INTERNATIONAL STANDARD 3147

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Heat exchangers — Verification of thermal balance of water-fed or steam-fed primary circuits — Principles and test requirements

Échangeurs thermiques — Établissement du bilan thermique des circuits primaires alimentés en eau ou en vapeur — Principes et conditions d'essai

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3147 was drawn up by Technical Committee ISO/TC 116, *Space-heating appliances*, and circulated to the Member Bodies in October 1973.

It has been approved by the Member Bodies of the following countries :

Australia	France	Romania
Belgium	Germany	South Africa, Rep. of
Bulgaria	Italy	Sweden
Czechoslovakia	Korea, Rep. of	Thailand
Denmark	Netherlands	Turkey
Egypt, Arab Rep. of	New Zealand	United Kingdom
Finland	Norway	Yugoslavia

No Member Body expressed disapproval of the document.

Printed in Switzerland

Heat exchangers — Verification of thermal balance of water-fed or steam-fed primary circuits — Principles and test requirements

1 SCOPE

This International Standard defines the principles and test requirements for the experimental verification of the thermal balance of water-fed or steam-fed primary circuits of heat exchangers.

A number of suitable arrangements of test apparatus are illustrated in the annex.

2 FIELD OF APPLICATION

This International Standard is applicable to tests performed in the steady-state condition, in accordance with the specifications laid down for each type of appliance in the relevant International Standards.

Where appropriate, special arrangements required for certain types of appliance may also be given in these International Standards.

3 TESTS

3.1 Principles

The energy input to the heat exchanger via the primary fluid may be ascertained by means of measurements performed in accordance with either of the following principles :

3.1.1 *Measurement of the flow of primary fluid through the heat exchanger and of its thermodynamic characteristics at inlet and outlet.*

The energy input is then given by the formula :

$$\phi = q_m (h_1 - h_2)$$

where

ϕ is the energy input to the heat exchanger, in watts;

q_m is the mean mass flow of the primary fluid, in kilograms per second;

h_1 and h_2 are the specific enthalpies of the primary fluid at the inlet and outlet respectively of the appliance, in joules per kilogram.

The values of h_1 and h_2 are deduced from the pressures, the temperatures and the state of the primary fluid at the inlet and outlet of the appliances under test, as presented in the current data published by the International Conference on Properties of Steam.

The value of q_m is measured throughout the course of the test.

3.1.2 *Measurement of the energy input to the primary fluid circuit (for example, by electrical immersion units) and subtraction from this value of the losses other than those from the appliance itself, determined for each test by calibration*

The entire circuit comprising the heat source and the heat exchanger must be so insulated (with the single exception of the heat exchanger itself) that heat losses are kept low.

The procedure adopted for determining these losses during calibration and the choice of parameters to be used to calculate them shall be stated jointly in the test report.[1)]

The energy input is then given by the formula :

$$\phi = \phi_c - \phi_p$$

where

ϕ is the energy input to the heat exchanger, in watts;

ϕ_c is the energy input to the entire circuit, in watts;

ϕ_p are the losses, in watts, calculated for the particular test conditions, with the heat exchanger connected. These losses must be as small as possible, and must not exceed 10 % of the output of the appliance under test in any circumstances.

1) These losses depend on

a) the temperatures of the primary fluid, which will be affected by the presence of the appliance under test; this will be of greater significance as the temperature drop increases;

b) the methods adopted for the cooling of various components of the primary circuit (steam generator, pump, pipework); this cooling is not generally controlled and can vary during calibration and testing.

3.2 Test requirements

3.2.1 *Water as the primary fluid (hot water, superheated water)*

When water is used, the flow rate is to be such that the temperature drop through the appliance under test stays within the limits specified in the individual International Standard for the appliance under test.

For this purpose, the temperatures and, for superheated water, the pressures, at the inlet and outlet under test shall be measured or, alternatively, the measurement shall be made at one position with a separate measurement of the drop across the appliance.

3.2.2 *Steam as the primary fluid*

When steam is used, the following precautions are necessary :

a) The steam at the appliance input must be slightly superheated, by at least 2 °C but not more than 5 °C.

b) The supply conditions and test arrangements shall ensure that only condensate leaves the appliance under test, its temperature being not more than 1 °C below the saturation temperature corresponding to the pressure of the steam at the inlet of the appliance. Steam pressures and temperatures shall be measured at the inlet and outlet of the appliance.

3.2.3 *Requirements applicable in all cases*

The primary fluid temperatures referred to in this International Standard are those at the inlet and outlet of the appliance under test. When it is not physically possible to carry out these measurements at these points, the connections between the temperature measuring points and the appliance shall be heavily insulated up to and beyond the measuring point so that the errors lie within the limits given below.

Temperature measuring points are not to be placed more than 0,3 m from the inlet and outlet of the appliance under test, and the insulation must extend for the same distance beyond the temperature measuring point.

3.2.4 *Accuracy of measurements*

Readings taken are to be accurate within the limits given below :

— flow rate[1] :	± 0,5 %
— temperature :	± 0,1 °C
— pressure (absolute) :	± 1 %
— pressure differences	
for Δp more than 1 kPa (10 mbar) :	± 5 %
for Δp less than 1 kPa (10 mbar) :	± 0,05 kPa (0,5 mbar)
— energy input (method 3.1.2)	± 0,5 %

3.2.5 *Steady-state conditions*

The requirements for steady-state conditions throughout the duration of the test are regarded as fulfilled if the readings obtained during at least six equal and successive periods do not fluctuate from the mean value by more than

± 2 % for the flow;

± 0,2 °C for the temperature;

± 2 % for the pressure;

± 1 % for the energy input (method 3.1.2).

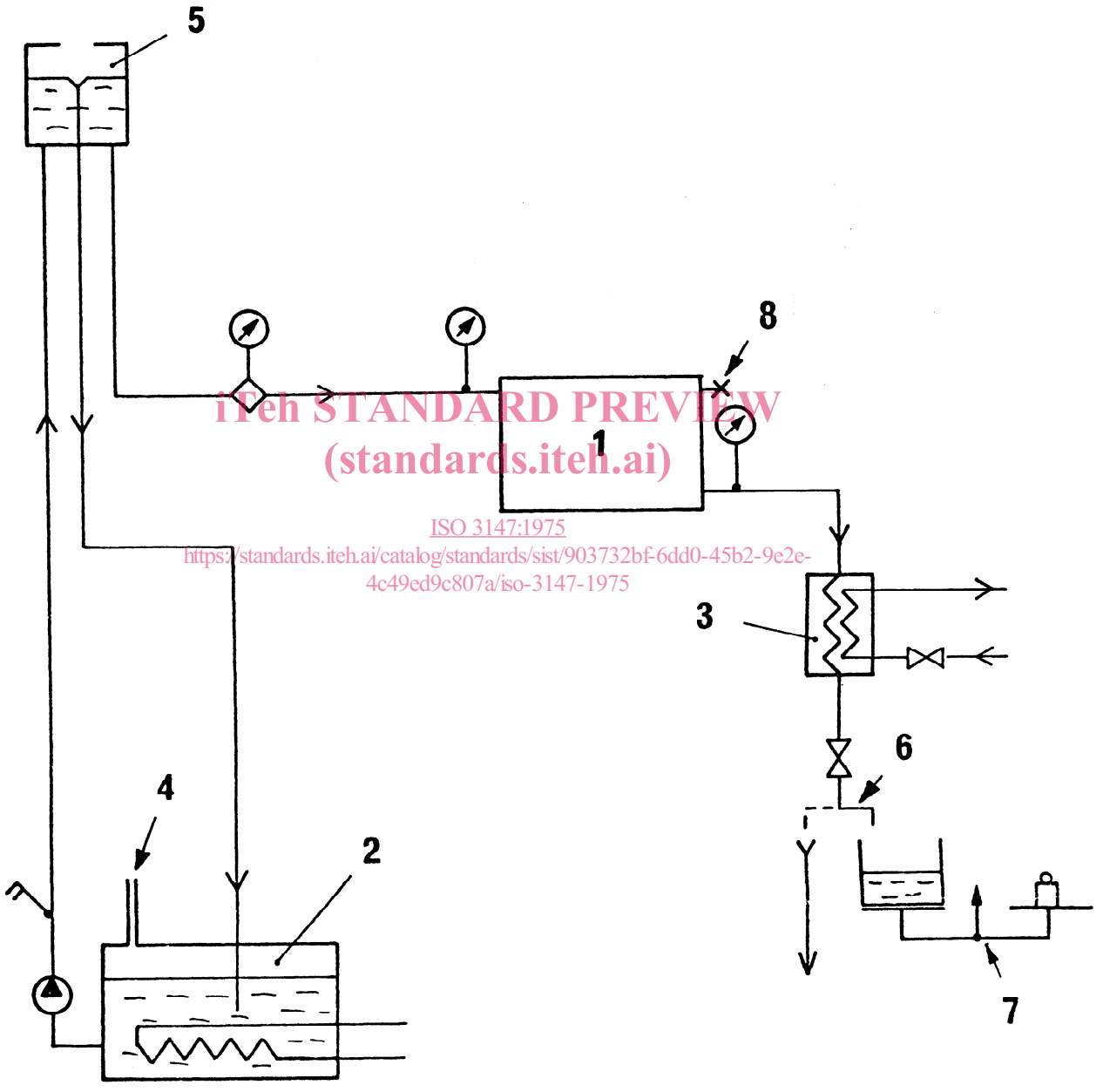
1) When the output cannot be found by weighing, the limits of accuracy of the flow rate readings shall be stated in the test report (see ISO 3150, sub-clause 4.3c)).

ANNEX

MEASUREMENTS : SCHEMATIC DIAGRAMS OF TEST ARRANGEMENTS

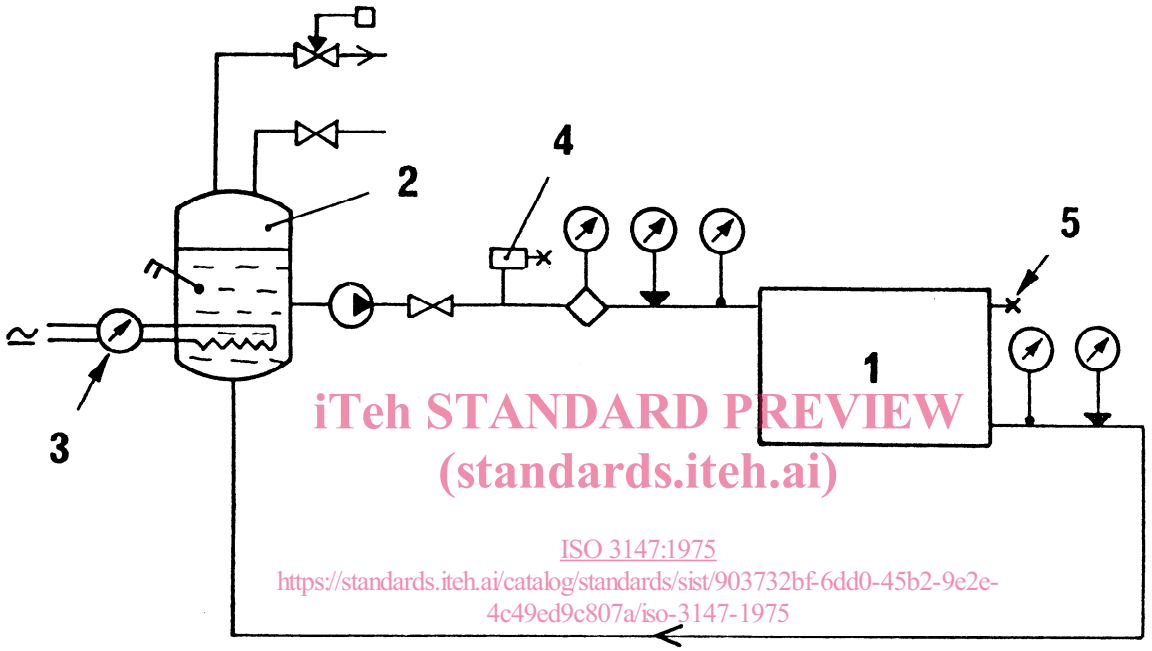
In order to illustrate different arrangements of test apparatus that may be used to measure the thermal balance in water or steam circuits, a number of schematic diagrams of such arrangements are given in this annex by way of example.

Any other arrangements meeting the requirements stated in the main text may be employed.



1 Heat exchanger
2 Boiler
3 Cooler
4 Vent pipe
5 Constant-level tank
6 Swivel spout
7 Balance
8 Air vent

FIGURE 1 – **Test arrangement for hot water – Weighing method**



1 Heat exchanger

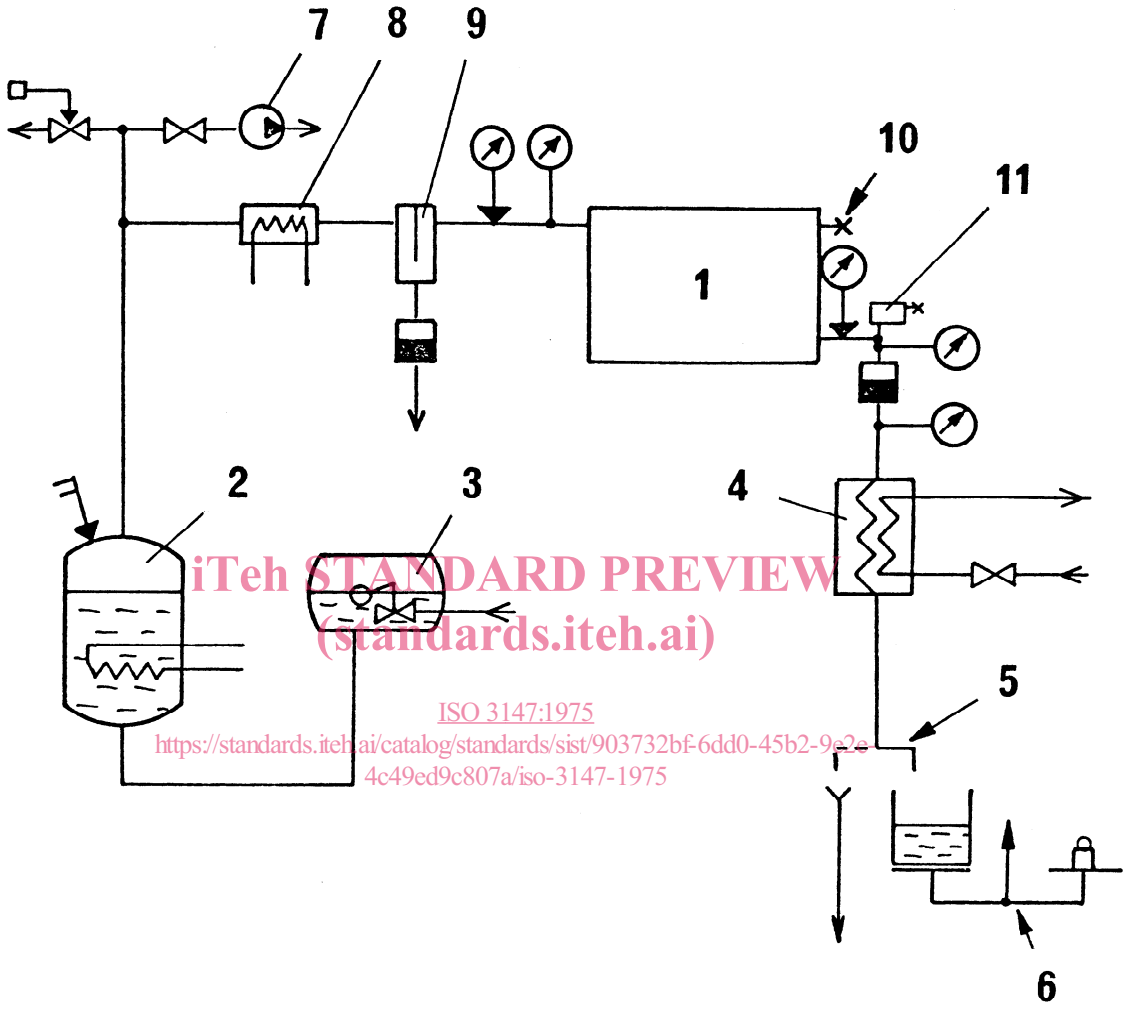
2 Boiler

3 Wattmeter

4 Air-purging device

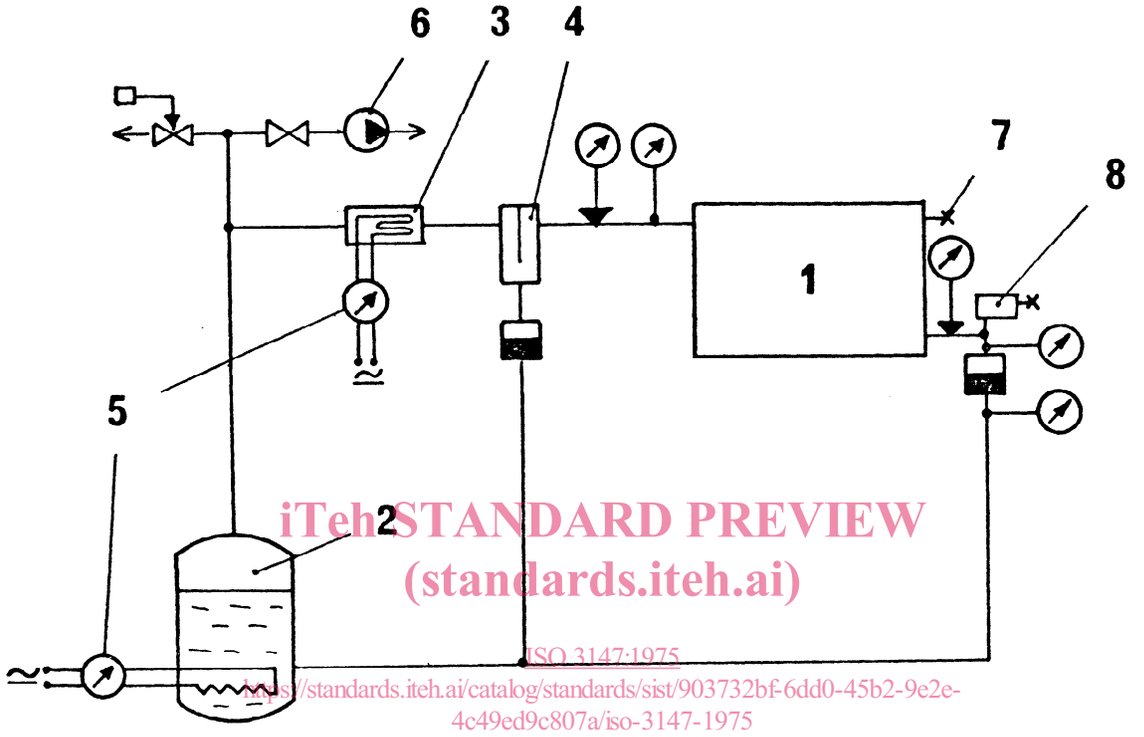
5 Air vent

FIGURE 2 — **Test arrangement for hot or superheated water — Electrical method**



1 Heat exchanger
2 Steam generator
3 Water supply
4 Condensate cooler
5 Swivel spout
6 Balance
7 Vacuum pump
8 Superheater
9 Steam drier
10 Air vent
11 Air-purging device

FIGURE 3 — **Test arrangement for steam — Weighing method**



1 Heat exchanger

2 Steam generator

3 Superheater

4 Steam drier

5 Wattmeter

6 Vacuum pump

7 Venting valve

8 Air-purging device

FIGURE 4 — **Test arrangement for steam — Electrical method**