INTERNATIONAL STANDARD

ISO 12374

First edition
1995-07-15

Agricultural irrigation — Wiring and equipment for electrically driven or controlled irrigation machines

Irrigation agricole — Câblage et matériel pour les machines d'irrigation entraînées ou commandées électriquement

Reference number
ISO 12374:1995(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12374 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Agricultural irrigation — Wiring and equipment for electrically driven or controlled irrigation machines

1 Scope

This International Standard provides detailed information for the application of electrical apparatus to electrically driven or controlled agricultural irrigation machines, covering all electrical equipment, apparatus, components and wiring necessary from the point of connection of electric power to the machine. It applies to electrical equipment for use on circuits operating at voltages from 30 V to 600 V.

The purpose of this International Standard is to improve the degree of personal safety in operation and application of products and materials under a reasonable range of conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11684:1995, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Safety signs and hazard pictorials — General principles.*

IEC 173:1964, *Colours of the cores of flexible cables and cords.*

IEC 228:1978, *Conductors of insulated cables.*

IEC 529:1989, *Degrees of protection provided by enclosures (IP Code).*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 ampacity: Allowable current-carrying capacity of a conductor determined by the conductor diameter and the insulation on the conductor.

NOTE 1 The conductors can carry more than the allowable current; however, the allowable current is set to prevent overheating and damage to insulation or equipment.

3.2 auxiliary conductor: Conductor that carries current to a device which is not necessary for movement of the machine.

3.3 auxiliary panel: Enclosure containing auxiliary control devices for the machine such as motor controllers, relays, switches and transformers, but not including the main controller and other main control devices that supply power to the entire machine.

NOTE 2 A junction box is not an auxiliary panel.

3.4 bonded connection: Reliable connection to ensure the necessary electrical conductivity between metal parts required to be electrically connected.

3.5 collector ring: Assembly of slip rings for transferring electrical energy from a stationary conductor to a rotating conductor.

3.6 control conductor: Conductor that carries current to a control device that is necessary for movement of the machine.

3.7 front-mounted device: Replaceable device mounted so that it may be individually replaced from the front of an enclosure without removing subpanels,

other devices or rear enclosure covers to gain access to hidden fasteners.

3.8 front-wired device: Replaceable device mounted so that it may be individually wired from the front of an enclosure without removing the device, subpanels or rear enclosure covers to gain access to electrical connections.

3.9 grounded: Connected to earth or to some conducting body which serves in place of earth.

3.10 grounded conductor: Conductor in a circuit which is intentionally grounded.

3.11 grounding conductor: Conductor used to connect non-current-carrying metal parts of a machine to a service-grounded conductor and/or a grounding-electrode conductor.

3.12 (irrigation) machine: Electrically driven or controlled machine, not portable by hand, used primarily to transport and distribute water for agricultural purposes.

3.13 machine isolator: Disconnecting means at the point of connection of electrical power to the machine.

3.14 main control panel: Enclosure containing the main controller and other control devices necessary for starting and stopping the machine.

3.15 metal-to-metal connection: Attachment of metal parts to the machine with bolts and screws to provide an adequate contact for bonding purposes where all paint and dirt have been removed from under the bearing surface area of bolt or screw heads.

3.16 nonwicking filler: Filler material within an electrical cable which has high resistance to moisture migration from one location to another within the cable.

3.17 power conductor: Conductor that carries current to provide electrical power from the machine isolator to a drive motor.

3.18 raceway: Enclosed channel designed expressly for holding electrical wires, cables or busbars.

3.19 readily accessible: Capable of being opened quickly for maintenance, repair or inspection.

NOTE 3 The object may be fastened by latches or held by mechanical interlocks or similar apparatus. A cover firmly attached by two or more screws is not considered readily accessible.

3.20 weatherproof: Constructed or protected so that exposure to the environment does not interfere with successful operation.

4 General requirements

4.1 Means of isolation

A mechanism to provide overcurrent protection to a machine with the capacity to lock the machine in the OFF position shall be provided at the point of connection of electrical power to the machine.

4.2 Enclosures

4.2.1 All enclosures shall have a degree of protection of IP 33 as specified in IEC 529.

4.2.2 Entrances into, exits from, and penetrations of the enclosure shall be made such as to reduce the possibility of the collection of water or contaminants at the point of connection and to preserve the rating of the enclosure specified in 4.2.1.

4.2.3 Dimensions of enclosures shall not be less than the maximum dimensions of the enclosed equipment plus the required electrical clearances which conform to the requirements in IEC 529.

4.2.4 Where used, gaskets shall be securely attached to one of the mating parts.

4.2.5 Enclosures should be mounted such as to minimize the possibility of subsequent physical damage to the enclosure.

4.3 Interlocking

Where personal hazard or property damage may be caused by the failure of any device to function properly, protective interlocks shall be provided. Where practicable, these interlocks shall interrupt all operations, providing such interruption does not create a hazardous condition.

4.4 Automatic or remote starting

4.4.1 Automatic restarting shall be connected so that restarting occurs only on resumption of full single-phase or three-phase power, as needed, following a power cut or upon resumption of fluid pressure.

Automatic restarting shall not be construed as encompassing the functions of a device or circuit de-

signed for reversing the direction of travel of the machine at a preset point or points.

4.4.2 Machines equipped with automatic restarting or remote starting shall have affixed to the machine a safety sign indicating that the machine can start automatically.

4.4.2.1 This safety sign shall be affixed to the machine isolator. It shall also be affixed to the main control panel if the machine isolator is not part of or adjacent to the main control panel.

4.4.2.2 The wording and size of this sign shall be as specified in clause 11.

4.5 Identification

All conductors within an enclosure shall be clearly marked or colour-coded for identification as specified in 9.6.

4.6 Transformer type

Transformers shall be of the isolated type with proper overcurrent protection for the transformer and conductors or control devices it serves.

4.7 Conductor rating

Terminal blocks or strips shall be sized to accommodate the number and size of the conductors terminated or connected to them, and shall be rated for the voltage and current transmitted on the connected or terminated conductors.

4.8 Control device rating

Control devices such as relays, limit switches and similar equipment shall be suitable for the application and shall be capable of handling the voltage and current imposed on or through the devices.

4.9 Panel mounting

Panel-mounted devices shall be front-mounted and front-wired for convenient servicing.

4.10 Current ratings

4.10.1 All machines except centre-pivot machines

Where a machine is multimotored and individual motors are controlled by alignment switches or similar devices, where the machine does not operate in a circle and where intermittent duty is inherent, the continuous-current rating and peak-current rating shall be determined as follows.

4.10.1.1 The equivalent continuous-current rating shall be calculated as 125 % of the full-load current rating of the largest motor plus a quantity equal to the sum of the full-load current ratings of all remaining motors multiplied by the maximum percent duty cycle factor at which the remaining motors can continuously operate.

4.10.1.2 The peak-current rating shall be calculated as the sum of the locked-rotor current of the two largest motors plus 100 % of the full-load current ratings of all other motors in the circuit.

4.10.2 Centre-pivot machines

Where a machine is multimotored and individual motors are controlled by alignment switches or similar devices, where the machine operates in a circle and where intermittent duty is inherent, the continuous-current rating and the peak-current rating shall be determined as follows.

4.10.2.1 The equivalent continuous-current rating shall be calculated as 125 % of the full-load current rating of the largest motor plus 60 % of the sum of the full-load current ratings of the remaining motors.

4.10.2.2 The peak-current rating shall be calculated as twice the locked-rotor current of the largest motor plus 80 % of the sum of the full-load current ratings of the remaining motors.

5 Grounding

5.1 A grounding conductor used for no other purposes than machine grounding shall be provided.

5.1.1 The grounding conductor shall be bonded to the machine within the main control panel enclosure and each auxiliary panel enclosure.

5.1.2 The grounding conductor shall be within the same sheath, jacket or conduit as the power, control or auxiliary conductors.

5.1.3 The grounding conductor may be bare or insulated as specified in 9.6.2.1.

5.1.4 The metallic sheath of any cable or metallic conduit shall not be used as the primary grounding conductor.

5.2 Metal-to-metal connection to a part which is bonded to the grounding conductor and the non-current-carrying parts of the machine shall be considered as an adequate grounding path.

5.3 The metallic sheath of cable or metallic conduit, where used, shall be grounded.

5.4 External metal parts which could become inadvertently energized shall be grounded.

5.5 Motor frames shall be bonded to the grounding conductor.

5.6 Metal frames of devices such as switches, solenoids and junction boxes shall be bonded to the grounding conductor or to the non-current-carrying metal parts of the machine.

5.7 The grounding conductor shall not have less ampacity than its associated power conductors. Where there is a reduction of conductor size because of the use of an interposing relay, controller or similar device, the grounding conductor may also be reduced to the same size as the power, control or auxiliary conductors originating at the interposing device.

5.8 Where a machine has a stationary point, such machine shall include provision for the connection of the machine-grounding conductor to the grounding-electrode conductor. Proper installation of the grounding-electrode conductor shall complete an electrical path from the machine-grounding conductor to the grounding electrode.

5.8.1 A prominently displayed durable sign shall be permanently affixed to the main control panel which indicates the need for proper grounding.

5.8.2 The installation and operating instructions for the machine shall include specific recommendations for connecting or installing the grounding electrode.

5.9 A common connection device for all grounding conductors shall be provided.

6 Main control panel

6.1 Enclosure

The enclosure for the main panel shall conform to 4.2.

6.2 Means of isolation

6.2.1 If the means to isolate a machine is not in or adjacent to the main control panel, an isolating mechanism which makes it possible to lock the machine in the OFF position shall also be provided in or adjacent to the main control panel.

6.2.2 If the main control panel is remote from the machine, a disconnecting mechanism which makes it possible to lock the machine in the OFF position shall be provided at the machine for removing power from all circuits of 30 V or more.

6.2.3 If the main control panel contains a means of isolation, the panel shall be interlocked with the enclosure opening.

Means may be provided for qualified persons to gain access to enclosures without removing power if the interlocking is reactivated automatically when the enclosure is closed.

6.2.4 If a means of isolation is adjacent to the main control panel and live parts of components are not readily accessible, the interlock in the enclosure opening is not required. It is recommended, however, that interlocking be provided.

6.2.5 Equipment within an enclosure receiving electrical energy from more than one source shall not be required to have a means of isolation for the additional source provided its voltage is 30 V or less and its power level not more than 1 000 V·A.

6.3 Doors

Hinged doors for enclosure openings shall have a mechanical stop to prevent strain on conductors and terminals contained in or on the door. Conductors to components or terminals contained in or on the hinged door shall be fastened so that any conductor flexing occurs at the fastener and not at conductor terminals.

6.4 Limitation

The main control panel shall not be used as a raceway.

6.5 Locking attachment

6.5.1 Attachment plugs and receptacles shall be of a standardized locking type to prevent accidental isolation and shall be of proper design for the voltage, current and environment for which they are used.

6.5.2 Where two or more mating receptacles are installed on a machine, they shall not be interchangeable unless both receptacles serve the same purpose, have the same voltage and current rating, and interchangeability would not affect the operation or safety of the machine. Mating receptacles shall be wired so that no energized terminals are exposed when the receptacles are disconnected.

6.6 Operator control devices

6.6.1 All operator control devices such as selector switches and start and stop controls shall be clearly marked as to their function.

6.6.2 All push-buttons and selector switches, and indicating lights which are exterior-mounted shall be of a weatherproof type and shall be installed to conform to 4.2.2.

6.6.3 "STOP" push-buttons shall be red in colour. Red-coloured buttons shall not be used for push-buttons having functions other than stopping.

6.6.4 All controls shall be protected from the possibility of accidental operation by normal servicing or by normal movement of the machine.

6.7 Overcurrent devices

Overcurrent protective devices shall be provided and sized in accordance with the requirements of the device or devices served.

The preferred main or master overcurrent device should consist of properly sized fuses (single or dual element) complete with the required holders or fuse blocks.

6.8 Intermittent running requirement

If the machine operates where intermittent duty is inherent, a controller in the main control panel, which is used manually or automatically to start and stop the complete machine, shall have an interrupting capability not less than the peak-current rating as determined in 4.10.1.2 or 4.10.2.2 and a continuous-current rating not less than as determined in 4.10.1.1 or 4.10.2.1.

6.9 Wiring diagram

A basic wiring diagram of the machine shall be affixed inside the main control panel with components properly identified.

6.10 Information nameplate

The main control panel shall contain a nameplate stating the manufacturer's name, the design voltage, phase and frequency of the incoming power supply and the current rating of the recommended overcurrent protection for the main power circuit.

7 Auxiliary panels

7.1 Enclosures for auxiliary panels shall conform to 4.2.

7.2 A means of isolation (one or more) shall be provided where an enclosure contains relays, controllers, switches or other similar devices that may need maintenance or repair and where such enclosures are further than 9 m from the machine isolator.

7.3 Enclosures covers shall be secured so as to prevent accidental opening or removal during or resulting from normal operation of the machine.

7.4 Each auxiliary panel shall have affixed to it a safety sign indicating the possible presence of a hazardous voltage. Wording and size of this safety sign shall be as specified in clause 11.

This safety sign is specified to dissuade casual opening of the panel and to indicate possible danger should the panel be opened for servicing, even though 7.2 provides for isolation of power in an auxiliary panel.

8 Motors and motor controllers

8.1 Motors

8.1.1 Motors shall be so constructed or protected so that exposure to the operating environment does not interfere with successful operation.

In addition to the other nameplate marking, the motors should be labelled by the motor manufacturer to indicate that they are specifically designed for use on an irrigation machine.

8.1.2 Motors shall be rodentproof.

8.1.3 If a junction box is supplied, the usable volume of the housing should be a minimum of 200 cm^3 with 50 mm minimum dimension of the opening.

The junction box shall be equipped with an easily accessible internal frame-grounding terminal.

8.2 Motor controllers

8.2.1 Marking

Controllers shall be marked with the manufacturer's name or identification, voltage, power rating and such other data as may be needed to indicate the motors for which they are suitable.

8.2.2 Motor-running overcurrent protection

8.2.2.1 Motor-running overcurrent protection shall be provided to protect each motor, motor controller and motor feeder conductor against excessive heating due to motor overload or failure to start.

8.2.2.2 To provide the maximum possible protection, motor-running overcurrent devices should be sized smaller than the maximum allowable whenever possible.

8.2.2.3 The minimum number and location of motor-running overcurrent protection devices shall be as specified in table 1.

8.2.2.4 Thermal devices or systems mounted in the motor and sensitive to the temperature of the motor, or to both motor temperature and current, may be used in lieu of externally mounted overload units. The thermal devices or systems shall be capable of protecting the motor against stalled conditions and repeated starting under locked-rotor conditions.

8.2.2.5 Automatic resetting of an overload protective device shall not restart the motor where restarting could damage the machine or result in unsafe operation.

9 Conductors

9.1 General

9.1.1 All conductors shall be within an enclosure, a raceway or a jacketed cable. See IEC 228 for insulated cables.

9.1.2 Conductors within 2,6 m of the ground shall be protected from physical damage by enclosure in a rigid metallic conduit, liquidtight flexible metallic conduit, jacketed metallic-sheathed cable or other suitable means.

9.1.3 Mechanical protection for conductors may be provided by the machine structure.

NOTE 4 Subclauses 9.1.2 and 9.1.3 are intended to protect conductors from physical damage by livestock or hazards encountered in normal usage of the machine.

9.2 Size

9.2.1 The size of power conductors shall be based on the assumption that the maximum voltage at any motor is the design motor voltage plus 5 % with allowance for a 10 % voltage drop using this assumed maximum and the average continuous current calculated from 4.10.1.1 or 4.10.2.1. In addition to voltage drop considerations, the ampacity of power conductors shall be adequate for the calculated load.

9.2.2 The size of control and auxiliary conductors shall provide sufficient ampacity to carry the total current drawn by the devices served and shall not be smaller than shown in table 2. IEC 228 contains further cable conductor specifications.

9.2.3 Conductors supplying a motor shall have an ampacity not less than 125 % of the full-load current of the motor.

9.3 Stranding

9.3.1 Conductors used to connect or interconnect control devices that are physically displaced in normal operation of the machine shall be of stranded construction.

9.3.2 All power, control and auxiliary conductors should be annealed stranded copper with minimum stranding as shown in table 2.

9.3.3 Crimp-type connectors shall not be used with solid conductor wires.

9.4 Insulation

9.4.1 Conductor insulation should be flame-resistant, moisture-resistant and corrosion-resistant and should be suitable for operation within temperatures from – 10 °C to 60 °C.

Conductor insulation shall be rated at not less than 75 °C wet location.

9.4.2 Conductors used to connect or interconnect components within an enclosure shall be rated at not less than 600 V within circuits of voltages between 300 V a.c. and 600 V a.c.

Table 1 — Motor-running overcurrent devices

Type of motor	Supply system	Minimum number and location of overcurrent units (such as trip coils and relays)
Single-phase a.c. or d.c.	Two-wire, single-phase a.c. or d.c., one conductor grounded	One in ungrounded conductor
	Three-wire, single-phase a.c. or d.c., grounded neutral	One in either ungrounded conductor
Three-phase a.c.	Any three-phase	Three, one in each phase

Table 2 — Copper conductor ampacity for single-conductor construction (control or auxiliary circuits)

Nominal cross-sectional area	Maximum resistance per unit length at 20 °C	Ampacity in		Recommended minimum stranding
		cable or raceway	control enclosure	
mm^2	Ω/km	A	A	
0,2	109	2	2	7
0,3	54	3	3	7
0,5	36	5	5	7
0,75	24,5	7	7	7
1	18,1	10	10	7
1,5	12,1	15	20	7
2,5	7,41	20	25	7
4	4,61	30	40	7
6	3,08	40	55	7

NOTE — Conductors smaller than 0,75 mm^2 are included to anticipate use of solid-state control devices which may operate at currents of 1 mA or less. Conductors smaller than 0,75 mm^2 shall not be used for circuits other than servicing solid-state control devices.

9.4.3 All conductors within an enclosure shall be insulated with the exception of the grounding conductor which may be bare.

9.4.4 Conductor insulation in a cable, conduit or tubing, where different voltages are present, shall be rated at or above the highest voltage carried in the cable, conduit or tubing.

However, control or auxiliary conductors may have lesser voltage insulation providing that the control or auxiliary conductors are within an inner cable with an outer protective covering rated at or above the highest voltage of the power conductors in the cable, conduit or tubing, and also providing that the conductor insulation within this protective covering is rated at or above the highest voltage used within the inner multiconductor cable.

9.5 Jacketing

Cable jacketing where the cable is attached to a metal frame and operated under a sprinkler system need not be flame-resistant. However, it should be resistant to sunlight, moisture and corrosion. The jacketing should also provide some mechanical protection and flexibility, and should be suitable for operation within temperatures from – 10 °C to 60 °C. Nonwicking filler material should be used. The jacketing construction should allow proper termination to provide a mechanically strong weatherproof connection that can be field-installed with standard electrical tools.