



U.S. Department  
of Transportation

# Memorandum

Research and  
Special Programs  
Administration

John A. Volpe  
National Transportation Systems Center

Subject: PROGRESS REPORT: Development of an  
Outline of Model Set of Work Rules

Date: 3/13/96

From: Ike Tingos

Reply to

Attn. of: DTS-701

To: G. Deily, RDV-31

Thru: R. Dorer

As part of the preliminary safety study of electrified railroad systems, the Volpe Center has developed an initial outline of a model set of electrical operating instructions (safety work rules). These may act as suggested guidelines for newly emerging electrified railroads which may be operated by an organization not having any previous experience in electrified operations.

The proposed outline is based upon the review of numerous industry standards, available railroad electrical operating instructions and safety rules, government regulations, and other relevant standards.

The main parts of a recommended model set of electrical operating instructions (safety rules) would include as a minimum:

- approach distances
- hot line work procedures
- tagout and lockout procedures
- protection duties
- grounding procedures
- use of personal protective equipment
- work in confined and enclosed spaces
- precautions for the operation of MOW and construction vehicles (including wire trains, etc.)
- work in elevated places and on platforms
- emergency first aid/rescue procedures.

A summary of the model work rules development has been developed and attached. At this time, draft text sections have been completed for all the above subjects, except for:

- 1) work on energized lines,
- 2) work on MOW and construction vehicles,
- 3) emergency first aid rescue procedures.

These completed sections are attached.

As mentioned in our previous progress report(attached), dated January 3, 1996, comprehensive reviews of existing standards, regulations and available railroad instructions have been completed. The results of the review are contained in a set of appendices that are attached. It is intended that these appendices provide the basis for the outline of the model electrical safety work rules.

In Appendix A a review of the National Electric Safety Code (NESC) was made. This review focused on the NESC applicability to railroads. Part 4 of the NESC, titled Rules for the Operation of Electric Supply and Communications Lines and Equipment, is the section of the NESC that contains its work rules. Table A.1 of Appendix A is an outline of these work rules.

In Appendix B, a review of the NFPA 70E, Electrical Safety Requirements for Employee Workplaces, was performed. This standard was revised in 1995. An outline of the work rules and safe work practices portion of the standard is provided in Table B.1 of Appendix B.

In Appendix C, a review of OSHA standards for work rules and safe work practices was performed. Safe work practices can be found in various parts of the OSHA regulations including Parts 1926 and 1910. A detailed outline of the following OSHA (29 CFR) standards are included as tables in Appendix C:

- Part 1910 Subpart S Electrical
- Part 1910 Subpart R Section 269 Electric Power Generation, Transmission and Distribution
- Part 1926 Subpart K Electrical
- Part 1926 Subpart V Power Transmission and Distribution.

In addition, brief reviews of other related OSHA regulations were also performed. These include Part 1910, Subpart J, Section 146, Permit Required Confined Spaces, Section 147, Control of Hazardous Energy Sources (Lockout and Tagout), and Part 1910, Subpart R, Section 268, Telecommunications.

In Appendix D, a review of the available electrified railroad operating instructions and safety rules was performed. The documents which were analyzed were provided by Amtrak, Long

Island Railroad, Metro-North Railroad, and New Jersey Transit through the National Traction Power Committee. A comparison of these instructions and rules was made and is summarized in Table D.1. Detailed outlines of Amtrak's Electrical Operating Instructions (AMT-2) and NJ Transit's Electrical Operating Instructions (TRO-3) were also developed, and are provided as Table D.2 and Table D.3, respectively. Preliminary comments also were prepared for each of the reviewed railroad operating instructions and safety rules. Selected requirements, as given in the railroad safety work rules, were compared to the OSHA, NESC, and NFPA 70E standards discussed in the other appendices. These comments focused on clearances, approach distances, protective grounding, tagout and lockout, and the use of personal protective equipment. Therefore, these comments are not intended to be all-inclusive but illustrate the differences between the various standards.

#### Attachments

cc:

F. Raposa, Unisys  
PPA #RR-693 File



DEVELOPMENT OF MODEL WORK RULES  
FOR ELECTRIFIED RAILWAY SYSTEMS

1.0 Background.

The recently completed study, "Safety Considerations With Electrification: A Preliminary Review and Assessment", made several recommendations for reducing the electrical hazards that are associated with the construction and operation of electrified railways. As part of that study, a preliminary risk reduction analysis was carried out which was directed at work rules and safe work practices. The preliminary analysis compared risk reduction methods to the requirements of selected existing regulations and industry standards. One of the recommendations of the study was that the electrical safety work rules and safe work practices used in the U.S. by current electrified railway operators be made available in some form for potentially new operators.

As part of a preliminary effort, the Volpe Center has developed an initial outline of a model set of electrical operating instructions, or electrical safety work rules. The elements of the initial outline may act as suggested guidelines for newly emerging electrified railroads which may be operated by organizations not having previous experience in electrified operations.

2.0 A Brief Historical Review of the Development of Safety Work Rules and Safe Work Practices.

In general, the specific safety work rules and safe work practices for an organization reflect the operating and maintenance experience of that organization. Specifically for railroads, electrical operating instructions are issued for the protection of employees and other authorized personnel, for the protection of the public, and for the protection of property. Railroads normally issue electrical safety instructions to those personnel in the engineering, operations and maintenance departments whose duties involve working on or working near electrical lines and equipment.

Industry standards such as the National Electrical Safety Code (NESC) have long contained what are considered to be the minimally acceptable requirements for electrical safety work rules and safe work practices. The NESC has had work rule requirements in the Code dating back to its earliest editions in the 1920s. The Institute of Electrical and Electronics Engineers (IEEE) operates as the secretariat for the NESC.

The National Fire Protection Association (NFPA) is the organization responsible for the National Electrical Code (NEC). In response to the need resulting from OSHA for electrical safety work rules, NFPA produced the standard, Electrical Safety Requirements for Employee

Workplaces, ANSI/NFPA 70E. This standard, first published in 1976, was used as a model standard for OSHA usage during the initial phases of the development of OSHA regulations. NFPA 70E has since undergone a continuous evolution and the current 1995 edition comprehensively addresses installation safety requirements, safety related work practices, and safety related maintenance requirements.

When the Occupational Safety and Health Act (OSHA) became law in 1970, an effort was formally initiated by the federal government to codify into regulations industry-wide work rules and safe work practices. These regulations have since been evolving in stages. Since the early history of OSHA, industry standards groups such as the IEEE and the NFPA have provided assistance to OSHA with its development of model electrical safety work rules and safe work practices for electrical systems.

Since the introduction of OSHA's electrical safety regulations, the NESC committee has provided explanatory comments within the Code where NESC rules have differed from corresponding OSHA rules. In the 1990 edition of the Code, the NESC work rules were harmonized with the OSHA regulations in effect at that time.

OSHA regulations (29CFR) pertaining to electrical work rules fall into three broad categories. These categories are:

- Electrical Design Safety Standards
- Electrical Work Rules
- Electrical Safety Rules for Construction Sites.

The first two categories are included in 29CFR Part 1910, and the last category is included in 29CFR Part 1926. Part 1910 underwent a major expansion 1994, which is of particular concern to the effort being described here. A new section, 1910.269, was put into effect. This section addresses the electric safety regulations for electric power generation, transmission and distribution. An electrified railway could make extensive use of these system elements.

### 3.0 Model Safety Work Rule Initial Outline.

The initial outline for the main elements parts of a recommended model set of electrical safety work rules (operating instructions) would include as a minimum the following major topics.

1. Minimum approach distances to energized lines and equipment
2. Work on energized lines (hot line work)
3. Tagout and lockout procedures for work on deenergized lines and equipment
4. Protection duties and responsibilities for overseeing unqualified workers
5. Protective grounding procedures
6. Use of personal and other protective equipment
7. Work in confined and enclosed spaces
8. Precautions for the operation of MOW and construction vehicles, including wire trains
9. Work in elevated places and on platforms on or near energized lines and equipment
10. Emergency first aid/rescue procedures.

At this time, draft text sections of recommended practices and procedures have been completed for all of the above subjects except items 2, 8, and 10. The completed drafts are further discussed in the attached sections.

Comprehensive reviews of the existing standards, regulations discussed as well as available railroad electrical safety operating instructions have been completed. The results of the review are contained in a set of appendices that are attached. It is intended that these appendices would provide the basis for expanding the model electrical safety work rule outline.

Appendix A contains a review of the NESC. This review has focused on the applicability of the NESC to railroads. Part 4 of the NESC, titled "Rules for the Operation of Electric Supply and Communications Lines and Equipment" is the section of the NESC that contains its work rules. Table A.1 of Appendix A is an outline of those work rules.

Appendix B contains a review of the NFPA 70E, Electrical Safety Requirements for Employee Workplaces. This standard was

extensively revised in 1995. An outline of the work rules and safe work practices portion of the NFPA standard is provided in Table B.1 of Appendix B.

In Appendix C, a review is given of OSHA standards for work rules and safe work practices. Safe work practices can be found in various parts of the OSHA regulations, including Parts 1926 and 1910. A detailed outline of the following OSHA (29 CFR) standards are included in several tables in Appendix C.

- Part 1910 Subpart S Electrical
- Part 1910 Subpart R Section 269 Electric Power Generation, Transmission and Distribution
- Part 1926 Subpart K Electrical
- Part 1926 Subpart V Power Transmission and Distribution.

In addition, brief reviews of other related OSHA regulations are also discussed. These include Part 1910, Subpart J, Section 146, Permit Required Confined Spaces, Section 147, Control of Hazardous Energy Sources (Lockout and Tagout), and Part 1910, Subpart R, Section 268, Telecommunications.

In Appendix D, the available electrified railroad operating instructions and safety rules is reviewed. The railroad standards analyzed were provided by Amtrak, Long Island Railroad, Metro-North Railroad, and New Jersey Transit. These were provided through the National Traction Power Committee. A comparison of these railroad instructions and rules is summarized in Table D.1. In addition, detailed outlines of Amtrak's Electrical Operating Instructions (AMT-2) and New Jersey Transit's Electrical Operating Instructions (TRO-3) were also developed, and are provided as Tables D.2 and Table D.3, respectively.

Preliminary comments also have been prepared for each of the reviewed railroad operating instructions and safety rules. Selected requirements, as given in the railroad safety work rules, are compared to the OSHA, NESC, and NFPA 70E standards discussed in the other appendices. These comments have been focused on clearances and minimum approach distances, protective grounding, tagout and lockout requirements and procedures, and the use of personal protective equipment. Therefore, these comments are not intended to be all-inclusive but to illustrate the differences between the various standards reviewed.





## RECOMMENDED APPROACH DISTANCES

### I APPROACH DISTANCES FOR ALL EMPLOYEES EXCEPT CLASS A EMPLOYEES

1. The following pertains to all employees except Class A employees. Until all conductors and apparatus are deenergized and properly grounded, all persons, and the largest conductive object that they may contact, must not approach such conductors and apparatus within the distances given in Table I. Objects that are not insulated for the voltage involved shall be considered to be conductive.

TABLE I. APPROACH DISTANCES TO EXPOSED CONDUCTORS AND APPARATUS FOR UNQUALIFIED PERSONS

Voltage Range (phase to phase, RMS)	Approach Distance (ft-in)
0 V to not over 50 V	Avoid contact
Over 50 V, and less than 750 V	3-6
Third rail (750 V)	4-0
Signal Power (up to 6.9 kV)	5-0
Catenary over 11 kV, not over 25 kV	5-0
Catenary over 25 kV	8-0
Railroad Transmission (any voltage)	8-0
Utility Transmission (any voltage)	8-0
* For single phase and dc systems, use the voltage line to ground.	

### II Approach Distances for Class A Employees

2. When Class A employees are required to work in the vicinity of energized conductors and apparatus, whether on the ground or in an elevated position, the employee shall not approach or take any conductive object without an approved insulated handle closer to any exposed energized conductor or apparatus than that given for the restricted boundary space in Table II, unless the provisions given in paragraph 3 apply.
3. When Class A employees are required to work in the vicinity of

energized conductors and apparatus, whether on the ground or in an elevated position, the employee shall not approach or take any conductive object without an approved insulated handle closer to any exposed energized conductor or apparatus than that given for the restricted boundary space in Table II, unless:

- The Class A employee is insulated or guarded from the energized conductors or apparatus and no unguarded part of the person's body enters the prohibited boundary space set forth in Table II, or
- The energized conductor or apparatus is insulated or guarded both from the Class A employee and any other conductive object at a different potential, or
- The Class A employee is isolated, insulated, or guarded from all conductive objects at a different potential from that of the energized part.

TABLE II. APPROACH DISTANCES TO EXPOSED CONDUCTORS AND APPARATUS FOR QUALIFIED PERSONS (CLASS A EMPLOYEES)

Voltage Range (phase to phase, RMS)	Approach Distance (ft-in)	
	Restricted Boundary	Prohibited Boundary
0 V to not over 50 V	Avoid contact	
Over 50 V, and less than 750 V	1-0	0-1
Third rail (750 V)	1-0	0-3
Signal Power (up to 6.9 kV)	2-2	0-7
Catenary over 11 kV, not over 25 kV	2-7	0-10
Catenary over 25 kV	2-10	1-5
Railroad Transmission (any voltage)	3-7	3-1
Utility Transmission (any voltage)	4-0	3-6
* For single phase and dc systems, use the voltage line to ground.		



## RECOMMENDED TAGOUT AND LOCKOUT PROCEDURES

### I General Requirements

1. Implementation Responsibility. The employer shall be responsible for the implementation of tagout and lockout procedures. Employees shall be trained to understand the safety significance of their responsibilities in implementing tagout and lockout procedures. The tagout and lockout procedures shall be complied with when work is performed on or near deenergized conductors and apparatus where there is a danger of injury due to unexpected energization of conductors or apparatus. The employer shall conduct periodic inspection of the tagout and lockout procedures to ensure that they are being carried out.
2. Tagout and Lockout. If an energy isolating device is capable of being locked out, the tagout and lockout procedures shall utilize the lockout procedure, unless the employer can demonstrate that the utilization of the tagout procedure only can provide full employee protection. The lockout procedure shall make use of both locks and tags. If the energy isolating device is not capable of being locked out, the tagout and lockout procedures shall make use of the tagout procedure only, and will require the employer to demonstrate that utilization of the tagout procedure only provides full employee protection. The tagout procedure shall make use of warning tags which shall be attached at the same location that lockout devices would have been attached.
3. Training. Training shall be provided to ensure that all employees who are assigned to work on or near deenergized conductors and apparatus understand the purpose of the tagout and lockout procedure, and further understand the requirements of the procedure that apply to their specific work assignments.
4. Coordination with Other Procedures. The electrical tagout and lockout procedure shall be implemented in coordination with other appropriate procedures for safely isolating other energy systems that could endanger employees. Other energy systems likely to be encountered by employees include mechanical, hydraulic, pneumatic, thermal and chemical systems.

5. Tagout and Lockout Device Requirements. The tags, locks and other hardware required to be used shall be provided by the employer and shall be the only devices used to tag out and lock out circuits and equipment for personnel protection. The tags and locks that are used for personnel protection shall be:

- Standardized according to color, shape, size, type, or format
- Distinctive in appearance, easily recognizable ,and clearly visible
- Designed to convey all information required for the application
- Designed to deter accidental or unauthorized removal
- Designed to withstand the environment to which they are exposed.

## II Procedural Requirements

1. Procedures. The tagout and lockout procedures shall be documented and shall contain requirements to safeguard employees while they are working near deenergized conductors and apparatus in any situation where there is a danger of injury due to unexpected energization of such conductors or apparatus.

2. Administrative Provisions. The scope, purpose, and areas of application of the tagout and lockout procedure shall be defined. Administrative requirements, shall be specified and shall include responsibilities for implementation, compliance, and training.

3. Procedures for Deenergizing Conductors and Apparatus. The procedures to be used for applying tag out and lock out to deenergized conductors and apparatus shall include:

- Preplanning to determine where and how conductors and apparatus can be disconnected to safely deenergize them
- Equipment shut down procedures
- Procedures for disconnecting electric circuits and equipment
- Procedures for discharging or releasing stored energy.

4. Procedures for Applying Tags and Locks. Lockout and tagout devices must be affixed to the energy isolating device (e.g., a switch, circuit breaker, or other disconnecting means) by an authorized person only. The procedures to be used for applying tags and locks shall include the following:
- Lockout devices where used must be affixed in a manner that will hold the energy isolating device in a "safe" or "off" position.
  - Tagout devices where used must be affixed in such a manner as to clearly indicate that the operation of the energy isolating device from the "safe" or "off" position is prohibited.
  - The lockout and tagout device shall be under the exclusive control of the authorized employee.
  - Where multiple work gangs are involved and where the nature of the work requires it, multiple tags and locks shall be applied by each of the authorized employees.
  - Provisions shall be made for the removal of tagout and lockout devices by a designated individual in the case of the absence of the original authorized employee(s).
5. Procedures for Verifying Deenergized Condition. Prior to starting work the procedures for verifying a deenergized condition shall be:
- The authorized employee must verify by inspection and test that isolation and deenergization of the conductors and apparatus have been accomplished
  - Where appropriate, protective grounding shall be applied.
6. Procedures for Shift Changes. Provisions shall be included in the tagout and lockout procedures to assure coordination during shift changes or changes in employee assignments. Specific procedures shall include:
- Transfer of responsibilities and transfer of tagout and lockout devices
  - Removal of tagout and lockout devices by a designated individual in the case of the absence of the original authorized employee.

7. Procedures for Restoring Electric Circuits and Equipment. Procedures for restoring electric circuits and equipment shall cover the following requirements:

- Verify the circuits and equipment are in a condition to be energized
- Verify that employees are clear of circuits and equipment
- Remove tagout and lockout devices
- Remove protective grounding
- Release circuits and equipment for reenergizing.

8. Procedures for Testing or Temporary Operation. Where there is a need for testing or temporary operation of circuits and apparatus which have been deenergized, the following procedures shall be included:

- Verify that circuits and apparatus are in a condition to be safely energized
- Verify that employees are clear of the circuits and apparatus
- Verify that protective grounds have been removed
- Verify that tagout and lockout devices have been removed
- Release circuits and equipment for reenergizing.





## RECOMMENDED PROTECTION DUTIES

1. Employees assigned to the duties of protecting other persons must be thoroughly knowledgeable of the engineering safety rules, electrical operating instructions and other safe work practices, system operating rules, and system timetables. These employees must have a copy of these rules and instructions in their possession while on duty.
2. Employees assigned to protection duties shall have passed all required examinations and have been approved by proper authority. Generally, they shall have been classified by their knowledge and experience according to a rating system established by their employer (e.g., a Class A employee). A Class A employee shall be qualified to erect, repair, and maintain electric apparatus, catenary and other conductors, or to supervise and protect other persons doing such work.
3. The Class A employee will be responsible for the protection of each person to which he has been assigned.
4. At the beginning of each tour of duty, the Class A employee will instruct the foreman and all members of the work gang that he is protecting, of the dangers surrounding them, calling to their particular attention any hazards to be encountered by the nature of the work to be done.
5. Before any work is started, the Class A employee must indicate to the foreman and all members of the work gang the area to be protected on which work can be done. If practicable, such protected areas shall be identified by barricades or other markers clearly showing the protected area from unprotected areas.
6. When, if in the opinion of the Class A employee, there is anyone in the work gang who does not understand the instructions issued by the Class A employee, that individual must not be permitted to work or observe in the protected area.
7. The Class A employee must place himself in a position which will permit close observation of all locations close to energized conductors and apparatus. The selected position must enable him to best observe the movement of all persons toward such locations.
8. The Class A employee will not assume that the workers instructed by him will adhere strictly to such instructions. The Class A employee must remain alert to detect any potential violations of such instructions.

9. When clearances have been obtained, and the conductors and apparatus deenergized and properly grounded, the Class A employee will indicate to the foreman and each worker the conductors and apparatus which have been deenergized, and the location of the grounding devices which have been applied. The Class A employee must then obtain, on the appropriate form, the signature of the foreman indicating that he and the members of the work gang have been instructed, and that they will confine their work within the limits outlined to them by the Class A employee.
10. When there are two or more Class A employees engaged on the same operation, the one obtaining the clearance must have a thorough understanding with the other Class A employees as to the clearances obtained and the protective grounds to be applied.
11. When the Class A employee must leave the work gang for any reason, he must notify the foreman and all workers to stop all work in the vicinity of the deenergized conductors and apparatus. The Class A employee shall assure himself that all workers have moved to a safe distance before his departure. The Class A employee will obtain the signature of the foreman, on the appropriate form, indicating that he and his work gang have been informed that the Class A employee is leaving the work gang, and that they will not resume work in the vicinity of the conductors and apparatus until the Class A employee returns.
12. When the clearances are to be released, the Class A employee will inform the foreman and each member of the work gang. The Class A employee will personally observe that all workers have moved a safe distance from the conductors and apparatus to be energized before removing any of the protective grounds. The Class A employee will obtain the signature of the foreman, on the appropriate clearance form, indicating that he and the members of the work gang have been advised that the conductors and apparatus will be energized, and that they shall remain at a safe distance from such conductors and apparatus, until notified otherwise by the Class A employee.
13. When a Class A employee is assigned to protect more workers than he feels he can look after safely, he should promptly report the circumstances to his immediate superior, or in his absence, to the Power Supervisor.

14. The Class A employee shall inform the foreman of any worker on the job who is not working safely or who will not comply with his instructions. If trouble is experienced with the foreman in maintaining safe working conditions, the Class A employee shall immediately notify the Power Supervisor.
15. When circuits adjacent to the work area are energized, the Class A employee in charge must take the necessary precautions to keep tools, equipment and workers at a safe distance from energized circuits in compliance with the approach distance requirements given in the rules. If practicable, the area where adjacent circuits are energized shall be clearly delineated by barricades which shall prevent access to such area.



## RECOMMENDED GROUNDING PROCEDURES

1. Before any work is done on a line or equipment which is deenergized, it must be tested for voltage with an approved testing device and then properly grounded on all sides of the work area. Approved grounding devices must be applied on the adjacent poles or structures or at the nearest feasible location. Where practicable, grounding devices must be placed within sight of the workmen.
2. The size of the ground cables to be used must be at least equal to the size of the conductors feeding the circuit or equipment to be serviced. The cross sectional area of the ground cable and connections must be sufficient to carry the short-circuit current.
3. The grounding device must first be attached to the ground side and then secured to the line or equipment to be serviced. When installing grounds on the line or equipment side, approved hot sticks or other suitable insulating devices rated for the voltage involved shall be used for making the connection.
4. Before the final connection is made to the line or equipment to be serviced, the impedance of the ground cable and clamps must be tested with an impedance meter and the value should be much less than one ohm. Unless the measured impedance is extremely low, the ground connection is not adequate for personnel protection.
5. The removal of grounding devices must be handled in the reverse order of that in applying grounds. The end of the ground wire or cable attached to the line or equipment must be removed first and the ground side removed last. Unless the supervisor or the person in charge deems it unnecessary, approved hot sticks or other suitable insulating devices shall be used for removing the connection to the line or equipment.
6. Personal protective equipment must be worn when making the ground connections. This equipment includes; electrical lineman's gloves with leather protectors, flame retardant coveralls, safety glasses, face shield, and hard hat.
7. Rubber sleeves must be worn while testing for voltage, or when applying or removing grounding devices from an elevated position, such as a ladder, pole, bucket truck, etc. Rubber sleeves are not required when such work is performed from the ground unless the supervisor or the person in charge deems it necessary.

8. No lines or equipment are permitted to be grounded without first receiving a proper clearance from the Power Supervisor unless an emergency exists.
9. When ground switches must be closed for protection after a clearance has been issued, it must be locked closed with an approved lock and tagged in accordance with the lockout and tagout rules.





**SAFETY WORK RULES AND REQUIREMENTS**  
**FOR USE OF PERSONAL and OTHER PROTECTIVE EQUIPMENT**

1. General Requirements.

Employees working in areas where there are possible electrical hazards shall be provided with, and shall use, protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed. Protective equipment shall be of safe design and construction for the specific parts of the body exposed to the hazard.

2. Care and Inspection of Equipment.

All such protective equipment shall be maintained in a safe and reliable condition. Protective equipment shall be periodically inspected or tested, or both. Wherever the insulating capability of insulating protective equipment is subject to damage, the insulating material shall be protected by means of leather protectors over rubber gloves, and suitable protection to prevent abrasion or puncture of rubber blankets and other rubber coverings.

Protective devices and equipment shall be subject to inspection or test to ensure that they are in safe working condition. Insulating gloves, sleeves and blankets shall be visually inspected before use. Insulating gloves and sleeves shall be tested as frequently as their use requires. Body belts, safety straps, and other personal fall protection equipment, whether furnished by employer or employee, shall be inspected before each use to ensure that they are in safe working condition.

3. Personal Protective Equipment.

Employees shall wear protective equipment for the head, face, neck, chin, eyes, ears, body, and extremities when determined necessary in accordance with the results of an evaluation of the degree of electrical hazard to which the employee is exposed to. Clothing and equipment that maximize worker protection shall be utilized. Clothing and equipment required by the degree of exposure shall be permitted to be worn alone or be integrated with normal apparel. Personal protective equipment shall cover associated parts of the body and all normal apparel that is not flash-flame resistant while allowing movement and visibility.

Employees shall wear clothing suitable for the assigned task and the work environment. Employers shall provide training on the advantages and limitations of various types, combinations, and materials of wearing apparel. When working in the vicinity of energized lines and equipment, employees should avoid wearing exposed metal articles.

All personal protective equipment shall be maintained in a sanitary and reliable condition.

3.1 Head, Face, Neck, and Chin Protection.

Employees shall wear nonconductive flame-resistant head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed, energized electrical conductors and circuit parts, or from falling objects. Where there is potential exposure to arc flash burns, or to flying objects, the head protection shall be supplemented by a cape, scarf, and full face shield or hood with a viewing window.

3.2 Eye Protection.

Face shields, windows, and safety glasses shall be used to protect the eyes from potentially falling objects. Where there is potential exposure to arc flash conditions, they shall protect the eyes from the resulting thermal and luminous energy.

3.3 Body Protection.

Employees shall wear clothing resistant to flash flame wherever there is possible exposure to and electric arc flash.

3.4 Hand and Arm Protection.

Insulating rubber gloves with leather protectors and insulating rubber sleeves shall be used as required where there is danger of hand and arm injury from electric shock or burns due to contact with exposed, energized electrical conductors or circuit parts. Appropriate hand and arm protection shall be worn where there is possible exposure to arc flash burns. Arm protection shall be accomplished by apparel resistant to flash flame.

3.5 Foot and Leg Protection.

Where insulated footwear must be depended on as the primary personal protection against step and touch potential, then dielectric overshoes shall be required. Appropriate foot

and leg protection shall be worn. Insulated soles shall not be used as an alternative to rubber insulated mats.

4. Standards for Personal Protective Equipment.

Personal protective equipment, such as head protection, eye and ear protection, gloves, sleeves, leather protectors, footwear, and apparel shall conform to all applicable ANSI and ASTM standards.

5. Other Protective Equipment

Other protective devices and equipment shall include but not be limited to:

- A. Fall arrest equipment including body belts, safety straps, lanyards, lifelines, and body harnesses.
- B. Insulating shields, covers, mats, and platforms.
- C. Insulating tools, including hot sticks, for handling or testing energized equipment or lines.
- D. **Person at Work** tags, portable danger signs and other safety signs, traffic cones, and flashers.
- E. Protective grounding material and devices.
- F. Fire-extinguishing equipment designed for safe use on energized parts or plainly marked that they must not be so used.
- G. Portable lighting equipment.
- H. First aid equipment and materials.
- I. Protective barriers.
- J. Nonconductive ladders and other supports.

The number and kinds of such equipment will depend upon the requirements of each use.

6. Fall Arrest Equipment and Their Usage.

Body belts, safety straps, lanyards, lifelines, body harnesses shall be inspected before use each day to determine that the equipment is in safe working condition.

Defective equipment may not be used.

Fall arrest equipment, work positioning equipment, or travel restricting equipment shall be used by employees working at elevated locations more than 4 feet above the ground on poles, towers, or similar structures if other fall protection has not been provided. The use of fall protection equipment is not required to be used by a qualified employee climbing or changing location on poles, towers, or similar structures, unless conditions such as, but not limited to ice, high winds, the design of the structure, or the presence of contaminants on the structure, could cause the employee to lose his or her grip or footing.

Before employees trust their weight to fall arrest equipment such as safety straps or other devices, the employees shall determine that the snaps or fastenings are properly engaged and that the employees are secure in their body belts, body harnesses, and safety straps.

7. Insulated Hand Tools

Insulated hand tools and their accessories shall be insulated for a voltage not less than that of the conductors and circuit parts on which they will be used. They shall be suitable for the environment in which they will be used and for the conditions of use.

8. Warning Signs

Permanent warning signs shall be displayed in conspicuous places at all entrances to facilities and work areas that contain exposed current-carrying parts. Means shall be provided so that identification of supply and communication lines can be determined before work is undertaken.

9. Personal Safety Grounding Equipment

Temporary protective grounding shall be required to meet the specific fault duty of the electrical system to which they might be temporarily applied and meet the requirements of the appropriate ASTM standard.

10. Fire Extinguishers

In fighting fires or in the vicinity of exposed energized equipment parts and lines, employees shall use fire extinguishers or materials that are suitable for the

purpose. If this not possible, all adjacent and affected equipment should ~~be~~ first be deenergized.

#### 11. Ladders and Supports

Employees shall not support themselves, or any material or equipment, on any portion of a tree, pole structure, scaffold, ladder, walkway, or other elevated structure or aerial device, etc., without first determining, to the extent practical, that such support is adequately strong, in good condition, and properly secured in place.

Portable wood ladders intended for general use shall not be painted except with a clear nonconductive coating, nor shall they be longitudinally reinforced with metal.

Portable metal ladders intended for general use shall not be used for working on or in the vicinity of energized parts.

If portable ladders are made partially or entirely conductive for specialized work, necessary precautions shall be taken to ensure that their use will be restricted to the work for which they are intended.

#### 12. Alternate Alerting Techniques

Where work areas are such that signs and barricades do not provide adequate warning and protection from electrical hazards, manual signaling and alerting shall be used to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.



## RECOMMENDED PRACTICE FOR WORK IN ENCLOSED AND CONFINED SPACES

### 1. Employer Responsibilities

The employer shall establish a program that sets forth the procedures and methods for work in enclosed and confined spaces. (Definitions of enclosed and confined spaces are provided at the end of this section.) The procedures shall specify the administrative processes to be carried out for those confined spaces for which entry permits are required.

The employer shall ensure the use of safe work practices for entry into and work in enclosed/confined spaces and for rescue of employees from such spaces.

Employers shall provide rescue equipment to ensure the prompt and safe rescue of employees from the enclosed space.

### 2. Safe Work Practices-General

When entering or coming out of an enclosed/confined space the employee should use a ladder. Do not use the cables or equipment to assist in climbing into or out of any enclosed/confined space.

Before entering or permitting any employee to enter an enclosed space containing machinery or circuits to be deenergized, appropriate lockout and tagout procedures shall be followed.

The employees should be careful not to place tools, maintenance equipment or other items where there is danger of their falling or being knocked into an open manhole.

### 3. Training

Employees who enter or who serve as attendants shall be trained in the hazards of enclosed space entry, in enclosed space entry procedures, and in enclosed space rescue procedures.

### 4. Evaluation of Potential Hazards

Before any entrance cover to an enclosed/confined space is removed, the employee shall determine whether it is safe to do so by checking for the presence of any atmospheric pressure or temperature differences and by evaluating whether there might be a hazardous atmosphere in this space. Any conditions making it unsafe to remove the cover shall be eliminated before the cover is removed.

5. Removal of Covers

Bump cover loose, and use salt or other appropriate means to loosen cover. Do not use fire or open flame for loosening cover. Completely remove the cover before cleaning the rim.

Use handle or suitable hook to remove or replace cover, keeping hands and feet in the clear. The manhole hook or bar must be in good condition before opening a manhole so that there is no danger of slipping or of the cover falling.

When covers are removed from enclosed/confined spaces, the opening shall be promptly guarded by a railing, temporary cover, or other barrier intended to prevent an accidental fall through the opening and to protect employees working in the space. Protection must be provided during the entire time the cover is removed.

Keep a safe distance from edge of an enclosed/confined space opening except when necessary for the purpose of construction, inspection, maintenance or use. Stepping or jumping across an open cover is prohibited.

Replace cover immediately after work is finished. Manhole covers must be perfectly seated when replaced.

6. Attendants

While work is being performed in the enclosed/confined space, a person with first aid training shall be immediately available outside the enclosed/confined space to render emergency assistance if there is reason to believe that a hazard may exist in the space or if a hazard exists because of traffic patterns in the area of the opening used for entry. That person is not precluded from performing other duties outside the enclosed/confined space if these duties do not distract the attendant from monitoring employees within the space. Entering an enclosed/confined space without an employee at top to render assistance in case of necessity, is prohibited.

7. Testing for Oxygen Deficiency and Flammable Gases and Vapors

Before entering a confined space, use an appropriate monitoring device to test atmosphere for flammable/combustible gas, vapors, and oxygen deficiency. Test instruments used to monitor atmospheres in enclosed spaces shall be kept in calibration, with a minimum accuracy of  $\pm 10$  percent.

8. Ventilation and Monitoring Requirements

If flammable gases or vapors are detected or if an oxygen deficiency is found, forced air ventilation shall be used to



maintain oxygen at a safe level and to prevent a hazardous concentration of flammable gases and vapors from accumulating. A continuous monitoring program to ensure that no increase in flammable gas or vapor concentration occurs may be followed in lieu of ventilation if flammable gases or vapors are detected at safe levels.

If continuous forced air ventilation is used, it shall begin before entry is made and shall be maintained long enough to ensure that a safe atmosphere exists before employees are allowed to enter the work area. The forced air ventilation shall be so directed as to ventilate the immediate area where employees are present within the enclosed/confined space and shall continue until all employees leave the such space. The air supply for the continuous forced air ventilation shall be from a clean source and shall not increase the hazards in the enclosed space.

If in an emergency it is necessary to enter a manhole or vault where gas is found to be present, the employee must put on a fresh air or blower type gas mask and must have an appropriately installed life line put around his/her body.

#### 9. Open Flames

Avoid, as far as practicable, open flames or torches in enclosed/confined spaces. In using hot paraffin or compound, use care to prevent it from reaching the temperature at which it will ignite.

If open flames are used in enclosed/confined spaces, a test for flammable gases and vapors shall be made immediately before the open flame device is used in the space and at least once per hour while the device is used in the space. Testing will be conducted more frequently if conditions present in the space indicate that once per hour is not sufficient to detect hazardous accumulations of flammable gases or vapors.

Smoking is prohibited in manhole or other place where gas may be present.

#### 10. Definitions

##### Definition of hazardous atmosphere:

Hazardous atmosphere means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness from one or more of the following causes:

1. Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL)
2. Airborne combustible dust at a concentration that meets or exceeds its LFL

3. Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent
4. Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in such standards as OSHA Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, of this part and which could result in employee exposure in excess of its dose or permissible exposure limit;
5. Any other atmospheric condition that is immediately dangerous to life or health.

Definition of Confined Space :

A confined space means a space that is large enough and so configured that an employee can bodily enter and perform assigned work, has limited or restricted means for entry or exit, and is not designed for continuous entry.

A confined space that is a permit-required space has one or more of the following characteristics:

- contains or has a potential to contain a hazardous atmosphere
- contains material that has the potential for engulfing an entrant
- has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section
- contains any other recognized serious safety or health hazard.

Definition of Enclosed Space : A space that has limited means of entry or egress, that is designed for periodic entry by employees under normal operating conditions, and that is not expected to contain a hazardous atmosphere, but may contain one under abnormal conditions.

Note: Spaces that are enclosed but not designed for employee entry under normal operating conditions are not considered to be enclosed spaces for purposes of this definition. Similarly, spaces that are enclosed and that are expected to contain a hazardous atmosphere are not considered to be enclosed spaces for purposes of this definition.



RECOMMENDED SAFE WORK PROCEDURES  
FOR WORK IN ELEVATED POSITIONS AND ON PLATFORMS

1. Personal General Precautions.

Employees working in the vicinity of energized lines and equipment shall consider all the effects of their actions on themselves, other coworkers, the property of others, and the public.

Employees shall promptly report abnormal conditions in lines, poles, insulators, equipment supports.

Only qualified employees may work on or with exposed energized lines or parts of equipment. Only qualified employees may work in areas containing unguarded, uninsulated, energized lines or parts of equipment operating at 50 V or more. Electric lines and equipment shall be considered and treated as energized unless it is positively known by test to be otherwise.

Employees should exercise care when extending metal ropes, tapes, or wires parallel to and in the proximity of energized high-voltage lines because of induced voltages. When it is necessary to measure clearances from energized objects, only devices approved for the purpose shall be used.

2. Fall Protection Equipment.

Fall protection equipment including fall arresting, work positioning, or travel restricting equipment, including but not limited to body belts with straps or lanyards, shall be used by employees working at elevated positions more than 4 ft above the ground on poles, towers or similar structures except where such use creates a greater hazard to the safety of employees, in which case other fall arresting safeguards shall be employed.

Fall protection equipment is not required to be used by a qualified employee who is climbing or changing location on a pole, tower, or similar structure, unless conditions such as ice, high winds, structures with no provisions for holding on with hands, or the presence of contaminants on the structure which could cause the employee to lose his/her grip or footing.

Safety straps or other similar devices shall be inspected before use by the employee to ensure that they are in safe working condition.

Before employees trust their weight to safety straps or other devices, the employees shall determine that the snaps or fastenings are properly engaged and that the employees are secure in their body belts and safety straps.

3. Tools, Protective Equipment and Clothing.

Employees shall use the personal protective equipment, the protective devices, and the special tools provided for their work. Before starting work, these devices and tools shall be carefully inspected to make sure that they are in good condition.

Employees shall wear clothing suitable for the assigned task and the work environment. Employers shall provide training on the advantages and limitations of various types, combinations, and materials of wearing apparel.

When working in the vicinity of energized lines and equipment, employees should avoid wearing exposed metal articles.

4. Minimum Approach Distances.

When employees are working in elevated positions near energized overhead lines or circuit parts that are not guarded, isolated, or insulated, they shall maintain a safe distance from such conductors and circuit parts.

Unless they are qualified, protected and authorized to do so, employees elevated above ground by vehicle-mounted or other elevated equipment shall exercise caution to avoid contacting energized conductors either directly, or indirectly through conductive objects such as portable tools, extension handles, metal pipes or tubes, and tree limbs or branches.

5. Ungrounded Metal Parts.

Employees shall consider all ungrounded metal parts of equipment or devices, such as transformer cases, and circuit breaker housings, to be energized at the highest voltage to which they are exposed, unless these parts are known by test to be free from such voltage.

6. Arcing Conditions.

Employees shall keep all parts of their bodies as far away as practical from switches, brushes, commutators, circuit breakers, or other parts at which arcing may occur either during operation or handling.

7. Ladders and Supports.

Employees shall not support themselves, or any material or equipment, on any portion of a tree, pole structure, scaffold, ladder, walkway, or other elevated structure or aerial device, etc., without first determining, to the extent practical, that such support is adequately strong, in good condition, and properly secured in place.

Ladders and platforms shall not be loaded in excess of the working loads for which they are designed.

Portable wood ladders intended for general use shall not be painted except with a clear nonconductive coating, nor shall they be longitudinally reinforced with metal.

Portable metal ladders intended for general use shall not be used for working on or in the vicinity of energized parts.

If portable ladders are made partially or entirely conductive for specialized work, necessary precautions shall be taken to ensure that their use will be restricted to the work for which they are intended.

8. Fuses.

When fuses must be installed or removed with one or both terminals energized, employees shall use special tools or gloves insulated for the voltage involved. When installing expulsion-type fuses, employees shall wear personal eye protection and take precautions to stand clear of the exhaust path of the fuse barrel.

9. Cable Reels.

Cable reels shall be securely blocked so they cannot roll or rotate accidentally.

10. Adverse Weather.

Except during emergency restoration procedures, work shall

be discontinued when adverse weather conditions would make the work hazardous in spite of the use of safe work practices.





APPENDIX A  
A REVIEW OF THE NATIONAL ELECTRICAL SAFETY CODE  
AND ITS APPLICABILITY TO RAILROADS

A.1 Summary.

The National Electrical Safety Code (NESC), ANSI C2-1993, is a compilation of design, installation, operation and maintenance requirements intended to ensure the safety of electric systems. As stated in its scope, the main objective of the NESC is to reduce the life hazards of electric systems.

Historically, the applicability of the NESC has been principally oriented to the electric supply infrastructure part of the system rather than to specific equipment and component parts. The exception to this is equipment associated with electric power generation. The system elements considered within the applicability of the NESC include the generation, transmission and distribution of electric power and wire-line communications facilities.

Rules for the utilization or use aspects of electric energy was originally part of earlier editions of the NESC. These rules for utilization are no longer under NESC jurisdiction. For many years now the rules related to utilization and use have been considered by the committee governing the NESC to be under the sole jurisdiction of the National Electrical Code (NEC). The primary scope of the NEC is concerned with the installation of conductors and equipment within buildings, industrial facilities, yards and lots. There is some jurisdictional overlap between the NESC and NEC rules, particularly with respect to the installation of conductors and equipment that connect to the supply of electricity and to wire-line communications.

The NESC considers any provider (it defines a utility as a provider) of electric and communication systems as coming under its jurisdiction. It explicitly considers electric railways as providers. There are numerous NESC rules which deal with the electrical clearance requirements of conductors used in railways. However, jurisdiction over several specific types of equipment are explicitly excluded from the NESC. As given in its scope, the rules of the NESC do not cover installations in mines, ships, railway rolling stock equipment, aircraft, and automotive equipment.

There has been a long standing relationship between the standing committee which oversees the rule making of the NESC and

transportation related organizations. For example, the Association of American Railroads (AAR) has traditionally been a member of the NESC Accredited Standards Committee which is the main oversight committee for the NESC. In addition, members of individual railroads and railroad labor organizations have served on various NESC subcommittees and working groups.

During the early years of OSHA regulations, many of the rules of the NESC had been adopted by OSHA. Further, where NESC rules and OSHA regulations differed, the NESC editions in effect had specific comments given as part of its rules which pointed out the differences between NESC and OSHA. More recently a serious attempt has been made to make the NESC work rules be in full agreement with the corresponding OSHA work rules.

### A.2 Purpose and Scope of the NESC.

The stated purpose of the rules of the NESC is the practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and their associated equipment [1]. These rules contain the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions. NESC rules are not intended to be a design specification or an instruction manual.

The scope of the NESC rules cover electric supply and communication lines, equipment, and associated work practices employed by a public or private electric supply, communications, railway, or similar utility in the exercise of its function as a utility (provider). The NESC rules also cover similar systems which are under the control of qualified persons, such as those associated with an industrial complex or a utility interactive system.

### A.3 NESC Historical Background.

The National Electrical Safety Code (NESC) originated with the National Bureau of Standards (NBS). It was started in 1913 as an initial set of work rules. The intent of the Code was to bring consistency and safety to the design, construction, operation and use of electric supply and communications installations throughout the United States. The early development of these kinds of facilities consisted of isolated systems which were initially intended to serve only specific communities and areas. As a consequence, their construction and operation was without standardization. This was found to be a major cause of problems of both integration and safe operation. The need for rules to ensure safe operation was a major impetus to the early development of the rules that eventually became the NESC. During the period of NBS stewardship, the different parts of the Code were issued under various NBS handbook numbers.

By the end of 1920, three editions of the Code had already been issued. Contemporary technical references to the NESC generally start with its third edition. With only a few significant changes, the third edition of the NESC was the relevant code for many years. Certain sections of the Code were revised in the 1930s and in the 1940s. The fifth edition of the NESC (NBS Handbook H30) was issued in 1948. The fifth edition, like its predecessors was not a completely revised edition of the Code, and it contained changes to only certain parts of it. The sixth edition (NBS Handbook 81) was issued in 1960.

The early organization of the NESC consisted of several independent parts. The Code initially contained five parts, and since 1961, with the removal of the section on the utilization and use of electricity, it has consisted of four parts. In the early editions, four of the five parts dealt with rules for safe construction and one part dealt with work rules for safe operation. The part (then Part 3) dealing with installation and maintenance of electric utilization equipment was dropped from the NESC sixth and subsequent editions, since it was felt that most of the subject matter of this part was covered by the National Electrical Code (NEC). In the sixth and succeeding editions, Part 3 became the safe construction rules for underground systems. The last part (Part 5) dealt with rules for radio installations. This part was also dropped as of the sixth edition.

Since the sixth edition, the parts of the NESC are:

- Part 1. Rules for the Installation of Electric Supply Stations and Equipment
- Part 2. Safety Rules for the Installation and Maintenance of Overhead Electric Supply and Communication Lines
- Part 3. Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines
- Part 4. Rules for the Operation of Electric Supply and Communication Lines and Equipment

At some point in its history, the NBS handbook numbers for the NESC also were assigned the American National Standards (ANSI) number C2.x, where the x designated the different parts of the code. Part 1 of the NESC (ANSI C2.1) dealt with the rules for the installation and maintenance of electrical supply stations and equipment. Part 2 of the Code (ANSI C2.2) dealt with the safety rules for installation and maintenance of electric-supply lines and communication lines. Since 1960, Part 3 (ANSI C2.3) dealt with the safety rules for the installation and maintenance of underground electric-supply and communication lines. Part 4 of the Code (ANSI

C2.4) dealt with the work rules for the operation of electric-supply and communication lines and equipment.

In 1973, NBS requested that its responsibility for oversight of the NESC be relinquished. NBS turned over its administrative responsibility for the NESC to the Institute of Electrical and Electronics Engineers (IEEE). In 1973, the sixth edition (also known as the 1973 Edition) of the Code was published by the IEEE. This edition of the Code was an update of certain sections and a compilation of the remaining sections from previous editions. Parts 1 and 2 were not updated for this edition and continued their identification as NBS handbooks. Parts 3 and 4 were updated revisions and they identified the IEEE as the administrative secretariat.

The IEEE had recommended and adopted the year designation of the Code to signify its edition. The 1977 Edition became the first edition to formally use the year designation, although the 1977 edition is sometimes also referred to as the NESC seventh edition. Since 1981, the Code has been revised every three years as ANSI C2. The 1981 Edition of the NESC became the first fully revised and integrated version of the code containing the above four parts. A section on grounding methods for electric supply and communications facilities also was added. From this version up to the present, the NESC now contains a common scope and purpose statement.

#### A.4 NESC Standards Committee Representation.

Through ANSI, an NESC accredited standards committee (Committee C2) has been an ongoing activity with its membership drawn from the numerous organizations that produce, supply, or utilize electrical energy. Membership to the C2 committee from transportation related industries have included representation from the American Public Transit Association (APTA) and the Association of American Railroads (AAR). This representation has been traced back to at least the fifth edition. (Representation to the NESC from these or their predecessor organizations also may have been earlier but requires access to the out-of-print early editions of the NBS handbooks for verification.)

Through ANSI, the NESC has become a consensus standard. It is a nearly universally accepted reference with legal status in most states for electrical safety in the areas that are germane to its scope. As discussed above, the early OSHA regulations had adopted the use of the NESC as its electrical safety standard.

#### A.5 NESC and OSHA Standards.

Safe work rules have been part of the NESC since its beginning and are contained in Part 4 of the NESC. Its purpose has been to

provide practical work rules as one means of safeguarding employees and the public from injury. The scope for this part of the NESC is to provide the work rules to be followed in the installation, operation and maintenance of electric supply and communications systems.

From the 1973 edition through the current 1993 edition, Part 4 of the Code was intended to be closely coordinated with available OSHA regulations in work rules for electrical safety. During this interval close coordination between the NESC work rule subcommittee and OSHA experts has been an ongoing activity. NESC work rule committee members have been active in giving testimony to OSHA on proposed rule making activities.

Up to the NESC 1993 Edition, there were differences between the requirements of NESC and of OSHA and these differences were highlighted as footnotes in the NESC. With the 1993 Edition of the NESC, the technical content of the NESC and the corresponding OSHA existing and proposed regulations as of 1989 for both construction and maintenance have been harmonized [1]. Harmonized used here is in the context of agreement between NESC rules and their corresponding OSHA regulations.

It is the apparent intent that future editions of the NESC as well future OSHA regulations would continue to be harmonized, although there may be time lags because of different publication cycles. The most recent revision to the OSHA regulations resulted in a major overhaul of the sections dealing with regulations for electrical protective equipment and for electric power generation, transmission, distribution, (29 CFR Part 1910 sections 137 and 269). The next edition of the NESC should be in about 1996 if it is to continue with its current three year revision cycle. One would expect to see in this coming edition revisions which reflect the newly adopted OSHA regulations as well as changes contemplated by OSHA in its next regulations cycle update.

#### A.6 Scope of the Applicability of the Present NESC to Railroads.

The NESC contains purpose and scope statements that describe its intent and applicability. Since the 1981 Edition of the NESC, the purpose and scope of the NESC has been stated as part of the introduction section of the Code and is intended for all parts of the Code. As discussed above, prior to 1981 the NESC consisted mainly of independent parts. Each part stated its purpose and scope independently of the other parts.

The current edition [2] states as part of its purpose that its rules provide the practical safeguarding of persons during the installation, operation and maintenance of electric supply and communication lines and their associated equipment. The rules contain the basic stipulations and conditions considered necessary

to ensure the safety of employees and the public. As part of its scope the current edition of the NESC rules cover supply and communication lines, equipment, and associated work practices employed by a public or private electric supply, communications, railway, or similar utility in the exercise of its function as a utility. The NESC defines a utility as an organization responsible for the installation, operation or maintenance of electric supply or communication systems.

As previously discussed, the NESC does identify several specific installations where its rules are not intended to apply. Among those installations which are excluded from the NESC are railway rolling stock equipment.

The above purpose and scope, except for minor word changes, can be found in all prior versions of the NESC reviewed here. This includes those editions reviewed prior to the 1981 Edition.

#### A.7 Work Rules of the NESC.

Part 4 of the NESC, "Rules for the Operation of Electric Supply and Communications Lines and Equipment," is the section of the NESC that contains its work rules. As stated in its purpose, Part 4 is to provide practical work rules as one of the means of safeguarding employees and the public from injury [2].

Section 41 and 42 of Part 4 are the rules applicable to employers and employees for both electric supply and communications systems. In Section 41, the general requirements for employers and the use of protective methods and devices are discussed. Section 42 provides both the general and personal precautions to be followed, the operating procedures and methods to be followed for work on both overhead line and underground line systems. This section also contains the special provisions required for work in confined spaces.

Section 43 contains the additional rules applicable to communications employees. The rules of Section 43 are intended to be applied to work on those facilities that are jointly used by communications and electric supply systems. These rules emphasize the precautions to be followed by communications workers in avoiding the hazards of nearby electric supply lines and equipment. Section 44 contains the additional rules for electric supply employees. The rules in Section 44 emphasize the special precautions needed for work on or near energized power circuits and equipment.

An outline of the NESC Part 4 is given in Table A.1. As seen from the table, detailed and comprehensive instructions are contained in section of the NESC. This is mainly in recognition of the increased hazards of working on electric supply systems. Part 4

provides numerous tables which define the allowable approach and working distance requirements for the different voltage levels that found in electric supply systems. The extraordinary precautions needed to support these requirements, especially for live-line work, are contained in the NESC text.

References.

1. Clapp, A., National Electrical Safety Code Handbook, The IEEE Standards Press, New York, NY, 1992, p 361.
2. National Electrical Safety Code, ANSI C2-1993, Institute of Electrical and Electronics Engineers, New York NY, 1992.
3. National Electrical Safety Code, ANSI C2-1981, Institute of Electrical and Electronics Engineers, New York NY, 1980.
4. National Electrical Safety Code, ANSI C2 Including C2.1-1971, C2.2-1960, C2.2a-1965, C2.3-1973, C2.4-1973, Institute of Electrical and Electronics Engineers, New York NY, 1973.



TABLE A.1  
OUTLINE OF NESC PART 4

- 40. Purpose and Scope
  - 400. Purpose
  - 401. Scope
  - 402. Referenced Sections (of NESC)
    - 1. Definitions
    - 2. Standards References
    - 3. Grounding Methods
  
- 41. Supply and Communications Systems - Rules for Employers
  - 410. General Requirements
    - A. General
      - 1. Employer to Inform Employees of Safety Rules.
      - 2. Employer to Provide Training.
      - 3. Employer to secure Compliance with Safety Rules.
      - 4. For Differences of Opinion, Decision of Employer is Final.
    - B. Emergency Procedures and First Aid Rules
      - 1. Employees to be Enformed of Procedures to be Followed.
      - 2. Regularly Instructed in First Aid and Emergency Procedures.
    - C. Responsibility
      - 1. Designated Person to be in Charge of Operation.
      - 2. One Person to be Designated in Charge.
  - 411. Protective Methods and Devices
    - A. Methods
      - 1. Access to Equipment to be Restricted to Authorized Personnel.
      - 2. Diagrams to be Maintained and Readily Available.
      - 3. Employees to be Instructed Prior to Work to be Taken.
      - 4. Additional Precautions for Unusual Hazardous Conditions.
    - B. Devices and Equipment
      - Adequate Supply of Protective Devices and Equipment. Protective Devices and Equipment to Conform to Applicable Standards.
    - C. Inspection and Testing of Protective Devices
      - 1. To be Inspected and Tested to Ensure Safe Working Condition.
      - 2. Insulating Gloves, Sleeves and Blankets to be Inspected Prior to Their use and Tested at Frequent Intervals.
      - 3. Body Belts, Safety Straps and Other Personal Equipment to be Inspected for Safe Working Condition.
    - D. Warning Signs
      - Permanent Signs to be Displayed in Conspicuous Places.
    - E. Identification and Location
      - Identify and Locate Supply and Communications Lines/Facilities.
  
- 42. General Rules for Employees
  - 420. Personal and General Precautions
    - A. Rules for Emergency Methods
      - 1. Be Able to Show Knowledge of the Rules.
      - 2. Be Familiar with Approved Methods of First Aid, Rescue Techniques and Fire Extinguishment.
    - B. Qualifications of Employees
      - 1. Only Those Tasks for Which They Are Trained, Equipped, Authorized and Directed. Inexperienced Employees to Work under Direction.
      - 2. To Request Instructions from Person in Charge if in Doubt.
      - 3. Proceed with Work Only When Authorized by a Qualified Person.
    - C. Safeguarding Oneself and Others
      - 1. Heed Warning Signs and Signals and Warn Others.
      - 2. Report Lines, Equipment Defects and Accidentally Energized Objects.
      - 3. Keep Away from Equipment; Avoid Working Under Overhead Work.
      - 4. Take into Account Their Own Safety as Well as Safety of Others.
      - 5. Not Approach or Take Any Conductive Object Within Allowable Approach

Distances.

6. Exercise Care with Metal Ropes, Tapes, or Wires in Proximity of Energized High Voltage Lines. Only Approved Devices to be Used.
- D. Energized or Unknown Conditions  
Must Consider Electric Supply Equipment and Lines as Energized Unless it Is Positively Known to Be Otherwise.
- E. Ungrounded Metal Parts  
All Ungrounded Metal Equipment or Devices Considered as Energized at the Highest Voltage Unless it Is Positively Known Otherwise.
- F. Arcing Conditions  
To Keep as Far Away as Possible from Switches, Brushes, Commutators, Circuit Breakers or Other Sources of Arcing.
- G. Liquid Cell Batteries
  1. Battery Areas to Be Adequately Ventilated Before Working in Area.
  2. Avoid Smoking, Using Open Flames and Other Sources of Sparking.
  3. To Use Eye and Skin Protection When Handling Electrolyte.
  4. Not Handle Energized Parts of Batteries Unless Precautions Taken to Prevent Short Circuits and Electrical Shocks.
- H. Tools and Protective Equipment  
Must Use Personal Protective Equipment and Devices and Special Tools Provided. Inspection of Protective Equipment and Devices Required.
- I. Clothing
  1. To Wear Suitable Clothing for the Assigned Task and Environment.
  2. Not Wear Exposed Metal Parts near Energized Lines and Equipment.
- J. Ladders and Supports
  1. Determine That Such Support Is Adequately Strong, in Good Condition and Properly Secured in Place.
  2. Portable Wooden Ladders to be Unpainted and Not Metal Reinforced.
  3. Portable Metal Ladders Not to be Used near Energized Parts.
  4. Conductive Portable Ladders Used Only for Work for which Intended.
- K. Safety Straps
  1. Safety Strap or Other Approved Means Required for Elevated Work.
  2. Safety Straps or Suitable Devices to be Inspected Prior to Use.
  3. Safety Straps or Other Approved Devices must be Properly Engaged Before Loading Them to Full Body Weight.
- L. Fire Extinguishers  
Equipment Made for the Purpose or Deenergize Affected Equipment.
- M. Machines or Moving Parts  
Use of Tags on Starting Devices or Locking and Blocking. Avoid Position Where Sudden Operation is Likely to Cause Injury.
- N. Fuses  
Special Tools and Gloves Suitable for the Purpose. Personal Eye Protection and Precaution When Removing Expulsion Type Devices.
- O. Cable Reels  
Securely Blocked to Prevent Accidental Movement.
- P. Street and Area Lighting
  1. Lowering Devices to Be Examined Periodically.
  2. Disconnection for Exceeding 300 V Unless Suitable Means Available.
421. General Operating Routines
  - A. Duties of First Level Supervisor or Person in Charge
    1. Adopt Precautions to Prevent Accidents.
    2. Assure That Safety Rules Are Procedures are Adhered to.
    3. Make all Necessary Record and Reports as Required.
    4. Prevent Unauthorized Persons from Accessing Work Site.
    5. Prohibit Use of Tools or Devices Not Suitable to the Work.
  - B. Area Protection
    1. Warning Signs, Barriers and Traffic Control Devices for Vehicular and Pedestrian Traffic. Traffic Control Person If Warranted.
    2. Warning Signs and Lights, Barricades and Other Such Devices.

3. Barricades and Barriers to Protect Against Accidental Contact in Areas Accessible Only to Employees.
4. Use Guard or Other Means for Area with Crossed or Fallen Wires.
- C. Escort
  - Person with Nonqualified Persons to Be Qualified to Safeguard.
422. Overhead Line Operating Procedures
  - A. Setting or Removing Poles in or near Energized Electric Lines
    1. Precautions to Avoid Direct Contact with Energized Lines.
    2. Avoid Contact with Trucks or Other Equipment Not Bonded to Ground Unless Wearing Suitable Protective Equipment.
  - B. Checking Structures Before Climbing
    1. Determine that Climbing Poles, Ladders, Scaffolds, or Other Elevated Structures are Capable of Sustaining the Loads.
    2. Unsafe Poles and Structures not to be Climbed until Made Safe.
  - C. Installing and Removing Wires and Cables
    1. Precautions to Prevent Wires and Cables Contacting Energized Wires and Equipment. Wires/Cables Considered Energized if Not Bonded.
    2. Sag of Wire or Cable Controlled to Prevent Danger to Pedestrians and Vehicular Traffic.
    3. Action Taken to Prevent Failure of Supporting Structures.
    4. Avoid Contact with Moving Winch Lines.
    5. Assure that Lines and Equipment Being Worked on are Free from Dangerous Leakage or Induction or have been Effectively Grounded.
423. Underground Line Operating Procedures
  - A. Guarding Manholes and Street Openings
    - To be Protected with Barrier, Cover or Other Suitable Guard.
  - B. Testing for Gas in Manholes and Unventilated Vaults
    1. Tested for Combustible or Flammable Gases Before Entry.
    2. Work Area to be Ventilated and Made Safe Before Entry.
    3. Tested for Oxygen Deficiency if Forced Ventilation not Used.
    4. Provision Made for Adequate and Continuous Supply of Air.
  - C. Flames
    1. No Smoking in Manholes.
    2. Precautions for Adequate Ventilation When Open Flame is Required.
    3. Atmosphere Tested and Made Safe Before Using Open Flame.
  - D. Excavation
    1. Cables and Buried Utilities to be Located Prior to Excavating.
    2. Hand Tools near Energized Cables to have Nonconductive Handles.
    3. Mechanized Equipment not used near Cables or Other Utilities.
    4. For Damaged Gas or Fuel Line, Excavation to be Left Open, Flames Extinguished, Authorities Notified and Public Protected.
  - E. Identification
    1. Exposed Facilities to be Identified and Protected.
    2. Unworked Cables to be Protected.
    3. Cable to be Identified and Verified Prior to Cutting or Opening.
    4. Cable Being Worked on to be Positively Identified.
  - F. Operation of Power-driven Equipment
    - Avoid Being in Manholes When Such Equipment is in Operation.
43. Additional Rules for Communications Employees
  430. General
    - Observe the Following Rules in Addition to Rules in Section 42.
  431. Approach to Energized Conductors or Parts
    - Must not Approach or Take Any Conductive Object Within Distances Listed in Table 431-1.
  432. Joint Use Structures
    - Must Not Approach Power Line Closer than Specified in Table 431-1; Remain below Lowest Supply Conductor Unless Protected by Barrier.
  433. Attendant on Surface at Joint-use Manholes
    - Employee Available Nearby on Surface to Render Assistance.
  434. Sheath Continuity
    - Maintain Sheath Continuity by Bonding or Equivalent Means.

44. Additional Rules for Supply Employees

440. General

Observe the Following Rules in Addition to Rules in Section 42.

441. Energized Conductors or Parts

A. Approach Distances to Live Parts

1. General

Not Approach or Take Conductive Object Within Distances in Table 441-1 or 441-4 Unless at Least One of Following Is Met:

A. Line or Part is Deenergized.

B. Insulated from Energized Line or Part.

C. Energized Part is Insulated from Employee and from any other Line or Part at a Different Potential.

2. Precautions for Approach Voltages from 300 V to 72.5 kV

A. Exposed Grounded Lines, Conductors or Parts in Work Area must be Guarded or Insulated.

B. Rubber Glove Work Method-Rubber Insulated Gloves near Energized Conductors/Parts and Either Insulating Sleeves Worn or Conductors Covered with Insulating Protective Equipment.

C. Protective Cover-up Be Used Which must Extend Beyond Reach.

3. Transient Overvoltage Control above 72.5 kV

Approach Distances may be Reduced Only if Anticipated Transient Overvoltage is Known and any of the Following:

A. Operation of Circuit Breaker or Other Switching Device be Appropriately Modified.

B. Overvoltage Itself Forcibly Held to an Acceptable Level.

C. System Operation be Changed to Restrict Potential Overvoltages.

4. Altitude Correction

Tables 441-1 through 441-4 for Elevations below 3000 Ft. Altitude Corrections per Table 441-5.

5. Calculation of Approach Distances.

A. Approaches Distances in Tables Calculated to 2 Decimal Places.

B. Interpolation Between the Values Not Permitted.

B. Additional Approach Requirements

1. Clear Insulation Distance to be Shortest Straight Line Air Gap Distance from Nearest Energized Part to Nearest Grounded Part.

2. For Live-Line Work Clear Insulation Distance to be not less than that given in the Tables.

3. Work Performed on the Grounded End of an Open Switch Only If:

A. Allowable Air Gap Distance Not less than Electrical Basis for Determining Approach Distance.

B. Minimum Approach Distance to Energized Part Is Maintained.

4. Special Rules for Working on Insulator Assemblies Operating above 72.5 kV.

A. Approach Distance to be Same as Straight Line Distance for Work on Ground End of Insulator Assembly.

B. First Assembly on Grounded End May be Shorted out.

C. For Live-Line Work Using the Bare-Hand Technique the First Insulator of the Energized End may be Shorted out.

C. Live-Line Clearance Insulation Length

1. Clear Live-Line Tool Length.

2. Live-Line Conductor Support Length.

442. Switching Control Procedures

A. Designated Person to be Informed of Operating Conditions, Maintain Record of Changes, Issue or Deny Authorization for Switching.

B. Specific Work Authorization Required from Designated Person Before Work is Begun and to be Notified When Work is Completed.

C. Operations at Stations-Authorization Required from Designated Person.

- D. Reenergizing after Work-Other Employees and Work Crews must Report Clear Before Reenergizing can be done.
- E. Tagging Electric Supply Circuits Associated with Work Activities
  - 1. Suitable Tags Located at all Energization Points Required for Equipment or Circuits to be Deenergized.
  - 2. Controls of Deactivated Equipment to Have Suitable Tags.
  - 3. Tags to Identify Equipment or Circuits to Be Worked on.
- F. Restoration of Service after Automatic Trip
  - 1. Controls with Tags Require Authorization Before Reclosing.
  - 2. Local Operating Rules for Manner and Frequency of Reclosing.
- G. Repeating Oral Messages
  - Messages Repeated Back to Sender and Identity of Sender Obtained.
- 443. Work on Energized Lines and Equipment
  - A. General Requirements
    - 1. Work on Energized Lines Requires One of the Following:
      - A. Insulate Employee from Energized Parts.
      - B. Isolate or Insulate Employee from Ground, Grounded Structures, and Potentials Other than the One Being Worked on.
    - 2. Not Place Dependence on the Covering of Wires. All Precautions for Working on Energized Parts to be Observed.
    - 3. Assure that Lines or Equipment Being Worked on are Free from Dangerous Leakage or Induction, or are Effectively Grounded.
    - 4. Cutting into Insulating Coverings or Energized Conductors.
      - A. Cable Not Positively Identified as Deenergized Requires Use of Special Purpose Severing Tool.
      - B. Operating Voltages to be Determined and Appropriate Precautions Taken Before Cutting into Energized Cable.
      - C. Use Suitable Protection and Tools When Cutting into Energized Cable. Extreme Caution to Prevent Short Circuiting Cable.
    - 5. Rule 441 Approach Distances to be Maintained.
    - 6. Noninsulated Objects not Bonded to an Effective Ground must be Treated as if Energized at Same Voltage Being Worked on.
  - B. Requirement for Assisting Employee
    - Unless Qualified No Employee to Work Alone near Conductors or Parts of More than 750 V Between Conductors.
  - C. Opening and Closing Switches
    - Manual Switches and Disconnectors to be Always Closed in Continuous Motion. Care Taken When Opening Switches to Avoid Serious Arcing.
  - D. Working Position
    - Avoid Working in Position from Which a Slip Results in Contact.
  - E. Protecting Employees by Switches and Disconnectors
    - Switches or Other Devices to be Opened First Before Disconnecting or Connecting Equipment/Lines from any Source of Electric Energy.
  - F. Making Connections
    - Connection to be Made First to the Deenergized Part. When Disconnecting, the Source Connection to be Removed First.
  - G. Switchgear
    - To be Deenergized Prior to Work Which Involves Removal of Protective Barrier Unless Other Suitable Means for Protection is Provided.
  - H. Current Transformer Secondaries
    - Not to be Opened When Energized and Bridging to be Done if Necessary.
  - I. Capacitors
    - Not to be Worked on until Disconnected from Source, Short Circuited and Grounded. Any Line to Which Capacitors are Connected must be Considered Energized Unless Short Circuited and Grounded.
  - J. Gas Insulated Equipment (GIE)
    - For Maintenance, Special Precautions Required to Ventilate GIE Compartment and Purge with Air.
  - K. Attendant on Surface
    - Employee to be Available to Render Assistance from the Surface.
  - L. Unintentional Grounds on Delta Circuits To be Removed as Soon as Practical.

444. Deenergizing Equipment or Lines to Protect Employees
- A. Application of Rule
    - 1. Employees Depending on Others must Follow Precautionary Measures.
    - 2. Designated Person Measures Omitted for Employee in Sole Charge.
    - 3. Records to be Kept on all Contractual Utility Interactive Systems and Such Systems to be Visibly Disconnected from the Lines.
  - B. Employee's Request  
Employee in Charge to Apply to the Designated Person.
  - C. Operating Switches, Disconnectors, and Tagging  
Designated Person to Direct Operation of all Switches and Disconnectors. Tagging and Records Required.
  - D. Employee's Protective Grounds  
Employee's Own Protective Grounds to be Applied. Grounds to be Applied at Each Side of the Work Location. Special Permission from Designated Person Required to Omit Protective Grounds.
  - E. Proceeding with Work
    - 1. Work to Proceed after Disconnection and Grounding.
    - 2. Additional Employee must Follow Same Procedures for Protection.
  - F. Reporting Clear-Transferring Responsibility
    - 1. Employee in Charge Responsible for Removing Protective Grounds and Notifying Designated Person to Remove Tags.
    - 2. Permission and Notification Required to Transfer Responsibility.
  - G. Removal of Tags
    - 1. Designated Person to Direct Removal of Tags and Records Kept.
    - 2. Name of Person Requesting Removal must be the Same Unless Responsibility Transferred.
  - H. Sequence of Reenergizing  
Operation of Switches and Disconnectors Allowed Only after Removal of Grounds and Tags.
445. Protective Grounds
- A. Installing Grounds
    - 1. Current Carrying Capacity of Grounds to be Sized to Carry the Induced Current and Anticipated Fault Current.
    - 2. Initial Connections to be Made to Effective Ground First.
    - 3. Voltage Test Made after Disconnection and Before Grounding.
    - 4. Completing Grounds
      - A. To be Completed if the Part Shows no Voltage.
      - B. If Voltage Present, its Source to be Determined Prior to Completion of Grounding.
      - C. After Ground Connection Completed the Grounding Device is to be Connected to Deenergized Part with Insulating Equipment.
  - B. Removing Grounds  
Grounding Device to be First Removed from Deenergized Part Using Insulating Equipment. Extreme Caution to Be Exercised.
446. Live-Line Work
- A. Training  
Training in Live-Line Work Required Before Being Allowed to Work.
  - B. Equipment
    - 1. Insulated Aerial and Other Equipment to be Tested Before Work.
    - 2. Equipment to be Maintained in Clean Condition.
    - 3. Tools/Equipment Not Used in Manner to Reduce Insulating Strength.
  - C. Clear Insulation Distance  
Not less than Distances Required by Tables 441-1 Through 441-4.
  - B. Bonding and Shielding for Bare-Hand Method
    - 1. Conductive Bucket Liner Required for Bonding Insulated Aerial Device to Energized Line or Equipment.
    - 2. Employee must be Bonded to Insulated Aerial Device.
    - 3. Adequate Electrostatic Shielding Required where Necessary.
    - 4. Aerial Device Bonded with a Connection to Energized Conductor.



**APPENDIX B**  
**A REVIEW OF NATIONAL FIRE PROTECTION ASSOCIATION**  
**STANDARD NFPA 70E, 1995 EDITION**  
**ELECTRICAL SAFETY REQUIREMENTS FOR EMPLOYEE WORKPLACES**

B.1 Summary.

The National Fire Protection Association (NFPA) publishes numerous standards on life safety and property safety. Included among the well known NFPA sponsored electrical safety standards are the National Electrical Code (NFPA 70), Electrical Safety Requirements for Employee Workplaces (NFPA 70E), Recommended Practice for Electrical Equipment Maintenance (NFPA 70B), the Lightning Protection Code (NFPA 780), and Static Electricity (NFPA 77). NFPA 70E contains the safety standards for equipment installation, electrical work rules and safety related work practices, and safety related maintenance requirements. NFPA 70E is intended to be a companion standard to the National Electrical Code (NEC). The development of NFPA 70E was started in 1976. The current 1995 edition is the fourth edition.

The development of NFPA 70E was prompted originally by the interest on the part of the NFPA to assist OSHA in its development of electrical safety regulations. Prior to this time, one of the primary electrical safety standards of interest to OSHA in its promulgation of new electrical safety regulations was the NEC. However, it was found by OSHA that the NEC was intended primarily by those who design, install and inspect electrical installations. OSHA's primary interest was for electrical regulations that addressed the employer and employee in their workplace. OSHA had determined that the NEC as written was too technical and complex. Further, it was found by OSHA that many of the detailed provisions of the NEC did not directly address the issues of electrical safety in the workplace.

In response to the then pending OSHA regulations, the NFPA decided to publish NFPA 70E as a companion standard to the NEC. As such, the new standard would primarily address the safety issues of the workplace, while maintaining the original intent of the NEC. It should be noted that, in the absence of workplace safety standards, the early versions of OSHA electrical safety regulations had adopted the general format of the NEC (NFPA 70).

Like its prior editions, the current edition of NFPA 70E contains three parts. Part I deals mainly with installation safety requirements, Part II with safety related work practices, and Part



III with safety related maintenance requirements. Suitable portions of the NEC have been extracted into NFPA 70E and those are contained primarily in Part I. The NFPA 70E standard is a combination of design safety standards, work rules and safety related work practices.

Part I contains the installation safety requirements for the following:

- General requirements for electrical installations
- Specific purpose equipment and installations
- Special systems, including systems over 600 V
- Wiring design and protection
- Wiring methods, components and equipment for general use protection
- Safety requirements for hazardous, or classified, locations.

Part II contains the safety-related work practices. Included in Part II are:

- General requirements for electrical work practices
- The use of personal and other protective equipment
- Specific safety-related equipment and work practices
- Procedures and practices of the use of lockout/tagout devices.

Part III contains the safety-related maintenance requirements for specific types of installations. The installations referred to in Part III include:

- Equipment found in substations
- Premises wiring
- Rotating machinery
- Batteries and battery rooms
- Portable electric tools and equipment
- Personal safety and protective equipment.

NFPA 70E contains several appendices directed at safety related work practices. The appendices provide additional information in the following:

- Limits of approach distances to energized conductors and circuit parts
- Sample calculation of the arcing flash protection boundary
- Sample electrical safety program
- Sample hazard/risk evaluation procedure
- Sample lockout/tagout procedure.

The safety-related work practice requirements of NFPA 70E are summarized in Table B.1. As seen from the Scope/General Requirements section, workers are grouped into two categories, Qualified Persons and Unqualified Persons. A Qualified Person is one who has been trained in and is knowledgeable of the construction and operation of equipment or a specific work method, and is trained to recognize and avoid those electrical hazards that might be present with respect to that equipment or work method. NFPA contains several specific training requirements for a Qualified Person. These requirements include the skills and knowledge to:

- Distinguish exposed energized parts from other parts of electric circuits and equipment
- Determine the nominal voltage of exposed energized parts of circuits and equipment
- Determine the allowable approach distances and corresponding voltages to which the qualified person would be exposed to
- Determine the degree and extent of the hazard presented and the personal protective equipment and job planning required to perform the task safely.

An unqualified person is allowed work near exposed energized parts, provided that approach distances more restrictive than those required of qualified workers are in effect, and provided that such persons work under the supervision of a designated person. An unqualified person is also to be trained in, be familiar with, and have general knowledge of electrical safe work practices. The NFPA standard contains several provisions of the required supervision of unqualified persons when they must work near electrical equipment, including specific requirements on allowable approach distances.

In the sections describing work practices, the standard assumes that work on energized conductors and circuit parts to be an exceptional circumstance. Work on energized conductors requires specific training, protection, as well as the use of appropriate tools.

For work on deenergized conductors and equipment, the standard requires that an electrically safe condition be established prior to work on or near deenergized conductors and equipment. According to the NFPA standard, an electrically safe condition is obtained by verifying by inspection and test that all sources of power have been removed, that lockout/tagout devices have been correctly applied, and by grounding all nearby deenergized conductors and circuit parts as protection against inadvertent reenergizing. The use of a formal lockout/tagout procedure is a key element to obtaining an electrically safe condition. The standard contains detailed lockout/tagout requirements and a sample lockout/tagout procedure.

For work on or near uninsulated overhead lines, the NFPA standard requires that suitable guarding, isolating and insulating be applied to protect workers.

NFPA 70E contains approach distance requirements for both qualified and unqualified persons. The approach distances to energized conductors and equipment are further divided into several categories that include; an arcing flash protection boundary, a limited approach boundary, a restricted approach boundary, and a prohibited approach boundary. The procedure for calculating the arcing flash protection boundary is given in the standard. The limited approach boundary pertains to allowable approach distances for unqualified persons and the restricted boundary approach pertains to the allowable approach distances for qualified persons. Work to be done in the prohibited approach boundary requires special provisions for personal protection. Table B.2 summarizes these requirements for those voltages that would be expected to be seen on a railroad right of way. Additional voltage levels are given in the NFPA standard.

A sample electrical safety program is contained in NFPA 70E and is given in Appendix C to Part II of the standard. It contains the elements of safety program principles, program controls, and program procedures. A hazard/risk procedure flowchart also is provided as a means for further defining the safety related work practices required for specific tasks.

TABLE B.1  
OUTLINE OF NFPA 70E PART II  
SAFETY RELATED WORK PRACTICES

1. Scope/General Requirements.
  1. Scope.
  2. Responsibility.
  3. Organization.
  4. Definitions.
  
2. Safety Training.
  1. Training Requirements.
  2. Type of Training.
  3. Emergency Procedures.
  
3. Employee Training
  1. Qualified Persons.
  2. Unqualified Persons.
  
4. Working On or Near Electrical Conductors or Circuit Parts and Equipment.
  1. General Requirements.
  2. Exposed Conductors and Circuit Parts to be Put Into an Electrically Safe Condition Prior to Working on Them.
  3. Work to be Done by Qualified Persons Only.
  4. Electrically Safe Condition to be Achieved and Verified.
  
5. Requirements for Working On or Near Electrical Conductors or Circuit Parts and Equipment that have Lock Out/Tagout Devices Applied.
  
6. Working On or Near Exposed Electrical Conductors or Circuit Parts that Are or Might Become Energized.
  1. Protection from Arc Flash and Accidental Contact.
  2. Flash Hazard Analysis Shall be Done Prior to Work.
  3. Only Qualified Persons to be Permitted to Work.
  
7. Working On or Near Uninsulated Overhead Lines.
  1. Uninsulated and Energized.
  2. Deenergizing or Guarding.
  3. Employer and Employee Responsibility.
  4. Approach Distances for Unqualified Persons.
  5. Approach Distances for Qualified Persons.
  6. Vehicular and Mechanical Equipment.

8. Electrical Safety Program.
  1. General Requirements.
    - Awareness and Self Discipline.
    - Electrical Safety Program Principles.
    - Electrical Safety Program Controls.
    - Job Briefing.
    - Hazard/Risk Evaluation Procedure.
  2. Alertness.
  3. Blind Reaching.
  4. Illumination.
  5. Conductive Articles Being Worn.
  6. Conductive Materials, Tools and Equipment Being Handled.
  7. Insulated Tools and Equipment.
  8. Protective Shields.
  9. Portable Ladders.
  10. Confined or Enclosed Work Spaces.
  11. Safety Interlocks.
  12. Housekeeping Duties.
  13. Occasional Use of Flammable Materials.
  14. Overcurrent Protection Modification.
  
9. Personal Safety and Other Protective Equipment.
  1. General Requirements.
  2. Care of Equipment.
  3. Personal Protective Equipment.
    - Head, Face, Neck and Chin Protection.
    - Eye Protection.
    - Body Protection.
    - Hand and Arm Protection.
    - Foot and Leg Protection.
    - Standards for Personal Protective Equipment.
  4. Other Protective Equipment.
    - Insulated Hand Tools.
    - Personal Safety Grounding Equipment.
    - Nonconductive Ladders.
    - Rubber Insulating Equipment.
    - Voltage Rated Plastic Guard Equipment.
    - Physical or Mechanical Barriers.
    - Safety Signs and Tags.
    - Barricades.
    - Alternate Alerting Techniques.
    - Protective Qualifications for Test Instruments and Equipment.
    - Standards for Other Protective Equipment.

10. Use of Specific Safety-Related Equipment and Work Practices.
  1. Working with Test Instruments and Equipment.
    - Qualified Employee Requirements
    - Visual Inspection of Test Instruments and Equipment.
  2. Energizing and Deenergizing Electrical Power Circuits.
    - Routine Opening and Closing of Circuits.
    - Reclosing Circuits After Protective Device Operation.
  3. Portable Electric Equipment and Flexible Cord Sets.
    - Protection from Damage.
    - Grounding of Portable Electric Equipment.
    - Visual Inspection of Portable Cord and Plug Connected Equipment and Flexible Cord Sets.

Conductive Work Locations.  
Connecting Attachment Plugs.
11. Lockout/Tagout Practices and Devices.
  1. General Requirements.
    - Principles of Lockout/Tagout Execution.
    - Responsibility.
    - Hazardous Electrical Energy Control Procedures.
    - Coordination.
  2. Training and Retraining.
  3. Lockout/Tagout Equipment.
    - Lock/Tag Application.
    - Lockout/Tagout Devices.
    - Electrical Circuit Interlocks.
    - Control Devices.
  4. Lockout/Tagout Procedures.
    - Planning.
    - Elements of Control.
    - Deenergizing Equipment.
    - Stored Energy.
    - Disconnecting Means.
    - Responsibility.
    - Verification.
    - Testing.
    - Grounding.
    - Shift Change.
    - Coordination.
    - Accountability for Personnel.
    - Lockout/Tagout Application.
    - Removal of Lockout/Tagout Devices.
    - Release for Return to Service.
    - Temporary Release for Testing/Positioning.

**TABLE B.2**  
**APPROACH DISTANCES TO EXPOSED**  
**ELECTRICAL CONDUCTORS AND CIRCUIT PARTS**

Nominal System Voltage Range Phase-Phase	Flash Protection Boundary	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary
		Movable Conductor	Fixed Circuit Part	Includes Standard Inadvertent Movement Adder	Includes Reduced Inadvertent Movement Adder
		Energized Part to Person - Distance in feet-inches			
300V and less	3ft 0in	10ft 0in	3ft 6 in	Avoid Contact	
300V to 750V	3ft 0in	10ft 0in	3ft 6in	1ft 0in	0ft 1in
750V to 2kV	4ft 0in	10ft 0in	4ft 0in	2ft 0in	0ft 3in
2kV to 15kV	16ft 0in	10ft 0in	5ft 0in	2ft 2in	0ft 7in
15kV to 36kV	19ft 0in	10ft 0in	6ft 0in	2ft 7in	0ft 10in
36kV to 48.3kV	*	10ft 0in	8ft 0in	2ft 10in	1ft 5in
48.3kV to 72.5kV	*	10ft 0in	8ft 0in	3ft 3in	2ft 1in

\* For values greater than 36 kV, calculate the value by using the formula in Sec 2-3.3.3.2 of NFPA 70E.





APPENDIX C  
A REVIEW OF OCCUPATIONAL HEALTH AND SAFETY STANDARDS  
FOR ELECTRICAL WORK RULES AND SAFE WORK PRACTICES

C.1 Summary.

The Occupational Health and Safety Administration (OHSA) is the federal agency responsible for workplace safety regulations. OSHA was created in 1970 under the federal Occupational Safety and Health act. Its responsibility is to reduce as much as possible the injuries and deaths to employees at the workplace. By its enabling act, OSHA is precluded from issuing regulations to industries whose working conditions are already regulated by other Federal agencies [1].

Included among those agencies which are exempt from OSHA regulations is the Federal Railroad Administration (FRA). This is apparently the case where the FRA has regulations specific to particular working conditions. It is unclear what the responsibility of OSHA is vis-a-vis the FRA for the case where specific FRA regulations do not exist and where specific OSHA regulations do exist. Examples of this can be found in the OSHA electrical safety regulations as given in 29 CFR 1910.269. These are recently issued comprehensive regulations for the operation and maintenance of electric power transmission and distribution systems. The FRA, in CFR 49, is largely silent in the area of electrical safety for wayside electrification infrastructure.

The OSHA safety regulations are given in the Code of Federal Regulations, Title 29-Labor (29 CFR). These regulations include design safety standards as well as safe work rules and practices. The work rules generally require that employers set up safe work procedures and programs which include electrical work rules and safe work practices. Electrical work rules and safe work practices are contained in 29 CFR Part 1910 for general industry and in 29 CFR Part 1926 for construction. Until recently, most of the electrical safety regulations of Part 1910 were contained in Subpart S-Electrical and to a lesser extent in Subpart J-General Environmental Controls. In 1994, Section 269 of Subpart R-Special Industries was issued. Section 269 contains the regulations which are specific to the electric utility industry.

Most of the electrical work rules for construction in Part 1926 are given in Subpart K-Electrical. A specific subpart exists for electric power and transmission construction. This is Subpart V-Power Transmission and Distribution.

## C.2 Historical Review of OSHA Electrical Work Rule Regulations.

When OSHA first issued its electrical regulations in 1972, it referenced the 1971 version of the National Electrical Code (NEC) as its primary basis. OSHA soon found out that although the NEC is an excellent document for design, installation and inspection, the use of the NEC alone did not meet all of its needs. OSHA found that the NEC did not contain comprehensive enough safety related work practices, electrical maintenance or special equipment.

In 1976 the National Fire Protection Association (NFPA), the sponsoring organization of the NEC, formed a committee to develop a standard for electrical safety requirements for employee workplaces. The forming of this committee was originally prompted by the interest on the part of NFPA to assist OSHA in the development of work rule based electrical safety regulations. In 1979, the NFPA issued NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces. The current version of this standard is the 1988 edition. NFPA 70E is intended to be a companion standard to the NEC which is issued as NFPA 70 [2].

In 1982, the organizational structure of NFPA 70E was adopted by OSHA to form the basis of its Subpart S. Although OSHA found that some parts of NFPA 70E were too detailed for possible industry-wide implementation, it also found that the safe work practices contained in NFPA 70E to be more effective than other standards in the issues dealing with employee protection [3]. In 1987, OSHA published its proposed Electrical Safety-Related Work Practices regulation which was based in part on NFPA 70E along with other industry standards. The final rule which is Subpart S, was issued in 1990.

Part 4 of the National Electrical Safety Code (NESC) contains the work rules for the operation of electric supply and communications lines and equipment. During the early years of development of OSHA regulations, many of the work rules of the NESC also had been adopted by OSHA. Further, where NESC rules and OSHA regulations differed, the NESC contained specific comments as part of its rules pointing out any differences between the NESC rule and the corresponding OSHA regulation. More recently, a serious attempt has been made to make the NESC work rules be in full agreement with corresponding OSHA regulations. There was significant coordination by the NESC and OSHA prior to the issue by OSHA in 1994 of Section 269 of Part 1910. Section 269 of Subpart R was issued for public comment in early 1989. The reference section to the 1993 edition of the NESC Part 4 stated that coordination had been effected between the pending OSHA regulation and corresponding NESC work rules such that the technical content of each document had been brought into agreement or harmonized [4].

### C.3 OSHA Regulations Applicable to Electrical Safety.

Electrical design safety standards, work rules and safe work practices are contained in 29 CFR Part 1910 for general industry. Part 1910 has several subparts which deal either exclusively or in part with electrical safety. Subpart S-Electrical (sections 301 through 399), is exclusively concerned with the subject. Subpart J-General Environmental Controls (sections 141 through 150), has several relevant sections which deal with electrical safety. Section 1910.146, Permit Required Confined Spaces, deals with the hazards of work required in confined work spaces. Section 1910.147, The Control of Hazardous Energy, deals with the requirements of lockout and tagout of deenergized circuits and equipment.

Subpart R-Special Industries (sections 261 through 275) also has several relevant sections to electrical safety. Section 268 of Subpart R deals with safety regulations for the telecommunications industry. As one would expect, this section contains numerous references to electrical safety. Section 269 of contains the new regulations specific to electric power generation, transmission, and distribution. This section is almost totally concerned with the issues of electrical safety.

Electrical design safety standards, work rules and safe work practices also are contained in 29 CFR Part 1926. Part 1926 contains the OSHA regulations for construction work. To a limited extent the regulations of parts 1910 and 1926 are duplicative and have some overlap. This is because of OSHA's intent to have self contained regulations issued by the industry to be regulated. The electrical safety regulations in Part 1926 are contained mainly in Subpart K-Electrical (sections 400 through 430) and in Subpart V-Power Transmission and Distribution (sections 950 through 960).

#### C.3.1 OSHA Part 1910.

C.3.1.1 Part 1910 Subpart S-Electrical. Subpart S contains several sections and is divided into five major headings:

- Safety Standards for Electrical Systems
- Safety-Related Work Practices
- Safety-Related Maintenance Requirements
- Safety Requirements for Special Equipment
- Definitions for this Regulation

The design safety standards are contained in the first section and the work rules are contained in the second section. The remaining two sections are reserved for future use by OSHA. The sections of Subpart S cover the following subjects:

- Electric Utilization Systems

- General Requirements
- Wiring Design and Protection
- Wiring Methods, Components and Equipment for General Use
- Specific Purpose Equipment and Installations
- Hazardous (Classified) Locations
- Special Systems
- Design Safety Standards (reserved)
- Safety-Related Work Practices
- Safety-Related Maintenance Requirements (reserved)
- Safety Requirements for Special Equipment (reserved)
- Definitions

Of particular interest to this study are sections 331 through 360 of Subpart S, which contain the regulations dealing with work rules and safe work practices. OSHA requires that employees be trained in safety related work practices. This includes any and all procedures and methods deemed necessary for safety from electrical hazards [5].

A detailed outline of the sections of 29 CFR Part 1910, Subpart S-Electrical is given in Table C.1. Subpart S covers work by both qualified and unqualified persons. The selection and use of work practices is broken into two major categories, namely working on or near exposed deenergized parts and working on or near exposed energized parts. Safeguards to personnel emphasize the use of personal protection equipment and alerting techniques.

C.3.1.2 Part 1910 Subpart J- Section 146, Permit Required Confined Spaces. This section contains the provisions for access and work in confined spaces such as in vaults, manholes and tunnels where periodic entry for work is required. A work space that is likely to contain a hazardous atmosphere under either normal or abnormal conditions fall under the requirement for an entry permit. An entry permit is required prior to entering and working in such space. Deficient air as well as noxious and explosive air mixtures are considered to be hazardous atmospheres.

The subsections of this regulation address the following subjects:

- Definition of a Permit Required Space
- Permit Required Confined Space Program Plan
- Measures to Isolate and Eliminate or Control Permit Space Hazards
- Permit Procedures
- Recommended Practices for Safe Entry into Permit Required Spaces
- Duties of Attendants and Supervisors
- Definitions for this Regulations

Employers are required to develop a program plan which define space entry permit requirements, responsibilities of the employer, employee and supervisor in permit procedures, and the duties of attendants and supervisors. Recommended practices for safe entry into permit required spaces include tests for combustible gases and other personal hazards, requirements for warnings and signs, and requirements for rescue and emergency procedures.

One recommended practice is the requirement for an attendant to be readily available to render emergency assistance to an employee working in a confined space. The OSHA regulation allows only for occasional entry into a confined space without the presence of an attendant. Furthermore, the attendant when present, is not allowed to be working in the confined space while carrying out the specific responsibilities of an attendant.

C.3.1.3 Part 1910 Subpart J- Section 147, Control of Hazardous Energy Sources (Lockout and Tagout). Many OSHA regulations have requirements for locking out and tagging out deenergized lines and equipment. With respect to electrical systems, Section J contains the provisions for the lockout and tagout of deenergized electric circuits and powered equipment such as motors, pumps, fans, heaters, transformers and other such equipment as well as the conductors themselves that are used in electrical systems.

The purpose locking out and tagging out of equipment is to prevent such equipment from inadvertently becoming reenergized. This enables employees to work on them safely or enables employees working nearby such equipment to be protected. Lockout and tagout procedures are primarily intended as part of servicing and maintenance activities.

The subsections of this regulation address the following subjects:

- General Requirements for a Lockout/Tagout Program
- Implementation Responsibility
- Lockout/Tagout Device Requirements
- Procedural Requirements for Applying and Removing Locks and Tags
- Periodic Inspections to Verify the Adequacy of a Lockout and Tagout Program
- Definitions for this Regulation

Employers are required to establish a formal lockout and tagout program and the corresponding procedures to be used. The program defines the formal controls to be applied to lockout and tagout, the work processes and procedures to be followed, the required

training and communication to affected workers, and the periodic evaluation of the effectiveness of the program. The procedures must specifically outline the scope, purpose, authorization, rules and procedures to be utilized for implementing lockout and tagout, and the means for enforcing compliance.

The procedures must provide for the release from a lockout and/or tagout condition. The release from lockout and/or tagout must include the specific and detailed procedures to be used for physically removing lockout and/or tagout devices, the inspection of the work area to insure that non essential items have been removed and that the affected equipment is operationally intact or ready to be reenergized, and that all employees in the immediate area have been notified of the intent to release from a lockout and/or tagout condition.

This section is intended by OSHA to be independent of the electrical installations covered by Subpart S discussed above. However, the processes and procedures for equipment lock out and tag out covered in Subpart J, also can be applied to the electrical installations covered by Subpart S.

C.3.1.4 Part 1910 Subpart R-Section 269, Electric Power Generation, Transmission and Distribution.

This section became effective in 1994 and is the newest OSHA regulation dealing with the requirements of safe work practices for electrical systems. It is applicable to the operation and maintenance of electric utility type power generation, transmission, and distribution facilities.

OSHA 29 CFR Part 1910.269 contains both design safety and safe work practice requirements. The standard addresses the following subjects:

- Requirements for Work in Enclosed Spaces
- Hazardous Energy Control
- Working Near Energized Parts
- Grounding for Employee Protection
- Work on Underground and Overhead Installations
- Line-Clearance Tree Trimming
- Work in Substations and Generating Plants
- Other Special Conditions Unique to the Generation, Transmission and Distribution of Electric Energy.
- Definitions for this Regulation

There is some overlap between Section 269 and the sections which make up Subpart S-Electrical. Subpart S predates Section 269 and was developed mainly for application to electric utilization systems. As previously discussed, Section 269 addresses the

generation, transmission and distribution of electric energy. Appendix A of Section 269 discusses the jurisdictional overlaps between the two sets of OSHA regulations. With respect to safe work practices, a key factor determining the applicability of Section 269 in lieu of Subpart S is the qualification requirements of employees. Further, the safe work practice requirements of Section 269 are applicable only to those installations which are accessible only to employees that meet the qualification requirements of Section 269.

For work which falls within the scope of Section 269, the permit required confined space requirements of Section 146 discussed above are modified. Section 269 defines a restricted space category as an enclosed space. An enclosed space is restricted working space having limited means of access and not expected under normal operation to contain a hazardous atmosphere, but may contain a hazardous atmosphere under abnormal conditions. If the hazards are controlled through the measures specified in Section 269, routine entry can be made into the space without the need for the permit controlled entry requirements of Section 146. Otherwise, the provisions of Section 146 remain applicable.

A detailed outline of Section 269 is contained in Table C.2. As seen from this table, the OSHA standard is quite extensive and detailed. This is primarily the consequence of the more hazardous work environment being addressed in Section 269. As expected, the general topics and special precautions listed in Table C.2, closely follow the outline of the work rules of Part 4 of the NESC given in Table A.1.

#### C.3.1.5 Part 1910 Subpart R-Section 268, Telecommunications.

Telecommunications workers are covered by Subpart R Section 268. These workers face similar hazards as electric utility workers, although the voltage levels of a telecommunications system are significantly less than the voltages seen in a utility system. The differences between these types of facilities are accounted for in the OSHA regulations.

The approach distances to exposed energized overhead power lines and employee protection requirements are the same as that specified in OSHA Part 1910 Section 269. In addition, telecommunications workers are prohibited from working above the lowest electric power conductors on jointly used poles. Special requirements are given for those pole facilities where telecommunications conductors are located above the electric power conductors.

The requirements for work in confined and enclosed work spaces are the same as called out in OSHA Part 1910 Sections 146 and 269.

### C.3.2 OSHA Part 1926.

#### C.3.2.1 Part 1926 Subpart K-Electrical.

Part 1926 Subpart K contains the OSHA regulations for electrical safety rules for construction sites for general industry. This subpart is applicable to construction sites employing mainly temporary electrical power systems that are used solely for the purpose of providing power to the site. The purpose of the standard is to improve the safety of employees involved in construction work [6].

Electrical systems that are intended to be part of the finished construction and which are used to provide temporary power during construction are covered by Part 1926 Subpart K. Upon completion of the construction work, these systems then become covered under Part 1910 Subpart S or under Section 1901.269, if they are electric power generation, transmission and distribution systems.

Subpart K contains several sections and is divided into five major headings:

- Installation Safety Requirements
- Safety-Related Work Practices
- Safety-Related Maintenance and Environmental Conditions
- Safety Requirements for Special Equipment
- Definitions for this Regulation

The design safety standards are contained in the first section and the work rules are contained in the second section. The third section deals with the maintenance of equipment and the environmental deterioration of equipment. The fourth section deals with battery locations and battery charging.

Of particular interest are sections 416 through 430 which contain the regulations dealing with work rules and safe work practices. These sections contain general safety requirements and the use of locking out and tagging of out electrical circuits. To a limited extent many of the requirements of 29 CFR Part 1910 Subpart S-Electrical also have been duplicated in 29 CFR Part 1926 Subpart K-Electrical.

A detailed outline of Subpart K is contained in Table C.3. The requirements for work on energized equipment is similar to that of Subpart S. The provisions for locking out and tagging out lines and equipment also parallel that of Subpart S.



### C.3.2.2 Part 1926 Subpart V-Power Transmission and Distribution.

Part 1926 Subpart V contains the OSHA safety regulations specific for the construction of electric power transmission and distribution facilities. Subpart V contains several sections and is divided into nine major subjects:

- General Requirements
- Tools and Protective Equipment
- Mechanical Equipment and Material Handling
- Grounding for Protection of Employees
- Overhead and Underground Lines
- Construction in Energized Substations
- External Load Helicopters
- Linemen Personal Safety Equipment
- Definitions for this Regulation

This subpart does not list requirements as either design safety or safe work practices. However, most of the rules have or contain work practice requirements.

An outline of the regulations of Subpart V is given in Table C.5. Because of the increased hazards associated with this type of construction, the requirements given in Subpart V are quite detailed and comprehensive. Like Part 1910 Section 269, the context and general content of the regulations of Subpart V in general follows that given by Part 4 of the NESC.

References.

1. The Federal Register, National Archives and Records Administration, 59 FR 4335, January 31, 1994, p4335.
2. Electrical Safety Requirements for Employee Workplaces, 1988 Edition, The National Fire Protection Association, Quincy, MA, 1992, p9.
3. Understanding Regulations on OSHA Electrical Work Rules, Intertec Publishing Corp., New York, NY, 1991, p5.
4. National Electrical Safety Code, ANSI C2-1993, Institute of Electrical and Electronics Engineers, New York NY, 1992, p201.
5. OSHA Regulations Simplified, J.G. Stallcup, Grayboy Publishing, Fort Worth, TX, 1992, p145.
6. Understanding Regulations on OSHA Electrical Safety Rules for Construction Sites, Intertec Publishing Corp., New York, NY, 1992, p5.

TABLE C.1  
OUTLINE OF OSHA 29 CFR PART 1910 SUBPART S ELECTRICAL

- I Scope (1910.331)
  - (a) Covered Work by Both Qualified and Unqualified Persons.
    - 1. Premises Wiring.
    - 2. Wiring for Connections to Supply.
    - 3. Other Wiring.
    - 4. Optical Fiber Cable.
  - (b) Other Covered Work by Unqualified Persons.
  - (c) Excluded Work by Qualified Persons.
    - 1. Generation, Transmission and Distribution Installation.
    - 2. Communications Installations.
    - 3. Installations in Vehicles.
    - 4. Railway Installations.
- II Training (1910.332)
  - (a) Scope.
  - (b) Content of Training.
    - 1. Practices Addressed in this Standard.
    - 2. Additional Requirements for Unqualified Persons.
    - 3. Additional Requirements for Qualified Persons.
  - (c) Type of Training.
- III Selection and Use of Work Practices (1910.333)
  - (a) General.
    - 1. Deenergized Parts.
    - 2. Energized Parts.
  - (b) Working On or Near Exposed Deenergized Parts.
    - 1. Application.
    - 2. Lockout and Tagging.
      - (i) Procedures.
      - (ii) Deenergizing Equipment.
        - A. Safe Procedures for Deenergizing.
        - B. Circuits and Equipment to be Disconnected.
        - C. Discharge of Stored Energy Sources.
        - B. Mechanical Blocks for Non-Electrical Storage Devices.
      - (iii) Application of Locks and Tags.
        - A. Locks and Tags Placed on Disconnecting Means.
        - B. Prohibiting Removal and Unauthorized Operation.
        - C. Use of Tags Without Locks.
        - D. Additional Safety Measures in Absence of Locks.
        - E. Special Conditions for Locks Without Tags.
      - (iv) Verification of Deenergized Conditions.
        - A. Demonstrate that Equipment Cannot be Operated.
        - B. Use of Test Equipment for Verification.
      - (v) Reenergizing Equipment.
        - A. Inspection, Tests/Verification Prior to Reenergizing.
        - B. Stay Clear Warnings.
        - C. Lock and Tag Removal Procedures.
  - (c) Working On or Near Exposed Energized Parts.
    - 1. Application.
    - 2. Work on Energized Equipment.
    - 3. Overhead Lines.
      - (i) Unqualified Persons.
        - A. Approach Distances in Elevated Postions.

- B. Approach Distances for Work on Ground.
        - (ii) Qualified Persons.
          - A. Approach Distances for Insulated from Energized Parts.
          - B. Approach Distances for Insulated Energized Parts.
        - (iii) Vehicular and Mechanical Equipment.
          - A. Clearance Requirements.
          - B. Barricades.
          - C. Insulation and Isolation.
      - 4. Illumination.
      - 5. Confined or Enclosed Work Spaces.
      - 6. Conductive Materials and Equipment.
      - 7. Portable Ladders.
      - 8. Conductive Apparel.
      - 9. Housekeeping Duties.
      - 10. Interlocks.
- IV Use of Equipment (1910.334)
- (a) Portable Electric Equipment.
    - 1. Handling.
    - 2. Visual Inspection.
      - (i) Portable Cord-and-Plug Connected.
      - (ii) Defects or Evidence of Damage.
      - (iii) Attachment Plug and Receptacle.
    - 3. Grounding-type Equipment.
      - (i) Grounding Conductor with Flexible-cord.
      - (ii) Grounding for Plugs and Receptacles.
      - (iii) Continuity of Grounding Connections.
    - 4. Conductive Work Locations.
    - 5. Connecting Attachment Plugs.
      - (i) Dry Hands With Energized Equipment.
      - (ii) Insulated Protective Equipment.
      - (iii) Securing Locking-type Connectors.
  - (b) Electric Power and Lighting Circuits.
    - 1. Routine Opening and Closing of Circuits.
    - 2. Reclosing Circuits After Protective Device Operation.
    - 3. Overcurrent Protection Modifications.
  - (c) Test Instruments and Equipment.
  - (d) Occasional Use of Flammable and Ignitable Materials.
- V Safeguards for Personnel Protection (1910.335)
- (a) Use of Protective Equipment.
    - 1. Use of Protective Equipment.
      - (i) Appropriate Protective Equipment.
      - (ii) Inspection, Test and Maintenance.
      - (iii) Protection of Insulating Material.
      - (iv) Nonconductive Headwear Protection.
      - (v) Face and Eye Protection.
    - 2. General Protective Equipment and Tools.
      - (i) Tools and Equipment for Hot Work.
      - (ii) Insulating Shields and Barriers.
  - (b) Alerting Techniques.
    - 1. Safety Signs and Tags.
    - 2. Barricades.
    - 3. Attendants.
- VI Definitions (1910.339)

**TABLE C.2**  
**OUTLINE OF OSHA 29 CFR PART 1910 SUBPART N SECTION 269**  
**ELECTRIC POWER GENERATION, TRANSMISSION AND DISTRIBUTION**

- (a) General.
  - 1. Application.
    - (i) Operation, Maintenance of Electric Power Generation, Control, Transmission and Distribution Lines and Equipment.
      - A. Accessible Only to Qualified Employees.
      - B. Sources of Energy for Electric Generators.
      - C. Test Sites Involving Measurements of PG,T&D.
      - D. Work Directly Associated With PG,T&D Installations.
      - E. Line Clearance Tree Trimming.
    - (ii) Exclusions.
      - A. Construction Work Covered by 1926.950.
      - B. Installations Covered by Subpart S 1910.301-1910.399.
    - (iii) Applicable in Addition to All other parts of 1910.
  - 2. Training.
    - (i) Familiar With Safety Related Work Practices, Procedures and Other Requirements that Pertain to their Job Assignments.
    - (ii) Special Requirements for Qualified Employees.
      - A. Skills and Techniques Necessary to Distinguish Exposed Live Parts From Other Parts of Electric Equipment.
      - B. Skills and Techniques Necessary to Determine the Nominal Voltage of Exposed Live Parts.
      - C. Minimum Approach Distances Voltage Levels Exposed to.
      - D. Techniques for Work On/Near Exposed Equipment.
    - (iii) Employer Supervision and Inspections.
    - (iv) Requirements for Additional Training for Employees.
      - A. Compliance Problems.
      - B. Technology, Equipment, Changes in Procedures.
      - C. Need for New Safety Related Work Practices.
    - (v) Training to Class Room or On the Job.
    - (vi) Training to Establish Proficiency.
    - (vii) Employer Certification for Training.
  - 3. Existing Conditions Related to Work Performed to be Determined.
- (b) Medical Services and First Aid.
  - 1. Cardiopulmonary Resuscitation and First Aid Training.
    - (i) Field Work.
    - (ii) Fixed Work Locations Such as Generating Stations.
  - 2. First Aid Supplies.
  - 3. First Aid Kits.
- (c) Job Briefing Requirements.
  - 1. Number of Briefings.
  - 2. Extent of Briefing.
    - (i) Nature of Work and Hazard.
    - (ii) Employee Response to the Hazard.
  - 3. Working Alone.
- (d) Hazardous Energy Control (Lockout/Tagout) Procedures.
  - 1. Application.
  - 2. General.
    - (i) Establish Control Procedures, Training and Inspections.
    - (ii) Energy Control Program Requirements.
      - A. Tagout in Lieu of Lockout for Certain Devices.
      - B. Lockout and Tagout Conditions.
      - C. Lockout Provisions for New Equipment/Installations.
    - (iii) Procedures to be Developed and Documented.
    - (iv) Procedures to be Applied.
      - A. Statement of Intended Use.

- B. Shutting Down, Isolating, Blocking and Securing.
- C. Placement, Removal and Transfer of Lockout Devices.
- D. Lockout and Tagout Testing Verification.
- (v) Employer to Conduct Periodic Inspection.
  - A. Inspection by Independent Authorized Employee.
  - B. To Identify and Correct Deviations or Inadequacies.
  - C. Employee Responsibility for Lockout Review.
  - D. Employee Responsibility for Tagout Review.
  - E. Employer Certification for Inspections.
- (vi) Employer to Provide Training.
  - A. Hazardous Energy Sources and Means/Methods for Isolation and Control.
  - B. Purpose and Use of Energy Control Procedures.
  - C. Prohibition to Restart or Reenergize Equipment that has Been Locked Out and/or Tagged Out.
- (vii) Additional Training on the Limitations of Tags.
  - A. Tags are Warning Devices and Do Not of Themselves Produce Control Similar to a Lock.
  - B. Unauthorized Removal or Bypass Prohibited.
  - C. Tags to be Legible and Understandable.
  - D. Tags to Withstand Environmental Conditions.
  - E. Use of Tags in the Overall Context of Energy Control.
  - F. Tags to be Securely Attached.
- (viii) Requirements for Retraining.
  - A. Retraining Whenever a Job Assignment Change.
  - B. Retraining Whenever Inspection Shows Deviations.
  - C. Retraining to Reestablish Proficiency.
- (ix) Employer Certification on Training.
- 3. Protective Materials and Hardware.
  - (i) Locks, Tags, Chains, Wedges, Key Blocks, Self-locking Fasteners and the Like to be Used.
  - (ii) Lockout and Tagout Devices to be Singularly Identified.
    - A. Devices to be Capable of Withstanding the Environment.
    - B. Devices to be Standardized Within a Facility.
    - C. Devices to Require Excessive Force to Remove.
    - D. Tagout Devices Strong Enough to Prevent Inadvertent or Accidental Removal.
    - E. Provide Means for Providing Employee Identification.
    - F. Warn of Hazardous Condition if Equipment Energized.
- 4. Energy Isolation.
- 5. Notification to Affected Employees of the Application and Removal of Lockout and Tagout Devices.
- 6. Lockout/Tagout Application.
  - (i) Employee to have Knowledge of the Hazard to be Controlled.
  - (ii) Equipment to be Deenergized Using Established Procedures.
  - (iii) Devices to Isolate Equipment from Energy Sources.
  - (iv) Lockout and Tagout Devices Applied by Authorized Persons.
  - (v) After Lockout/Tagout All Potentially Hazardous Stored or Residual Energy to be Relieved.
  - (vi) Isolation of if Reaccumulation of Energy is a Possibility.
  - (vii) Tests to Verify Isolation.
- 7. Release of Lockout/Tagout.
  - (i) Work Area to be Inspected.
  - (ii) Personnel to be Safely Away from Work Area.
  - (iii) Notification of Removal of Lockout and Tagout.
  - (iv) Authorized Employee to Remove Lockout and Tagout.
- 8. Additional Requirements.
  - (i) Temporary Removal of Locks and Tags.
  - (ii) Group Lockout and Tagout Devices.
  - (iii) Procedures to be Used During Shift Changes.
  - (iv) Lockout/Tagout Procedures for Contractor Personnel.

- (v) Requirements for Centrally Located and Exclusively Controlled Energy Isolating Devices.
- (e) Enclosed Spaces.
  - 1. Safe Work Practices.
  - 2. Training.
  - 3. Rescue Equipment.
  - 4. Evaluation of Potential Hazards.
  - 5. Removal of Covers.
  - 6. Hazardous Atmosphere.
  - 7. Attendants.
  - 8. Calibration of Test Instruments.
  - 9. Testing for Oxygen Deficiency.
  - 10. Testing for Flammable Gases and Vapors.
  - 11. Ventilation and Monitoring.
  - 12. Specific Ventilation Requirements.
  - 13. Air Supply.
  - 14. Open Flames.
- (f) Excavations-Meet Section 1926 Subpart P.
- (g) Personal Protective Equipment.
  - 1. General Requirements.
  - 2. Fall Protection.
    - (i) Requirements for Personal Fall Arrest Equipment.
    - (ii) Requirements for Body Belts and Safety Straps.
    - (iii) Inspection Requirements.
    - (iv) Protection of Lifelines From Being Cut or Abraded.
    - (v) Fall Protection Equipment for Elevations of More than 4 ft.
    - (vi) Safety Design Requirements for Personal Fall Arrest Systems.
    - (vii) Usage Requirements for Lifelines or Drop Lines.
    - (viii) Restrictions on Usage of Snaphooks.
- (h) Ladders, Platforms, Step Bolts, and Manhole Steps.
  - 1. General Requirements.
  - 2. Requirements for Special Ladders and Platforms.
    - (i) Requirements for Securing.
    - (ii) Loading not to Exceed Design Loads.
    - (iii) Usage Restrictions.
    - (iv) Loading Capability to 2.5 Times the Maximum Intended Load.
  - 3. Conductive Ladders-Restrictions on Usage.
- (i) Hand and Portable Power Tools.
  - 1. General Requirements.
  - 2. Cord-and Plug-connected Equipment.
    - (i) Safety Design Requirements for Equipment Supplied by Premises Wiring.
    - (ii) Safety Design Requirements for Equipment Supplied by Other Than Premises Wiring.
  - 3. Safety Design Requirements for Portable and Vehicle Mounted Generators.
  - 4. Safety Design Requirements for Hydraulic and Pneumatic Tools.
- (j) Live-line Tools.
  - 1. Safety Design Requirements for Tools.
  - 2. Condition of Tools.
    - (i) Visual Inspection and Cleaning Before Use.
    - (ii) Visual Examination and Testing for Inspection Failures.
    - (iii) Removal From Service Every 2 yrs for Examination, Cleaning, Repair and Testing.
    - (iv) Maximum Time Interval for Removing Tools From Service for Cleaning, Examination and Testing.

- (k) Materials Handling and Storage.
  - 1. Safety Design General Requirements.
  - 2. Requirements for Material Storage Near Energized Lines/Equipment.
  
- (l) Working On or Near Exposed Energized Parts.
  - 1. Requirements for Use of Qualified Employees Only.
    - (i) Requirements for Use of Two or More Employees:
      - A. Installation, Removal or Repair of Lines that are Energized at More than 600-V.
      - B. Installation, Removal or Repair of Deenergized Lines if Exposed to Parts at More than 600-V.
      - C. Installation, Removal or Repair of Transformers, Capacitors, Regulators Energized at More than 600 V.
      - D. Work with Mechanical Equipment, Other than Insulated Aerial Lifts, Near Parts Energized at More than 600 V.
      - E. Any Work that Exposes Employee to Equivalent Hazards.
    - (ii) The Above Do Not Apply to:
      - A. Routine Switching of Circuits If it Can be Demonstrated that the Work can be Done Safely.
      - B. Work Performed With Live-line Tools if Employee is so Positioned that Exposure to Contact is Out of Reach.
      - C. Emergency Repairs to Safeguard the Public.
  - 2. Minimum Approach Distances to be Maintained Unless:
    - (i) Employee is Insulated from the Energized Part.
    - (ii) Energized Part is Insulated From Employee and From Any Other Conductive Object Energized at a Different Potential.
    - (iii) Employee Insulated from Any Conductive Object.
  - 3. Type of Insulation-Insulating Gloves and Insulating Sleeves to be Used Unless:
    - (i) Exposed Energized Parts Not Worked on are Insulated From Employee.
    - (ii) Insulation Placed Not to Expose the Employee's Upper Arm to Contact With Other Energized Parts.
  - 4. Working Position.
  - 5. Making Connections.
    - (i) Connections to be Made First to Deenergized Part.
    - (ii) Disconnection From Energized Circuit Shall First Remove Source End.
    - (iii) Loose Conductors to be Kept Away From Lines.
  - 6. Apparel.
    - (i) All Exposed Conductive Articles to be Rendered Non-conductive.
    - (ii) Training for the Hazards of Flames or Electric Arcs.
    - (iii) Exposed Clothing Not to Increase Extent of Injury.
  - 7. Fuse Handling.
  - 8. Covered Non-insulated Conductors.
  - 9. Non-current Carrying Metal Parts to be Treated as if Energized.
  - 10. Opening Circuits Under Load-Devices to Interrupt Current Involved.
  
- (m) Deenergizing Lines and Equipment for Employee Protection.
  - 1. Application-To the Deenergizing of Transmission and Distribution Lines and Equipment.
  - 2. General.
    - (i) Safety Requirements if System Operator in Charge.
    - (ii) If no System Operator in Charge One Employee to be Designated in Charge of Clearance for Work.
    - (iii) Disconnection is Visible and Accessible.
    - (iv) Disconnecting Means Outside of Employer's Control to be Rendered Inoperable While They are Opened.
  - 3. Deenergizing Lines and Equipment.
    - (i) Designated Employee in Charge of the Work and the Point of Contact to the Employer.
    - (ii) All Disconnecting Means and Taps to be Opened, Rendered



- Inoperable if Feasible, and Tagged.
  - (iii) Automatic and Remote Switches to be Inoperable.
  - (iv) Tags to Prohibit Operation of Disconnecting Means and to Indicate that Employees are at Work.
  - (v) Employee in Charge to Have Clearance by Employer.
  - (vi) Protective Grounds to be Used as Required.
  - (vii) Lines and Equipment to be Worked as Deenergized.
  - (viii) Independent Work Crews to Comply With Above.
  - (ix) Provision for Enable Transfer of Clearance Responsibility.
  - (x) Procedures for Releasing a Work Clearance:
    - A. Notification to Employees.
    - B. All Crew Employees are Clear of Lines and Equipment.
    - C. All Protective Grounds Have Been Removed.
    - D. Report to System Operator that Above Has Occurred.
  - (xi) Person Releasing Clearance to be the Same as Person Requesting Clearance Unless Responsibility Transferred.
  - (xii) Tags Not to be Removed Until Clearance Obtained.
  - (xiii) Reenergizing Only After Above Has Been Done.
- (n) Grounding for the Protection of Employees.
1. Application-Grounding of Transmission and Distribution Lines and Equipment.
  2. General Conditions:
    - (i) Lines and Equipment Have Been Deenergized:
    - (ii) No Possibility of Contact with Another Energized Source.
    - (iii) Hazard of Induced Voltage Not Present.
  3. Temporary Protective Grounds to be Installed to Achieve an Equipotential Zone.
  4. Protective Grounding Equipment.
    - (i) To be Capable of Conducting Maximum Fault Current.
    - (ii) Impedance of Protective Ground to Enable Protective Device Operation if System Becomes Energized.
  5. Test Before Grounding to Verify that Lines/Equipment Deenergized.
  6. Order of Connection-Ground End Connection to be Attached First.
  7. Order of Removal-Grounding Device to be Removed from Line or Equipment First.
  8. Additional Precautions for Work on Cable.
  9. Removal of Grounds for Test.
- (o) Testing and Test Facilities.
1. Application-Provides Safe Work Practices for High-Voltage and High-Power Testing in Laboratories, Shops, Substations, Field.
  2. General Requirements.
    - (i) Establish and Enforce Safe Work Practices.
    - (ii) Employees to be Trained in Safe Work Practices.
  3. Guarding of Test Areas.
    - (i) Permanent Test Areas Guarded by Walls, Fences, or Barriers.
    - (ii) One of Following for Field Testing or Temporary Test Site.
      - A. Area to be Guarded by Safety Tape.
      - B. Area to be Guarded by a Barrier or Barricade.
      - C. Test Area to be Guarded by Test Observers.
    - (iii) Barriers to be Removed When No Longer Needed.
    - (iv) Guarding to be Provided in Test Areas to Control Access to Equipment or Apparatus Under Test.
  4. Grounding Practices.
    - (i) Safe Grounding Practices to be Implemented.
      - A. All Conductive Parts at Ground Potential.
      - B. All Ungrounded Terminals to be Treated as if Energized.
    - (ii) Visible Grounds to be Applied.

- (iii) Isolated Ground Conductor System to be Used. Conditions for Not Using an Isolated Ground System:
    - A. Distance Energy Source from Test Site.
    - B. Protected from Hazardous Step and Touch Potentials.
  - (iv) Equivalent Safety to be Provided if Test Equipment Grounds Located in Power Cords Cannot be Used.
  - (v) Grounding Conductor to be Placed at High Voltage Terminal and any Exposed Terminals.
    - A. High Capacitance Equipment to be Discharged Through a Resistor.
    - B. Ground to be Applied to Exposed Terminals.
  - (vi) Chassis of Test Vehicles or Trailers to be Grounded.
  - 5. Control and Measuring Circuits.
    - (i) Control Wiring to be Contained in Grounded Metallic Sheaths and Terminated to Ground.
    - (ii) Meters and Other Instruments With Accessible Terminals to be Isolated from Test Personnel.
    - (iii) Routing and Connections Protected Against Damage.
  - 6. Safety Check.
    - (i) Safety Checks of the Test Area Before the Each of the Tests.
    - (ii) Test Operator to Verify:
      - A. Barriers and Guards have been Properly Placed.
      - B. System Test Status Signals in Operable Condition.
      - C. Test Power Disconnects to be Clearly Marked and Readily Available.
      - D. Ground Connections to be Clearly Identifiable.
      - E. Personal Protective Equipment to be Provided.
      - F. Signal, Ground and Power Cables Properly Separated.
- (p) Mechanical Equipment.
- 1. General Requirements.
    - (i) Critical Safety Components to be Visually Inspected Before Use on Each Shift.
    - (ii) Vehicular Equipment With Obstructed View to the Rear Not to be Used Unless:
      - A. Vehicle to have a Reverse Signal Alarm.
      - B. Vehicle to Backed up Only When Designated Employee Signals that it is Safe to do so.
    - (iii) Operator to Remain at Controls While Loaded.
    - (iv) Rollover Protective Structures Required.
  - 2. Outriggers.
    - (i) If Provided on Vehicules, Outriggers to be Fully Extended.
    - (ii) Maximum Load Without Outriggers Not to be Exceeded if Operation Without Outriggers Fully Extended.
  - 3. Applied Loads to be Within Maximum Ratings.
  - 4. Operations Near Energized Lines or Equipment.
    - (i) Minimum Approach Distance Requirements.
    - (ii) Designated Employee to Observe Approach Distance.
    - (iii) Mechanical Equipment that Could Become Energized.
      - A. Insulated Coverings on Energized Lines.
      - B. Equipment Insulated for the Voltage Involved.
      - C. Employees to be Protected.
- (q) Overhead Lines.
- 1. General Requirements.
    - (i) Elevated Structures be Capable of Additional Loads/Stresses.
    - (ii) Moving Pole Not to Touch Energized Conductors.
    - (iii) Personal Protective Equipment for Employees.
    - (iv) Holes to be Guarded.
  - 2. Installing and Removing Overhead Lines.
    - (i) Tension Stringing to Avoid Contact With Other Lines.
    - (ii) Safety Requirements for Tensioning and Pulling Equipment.

- (iii) Automatic Reclosing Equipment to be Disabled.
  - (iv) For Work on Parallel Lines, Determine Approximate Value of Induced Voltages and Lines to be Grounded.
  - (v) Reel Handling Equipment to be in a Safe Condition.
  - (vi) Stringing Equipment Load Ratings Not Exceeded.
  - (vii) Pulling Lines to be Repaired or Replaced.
  - (viii) Wire Grips Specifically Designed for the Usage.
  - (ix) Reliable Communications Between Reel Tender and Pulling Rig Operator to be Maintained.
  - (x) Pulling Rig to be Operated Only When Safe to do so.
  - (xi) Employee Not Permitted to be Directly Under Overhead Operations or On Cross Arm During Power Driven Pulling Work.
3. Live-line Bare-hand Work.
- (i) Employees Trained in the Technique and Safety Requirements.
  - (ii) Requirements Prior to Live-line Work:
    - A. Nominal Voltage Rating of Circuit Worked On.
    - B. Minimum Approach Distances to Ground.
  - (iii) Equipment and Tools Designed, Tested for the Work.
  - (iv) Automatic Reclosing Equipment Disabled if Possible.
  - (v) Work Not to be Performed During Adverse Weather.
  - (vi) Conductive Bucket Liner to be Provided for Bonding Aerial Device to Energized Line or Equipment.
    - A. Employee to be Properly Connected to Bucket Liner or Other Conductive Device.
    - B. Electrostatic Shielding Used Where Needed.
  - (vii) Bucket Liner or Other Conductive Device to be Connected to Energized Line Prior to Employee Contacting Energized Line.
  - (viii) Aerial Lifts to Have Dual Controls.
  - (ix) Lower Lift Controls Operated Only in Emergency Conditions.
  - (x) Bucket and Lift Controls to be Checked Prior to Elevating.
  - (xi) Truck to be Grounded Prior Elevating Aerial Lift.
  - (xii) Boom Current Test Before Work is Started Each Day.
  - (xiii) Minimum Approach Distances to be Maintained.
  - (xvi) Requirements for Use of Hand Lines.
  - (xvii) Uninsulated Equipment Not to be Passed to Bucket While Employee is Bonded to Energized Line.
  - (xviii) Minimum Approach Distances to be Printed and Visible.
  - (xix) Non-conductive Measuring Device be Available and Accessible.
4. Towers and Structures.
- (i) Not Allowed Under Overhead Work Unless Needed for Job.
  - (ii) Tag Lines or Other Similar Devices to Maintain Control.
  - (iii) Loadline Not to be Removed Until Load Safely Secured.
  - (iv) Work to be Discontinued During Adverse Weather Except for Emergency Conditions.
- (r) Line-clearance Tree Trimming Operations.
1. Electrical Hazards.
- (i) Maximum Nominal Voltage to be Determined.
  - (ii) Requirements for Presence of Second Tree Trimmer:
    - A. Approach Distance to be 10 ft for Greater than 750 V.
    - B. Branches or Limbs Being Removed Within Specified Approach Distances.
    - C. If Roping is Required for Removal of Limbs/Branches.
  - (iii) Line Clearance Tree Trimmers to Maintain Approach Distances.
  - (iv) Insulating Equipment Required for Removal of Limbs/Branches Touching Energized Lines or Equipment.
  - (v) Clearance Requirement for Ladders, Platforms, Aerial Devices.
  - (vi) No Tree Trimming Operations During Adverse Weather.
2. Brush Clippers.
- (i) Ignition System Locking Device Requirements.
  - (ii) Access Panels to be In Place and Secure.
  - (iii) Infeed Hopper Requirements.

- (iv) Trailer Chippers to be Chocked or Secured.
  - (v) Personal Protective Equipment Wearing Requirements.
  - 3. Sprayers and Related Equipment.
    - (i) To be Covered With Slip Resistant Material.
    - (ii) Guardrail Requirements for Equipment in Motion.
  - 4. Stump Cutters.
    - (i) To be Equipped With Enclosures or Guards.
    - (ii) Personal Protective Equipment Wearing Requirements.
  - 5. Gasoline Engine Power Saws.
    - (i) Requirements for Support Lines.
    - (ii) Requirements for Engine Controls.
    - (iii) Requirements for Engine Clutching.
    - (iv) Requirements for Saw Placing During Starting.
    - (v) Employees to be Clear of Saw During Starting and Operation.
    - (vi) Saw Not to be Running While Tree Climbing.
    - (vii) Engines Stopped During Cleaning, Refueling, or Adjustments.
  - 6. Backpack Power Units for Use in Pruning and Clearing.
    - (i) Distance Requirements During Operation.
    - (ii) Requirements for Quick Shut-Off and Accessible Switch.
    - (iii) Power Units to be Stopped During Cleaning, Refueling, Adjustments or Repairs.
  - 7. Rope.
    - (i) Climbing Ropes to be Used for Working Aloft.
    - (ii) Inspection Requirements for Ropes.
    - (iii) Storage Requirements.
    - (iv) Requirements for Air Circulation During Storage.
    - (v) Rope Ends to be Secured.
    - (vi) Climbing Rope Not to be Spliced.
    - (vii) Insulation for Rope Used Near Energized Lines or Equipment.
  - 8. Fall Protection Requirements.
- (s) Communication Facilities.
- 1. Microwave Transmission.
    - (i) Prohibitions Around Open Waveguides and Antenna Considered Connected to Energized Microwave Source.
    - (ii) Posting Requirements With Warning Symbols.
    - (iii) Employer to Ensure that Exposure Limits are Not Exceeded.
  - 2. Power Line Carrier-Requirements for Treating it as if Energized.
- (t) Underground Electrical Installations.
- 1. Access.
  - 2. Lowering Equipment Into Manholes.
  - 3. Attendants for Manholes.
    - (i) First Aid Training Required or to be Available.
    - (ii) Allowed to Briefly Enter Manhole.
    - (iii) Brief Entry Allowed to Assist Employee Working Alone.
    - (iv) Reliable Communications Through Radios or Equivalent.
  - 4. Duct Rods to be Installed in Direction Presenting Least Hazard.
  - 5. Multiple Cables-Cable to be Worked to be Identified by Electrical Means Unless its Identity is Obvious.
  - 6. Moving Cables-Energized Cables to be Inspected for Defects.
  - 7. Defective Cables to be Deenergized Before Entry into Manhole Unless Physical Protective Devices are Used.
  - 8. Metallic Sheath Continuity to be Maintained or Cable Sheath Treated as if Energized.
- (u) Substations.
- 1. Access and Working Space to be Sufficient and Maintained.
  - 2. Draw-out Circuit Breakers to be in Open Position and Controls Made Inoperative When Removed or Inserted.
  - 3. Substation Fences-Conductive Fences to be Grounded and Grounding Continuity to be Maintained.
  - 4. Guarding of Rooms Containing Electric Supply Equipment.

- (i) Requirements for and Conditions.
    - A. Exposed Live Parts at 50 to 150 V are Located Within 8 ft of the Ground or Other Working Surface.
    - B. Exposed Live Parts at 151 to 600 V Within 8 ft of Ground/Working Surface and Guarded Only by Location.
    - C. Exposed Live Parts Over 600 V that are Not Metal Enclosed or Not Isolated by Height.
  - 5. Guarding of Energized Parts.
    - (i) Guards Required for Live Parts at More than 150-V Unless Separation Minimizes Possibility of Contact.
    - (ii) Except for Fuse Replacement or Other Necessary Access, Guarding to be Maintained.
    - (iii) Barriers to be Installed When Guards are Removed.
  - 6. Substation Entry.
    - (i) Presence to be Reported to Person in Charge.
    - (ii) Job Briefings Required.
- (v) Power Generation.
- 1. Interlocks and Other Safety Devices.
    - (i) To be Maintained in a Safe and Operable Condition.
    - (ii) Not to be Modified to Defeat its Purpose.
  - 2. Grounding Condition to be Checked Prior to Changing Brushes.
  - 3. Access and Minimum Working Space to be Maintained.
  - 4. Guarding of Rooms Containing Electric Supply Equipment.
    - (i) Requirements for and Conditions.
      - A. Exposed Live Parts at 50 to 150 V are Located Within 8 ft of the Ground or Other Working Surface.
      - B. Exposed Live Parts 151 to 600 V Located Within 8 ft of Ground/Working Surface and Guarded Only by Location.
      - C. Exposed Live Parts Over 600-V that are Not Metal Enclosed or Not Isolated by Height.
  - 5. Guarding of Energized Parts.
    - (i) Guards Required for Live Parts at More than 150-V Unless Separation Minimizes Possibility of Contact.
    - (ii) Except for Fuse Replacement or Other Necessary Access, Guarding to be Maintained.
    - (iii) Barriers to be Installed When Guards are Removed.
  - 6. Water or Steam Spaces.
    - (i) Designated Employee to Inspect Before Work and Personal Protective Devices Required.
    - (ii) Shielding to be Provided at Tube Ends
  - 7. Chemical Cleaning of Boilers and Pressure Vessels.
    - (i) Area to be Cordoned Off.
      - A. Signs to be Posted Restricting Entry.
      - B. Smoking, Welding or Other Ignition Sources Prohibited.
    - (ii) Number of Personnel to be Restricted.
    - (iii) Water or Shower Access for Emergency Use.
    - (iv) Requirement for Use of Personal Protective Devices.
  - 8. Chlorine Systems.
    - (i) Signs Restricting Entry and Hazard Warnings.
    - (ii) Entry Limited to Designated Employees Only.
    - (iii) Emergency Repair Kits to be Available Nearby.
    - (iv) Purging With Dry Air and Isolation Prior to Repair.
    - (v) Ensure that Chlorine is Not Mixed With Other Materials.
  - 9. Boilers.
    - (i) Inspection and Protection from Overhead Objects.
    - (ii) Stand Clear of Door When Opening Operating Boiler.
  - 10. Turbine Generators.
    - (i) Ignition Sources Prohibited and Warning Signs Required.
    - (ii) Emergency Action for Abnormal Loss of Pressure or if Excessive Hydrogen Makeup is Present.
  - 11. Coal and Ash Handling.
    - (i) Designated Person to Operate Railroad Equipment.

- (ii) Warnings Before Locomotive/Crane Movements.
  - (iii) Feet Not to be Used for Lining up Drawheads.
  - (iv) Drawheads and Knuckles Not to be Shifted While Locomotives or Cars are in Motion.
  - (v) Stopped Railroad Cars Secured from Unsafe Displacement.
  - (vi) Emergency Means of Stopping at Railroad Dumps.
  - (vii) Requirements for Training in Conveyor Operations.
  - (viii) Employees Not to Ride Conveyor Belts.
  - (ix) Alerting Requirements Prior to Starting Conveyors.
  - (x) Audible Alarms for Operating Conveyors.
  - (xi) Emergency Stop Buttons or Other Stop Devices When Required.
    - A. Emergency Stop Device to be Readily Identified.
    - B. Emergency Stop Device to Operate Directly on Controls.
    - C. Emergency Stop Devices Not to be Overridden.
12. Hydroplants and Equipment Warnings Required on/or Near Water Gates, Valves, Intakes or Other Sources of Flow or Levels.
- (w) Special Conditions.
- 1. Capacitors.
    - (i) Capacitors Disconnected from Sources and Short Circuited.
    - (ii) Series-Parallel Capacitor Banks to be Shorted Circuited Between all Terminals and Capacitor Case.
    - (iii) Lines With Capacitors Shall be Short Circuited.
  - 2. Current Transformer Secondaries. Secondary Not to be Opened While Transformer is Energized.
  - 3. Series Streetlighting.
    - (i) Safe Work Practices for Circuits Exceeding 600 V to be Applied for Streetlighting Circuits of 600 V.
    - (ii) Series Loop to be Opened Only After Streetlighting Transformer is Deenergized and Isolated.
  - 4. Sufficient Illumination to be Provided to Work Area.
  - 5. Protection Against Drowning.
    - (i) USCG Approved Personal Flotation Devices to be Provided.
    - (ii) Flotation Devices to be Maintained and Frequently Inspected.
    - (iii) Safe Means of Passage.
  - 6. Employee Protection in Public Work Areas.
    - (i) Traffic Control Signs and Devices.
    - (ii) Warning Signs/Flags Located in Visible Locations.
    - (iii) Barricades to be Used if Necessary.
    - (iv) Excavated Areas to be Barricaded.
    - (v) Warning Lights to be Displayed at Night.
  - 7. Backfeed. Live-line Work Methods Used for Energized Circuits.
  - 8. Lasers to Meet Design Safety Requirements of 1926.54.
  - 9. Hydraulic Fluids to Provide Insulation for the Voltage Involved.
- (x) Definitions.

**TABLE C.3**  
**OUTLINE OF OSHA 29 CFR PART 1926 SUBPART K ELECTRICAL**

- I General Requirments (1926.416)
  - (a) Protection of Employees.
    - 1. Protection Against Electric Shock.
    - 2. Requirement for Insulated Protective Gloves.
    - 3. Warning Signs Where Energized Circuits Exist.
    - 4. Work on Energized Equipment.
  - (b) Passageways and Open Spaces.
    - 1. Requirements for Barriers or Other Means of Guarding.
    - 2. Working Spaces, Walkway/Locations Kept Clear of Electric Cords.
  - (c) Load Ratings.
  - (d) Fuses.
  - (e) Cords and Cables.
    - 1. Worn and Frayed Electric Cords or Cables Not to be Used.
    - 2. Installation of Extension Cords.
  - (f) Specific Procedures.
    - 1. Temporary Override of Interlocks.
    - 2. Portable Electric Equipment-Handling.
    - 3. Visual Inspection.
    - 4. Connecting Attachment Plugs.
      - (i) Requirement for Dry Hands When Plugging and Unplugging Cords for Energized Equipment.
      - (ii) Insulated Protective Equipment for Handling Energized Plug and Recepticle Connections.
      - (iii) Proper Securing of Locking Type Connectors.
    - 5. Routine Opening/Closing of Power and Lighting Circuits.
    - 6. Reclosing Circuits After Protective Device Operation.
    - 7. Test Instruments and Equipment.
    - 8. Visual Inspection.
    - 9. Rating of Equipment.
    - 10. Occassional Use of Flammable or Ignitable Materials.
  - (g) Use of Equipment.
    - 1. Work on Energized Equipment.
    - 2. Overhead Lines.
      - (i) Unqualified Persons.
        - A. Clearance for Work in Elevated Positions.
        - B. Clearance Requirements for Work on the Ground.
      - (ii) Qualified Persons.
        - A. Clearance Requirements for Persons Insulated from an Energized Part.
        - B. Clearance Requirements for An Energized Part Insulated from Both the Person and All Other Conductive Objects at a Different Potential.
        - C. Clearance Requirements for Persons Insulated from All Conductive Objects at a Potential Different from the Energized Part.
      - (iii) Vehicular and Mechanical Equipment.
        - A. Clearance Requirements for Equipment Capable of Being Elevated.
        - B. Requirements for Employee Clearance from Vehicular and Mechanical Equipment.
        - C. Additional Requirements for Clearances and the Use of Barricades and Insulation.

3. Illumination.
    - (i) Requirements for Spaces Containing Exposed Energized Parts.
    - (ii) Requirements for Clear Observation of the Work.
  4. Confined or Enclosed Work Spaces.
  5. Conductive Materials and Equipment.
  6. Portable Ladders.
  7. Conductive Apparel.
  8. Housekeeping Duties.
- II Lockout and Tagging of Circuits (1926.417)
- (a) Controls.
  - (b) Equipment and Circuits.
  - (c) Tags.
  - (d) Lockout and Tagging.
    1. Procedures.
    2. Deenergizing Equipment.
      - (i) Safe Procedures.
      - (ii) Disconnecting Requirements.
      - (iii) Stored Electric Energy Discharge Requirements.
      - (iv) Blocking of Non-Electric Energy Storage Devices.
    3. Application of Locks and Tags.
      - (i) Placement Procedures.
      - (ii) Required Statements on Tags.
      - (iii) Tags Only Instead of Locks and Tags.
      - (iv) Additional Safety Measures When Tags Only are Applied.
      - (v) Locks Only Instead of Locks and Tags.
        - A. Only One Circuit or Equipment is Deenergized.
        - B. Lockout Period Goes Not Beyond the Work Shift.
        - C. Employees Exposed to Hazards of Reenergizing are Familiar With Procedure.
    4. Verification of Deenergized Condition.
      - (i) Qualified Person to Verify by Attempted Operation that Equipment Cannot be Restarted.
      - (ii) Qualified Person to Test to Verify that Equipment is Deenergized.
    5. Reenergizing Equipment.
      - (i) Qualified Person to Test and Inspect to Verify that Equipment Can be Reenergized.
      - (ii) Requirement for Warnings to Stay Clear.
      - (iii) Lock and Tag Removal Procedures.
      - (iv) Visual Determination that Persons are Clear Prior to Reenergizing.



**TABLE C.4**  
**OUTLINE OF OSHA 29 CFR PART 1926 SUBPART V**  
**POWER TRANSMISSION AND DISTRIBUTION**

(Most sections of appear to be safe work practices.)

- I General Requirements (1926.950)
  - (a) Application.
    - 1. Definition - Erection, Alteration, Conversion and Improvement.
    - 2. Conformance Requirement.
    - 3. Minimum Requirements for Adherence.
  - (b) Initial Inspections, Tests, or Determinations.
    - 1. Existing Conditions to be Determined.
    - 2. Electric Equipment and Lines to be Considered Energized.
    - 3. Operating Voltage to be Determined Before Work Started.
  - (c) Clearances.
    - 1. Insulating Handle Requirement to Exposed Energized Parts.
      - (i) Insulated or Guarded from the Energized Part.
      - (ii) Part Insulated or Guarded and at Different Potential.
      - (iii) Isolated or Guarded from any Conductive Objects.
    - 2. Minimum Distances.
      - (i) Minimum Working Distance and Clear Hot Stick Distance.
      - (ii) Insulation Requirement for Conductor Support Tools.
  - (d) Deenergizing Lines and Equipment.
    - 1. Lines and Equipment Operated in Excess of 600 V and Means of Disconnecting Not Visible.
      - (i) Identification and Isolation.
      - (ii) Notification and Assurance.
        - A. Switches and Disconnects Have Been Deenergized.
        - B. Switches and Disconnectors are Tagged.
        - C. Switches and Disconnectors Rendered Inoperable.
      - (iii) Visual Inspection, Test to Verify Deenergization.
      - (iv) Protective Grounds to Disconnected Lines and Equipment.
      - (v) Guards or Barriers to be Erected to Adjacent Energized Lines.
      - (vi) Prominent Tags for Each Independent Work Crew.
      - (vii) Removing Tags and Protective Grounds.
    - 2. Lines and Equipment Where Means of Disconnecting are Visible.
      - (i) Guards or Barriers to be Erected to Adjacent Energized Lines.
      - (ii) Removing Tags and Protective Grounds.
  - (e) Emergency Procedures and First Aid.
    - 1. Employer to Provide Training.
      - (i) Procedures for Emergency Situations.
      - (ii) First Aid Fundamentals Including Resuscitation.
    - 2. Availability of Person With Certified First Aid Training.
  - (f) Night Work.
  - (g) Working Near or Over Water.
  - (h) Sanitation Facilities.
  - (i) Hydraulic Fluids.
- II Tools and Protective Equipment (1926.951)
  - (a) Protective Equipment.
    - 1. Rubber Protective Equipment.
      - (i) ANSI Safety Design Requirements.
      - (ii) Visual Inspection Prior to Use.

- (iii) Air Test Prior to Use.
- (iv) Protective Equipment Requirement Other Than Rubber.
- 2. Protective Hats ANSI Safety Design Requirments.

(b) Personal Climbing Equipment.

- 1. Body Belts With Straps or Lanyards to be Worn.
- 2. Body Belts and Safety Straps Safety Design Requirments.
- 3. Inspection Requirements.
- 4. Lifelines and Lanyards.
  - (i) Safety Design Safety Requirements.
  - (ii) Safety Lines Design Safety Requirements.
- 5. Defective Ropes to be Replaced.

(c) Ladders.

- 1. Metal or Conductive Ladders Not Used Near Energized Parts.
- 2. Hook or Other Type Ladders to be Positively Secured.

(d) Live Line Tools.

- 1. Certification Requirments.
  - (i) Fiberglass-100,000 V/ft for 5 min.
  - (ii) Wood-75,000 V/ft for 3 min.
  - (iii) Other Test Equivalent to d1(i) and d1(ii).
- 2. Live Line Tools to be Visually Inspected Every Day.

(e) Measuring Tapes or Measuring Ropes.

(f) Handtools.

- 1. Powered Tools to Meet Safety Requirements for On-Off Control.
- 2. Requirements for Portable Electric Handtools.
  - (i) Equipped With Three-wire/Permanent Ground Connection.
  - (ii) Be of the Double Insulated Type.
  - (iii) Isolating Transformer or Isolated Power Supply.
- 3. Hydraulic Tools to Use Nonconducting Hoses.
- 4. Pneumatic Tools Used On or Around Energized Lines and Equipment.
  - (i) Have Nonconducting Hoses With Adequate Strength.
  - (ii) Have an Accumulator on Compressor to Collect Moisture.

III Mechanical Equipment (1926.952)

(a) General.

- 1. Visual Inspections to be Made Daily.
- 2. Tests Required at the Beginning of Each Shift.
- 3. Requirements for Vehicle Equipment With Obstructed Rear View.
  - (i) Reverse Signal Alarm.
  - (ii) Observer Signals Required for Backing Up.

(b) Aerial Lifts.

- 1. Design Safety Requirements per Subpart N of 1926.
- 2. Grounding and Barricading When Working Near Energized Parts.
- 3. Restrictions on Equipment or Material Movements.

(c) Derrick Trucks, Cranes and Other Lifting Equipment.

- 1. Design Safety Requirements per Subpart N and O of 1926.
- 2. Grounding Requirements for Work Near Energized Lines/Equipment.

IV Material Handling (1926.953)

(a) Unloading.

(b) Pole Hauling.

- 1. Loads to be Secured and Red Flag Usage.
- 2. Precautions to Prevent Blocking Roadways or Endangering Traffic.
- 3. Illumination Warning Devices for Hauling During Darkness.

(c) Storage.

1. No Storage Under or Near Energized Lines and Equipment.
2. Clearance When Storage Near Energized Lines and Equipment.

- (d) Tag Line.
- (e) Oil Filled Equipment.
- (f) Framing.
- (g) Attaching the Load.

V Grounding for Protection of Employees (1926.954)

- (a) General.
- (b) New Construction.
  1. Lines Considered Deenergized Where Lines/Equipment are Grounded.
  2. Hazard of Induced Voltage and Adequate Clearances/Other Means.
- (c) Communication (Bare) Conductors to be Considered Energized.
- (d) Voltage Testing to be Done on Deenergized Conductors.
- (e) Attaching Grounds.
  1. Ground End to be Attached First and Other End to be Attached Using Insulated Tools or Other Similar Means.
  2. Grounding Device to be First Removed From the Line or Equipment Using Insulated Tools or Other Similar Means.
- (f) Grounds Between Work Location and All Sources of Energy.
- (g) Testing Without Grounds.
- (h) Grounding Electrode.
- (i) Grounding to Tower.
- (j) Ground Lead.

VI Overhead Lines (1926.955)

- (a) Specific Requirements.
  1. Applicable Requirements.
  2. Inspection of Structures Prior to Climbing.
  3. Poles and Structures to be Made Safe Prior to Climbing.
  4. Action to be Taken to Prevent Failure of Supporting Structures.
  5. Requirements for Moving and Setting Equipment.
    - (i) Avoid Contact With Energized Lines/Equipment.
    - (ii) Clearance Requirements.
  6. Grounding When Near Energized Lines and Equipment.
    - (i) Employee to Avoid Contact With Equipment and Machinery.
    - (ii) Lift Equipment Bonded to Effective Ground and Barricaded.
  7. Pole Holes Not to be Left Unattended or Unguarded.
  8. Tag Lines to be of a Nonconductive Type.
- (b) Metal Tower Construction.
  1. Shoring Requirements for Working in Unstable Material.
  2. Employees Not to Enter Footing Holes in Unstable Material.
  3. Working Near Footings.
    - (i) Designated Employee to be Used in Directing.
    - (ii) No One to be in Footing While Equipment is Nearby.
    - (iii) Grading and Leveling for Stability of Equipment.
  4. Tower Assembly.
    - (i) Minimum Exposure to Employees From Falling Objects.

- (ii) Guy Lines to be Used as Necessary.
  - (iii) Members and Sections to be Adequately Supported.
  - 5. Assembling and Erecting Towers.
    - (i) Site Construction Machinery Requirments.
    - (ii) Work Restrictions Under Towers.
    - (iii) Extraordinary Caution to be Maintained.
  - 6. Tower Assembling and Erecting.
    - (i) Erection Cranes to be Set on Firm and Level Foundations.
    - (ii) Tag Lines Required for Control of Tower Sections.
    - (iii) Loadline Not to be Detached.
    - (iv) Work to be Discontinued During Adverse Weather.
    - (v) Inspection and Maintenance Requirements.
  - 7. Traffic Control Requirements.
  - 8. Designated Employee Required Near Energized Lines.
- (c) Stringing or Removing Deenergized Conductors.
- 1. Requirments.
  - 2. Briefing to be Held Prior to Stringing Operations.
  - 3. Conductors to be Grounded or Insulated to Protect Employees.
  - 4. Grounding and Guarding Procedures.
    - (i) Clearance Authorization and Line Grounding.
    - (ii) Rope Net/Guard Structure for Stringing Over Conductor.
  - 5. Conductors Being Strung to be Under Positive Control.
  - 6. Guard Structures to be Sound and Adequately Supported.
  - 7. Requirements for Hoist and Pulling Accessories.
    - (i) Requirments for Catch-off Anchors, Rigging and Hoists.
    - (ii) Manufacturers Load Ratings Not to be Exceeded.
    - (iii) Inspection for Pulling Lines and Accessories.
  - 8. Conductor Grips Requirements.
  - 9. Not Permitted Directly Under Overhead Operations or on Crossarms.
  - 10. Transmission Clipping Crew Requirments.
  - 11. Adverse Environments.
    - (i) Work to be Discontinued During Adverse Weather.
    - (ii) Work to be Discontinued During Electrical Storms.
  - 12. Reel Handling Equipment.
    - (i) Capacity and Operating Requirements.
    - (ii) Communication Between Reel Tender/Pulling Rig Operator.
    - (iii) Snubbing or Dead Ending Requirements.
- (d) Stringing Adjacent to Energized Lines.
- 1. Inspection Prior to Start Work Requirements.
  - 2. Tension Stringing Methods to Assure Unintentional Contact.
  - 3. Pulling/Tensioning Equipment be Isolated, Insulated or Grounded.
  - 4. Grounding Between Tensioning Reel Setup and First Structure.
  - 5. Grounding Requirement During Stringing Operation.
  - 6. Grounding Requirement at Dead End or Catch Off Points.
  - 7. Grounding Location Requirement Near Work Areas.
  - 8. Bonding and Grounding Requirement to Towers.
  - 9. Individual Grounds at Every Work Location.
- (e) Live-line Bare Hand Work.
- 1. Instruction and Training Requirements.
  - 2. Checks to be Made.
    - (i) Voltage Rating of the Circuit to be Worked on.
    - (ii) Clearances to Ground for Lines and Other Energized Parts.
    - (iii) Voltage Limitations of Aerial-lift Equipment.
  - 3. Only Equipment Designed, Tested and Intended to be Used.
  - 4. Personal Supervision Requirements.
  - 5. Automatic Reclosing Interrupting Devices to be Made Inoperative.
  - 6. Work to be Suspended During Electrical Storms.
  - 7. Conductive Bucket Liner be Provided for Insulated Aerial Devices.
    - (i) Employee to be Electrically Connected to Bucket Liner.
    - (ii) Adequate Electrostatic Shielding or Conductive Clothing.

8. Only Tools and Equipment Intended for Live-line Work to be Used.
9. Aerial Lift Outriggers to be Used and Body of Truck Grounded.
10. Aerial Lift Controls to be Tested.
11. Electrical Tests to Verify Aerial Lift Arm Insulation Integrity.
12. Dual Controls Requirements.
13. Ground Level Lift Control Not to be Used.
14. Conductive Bucket Liner to be Bonded to Energized Conductor.
15. Minimum Clearance Distance Requirement for Live-line Hand Work.
16. Minimum Clearance Distance for Approaching, Leaving or Bonding to an Energized Circuit.
17. Minimum Clearance Positioning the Bucket Alongside.
18. Prohibitions.
  - (i) Handlines Between Buckets, Booms and the Ground.
  - (ii) No Conductive Material Over 36 in. Long in Bucket.
  - (iii) Nonconductive Handlines to be Used.
19. Manufacturer's Lift Weight Requirements Not to be Exceeded.
20. Minimum Clearance Measurements.
  - (i) Minimum Clearance Table to be Mounted in Bucket.
  - (ii) Insulated Measuring Sticks be Used.

#### VII Underground Lines (1926.956)

- (a) Guarding and Ventilating Street Opening Used for Access.
  1. Appropriate Warning Signs to be Promptly Placed.
  2. Barriers, Temporary Covers or Other Suitable Guards.
  3. For Work to be Performed in a Manhole or Unvented Vault:
    - (i) Forced Ventilation or Safe Atmosphere before Entering.
    - (ii) Work Area to be Ventilated or Otherwise Made Safe.
    - (iii) Provisions for Adequate, Continuous Supply of Air.
- (b) Work in Manholes.
  1. Employee Available for Emergency Assistance. Does Not Preclude Qualified Employees from Working Alone for Brief Periods.
  2. Extra Precautions for Ventilation When Open Flames Must be Used.
  3. Atmosphere to be Found Safe Before Use of Open Flames.
- (c) Trenching and Excavating.
  1. Underground Location of Dangerous Facilities to be Determined Before Trenching and Excavating.
  2. Requirements for Warnings and Protective Systems.
  3. Protection to Exposed Underground Facilities.
  4. Protection to Cables.
  5. Cables to be Identified by Electrical or Other Suitable Means.
  6. Identification/Verification Required Before Cutting and Splicing.
  7. Metallic Sheath Continuity to be Maintained.

#### VIII Construction in Energized Substations (1926.957)

- (a) Work Near Energized Equipment Facilities.
  1. Authorization Requirements.
  2. The Following to be Determined:
    - (i) What Facilities Are Energized.
    - (ii) Necessary Protective Equipment and Precautions.
  3. Extraordinary Cautions in the Handling of Busbars/Materials.
- (b) Lockout Provisions for Deenergized Equipment and Lines.
- (c) Barricades and Barriers.
  1. To be Installed to Prevent Accidental Contact.
  2. Signs to be Posted Near Barricades and Barriers.
- (d) Control Panels.
  1. Work to be Done by Designated Employee.
  2. Prevent Accidental Operation of Relays/Other Protective Devices.

- (e) Mechanized Equipment.
  - 1. To be Controlled by Designated Employee.
  - 2. Grounding Requirements for Work Near Energized Lines or Equipment.
  - 3. Requirements for Transporting Large Equipment.
- (f) Storage Requirements.
- (g) Substation Fences.
  - 1. Grounding Requirement for Temporary/Extensions to Fences.
  - 2. Locking Requirements for Gates.
- (h) Footing Excavation.
  - 1. Same Precautions as for Metal Tower Construction.
  - 2. Employee Restrictions for Entering Unsupported Excavation of Unstable Material.

IX External Load Helicopters (1926.958)

X Lineman's Body Belts, Safety Straps and Lanyards (1926.959)

- (a) General Requirements.
  - 1. Hardware to Meet ASTM Design Safety Requirements.
  - 2. Tensile Strength Requirements.
  - 3. D Ring Strength Requirements.
  - 4. Snaphook Strength Requirements.
- (b) Specific Requirements.
  - 1. Fabric Used for Safety Straps.
    - (i) AC High Voltage Dielectric Strength Requirements.
    - (ii) Leakage Current Requirements for Fabric and Leather.
    - (iii) DC Tests in Lieu of AC Tests.
  - 2. Cushion Part of Body Belts.
    - (i) No Exposed Rivets on Inside.
    - (ii) At Least 3 Inches Wide.
    - (iii) Thickness Requirements.
    - (iv) Extension Requirements for Pocket Tabs.
  - 3. Requirements on Tool Loops.
  - 4. Requirements on Liners.
  - 5. Strength Requirements for Stitching.
  - 6. Requirements on Snaphooks.
  - 7. Testing Requirements and Procedures for Safety Straps.

XI Definitions (1926.960)



APPENDIX D  
REVIEW OF ELECTRIFIED RAILROAD  
ELECTRICAL OPERATING INSTRUCTIONS AND SAFETY RULES

D.1 Purpose of Review.

The member railroads of the National Traction Power Committee (NTPC) consist of most of the electrified railways in the U.S. A selected set of electrical operating instructions and safety rules from NTPC member railroads had been informally provided to the FRA for its use in the general review and preliminary assessment of electrical safety standards. These NTPC railroad standards formed the basis of the review to be discussed here.

The purpose this review was to compare how electrified railroads specified their electrical operating instructions and safe work practices. Also reviewed was how railroad instructions and safe work practices compared to the general requirements of OSHA. It is recognized that oversight of the safety rules of railroads is not an OSHA responsibility, but is an FRA responsibility. However, the development of OSHA safety regulations have involved authoritative input from interested industry groups. Therefore, these standards represent a reasonable point of reference for review of railroad safety related work rules and recommended work practices.

The railroads included in this review consisted of Amtrak (AMTK), Long Island Railroad (LIRR), Metro North Commuter Railroad (MNCR.) and New Jersey Transit Rail Operations (NJTR). Specifically, the following instructions and rules were reviewed:

- Electrical Operating Instructions, AMT-2 (AMTK)
- Electrical Operating Instructions, CT-290 (LIRR)
- Electrical Operating Instructions, MN-290 (MNCR.)
- Electrical Operating Instructions, TR03 (NJTR)
- Maintenance of Way Safety Rules, NRPC-1908 (AMTK)
- Engineering Department Safety Rules, S-7C (LIRR)

D.2 General Comment on OSHA Safety Regulations.

The OSHA electrical safety regulations are contained in the Code of Federal Regulations, Labor 29 CFR. Historically, these regulations



have been based, to a large extent, on two major industry safety standards, the National Electrical Safety Code, ANSI C2, and the Electrical Safety Requirements for Employee Workplaces, NFPA 70E. The OSHA electrical safety regulations address the following subjects:

- Worker Skill Qualification Requirements
- Safety Training and First Aid Training
- Working On or Near Exposed Electrical Parts and Equipment that May be Deenergized or May be Energized
- Connecting and Disconnecting Electric Power Equipment and Circuits
- Use of Test Instruments and Portable Electric Equipment
- Personal Safety and Other Protective Equipment
- Physical Warnings and Alerting Techniques
- Grounding
- Approach Distances and Clearances
- Requirements and Procedures for Lockout and Tagout
- Work in Enclosed and Confined Work spaces
- Work on Poles, Towers and Structures

The OSHA regulations covering the above subjects are contained in 29 CFR Part 1910, Occupational Safety Health Standards for General Industry, and Part 1926, Safety and Health Regulations for Construction. These regulations tend to be generic, and where applicable, they do contain specific and some cases quantitative requirements. For example, specific approach distances and electrical clearances are required for different operating voltage conditions.

The OSHA regulations also require that a written program plan and work procedures be prepared for implementing the requirements, procedures, and methods for the locking out and tagging out of electrical circuits and equipment. A similar document is required for work that is to be done in confined and enclosed work spaces. The electrical portions of OSHA Parts 1910 and 1926 are divided into approximately 20 sections which occupy more than 150 pages in the CFR.

As discussed in Appendix A, the work rules section of the NESC (Part 4 of the NESC) covers the same general subjects discussed above. Historically Part 4 of the NESC predates OSHA and was the basis for many of the earlier OSHA standards. As OSHA standards were further developed, some divergence between the NESC and OSHA occurred. In recent years serious efforts on the part of the NESC has been made to make its operating rules be more in concert with those of OSHA.

### D.3 Review of Railroad Operating Instructions and Rules.

A railroad's electrical operating instructions and safety rules are primarily addressed to four of the railroad's operating and maintenance organizations, namely the transportation, maintenance of way, electric traction or power, and mechanical departments. There are general instructions and rules which are applicable to all of these organizations as well as specific instructions and rules that pertain to the specific activities of a particular department. Operating instructions and safety rules can be organized in the form which address each specific organization, or they can be organized in a more generic way.

It was found in the review of the instructions and safety rules for the above railroads that both of these approaches to the structure of instructions had been used. The instructions and rules for two of the above railroads were organized along organizational or departmental lines. The instructions and rules of the other two railroads were organized in a more generic manner. It was further found that the instructions and safety rules for each of the railroads reviewed followed a nearly unique style, format, and sequence.

Table D.1 was prepared as a summary of the operating instructions and safety work rules reviewed. The table is organized with four columns with each column identifying the particular railroad and the standards of that railroad that were reviewed. The underlined categories shown in the table are either the titles or subtitles as given in that particular standard. In a few cases where no section headings were given, the underlined category shown in the table was the subject matter of that particular section of the standard.

The unique organizational format used by each the railroads reviewed did not allow for a one-to-one comparison. The sequential order and organization of topics differed among these railroads. The format of NJ Transit Rail Operations and Metro North Commuter Railroad were similar to each other and had many of their instructions oriented towards a particular operating department. The instructions of Amtrak and the Long Island Railroad were similar to each other in that many of the instructions given could be applied to several different departments. As a result, the summary table as shown has been sorted to show similar topics and

therefore, does not follow the sequence of any particular railroad. The sort as shown attempts to group similar topics and railroad department specific items. Detailed outlines were prepared for the Electrical Operating Instructions of Amtrak, AMT-2, and for NJ Transit Rail Operations, TRO-3. These are contained in tables D.2 and D.3 respectively.

The summary list of OSHA and NESC work rules and safe work practices discussed above were compared to the railroads listed in the table. It was found that the instructions for each of the railroads reviewed covered the same overall subjects that are contained in both of the OSHA and NESC requirements. In general, OSHA's safety rules are more generally stated, and NESC work rules are more specific to communications and electric supply utilities. As expected, the emphasis of the railroad developed instructions were quite specific to the job. An example, of one of the railroad specific safety instructions, is that related to working on or near third rail, or on or near overhead catenary. With few exceptions, railroad instructions for allowable clearances from live circuits tended to require larger clearance distances than that specified by both OSHA and NESC standards.

Another example of railroad specific safety instructions pertained to that of the specific requirements for the protection of maintenance workers. The railroad operating instructions reviewed require that this protection is to be provided through the active presence of a skilled, trained and knowledgeable individual with sole responsibility and authority for providing such protection. The duties of this individual are to assure, where practicable, that the system be in a safe mode for work, that workers under his/her jurisdiction adhere to safety instructions and safe work practices, and that any work required to be done in a hazardous situation be only done by those qualified to do such work.

OSHA and related industry standards specified the requirement to develop formal programs, procedures and processes for the use of locking out and tagging out circuits and equipment, and for controlling entry and work in confined work spaces. All railroads reviewed used some form of lockout and tagout method for working on deenergized equipment. However, it was found that none of the railroads' documents reviewed here discussed lockout and tagout procedures and methods to the same level of detail as found in OSHA and other industry related standards. It is possible that such detail could be found in other railroad documentation and that the training referred to in the OSHA regulations is covered elsewhere by the railroads. A similar finding was made for the lack of detailed procedures and processes for work to be done in confined and enclosed spaces.

TABLE D.1

## SUMMARY OF ELECTRICAL OPERATING INSTRUCTIONS FOR SELECTED ELECTRIFIED RAILROADS

F. L. Reposa 12/26/95

NJ Transit Rail Operations Electrical Operating Instructions TRO3	Metro North Commuter Railroad Electrical Operating Instructions MN-290	Long Island Railroad Electrical Operating Instructions CT-290 Engineering Department Safety Rules S-7C	Amtrak Electrical Operating Instructions AMT-2 Maintenance of Way Safety Rules NRPC-1908
<u>General Definitions</u> Classification of Employees Warning Tags	<u>Definitions</u> Classification of Employees Warning Tags	<u>Definitions</u>	<u>General Definitions</u> Classification of Employees
<u>General Instructions</u> Deenergized Circuits Energized Circuits Fires within Electrified Territory Instructions for Releasing Victim from Contact With a Live Conductor Pantographs Pole Top Rescue Resuscitation from Electric Shock Third Rail	<u>General Instructions</u> Extinguishing Fires First Aid Information General Immediate Procedures Specific Procedures Cardiopulmonary Resuscitation Special Conditions Requiring Early Medical Care  <u>Third Rail System</u>  <u>Catenary System</u>	<u>General Instructions</u>  First Aid Resuscitation from Electric Shock and Apparent Death Artificial Respiration First Aid Treatment for Burns Instructions for Releasing Victim from Contact with Live Electrical Conductor	<u>Electrical Instructions</u> Approach Distances to Energized (Live) Circuits High Voltage Circuits to be Deenergized and Grounded Damaged Wires, Third Rail, Attachments or Supports Working Near Overhead Wires Persons and/or Employees Working On Wire Train  <u>Third Rail</u> Connecting to and Disconnecting from Third Rail Removing Fuses Connecting and Disconnecting Bus Jumpers  <u>Protection to Other Than Electric Traction Employees</u> Electric Traction Employee Protection Duty Responsibility Grounding Procedures
<u>Instructions Pertaining to Transportation Department Personnel</u> Catenary Plate Order Procedures Derailment: Electric Equipment Drop Pantograph Instructions Electric Train Stop Signs Loss of Catenary Power Movement of Dead Electric Engines & Multiple Unit Cars Multiple Unit Car Instructions MU Master Controller Operation of Remote Control Boards Phase Gap Instructions Steel/Ice Pantograph Instructions	<u>Instructions Pertaining to Transportation Department Personnel</u> Normally Deenergized Tracks Phase Break Signs and Indicators Phase Gap Signs Movement of Dead Electric Engines & Multiple Unit Cars Drop Pantograph Order Loss of Catenary Power Miscellaneous Instructions Multiple Car Units Steel Instructions	<u>Instructions</u> Energized (Live) Circuits Damaged Wire, Third Rail, Attachments or Supports  <u>DC Electrified Territory</u> Third Rail System Operation of Electric Equipment Energized-Deenergized Units Manipulation of 750 Volt Bus Jumpers and 220 Volt Jumpers Working Near Third Rail Operation of Wrecking Equipment in Third Rail Territory	<u>Working on Electric or Other Equipment in AC Electrified Territory</u> Employee Responsibilities Grounding Procedures Lockout and Tagout Procedures Danger Tags Near Energized Equipment  <u>Pantographs</u> Observe for Proper Operation Qualifications for Car Roof-top Access  <u>Drop Pantograph Instruction Form D</u>
<u>Instructions Pertaining to Mechanical Department Personnel</u> Working on Electric Engines or MU Cars	<u>Instructions Pertaining to Mechanical Department Personnel</u> Renewing Pantograph Shoes Operation of Wreck Derricks	<u>AC Electrified Territory</u> Keep Off Top of High Equipment Operation of Wrecking Equipment Operation of Maintenance of Way Machinery Employee Assigned to Protection Duties Working Near Overhead Lines	<u>Keep Off Top of High Equipment</u> Deenergizing and Grounding Procedures  <u>Operation of Electric Equipment</u> No Contact With Derailed Equipment and Earth
<u>Instructions Pertaining to Maintenance of Way and Work Train Personnel</u> Operation of Maintenance and Construction Roadway Machinery Operation of Maintenance of Way Machinery Operation of Wrecking Equipment Traction Return Protection	<u>Instructions Pertaining to Track &amp; Structures Department Personnel</u> Operation of Maintenance and Construction Roadway Machinery		<u>Deenergizing Catenary Wires</u> Plate Order Form Requirements  <u>Phase Break Signs and Indicators</u> Propulsion Controller to be Off Pantographs to be Down  <u>Operation Through Dead Sections</u>
<u>Instructions Pertaining to Electric Traction Department Personnel</u> Line Ladders & Tools Entry Rooms Market Barner Process Body Belt & Safety Strap Capacitors Current Transformers Electrical Clearances Electrical Clearances-Special Conditions Electrical Protective Gloves & Sleeves Evacuation of SF-6 Gas for Breaker Repair or Inspection Grounding Procedures Lightning Arrestors Manholes & Vaults Metal Enclosed Equipment New Installation Other Company's Representative Overhead Line Work Overhead Work-Aerial Equipment Overhead Work-Energized Conductors Overhead Work-Installing and Removing Line Wire Overhead Work-Installing and Removing Poles Personnel Protective Equipment Protection Duties Rubber Goods Safety Helmets (Hard Hats) Safe Working Clearances SF-6 Gas "Sulfur Hexafluoride" Warnings Signal Supply Generators Standard Warning Tags, Definition Standard Warning Tags, Instructions Substation Houses Including High Voltage Pads, Etc Switching Electrical Equipment Tools (Electrical Work) Transformers Tree Trimming Underground High Voltage Cables Westinghouse SF-6 2&3 Pole Breakers	<u>Instructions Pertaining to Power Department Personnel</u> Electrical Protective Gloves Employees Assigned to Protection Duties Working on Wire Train or High-Rail Trucks Operation of Remote Control Boards	<u>Working On or About Electrical Circuit, Apparatus and Equipment</u> Qualification Requirements Personal Protection Equipment Approach Distances and Clearances Prohibition on Work During Electrical Storm Use of Grounding Devices Use of Barricades and Barriers Deenergize Equipment, Test Where Feasible Tagout Procedures  <u>Overhead Line Work</u> Pole Climbing Body Belts and Safety Straps Inspection Prior to Climbing  <u>Erecting and Removing Poles</u>  <u>Manhole</u> Test for Gas and Oxygen Deficiency Employee at Top to Render Assistance  <u>Ladder, Scaffold, Trestle and Working at Elevated Place</u> Use of Safety Belts and Ladder Lashing Protection from Falling Tools, Objects Personal Protection Equipment  <u>Tree Trimming</u>  <u>Use and Care of Electrical Protective Gloves</u> Inspection Before Use Periodic Electrical Tests	<u>Working On or About Electrical Circuit, Apparatus and Equipment</u> Qualification Requirements Personal Protection Equipment Approach Distances and Clearances Prohibition on Work During Electrical Storm Use of Grounding Devices Use of Barricades and Barriers Deenergize and Test Where Feasible Tagout Procedures  <u>Transfer of Persons Between Equipment on Adjacent Track</u> Avoid Contact Between Adjacent Electrical Equipment  <u>Overhead Line Work</u> Pole Climbing Body Belts and Safety Straps Inspection Prior to Climbing  <u>Operation of Remote Control Boards</u> Tags and Blocking Devices  <u>Manhole</u> Test for Gas and Oxygen Deficiency Employee Required at Top of Manhole to Render Assistance  <u>Ladder, Scaffold, Trestle and Working at Elevated Place</u> Use of Safety Belts and Ladder Lashing Protection from Falling Tools, Objects Personal Protection Equipment  <u>Operation of MQW Equipment With or Without Boom</u> Clearance Distances  <u>Operation of Other Equipment With or Without Boom</u> Approach Distances and Grounding  <u>Operation of Wreck Derricks</u> <u>Steel Instructions</u>  <u>Use and Care of Electrical Protective Gloves</u> Inspection Before Use Periodic Electrical Tests  <u>First Aid Information</u> General Instructions Releasing Victim From Contact With a Conductor First Aid Treatment for Burns and Scalds  <u>Extinguishing Fires</u>

TABLE D.2  
OUTLINE OF ELECTRICAL OPERATING INSTRUCTIONS  
AMTRAK AMT-2

1. General Instructions (3.0)

- Purpose and requirements for safety
- General precautions to be taken during adverse weather

2. General Definitions (4.0)

- Special terms
- Classification of employees

3. Electrical Instructions (5.0)

A. Energized Circuits (5.1)

- All overhead lines to be considered energized except when known that they been deenergized and grounded
- Approach distances to energized conductors and apparatus
- Tools, clothing or any part of body not to be brought into contact with third rail; contact never to be made from third rail to track rails or rail system; protection board over third rail not to be brushed against, stepped, sat, or walked upon
- No work to be performed on high voltage transmission circuits unless they have been deenergized and grounded; protection to be provided for work on railroad circuits with utility transmission system energized
- Knowledge required of instructions for electrical operations
- Tank cars or open cars on which lumber, pipe, structural iron, trees not to loaded or unloaded under catenary unless catenary is deenergized and grounded

B. Damaged Wires, Third Rail, Attachments, or Supports (5.2)

- Conditions likely to affect electric operation to be reported:
  - Broken or loose wires
  - Attachments out of place
  - Broken overhead or third rail insulators
  - Foreign objects (including kite strings)
  - Loose third rail joints
  - Broken or loose protection boards

End approaches out of place

Defective anchors

Buckled anchors

Buckled third rail

Other abnormal conditions

Loose or broken impedance bonds

- Employees not to touch dangling wires or foreign objects in contact with overhead wires including trees
- Broken impedance bond connections to be considered energized and requires immediate reporting
- When an overhead or third rail failure occurs, protection to be immediately provided to all tracks and Power Director notified
- When a broken wire or obstruction below the contact wire is found which may damage pantograph, a drop pantograph signal must be issued
- When reporting a power emergency use prescribed protocol

C. Hand, Flag, and Lamp Signals (5.3)

- Instructions for drop or raise pantographs

D. Working Near Overhead Wires (5.4)

- Class A employee protection to be provided to all authorized workers
- Emergency repair work under catenary not to be done on roof of cars or on top of high lading, except by or under the supervision Class A or Class B employee

E. Persons and/or Employees Working on Wire Train (5.5)

- Foreman of wire train responsible for the strict observance and enforcement of these rules
- Foreman or his designated Class A employee to obtain clearance for the work to be performed and upon completion advise all persons that the circuit is to energized
- When the foreman leaves the work area, he must assign a Class A employee to take charge and must advise every member of the work gang
- The employee who has obtained the clearance shall direct the raising of the grounding pantograph and verify contact with wire, be the first person to ascend to the top of the car, direct the application of all grounding devices, direct attention of each person to the location of nearby energized conductors, observe at all times the movement of all persons on top of the equipment; upon completion of the work direct the removal of all grounding devices, be the last person down from the top of the car and lower and lock the grounding pantograph

- All persons upon boarding the wire train must report to the person in charge and sign the clearance form
- The foreman or designated Class A employee to observe all work when working near to energized lines and shall require that all approach distances be maintained
- Class A employees only to be allowed to approach within 3 ft to wires energized at 12000 V

F. Third Rail (5.6)

- Operating procedures to deenergize third rail
- Emergency third rail jumpers may be used by Class A employees to supply power; jumpers are to be connected to the shoe first and third rail last; this sequence is to be reversed when disconnecting emergency jumpers
- When necessary to insulate equipment from third rail, only a dry insulated shoe paddle shall be used; main switch and all auxiliary switches to be opened first and then insulated shoe inserted
- Insulated shoe paddle or other appropriated device to be used prior to remove the 750 V main fuse
- When connecting and disconnecting 750 V bus jumpers, all contact shoes to insulated from third rail
- The third rail shall be considered energized except when it is known to be deenergized and protection afforded by a Class A employee
- Contact never to be made from energized third rail and track rails or rail return system

G. Employees Assigned to Protect Other than Electric Traction Employees (5.7)

- See recommended protection duties

H. Working on Electric Equipment or Other Equipment in A.C. Electrified Territory (5.8)

- Work must not be done on any car roof except as permitted in these instructions and then by or under the supervision of a Class A or Class B employee
- All electric equipment under overhead wires must be considered to be energized except when it is known that pantographs are down and grounding switches closed, or that overhead wires are deenergized and properly grounded
- Employees must know that all pantographs are down and grounding switches close; before any person starts to perform sanding or renewing fuses, he shall obtain permission from the Class A or Class B employee in charge

- Units to be coupled or decoupled shall be deenergized before control jumpers are applied or removed; 480 V power switch must be opened first for those cases where pantograph cannot be lowered
- Married pair units must have pantographs lowered and grounding switches closed prior to removing or applying power bus jumpers and controls
- A Class B employee must take charge of inspecting or testing single or coupled equipment
- Inspection and repair work on electric equipment under overhead wires shall be done under deenergized and grounded wire at locations with grounding devices, or if wires are energized will work under the instructions for Working Near Overhead Wires
- No repair work or cleaning to be performed on main power circuits while the units are energized; when repair or cleaning work is required, the Class B employee shall lower all pantographs and close all grounding switches; personal danger tags are required to be placed; grounding switches shall not be opened until all tags have been removed and it is known that all persons, tools and working materials are clear of main power circuits; no employee may go on top of electric equipment unless that person is or is supervised by qualified Class A or Class B employee
- Pantographs must not be raised until it is known that all persons, tools, and equipment are clear of all circuits and it is understood that the equipment is to be energized
- Roof areas of married pair units are to be considered as energized until the pantograph of the married pair is locked down

I. Pantographs (5.9)

- When practical, condition of pantographs should be observed
- When there are visible defects or obstructions in the catenary that may damage pantographs, pantographs shall be dropped and catenary conditions reported
- When pantographs are broken or damaged, electric equipment must be stopped immediately; the Class A or Class B employee may go to the roof and remove or secure broken pantograph only if the overhead wire has been deenergized and properly grounded and the position and condition of all overhead wires have been noted
- Electric equipment not to be moved until all broken pantographs have been removed or properly isolated
- Whenever a pantograph is up on a 2-pantograph unit, the pantograph in the Down position shall be considered energized until jumpers are physically removed



- Pantograph poles when used to raise or lower pantographs; the pole must be clean and dry, hands shall be kept at least 8 ft from the hook, pole must be pivoted on roof of electric equipment, and pole must be kept clear of clothing and body
  - On electric equipment hauled dead, the pantograph shall be tied down and grounding switches in the open position and pinned
  - Pantographs must be locked down and grounding switches closed and pinned when electric equipment is moved from electrified to non electrified tracks and vice versa
- J. Drop Pantograph Instruction Form D (5.10)
- Instructions, testing, and visual observations
- K. Keep Off Top of High Equipment (5.11)
- Employees except for authorized Class A and Class B employees are prohibited from being on top of roof of any car or on top of high lading while under energized catenary system
  - Designated supervisors or their authorized representatives must forbid all persons to go on top of high lading or on car roofs until the catenary system is deenergized, grounded and Class A protection provided
- L. Operation of Electric Equipment (5.12)
- When a section of the catenary system has been deenergized, electric equipment must not be run into or out of such sections with pantographs up
  - When electric equipment loses power, or a defect develops in main power circuits, pantographs shall be lowered and grounding switches closed
  - Instructions for raising pantographs
  - When electric equipment is derailed, it shall be considered energized, pantographs shall be dropped, if possible, and grounding switches closed
  - Instructions for setting hand brakes and lowering pantographs at A.C. motor stop signs
- M. Deenergizing Catenary Wires (5.13)
- Instructions for issuing plate orders
- N. Phase Break Signs and Indicators (5.14)
- Instructions for operating through
- O. Dead Sections (5.15)
- Instructions for operating through

P. Sleet Instructions (5.16)

- Operating instructions
- Observe and report when excessive arcing occurs
- When pantograph lowers due to sleet, attempts should be made to raise pantographs without touching catenary, and if excessive sleet exists, it will require deenergizing catenary and proper grounding before sleet is removed
- All pantographs shall be left down during inspection

Q. Operation of Maintenance of Way Equipment (With or Without Boom) (5.17)

- Equipment grounding requirements and minimum approach distances for energized and deenergized wires
- Class A employee protection must be requested if a question of a hazard exists

R. Operation of Other Maintenance or Construction Equipment (With or Without Boom) (5.18)

- Equipment grounding requirements
- Class A employee protection must be requested if a question of a hazard exists

S. Operation of Wreck Derricks (5.19)

- Class A employee required when a wreck derrick is necessary
- Approach distance requirements that do not require Class A employee protection
- Approach distance requirements that do require Class A employee protection
- Derrick work that requires Class A employee protection and Traction Dept personnel
- Class A protection required for work near energized third rail; third rail to be deenergized or approved protection required
- Third rail protection boards to be avoided when using outriggers

T. Operation of Remote Control Boards (5.20)

- To be operated only by employees who have been properly instructed on the operation
- Testing requirements for qualified employees
- Operating sequences
- Lockout and tagout requirements

4. Transfer of Employees or Passengers Between Equipment or Adjacent Track (6.0)

- Avoid simultaneous contacts with both units or equipment while dismounting and mounting; dismounting to the ground first
- Power not to be applied until transfer process is complete
- Third rail to be deenergized before transfer occurs

5. Resuscitation from Electric Shock and Apparent Death (7.0)

- General instructions on emergency procedures
- Electric shock and instructions for releasing victim from contact with a live conductor
- Release of victim from contact with live conductors if known to be 750 V or less
- Release of victim from contact with live conductors of unknown voltage of more than 750 V

6. First Aid Treatment for Burns and Scalds (8.0)

- General instruction

7. Extinguishing Fires (9.0)

- Fire extinguishing apparatus should be available for service at all times
- Conductors to be deenergized and grounded when fire apparatus must be placed near them; grounding of overhead lines to be done by Class A employee
- Power must be removed at once for fire on electric equipment or apparatus and grounded if possible
- All persons must be kept as far as possible from energized high voltage conductors which might fall
- Hand extinguisher not to be used in a way that results in stream coming into contact with energized line; all lines and apparatus to be considered energized and approach distances maintained until it is known that proper grounds have been applied
- Instructions and cautions for the use of various types of fire extinguisher
- For air cooled apparatus, stop all air-cooling appliances and close dampers before applying extinguisher to burning parts

**TABLE D.3**  
**OUTLINE OF ELECTRICAL OPERATING INSTRUCTIONS**  
**NJ TRANSIT RAIL OPERATIONS**

1. General Definitions

- Special terms
- Classification of employees

2. General Instructions (1-12)

- Purpose and requirements for safety
- Occurrences and conditions likely to affect electric operation to be reported:
  - Arcing
  - Broken or loose wire
  - Attachments out of place
  - Broken overhead or third rail insulators
  - Foreign objects (e.g., kites)
  - Loose third rail joints
  - Broken or loose protection boards
  - End approaches out of place
  - Defective anchors
  - Buckled anchors
  - Buckled third rail
  - Other abnormal conditions
  - Loose or broken impedance bonds
- Overhead or third rail failure-affected tracks must be immediately protected
- Drop pantograph orders for broken wire or obstructions
- Prohibition to unauthorized entry to electrical substations, power plant enclosures, etc

3. Energized Circuits (13-22)

- Warning to considered all conductors and apparatus to be energized until it is known that they have deenergized and properly grounded
- Working on or near energized conductors and apparatus requires permission and protection
- Approach distance requirements
- When authorized and qualified, employees must have full knowledge as to operating voltage and service handled
- Tools and appliances must be approved for use and rated for the voltage working on
- Conductive tools and appliances not permitted around energized conductors and apparatus

- Prohibition from removing dangling wires and objects from energized conductors and apparatus
- Insulation and covering on conductors not to be dependent upon for protection from electric shock

4. Deenergize Circuits (23-25)

- Supervisor notification and permission required before circuits can be deenergized
- Trains not to be operated in deenergized sections with raised pantographs

5. Pantographs (26-32)

- Condition of pantographs to be frequently observed
- Use of pantograph poles
- Restrictions on work on roof of electric equipment
- Changing pantographs on equipment equipped with multiple pantographs
- Derailed electric equipment to be considered energized

6. Third Rail (33-36)

- Shock hazard and no reliance to be made on board covers
- Permission required to deenergize
- Third rail to be considered energized except when it is known to be deenergized and protected by Class A employee
- Contact never to be made from third rail and track rails or rail system return

7. Fires in Electrified Territory (37-40)

- Fire apparatus to have special nozzles and be grounded when water streaming near high voltage lines
- When grounding is removed, water stream must be kept clear of energized lines
- Conductors to be deenergized and grounded when fire apparatus must be placed near them
- Hand extinguishers not to be used in a way that results in stream coming into contact with energized line

8. Emergency Procedures (41-51)

- A. Resuscitation from Electric Shock (41-44)
- B. Instructions for Releasing Victim from Contact from a Live Conductor (45-50)
- C. Pole Top Rescue (51)

9. Instructions Pertaining to Transportation Personnel

A. General Instructions (100-113)

- General warnings of electrified territory
- Prohibition from going on top of high lading or on roofs of car when under catenary
- Drop pantographs when visible obstructions on catenary observed
- Prohibitions on moving electric equipment with broken or damaged pantographs
- Restrictions on closely spaced train movements
- Additional inspections of catenary and third rail during temperature extremes
- Train movement restrictions
- Drop pantographs when equipment derailed

B. Phase Gap Instructions (114-117)

- Controller to be off before entering phase gap for speeds greater than 25 mph
- Avoid train stops within phase gap area

C. Movement of Dead Electric Engines and MU Cars (118-121)

- Pantographs to be down and locked with ground switch

D. Drop Pantograph Instructions (122-126)

- Pantographs to be tested in Down position prior to reaching specified limits

E. Loss of Catenary Power (127-130)

- Train dispatcher notification for stopped trains
- Secure pantograph instructions when catenary has been grounded
- Pantograph raising to prevent arcing or catenary damage

F. Multiple Unit Cars (131-133)

- Procedures for operating with inoperative traction motors

G. Sleet Instructions (134-142)

- Alert for excessive arcing, speed restrictions and requirements for frequent inspections

H. Operation of Remote Control Boards (143-154)

- To be operated only by employees who have been properly instructed on the operation
- Testing requirements for qualified employees
- Operating sequences
- Lockout and tagout requirements

I. Catenary Plate Order Procedures (155-161)

- Removing track from service in order to provide protection

- Blocking devices to be applied to signals and switches
- Coordination responsibilities between train dispatchers and power supervisors

10. Instructions Pertaining to Mechanical Department Personnel

A. Working on Electric Engines and Multiple Unit Cars (200-213)

- Work prohibited on roof of engine or car while under catenary except under the supervision of a Class A employee
- All electric engines and MU cars under catenary to be considered energized unless pantographs are down and locked or that it is known that catenary has been deenergized and properly grounded
- Work not to be done on any circuit of an energized MU car except when the switch disconnecting that car has been opened
- All pantographs must be down and locked when sanding, renewing fuses, general cleaning of equipment is done
- Permission of Class A or B employee required before above work can be done
- When necessary to test engines and MU cars, a Class B employee must take charge and such work governed by his instructions
- Repair work on or near main energized power circuits prohibited unless pantographs are down, locked and tagged and under general supervision of Class A or B employee
- Inspection and repair work at designated locations requires that pantograph is down, locked and grounding switches applied, and tagged
- Pantographs not to be raised until it is known that all persons are clear
- Emergency repair work on car roofs or on top of high lading under energized wire prohibited except for Class A employees or Class B employees under the protection of Class A employees

11. Instructions Pertaining to Maintenance of Way and Work Train Personnel

A. Operation of Maintenance of Way Machinery (300-301)

- Machinery with booms to be properly grounded, meet minimum approach distances, and be under the supervision of a Class A employee
- Protection of Class A employee required if work to be done results in a hazardous situation

B. Operation of Maintenance and Construction Roadway Machinery (302-305)

- Equipment with buckets and booms to be properly grounded and meet minimum approach distances
- Equipment the property of others to not operate closer than 15 ft to overhead conductors unless properly grounded and under the supervision of Class A employee
- Location and work hours of all such machinery to be reported to Power Supervisor
- If work is to be done within 3 ft of an energized conductor or if any other hazard is involved, requires the protection of a Class A employee

C. Operation of Wrecking Equipment (306-310)

- Class A employee to be dispatched the wreck to determine the extent of electrical damage
- Class A employee protection required if wreck derrick must operate within 8 ft of transmission line or within 3 ft of catenary
- Wires to be deenergized and properly grounded by Class A employee
- Direction of Class A employee required if boom to come into contact with deenergized and grounded wires

D. Traction Return Protection Electrified Territory (311-313)

- Instructions for applying temporary rail jumpers

12. Instructions Pertaining to Electric Traction Department Personnel

A. General (400-404)

- Qualified employees only to work on or about electrical circuits and apparatus
- Power supervisor responsible for coordinating clearances, switching and tagging
- Only Class A employees permitted to request electrical lines and equipment for clearance protection
- Switching and tagging lists to be maintained of Class A employees authorized to perform switching
- Authorized Class A employees while on duty to have data, drawings, instructions and other materials

B. Safe Working Clearances (405-407)

- Minimum clearance requirements
- Approved temporary barriers required for work to be done at less than minimum clearance requirements
- Unless approved "Hot Line" equipment is used, all work to be done on deenergized and properly grounded conductors and apparatus



C. Standard Warning Tags (408-415)

- Definitions of Red, Blue and Yellow warning tags

D. Switching Electrical Equipment (416-424)

- General instructions for switching orders
- Lock and tag requirements and requirement for the disconnect between power source and line to be a visible break
- Disconnect switches to be opened only after circuit breaker has been opened
- Personal protection equipment required when opening disconnect switches
- Lockout and tagout required for manually operated disconnect switches
- Additional protection requirements for motor operated opened disconnect switches
- For draw out interrupting equipment, visible break considered when devices fully drawn out; switchgear where visible break cannot be observed not to be relied upon for protection from a source of power
- Opened circuit breakers required verification as being properly opened before proceeding with any further switching
- Additional visual inspection requirements for SF6 GIS equipment

E. Electrical Clearances (425-436)

- Power Supervisor to be informed prior to any inspecting, testing or other work on or near electrical conductors and apparatus
- Information required to be provided to Power Supervisor
- Switching orders to be issued to Class A employee for switching; tagging requirements
- Power Supervisor to notify employee requesting clearance the locations where all switches have been opened and tagged and clearance issued
- It is the responsibility of the person requesting the clearance to test it for voltage and to properly apply grounding devices
- Notification to Power Supervisor if any changes in work schedule
- Before any clearance is issued to a second employee, his tags must be applied to all associated switchgear as if his clearance was the only one
- Procedures for transferring clearance
- After all work has been completed and all men are safely in the clear, the Class A employee in charge will release the clearance, remove all protective grounds and notify the Power Supervisor that the circuit is ready to be reenergized
- Tag removing requirements after clearance has been released

- F. Special Conditions (437)
  - Procedures for restoring service after lengthy interruption to service
- G. New Installations (438)
  - Rules to apply to all new work when energized
- H. Other Company's Representative (439-440)
  - Must be on the approved Switching and Tagging List
- I. Non Compliance (441)
  - When rules cannot be complied with, higher management approval required before the start of any work
- 12. Grounding Procedures (442-447)
  - See Recommended Grounding Procedures
- 13. Protection Duties (500-513)
  - See Recommended Protection Duties
- 14. Personal Protective Equipment
  - A. General Requirements (600)
    - General care, inspection and maintenance
  - B. Rubber Goods, Protective Gloves and Sleeves (601-620)
    - Requirements for selecting, testing and use of electrical protective gloves and sleeves
    - Requirements for usage where voltage is greater than 120 V and prohibition against use for protection for voltages greater than 7200 V
    - Requirements for gloves and sleeves when removing or replacing power fuses, and working in an elevated position
  - C. Safety Helmets (Hard Hats) (621)
    - Requirements for usage
  - D. Approved "Hotline" Ladders and Tools (622-626)
    - Requirements for usage and prohibitions against inadvertent contact with ground when on an approved ladder
    - Visual inspection requirements
    - Class A employees qualified for Hot Stick work may apply insulating covers over energized conductors
- 15. Work Practice Requirements for Specific Installations
  - A. Substations, Switch houses, High Voltage Pads (700-706)
    - Requirement to notify supervisor of any alarms or abnormal conditions
    - Authorization required to perform Switching and Tagging

- Employee in charge to insure that work site is barricaded and safe working clearances are maintained
  - Approved safety belts and straps to be used for work in elevated position
  - Trucks, cranes and equipment to be grounded
- B. Battery Rooms (707-710)
- Requirement for No Smoking
  - Proper ventilation and protective clothing and equipment required
- C. Metal Enclosed Equipment (711)
- Requirement for barricades for exposed equipment
- D. Lightning Arresters (712)
- To be treated as energized and charged until known to be disconnected and grounded
- E. Capacitors (713)
- Not to be worked on until disconnected, discharged, short-circuited and grounded
- F. Signal Supply Generators (714)
- Switching and tagging rules to be applied when required to shut down equipment
- G. Transformers (715-716)
- Voltage test required to ensure equipment is deenergized before doing work and secondary circuits to be removed to protect against backfeed
- H. Current Transformers (717)
- Prohibition on opening secondary circuit while primary is energized
  - Secondary circuit to be bridged if primary cannot be deenergized
- I. Transformers Internal Inspection (718)
- Equipment to be deenergized and grounded
  - Check for no pressure build-up and at least 2 openings/covers to be removed
  - Adequate air flow and continuous checks made for oxygen deficiency
  - Employee to be at entrance point when internal inspection is to be made
  - Windings and associated equipment to be short-circuited and grounded during oil filling
- J. SF6 Equipment (719-722)
- Specific instructions for Westinghouse type equipment
  - Exposure warnings
  - Specific instructions for breaker repair or inspection

- K. Manholes and Vaults (800-810)
- Test for combustible gas oxygen deficiency
  - Continuous ventilation required or the respirator equipment to be used
  - Attendant required at the surface
  - Avoid the use of open flames and torches
  - Specific requirements for lowering and handling
  - Gas mask and life line required for emergency access to vault where gas is found to be present
  - Proper seating and sealing of manhole cover
- L. Underground High Voltage Cables (811-818)
- Switching and tagging rules, shorting and grounding of opened and deenergized cables
  - Testing required to determine that cable is deenergized
  - No employee allowed to be in manhole during cable spiking process
  - Switching and tagging rules during reenergization
  - Prohibitions during cable pulling
- M. Overhead Line Work (900-909)
- Requirements for qualifications, authorization, use of body belts and knowledge of work to be done
  - Use of personal protective equipment work near energized lines
  - Specific instructions for inspecting, safeguarding, climbing and working on pole
- M. Overhead Work Installing and Removing Poles (910-918)
- Specific instructions for setting and removing poles
- N. Body Belts, Safety Straps and Other Climbing Equipment (919-925)
- Specific instructions for usage of body belt and safety straps
  - Specific instructions for use of wood pole and steel pole climbers
- O. Overhead Line Work Installing and Removing Line Wires (926-936)
- Requirements for deenergizing and grounding whenever practicable
  - Specific instructions and work methods
- P. Overhead Work Energized Conductors (937-949)
- Specific instructions for extreme care, use of personal protective equipment, protective coverings over conductors
  - Prohibitions on reliance of insulations and coverings to protect against electric shock
  - Requirements for visual inspections of all tools, devices, equipment and proper body positioning

O. Overhead Work Aerial Equipment (950-962)

- Responsibilities of person in charge
- Instructions for work in buckets and platforms
- Protection duties for assigned Class A employee
- Requirements for use of grounding procedures and devices
- Requirement for grounding of trucks, cranes and other equipment

R. Tools (Electrical Work) (963-971)

- Requirements for inspection, care and usage
- Precautions of usage from elevated positions

S. Tree Trimming (972-974)

- Instructions for proper work methods and use of tools

#### D.4 Specific and Preliminary Comments for Electrical Operating Instructions and Safety Rules

Preliminary comments were prepared for each of the reviewed railroad electrical operating instructions and, where applicable, to their safety rules. These instructions and safety rules were compared to similar information contained in the OSHA, NESC and NFPA 70E standards previously discussed.

The comments which follow are not intended to be all inclusive. They are focused on such common safety issues as clearances and approach distances, protective grounding, tagout and lockout, and the use of personal protection equipment.

The limited scope of this preliminary review did not allow comments to be prepared on other important safety issues such as working in elevated positions, the precautions required for the use of construction and maintenance machinery, and the use of special methods and tools required for live-line (hot-line) work. Comments on these and other important safety issues requires a more comprehensive review of the regulations and standards.

COMMENTS ON AMTRAK ELECTRICAL OPERATING INSTRUCTIONS AMT-2

I Section 5.1 Energized (Live) Circuits

1. Instruction 5.1.1. Deenergizing and grounding wires.

Comment.

Grounding procedures not specified. Grounding procedures should include the requirement for grounding on all sides of the work area in order to provide a zone of protection.

II Section 5.5 Persons an/or Employees Working on Wire Train

1. Instruction 5.5.8. When adjacent circuits are energized and it is necessary to work in proximity to them.

Comment.

The precautions required to be taken by Class A employee in charge are not specified. The special precautions required for allowing approach distances of down to 14 inches are also not specified.

III Section 5.6 Third Rail

1. Instruction 5.6.4. Use of third rail emergency portable jumpers.

Comment.

The need for the use of personal protective equipment has not been specified, as well as the type of personal protective equipment required for work on a live third rail.

2. Instruction 5.6.5. When necessary to insulate equipment from third rail.

Comment.

The need for grounding out the equipment has not been specified. The equipment, once insulated from the third rail, should be grounded. If work is to be done in a specific location on or near the equipment, protective grounds should be placed on both sides of the work area.

3. Instructions 5.6.6 and 5.6.7.

Comment.

See comments for Instruction 5.6.5.

4. Instruction 5.6.8. Third rail to be considered as energized at all times unless it is known to be deenergized.

Comment.

If segments of the third rail are deenergized and persons are to be in the immediate vicinity, barricades should be used to clearly differentiate energized sections from deenergized sections.

IV Section 5.8 Working on Electric Equipment or Other Equipment in A.C. Territory

1. Instruction 5.8.2. Pantographs down and grounding switches closed.

Comment.

Lockout and tagout procedures should be considered and used as appropriate. NFPA 70E has recommended procedures. Also see OSHA 1910.269 and 1910, Subpart S.

2. Instruction 5.8.5. Units to be coupled or decoupled.

Comment.

Where feasible deenergized units (or 480 V disconnected units) should be grounded during the coupling/decoupling process.

3. Instruction 5.8.6. Applying or removing bus jumpers.

Comment.

Lockout and tagout procedures should be considered and used as appropriate. See comment for Instruction 5.8.2.

V Section 5.9 Pantographs

1. Instruction 5.9.11. Use of pantograph poles.

Comment.

Use of personal protective equipment should be considered.



VI Section 5.12 Operation of Electric Equipment

1. Instruction 5.12.3. Pantograph grounding switches closed.

Comment.

Lockout and tagout procedures should be considered and used as appropriate. See comment for Instruction 5.8.2.

VII Section 5.16. Sleet Instructions

1. Instruction 5.16.9. Pantograph lowering and grounding.

Comment.

Lockout and tagout procedures should be considered and used as appropriate. See comment for Instruction 5.8.2.

VIII Section 5:19 Operation of Wreck Derricks

1. Instruction 5.19.3 Wires deenergized and grounded.

Comment.

Protective grounding should be installed on all sides of the work area to provide a zone of protection.

IX Section 6.0 Transfer of Employees or Passengers Between Equipment on Adjacent Tracks

1. Instruction 6.0.1 Dismounting from deenergized equipment.

Comment.

Safety grounding of individual cars, if feasible to be applied, should be considered as part of the dismounting procedure.

2. Instruction 6.0.3. Dismounting in third rail territory.

Comment.

See comment on Instruction 6.0.1.

COMMENTS ON AMTRAK SAFETY RULES AND INSTRUCTIONS FOR MAINTENANCE OF WAY EMPLOYEES - NRPC-1908

I Manhole, Trench, Sewer, Turntable, Pit or Other Excavation

1. Rule 4425. Rule allows entrance to a C&S manhole unattended if the manhole is less than 8 ft deep, providing it is safe to do so.

Comment.

Rule 4424 addresses the issue of the requirement of testing the atmosphere for combustible/explosive gases and oxygen deficiency for safe entry. However, for Rule 4425, if a person in the manhole makes inadvertent contact with an energized conductor or equipment, how will assistance be rendered in rescuing the person if there is no attendant available? This problem seems to be independent of the depth of the manhole.

NESC Rule 433 requires that an attendant be on the surface to render assistance for work in joint power-communications use manholes. Also see OSHA regulations in 1910.146 and 1910.269 dealing with permit-required and confined spaces.

II Working On or About Electrical Apparatus and Equipment

1. Rule 4533. The rule implies, but is not explicit that grounds are to applied to all sides the work area.

Comment.

Unless it is known that there is no possibility for backfeed, the requirement for grounding protection to be applied to all sides of the work area should be more explicit.

2. Rule 4534. Approach distance requirements:

175 to 2,500 volts	Avoid contact
2,500 to 50,000 volts	3 feet
Above 50,000 volts	8 feet

Comment.

The requirement to only "avoid contact" for voltages as high as 2,500 V may lead to a dangerous situation.

NESC Rule 431 has the "avoid contact" requirement for voltages between 50 V and 300 V. For less than 50 V, there is no approach distance requirement. The NESC rule has

approach distances given for several voltage increments between 300 V and 2,500 V. At the voltage level of 2,500 V, the NESC approach distance requirement is 2 ft.

3. Rule 4540. Fire extinguishing.

Comment.

The NFPA, in its fire safety codes, may have a recommendation that hoses and other water streaming equipment be grounded to provide personal protection if the hose stream becomes energized if it comes into contact or is too close to energized conductors and equipment.

4. Rule 4541. Work on energized equipment.

Comment.

The requirement for the use of personal protective equipment should be given here or in some other rule. A general rule at the beginning of the electrical rules may be appropriate, as the use of personal protective equipment is an element that would be common to most of the rules.

5. Rule 4543. Touching a structure carrying live circuit.

Comment.

The rule should require that the structure be tested for voltage from structure-to-ground as well as visually examined.

6. Rule 4547. Tagout of equipment.

Comment.

Where feasible lockout also should be applied. Procedures for applying and removing tagout and lockout could be incorporated into this rule or given as a separate rule specific to tagout and lockout procedures. NFPA 70E has recommended procedures. Also see OSHA 1910.269 and 1910, Subpart S.

7. Rule 4567. Work on catenary.

Comment.

If it is not practical to deenergize conductors and circuit parts, an insulating barrier should be used.

8. Rule 4577. Catenary grounding.

Comment.

Grounds should be placed on each side of the work area to provide a zone of protection.

9. Rule 4578. Working on a transformer.

Comment.

Primary and secondary terminals of the transformer should be grounded prior to the start of work.

10. Rule 4581. Blocking open operating contactors.

Comment.

Tagout should be applied and, if possible, lockout also should be applied.

11. Rule 4582. Control cut-out switch for transformer.

Comment.

Grounding should be applied as appropriate.

12. Rule 4585. Working on signal power apparatus.

Comment.

Tagout and lockout procedures should be applied. As appropriate, grounding procedures also should be applied.

13. Rule 4587. Working on static condenser or lightning arrester.

Comment.

Grounds should be applied to the component after it has been discharged.

14. Rule 4588. Work on supply circuits to certain electrical equipment.

Comment.

If feasible, lockout procedures in addition to tagout procedures should be applied.

15. Rule 4591. Use of test instruments.

Comment.

Suitable personal protective equipment should be worn and grounds applied where appropriate (e.g., Rule 4591.5).

16. Rule 4593. Work on energized third rail equipment.

Comment.

Personal protective equipment should be used in addition to insulated tools.

COMMENTS ON LONG ISLAND RAILROAD CO. ELECTRICAL OPERATING  
INSTRUCTIONS CT-290

Instructions

I Energized (Live) Circuits

1. Instruction 4. Approach distances to energized conductors.

Comment.

The specified approach distance of 16 in for 2500 V signal wires and "avoid contact with third rail" are not in accordance with the NESC Rule 420. NESC Table 431-1 contains the following approach distance requirements for the above voltages: 2 ft for voltages between 2 kV and 15 kV and 1 ft for voltages between 300 V and 750 V.

D.C. Electrified Territory

II Third Rail System

1. Instruction 5. Deenergizing third rail or overhead wires.

Comment.

Where feasible, tagout and lockout procedures should be applied. NFPA 70E has recommended procedures. Also see OSHA 1910.269 and 1910, Subpart S.

III Operation of Electric Equipment

1. Instruction 5. Use of emergency jumpers to supply electric power for short movement.

Comment.

Instruction 5.d. requires that the jumper first be removed from the equipment while the other end of the jumper is still connected to the third rail. This results in an energized jumper being handled and would appear to violate industry standard practice as reflected in other railroad operating instructions (See Amtrak AMT operating instructions) as well as OSHA regulations. The jumper should first be removed from the energized conductor, which in this case is the third rail, and then removed from the equipment.

The use of personal protective equipment when connecting and disconnecting third rail jumpers also should be specified.

## A.C. Electrified Territory

### IV Keep Off Top of High Equipment

1. Instruction 2. Loading and unloading under deenergized catenary or near third rail.

Comment.

Grounding should be applied on all sides of the work area to provide a zone of protection.

2. Instruction 3. Loading and unloading of material on top of high lading or on the roof of cars under deenergized catenary system.

Comment.

Grounding should be applied on all sides of the work area.

See comment for Energized (Live) Circuits, Instruction 4 for recommended approach distances to signal power wires.

### V Operation of Wrecking Equipment

1. Instruction 2. Approach distances for wrecking equipment.

Comment.

See comment for Energized (Live) Circuits, Instruction 4 for recommended approach distances to signal power wires.

2. Instruction 3. Grounding of deenergized wires.

Comment.

Grounding should be applied to all sides of the work area.

See comment for Energized (Live) Circuits, Instruction 4 for recommended approach distances to signal power wires.

3. Instructions 4 and 5. Grounding of deenergized wires.

Comment.

Grounding should be applied to all sides of the work area.

VI    Operation of Maintenance of Way Machinery

1.    Instruction 1.    Approach distances.

Comment.

See comment for Energized (Live) Circuits, Instruction 4 for recommended approach distances to signal power wires.

VII    Employee Assigned to Protection Duties

1.    Instruction 11.    Grounding.

Comment.

Grounding should be applied to all sides of the work area.

Where appropriate tagout and lockout procedures should be applied. See comment for Third Rail Systems, Instruction 5 for recommendations for tagout and lockout.

Instructions for Releasing Victim from Contact with a Live Electrical Conductor

VIII

1.    Instruction 1.    Releasing a victim from contact with live wire.

Comment.

If the wire has been deenergized to allow for access to a victim, protective grounding should be applied to all sides of the area prior to effecting recovery of the victim.

Extinguishing Fires

IX

1.    Instruction 2.    Fires in proximity to overhead wires.

Comment.

If overhead wires are not known to be deenergized, fire hoses and other water streaming equipment should be grounded. The NFPA, in its fire safety rules, may have a recommendation that hoses other water streaming equipment be grounded to provide personal protection, if the hose stream becomes energized from contact with the overhead wires.



COMMENTS ON LONG ISLAND RAILROAD CO. SAFETY RULES FOR ENGINEERING  
DEPARTMENT EMPLOYEES - S-7C

I Extinguishing Fires

1. Rule 3481. Use of water hoses near electric lines.

Comment.

When electric lines have not deenergized, fire hoses and other water streaming equipment should be grounded. The NFPA, in its fire safety codes, may have recommendations that hoses and other water streaming equipment be grounded to provide personal protection if the hose stream becomes energized if it comes into contact, or is too close to energized conductors and equipment.

II Working on or About Electrical Circuit, Apparatus or Equipment

1. Rule 3717. Protection for work on circuits and equipment at various voltage levels.

Comment.

The rule requires electrical protective gloves be used for work on energized circuits which have a voltage from 175 V to 500 V (or 750 V for third rail).

NESC Rule 441 A requires electrical protective gloves be worn when working on circuits of 50 V to 300 V. For work on energized circuits greater than 300 V, the NESC rule requires that additional protective measures be taken such as the use of rubber sleeves and insulating coverings over exposed electric circuits.

When grounding deenergized circuits, the grounds should be applied on all sides of the work area to provide a zone of protection.

2. Rule 3718. Minimum approach distances.

Comment.

For the voltages up to 2,500 V and the for the ranges of between 2,500 V to 50,000 V, it is recommended that NESC Table 431-1, or its equivalent, be used.

3. Rule 3721. Touching a structure carrying live circuit.

Comment.

The rule should require that structure be tested for voltage from the structure-to-ground as well as visually examined.

4. Rule 3725. Tagout of deenergized line or apparatus.

Comment.

Where feasible lockout procedures should also be applied. Procedures for applying and removing tagout and lockout could be incorporated into this rule or given as a separate rule specific to tagout and lockout procedures. NFPA 70E has recommended procedures. Also see OSHA 1910.269 and 1910, Subpart S.

5. Rule 3729. Removing or replacing fuse on energized circuits of 400 V or more.

Comment.

Recommend that the voltage threshold be reduced to 300 V or more. See NESC Rule 441 A.

6. Rule 3736. Use of proper grounding devices.

Comment.

Grounding should be applied on all sides of the work area for those situations where potential backfeed is present.

7. Rule 3746. Working on transformer.

Comment.

After isolating the transformer, protective grounds should be applied to the primary and secondary terminals to discharge any stored energy.

8. Rule 3750. Tagout of circuits supplying power to power devices.

Comment.

Where appropriate lockout devices should be used in addition to tagout. See comment to Rule 3725.

9. Rule 3751. Do Not Operate warning tags.

Comment.

Where appropriate lockout devices should be used in addition to tagout. See comment to Rule 3725.

COMMENTS ON METRO-NORTH COMMUTER RAILROAD ELECTRICAL OPERATING INSTRUCTIONS MN-290

I General Instructions

1. Instruction 16. Protection for various voltage levels.

Comment.

Electrical protective gloves should be required for voltages as low as 50 V. See NESC Rule 441.

II Third Rail System

1. Instruction 1. Working near or passing by energized third rail.

Comment.

An approach distance requirement of 1 ft per NESC Table 431-1 should be specified.

2. Instruction 4. Connecting and disconnecting jumpers to energized third rail.

Comment.

Personal protective equipment should be used during the connecting-disconnecting procedure.

3. Instructions 5, 6, and 7. Working near energized third rail.

Comment.

Personal protective equipment should be used.

III Catenary System

1. Instruction 6. Use of pantograph poles.

Comment.

The need for the use of other personal protective equipment is not specified. Other personal protective equipment such as gloves and safety glasses should be used.

2. Instruction 8. Class A and B employees working on a roof of electric equipment under the catenary.

Comment.

Grounding should be applied on all sides of the work area to provide a zone of protection. Tagout and lockout devices, if feasible, also should be applied. Procedures for applying tagout and lockout could be incorporated into this instruction or given as a separate instruction specific to tagout and lockout procedures. NFPA 70E has recommended procedures. Also see OSHA 1910.269 and 1910, Subpart S.

3. Instruction 11. Work on or near derailed power units and cars.

Comment.

Tagout and lockout procedures and devices, if feasible, should be applied. See comment Catenary System, Instruction 8.

Rules Pertaining to Power Department Personnel.

IV

1. Instruction 1. Work done on any transmission line, feeder or catenary circuit.

Comment.

Protective grounding should be placed on all sides of the work area to provide a zone of protection.

2. Instruction 3. Approach distances for work on live lines.

Comment.

The approach distance requirement of 6 in is much less than that specified by the NESC in Rule 441 for AC live-line work. It is recommended the 2 ft plus distances (dependent on voltage) given in NESC Table 441-1 be used. For distances less than that given in Table 441-1, extraordinary means for personal protection would be required.

V Working on Wire Train or High-Rail Truck

1. Instruction 8. Working next to energized circuits.

Comment.

For close proximity work, insulating barriers should be considered as a means of isolating energized wires from the work area.

Rules Pertaining to Mechanical Department Personnel.

VI Working on Electric Engines or Multiple-Unit Cars

1. Instruction 4. Work on electric engines under overhead wires.

Comment.

Where appropriate tagout and lockout procedures should be applied. See comment for Catenary System, Instruction 8.

2. Instruction 7. Repair work on or near main power circuits.

Comment.

Where appropriate tagout and lockout devices and personal protective equipment should be used. See comment for Catenary System, Instruction 8.

3. Instruction 8. Inspection and repair work on electric engines at engine terminals.

Comment.

Where backfeed is possible, protective grounding should be applied on all sides of the work area, and tagout and lockout procedures applied. See comment for Catenary System, Instruction 8.

4. Instruction 12. Emergency repair work on top of rolling stock by Class A employees.

Comment.

Personal protective equipment should be used.

## Rules Pertaining to Track & Structures Department Personnel

### VII Operation of Maintenance-of-Way Machinery

1. Instruction 1.A. Clearance requirements for maintenance-of-way machinery.

Comment.

For transmission lines exceeding 37 kV, the NESC approach distance requirements given in Table 431-1 exceed the 3 ft limit given in MN-290. It is recommended that the increased NESC limits be used.

### VIII Operation of Maintenance and Construction Roadway Machinery

1. Instruction 2. Clearances to overhead electrification wires and power lines.

Comment.

See comments for clearances in Operation of Maintenance-of-Way Machinery, Instruction 1.A.

### IX Sleet Instructions

1. Instruction 9. Raising and lowering pantograph to clear sleet loading.

Comment.

Personal protective equipment should be used.

2. Instruction 11. Pantograph inspection.

Comment.

Where appropriate, tagout and lockout procedures should be used. See Catenary System, Instruction 8.

### X Extinguishing Fires

1. Instruction 2. Fire fighting apparatus.

Comment.

If overhead lines cannot be deenergized, fire hoses used near overhead lines should be grounded. The NFPA, in its fire safety codes, may have recommendations that hoses and other water streaming equipment be grounded to provide personal protection if the hose stream becomes energized if it comes into contact, or is too close to energized conductors and equipment.

COMMENTS ON NJ TRANSIT RAIL ELECTRICAL OPERATING INSTRUCTIONS  
TR-03

I Energized Circuits

1. Instruction 15. Approach distances to deenergized and grounded wires.

Comment.

The maximum approach distances for voltages less than 750 V are not specified.

It is recommend that NESC table 431-1 be applied. For voltages between 300 V and 750 V, the approach distances are 1 ft, and for voltages between 50 V and 300 V, the approach distance requirement should be to "avoid contact".

2. Instruction 18. Working on top of rolling stock equipment with energized catenary is permissible only for Class A employees.

Comment.

Safe works practice requirements for Class A employees not specified.

II Deenergize Circuits

1. Instruction 24. Deenergizing a section of catenary to perform work.

Comment.

Protective grounds should be applied on all sides of the work area after the catenary section has been deenergized.

III Pantographs

1. Instruction 26. Use of pantograph poles.

Comment.

The need for the use of other personal protective equipment has not been specified.

2. Instruction 28. Class A and B employees working on a roof of electric equipment under the catenary.

Comment.

Where feasible, lockout devices should be used in addition to tagout. Procedures for applying tagout and lockout could be incorporated into this instruction or given as a separate instruction specific to tagout and lockout procedures. NFPA 70E has recommended procedures. Also see OSHA 1910.260 and 1910, Subpart S.

3. Instruction 32. Working on or near derailed power units and cars.

Comment.

Tagout and lockout devices, if applicable, should be applied. See comment to Instruction 28.

#### IV Third Rail

1. Instruction 33. Working near or passing by energized third rail.

Comment.

An maximum approach a distance requirement of 1 ft (per NESC Table 431-1 for voltages up to 750 V) should be specified.

2. Instruction 35. Deenergized third rail.

Comment.

Protective grounding of the deenergized third rail should be included.

#### V Instructions for Releasing Victim from Contact with a Live Conductor

1. Instruction 48d. Deenergizing system.

Comment.

Protective grounding of the deenergized wire on all sides of the victim should be considered for obtaining a zone of protection.

2. Instruction 49. Handling a live wire or conductor.

Comment.

Personal protective clothing and equipment should be used, if feasible.



VI Catenary Plate Order Procedures

1. Instruction 156. Blocking devices to be applied to signals or switches.

Comment.

Tagout procedures should be considered, if appropriate. See comment to Pantographs, Instruction 28.

VII Working on Electric Engines or Multiple Unit Cars

1. Instruction 202. Work done on any circuit after disconnecting switch opened.

Comment.

Where appropriate tagout and lockout should be used and protective grounding applied on the load side of the disconnect switch.

2. Instruction 203. Working on electric equipment under overhead wires.

Comment.

Where appropriate, tagout and lockout procedures should be applied. See comment to Pantographs, Instruction 28.

3. Instruction 206. Repair work on or near main power circuits under energized lines.

Comment.

Where appropriate tagout and lockout devices and personal protective clothing and equipment should be used. See comment to Pantographs, Instruction 28.

4. Instruction 211. Emergency repair work.

Comment.

Where appropriate, personal protective equipment should be used.

VIII Instructions Pertaining to Electric Traction Department Personnel

1. Instruction 402. Class A employee switching and tagging tasks.

Comment.

Where appropriate lockout devices also should be applied. See comment to Pantographs, Instruction 28.

IX Safe Working Clearances

1. Instruction 405. Minimum working clearances.

Comment.

It is recommended that the maximum approach distances given in NESC Table 431-1 be used for voltages less than 1 kV.

X Switching Electrical Equipment

1. Instruction 417. Tagging out deenergized equipment.

Comment.

Where appropriate, lockout devices should be used in addition to tagout. See comment to Pantographs, Instruction 28.

XI Protection Duties

1. Instruction 513. Working next to energized circuits.

Comment.

Barricades should be used as a means to clearly identify energized areas from deenergized areas. Also, if work is to be done very closely to energized circuits, insulated barriers be used to provide personal protection.

XII Transformers

1. Instruction 715. Working around supply or power transformers.

Comment.

Where feasible, apply protective grounds to all terminals of the transformer to protect against possible backfeed.

### XIII Underground High Voltage Cables

1. Instruction 811. Switching and tagout out deenergized cables.

Comment.

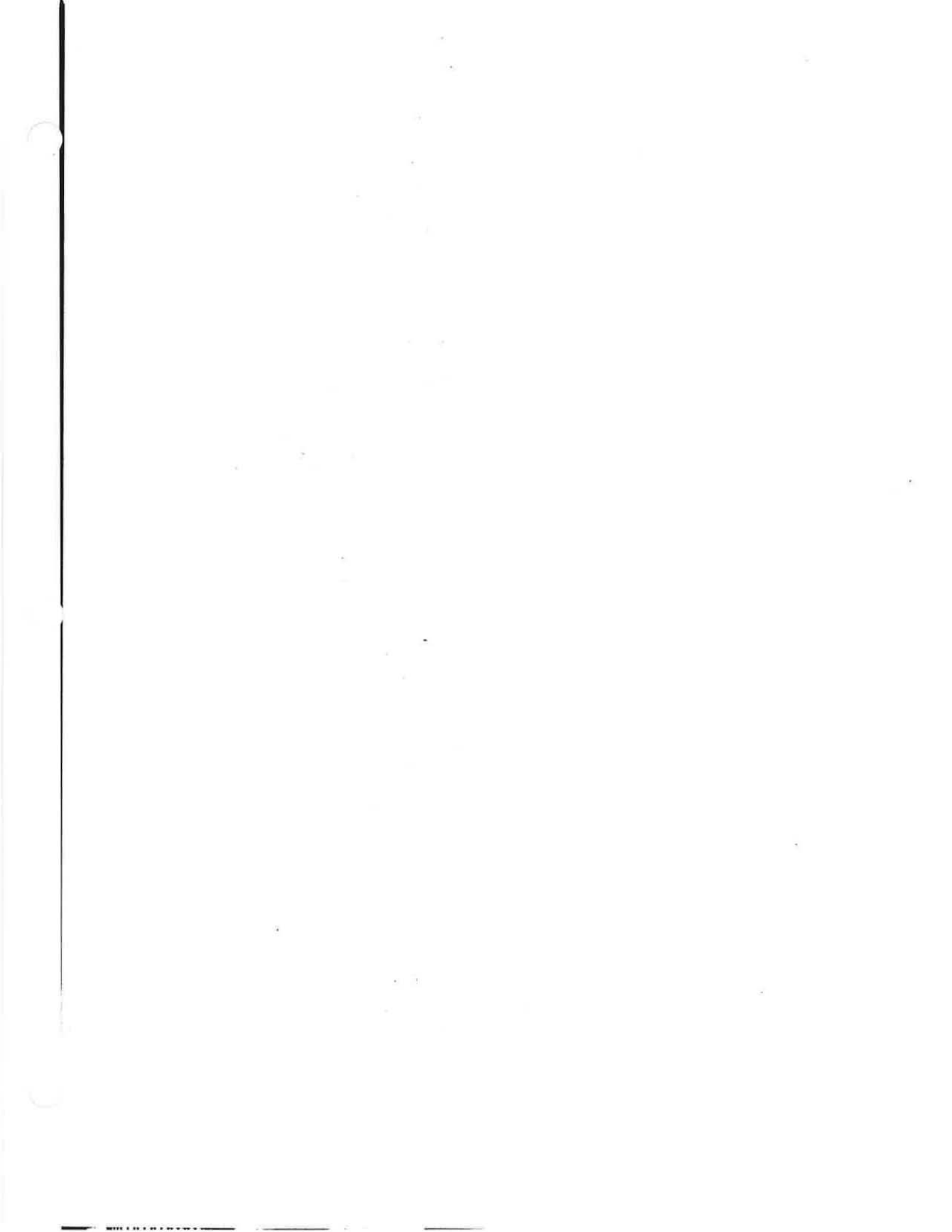
Lockout devices should be used if feasible. See comment to Pantographs, Instruction 28.

### XIV. Tree Trimming

1. Instruction 973. Removing trees or large branches.

Comment.

When working in close proximity to energized conductors, care should be taken to prevent simultaneous contact of a falling tree branch that still has some attachment to the tree and to the energized conductor. Personal protective clothing and equipment should be used by tree trimmers.





U.S. Department  
of Transportation

# Memorandum

Research and  
Special Programs  
Administration

John A. Volpe  
National Transportation Systems Center

**Subject:** PROGRESS REPORT: Development of an  
Outline of Model Set of Work Rules

**Date:** 1/3/96

**From:** Ike Tingos

**Reply to**  
**Attn. of:** DTS-701

**To:** G. Deily, RDV-31

**Thru:** R. Dorer

As part of the preliminary safety study of electrified railroad systems, the Volpe Center has been developing an initial outline of a model set of electrical operating instructions (safety work rules). These may act as suggested guidelines for newly emerging electrified railroads which may be operated by an organization not having any previous experience in electrified operations.

The proposed outline is being based upon the review of numerous industry standards, available railroad electrical operating instructions and safety rules, government regulations, and other relevant standards.

The main parts of a recommended model set of electrical operating instructions (safety rules) would include as a minimum:

- approach distances
- hot line work procedures
- tagout and lockout procedures
- protection duties
- grounding procedures
- use of personal protective equipment
- work in confined and enclosed spaces
- precautions for the operation of MOW and construction vehicles (including wire trains, etc.)
- work in elevated places and on platforms
- emergency first aid/rescue procedures.

At this time, draft text sections for approach distances, tagout and lockout procedures, protection duties, grounding procedures,

and work in confined and enclosed spaces have been developed and are attached.

Comprehensive reviews of existing standards, regulations and available railroad instructions have been completed. The results of the review are contained in a set of appendices that are attached. It is intended that these appendices provide the basis for the outline of the model electrical safety work rules.

In Appendix A a review of the National Electric Safety Code (NESC) was made. This review focused on the NESC applicability to railroads. Part 4 of the NESC, titled Rules for the Operation of Electric Supply and Communications Lines and Equipment, is the section of the NESC that contains its work rules. Table A.1 of Appendix A is an outline of these work rules.

In Appendix B, a review of the NFPA 70E, Electrical Safety Requirements for Employee Workplaces, was performed. This standard was revised in 1995. An outline of the work rules and safe work practices portion of the standard is provided in Table B.1 of Appendix B.

In Appendix C, a review of OSHA standards for work rules and safe work practices was performed. Safe work practices can be found in various parts of the OSHA regulations including Parts 1926 and 1910. A detailed outline of the following OSHA (29 CFR) standards are included as tables in Appendix C:

- Part 1910 Subpart S Electrical.
- Part 1910 Subpart R Section 269 Electric Power Generation, Transmission and Distribution
- Part 1926 Subpart K Electrical
- Part 1926 Subpart V Power Transmission and Distribution.

In addition, brief reviews of other related OSHA regulations were also performed. These include Part 1910, Subpart J, Section 146, Permit Required Confined Spaces, Section 147, Control of Hazardous Energy Sources (Lockout and Tagout), and Part 1910, Subpart R, Section 268, Telecommunications.

In Appendix D, a review of the available electrified railroad operating instructions and safety rules was performed. The documents which were analyzed were provided by Amtrak, Long Island Railroad, Metro-North Railroad, and New Jersey Transit through the National Traction Power Committee. A comparison of these instructions and rules was made and is summarized in Table D.1. Detailed outlines of Amtrak's Electrical Operating Instructions (AMT-2) and NJ Transit's Electrical Operating Instructions (TRO-3) were also developed, and are provided as Table D.2 and Table D.3, respectively. Preliminary comments also were prepared for each of the reviewed railroad operating instructions and safety rules. Selected requirements, as given

in the railroad safety work rules, were compared to the OSHA, NESC, and NFPA 70E standards discussed in the other appendices. These comments focused on clearances, approach distances, protective grounding, tagout and lockout, and the use of personal protective equipment. Therefore, these comments are not intended to be all-inclusive but illustrate the differences between the various standards.

Attachment

cc:  
F. Raposa, Unisys  
PPA #RR-693 File