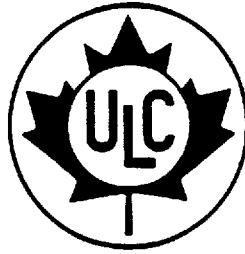


ULC Subject C583-1974



GUIDE
FOR
THE INVESTIGATION
OF
ELECTRIC BATTERY POWERED
INDUSTRIAL TRUCKS

UNDERWRITERS' LABORATORIES OF CANADA

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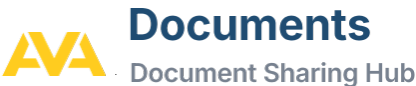


TABLE OF CONTENTS

	Page
FOREWORD	1
GENERAL	2
TYPE E, EE, AND EX ELECTRIC TRUCKS	2
1. Scope	2
2. General	2
TYPE E INDUSTRIAL ELECTRIC TRUCKS	2
Construction	2
3. General	2
4. Motors and Resistors	3
5. Electric Controls	3
6. Wiring	4
7. Overcurrent Devices	6
8. Battery Enclosure	7
9. Battery	7
10. Battery Leads	7
11. Battery Plugs and Receptacles	8
12. Lights	8
13. Horn	8
14. Spacings	8
Performance	11
15. Abnormal-Operation Test	11
16. Temperature Test	11
17. Brake Test	13
18. Arc-Rupturing Tests	13
19. Burnout Test	15
20. Dielectric-Withstand Test	16
Markings	16
21. Details	16
Service Manual	17
22. Details	17
TYPE EE INDUSTRIAL ELECTRIC TRUCKS	18
Construction	18
23. General	18
24. Motors	18
25. Resistors	18
26. Electric Controls	19
27. Wiring	19
28. Overcurrent Devices	19
29. Battery Enclosure	19
30. Wheels and Tires	20
Performance	20
31. Details	20
Markings	20
32. Details	20
TYPE EX INDUSTRIAL ELECTRIC TRUCKS FOR HAZARDOUS LOCATIONS, CLASS I, GROUP D	21
Construction	21
33. General	21
34. Motors	21
35. Electric Controls	21



Documents

Document Sharing Hub

36. Wiring	21
37. Battery Enclosure	22
38. Battery	22
39. Battery Plugs and Receptacles	22
40. Wheels and Tires	23
41. Safeguards Against Mechanical Sparks	23
Performance	24
42. General	24
43. Nonmetallic Conductive Tires	25
Markings	28
44. Details	28
TYPE EX INDUSTRIAL ELECTRIC TRUCKS FOR HAZARDOUS LOCATIONS, CLASS II, GROUP G	29
Construction	29
45. General	29
46. Motors	29
47. Electric Controls	29
48. Wiring	30
49. Battery Enclosure	30
50. Battery	30
51. Battery Plugs and Receptacles	30
52. Wheels and Tires	31
53. Exterior-Surface Temperatures	31
54. Safeguards Against Mechanical Sparks	31
Performance	31
55. Details	31
Markings	32
56. Details	32





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In Replying

Please Refer to ULC Subject C583-1974

GUIDE FOR THE INVESTIGATION OF ELECTRIC BATTERY POWERED INDUSTRIAL TRUCKS

FOREWORD

These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

GENERAL

TYPE E, EE, AND EX ELECTRIC TRUCKS

1. Scope

1.1 These requirements cover the fire-, electric-shock, and explosion-hazard aspects of electric battery powered industrial trucks such as tractors, platform-lift trucks, fork-lift trucks, and other specialized vehicles for industrial use. These requirements do not cover other possible hazard aspects of such equipment.

1.2 Electric battery powered industrial trucks covered by these requirements are identified as follows:

Type E - Electric trucks having minimum acceptable safeguards.

Type EE - Electric trucks provided with safeguards in addition to those required for Type E electric trucks.

Type EX - Electric trucks for hazardous locations, Class I, Group D and for Class II, Group G, as defined in Section 18 of the Canadian Electrical Code, Part 1, 1972.

1.3 Types E, EE, and EX trucks are electrically powered by batteries supplying 150 volts or less.

1.4 Other reference standards applying to power-operated industrial trucks are Powered Industrial Trucks, Type Designations, Areas of Use, Maintenance, and Operation, NFPA No. 505-1971 (relates to a classification of industrial trucks as to areas of use maintenance, and operation), Internal Combustion Engine Powered Industrial Trucks, ULC Subject C558 (requirements relating to fire hazards).

2. General

2.1 A component of a truck shall comply with the requirements noted herein for that component, except that such requirements may be modified if appropriate for the particular application. Unless otherwise expressly stated herein, the performance requirements for an industrial truck shall be satisfied by the testing of a representative model of a new vehicle.

TYPE E INDUSTRIAL ELECTRIC TRUCKS

Construction

3. General

3.1 A Type E industrial electric truck shall comply with the requirements given in paragraphs 3.2-22.1.

3.2 All wiring and other current-carrying parts of an industrial electric truck shall be so constructed and enclosed as to protect them from physical injury and to resist the abuses to which they may be subjected.

3.3 Except as noted in paragraph 6.9, all electrical parts, including wiring, shall be mounted within the body of the truck.

3.4 Contactors and fuses shall be so located as to be readily accessible for servicing, such as complete replacement or the replacement of contacts and inspection after the removal of a cover or covers. Other arcing and operating parts shall be accessible for servicing and inspection.

3.5 No uninsulated current-carrying part shall be exposed on the outer surface of the truck.

3.6 A gasket employed between a cover and a box shall be cemented or otherwise secured to one of the gasketed surfaces.

3.7 A drip pan shall not permit the collection of oil.

3.8 A current-carrying part of the power circuit, other than a resistor, shall be of nonferrous metal, except as covered in paragraph 6.17. Ferrous metal may be used for a resistor terminal in the power circuit and for all parts of the lighting, warning-signal, and other auxiliary and motor-control circuits. Steel, other than stainless, shall be zinc-coated, cadmium-plated, or equivalently protected against corrosion.

4. Motors and Resistors

4.1 Unless they are enclosed, power-circuit resistors shall be located to provide free air circulation about the resistance elements. Power-circuit resistors shall be installed so as to minimize the possibility of physical damage.

4.2 If the motor lead wires do not pass out of a motor directly into an acceptable raceway, or if they are brought out through the motor case, they shall pass through openings provided with an insulating bushing fastened in place. A bushing of neoprene rubber or rubber-like composition shall be no less than: 1/16 inch in wall thickness for a No. 10 AWG or smaller conductor, 1/8 inch in wall thickness for a conductor larger than No. 10 AWG up to and including No. 4 AWG, 3/16 inch in wall thickness for a conductor larger than No. 4 AWG up to and including No. 1/0 AWG, and 1/4 inch in wall thickness for a conductor larger than No. 1/0 AWG. A bushing of other insulating material shall be suitable for the purpose and shall be no less than 0.045 inch in thickness.

4.3 Terminals for a motor or for a power circuit resistor shall comply with the requirements of paragraphs 5.3-5.5.

5. Electric Controls

5.1 All arcing parts in the power circuits shall be enclosed or installed so as to minimize the possibility of flame or molten metal reaching surrounding combustible material on the truck.

5.2 Reversing controllers shall be interlocked, either mechanically and/or electrically, to prevent reversal of the motor when power is applied to the motor being reversed unless the controllers are tested for the reversing arrangement provided.

5.3 Terminals and terminal construction shall be of such size and shape as to provide the necessary capacity and mechanical support for the conductors connected to them. Terminals employing a threaded screw or bolt for securing the conducting lug to a terminal plate shall provide a minimum of two full threads in the metal. All terminal nuts shall be fastened by lockwashers or equivalent means to prevent loosening of conductors.

5.4 A base for the support of a live part shall be of treated fibre, molded-phenolic composition, sheet-phenolic composition, silicone-, melamine-, polyester-impregnated glass-fibre laminated sheet, cold-molded composition, treated asbestos-cement composition, or other nonabsorptive noncombustible material evaluated in accordance with paragraph 5.5.

5.5 In determining the acceptability of a material other than one specifically mentioned in paragraph 5.4 for the support of a live part, consideration shall be given to its resistance to moisture, to its physical strength if it is exposed or otherwise subject to physical damage, to the means for securing it in place, and whether or not the material is so located as to be adversely affected by operation of the equipment in service - particularly by arcing. The performance of a material with respect to these properties is to be evaluated in comparison to the performance of a material given in paragraph 5.4.

6. Wiring

6.1 Battery leads shall comply with the requirements in paragraph 10.1.

6.2 The internal wiring of an electric truck shall consist of appliance-wiring material of a type or types that are suitable for the particular application. This wiring shall be considered with respect to the temperature and conditions of service to which the wiring can be subject, as determined during the tests given in paragraphs 15.1-20.3.

6.3 Appliance-wiring material of one or more of the types indicated in Table 6.1 may be used for internal wiring.

30 mils = 1/32 inch

TABLE 6.1
APPLIANCE-WIRING MATERIAL

Wire Insulation	Minimum Acceptable Average Insulation Thickness
Thermoplastic (PVC)	30 mils
Rubber	15 mils plus an impregnated braid, or 30 mils without a braid.
Neoprene	15 mils plus an impregnated braid, or 30 mils without a braid.

NOTE: 30 mils = 1/32 inch.

6.4 Appliance-wiring material having a thickness of insulation less than those indicated in Table 6.1 may be used for a particular application, provided that the insulation is considered with respect to temperature and conditions of service, and is equivalent to one of those given in that table.

6.5 Bare conductors may be insulated with insulating tubing or with noncarbonizable beads.

6.6 A short length of rubber-insulated conductor exposed to temperatures which normally are in excess of the acceptable temperatures for the compound involved (such as to resistor terminals) is acceptable if supplementary heat-resistant insulation of dielectric withstand as required in paragraph 20.1 is employed on the individual conductors to safeguard against failure of the insulation because of deterioration of the rubber. An insulating sleeve shall be secured in place.

6.7 Except as noted in paragraphs 6.8 and 6.9, all wiring shall be protected against physical damage (1) by enclosing it in the body of the truck, (2) by enclosing it in metal raceway, such as armoured cable, rigid metal conduit, or electrical metallic tubing, or (3) by protecting it with metal, phenolic composition, or other thermosetting material of equivalent mechanical strength and resistance to impact. The electrical wiring mounted on booms, lifts, and similar parts shall be installed so as to minimize the possibility of physical damage and kinking.

6.8 Protection for insulated leads located within the operator's compartment is not required if the walls and floor of this compartment are of metal, phenolic composition, or other thermosetting material of equivalent mechanical strength and resistance to impact, and if the leads are not likely to be subjected to physical injury by the operator.

6.9 Conductors connected to moving or movable parts which cannot be protected as indicated in paragraph 6.7 are to be designed for their intended use and shall satisfy the test requirements in this standard. Particular attention shall be given to resistance of conductors to damage resulting from flexing, abrasion, or impact. Flexible metal conduit may be used only for flexible connections subject to small and infrequent movements. Wiring connections to continuously moving parts, or parts where the degree of movement is appreciable, are to be Type S, SO, ST, or STO flexible cord, except as noted in Paragraph 6.10.

6.10 In lieu of the flexible cord mentioned in Paragraph 6.9, individual conductors having flexible stranding, such as Type FFH-2, TFF, or SFF-2, enclosed in flexible tubing may be used. The tubing may be omitted from those exposed moving conductors which are readily visible to the operator and are therefore subject to replacement if damaged.

6.11 Except where plug and receptacle splicing devices are used, splices in the internal wiring of the truck shall be employed only at connections to leads provided as part of components of the device.

6.12 All of the splices and connections mentioned in Paragraph 6.11 shall be mechanically secure and shall provide adequate and reliable electrical contact without strain on connections and terminals. A splice shall be provided with insulation equivalent to that on the wires involved.

6.13 A hole by means of which insulated conductors pass through a sheet-metal wall shall be provided with a smooth well-rounded bushing or shall have smooth, well-rounded surfaces upon which the insulated conductors may bear.

6.14 Wireways shall be smooth and free from sharp edges, burrs, fins, or moving parts that can damage wiring.

6.15 All internal-wiring connections shall be made with solder lugs or pressure-type wire connectors, except that control wiring and other small conductors may be connected by crimped or soldered special-type lugs or eyelets.

6.16 Terminal lugs shall be so arranged that in any position of shifting they cannot contact either the frame of the truck or other electrical circuits, or the shanks of the lugs shall be provided with insulation equivalent to that on the conductor.

6.17 No part of the frame or enclosure of the truck shall be in electrical contact with current-carrying parts or used as a part of the electrical circuit except that, for trucks having a nominal 24-volt or lower rating, the frame of the truck may be used as a part of the electrical circuit if the circuit is protected by an overcurrent device or disconnect switch or connector. The switch or connector shall be positive in action and readily and quickly operable by the driver of the vehicle without leaving his normal driving position.

7. Overcurrent Devices

7.1 An overcurrent device of suitable capacity, as determined by the size necessary to prevent overheating of the smallest conductor in the circuit, shall be provided in a light, warning-signal, or other auxiliary circuit. Such a protective device may also be used in a motor-control circuit. A No. 18 or 16 AWG conductor is to be considered as being protected by an overcurrent device of 15-ampere rating or setting.

7.2 The need of an overcurrent device in the power circuit is to be determined on the basis of the burnout test described in paragraphs 19.1-19.6 and not by the need for protecting the wiring against overloads of short duration. Also, an overcurrent device may be required on the basis of the construction described in paragraph 6.17.

7.3 An overcurrent protective device provided in a control circuit in accordance with paragraph 7.1 or an overcurrent device in a power circuit provided in accordance with paragraph 7.2 is to be located as close as practicable to the battery terminals. Such a device is to be identified as to the maximum rating of the overcurrent protection to be employed, and it is recommended that it also be identified to indicate the circuit in which it is employed.

8. Battery Enclosure

8.1 The battery shall be provided with support and protection by means of a noncombustible enclosure which, if of metal, shall be no less than 0.053 inch (No. 16 MSG) and either shall be flanged not less than 1/2 inch on all sides or shall be provided with a construction that gives equivalent strength. A cover shall remain closed by the force of gravity or shall be provided with a fastener.

8.2 A metal cover shall have such strength and rigidity that, in conjunction with an air spacing provided between it and the battery terminals, the battery terminals are not short-circuited when a 250-pound force is applied to any one square foot area of the cover. In lieu of the spacing, insulation designed to prevent short-circuiting of the battery terminals shall be secured to the inner surface of a metal battery-compartment cover.

9. Battery

9.1 A battery furnished with a noncombustible tray and cover intended to form the ultimate enclosure for the battery shall comply with the requirements in paragraphs 8.1 and 8.2.

9.2 The battery enclosure shall be provided with means for ventilation that minimizes the possibility of accumulation of explosive hydrogen-air mixtures above the battery.

9.3 A battery of nominal voltage rating and representative of maximum ampere-hour capacity rating is to be supplied for the purpose of examining the truck.

9.4 Cells employing metal containers (such as alkaline batteries) shall be insulated from one another and from a metal tray or metal battery compartment. Insulation of wood or other material shall be (1) treated or painted to minimize deterioration by the battery electrolyte, and (2) constructed to minimize the risk of damage to the insulation in the normal operation and maintenance of the truck.

9.5 The connections shall be such that the potential between any two adjacent cells cannot be more than 24 volts (nominal).

9.6 Means shall be provided as a part of the truck to restrain the battery from moving more than a total of 1/2 inch in a horizontal direction.

10. Battery Leads

10.1 Battery leads shall be of a size and current-carrying capacity adequate for the application. They shall be neoprene insulated or insulated with an equivalent material, resistant to acids and/or alkalies, and able to withstand flexing, handling, and impact at temperatures between 54°C (130°F) and minus 29°C (minus 20°F). The average insulation thickness shall be no less than 0.060 inch for a No. 8 - 2 AWG wire and no less than 0.080 inch for a No. 1 - 4/0 AWG wire.