ISO 14990-1:2016-11 (E)

Earth-moving machinery - Electrical safety of machines utilizing electric drives and related components and systems - Part 1: General requirements

Contents

Page

Foreword vii

Introduction viii

1 Scope 1

2 Normative references 2

3 Terms,definitionsandabbreviatedterms 3
3.1 Electric shock protection-related terms and definitions 3
3.2 Control-related terms and definitions 5
3.3 Electrical infrastructure-related terms and definitions 6
3.4 Risk-related terms and definitions 7
3.5 Miscellaneous terms and definitions 8
3.6 Abbreviated terms 9

4 General requirements 9
4.1 General 9
4.2 Provisions for handling 9
4.3 Provisions for transportation and storage 10
4.4 Components and devices 10
4.5 Intended operating environment 10
4.5.1 General 10
4.5.2 Exposure 10
4.5.3 Altitude 11
4.5.4 Ingress protection 11
4.6 Electrical source 11

5 Protection against electric shock hazards 11
5.1 General 11
5.2 Protection by enclosures 11
5.3 Protection by insulation 12
5.4 Protection against residual voltages 13
5.5 Protection by barriers 13
5.6 Protection by inaccessibility 13
5.7 Special considerations for low voltage energy storage devices and related buses 13
5.8 Prevention of touch voltage 14
5.8.1 General 14
5.8.2 Protection by class II construction or equivalent 14
5.8.3 Protection by electrical separation 14
5.9 Protection by automatic disconnection of source 15
5.10 Protection by equipotential bonding 15
5.10.1 General 15
5.10.2 Protective equipotential bonding circuit 16
5.10.3 Functional equipotential bonding 18
5.10.4 Devices for earthing and short-circuiting live parts 19
5.11 Protection by use of PELV 19
5.11.1 General 19
5.11.2 Sources for PELV 19

6 Protectionagainstelectricalfirehazards 20

6.1 General 20
6.2 Fire hazard assessment 20
6.3 Prevention of ignition 20
6.4 Minimizing the spread of fire 20

7 Protection against thermal hazards 20

8 Protection against mechanical hazards 20

9 Protectionagainstabnormaloperationhazards 20
9.1 General 20
9.2 Overcurrent protection (OCP) 21
9.2.1 General 21
9.2.2 Transformers 21
9.2.3 Overcurrent protection (OCP) implementation 21
9.2.4 Rating and setting of overcurrent protective systems 21
9.2.5 Placement of overcurrent protective devices 21
9.3 Abnormal temperature protection 22
9.4 Earth (or chassis in the case of self-powered machines) fault/residual current protection 22
9.5 Protection against overvoltages due to lightning and to switching surges 22
9.6 Protection against other abnormal operation hazards 22

10 Electric power source 22
10.1 Disconnection of source 22
10.1.1 General 22
10.1.2 Source disconnecting devices 23
10.1.3 Equipment disconnecting devices 24
10.2 Prevention of unintended start-up 24
10.3 External electrical charging 24

11 Wiring 24
11.1 General 24
11.2 Conductors 25
11.3 Insulation 25
11.4 Conductor and cable ampacity 25
11.5 Flexible cables 26
11.5.1 General 26
11.5.2 Mechanical rating 26
11.5.3 Ampacity of cables wound on reels 26
11.6 Assemblies having sliding contacts 26
11.6.1 Accessibility of live parts 26
11.6.2 Protective conductor circuit 27
11.6.3 Protective conductor current collectors 27
11.6.4 Removable current collectors used for disconnection 27
11.6.5 Clearances 27
11.6.6 Creepage distances 27
11.6.7 Conductor system sectioning 28
11.6.8 Construction and installation 28
11.7 Connections and routing 28
11.7.1 General 28
11.7.2 Conductor and cable runs 28
11.7.3 Conductors of different circuits 29
11.8 Identification of conductors 29
11.8.1 General 29
11.8.2 Protective conductor identification 29
11.8.3 Neutral conductor identification 29
11.8.4 Identification by colour 30
11.9 Wiring inside enclosures 31
11.10 Wiring outside enclosures 31
11.10.1 General 31
11.10.2 External ducts 31

11.10.3 Connection to moving elements of the EMM 31
11.10.4 Interconnection of devices on the EMM 32
11.10.5 Plug/socket combinations 33
11.10.6 Dismantling for shipment 34
11.10.7 Spare conductors 34
11.11 Ducts and boxes 34
11.11.1 General 34
11.11.2 Rigid metal conduit and fittings 35
11.11.3 Flexible metal conduit and fittings 35
11.11.4 Flexible nonmetallic conduit and fittings 35
11.11.5 Cable trunking systems 35
11.11.6 EMM compartments and cable trunking systems 35
11.11.7 Boxes 35
11.11.8 Motor wiring boxes 35

12 Electric motors and generators 36
12.1 General 36
12.2 Enclosures 36
12.3 Dimensions 36
12.4 Mounting and compartments 36
12.5 Criteria for motor selection or design 36
12.6 Overheating protection 37
12.7 Overspeed protection 37

13 Non-motor loads 37
13.1 Accessories 37
13.2 Local lighting 38
13.2.1 General 38
13.2.2 Source 38
13.2.3 Protection 38
13.2.4 Fittings 38

14 Controls 39
14.1 Control circuits 39
14.1.1 Control circuit voltages 39
14.1.2 Protection 39
14.2 Control functions 39
14.3 Protective interlocks 39
14.3.1 Reclosing or resetting of an interlocking safeguard 39
14.3.2 Operating limits, auxiliary functions, interlocks, and reverse current braking 39
14.4 Control functions in the event of failure 39
14.4.1 General 40
14.4.2 Measures to minimize risk in the event of failure 40
14.4.3 Protection against malfunction due to earth (or chassis in the case of self- powered machines) faults, voltage interruptions and loss of continuity 41
14.5 Operator interface and machine-mounted control devices 42
14.5.1 General 42
14.5.2 Push-buttons 42
14.5.3 Indicator lights and displays 43
14.5.4 Illuminated push-buttons 43
14.5.5 Rotary control devices 43
14.5.6 Start devices 43
14.5.7 Emergency stop devices 43
14.5.8 Emergency switching off devices 43
14.5.9 Enabling control devices 43
14.6 Controlgear: location, mounting, and enclosures 43
14.6.1 General 43
14.6.2 Location and mounting 43
14.6.3 Degrees of protection 44
14.6.4 Enclosures, doors, and openings 45
14.6.5 Access to controlgear 46
14.7 Access to low and high-voltage equipment 46

15 Manuals and technical documentation 46
15.1 General 46
15.2 Information to be provided 46
15.3 Documentation 46
15.4 Overview diagrams and function diagrams 47
15.5 Circuit diagrams 47
15.6 Operator's manual 47
15.7 Maintenance manual and service literature 47
15.7.1 General 47
15.7.2 Reduction of electrical hazards while servicing 48
15.8 Parts list 48

16 Marking 49
16.1 General 49
16.2 Warning signs 49
16.2.1 Electric shock hazard 49
16.2.2 Hot surfaces hazard 49
16.2.3 Magnetic field hazard 49
16.2.4 Arc flash hazard 49
16.2.5 Residual voltage hazard 50
16.3 Functional identification 50
16.4 Marking of equipment 50
16.4.1 General 50
16.4.2 Indication of hazardous voltages (all machines) 50
16.5 Reference designations 50
16.6 Protective equipotential bonding terminals 50

17 Tests 50
17.1 General 50
17.2 Protective equipotential bonding circuit continuity 51
17.3 Conditions for protection by automatic disconnection of source 51
17.3.1 General 51
17.3.2 Fault loop impedance verification and suitability of the associated overcurrent protective device in TN systems 52
17.4 Insulation resistance tests 52
17.4.1 Low-voltage insulation resistance test 52
17.4.2 High-voltage insulation resistance test 52
17.5 Voltage withstand tests 52
17.6 Protection against residual voltages 53
17.7 Functional tests 53
17.8 Retesting 53
17.9 IP test for high-voltage equipment 53

Annex A (informative)Listofsignificanthazards 54

Annex B (normative) TN systems -- Protection against indirect contact 56

Annex C (informative) Explanation of emergency operation functions 59

Bibliography 65