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(JRPS/JSA)

**Glass-fiber reinforced thermosetting  
resin chemical-resistant tanks**

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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 The Japan Reinforced Plastics Society (JRPS)/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 K 7012:1999** is replaced with this Standard.

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# Glass-fiber reinforced thermosetting resin chemical-resistant tanks

## Introduction

This Japanese Industrial Standard was established in 1992 and has gone through two revisions up to the present. The last revision was made in 1999, and the revision at this time is to respond to diversified usages and design methods of tanks seen since the last revision.

No corresponding International Standard has been established at this point.

## 1 Scope

This Standard specifies vertically positioned cylindrical chemical-resistant tanks (hereafter referred to as “tanks”) attached with a fixed roof, made of glass-fiber reinforced thermosetting resin (hereafter referred to as “FRP”), which can store liquid chemicals (hereafter referred to as “liquid”) of 140 m<sup>3</sup> or less capacity under atmospheric pressure.

This Standard is not applicable to accessories such as valves, piping, or measuring instruments that are attached to the nozzle of the tank body or to bases, oil retaining walls, paintings, thermal insulating work or others.

NOTE : It should be noted that the tanks specified in this Standard, depending on their contents, can be subject to related laws and regulations such as Fire Service Act.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7502 *Micrometer callipers*

JIS B 7507 *Vernier, dial and digital callipers*

JIS K 6745 *Plastics—Unplasticized poly (vinyl chloride) sheets*

JIS K 6900 *Plastics—Vocabulary*

JIS K 6919 *Liquid unsaturated polyester resins for fiber reinforced plastics*

JIS K 7010 *Vocabulary for fibre reinforced plastic*

JIS K 7052 *Textile glass reinforced plastics—Prepregs, moulding compounds and laminates—Determination of the textile-glass and mineral-filler content—Calcination method*

JIS K 7060 *Testing method for barcol hardness of glass fiber reinforced plastics*

JIS K 7070 *Testing method for chemical resistance of fiber reinforced plastics*

JIS K 7075 *Testing methods for carbon fiber content and void content of carbon fiber reinforced plastics*

JIS K 7164 *Plastics—Determination of tensile properties—Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

JIS K 7171 *Plastics—Determination of flexural properties*

JIS R 3411 *Textile glass chopped strand mats*

JIS R 3412 *Textile glass roving*

JIS R 3415 *Textile glass tapes*

JIS R 3416 *Finished textile glass fabrics*

JIS R 3417 *Textile glass—Woven roving*

### 3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS K 6900** and **JIS K 7010** and the following apply.

#### 3.1 corrosion-resistant barrier

barrier to give adequate corrosion resistance to a tank, composed of an inner surface layer and an interior layer as shown in Figure 1

#### 3.2 inner surface layer

layer to be directly in contact with the liquid contained in the tank, which serves to give adequate corrosion resistance to a tank (see Figure 1)

#### 3.3 interior layer

layer rolled subsequently to the inner surface layer, which serves to give adequate corrosion resistance to a tank (see Figure 1)

#### 3.4 reinforcement layer (external layer)

layer rolled subsequently to the interior layer, which serves to give adequate structural strength to the tank (see Figure 1)

#### 3.5 outermost layer

outermost layer of the tank which is exposed to the atmosphere, provided to improve the weathering resistance of the tank (see Figure 1)

#### 3.6 pit

hole (dent) generated on the plastic surface, so called pock mark

The term may be used to distinguish relatively large holes from very small ones, which are called pin holes.

#### 3.7 secondary laminate

laminate joined to the cured FRP at the time of assembly of FRP

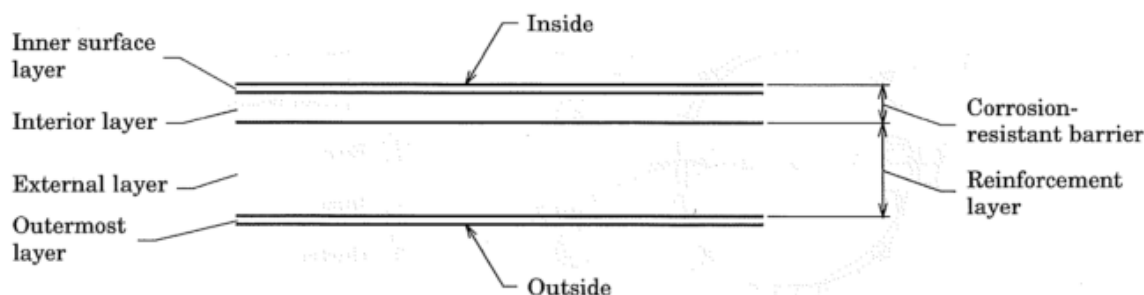


**Figure 1 FRP laminate construction and designations of constituting layers**

## 4 Tank

### 4.1 Designations of tank parts

Designations of parts of the tank are shown in Figure 2 and as follows.

- a) Parts ①, ② and ③ in Figure 2 are collectively designated as tank body.
- b) Parts ④ to ⑮ in Figure 2 are designated as accessories of the tank.
- c) Among accessories of the tank, parts ④, ⑤, ⑥, ⑨, ⑭ and ⑮ in Figure 2 are designated as nozzles.
- d) Among accessories of the tank, parts ⑨ to ⑮ in Figure 2 may be omitted on tanks of certain sizes.
- e) Part ⑦ in Figure 2, designated as manhole, includes the cover.
- f) Parts ⑧, ⑩ and ⑬ in Figure 2 are designated as metal fittings, though they include those made of FRP.

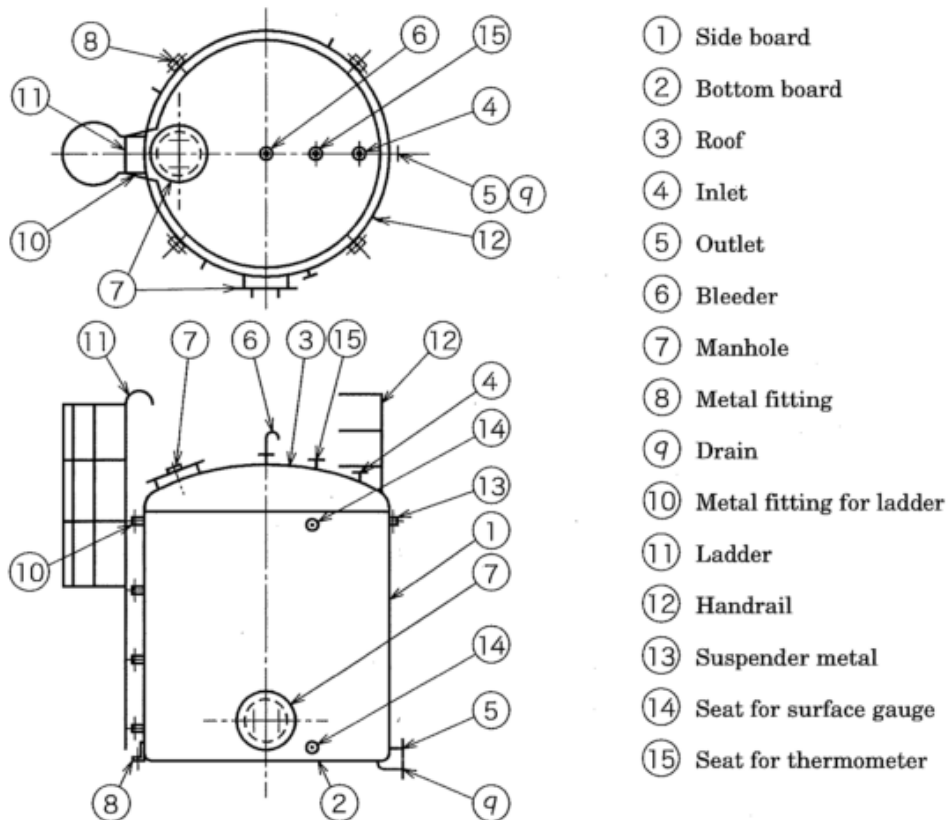


**Figure 2 Designations of tank parts**

#### 4.2 Diameter and height of tank

The diameter and height of the tank shall be as shown in Figure 3.

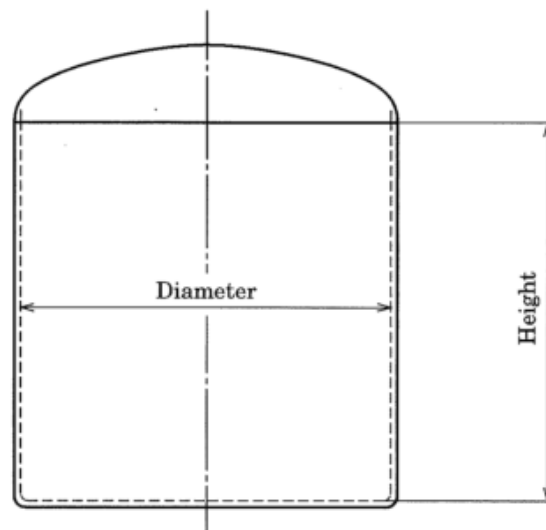


**Figure 3 Diameter and height of tank**

### 4.3 Classification of tanks

The tanks shall be classified according to the specifications and resin of corrosion-resistant barrier (see Table 1), and forming method and resin of reinforcement layer (see Table 2).

The marking of tank classification shall be in accordance with clause 10.

**Table 1 Specification of corrosion-resistant barrier**

| Classification                                                                                                                                                                                                                                                   | Construction of corrosion-resistant barrier                               | Resin               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------|
| Class 1                                                                                                                                                                                                                                                          | SM <sup>a)</sup> + M <sup>b)</sup>                                        | Thermosetting resin |
| Class 2                                                                                                                                                                                                                                                          | SM + M + M                                                                |                     |
| Class 3                                                                                                                                                                                                                                                          | SM + SP <sup>c)</sup>                                                     |                     |
| Class 4                                                                                                                                                                                                                                                          | Glass-fiber laminate construction other than Class 1, Class 2 and Class 3 |                     |
| Class 5                                                                                                                                                                                                                                                          | Thermoplastic resin plate not containing fiber-reinforcing material       | Thermoplastic resin |
| Class 6 <sup>d)</sup>                                                                                                                                                                                                                                            | Laminate construction other than glass-fiber                              | Thermosetting resin |
| Notes <sup>a)</sup> SM: glass surfacing mat<br><sup>b)</sup> M: glass chopped strand mat<br><sup>c)</sup> SP: spray up<br><sup>d)</sup> Specification of Class 6 corrosion-resistant barrier is subject to agreement between the purchaser and the manufacturer. |                                                                           |                     |

**Table 2 Forming method for side board reinforcement layer and resin of corrosion-resistant barrier and reinforcement layer**

| Forming method for side board reinforcement layer | Resin of corrosion-resistant barrier and reinforcement layer                                                                                                                                                                                                                                                                    |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hand lay-up method (HLU method)                   | The same thermosetting resin is used for corrosion-resistant barrier and reinforcement layer.<br>Different thermosetting resins are used respectively for corrosion-resistant barrier and reinforcement layer.<br>Thermoplastic resin is used for corrosion-resistant barrier, and thermosetting resin for reinforcement layer. |
| Filament winding method (FW method)               | The same thermosetting resin is used for corrosion-resistant barrier and reinforcement layer.<br>Different thermosetting resins are used respectively for corrosion-resistant barrier and reinforcement layer.<br>Thermoplastic resin is used for corrosion-resistant barrier, and thermosetting resin for reinforcement layer. |
| Tape wrapping method (TP method)                  | The same thermosetting resin is used for corrosion-resistant barrier and reinforcement layer.<br>Different thermosetting resins are used respectively for corrosion-resistant barrier and reinforcement layer.<br>Thermoplastic resin is used for corrosion-resistant barrier, and thermosetting resin for reinforcement layer. |

**Table 2 (concluded)**

|                                                                                                             |                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Forming method for side board reinforcement layer                                                           | Resin of corrosion-resistant barrier and reinforcement layer                                                                                                                                                                                                                                                                                   |
| Other forming method <sup>a)</sup>                                                                          | <p>The same thermosetting resin is used for corrosion-resistant barrier and reinforcement layer.</p> <p>Different thermosetting resins are used respectively for corrosion-resistant barrier and reinforcement layer.</p> <p>Thermoplastic resin is used for corrosion-resistant barrier, and thermosetting resin for reinforcement layer.</p> |
| Note <sup>a)</sup> Other forming methods include a combination of such methods as HLU method and FW method. |                                                                                                                                                                                                                                                                                                                                                |

## 5 Quality

### 5.1 Performance

The tank and FRP, regardless of the classification in 4.3, when tested in accordance with the methods specified in clause 8, shall satisfy the performance requirements given in Table 3.

**Table 3 Performance of tanks**

| Item                              |                                                 |                                        | Performance        | Test method | Sample <sup>c)</sup>  |
|-----------------------------------|-------------------------------------------------|----------------------------------------|--------------------|-------------|-----------------------|
| Chemical resistance               | Corrosion-resistant barrier                     |                                        | Conforming to 5.4. | 8.2.3       | No. 7                 |
| Strength (MPa)                    | Reinforcement layer                             | Tensile strength                       | 62 min.            | 8.2.4       | No. 5 or No. 6        |
|                                   |                                                 | Tensile modulus of elasticity          | 6 300 min.         |             |                       |
|                                   |                                                 | Bending strength                       | 108 min.           | 8.2.5       |                       |
|                                   |                                                 | Bending modulus of elasticity          | 4 800 min.         |             |                       |
| Mass content of resin             | Corrosion-resistant barrier <sup>a)</sup>       | Inner surface layer                    | 85 % min.          | 8.2.6       | No. 5 or No. 6        |
|                                   |                                                 | Interior layer                         | 73 % ± 5 %         |             |                       |
|                                   | Reinforcement layer (external layer)            |                                        | 70 % max.          |             |                       |
|                                   | Outermost layer                                 |                                        | 85 % min.          |             |                       |
| Degree of hardening <sup>b)</sup> | Corrosion-resistant barrier and outermost layer | Barcol hardness (Type A of JIS K 7060) | 30 min.            | 8.2.7       | No. 1, No. 2 or No. 5 |
|                                   |                                                 | Acetone test                           | No stickiness.     | 8.2.8       |                       |

Table 3 (concluded)

| Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                    |                                                                                              | Performance                                          | Test method | Sample <sup>c)</sup>         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------|-------------|------------------------------|
| Tank                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Appearance         | Inner surface layer, corrosion-resistant barrier, outermost layer                            | Conforming to 5.2 a), b), and c).                    | 8.2.1       | No. 1                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Dimensions         | Diameter, height, thickness, nozzle installation position, inclination of nozzle flange face | Conforming to 5.3.                                   | 8.2.2       | No. 1                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Filling water test | Leakage                                                                                      | No leakage.                                          | 8.2.9       | No. 1 or No. 2               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                    | Deformation                                                                                  | No detrimental deformation such as local blistering. |             |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Roof loading test  | Damage                                                                                       | No damage.                                           | 8.2.10      | No. 1, No. 2, No. 3 or No. 4 |
| <p>Notes a) When thermoplastic resin is used for corrosion-resistant barrier (inner surface layer, interior layer), the resin content for inner surface layer and interior layer shall not apply.</p> <p>b) The performance requirement for hardening degree above is given for most typical material used for tanks, namely, glass-fiber, unsaturated polyester resin and vinylester resin. If other fiber or resin than these is used, requirement for hardening degree shall be as agreed between the purchaser and the manufacturer.</p> <p>c) For samples, see 8.1.</p> |                    |                                                                                              |                                                      |             |                              |

## 5.2 Appearance

The appearance of the tanks shall be as follows.

- Inner surface layer** There shall be no cracks, crazes, or poor impregnation on the inner surface layer. On its finished surface, no pits equal to or more than 3 mm in diameter and 0.5 mm in depth shall be found. For pits less than 3 mm in diameter or less than 0.5 mm in depth, no more than two on average shall be found per 30 cm square, and the fiber of the inner surface layer shall be adequately covered by resin so as not to be exposed. If these pits are observed in eccentric distribution, the judgement shall be subject to the agreement between the purchaser and the manufacturer. Air bubbles or other defects shall not exist in a level where they impair the serviceability of the product under corrosive circumstances.
- Corrosion-resistant barrier** Permissible level of damage on corrosion-resistant barrier including inner surface layer and interior layer shall be as given in Table 4.