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**Equipment for water supply
service—Test methods of effect
to water quality**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS S 3200-7 : 2000** is replaced with this Standard.

JIS S 3200 consists of the following 7 parts under the general title *Equipment for water supply service*:

- Part 1 : Test methods of hydrostatic pressure*
- Part 2 : Test method of low temperature resistant*
- Part 3 : Test method of water hammer*
- Part 4 : Test method of prevention from back current*
- Part 5 : Test methods of destruction by vacuum pressure*
- Part 6 : Test methods of durability*
- Part 7 : Test methods of effect to water quality.*

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Equipment for water supply service— Test methods of effect to water quality

1 Scope This Japanese Industrial Standard specifies test methods of evaluating effect to water quality applicable to such equipment for water supply service as valves which include faucets, pressure reducing valves and relief valves, and pipes, fittings, piping units for dwellings, drinking-water coolers, electric storage tank water heaters, gas burning water heaters, oil burning water heaters.

2 Normative references The standards listed in attached table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) shall be applied.

3 Definitions For the purpose of this Standard, the following definitions shall apply:

- a) **leachate** Water specially prepared for performing the test.
- b) **equipment test** A test in which the elution operation is performed with leachate on equipment for water supply service.
- c) **part test** A test in which the elution operation is performed with leachate on parts in contact with drinking water in the equipment for water supply service.
- d) **material test** A test in which the elution operation is performed with leachate on intermediate products (materials) in contact with drinking water in the equipment for water supply service. However, it cannot apply when materials are metals.
- e) **blank test** A test in which the operation of the equipment test, part test or material test is performed with leachate and glassware instruments without samples.
- f) **sample liquid** The solution obtained by performing the elution treatment in the equipment test, part test or material test.
- g) **blank test liquid** The solution obtained by performing the elution treatment in the blank test.
- h) **test water** The solution separated from the sample liquid for the analysis.
- i) **test liquid** The test water treated in the process of analysis operation.
- j) **contact surface area ratio of equipment under test, part under test or material under test** The value obtained by dividing “the surface area of the equipment under test, part under test or material under test of which the portion is in contact with the leachate” by “the leachate volume”.
- k) **contact surface area ratio of equipment to be evaluated, part to be evaluated or material to be evaluated** The value obtained by dividing “the surface area of the equipment, part or material to be evaluated on the result of the part test or material test, of which the portion is actually in contact with drinking water” by “the volume of the relevant equipment, part or material to be evaluated”.

- 1) **standard bank** The bank prepared by changing the concentration of reference solution in stages in order to measure the quantity of the analyte in the test liquid.

4 Items The test items shall be as shown in table 1. The test items by materials shall be as shown in table 2 in addition to taste, odour, chromaticity, and turbidity.

Table 1 Test items

Item	Analytical method	Item	Analytical method
Cadmium and its compound	Annex 1	Sodium and its compound	Annex 1
Mercury and its compound	Annex 2	Manganese and its compound	Annex 1
Selenium and its compound	Annex 3	Chlorine ion	Annex 6
Lead and its compound	Annex 1	Evaporation residue	Annex 11
Arsenic and its compound	Annex 4	Anionic surfactant	Annex 12
Hexavalent chromium compound	Annex 1	Nonionic surfactant	Annex 12
Cyanide ion and a cyanogen chloride	Annex 5	Phenols	Annex 13
Nitrate nitrogen and nitrite nitrogen	Annex 6	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾	Annex 14
Fluorine and its compound	Annex 6	Taste	Annex 16
Boron and its compound	Annex 1		
Carbon tetrachloride	Annex 7	Odour	Annex 17
1,4-Dioxane	Annex 8		
1,2-Dichloroethane	Annex 7	Chromaticity	Annex 18
1,1-Dichloroethylene	Annex 7	Turbidity	Annex 19
Cis-1,2-dichloroethylene	Annex 7	Epichlorohydrin	Annex 22
Dichloromethane	Annex 7	Amines	Annex 23
Tetrachloroethylene	Annex 7	2,4-Toluene diamine	Annex 24
1,1,2-Trichloroethane	Annex 7	2,6-Toluene diamine	Annex 24
Trichloroethylene	Annex 7	Formaldehyde	Annex 9
Benzene	Annex 7	Vinyl acetate	Annex 25
Zinc and its compound	Annex 1	Styrene	Annex 26
Aluminium and its compound	Annex 1		
Iron and its compound	Annex 1	1,2-Butadiene	Annex 27
		1,3-Butadiene	Annex 27
Copper and its compound	Annex 1		

Note ⁽¹⁾ Organic matters, etc. (consumption of potassium permanganate) shall apply by Mar. 31, 2005.

Table 2 Item by materials

Materials of the portion in contact with drinking water	Item
Polyethylene lead composite pipes	Lead, organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾
Copper sheets, plates and strips, rods and bars, and pipes and tubes specified in JIS H 3100 , JIS H 3250 and JIS H 3300	Copper
Copper and copper alloy sheets, strips, rods and bars, wires, pipes and tubes, and castings specified in JIS H 3100 , JIS H 3250 , JIS H 3260 , JIS H 3270 , JIS H 3300 , JIS H 3320 , JIS H 5120 and JIS H 5121	Copper, lead, zinc, cadmium
Stainless steel pipes and tubes, rods and bars, sheets, plates, wire rods, and wires specified in JIS G 3459 , JIS G 3463 , JIS G 4303 , JIS G 4304 , JIS G 4305 , JIS G 4308 , JIS G 4309 , JIS G 4312 , JIS G 4313 and JIS G 4314	Iron, hexavalent chromium
Steel materials, steel sheets, steel plates, and steel pipes and tubes specified in JIS G 3101 , JIS G 3131 , JIS G 3133 and JIS G 3141	Iron
Polyethylene (PE) using materials specified in clause 8 of JIS K 6762 , crosslinked polyethylene (XPE) using materials specified in clause 8 of JIS K 6769 and in clause 8 of JIS K 6787 , and polybutene (PB) (including paints) using materials specified in clause 8 of JIS K 6778 and in clause 7 of JIS K 6792	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾
Polyvinyl chloride (PVC) using materials specified in clause 8 of JIS K 6742 , in 8.1 of JIS K 6743 , and chlorinated polyvinyl chloride (CPVC) using materials specified in 8.1 of JIS K 6776 , in 8.1 of JIS K 6777	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , lead, zinc
Acrylonitrile/butadiene/styrene (ABS)	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾
Polyoxymethylene (polyacetal): Polyformaldehyde (POM)	
Polyphenylene ether (PPE)	
Polyphenylene sulfide (PPS)	
Polytetrafluoroethylene (PTFE)	
Polyamide (PA)	
Polybutylene terephthalate (PBT)	
One-component system epoxy resin	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , phenols, cyanogen, epichlorohydrin, amines, formaldehyde, vinyl acetate, styrene, 1,2-butadiene, 1,3-butadiene

Table 2 (concluded)

Materials of the portion in contact with drinking water		Item
Two-component system epoxy resin		Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , phenols, cyanogen, epichlorohydrin, amines, 2,4-toluene diamine, 2,6-toluene diamine, formaldehyde, vinyl acetate, styrene, 1,2-butadiene, 1,3-butadiene
Acrylate resin		Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , formaldehyde, vinyl acetate, styrene, 1,2-butadiene, 1,3-butadiene
Rubber specified in JIS K 6353	Ethylene/propylene/diene (EPDM)	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , phenols, zinc
	Acrylonitrile butadiene rubber (NBR)	
	Styrene butadiene rubber (SBR)	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ , zinc
	Fluoro rubber (FKM)	
	Silicone rubber	
	Others	Organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ . However, for materials which contain materials given in table 1 as components, the test of the contained materials in addition to the organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) ⁽¹⁾ shall be also performed. However, in the case where it can be proved that the amount of leaching is 1/10 or less of the reference value even if the test is performed, that item may be omitted.
Others		All the items having a possibility of leaching in table 1. However, in the case where it is proved by performing the component test, etc. that the component is not contained in materials or their raw materials or in the case where it can be proved that the amount of leaching is 1/10 or less of the reference value, that item may be omitted.

- Remarks 1 For the stainless steel which is used for washers, springs, etc. and of which the contact surface area ratio is not exceeding 10 cm²/L, the determination of items given in this table may be omitted.
- 2 When substances corresponding to the standard item are contained as additives, etc., the analysis of these substances shall also be taken as the object to be studied.

- 3 For the rubber and resin which are used for packing, the gasket, etc. and of which the contact surface area ratio is not exceeding 10 cm²/L, the determination of items given in this table may be omitted except organic matters [amount of total organic carbon (TOC)] or organic matters, etc. (consumption of potassium permanganate) and phenols.
- 4 For materials of which the portion in contact with drinking water is lined, the determination of components contained in the lining only is sufficient. However, for materials such as metal plating (except for hot-dip coating) and paint, which have a possibility of peeling, the determination of the base material shall also be performed.
- 5 Materials containing metal in those specified in 8.1 of JIS K 6743 and 8.1 of JIS K 6777 are not applied.

5 Common conditions For the common matters on the chemical analysis, JIS K 0050, JIS K 0114, JIS K 0115, JIS K 0116, JIS K 0121 and JIS K 0123 and the following shall apply.

- a) Water which is specified in 7.3 of JIS K 0050, and of which electric conductivity is not exceeding 2 µS/cm shall be used.
- b) The glassware instruments shall be those specified in JIS R 3503 those specified in JIS R 3505 which is made of hard glass, or those of quality equivalent or superior to.
- c) Class 5 of the filter paper specified in JIS P 3801 shall be used.

6 Preparing method of leachate

6.1 Reagents The following reagents shall be used.

- a) **Sodium hypochlorite solution (available chlorine concentration of 0.3 mg/mL)** Dilute the sodium hypochlorite solution with water so that available chlorine concentration becomes 0.3 mg/mL. Put the prepared solution into a flask with a ground stopper, seal it, and store in a cool and dark place.
- b) **Calcium chloride solution (0.04 mol/L)** Dissolve 4.44 g of calcium chloride specified in JIS K 8123 in water to make 1 L.
- c) **Sodium hydrogen carbonate solution (0.04 mol/L)** Dissolve 3.36 g of sodium hydrogen carbonate specified in JIS K 8622 in water to make 1 L.
- d) **Hydrochloric acid (1+99)**
- e) **Sodium hydroxide solution (0.1 mol/L)** Dissolve 4.0 g of sodium hydroxide specified in JIS K 8576 in water to make 1 L.

6.2 Preparing method The preparing method shall be as follows:

- a) Take 900 mL of water into a beaker, add the proper amounts of sodium hypochlorite solution (available chlorine concentration of 0.3 mg/mL), sodium hydrogen carbonate solution (0.04 mol/L) and calcium chloride solution (0.04 mol/L), and add water to make 1 L.

Information : For preparing a prescribed leachate, it is preferable to prepare by adding 1 mL of sodium hypochlorite solution (available chlorine

concentration of 0.3 mg/mL), 22.5 mL of sodium hydrogen carbonate solution (0.04 mol/L) and 11.3 mL of calcium chloride solution (0.04 mol/L) as the standard amount.

- b) Adjust pH of this solution by using hydrochloric acid (1+99) and the solution prepared by diluting it ten times, and sodium hydroxide solution (0.1 mol/L) and the solution prepared by diluting it ten times, and prepare so that the water quality satisfies pH 7.0 ± 0.1 , hardness $45 \text{ mg/L} \pm 5 \text{ mg/L}$, alkalinity $35 \text{ mg/L} \pm 5 \text{ mg/L}$, and residual chlorine $0.3 \text{ mg/L} \pm 0.1 \text{ mg/L}$.
- c) Confirm the pH, hardness, alkalinity and residual chlorine of the prepared leachate by the following methods.
 - 1) pH According to annex 15.
 - 2) Hardness According to annex 10.
 - 3) Alkalinity According to annex 20.
 - 4) Residual chlorine According to annex 21.

7 Preparation of sample liquid

7.1 Equipment test

7.1.1 End feed water implements Prepare the sample liquid of end feed water implements by performing the operations of washing, conditioning and leaching without an idle time according to the following methods.

In addition, the operation of conditioning may be omitted when the relevant leachate obviously conforms to the standard even if conditioning is not performed, and in this case, after the operation of washing, wash three times with the leachate, and perform the operation of leaching.

- a) **Washing** Wash the equipment under test with tap water for 1 h and wash with water 3 times.

In addition, start the operation of conditioning within 72 h after washing while filling the equipment under test with the leachate for this period.

- b) **Conditioning** The conditioning shall be as follows:
 - 1) **End feed water implements (except for the water heater installed at the end of feed water equipment among the instantaneous water heater, water heater containing water, storage tank water heater)** Use the leachate of about 23 °C, and perform the following procedures without intervals.

In addition, maintain the liquid temperature of leachate at about 23 °C during the standing.

- 1.1) Fill the inside of equipment under test with the leachate, and seal. After standing for 2 h, discard the leachate. Those operations are repeated 4 times.

Then, fill the inside of equipment under test with the leachate, and seal. After standing for 16 h, discard the leachate.

- 1.2) Repeat the procedure of 1.1) 3 times again.
 - 1.3) Fill the inside of equipment under test with the leachate, and seal. After standing for 2 h, discard the leachate. Those procedures are repeated 4 times. Then, fill the inside of equipment under test with the leachate, and seal. After standing for 64 h, discard the leachate.
 - 1.4) Repeat the procedure of 1.1) to 1.3).
 - 1.5) Repeat the procedure of 1.1) 3 times. Then, seal after filling the equipment under test with the leachate, and after standing for 2 h, discard the leachate. The procedures from filling are repeated 4 times.
 - 2) **Water heaters installed at the end of feed water equipment among the instantaneous water heaters** Use the leachate heated in the allowable range of the maximum working temperature of the equipment under test, and perform the same procedures as that of 1). It is not necessary to maintain the liquid temperature of leachate during standing. Here, the heating of leachate may be carried out by using the heat source of the relevant equipment.
 - 3) **Water heaters installed at the end of feed water equipment in the water heater containing water and the storage tank water heaters** Use water of the leachate heated in the allowable range of the maximum working temperature of the equipment under test, and perform the same procedures as that of 1). It is necessary to maintain the liquid temperature of leachate during standing. Here, the heating of leachate may be carried out by using the heat source of the relevant equipment, and in this case the time of standing shall contain the time of heating.
- c) **Leaching** The leaching shall be carried out as follows:
- 1) **End feed water implements (except for the water heater installed at the end of feed water equipment among the instantaneous water heater, water heater containing water, storage tank water heater)** Fill the inside of equipment under test with the leachate of about 23 °C, seal, and maintain this liquid temperature. After standing for 16 h, take the sample liquid into a hard glass bottle which has been washed with nitric acid (1+15) beforehand and further washed with water.
 - 2) **Water heaters installed at the end of feed water equipment among the instantaneous water heaters** Heat the leachate in the allowable range of the maximum working temperature of the equipment, and after passing about 5 times of the volume inside the equipment the minimum amount of working water of the equipment under test, take the sample liquid into the hard glass bottle which was washed with nitric acid (1+15) beforehand and further washed with water. Here, the heating of leachate may be carried out by using the heat source of the relevant equipment of itself.
 - 3) **Water heaters installed at the end of feed water equipment among the water heater containing waters and the storage tank water heaters** Heat the leachate in the allowable range of the maximum working temperature of the equipment under test, and fill the inside of the

equipment under test, maintain this temperature. After standing for 16 h, take the sample liquid into a hard glass bottle which has been washed with nitric acid (1+15) beforehand and further washed with water. Here, the heating of leachate and the maintenance of liquid temperature may be carried out by using the heat source of the relevant equipment, and in this case the time of standing shall contain the time of heating.

7.1.2 Feed water pipe Prepare the sample liquid of feed water pipe by performing the operation of washing, conditioning and leaching without intervals according to the following methods.

In addition, the operation of conditioning may be omitted when the relevant leachate obviously conforms to the standard even if conditioning is not performed. In this case after the operation of washing, wash with the leachate 3 times and perform the operation of leaching.

- a) **Washing** Wash the equipment under test with tap water for 1 h, and then wash with water 3 times.
- b) **Conditioning** The conditioning shall be performed as follows:

In addition, in the case of the feed water pipe applicable to both 1) and 2), or when applicable category is unknown, only the procedure of 2) may be performed.

- 1) **Feed water pipe (except for the feed water pipe for the purpose of passing heated water)** Use the leachate of about 23 °C, and fill the inside of pipe under test with the leachate, seal, and allow it stand for 14 days. Exchange the leachate at least 9 times during the 14 days without intervals, and the time of each standing period shall be 24 h or longer.

In addition, maintain the liquid temperature of leachate during standing at about 23 °C.

- 2) **Feed water pipe for the purpose of passing heated water** After performing the same procedure as that of 1), heat the leachate to the maximum working temperature of the pipe under test ± 2 °C (90 °C ± 2 °C when the maximum working temperature is not specified), and fill the inside of equipment under test, and seal. After standing for 1 h, perform the operation of discarding the liquid. Repeat the procedures from heating. During standing, it is not necessary to maintain the liquid temperature of leachate.

- c) **Leaching** The operation of leaching shall be performed as follows:

In addition, in the case of the feed water pipe applicable to both 1) and 2), or when which feed water pipe is applicable is not known, only the operation of 2) may be performed.

- 1) **Feed water pipe (except for the feed water pipe for the purpose of passing heated water)** Seal one end of the pipe under test with the stopper wrapped with polyethylene film washed with water, fill the inside of pipe under test with the leachate of about 23 °C, seal, and maintain this liquid temperature. After standing for 16 h, take the sample liquid into a hard glass bottle which has been washed with nitric acid (1+15) beforehand and further washed with water.

- 2) **Feed water pipe for the purpose of passing heated water** Seal one end of the pipe under test with the stopper wrapped with polyethylene film washed with water, heat the leachate to the maximum working temperature of the pipe under test $\pm 2\text{ }^{\circ}\text{C}$ ($90\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ when the maximum working temperature is not specified), and fill the inside of equipment under test, seal. After standing for 16 h, take the sample liquid into a hard glass bottle which has been washed with nitric acid (1+15) beforehand and further washed with water. It is not necessary to maintain the liquid temperature of leachate during standing.

7.1.3 Feed water implements installed in the middle of piping Prepare the sample liquid of the feed water implement installed in the middle of piping by performing the operation of washing, conditioning and leaching without intervals according to the following methods.

In addition, the operation of conditioning may be omitted when the relevant leachate obviously conforms to the standard even if the conditioning is not performed. In this case after the operation of washing, wash with the leachate 3 times and perform the operation of leaching.

- a) **Washing** Perform the same procedure as that of **7.1.2 a)**.
- b) **Conditioning** The operation of conditioning shall be performed as follows:

In addition, in the case of the feed water pipe applicable to both 1) and 2), only the operation of 2) may be performed.

- 1) **Feed water implements installed in the middle of piping (except for the feed water implement for the purpose of passing heated water)** In accordance with **7.1.2 b) 1)**.
- 2) **Feed water implements installed in the middle of piping [the feed water implement for the purpose of passing heated water⁽²⁾]** In accordance with **7.1.2 b) 2)**.

Note (2) The feed water implements installed in the middle of piping among the instantaneous water heater, water heater containing water, storage tank water heater are excluded.

- 3) **Feed water implements installed in the middle of piping among instantaneous water heaters** After performing the same procedure as that of **7.1.2 b) 1)**, heat the leachate in the allowable range of the maximum working temperature of the equipment under test, and fill the inside of the equipment under test, seal. After standing for 1 h, perform the operation of discarding the liquid. Repeat the procedures from heating. It is not necessary to maintain the liquid temperature of leachate during standing. Here, the heating of leachate may be carried out by using the heat source of the relevant equipment.
- 4) **Feed water implements installed in the middle of piping among water heater containing waters and storage tank water heaters** After performing the same procedure as that of **7.1.2 b) 1)**, heat the leachate in the allowable range of the maximum working temperature of the equipment under test, and fill the inside of the equipment under test, seal. After standing for 1 h, perform the operation of discarding the liquid. Repeat

the procedures from heating. During standing, maintain the liquid temperature in the allowable range of the maximum working temperature of the equipment under test. Here, the heating of leachate and the maintenance of liquid temperature may be carried out by using the heat source of the relevant equipment, and the standing time in this case shall include the heating time.

c) **Leaching** The leaching shall be carried out as follows:

In addition, in the case of the feed water implement applicable to both 1) and 2), only the operation of 2) may be performed.

- 1) **Feed water implements installed in the middle of piping (except for the feed water implement for the purpose of passing heated water)** In accordance with 7.1.2 c) 1).
- 2) **Feed water implements installed in the middle of piping [the feed water implement for the purpose of passing heated water⁽²⁾]** In accordance with of 7.1.2 c) 2).
- 3) **Feed water implements installed in the middle of piping in instantaneous water heaters** In accordance with 7.1.1 c) 2).
- 4) **Feed water implements installed in the middle of piping in water heaters containing water and storage tank water heaters** In accordance with 7.1.1 c) 3).

7.2 Part test and material test The sample liquid for part test and material test shall be in accordance with the preparing method of the sample liquid of the equipment for which the relevant part and material are used, and carry out the test by using the method of immersing the part or material in the leachate under the condition that would surely avoid voids generated on the upper part in the hard glass container which has been washed with nitric acid (1+15) beforehand and further washed with water or the method of filling the inside of part under test with the leachate.

In addition, the contact surface area ratio of the equipment under test, part under test, or material under test shall not be less than that of the equipment to be evaluated, part to be evaluated, or material to be evaluated.

7.3 Storage of sample liquid It is preferable to perform the sampling of the test water from the sample liquid as early as possible. When storing the sample liquid, seal and shut out light, and store in a dark and cold place.

8 Analytical method The methods for determination of the test water shall be in accordance with annexes 1 to 9, 11 to 14, 16 to 19, 22 to 27 (for the relation between item and methods for determination, see table 1).

In addition, regard the differences of the analysis result of the test water obtained by the equipment test, part test, or material test, and the analysis result of the test water obtained by the blank test as the analysis result of equipment, part, or material. However, for the taste and odour, when the analysis result of the test water obtained by the equipment test, part test, or material test is abnormal compared with the analysis result of the test water obtained by the blank test, that analysis result shall be "abnormal".

9 Correction of analysis result

- a) For the evaluation of odour and taste, the result is expressed by “presence” or “absence”, and it is not necessary to correct or round off.
- b) For the item other than **a)**, after correcting by the following formula⁽³⁾ of **1)**, round off in accordance with **JIS Z 8401**.

When performing the part test or material test, first calculate the elution concentration of the equipment under test by the formula of **2)**, by using this result, next, carry out the correction calculation for evaluating the equipment to be evaluated by the formula of **1)**. In this case, “the analysis result as equipment” shall be regarded as “the analysis result of equipment under test”.

1) Equipment test

$$\rho_B = NF \times C'$$

$$NF = \frac{SAF}{SAL} \times \frac{VL}{VF}$$

where, ρ_B : correction value (elution concentration) of equipment to be evaluated (mg/L, or degree)

The correction value of hot-and-cold-water mixing taps is as follows:

$$\rho'_B = NF \times \frac{V_w}{V} \times C'$$

where, ρ'_B : correction value of hot-and-cold-water mixing taps

V_w : contact volume of drinking water (except heated water) in the equipment to be evaluated (L)

V : contact volume of all of hot-and-cold-water mixing taps (L)

C' : analysis result of equipment under test (mg/L, or degree)

NF : correction factor

SAF : contact surface area of the portion in contact with drinking water in the equipment to be evaluated (cm²)

SAL : contact surface area of the portion in contact with the leachate in the equipment under test (cm²)

VL : internal volume of the portion in contact with the leachate in the equipment under test (L)⁽⁴⁾

VF ⁽⁵⁾ : internal volume of the portion in contact with drinking water in the equipment to be evaluated (L)⁽⁶⁾

Notes ⁽³⁾ This formula is applicable only to the case where the equipment to be evaluated meets the following conditions.

- a) The material of the equipment to be evaluated and that of the equipment under test are equivalent in quality.
 - b) The equipment to be evaluated and the equipment under test are similar in the structure and manufacturing method.
 - c) The contact surface area ratio of the equipment to be evaluated [for the instantaneous water heater, (the surface area of the portion in contact with water)/(the minimum working water quantity)] is not more than the contact surface area of the equipment under test.
- (4) In the case of the instantaneous water heater, it is “the minimum working water quantity in the equipment under test (L/min)”.
- (5) When VF of the end feed water implement (except for the instantaneous water heater) is 1 L or under, VF shall be 1 L. Furthermore, for the feed water implement installed in the middle of piping (except for the instantaneous water heater, the water heater containing water, and the storage tank water heater), VF shall be 25 times the internal volume of the portion in contact with water in the equipment to be evaluated.

Information : In the typical composition where feed water pipes, fittings, and valves are arranged, the percentage of fittings and valves accounts for about 4 %. Therefore, in the elution test only for fittings and valves, if VF is set to 25 times the internal volume above-mentioned, it becomes 25 times $\times 0.04 = 1$ time in the actual typical composition. Moreover, in the case of the feed water pipe, the final product to be installed and the equipment under test are the same and both members SAF/SAL and VL/VF become 1, therefore, NF becomes also 1.

- (6) In the case of the instantaneous water heater, it is “the minimum working water quantity in the equipment to be evaluated (L/min)”.

Remarks : Among the end feed water implements (except for the instantaneous water heater, the water heater containing water, and the storage tank water heater), for those which have the structure also capable of supplying heated water, correct further according to the following formula.

$$\rho_{BB} = \rho_B \times \frac{VF_1}{VF_2}$$

where, P_{BB} : elution concentration, obtained by further correcting the elution concentration of equipment of equipment to be evaluated (mg/L, or degree)

VF_1 : internal volume of the portion in contact with drinking water (except heated water) in the equipment to be evaluated (cm³)

VF_2 : total volume of the portion in contact with water in the equipment to be evaluated (cm³)

2) **Part test or material test**

$$C = \frac{\sum N_i}{V_F}$$

$$N_i = \frac{S_{Fi} \times A_i \times V_{Li}}{S_{Li}}$$

- where,
- C : analysis result as the equipment (mg/L, or degree)
 - N_i : leaching amount for each part or material in the state of equipment (mg, or degree)
 - V_F : internal volume of the portion in contact with water or leachate in the state of equipment (L)
 - S_{Fi} : surface area of the portion in contact with water or leachate for each part or material in the state of equipment (cm²)
 - A_i : analysis result for each part under test or material under test in the state of equipment (mg/L, or degree)
 - V_{Li} : volume of leachate used for elution operation for each part under test or material under test (L)
 - S_{Li} : surface area of the portion in contact with leachate for each part under test or material under test (cm²)

Attached Table 1 Normative references

JIS G 3101	<i>Rolled steels for general structure</i>
JIS G 3131	<i>Hot-rolled mild steel plates, sheets and strip</i>
JIS G 3133	<i>Decarburized steel sheets and strip for porcelain enamelling</i>
JIS G 3141	<i>Cold-reduced carbon steel sheets and strip</i>
JIS G 3459	<i>Stainless steel pipes</i>
JIS G 3463	<i>Stainless steel boiler and heat exchanger tubes</i>
JIS G 4303	<i>Stainless steel bars</i>
JIS G 4304	<i>Hot rolled stainless steel plates, sheets and strip</i>
JIS G 4305	<i>Cold rolled stainless steel plates, sheets and strip</i>
JIS G 4308	<i>Stainless steel wire rods</i>
JIS G 4309	<i>Stainless steel wires</i>
JIS G 4312	<i>Heat-resisting steel plates and sheets</i>
JIS G 4313	<i>Cold rolled stainless steel strip for springs</i>
JIS G 4314	<i>Stainless steel wires for springs</i>
JIS H 3100	<i>Copper and copper alloy sheets, plates and strips</i>
JIS H 3250	<i>Copper and copper alloy rods and bars</i>
JIS H 3260	<i>Copper and copper alloy wires</i>
JIS H 3270	<i>Copper beryllium alloy, Phosphor bronze and nickel silver rods, bars and wires</i>
JIS H 3300	<i>Copper and copper alloy seamless pipes and tubes</i>
JIS H 3320	<i>Copper and copper alloy welded pipes and tubes</i>
JIS H 5120	<i>Copper and copper alloy castings</i>
JIS H 5121	<i>Copper alloy continuous castings</i>
JIS K 0010	<i>Reference materials—Standard solution—Copper</i>
JIS K 0011	<i>Zinc standard solution</i>
JIS K 0012	<i>Cadmium standard solution</i>
JIS K 0015	<i>Lead standard solution</i>
JIS K 0016	<i>Iron standard solution</i>
JIS K 0024	<i>Reference material—Standard solution—Chromium</i>
JIS K 0026	<i>Reference material—Standard solution—Arsenic</i>
JIS K 0027	<i>Reference material—Standard solution—Manganese</i>
JIS K 0029	<i>Chloride ion standard solution</i>
JIS K 0030	<i>Fluoride ion standard solution</i>
JIS K 0050	<i>General rules for chemical analysis</i>

Attached Table 1 (continued)

JIS K 0114	<i>General rules for gas chromatographic analysis</i>
JIS K 0115	<i>General rules for molecular absorptiometric analysis</i>
JIS K 0116	<i>General rules for atomic emission spectrometry</i>
JIS K 0121	<i>General rules for atomic absorption spectrochemical analysis</i>
JIS K 0123	<i>General rules for analytical methods in gas chromatography mass spectrometry</i>
JIS K 1105	<i>Argon</i>
JIS K 6353	<i>Rubber goods for water works</i>
JIS K 6742	<i>Unplasticized poly(vinyl chloride) (PVC-U) pipes for water works</i>
JIS K 6743	<i>Unplasticized poly(vinyl chloride) (PVC-U) pipe fittings for water works</i>
JIS K 6762	<i>Double wall polyethylene pipes for water supply</i>
JIS K 6769	<i>Crosslinked polyethylene (XPE) pipes</i>
JIS K 6776	<i>Chlorinated polyvinyl chloride (CPVC) pipes for hot and cold water supply</i>
JIS K 6777	<i>Chlorinated polyvinyl chloride (CPVC) pipe fittings for hot and cold water supply</i>
JIS K 6778	<i>Polybutene (PB) pipes</i>
JIS K 6787	<i>Crosslinked polyethylene (XPE) pipes for water works</i>
JIS K 6792	<i>Polybutene (PB) pipes for water works</i>
JIS K 8005	<i>Reference materials for volumetric analysis</i>
JIS K 8019	<i>Sodium nitrite</i>
JIS K 8034	<i>Acetone</i>
JIS K 8039	<i>Acetonitrile for pesticide residue and polychlorinated biphenyl analysis</i>
JIS K 8040	<i>Acetone for pesticide residue and polychlorinated biphenyl analysis</i>
JIS K 8048	<i>4-Amino antipyrine</i>
JIS K 8059	<i>Sodium hydrogensulfite</i>
JIS K 8069	<i>Aluminium</i>
JIS K 8085	<i>Ammonia solution</i>
JIS K 8102	<i>Ethanol (95)</i>
JIS K 8107	<i>Disodium dihydrogen ethylenediamine tetraacetate dihydrate</i>
JIS K 8116	<i>Ammonium chloride</i>
JIS K 8117	<i>Dichloromethane for pesticide residue analysis</i>
JIS K 8121	<i>Potassium chloride</i>

Attached Table 1 (continued)

JIS K 8123	<i>Calcium chloride</i>
JIS K 8129	<i>Cobalt (II) chloride hexahydrate</i>
JIS K 8136	<i>Tin (II) chloride dihydrate</i>
JIS K 8139	<i>Mercury (II) chloride</i>
JIS K 8150	<i>Sodium chloride</i>
JIS K 8163	<i>Potassium hexachloroplatinate</i>
JIS K 8180	<i>Hydrochloric acid</i>
JIS K 8201	<i>Hydroxylammonium chloride</i>
JIS K 8247	<i>Potassium permanganate</i>
JIS K 8283	<i>Citric acid monohydrate</i>
JIS K 8288	<i>Trisodium citrate dihydrate</i>
JIS K 8295	<i>Glycerol</i>
JIS K 8312	<i>Potassium chromate</i>
JIS K 8318	<i>Sodium p-toluenesulfonchloramide trihydrate</i>
JIS K 8322	<i>Chloroform</i>
JIS K 8355	<i>Acetic acid</i>
JIS K 8371	<i>Sodium acetate trihydrate</i>
JIS K 8432	<i>Magnesium oxide</i>
JIS K 8443	<i>Potassium cyanide</i>
JIS K 8495	<i>p-Dimethylaminobenzylidene rhodanine</i>
JIS K 8500	<i>N,N-Dimethylformamide</i>
JIS K 8506	<i>Potassium bromide</i>
JIS K 8528	<i>Sodium oxalate</i>
JIS K 8530	<i>Potassium bromate</i>
JIS K 8540	<i>Sodium (+)-tartrate dihydrate</i>
JIS K 8549	<i>Calcium nitrate tetrahydrate</i>
JIS K 8550	<i>Silver nitrate</i>
JIS K 8552	<i>Cobalt (II) nitrate hexahydrate</i>
JIS K 8562	<i>Sodium nitrate</i>
JIS K 8567	<i>Magnesium nitrate hexahydrate</i>
JIS K 8574	<i>Potassium hydroxide</i>
JIS K 8576	<i>Sodium hydroxide</i>
JIS K 8598	<i>Selenium</i>
JIS K 8622	<i>Sodium hydrogen carbonate</i>

Attached Table 1 (concluded)

JIS K 8625	<i>Sodium carbonate</i>
JIS K 8637	<i>Sodium thiosulfate pentahydrate</i>
JIS K 8659	<i>Starch, soluble</i>
JIS K 8680	<i>Toluene</i>
JIS K 8736	<i>Eriochrome black T</i>
JIS K 8798	<i>Phenol</i>
JIS K 8801	<i>Potassium hexacyanoferrate (III)</i>
JIS K 8809	<i>Potassium hydrogen phthalate</i>
JIS K 8821	<i>Sodium fluoride</i>
JIS K 8825	<i>Hexane for pesticide residue and polychlorinated biphenyl analysis</i>
JIS K 8840	<i>Bromocresol green</i>
JIS K 8863	<i>Boric acid</i>
JIS K 8866	<i>Sodium tetraborate decahydrate</i>
JIS K 8891	<i>Methanol</i>
JIS K 8896	<i>Methyl red</i>
JIS K 8913	<i>Potassium iodide</i>
JIS K 8920	<i>Iodine</i>
JIS K 8951	<i>Sulfuric acid</i>
JIS K 8983	<i>Copper (II) sulfate pentahydrate</i>
JIS K 8987	<i>Sodium sulfate</i>
JIS K 9000	<i>Ammonium thiocyanate</i>
JIS K 9005	<i>Phosphoric acid</i>
JIS K 9007	<i>Potassium dihydrogenphosphate</i>
JIS K 9019	<i>Disodium hydrogenphosphate 12-water</i>
JIS K 9548	<i>3-Methyl-1-phenyl-5-pyrazolone</i>
JIS K 9901	<i>Highly purified nitric acid</i>
JIS P 3801	<i>Filter paper (for chemical analysis)</i>
JIS R 3503	<i>Glass apparatus for chemical analysis</i>
JIS R 3505	<i>Volumetric glassware</i>
JIS Z 8401	<i>Guide to the rounding of numbers</i>
JIS Z 8802	<i>Methods for determination of pH of aqueous solutions</i>
JIS Z 8901	<i>Test powders and test particles</i>

Related standards:

- JIS A 4413 *Piping units for dwellings*
- JIS B 2061 *Faucets, ball taps and flush valves**
- JIS B 2301 *Screwed type malleable cast iron pipe fittings**
- JIS B 2302 *Screwed type steel pipe fittings**
- JIS B 8410 *Pressure reducing valves for water works**
- JIS B 8414 *Relief valves for hot water appliances**
- JIS C 9219 *Electric storage tank water heaters*
- JIS C 9618 *Drinking-water coolers*
- JIS G 3447 *Stainless steel sanitary pipes**
- JIS G 3448 *Light gauge stainless steel tubes for ordinary piping**
- JIS H 3401 *Pipe fittings of copper and copper alloys**
- JIS K 6770 *Crosslinked polyethylene (XPE) pipe fittings**
- JIS K 6779 *Polybutene (PB) pipe fittings**
- JIS K 6788 *Crosslinked polyethylene (XPE) pipe fittings for water works**
- JIS K 6793 *Polybutene (PB) pipe fittings for water works**
- JIS S 2109 *Gas burning water heaters for domestic use**
- JIS S 2116 *Water heaters containing water under atmospheric pressure**
- JIS S 3021 *Oil burning water boilers**
- JIS S 3024 *Oil burning water heaters for domestic use**
- JIS S 3027 *Oil burning bath boilers with water heaters for domestic use**
- ISO 8795 *Plastics piping systems for the transport of water intended for human consumption—Migration assessment—Determination of migration values of plastics pipes and their fittings and their joints*
- ANSI/NSF61 *Drinking Water System Components—Health Effects*
- Note * The standard which quotes this Standard.

Annex 1 (normative)
Methods for determination of metals

1 Scope This annex specifies the methods for determination of metals leached from the equipment for water supply service using an electrothermal (flameless) atomic absorption method, a flame atomic absorption method, an inductively coupled-plasma-atomic emission spectroscopy method (hereafter referred to as “ICP emission spectroscopy method”), an inductively coupled-plasma-mass spectroscopy method (hereafter referred to as “ICP mass spectroscopy method”), and an ion-chromatography.

2 Electric heating (flameless) atomic absorption method The metals to be determined by this method shall be cadmium, selenium, lead, arsenic, hexavalent chromium [chromium (VI)], zinc, aluminium, iron, copper, sodium and manganese.

2.1 Reagents The following reagents shall be used.

- a) **Nitric acid** Specified in **JIS K 9901**.
- b) **Nitric acid (1+1)**
- c) **Nitric acid (1+30)**
- d) **Nitric acid (1+160)**
- e) **Standard stock solution (1 mg metal/mL)** Standard stock solution (1 mg metal/mL) shall be as follows. Put the standard stock solution into a brown bottle, and store in a dark and cold place.
 - 1) **Cadmium standard stock solution** Take 1.000 g of cadmium into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Or Cd1 000 cadmium standard solution specified in **JIS K 0012**.
 - 2) **Selenium standard stock solution**
 - 2.1) Take 1.405 g of selenium dioxide into a measuring flask, and after dissolving with a small amount of water, add nitric acid (1+160) to make 1 L.
 - 2.2) Take 1.000 g of selenium (99.5 % or over) specified in **JIS K 8598**, add 20 mL of nitric acid (1+1), heat it to dissolve, and boil it to expel nitrogen oxides. After allowing it to cool, move it to a measuring flask, and add water to make 1 L.
 - 3) **Lead standard stock solution** Take 1.000 g of lead into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Or Pb1 000 cadmium standard solution specified in **JIS K 0015**.
 - 4) **Arsenic standard stock solution** Take 1.320 g of arsenic trioxide into a beaker, add a small amount of sodium hydroxide solution (0.4 g/L) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add hydrochloric acid (1+50) to make 1 L. Or As1 000 arsenic standard solution specified in **JIS K 0026**.

- 5) **Chromium standard stock solution** Take 2.829 g of potassium dichromate into a measuring flask, and after dissolving it with a small amount of purified water, add nitric acid (1+160) to make 1 L. Or Cr1 000 chromium standard solution specified in **JIS K 0024**.
 - 6) **Zinc standard stock solution** Take 1.000 g of zinc into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Or Zn1 000 zinc standard solution specified in **JIS K 0011**.
 - 7) **Aluminium standard stock solution** Take 1.000 g of aluminium specified in **JIS K 8069** into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+30) to make 1 L.
 - 8) **Iron standard stock solution** Take 1.000 g of iron into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Or Fe1 000 iron standard solution specified in **JIS K 0016**.
 - 9) **Copper standard stock solution** Take 1.000 g of copper into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Or Cu1 000 copper standard solution specified in **JIS K 0010**.
 - 10) **Sodium standard stock solution**
 - 10.1) Dissolve 2.542 g of sodium chloride specified in **JIS K 8150** obtained by heating it heavily in a platinum crucible at 500 °C to 550 °C for 40 min to 50 min, and allowing it to cool in a desiccator, in water to make 1 L.
 - 10.2) Heat sodium chloride which is the reference material for volumetric analysis specified in **JIS K 8005** at 600 °C for about 1 h beforehand, and make it stand to cool. After dissolving 2.542 g of NaCl 100 % in water, move it to a measuring flask, and add water to make 1 L.
 - 11) **Manganese standard stock solution** Take 1.000 g of manganese into a beaker, add a small amount of nitric acid (1+1) and heat it to dissolve, and after allowing it to cool, move it to a measuring flask, and add nitric acid (1+160) to make 1 L. Mn1 000 manganese standard solution specified in **JIS K 0027**.
- f) **Standard solution (0.01 mg metal/mL)** Take 5 mL of the following metals standard stock solution into a measuring flask, and add water to make total 500 mL. Prepare this solution at every use.
- 1) **Iron standard stock solution**
- g) **Standard solution (0.001 mg metal/mL)** Take 5 mL each of the following metals standard stock solutions into separate measuring flasks, and add water to make total 500 mL. Furthermore, take 25 mL of these solutions into another measuring flasks separately, and add water to make total 250 mL. Prepare these solutions at every use.
- 1) **Selenium standard stock solution**

- 2) **Lead standard stock solution**
- 3) **Arsenic standard stock solution**
- 4) **Chromium standard stock solution**
- 5) **Zinc standard stock solution**
- 6) **Aluminium standard stock solution**
- 7) **Copper standard stock solution**
- 8) **Sodium standard stock solution**
- 9) **Manganese standard stock solution**
- h) **Standard solution (0.000 1 mg metal/mL)** Take 5 mL of the following metals standard stock solution into a measuring flask, and add water to make total 500 mL. Furthermore, take 5 mL of this solution into another measuring flask, and add water to make total 500 mL. Prepare this solution at every use.
 - 1) **Cadmium standard stock solution**

2.2 Instrument and apparatus The instrument and apparatus shall be as follows:

- a) **Electrothermal atomic absorption analysis apparatus** The electric heating type capable of correcting the background.
- b) **Flow gas** Argon class 2 specified in **JIS K 1105**.

2.3 Sampling and storage of the test water Take the sample liquid into a glass bottle or polyethylene bottle which has been washed with nitric acid and water, add 10 mL of nitric acid per 1 L of the test water to make the test water, and promptly perform the analysis. When the analysis is not able to be performed promptly, store the test water in a dark and cold place, and perform the analysis within one month.

2.4 Test operation

2.4.1 Pretreatment

- a) Take 10 mL to 100 mL of the test water (or the test water with water added so that the concentration of each object metal falls within the range shown in annex 1 table 1) into a beaker, and add nitric acid so that the concentration of nitric acid becomes 1 % to the amount of the test water including the amount added at the time of sampling the test water, and heat gently.
- b) Stop heating when the amount of liquid becomes 10 mL or under, and after allowing it to cool, add water to make 10 mL, let it be the test liquid. However, when it is turbid, filter it, and let the filtrate be the test liquid.

Annex 1 Table 1 Concentration range and absorption-line wavelength

Metals	Concentration range mg/L	Absorption-line wavelength nm
Cadmium	0.000 1 to 0.01	228.8
Selenium	0.001 to 0.1	196.0
Lead	0.001 to 0.1	283.3
Arsenic	0.001 to 0.1	193.7
Hexavalent chromium	0.001 to 0.1	357.9
Zinc	0.001 to 0.1	213.8
Aluminium	0.001 to 0.1	309.3
Iron	0.01 to 1	248.3
Copper	0.001 to 0.1	324.7
Sodium	0.002 to 0.2	589.0
Manganese	0.001 to 0.1	279.5

2.4.2 Analysis

- Inject the fixed amount of the test liquid into the electrothermal furnace, and measure the absorbance at the wavelength of each metal shown in annex 1 table 1.
- Calculate the concentration of each metal in the test liquid from the working curve prepared in accordance with 2.5.
- Calculate the concentration of each metal in the sample liquid by the following formula.

$$e = a \times \frac{c}{b}$$

where, e : concentration of metal in the sample liquid (mg/L)
 a : concentration of metal obtained from the test liquid (mg/L)
 b : amount of the test water separated from the sample liquid (mL)
 c : amount of the test liquid (mL)

2.5 Preparation of working curve

- Take several different amounts of each metal standard solution, increasing stepwise, into separate measuring flasks, add 1 mL of nitric acid and water to make each 100 mL.
- Follow the same procedure as that in 2.4.2 a), and determine the relation between the concentration of each metal and absorbance.

3 Flame atomic absorption method The metals to be determined by this method shall be cadmium, hexavalent chromium [chromium (VI)], zinc, iron, copper, sodium, manganese, calcium and magnesium.

3.1 Reagents The following reagents shall be used.

- a) **Nitric acid** Specified in **JIS K 9901**.
- b) **Nitric acid (1+160)**
- c) **Standard stock solution (1 mg metal/mL)** Standard stock solution (1 mg metal/mL) other than calcium and magnesium standard stock solution shall be in accordance with **2.1 e)**. Calcium and magnesium standard stock solution shall be as follows. Put the standard stock solution into a brown bottle, and store in a dark and cold place.
 - 1) **Calcium standard stock solution** Take 5.893 g of calcium nitrate tetrahydrate specified in **JIS K 8549** into a beaker, add nitric acid (1+160) to dissolve, move it to a measuring flask, and add nitric acid (1+160) to make 1 L.
 - 2) **Magnesium standard stock solution** Take 10.550 g of magnesium nitrate hexahydrate specified in **JIS K 8567** into a beaker, add nitric acid (1+160) to dissolve, move it to a measuring flask, and add nitric acid (1+160) to make 1 L.
- d) **Standard solution (0.01 mg metal/mL)** Standard solution (0.01 mg metal/mL) other than calcium standard solution shall be in accordance with **2.1 f)**. For calcium standard solution, take 5 mL of calcium standard stock solution into a measuring flask, and add water to make 500 mL. Prepare this solution at every use.
- e) **Standard solution (0.001 mg metal/mL)** Standard solution (0.001 mg metal/mL) other than magnesium standard solution shall be in accordance with **2.1 g)**. For magnesium standard solution, take 5 mL of magnesium standard stock solution into each measuring flask, and add water to make 500 mL. Furthermore, take 25 mL of this solution into another measuring flask, and add water to make total 250 mL. Prepare this solution at every use.
- f) **Standard solution (0.000 1 mg metal/mL)** In accordance with **2.1 h)**.

3.2 Instrument and apparatus The instrument and apparatus shall be as follows:

- a) **Flame atomic absorption analysis apparatus**

3.3 Sampling and storage of the test water In accordance with **2.3**.

3.4 Analysis operation

3.4.1 Pretreatment

- a) Take 10 mL to 100 mL of the test water (or the test water with water added so that the concentration of each object metal falls within the range shown in annex 1 table 2) into a beaker, and add nitric acid so that the concentration of nitric acid becomes 1 % to the amount of the test water including the amount added at the time of sampling the test water, and heat gently.

- b) Stop heating when the amount of liquid becomes 10 mL or under, and after allowing it to cool, add water to make 10 mL for the test liquid. However, when it is turbid, filter it, and use the filtrate as the test liquid.

Annex 1 Table 2 Concentration range and absorption-line wavelength

Metals	Concentration range mg/L	Absorption-line wavelength nm
Cadmium ⁽¹⁾	0.001 to 0.01	228.8
Hexavalent chromium ⁽¹⁾	0.005 to 0.05	357.9
Zinc	0.02 to 0.2	213.8
Iron ⁽¹⁾	0.01 to 0.1	248.3
Copper	0.04 to 0.4	324.7
Sodium	0.06 to 0.6	589.0
Manganese ⁽¹⁾	0.005 to 0.05	279.5
Calcium	0.02 to 0.2	422.7
Magnesium	0.005 to 0.05	285.2

Note (1) Metal element necessary for 10-times concentration.

3.4.2 Analysis

- Splay the fixed amount of the test liquid into the flame, and measure the absorbance at the wavelength of each metal shown in annex 1 table 2.
- Calculate the concentration of each metal in the test liquid from the working curve prepared in accordance with 3.5.
- Calculate the concentration of metal in the sample liquid in accordance with 2.4.2 c).

3.5 Preparation of working curve

- Take several different amounts of each metal standard solution, increasing stepwise, into separate measuring flasks, add 1 mL of nitric acid and water to make each 100 mL.
- Follow the same procedure as that in 3.4.2 a), and determine the relation between the concentration of each metal and absorbance.

4 ICP emission spectroscopy method The subject metals of this method shall be cadmium, lead, hexavalent chromium [chromium (VI)], boron, zinc, aluminium, iron, copper, sodium, manganese, calcium and magnesium.

4.1 Reagents The following reagents shall be used.

- Internal standard stock solution (1 mgY/mL)** Take 0.318 g of yttrium (III) oxide into a beaker, add 3 mL of hydrochloric acid specified in JIS K 8180, dissolve by heating, and after allowing it to cool, transfer it into a measuring flask, add water to make 250 mL. Put this solution in a brown bottle, and store in a dark and cold place.

- b) **Internal standard solution (0.005 mgY/mL)** Weigh 5 mL of internal standard solution into a measuring flask, and add water to make total 1 L. Prepare this solution at every use.
- c) **Nitric acid** Specified in **JIS K 9901**.
- d) **Standard stock solution (1 mg metal/mL)** Cadmium, lead, hexavalent chromium [chromium (VI)], boron, zinc, aluminium, iron, copper, sodium, manganese standard stock solutions shall be in accordance with **2.1 e)**. Calcium and magnesium standard stock solutions shall be in accordance with **3.1 c)**. Boron standard stock solution shall be as follows. Put the standard stock solution into a brown bottle, and store in a dark and cold place.
 - 1) **Boron standard stock solution** Take 5.715 g of boric acid specified in **JIS K 8863**, dissolve it in water, transfer it to a measuring flask, and add water to make 1 L.
- e) **Metal mixed standard stock solution** Take each of cadmium, lead, hexavalent chromium [chromium (VI)], boron, zinc, aluminium, iron, copper, sodium, manganese, calcium and magnesium standard stock solutions by 10 mL into separate measuring flasks, and after adding water to make 1 L, take 10 mL of these solutions, and add water to make 1 L. 1 mL of these solutions shall include 0.000 1 mg of each metal. Prepare these solutions at every use.

4.2 Instrument and apparatus The instrument and apparatus shall be as follows:

- a) **ICP emission spectroscopy apparatus** Equipped with an ultrasonic atomiser.
- b) **Argon gas** Argon class 2 specified in **JIS K 1105**.

4.3 Sampling and storage of the test water In accordance with **2.3**.

4.4 Analysis operation

4.4.1 Pretreatment

- a) Take 50 mL to 500 mL of the test water (or the test water with water added so that the concentration of each object metal falls within the range shown in annex 1 table 3) into a beaker, and add nitric acid so that the concentration of nitric acid becomes 1 % to the amount of the test water including the amount added at the time of sampling the test water, and heat gently.
- b) Stop heating when the amount of liquid becomes 45 mL or under, and after allowing it to cool, add water and 5 mL of internal standard solution to make 50 mL for the test liquid. However, when it is turbid, filter it, and use the filtrate as the test liquid.

Annex 1 Table 3 Concentration range and measurement wavelength

Metals	Concentration range mg/L	Measurement wavelength nm
Cadmium	0.000 5 to 0.05	226.502, 214.438
Lead	0.001 to 0.1	220.353
Hexavalent chromium	0.000 8 to 0.08	267.716, 206.149
Boron	0.006 to 0.6	249.773, 208.893
Zinc	0.000 6 to 0.06	202.546, 213.856
Aluminium	0.000 4 to 0.04	396.152, 309.271
Iron	0.001 to 0.1	259.940, 238.204
Copper	0.000 6 to 0.06	324.754, 224.700
Sodium	0.006 to 0.6	589.592
Manganese	0.000 2 to 0.02	257.610
Calcium	0.04 to 4	422.673, 396.847, 393.366
Magnesium	0.000 6 to 0.06	279.553
Yttrium ⁽²⁾	—	371.029

Note (2) Internal standard material

4.4.2 Analysis

- Introduce the fixed amount of the test liquid into the ICP emission spectroscopy apparatus, and measure the emission intensity at the wavelength of each metal shown in annex 1 table 3. Then, obtain the emission intensity ratio of each metal to yttrium.
- Calculate the concentration of each metal in the test liquid from the working curve prepared in accordance with 4.5.
- Calculate the concentration of metal in the sample liquid in accordance with 2.4.2 c).

4.5 Preparation of working curve

- Take several different amounts of each metal mixture standard solution, increasing stepwise, into separate measuring flasks, add 5 mL of nitric acid and 5 mL of internal standard solution, and further add water to make each 50 mL.
- Follow the same procedure as that in 4.4.2 a), and determine the relation between the concentration of each metal and emission standard.

5 ICP mass spectroscopy method The subject metals of this method shall be cadmium, selenium, lead, arsenic, hexavalent chromium [chromium (VI)], boron, zinc, aluminium, copper, and manganese.

5.1 Reagents The following reagents shall be used.

- Internal standard stock solution (1 mg metal/mL)** The preparation method of internal standard stock solution shall be as given in annex 1 table 4. Put this solution in a brown bottle, and store in a dark and cold place.

Annex 1 Table 4 Preparation method of internal standard stock solution

Internal standard	Preparation method
Scandium	Take 1.283 g of scandium nitrate into a measuring flask, and after dissolving with a small amount of nitric acid (1+1), add water to make 250 mL.
Yttrium	In accordance with 4.1 a).
Thallium	Take 0.326 g of thallium (I) nitrate into a measuring flask, and after dissolving with a small amount of nitric acid (1+1), add water to make 250 mL.

- b) **Mixed internal standard solution** Take each of scandium, yttrium, thallium internal standard stock solutions into a measuring flask by 10 mL, and add water to make 1 L. 1 mL of this solution shall include 0.000 05 mg of each internal standard material. Prepare this solution at every use.
- c) **Nitric acid (1+1)**
- d) **Standard stock solution (1 mg metal/mL)** Cadmium, selenium, lead, arsenic, hexavalent chromium [chromium (VI)], zinc, aluminium, iron, copper and manganese standard stock solutions shall be in accordance with 2.1 e). Boron standard stock solution shall be in accordance with 4.1 d).
- e) **Metal mixed standard stock solution** Take each of cadmium, selenium, lead, arsenic, hexavalent chromium [chromium (VI)], boron, zinc, aluminium, copper and manganese standard stock solutions by 10 mL into a measuring flask, and add water to make 1 L. 1 mL of this solution shall include 0.000 1 mg of each metal. Prepare this solution at every use.

5.2 Instrument and apparatus The instrument and apparatus shall be as follows:

- a) **ICP mass spectroscopy apparatus**
- b) **Argon gas** Argon class 2 specified in JIS K 1105.

5.3 Sampling and storage of the test water In accordance with 2.3.

5.4 Analysis operation

5.4.1 Pretreatment

- a) Take 100 mL of the test water (or the test water with water added to make 100 mL so that the concentration of each object metal falls within the range given in annex 1 table 5) into a beaker, and add nitric acid so that nitric acid becomes 1 mL including the amount added at the time of sampling the test water, and heat gently until the amount of liquid becomes 90 mL or under.
- b) After allowing it to cool, add water and 10 mL of mixed internal standard solution to make 100 mL for the test liquid. However, when it is turbid, filter it, and use the filtrate as the test liquid.

Annex 1 Table 5 Concentration range and mass number

Metals	Concentration range mg/L	Mass number
Cadmium	0.000 07 to 0.007	111, 112, 114
Selenium	0.000 4 to 0.04	77, 78, 80, 82
Lead	0.000 2 to 0.02	208
Arsenic	0.000 06 to 0.006	75
Hexavalent chromium	0.000 2 to 0.02	52, 53
Boron	0.002 to 0.2	11
Zinc	0.000 2 to 0.02	64, 66
Aluminium	0.000 4 to 0.04	27
Copper	0.000 2 to 0.02	63, 65
Manganese	0.000 08 to 0.008	55
Scandium ⁽³⁾	—	45
Yttrium ⁽³⁾	—	89
Thallium ⁽³⁾	—	205

Note ⁽³⁾ Internal standard material

5.4.2 Analysis

- Introduce the fixed amount of the test liquid into the ICP mass spectroscopy apparatus, and measure the ion intensity of mass number of each metal and mass number of the internal standard shown in annex 1 table 5, and determine the ratio of ion intensity of each metal to that of the internal standard.
- Calculate the concentration of each metal in the test liquid from the working curve prepared in accordance with **5.5**.
- Calculate the concentration of metal in the sample liquid in accordance with **2.4.2 c)**.

5.5 Preparation of working curve

- Take several different amounts of each metal mixture standard solution, increasing stepwise, into separate measuring flasks, add 1 mL of nitric acid and 10 mL of mixed internal standard solution, and further add water to make 100 mL.
- Follow the same procedure as that in **5.4.2 a)**, and determine the relation between the concentration of each metal and the ion intensity ratio.

6 Ion chromatography (cations) The metals to be determined by this method shall be sodium, calcium and magnesium.

6.1 Reagents The following reagents shall be used.

- Water** Water which is filtrated with membrane filter of about 0.2 µm in pore size and has no peak in the retention time of an ion to be measured in chromatogram. Use this water for the test operation and preparation of reagents.

- b) **Eluent** Capable of separating materials to be measured.

Example 1 **In the case of suppressor type**

Methanesulfonic acid solution (20 mmol/L) Take 192.3 g (about 123 mL) of methanesulfonic acid, and dissolve it in water to make 1 L. Take 10 mL of this solution and add water to make 1 L.

Nitric acid (5 mmol/L) Add 10 mL of nitric acid (0.5 mol/L) (dissolve 36 mL of nitric acid specified in **JIS K 9901** in water to make 1 L) to water to make 1 L.

Example 2 **In the case of non-suppressor type**

[2,6-pyridine dicarboxylic acid solution (1 mmol/L)–tartaric acid solution (5 mmol/L)] Take 0.16 g of 2,6-pyridine dicarboxylic acid and 0.750 g of L(+)-tartaric acid specified in **JIS K 9901**, and dissolve them in water to make 1 L.

Nitric acid (2 mmol/L) Add 4 mL of nitric acid (0.5 mol/L) (dissolve 36 mL of nitric acid specified in **JIS K 9901** in water to make 1 L) to water to make 1 L.

- c) **Regenerant** Capable of actuating suppressor.

Example : **Tetra-methyl ammonium hydroxide solution (40 mmol/L)**
Dissolve 7.25 g of tetra-methyl ammonium hydroxide pentahydrate in water to make 1 L.

- d) **Standard stock solution (1 mg metal/mL)** Sodium standard stock solution shall be in accordance with 2.1 e) 10). Calcium and magnesium standard stock solution shall be in accordance with 3.1 d).
- e) **Cation mixture standard solution** Take each of sodium standard stock solution, calcium standard stock solution and magnesium standard stock solution by 50 mL into a measuring flask, and add water to make 1 L. 1 mL of this solution shall include 0.05 mg of each metal. Prepare this solution at every use.

6.2 Instrument and apparatus The instrument and apparatus shall be as follows:

- a) **Membrane filter** Equipped with membrane filter of about 0.2 μm in pore size.
- b) **Ion chromatograph**
- 1) **Sample injector** Having a capacity of 50 μL to 250 μL and capable of injecting the fixed amount of sample.
 - 2) **Separation column** The suppressor type shall be the column with fillers coated by cation exchanger packed in the pipe made of an inert synthetic resin of 2 mm to 4.6 mm in internal diameter and 10 cm to 25 cm in length, or the column with the separation performance equivalent or superior to this column.

The non-suppressor type shall be the column with fillers coated by cation exchanger packed in the pipe made of an inert synthetic resin of 4 mm to 4.6 mm in internal diameter and 5 cm to 25 cm in length, or the column with the separation performance equivalent or superior to this column.

- 3) **Flow rate of eluent** Capable of making the eluent flow at a flow rate of 0.5 mL/min to 2 mL/min.
- 4) **Flow rate of regenerant** Capable of making the eluent flow at a flow rate of 0.5 mL/min to 5 mL/min. Used for the suppressor type.
- 5) **Detector** An electric conductivity detector.

6.3 Sampling and storage of the test water Take the sample liquid into a glass bottle or polyethylene bottle which has been washed with water to make the test water, and promptly perform the analysis. When the analysis is not able to be performed promptly, store in a dark and cold place, and perform the analysis within 24 h.

6.4 Analysis operation

6.4.1 Pretreatment

- a) Filter the test water (or the test water prepared by adding water so that the concentration of each cation ion becomes 0.1 mg/L to 50 mg/L) with the membrane filter defecator, discard about 10 mL of the first filtrate, and use the next filtrate as the test liquid.

6.4.2 Analysis

- a) Inject the fixed amount of the test liquid into the ion chromatograph, and determine the peak height or peak area of each cation.
- b) Determine the concentration of each cation in the test liquid from the working curve prepared in accordance with **6.5**, and calculate the concentration of each cation in the sample liquid.

6.5 Preparation of working curve

- a) Take several different amounts of cation mixture standard solution, increasing stepwise, into separate measuring flasks, and add water to make each 100 mL.
- b) Follow the same procedure as that in **6.4.2 a)**, and determine the relation between the concentration and the peak height or peak area of each cation.