Company, be installed and maintained either overhead or underground. The number, capacity and distribution of such transmission lines in connection with each substation shall be such that the cutting out of any one of such lines will not prevent the delivery of the required amount of energy to the Railroad Company at such substation in accordance with the provisions of Section 8 of this Article.

Source of  
energy.

SECTION 7. All or any part of the energy supplied hereunder to the Railroad Company may be generated by the Edison Company at its own stations or may be procured by it from any other equally reliable source.

Voltage regu-  
lation of D. C.  
energy.

SECTION 8. Energy furnished hereunder in the form of direct current shall have a normal voltage of fifteen hundred (1500) volts at the point of delivery at the Railroad Company's right of way, and under normal and regular conditions of railroad traffic this voltage shall not be higher than

fifteen hundred fifty (1550) volts nor lower than fourteen hundred (1400) volts.

Under normal and regular conditions of use the frequency and voltage of energy supplied hereunder in the form of alternating current shall not vary more than five per centum (5%) above or below normal.

**Voltage and frequency regulation of A. C. energy.**

In general, the Edison Company will approximately compensate for voltage drop in its transmission lines by carrying its power plant voltage higher at times of peak load than at times of light load. The voltage characteristics of the conversion apparatus installed in the substations of the Edison Company for the purposes of this contract shall be in accordance with the most approved engineering practice for railway service and satisfactory to the Railroad Company.

**Voltage characteristics of supply.**

SECTION 9. If the Railroad Company shall at any time own property that is available and suitable for a substation from which energy is to be supplied to it hereunder, the Railroad Company agrees to lease such property to the Edison Company for substation purposes during the term of this contract. So long as any substation located upon property of the Railroad Company shall be used primarily and to the extent of at least eighty per centum (80%) thereof for supplying energy hereunder to the Railroad Company, the rental which the Edison Company shall pay to the Railroad Company for the use of such property shall be a nominal rental of One Dollar (\$1.00) per year for each piece of property upon which a substation is erected. The Edison Company may distribute energy from any such substation to other customers as well as to the Railroad Company, but if in any year the amount of energy distributed from any such substation to customers of the Edison Company other than the Railroad Company shall exceed twenty per centum (20%) of the entire output of such substation in such year, the Edison Company shall pay to the Railroad Company as rental for the use of the property upon which such substation is located,

**R. R. property for Edison Co. substations.**

**Lease of same.**

**Rental.**

a rental for such year ascertained as follows: The value of such property at the beginning of such year shall be determined by agreement of the parties, or if they are unable to agree, by arbitration under the provisions of Article VIII of this contract, and the rental which the Edison Company shall pay for such year shall be such proportion of six per centum (6%) of such value as the number of kilowatt hours distributed by the Edison Company in such year from such substation to its customers other than the Railroad Company shall bear to the total number of kilowatt hours distributed by the Edison Company from such substation in such year. The Edison Company may install and maintain upon or across the right of way of the Railroad Company the necessary underground transmission and distribution lines to connect such substation with the premises of any other customer, *provided*, that such installation and maintenance shall be satisfactory to the Railroad Company. Detailed plans of any such installation shall be submitted by the Edison Company to the Railroad Company for approval, and shall be approved by it before any work is done or installation made under the provisions of this Section.

Conditions of  
use by Edison  
Co. of R. R.  
property.

It is further understood and agreed that wherever in this contract permission or authority is given to the Edison Company to install or maintain upon or across the right of way or lands of the Railroad Company any lines, conduits, wires, or other equipment, property or structures, other than such as are required for the performance of this contract by the Edison Company, it shall be and is upon the express condition that no such use, installation, construction or maintenance shall be made without the specific approval of the Railroad Company in each particular instance, and that whenever the Railroad Company shall desire the removal of any such installation, construction or maintenance or the discontinuance of any such use, such removal and discontinuance shall be promptly made by the Edison Company upon

notice from the Railroad Company, and upon failure of the Edison Company so to do, such removal may be made by the Railroad Company at the expense of the Edison Company, and such use may be prevented.

SECTION 10. The Edison Company shall, in conformance with the request of the Railroad Company, operate from its substations certain remote-controlled auxiliary switching equipment for paralleling and sectionalizing the distribution lines of the Railroad Company along its right of way. But in the event that any auxiliary switching equipment required to be installed in the original construction of any substation shall have been completed, and the Railroad Company shall desire to increase this equipment in any substation to the extent of requiring a larger building, the Railroad Company shall pay for such extension of substation building and any other expense involved in the installation of such apparatus.

**Edison Co.  
operation of  
E. E. tie-  
stations.**

SECTION 11. The Railroad Company may, at its option, maintain and operate a suitable system of apparatus and wiring for the purpose of enabling it to communicate or indicate at any time to its Power Director the operating conditions of all machinery, equipment and feeders serving the Railroad Company's distribution lines hereunder. Any such apparatus and wiring may be installed in any substation of the Edison Company from which energy is supplied to the Railroad Company hereunder, in conjunction with equipment owned and operated by the Edison Company, *provided*, that in the judgment of the Edison Company such installation will not interfere with the safe and satisfactory operation of the Edison Company's apparatus. The Edison Company shall co-operate in all reasonable degree with the Railroad Company in the installation and operation of such apparatus and wiring.

**Railroad Co.  
indicating sys-  
tem in Edison  
Co. substations.**

SECTION 12. All equipment and apparatus and the wiring in connection therewith installed under the provisions

**Installation of  
apparatus  
under Secs. 10  
and 11.**

of Sections 10 or 11 of this Article in or upon the right of way or property of the Railroad Company shall be installed by and at the expense of the Railroad Company except as may be otherwise agreed upon by the parties hereto. All such equipment, apparatus and wiring installed in any substation of the Edison Company or installed elsewhere than in or upon the right of way or property of the Railroad Company shall be installed by and to the satisfaction of the Edison Company, under the direction and at the expense of the Railroad Company. As soon as practicable after the completion of any such installation by the Edison Company, it shall render to the Railroad Company a bill or bills for the expense thereof, and such bill or bills in so far as they relate to any equipment, apparatus, or wiring installed for the benefit of both parties hereto shall be based on an equitable apportionment of the cost of labor and material; and the Railroad Company shall pay such bill or bills within thirty (30) days after the receipt thereof or within thirty (30) days after the approval and/or acceptance of such installation by the Railroad Company.

**Apportionment  
of cost and  
bills therefor.**

**Determination  
of expense of  
work done by  
either party  
for other.**

SECTION 13. When any work is performed by the Railroad Company for the Edison Company or by the Edison Company for the Railroad Company, including work as mentioned under Sections 10 and 11 of this Article, the expense, except as may otherwise be agreed upon by the parties hereto, shall consist of the actual cost of materials and supplies furnished, including transportation charges at the established rates, all plus fifteen per cent (15%), and the actual cost of labor involved below the rank of general foreman, plus ten per cent (10%).

**Operation of  
R. R. feeders.**

SECTION 14. All direct current and alternating current feeder switches and circuit breakers in and controlled from the substations of the Edison Company hereunder and serving distribution lines of the Railroad Company shall be op-

erated by operators employed by the Edison Company under direct orders from the Railroad Company's Power Director, and in accordance with rules to be agreed upon and issued by the Railroad Company and the Edison Company.

## ARTICLE V.

### METERS AND METERING.

The energy to be supplied hereunder shall be measured, both as to maximum demand and as to kilowatt hours, by meters to be installed by the Edison Company at its expense for the measurement of the energy supplied to the Railroad Company. Except as may be otherwise agreed upon by the parties hereto, such meters shall be installed, maintained and operated in the manner and under the conditions hereinafter in this contract set forth. Such meters shall be installed in each substation from which energy is supplied. In any case where any such substation is located upon or immediately adjacent to the right of way of the Railroad Company, energy shall be considered as delivered hereunder to the Railroad Company in such substation. In any case where such substation is not located upon or immediately adjacent to the right of way of the Railroad Company, energy shall be considered as delivered hereunder to the Railroad Company at the point where the feeders leading from such substation intersect the Railroad Company's right of way line, and in such case the readings of the meter or meters in such substation shall be reduced by an appropriate factor to compensate for energy losses between the point of metering and the point of delivery, such factor in each case to be mutually agreed upon by the parties hereto.

Edison Co. to furnish meters.

Points of delivery; location of meters.

Meter readings to be adjusted to points of delivery.

The meters for measuring energy supplied under this contract in the form of direct current shall be installed on the fifteen hundred (1500) volt bus bars supplying the outgoing feeders to the Railroad Company's system. One watt

D. C. meters.

hour meter or several watt hour meters in multiple, as shall be required according to good engineering practice, shall be installed on each such bus bar, and such meter or meters shall be read on the last day of each calendar month at midnight for the purpose of ascertaining the kilowatt hours drawn and used during the month.

**A. C. meters.**

The meters for measuring energy supplied under this contract in the form of alternating current shall be installed on the low tension side of the three (3) phase step-down transformer or set of transformers used for transforming energy supplied hereunder in any substation, one (1) three (3) phase watt hour meter being installed on each three (3) phase transformer or set of transformers; or in case any such energy is supplied at a pressure of twelve thousand (12000) volts in such substation, then a three (3) phase watt hour meter or meters shall be installed directly on the outgoing feeder or feeders supplying such energy. All such watt hour meters shall be read on the last day of each calendar month at midnight for the purpose of ascertaining the kilowatt hours drawn and used during the month.

**Demand meters.**

For the purpose of obtaining data for the ascertainment of the maximum demand a demand meter shall be installed in connection with each watt hour meter (whether used for measuring energy in the form of direct or of alternating current), and such demand meter shall record automatically hourly, from the commencement of each hour, the kilowatt hours drawn and used during such hour.

**Testing of meters.**

The following provisions of this Article shall be applicable to any kind of meter that shall be used. The Railroad Company shall have the right to have representatives present at any or all of said readings, and all payments other than the guaranteed minimum payments representing the primary charge shall be based thereon. All watt hour meters shall be tested and calibrated monthly in the presence of duly appointed representatives of both parties, and if as a result of

any test a meter shall be found incorrect or inaccurate it shall be restored to an accurate condition or a new meter shall be substituted. In case either the Edison Company or the Railroad Company shall at any time believe that any meter so installed registers incorrectly, the party holding such belief shall have a right to require that a test be made of such meter. The party desiring such test shall make a request therefor in writing upon the other party and thereupon such meter shall be tested and calibrated in the presence of duly appointed representatives of both parties, and if as a result of such test the meter shall be found incorrect or inaccurate it shall be restored to an accurate condition or a new meter shall be substituted. Any meter tested and found to be not more than one per centum (1%) from normal shall be considered correct and accurate as to the registration of the number of kilowatt hours drawn and used. If as a result of any such test any meter shall be found to register in excess of one per centum (1%), either above or below normal, then the readings of such meter previously taken for the purpose of ascertaining the number of kilowatt hours drawn and consumed, or for the purpose of ascertaining the maximum demand, shall be corrected according to the percentage of inaccuracy so found; but no such correction either in respect to maximum demand or kilowatt hours drawn and consumed shall extend back beyond thirty (30) days previous to the day on which such inaccuracy shall be discovered by such test, and if during such previous thirty (30) days one or more prior tests shall have been made under the provisions hereof, then no such correction shall extend back beyond the date of the last of such prior tests. If any test of any meter shall be made at the request of the Railroad Company with the result that such meter shall be found to register correctly or within two per centum (2%) of normal, the Railroad Company shall bear the expense of such test. The expense of all other tests shall

be borne by the Edison Company. All meters shall be kept under the seals of both Companies.

## ARTICLE VI.

### INTERRUPTION AND DEFAULT.

Reduction of charges in case of failure of supply.

SECTION 1. If at any time in any month the Edison Company shall be unable to supply energy to the Railroad Company, in whole or in part, as required to be supplied by it under the provisions of this contract, the primary charge for such month, as determined under the provisions of Section 1 of Article III, shall be proportionately and equitably reduced, and if any such inability to supply energy shall cause the Railroad Company's load factor in such month to fall below the guaranteed amount specified in Section 4 of Article III hereof, the Railroad Company shall be relieved of such guaranty for such month or months, and the average secondary charge per kilowatt hour for energy consumed in such month shall not be at a higher rate, due to smaller consumption, than the average secondary charge per kilowatt hour for the consumption in the next preceding normal month. Any such reduction or abatement shall be made as soon as practicable after the end of the month in which the failure of delivery occurs by agreement of the parties, or, if the parties cannot agree, then by arbitration under the provisions of Article VIII hereof.

Failure due to strikes, fire, riot, action of elements, etc.

It is agreed that nothing in this section shall be construed to discharge or relieve the Edison Company from its obligation to furnish energy hereunder as required by Section 2 of Article II hereof, but it is agreed that if the Edison Company shall fail so to do at any time and such failure is caused by strikes not due to collusion of the Edison Company or caused by fire, civil or military authority, insurrection or riot, the action of the elements or by any other cause beyond its control, the concessions above in this Article made to the Railroad

Company shall be accepted by it as full satisfaction of the Edison Company's liability to the Railroad Company for its loss or damage due to the Edison Company's failure so caused.

SECTION 2. If on any day or days in any month the Railroad Company shall be prevented from operating its regular train service, either in whole or in part, by strike, fire or explosion, civil or military authority, insurrection or riot, abnormal weather condition, or by any other cause reasonably beyond its control, and if such prevention shall cause the Railroad Company's load factor in such month to fall below the guaranteed amount specified in Section 4 of Article III hereof, then and in that case the provisions of said Section 4 of Article III shall not be effective for such day or days and the minimum load factor of thirty per centum (30%) specified in said Section 4 shall apply only during those days in such month in which the Railroad Company shall not have been so prevented from operating its regular train service; *provided*, that the Railroad Company shall give to the Edison Company notice of any such prevention as required under the provisions of Section 1 of Article XII hereof.

Minimum load factor in case of suspension of R. R. service.

SECTION 3. It is recognized that the Railroad Company must receive regular and uninterrupted service from the Edison Company in order to make this contract of value to it, and if for any reason interruption of service to be supplied under this contract shall be so frequent or of such duration as to interfere materially with the Railroad Company's operation of its lines, or if the character of service supplied hereunder shall not be in accordance with the provisions of this contract, then the Railroad Company may in writing notify the Edison Company thereof, specifying the reasons for complaint, and the Edison Company shall forthwith promptly correct its service so as to remedy the trouble so specified. If the trouble so specified is not promptly remedied and in every

Cancellation of contract by Railroad Co.

event within not to exceed ninety (90) days from the date of such notice, the Railroad Company may elect to cancel this contract by giving to the Edison Company not less than thirty (30) days' notice in writing of its intention to cancel the contract, stating in such notice the date of proposed termination. If such notice shall be given, the contract shall terminate upon the date for cancellation specified in the notice or at any earlier date upon which the Railroad Company may be able to obtain elsewhere the necessary energy required for the operation of its lines and shall notify the Edison Company of such fact; and until such date of termination the Edison Company shall continue to supply energy hereunder to the Railroad Company in accordance with the terms and conditions of this contract, but no such notice or termination of this contract shall relieve the Edison Company from its liability under this contract with respect to any matters arising prior to such date of termination. If prior to such date of termination the Edison Company should at any time or times fail to supply to the Railroad Company any portion of the energy which the Edison Company is required to supply under the provisions of this contract, the Railroad Company shall have the right during the period of any such failure to secure the supply of such portion from some other source for the account of the Edison Company.

Interest on defaulted bills.

SECTION 4. Should the Railroad Company fail to pay when due in accordance with the terms hereof, any bill rendered hereunder, and such bill shall remain unpaid for a period of sixty (60) days after the same became due and payable, the Edison Company shall be entitled to receive, and the Railroad Company shall pay, interest upon the amount of such bill at the rate of six per centum (6%) per annum from the date upon which such bill became due and payable.

## ARTICLE VII.

## PROTECTION AGAINST CLAIMS FOR DAMAGES.

The Railroad Company shall indemnify and save harmless the Edison Company from and against any and all claims for damages in favor of any person, persons or corporation founded upon or arising from improper or negligent insulation, maintenance or operation of the electric wires, conductors and equipment of the Railroad Company during the life of this contract, and shall pay and reimburse the Edison Company for all costs, expenses and reasonable attorneys' fees which the Edison Company may be put to or incur in defending any suit or suits brought against it for such damages, *provided*, the Edison Company shall not have been responsible for such defective condition of the electric wires, conductors and equipment of the Railroad Company and the said condition shall not have been caused by its acts or negligence. The Edison Company shall indemnify and save harmless the Railroad Company from and against any and all claims for damages in favor of any person, persons or corporation founded upon or arising in whole or in part from improper or negligent insulation, maintenance or operation of the electric wires, conductors and equipment of the Edison Company during the life of this contract, and from and against all other claims for damages due to its acts or negligence and not above assumed by the Railroad Company, and shall pay and reimburse the Railroad Company for all costs, expenses and reasonable attorneys' fees which the Railroad Company may be put to or incur in defending any suit or suits brought against it for such damages. It is agreed, however, that the respective party shall have prompt notice of any such claim, demand or suit, and shall be given an opportunity to defend the same.

**Railroad Co. to  
indemnify  
Edison Co.**

**Edison Co. to  
indemnify  
Railroad Co.**

Edison Co.  
liable for im-  
properly closed  
switch.

If the Edison Company, at the request of the Railroad Company, shall have opened any switch supplying electrical energy to the Railroad Company under this contract, the Edison Company shall be liable for any damage resulting in case the Edison Company shall close such switch without first receiving from the Railroad Company or one of its duly authorized employees an order to close such switch.

## ARTICLE VIII.

### ARBITRATION.

Selection of  
arbitrators.

If at any time a difference of opinion shall arise between the parties hereto in regard to their respective rights, duties and obligations under this contract and within its terms and provisions or in respect of any payments to be made by virtue of this contract, the question in dispute shall be referred to a Board of Arbitrators consisting of three (3) competent disinterested persons experienced in the particular matter which is the subject of dispute. One (1) of said arbitrators shall be chosen by each of the parties hereto and the two (2) so chosen shall select the third arbitrator. The party desiring such arbitration shall give written notice of the same to the other party, setting forth definitely therein the point in dispute, and naming the person selected by such party to act as arbitrator. If the party on whom such notice is served shall for twenty (20) days thereafter neglect to name by notice to the other party a person to act as its arbitrator, then the party giving such notice shall name the second arbitrator, and the two (2) thus chosen shall select the third arbitrator. If the two (2) arbitrators chosen as provided in this Article shall be unable to agree upon a third arbitrator within twenty (20) days after their appointment (or if they were appointed on different days then within twenty (20) days after the appointment of the one last appointed), then such third

arbitrator shall be named and selected by the person who at the time shall be the senior Judge, in point of service, of the United States District Court for the Eastern Division of the Northern District of Illinois, and application may be made upon two (2) days' notice in writing to the parties hereto by either or both arbitrators to such Judge for such purpose. The Board of Arbitrators so chosen shall immediately proceed to hear and determine all matters submitted to them after giving to each party hereto not less than five (5) days' notice of the time and place of meeting; and at the time and place appointed they shall proceed summarily to hear and dispose of the matters in dispute unless in their judgment the hearing shall be adjourned to a later day or days, of which adjournment like notice shall be given unless such notice is waived by both parties, in which case the hearing may proceed at an earlier day.

**Proceedings  
before arbitra-  
tors.**

The determination of such Board of Arbitrators, or a majority of them, as to any matter so submitted to them shall be final and conclusive upon the parties hereto and said parties shall abide by such decision and perform the conditions thereof as if the same were made a part of this contract. In case the Railroad Company shall dispute and shall desire to submit to arbitration, as aforesaid, any of the bills rendered by the Edison Company hereunder the Railroad Company shall nevertheless pay such bills promptly within thirty (30) days after such rendition, without prejudice, however, to its right to receive or recover back any sum which the decision of the arbitrators shall find to be overpayment, with interest thereon at the rate of six per centum (6%) per annum from the time when such overpayment was made until the date of refund. Reasonable compensation shall be paid to said arbitrators, which compensation shall be paid in equal part by the parties hereto. Other expenses of said ar-

**Conditions to  
attend and re-  
sult from  
arbitration.**

bitration shall be borne by the party making the expense, unless otherwise agreed or unless otherwise determined by said Board of Arbitrators or a majority of them.

## ARTICLE IX.

### DISCRIMINATION IN RATES.

**Reduction of rates, if lower rates to other traction customers.**

If at any time during the life of this contract the Edison Company shall supply energy to any other consumer for traction or transportation service at a lower rate than that hereinabove given to the Railroad Company hereunder, and such lower rate shall not be justified by different conditions of service, making the cost of production and distribution to such other consumer relatively less than to the Railroad Company (and the burden of proving such different conditions of service justifying the lower rate shall be upon the Edison Company), then and in that event and so long as such lower rate shall be given to such other consumer while this contract is in force the Railroad Company shall be entitled to a reduction in its said rate equal to so much of the amount of the difference between such lower rate and the Railroad Company's said rate as shall not be so justified.

## ARTICLE X.

### SCOPE OF CONTRACT.

**Definition of railway system.**

The railway system and appurtenances of the Railroad Company for the operation, construction and maintenance of which energy is to be supplied by the Edison Company when and as provided in this contract shall, for the purposes of this contract, include any railway lines within the Chicago Terminal District of the Railroad Company which shall be electrified in compliance with the provisions of the aforesaid ordi-

nance of the City of Chicago and which are now operated by the Railroad Company or which shall hereafter be constructed or acquired by lease, purchase, stock ownership, or operating agreement to be operated by it and shall also include any terminal company operating the Chicago terminal station of the Railroad Company when and as requested by the Railroad Company. The term "Chicago Terminal District", as used in this contract, shall be considered to include the territory within the City of Chicago and also all territory within fifteen (15) miles of the present city limits of said City of Chicago. The Michigan Central Railroad Company, which is at present a tenant of the Railroad Company, and any other railway company or companies now using or that may hereafter use the Railroad Company's Chicago terminal or the Railroad Company's right of way within the Chicago Terminal District of the Railroad Company, are to be recognized and considered as part of the Railroad Company's railway system and for which energy is to be furnished under this contract to the extent and as and upon such limitations as the Railroad Company may from time to time request and direct. All electric service required to be furnished hereunder shall be deemed to be furnished to and shall be paid for by the Railroad Company. The energy furnished hereunder shall be used only for traction and other railway purposes within the Chicago Terminal District of the Railroad Company, including the operation of trains and signals, and the construction, operation and lighting of stations, shops and other buildings owned, used or operated for railroad purposes by the Railroad Company or by the other railway companies or the terminal company hereinabove in this Article referred to.

All other contracts under which the Edison Company shall be supplying energy to any company entitled to use any energy furnished under this contract which shall be in force at the date of this contract or which may hereafter be

**"Chicago Terminal District."**

**Tenants of Railroad Co. included.**

**Limitations on use of energy hereunder.**

**Provision for termination of existing contracts.**

entered into shall continue in force unaffected by the terms hereof, *provided, however*, that any such company may at any time after the date hereof terminate any such contract with it by giving to the Edison Company, not less than sixty (60) days prior to the date of desired termination, notice in writing of its election to terminate such contract, specifying therein the date of desired termination, and, if such notice be given, such contract shall terminate on the date so specified, and the energy theretofore required to be supplied under any contract so terminated shall thereafter be a part of the energy to be supplied hereunder by the Edison Company, *provided, further*, that such termination of such contracts, respectively, and the supply of energy under this contract in lieu thereof be approved by the Railroad Company.

## ARTICLE XI.

### PURCHASE OF SUBSTATION EQUIPMENT BY RAILROAD COMPANY.

**Conditions of purchase.**

SECTION 1. If at the expiration of the original term of this contract or at the expiration of the first five (5) year extension of the term herein authorized, the Railroad Company shall not have effected a further extension under the provisions of Section 2 of Article I, it shall purchase from the Edison Company all the apparatus which the Edison Company shall have installed in any substation for the purpose of supplying direct current energy hereunder for traction service, including high tension switches, transformers, conversion apparatus, low tension switches, connections and switches to fifteen hundred (1500) volt feeders, and all other auxiliary equipment installed in any substation for the purpose aforesaid, except such of said apparatus as the Edison Company shall elect to use for other purposes. If the term hereof shall be extended by the election of the Railroad Company under the provisions of Section 2 of Article I for more

than one five (5) year period, the Railroad Company shall purchase at the expiration of the term so much of the apparatus just described as shall at such expiration have been in service for fifteen (15) years, or less, and as the Edison Company shall not elect to use for other purposes. The Railroad Company may, at its option, however, at the expiration or termination of this contract, purchase any or all of such substation equipment as the Edison Company may have installed in any substation erected upon the right of way or property of the Railroad Company and required for the service of the Railroad Company. After such expiration or termination the Edison Company shall, within sixty (60) days after receipt from the Railroad Company of a request so to do, remove at the expense of the Edison Company all substation apparatus and equipment not purchased by the Railroad Company. The Railroad Company shall also purchase at the expiration or termination of this contract all substation buildings which the Edison Company shall have erected under the provisions of Sections 3 and 4 of Article IV upon the right of way or other property owned by the Railroad Company. It is agreed, however, that nothing in this section contained shall require the Railroad Company to purchase any of the equipment or apparatus above mentioned that shall have become defective or obsolete to such extent as to be unserviceable or not useful to the present system of traction of the Railroad Company.

SECTION 2. The purchase price to be paid by the Railroad Company for any substation building or for any equipment or apparatus purchased under the provisions of Section 1 of this Article shall be determined on an equitable basis by agreement between the parties, giving due consideration to the matters of replacement cost, obsolescence, normal depreciation and condition with respect to repair and serviceability of building or equipment or apparatus and all other matters affecting the then value of such building, equipment or apparatus. If the parties are unable to agree upon such

**Determination  
of purchase  
price.**

purchase price in any instance the same shall be determined by arbitration under the provisions of Article VIII hereof.

## ARTICLE XII.

### OPERATING RELATIONS.

**Notice of abnormal period or of suspension of train service.**

SECTION 1. In case of any railroad accident or of any abnormally heavy railroad traffic resulting, or which may result, in any substantial increase of the Railroad Company's load of energy supplied hereunder, or in case of any suspension by the Railroad Company of its regular train service, either in whole or in part, under any of the conditions specified in Section 2 of Article VI hereof, the Railroad Company shall give to the Edison Company immediate notice thereof by telephone or otherwise, confirmed within forty-eight (48) hours by letter. In either case, unless such notice shall have been given and so confirmed, an abnormal period because of "abnormally heavy railroad traffic," as defined in Section 1 of Article II, or a suspension of train service under the provisions of Section 2 of Article VI, as the case may be, shall not be considered to have come into existence. Whenever an abnormal period as defined in Section 1 of Article II or a suspension of train service shall come into existence and notice thereof shall be given when required as above provided, the parties hereto, as soon as practicable after such abnormal period or such suspension of train service shall have terminated, shall agree, if possible, upon the duration of such abnormal period or such suspension of train service, as the case may be, or if they are unable to agree upon such duration within ten (10) days after such termination the same shall be determined by arbitration under the provisions of Article VIII of this contract; and when so agreed upon or so determined a memorandum of such duration shall be made in duplicate and signed by a duly author-

**Determination of duration of same.**

ized representative of each party hereto, and one copy of such memorandum shall be retained by each party. Any notice under the provisions of this section shall be given to the Load Dispatcher of the Edison Company on duty at the time of the giving of such notice.

SECTION 2. The Railroad Company shall have the privilege at any time or at all times during the life of this contract of keeping an employee of the Railroad Company in the Load Dispatcher's office of the Edison Company, and such employee shall have the right to observe and to keep records of the load dispatching operations of the Edison Company so far as they relate to service to be supplied to the Railroad Company, but in no event shall such records be given to any employee of the Railroad Company except for the Railroad Company's private use.

Railroad Co.  
representa-  
tives in Edison  
Co. Load Dis-  
patching office.

SECTION 3. Each party shall allow properly authorized employees of the other party to have access to its premises, books, records and accounting for any purpose necessary for or incidental to the carrying out of this contract.

Access to  
premises and  
records.

SECTION 4. Whenever either party shall install any conduit, cable, wire or other apparatus or equipment in or upon the premises of the other party, under any provision hereof, the party owning the same shall have the right, upon giving due notice to the other party, to repair or remove such apparatus at any and all reasonable times, *provided* such repair or removal shall not interfere with the carrying out of this contract; and upon the termination of this contract, by lapse of time or otherwise, such party shall remove permanently any and all property owned by it upon the premises of the other party not required to be purchased by such other party under any other provisions of this contract, or which such other party shall not elect to purchase where the right of such election is given to it.

Access to  
apparatus for  
repair or  
removal.

Serving of notices by either party.

SECTION 5. Any notice, request or demand which may be given to, or made upon, either party by the other under any of the provisions of this contract shall, unless otherwise specifically provided, be given or made by serving the same personally in writing upon, or by sending the same by registered mail addressed to, the President, Vice President or General Manager in charge of operation for the time being of such party.

Termination of privileges.

SECTION 6. All rights and privileges granted by either party to the other under the terms of this contract shall terminate at the termination of the contract, by lapse of time or otherwise; *provided, however*, that upon such termination each party shall have the right to remove with reasonable promptness from the premises of the other party any property which it is authorized to remove therefrom under the foregoing provisions of this contract.

Waivers not to affect subsequent rights.

SECTION 7. Any waiver or any number of successive waivers of any of the rights that may accrue to either party hereto through the default of the other in keeping and performing any of the terms or obligations of this contract shall not estop the party so waiving the default from having the benefit in accordance with the terms of this contract of any other or subsequent defaults, but at any time during the life of this contract either party shall have the benefits herein provided in case of default by the other, without regard to any prior waivers or the number or time of such antecedent waivers.

Contract in duplicate; successor and assigns.

SECTION 8. This contract is executed in duplicate and shall inure to and be binding upon the successors and assigns of the respective parties hereto.

Approval by Illinois Commission.

SECTION 9. It is understood and agreed that this contract is made subject to the approval of the Illinois Commerce Commission.

IN WITNESS WHEREOF, the parties hereto have caused this

electric service agreement to be executed in duplicate by their duly authorized officers, and to be sealed with their respective corporate seals, attested by their respective Secretaries or Assistant Secretaries, the day and year first above written.

COMMONWEALTH EDISON COMPANY,  
By SAMUEL INSULL,  
*President.*  
(CORPORATE SEAL)

Attest:

JOHN W. EVERS, JR.,  
*Secretary.*

ILLINOIS CENTRAL RAILROAD COMPANY,  
By C. H. MARKHAM,  
*President.*  
(CORPORATE SEAL)

Attest:

BURT A. BECK,  
*Assistant Secretary.*

Approved as to Engineering:

D. J. BRUMLEY,  
*Chief Engineer Chicago Terminal  
Improvement.*

Approved as to form:

W. S. HORTON,  
*General Counsel.*

Approved as to Accounting:

G. J. BUNTING,  
*Vice President.*