ELECTRIC LIGHTING

SPECIFICATIONS.

FOR THE USE OF

ENGINEERS AND ARCHITECTS.

BY

E. A. MERRILL.

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INTRODUCTION.

The following "Specifications" are intended as outlines to aid in the construction of specifications for individual installations. They do not in an way take the place of the rules and regulations adopted by insurance companies and electric light associations, but on the contrary are so drawn as to depend almost entirely on such rules for the details of method; such rules should therefore invariably be incorprated as provided for in the General Specificaton under "Inspection," Sec. 17, p. 40, and under "Insurance Rules," Sec. 18, p. 40.

For ready reference there is added to these specifications the latest Rules and Regulations governing electrical installations of the National Electric Light Association, the National Board of Fire Underwriters, and the New England Insurance Exchange. These Rules and Regulations being practically standard all over the country and seldom changed by local boards except in detail to cover local conditions it is generally safe to specify that the rules of the local board or of one of the above boards shall be followed.

It is not expected that these specifications will be followed in detail or without elaboration for all classes of work, and if so followed

will lead into serious error, but they are put out with the hope that in their proper use constructing engineers, architects, and others called upon to get out specifications may be relieved of much of the petty detail accompanying such work, which, though important, is too often neglected on account of its tediousness and the time it consumes.

In fact, the conditions under which electric light plants must be installed to meet the varied requirements arising from the diversity of their application are so numerous that many of them it is impossible even to mention in a general specification. Though it is expected that these specifications will be found sufficiently full and explicit for some of the smaller installations, not requiring special appliances or precautions, in the majority of instances a careful study must be made, for reasons which will suggest themselves, of the surrounding conditions and limitations.

In a large class of installations no small amount of judgment, ability and ingenuity is often required to overcome difficulties met with, to adapt the material at hand to new purposes, or to devise new methods for securing unusual results; in such instances especial care should be taken in the details of the specifications in order that bidders may thoroughly understand all the requirements and conditions, thus leaving no excuse for poor workmanship or materials on the score of inadequate information from which to make

estimates, an excuse that too often has a large foundation on fact. Among such installations may be named:

Art Galleries, Museums, etc.	Hospitals.
Asylums.	Hotels, Apartment Houses, etc.
Bleacheries.	Mines, Shafts, Tunnels, etc.
Breweries, Distilleries, etc.	Oil Works.
Chemical Works and Laboratories.	Paper and Pulp Mills.
	Prisons and Penitentiaries.
Canning Factories.	Packing Houses.
Cold Storage Warehouses.	Slaughter Houses.
Dye Houses.	Tanneries.
Flour and similar mills.	Theatres, Concert Halls, etc
Fabric Mills.	Vessels.
Finished Residences.	Etc., etc.

As an example of the extent to which such study and analysis should be carried before making a detailed specification let us take the last type noted, that of vessels. Here such various requirements and conditions imposed by questions of safety, reliability, utility, economy, or æsthetic effects are met with that almost invariably a particular specification must be made out for each installation. For whatsoever purpose the plant is installed, however, safety and reliability should be the first considerations. On account of the disastrous results that might accompany the extinguishment of the lights on shipboard it is of the utmost importance that no device that can increase the safety and reliability of the plant shall be omitted, and that the utmost care shall be exercised in every part of the installation. Economy should never be more than a secondary consideration.

Nearly, if not quite, all plants installed on shipboard are arc plants or low-potential, direct-current incandescent plants. The former are, for the most part, confined to small excursion boats, river barges, scows, dredges, etc., the conditions and requirements comparatively simple, and the specification may be made up from the general form for arc plants. For incandescent plants on similar boats the specification is equally simple, but for the larger plants, especially on sea-going vessels, the necessary modifications are numerous and important.

A careful study should be made of the purpose for which the plant is installed; the material of which the boat is built; the character of the cargo; the class of passengers; the length of voyages or trips; temperatures and vapors to which the apparatus and appliances will be exposed; character of the power; limitations of speed, weight, space, etc.; method of connecting engines with dynamos; duplication of parts for renewals, repairs or extensions; magnetic effects; location of switches and cut outs; location and manipulation of search lights or projectors, flash lights, signal lights, etc.; motors; and any special devices that may be operated from the dynamo circuits. There should be supplied with the dynamos a complete set of wrenches, screw-drivers, pliers, oil cups, oil cans, drip pans, guard rails, extra brushes, bearings, and such other tools and appurtenances of the

most approved kind as are necessary in their operation, care, and maintenance. There should be furnished in addition to the ordinary regulating apparatus a tachometer, or speed indicator, an efficient apparatus for testing insulation, and at least one portable voltmeter and ampère meter of known accuracy and reliability. Compound wound or automatically regulated dynamos are in general preferable to shunt wound and hand regulated dynamos.

The switchboard should be so arranged that any circuit or circuits may be attached to any dynamo; that dynamos may be operated separately or in parallel; that any dynamo may be added to or taken from the circuit quickly and without disturbing the operation of the remaining dynamos in circuit, or causing any change in the lights.

Special attention should be paid to the character of the insulation. Climatic and temperature effects should be considered. The dynamos, all wires, fixtures, metal junction boxes, switches, receptacles, and other apparatus or appliances carrying current, should be carefully insulated from the ship. All junction boxes, switches, conductors, and entrances to fixtures should be water-tight. Wires should pass through bulkheads and decks, junction boxes, etc., in water-tight stuffing boxes. Where necessary, lamps and sockets should be inclosed in waterproof globes. All cut-outs, switches, etc., should be of moisture proof,

incombustible material. Joints will prove a source of trouble unless made with extreme care. Sockets, binding screws, switches, receptacles, shade holders, etc., must be protected from corrosion. Circuits should be so arranged that no part of the vessel will be in darkness through the failure of a single circuit. The wire should be figured with an ample margin in carrying capacity. The size, character, and position of search lights and projectors will be determined by local conditions. Permanent signal lights should be provided with a duplicate light, which is automatically switched into circuit when the first lamp fails and gives a signal calling attention to the failure of one lamp Where necessary, springs should be provided to guard lamps or fixtures from injurious shocks. Lamps should be adapted to the purpose for which they are to be used both as regards candle power and economy. In the selection of measuring instruments such as voltmeters and ammeters not only must the effect of the rolling and pitching of the vessel be considered, but also the magnetic effect of the iron and steel used in the construction of the vessel and the proximity of large masses of iron and steel in engines, shafting, etc. Cut-outs and switches should be plainly labeled with the location of the circuit and number of lamps. Lights to be controlled by passengers should be provided with a card containing printed instructions concerning their use.

From an analysis of this general character a complete specification may be made up, the purposes, conditions and limitations of the installation being known.

In any specification calling for an insulation for a particular purpose, a careful distinction should be made between so-called "weather proof," "moisture proof," and "rubber covered" insulations, bearing in mind the seemingly paradoxical fact that a "weather proof" wire is not necessarily a "moisture proof" wire, nor a "moisture proof" wire always the best wire for a wet place, and that conditions will be met demanding a high grade of insulation where a bare wire will give better satisfaction than the best "rubber covered and braided" wire on the market.

In the determination of the number and sizes of dynamos, reference should be had to the maximum number of lamps that will be lighted at one time, the length of time of maximum load, the length of time of light load, the day load, possibilities of extension, etc.; the sizes of the units being such as to have as near the maximum load as possible on the dynamos when operating, and the least possible amount of idle machinery, allowance being made for possible breakdowns and similar contingencies. The question of variation in load must be determined largely from

experience with the given class of installation and one's judgment.

A question that too seldom receives the attention its importance demands is the question of the allowable variation in pressure or maximum difference of potential, especially in large isolated plants, between the centre of distribution and the farthest lamp in the installation. No fixed or arbitrary rule can be laid down, but each case must be considered by itself. The loss should be based not so much on the total number of lamps wired for as upon the maximum number that will be in use at any one time, upon the distances between groups of lamps rather than the total distance from the centre of distribution to the farthest lamp on any circuit, and upon the usual variation in load rather than extreme variations; the object should be primarily to obtain a minimum variation in the candle power of the lamps, and though this is attained by allowing but a small percentage of loss between the centre of distribution and the farthest lamp, yet for all practical purposes the same result may often be gained with a larger percentage of loss provided it be given the proper distribution. For example, the distribution of losses is evidently entirely different in a theatre from the distribution in an office building for the same limits of variation in the candle-power when operating under the normal conditions of variation in load.

There is 50 per cent. more copper in a circuit figured with 2 per cent. loss than in the same circuit figured with 3 per cent. loss, and the question of which is ultimately the greater economy is by no means an easy one to answer. This question comes with peculiar force when considering the method of wiring, whether it shall be two-wire fifty-volt, two-wire one-hundred-volt, three-wire one-hundred-volt, or a system so designed that any given combination of the above systems can be used with a limiting maximum loss for the system using the largest current and the lowest voltage. A very careful analysis should therefore be made both of the conditions at the time of the installation and of conditions that are likely to arise in the more or less remote future which will influence the character of the system to be adopted.

In this connection it may not be out of place to mention two methods of wiring which may be used where economy as well as adaptation to surroundings is a necessity, but which for various reasons have not been very extensively used. If it is desirable to wire for a 100-volt system and yet necessary to connect with an alternating system, reducing to 50 volts, the system may be adapted to the wiring by installing converters in pairs and connecting their secondaries in series. If it is desirable to operate a direct current system where the cost of copper becomes excessive on account of distances or other limiting conditions,

this item of expense, as well as the accompanying expenses in pole line and labor, can be very materially reduced by using the double three-wire system with a 250-volt dynamo and two lamps in series on either side of the system.

Of paramount importance to bidders estimating on wiring contracts, and to the contractor who secures the contract, are accurate plans showing in detail the locations of the various elements of the installation. A strictly accurate and reliable estimate cannot be made without plans drawn to scale and having the exact location of each fixture, switch, and meter outlet, together with that of the dynamo if there be one, the switchboard and the risers, or feeders. In a large installation with a small percentage of loss, a difference of 50 feet in the position of the switchboard may entirely alter the location of the risers, or of the distribution boxes, or increase or diminish the cost of the installation by several hundreds of dollars. A single example will illustrate this: figure the cost, including wire, conduit, and labor, of a riser 100 feet in length, feeding 1,000 50-volt 16-c. p. lamps uniformly distributed along its length, on the basis of using a conduit system, the best grade of rubber covered and braided stranded wire, with a maximum loss of 2 per cent. on the 50-volt system; remove the switchboard 50 feet, making the length of the riser 150 feet

with the 1,000 lights along the farther 100 feet, and figure the cost by the same method; the difference between the two figures graphically represents the necessity of carefully selecting the centre of distribution and location of the risers, and of knowing their exact position before making an estimate.

Of no less importance is the position of all outlets and the number of lights per outlet, since this determines the number of circuits, the lengths and sizes of tap lines, the method of running the circuits, the number of cut-outs, and the amount of labor involved. The location of the switch and meter outlets with reference to the number and position of the lights they control is necessary for the same reason. Outlets, especially side outlets, should be located as far as possible by actual dimensions in feet and inches from floors, ceilings or walls; it is only necessary in some cases to specify that *all outlets* shall be wired to, leaving the dimensional location of the outlet to the gasfitter, but with the rapid increase of buildings fitted for the electric light only, with its more frequent adaptation to architectural and æsthetic effects, and the thousand and one purposes and places from which other forms of illuminant are excluded, the contractor is compelled in an increasing number of cases to rely upon detailed plans showing their exact location and to work to scale. Several methods will suggest them-

selves for denoting the number of lights for a given outlet; a convenient way is to locate the outlet with a circle and denote the number of lights by a figure within the circle, thus (5) is a five-light outlet. To distinguish side from ceiling outlets, a straight line may be drawn from the circle to the wall to denote the former, thus (2) is a two-light side outlet. For switches and meters the letters S and M are similarly inclosed, thus (S) (M). Another method used is to indicate the gas outlets by a simple circle while the number of electric lights at the same outlet is denoted by the number of lines terminating in the circle, thus –○– is a three-light ceiling outlet, –○– is a two-light side outlet, the third line drawn to the wall designating it as a side outlet.

The *exact* position of outlets may usually be located on the plans, but in certain cases it is also advisable to add explanatory notes to the specification, especially if the lights are to be worked into architectural or decorative designs.

To avoid complication and the confusing of circuits with partition and other lines, it is often more satisfactory to designate in the specification, rather than on the plans, the outlets each switch and meter is to control.

Distribution boxes should be located in the same manner as switches and meters.

If the locations of the vertical risers are determined by other than the contractor, they also should be plainly indicated.

In case the installation is intended to be connected both to dynamos in the building and to an external source of supply, this fact should be taken into consideration in the location of the centre of distribution and of the risers; where the outside mains enter the building overhead it is sometimes advisable from considerations of economy or convenience to have a second centre of distribution located with reference to this external source of supply.

No attempt has been made throughout the specifications to lay down ironclad rules or to volunteer technical information. It is fairly assumed that no one will attempt to make out a definite and detailed specification who is not himself competent to determine for any installation under consideration the best methods and system to be adopted, and the kind and quality of materials and workmanship required by its purposes or by local conditions. These few preliminary notes are intended merely as suggestions to call to mind points that, through their very simplicity, or obscurity, might escape attention, but yet are deserving of consideration.

ELECTRIC LIGHTING SPECIFICATIONS.

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1. Working Outline.

The outline given below is one that I have often found convenient for use in checking a specification, or for reference in outlining the points to be taken up in detail in making up a specification.

In those cases where a formal specification is not required, as sometimes occurs in the case of a preliminary specification or a specification for a small isolated plant or wiring job, the necessary data for estimates and bids can often be easily and rapidly dictated, item by item, as suggested by these headings, with little liability of making any important omissions.

Plant to comprise?

- Dynamos and erection.
- Switchboard.
- Wiring
  - Interior.
  - Exterior.
- Fixtures.
- Pole line.
- Engines and erection.
- Boilers and erection.

System?
- Incandescent.
  - Direct current.
  - Alternating current.
  - Constant current.
  - Constant potential.
  - High potential.
  - Low potential.
  - Series.
  - Two wire parallel.
  - " " " series.
  - Three wire parallel
  - " " " series.
  - Combination.
- Arc.
  - Direct current and constant current or constant potential.
- Combination of arc and incandescent.

Dynamos?
- Number.
- Capacity in volts and ampères.
- Series.
- Shunt
- Compound.
- Self-excited.
- Separately excited.
- Hand regulated.
- Automatically regulated.
- Connected directly or by belt.
- Foundation.
- Regulating instruments.
  - Regulators { Hand. / Automatic.
  - Ampèremeters.
  - Voltmeters.
  - Galvanometers.
  - Indicators.
  - Shunts.
  - Equalizers.
  - Compensators.
  - Impedance coils.
- Renewal parts.

- Wires to switch-boards?
  - Insulation.
  - Wires to be run.
    - On insulators.
    - Under cleats.
    - In molding.
    - Concealed.
    - In conduit.
  - Capacity.

- Switch-boards?
  - Number.
  - Material.
  - Size.
  - Design.
  - To be wired how.
  - Instruments.
    - *See* dynamo regulating instruments.
    - Lightning arresters.
    - Ground detectors.
    - Testing sets.
    - Switches.
      - Single pole.
        - Plug.
        - Snap.
        - Knife.
        - Automatic.
      - Double "
        - Breakdown.
        - Throwover.
      - Three wire.
        - Dynamo changing.
        - Circuit changing.
        - Short circuiting.
        - Reversing, etc.
    - Cut-outs.
      - Single pole.
        - Fusible.
      - Double "
        - Automatic.
      - Three wire.
        - Magnetic.

- **Interior wiring?**
  - Number of circuits.
  - Number of outlets.
    - Lamp.
    - Switch.
    - Meter.
  - Number of lights.
    - Incandescent.
    - Arc.
  - Insulation.
  - Insulation resistance.
  - Method of wiring.
    - Under cleats.
    - In molding.
    - On insulators.
    - Concealed.
    - In conduits.
  - Variation in pressure.
  - Cut-outs.
  - Switches.
  - Cabinets, junction boxes, etc.
  - Meters.
    - Number.
    - Kind.
    - Capacity.
  - Converters.
    - Number.
    - Capacity.

- **Sockets and receptacles?**
  - Number.
  - Key.
  - Keyless.
  - Base.
    - Porcelain.
    - Wood, etc.
  - Finish.
    - Plain.
    - Polished.
    - Plated, etc.
  - Waterproof.

- **Lamps?**
  - Incandescent.
    - Number.
    - Voltage or ampèrage.
    - Candle power.
    - Kind.
      - Plain.
      - Frosted.
      - Colored, etc.
  - Arc.
    - Number.
    - Candle power.
    - Single carbon.
    - Double "
    - Triple "
    - Seven-hour, single mechanism.
    - Fourteen-hour, " "
    - Plain or ornamental.

- Fixtures?
  - Incandescent.
    - Interior.
      - Number.
      - Kind.
      - Finish.
    - Exterior.
      - Hoods.
      - Reflectors.
      - Brackets.
      - Cross-suspension fixtures.
      - Waterproof globes.
    - Hoods.
    - Globes.
      - Plain.
      - Opal.
      - Ground.
      - Half-ground.
      - Colored, etc.
    - Spark arresters.
  - Arc.
    - Nets.
    - Hanger boards.
    - Circuit cut-outs.
    - Outriggers.
    - Pole tops.
    - Mast arms.
    - Posts.
    - Lowering devices.

- Pole line?
  - Number of circuits.
  - Number of street lamps.
  - Insulation.
  - Poles.
  - Cross arms.
  - Pins and insulators.
  - Steps.
  - Line lightning arresters.
  - Fall of potential.

Engines?
- Number.
- Kind.
  - Horizontal.
  - Vertical.
  - High speed.
  - Low speed.
- Horse power.
- Fittings.
- Foundations.
- Belts.
- Renewal parts.

Boilers?
- Number
- Kind.
  - Return tubular.
  - Water tube.
  - Vertical, etc.
- Horse power.
- Fittings.
- Setting.
- Tools.
- Renewal parts.

Stack.
Pumps and injectors.
Heaters and purifiers.
Separators.
Piping.
Shafting and pulleys.
Date of commencement and completion.
Date of starting plant.
Inspections.
Tests.
Terms of payment.

SPECIFICATIONS FOR THE INSTALLATION OF ——— —— ——— ELECTRIC LIGHTING PLANT AT ——— ———

2. Warning.

Parties making bids for any portion of the work contemplated under these specifications (and plans) must familiarize themselves therewith both as regards that portion of the work covered by their bid and such other work as must be carried on, or is intended to operate in conjunction therewith, in order that the true spirit and intent of these specifications (and plans) may be fulfilled. In case these specifications (and plans) are in any part deficient or not clearly expressed, the parties making bids shall apply to ——— for the required information before such bids are submitted, as no changes will be allowed in specifications (or plans) after the contract is awarded except under the conditions named in article "Additional, Omitted or Changed Work."

It must be understood and agreed that these specifications (and plans) shall be fulfilled in their true spirit and intent, and that any apparatus or appliances essential to the proper and convenient operation of the system shall be supplied and installed without extra charge even though not specifically called for.

PREAMBLE.

3. Bids. Parties bidding shall state specifically just what part of these specifications their bid covers.

A complete and correct copy of these specifications shall be attached to each bid submitted.

All bids must be submitted on or before ———.

The right is reserved to reject any or all bids.

No bid will be considered unless accompanied by a certified check in the sum of ———, payable to ———, said check to be forfeited if the successful bidder shall fail to deposit with ——— within —— days after the acceptance of his bid the bond required under these specifications. The checks of unsuccessful bidders will be returned to them within ——— days from date of opening bids.

4. Bond. Successful bidders will be required to furnish an approved bond within —— days after the acceptance of their bid in the sum of ——— to faithfully commence, carry on, and complete their work in every respect according to the true spirit and intent of these specifications.

5. Contractor. The word "contractor" as herein used refers to the party or parties whose bid or bids for the whole or any part of the work contemplated under these specifications have been accepted.

6. Commencement and Completion of Work.

Contractors under these specifications shall commence work on dates to be assigned, notice to be given of such dates not less than —— days in advance. All work shall proceed as rapidly as is consistent with thoroughness and good workmanship, and shall be completed in the following times:

Installation of dynamos and apparatus within —— days after assigned date of commencement.

Installation of wiring and wiring devices within —— days after assigned date of commencement.

Erection of pole line and wire within —— days after assigned date of commencement.

Installation of fixtures and dependent work within —— days after assigned date of commencement.

Installation of steam plant complete within —— days after assigned date of commencement.

But delays due to strikes, riots, or accidents beyond the control of contractors shall be added to the time stipulated above for the completion of the work, provided application is made in writing by the contractor at the time such delay occurs, giving its nature and extent, such application to be subject to the approval of ———.

7. Damages.

If any contractor shall fail to complete his work in the time stipulated above, including time lost through unavoidable delays if such

time has been approved, there shall be deducted as liquidated damages from the contract price the sum of ——— per day for each and every day the work remains uncompleted after the date set as above.

GENERAL SPECIFICATION.

8. Duties of Contractors. Each contractor shall personally or through an authorized and competent representative constantly supervise the work from its beginning to its completion and acceptance.

He shall furnish all transportation, labor, apparatus, and materials necessary for performing his work according to the true spirit and intent of these specifications (and plans).

He shall obtain all necessary permits and licenses for temporary obstructions, etc.

He shall at all times, until its completion and final acceptance, protect his work, apparatus and materials from accidental damage by other contractors or otherwise, making good any damage thus occurring at his own expense; also making good any injury done the building in the performance of his work.

He shall be responsible for all accidents resulting through his work.

(The purchaser) agrees to afford the contractor all possible facilities to enable the work to proceed without interruption from beginning to end, and to make good any loss which the contractor suffers in consequence of delay on the part of said (purchaser).

9. Work, Labor and Materials.

All work contemplated under these specifications shall be executed in a workmanlike and substantial manner; no patched or slovenly work will be allowed.

The labor shall be thoroughly competent and skillful in its line.

Materials shall be of the highest grade unless specifically stated otherwise.

10. Additional, Omitted or Changed Work.

Additional work will be allowed only on the written order of (the purchaser).

Specified work shall be omitted or changed only by written agreement between the contracting parties.

The addition or rebate for such added, omitted, or changed work shall be as mutually agreed upon, the amount to be stipulated in the order or agreement.

11. Replacement of Defective Material.

The contractor shall make good for a period of —— days after the final acceptance of the work all defects which develop on account of defective work or material.

12. Patented Apparatus.

All patented apparatus and material must be furnished by the contractor under guarantee against loss through suits, royalties, or claims of any kind whatsoever, and that any loss or damage to (purchaser) through such suits or claims will be made good by said contractor.

13. Special Devices.

Every bidder is expected to include in his proposal not only everything called for in

these specifications, but also any special devices or methods peculiar to his system which will add to the safety, completeness, or efficiency of the plant, stating clearly the advantages to be derived from their use.

14. Safeguards and Débris. Contractors must provide all necessary safeguards from accidents to persons or property; must keep all passages, entrances, sidewalks, etc., free from débris and incumbrances; and on the completion of the work must remove from the premises all surplus material of every kind and description.

15. Plans. All plans and detailed drawings necessary to show the scope and character of the work contemplated under these specifications will be furnished by the {engineer / architect} as required. Figured dimensions and detailed drawings are in all cases to be followed in preference to scaled dimensions. The interpretation of all plans and drawings shall rest with the {engineer / architect} and in case any doubt arises as to their interpretation or correctness, work shall be discontinued until such doubt is removed, or if continued it shall be at the risk of the contractor.

16. Tests. (Note.—The character and extent of the tests, especially the final tests, must be deter-

mined for the most part by a consideration of each individual case. The purpose for which the plant is installed, unusual conditions to which any part may be subjected, necessary delays occurring during the process of construction, relation of one part of the installation to another, time intervening between the completion of the plant and its active operation, operation before completion and like considerations should be given careful attention).

All work shall be regularly and systematically tested while in process of construction and any defects found shall be immediately remedied.

The final tests shall be made in the presence of the {engineer / architect} or his representative, and the right is reserved by (the purchaser) in case any doubt arises as to the fulfillment of the true spirit and intent of the specifications, to demand a test by expert engineers selected as is usual in matters of arbitration, whose decision shall be final on all disputed points, the expense of such test to be borne equally by both parties unless the apparatus or material shall prove defective, in which case the contractor shall bear the expense, and shall also remedy the defects. He shall also be liable for any damage or loss to (the purchaser) resulting from conditions incident to the remedying of such defects.

17. Inspection. During its progress the work shall be subject to the inspection of the {engineer / architect} or his representative, and of the

{——— Board of Fire Underwriters. / ——— Board of Inspectors.}

On its completion a {Board of Fire Underwriters / Board of Inspectors} certificate shall be furnished (the purchaser) by the contractor stating that all the insurance rules and regulations under which the work was done have been complied with. All costs of such inspection to be borne by the contractor.

18. Insurance Rules. All work shall be done in accordance with the rules and regulations of ———.

19. Acceptance. (Note.—The same considerations that determine the character of the tests will also enter largely into the conditions of the acceptance.)

(The purchaser) will assume no liability nor responsibility for any part of the installation until formally accepted in writing.

No part of the installation will be accepted until (the purchaser) is satisfied that it fully complies with the spirit and intent of the specifications.

The acceptance of any portion of the work shall not be construed as a final acceptance, and the failure of any part to perform its proper function shall be sufficient ground for the rejection of the whole.

The final acceptance shall be given only after the completion of the work contemplated under the specifications according to their true spirit and intent, and after the final tests as specified. Such acceptance, however, shall not prejudice any claim which (the purchaser) may have for the replacement of defective material for the time specified.

The date of the completion of the final tests shall be taken as the date of such final acceptance, provided such tests prove satisfactory.

(To conform to individual cases.)

40. Terms of Payment.

INSTALLATION OF DYNAMOS AND SWITCHBOARDS.

Low Potential, Direct Current System, Two-Wire or Three-Wire.

This contractor shall furnish, and, unless otherwise specified, erect the following apparatus and material:

21. Dynamos. ——— direct current, constant potential dynamo(s) (each) having a normal capacity of —— ampères at —— volts.

The(se) dynamo(s) shall be { shunt wound, compound wound or provided with an efficient automatic regulator; } of the latest and most efficient pattern; mounted on a base provided with an adjustable belt tightener, so that the belt may be tightened while in operation; capable of operating under full load for —— consecutive hours without increasing the temperature of any part, especially the armature, fields, and commutator, to such a degree as to endanger the insulation or decrease the efficiency of operation; shall not spark appreciably with proper care of the commutator and adjustment of brushes, nor under considerable variation of load; shall have an insulation resistance of not less than —— ohms between all

parts insulated from each other; shall be adapted to operate at such speed as will allow the use of high speed, automatic cut-off engines belted direct; shall be provided with efficient oiling devices; the armature shall be balanced both electrically and mechanically so that there will be no tendency to spring the shaft, or to draw the armature toward either bearing so as to cause excessive friction and heating, and no vibration; the dynamo(s) shall be so designed that the power required will be automatically proportioned to the number and candle power of the lamps burning at any time; that with the proper connections any number may be operated in parallel of whatever ampère capacity, provided the voltage be the same; that when connected so to operate it shall be possible, with ordinary care and precaution, to add to or take away from the circuit any dynamo without in any manner affecting the operation of the remainder, or causing any change in the candle power or steadiness of the lamps; and that when two or more are operating on the same circuit in parallel the load may be divided between them in proportion to their respective capacities under all conditions, from no load to full load; and that with the proper connections any number of pairs, a pair consisting of two similar dynamos, may be manipulated in the same manner and with the same effect as single dynamos, as indicated above.

The dynamo(s) shall be rated with such margin of safety that { they / it } shall not be injured if subjected to a temporary overload of —— per cent. above such rating.

22. Foundations.

(Note.—In the specification for foundations it should be borne in mind that a dynamo is not subject to vibration if its armature is properly balanced, nor to the strains and shocks due to the movement of rapidly reciprocating parts, it is therefore only necessary to provide such foundation as will amply sustain its weight and resist the belt strain.)

The foundation(s) for the(se) dynamo(s) shall be built by the { contractor / purchaser } of —— laid ——, or of other material subject to the approval of the { engineer, / architect, } and shall be of sufficient length, width and depth to safely and firmly sustain { their / its } weight.

All necessary excavating or filling, and the removal of all débris shall be done by the { contractor. / purchaser. } The height of the dynamo base-frame(s) above the ground will be ——.

The dynamo base-frame(s) shall be firmly and securely fastened to the(se) foundation(s) in such a way as to prevent lateral motion in either direction, and to give an even bearing surface at every point.

(Note.—This specification simply provides for such instruments as it is customary to furnish with a dynamo; if extra instruments are desired, such as portable voltmeters, portable ammeters, testing sets, etc., they should be distinctly specified, as well as the make if a particular kind is preferred.) 23. Instruments.

There shall be provided with each dynamo one hand regulator for adjusting the pressure, made entirely of incombustible material; one ampère meter for indicating the current supplied by the dynamo and graduated to read ampères; one voltmeter or pressure indicator, which shall remain constantly in circuit, so as to indicate continuously the pressure at the point to which it is connected, and which shall be so constructed that the scale is plainly visible at a distance of at least ——; one brush jig for trimming the brushes; one insulating baseframe provided with rails and a suitable device for shifting the position of the dynamo to alter the belt tension; and one headboard switch for cutting off the current at the dynamo itself. There shall also be provided for the installation —— ground detector(s), which shall continuously indicate the insulation from the ground maintained on both sides throughout the system, and —— lighting arresters of the most efficient type known.

(Note.—In the case of compound dynamos operating in parallel the equalizing wire may often more conveniently be carried direct 24. Cables to Switchboard.

from dynamo to dynamo, in which case this contractor should furnish and connect a suitable equalizing switch at each dynamo.)

This contractor shall carry to the switchboard location at —— all regulator and main wires, leaving the ends coiled up neatly, properly tagged, and sufficiently long to make the necessary switchboard connections. All main wires shall have a capacity of at least —— C. M. per ampère, and no wire smaller than —— B. & S. or —— B. W. G. shall be used. Regulator wires shall be covered with —— insulation, and shall be

{cleated to the ceiling, / carried on insulators, / concealed in molding;} main wires shall be of {bare copper wire supported on porcelain insulators.} *or* insulated wire {carefully cleated to the ceiling, / carried on porcelain insulators, / concealed in molding consisting of a backing — thick and a capping — thick}

wires of opposite polarity being separated not less than ——. In no case shall insulated wires be carried in such proximity to heated surfaces, vapors, or air as to endanger their insulation.

25. Starting Plant and Instruction. When the plant shall be ready for operation the dynamo(s) shall be run for a period of —— days by competent engineers furnished by the contractor. All oil, waste, power, etc., to be furnished by (the purchaser). This con-

tractor shall also give all necessary instruction to the engineer of (the purchaser) for the proper care, maintenance, and operation of the dynamo(s), such instruction to be given during the trial period stipulated above.

26. Renewal Parts.

This contractor shall furnish such renewal parts as it is advisable to keep on hand, adding hereto an itemized list of same.

27. Summary.

(Note.—The object of this summary is to present in a concise, tabulated form, the essential data concerning the apparatus to be supplied, thus enabling the different bids to be easily and quickly compared. For complete plants a single form, systematically arranged, will be found extremely convenient both in making comparisons and in being able to see at a glance just what apparatus and appliances are called for, thus constituting a check on the specifications themselves.)

Each bidder shall fill out completely the following summary:

Number of dynamos . . . . ——
Trade number or designation . . ——
Rating in volts . . . . . ——
Rating in ampères . . . . . ——
Shunt or compound . . . . . ——
Make of lamp recommended for use . ——
Dynamo capacity in —— c. p. lamps of the above make . . . . . ——
Speed . . . . . ——
Size of pulleys . . . . . ——

H. P. required to be delivered at the pulley at full load with no loss in the feeders . . . . . ——

Switchboard and Appliances.

This contractor shall furnish and erect the following apparatus and material:

28. Switchboard. (Note.—In plants of any considerable size the switchboard specification is an extremely important one. Its general characteristics will be determined by questions of purpose, economy, utility, available space, beauty, etc., but the details of material, method of wiring, attachment of instruments, location, number of switchboards, etc., demand the most careful study. It may be advisable in one instance to have a single switchboard controlling everything from a single centre, in another to have a dynamo switchboard and a separate circuit switchboard, while in yet another to even divide the dynamo switchboard into two or more parts and to have several circuit switchboards. In determining the location of switchboards, not only should questions of convenience be considered, but also questions of its relation to economy in the wiring; the example given on p. 22 illustrates this. Upon the arrangement of the instruments will depend the facility and certainty with which they may be operated.)

The switchboard shall be made of ——, neatly and substantially built, of sufficient

size to accommodate all the regulating apparatus, switches, 'bus bars, etc., named below without crowding, supported on a stout framing of ——, and set out not less than —— from the wall. A design of the switchboard shall be submitted with the bid.

29. Switchboard Apparatus.

(Note.—This specification includes only the instruments used in the simplest of installations. The instruments required for any particular installation must, of course, be determined by its individual purposes and necessities.)

There shall be placed upon this switchboard all the dynamo regulating apparatus and the following appliances:

——— main ampère meters.
——— ampère meters for risers.
——— dynamo galvanometers.
——— dynamo galvanometer switches.
——— dynamo switches.
——— { riser / feeder } switches.
——— switches for connecting system with dynamos in the building or with external source of supply.
——— breakdown switch.
——— double-pole fusible cut-outs.
(switches, cut-outs, etc., for purely local conditions).

All switches carrying over —— ampères shall be knife switches; all other switches shall have sliding contacts, and shall make

and break contact automatically beyond the control of the operator, who shall simply set the switch at the point of making or breaking.

Cut-outs shall be so protected that the molten metal cannot be spattered about on the fusing of the strip.

All switches and cut-outs shall be mounted on incombustible bases.

30. Connections (concealed). All connecting wires shall be carried back of the switchboard using only —— insulated wire. All joints shall be soldered. All connections to switches, cut-outs, etc., shall be soldered or made with an approved form of lug or set screw, in all cases care being taken to secure good and sufficient contact to prevent heating and insure permanency; when made with lugs or set screws they shall be in plain sight and easily accessible for tightening. Connecting wires shall be so run and secured that crosses or grounds are impossible in the normal operation of the plant. All main wires shall have a capacity of at least —— C. M. per ampère, and no wire smaller than —— B. & S. or —— B. W. G. shall be used.

31. Connections (surface). All dynamo, 'bus, feeder and riser wires shall be of {bare / insulated} wire fastened neatly and securely to the front surface of the switchboard. All bare wires shall be separated from the board by an air space of not

less than ——. Bus bars shall be of —— section. All minor connections, such as to pressure indicators, ground detectors, etc., shall be made on the {rear / surface} of the board using —— insulated wire. All joints shall be soldered. All connections to switches, cut-outs, etc., shall be soldered or made with an approved form of lug or set screw, in all cases care being taken to secure good and sufficient contact to prevent heating and insure permanency, when made with lugs or set screws they shall be in plain sight and easily accessible for tightening. All main wires shall have a capacity of at least —— C. M. per ampère, and no wire smaller than —— B. & S. or —— B. W. G. shall be used.

32. Circuits.

The following circuits will centre at the switchboard:

(Enumeration of circuits
To different floors;
To different sections of the building;
Residence circuits;
Commercial circuits;
Street lighting circuits;
Power circuits, etc.
This enumeration will largely determine the extra instruments to be supplied.)

Incandescent Series System, Dynamos Medium or High Potential (Variable or Constant), Current Direct or Alternating.

This contractor shall furnish, and, unless otherwise specified, erect the following apparatus and material:

33. Dynamo(s). ——— dynamo(s) (each) having a capacity of ——, —— c. p., incandescent lamps. The maximum voltage at the terminals of the dynamo(s) shall not exceed —— volts at full load.

The dynamo(s) shall be of the latest and most efficient pattern; mounted on a base provided with an adjustable belt tightener, so that the belt may be tightened while in operation; capable of operating under full load for —— consecutive hours without increasing the temperature of any part, especially the armature, fields, and commutator, to such a degree as to endanger the insulation or decrease the efficiency of operation; shall not spark unduly with proper care of the commutator and adjustment of the brushes, nor under considerable variation of load; shall have an insulation resistance of not less than —— ohms between all parts insulated from each other;

shall be adapted to operate at such speed as will allow the use of high-speed, automatic cut-off engines belted direct; shall be provided with efficient oiling devices; the armature shall be balanced both electrically and mechanically so that there will be no tendency to spring the shaft, or to draw the armature toward either bearing so as to cause excessive friction and heating, and no vibration; the dynamo(s) shall be of such design that the power required will be automatically proportioned to the number and candle-power of the lamps burning at any time; if of the direct and constant-current type { they / it } shall be so designed that with the proper connections two or more may be operated successfully in series, so that with ordinary care and precaution any dynamo may be added to or taken from the circuit without in any manner affecting the efficient operation of the remainder, and with but a momentary fluctuation in the candle power and steadiness of the lamps; if of the direct-current, constant-potential type { they / it } shall be so designed that with the proper connections two or more may be operated successfully in parallel so that with ordinary care and precaution any dynamo may be added to or taken from the circuit without in any manner affecting the operation of the remaining dynamos in circuit or causing any change in the candle

power of the lamps; and that when two or more are operating on the same circuit the load may be divided between them in proportion to their respective capacities under all conditions from no load to full load; if of the alternate current, constant-current or constant-potential type, {they / it} shall be guaranteed as efficient in {their / its} operation as any of the direct-current types.

The dynamo(s) shall be rated with such margin of safety that {they / it} will not be injured if subjected to a temporary overload of —— per cent. above such rating.

34. Foundation(s).

(See Note: p. 44., sec. 22.)

The foundation(s) for the(se) dynamo(s) shall be built by the {contractor / purchaser} of ——, laid ——, or of other material subject to the approval of the {engineer, / architect,} and shall be of sufficient length, width, and depth to safely and firmly sustain {their / its} weight. The foundation(s) shall be capped with a framing of well seasoned timber securely fastened thereto, the dynamo base-frame(s) being securely fastened to the framing or to the foundation through the framing, both framing and baseframe being secured in such a manner as to prevent lateral motion in either direction

and to give an even bearing surface at every point. If metal is used to fasten framing or baseframe to the foundation it must be thoroughly insulated where it passes through them, and at all places liable to come in contact with the dynamo must be countersunk and covered with a moisture-proof insulating compound.

All necessary excavating and filling, and the removal of all débris shall be done by the {contractor. / purchaser.} The height of the dynamo baseframe(s) above the ground will be ——.

(See Note: p. 45, sec. 23.)

35. Instruments.

There shall be provided with each dynamo one voltmeter or pressure indicator which shall remain constantly in circuit so as to indicate at all times the pressure at the point to which it is connected; one brush jig for trimming the brushes; one insulating baseframe provided with rails and a suitable device for shifting the position of the dynamo to alter the belt tension; if of the constant potential type, one hand regulator made entirely of incombustible material, a headboard switch for cutting off the current at the dynamo, a compensator or suitable balancing device for keeping the current in each circuit practically constant; if of the constant current type an automatic regulator for so controlling the potential as lights are turned on or off that the current shall not vary appre-

ciably from its normal value under any condition of load. There shall be provided for each circuit one ampère meter for indicating the current in said circuit, one ground detector which shall continuously indicate the insulation from the ground maintained at both poles and approximately the distance of any ground from the station, and one pair of efficient lighting arresters. There shall also be provided one testing magneto capable of ringing through —— ohms.

36. Cables to Switchboard. This contractor shall carry to the switchboard location at —— all regulator, exciter, auxiliary, and main wires, leaving the ends coiled up neatly, properly tagged and sufficiently long to make the necessary switchboard connections. All main wires shall have a capacity of at least —— C. M. per ampère and no wire smaller than —— B. & S. or —— B. W. G. shall be used. All wires shall be insulated with ——; shall be run ——; when of opposite polarity shall be separated at least ——; and where crossing each other, wires of other circuits, or passing near metal pipes, girders, etc., shall be further protected by ——. In no case shall insulated wires be carried in such proximity to heated surfaces, vapors, or air as to endanger their insulation.

37. Starting Plant and Instruction. (See p. 46, sec. 25.)

38. Renewal Parts. (See p. 47, sec. 26.)

(See Note: p. 47, sec. 27.) 39. Summary.

Each bidder shall fill out completely the following summary:

Number of dynamos . . . . ——
Trade number or designation . ——
Rating in volts at maximum load . ——
Rating in ampères at maximum load ——
Direct or alternating current . . ——
Constant or varying current . . ——
Constant or varying potential . ——
Series, shunt, compound, self or separately excited . . . . ——
Rating of exciter in volts . . ——
Rating of exciter in ampères . . ——
Trade number or designation . ——
Regulation by hand or automatic . ——
Number of fully loaded circuits possible to operate per dynamo . ——
Make of lamp recommended for use . ——
Number of —— c. p. lamps of above make per circuit . . . ——
Volts per —— c. p. lamp . . . ——
Ampères per —— c. p. lamp . . ——
H. P. required to be delivered at the pulley at full load with no loss in the feeders but including exciter . ——

(See p. 48, sec. 28.) 40. Switchboard.

There shall be placed upon this switchboard, in addition to all the dynamo regulating apparatus, such switches, cut-outs, and other appliances as are necessary for the 41. Switchboard Apparatus and Connections.

proper and convenient manipulation of the circuits, such appliances to be named by each bidder in his proposal. For systems operating dynamos and circuits in parallel, the appliances and connections shall be such as will permit adding to or taking from the circuit any dynamo without in any manner affecting the operation of the remaining dynamos in circuit or the candle power of the lamps, and will permit the cutting in or out of any circuit without affecting the stability of other circuits. For systems operating one dynamo for each circuit or series of circuits the connections shall be such as will permit any circuit to be connected to or disconnected from any dynamo with certainty and rapidity. (For switchboard connections see secs. 30 and 31, p. 50).

42. Circuits. (See p. 51, sec. 32.)

Constant Potential, Alternating Current System.

This contractor shall furnish, and, unless otherwise specified, erect the following apparatus and material:

43. Dynamo(s). ——— constant potential, alternating current dynamo(s) (each) having a capacity of ——, —— c. p., —— volt incandescent lamps.

The maximum voltage at the terminals of the dynamo(s) shall not exceed —— volts.

The dynamo(s) shall be of the latest and most efficient pattern; mounted on a base provided with an adjustable belt tightener, so that the belt may be tightened while in operation; capable of operating under full load for —— consecutive hours without increasing the temperature of any part, especially the armature, fields, and commutator, to such a degree as to endanger the insulation or decrease the efficiency of operation; shall have an insulation resistance of not less than —— ohms between all parts insulated from each other; shall be adapted to operate at such speed as will allow the use of high-speed, automatic cut-off engines belted direct; shall be supplied with efficient oiling devices; the armature shall be balanced both electrically and mechanically so that there will be no tendency to spring the shaft, or to draw the armature toward either bearing so as to cause excessive friction and heating, and no vibration; all contacts, brushes, binding posts, etc., shall be so placed and protected that there is the least possible danger of receiving a shock; special attention shall be given to the proper securing of armature conductors to its surface; the dynamo(s) shall be so designed that the power required will be automatically proportioned to the number and the candle power of the lamps burning at any time, and shall be rated with such margin of

safety that { they / it } will not be injured if subjected to a temporary overload of —— per cent. above such rating; if self-exciting, the coils furnishing the exciting current, and the commutator shall be so insulated and protected that it will be impossible under the ordinary conditions of operation to ground or cross them on themselves or on the armature circuit; if separately excited the exciting dynamo(s) also shall be subject to the general conditions given above, shall operate at a potential not exceeding —— volts, shall be of ample capacity to excite the fields of —— dynamo(s) (each) having a capacity of ——, —— c. p. incandescent lamps, and shall operate with no appreciable sparking at the brushes.

41. Foundations. (See p. 54, sec. 34.)

45. Instruments. (See Note: p. 45, sec. 23.)

There shall be provided with each dynamo one ampère meter for indicating the current supplied by the dynamo; one voltmeter or pressure indicator which shall remain constantly in circuit so as to indicate continuously the pressure on the primary mains at the point to which it is connected, and shall be so constructed that the scale is plainly visible at a distance of at least ——; one insulating base-frame provided with rails and a suitable device for shifting the position of the dynamo

to alter the belt tension; one ground detector which shall continuously indicate the insulation maintained on both sides throughout the system; one pair of efficient lightning arresters; for the field-exciting circuit one hand regulator made entirely of incombustible material, one voltmeter, one brush jig, one double-pole knife switch mounted on an incombustible base, one double-pole fusible cut-out mounted on an incombustible base; if the fields are separately excited there shall be provided with the exciting dynamo one insulating baseframe as above, one endless belt, and also, if it excites the fields of more than one dynamo, one hand regulator for the field circuit of the exciting dynamo, one hand regulator for each of the field circuits of the excited dynamos, and one double-pole knife switch and double-pole fusible cut-out for each of the above field circuits, including that of the exciting dynamo unless lights are operated therefrom, in which case a switch and cut-out shall be placed in the main circuit before branching off to the various dynamos.

46. Converters.

There shall be provided the following numbers and sizes of converters:

Number.	Size.
———	—— lt.
etc.	etc.

Each converter shall reduce the voltage on the primary circuit to —— volts on the secondary circuit; shall have its capacity plainly

marked upon it; shall be provided with fuses on both the primary and secondary circuits; and shall be so arranged that when replacing fuses or otherwise working about the converter both the primary and secondary circuits may be opened.

47. Cables to Switchboard. (See p. 56, sec. 36.)

48. Starting Plant and Instruction. (See p. 46, sec. 25.)

49. Renewal Parts. (See p. 47, sec. 26.)

50. Summary. (See Note: p. 47, sec. 27.)

Each bidder shall fill out completely the following summary:

Number of alternators . . . ———
Trade number or designation . . ———
Number of exciters . . . . ———
Trade number or designation . ———
Rating of alternators in volts . . ———
Rating of alternators in ampères . ———
Rating of exciters in volts . . . ———
Rating of exciters in ampères . ———
Self or separately excited . . . ———
Reduction recommended in converters ———
Make of lamps recommended for use ———
Dynamo capacity in —— c. p. lamps of above make . . . . ———
H. P. required to be delivered at the pulley at full load with no loss in the feeders but including exciter . ———

(See p. 48, sec. 28.)

51. Switchboard.

52. Switchboard Apparatus and Connections.

There shall be placed upon this switchboard, in addition to the dynamo regulating apparatus, such switches, cut-outs, and other appliances as are necessary for the proper and convenient manipulation of the circuits, such appliances to be named by each bidder in his proposal.

The appliances and connections shall be such as will permit the operation of any dynamo on any circuit or number of circuits, and the cutting in or out of any dynamo or circuit with certainty and rapidity without in any manner affecting the operation of other dynamos or circuits. They shall also be arranged in such manner as to render it impossible to connect two dynamos together by any arrangement of switches or combination of circuits. (For switchboard connections see secs. 30 and 31, p. 50.)

(See p. 51, sec. 32.)

53. Circuits.

Alternating Current or Direct Current System, with the Parallel System of Distribution.

This contractor shall furnish, and, unless otherwise specified, erect the following apparatus and material:

54. Dynamo(s). A dynamo capacity of, as nearly as possible, ——, —— c. p. incandescent lamps. (The number of dynamos shall not be less than ——, nor more than ——.)

The dynamo(s) shall be of the latest and most efficient pattern; shall be mounted upon a base provided with an adjustable belt tightener so that the belt may be tightened while in operation; capable of operating under full load for —— consecutive hours without increasing the temperature of any part, especially the armature, fields, and commutator, to such a degree as to endanger the insulation or decrease the efficiency of operation; shall not spark appreciably with proper care of the commutator and adjustment of the brushes, nor under considerable variation of the load; shall have an insulation resistance of not less than —— ohms between all parts insulated from each other; shall be adapted to operate at such speed as will allow the use of high-speed, automatic cut-off engines belted direct; shall be provided with efficient oiling devices; the armature shall be balanced electrically and mechanically so that there will be no tendency to spring the shaft, or to draw the armature toward either bearing so as to cause excessive friction and heating, and no vibration; all contacts, binding posts, brushes, etc., having considerable differences of potential between them shall be so placed and protected that the danger of receiving a shock is the least possible; arma-

ture conductors shall be so securely attached to the surface of the armature as to preclude any possibility of their being dragged from their proper position under normal conditions of operation; all coils, connections, commutators, brushes, etc., belonging to different circuits shall be so insulated and protected that it will be impossible under the ordinary conditions of operation to cross or ground them; the dynamo(s) shall be so designed that the power required will be automatically proportioned to the number and candle power of the lamps burning at any time; and shall be rated with such margin of safety that {they / it} will not be injured if subjected to a temporary overload of —— per cent. above {their / its} normal rating; if (an)auxiliary dynamo(s) {are / is} required for the operation of the dynamo(s) specified above {they / it} shall be subject to the same conditions.

(See Note: p. 44, sec. 22.)

55. Foundations.

The foundation(s) for the(se) dynamo(s) shall be built by the {contractor / purchaser} of ——, laid ——, or of other material subject to the approval of the {engineer, / architect,} and shall be of sufficient length, width, and depth to safely

and firmly sustain {their / its} weight.

For dynamos operating at voltages below —— the baseframe may be firmly and securely fastened directly on the foundation. For dynamos operating at voltages above —— the foundation shall be capped with a framing of well seasoned timber securely fastened thereto, the baseframe being securely fastened to the framing or to the foundation through the framing; both framing and baseframe being secured in such a manner as to prevent lateral motion in either direction, and to give an even bearing surface at every point.

If metal is used to fasten framing or baseframe to the foundation it shall be thoroughly insulated where it passes through them, and at all places liable to come in contact with the dynamo shall be countersunk and covered with a moisture-proof insulating compound.

All necessary excavating and filling, and the removal of all débris shall be done by the {contractor. / purchaser.} The height of the dynamo baseframe(s) above the ground will be ——.

56. Instruments.

(See Note: p. 45, sec. 23.)

There shall be provided with each dynamo one hand regulator for adjusting the pressure, made entirely of incombustible material; one ampère meter for indicating the current supplied by the dynamo; one voltmeter or pres-

sure indicator, which shall remain constantly in circuit so as to indicate continuously the pressure at the point to which it is connected, and shall be so constructed that the scale is plainly visible at a distance of at least ——; one insulating baseframe provided with rails and a suitable device for shifting the position of the dynamo to alter the belt tension; there shall be provided for the installation one ground detector, or if the circuits have no common junction one ground detector for each circuit, which shall continuously indicate the insulation from the ground maintained on both sides throughout the system, and one pair of efficient lightning arresters for the common circuits, or for each circuit if they are kept separate; there shall also be provided such brush jigs, switches, cut-outs, belts and other appliances as are requisite and proper in the operation of the system and would be found in a correct installation; switches and cut-outs to be double pole and mounted on incombustible bases; belts to be endless and capable of transmitting the power required safely and efficiently.

57. Converters.

For alternating systems there shall be provided the following numbers and sizes of converters:

Number.	Sizes.
———	——— lt.
etc.	etc.

58. Cables to Switchboard.

(See Note: p. 45, sec. 24.)

This contractor shall carry to the switchboard location at —— all regulator, exciter, auxiliary, and main wires, leaving the ends coiled up neatly, properly tagged, and sufficiently long to make the necessary switchboard connections. All main wires shall have a capacity of at least —— C. M. per ampère, and no wire smaller than —— B. & S. or —— B. W. G. shall be used. All regulator, exciter. and for systems carrying over —— volts all auxiliary and main wires, shall be insulated with ——; all wires of systems carrying over —— volts shall be run ——; where of opposite polarity shall be separated at least ——; and where crossing each other, wires of other circuits or passing near metal pipes, girders, etc., shall be further protected by ——.

For systems carrying less than —— volts the main wires shall be of

{ bare copper wire supported on porcelain insulators.

—— insulated wire { carefully cleated to the ceiling, carried on porcelain insulators, concealed in a molding consisting of a backing —— thick and a capping —— thick

wires of opposite polarity being separated not less than ——.

In no case shall insulated wires be carried in such proximity to heated surfaces, vapors, or air as to endanger their insulation.

(See p. 46, sec. 25.) 59. Starting Plant and Instruction.

(See p. 47, sec. 26.) 60. Renewal Parts.

(See Note: p. 47, sec. 27.) 61. Summary.

Each bidder shall fill out completely, so far as it pertains to his apparatus, the following summary:

Number of direct-current dynamos . ———
Trade number or designation . . ———
Number of alternate-current dynamos ———
Trade number or designation . . ———
Number of exciter dynamos . . ———
Trade number or designation . . ———
Rating of dynamos in volts . . ———
Rating of dynamos in ampères . . ———
Rating of exciters in volts . . ———
Rating of exciters in ampères . . ———
Self or separately excited . . ———
Shunt or compound . . . . ———
Reduction recommended in converters ———
Make of lamp recommended for use . ———
Dynamo capacity in —— c. p. lamps of the above make . . . ———
H. P. required to be delivered at pulley at full load with no loss in the feeders but including exciter . . ———

(See p. 48, sec. 28.) 62. Switchboard.

63. Switchboard Apparatus and Connections.

There shall be placed upon this switchboard, in addition to all the dynamo regulat-

ing apparatus, such switches, cut-outs, and other appliances as are necessary for the proper and convenient manipulation of the circuits, such appliances to be named by each bidder in his proposal.

For the two-wire, direct-current system the appliances and connections shall be such as will permit any dynamo to be added to or taken from parallel circuit without in any manner affecting the operation of the remaining dynamos in circuit, or the candle power and steadiness of the lamps.

For the three-wire, direct-current system the appliances and connections shall be such as will permit any dynamo on either side to be added to or taken from parallel circuit without in any manner affecting the operation of the remaining dynamos in circuit on that side, or the candle power and steadiness of the lamps; and a breakdown switch for connecting the two outside wires in case it shall become necessary or desirable to operate on the two-wire system.

For the alternating-current system the appliances and connections shall be such as will permit the operation of any dynamo on any circuit or number of circuits, and the cutting in or out of any dynamo or circuit with certainty and rapidity, without in any manner affecting the operation of other dynamos or circuits, and such that it will be impossible to connect two dynamos together by any arrangement of switches or combination of

circuits. (For switchboard connections see secs. 30 and 31, p. 50.)

(See p. 51, sec. 32.) 64. Circuits.

Arc Series System, Direct Current.

This contractor shall furnish, and, unless otherwise specified, install the following apparatus and material:

——— arc light dynamo(s) (each) having a capacity of ——, —— c. p., —— ampère, —— volt arc lamps. 65. Dynamo(s).

Each dynamo shall be provided with a regulator which shall automatically make the proper adjustments for all changes of load from no load to full load, the adjustments to be made in such a way as not to endanger any part of the dynamo, appliances or lamps, nor to cause any perceptible change in the balance remaining in operation; shall be of the latest and most efficient pattern; mounted on a base provided with an adjustable belt-tightener, so that the belt may be tightened while in operation; capable of operating under full load for —— consecutive hours without increasing the temperature of any part, especially the armature, fields, and commutator, to such a degree as to endanger the insulation or decrease the efficiency of operation; shall have an insulation resistance of

not less than —— ohms between all parts insulated from each other; shall be adapted to operate at such speed as will allow the use of high-speed, automatic-cut-off engines belted direct; shall be provided with efficient oiling devices; the armature shall be balanced both electrically and magnetically, so that there will be no tendency to spring the shaft, or to draw the armature toward either bearing so as to cause excessive friction and heating, and no vibration; especial attention shall be given the insulation, protection, and separation of contacts, binding posts, and bared surfaces having extreme differences of potential, in order to minimize the danger of accidental shocks, crosses, or grounds under normal conditions of operation; the dynamo(s) shall be so designed and automatically regulated that the power will be automatically proportioned to the number and candle power of the lamps burning at any time.

66. Foundations. (See p. 54, sec. 34.)

67. Instruments. (See Note: p. 45, sec. 23.)

There shall be provided with each dynamo, in addition to the automatic regulator required above, one ampère meter for indicating the current supplied by the dynamo and graduated to read ampères; one brush jig for trimming the brushes; one insulating base-frame, provided with rails and a suitable device for shifting the position of the dynamo

to alter the belt tension; one main switch; one pair of efficient lightning arresters; and for the general installation one testing magneto capable of ringing through —— ohms.

(See p. 56, sec. 36.)

68. Cables to Switchboard.

69. Arc Lamps.

There shall be provided ——— { single carbon / double carbon / triple carbon / single mechanism 7-hour / single mechanism 14-hour } arc lamps of —— nominal candle power. Each lamp shall be provided with a switch by which it may be cut in or out of circuit; shall be regular in its feeding action; shall be free from hissing, flickering, or flaming when provided with proper carbons; shall contain an efficient device which shall automatically cut out a lamp for any reason defective, without interfering with the operation of the remaining lamps in circuit; and shall be simple, strong, and durable in its mechanical construction.

70. Hanger Boards.

——— hanger boards for inside use, each hanger board to contain a switch by which the lamp may be cut entirely out of circuit.

71. Hoods.

——— waterproof hoods, complete with { hanger boards for outside use / out-rigger attachments / cross-suspension attachments. }

72. Globes. —— { clear glass / full ground / half ground / opal / colored, etc. } globes.

73. Spark Arresters and Nets. —— wire-gauze spark arresters, and —— wire globe-nets.

74. Carbons. —— sets of carbons, a set consisting of one upper and one lower carbon.

75. Starting Plant and Instruction. (See p. 46, sec. 25.)

76. Renewal Parts. (See p. 47, sec. 26.)

77. Summary. (See Note: p. 47, sec. 27.)

Each bidder shall fill out completely the following summary:

Number of dynamos . . . ——
Trade number or designation . . ——
Rating in volts . . . . . ——
Rating in ampères . . . . . ——
Capacity in —— c. p. lamps . . ——
Series or shunt wound . . . ——
H. P. required to be delivered at pulley at full load with no loss in the line ——

SWITCHBOARD, APPARATUS, AND CONNECTIONS.

This contractor shall furnish and erect the following apparatus and material:

78. Switchboard Complete. One combination (material) switchboard with a capacity for —— circuits, and provided with the necessary sockets, plugs, main and

transfer cables, testing connections, and a suitable and convenient device for holding cables not in use. It shall be so arranged and marked that any circuit or series of circuits may be quickly connected with or disconnected from any dynamo with the least possible danger of short-circuits or error. Sockets shall be so designed that it is practically impossible to short-circuit, ground, or receive a shock from them. All connections with the dynamo leads shall be easily accessible. All wires used in making connections shall have —— insulation. All plugs shall have well insulated wooden handles, and the cables shall be covered with soft-rubber tubing or equivalent as an extra precaution. All cables shall be of stranded wire.

All joints shall be soldered. All connections to switches, cut-outs, etc., shall be soldered or made with an approved form of lug or set-screw, in all cases care being taken to secure good and sufficient contact to prevent heating and insure permanency; when made with lugs or set-screws they shall be in plain sight and easily accessible for tightening. Connecting wires shall be so run and secured that crosses or grounds are impossible in the normal operation of the plant.

FIXTURES, ETC.

79. Fixtures and Shades.

(Note.—No set specification can be made for fixtures and shades; their character must be

determined wholly from individual requirements. See schedule, p. 107.)

80. Lamps. This contractor shall furnish and deliver at —— the following number, sizes, and kinds of incandescent lamps:

Number.	C. p.	Voltage. Ampèrage.	Plain. Frosted. Colored, etc.
etc.	etc.	etc.	etc.

stating, also, their make and the make of the socket for which they are adapted.

Lamps shall be guaranteed to have an average life of not less than —— hours if burned at their normal voltage. They shall burn with a white light, and shall not blacken under proper use. All lamps giving out or proving defective during the trial period of —— days under normal and proper use shall be replaced without charge.

81. Sockets and Receptacles. This contractor shall furnish and deliver at —— the following numbers and kinds of sockets and receptacles:

Number.	Kind.	Finish.
etc.	etc.	etc.

82. Meters. This contractor shall furnish and { deliver at —— / place in position } the following numbers and sizes of the —— { watt meter, / recording ampère meter, / current counter,

Number.	Capacity in ampères.	Two or three-wire.
etc.	etc.	etc.

INTERIOR WIRING.

Alternating or Direct Current, Two-Wire System.

83. Outlets and Lights. The building shall be wired to —— lamp outlets, —— switch outlets, (and —— meter outlets) for the equivalent of ——, ——c. p., —— volt lamps. The wiring shall be (to outlets only) (except for cut-outs and switches; cut-outs and switches shall be furnished and installed complete). At each outlet the loose wire shall be neatly coiled and the ends carefully taped.

84. System. All wiring shall be for the parallel, two-wire system of distribution.

85. Variation in Pressure. The fall of potential between the switchboard (centre of distribution) and the (farthest lamp) shall not exceed at —— load —— per cent. of the initial pressure; this difference to be divided as follows: $\left\{\begin{matrix}\text{risers}\\\text{feeders}\end{matrix}\right\}$ —— per cent., mains —— per cent., taps —— per cent.

86. Insulation. All wire used throughout the installation shall be insulated with ——.

87. Insulation Resistance.

Each {riser, / feeder,} main, and tap shall test out with an insulation resistance of at least —— ohms. The entire installation shall test out with an insulation resistance of at least —— ohms divided by the sum of the number of separate {risers, / feeders,} mains, and taps.

88. Subdivision of {Risers / Feeders}.

From the switchboard (or centre of distribution) —— {risers, / groups of risers, / feeders,} shall be carried to the following points: {Riser / Group / Feeder} No. 1 to ——, {riser / group / feeder} No. 2 to ——, etc.

{Riser / Group / Feeder} No. 1 shall feed all lights (location),

{riser / group / feeder} No. 2 shall feed, etc.

89. Location of {Risers / Feeders}.

From the switchboard (or centre of distribution) the {risers / feeders} shall be carried {under cleats, / on insulators, / in molding, etc.,} to ——, and thence upward in (channels, wooden conduits, elevator shaft, air shaft, etc., with location) to their respective cut-out boxes.

90. Mains (If taps terminate in secondary distribution boxes).

From the {riser / feeder} cut-out boxes mains shall be carried {under cleats, / on insulators, / in molding, etc.,} to secondary cut-out boxes where all tap lines shall centre. From {riser / feeder} No. 1 shall be carried —— mains terminating at ——; from {riser / feeder} No. 2, etc.

91. Taps.

(Note.—In certain cases it is advisable to run the circuits in such a manner that no room shall be dependent on one circuit only; if so desired it should be added under this heading.)

From the {riser / feeder / main} cut-out boxes distributing circuits shall be run to the various outlets as specified in the schedule and located on the plans. The wires shall be run {under cleats, / on insulators, / in molding, / concealed under plaster, / concealed in walls and ceilings,} in such a manner that the highest possible insulation shall be maintained under all circumstances.

Except in case of single outlets for a group of lamps and circuits specifically mentioned no distributing circuit shall carry over ——

ampères. Distributing circuits shall be of one size of wire throughout their entire length.

92. Joints. Throughout the installation joints shall be avoided where possible; where absolutely necessary they must be made mechanically strong and secure, carefully soldered, wiped free from any moisture and excess of flux and so taped and compounded that the insulation of the joints shall be equal to the original insulation; the solder shall be relied on only to give a good electrical connection.

93. Cut Out and Switch Cabinets. (Note.—A complete description of the cabinets should be given covering material, doors, hinges, locks, finish, etc.; also stating what parts, if any, will be furnished by other contractors, specifying what switches are to be placed in the cabinets, and locating and describing cabinets for switches alone if such are to be provided; if name plates are to be furnished so specify and describe.)

The terminals of all { risers, / feeders, } mains, and taps shall be brought together in cabinets at the points designated in this specification and on the plans. (If wiring contractor does not furnish cut-outs and switches, add: the terminals of the { risers, / feeders, } mains and taps shall be brought into these cabinets in such a way as to permit the easy and con-

venient insertion and connection of the cut-outs and switches specified.)

94. Cut-Outs. A cut-out shall be provided for each branch circuit. All cut-outs shall be double-pole, mounted on incombustible bases, and with connections of such size and shape as to afford ample contact surface for both conductors and fuses.

95. Fuses. No fuses shall be put in the cut-outs except by special order, but a complete supply, consisting of not less than —— sets for each cut-out, shall be provided. These fuses shall be of the plug type or furnished with metal tips, and shall have their capacity plainly marked upon them.

96. Switches. For the number and capacity of switches see the attached schedule.

All switches shall be double-pole, mounted on incombustible bases, with automatic make and break, the switch being merely set at the point of making and breaking by the operator, and with sliding contacts. The capacity of each switch shall be plainly marked upon it and shall not be less than —— per —— c. p. lamp controlled.

All switches located on brick or stone walls shall be mounted on wooden blocks of suitable size secured to the wall in such a manner that they shall not become loosened with the continued use of the switch.

97. Fixture Supports. Where no fixture support is provided, this contractor shall furnish for all {side / ceiling} outlets a suitable support consisting of {a wooden block firmly fastened to the wall flush with the plaster, and of sufficient dimensions to securely hold the fixture. / A piece of gas-pipe securely anchored by means of an iron plate —— thick and —— square set into the {wall, / ceiling,} the end of the gas pipe to extend —— beyond the surface of the plaster.}
(Specify approximate number required.)

98. Meter Outlets. At the places located in the schedule and on the plans, meter outlets shall be run (and a support for each meter provided consisting of —— securely fastened to the wall).

99. Elevator Lights. Each elevator is to be provided with ——, —— c. p. lamp(s). Each elevator shall be on its own cut-out and circuit, which shall be run from the distribution box at (location). The wiring shall include the wiring of the elevator car, all necessary cables, and the connection with its outlet. The cables shall be well insulated, flexible, and properly protected from abrasion.

100. Molding. The molding used in the places specified above shall be of ——, and finished ——.

On all outside walls, bare brick or stone walls, etc., it shall consist of a backing and capping.

101. Additions and Deductions.

While the schedule is intended to represent very closely the number of lights and outlets to be wired to, yet, as some changes may become necessary during the process of construction, each bidder shall name in his proposal a price to be added to or deducted from the contract price for each light or outlet wired for in excess of the number specified, or which shall be cancelled, provided such addition or cancellation involves no change in the work already completed, and shall be along the lines of existing circuits.

102. Instruction.

(Note.—It may be desirable that the purchaser furnish one man to work under the contractor, in order that he may have a man thoroughly familiar with all the details of the construction; the contractor to give such instruction as will enable him to acquire a thorough and intelligent knowledge of methods, appliances, location of circuits, etc.)

103. Hanging of Fixtures.

(Note.—To be inserted if this contractor is to complete the wiring, including the attachment of lamps and sockets).

This contractor shall hang all fixtures, including the assembling and wiring of the fixtures (unless provided for under Fixtures), the attaching of sockets, lamps, and shades, and the connection with the ends of the taps.

Insulating joints will be furnished, where required, by the fixture contractor, but this contractor shall furnish and connect a suita-

ble cut-out for each outlet, protecting both sides of the circuit.

104. Wiring and Attaching Sockets to Fixtures Already in Place.

This contractor shall attach —— sockets by means of a (suitable gas attachment) to the (gas) fixtures already in place. These fixtures shall be properly insulated, and shall be wired in the following manner: —— ——, with ——. At each outlet a suitable cut-out shall be provided, protecting both sides of the circuit. In each socket shall be placed the proper lamp, and all shades shall be attached.

105. Suspension of Sockets and Lamps.

Sockets and lamps shall be suspended by means of —— pendants from the ceiling. Each pendant to be —— in length (provided with a cord adjuster) and protected by a double-pole ceiling cut-out. Both at the cut-out and in the socket the cord shall be knotted so that in no case will the weight come on the binding screws. Where the cord passes through the neck of the socket it shall be protected by a —— bushing. In each socket shall be placed the proper lamp, and all shades shall be attached.

Three-Wire System.

This specification is identical with the two-wire specification, except in "System," p. 77, sec. 84, in place of which insert the following:

106. System.

All { risers / feeders } and mains shall be figured on the basis of the three-wire system, but the distribution circuits shall consist of two wires only except to outlets for a group of ——, —— c. p., lamps or more, and for special circuits specifically mentioned. Care shall be taken in arranging the distribution circuits to have the same number of lamps on each side of the system, and that no circuit shall be connected across the outside wires. The neutral wire shall in all cases be properly tagged and shall be run between the outside wires.

Three-Wire System Adapted to the Two-Wire System.

This specification is identical with the two-wire specification, except in "System," p. 77, sec. 84, in place of which insert the following:

107. System.

All { risers / feeders } and mains shall consist of three wires, but the neutral wire shall consist of two wires, each equal in cross-section to the outside wires, or of one wire equal in cross-section to the outside wires combined, in order that if desired all lights may be operated on the two-wire system; if two neutral wires are run they shall be permanently connected at each cut-out box. All distribution circuits shall consist of two wires only except to outlets for a group of ——, ——c. p.,

lamps or more, and for special circuits specifically mentioned. In all three-wire distribution circuits the neutral shall be equal in cross-section to the two outside wires combined. Care shall be taken in arranging the distribution circuits to have the same number of lamps on each side of the system and that no circuit shall be connected across the outside wires or between the neutral wires. The neutral shall in all cases be properly tagged and shall be run between the outside wires.

Arc System.

108. Circuits. The lights shall be divided into the following circuits:
Circuit No. 1 (Number of lights and location.)
" No. 2 (" " "),
etc.

109. Insulation of Wire. All wire used in the installation shall be insulated with —— for inside circuits, and with —— for outside circuits.

110. Insulation Resistance. Each circuit shall test out with an insulation resistance of at least —— ohms.

111. Joints. See p. 80, sec. 92.

112. Method of Wiring. All interior wires shall be run { on insulators / in conduits } in such a manner that the

highest possible insulation is obtained. All wiring shall be neat in its mechanical appearance and arrangement. All exterior wires shall be run ——.

113. Suspension of Lamps.

In the interior of (the) building(s) the lamps specified shall be suspended from —— securely fastened to the ceiling (and provided with a suitable device for raising and lowering). On the exterior of (the) building(s) the lamps specified shall be suspended from ——, securely attached to ——, (and provided with a suitable device for raising and lowering).

(Add details concerning any posts, pole-steps, ornamental treatment desired, etc.)

Conduit System. Two-Wire.

114. Method of Wiring.

No wires shall be run in contact with any part of the building material, but the building shall be equipped from the source of supply to each outlet with the insulating conduits of —— in such manner as to provide continuous channels or raceways for the wires. The continuity of each tube employed for this purpose shall be such as would be required if it were to be used for conveying water or gas. Strict compliance with this requirement will be demanded.

115. Accessibility.

In order that every wire may be at all times accessible for inspection, repairs, or renewals

without injury to the building, the location, sectional division, joining, intermediate and terminal elbowing, the placing of switches, cut-outs, and junction boxes, and the final emergence of the tube beyond the finished surface at the fixture outlet shall be done in strict compliance with this specification.

116. Appliances. All appliances employed shall be such as are especially adapted for use in conjunction with the conduit system.

117. Placing of Conduits. All conduits shall be placed in position {before / after} the plastering is done, and shall be firmly secured {to / within} walls and ceilings.

118. Outlets and Lights. (See p. 77, sec. 83.)

119. System. (See p. 77, sec. 84.)

120. Variation in Pressure. (See p. 77, sec. 85.)

121. Insulation. All single conductors shall be insulated with ——. All duplex conductors shall be insulated with ——. Duplex conductors and all single conductors larger than —— {B. & S. / B. W. G.} shall be stranded.

122. Insulation Resistance. (See p. 78, sec. 87.)

123. Subdivision of {Risers / Feeders}.

From the switchboard (or centre of distribution) —— {risers / groups of risers / feeders} shall be carried to the following points: {Riser / Group / Feeder} No. 1 to ——, {riser / group / feeder} No. 2 to ——, etc.

Every conductor in each {riser / group of risers / feeder} and main shall be provided with an independent tube.

{Riser / Group / Feeder} No. 1 shall feed all lights (location), {riser / group / feeder} No. 2 shall feed, etc.

124. Location of {Risers / Feeders}.

From the {switchboard / centre of distribution} the {risers / feeders} shall be carried to —— and thence upward in (channels, elevator shaft, etc., with location) to their respective junction boxes.

125. Mains (If taps terminate in secondary junction boxes).

From the {riser / feeder} junction boxes mains shall be carried to secondary junction boxes where all tap lines shall centre. From

{riser / feeder} No. 1 shall be carried —— mains terminating at ——; from {riser / feeder} No. 2, etc.

126. Taps. (Note.—In certain cases it is advisable to run the circuits in such a manner that no room shall be dependent on one circuit only; if so desired, it should be added under this heading.)

From the {riser / feeder / main} junction boxes distributing circuits shall be run to the various outlets as specified in the schedule and located on the plans. For all taps duplex conductor requiring but one tube may be employed provided the current required does not exceed —— ampères.

127. Junction Boxes. The terminals of all the {risers, / feeders,} mains and taps shall be brought together in junction boxes at the points designated in this specification and on the plans, [and connected with their respective cut-outs and switches; (unless the wiring contractor does not furnish cut-outs and switches, in which case add: in such a way as to permit the easy and convenient insertion of the cut-outs and switches specified.)].

128. Cut-Outs. (See p. 81, sec. 94.)

(See p. 81, sec. 95.) 129. Fuses.

(See p. 81, sec. 96.) 130. Switches.

Where no gas pipes or other support for the fixture exists, the special form of terminal box designed to furnish such support shall be employed and shall be substantially fixed to a suitable foundation in the ceiling or wall. 131. Fixture Supports.

All tubes shall be of sufficient size to allow the wires to be readily drawn in, withdrawn and reinserted at will. A quarter-inch tube will be permitted only where space is extremely limited. 132. Sizes of Tubes.

Tubes, whether concealed or on the surface, should be held in place by metal clips; the use of staples for such purpose will not be allowed where it can be avoided. 133. Clips.

The tubes shall be cut squarely, reamed out smoothly, and the ends joined by the use of the coupling designed for that purpose. 134. Joints.

Where more than four elbows are unavoidable an intersection box shall be inserted to relieve both the wires and the tubes of strain when the wires are being drawn in. 135. Elbow Limitations.

All tubes shall emerge at outlets in terminal boxes, leaving the outlets so protected as not to be injured by the plasterers. 136. Outlets.

137. Floor Work. To guard against mechanical injury and the destructive action of cement, all floor conduits shall be made of double tube, one telescoped within the other, and both the outer and inner tubes joined in the usual manner. The outer tube shall, in the case of contact with cement, be alkali proof. As a further protection, floor tubes shall be covered during construction with a light board. Such other precautions shall be taken to insure the safety of the tubes as the character of the building and work require.

138. Separation of Wires. Each side of circuits carrying more than —— ampères shall be run in a separate tube. Wires forming parts of two distinct circuits shall in no case be inclosed in the same tube.

139. Meter Outlets. (See p. 82, sec. 98.)

140. Elevator Lights. (See p. 82, sec. 99.)

141. Additions and Deductions. (See p. 83, sec. 101.)

142 Instruction. (See p. 83, sec. 102.)

143. Hanging of Fixtures. (See p. 83, sec. 103.)

144. Wiring and Attaching Sockets to Fixtures Already in Place. (See p. 84, sec. 104.)

145. Suspension of Sockets and Lamps. (See p. 84, sec. 105.)

146. Three-Wire System. (See p. 85, sec. 106.)

(See p. 85, sec. 107.)

147. Three-Wire System Adapted to the Two-Wire System.

Interior Wiring for Central Station Plants.

This specification contemplates the complete installation of ——, —— c. p., incandescent lamps located in blocks as designated on the plans hereto attached and made a part of this specification. 148. Number of Lights.

(See p. 75, sec. 79.) 149. Fixtures.

(See p. 76, sec. 80.) 150. Lamps.

(See p. 76, sec. 81.) 151. Sockets.

(Note.—Specify whether bids for two-wire direct-current systems only, for three-wire direct-current, for two-wire alternating current, or for any system will be considered.) 152 System.

The fall of potential between the service cut-out and the most distant lamp in any building shall not exceed —— per cent. 153. Variation in Pressure.

All wires used inside of buildings shall be insulated with ——. 154. Insulation.

All wiring shall be { open cleat / molding / concealed } work, 155. Character of the Work. neat in its mechanical appearance and arrangement.

156. Circuits. No distributing circuit shall carry more than —— ampères. In buildings requiring a greater supply of current the lights shall be divided into circuits; these circuits shall be brought together at convenient and accessible centres of distribution, where all branch cut-outs shall be placed.

157. Cut-Outs and Switches. Each branch circuit shall be provided with a double-pole cut-out. The switches specified below shall be furnished and installed. All cut-outs and switches shall be mounted on incombustible bases.

(List of numbers and sizes of switches.)

158. Meters. (See p. 76, sec. 82.)

159. Suspension of Lamps. (All) lamps shall be suspended with flexible cord pendants from double-pole ceiling cut-outs, the average length of the pendants to be ——. This contractor is to furnish all necessary —— cord, ceiling cut-outs, and socket bushings. In both cut-outs and sockets the cord shall be knotted so that no weight shall come on the binding screws.

160. Molding. (See p. 82, sec. 100.)

161. Additions and Deductions. (See p. 83, sec. 101.)

162. Instruction. (See p. 83, sec. 102.)

(See p. 83, sec. 103.)
(May require slight modification.)

163. Hanging of Fixtures.

(See p. 84, sec. 104.)
(May require slight modification.)

164. Wiring and Attaching Sockets to Fixtures Already in Place.

POLE LINES.

Low Potential—Direct Current System—Two or Three-Wire.

(The purchaser) shall secure all franchises, rights of way, and permits from the —— authorities and abutting property owners for the erection and guying of poles and stringing of wires along the routes on the map hereto attached and made a part of this specification, shall make all necessary arrangements with companies already having pole lines on any part of the same route for crossing, raising, lowering, or otherwise moving their wires, and for using, moving, or changing their poles, cross-arms, etc.; shall do all necessary trimming of trees; and in every reasonable way shall secure and furnish facilities for the uninterrupted continuance of the work to its completion.

165. Franchises and Permits.

The lights shall be supplied by circuits divided as follows: —— ——, etc.

166. Division of Circuits.

All circuits shall be controlled by switches placed (location.)

167. Point of Control.

168 Poles. The pole line shall be composed of straight, select, shaved —— poles, sound and free from shakes, checks or large knots; poles subject to extra strain shall be specially selected and of ample strength to bear the strain.

169. Setting and Guying. All poles must be set —— of their length in the ground and solidly tamped, must measure not less than —— in diameter at the top, and the distance from the ground line to the lowest cross-arm shall be not less than ——. Corner, terminal, and other poles subject to extra strain shall be securely guyed wherever possible; where impossible to guy them they shall be set with such rake and to such extra depth that the strain shall not pull them beyond the vertical position, allowance being made for the action of water and frost.

170. Distances. No two consecutive poles shall be set at a greater distance apart than ——, except by special permission from ——, and all poles carrying heavy feeders or mains shall be set not more than —— apart.

171. Painting. (As desired.)

172. Gains and Cross-Arms. Gains shall be carefully cut so that the cross-arms make a snug fit and stand at right angles to the pole.

Cross-arms shall be of ——, thoroughly seasoned, sound and free from large knots; painted ——; the vertical distance between

cross-arms shall not be less than ——. Double cross-arms must be placed on terminal poles and corner poles carrying wires larger than —— { B. & S. / B.W.G. } At all corners making an angle greater than —— two sets of cross-arms shall be used placed at the proper angle to each other.

Pins shall be of selected ——, shall fit closely in the cross-arms and be nailed in place. 173. Pins and Insulators.

Insulators shall be of glass, —— pattern, and of a size suitable for the wire they are to hold.

All poles on which cut-outs are placed shall be stepped. 174. Steps.

(Note.—Specify character of soil, as loam, sand, etc.; also whether rock will be met with, marsh land, quicksands, etc., requiring special work.) 175. Soil.

All feeder, main, and pressure wires shall be { of bare copper wire; / insulated with ——; } all service wires shall be insulated with ——. 176. Wiring.

All wires shall be so handled as to avoid kinking; wagons, drays, etc., shall not be allowed to drive over them; they shall not be dragged along the ground, over cross-arms or through trees in such a way as to injure the insulation; and shall not be allowed to sag

unduly between supports, allowance being made for expansion and contraction with changes of temperature. All necessary and proper precautions shall be taken in passing over, through, or near buildings of every description, through trees, crossing other lines, turning corners, etc.

Pressure wires shall be carried from the (switchboard) to each centre of distribution unless such centres are connected by an equalizing main, in which case the pressure wires shall be carried to a point on the equalizing main electrically equidistant from the centres of distribution which it connects.

177. Joints. Joints shall be mechanically strong and secure so that no movement of the two ends relatively to each other is possible, and shall be carefully sweat-soldered, the joint being wiped free from any excess of flux; the solder shall be relied on only to give good electrical connection.

178. Lightning Arresters. An efficient lightning arrester shall be placed on the pole, connected to the line and to a permanent ground for every —— of conductor.

179. Maximum Fall of Potential. The mains shall be so proportioned that the maximum fall of potential between the centre of distribution and any service cut-out, including the loss in any transforming device, shall not exceed —— per cent. under full load.

Alternating Current System.

180. Alternating System.

(Note.—The specification for the low potential system, p. 95 et seq., may be followed in general. There should be added a specification for placing converters on poles where so required, and for running secondary mains where a single converter supplies a number of buildings, including the distance that the secondary main must be kept from the primary.)

Street Lighting Circuits—Arc or Incandescent.

181. Street Lighting Circuits.

(Note.—The specification for the low potential system, p. 95 et seq., may be followed in general, but the following additions and modifications should be introduced.)

182. Poles.

(Add to sec. 168, p. 96.)

Lamp poles shall be not less than —— in length, with tops not less than —— in diameter, and set —— of their length in the ground.

183. Gains and Cross-Arms.

(Add to sec. 172, p. 96.)

Where there is but a single wire on a pole a bracket may be used instead of a cross-arm. Where necessary break-arms shall be used to carry wires from the line out to the lamp.

184. Steps. (Note.—Steps may be desirable on lamp poles, if so add to sec. 174, p. 97.)

185. Suspension of Lamps. Lamps shall be suspended at the places located on the attached map by means of (brackets, mast-arms, cross suspension, etc.) The bottom of the lamp to be not less than —— above the roadway.

The lamps and fixtures must be secured against damage or interference through ordinary wind storms, and all wires so connected that there shall be a minimum danger of short-circuiting or grounding.

186. Fixtures (Incandescent). The following fixtures and appliances shall be furnished and erected:

——— water-proof hoods complete with reflectors, sockets, and { bracket / cross-suspension } attachments.

——— goose-neck brackets, —— in length complete with post-socket or flange and the necessary guy wires.

——— sleet-proof pulleys.

——— feet —— inch weather-proof rope for raising and lowering lamps.

——— double cleats for winding up surplus rope.

——— feet —— inch rope for suspending lamps, ——, —— c. p. —— volt lamps.

187. Fixtures (Arc. See also Secs. 69, 70, 71, 72, 73 and 74). ——— water-proof circuit cut-outs for cutting out circuits inside buildings from the

exterior circuit. The "Off" and "On" positions shall be plainly marked, and the switch shall be so constructed that when at the position marked "Off" the wires on the inside shall be entirely cut out of the main circuit.

——— outriggers, —— in length for attaching to the exterior of buildings.

——— outriggers, —— in length for attaching to poles.

——— { plain / ornamental } pole tops.

——— mast-arms, —— in length, with proper arrangement for raising and lowering lamps. Bidders shall submit design of mast-arm recommended.

——— sleet-proof pulleys.

——— feet —— inch weather-proof rope for raising and lowering lamps.

——— feet —— inch { weather-proof rope / stranded cable } for suspending lamps.

——— { double cleats / windlasses } for winding up surplus rope.

(Note.—The specification for wiring must be made up with reference to the system or systems to be installed, whether parallel or series wiring with incandescent or arc lamps, or a combination of systems.) 188. Wiring.

(Note.—The point at which street lighting circuits will be controlled will depend much 189. Point of Control.

on the system adopted and on local conditions; it is sometimes absolutely necessary that they shall be controlled from the station; in other cases for the sake of economy or convenience it is desirable to have them controlled from some other point such as the centre of distribution.)

All street lighting circuits shall be controlled by switches at (location).

190. Additions and Deductions. While the schedule is intended to represent very closely the number of lights to be installed, yet as some changes may become necessary during the process of construction, each bidder shall name in his proposal a price to be added to or deducted from the contract price for each light installed in excess of the number specified or which shall be canceled, provided such addition or cancellation involves no change in the work already completed, and shall be along the line of existing circuits. The price shall include lamp, fixtures, extra poles required, and labor.

191. Instruction. (See p. 83, sec. 102.)

192. Schedules. In order to tabulate clearly and concisely the location and number of outlets for lights, switches, and meters, together with the number of lights per outlet in each individual case, and the capacity of each switch and meter, also the location, catalogue number,

and incidental information on each fixture and shade, the attached schedules will often be found of great convenience; indeed, in making up estimates, such schedules are almost indispensable, and will prove of very considerable assistance if incorporated in the specification. They will also be found useful in checking the accuracy with which the details have been taken from the plans and an aid in checking the work during construction, since they give the detailed distribution in a concise form, free from distracting explanatory clauses or directions, and are more convenient and accessible than plans; plans, too, often have the disadvantage of containing details foreign to the electrical work, which may confuse and mislead.

The shade schedule can often be incorporated in the fixture schedule. The catalogue number of fixtures is added in this schedule in order to keep in mind the exact fixture for which a given shade is intended, thus insuring against mistakes in putting them on.

In the fixture schedule, if sockets are to be furnished by another contractor, the column for same may be cancelled. As a memorandum notes concerning the supplying of insulating joints or flanges, the wiring of fixtures, etc., may be added. The item "length" is very important and should never be omitted.

The capacity of switches is often marked in lights, and is so given in the schedule; it may,

however, often be advisable to designate them by their current carrying capacity in ampères to provide for the use of low volt as well as high volt lamps. The form of schedule for switches can also be used for meters, but in this case the current consumed by the lamp should be given, and it should be clearly specified whether the meter is to measure direct currents only, alternating currents only, or either direct or alternating currents, also whether two or three wire.

In the lamp schedule the vertical column of outlets gives the total number for each location, the horizontal line across the bottom of the page gives the total number of outlets of each size in the building, the sum in each case should be the same. The vertical column of lights gives the total number of lights in the building, this sum may be checked from the horizontal line of totals by multiplying those totals by the number of lights per outlet given at the top and adding the results. If the results obtained by the two methods do not agree some mistake has been made either in the arithmetical work or in placing outlets under the wrong heading; the results, to be correct, must agree. The division into "side" and "ceiling" outlets is important to the contractor, since the quantity both of labor and material required is often very largely dependent upon this relation, which may also determine the method of running the circuits.

LAMP OUTLET SCHEDULE.

Location.	One Light.		Two Light.		Three Light.		Four Light.		Six Light.		Light.		Totals.	
	Side.	Ceiling.	Side.	Ceiling.	Side.	Ceiling.	Side.	Ceiling.	Side.	Ceiling.	Side.	Ceiling.	Outlets.	Lights.
FIRST FLOOR.														
Hall	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2	3
Manager's Office	2	.....	1	.....	.....	1	.....	.....	.....	1	.....	.....	5	13
Secretary's Office	1	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	3	6
Consultation Room	.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	2	5
Etc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals	4	1	2	1	..	2	..	1	..	1	..	..	12	27

SWITCH / METER SCHEDULE.

Location.	No. and Capacity. 3 Lt.	6 Lt.	10 Lt.	Lt.	Total Switches / Meters.	Outlets to be controlled and remarks.
Totals.						

FIXTURE SCHEDULE.

Location.	No. of Fixtures	Cat. No.	No. of Lights.	Length.	Finish.	Sockets Key or Keyless.	Remarks.

SHADE SCHEDULE.

Number of Shades.	Cat. No.	Cat. No. of Fixture.	No. Shade-holders.	Cat. No.	Finish.	Remarks.

Specification for Steam Plant.

193. Specification for Steam Plant.

(Note.—Though technically steam engineering is not within the province of the electrical engineer, yet in practice electrical and steam engineering are so intimately associated, and so many contractors undertake both classes of installation, that I am constrained to add a short specification for a single-expansion, non-condensing steam plant of the simplest type. It will be found applicable to many, perhaps the majority, of central station plants up to 100 h. p. or 150 h. p , and for isolated plants where the conditions imposed by municipal and insurance regulations, considerations of the utilization of exhaust steam, or of combining a heating and power plant, and questions of a similar nature do not require special attention.

The form of Warning, Preamble, and General Specification are, with but slight changes, also adapted to this specification.

This contractor shall furnish and erect, complete in all its details, the following steam plant:

194. Engines.

——— { horizontal / vertical } single cylinder, non-condensing. { high-speed, / low-speed, } —— cut-off engine(s) especially adapted for electric light-

ing service, rated at —— brake h. p. at —— revolutions per minute, with —— lbs. initial steam pressure (above the atmosphere), —— lbs. back pressure, and cutting off at —— stroke. When operating at its full rated load under normal and regular working conditions {each / the} engine shall be guaranteed not to exceed a steam consumption of —— lbs. of dry steam per brake h. p. and per hour. The speed variation between no load and full load shall be guaranteed not to exceed —— per cent.

{Each / The} engine shall be provided with {—— pulleys / a band flywheel} —— in diameter by —— face.

All material and workmanship shall be of the highest grade; all parts accurately made to standard gauge and interchangeable; all moving parts carefully balanced; all valves and packing free from leakage.

{They / It} shall operate noiselessly and without pounding or vibration when set on suitable foundation.

{Each / The} engine shall be provided with all necessary foundation bolts and plates, lubricators, oil cups, cans, drips, guards, collectors, steam and exhaust valves, safety cocks, etc., and a full set of wrenches and spanners. 195. Fittings.

Also with the necessary pipes, valves, and attachments, permanently connected with the engine, for taking indicator cards from both ends of the cylinder (at once). Indicators to be furnished by (the purchaser).

196. Oil Filter(s). ——— oil filter(s) (each) having a capacity of ——.

197. Painting. (As required.)

198. Foundations. The foundation(s) for the(se) engine(s) shall be built by the {contractor / purchaser} of ——, laid ——, and shall be of sufficient length, width and depth to safely and firmly sustain {their / its} weight and all strains to which {they are / it is} subjected. All necessary excavating or filling and the removal of all débris shall be done by the {contractor; / purchaser;} the height of the floor line above the ground is ——. The foundation(s) shall be surmounted by (a) neat capstone(s) of —— upon which the engine(s) shall be placed. (If capstones are not specified, each engine should be provided with an iron sub-base or bed plate.) The foundations shall be of such height that the driving pulley(s) will swing {clear of / below} the floor ——.

(Character of the soil should also be specified.)

(Note.—If this contractor furnishes plant complete, this section can be put before final summary.)

199. Starting Plant and Instruction.

When the {engine(s) / plant} {are / is} ready for operation {they / it} shall be run for a period of —— days by competent engineers furnished by the contractor. All oil, waste, etc., and a sufficient supply of {dry steam / a suitable fuel} will be furnished by (the purchaser).

This contractor shall also give all necessary instructions to the engineer of (the purchaser) for the proper care, maintenance, and operation of the {engine(s), / plant,} such instructions to be given during the trial period stipulated above.

200. Belts.

—— { double leather, endless, solid / " " " perforated / link / rubber / cotton-leather / rope, etc., } belts,

free from defects of any kind, —— in width by —— in length, and capable of transmitting —— horse-power at a belt speed of ——.

201. Renewal Parts.

Such renewal parts as it is advisable to keep on hand, adding hereto an itemized list of same.

202. Summary. (See Note.—p. 47, sec. 27.)

Each bidder shall fill out completely the following summary:

Number of engines . . . . . ——
Size of cylinder . . . . . ——
Diameter of steam pipe . . . . ——
Diameter of exhaust pipe . . . . ——
Floor space . . . . . ——
Brake horse-power at —— revolutions, —— initial steam pressure, ——back pressure, cutting off at —— stroke ——
Speed . . . . . ——
Variation between no load and full load . . . . . ——
Number of pulleys . . . . . ——
Dimensions of pulleys . . . . ——
Steam consumption per brake horse-power and per hour . . . ——

203. Counter-Shaft. —— of {turned steel / hammered iron / etc.} shafting —— in diameter.

—— {floor stands, / drop hangers, / post hangers, / pedestals, etc.} complete with adjustable, (self-oiling) boxes, base plates, bolts, etc. {Height / Drop} from {floor / ceiling} to centre line of shaft ——.

Shafting to be {tapped for set screws / provided with key seats} for the pulleys specified below, and (provided) with all necessary collars, guard rings, etc.

204. Pulleys.

—— { plain cast iron, / split " " / plain wood, / split " / grooved, etc. } pulleys accurately bored, turned, balanced, and provided with { set screws. / key seats and keys. } Pulleys to be —— in diameter by —— face, and capable of transmitting —— horse-power at —— revolutions.

——, —— arm, balanced friction-clutch pulleys, —— in diameter by —— face, and capable of transmitting —— horse-power at —— revolutions. Each pulley to be provided with a —— shifter rig, to be operated from ——. The clutch must pick up the load without shock or jar, and the shifter rig must be positive in its action, not liable to get out of order, free from any tendency or liability to be thrown in or out accidentally.

(—— friction-clutch couplings, cut-off couplings, compression couplings, plate couplings, jaw clutches, etc.)

205. Foundations.

(Note.—Specify character of foundation upon which shafting is to be placed, whether special foundations of brick or stone, floor timbers, walls, ceilings, posts, etc.)

206. Boiler(s).

——, ——, —— front boiler(s) (each) rated at —— horse-power.

The boiler(s) shall contain not less than —— of effective heating surface and —— of grate area per rated horse-power. The

shell(s) shall be made of steel having a tensile strength of not less than ——, and shall be tested to —— pounds hydrostatic pressure. Bidders shall state the guaranteed evaporation from feed water at —— to dry steam at—— pounds gauge pressure per rated horse-power, and per hour, and the amount of —— consumed.

{They / It} shall be inspected and insured by a responsible steam boiler insurance company, this contractor to furnish a certificate of inspection and a policy of insurance for ——.

207. Fittings. {Each / The} boiler shall be provided with the necessary lugs, brackets, plates, bolts, stays, anchor and binder rods, man and hand poles, steam and blow-off connections, stop and safety valves, pressure gauge, water column, gauge cocks and drip, set of stoking tools consisting of ——, and all other appliances properly coming under this head.

208. Setting. The boiler(s) shall be set in masonry in a first-class manner, according to standard practice. This contractor to do all necessary excavating or filling for the foundation(s) and to remove all débris. The foundation(s) must be firm and substantial. All material shall be such as is especially adapted to the strains, stresses, and variations in temperature to which it will be subjected.

(Specify character of soil upon which boilers will be placed.)

Smoke connections of ——, having an area ——, are to be made with the stack, and are to be provided with —— dampers and —— cleaning doors arranged as follows: ——. 209. Smoke Connections

(Note.—Specify material, height, capacity, etc.) 210. Stack.

—— automatic stoker(s) of standard manufacture connected——, and operated ——. 211. Automatic Stoker(s).
(Specify how coal is to be delivered to them.)

——, —— feed pump(s) of standard manufacture (each) having a capacity of ——, together with —— injector(s) as an auxiliary source of supply. (Specify suction heads.) 212. Feed Pump(s) and Injector(s).

—— feed-water heater(s) [and purifier(s)] of standard manufacture (each) having a capacity of —— heated from —— to ——. 213. Feed-Water Heater(s) (and Purifier(s)).
(Specify character of water to be used, and whether exhaust steam is to be used for any other purpose than heating feed-water.)

—— separator(s) of standard manufacture, having a capacity of ——, and a guaranteed efficiency of ——. 214. Separator(s).

(Note.—Specify kind of pipe to be used, method of suspension, all distances, locations of pumps, separators, etc., headers required, 215. Piping.

walls to be pierced, auxiliary connections, etc. It is sometimes very desirable, where a number of engines and boilers are installed, to place a valve in the main steam pipe both near the boilers and near the engines by either of which steam can be cut off from all engines at once; there should invariably be in addition to these valves a valve in each branch so that steam may be shut off from any boiler or any engine without interfering with the operation of the remainder.)

From boiler(s) to engine(s); from engine(s) to heater(s), and from heater(s) to ——; from boiler(s) to pump(s) and injector(s); from pump(s) and injector(s) to (water supply), and from pump(s) to feed-water heater(s) and exhaust pipe; together with all check, globe, gate, angle, safety and other valves, traps, catch basins, drips, cocks, gauges, by-passes, and other devices necessary for the proper and convenient control and manipulation of the steam and water supply. Bends and elbows are to be avoided when possible.

216. Gauge Board. A gauge board of —— shall be erected in ——, and the following instruments mounted thereon: ——. Connection shall be made between these instruments and —— in the following manner ——.

217. Pipe Covering. All —— shall be carefully covered with a substantial, non-heat-conducting material, such as ——.

(As required.) 218. Painting.

Such renewal parts as it is advisable to have on hand shall be furnished, a list of same to be added hereto. 219. Renewal Parts.

(See note.—p. 47, sec. 27.) 220. Summary.

Each bidder shall fill out completely the following summary:

Number of boilers . . . . . ———
Rated horse power . . . . . ———
Kind . . . . . ———
Diameter . . . . . ———
Length . . . . . ———
Number of tubes . . . . . ———
Diameter of tubes . . . . . ———
Heating surface . . . . . ———
Grate area . . . . . ———
Tensile strength of shell . . ———
Testing pressure . . . . . ———
Guaranteed evaporation . . ———
(Fuel) per horse-power and per hour . ———
Outside dimensions of setting . ———
Number of pumps . . . . . ———
Capacity of each . . . . . ———
Number of heaters . . . . . ———
Capacity of each . . . . . ———
Number of separators . . . . . ———
Capacity of each . . . . . ———

RULES OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Adopted at Montreal, Sept. 10, 1891, and Amended at Buffalo, Feb. 23, 1892.

CLASS A.—CENTRAL STATIONS.—FOR LIGHT OR POWER.

These Rules also Apply to Dynamo-Rooms in Isolated Plants, Connected With or Detached from Buildings Used for Other Purposes. Also to all Varieties of Apparatus, of both High and Low Potential.

GENERATORS OR MOTORS—Must be:

1. Located in a dry place.

2. Insulated on floors or base frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry.

3. Not exposed to flying or combustible materials.

4. Each covered with a waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working room of a cotton, jute, flax, woolen or flour mill.

CARE AND ATTENDANCE.—A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in metal cans and removed daily.

CONDUCTORS. — From generators, switchboards, rheostats, or other instruments, and thence to outside lines, conductors must be:

1. In plain sight.

2. Wholly on non-combustible insulators, such as glass or porcelain.

3. Separated from contact with floors, partitions or walls through which they may pass by non-combustible insulating tubes.

4. Kept rigidly so far apart that they cannot come in contact.

5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.

6. Ample in carrying capacity to prevent heating. (See Capacity of Wires Table.)

7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered, if necessary to make them efficient and permanent.

8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

SWITCHBOARDS—Must be:

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the

connections are on the back; or may be placed against a brick or stone wall when the connections are entirely on the face.

2. Kept free from moisture.

3. Made of non-combustible material, or of hard wood, filled to prevent absorption of moisture.

4. Equipped with bars and wires in accordance with Rules 1, 2, 4, 5, 6, and 7, for placing interior conductors.

RESISTANCE BOXES AND EQUALIZERS—Must be:

1. Equipped with metal or non-combustible frames.

2. Treated as sources of heat.

3. Placed on the switch, or a distance of a foot from comustible material, or separated therefrom by asbestos or cement.

LIGHTNING ARRESTERS—Must be:

1. Attached to each side of every overhead circuit connected with the station.

2. In plain sight.

3. On the switchboard, or in an equally accessible place, away from combustible material.

4. Connected with at least two earths by separate wires of large size.

5. So constructed as not to maintain an arc after the discharge has passed.

TESTING.—All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple arc low potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

CLASS B.—ARC (SERIES) SYSTEM.

OVERHEAD CONDUCTORS.—All outside overhead conductors (including services) must be:

1. Covered with some insulating material not easily abraded.

2. Firmly secured to properly insulated and substantially built supports, all the wires having an insulation equal to that of the conductors they confine.

3. So placed that moisture cannot form a cross connection between them, not less than a foot apart and not in contact with any substance other than proper insulating supports.

4. At least seven feet above the highest point of flat roofs and at least one foot above the ridge of pitched roofs over which they pass or to which they are attached.

5. Protected, whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by dead insulated guard irons or wires. Special precautions of this kind

must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.

6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.

7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to insure preservation, and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved:

Saturated solution of zinc . .	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

Conductors should not be run over or attached to buildings other than those in which light or power is being, or is to be, used, but on separate poles or structures always easily inspected.

SERVICE BLOCKS must be covered over their entire surface with at least two coats of waterproof paint, and so maintained.

Telegraph, telephone, and similar wires must not be placed on the same arm with electric or power wires, and *should not* be placed on the same structure or pole.

Interior Conductors.

ALL INTERIOR CONDUCTORS—Must be:

1. Where they enter buildings from outside terminal insulators to and through the walls

covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside, and bushed with waterproof and non-combustible insulating tube.

2. Arranged to enter and leave the building through a double contact switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture, and easy of access to police or firemen.

3. Always in plain sight, never covered, except in special cases, where an armored tube may be necessary.

4. Covered in all cases with a waterproof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150 degrees F. without softening.

5. In dry places, kept rigidly apart at least ten inches, except when covered (in addition to insulation)—by a waterproof, non-conducting and non-inflammable tubing, which must be strong enough to protect the insulating covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or

saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.

6. In damp places, attached to glass or porcelain insulators, and separated ten inches or more.

7. When passing through walls, floors, timbers, or partitions, treated as in central stations under like conditions.

Lamps and Other Devices.

ARC LAMPS—Must be in every case:

1. Carefully isolated from inflammable material.

2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.

3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons should they fail to feed properly.

4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

5. Carefully insulated from the circuit in all their exposed parts.

6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark arrester above, to prevent escape of sparks, melted copper or carbon.

Incandescent lamps in series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series. such switches and cut-outs must not control less than a single group of lights. Electro-magnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS.—300 VOLTS OR LESS.

Overhead Conductors.

OUTSIDE OVERHEAD CONDUCTORS—Must be:

1. Erected in accordance with general rules for arc (series) circuit conductors.

2. Separated not less than six inches, where they enter buildings as service conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

Underground Conductors.

UNDERGROUND CONDUCTORS—Must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services in-

side the walls of buildings, as a guard against moisture and injury.

2. Terminated at a properly placed double-pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10 inches, until the double-pole cut-out is reached.

Inside Wiring.

Wires should be so placed that in the event of the failure or deterioration of their insulating covering the conductors will still remain insulated.

At the entrance of every building there shall be a double-pole switch placed in the service conductors, whereby the current may be entirely cut off.

CONDUCTORS—Must not be:

1. Of sizes smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.

2. Lead or paraffine covered.

3. Covered with soft rubber tube.

4. Laid in molding of any kind in damp places.

5. Laid in moldings with open grooves against the wall or ceiling.

6. Laid in molding where less than half an inch of solid insulation is between parallel wires, and between wires and walls or ceilings.

7. Inside conductors must not be laid in plaster, cement, or similar finish without an exterior metallic protection.

CLEATWORK is not desirable, and cleats must *not* be used unless—

1. In a very dry place.

2. In a place perfectly open for inspection at any time.

3. They are porcelain, or well seasoned wood, filled, to prevent absorption of moisture.

4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least two and one-half inches apart, and that where a higher voltage is used, this distance be increased proportionately.

5. There is a backing provided, of wood at least half an inch thick, well seasoned and filled, to prevent absorption of moisture.

METAL STAPLES must never be used to fasten conductors unless—

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.

2. Under conditions in which cleatwork would be acceptable, or where driven into a molding specially adapted for open work.

Special Wiring.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one

inch. In crossing arc light wires the low-tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run over all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In rooms where inflammable gases exist the incandescent lamp and socket must be inclosed in a vapor-tight globe. This is not understood to include rooms where illuminating gases are used in the ordinary manner.

In breweries, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least six inches.
2. Provided with a durable moisture-proof covering.
3. Supported by porcelain or glass insulators.

Moisture-proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

INTERIOR CONDUITS—Must not be:

1. Combustible.
2. Of such material or construction that will be injured by plaster or cement, or other

surrounding material, or that the insulation of the conductor will be ultimately injured or destroyed by the elements.

3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.

4. Subject to mechanical injury by saws, chisels, or nails.

5. Supplied with a twin conductor in a single tube where a current of more than 10 ampères is expected.

6. Depended upon for insulation. The conductors must be covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and as far as possible, from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonizable substance.

Conductors passing through walls or ceilings must be encased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

DOUBLE POLE SAFETY CUT-OUTS—Must be:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.

2. Placed at every point where a change is made in the size of wires (unless the cut-out in the larger wire will protect the smaller.) This includes all flexible conductors. All such junctions must be in plain sight.

3. Constructed with bases of non-combustible and moisture-proof material.

4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.

5. So placed that on any combination fixture, no group of lamps requiring a current of six ampères or more shall be ultimately dependent upon one cut-out.

6. Wherever used for more than six ampères (or where the plug or equivalent device is not used) equipped with fusible strips or wires provided with contact surfaces or tips of harder metal soldered or otherwise having perfect electrical connection with the fusible part of the strip.

SAFETY FUSES must be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of ampères equal to the safe carrying capacity of the wire they protect.

All cut-out blocks, when installed, must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about 40

per cent. less when the wire is closed in a tube or piece of molding than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe and Edison gauges, which must be followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham.		Edison Standard.	
Gauge No.	Ampères.	Gauge No.	Ampères.	Gauge No.	Ampères.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	110	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	24	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

SWITCHES—Must:

1. Be mounted on moisture-proof and incombustible bases, such as slate or porcelain.

2. Be double pole when the circuits which they control are connected to fixtures attached to gas pipes, and when six ampères or more are to pass through them.

3. Have a firm and secure contact, must make and break readily, and not stick when

motion has once been imparted by the handle.

4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.

5. Be placed in dry accessible places, and be grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back boards.

MOTORS.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double-pole cut-out and controlled by a double-pole switch.

ARC LIGHTS ON LOW POTENTIAL CIRCUITS—

—Must be:

1. Supplied by branch conductors not smaller than No. 12 B. & S. gauge.

2. Connected with main conductors only through double-pole cut-outs.

3. Only furnished with such resistances or regulators as are inclosed in non-combustible material, such resistances being treated as sources of heat.

4. Supplied with globes protected as in the case of arc lights on high potential circuits.

Fixture Work.

1. In all cases where conductors are concealed within or attached to fixtures, the latter must be insulated from the gas pipe system of the building.

2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings, or motion of the fixtures.

3. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.

4. All burrs or fins must be removed before the conductors are drawn into a fixture.

5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.

6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.

7. Each fixture must be tested for possible "contacts" between conductors and fixture, and for "short circuits," before the fixture is connected to its supply conductors.

8. The ceiling blocks of fixtures should be made of insulating material.

Electric Gas-Lighting.

Where electric gas-lighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gas-lighting circuit.

2. The wires used with the fixture must have a non-inflammable insulation, or where

concealed between the pipe and shell of the fixture the insulation must be such as is required for fixture wiring for the electric light.

3. The whole installation must test free from "grounds."

4. The two installations must test perfectly free of connection with each other.

Pendants and Sockets.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

CORD PENDANTS—Must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture-proof and a non-inflammable layer.

2. Protected by insulating bushings where the cord enters the socket.

3. So suspended that the entire weight of the socket and lamp will be borne by knots, above the points where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas pipe size.

4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case sufficient

provision should be made by an extra heavy cord or wire, as a mechanical reinforcement.

5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than fifty (50) candle-power be placed in a key socket on a flexible pendant.

CLASS D.—ALTERNATING SYSTEMS.

Converters or Transformers.

CONVERTERS—Must not:

1. Be placed inside of any building except the central station unless as hereinafter provided.

2. Be placed in any but metallic or noncombustible cases.

3. Be attached to the outside walls of buildings, unless separated therefrom by substantial insulating supports.

4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building such as a vault) when an underground service is used.

5. Be placed without safety fuses at the junction between main and service conductors and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

Primary Conductors.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.

2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.

3. The primary conductors, if within a building, must be furnished with a double pole switch, and also with an automatic double pole cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should, if possible, be inclosed in secure and fireproof boxes outside the building.

4. The primary conductors, when inside a building, must be kept apart at least 10 inches, and at the same distance from all other conducting bodies.

Secondary Conductors.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low potential systems."

CLASS E.—ELECTRIC RAILWAYS.

Power Stations.

All rules pertaining to arc light wires and stations shall apply (so far as practicable) to street railway stations and their conductors.

Railway Systems with Ground Return.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited *except* as hereinafter provided:

1. When there is no liability of other conductors coming in contact with the trolley wire.

2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.

3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded is introduced in each circuit as it leaves the power station. This device must be mounted on a fireproof base, and be in full view of the attendant.

Trolley Wires.

TROLLEY WIRES—Must be:

1. No smaller than No. 0 B. & S. copper, or No. 4 B. & S. silicon bronze, and must readily stand the strain put upon them when in use.

2. Well insulated from their supports, and in case of the side or double pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.

3. Capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route the current may be shut off from the particular section and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.

4. Safely protected against contact with all other conductors.

Car Wiring.

All wires in cars must be run out of reach of the passengers, and shall be insulated with a waterproof insulation.

Lighting and Railway Power Wires.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, car houses, and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double-pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F.—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the

same general regulations must be observed as apply to such wires fed from dynamo generators developing the same difference of potential.

CLASS G.—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magneto bell that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.

2. No ground wires for lighting arresters may be attached to gas pipes within the building.

3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time, and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

RULES OF THE NATIONAL BOARD OF FIRE UNDERWRITERS.

At the 24th Annual Meeting of the Board, held June 8th, 1890, the New York Board rules regulating Electric Light Installations were adopted for promulgation to members.

Amended Standard for Electric Equipments, Adopted January 15, 1890, by the New York Board of Fire Underwriters.

CONDUCTORS.

Capacity of Wires.

1. The conducting wires must be of copper, and must have a weight per running foot at least equal to that of the wire (or parallel group of wires) constituting the main circuit of the magnetic regulator of the electric lamps (arc lamps), or of the armature of the machine employed, whichever of these is greatest.

Joints or Splices.

2. All joints in wires must be so made as to secure perfect and durable contacts, which

shall always maintain a degree of conductivity at the joint at least equal to that of the wire generally.

3. The joint must be so made as in the ordinary "telegraph splice" that it is mechanically secure against motion or displacement, and must then be further electrically connected by solder so applied as to leave no corrosive or otherwise injurious substance on the connection. After joining and soldering, the joint must be covered with insulating material in such a way as to make the insulation of the joint as good as that of the rest of the line.

4. A joint made by the process of electric welding would be the equivalent of one made as indicated above, but no joint depending upon solder for its mechanical integrity either wholly or in part will be allowed.

Wires Exterior to Buildings.

5. Outside wires must be covered with at least two coatings, one of insulating material, impervious to water, next to the wire, and the other of some substance fitted to resist abrasion or like mechanical injury, and must be firmly secured to substantial approved insulators, adequately supported. All "tye wires," or those used to secure the conductors to the "insulators," must be themselves covered with waterproof insulating and mechanically resistant material similar to that used on the conductors themselves.

6. Overhead conducting wires must be supported on poles as far as possible, so that they can be easily reached for inspection, and when this cannot be done, and special permit is granted allowing them to be carried over or attached to buildings, they must be supported at least seven feet above the general level of the roof and at least one foot above the ridge of "pitched roofs."

7. Where wires approach buildings to enter them they should be so located as not to be readily reached by the occupants of such buildings, and in the case of arc light systems must maintain a minimum distance of ten inches, and for incandescent systems of six inches, except where the wires are carried in conduits.

8. When these exterior electric light wires are near other conductors of any kind capable of carrying off a part of the current, if contact should be made, dead-insulated guard irons must be placed so as to prevent any such contact in case of accidents affecting the wires or their supports.

9. Like precautions must be taken where acute angles occur in the line wires.

10. Overhead wires from the main circuit or pole lines in the street to the insulators attached to the buildings which they enter, must not be less than ten inches apart for arc wires, or six inches for incandescent wires carrying currents of 250 E. M. F. as a maximum. They must be securely and rigidly

supported on "insulators" of glass, porcelain, or other approved material.

Wires Entering Buildings.

11. Wherever electric light wires enter buildings through their exterior walls the wires must be firmly supported and incased in tubes of non-conducting material not liable to absorb moisture (*e.g.*, porcelain or glass) and so placed as to prevent the entrance of rain water along the wires (*e. g.*, the tubes must slope *upward* as they pass *inward* through the wall).

12. Both the ingoing and return wires should enter the building at the same location and pass through an approved manual "cut-out-box" or switch, which must be placed where it will be easy of access to firemen and the police.

High Potential Wires Within Buildings.

13. In the interior of buildings, wires for arc lights, besides being covered with an insulating covering such as has been already described, must be in all cases securely attached and supported by insulators which shall keep them out of contact with any wall, partition, ceiling, or floor, so as to secure an air space of at least one-quarter inch between the wire and any adjacent wall, partition, ceiling, or floor, and wherever the wires cross or come near to any other wires, pipes, or

other conductors, the wires must all be rigidly secured and separated from each other or any other conductors by means of some rigid non-conducting material.

14. Arc wires of opposite polarities (*i. e.*, the incoming and outgoing wires from each lamp or of each circuit) must be kept at a distance not less than eight inches from each other, except within the structure of lamps or on switchboards, cut-out boxes, or the like, where a nearer approach is necessary.

15. In exceptional cases, however, where the wires are so rigidly secured and insulated that contact or connection between them is quite impossible, they may be allowed to approach much nearer. (*E. g.* If each wire or conductor is covered with a thick and indisplaceable insulation, which in turn is covered by a leaden sheath or pipe, and then two or more such pipes are inclosed in an iron pipe in such manner that injury to the lead covered cables is impossible, this would be an allowable substitute for the eight inches of absolute separation called for in the general rule.)

16. Wherever wires are carried through walls, partitions, or floors within a building, they must be surrounded by a special rigid insulating tube or casing impervious to water, and must be so attached and supported as to be secure from abrasion or other mechanical injury.

(Note.—Rubber tubing will not meet the above requirement as an insulation.)

Arc Lamps.

17. The exterior frames and other exposed parts of arc lamps must be securely insulated from the electric circuit, and all such lamps must have glass globes surrounding the light and inclosed below, so as to prevent the fall of ignited particles. Where inflammable materials are placed below such lamps, the globe must be surrounded by a wire netting capable of keeping the parts of the globe in place if it is fractured in use.

(Note.—Broken globes must be replaced as soon as practicable by new ones.)

18. In show windows and other places where inflammable materials are displayed, and in factories or wood-working establishments where "flyings" may be present in the air, each lamp must be provided with "spark arresters."

19. Each lamp must be provided with a hand switch, and also with an automatic switch which shall shunt the current round the carbons before the arc between them reaches a dangerous length.

LOW POTENTIAL SYSTEMS.

Direct Systems.

20. In direct incandescent systems, the rules as to the capacity, location, and arrangement of conductors are substantially the same as

has been already stated, with the following exceptions:

21. In case the difference of potential at the positive and negative posts of the dynamo or dynamos developing the current is not more than 250 volts, the positive and negative wires in aerial lines and elsewhere which would otherwise be required to maintain a minimum distance of ten inches, may be brought to within six inches of each other. Also underground conductors may be inclosed both in the same tube, and if rigidly and securely supported, and surrounded by and imbedded in a solid insulating substance, may lie within one-quarter inch of each other.

22. When underground service conductors enter a building care must be taken that they are at once separated to the required distance (see below), and are adequately and permanently insulated from each other and from the pipe in which they were inclosed, if they were inclosed in a metallic pipe or conduit.

23. They must also be adequately protected from mechanical injury, and must be so located that a cut-out can be safely and conveniently located close to the end of the service pipe or conduit by which they are brought in.

Low Potential Wires Within Buildings.

24. In the distribution of the conductors through buildings, "concealed work," such as the placing of wires under floors or within

partitions, walls, or ceilings, should be avoided as much as possible.

25. In perfectly and securely dry localities an approved insulated wire without waterproof covering may be used, provided the wires are not concealed and are supported by cleats or insulators.

26. Wherever the wires are to be in any way covered up they must be coated with an approved waterproof insulation, or otherwise protected in such manner as may be from time to time aproved by the Committee.

27. In all cases of concealed work, the company proposing to introduce the same will be required to furnish the Board with a detailed diagram of the work, showing the kind and size of wire used at the different branches, with particulars as to the insulation and in what materials imbedded, location of cut-outs, switches, etc. The diagram to be signed and sworn to by an officer of the company, and filed with the Board for reference.

28. If wires are imbedded in the plaster of walls, ceilings, or partitions, they must be separated not less than ten inches from each other, in addition to being insulated as above described, unless they are inclosed in approved conduits.

29. In buildings in course of construction, terminal wires must be so arranged as to be secure from injury by the plasterers.

30. Wires insulated as above may be covered by or imbedded in moldings in dry locations,

but in breweries, paper mills, dye-houses, and other like places where they are exposed to moisture, they must be carried out of contact with the walls, ceilings, and the like, on approved "insulators," or in such waterproof and insulating conduits as may be approved by the Committee.

Conduits.

31. Conduits to be approved must be continuous from one junction box to another or to fixtures, and be of material that will resist the fusing of wire or wires they contain without destroying or igniting the conduit; and if not entirely imbedded in plaster or other non-inflammable material or not inflammable themselves, must have an outer covering that is non-inflammable, and be so placed that they will be protected from injury and breakage; and all wires intended to carry more than five-ampère currents shall be placed in separate conduits unless a special permit is issued for same; on branches intended for wires of five-ampère currents and less, the positive and negative wires, if properly insulated, may be placed in the same conduit, provided a double pole safety fuse is inserted at each branch connection.

Secondary Systems.

32. In these systems where alternating currents of high electromotive force are used on

the main lines, and secondary currents of low electromotive force are developed in local "converters" or "transformers," it is important that the entire primary circuit and the transformers should be excluded from any insured building, and be confined to the aerial line (the transformers being attached to the poles or the exterior of the buildings) or to underground conduits, if such are used, or placed in fireproof vaults or exterior buildings.

33. In those cases, however, where it may not be possible to exclude the transformers and entire primary from the buildings, the following precautions must be strictly observed:

34. The transformer must be constructed with or inclosed in a fireproof or incombustible case, and located at a point as near as possible to that at which the primary wires enter the building. Between these points the conductors must be heavily insulated with a coating of approved waterproof material, and in addition must be so covered in and protected that mechanical injury to them, or contact with them, shall be practically impossible.

35. These primary conductors, if within a building, must also be furnished with a double-pole switch, or separate switches on the ingoing and return wires, and also with automatic double-pole cut-out where they enter the building or where they leave the main line, on the pole or in the conduit. The switches above referred to should, if possible,

be inclosed in secure and fireproof boxes outside the building.

36. In the case of isolated plants using the secondary system, the transformers must be placed as near to the dynamos as possible, and all primary wires be protected in the same manner as is indicated in paragraph 34.

Insulation.

37. Where there is a possible exposure to water, the first or second coating must be impervious to the fluid.

38. For incandescent lamp fixtures and electroliers, exceptions may be made to the foregoing rule in which the wires can be placed nearer than the prescribed distance to each other, or to other conductors, provided the fixture is fully insulated at the base from house and ground piping, and further provided that a double pole safety catch is placed at the base of each fixture, or at the nearest branch connection as may be required by the Inspector of the Board.

39. In all cases where combination (gas and electric) fixtures are used, extra precaution must be taken to secure complete and continuous insulation from the gas piping.

Insulation in General.

40. It is to be understood as a general or universal rule that all machines, lamps, wires,

and other parts of electric systems are to be so constructed, mounted and secured as to insure complete and continuous insulation; with such exceptions only as are hereinbefore stated, and that in no case shall ground circuits be employed, or any part of the system be allowed to come in contact with the earth through gas or water pipes, or the like.

Automatic Shunt.

41. Wherever a current of such high electromotive force is employed that if concentrated on one lamp or motor of the series it would produce an arc capable of destroying or fusing parts of such lamp, an automatic switch must be introduced in each lamp or motor by which it will be thrown out of circuit before the arc approaches any such dangerous extent.

42. Means by which those in charge of the dynamo-electric machines will be warned of any excessive flow of current, or means whereby the same will be automatically checked, must in all cases be provided.

Fusible or Other Automatic Cut-Outs for Low Potential Circuits.

43. Wherever a connection is made between a larger and smaller conductor at the entrance to or within a building, some approved automatic device must be introduced into the cir-

cuit of the smaller conductor at or close to its junction, by which it shall be interrupted whenever the current passing is in excess of its safe carrying capacity.

44. The safe carrying capacity of a wire is the current which it will convey without becoming painfully warm when grasped for a minute in the closed hand.

Cut-Out Boxes or Switches.

45. All cut-out boxes or switches which shift, transmit, or break a current must be mounted on incombustible bases, and so arranged as to close one circuit before they open another and operate in such a manner that no arc can be formed between the contact surfaces when thrown "on" or "off." It must be so far positive in its action that it cannot stop between its extreme positions. It must indicate on inspection whether current is "on" or "off." This rule applies to isolated plants as well as to those connected with central stations.

Motors.

46. The Rules and Regulations under the head of *Capacity of Wires, Insulation, Automatic Cut-Outs and Switches* shall be observed, where electric motors are used, and in addition the motor frames must be properly insulated, and so mounted as to be free from

grounds, and each motor shall be provided with an approved switch to prevent an excessive flow of current.

Storage Batteries.

47. When the current for lights or power is taken from storage batteries, the same general regulations are to be observed.

Meaning of Technical Terms, Etc., Etc.

48. HIGH POTENTIAL CIRCUITS OR WIRES.—This term includes all wires arranged with the view of carrying currents of more than 250 volts difference of potential between any two parts of the system, even if such current is used to run incandescent lamps.

49. LOW POTENTIAL CIRCUITS OR WIRES are such as do not carry currents of more than 250 volts.

50. Companies furnishing electricity from central stations must enter into an agreement with the New York Board of Fire Underwriters, binding themselves to test their lines for ground connections at least once every day (and preferably three times per day), and to report the result of such tests to the Board weekly.

51. The Rules and Regulations of the Board of Electrical Control and all existing regulations of the local authorities in reference to the stringing of wires must be strictly observed.

RULES AND REQUIREMENTS OF THE NEW ENGLAND INSURANCE EXCHANGE FOR ELECTRIC LIGHTING.

Adopted September 27, 1890, and Superseding all Previous Rules. Revised in Conjunction with Committee from New England Electric Exchange.

GENERAL REQUIREMENTS.

A certificate for all new work or changes in old work (Form "C" for arc, form "F" for incandescent) should be signed by the party installing or controlling any apparatus. The certificate should be filed with the Secretary of the Local Board of Fire Underwriters having jurisdiction, if there be such; otherwise, with the Secretary of the New England Insurance Exchange, Boston.

This certificate is relied upon as a guaranty until the work can be inspected. Permits for the use of the light or power may be granted as soon as the certificate is duly filed.

Blank certificates may be obtained by application to the Secretary of the New England Insurance Exchange, Boston.

All work should be inspected before any of it is concealed, and to this end notice of concealed work must be given this Exchange as soon as work is commenced.

The New England Insurance Exchange reserves the right at any time to add to, change, or modify the accompanying Rules, and to enforce such modifications, changes, etc., as it shall deem necessary for safety; and it will use all reasonable efforts to promptly notify all electric light companies of any such change.

Any additional loading of wires, either in a building as a whole, or in any department thereof, without previous notification to the Exchange, such as is required, shall be deemed a sufficient cause for the suspension of any permit previously granted, until the same shall have been inspected and approved by this Exchange.

This Exchange reserves the right to disapprove of the use of any wire, switch, cut-out, or any device, or form of material, which it may consider inconsistent with safety from fire risk, even though it may be proposed to install the same in conformity with these Rules.

The following Rules will be strictly enforced, and in no case will a certificate of inspection be issued for work which does not fully comply with the Rules in all particulars.

RULES FOR WIRING.

Outside Wires.

1. Conducting wires carried over or attached to buildings must be (*a*) at least seven feet above the highest point of flat roofs, and (*b*) one foot above the ridge of pitch roofs; (*c*) when in proximity to other conductors likely to divert any portion of the current, they must be protected by guard irons or wires, or a proper additional insulation, as the case may require.

2. For entering buildings, (*a*) wires with an extra heavy waterproof insulation must be used, (*b*) they must be protected by drip loops, (*c*) also protected from abrasion by awning frames, (*d*) be at least six inches apart, (*e*) the holes through which they pass in the outer wall of such building must be bushed with a non-inflammable, waterproof, insulating tube, and (*f*) should slant upward toward the inside.

3. The inspector may, at his discretion, require wires other than those used for conveying current for electric light or power entering buildings to be protected by some approved automatic cut-out, in any locality where such wires are, in his opinion, liable to come in contact with electric light or power wires.

4. Converters, and the primary wires leading thereto, (*a*) must not be placed inside of

any building (central stations excepted); (*b*) they may be attached to the walls on the outside if securely supported by substantial wooden cross-pieces or cleats.

5. Wires attached to buildings should be (*a*) free of contact with the building, and (*b*) supported by rubber hooks, glass insulators, or porcelain knobs. (Porcelain knobs should not be used to support high potential wires.)

Inside Wires. High Potential (Over 350 Volts) Arc and Series Incandescent.

6. Wires must enter and leave the building (*a*) at the same place, (*b*) through an approved cut-out switch, which must be (*c*) mounted on a non-combustible base if attached to any combustible substance, (*d*) kept free from moisture, and (*e*) easy of access to firemen and police.

7. The cut-out switch must be (*a*) double contact, (*b*) must effectually close the main circuit and cut off the interior, when turned "off" (*c*) so constructed that there shall be no arc between the points when thrown "on" or "off," (*d*) automatic in its action (not stopping between points when once started), (*e*) and indicate upon inspection whether the current be "on" or "off."

8. Wires (*a*) must be rigidly supported (*b*) on porcelain, glass, or other non-combustible insulators, (*c*) free from contact with the building, (*d*) have waterproof insulation

wherever there is a possible exposure to moisture, (*e*) be at least twelve inches apart, and (*f*) at least three inches from any other substance capable of acting as a conductor.

9. (*a*) When wires pass through walls, floors, partitions, etc., (*b*) or wherever protection from mechanical injury is necessary, (*c*) they must be protected by glass, hard rubber, or other moisture-proof, non-inflammable tubing. (*d*) (Soft rubber tubing will not be approved.)

10. (*a*) No concealed work (*b*) or wires fastened with metallic staples will be approved.

11. In perfectly dry places wires (*a*) supported by wooden cleats, which (*b*) are "filled" to prevent the absorption of moisture, and (*c*) have a backing so as to separate the wire at least one fourth inch from the building, may be approved by the inspector.

12. A wire (*a*) having a non-inflammable insulation, and (*b*) inclosed in a moisture-proof (*c*) insulating conduit or tubing (*d*) sufficiently strong to protect the wire from mechanical injury, may be used, in which case the tube may be fastened by metallic loops if desired, and the distance between wires reduced to three inches; but (*e*) the entire "conduit system" must be moisture-tight—*i. e.*, joints and open ends must be sealed with some approved cement.

13. The "series" incandescent lamp must (*a*) be provided with a proper hand switch, and (*b*) an approved automatic device which will

shunt the circuit around the carbon filament should it break; (*c*) it must be suspended from a hanger board by means of a rigid tube, and (*d*) must not be used in damp or wet places.

14. Any method of distributing current to incandescent lamps on high potential circuits other than as above provided for must receive the approval of this Exchange before being put into use.

15. In arc lamps indoors, (*a*) the light must be surrounded by a globe with a closed base; (*b*) the depth of the globe must be such that the point of contact between the carbons when the lamp is newly trimmed shall not be less than three inches below the upper edge of the globe; and (*c*) the globe must be inclosed by a wire netting where there is any material under the lamp that could be damaged or ignited by hot cinders, or (*d*) when the lamp is an "all-night" lamp. (*e*) Where exposed to flyings, or where any inflammable material is suspended near the lamp, spark arresters must be used.

16. Hanger boards for arc or series incandescent lamps must not be used in damp or wet places.

17. Each arc lamp must be provided (*a*) with a proper hand switch, (*b*) with an automatic switch that will shunt the current around the carbons should they fail to feed properly, and (*c*) with "stops" to prevent the carbons from falling out in case their clamps fail to hold them.

18. The entire installation must test free from grounds.

Low Potential (350 Volts or Less) Incandescent.

GENERAL RULES.

19. For inside work, no wire smaller than No. 14 "B. & S.," or No. 16, "B. W. G.," will be approved.

20. Samples of wire to be used, or in actual use, must be submitted to this Exchange, for tests of conductivity or of insulation, at any time when required.

21. (*a*) Wires must never be left exposed to mechanical injury, or to disturbance of any kind. (*b*) Wires must not be fastened by metallic staples. (*c*) When wires pass through walls, floors, partitions, timbers, etc., glass tubing or so-called "floor insulators," or other moisture-proof, non-inflammable insulating tubing must be used. (*d*) At all outlets to and from cut-outs, switches, fixtures, etc., wires must be separated from gas pipes or parts of the building by porcelain, glass, or other non-inflammable insulating tubing (*e*), and should be left in such a way as not to be disturbed by the plasterers. (*f*) Wires of whatever insulation must not in any case be taped or otherwise fastened to gas piping. (*g*) If no gas pipes are installed at the outlets an approved substantial support must be provided for the fixtures.

22. In crossing any metal pipes, or any other conductor, (*a*) wires must be separated from the same by an air space of at least one-half inch, where possible, and (*b*) be so arranged that they cannot come in contact with each other by accident. (*c*) They should go over water pipes where possible.

23. Twin wire must not be used except (*a*) as allowed in "conduit" wiring, (*b*) or for "pendants," fixture wiring, and "portables." (*c*) An exception may be made to this rule, by the inspector, where it is necessary to run a short distance, if the wire (*d*) has a non-inflammable covering, (*e*) is not concealed, and (*f*) carries but a small current.

24. The safe carrying capacity of wires when exposed to the air may be taken from the following table:

B. & S. Gauge.	Current in Ampères.
0000	300
000	245
00	215
0	190
1	160
2	135
3	115
4	100
5	90
6	80
7	67
8	60
10	40
12	30
14	22
16	15

When wires are inclosed in molding or otherwise treated so as to prevent cooling by radiation, the carrying capacity is reduced about forty per cent. under such circumstances, or when the wires are installed where

the temperature is unusually high, as in boiler rooms, dry rooms, and the like, wires should be fused accordingly.

25. (*a*) In rooms where inflammable gases may develop, or (*b*) where the amosphere is very damp, the incandescent lamps should be inclosed in vapor-tight globes. (*c*) Switches are not permitted in places filled with inflammable gases (breweries, distilleries, etc.), as the spark at make or break might cause an explosion. (*d*) Fusible safety plugs, if necessary in such places, must be inclosed in air-tight, non-combustible cases.

26. Soft rubber tubing will not be approved in cases where these rules require an additional covering to the insulation of the wire.

27. The entire installation must test free from grounds.

WIRING.

Cleat-Work.

28. (*a*) Cleats made of well filled, dry, hard wood may be used to support wires not concealed, in perfectly dry places only. (*b*) They must be so constructed as to separate wires of opposite polarity at least two and one-half inches. (*c*) Wires must be drawn taut, and cleats placed near enough together to prevent the possibility of contact between the wires.

29. Except on wooden surfaces so filled as to prevent the absortion of moisture, (*a*) the wire must have a waterproof insulation, or (*b*) the cleats must have a backing that will

separate the wire at least one-fourth inch from the building.

Molding.

30. Moldings must not be used (*a*) in concealed work, nor (*b*) in places where there is any probable exposure to moisture.

31. (*a*) Molding must consist of two parts; viz., a back piece, which shall separate the wire at least one fourth inch from the part of the building to which it is fastened, and a cover, one of which parts shall contain the grooves, (*b*) these grooves to have between them a septum or tongue of wood so as to separate the wires at least one-half inch. (*c*) The molding must be coated inside and out with shellac or waterproof paints, or treated in some other manner so as to prevent any possible absorption of moisture. (*d*) Moldings with open grooves laid against walls or ceilings will only be approved when such walls or ceilings are of wood and so filled as to prevent the absorption of moisture.

Concealed Work.

32. In unfinished lofts, between floors and ceilings, in partitions, and other concealed places, wires must (*a*) be kept free of contact with the building, (*b*) be supported on glass, porcelain, or other non-combustible insulators, (*c*) have at least one inch clear air space surrounding them, (*d*) be at least ten inches apart when possible, and (*e*) should be run

singly on separate timbers or studding. (*f*) When thus run in perfectly dry places not liable to be exposed to moisture, a wire having simply a non-combustible insulation may be used.

33. Wires run as above (*a*) immediately under roofs, (*b*) in proximity to water tanks, or pipes, will be considered as exposed to moisture; and in such places the insulating covering of the wire must consist of a waterproof covering next the wire, protected by an external covering not easily abraded, and that will not support combustion.

34. Wires must not be fished (*a*) for any great distance, and (*b*) only in places where the inspector can satisfy himself that the above rules have been complied with. (*e*) Twin wires must never be employed in this class of concealed work.

Conduit Wiring.

35. Wires may also be concealed by means of a system of insulating tubes, or "conduits," that are moisture-proof and practically non-inflammable, and have a threaded joint. (*a*) A separate tube must be provided for each wire, except (*b*) in case of taps or branches carrying a current that does not exceed fifteen ampères, in which case a flexible twin cable may be used; but (*c*) the two conductors of this cable must not be insulated from each other by a rubber compound. A cotton or other fibrous covering should be used, and (*d*)

the joints between sections must be made moisture proof, with some cement proper for the purpose; *i. e.*, the whole system must be free from joints, cracks, etc., where it would be possible for moisture to enter the tubing.

36. These tubes may be secured by metallic loops, and may be laid side by side.

37. This is the only manner in which wires may be run imbedded in plaster, cement, or any similar material. Wires run on brick walls or below timbers furred for lath and plaster will be considered as imbedded in plaster, unless the furring strips are of such thickness as to prevent any contact between the wire and the clinches of plaster.

Wires in Damp Places.

38. In dye-houses, paper and pulp mills, and other buildings especially liable to moisture, all wires, except those used for pendants, must (*a*) be separated at least six inches, (*b*) be thoroughly and carefully put up, and (*c*) be supported by glass or porcelain insulators, or by rubber hooks.

39. Where it is necessary to run the wires down a side wall in order to pass through a floor, the wires must (*a*) be supported from the ceiling to the floor on insulators, (*b*) placed, if necessary, on a back-board, and (*c*) to protect the wires from injury, they should be boxed over from the floor to a point five or six feet above.

40. Where exposed to acid fumes, vapors of ammonia, etc., wires should (*a*) be provided with an insulation, and (*b*) supported on insulators that will not be injured thereby.

41. In places covered by Rules 38 and 40 wires may be run under rules for "conduit" wiring, and if to be concealed they must be so run, but in either case will be subject to special approval by the inspector.

FITTINGS AND APPARATUS.

Safety Cut-Outs.

42. (*a*) Every portion of each installation must be equipped with safety cut-outs, that will interrupt the passage of a current in excess of the amount which that portion of the apparatus is adequate to transmit. (*b*) Fusible leads designed to carry a current of ten ampères or over must have contact surface of some harder metal. (*c*) Fusible leads should be proportioned to the capacity of the wire they are to protect, and not to the number of ampères required to supply the lamps on that particular circuit. (*d*) A cut-out must be placed where the underground or overhead service joins the inside wires, and (*e*) at every point where a change is made in the size of the wire (unless the cut-out in the larger wire is intended to protect the smaller). (*f*) A cut-out must be provided for each fixture, and (*g*) in concealed wiring, for each pendant also; but (*h*) where the wires are exposed, one cut-

out may be employed to protect two or more pendants, provided (*i*) the amount of current they require does not exceed seven ampères. (*j*) Stiff brackets not attached to gas pipes may be treated as pendants in this connection.

43. All cut-out devices must (*a*) be made of non-combustible material, (*b*) be placed so as to protect both sides of the circuit, and (*c*) be provided with close-fitting covers.

44. When lights are grouped, as upon electroliers, etc., the small wires to each light cannot always have cut-outs. Care should be taken, however, that the last controlling cut-out (*a*) carries as small an amount as practicable, and (*b*) that it will act before the smallest wire runs any risk of being unduly heated.

Switches.

45. All switches must (*a*) be composed entirely of non-combustible material, and (*b*) be automatic in action.

46. All switches must be double-pole, in circuits (*a*) connected to fixtures attached to gas pipes, or (*b*) carrying a current of ten ampères or over.

Pendants, Portables, Etc.

47. (*a*) Lamps may be suspended by flexible cord pendants not less than No. 16 B. & S. or No. 18 B. W. G. (*b*) Where it enters the lamp socket, the cord must be protected by a bushing of rubber, wood, or some similar

insulating material, and (*c*) the cord must be so arranged that the weight of the lamp, etc., shall not be borne by the joints or binding screws.

48. (*a*) The covering of the flexible cord, as a whole, shall be of such a nature that it will not support combustion, (*b*) in damp places the cord must have a moisture-proof covering, and (*c*) the opening at the top of the socket must be closed, so as to prevent the entrance of water. (*d*) The flexible leads of portable fittings must in all cases be protected by cut-outs at their fixed points of connection.

Fixtures.

49. (*a*) Each fixture to which wires are attached must be insulated from the piping of the building by an insulating joint. (*b*) Burrs and sharp edges must be removed before wires are drawn into a fixture. (*c*) Wires attached to or concealed within fixtures must have an insulating covering that cannot be easily cut or abraded, and (*d*) that is moisture proof; (*e*) where attached to the outside of a gas fixture, the conductors must be so secured that their covering will not be cut or abraded by the swaying of the fixture or the movement of the bracket arm. (*f*) The difference of potential between any two wires connected with a combination or gas fixture must not exceed 125 volts. (*g*) No wire smaller than No. 16 B. & S. or No. 18 B. W. G. must be used in fixture wiring.

Electric Gas-Lighting.

50. Where electric gas-lighting is to be used on the same fixture with electric light, (*a*) no part of the gas piping or fixture shall be in connection with the gas-lighting circuit; (*b*) the wire used for the fixture must have a non-inflammable insulation, or (*c*) if concealed between the pipe and shell of the fixture must have an insulation such as is required for fixture wiring for the electric light; (*d*) the whole installation must test free of grounds, and (*e*) the two installations must test perfectly free of connection with each other. (*f*) Any such installation will then be subject to special approval by the inspector.

Arc Lights on Low Potential Circuits.

51. This system of lighting will in general be governed by the foregoing rules for low potential work, but (*a*) no wire smaller than No. 12 B. & S. must be used; (*b*) there must be a double pole cut-out at the junction of the branch with the main, and (*c*) a double-pole switch in the branch. (*d*) The cut-out, switch, and resistance device must be composed of non-inflammable material. (*e*) The light must be protected by a globe, etc., the same as is required for a high potential lamp.

ISOLATED PLANTS.

52. In isolated plants, (*a*) the dynamo, regulating devices, switchboards, and all wires connecting the same, must be installed

in conformity with the requirements for a standard central station (see 53 to 67) and (*b*) should never be placed in any room where they will be exposed to flyings of any combustible materials.

Dynamos.

53. (*a*) Insulated on thoroughly dry wood, (*b*) "filled" to prevent absorption of moisture. (*c*) A waterproof cover should be provided, and kept over each dynamo when not running.

Wires.

54. (*a*) Wires from dynamos to switch-board, and (*b*) thence to outside lines ('bus wires, feeders, primary mains, arc circuit leads and returns), (*c*) to be wholly exposed to view, (*d*) supported by glass or porcelain insulators, and (*e*) of sufficient sectional area to prevent heating. (*f*) Where passing through floors, partitions, or other wood-work, (*g*) to be protected by substantial tubes of glass or porcelain, (*h*) which shall project above and below floors, and beyond the surface of partitions, so as to insure perfect insulation. (*i*) Hard rubber tubing may be used except where passing through the floors at or near the dynamo.

55. (*a*) Where leaving the building, the wires to be looped downward, and (*b*) the tubes in which they are inclosed to be inclined so as to prevent the entrance of rain water along the wires.

56. (*a*) Wires of opposite polarity should be separated at least twelve inches, (*b*) particularly where passing through floors and partitions.— (*c*) Conductors from ceiling or floor to switchboard may be run at a less distance than twelve inches from each other, (*d*) but in that case an approved insulation must be provided.

57. If (*a*) conductors from dynamos are run under floors—(*b*) except the space underneath be a perfectly dry, finished room, and (*c*) not less than six feet between floors—(*d*), they must be specially insulated, and will then be subject to approval.

58. (*a*) Each feeder and primary main to be provided with a safety fuse on a non-combustible base. (*b*) All wire connections must be soldered, if necessary, to secure good contact.

59. Branch wires for station lighting to be in accordance with the requirements of this Exchange for electric light wiring.

Switchboards.

60. (*a*) To be kept free from moisture, (*b*) located apart from woodwork, (*c*) accessible from all sides, (*d*) not inclosed, and (*e*) with all electrical devices, wires and connections in plain sight.— (*f*) When all wires and electrical devices are on the front the switchboard may be set against a brick wall, (*g*) but must be detached from any woodwork.— (*h*) The switchboard should be constructed

either of slate or some other non-combustible insulating substance, or (*i*) so-called "Skeleton."

61. (*a*) All switches and wires on the switchboard must have ample capacity and (*b*) contact to carry their possible maximum load without heating.

Lightning Arresters.

62. (*a*) To be located in sight of attendants, and (*b*) so placed and constructed that an arc if formed will not come in contact with woodwork or other combustible material. (*c*) Lightning arresters should be so designed as to automatically destroy any arc which may be formed by a lightning discharge or otherwise.

Equalizers.

63. (*a*) Frames to be constructed of non-combustible material. (*b*) To be open and accessible from all sides, (*c*) supported at least twelve inches from all woodwork, (*d*) and located so as to be in sight of dynamo attendants.

64. (*a*) All resistance devices to be so designed as to heat but slightly when in use, and (*b*) connected so as not to be liable from a short circuit or other cause to an overcharge of current; (*c*) otherwise they must be inclosed in non-combustible cases and (*d*) kept away from any woodwork.

Care and Attendance.

65. A competent man must be kept constantly in the dynamo room while the dynamos are running.

66. (*a*) Oil must not be allowed to accumulate on the floor, and (*b*) all oily waste must be kept in standard metal waste-cans, or (*c*) removed from the station daily after the dynamos are stopped and cleaned.

67. Arc lamps must always be provided with perfect globes.

MOTORS.

68. Motors must (*a*) be placed as near as possible to the point where wires enter the building. (*b*) be mounted on filled dry wood, (*c*) be raised at least eight inches above the surrounding floor, (*d*) be kept clean, and (*e*) covered with a waterproof cover when not in use, and (*f*) if deemed necessary by the inspector, be inclosed in an approved case.

69. Standard metal waste-cans, with a self-closing cover and legs raising the can at least three inches from the floor, must be provided for oily waste.

Switches, Regulators, and Cut-Outs.

70. (*a*) The controlling switches must be so constructed as to entirely disconnect the motor from the circuit, and (*b*) a cut-out such as is required for a similar lighting circuit must be placed as near as possible to the point where the wires enter the building.

71. All switches, regulators, cut-outs, etc., must (*a*) be as nearly non-combustible as possible, (*b*) be protected from moisture, (*c*) have a backing of porcelain, slate, cement, asbestos, or other equally non-combustible substance, and (*d*) be perfectly insulated.

Wiring.

72. (*a*) Wire having a waterproof insulation must be used. (*b*) The wire must be rigidly supported (*c*) on porcelain, glass, or other non-combustible insulators, free from contact with the building, and (*d*) at least six inches apart. (*e*) No concealed work, (*f*) cleat-work, or (*g*) wires fastened with metallic staples will be approved.

73. (*a*) When wires pass through walls, floors, partitions, etc., or (*b*) wherever protection from mechanical injury is necessary, (*c*) they must be protected by glass, hard rubber, or other moisture-proof, non-inflammable tubing. (*d*) Soft rubber tubing will not be approved.

74. These rules are not intended to preclude the running of small motors for fans and the like on low potential lighting circuits, the installation of which has received the approval of the inspector.

75. The entire installation must test free from grounds; but motors run on a "ground circuit" may be approved by the inspector, under these rules, provided the return

wire is carried to a ground outside of the building.

LIGHTING FROM GROUND RETURN POWER CIRCUITS.

76. Electric railway power stations and their car sheds may be lighted by incandescent lamps connected with their power wires, if the installation of the wires meets with the approval of the Inspector, but no other property may be so lighted.

MISCELLANEOUS.

77. Splices, in both arc and incandescent circuit wires, must be made so that a perfectly secure and unvarying connection fully equal to the cross-section of the wire will be secured. The splice must be soldered, but solder must never be employed to complete a joint that would be loose or insecure without it Either resin or an acid solution may be used as a flux; both are objectionable if not carefully applied.

78. Architects are urged to familiarize themselves with these rules, and to see that all contracts are made subject to the work being done in accordance therewith, and also to see that it is so done. The New England Insurance Exchange will gladly aid them to this end by giving information, advice, or inspection to as great an extent as possible.

79. A great danger in all installations is from poor contacts; consequently avoid screw joints as much as possible; screw them up tight with good areas of contact; on no account allow them out of sight. Solder every connection as far as practicable.

80. When an electrical fire breaks out, turn off the current at the nearest switch, or sever the conductors one at a time ; then use your appliances. The injudicious use of water with out these precautions may only increase the extent of the fire. In severing conductors of high electromotive force, be careful that you stand on a good insulator, such as dry wood, and that the handle of your hatchet is dry, or personal injury may result.

DEFECTIVE APPARATUS.

81. The electric inspector of this Exchange shall report to its Secretary such electrical apparatus as he finds is not installed in accordance with the rules of this Exchange.

82. The Secretary shall at once notify both the assured and the party installing the apparatus of all defects; and if at the expiration of thirty days from such notice he shall not have been duly notified that said defects have been remedied, the rate on both building and contents shall be advanced at least 10 cents, and the new rate duly promulgated by him.