

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

**SAFETY RULES FOR
ELECTRIC FENCES**

**Comprising Part 6 of the Fifth Edition
National Electrical Safety Code**

NATIONAL BUREAU OF STANDARDS HANDBOOK H36

reau of Standards

MAY 17 1940

U. S. DEPARTMENT OF COMMERCE

HARRY L. HOPKINS, Secretary

NATIONAL BUREAU OF STANDARDS

LYMAN J. BRIGGS, Director

National Bureau of Standards Handbook H36

SAFETY RULES FOR
ELECTRIC FENCES

Comprising part 6 of the Fifth Edition
National Electrical Safety Code

Issued April 17, 1940



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1940

PREFACE

This handbook contains part 6 of the National Electrical Safety Code. This part of the code is new and has not appeared in previous editions. The rapid growth in the use of electric fences has made it seem imperative to set up rules for guidance in the use of such equipment.

Owing largely to the use of home-made devices and improperly designed controllers, a number of accidents resulting in death both to human beings and to animals have occurred in connection with electric fences, and it has appeared very important that regulations for the proper design and use should be made available. These rules represent a consensus of those who have cooperated with the National Bureau of Standards in this matter. They have been approved by the sectional committee organized under the rules of procedure of the American Standards Association. Since rapid developments are taking place in this field, it seems desirable to proceed promptly with a consideration of revision of this part of the code, and it has been agreed that this revision shall be carried out with a separate sectional committee made up of those qualified to deal with the conditions involved in electrical shock and with the use of electric fences in their practical application.

Criticism of the rules and suggestions for their improvement are invited, especially from those who have had experience in the use of electric fences or who are familiar with the conditions under which electrical shock may be fatal. Since the purpose of an electric fence is to give shock to animals which touch it, it is not feasible to make it shockproof to human beings, and efforts are directed to preventing such shocks as may be experienced from being fatal.

In future editions every effort will be made to perfect the rules and make the use of electric fences comparatively safe for human beings, while at the same time not interfering with their effectiveness in the practical restriction of animals to enclosed areas, which is, of course, their purpose.

LYMAN J. BRIGGS, *Director.*

CONTENTS

	Page
Preface.....	11
Definitions.....	1
Sec. 60. Scope and intent of rules.....	3
600. Scope.....	3
601. Intent.....	3
Sec. 61. Identification of fence wire.....	3
610. Identification.....	3
611. Approved marker.....	3
Sec. 62. Conditions of use.....	3
620. Control device required.....	3
621. Number of controllers.....	4
622. Maximum supply voltage.....	4
623. Use of controllers.....	4
A. Battery type.....	4
B. Alternating-current type.....	4
624. Charging batteries.....	4
625. Grounding.....	4
626. Lightning arrester.....	4
Sec. 63. Types of control devices.....	5
630. Nature of controllers.....	5
A. Battery type.....	5
B. Alternating-current type.....	5
C. Inductive-discharge type.....	5
D. Capacity-discharge type.....	5
631. Converters.....	5
Sec. 64. Output of control devices.....	6
640. Output limited.....	6
A. Inductive-discharge type.....	6
B. Capacity-discharge type.....	7
C. Intermittent alternating-current output type.....	7
D. Continuous type.....	8
641. Measurement of output.....	8
Sec. 65. Construction of controlling devices.....	8
650. Marking.....	8
651. Enclosures.....	9
652. Bonding.....	9
653. Barriers.....	9
654. Transformer assembly.....	10
655. Ground terminal.....	10
656. Cutout.....	10
657. Integrity of adjustment.....	10
658. Converters.....	11
659. Effect of voltage variation.....	11

	Page
Sec. 66. Dielectric and leakage tests.....	11
660. Battery-operated controllers.....	11
A. Insulation test.....	11
B. Humidity test.....	11
661. Alternating-current controllers.....	12
A. Insulation test.....	12
B. Humidity test.....	13
662. Converters.....	13

SAFETY RULES FOR ELECTRIC FENCES

COMPRISING PART 6 OF THE FIFTH EDITION OF THE NATIONAL
ELECTRICAL SAFETY CODE

DEFINITIONS

Conductor means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current. It does not include bus bars.

Effectively grounded means permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient current-carrying capacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

Enclosed means surrounded by a case which will prevent accidental contact of a person with live parts. A solid enclosure means one which will neither admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

Electric fence means a barrier to animals or fowls, consisting of an electrified conductor energized through an electric-fence controller.

Electric-fence wire means any electrified conductor, such as a wire, ribbon, tape, rod, tube, plate, mesh, or any other form suitable for, and used as, a barrier to animals or fowls.

Grounded means connected to earth or to some extended conducting body which serves instead of the earth, whether the connection is intentional or accidental.

Lightning arrester means a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current if present, and restores itself to its original operating conditions.

SEC. 60. SCOPE AND INTENT OF RULES

600. SCOPE.

These rules apply to the installation, use, and identification of electric fences and to the construction and characteristics of the controllers used with them and through which electric energy is delivered to the fence.

601. INTENT.

The nature and use of electric fences are such that a person, as well as an animal, will receive an electrical shock if the electric-fence wire is touched while standing on the ground. It is the purpose of these rules so to limit such electrical shock that it will not cause serious or permanent injury.

SEC. 61. IDENTIFICATION OF FENCE WIRE

610. IDENTIFICATION.

Any electric fence or portion thereof installed along a public highway or as a property-line fence shall be identified by approved markers or signs clamped to the fence wire or fastened to posts at intervals not greater than 200 feet.

611. APPROVED MARKER.

An approved marker shall be as follows: A metal plate, wooden board, or other durable waterproof material not less than 4 inches by 8 inches, painted on both sides with a pure chrome-yellow background, with the following text on one or both sides: "ELECTRIC FENCE." The lettering of the text shall be in black letters not less than 1 inch high. Other lettering, with letters not more than $\frac{5}{8}$ inch high, may be placed on the reverse of the side with the required lettering.

SEC. 62. CONDITIONS OF USE

620. CONTROL DEVICE REQUIRED.

No fence shall be energized from any electric source except through an approved controller.

620. Control Device Required—Continued.

No device will be approved which fails to comply with these regulations or is of poor construction.

621. NUMBER OF CONTROLLERS.

No metallically continuous fence or set of electrically connected fences shall be supplied by more than one controller.

622. MAXIMUM SUPPLY VOLTAGE.

Controllers shall not be used to operate electric fences from electric sources having a voltage rating higher than 125 volts (effective or rms value).

623. USE OF CONTROLLERS.**A. Battery Type.**

A controller designed and approved for battery operation shall not be connected to any other type of power supply or connected to a supply voltage higher than the voltage for which it is designed, except through a converter approved for use with this controller.

B. Alternating-Current Type.

Alternating-current controllers shall not be connected to any supply circuit having different characteristics than the supply circuit for which the controller is designed.

624. CHARGING BATTERIES.

Batteries shall not be charged while the fence is in use.

625. GROUNDING.

The grounding terminal of the controller and the grounding terminal of any converter shall be effectively grounded in accordance with the rules of section 9.

626. LIGHTNING ARRESTER.

Where lightning is prevalent and the controller is located in or on a building, a lightning arrester of approved type shall be installed on the fence circuit and shall be effectively grounded in accordance with the rules of section 9 of this code.

SEC. 63. TYPES OF CONTROL DEVICES

630. NATURE OF CONTROLLERS.

Controllers fall into the following categories, depending on the kind of electric current used for the operation of the fence, the voltage of the primary source, and principle of operation.

A. Battery Type.

Battery controllers are used where the power source is a battery or batteries connected to have an open-circuit voltage not in excess of 15 volts.

B. Alternating-Current Type.

Alternating-current controllers are used where the source is alternating. Such controllers shall provide separation by insulation between the primary source of electric power and the fence wire when the no-load voltage of the source is in excess of 15 volts, rms value.

C. Inductive-Discharge Type.

Inductive-discharge types are those which deliver one or more pulses during each shock period from the secondary winding of an induction coil or transformer to the fence, resulting from the making and breaking of the primary circuit.

D. Capacity-Discharge Type.

Capacity-discharge types are those which deliver a pulse resulting from the discharge of a capacitor.

631. CONVERTERS.

Converters are used to allow battery controllers to be supplied from a direct-current source having an open-circuit voltage in excess of 15 volts, or from an alternating-current source.

SEC. 64. OUTPUT OF CONTROL DEVICES**640. OUTPUT LIMITED.**

The intent of this section is to require that the electric energy supplied to fences shall be so limited by controlling devices that the energy which the electric fence can deliver under the most severe conditions shall not be hazardous. To this end the limits have been fixed for the various types of control devices, as given in the following paragraphs.

A shock period referred to in the following paragraphs means that period of time during which the shocking current is flowing to the fence wire. In certain types, a small amount of current is permitted to flow on the fence wire between the shock periods.

A. Inductive-Discharge Type.

During each shock period, the product of the rectified current in milliamperes capable of being supplied by the controller, and the duration of such period in seconds shall not exceed 3 milliamperes-seconds (3 millicoulombs).

The maximum peak value of the current pulse delivered by the controller shall not exceed 500 milliamperes and it shall not exceed 10 milliamperes after 0.1 second. Between shock periods, there shall be an "off" period of 0.75 second or more, during which time no current is delivered to the fence.

The limits of 3 milliamperes-seconds and 500 milliamperes shall not be exceeded when the controller is connected in series with the measuring instrument and with load conditions which will result in the maximum current output of the device. In no case shall a test load of less than 500 ohms be used.

A cut-out or equivalent device as specified in rule 656 shall be provided, and the steady current shall be limited to 25 milliamperes, unless the construction is such as to limit the maximum steady current deliverable under any condition to 3 rms milliamperes. This paragraph refers particularly to conditions where the interrupter points may stick in

640. A. Inductive-Discharge Type—Continued.

the closed position or be shorted in some manner; also to the condition resulting from energizing the unit by means of an a. c. converter instead of a battery. In some cases the use of a converter will cause a flow of current to the fence wire during the "off" period.

This cut-out will not be required in a controller for which the power source is a battery with an open-circuit voltage less than 15 volts.

B. Capacity-Discharge Type.

During each shock period, the product of the rectified current in milliamperes capable of being supplied by the controller, and the duration of such period in seconds, shall not exceed 3 milliampere-seconds (3 millicoulombs).

The maximum peak value of the current pulse delivered by the controller shall not exceed 500 milliamperes; its value after 0.0001 second shall not exceed 150 milliamperes; it shall not exceed 10 milliamperes after 0.1 second; and the maximum steady current delivered shall not exceed 3 milliamperes. The initial and the 0.0001-second values of current shall be computed on the basis of measured capacitance, charging voltage, and impedance of the discharge circuit.

Those controllers which deliver their shock intermittently (cyclicly) shall provide an "off" period between shocks of 0.75 second or more, during which time no current is delivered to the fence.

The limits of 3 milliampere-seconds and 500 milliamperes shall not be exceeded when the controller is connected in series with the measuring instrument and with load conditions which will result in maximum current output of the device. In no case shall a test load of less than 500 ohms be used.

C. Intermittent Alternating-Current Output Type.

The maximum current which can be delivered by the controller under any load condition, but not

640. C. Intermittent Alternating-Current, etc.—Con.

less than 500 ohms, including the measuring instrument connected in series with the fence terminals, shall not exceed 25 rms milliamperes, measured over the shock period. The duration of a shock period shall not exceed 0.1 second, and the frequency of such shock periods shall not exceed one per second. A current of 1 rms milliampere is permissible during the nominally "off" period of the controller.

D. Continuous Type.

The maximum current which can be delivered by the controller under any load condition, but not less than 500 ohms, including the measuring instrument connected in series with the fence terminals, shall not exceed 8 rms milliamperes.

641. MEASUREMENT OF OUTPUT.

The output current of all types of controllers shall be measured with an electromagnetic oscillograph having a natural frequency of not less than 3,000 cycles per second connected in series with the fence load. In determining the steady output of any controller, the rms value may be measured with an instrument of low impedance instead of being calculated from an oscillogram.

All timing and output tests are made at the rated supply voltages and frequencies and at voltages specified in rule 659.

SEC. 65. CONSTRUCTION OF CONTROLLING DEVICES**650. MARKING.**

Every electric-fence controller or converter shall carry a clear and permanent marking where it will be readily visible after it has been installed as intended, giving the manufacturer's or distributor's name and address, the catalog or model number, the voltage and type of electric-supply circuit with which it is to be used, and whether it is designed for inside or outdoor use. Every controller shall also carry a notice that it must be

650. *Marking*—Continued.

operated on the supply circuit for which the controller is designed, unless an approved device is used to connect it to a different source. Every converter shall also carry a notice of the type and the voltage rating of the controller and the supply circuit with which it is to be used.

651. ENCLOSURES.

The current-limiting and the timing devices of controllers and converters shall be so enclosed that removing, shunting out of circuit, readjusting, or replacing these devices cannot be accomplished without the use of special tools or will be accompanied by such mutilation or destruction of the enclosure that efforts at tampering shall be immediately evident upon inspection. The enclosure shall be so formed as to prevent the entrance of dust, dirt, moisture, insects, and vermin. An ordinary tight-fitting door is not considered satisfactory for this purpose.

652. BONDING.

One side of the controller output circuit, the core of any transformer used, any metallic enclosure of transformers or equipment, and any shields or barriers that may be used, shall be permanently, mechanically, and electrically connected to the inside of the case or housing. These connections shall be free from insulating paints and shall be securely riveted, welded, soldered, or permanently bolted together. Leads used to make these grounding connections shall be not less than No. 14 AWG stranded and tinned copper wire or the equivalent, except the grounded wire of the fence winding of the transformer which shall be of not less than No. 18 AWG stranded and tinned copper wire or the equivalent.

653. BARRIERS.

Each controlling device shall be provided with a metallic barrier between the input circuit and the fence circuit or the output circuit. This barrier shall effectively separate the input circuit from the fence circuit or the

653. Barriers—Continued.

output circuit and shall be effectively bonded to the controller enclosure. Controllers operated from batteries shall be exempt from this requirement.

654. TRANSFORMER ASSEMBLY.

The input and fence windings of the transformer shall be on separate sections of the transformer core or otherwise separated, so that in case of failure of the insulation of the primary winding the breakdown will be to a grounded metallic barrier. Controllers operated from batteries are exempt from this requirement.

655. GROUND TERMINAL.

A suitable corrosion-resistant grounding terminal without insulator or bushing shall be provided on the case or housing and shall be marked "GROUND" or "GND" in a plain and permanent manner.

656. CUTOUT.

The input circuit of the intermittent a-c output type and of the inductive-discharge-type controllers, if not exempted by rule 640 A, shall be provided with a cut-out which will open within 5 seconds when the ambient temperature is 120° F, and within 30 seconds when the ambient temperature is 0° F, should the interrupter points stop in a closed position or should a jumper be placed across the interrupter points. This cut-out shall be so located in the circuit that the controller cannot be used without it, and shall be installed according to the requirements of rule 651.

657. INTEGRITY OF ADJUSTMENT.

The construction of controlling devices shall be such that tilting or changing of position, substitution of other pilot or signal lamps for those originally provided, the application of a "jumper," or any tampering short of mutilation or destruction of enclosures shall not cause an increase in current output or an increase in the duration of the shock period or a decrease in the duration of the "off" period, outside the limits imposed in section 64.

657. Integrity of Adjustment—Continued.

The construction shall be such that the limits imposed in section 64 shall not be violated at any ambient temperature between 0° and 135° F. The controller shall be exposed to an ambient temperature for 4 hours before making the above determination and shall remain in this atmosphere until after the determination is made.

658. CONVERTERS.

Converters shall be so designed that when used in conjunction with a battery-type controller, they will not cause the output or the timing requirements of section 64 to be violated.

659. EFFECT OF VOLTAGE VARIATION.

Control devices for use with a-c supply shall meet the requirements of this code with a voltage 10 percent above or below the rated voltage; at no point shall the limits of output specified in section 64 be exceeded. Controllers designed for battery operation shall not exceed the limits of section 64 for battery voltages between 67 percent and 110 percent of normal, or rated, voltage.

SEC. 66. DIELECTRIC AND LEAKAGE TESTS**660. BATTERY-OPERATED CONTROLLERS.****A. Insulation Test.**

A voltage equal to one and one-half times rated primary or input voltage shall be applied to the primary circuit for a period of 1 minute with the fence terminals remaining open. There shall be no breakdown or flashover.

B. Humidity Test.

Following the above test, and after the complete device has been exposed for 48 hours to an atmosphere having a relative humidity of 90 percent and a temperature of 90° F, and before being removed from that atmosphere, maximum rated voltage shall

660. B. Humidity Test—Continued.

be impressed on the primary or input circuit. The current delivered at the fence terminals under these conditions shall not exceed the value specified in rule 640.

661. ALTERNATING-CURRENT CONTROLLERS.

A. Insulation Test.

After the complete controller has been exposed to an ambient temperature of 135° to 140° F for a period of 2 hours, it shall immediately be subjected to the following insulation tests and withstand these tests without flashover or breakdown.

1. A voltage equal to one and one-half times maximum rated primary or input voltage shall be applied to the primary circuit for a period of 1 minute, with the fence terminals remaining open.
2. A voltage equal to twice maximum rated primary voltage plus 1,000 volts (rms value, 60-c/s supply) shall be applied between the primary circuit, and the fence and ground terminals connected to case, for a period of 1 minute. On interrupted a-c controllers, this test shall be made (a) with the interrupter points open and (b) with the interrupter points closed.
3. With the transformer removed, a voltage of 3,000 volts (rms value, 60-c/s supply) shall be applied between the input or primary windings and the secondary or fence winding connected to core for a period of 1 minute.
4. With the transformer removed, a voltage of 3,000 volts (rms value, 60-c/s supply) shall be applied between the secondary or fence winding and the core, to which last the primary winding shall also be connected. This voltage shall be applied for a period of 1 minute.

661. *Alternating-Current Controllers—Continued.***B. Humidity Test.**

Following the above tests, and after the complete device has been exposed for 48 hours to an atmosphere having a relative humidity of 90 percent and a temperature of 90° F, and before being removed from that atmosphere, the unit shall comply with the following:

1. The current delivered at the fence terminals under these conditions, and with maximum rated voltage impressed on the primary, shall not exceed the value specified in rule 640.
2. The insulation shall withstand the application for 1 minute of a voltage equal to twice maximum rated primary voltage plus 1,000 volts (rms value, 60-c/s supply) impressed between the primary circuit and the fence and ground terminals connected to case.

662. **CONVERTERS.**

If a converter is to be used in conjunction with a controller, the tests of rule 660 or 661 shall be applied to the complete assembly.

Calwest