
**Ships and marine technology — Potable
water supply on ships and marine
structures —**

Part 2:
Method of calculation

*Navires et technologie maritime — Approvisionnement en eau potable sur
navires et structures maritimes —*

Partie 2: Méthode de calcul



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

STANDARDSISO.COM : Click to view the full PDF of ISO 15748-2:2002

© ISO 2002

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

| | |
|--|----|
| Foreword..... | iv |
| 1 Scope | 1 |
| 2 Normative references | 1 |
| 3 Potable water consumption..... | 2 |
| 4 Potable water storage | 2 |
| 5 Determination and sizing of system components | 2 |
| 6 Flow rates | 3 |
| 7 Supply pressure..... | 3 |
| 8 Generation and maintenance of pressure..... | 3 |
| 9 Pipe diameters of distribution lines..... | 4 |
| 10 Hot water requirements..... | 5 |
| 11 Water heaters | 5 |
| 12 Circulation lines and circulating pumps | 6 |
| 13 Calculation example | 6 |
| Annex A (informative) Tables and figures with useful information | 7 |
| Annex B (informative) Form sheets for calculation..... | 18 |
| Annex C (informative) Calculation example | 22 |
| Annex D (informative) Information concerning the installation of sanitary facilities | 38 |

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 15748 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15748-2 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

ISO 15748 consists of the following parts, under the general title *Ships and marine technology — Potable water supply on ships and marine structures*:

- *Part 1: Planning and design*
- *Part 2: Method of calculation*

Annexes A, B, C and D of this part of ISO 15748 are for information only.

Ships and marine technology — Potable water supply on ships and marine structures —

Part 2: Method of calculation

1 Scope

This part of ISO 15748 applies to the planning, design and configuration of potable water supply systems on ships, stationary or floating marine structures and inland waterway crafts.

This part of ISO 15748 serves to determine the quantity of potable water to be carried on board, the capacity of the pressurized reservoirs and water heaters, the pumping capacity, etc.

NOTE In accordance with ISO 15748-1 plastic pipes are permitted but are rarely used at present due to the restrictive conditions laid down by the classification societies. Pressure losses in plastic pipes have not yet been included in ISO 15748 owing to their limited applicability.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15748. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15748 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 65, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 274, *Copper tubes of circular section — Dimensions*

ISO 1127, *Stainless steel tubes — Dimensions, tolerances and conventional masses per unit length*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

ISO 5620-1, *Shipbuilding and marine structures — Filling connection for drinking water tanks — Part 1: General requirements*

ISO 15748-1, *Ships and marine technology — Potable water supply on ships and marine structures — Part 1: Planning and design*

3 Potable water consumption

3.1 General

The consumption of potable water depends on the type of ship, underway time (time the crew and passengers are embarked), number of potable water dispensing and supply points and the cruising area.

Rough calculations of the daily potable water requirements should be based on the guide values in Table A.1.

Determination of potable water consumption with respect to the planned/existing dispensing points should be based on the guide values in Table A.2 for cargo ships and in Table A.3 for passenger ships.

3.2 Potable water requirements of technical equipment

The quantity of potable water required by other technical facilities including air conditioning equipment/plants for air humidification is to be taken from the information supplied by the manufacturer of the respective facility and added to the potable water consumption determined in accordance with 3.1.

3.3 Potable water consumption of commissary equipment

The following guide values for water consumption have been determined; detailed values shall be supplied by the manufacturer. The determined quantity shall be added to the values determined in accordance with 3.1.

| | | |
|---|---|-------------------------|
| — garbage grinders for food disposal | = | 20 l/min |
| — dishwashing machines | = | 3 l/rack up to 8 l/rack |
| — coffee and tea machines | = | 18 l/h to 120 l/h |
| — vegetable peeling and cleaning machines | = | 5 l/filling |
| — washing machines | = | 25 l/kg dry laundry |

4 Potable water storage

Potable water storage and potable water distilling plants shall be provided in consultation with the contractor.

5 Determination and sizing of system components

The sizes of system components shall be determined taking into account:

- the pipe material to be used;
- the configuration of the potable water installations (pipelines, fittings, service devices);
- the calculation plans for cold water, hot water and circulation lines.

The sizing of components is calculated based on to the expected volume flow at the time of the maximum water consumption = peak flow.

The values and information required for the calculations are listed in Tables A.4 to A.11 and in Figures A.1 to A.4.

The use of the forms supplied in annex B has proved helpful for the calculation process.

6 Flow rates

In order to prevent flow noises and pressure surges, flow rate limitations should be considered.

NOTE Two examples of flow rate limitation are given below.

Example 1

- 2,5 m/s in engine rooms and machinery trunks;
- 2,0 m/s in commissary spaces;
- 1,4 m/s in accommodation decks;
- 1,0 m/s in the hospital and close vicinity;
- 1,0 m/s in pump suction lines;
- 0,5 m/s in circulating lines.

Example 2

- 2,5 m/s for CuNi pipes with $DN \leq 65$ (delivery);
- 2,0 m/s for CuNi pipes with $DN \leq 50$ and steel pipes with $DN \leq 65$ (delivery);
- 1,4 m/s for CuNi pipes with $DN \leq 25$ and steel pipes with $DN \leq 32$ (delivery); any material pipe with $DN \leq 65$ (suction);
- 1,0 m/s for pipes with $DN \leq 15$ (delivery); any material pipe with $DN \leq 32$ (suction);
- 0,7 m/s for any material pipe with $DN \leq 15$ (suction).

7 Supply pressure

The minimum system supply pressure (pump, water reservoir) is determined by adding the pressure losses due to:

- geodetic differences in altitude;
- pressure losses in the apparatus;
- pressure losses from pipe friction and individual resistances;
- minimum flow pressure of 1,5 bar or, following greater demands at the highest dispensing point, plus 10 %. The pressure losses at the suction side shall be taken into consideration.

8 Generation and maintenance of pressure

8.1 General

Potable water may either be supplied directly, or indirectly, via pressurized water reservoirs. Direct supply is appropriate if large quantities of potable water per hour are consumed, e.g. on passenger ships. In all other cases mostly pressurized water reservoirs are used.

The decision as to which method of potable water supply is suitable depends on the peak demand for potable water and is also influenced by the arrangement, space requirements, weight etc. of the components or component groups within the entire supply system.

The limit for deciding between pressurized water reservoirs of direct pump supply lies between 30 m³/h and 40 m³/h.

Minimum supply pressure in accordance with clause 7 shall be ensured.

The design temperature for the system is 10 °C.

8.2 Pressurized water reservoirs

In order to keep the available quantity of water, i.e. the quantity between pump cut-ins and cut-offs, as great as possible, and to prevent frequent switchings of the pump, the water stored in the pressurized reservoirs is sufficiently pre-compressed with air.

This pre-compression shall be 0,3 bar less than the pump cut-in pressure. The pressure difference between cut-in and cut-off pressure shall be between 1 bar and 2 bar.

The switching frequency is usually between 6 and 8 switching events h⁻¹; however, 12 switching events h⁻¹ shall not be exceeded.

The required reservoir capacity is to be determined in accordance with Figure A.4.

8.3 Supply pumps

8.3.1 General

The capacity of centrifugal pumps shall be such that when the cut-off pressure is reached the capacity corresponds to 110 % of the calculated maximum consumption (10 % margin). Reciprocating pumps shall be dimensioned for 120 % to 130 % of the maximum consumption rate determined.

Pumps with flat characteristic curves shall be selected. If several pumps are used, the cut-in and cut-off pressures of each pump shall be stepped with respect to each other, e.g. 4 bar, 3,5 bar, 3 bar.

Provisions shall be made for quantities of water supplied from continuous-action pumps but remaining unused to be fed back to the potable water reservoirs.

8.3.2 Pump suction lines

The guide values listed in Table A.4 are valid for steel pipes and do not include losses caused by pipe elbows, fittings, etc. These losses shall be taken into consideration.

8.3.3 Pump discharge lines

The pump discharge line connects the supply pump with the water reservoir via a shut-off fitting. The nominal width shall be determined in accordance with Table A.5.

9 Pipe diameters of distribution lines

The pipe diameters shall be determined as follows:

- ascertain the calculation flow at service points of pipe sections (for guide values see Table A.12);
- determine the sum flows for these pipe sections and allocate to the pipes;
- determine the peak flow for these pipe sections in accordance with Figure A.3;
- determine pipe diameters and pressure losses provisionally with the help of Figure A.1; if pressure losses are too high, larger diameters shall be selected;

or

by means of a more simple procedure by determining nominal widths from Table A.11 on the basis of the respective maximum flows.

10 Hot water requirements

The volume of hot water to be provided or to be kept in store shall be determined from the peak demand for mixed water using the following equations:

$$V_M = V_C + V_H \quad (1)$$

$$\frac{H}{C} = \frac{t_M - t_C}{t_H - t_M} \quad (2)$$

$$V_H = \frac{V_M}{H + C} \times H \quad (3)$$

where

V_M is the mixed water volume;

V_C is the cold water volume;

V_H is the hot water volume;

C is the cold water portion;

H is the hot water portion;

t_M is the mixed water temperature;

t_C is the cold water temperature;

t_H is the hot water temperature.

11 Water heaters

11.1 Determination of the necessary water heater volume

a) Continuous-flow water heaters

They shall be sized with respect to the peak demand for hot water.

b) Storage heaters

The size of storage heaters shall be selected so that the peak demand for hot water:

— on passenger ships can be heated in 4 h;

— on other ships can be heated in 2 h.

An additional heating facility which may be required for emergency use or during docking may be smaller in capacity. For passenger ships, it is recommended that the necessary hot water volume be divided between two or more water heaters.

The supply of hot water shall also be ensured in port.

11.2 Guide values for water heater volumes

Guide values for necessary water heater volume (depending on the load/number of persons), heating power and additional heating are listed in Table A.6.

12 Circulation lines and circulating pumps

12.1 Determination of nominal widths

The nominal widths of circulating lines depend on the nominal widths of the water supply lines. The respective guide values are listed in Table A.7.

For systems including several circulating lines, installation of restriction fittings in the direction of flow upstream of the shut-off fitting is recommended.

12.2 Determination of pump delivery flow

The pump delivery flow \dot{V}_{UP} required is determined from the total volume V_{tot} of the water supply and circulating lines (not including the storage reservoir or water heater capacities) and the number of water circulations per hour according to the following equation:

$$\dot{V}_{UP} = n \times V_{tot} \quad (4)$$

where

\dot{V}_{UP} is the pump delivery flow, in litres per hour;

n is the number of circulations per hour;

V_{tot} is the total volume of water supply and circulating lines, expressed in litres.

Circulating the hot water three times per hour is enough to prevent excessive cooling of the water. For the volume of water per meter of pipe see Tables A.8 to A.10.

12.3 Determining the head of the pump

The head of the pump required, H_{UP} , is determined from the sum of the pressure losses due to pipe friction and individual resistances in the longest circulation section plus 40 %.

The slight pressure losses due to the circulation flow through the water distributing lines and risers may be neglected in determining the head of a pump, H_{UP} .

12.4 Selection of pumps

Once the pump delivery and the required head, H_{UP} , have been determined, the adequate size of the pump shall be selected with the help of the pump diagram, which shall be supplied by the manufacturer.

If the operating point determined is between two pump-performance characteristics curves (P1 and P2 see Figure A.2), selection of the smaller pump is recommended for economic reasons.

13 Calculation example

A calculation example for the application of this part of ISO 15748 including tables and figures shown in annex A and the sheets shown in annex B, is given in annex C.

Annex A (informative)

Tables and figures with useful information

Table A.1 — Guide values for potable water consumption in litre per person/bed and day

| Type of ship | | Group of persons embarked | Water consumption when fitted with | |
|------------------------------------|--|---------------------------|------------------------------------|----------------------|
| | | | Flushing toilet system | Vacuum toilet system |
| Seagoing ship | Cargo ship | Crew/bed | 220 l | 175 l |
| | Passenger ship | Passenger/bed | 270 l | 225 l |
| | Luxury liner | Passenger/bed | — | 275 l |
| | Ferryboat with cabins | Passenger/bed | 205 l ^a | 160 l ^a |
| | | Passenger without bed | 100 l | 55 l |
| | Ferryboat without cabins | Passenger without bed | 150 l | 105 l |
| | | Crew without bed | 100 l | 55 l |
| Inland waterway craft | Cargo ship | Crew/bed | Minimum 150 l | |
| | Passenger ship with cabins | Passenger/crew/bed | 220 l | 175 l |
| | Passenger ship without cabins | Crew/passenger | 100 l | |
| Special-purpose ship | Research ship | per bed | 220 l | 175 l |
| | Federal armed forces tender and larger | Crew/bed | 160 l | 110 l |
| | Federal armed forces – smaller than tender | Crew/bed | 100 l | 55 l |
| Fishing vessel | | Crew/bed | Minimum 150 l | |
| Offshore | | Crew/bed | 350 l | |
| ^a No shipboard laundry. | | | | |

Table A.2 — Guide values for cargo ships water consumption at different service points per person and day

| Service point | Consumption per use l | Frequency of use per day | Consumption | | |
|-------------------------------|--------------------------|-----------------------------|----------------------------------|---------------------|---------------------------------|
| | | | Total quantity of water l/day | Cold water l/day | Hot water ^a l/day |
| Wall-hung/pedestal wash basin | 2 | 6 × | 12 | 5 | 7 |
| Shower base | 60 | 2 × | 120 | 50 | 70 |
| Flushing W.C. ^b | 10 | 6 × | 60 | 60 | — |
| Vacuum W.C. ^b | 1,2 | 6 × | 8 | 8 | — |
| Urinal ^b | 3 | 5 × | 15 ^c | 15 ^c | — |
| Galley area | — | — | 20 | 8 | 12 |
| Laundry ^b | — | — | 38 | 15 ^d | 23 |
| Cleaning | — | — | 5 | 2 | 3 |

^a At a hot water inlet temperature of 60 °C.
^b If non-potable water is used the consumption of potable water decreases accordingly.
^c The use of the urinals reduces the use of the WCs.
^d Consumption of appliances with hot water connections.

Table A.3 — Guide values for passenger ships water consumption at different service points per person and day

| Service point | Consumption per use | Frequency of use per day | Consumption | | |
|-------------------------------|---------------------|-----------------------------|----------------------------------|---------------------|---------------------------------|
| | | | Total quantity of water l/day | Cold water l/day | Hot water ^a l/day |
| Wall-hung/pedestal wash basin | 2,5 | 8 × | 20 | 8 | 12 |
| Shower base ^d | 60 | 2 × | 120 | 50 | 70 |
| Bath tub | 150 | 1 × | 150 | 60 | 90 |
| Flushing W.C. ^b | 10 | 6 × | 60 | 60 | — |
| Vacuum W.C. ^b | 1,2 | 6 × | 8 | 8 | — |
| Urinal ^b | 3 | 5 × | 15 ^c | 15 ^c | — |
| Galley dining rooms | — | — | 25 | 10 | 15 |
| Laundry ^b | — | — | 75 to 100 | 30 to 40 | 45 to 60 |
| Cleaning | — | — | 20 | 8 | 12 |
| Shower and swimming pool | — | — | 10 ^e | — | — |
| Fresh water for swimming pool | — | — | 10 ^e | — | — |
| Whirlpool | — | — | 60 ^e | — | — |
| Sauna | 60 | 1 × | 60 | — | — |

^a At a hot water inlet temperature of 60 °C.
^b If non-potable water is used the consumption of potable water decreases accordingly.
^c The use of the urinals reduces the use of the WCs.
^d If bath tubs and showers are provided, one use per day shall be anticipated.
^e Additional quantity of water per user and day.

Table A.4 — Pump suction lines, nominal widths and maximum pipe lengths

| | | | | | | | | | | | | | | | |
|--------------------|-------------------|-------------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Pump delivery flow | l/s | 0,5 | 0,67 | 0,83 | 1,0 | 1,2 | 1,3 | 1,5 | 1,8 | 2,1 | 2,8 | 4,2 | 5,5 | 7,0 | 8,3 |
| | m ³ /h | 1,8 | 2,4 | 3,0 | 3,6 | 4,2 | 4,8 | 5,4 | 6,6 | 7,5 | 10 | 15 | 20 | 25 | 30 |
| Nominal width | DN | 25 | | 32 | | 40 | | 50 | | 65 | | 80 | | 100 | |
| Suction lift | m | Length of pipe line (m) | | | | | | | | | | | | | |
| 0 | | 120 | 80 | 105 | 80 | 210 | 140 | 280 | 210 | 140 | 120 | 130 | 100 | 120 | 105 |
| 1 | | 100 | 70 | 90 | 70 | 180 | 120 | 240 | 180 | 120 | 100 | 110 | 85 | 95 | 90 |
| 2 | | 85 | 55 | 75 | 55 | 150 | 100 | 200 | 150 | 100 | 85 | 90 | 70 | 75 | 70 |
| 3 | | 70 | 45 | 60 | 45 | 120 | 80 | 160 | 120 | 80 | 75 | 70 | 60 | 55 | 45 |

Table A.5 — Pump pressure lines, nominal widths

| | | | | | | | | | | | | | | | |
|--------------------|-------------------|-----|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Pump delivery flow | l/s | 0,5 | 0,67 | 0,83 | 1,0 | 1,2 | 1,3 | 1,5 | 1,8 | 2,1 | 2,8 | 4,2 | 5,5 | 7,0 | 8,3 |
| | m ³ /h | 1,8 | 2,4 | 3,0 | 3,6 | 4,2 | 4,8 | 5,4 | 6,6 | 7,5 | 10 | 15 | 20 | 25 | 30 |
| Nominal DN width | | 20 | | 25 | | 32 | | 40 | | 50 | | 65 | | 80 | |

Table A.6 — Guide values for water heater volumes, heating power and additional heating

| Number of persons | Water heater volume l | Heating power kW | Heating-up time from 10 °C to 65 °C min | Quantity in l of mixed water of 40 °C to be produced in | | Additional heating power kW |
|-------------------|--------------------------|---------------------|---|--|--------|--------------------------------|
| | | | | 1 h | 2 h | |
| 1 to 10 | 200 | 15 | 51 | 660 | 1 030 | 8 |
| | 300 | 10 | 115 | 680 | 930 | 5 |
| 11 to 20 | 400 | 30 | 51 | 1 320 | 2 060 | 15 |
| | 650 | 20 | 125 | 1 440 | 1 940 | 10 |
| 21 to 30 | 650 | 40 | 62 | 1 940 | 2 920 | 20 |
| | 1 000 | 20 | 192 | 1 960 | 2 450 | 10 |
| 31 to 50 | 1 000 | 40 | 96 | 2 450 | 3 440 | 20 |
| | 1 500 | 25 | 230 | 2 820 | 3 440 | 13 |
| 51 to 75 | 1 000 | 80 | 48 | 3 440 | 5 400 | 40 |
| | 1 500 | 60 | 96 | 3 680 | 5 160 | 30 |
| | 2 000 | 40 | 192 | 3 930 | 4 910 | 20 |
| 76 to 100 | 2 000 | 80 | 96 | 4 910 | 6 880 | 40 |
| | 3 000 | 40 | 288 | 5 400 | 6 380 | 20 |
| 101 to 150 | 3 000 | 100 | 115 | 6 880 | 9 330 | 50 |
| | 5 000 | 40 | 480 | 8 350 | 9 330 | 20 |
| 151 to 200 | 3 000 | 160 | 72 | 8 350 | 12 280 | 60 |
| | 5 000 | 100 | 192 | 9 820 | 12 280 | 50 |
| 201 to 300 | 5 000 | 200 | 96 | 12 280 | 17 200 | 60 |
| | 7 000 | 150 | 179 | 14 000 | 17 690 | 50 |
| 301 to 500 | 7 000 | 300 | 90 | 17 690 | 25 060 | 70 |
| | 10 000 | 200 | 192 | 19 650 | 24 570 | 60 |
| 501 to 700 | 7 000 | 400 | 67 | 20 140 | 29 970 | 80 |
| | 10 000 | 300 | 128 | 22 110 | 29 480 | 70 |
| 701 to 1 000 | 10 000 | 550 | 70 | 28 250 | 41 770 | 100 |

NOTE 1 As a rule, single water heaters with more than 3 000 l capacity are not used. For greater hot water demands, two or more water heaters of appropriate size, or continuous-flow heaters are provided.

NOTE 2 For every size of number of persons two possible decisions are shown.

NOTE 3 The column "Additional heating power" takes into consideration the hot water supply to be ensured in port (see 11.1).

Table A.7 — Guide values for nominal widths of circulating lines

| Water supply line nominal width DN | Circulating line nominal width DN |
|------------------------------------|-----------------------------------|
| 12 | 12 |
| 15 | 12 |
| 20 | 12 |
| 25 | 12 |
| 32 | 12 |
| 40 | 20 |
| 50 | 20 |
| 65 | 25 |
| 80 | 25 |
| 100 | 32 |

NOTE The value given in Tables A.8 to A.10 are valid for those pipes included in ISO 15748-1.

Table A.8 — Water volume in steel pipes

| Nominal width | Water volume in l/m in | | | | |
|---------------|--|---------------|--------------|----------|--|
| | Unalloyed steel pipes in accordance with | | | | Stainless steel pipes in accordance with |
| | ISO 65 | | ISO 4200 | | |
| | DN | Medium series | Heavy series | Seamless | Welded |
| 6 | 0,030 | 0,019 | — | — | — |
| 8 | 0,061 | 0,047 | — | — | — |
| 10 | 0,123 | 0,102 | 0,145 | 0,145 | 0,154 |
| 12 | — | — | — | — | — |
| 15 | 0,201 | 0,172 | 0,235 | 0,235 | 0,257 |
| 20 | 0,366 | 0,327 | 0,391 | 0,412 | 0,441 |
| 25 | 0,581 | 0,515 | 0,638 | 0,693 | 0,731 |
| 32 | 1,012 | 0,924 | 1,087 | 1,122 | 1,207 |
| 40 | 1,372 | 1,269 | 1,459 | 1,500 | 1,598 |
| 50 | 2,206 | 2,067 | 2,333 | 2,437 | 2,561 |
| 65 | 3,718 | 3,536 | 3,882 | 3,948 | 4,015 |
| 80 | 5,128 | 4,927 | 5,346 | 5,434 | 5,581 |
| 100 | 8,709 | 8,413 | 9,009 | 9,144 | 9,348 |

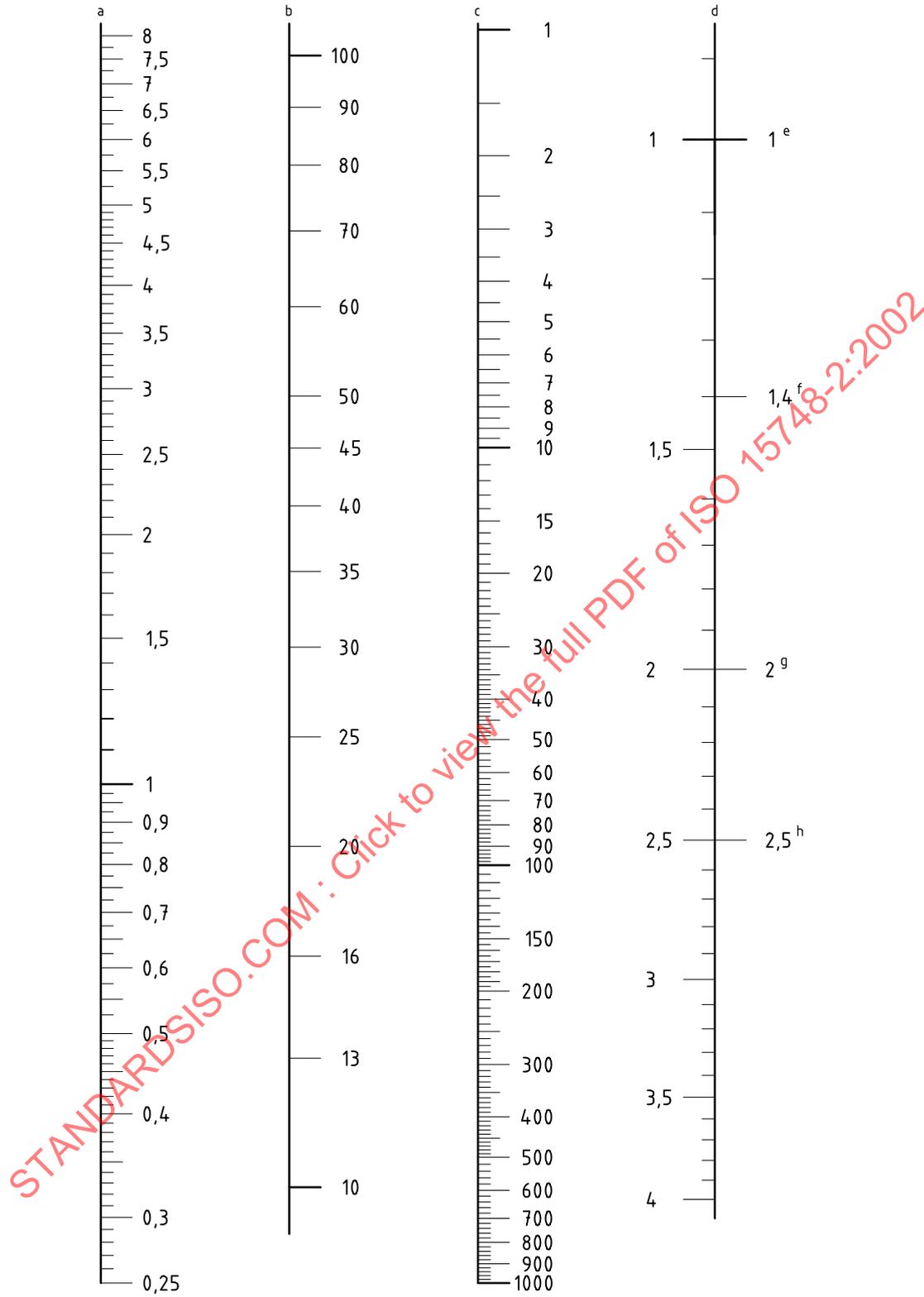
Table A.9 — Water volume in copper pipes

| Nominal width DN | Water volume in l/m in pipes of | |
|---------------------|-------------------------------------|---|
| | SF-Cu in accordance with ISO 274 | CuNiFe dimensions in accordance with ISO 274 |
| 6 | 0,028 | 0,050 |
| 8 | 0,038 | 0,079 |
| 10 | 0,064 | — |
| 12 | 0,133 | 0,154 |
| 15 | 0,227 | 0,254 |
| 20 | 0,380 | 0,380 |
| 25 | 0,531 | 0,573 |
| 32 | 0,908 | 0,962 |
| 40 | 1,195 | 1,353 |
| 50 | 1,963 | 2,290 |
| 65 | 4,077 | 4,072 |
| 80 | 5,668 | 5,675 |
| 100 | 8,332 | 8,332 |

Table A.10 — Water volume in plastic pipes

| Nominal width DN | Water volume in l/m in | | | | | | |
|---------------------|--|--------------------|-------|-------|---------------------------|------------------------|-------|
| | Polybutene pipes PB | Polyethylene pipes | | | Polypropylene pipes PP | Polyvinylchlorid pipes | |
| | | PE-LD | PE-HD | PE-X | | PVC-C | PVC-U |
| | Outside diameters in accordance with ISO 161-1 | | | | | | |
| 6 | 0,032 | 0,028 | 0,032 | 0,032 | 0,028 | 0,045 | — |
| 8 | 0,055 | 0,050 | 0,055 | 0,055 | 0,072 | 0,066 | 0,079 |
| 10 | 0,121 | 0,088 | 0,121 | 0,106 | 0,113 | 0,121 | 0,145 |
| 12 | — | 0,137 | — | 0,163 | 0,177 | 0,186 | — |
| 15 | 0,206 | 0,216 | 0,201 | 0,254 | — | 0,296 | 0,227 |
| 20 | 0,327 | 0,353 | 0,327 | 0,423 | 0,290 | 0,483 | 0,353 |
| 25 | 0,531 | 0,556 | 0,531 | 0,661 | 0,452 | 0,755 | 0,581 |
| 32 | 0,835 | 0,866 | 0,835 | 1,029 | 1,122 | 1,182 | 1,018 |
| 40 | 1,307 | 1,385 | 1,307 | 1,633 | 1,590 | 1,886 | 1,425 |
| 50 | 2,075 | 1,963 | 2,075 | 2,324 | 2,290 | 2,697 | 2,256 |
| 63 | 4,254 | 4,208 | 2,942 | 3,339 | 3,421 | 3,848 | 3,610 |
| 80 | 6,362 | 5,437 | 4,254 | 5,001 | 5,542 | 5,728 | 5,204 |
| 100 | 8,203 | — | 8,203 | 8,107 | 9,161 | 9,297 | 7,760 |

To facilitate the decision as to appropriate nominal widths of pipes, Table A.11 lists nominal pipe widths and respective pressure differential R as functions of flow rates for selected peak flows \dot{V}_S . This interdependence of the individual factors is based on the diagram presented in Figure A.1.



- a Peak flow, \dot{V}_s , in l/s
- b Internal pipe diameter, d_1 , in mm
- c Pressure differential, R (the pressure differences include losses in elbows, branches, valves, etc.)
- d Flow rate, v , in m/s
- e Hospital and close vicinity
- f Accommodation data
- g Commissary spaces
- h Machinery spaces and trunk

Figure A.1 — Nomogram for determination of nominal pipe widths and pressure differentials for given peak flows and flow rates for copper and stainless steel pipelines

The values listed in Table 11 are rounded up/down.

Table A.11 — Peak flows, nominal widths, pressure differentials for copper and stainless steel pipelines

| Peak flow V_s l/s | Flow rate v m/s | | | | | | | |
|-------------------------------|----------------------|--|---------------------|--|---------------------|--|---------------------|--|
| | 1 | | 1,4 | | 2 | | 2,5 | |
| | Nominal width DN | Pressure differential R mbar/m | Nominal width DN | Pressure differential R mbar/m | Nominal width DN | Pressure differential R mbar/m | Nominal width DN | Pressure differential R mbar/m |
| 0,2 | 15 | 20,0 | 12 | 50 | 10 | 125 | 10 | 220 |
| 0,3 | 20 | 14,0 | 15 | 36 | 12 | 95 | 12 | 170 |
| 0,45 | 25 | 11,0 | 20 | 27 | 15 | 70 | 15 | 130 |
| 0,7 | 32 | 8,0 | 25 | 20 | 20 | 52 | 20 | 95 |
| 1,0 | 40 | 6,0 | 32 | 15 | 25 | 40 | 25 | 75 |
| 1,5 | 40/50 | 4,8 | 40 | 11,5 | 32 | 30 | 32 | 55 |
| 2,25 | 50 | 3,5 | 50 | 8,6 | 40 | 23 | 32 | 42 |
| 3,5 | 65 | 2,6 | 65 | 6,5 | 50 | 16,5 | 40 | 30 |
| 5,25 | 80 | 1,9 | 65 | 4,7 | 65 | 12 | 50 | 23 |
| 8,0 | 100 | 1,5 | 80 | 3,7 | 65 | 9,5 | 65 | 17 |

NOTE The pressure differentials mentioned include losses occurring at elbows, branchings, valves, etc. Pressure differentials due to pipe friction are only very small over a temperature range of up to 60 °C; this alteration of the pressure differential is negligible.

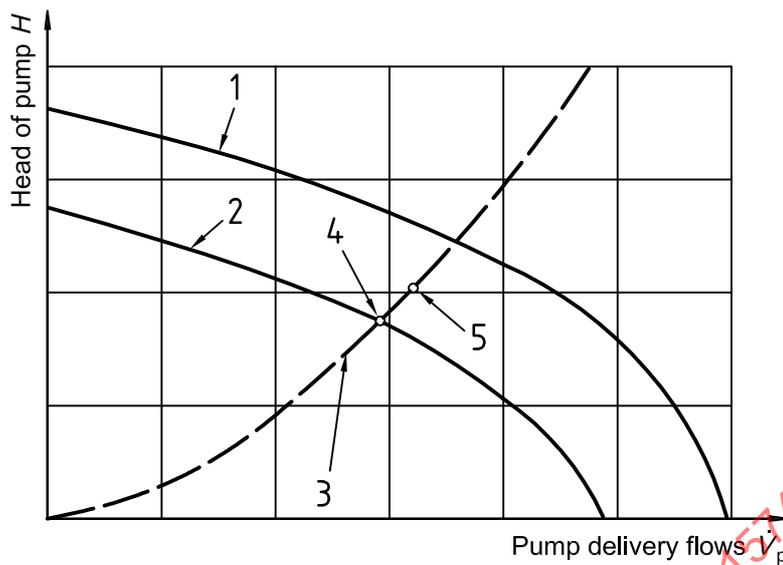
Table A.12 — Guide values for minimum flow pressures and calculation flow of standard potable water service points

| Minimum flow pressure $p_{\min FI}$ bar | Type of potable water service point | Calculation flow for withdrawal of | | |
|---|--|------------------------------------|----------------------------|-----------------------------------|
| | | Mixed water ^a | | Cold or heated potable water only |
| | | \dot{V}_R cold l/s | \dot{V}_R warm l/s | \dot{V}_R l/s |
| | Output valves | | | |
| 0,5 | without bubbler ^b DN 15 | — | — | 0,30 |
| 0,5 | DN 20 | — | — | 0,50 |
| 0,5 | DN 25 | — | — | 1,00 |
| 1,0 | with bubbler DN 10 | — | — | 0,15 |
| 1,0 | DN 15 | — | — | 0,15 |
| 1,0 | Shower heads for cleaning purposes DN 15 | 0,10 | 0,10 | 0,20 |
| 1,2 | Flush valve for flushing W.C. DN 15 | — | — | 0,70 |
| 1,2 | Flush valve for flushing W.C. DN 20 | — | — | 1,00 |
| 0,4 | Flush valve for flushing W.C. DN 25 | — | — | 1,00 |
| 1,0 | Flush valve for urinals DN 15 | — | — | 0,30 |
| 1,0 | Household dishwasher DN 15 | — | — | 0,15 |
| 1,0 | Household washing machine DN 15 | — | — | 0,25 |
| — | Commissary machines and appliances (data according to manufacturer) DN ... | — | — | — |
| | Mixer taps | | | |
| 1,0 | Shower bases DN 15 | 0,15 | 0,15 | — |
| 1,0 | Bath tubs DN 15 | 0,15 | 0,15 | — |
| 1,0 | Kitchen sinks DN 15 | 0,07 | 0,07 | — |
| 1,0 | Pedestal wash basins DN 15 | 0,07 | 0,07 | — |
| 1,0 | Bidets DN 15 | 0,07 | 0,07 | — |
| 1,0 | Foot baths DN 15 | 0,07 | 0,07 | — |
| 1,0 | Mixer taps DN 20 | 0,30 | 0,30 | — |
| 0,5 | Flush tanks for flushing W.C. DN 15 | — | — | 0,13 |
| 1,5 | Vacuum lavatory DN 15 | — | — | 0,30 |
| 1,0 | Electrical water boiler DN 15 | — | — | 0,10 |

NOTE For supply points and apparatus not included in this table and that are of the same type as those listed but with greater flows or minimum flow pressures than those given here, the data supplied by the manufacturer are to be taken into consideration when determining the required pipe diameter.

^a The calculation flows for the withdrawal of mixed water are based on 15 °C for cold and 60 °C for hot drinking water.

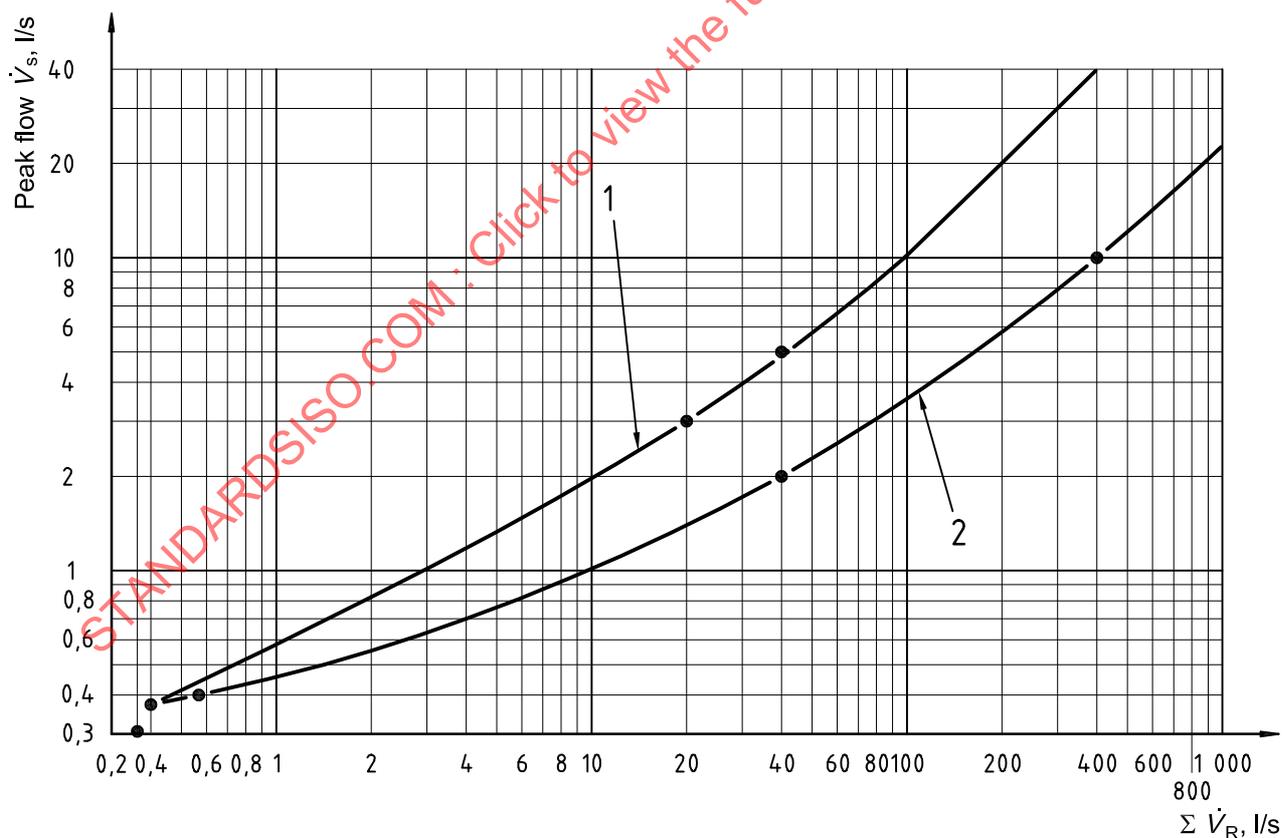
^b For output valves without bubblers and with hose end fittings, a standard value for the pressure loss in the hose line (up to 10 m) and in the apparatus (e.g. high-pressure cleaner) connected is included in the minimum flow pressure. In this case, the minimum flow pressure increases by 1 bar to 1,5 bar.



Key

- | | |
|--|---------------------------------|
| 1 Pump performance characteristic (P1) | 3 Pipeline characteristic |
| 2 Pump performance characteristic (P2) | 4 Computed operating point (BP) |
| | 5 Recommended operating point |

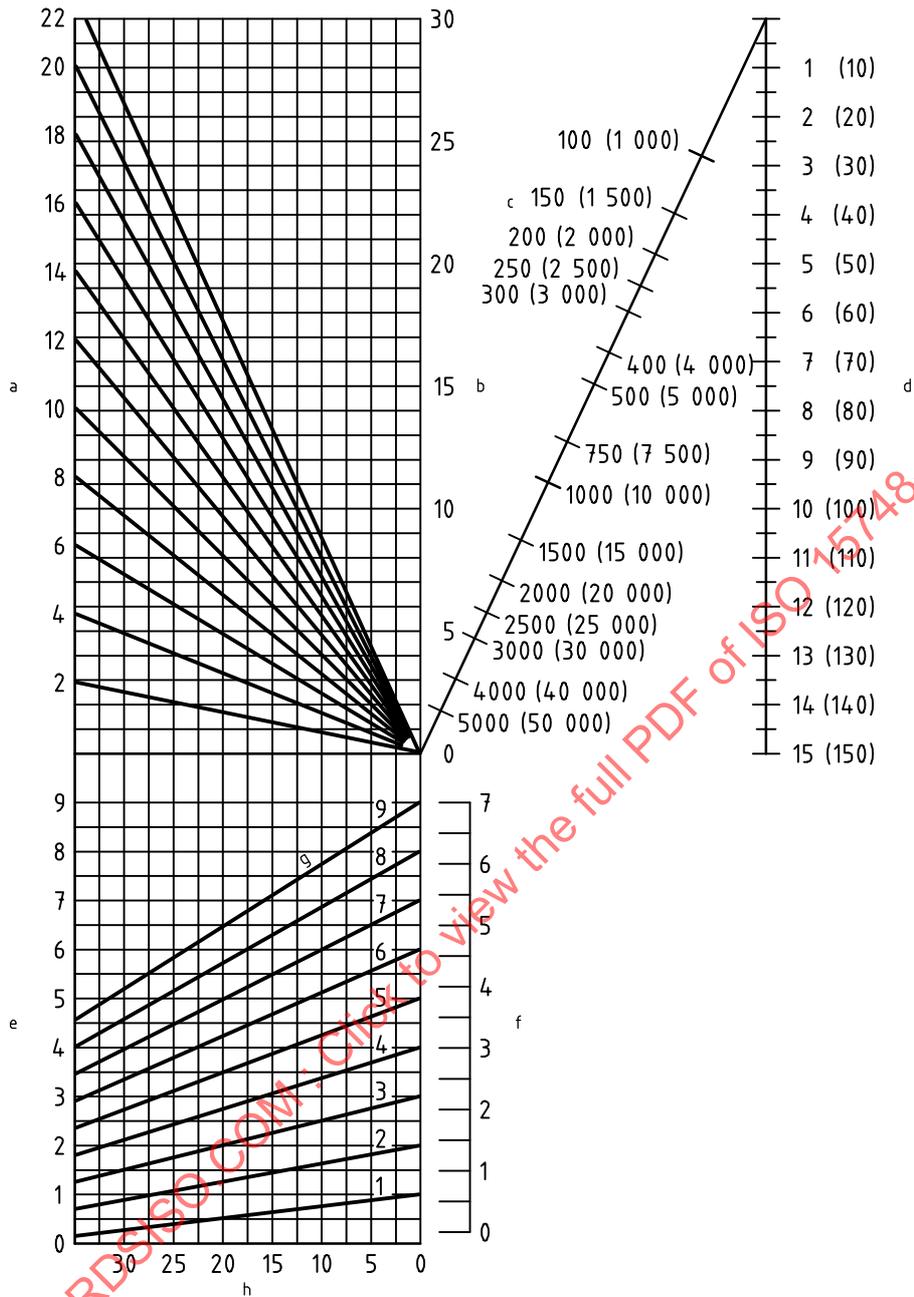
Figure A.2 — Selection of suitable pump size



Key

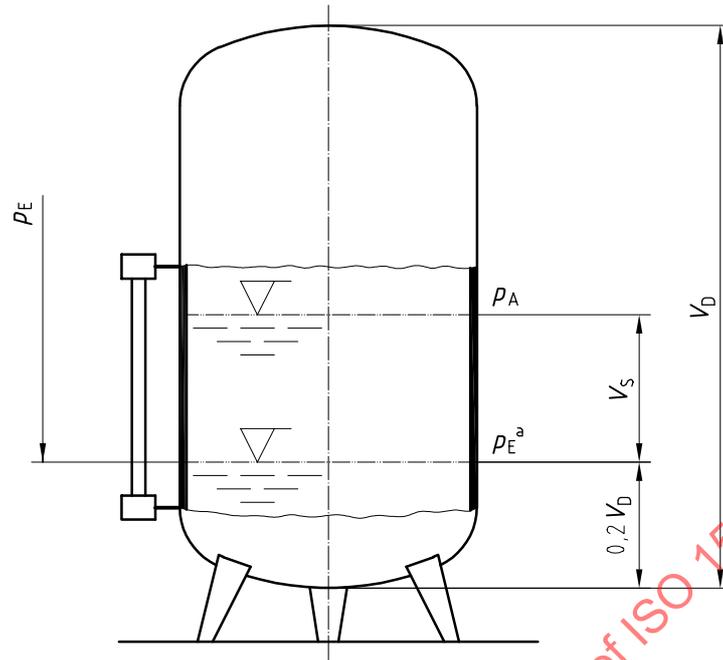
- 1 Passenger ship
- 2 Cargo ship

Figure A.3 — Peak flow \dot{V}_s as a function of the sum flow $\Sigma \dot{V}_R$



- a Switching frequency per h S
 - b $\frac{\text{Pump delivery flow}}{\text{Reservoir volume}} \times \frac{\dot{V}_p}{V_D} \times \frac{\text{m}^3}{\text{h} \cdot \text{m}^3}$
 - c Reservoir volume V_D l
 - d Pump delivery flow $\dot{V}_p = \dot{V}_{p\text{min}}$ in m^3/h
 - e Cut-in pressure p_E of the pump in bar
 - f Pre-pressure p_V in bar; for compressed air in the water reservoir
 - g Cut-out pressure p_A in bar
 - h Usable volume of water reservoir V_{eff} in %
- $$V_{\text{eff}} = \frac{V_s}{V_D} \times 100$$

Figure A.4 — Functional diagram for determination of the size of water reservoirs



^a p_E marking on the level indicator.

Figure A.5 — Determination of the size of the pressurized water reservoir

For computation of this value the equations (A.1) to (A.3) can be used:

$$\frac{V_S}{V_D} = \frac{p_A \times p_E}{p_A + p_E} \times 0,8 \quad (\text{A.1})$$

$$p_V = 0,8 - p_E \times 0,2 \quad (\text{A.2})$$

$$\frac{\dot{V}_p}{V_D} = \frac{V_S}{V_D} - 4 - S \quad (\text{A.3})$$

where

p_A is the pump cut-off pressure in bar;

p_E is the pump cut-in pressure in bar;

p_V is the pre-pressure for compressed air cushions inside the water reservoir in bar;

\dot{V}_p is the pump delivery in cubic metres per hour;

S is the pump switching frequency per hour (h^{-1});

V_D is the water reservoir volume in cubic metres;

V_S is the storage volume = maximum storable volume of water.

Annex B
(informative)

Form sheets for calculation

The user of this part of ISO 15748 may reprint the form sheets shown in annex B.

B.1 Form sheet for the determination the maximum flow by using the sum flow

| Building No: | | | | | | | | | | | |
|----------------------------------|------|--------|--|---|----------------------------|---------------------------|--------------------------------------|-------------------------|------------------------|-------------------------|------------------------|
| Official in charge: | | | | Date: | | | | Sheet-No: | | | |
| Riser (trunk line) No. | Deck | Number | Outlet fitting combination of outlet fitting | Minimum flow pressure pressure loss $p_{min FI}$ mbar | Calculated flow | | | Sum flow | | | |
| | | | | | Water | | Mixed water \dot{V}_R l/s | Deck line | | Riser (trunk line) | |
| | | | | | cold \dot{V}_R l/s | hot \dot{V}_R l/s | | cold Σ l/s | hot Σ l/s | cold Σ l/s | hot Σ l/s |
| | | | | | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 2 | 3 | 4 | 5 | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

B.2 Form sheet for the determination of pipe diameters and pressure losses

| | | | | | | | | | | | | |
|----------------------|----------------|----------|-------------|--------------------------------|-----------------------|-----------------------|---------------|----------------------------|-----------------------|-----------------------|---------------|----------------------|
| Building No.: | | | | | | | | | | | | |
| Official in charge: | | | | Date: | | | | Sheet-No.: | | | | |
| Trunk No.: | | | | Type of pipe: | | | | In accordance with: | | | | |
| Cold water/Hot water | | | | | | | | | | | | |
| From the pipe plan | | | | Used provisional pipe diameter | | | | Used changed pipe diameter | | | | Difference |
| Line part | Length of pipe | Sum flow | Peak flow | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Pressure loss |
| | l | Σ | \dot{V}_s | | v | R | $l \times R$ | | v | R | $l \times R$ | $\Delta(l \times R)$ |
| TS | m | l/s | l/s | DN | m/s | mbar/m | mbar | DN | m/s | mbar/m | mbar | mbar |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | | | | | | | | | | | | |

STANDARDSISO.COM : Click to view the full PDF of ISO 15748-2:2002

B.3 Form sheet for the calculation of a circulation system

| Building No.: | | | | | | | | | | | | | |
|-----------------------------|----------------|------------------|---------------------------|----------|--|----------------|------------------|---------------------------|----------|-------------|------------|-----------------------|---------------|
| Offical in charge: | | | | | Date: | | | | | Sheet-No.: | | | |
| Potable water line cold/hot | | | | | Circulation line, calculation in accordance with clause 12 | | | | | | | | |
| Line part | Length of pipe | Nominal diameter | Water capacity per m pipe | Capacity | Line part | Length of pipe | Nominal diameter | Water capacity per m pipe | Capacity | Peak flow | Flow speed | Pressure differential | Pressure loss |
| | l | | V/l | V | | l | | V/l | V | \dot{V}_s | v | R | $l \times R$ |
| TS | m | DN | l/m | l | TS | m | DN | l/m | l | l/s | m/s | mbar/m | mbar |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | | | | | | | | | | | | | |

STANDARDSISO.COM : Click to view the full PDF of ISO 15748-2:2002

Annex C (informative)

Calculation example

C.1 General

The following example shows how to use formulae, tables and form sheets given in this part of ISO 15478.

The calculation example is given for a cargo ship with passenger cabins, with central supply of hot water.

All numbers in bold letters correspond to the clause number or Table number in the text or in annex A or annex B.

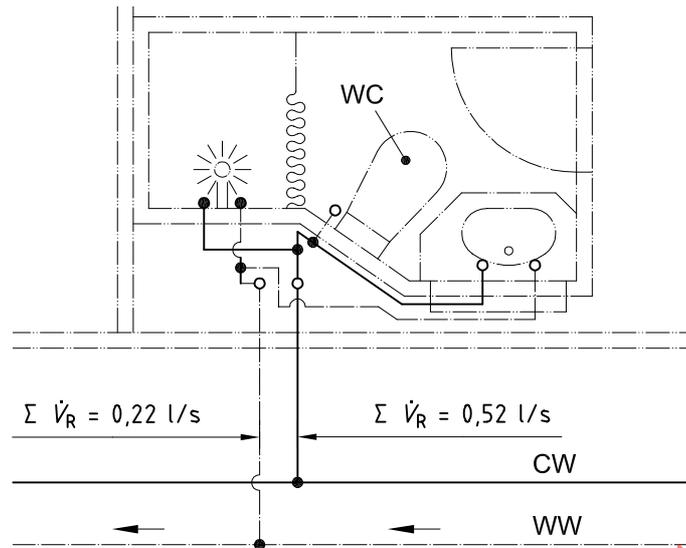
C.2 Basic for calculation

C.2.1 The following requirements, basics or values are given by the building contract, the general arrangement plan or similar documents:

- a) cargo ship with a crew of eighteen members and six passenger cabins;
- b) one standard sanitary unit per passenger cabin;
- c) one room and one standard sanitary unit per crew member;
- d) central supply of hot water by means of storage heaters;
- e) supplied indirectly via pressurized water reservoir;
- f) UV-sterilization plant.

C.2.2 The following documents are to be established:

- a) arrangement of potable water installations (equipment, piping, water consuming equipment, valves etc.) (see Figures C.1 and C.2);
- b) calculation plan for potable water pipework for hot and cold water, (see Figure C.2);
- c) calculation plan for circulating lines;
- d) selection of type of pipes.

**Key**

- CW cold water, trunk line
 WW hot water, trunk line
 WC vacuum WC

Service lines:

- Trunk — wash basin 1,25 m horizontal + 1,5 m vertical = 2,75 m for CW and WW
 Trunk — shower 1,25 m horizontal + 1,0 m vertical = 2,25 m for CW and WW
 To the WC ≈ 2,0 m for CW (downwards)
 Trunk — trunk line 0,75 m for CW and WW

Figure C.1 — Standard sanitary unit (sanitary cold and warm water supply)

C.3 Method of calculation**C.3.1 Determination of required potable water volume**

- according to Table A.1 or Table A.2;
- potable water reservoirs according to clause 4.

C.3.2 Determination of the peak flow

The values are presented in the form sheet C.1, (see Table D.1).

- registration of all outlet fittings and service points with minimum flow pressure and calculated flow (for guide values see Table A.12).
- calculate and associate sum flows of line parts. Insert values in calculation plan Figure C.2.
- evaluate peak flow by the sum flow using diagram Figure A.3. Add consumption of permanent users (e.g. laundry) to the sum flow.

C.3.3 Determination of pipe diameters and of pressure losses

The values are presented in Table D.2 (see form sheet B.2).

- insert line parts and sum flows of line part taken from calculation plan Figure C.2 or form sheet B.1. The rating starts versus flow direction, beginning at the most distant outlet and ending at the pressure vessel or the pump;
- peak flows evaluated from the sum flows of line parts taken from diagram Figure A.3;
- determine preliminary pipe diameter and pressure differential R , based on pipe friction and the resistance of components, due to the peak flow and the permissible flow rates, using diagram Figure A.1 (The pressure differential include losses at elbows, branches, valves etc.);
- calculate pressure losses $l \times R$.

A simplified determination is possible using Table A.11.

Depending on the permissible flow rates, nominal diameters are associated with peak flows. Sum flow/part line should be selected in such a way that the resulting peak flows are as near as possible to those given in the Table A.11. By this means the determination of a longer part of the pipework and the calculation of the pressure losses is possible.

C.3.4 Calculation of the circulating system

See Table C.5.

The values are presented in form sheet B.3

- insert values taken from Table C.2 (see form sheet B.2 columns 1, 2 and 3);
- take nominal diameters of circulating lines from Table A.7 and allocate them to the distribution lines;
- calculate the volume of the potable water lines and the circulating lines with the values according to Tables A.8 to A.10 (without storage tanks and water heaters);
- calculate the pump delivery flow in accordance with 12.2;
- determine pressure losses with respect to the head of the pump in accordance with 12.3;
- check the flow rates (see clause 6).

C.3.5 Determination of pressure losses and of the necessary head of the pump (supply pressure)

The values are presented in Table C.6 (see form sheet B.4).

The necessary head of the pump is calculated in accordance with clause 7 for the higher value of the hot water and of the cold water.

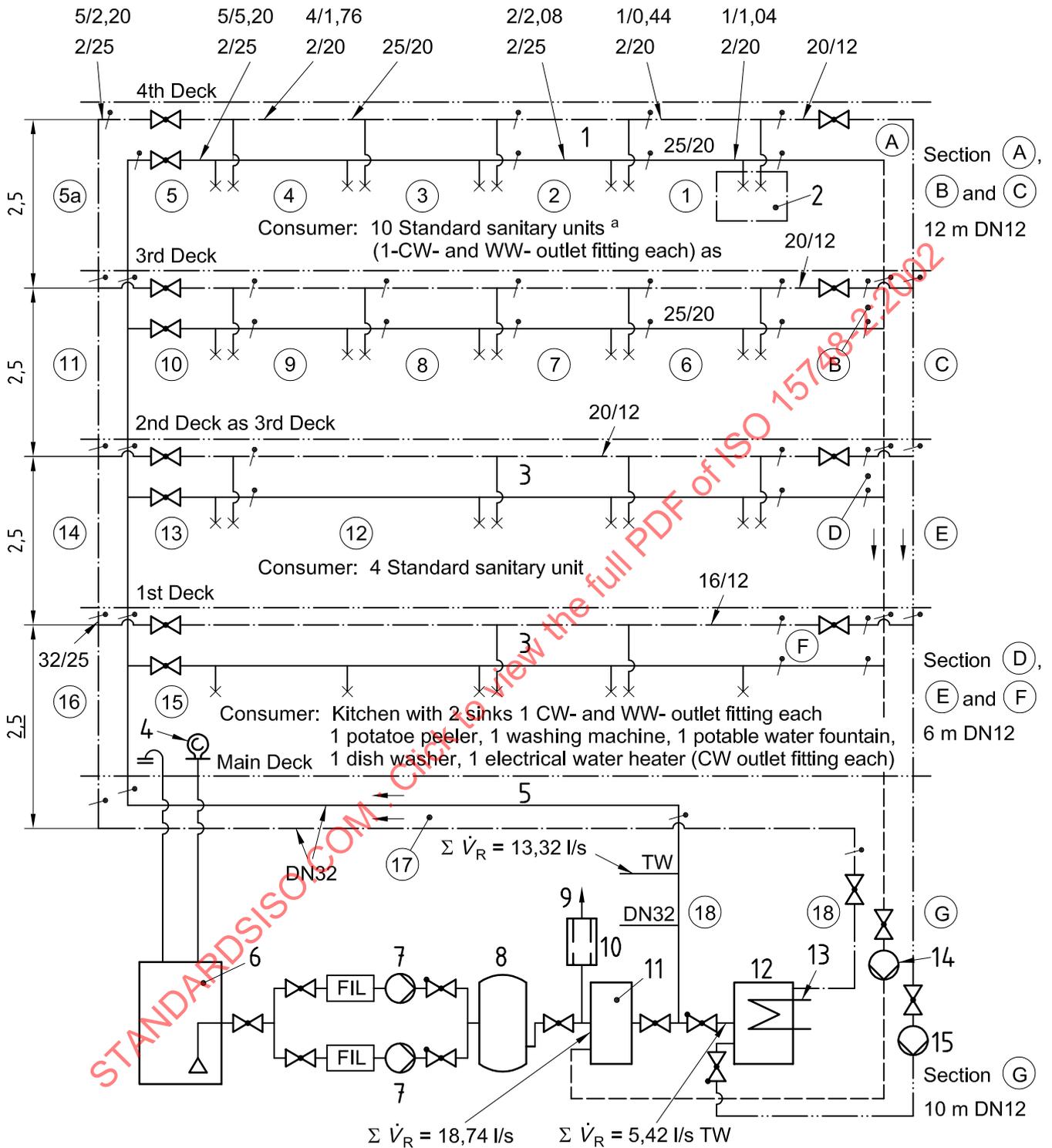
C.3.6 Determination of the capacity of the supply pump

The capacity of the pump is calculated in accordance with 8.3 using the peak flow given in Table C.1 (see form sheet B.1).

C.3.7 Determination of the pressurized water reservoir volume

Determine the pressurized water reservoir volume in accordance with 8.2, using the diagram in Figure A.4 with the pump capacity (see C.3.6) and the head of pump = cut-in pressure (see C.3.5) and the chosen cut-off pressure $p_A = 6,25$ bar and 12 switching events h^{-1} .

Dimensions in meters



Limitations of the single line parts: numbers and letters in circles represent line part information.

Example how to read: $\frac{1/1,04}{2/20} = \frac{\text{No. of the part line} / \text{sum flow } \Sigma \dot{V}_R \text{ in l/s}}{\text{length in m} / \text{nominal diameter}}$

Key

1 10 m length, 6 elbow

- 2 Standard sanitary unit
- 3 10 m length, 6 elbow 90°
- 4 Filling connection for potable water tanks (see ISO 5620-1)
- 5 15 m length, 6 elbow 90°, 5 m to main deck
- 6 Potable water reservoir
- 7 Potable water supply pump
- 8 Pressure vessel
- 9 Technical consumers
- 10 Pipe disconnecter
- 11 Sterilization unit
- 12 Water heater
- 13 Heating media
- 14 Cold water circulating pump
- 15 Hot water circulating pump

CW = cold water; WW = hot water; TW = potable water

^a Only 5 units are shown.

Figure C.2 — Example for a calculation scheme (the determined nominal diameters are recorded)

STANDARDSISO.COM : Click to view the full PDF of ISO 15748-2:2002

Table C.1 — Form sheet B.1 for the determination the maximum flow by using the sum flow

| Building No: | | | | | | | | | | | | |
|--|--------------|--------|--|--|----------------------------|---------------------------|--------------------------------------|-------------------------|------------------------|-------------------------|------------------------|--|
| Official in charge: | | | | Date: | | | | Sheet-No: | | | | |
| Riser (Trunk line) No. | Deck | Number | Outlet fitting combination of outlet fitting | Minimum flow pressure pressure loss p_{\min} Fl mbar | Calculated flow | | | Sum flow | | | | |
| | | | | | Water | | Mixed water \dot{V}_R l/s | Deck line | | Riser (Trunk line) | | |
| | | | | | cold \dot{V}_R l/s | hot \dot{V}_R l/s | | cold Σ l/s | hot Σ l/s | cold Σ l/s | hot Σ l/s | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Standard sanitary unit as given in Figure C.1 | | | | | | | | | | | | |
| | | 1 | Mixer tap wash basin | 1 000 | 0,07 | 0,07 | | | | | | |
| | | 1 | Mixer tap shower | 1 000 | 0,15 | 0,15 | | | | | | |
| | | 1 | Vacuum-WC | 1 500 | 0,30 | | | | | | | |
| | | | | | 0,52 | 0,22 | | | | | | |
| 5 | 3 | 10 | Units | | | | | 5,2 | 2,2 | | | |
| 10 | 2 | 10 | Units | | | | | 5,2 | 2,2 | | | |
| 11 | | | | | | | | | | 10,4 | 4,4 | |
| 13 | 1 | 4 | Units | | | | | 2,08 | 2,08 | | | |
| 14 | | | | | | | | | | 12,48 | 5,28 | |
| 15 | Main deck | 2 | Kitchen sinks | 1 000 | 0,14 | 0,14 | | | | | | |
| | | 1 | Potato peeler | 1 000 | 0,13 | | | | | | | |
| | | 1 | Dish washer | 1 000 | 0,15 | | | | | | | |
| | | 1 | Electrical water heater | 1 000 | 0,10 | | | | | | | |
| | | 1 | Water fountain | 1 000 | 0,07 | | | | | | | |
| | | 1 | Washing machine | 1 000 | 0,25 | | | | | | | |
| | | | | | — | — | | | | | | |
| | | | | | 0,84 | 0,14 | | 0,84 | 0,14 | | | |
| 16 + 17 Main lineCW WW | | | | | | | | | | 13,32 | 5,42 | |
| Total flow for CW and WW + permanent consumers = calculation volume 18,74 l/s + ... = ... | | | | | | | | | | | | |
| By $\Sigma = 18,74$ l/s there is for cargo ships according to Diagram Figure A.3 a peak flow $\dot{V}_s \approx 1,4$ l/s | | | | | | | | | | | | |

Table C.2 — Form sheet B.2 for the determination of pipe diameters and pressure losses

| Building No.: | | | | Date: | | | | Sheet-no.: | | | | | | | | | |
|---|----------------|----------|-------------|--------------------------------|-----------------------|-----------------------|----------------|---|-----------------------|-----------------------|---------------|-----------------------|--|--|--|-----|--|
| Official in charge: | | | | Type of pipe: | | | | In accordance with: | | | | | | | | | |
| Trunk No.: | | | | Cold water | | | | | | | | | | | | | |
| From the pipe plan | | | | Used provisional pipe diameter | | | | Used changed pipe diameter | | | | Difference | | | | | |
| Line part | Length of pipe | Sum flow | Peak flow | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Pressure loss | | | | | |
| | l | Σ | \dot{V}_s | | v | R | $l \times R$ | | v | R | $l \times R$ | $\Delta (l \times R)$ | | | | | |
| TS | m | l/s | l/s | DN | m/s | mbar/m | mbar | DN | m/s | mbar/m | mbar | mbar | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | | | | | |
| Trunk | 0,75 | 1,04 | 0,46 | 20 | 1,48 | 29 | 22 | Connections for 2 standard sanitary units Same consumers as on the 3rd deck; and DN as on the 3rd deck. Consideration of pressure losses may be deleted, when sufficient flow pressure is available at the most distant outlet fitting at the most upper deck. | | | | | | | | | |
| 1 | 2,0 | 1,04 | 0,46 | 25 | 1,48 | 29 | 58 | | | | | | | | | | |
| 2 | 2,0 | 2,08 | 0,55 | 25 | 1,15 | 13 | 26 | | | | | | | | | | |
| 3 | 2,0 | 3,12 | 0,63 | 25 | 1,30 | 16 | 32 | | | | | | | | | | |
| 4 | 2,0 | 4,16 | 0,71 | 25 | 1,47 | 21 | 42 | | | | | | | | | | |
| 5 | 2,0 | 5,20 | 0,78 | 25 | 1,61 | 26 | 52 | | | | | | | | | | |
| 5a | 2,5 | 5,20 | 0,78 | 25 | 1,61 | 26 | 65 | | | | | | | | | | |
| | | | | | | | $\Sigma = 297$ | | | | | | | | | 297 | |
| 6 | | 1,04 | | | | | | | | | | | | | | | |
| 7 | | 2,08 | | | | | | | | | | | | | | | |
| 8 | | 3,12 | 4,16 | | | | | | | | | | | | | | |
| 9 | | 5,20 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |
| 11 | 2,5 | 10,4 | 1,02 | 25 | 2,09 | 45 | 113 | | | | | | | | | | |
| $l \times R = 113$ value too high; new DN | | | | | | | | 32 | 1,26 | 12 | 30 | (83) | | | | | |
| 12 | 5,0 | 1,04 | 0,46 | 20 | 1,48 | 29 | | | | | | | | | | | |
| 13 | 5,0 | 2,08 | 0,55 | 25 | 1,15 | 13 | | | | | | | | | | | |
| 14 | 2,5 | 12,48 | 1,10 | 25 | 2,25 | 52 | 130 | | | | | | | | | | |
| $l \times R = 130$ value too high; new DN | | | | | | | | 32 | 1,38 | 14 | 35 | (95) | | | | | |
| 15 | 10,0 | 0,84 | 0,41 | 16 | 2,05 | | | | | | | | | | | | |
| 16 | 2,25 | 13,32 | 1,17 | 25 | 2,40 | 59 | 133 | | | | | | | | | | |
| $l \times R = 133$ value too high; new DN | | | | | | | | 32 | 1,47 | 16 | 36 | (97) | | | | | |
| 17 | 15,0 | 13,32 | 1,17 | 25 | 2,40 | 59 | 885 | | | | | | | | | | |
| $l \times R = 885$ value too high; new DN | | | | | | | | 32 | 1,47 | 16 | 240 | (645) | | | | | |
| 18 | 5,0 | 13,32 | 1,17 | 25 | 2,40 | 59 | 295 | | | | | | | | | | |
| $l \times R = 295$ value too high; new DN | | | | | | | | 32 | 1,47 | 16 | 80 | (215) | | | | | |
| Total pressure loss by altered DN $\frac{1\ 853}{1\ 135}$ | | | | | | | | | | | 1 135 | | | | | | |
| Total pressure loss when DN altered | | | | | | | | | | | 718 | | | | | | |

Table C.3 — Simplified determination by using Table A.11

| Part line | Pipe length | Sum flow | Peak flow | Nominal diameter | Calculated flow rate | Pressure differential | Pressure loss |
|----------------|---------------------|----------|-------------|------------------|----------------------|-----------------------|----------------|
| <i>TS</i> | <i>l</i> | Σ | \dot{V}_s | | <i>v</i> | <i>R</i> | $l \times R$ |
| | m | l/s | l/s | DN | m/s | mbar/m | mbar |
| Trunk line + 1 | 2,75 | 1,04 | 0,46 | 20 | 1,4 | 27 | 74,25 |
| 2 to 5a | 10,5 | 5,20 | 0,78 | 25 | 1,4 | 20 | 210 |
| 6 to 10 | the same as 2 to 5a | | | | | | |
| 11 | 2,5 | 10,4 | 1,02 | 32 | 1,4 | 15 | 37,5 |
| 12 | 5,0 | 1,04 | 0,46 | 20 | 1,4 | 27 | |
| 13 | 5,0 | 2,08 | 0,55 | 25 | 1,4 | 20 | |
| 14 | 2,5 | 12,48 | 1,10 | 32 | 1,4 | 15 | 37,5 |
| 15 | 10,0 | 0,77 | 0,41 | 20 | 1,4 | 27 | |
| 16 to 18 | 22,25 | 13,25 | 1,17 | 32 | 1,4 | 15 | 333,75 |
| | | | | | | | $\Sigma = 693$ |

STANDARDSISO.COM : Click to view the full PDF of ISO 15748-2:2002

Table C.4 — Form sheet B.2 for the determination of pipe diameters and pressure losses

| Building No.: | | | | Official in charge: | | | | Date: | | | | Sheet-No.: |
|---|----------------|----------|-------------|--------------------------------|-----------------------|-----------------------|----------------|---|-----------------------|-----------------------|---------------|-----------------------|
| Trunk No.: | | | | Type of pipe: | | | | In according with: | | | | |
| Hot water | | | | | | | | | | | | |
| From the pipe plan | | | | Used provisional pipe diameter | | | | Used changed pipe diameter | | | | Difference |
| Line part | Length of pipe | Sum flow | Peak flow | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Nominal diameter | Calculated flow speed | Pressure differential | Pressure loss | Pressure loss |
| TS | l | Σ | \dot{V}_s | | v | R | $l \times R$ | | v | R | $l \times R$ | $\Delta (l \times R)$ |
| | m | l/s | l/s | DN | m/s | mbar/m | mbar | DN | m/s | mbar/m | mbar | mbar |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Trunk | 0,75 | 0,44 | 0,37 | 20 | 1,20 | 20 | 15 | Connections for 2 standard sanitary units | | | | |
| 1 | 2,0 | 0,44 | 0,37 | 20 | 1,20 | 20 | 40 | | | | | |
| 2 | 2,0 | 0,88 | 0,44 | 20 | 1,40 | 27 | 54 | | | | | |
| 3 | 2,0 | 1,32 | 0,49 | 20 | 1,58 | 35 | 70 | | | | | |
| 4 | 2,0 | 1,76 | 0,54 | 20 | 1,72 | 41 | 82 | | | | | |
| 5 | 2,0 | 2,20 | 0,58 | 25 | 1,20 | 14 | 28 | | | | | |
| 5a | 2,5 | 2,20 | 0,58 | 25 | 1,20 | 14 | 35 | | | | | |
| | | | | | | | $\Sigma = 324$ | | | | 324 | |
| 6 | | 0,44 | | | | | | | | | | |
| 7 | | 0,88 | | | | | | | | | | |
| 8 | | 1,32 | | | | | | | | | | |
| 9 | | 1,76 | | | | | | | | | | |
| 10 | | 2,20 | | | | | | | | | | |
| 11 | 2,5 | 4,40 | 0,73 | 25 | 1,51 | 23 | 58 | | | | 58 | |
| 12 | 5,0 | 0,44 | 0,37 | 20 | 1,20 | 20 | | | | | | |
| 13 | 5,0 | 0,88 | 0,44 | 20 | 1,40 | 27 | | | | | | |
| 14 | 2,5 | 5,28 | 0,80 | 25 | 1,61 | 26 | 65 | | | | 65 | |
| 15 | 10,0 | 0,14 | 0,14 | 12 | | | | | | | | |
| 16 | 2,25 | 5,42 | 0,80 | 25 | 1,61 | 26 | 59 | | | | 59 | |
| 17 | 15,0 | 5,42 | 0,80 | 25 | 1,61 | 26 | 390 | | | | | |
| $l \times R = 390$ value too high; new DN | | | | | | | | 32 | 1,01 | 7,5 | 112,5 | (277,5) |
| 18 | 5,0 | 5,42 | 0,80 | 25 | 1,61 | 26 | 130 | | | | | |
| $l \times R = 130$ value too high; new DN | | | | | | | | 32 | 1,01 | 7,5 | 37,5 | (92,5) |
| $\frac{\text{Total pressure loss}}{\Delta \text{ pressure loss}} \text{ by altered DN } \frac{1026}{370}$ | | | | | | | | | | | 370 | |
| Total pressure loss when DN altered 656 | | | | | | | | | | | 656 | |

Table C.5 — Form sheet B.3 for the calculation of a circulating system

| Building No.: | | Official in charge: | | | Date: | | Sheet-No.: | | | | | | |
|-------------------------|----------------|--|---------------------------|----------|--|----------------|------------------|---------------------------|----------|-------------|------------|---|---------------|
| Drinking water line hot | | | | | Circulation line, calculation in accordance with clause 12 | | | | | | | | |
| Line part | Length of pipe | Nominal diameter | Water capacity per m pipe | Capacity | Line part | Length of pipe | Nominal diameter | Water capacity per m pipe | Capacity | Peak flow | Flow speed | Pressure differential | Pressure loss |
| TS | l | DN | V/l | V | TS | l | DN | V/l | V | \dot{V}_s | v | R | $l \times R$ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 18 | 5,0 | 32 | 0,80 | 4,0 | G | 10 | 12 | 0,13 | 1,30 | 0,031 | 0,24 | 1,0 | 10,0 |
| 17 | 15,0 | 32 | 0,80 | 12,0 | | | | | | | | | |
| 16 | 2,25 | 25 | 0,49 | 1,11 | | | | | | | | | |
| 15 | 10,0 | 15 | 0,20 | 2,0 | | | | | | | | | |
| 14 | 2,5 | 25 | 0,49 | 1,23 | | | | | | | | | |
| 13 | 5,0 | 20 | 0,31 | 1,55 | | | | | | | | | |
| 12 | 5,0 | 20 | 0,31 | 1,55 | DEF | 6 | 12 | 0,13 | 0,78 | 0,016 | 0,12 | 0,35 | 2,1 |
| 11 | 2,5 | 25 | 0,49 | 1,23 | | | | | | | | | |
| 10 | 2,0 | 25 | 0,49 | 0,98 | | | | | | | | | |
| 9 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 8 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 7 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 6 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 5a | 2,5 | 25 | 0,49 | 1,23 | | | | | | | | | |
| 5 | 2,0 | 25 | 0,49 | 0,98 | | | | | | | | | |
| 4 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 3 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 2 | 2,0 | 20 | 0,31 | 0,62 | | | | | | | | | |
| 1 | 2,0 | 20 | 0,31 | 0,62 | ABC | 12 | 12 | 0,13 | 1,56 | 0,016 | 0,12 | 0,35 | 4,2 |
| | | $V = 32,82 \text{ l}$ $+ 3,64 \text{ l}$ <hr/> $V_g = \Sigma V = 36,48 \text{ l}$ ===== | | | | | | $V = 3,64 \text{ l}$ | | | | $\Sigma l \times R = 16,3 \text{ mbar}$ | |

Volume of warm water line: 36,48 l

According to 12.2 the flow \dot{V}_{UP} of the circulating pump is: $\dot{V}_{UP} = 3 \times \Sigma V$ to $\dot{V}_{UP} = 3 \times 36,48 \approx 110 \text{ l/h}$

According to 12.3 the head of the pump H_{UP} of the circulating pump is: $H_{UP} = \Sigma l \times R \times 1,4$

$H_{UP} = 16,3 \times 1,4 = 23 \text{ cm} \approx 23 \text{ mbar}$

Table C.6 — Form sheet B.4 for the calculation of the supply pressure

| Building No.: | | Official in charge: | | Date: | | Sheet No.: | | |
|--|--|-----------------------------------|------|---------------------------------|--------------------------------|------------|---|--------------------------|
| Cold water | | | | b) Central potable water heater | | | | |
| Information about the system: | | a) Connected to the supply use | | | Sectional potable water heater | | | <input type="checkbox"/> |
| Direct <input type="checkbox"/> | | Indirect <input type="checkbox"/> | | | | | | |
| No. | Term | Symbol | Unit | Trunk | | | | |
| | | | | 1 | 2 | 3 | 4 | 5 |
| 1 | Pressure loss caused by geodetic difference in altitude | Δp_{geo} | mbar | 1 475 | | | | |
| 2 | Pressure loss in apparatus e.g. | | | | | | | |
| | a) Pressure tanks | Δp_{PT} | mbar | 30 | | | | |
| | b) Filter | Δp_{FIL} | mbar | | | | | |
| | c) Sterilization plant | Δp_{EH} | mbar | 40 | | | | |
| | d) Dosing devices | Δp_{DOS} | mbar | | | | | |
| | e) Potable water heater | Δp_{TE} | mbar | | | | | |
| | f) Other apparatus | Δp_{Ap} | mbar | | | | | |
| 3 | Minimum flow pressure | $p_{min FI}$ | mbar | 1 500 | | | | |
| 4 | Pressure loss of the lines from sheet B.2 | Δp_{LE} | mbar | 718 | | | | |
| 5 | Sum of pressure losses from No. 1 to No. 4 ^a = minimum supply pressure | $\Sigma \Delta p$ | mbar | 3 763 | | | | |
| ^a The pressure losses of the pump suction line and the pump pressure line are not taken into consideration in this example. | | | | | | | | |