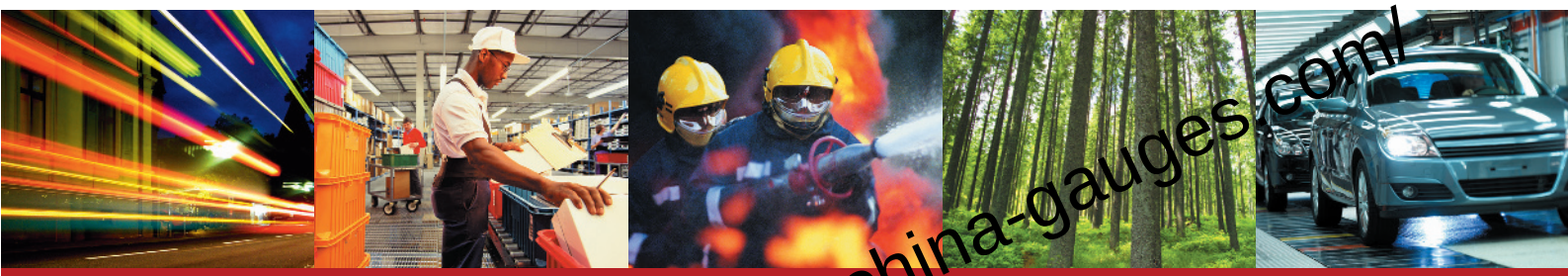
BS EN 60974-2:2013



BSI Standards Publication

Arc welding equipment

Part 2: Liquid cooling systems

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National foreword

This British Standard is the UK implementation of EN 60974-2:2013. It is identical to IEC 60974-2:2013. It supersedes BS EN 60974-2:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/6, Electric arc welding equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English version

Arc welding equipment - Part 2: Liquid cooling systems

(IEC 60974-2:2013)

Matériel de soudage à l'arc
Partie 2: Systèmes de refroidissement par liquide
(CEI 60974-2:2013)

Lichtbogenschweißeinrichtungen - Teil 2: Flüssigkeitskühlsysteme
(IEC 60974-2:2013)

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Ref. No. EN 60974-2:2013 E

Foreword

The text of document 26/494/FDIS, future edition 3 of IEC 60974-2, prepared by IEC/TC 26 "Electric welding" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60974-2:2013.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2013-11-30
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-02-28

This document supersedes EN 60974-2:2008.

EN 60974-2:2013 includes the following significant technical changes with respect to EN 60974-2:2008:

- changes induced by the publication of EN 60974-1:2012;
- addition of a liquid temperature fixed to 65 °C during the heating test in order to allow testing at different ambient air temperature (see 10 d));
- correction factor of cooling power at 40 °C required in instruction manual (see 12.1 o)).

This standard shall be used in conjunction with EN 60974-1:2012.

In this standard, the following print types are used:

- *conformity statements: in italic type.*

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60974-2:2013 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60974-1	2012	Arc welding equipment - Part 1: Welding power sources	EN 60974-1	2012
IEC 60974-7	-	Arc welding equipment - Part 7:Torches	EN 60974-7	-
IEC 60974-10	-	Arc welding equipment - Part 10: Electromagnetic compatibility (EMC) requirements	EN 60974-10	-

CONTENTS

ARC WELDING EQUIPMENT –

Part 2: Liquid cooling systems

1 Scope

This part of IEC 60974 specifies safety and construction requirements for industrial and professional liquid cooling systems used in arc welding and allied processes to cool torches.

This part of IEC 60974 is applicable to stand-alone liquid cooling systems that are either connected to a separate welding power source or built into the welding power source enclosure.

This part of IEC 60974 is not applicable to refrigerated cooling systems.

NOTE 1 Typical allied processes are electric arc cutting and arc spraying.

NOTE 2 This part of IEC 60974 does not include electromagnetic compatibility (EMC) requirements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60974-1:2012, *Arc welding equipment – Part 1: Welding power sources*

IEC 60974-7, *Arc welding equipment – Part 7: Torches*

IEC 60974-10, *Arc welding equipment – Part 10: Electromagnetic compatibility (EMC) requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60974-1 and IEC 60974-7, as well as the following apply.

3.1
cooling power
P
cooling energy related to the flow rate

3.2
liquid cooling system
system that circulates and cools liquid used for decreasing the temperature of torches

3.3
cooling power at 1 l/min
$P_{1\ l/min}$
cooling power at 1 l/min flow rate defined for comparison

4 Environmental conditions

As specified in Clause 4 of IEC 60974-1:2012.

5 Tests

5.1 Test conditions

As specified in 5.1 of IEC 60974-1:2012.

Stand-alone cooling systems may be tested without a welding power source.

Built-in cooling systems shall be tested with the welding power source.

5.2 Measuring instruments

The accuracy of measuring instruments shall be:

a) electrical measuring instruments: class 1 (± 1 % of full-scale reading), except for the measurement of insulation resistance and dielectric strength where the accuracy of the instruments is not specified, but shall be taken into account for the measurement;
b) thermometer: ± 2 K;
c) pressure measuring instruments: class 2,5 (± 2,5 % of full-scale reading);
d) flow-rate measuring instruments: class 2,5 (± 2,5 % of full-scale reading).

5.3 Conformity of components

As specified in 5.3 of IEC 60974-1:2012.

5.4 Type tests

All type tests shall be carried out on the same cooling system unless specified otherwise.

As a condition of conformity the type tests given below shall be carried out in the following sequence:

a) general visual inspection (as defined in 3.7 of IEC 60974-1:2012);
b) protection provided by the enclosure (as specified in 6.2.1 of IEC 60974-1:2012);
c) mechanical provisions (as specified in Clause 7);
d) insulation resistance (as specified in 6.1.4);
e) dielectric strength (as specified in 6.1.5).

The other tests included in this standard and not listed here may be carried out in any convenient sequence.

5.5 Routine tests

All routine tests given below shall be carried out on each cooling system in the following sequence:

a) visual inspection in accordance with manufacturer’s specification;
b) continuity of the protective circuit (as specified in 10.4.2 of IEC 60974-1:2012);
c) dielectric strength (as specified in 6.1.5).

6 Protection against electric shock

6.1 Insulation

6.1.1 General

As specified in 6.1.1 of IEC 60974-1:2012.

6.1.2 Clearances

As specified in 6.1.2 of IEC 60974-1:2012.

6.1.3 Creepage distances

As specified in 6.1.3 of IEC 60974-1:2012.

6.1.4 Insulation resistance

As specified in 6.1.4 of IEC 60974-1:2012.

The test may be carried out without cooling liquid.

6.1.5 Dielectric strength

As specified in 6.1.5 of IEC 60974-1:2012.

The test may be carried out without cooling liquid.

6.2 Protection against electric shock in normal service (direct contact)

As specified in 6.2 of IEC 60974-1:2012.

6.3 Protection against electric shock in case of a fault condition (indirect contact)

6.3.1 Protective provisions

As specified in 6.3.1 of IEC 60974-1:2012.

6.3.2 Isolation between windings of the supply circuit and the welding circuit

As specified in 6.3.2 of IEC 60974-1:2012.

6.3.3 Internal conductors and connections

As specified in 6.3.3 of IEC 60974-1:2012.

6.3.4 Touch current in fault condition

As specified in 6.3.6 of IEC 60974-1:2012.

6.4 Connection to the supply network

6.4.1 Supply voltage

As specified in 10.1 of IEC 60974-1:2012.

6.4.2 Multi-supply voltage

As specified in 10.2 of IEC 60974-1:2012.

6.4.3 Means of connection to the supply circuit

As specified in 10.3 of IEC 60974-1:2012.

6.4.4 Marking of terminals

As specified in 10.4 of IEC 60974-1:2012.

6.4.5 Protective circuit

As specified in 10.5 of IEC 60974-1:2012.

6.4.6 Cable anchorage

As specified in 10.6 of IEC 60974-1:2012.

6.4.7 Inlet openings

As specified in 10.7 of IEC 60974-1:2012.

6.4.8 Supply circuit on/off switching device

As specified in 10.8 of IEC 60974-1:2012.

6.4.9 Supply cables

As specified in 10.9 of IEC 60974-1:2012.

6.4.10 Supply coupling device (attachment plug)

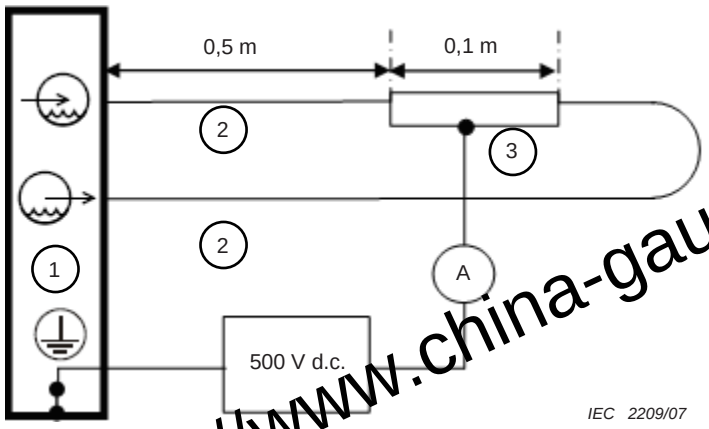
For supply networks up to 125 V, the rated current of the supply coupling device (attachment plug) shall be not less than 70 % of the supply current, as measured with the fan motor or pump stalled, whichever is greater.

6.5 Leakage current between welding circuit and protective earth

With the cooling system filled with the cooling liquid specified by the manufacturer (see 12.1 e)), the leakage current from the torch to the protective earth connection of the cooling system shall not exceed 10 mA d.c.

Conformity shall be checked by applying a d.c. voltage of 500 V at room temperature between the protective earth connection and a copper pipe to simulate the torch connected to the output of the cooling system by a hose with a maximum length of 0,5 m as shown in Figure 1. The minimum inner diameter of the hose shall be 5 mm. The minimum length of the copper pipe shall be 10 cm with a minimum internal diameter of 5 mm. The cooling system and the simulated torch are filled with liquid for the test. The pump is operating.

NOTE The design of the torch can influence the leakage current value; therefore, a conventional copper pipe is used to simulate the torch during the conformity test.



Key

1 Liquid cooling system
2 Hose
3 Copper pipe

Figure 1 – Leakage current measurement configuration

7 Mechanical provisions

7.1 General

As specified in Clause 14 of IEC 60974-1:2012.

The test shall be carried out with cooling liquid.

7.2 Cooling liquid overflow

When filling the cooling system in accordance with the manufacturer's instructions, overflow or spillage shall not result in electric shock.

Conformity shall be checked by the following treatment and test. The liquid container is completely filled. A further quantity of liquid equal to 15 % of the capacity of the container or 0,25 l, whichever is the greater, is then poured in steadily over a period not to exceed 60 s. Immediately after this treatment, the equipment shall pass the dielectric strength test of 6.1.5 between input circuits and exposed conductive parts.

7.3 Hose coupling devices and hose connections

If hose coupling devices or hose connections, which often have to be undone, are placed above or near to live parts, these live parts shall be protected from cooling liquid by splash proof enclosures, with drains or other appropriate measures. An exception is made for live parts of the welding circuit.

8 Cooling system

8.1 Rated maximum pressure

The manufacturer shall determine the rated maximum pressure attainable by the cooling system (see 11.3 c), box 12).

Conformity shall be checked by measuring the pressure when the outlet is blocked.

8.2 Thermal requirements

8.2.1 Heating test

Liquid cooling systems shall be capable of operating at rated cooling power without causing any component to exceed its rated temperature.

Conformity shall be checked in accordance with Clause 10.

8.2.2 Tolerances of test parameters

a) p pressure: $p^{+10\,\%}_{-2\,\%}$

b) q_v volume flow: $q_{v\,-2\,\%}^{+10\,\%}$

c) T temperature: $T \pm 2$ K

8.2.3 Duration of test

As specified in 7.1.3 of IEC 60974-1:2012.

8.3 Pressure and temperature

Liquid cooling systems shall be capable of operating without leakage at the maximum pressure with a cooling liquid temperature of 70 °C.

Conformity shall be checked by visual inspection during 120 s of operation or until shutdown by a protection system, immediately following the heating test while the outlet of the cooling system is blocked.

9 Abnormal operation

9.1 General requirements

A cooling system shall not break down and increase the risk of electric shock or fire, under the conditions of operation of 9.2. These tests are conducted without regard to temperature attained on any part, or the continued proper functioning of the cooling system. The only criterion is that the cooling system does not become unsafe. These tests may be conducted on any cooling systems that function correctly.

The cooling system, protected internally by, for example, a circuit-breaker or thermal protection, meets this requirement if the protection device operates before an unsafe condition occurs.

Conformity shall be checked by the following tests.

a) A layer of dry absorbent surgical type cotton is placed under the cooling system, extending beyond each side for a distance of 150 mm.

b) Starting from the cold state, the cooling system is operated in accordance with 9.2.

c) During the test, the cooling system shall not emit flames, molten metal or other materials that ignite the cotton indicator.

d) Following the test and within 5 min, the cooling system shall be capable of withstanding a dielectric test in accordance with 6.1.5 b) of IEC 60974-1:2012.

9.2 Stalled test

A cooling system, which relies on motor-driven fan(s) and pump(s) for conformity with the tests of 8.2, is operated at rated supply voltage or rated load speed for a period of 4 h while

the fan motor(s) and pump(s) is(are) stalled or disabled at the output condition of 8.2.1, which produces the maximum heating.

The test may be carried out without cooling liquid.

NOTE The intention of this test is to run the cooling system with the fan stationary. The fan can be blocked mechanically or disconnected.

10 Cooling power

Cooling power data shall be given in kW for 100 % duty cycle, with the cooling liquid as recommended by the manufacturer and at an ambient air temperature at 25 °C (see tolerances of test parameters in 8.2.2). For these values the volume flow shall be 1 l/min.

This test may be carried out on a separate cooling system.

A built-in cooling system may additionally be heated by the welding power source. Therefore, the test shall be performed together with the welding power source, set for maximum heating.

This test is not required for liquid cooling systems specified by the manufacturer to be used only with dedicated torches.

Conformity shall be checked by the following test and calculation:

a) the liquid cooling system is filled with the amount and type of cooling liquid recommended in the manufacturer's instructions (see 12.1 e));

b) the liquid cooling system is connected to a measuring circuit according to Figure 2;

c) the valve is adjusted to obtain a flow of 1 l/min ± 0,1 l/min;

d) the electric heater is adjusted to give a stable condition at a temperature of 65 °C ± 2 K at the inlet of the liquid cooling system;

e) the inlet and outlet temperature is measured directly at the liquid cooling system. Heat losses of the measuring device should be as low as possible;

f) the test is carried out for a period of not less than 60 min and continued until the rate of temperature rise does not exceed 2 K/h.

The cooling power is calculated by the following formulae:

$$P = (T_1 - T_2) \times q_m \times c \qquad q_m = q_v \times \rho$$

where

P is the cooling power (kW);

T_1 is the temperature of inlet flow (K);

T_2 is the temperature of outlet flow (K);

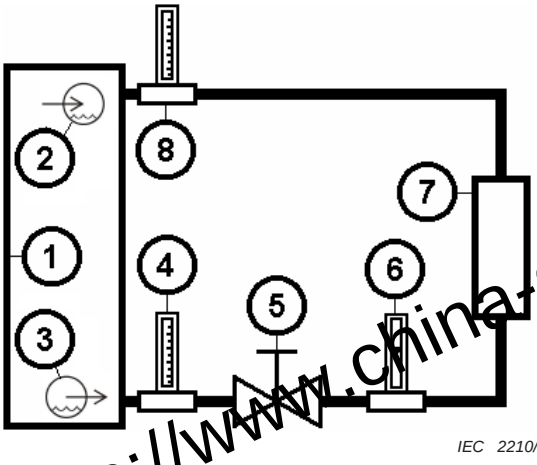
$T_1 - T_2$ is the temperature difference (K);

q_m is the mass flow (kg/s);

q_v is the volume flow (l/s);

c is the specific heat capacity of the cooling liquid (see example in Table 1)(kJ/(kg×K));

ρ is the density of the cooling liquid (see example in Table 1) (kg/l).



Key

1	Liquid cooling system	4	Thermometer (T_2)	7	Electrical heater
2	Inlet flow	5	Adjustable valve	8	Thermometer (T_1)
3	Outlet flow	6	Flow meter		

Figure 2 – Measuring circuit for determination of the cooling power

Table 1 – Example of cooling liquid data at 60 °C

Liquid	Specific heat capacity (*c*) kJ/(kg × K)	Density (ρ) kg/l
Water	4,18	0,98
Water/ethanol (50/50)	3,85	0,88
Water/ethylene glycol (50/50)	3,44	1,07
Water/propylene glycol (50/50)	3,69	1,04
Water/ethylene glycol (10/90)	2,670	1,10
Water/propylene glycol (10/90)	2,846	1,02
NOTE 1 Figures in parentheses in column 1 are volume ratios. NOTE 2 Water is not suitable for the negative temperature range of operating conditions given in Clause 4.		

11 Rating plate

11.1 General

As specified in Clause 15 of IEC 60974-1:2012.

11.2 Description

The rating plate shall be divided into three sections:

a) identification of stand-alone cooling systems;

b) energy supply of stand-alone cooling systems;

c) liquid cooling system.

The arrangement and sequence of the data shall comply with the principle shown in Figure 3 (for an example, see Annex B).

The dimensions of the rating plate are not specified and may be chosen freely.

NOTE Additional information may be given, if necessary, on the rating plate. Further useful information may be given in technical literature supplied by the manufacturer (see Clause 12).

In the case of built-in cooling systems, section c) of Figure 3 shall be added to the rating plate of the welding power source, as specified in Clause 15 of IEC 60974-1:2012.

IEC 2211/07

Figure 3 – Principle of the rating plate of stand-alone cooling systems

11.3 Contents

a) Identification

Box 1 Name and address of the manufacturer or distributor or importer and, optionally, a trade mark and the country of origin, if required.

Box 2 Type (identification) as given by the manufacturer.

Box 3 Traceability of design and manufacturing data, for example, serial number.

Box 4 Reference to this part of IEC 60974 confirming that the cooling system complies with its requirements.

b) Energy supply

Box 5		Energy supply symbol.
Box 6	U_1 ... V / 1(3)~ ... Hz	Rated supply voltage, number of phases (for example, 1 or 3), symbol for alternating current ~ and the rated frequency (for example, 50 Hz or 60 Hz).
Box 7	I_{1max} ... A	Maximum rated supply current.
Box 8	IP	Degree of protection, for example, IP 21 or IP 23.
Box 9		Symbol for class II equipment, if applicable.

c) Liquid cooling system

Box 10		Symbol for cooling.
Box 11	$P_{1\ l/min}$ ... kW	Rated cooling power at 1 l/min of cooling liquid flow at 25 °C, if required by Clause 10. In addition, cooling power at different volume flow values specified by manufacturer may be given.
Box 12	p_{max} ... Pa (bar)	Rated maximum pressure.

Conformity shall be checked by visual inspection and by checking of the complete data.

11.4 Tolerances

Manufacturers shall meet rating plate values within the following tolerances by controlling component and manufacturing tolerances:

a) P cooling power in kW.

The value shall be not less than that stated on the rating plate.

b) p_{max} rated maximum pressure in Pa (bar).

The value shall be not greater than that stated on the rating plate.

Conformity shall be checked by comparing the values with those stated on the rating plate.

12 Instructions and markings

12.1 Instructions

Each cooling system shall be delivered with instructions including the following, as applicable:

a) general description;

b) mass and correct methods of handling stand-alone liquid cooling systems;

c) meaning of indications and graphical symbols;

d) interface requirements for an arc welding power source, for example control power, control signals, static characteristics and means of connections;

e) recommended cooling liquid and correct operational use of the liquid cooling system, for example cooling conditions, location, pump characteristic, cooling power characteristic, antifreezes, recommended additives, pressure range, etc.;

f) limitations and explanation of thermal protection, if relevant;

g) limitations related to the degree of protection provided, for example a cooling system with a degree of protection of IP 21S is not suitable for storage or use in rain or snow;

h) conditions under which extra precautions are to be observed when welding or cutting, for example environment with increased hazard of electric shock;

i) maintenance and service of the liquid cooling system;

j) a list of parts typically replaced due to wear;

k) warning against the use of non-suitable and conductive cooling liquids and antifreezes;

l) precautions against toppling over, if the liquid cooling system shall be placed on a tilted plane;

m) correct handling and disposal of the cooling liquid;

n) EMC classification in accordance with IEC 60974-10 (stand-alone cooling systems only);

o) correction factor on the cooling power for the ambient temperature of +40 °C.

Conformity shall be checked by reading the instructions.

12.2 Markings

12.2.1 General

As specified in 17.2 of IEC 60974-1:2012.

12.2.2 Inlet and outlet

The inlet and outlet connections for the cooling liquid shall be clearly and indelibly marked with the following symbols.

a) Inlet 

b) Outlet 

In addition, a colour code may be used in accordance with manufacturer's specification.

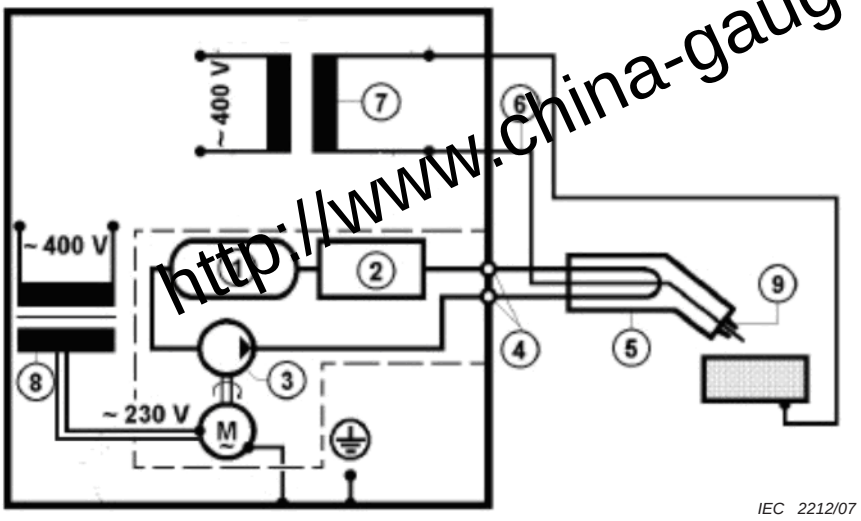
12.2.3 Pressure warning

If the rated maximum pressure of the liquid cooling system is higher than 0,5 MPa (5 bar), a warning shall be attached, for instance:

p_{max} X MPa

Annex A
(informative)

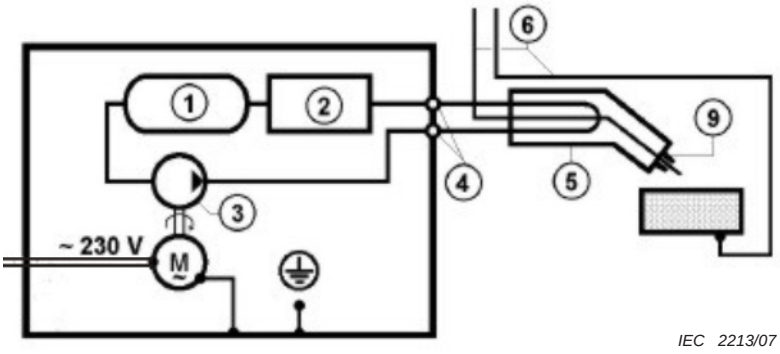
Example diagram of built-in and stand-alone liquid cooling systems



Key

1 Tank
2 Heat exchanger
3 Pump
4 Grounded cooling liquid pipes
5 Torch
6 Welding circuit
7 Welding transformer
8 Transformer
9 Contact tip

Figure A.1 – Example diagram of built-in liquid cooling systems



Key

1 Tank
2 Heat exchanger
3 Pump
4 Grounded cooling liquid pipes
5 Torch
6 Welding circuit
9 Contact tip

Figure A.2 – Example diagram of stand-alone liquid cooling systems

Annex B
(informative)

Example for a rating plate of stand-alone cooling system

a) Identification

1)	Manufacturer Address	Trademark
2)	Type	3) Serial No.
		4) **IEC 60974-2**

b) Energy supply

5)	6) U_1 = 230 V / 1~ 50 Hz	7) I1max = 1,2 A
	8) IP23S	9) —

c) Liquid cooling system

10)	11) P_1 l/min = 0,55 kW	12) $p$max = 0,38 MPa

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