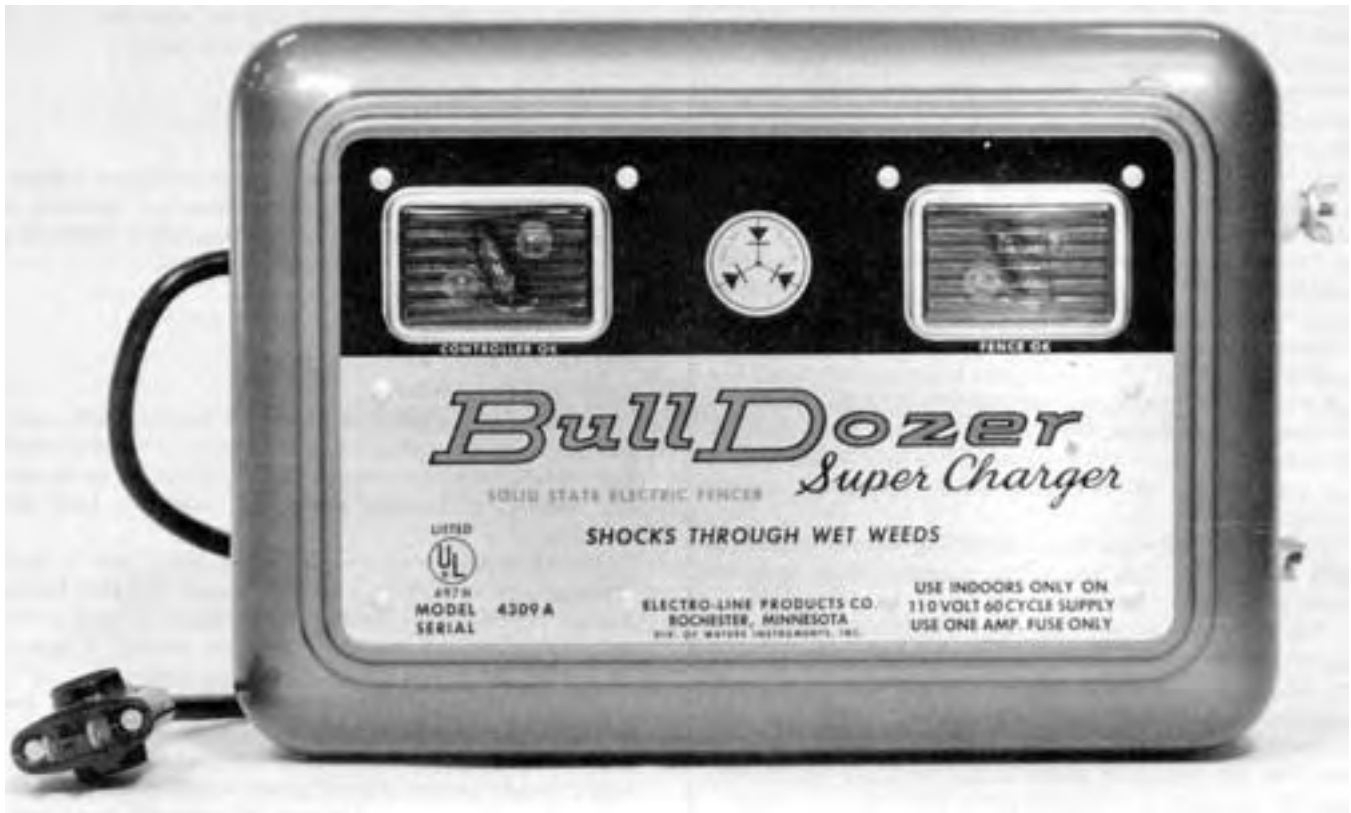


Evaluation Report

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Bull-Dozer 4309A Electric Fence Controller

A Co-operative Program Between



BULL-DOZER 4309A ELECTRIC FENCE CONTROLLER

MANUFACTURER:

Electro-Line Products Company
P.O. Box 6117
Rochester, Minnesota 55901
U.S.A.

DISTRIBUTOR:

Crist Products Ltd.
P.O. Box 640
Broadview, Saskatchewan
S0G 0K0

RETAIL PRICE:

\$75.00 (August, 1979, f.o.b. Humboldt)

SUMMARY AND CONCLUSIONS

The Bull-Dozer 4309A electric fence controller was suitable for use over a wide range of fence conditions.

Peak voltage output on a 5.4 km (3.3 mi) single wire fence varied from 4000 V for a well-insulated, grass-free, dry fence to 1035 V for an uninsulated, grass-grown, wet fence. For most normal fence conditions, output was above the 2000 V minimum guard voltage recommended for long-haired animals, while for extreme conditions it was above the 700 V minimum needed for short-haired animals. For most fence conditions, the Bull-Dozer 4309A could be used without wire insulators on this fence length.

Peak voltage output on a 16 km (10 mi) single wire fence varied from 1850 V for a well-insulated, grass-free, dry fence to 790 V for an uninsulated, grass-grown, wet fence. Plant growth touching an insulated, dry fence did not appreciably reduce voltage output.

Peak current flow through a cow touching well-insulated 5.4 and 16 km (3.3 and 10 mi) single wire fences varied from 2.1 to 1.6 A for a cow standing in water and from 0.74 to 0.41 A for a normally-grounded cow. The high peak current output indicated that the Bull-Dozer 4309A generated quite an intense shock and was suitable for fairly long fences or poorly insulated fences.

Total charge delivered by the Bull-Dozer 4309A varied from 0.33 to 0.35 mC. This was within accepted safety limits for cattle or humans.

The Bull-Dozer 4309A was very suitable for cold weather use on feeding fences. Peak voltage output at -37°C on a 5.4 km (3.3 mi) single wire fence was about 3480 V, only 13% lower than its output at room temperature.

The test machine had not been submitted for CSA certification. The two conductor power supply cord and ungrounded plug did not conform to current safety practice.

No durability problems occurred during testing, however, the ground fault indicator light was non-operational when received from the manufacturer.

RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Submitting the controller to Canadian Standards Association for certification, to comply with regulations in the prairie provinces.
2. Equipping the controller with a three conductor power cord, standard three-prong grounded plug and corresponding fuse.
3. Modifications to permit field replacement of indicator light bulbs.

Chief Engineer -- E. O. Nyborg
Senior Engineer -- L. G. Smith

Technical Officer -- J. M. Williams

THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. & 2. The Bull-Dozer fence controller has now received CSA certification. To avoid confusion with other models in inventory, the model number has been changed to 4409.
2. The indicator light bulbs are of the non-filament neon discharge type and are not likely to require replacement.

GENERAL DESCRIPTION

The Bull-Dozer 4309A electric fence controller is designed for 115 V AC operation and is equipped with a cord and plug for connection to a standard electrical receptacle. It is meant to be mounted in a suitable weather-proof enclosure.

The Bull-Dozer 4309A contains solid-state electronics, with no moving parts. Lights are provided to indicate operation, shock intensity and inadequate grounding of the controller.

Detailed specifications are given in APPENDIX I

SCOPE OF TEST

The performance characteristics of the Bull-Dozer 4309A were determined in the laboratory for a range of simulated fence conditions.* It was evaluated for ease of operation, quality of work, safety and suitability of the instruction manual.

RESULTS AND DISCUSSION

EASE OF OPERATION

Installation: The Bull-Dozer 4309A is equipped with a two wire cord and plug for connection to a standard 115 V AC receptacle. The manufacturer recommends that the controller be located in a dry building or suitable shelter to protect it from adverse weather.

The controller is connected to the fence with a length of insulated wire. In addition, a suitable ground rod has to be installed and connected to the controller. Depending on ground conditions, a 2 to 3 m ground rod length may be needed. A ground rod connecting clamp is supplied with the controller.

Fence Condition: The manufacturer recommends that the Bull-Dozer 4309A be used only on insulated fences. If the fence is properly insulated, the controller is designed to operate effectively with a certain amount of plant growth touching the charged wire.

The manufacturer recommends that for cattle fences, in areas with normal ground conditions, a single charged wire fence erected about two-thirds of animal height above ground provides a suitable fence. For very dry or frozen soil, which provide poor ground conditions, a two-wire fence, with one charged wire and one ground wire, may be necessary.

Operation: The Bull-Dozer 4309A is equipped with three indicator lights. One light indicates that the controller is operating, while a second light indicates that a charge is being supplied to the fence. When this light flashes normally, it indicates that the fence is properly charged. Conversely, if this light is very dim, it indicates that insufficient charge is being placed on the fence, which may be the result of too long a fence or poor insulation. The third light is a ground fault detector. It is on whenever the controller is operating. If this light flashes or is off, it indicates that the controller is not adequately grounded.

The ground fault light was not operational when the controller was received from the manufacturer. This was caused by a burnt out bulb and did not affect operation, however, the controller was sealed from the factory and indicator lights could not be replaced without factory servicing. Although, for safety reasons, factory sealing is necessary for power line-operated fences, it is recommended that the manufacturer consider modifications to permit indicator light bulb replacement without chassis disassembly.

QUALITY OF WORK

General: Operation of an electric fence controller is quite complex. To be effective, an electric fence has to deliver a minimum guard voltage to overcome the insulation resistance of the hide and hair of an animal. In addition, once the insulation resistance of the animal is overcome, the controller must deliver a pulse of electrical energy to the animal to create a shock. The amount of energy

*PAMI T7850, Detailed Test Procedures for Electric Fence Controllers.

(charge) delivered is related to the current flow and its duration. If too much energy is delivered, the fence will be hazardous to both animals and humans while if not enough energy is delivered, animal control will be ineffective. For safety reasons, the total electrical charge in each pulse of power line-operated controllers should not exceed 1 mC if it has an on-time less than 14.2 ms. For an on-time of 200 ms, 4 mC is the allowable total electrical charge. Electrical regulations do not apply to battery-operated controllers.

Little is known about the physiological effect of shock pulses on animals. In general, the following guidelines are used in assessing fencer performance: the minimum guard voltage needed to overcome animal insulation resistance should be at least 2000 V for sheep and for long-haired cattle, such as Herefords or Charolais. For shorter haired animals, such as most dairy cows, a minimum guard voltage of 700 V is sufficient. The shape of the current pulse affects what the animal feels when it touches an electrical fence, but little reliable information is available. It has been found that shock intensity is more related to the peak current value in a pulse than to the total value of the electrical charge.

Fence conditions determine the guard voltage produced by a fence controller and limit the amount of charge, which a controller is capable of delivering to an animal. The insulation resistance of a 1.6 km single wire fence typically varies from about 1 kΩ for an uninsulated, grass-grown, wet fence to well above 500 kΩ for a well-insulated, grass-free, dry fence. The higher the fence insulation resistance, the greater is the length of fence on which a certain controller can be effectively used. To receive a shock from a single wire electrified fence, an animal must be sufficiently grounded to permit current to flow from the fence, through the animal. Typical electrical resistances of cattle vary from about 0.5 kΩ for a cow standing in water and licking a charged wire to about 4 kΩ for typical ground conditions. If ground conditions are too poor, animal resistance to ground is so great that no shock occurs.

Peak Voltage Output: FIGURES 1 and 2 show peak voltage outputs of the Bull-Dozer 4309A for 5.4 and 16 km lengths of single wire fence over a range of insulation resistances. On a 5.4 km fence (FIGURE 1), peak voltage output varied from 4000 V for a well-insulated, grass-free, dry fence to 1035 V for an uninsulated, wet fence with considerable grass touching the charged wire. The voltage output was above the 700 V minimum guard voltage needed for short-haired animals, for all fence conditions, while it was above the 2000 V minimum guard voltage needed for long-haired animals for fence insulation values greater than 1.5 kΩ. From FIGURE 1, it can be seen that the Bull-Dozer 4309A can be satisfactorily used on this length of fence, without wire insulators, in most conditions.

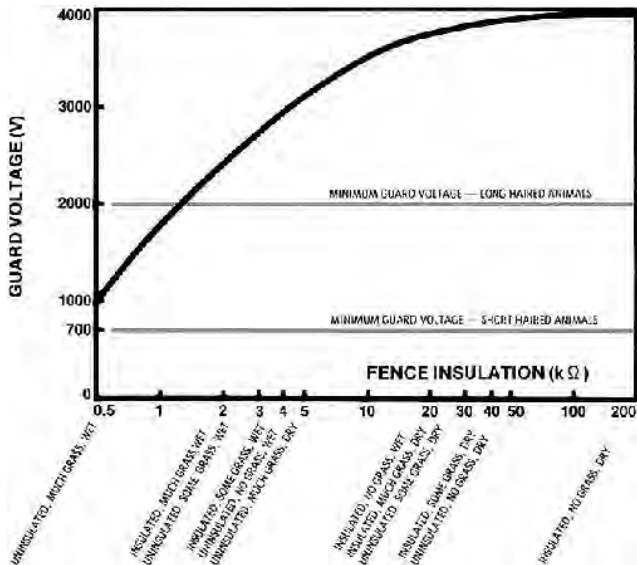


FIGURE 1. Guard Voltage Produced on a 5.4 km Single Wire Fence.

On a 16 km fence (FIGURE 2), peak voltage output ranged from 1850 V for a well-insulated, grass-free, dry fence to 790 V for an uninsulated, grass-grown, wet fence. Voltage output was below the 2000 V minimum required for long-haired animals, but was above the 700 V minimum required for short-haired animals, for all

fence conditions.

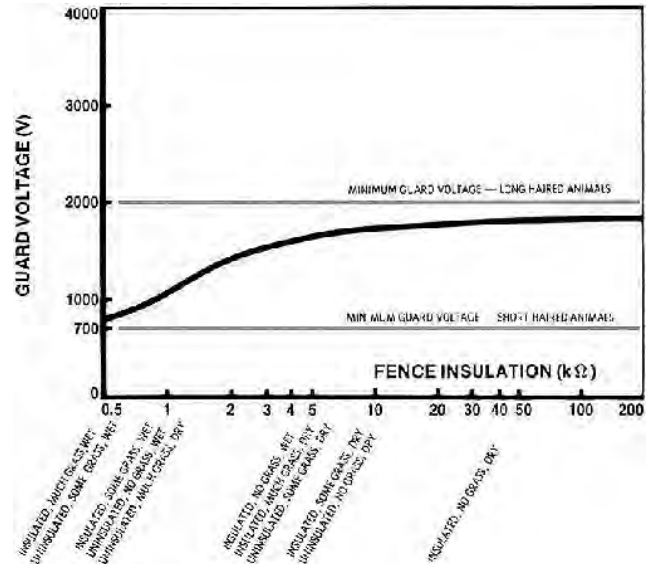


FIGURE 2. Guard Voltage Produced on a 16 km Single Wire Fence.

As can be seen from both FIGURES 1 and 2, plant growth touching an insulated, dry fence did not appreciably reduce the voltage output. The Bull-Dozer 4309A can be expected to operate well over a wide range of fence conditions.

Electrical Charge: FIGURES 3 to 6 show the current output of the Bull-Dozer 4309A when a cow touches 5.4 and 16 km lengths of well-insulated, single wire, fence. FIGURES 3 and 4 were for an animal resistance of 0.5 kΩ, which represent the most extreme condition of a cow standing in water and licking the charged wire, while FIGURES 5 and 6 are for an animal resistance of 4 kΩ, representing more normal ground conditions. The shock intensity is related to the peak current in the pulse; the higher the peak current, the more intense will be the shock. For safety reasons, total charge should not exceed 1 mC.

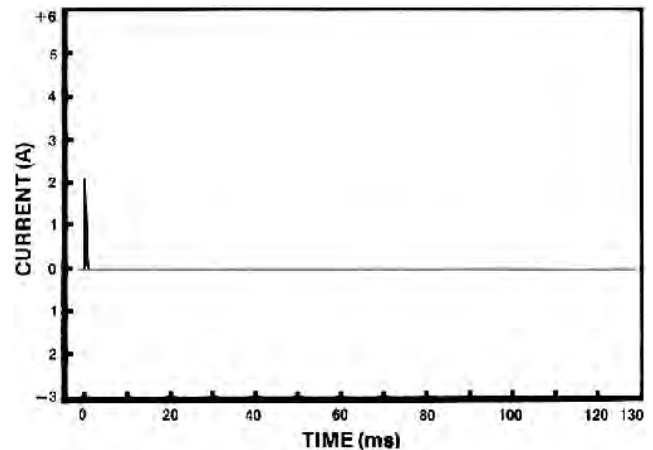


FIGURE 3. Current Delivered to a Well-Grounded Cow Touching a 5.4 km Well-Insulated Fence.

The peak current delivered by the Bull-Dozer 4309A varied from 2.1 A for a well-grounded cow touching the 5.4 km fence to 0.41 A for a normally-grounded cow touching the 16 km fence. The total charge delivered to the cow was within the accepted safety limits, varying from 0.33 to 0.35 mC. The Bull-Dozer 4309A gave quite an intense shock and was suitable for fairly long fence lengths or poorly insulated fences.

About 54 charge pulses per minute were delivered. The number of pulses did not vary with fencer load however the on-time was affected by load. On-time varied from about 0.5 to 8.5 ms.

Low Temperature Operation: The Bull-Dozer 4309A could effectively be used to energize cattle feeding wires during low winter temperatures. The peak voltage output of the controller at -37°C on a 5.4 km single wire fence was about 3480 V, only 13% lower than

its output at room temperature. A higher peak voltage output could be expected on a short feeding fence. Since the peak voltage output was well above the 2000 V minimum required to overcome the insulation resistance of long-haired animals, the Bull-Dozer 4309A was very suitable for feeding enclosures.

As frozen ground is often a very poor electrical conductor, two-wire systems, utilizing a separate ground wire, are usually most suitable for winter cattle feeding.

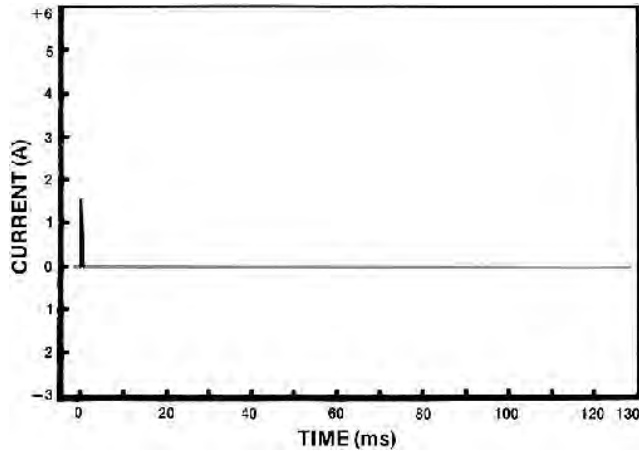


FIGURE 4. Current Delivered to a Well-Grounded Cow Touching a 16 km Well-Insulated Fence.

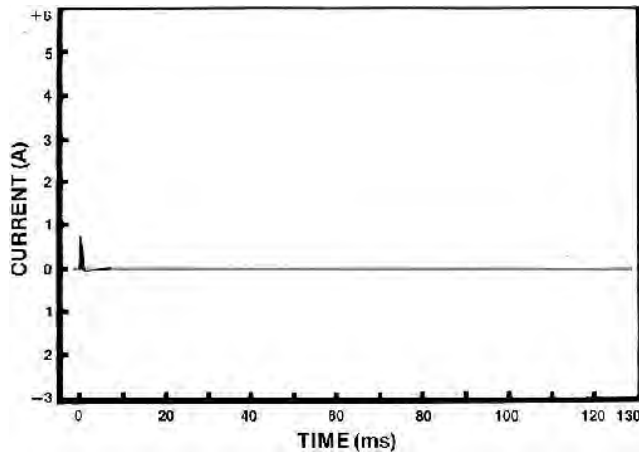


FIGURE 5. Current Delivered to a Normally-Grounded Cow Touching a 5.4 km Well-Insulated Fence.

SAFETY

The instruction manual clearly outlined safety considerations. No safety problems were evident if the manufacturer's instructions were followed.

The Bull-Dozer 4309A was equipped with a two conductor power supply cord and a fused two-prong plug. It is recommended that the manufacturer equip the controller with a three conductor power supply cord, a standard three-prong grounded plug and corresponding fuse to comply with current safety practice.

The test machine was marketed in Saskatchewan without Canadian Standards Association certification. Since CSA certification of power line-operated fence controllers is a requirement in the prairie

provinces, it is recommended that the manufacturer submit the controller for certification.

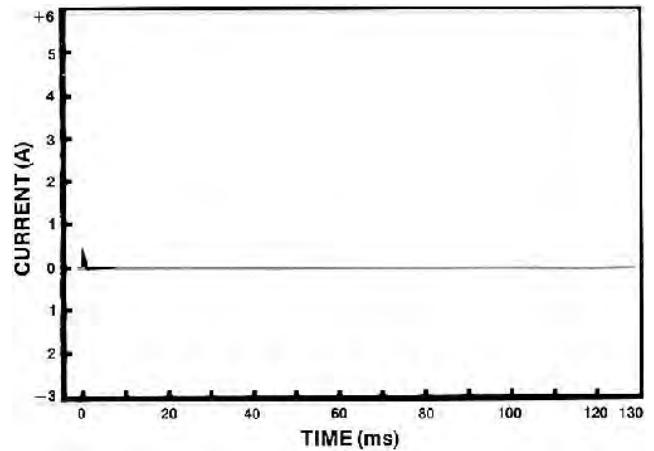


FIGURE 6. Current Delivered to a Normally-Grounded Cow Touching a 16 km Well-Insulated Fence.

INSTRUCTION MANUAL

The instruction manual was clear, concise and well illustrated. It outlined installation, safety considerations and operation, as well as discussing types of fences suitable for various livestock.

DURABILITY RESULTS

The intent of the test was functional evaluation. An extended durability evaluation was not conducted. No problems occurred during functional testing, however, the ground fault indicator light was non-operational when the controller was received.

APPENDIX I SPECIFICATIONS	
MAKE:	Bull-Dozer Electric Fence Controller
MODEL:	4309A
SERIAL NUMBER:	76096
TYPE:	Solid State Electronic
POWER REQUIREMENTS:	115 V AC
WEIGHT:	3.6 kg
OVERALL DIMENSIONS:	
-- length	320 mm
-- width	140 mm
-- height	225 mm
NUMBER OF INDICATOR LIGHTS:	3 (for operation, shock intensity and ground fault)
TYPE OF ENCLOSURE:	for indoor operation

APPENDIX II SI UNITS AND SYMBOLS	
(a) In keeping with the Canadian metric conversion program, this report has been prepared in SI units. For comparative purposes, the following conversions may be used:	
1 millimetre (mm)	= 0.039 inches (in)
1 metre (m)	= 3.28 feet (ft)
1 kilometre (km)	= 0.62 mile (mi)
1 kilogram (kg)	= 2.2 pounds (lb)
(b) The following symbols are used in this report:	
electric current	= ampere (A)
electric potential	= volt (V)
electric charge	= coulomb (C)
electric resistance	= ohm (Ω)
pulse time	= second (s)



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