DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 49

SAFETY RULES

TO BE OBSERVED IN THE OPERATION OF ELECTRICAL EQUIPMENT AND LINES

Being Part 4 of the Proposed National Electrical Safety Code

[2d Edition]
Issued May 4, 1915

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SAFETY RULES TO BE OBSERVED IN THE OPERATION OF ELECTRICAL EQUIPMENT AND LINES

INTRODUCTION

The study of life and property hazards incident to the generation, distribution, and use of electrical energy includes the consideration of construction methods on the one hand and of operation methods on the other.

Analysis of the available electrical accident data shows a large proportion of accidents to be preventable by the observance of definite operating precautions. A considerable number of electrical utilities and some manufacturing companies have published sets of such operating rules as were suggested by their own experience or derived from the experience of other companies. Recently the value of such rules in promoting the safety of employees and the public has been given more widespread attention, and some study of the subject has been made independently by several State commissions.

For nearly two years the Bureau of Standards has been engaged in a study of safety rules to govern the operating practice of employers and employees in electrical work. Both practice and results are found to vary widely in different localities, and hence local opinion and custom are evidently not a sufficient guide for commissions and companies desiring to secure adequate protection of this character. Where rules have their source chiefly in local experience or in exchange of experiences with a limited number of other companies, they may be open to the objection that precautions are prescribed to prevent a particular class of accident only after such an accident has occurred locally. They may thus permit the occurrence of accidents which might be avoided by the observance of rules proceeding from a broader

study and experience. Thousands of the smaller companies, in the absence of sufficient data and experience to prepare rules, have no printed rules at all. The growth of compensation laws has emphasized the urgent necessity for State commissions to adopt rules for the electrical industry as well as for other industries, and the demand for an adequate standard set of such rules has now become general.

After extended comparisons and analyses of existing sets of rules and aided by the suggestion of commissions, company officials, and workmen, a code of safety rules was drawn up and offered for criticism, discussion, and in so far as was found desirable for adoption. This set of rules was published August 1, 1914, as Bureau Circular No. 49, and about 2000 copies were distributed to electrical companies, besides a large number to State commissions and committees of engineering societies and others, with a request for comment and criticism. Several hundred letters were received in response to this request, and the many careful criticisms received were utilized in a thorough revision of the rules.

In the meantime the accident committee of the National Electric Light Association had the rules of Circular 49 reprinted with some modifications of their own and sent them out for criticism to a considerable number of companies, receiving a large number of careful letters in reply. The committee then met the representatives of the Bureau, and together they made a final revision, which is presented in this second edition of Circular 49.

The thanks of the Bureau are presented to all those who have assisted in the work of revision, and particularly to the National Electric Light Association and its accident committee for its valuable cooperation.

Great advantage will result to companies and workmen alike by the general adoption by the several States of a single standard set of safety rules for operation, which can be revised from time to time in accordance with the progress of the art and the combined experience of all the companies and commissions using them. Thus will every State and every company secure the advantage of the experience of all.

Where particular rules do not apply, their omission will, of course, cause no conflict in practice. If it is necessary for any State commission to adopt additional rules, that could be done at any time by special orders. This would be easier and less confusing than to have a different set of rules for each separate State.

The present urgent demand for a standard set of safety rules for operation is due to a very general recognition of the need of such rules. The following rules are offered with the hope that they will in large measure meet this need, and with the belief that the general adoption and use of these rules will result in a material reduction in the life hazards to electrical workers and the public.

S. W. Stratton,
Director.

Approved:
A. L. Thurman,
Acting Secretary.

PLAN AND SCOPE OF THE RULES

The following safety rules apply to the operation of, and work on or about, power and signal lines, the electrical equipment of central stations, substations, private plants, and on electrical tests, and tunnel, subway, or similar underground work.

The first two sections of the rules are addressed to the employer. The next six sections contain general rules for employees, and these are followed by rules under separate headings which refer to special classes of work.

The rules for the employer are subdivided for convenience into two groups. The first covers matters relating to the organization, such as the issuance of rules, diagrams, and emergency instructions to employees, the determination of the qualifications of employees by suitable examinations, and the division of responsibility among employees. The second treats of the portable safeguards which the employer should provide, the operating precautions which he should enforce, and the uniform reporting of accidents on which the ultimate analysis and elimination of electrical accident causes must depend, which latter is so inadequately handled by most States and companies to-day. The employer is required to enforce the observance of the safety rules issued to the employees.

The general rules for the employees are subdivided into six groups. The first enumerates those general precautions the necessity for which seems obvious but the noncompliance with which is, nevertheless, responsible for many injuries. The second presents general operating rules defining the duties and relations of those employees who direct others and the operating methods by which safety is secured. The third group prescribes the precautions for handling live parts under varying conditions of voltage and location. The fourth and fifth deal with the procedures for assuring the continued safety of work about normally live or moving parts, respectively, by avoiding all possible sources of misunderstanding when killing such parts. The sixth

group covers in some detail the procedure for making grounds on equipment or lines for the protection of workmen.

Special rules for employees are grouped into separate headings, each covering those peculiar to some special class of electrical work. Each class of worker is directed to familiarize himself also with the general rules which apply to all classes of electrical employment. By this arrangement a more adequate treatment has been realized without unnecessary repetition.

While all the rules find application in the larger industrial or private plants and in moderate-sized utilities, some do not apply (or apply less fully) in the smaller. It has seemed unwise, however, to attempt to restrict the scope of the rules to those which are applicable to all organizations or to all classes of electrical work.

These rules do not cover requirements for the construction, installation, and maintenance in safe condition of electrical lines and equipment. Such rules, which are also necessary for the safety of employees and the public, are included in a separate set, which is divided into three parts. The first part on stations and substations contains rules which are numbered from 100 up; the second, on overhead and underground supply and signal lines, contains rules which are numbered from 200 up; the third, on utilization equipment, contains rules numbered from 300 up. Together with these operating rules, which are numbered from 400 up, they will constitute a complete code of safety rules for electrical practice, except that the rules for signal line operation have not been brought together as compactly as could be desired. This defect will be remedied in the near future by a fuller treatment in a separate section of operating rules for signal linemen working on telephone and telegraph circuits for public use, with terminology better adapted to their special needs.

When the first three sections of the code have been as thoroughly criticized and as carefully revised as these operating rules have been, the whole will be issued together as a National Electrical Safety Code.

RULES FOR THE EMPLOYER

40. ORGANIZATION

400. Copy of Rules

The employer shall furnish to each employee operating or working on electrical supply equipment, power or signal lines, or electrical tests, with a copy of these safety rules for operation, and shall take suitable means to secure the employee's compliance with the same.

Many companies number their books of rules and require a receipt from each employee for his copy.

401. Organization Diagram

To better assure the safe and accurate performance of work, an organization diagram or written statement clearly showing the division of responsibility between members of the organization, should be supplied with the book of rules or posted conspicuously in offices or stations of the company.

402. Address List and Emergency Rules

The rule book should contain or be accompanied by the following:

(*a*) A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.

(*b*) A copy of rules for first aid, resuscitation, and fire extinguishment.

403. Drilling Employees

Employees working on or about equipment or lines shall be thoroughly and regularly drilled in approved methods of first aid, resuscitation, and fire extinguishment.

404. Posting Rules and Diagrams Permanently

Copies of these safety rules, address list, and directions for emergencies shall be permanently kept in a conspicuous location in every station and testing room. It is recommended that they be placed also in every line wagon.

405. Qualification of Employees

Each employer should use every reasonable means and precaution to assure himself that each employee is mentally and

physically qualified for the work he is to perform, and that he is not addicted to the use of intoxicants and habit-forming drugs.

The employee shall be instructed in the application of these rules to his work, and sufficient further instruction and supervision shall be given to assure his continued fitness and knowledge of these rules.

The demonstration of the employee's fitness may be by oral or written examination or by any other satisfactory means.

406. Chief Operator

A properly qualified chief operator, system operator, load dispatcher, general superintendent, or otherwise designated official shall be placed in charge of the operation of electrical equipment and lines as provided in rule 430, and he shall be directly responsible to the management for the safe conduct of all operation.

In large organizations the duties of the chief operator may be delegated for particular sections of the system to deputy chief operators (or otherwise designated officials), who shall report as required to the chief. A deputy may perform these duties only for circuits which have no separate source of energy supply not entirely under his control.

In small organizations the duties of the chief operator may be performed by the superintendent, electrician, engineer, or some other employee who may also perform other duties.

In these rules the various officials listed by above titles, including the deputy chief operator, will be designated (for simplicity) by the title of chief operator.

407. Local Foreman

If more than one person is engaged in work on or about the same electrical equipment or lines at any one location, one of the persons shall always be designated as the foreman locally in charge of the work.

41. PROTECTIVE METHODS AND DEVICES

410. Attendance

A qualified employee shall be kept on duty where generators or rotary converters are operating, excepting small, low voltage apparatus for telephone and similar work, unless the equipment is remotely controlled and its operating conditions indicated by use of pilot circuits or other suitable method at a station where an operator is located. In the latter case the generating equipment shall be made inaccessible to unauthorized persons.

411. Two Workmen

Except in emergencies, at least two employees should be provided where work is done on live lines above 750 volts in wet weather or at night.

412. Uninstructed Workmen and Visitors

No unqualified employee or visitor shall be allowed to approach any live parts, unless accompanied and safeguarded by a qualified employee.

413. Diagrams for Chief Operator

Diagrams or equivalent devices showing plainly the arrangement and location of the electrical equipment and lines should be maintained on file or in sight of the chief operator.

The diagrams for lines should show the relative position and voltage for different wire arrangement on poles or other supports on which power lines are carried, and for each crossing with other lines.

These diagrams may be of the entire system, of each specific portion of the system, or they may show typical arrangements.

414. Instructions for Foremen

Suitable means for identifying all equipment or lines on or near which work must be done should be supplied to the foreman locally in charge of such work.

Instructions shall describe the equipment and lines to be worked on, identifying them by position, letter, color, number, or name.

415. Protective Devices

There shall be provided in conspicuous and suitable places in electrical stations, testing departments, and line wagons a sufficient supply of suitable protective, first-aid, and fire-extinguishing devices and equipment, to enable employees to meet the requirements of these rules. Such devices and equipment shall be periodically inspected and tested to insure that they are kept in good order. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

(*a*) First-aid outfits.

(*b*) Insulating wearing apparel, such as insulating gloves, sleeves, and boots.

Insulating shields, covers, mats, stools, and platforms.

Insulating appliances, such as rods and tongs, for any necessary handling or testing of live equipment or lines.

(*c*) Protective goggles of suitable materials and construction.

(*d*) Tools of such special design and insulation as to eliminate so far as practicable the danger of forming short circuits across conducting parts at different potentials or bringing the user into circuit with such parts.

(*e*) "Men at work" tags, log books, operating diagrams or equivalent devices, and portable danger signs.

(*f*) Fire-extinguishing covers and appliances, either designed for safe use on live parts, or plainly marked that they must not be so used.

(*g*) Grounding devices for making protective grounds.

The above devices shall be kept, when not in use, in their regular location and in good working order.

Safety belts, whether furnished by employer or employee, should be inspected periodically to assure their safety.

416. Warning and Danger Signs

There shall be displayed in conspicuous places at all unattended or unlocked entrances to electrical supply stations and testing rooms or rooms containing exposed live or moving parts permanent warning signs forbidding entrance to unauthorized persons.

Suitable danger signs shall be placed in power stations and testing rooms about equipment having exposed current carrying parts above 750 volts.

417. Accident Reports

A report for each personal injury should be made at the time of the accident or as soon thereafter as practicable. The report should contain the following information in addition to that otherwise required·

(*a*) Nature and cause of accident. State whether carelessness of injured person or defects of construction, protection, or illumination, caused the accident.

(*b*) Nature and extent of injury.

(*c*) Was original cause of injury electrical or otherwise?

(*d*) Voltage and type of circuit if concerned in the accident.

(*e*) What first aid was given; how soon after the injury; and how long continued?

(*f*) How could this accident have been prevented?

GENERAL RULES FOR THE EMPLOYEE

42. GENERAL PRECAUTIONS

420. Rules and Emergency Methods

The safety rules should be carefully read and studied. Employees may be called upon at any time to show their knowledge of the rules.

Employees should familiarize themselves with approved methods of first-aid, resuscitation, and fire-extinguishment by regular drills.

421. Heed Warnings, Warn Others

Employees whose duties do not require them to approach or handle electrical equipment and lines should keep away from such equipment or lines.

They should cultivate the habit of being cautious, heed warning signs and signals, and always warn others when seen in danger near live equipment or lines.

422. Inexperienced or Unfit Employees

No employee shall do work for which he is not properly qualified on or about live equipment or lines, except under the direct supervision of an experienced and properly qualified person.

Employees should not undertake any work which they believe themselves unable safely to perform.

423. Supervision of Workmen

Workmen whose employment incidentally brings them in the neighborhood of electrical supply equipment or lines, with the dangers of which they are not familiar, shall proceed with their work only when authorized. They shall be accompanied by a properly qualified and authorized person, whose instructions must be strictly obeyed.

424. Exercise Care

Employees about live equipment and lines should consider the effect of each act and do nothing which may endanger themselves or others. Employees should be careful always to place them-

selves in a safe and secure position to avoid slipping, stumbling, or moving backward against live parts. The care exercised by others should not be relied on for protection.

425. Live and Arcing Parts

(*a*) TREAT EVERYTHING AS ALIVE.—Electrical equipment and lines should always be considered as alive unless they are positively known to be dead. Before starting to work preliminary inspection or test should always be made to determine what conditions exist.

(*b*) PROTECTION AGAINST ARCS.—If exposed to arcing, the hands should be protected by insulating gloves, and the eyes by suitable goggles or other means.

Employees should keep all parts of their bodies as distant as possible from brushes, commutators, switches, circuit breakers, or other parts at which arcing can occur during operation or handling.

426. Safety Appliances and Suitable Clothing

(*a*) SAFETY APPLIANCES.—Employees at work on or near live parts should use the protective devices and the special tools provided, first examining them to make sure that these devices and tools are suitable and in good condition. Protective devices may get out of order or be unsuited to the work in hand.

(*b*) SUITABLE CLOTHING.—Employees should wear suitable clothing while working on or about live equipment and lines. In particular, they should keep sleeves down and avoid wearing unnecessary metal articles, celluloid collars, celluloid or metal cap visors, or similar articles. Near live or moving parts loose clothing and shoes that slip easily on floors worked upon should not be worn.

427. Safe Supports and Safety Belts

(*a*) SAFE SUPPORTS.—Employees should not support themselves on any portion of a tree, pole structure, scaffold, ladder, or other elevated structure without first making sure that the supports are strong enough, reinforcing them if necessary.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the surfaces are smooth or vibrating.

(*b*) SAFETY BELTS.—Employees should not work in elevated positions unless secured from falling by an approved safety belt or by other adequate means.

428. Repeat Messages

To avoid misunderstandings and to prevent accidents, each person receiving an unwritten message concerning the handling of lines and equipment shall immediately repeat it back to the sender and secure his full name and acknowledgment. Each person sending an unwritten message shall require it to be repeated back to him by the receiver and secure the latter's full name.

43. GENERAL OPERATION

430. Duties of Chief Operator

The chief operator, as described in rule 406, shall keep informed of all conditions affecting the safe and efficient operation of the system, and shall keep a suitable record or log book showing all changes in such conditions. He shall read and sign such record when assuming duty and sign again on being relieved. He shall keep within sight operating diagrams or equivalent devices indicating whether electrical supply circuits are open or closed at stations under his immediate jurisdiction and where work is being done under his special authorization.

His further duties will vary according to the size and character of the system.

(*a*) In the case of distribution from a single station, such further duties would usually be as follows:

He shall direct the starting and stopping of generating equipment and the opening and closing of outgoing circuits. He shall give permission for work to be done on live lines above 7500 volts and in all cases where circuits are killed at the station for the protection of workmen.

(*b*) In the case of a system consisting of one or more generating stations and a number of substations the duties of the chief operator would usually be as follows:

He shall have direct charge of all generating and substation equipment and interconnected transmission and feeder lines, and

except where definite operating schedules are in effect, shall direct the starting and stopping of generating and substation equipment.

He shall give permission for all work on live interconnected lines and for all work where circuits are killed at the generating stations for the protection of workmen.

In these rules, the person performing these duties is designated as chief operator, regardless of his ordinary title.

431. Duties of Foremen

(*a*) Each foreman in charge of work shall see that the safety rules are observed by the employees under his direction. He shall make all the necessary records, reporting to the chief operator when required. He shall permit only authorized persons to approach places where work is being done.

(*b*) The qualified person accompanying uninstructed workmen or visitors near electrical equipment or lines shall take such precautions as are necessary to provide suitable safeguards, and see that the safety rules are observed.

432. Special Authorizations

(*a*) SPECIAL WORK.—Special authorization from the chief operator shall be secured before work is begun on or about station equipment, transmission or interconnected feeder lines, or live lines above 7500 volts, and in all cases where lines are to be killed by regular procedure at stations, and a report shall be made to him when such work ceases. When there is more than one workman at any location, the foreman shall secure the authorization.

Exception.—In emergency, to protect life or property, or when communication with the chief operator is impossible, due to storms or other causes, any qualified employee may make repairs on or about the equipment or lines covered by this rule without special authorization, if he is sure that his action will promote safety, and that the trouble is such as he can promptly clear with the help available, in compliance with these rules. The chief operator must thereafter be notified as soon as possible of the action taken. (See rule 436.)

(*b*) OPERATIONS AT STATIONS.—In the absence of specific operating schedules for opening and closing supply circuits at stations, or starting and stopping equipment, employees shall secure special

authorization from the chief operator before performing these operations. In all cases such special authorization shall be secured where circuits or equipment control devices are tagged at stations to protect workmen.

Exceptions.—In emergency, to protect life and property, any employee may open circuits and stop moving equipment without special authorization, if he is sure that his action will promote safety, but the chief operator must be notified as soon as possible of such action, with reasons therefor. To maintain service, any qualified employee may also reclose circuits opened by automatic cutouts, subject to the provisions of rule 434 of this section.

(*c*) Cutting Out Sections of Circuits.—Portions of distribution circuits below 7500 volts may be cut off by authorized workmen by means of sectionalizing switches, where provided, without permission from the chief operator. In such cases the switches should be tagged (and if possible, blocked) as usually done at stations. Protective grounds should also be made, where this will promote the safety of the workmen.

433. Restoring Service after Work

No instructions for making alive equipment or lines which have been killed by permission of the chief operator to protect workmen, shall be issued by him until all workmen have reported clear. When there is more than one workman at a location, the foreman shall report clear for all his workmen, but only after all have reported clear to him. If there is more than one gang, each foreman shall separately report clear to the chief operator.

434. Maintaining Service

(*a*) When live circuits on which "Men at work" tags have been placed are opened automatically, they should be kept disconnected until the chief operator has given proper authorization for reconnection.

(*b*) When overhead circuits other than trolley and third-rail circuits open automatically, the local operating rules shall determine how they may be closed with safety for persons on or near those circuits. The chief operator shall be advised of the conditions.

(*c*) When circuits feeding supply lines become accidently grounded, as shown by the indication of ground detectors at stations, they shall be tested to determine where the ground exists. If the ground can not be definitely located and removed by the operator, an immediate report of the finding shall be given to the chief operator, who shall order a patrol of the lines affected to definitely locate and remove the ground as soon as practicable.

Above 7500 volts it will usually be found advisable to disconnect until the lines have been found cleared of the ground.

435. Tagging Electrical Supply Circuits

Before work is done on or about any equipment or lines used as transmission or interconnected feeder lines, or lines operating above 7500 volts, or lines killed at stations or substations to protect workmen, the chief operator shall have "Men at work" tags attached at all points where such equipment or lines can be manually controlled by regular operators, to plainly identify the circuits worked on.

Before work is done on or about any equipment or lines which are killed by the foreman in charge of the work, at points other than stations, the foreman shall have "Men at work" tags placed at all points where the circuit has been disconnected, to identify the portion worked on.

436. Protecting Traffic

(*a*) Barrier Guards.—Before engaging in such work as may endanger traffic, employees shall first erect suitable barrier guards. They shall also display danger signs or red lamps from two sides of the barrier at right angles to the direction of the traffic. Where traffic requires it a man shall be stationed to warn passers-by while work is going on.

(*b*) Crossed or Fallen Wires.—When crossed or fallen wires are found of your own or other utilities, the employee shall remain on guard and have the chief operator notified. If the voltage is below 7500, and the employee can observe the rules for handling live parts by the use of insulating appliances, he may correct the condition at once. Otherwise he shall first secure the authorization from the chief operator for so doing. (See rule 432.)

437. Protecting Workmen by Disconnectors

When equipment or lines are to be disconnected from any source of electrical energy, for the protection of workmen, the operator must first open the switches or circuit breakers designed for operation under load, and then the air-break disconnectors, when provided.

44. HANDLING LIVE EQUIPMENT AND LINES

In all the rules, voltage means in general the effective voltage of the circuit, except that in a three-wire circuit with grounded neutral (either d. c. or low-voltage secondary a. c.) the voltage is the effective voltage between either side and the neutral. When one circuit is electrically connected to another circuit of higher voltage as in an autotransformer, both are considered as having the voltage of the higher, unless the lower is effectively grounded. In three-phase systems the voltage is the maximum effective voltage between phase wires.

Signal equipment and lines not over 400 volts are not considered alive, except where made alive by leakage from power equipment or lines. They are, however, a source of danger when near live supply lines, due to their liability of being grounded.

440. General Requirements

(*a*) Touching Live Parts.—No employee should touch at the same time two parts of different potential. Where this must be done, insulating gloves or other protection shall be used.

No employee should touch any exposed ungrounded live parts above 150 volts to ground unless he is insulated from other conducting surfaces.

Concrete, masonry, earth, and the damp surfaces of wood poles, platforms, floors, and other structures are conducting surfaces.

(*b*) Wire Insulation.—Employees shall not place dependence for their safety on the insulating covering of wires.

All precautions for handling live parts in this section should be observed in handling insulated wires.

Insulation on a wire may look perfect, but it frequently can not be relied on to prevent shock.

(*c*) Exposure to Higher Voltages.—Every employee working on or about equipment or lines exposed in overhead construction to higher voltages should assure himself that they are free from dangerous leakage or induction or have been effectively grounded.

(*d*) Cutting Into Insulation on Live Conductors.—When the insulating covering on live wires or cables must be cut into, the employee should use a suitable tool. While doing such work it is recommended that suitable goggles be worn to protect the eyes and insulating gloves to protect the hands.

When metal sheathing must be removed from cables, it should be done with special tools which will not injure the insulation. The sheathing should be so cut as to leave enough exposed insulation after the conductor has been bared to avoid arcing over between the conductor and the sheath. If the cable consists of more than one conductor, similar exposed insulating surface should be left for each conductor, using insulating blocks between conductors, if necessary.

Other insulating devices, such as wood separators, etc., should be examined to eliminate conducting materials, sharp edges, nails, or offsets which may defeat the purposes for which they were intended.

441. Voltages between 750 and 7500

Where practicable, no employee should come or bring any conducting object within 6 inches of any exposed live part whose voltage exceeds 750 in stations, testing rooms, in underground construction, or in overhead construction, except as follows:

(*a*) In dry locations this distance may be less than 6 inches, if approved insulating or grounded metal devices are placed between the person and the part or object.

Insulating devices might be shields, covers or gloves. Grounded devices might include metal barriers, switch cases, etc.

The distance may also be reduced if approved insulating barriers (such as mats, stools or platforms, as well as shields or other approved barriers) are placed between the person and the ground, as well as between the person and all other conducting surfaces which he could accidentally touch at the same time.

(*b*) In all damp or dark locations, also, where grounded surfaces are exposed (unless grounded metal barrier devices are employed),

the distance may be less than 6 inches if insulating devices are used both between the person and the live parts and between him and all other conducting surfaces.

Where safe distance can not be secured by use of the special insulating tools and appliances furnished, properly tested insulating gloves and sleeves may serve as portable insulating devices between the person and live parts.

Care should be exercised in using insulating gloves to avoid puncturing them on sharp edges, especially in making wire splices.

442. Voltages above 7500

No employee should come or bring any conducting object within the distances named below from any exposed live part at or above the voltage specified, except as permitted by this rule.

Operating voltage.	Distance (feet).
7500	1
27 000	2
47 000	3
70 000	5

(*a*) In dry locations these distances may be reduced if approved insulating or grounded metal guards or barriers are placed between the person and such part or object.

The inclosing case of a transformer, oil switch, or other equipment is such a guard.

(*b*) If the part is being directly worked on, the tools or other mechanical appliances used must provide the full distance of insulating material, unless protective guards are also used between the person and the live part. These protective guards may be disks of insulating material on the handles of rods or tools which are suitable for the voltages to be handled.

443. Working Alone

Except in emergencies, no employee shall work alone near live lines above 750 volts in wet weather or at night.

444. When to Kill Parts

No employee shall approach any exposed ungrounded part normally alive, except as provided in rules 441 and 442 of this section, unless he has first assured himself of his own safety and the safety of those working under his direction by following the regular procedure for killing supply equipment and lines.

445. Opening Circuits and Working from Below

(*a*) Opening and Closing Switches.—Manual switches and disconnectors should always be closed by a single unhesitating motion, and, if possible, with one hand.

(*b*) Work from Below.—Employees should avoid working on equipment or lines from any position by reason of which a shock or slip will tend to bring the body toward exposed live parts. Work should be done from below, rather than above.

446. Connecting Wires and Grounds

(*a*) Handling Connecting Wires.—In connecting dead equipment or lines to a live circuit by means of a connecting wire or device, employees should first apply the wire to the dead part before attaching it to the circuit. When disconnecting, the live end should be removed first.

Loose conductors should be kept away from exposed live parts.

Metal measuring tapes or those having metal threads woven into the fabric should be avoided.

(*b*) Applying Grounds.—In applying a grounding device to normally live parts the device must be grounded before bringing it near the parts, and must be removed from the live parts before removing it from the ground connection.

447. Never Open Series Circuits

Live series circuits, such as arc light circuits or secondaries of current transformers to meters or other devices, should never be opened until a jumper has been connected across the point of opening. Before working on any device in a series circuit, a jumper shall be connected around it.

448. Stringing Wires

In stringing wires near live lines the wires being handled should be treated as alive unless they are effectively grounded by approved means.

Hand lines used to pull wires over live circuits should not contain metal strands.

449. Fire Extinguishers

Fire-extinguishing liquids or covers which are not insulating should never be employed in fighting fires near exposed live parts.

A stream of water, or a wet blanket, or a stream from an ordinary carbonate of soda extinguisher, should not be used on live parts. If necessary to use them, have all neighboring equipment killed.

45. KILLING SUPPLY EQUIPMENT AND LINES

Except where circuits below 7500 volts are killed by the foreman himself at points other than at stations, the following precautionary measures shall be taken in the order given as a means of preventing misunderstanding and accident. In small organizations the chief operator may himself operate the switches and disconnectors, in which case the procedure is much simplified.

450. Foreman's Request

The foreman in charge of the work shall request from the chief operator permission to have the particular equipment or lines killed, identifying them by position, letter, color, number, or other means.

451. Opening Disconnectors and Tagging

The chief operator shall direct the proper persons to open all switches and air-break disconnectors through which electrical energy may be supplied to the particular equipment and lines to be killed and shall require each person to block each disconnector open and to tag the same, and each tag shall state in large letters "Men at work".

The person shall, when placing the tag, record thereon the time of disconnection, his own name, the name of the foreman who requested the disconnection, and the name of the chief operator.

Where equipment or lines can be made alive from two or more sources, all such sources must be disconnected. This will apply to work on lines with more than one station, also to transformers in banks, rotary converters, motor generators, switches, and other similar equipment.

452. Station Protective Grounds

When all disconnectors designated have been opened, blocked, and tagged the chief operator shall require each person operating them to make protective grounds upon the lines being killed and to report to him when such grounds are in place.

453. Permission to Work

Upon receipt of information from all persons operating disconnectors that protective grounds are in place the chief operator shall advise the foreman that the specified equipment or lines have been killed and that he may proceed to work.

454. Foremen's Protective Grounds for Overhead Lines

The foreman should immediately proceed to make his own protective grounds on the disconnected lines. Such grounds shall be made between the particular point at which work is to be done and each disconnector which has been opened by the above procedure for his protection.

455. Proceed with Work

After the equipment or lines have been killed (and grounded, if overhead lines), the foreman and those under his direction may proceed with work without taking the precautions required on or about live parts.

456. Other Gangs

Each additional foreman desiring the same equipment or lines to be killed for the protection of himself or the men under his direction shall follow the same procedure as the first foreman and secure similar protection.

457. Reporting Clear

The foreman upon completion of his work, and after assuring himself that all men under his direction are in safe positions, shall remove his protective grounds and shall report to the chief operator that all tags protecting him may be removed, and shall further report himself "Mr. —— and men clear and all grounds removed", and shall give his location.

458. Removal of Tags

The chief operator shall then direct the removal of tags for that foreman from the disconnectors, and the removal shall be reported back to him immediately by the persons removing them.

Upon the removal of any tag, there shall be added to its record the name of the chief operator and foreman who requested the tag, the time of removal, and the signature of the person removing the tag.

459. Restoring Service and Filing Tags

Only after all protecting tags have been removed by the above procedure from all disconnectors shall the chief operator, at his discretion, direct the removal of protective grounds and blocks and the closing of any or all disconnectors.

The chief operator shall file all tags.

46. KILLING MOVING PARTS

Except where the employee about to work on normally moving parts of electrical equipment during periods of rest can protect himself against their accidental starting by locking or blocking the starting devices, the following precautionary measures shall be taken in the order given as a means of preventing misunderstandings and accidents. In small organizations, the chief operator may himself adjust the starting devices, in which case the procedure is much simplified.

460. Foreman's Request

The foreman shall request from the chief operator permission to have the particular moving parts killed.

461. Blocking and Tagging

The chief operator shall direct the proper persons to so adjust all cutouts, valves, or other devices by which motion of such parts is controlled that motion will be prevented, and shall require each person to block the devices in a safe position and to tag the same, and each tag shall state in large letters "Men at work".

The person shall, when placing the tag, record thereon the time of such adjustment, his own name, the name of the foreman who requested the adjustment, and the name of the chief operator.

462. Permission to Work

Upon receipt of information from all persons operating cutouts, valves, or other devices that such devices have been properly adjusted, blocked, and tagged, the chief operator shall advise the foreman that the specified moving parts have been killed and that he may proceed to work.

463. Other Gangs

Each additional foreman desiring the same moving parts to be killed shall secure authorization in the same manner from the chief operator.

464. Reporting Clear

Each foreman upon completion of his work, and after assuring himself that all men under his direction are in safe positions, shall report to the chief operator that all tags protecting him may be removed and shall report himself "Mr. ——— and men clear".

465. Removal of Tags

The chief operator shall then direct the removal of tags for that foreman from the starting devices, and the removal shall be immediately reported back to him by the person removing them, who shall record on each tag the name of the chief operator and foreman who requested the tag, time of removal, and his own signature.

466. Restoring Service and Filing Tags

Only after all protecting tags are properly removed from all starting devices may the chief operator direct the removal of blocks and the operation of any starting device.

The chief operator shall file all tags.

47. MAKING PROTECTIVE GROUNDS

470. Procedure

When making protective grounds on a circuit the following precautionary measures must be observed in the order given. The ground must be made to each wire of the circuit separately, unless after the first is grounded the others are successively short-circuited with it.

471. Ground Connections

The employee making protective grounds on equipment or lines shall first connect one end of an approved grounding device to an effective ground connection supplied for the purpose.

Where permanent ground connections are used they should be periodically tested.

472. Test of Circuit

The normally live parts which are to be grounded should be tested for any indication of voltage, the employee carefully keeping all portions of his body at the distance required from such parts when alive, by the use of suitable insulating rods or handles of proper length.

Dangerous voltages may exist on equipment or lines entirely disconnected from their source of energy, through induction from other lines or through the retention of a static charge. Hence, a test is necessary even where equipment or lines are known to have been disconnected.

473. Completing Grounds

If the test shows no voltage, the free end of the grounding device shall be brought into contact with the normally live part and securely clamped or otherwise secured thereto.

In stations, remote control switches can generally be employed to connect the equipment or lines being grounded to the actual ground connection. On lines, it is generally necessary to resort to portable grounding devices or chains handled directly by means of insulating handles, rods or ropes.

474. Removing Grounds

In removing a protective ground the employee shall not remove the grounding device from the ground connection until the device has been disconnected from all normally live current-carrying parts.

SPECIAL RULES FOR EMPLOYEES

48. SUPPLY STATION AND SWITCHBOARD OPERATION

Engineers, machine attendants, switchboard operators, and helpers shall study and strictly observe the following, in addition to all the general rules in sections 42 to 47.

480. Care About Machines

Do not allow oil cans, tools, dusters, or wiping cloths to catch in moving parts of machinery. In passing any switchboard or machine in operation, do not touch it unnecessarily nor allow metal tools or other metal objects to touch the apparatus or its connections. Do not use iron or tin oil cans near field magnets. Use only oilers, dusters, or wipers with insulated handles on or about commutators, switches, switchboards, or other electrical equipment.

481. Care About Live or Moving Parts

Do not work on or near exposed live or moving parts unless authorized to do so, and then strictly observe the rules for such work.

When working near fuses and circuit breakers or other apparatus which may arc suddenly, be careful to avoid injury from their operation.

When working on one section of a switchboard or in one compartment, mark it conspicuously and place barriers to prevent your accidental contact with live parts in that section or adjacent sections.

When working on or about live parts and standing on insulated stools, ladders, or otherwise insulated from the ground, avoid handing metal tools or other conducting objects to other persons who are not insulated.

482. Handling Fuses or Brushes

In handling fuses above 750 volts, use the special rods or tongs and stand on insulating platforms or mats, where provided. Keep the body as distant and as far below as possible and use only one hand.

Replace or remove link fuses from live terminals or brushes on live equipment only when absolutely necessary, and then with due precautions.

483. Battery Rooms

Do not smoke or cause arcing in storage battery rooms. The use of open flames should be avoided, especially while the cells are gassing, and should be permitted only in special cases under the direct supervision of an experienced person, and after the room has been thoroughly ventilated.

484. Elevated Positions

When working in an elevated position, especially above live or moving parts, assure yourself of the security of your position and support, taking precautions to avoid dropping tools or materials.

485. Handling Switchboard Equipment

All ungrounded metal parts of devices on switchboards shall be handled as if operating at the highest voltage to which any portion of the equipment on the same switchboard panel is subject, unless the parts are known by test or otherwise to be free from such voltage.

When cable plug connectors are used, do not allow one end to remain hanging loose while the other end is connected to a live terminal.

In handling instrument circuits never open the secondary of current transformers when alive.

486. Report Circuit Trouble to Chief Operator

Report to the chief operator any unusual conditions of load, the opening of any automatic cutout, and the indication of any accidental ground on an outgoing circuit.

487. Report Defects

Promptly report to your superior any dangerous conditions of equipment or surroundings, including defective tools, switches, or protective devices, or live cases or frames of apparatus or instruments.

49. OVERHEAD LINE OPERATION

Linemen and assistants and groundmen, in construction, extension, removal or repair work, shall study and strictly observe the following, as well as all the general rules in sections 42 to 47.

490. Test Poles Before Climbing

Before climbing poles, ladders, scaffolds, or other elevated structures first assure yourself that the pole, ladder, scaffold, tree, crossarm, messenger wire, cable car, or boatswain's chair or other elevated support is strong enough to safely sustain your weight.

Poles should be tested for decay near the ground line with a bar, screwdriver or other tool, and sounded for decay at the center by rapping with a heavy tool or block of wood.

When poles or crossarms are apparently unsafe from decay or unequal strains of wires on them they should be properly braced and guyed, if necessary, before climbing.

491. Use Pole Steps

Where poles are stepped, make use of such steps in climbing.

Do not support yourself by pins, brackets, crossarm braces, or conductor wires.

492. Care About Live Parts

Do not go among any wires until you know their voltage.

Leaning over and crowding through unprotected wires should be avoided wherever possible. Place yourself so that you will not be liable to fall on wires should an accident occur.

Do not depend on the insulation of wires, and treat all lines as alive unless they have been properly killed (except signal lines known to be clear).

Treat also as alive all wires (unless thoroughly grounded) which are being strung near supply lines; regard them as being of the same voltage as the supply lines.

Avoid use of hand lines or measuring tapes containing metal strands.

In handling switches or fuses use only suitable insulating handles, rods or tongs.

493. When Touching Live Parts

When working on live equipment or lines never allow any portion of the body to come in contact with any live or grounded part other than that worked on.

While touching supply lines or equipment, avoid touching ground wires, guy wires, span wires, metal pipes, metal sheaths, signal lines or equipment, transformer cases, hangers and other

metal fixtures on poles, or metal poles. (Signal lines are included because of their liability to become grounded.)

While touching signal lines or equipment, metal sheaths, metal pipes, ground wires, or metal fixtures on poles, avoid touching supply lines or equipment, guy or span wires.

494. Protecting Traffic

When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand line in proper receptacle.

Workmen must not stand where they can be struck by materials dropped by men working overhead.

Pole holes and obstructions shall be protected by watchmen or by suitable guards and danger signals or lights in a location conspicuous to traffic.

When working overhead, or hoisting or lowering materials above spaces where traffic occurs, a man should be stationed to warn passers-by.

Where traffic is light, warning signs may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

495. Stringing Lines

Never string wires near live lines except by means of suitable insulating hand-lines or other appliances.

Wires should not be strung above live lines operating at over 750 volts, unless the wires being strung are effectively grounded or all the precautions for approaching those live parts are observed, and the spacings provided in rules 441 and 442 are maintained.

Never change the strains on a pole by adding or removing wires, until assured that the pole will stand the altered strains.

496. Report Defects

Report promptly to your immediate superior any dangerous condition of your own or other utilities observed arising from defective insulators, pins, cross arms, sagging wires, etc.

50. UNDERGROUND OPERATION

All cable splicers and other workmen in underground construction or operation shall study and strictly observe the following in addition to the general rules in sections 42 to 47.

500. Guarding Manholes, Handholes, and Street Openings

When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier or other suitable guard, and display danger signals or red lights in a location conspicuous to the traffic until covers are in place or excavations filled.

501. Test for Gas

Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, by testing with approved safety lamps, by ventilation, or by other adequate methods.

502. Watchman at Surface of Manholes

Do not enter manholes unless a man is stationed at the surface.

Do not leave manholes unwatched until all workmen are out.

503. Avoid Flames

Do not smoke in manholes and avoid as far as practicable open flames or torches in or near manholes.

Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffiine see that it does not reach a temperature at which it will ignite.

504. Pulling Cables

In pulling in cables make sure that the gear can not slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

505. Testing and Splicing Live Cable

If lines and cables are not properly identified by markings or positions, do not work upon them.

Always test cables with the test devices provided before cutting into the cable sheaths. Live cables should be spliced only by men experienced in the work, and they should use extreme caution and suitable devices in so doing.

506. Report Defects

Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly report insanitary conditions, gas or missing cable tags in manholes, and sagging wires or broken supports in overhead construction.

51. SERIES LAMP OPERATION

All series lamp trimmers, hangers, and inspectors shall study and strictly observe the following in addition to the general rules in sections 42 to 47, and the special rules under the sections for overhead and underground operation, respectively, in sections 49 and 50.

510. Treat as Alive

Series lamps and devices in series circuits should always be treated as alive unless disconnected by absolute cutouts or protected by the grounding of the circuit.

511. Handling Series Lamps

Trimmers, inspectors or patrolmen shall wear suitable insulating gloves and stand on insulating platforms or dry, well-seasoned wood poles, while touching series lamps or their cutouts, when these are alive.

Where stools or tower wagons are used which provide sufficient insulation from ground for the voltages to be handled, the insulating gloves may be dispensed with.

Trimmers, inspectors or patrolmen should not handle any live lamps, except upon authorization to work on them in that condition, and shall then observe the rules for handling live parts in section 44.

512. Bridge Series Lamps

Before working on lamps or other devices in live series circuits, always bridge the devices with jumpers such as series lamp cutouts usually provide, so that the circuit can not be opened at the device.

513. Testing Series Lamp Circuits

Series lamp circuits should not be tested with their full operating voltage unless otherwise impracticable, and then only at specified times, and all persons whose safety may be affected shall be notified.

514. Periodically Disconnected Circuits

Circuits such as series lamp circuits shall be effectively grounded during the idle period, or else all rules for handling live parts shall be strictly observed.

515. Report Defects

Report promptly to your immediate superior any sagging wires, broken insulators, leaning poles, defective pole steps, broken globes, lamp supports, and other defects giving rise to a dangerous condition of your own or other utilities, or any indication of voltage on lines supposed to be dead.

52. METER OPERATION

All meter setters and adjusters must study and strictly observe the following in addition to all the general rules in sections 42 to 47.

520. Taped Joints

Never leave joints or loose ends of wires untaped.

521. Care About Live Parts

Do not use bare fingers or hands to determine whether a circuit is alive. Never remove or replace fuses in live circuits above 750 volts without the approved appliances provided.

522. Open Circuits at Switches

Do not open circuits at meter connections until the circuits have been first properly opened at switches.

523. Special Tools

Use only suitable hand tools, and so reduce the danger of short circuits.

524. Report Defects

Promptly report to your immediate superior any live meter case, or any condition of a meter or its connections, of the interior wiring, or of overhead lines, of your own or other utilities, which might endanger life and property.

53. TESTING OPERATIONS

All electrical testers, helpers, and others working about electrical tests shall study and strictly observe the following in addition to all the general rules in sections 42 to 47. Owing to the diversified character of testing work, this study should usually extend also to the special rules in sections 48 to 55.

530. Authorization

Do not work on or about equipment or lines without first receiving authorization from the person in charge.

If such equipment or lines are under control of a chief operator, this authorization must come from him. This will include the attaching of tags at the proper points and the observation of all rules for general operation in section 43.

531. Check All Conditions

Thoroughly familiarize yourself with all conditions surrounding equipment or lines to be tested before making any change in these conditions.

Do not make any change in equipment or lines unless you fully understand the effect of the change.

532. Local Foreman

One properly qualified person must be in immediate charge of all testing work.

533. Warnings and Barriers

Display danger signs and erect suitable guards about all equipment or lines under test when in places where traffic occurs.

Where temporary wiring, belts, pulleys, or other temporary live or moving parts must be guarded, suitable portable guards and warning signs shall be used.

534. Two Men

No person should work unaccompanied in testing or experimental work on or about parts on which the voltage can exceed 750 volts.

535. Report Defects

Promptly report to your immediate superior any conditions of equipment or lines under test which may endanger life or property.

54. SIGNAL LINE OPERATION

All men working on or near overhead or underground telegraph, telephone, police, fire, district messenger, or other signal lines shall study and strictly observe the following, in addition to all the general rules in sections 42, 43, and 44, and the special rules in sections 49 and 50.

Only a portion of the rules in other sections apply to work on or about signal lines which are not operated in conjunction with supply lines. Conveniently arranged rules for workers on

such lines used for commercial purposes and subjecting workmen to electrical life hazard through leakage or induction from neighboring supply lines are being prepared as a separate section of these rules, and will appear in later editions.

540. Official in Charge of Operation

In those rules where the words chief operator are used the official in charge of safeguarding operation is to be understood.

541. Before Climbing Poles

Before climbing poles or other structures to work on or about signal lines, especially where occupied jointly with or running near power circuits, make a careful inspection to ascertain if there are any crosses with foreign circuits.

If such supply lines exist, do not proceed to work unless instructions for your protection have been received from the proper official and you are complying with such instructions.

Apply mechanical tests on messenger wires before trusting them to carry your weight.

542. Approaching Supply Lines

Avoid contact with all wires other than those you know to be signal wires, assuming such other wires always to be alive. Signal wires in trouble may be in contact with supply lines at some distant point and should be treated as live supply lines, unless known to be free from any dangerous voltage.

Do not approach any power line or power equipment within the distances given in rules 441 and 442 under section 44, unless you comply with all the rules under that section.

543. Touching Equipment

While handling signal lines, metal sheaths or signal equipment, avoid touching guy or span wires and supply lines or equipment. Especially avoid standing on or touching transformer cases, hangers or connections.

544. Stringing Wires

When stringing wires or cables over or under supply lines, avoid any possibility of their coming in contact. Where liability of contact can not be entirely avoided, the lines being handled shall be treated as alive (unless they are effectively grounded), and you must carefully observe the rules in section 44, so far as they are applicable.

545. Report Dangerous Conditions

Promptly report sagging wires, broken insulators, pins, crossarms, leaning poles, or any dangerous conditions of your own or other utilities on or near your lines to the proper official.

55. TUNNEL AND SUBWAY OPERATION

Tunnel and subway electricians, operators, and others working on or about underground electrical equipment shall study and strictly observe the following, in addition to the rules in sections 42, 43, 44, 48, and 50.

DANGEROUS LOCATIONS.—The value of insulation as protection from shocks is reduced by the dampness usually present in these and similar locations. The restricted spaces often bring the worker closer to equipment and wires than in other kinds of electrical work, and the imperfect illumination also makes special care necessary to avoid contacts. The human body and all surrounding surfaces become more conducting where dampness exists, and electrical shocks are therefore more severe.

550. Live Electrical Parts

Before handling any electrical equipment or wires, make sure whether they are alive or dead. It is not advisable to work on live equipment or wires when the current can be shut off without interrupting necessary operations.

Never touch or disturb any electrical equipment or wires without being authorized by the chief electrician in charge. It is dangerous to fool with live wires. Never enter an electric-motor room, or interfere with its operation, unless authorized to do so.

551. Standing on Ground

Do not touch any electric wire, cable or third rail, no matter how well it is insulated, while you are standing on the ground or on any pipe, track, rail, or other conducting surface, unless insulated from the latter. Also avoid slipping and stumbling while near wires or third rail.

Do not touch the metal frame or case of a motor, unless you are insulated from the ground or the frame is effectively grounded.

Remember that the surfaces of damp ground and water are conducting surfaces. Insulation on a wire may look perfect, but it can not be relied on to prevent shock.

552. Carrying Tools

In carrying tools or metal implements in passageways containing electric wires, especially near exposed trolleys, never permit the tools or implements to touch them.

In particular, do not carry such objects on the shoulder when there are bare wires overhead. Do not carry objects on that side of the passageway where third rails or side trolley wires are exposed.

553. Repairing Live Parts

When necessary to handle or repair live trolley wires, third rails, cables, motors, or other electrical equipment, wear suitable insulating gloves and stand on the waterproof insulating mats or platforms provided.

Do not rely entirely on gloves for protection. They may have been punctured since they were previously tested.

Before handling or making use of any electrical cable, carefully examine it to make sure that its insulation is not injured.

Inspect trailing cables at least once daily during the period of their use.

554. Handling Portable Devices

In handling portable motors or lamps, first make sure that the external metal frame is not alive by contact with or leakage from live parts within.

Have such portable devices inspected at least once daily during the period of their use.

555. Fuses and Switches

Never handle fuses or close switches or circuit breakers unless you are authorized to perform that special duty, and then use the insulating handles or rods provided.

Before closing switches first make sure that you are not endangering others.

556. Injuring Cables and Wires

Do not fire shots, handle tools, or perform other work in such a manner as to injure cables or wires in the vicinity. If in doubt, consult the chief electrician.

557. Temporary Circuits

Never arrange the wiring of any temporary circuits for ground return.

This particularly applies to shot-firing circuits and cables to portable motors and lamps.

558. General Precautions

Never get on or off locomotives or cars on the trolley-wire or third-rail side.

Do not place combustible or explosive materials near electric wires, trolley tracks, third rails or motors.

Do nothing that will cause sparking, or expose parts that may arc or spark during operation, if any explosive gases are present.

559. Report Dangerous Conditions

Report any dangerous or unusual conditions observed to the proper authority. In particular, report the presence of gas, sagging wires, broken insulators, bad insulation on wires, defective third-rail construction, live frames of motors, broken ground wires on motor frames, and sparking or arcing noticed at any point.

Report also any fallen or crossed wires, whether electrical or not. This also includes trolley wires at partings, and crossings and wires injured through falling roofs.

NOTES ON THE RULES FOR OPERATION

401. Organization Diagram

The organization diagram is important in small as well as large organizations, so that team work will be encouraged and the acts of each workman be governed by intelligent appreciation of his relation to the organization as a whole. Emergencies are thus more readily and safely met and service correspondingly improved. It is particularly important that each man in charge of other men should have the relative duties of these clearly defined, and so be better able to direct the conduct of work.

403. Drilling Employees

The drilling of employees in emergency methods, the resuscitation of persons rendered unconscious electrically, the temporary treatment of wounds and fractures, or the extinguishment of fire, are all essential to avoid panic or nervousness when emergencies arise. By actual drilling the method becomes a part of the employee's regular habit, and dependence can be placed on its being properly used when need arises. With some companies such drills are given by the various foremen, with others they are a part of the instruction given by regular instructors in the business of electrical operation.

404. Posting Rules and Diagrams Permanently

The posting of operating rules is an effective means for keeping them constantly before the workmen, so encouraging them through familiarity with the rules. In emergency even the best trained man may lose his self-possession, and instructions conspicuously posted will frequently supply the necessary fixed ideas at such times.

405. Qualification of Employees

The mental and physical condition of employees constitute a strong factor in the character of the service of the utility and no less a factor in the accident record. The choice of employees has been less carefully made than must necessarily be the case in the future with the various compensation laws imposing on the industry the disability losses entailed by defective men as well as by defective installations.

Suitable choice of workers also demands inquiry into their use of intoxicants or habit-forming drugs. Users of either, even to so mild a degree as would ordinarily excite no comment, may become sufficiently affected to impair their judgment, and, because of the special nature of

electrical work, to greatly increase the danger to many others besides themselves. As it is so difficult to test the exact effect of the use of intoxicants or drugs in some individuals, and the danger is in general so apparent, some companies have found it advisable to prohibit all use of either of them at any time. Others have so far restricted this prohibition to working hours. There is a growing tendency toward greater strictness in this regard.

The initial fitness of a worker does not insure the continued maintenance of such fitness. This must be secured by instruction and frequent examination, and those companies most carefully pursuing such follow-up methods claim that the expense of such constant supervision is small and the results in better service and reduced disability are very marked.

406. Chief Operator

In all operating organizations a responsible head is essential to prevent conflict among various parts of the organization and so to secure smooth and efficient operation. This need is very evident in operation involving so much danger for workers as does that of electrical supply systems. Many companies have arranged a very definite division of responsibility, including the assignment of a chief who directly controls all manual operations affecting work on or about transmission lines and interconnected feeders, and keeps informed of all conditions affecting the safety of public and workers.

Such an arrangement is of the greatest importance in emergencies, when general understandings, which are unreliable at the best, break down entirely. The more diversified organizations will frequently require a chief operator, all of whose time is given to proper correlation of the work for the safety of the workers and proper maintenance of the service. With smaller or less complicated organizations the chief operator will frequently have other duties occupying most of his time, but from which he can detach himself when necessary to direct operation.

407. Local Foreman

In every group of workers, however small, one should always be understood to be the leader or senior, to give and receive messages and orders for the group. He may be called "boss," "leader," or by any term, but for convenience is referred to as "foreman," although not necessarily having such rank.

410. Attendance

When generating equipment is operating without any attendance or knowledge of its operating conditions, the outgoing circuits may be doing serious damage to life or property unknown to those responsible for this condition. Good service usually demands this attention, but

with some induction generators and some specially arranged remotely controlled generators the presence of an operator at the point of operation is unnecessary. In such cases the building must be secured against damage by fire or entrance of unauthorized persons from without. It is no less essential that the condition of outgoing circuits be known through instrument indications at points under competent attendance.

411. Two Workmen

Where a workman on dangerous work is accompanied and watched by another person, he is ordinarily less subject to nervousness and can be carefully warned when necessary. He can be saved from unnecessary movements and aided in many ways so as to make the work as safe as possible. In case of injury he can be quickly aided and help called if necessary.

Many companies make the assignment of two men mandatory on any highly dangerous work, and some have defined closely the cases under which two men will be required. Several statutes and some commission orders also deal with the safeguarding by an additional employee. The British factory law requires that no one unaccompanied by another workman shall do any work where technical knowledge or experience is required to avoid danger.

417. Accidents Reports

Reports of electrical accidents are now required by many State commissions, municipalities, and casualty companies for those cases falling under their jurisdictions. The nature of these reports is not identical among these various authorities, and on some injuries several separate reports to different authorities are called for, while on others no reports are made to any authority, unless death results, in which case reports are usually made by the coroner. In none of these report forms at present in use is sufficient information called for on many important electrical factors of the accident, such as voltage and character of construction or method of operation. Definite information of this kind will often indicate what improvements in construction or operation are desirable.

An agreement is desirable among States and casualty interests as to an accident report covering all essential features of the accident on which to base an adequate statistical study and search for preventive measures. The various reports now in use are being studied by the Bureau, with the purpose of ultimately proposing such a report form. Some European countries require certain information which is lacking in reports as made in this country.

420. Rules and Emergency Methods

Rules to employees, no matter how excellent in themselves, must become thoroughly familiar to the workmen, if they are to be valuable in the emergencies which occur in operation. The distribution of rules has been required in order to make this information available and so promote the safety of the employees; and each employee in turn owes a duty to others to know the methods which will best safeguard them as well as himself. The employer will serve his own interest and that of employees by requiring employees to know the rules. Many companies have established schools of instruction, and where this is practicable the enthusiasm and team work brought about tend toward better as well as safer service. Local bulletins, suggestion and question boxes, working models of poles, manholes, and equipment all serve to develop and maintain the necessary active interest and cooperation of employees.

423. Supervision of Workmen

Though a man may be experienced for his own particular class of work, as, for instance, a painter, carpenter, etc., he may be quite ignorant of the danger in approaching the live parts of electrical equipment and lines with which he is inexperienced. The regular station attendant and the lineman may approach such parts with comparative safety. It is, therefore, advisable for men without the special experience which will safeguard them about electrical equipment to be under the direct supervision of an experienced and properly qualified person while in such locations.

425. Live and Arching Parts

As it is frequently impossible to see whether equipment is operating, and just as impossible to know whether crosses exist at a distant point with other live lines, it is usually better to consider the electrical equipment and lines alive and treat them as in that condition.

428. Repeat Messages

Many accidents are due to misinterpretation of instructions or information, and the practice of repetition of unwritten messages is widely practiced to avoid misunderstandings of this kind.

The regulations of some companies require that both parties make a written record of telephone messages, which are later preserved for references.

430. Duties of Chief Operator

In order that the chief operator may properly perform his duties, full information regarding the equipment and its operating conditions should

be maintained, so as to be quickly available for his use. His decisions require sound judgment and prompt attention. Loss of time in getting at the conditions should be reduced to a minimum. It is clearly impossible to keep all records in sight, but better results should be obtained from having them at hand and the more important features kept in diagrams in plain sight.

In some organizations the duties of chief operator are too heavy for a single person, and hence these duties are subdivided along lines determined largely by the physical arrangements of the operating system. Where one or more stations feed into an interconnected system a single head is indispensable for avoiding dangerous conflicts of judgment and of instructions. Where any one of these stations, however, feeds outgoing lines not also fed from any other source, it is perfectly feasible for the operator at such a station to perform the duties of chief operator so far as such lines are concerned. He may be called chief operator, or division operator, or simply station operator, but so long as he is duly invested with certain authority over conduct of work on such lines—the opening and closing of circuits and similar duties—the purpose is accomplished, and his records and reports can in turn be submitted as required to the system operator (or otherwise designated official) in charge of the entire system.

435. Tagging Electrical Supply Circuits

This rule defines the character of circuits which must be tagged to prevent careless closing while persons are at work thereon. The procedure by which one person may disconnect lines and tag them as a protection for other workmen, sometimes at distant locations, is covered in detail in section 45.

437. Protecting Workmen by Disconnectors

With high voltage circuits where oil switches are commonly employed to interrupt the circuit under load air-break disconnectors are generally necessary and usually inserted to obviate the slight leakage which usually occurs through oil switches and which would seriously endanger persons working on lines disconnected from the source of energy only by those oil switches.

442. Voltages over 7500

Work on or about live lines or equipment over 7500 volts should be undertaken only when absolutely necessary, and then only when the most thorough precautions are taken. Insulating rods, tongs, and similar appliances have, however, been so developed that lines even of 40 000

volts can be tied to insulators, and other similar work accomplished with apparently no greater hazard than accompanies the handling of ordinary 2300-volt circuits with the protection afforded by insulating gloves.

European countries usually permit no work whatever on live lines or equipment over 1000 volts. This results in comparatively few fatalities to overhead linemen, but in this country probably such a requirement would often make the highly desirable continuity of service an impossibility.

Exact distances may be mentioned in tables, but it will often be impossible to measure the distance except with the eye. Personal judgment must be relied on to a large degree, and the distances specified will sometimes be insufficient.

It is thought that forming safe habits soon results in involuntary carefulness and will minimize the loss of time.

446. Connecting Wires and Grounds

The great importance of making the ground connection first when grounding normally live parts and breaking the ground connection last, is well illustrated by a fatality which recently occurred when an entirely dead line was grounded, and when the operator pulled up the grounding rod before removing the connections from the line wires. The lines were of considerable extent, very well insulated, but the charging current was sufficient to kill the workman, who probably thought that the rule might be neglected in that particular case, since he knew the lines were dead.